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U.S. DEPARTMENT OF COMMERCE National Oceanic and Atmospheric Administration Environmental Data Service

An Annotated Bibliography on Weather Modification 1960-1969

ANNIE E. GRIMES

Environmental Science Information Center

> ROCKVILLE, MD. June 1972

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AN ANNOTATED BIBLIOGRAPHY ON WEATHER MODIFICATION
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INTRODUCTION

This bibliography consists of annotated references on statistical evaluation of cloud seeding operations and potentialities, cloud seeding theories and experiments, legal aspects of weather modification, economic implications, hail control and lightning suppression, cloud and fog dissipation, atomic explosion effects, hurricane control, and large-scale climate modification for the 10-year period 1960-1969. Much of the material published prior to 1965 has been presented in four special annotated bibliographies in Meteorological & Geoastrophical Abstracts, Vol. 11, No. 12, Pt. III, December 1960; Vol. 13, No. 3, March 1962; Vol. 14, No. 1, January 1963; Vol. 15, No. 7, July 1964. References in these special bibliographies have not been repeated in this collection of annotated references.

The author, subject and geographic indexes are at the end of the annotated references.

Explanation of Symbols

Symbols used in this bibliography may be found in the following list:

DAS Atmospheric Sciences Library, Silver Spring, Maryland

DLC Library of Congress, Washington, D. C.

IN-HO U. S. Navy Oceanographic Office Library, Suitland, Maryland

JPRS Joint Publications Research Service

MGA Meteorological and Geoastrophysical Abstracts

WMSU "Weather Modification in the Soviet Union, 1946-1966: A Selected Annotated Bibliography" by Nikolay T. Zikeev and George A. Doumani

The Atmospheric Sciences Library call number follows the symbol DAS.

AN ANNOTATED BIBILIOGRAPHY ON WEATHER MODIFICATION

Sources and Abstracts

1960

1. Australia. Commonwealth Scientific and Industrial Research Organization.

Division of Radiophysics. Cloud seeding experiment: annual report

con- Darling Downs, 1960. 12 pp. DAS MO9.67 A938 1960 Darling Downs.

As the first of 2 annual reports, describes the first year of a cloud seeding experiment conducted during the summers of 1960 and 1961 over the Darling Downs about 100 mi west of Brisbane, Australia. Purpose of the experiment was to determine the amount by which the seeding of clouds with silver iodide smoke released from aircraft could increase precipitation in the area. The test is part of a major cloud-seeding program (5 experiments of similar type) to determine those regions and circumstances of southeastern Australia in which cloud seeding is effective. Following a summary of the physical principles involved in such an experiment, the experimental plan is described with relation to the areas selected for cloud seeding; the length of period of seeding; the topography, climate, and agriculture of the general area: suspension of test during periods of heavy rainfall; and the definition of suitable clouds. Also discussed are the seeding equipment employed and the aircraft used, navigational aids, responsibilities of the crew, and the operational objectives of the seeding techniques. Rainfall was measured by standard procedures. A detailed report is provided of the first year's operations, including discussion of general weather conditions, seeding, flight reports and summaries, and rainfall recorded. Methods of analysis of the results are explained. From the empirical data it is concluded that for the operational point of view, the experiment made a successful start, but that rainfall distribution following seeding was much more variable in space and time than was anticipated in the experimental design, thus rendering difficult the detection of the order of rainfall differences produced by seeding. - MGA 21.2-49.

2. Jiusto, James E. and Rogers, R. R. Greenland whiteout experiments:

summer 1960. Cornell Aeronautical Laboratory, Inc., Buffalo,
Report no. RM-1430-P-2, November 1960. Summary Report for the
U. S. Army. Snow, Ice, and Permafrost Research Establishment, Corps
of Engineers under Contract DA-11-190-ENG-100. 36 pp. DAS M(051)
C814rep 1430-P-2.

A two-month experimental program was conducted in Greenland to determine the extent to which arctic whiteouts and low clouds could be modified using cloud dissipation techniques. Seven seeding agents, applicable to supercooled or warmer-than

freezing clouds, were tried employing aircraft, tethered blimp, and rocket delivery modes.

Successful dissipation of supercooled clouds was achieved with dry ice. As little as 5 lb of dry ice per mile, dispersed from aircraft, produced efficient clearing action and line openings up to 2.5 miles wide. An inexpensive seeding scheme, involving a tethered blimp and open baskets of dry ice attached at intervals along the blimp tether, was shown to be capable of opening holes in low cloud overcasts. Such a technique appears feasible for maintaining safe landing corridors at Ice Cap airstrips during fog and low stratus conditions.

Seeding materials that were ineffective in dissipating the supercooled clouds or warmer-than-freezing clouds encountered were liquid carbon dioxide, Greenland soil particles, silver iodide, carbon black, calcium chloride, and sodium chloride.

Cloud hydrometeor and atmospheric nuclei measurements were made in relation to the modification tests. Specialized seeding equipments for specific arctic operations are recommended. - Authors' abstract

1961

3. Jones, R. F. Layer cloud over southern England. Royal Meteorological Society, Quarterly Journal, 87(371): 65-71, January 1961. DAS M(05) R888q 87: 1961.

599 morning weather reconnaissance flights from the Royal Aircraft Establishment, Farnborough, over a period of approximately four years have been examined to determine the frequency of occurrence and thickness of layer cloud over Southern England. The chance of encountering 4/8 or more layer cloud in any kilometre height range decreased with height from about 1 in 2 near the surface to about 1 in 50 at a height of 12 km. Cloud layers when encountered were more likely to exceed one or two kilometres depth in the upper troposphere than in the lower but the frequency of encountering a layer more than 1 1/2 km deep was about 7 to 8 per cent at all heights. About 1 in 9 of all flights encountered cloud above the melting level more than 3 km thick. An examination of clouds in the temperature band 0 to-15°C suggested that conditions suitable for severe clear ice formation on some aircraft might be encountered on about one per cent of flights. The same examination suggests that seeding of layer clouds by silver-iodide smokes should produce some detectable modification of the cloud sheet on about 8 days a year. - Author's abstract.

4. List, Roland. <u>Uber einen Einfluss des AgJ auf den atmosphärischen Vereisungsprozess</u>. (Influence of silver iodide on the atmospheric ice forming process.) Zeitschrift für Angewandte Mathematik und Physik, Basel, 12(5): 474-476, 1961. DLC.

An account of an experiment carried out in a hail chamber with the purpose to prove the effect of silver iodide on atmospheric ice formation. Two curves are presented showing ice formation with and without the addition of silver iodide. The influence of silver iodide becomes apparent below -10°C, especially between -10°C and -15°C. It was found that the theory of controlling hail by freezing all supercooled cloud particles is basically sound. - MGA 15F-60.

5. López, Manuel E. and Howell, Wallace E. The campaign against windstorms in the banana plantations near Santa Marta, Colombia, 1956-57.

American Meteorological Society, Bulletin, 42(4): 265-276, April 1961.

DAS M(05) A512b.

Windstorms do great damage in banana plantations near the Sierra Nevada de Santa Marta in Colombia. These plantations, which owe their location to the rainfall maximum cause by convergence in the trade winds as they flow around the mountain massif, suffer most damage from the few most violent tempests and relatively little from the frequent milder squalls, offering the prospect that even slight mitigation of severe storms would be economically rewarding. Most damage was found to be triggered by easterly waves and similar large-scale disturbances, though the windstorms themselves remained purely local. Cloud seeding to attempt reduction of windstorm intensity was undertaken during the 1956 and 1957 seasons on the hypothesis that stimulation of showers early in the diurnal build-up of instability would dissipate some of the instability and reduce insolation at the ground, thus diminishing the intensity of later convective overturning. Comparison of damages during these seeded seasons with those of preceding and subsequent seasons showed a marked reduction in the ratio of severe windstorms to mild ones during the campaign and a reduction perhaps as much 39 per cent in damages, worth several million dollars annually. - Authors' abstract.

1962

6. Aksenov, M. Ia. et al. <u>Issledovanie l'doobrazuiushchei aktivnosti</u>

<u>aerozolia iodistogo serebra, generiruemogo pri gorenii</u>

<u>pirotekhnicheskikh sostavov.</u> (Investigation of the ice forming activity of silver iodide aerosol generated by burning pyrotechnical compounds.) Akademiia Nauk Gruzinskoi SSR, Institut Geofiziki, Trudy, 20: 197-207, 1962. DLC.

A laboratory experiment is described, in which the ice-forming capacity of AgI particles produced by burning three different pyrotechnical compounds was investigated. Relative effectiveness of each compound is determined. Data are also presented on the temperature dependence of crystal formation. The upper temperature limit of crystal formation was found to be -5°C. At this

temperature the number of crystals formed per g of AgI was 10^{10} . At -20° C the number of crystals was 10^{10} per g of AgI. The AgI particles were also examined with an electron microscope (microphotographs are presented). The mean radius of particles was found to be 5.10^{-6} cm. - MGA 15F-2.

7. Aksenov, M. Ia.; Vernidub, I.I.; Gaivoronskii, I.I.; Kartsivadze, A.I.; Plaude, N.O.; Solov'ev, A.D.; Shishmintsev, V.V. Poluchenie l'doobrazuiushchego aerozolia iodistogo svintsa s pirotekhnicheskikh sostavov. (Production of ice forming lead iodide aerosol from pyrotechnical compounds.) U.S.S.R. Tsentral'naia Aerologicheskaia Observatoriia, Moscow, Trudy, No. 14: 63-69, 1962. Russian summary p. 63. DAS M(055) U581tt.

Pyrotechnical compounds with lead iodide have been produced and tested for the purpose of obtaining ice forming PbI₂ aerosol. The production of ice forming particles was measured and found to come close to the production of AgI particles from similar compounds. - MGA 15F-3.

8. Bakulina, E.V.; Gromova, T.N.; Krasikov, P.N. O metodike primeniia vodnykh rastvorov iodistogo svintsa dlia vozdeistviia na pereokhlazhdennye oblaka i tumany. (Method for the use of aqueous solutions of lead iodide as agents in supercooled clouds and fog.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 126: 10-15, 1962. Russian summary p. 10. DAS M(055) U581tg. Translated into English as U. S. Joint Publications Research Service, JPRS, No. 18,696, April 15, 1963, pp. 11-19. DAS M77 U5868tr.

With the aid of laboratory experiments, the authors demonstrate that aqueous solution of lead iodide, PbI₂, can be used to act upon supercooled clouds. A method for obtaining solutions of PbI₂ by using solutions of Pb(NO)₂ and any iodide salt soluble in water, such as ammonium iodide NH₄I or potassium iodide KI or sodium iodide. Mixtures of Pb(NO)₂ and NH₄I remain transparent and do not give precipitants in the tank. In vaporizing the solutions the pipes and burners are not soiled. The solutions of PbI₂ introduced in supercooled fog at a temperature of -10°C yield up to 10 ice crystals per 1 g of substance. - MGA 15F-6.

9. Balabanova, V.N. and Zhigalovskaia, T.N. O kristallizatsii

percokhlazhdennoi vody iodistym serebrom. (Crystallization of supercooled water by silver iodide.) Akademiia Nauk SSSR, Moscow, Izvestiia, Seriia Geofizicheskaia, No. 10: 1453-1455, October 1962.

DAS P. Translated into English in the corresponding issue of its Bulletin cof the Academy of Sciences USSR, Geophysics Series, issued Washington, D. C. DAS P.

The position of nuclei of crystallization within ice crystals was investigated by introducing silver iodide particles into a cloud chamber after filling it with fog droplets. The experimental procedure is described. The silver iodide particles are situated

within ice crystals primarily at the faces and rarely in the center. The number of silver iodide particles participating in crystallization can exceed the number of crystals by as much as 60 per cent. - From MGA 15F-8.

10. But, I.V. K probleme aktivnykh vozdejstvij na frontal nye oblachnye sistemy v gornykh rajonakh. (Artificial modification of frontal cloud systems in mountain regions.) Meteorologija i Gidrologija, Moscow, No. 4: 46-47, April 1962. DAS M(05) M589 1962.

The orographic systems in the southern U.S.S.R. considerably influence the general atmospheric circulation; this is evident during the cold season when the planetary frontal zone divides into branches under the action of the Central Asian Massif and the northern branch passes over the bordering regions of Central Asia and Siberia. In this branch cyclone activity develops. Cyclogenesis is observed primarily during the cold season in the frontal zone areas oriented in the direction of the mountain massifs. The cyclones are weaker than those of the middle latitudes which develop over plains. Here they are most often encountered during the initial stages of development and they move along mountain systems since the frontal zone and its steering current are oriented in this manner. The nature of the disturbance of the structure of the frontal zone by the relief varies over different regions so that there are regions where cyclones form in connection with a particular synoptic situation involving the development of a series of cyclones having a general center of origin. The synoptic situation is decisive in the total amount of annual precipitation in the mountain regions of Central Asia and Siberia. An examination of the synoptic situation, cyclogenesis in the frontal zone and orography indicates the existence of favorable conditions for frontal precipitation in the southern U.S.S.R. Since during some synoptic situations dynamic conditions favor the regeneration of cloud systems it is possible to modify the clouds and increase the precipitation. In the Carpathians, in the Northern Caucasus, the northeastern foothills of Konet Dagh, the Western Pamir, the Altai and Sayan Mts. the amount of precipitation during the cold season is large. Hence an artificial modification of clouds during this season will increase the amount of precipitation. As a result of increase on solid precipitation extensive moisture supplies can accumulate. - MGA 14.3-539.

11. Dessens, Henri and Dessens, Jean. Les plus anciennes descriptions de nuages et de pluies consécutifs à des incendies. (The oldest descriptions of clouds and rain resulting from fires.) Puy de Dome. Observatoire. Bulletin, Ser. 2, No. 2: 103-105, April - June 1962. DAS M(055) P994bu Ser. 2.

Short review of descriptions of clouds and rain resulting from fires, as found in ancient literature. The authors give

a reproduction of an engraving by Albrecht Dürer extracted from The courtesan of Babylonia dated 1498. Comparing this engraving with a photograph of a fire-generated cumulus, taken by the authors at Lukolela (Congo), it appears that the engraving represents a careful observation of a cloud formed over a fire. Texts of Thucydides relating to the siege of Plataea (429 B.C.) and of Herodotus relating to an episode in the life of Croesus are also quoted. Some analogies of these texts which relate two fires of ancient times, confirm them as remarkably authentic. In both cases the absence of winds and clouds before the sudden occurrence of stormy showers is reported. The authors conclude that these observations of rain were artificially provoked by the experimenters of ancient times, probably without their knowledge. - MGA 14.9-78.

12. Dufour, L. Microphysique des nuages. XI. Les précipitations

provoquées. (Microphysics of clouds. XI. Induced precipitation.)

Ciel et Terre, Brussels, 78 (11-12): 379-390, November - December

1962. DAS M(05) C569.

This chapter deals with experiments and results of artificial precipitation on both a small scale and a large scale. The author also discusses the experiments on artificial dispersal of clouds.

13. Elliott, Robert D. and Shaffer, Russell W. The development of quantitative relationships between orographic precipitation and air-mass parameters for use in forecasting and cloud seeding evaluation. Journal of Applied Meteorology, Boston, 1(2): 218-228, June 1962. DAS M(05) J86joa.

The physical basis for a relationship between orographic precipitation and air-mass characteristics, wind flow pattern and gross terrain features is outlined. Consideration is also given to the manner in which the precipitation falls from cloud and is caught in a rain gage. A model is developed which is employed in conjunction with numerous storm sounding data to establish semi-empirical relationships between precipitation at four mountain stations in Southern California and upwind air-mass characteristics.

The sounding sites were several hours upwind of the mountain stations. This arrangement makes it possible to employ the relationships established for short term quantitative precipitation forecast purposes as well as for cloud seeding evaluation. It is believed that the general method employed is applicable in other climatic zones. - Authors' abstract.

14. Fletcher, N.H. The physics of rainclouds. With an introductory chapter by P. Squires. And a foreword by E. G. Bowen. Cambridge University Press, 1962. 386 pp. DAS M74.1 F613ph. Review by F. H. Ludlam in Royal Meteorological Society, Quarterly Journal, 88 (378): 559,

October 1962. DAS M(05) R888q. Review by R. H. Douglas in American Meteorological Society, Bulletin, 44(5): 346-347, May 1963. DAS M(05) A512b.

This new and up-to-date review of the status of knowledge of cloud physics and weather modification emphasizes the microphysical processes as they contribute to the macrophysical developments of clouds, rain, hail, snow, etc. It is intended for physicists and meteorologists new to the subject and for specialists who want thorough review and source of references and data from recent experiments throughout the world. The area of electrification of clouds has been purposefully neglected. Areas covered are: 1) cloud dynamics (by P. Squires): 2) cloud microphysics: 3) condensation; 4) condensation nuclei in atmosphere; 5) microstructure of nonfreezing (warm) clouds; 6) theory of development of warm clouds: 7) rain from warm clouds: 8) nucleation of ice-phase: 9) ice forming nuclei; 10) growth of ice crystals; 11) rain from sub-freezing clouds; 12) artificial cloud modification: 13) production and action of AgI nuclei and 14) large scale rain making experiments. A list of about 550 references. arranged by author, but with references to page numbers in text where article was cited, and an excellent subject index are appended. The text contains sufficient theory for the professional, and considerable numerical and graphical data obtained from laboratory. and field experiments. The author, an expert on nucleation of the ice-phase, has included a wealth of mss. material in this broad field from Australian experiments in his orderly summary. - MGA 14.8-15.

15. Gromova, T.N.; Krasikov, P.N.; Lenshin, V.T.; Nikandrova, G.T.; Khimach, M.A.; Shishkin, N.S. Opyty po vozdelstviiu na pereokhlazhdennye oblaka vodnymi rastvorami lodistogo svintsa. (Experiments in treating supercooled clouds with aqueous solutions of lead iodide.)
U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Trudy, No. 126:
16-21, 1962. Russian summary p. 16. DAS M(055) U581tg. Translated into English as U.S. Joint Publications Research Service, JPRS No. 18.696. April 15, 1963, pp. 20-28. DAS M77 U5868tr.

The results of experiments on the effect of aqueous solutions of PbI₂ upon a supercooled cloud introduced from an aircraft are examined. The manner in which the PbI₂, was introduced into the clouds is described. When solutions of PbI₂ were introduced into cumulus clouds with a thickness of 2 km and more at a temperature below -7°C precipitation was produced in all the **trials.** By vaporizing solutions of PbI₂ in continuous stratocumulus cloud with a thickness of 200-400 m it was possible to dissipate them at a temperature below -15°C. When the temperature is around -20°C an effect of cloud dissipation similar to that following the vaporization of PbI₂ was observed with pure water. - MGA 15F-34.

16. Hoffer, Thomas E. and Braham, Roscoe R., Jr. A laboratory study of atmospheric ice particles. Journal of Atmospheric Sciences, Boston, 19(3): 232-235, May 1962. DAS M(05) A512j.

As a means of studying ice nucleation, snow and ice pellets collected from the tops of clouds were melted and refrozen in order to determine their freezing temperatures. In all cases where a definite cloud top temperature could be assigned, the melted ice pellets froze at a temperature colder than that of the cloud top, indicating that these pellets did not originate through the heterogeneous freezing of cloud drops. Essentially no difference was indicated in the freezing temperatures of ice pellets collected on seeded and nonseeded days. A firm statement on this point could not be made as the number of observations is limited, and it is not certain that the seeding agent had been ingested into the cloud being studied. - MGA 14.2-528.

17. Katz, Ulrich. Wolkenkammeruntersuchungen der Eiskeimbildungs - aktivität einiger ausgewälter Stoffe. (Cloud chamber studies of the ice nucleating activity of a few selected substances.)

Zeitschrift für Angewandte Mathematik und Physik, Basel, 13(4): 333-358, 1962. English summary pp. 357-358. DLC.

The author investigated the problem of whether artificial ice nuclei are formed from vapor molecules which are adserbed at the surface of a particle or whether they arise during collisions of dust particles with drops whose icing begins. The contents of this paper include the following: construction and operation of the cloud chamber and the measurement procedure; the temporal variation of the observed number of ice crystals; collisions of dust particles with fog droplets; ice nuclei formation and surfaceice nuclei density involving a study of Cu20 and FeS and a porous substance such as silica gel; and the temperature dependence of surface ice nucleation. The cloud chamber studies have demonstrated the following: the inoculation particles collide only to a slight extent with fog particles; the temporal course of the appearance of ice crystals corresponds to theoretical expectation; the activity q(T) enables the calculation of a surface ice nucleus density δ as a function of temperature if q(T) < 1; the variation of q(T) or & (T) is not a function of the dust particle size distribution but of the "initial temperature distribution" of the ice nucleation loci upon the surface of the particles; the surface ice nuclei density has considerable importance in meteorology for in the case of experiments on weather control it allows approximate calculation of the number of ice crystals which can be produced at a particular temperature and humidity by a given amount of dust-like inoculation material in case the dust particle diameter is >0.54 and the relative humidity is 100 per cent. - MGA 15F-46.

18. Langer, G. and Rosinki, J. A study of organic crystals as icing nuclei.

Armour Research Foundation, Chicago, Final Report, Contract AF 19(628)208. May 1962. 30 pp. DAS M74.11 A733st final.

This project was concerned with a study of organic icing nuclei as cloud-seeding agents. To secure openings in cloud decks to facilitate landings, etc., the Air Force needs a routine system which can be easily installed in transport aircraft. Presently cloud seeding is accomplished by converting liquid carbon dioxide to dry-ice pellets. Because inorganic substances have been studied exhaustively, a study of organic substances was more promising.

The results of the laboratory work showed that organic compounds are indeed promising. The following substances gave complete nucleation: phloroglucinol at -2°C, trichlorobenzene at -12°C, d-raffinose at -14°C, trimesic acid at -15°C, and melamine at -15°C. In all. 32 organic compounds were investigated. Phloroglucinol, the most effective organic compound found, promises to exceed silver iodide in cloud-seeding efficiency, if an effective dispersal system can be developed. It is hygroscopic and fairly soluble in water -- properties which are radically different from those of the established inorganic agents. It can be dispersed by heating or by atomization from a water solution. The heating procedure is probably the better one for field use, but it requires further study. Preliminary dispersal tests with organic solvents also showed promising results: the nuclei appeared much more active when atomized from methyl alcohol.

Theoretical analysis indicates that the activity of organic icing nuclei is determined by the configuration of the electric link-dipole moments in the molecules. The action of organic nuclei is somewhat different from that of inorganic nuclei, for which the evidence shows that the nucleating surface should contain equal numbers of positive and negative ions. The experiments to date indicate that organic compounds which exhibit ice-nucleating properties should possess more elements of molecular symmetry than ice and that the electric link-dipole moments should be arranged in such a fashion that the molecule will not have a resultant dipole. - Authors' abstract.

19. Nikandrov, V. Ia. O primenenii gigroskopicheskikh solei v protivogradovykh raketakh. (Use of hygroscopic salts in antihail rockets.) U.S.S.R Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy. No. 126: 8-9. 1962. Russian summary p. 8. DAS M(055) U581tg. Translated into English as U. S. Joint Publications Research Service, JPRS, No. 18,896, April 15, 1963, pp. 8-10. DAS M77 U5868tr.

The results of laboratory investigations on hygroscopic salts employed with explosive substances in Italian antihail rockets are presented. These salts are sodium chlorate and potassium chlorate. They were vaporized in a chamber with a volume of 1.3 M³ and the variations in the transparency during natural dissipation and during the action of the vaporization of the reagents are presented in a graph. The reagents were found to exert a stabilizing effect; the time of persistence of the fog increased

perceptibly with an increase in the amount of the vaporized reagent. This is explained by the formation of a large number of drops out of the hygroscopic nuclei as a result of the recondensation of moisture from earlier drops on newly formed ones. The stabilization of clouds in combating hail and flash floods is discussed. - MGA 15F-79.

20. Nikandrov, V. Ia. Sukhie fakely kak sredstvo vvedeniia iader kristallizatsii v tuman s zemli. (Solid fuel torches as a means for introducing crystallization nuclei from the ground into fog.)
U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad,
Trudy, No. 126: 22-24, 1962. Russian summary p. 22. DAS M(055)
U581tg. Translated into English as U. S. Joint Publications Research Service, JPRS, No. 18,696, April 15, 1963. pp. 29-33.
DAS M77 U5868tr.

The use of torches whose fuel contains admixtures of silver iodide for dissipating fogs is described. The fuel consisted of 36 g (49.2 per cent) barium nitrate, 4 g (5.6 per cent) aluminum powder, 9 g (12.3 per cent) dextrine, 21 g (28.8 per cent) metallic dust and 3 g (4.1 per cent) silver iodide. The number of dispersed particles of ice forming substance per unit volume is given by the equation

$$N' = \frac{M}{4Dfmt^2}$$

where M equals mass of ice forming substance, m equals mass of individual silver iodide particles, f equals wind speed, t equals time of burning of flare and D equals coefficient of turbulent diffusion. - MGA 15F-80.

21. Rastogi, R. P. and Bassi, Parmjit S. <u>Heterogeneous nucleation</u>.

Journal of Scientific and Industrial Research, Sec. A, New Delhi,
21 (10): 462-473, October 1962. DLC.

In phase-transformations and certain solid-state reactions, the formation of nuclei of new phase is the primary process. It is generally agreed that in most cases the formation of nuclei takes place on foreign surfaces or cavities. Such nucleation is called heterogeneous nucleation. Various reviews on nucleation have appeared recently, but a comprehensive review on heterogeneous nucleation is not available. During recent years methods have been developed for the artificial production of rain, the most important of which involves the use of silver iodide as nucleation catalyst. This has stimulated search for more efficient nucleation catlysts and greater insight has been obtained in elucidating the role of foreign substances in nucleation processes. The object of this article is to review the work done in the field of heterogeneous nucleation and nucleation catalysts.

- MGA 15F-92.

22. Vernidub, I.I.; Zhikharev, A.S.; Medaliev, Kh. Kh.; Pravdun, N.S.;

Sulakvelidze, G.K.; Chumakova, G.G. <u>Issledovanie l'doobrazuiushchikh</u>

svoistv aerozolei iodistogo svintsa. (Investigation of ice forming

properties of lead iodide.) Akademiia Nauk SSSR, Izvestiia, Seriia

Geofizicheskaia, No. 9: 1286-2193, September 1962. Russian summary

p. 1286. DAS P. Translated into English in the corresponding issue

of its Bulletin of the Academy of Sciences U.S.S.R., Geophysics

Series, issued Washington, D. C. DAS P.

The possibility and feasibility of using aerosol of lead iodide in field experiments to modify artificially clouds are examined. method for obtaining PBIo under laboratory conditions, the determination of the ice forming effectiveness of lead iodide and the determination of the disperse composition of the aerosol are described. The results of experiments carried out in the laboratory lead to the following conclusions: the disperse constitution of lead iodide obtained by the method of lead iodide sublimation and concentration of vapor depends upon the method of sublimation. The content of particles up to 0.20 microns varies from 60.8 for aerosols obtained by sublimating lead iodide upon an electric heater (1 = 900°C) to 86.7 percent for aerosol formed during the burning of a pyrotechnical compound with 50 percent lead iodide. The predominant number of particles are 0.05 to 0.15 microns in size. When the temperature of the water fog is -5/C the lead iodide aerosol has a sufficiently high ice forming activity characterized by a production of up to 1.4 x 1012 ice crystals from 1 gram of lead iodide. As the temperature of the fog falls the crystallizing activity of lead iodide rises because of the crystallizing action of small fractions. The ice forming effectiveness of aerosols of lead iodide increases with an increase in the content of small crystallizing fractions within them. - MGA 15F-118.

23. Air Force Scientist develop technique for cutting holes in "cold" clouds.

American Meteorological Society, Bulletin, 43(7): 346-347, July
1962. DAS M(05) A512b 43: 1962.

The technique developed by the United States Air Force for seeding supercooled clouds with dry-ice pellets, made on the aircraft in order to create sizeable holes in clouds is described. The machine known as the "cloudbuster" which makes dry ice pellets directly from liquid carbon dioxide stored in the seeding aircraft is illustrated with a photograph and its operation is described. The contracting organizations involved in the program of cutting cloud holes are listed. - MGA 14.4-537.

1963

24. Balabanova, V.N. O sposobnosti nekotorykh veshchestv kristallizovat pereokhlazhdennyi tuman. (On the capability of certain substances to crystallize supercooled fog.) Akademiia Nauk SSSR, Izvestiia,

Seriia Geofizicheskaia, No. 6: 978-984, June 1963. Russian summary p. 978. DAS P. Translated into English in the corresponding issue of its Bulletin cof the Academy of Sciences U.S.S.R., Geophysics Series, issued in Washington, D. C. DAS P.

An evaluation of the capability of several inorganic and organic substances to crystallize water is presented, based on quantitative measurements of the number of ice crystals in a supercooled fog. The possibility of crystallization by an expansion of compressed air in it, as well as by the introduction into the fog of actual ice crystals, formed by finely spraying water at below-freezing temperatures, is apparently of great practical interest. - MGA 15F-9.

25. Bourquard, A. Don. <u>Ice nucleus concentrations at the ground</u>. <u>Journal of Atmospheric Sciences</u>, 20(5): 386-391, September 1963. DAS M(05) A512j.

Daily observations of the surface concentration of ice nuclei have been made for three summers in Missouri as a part of Project Whitetop. The observations were taken with a nucleus counter of the expansion type. Ice nucleus counts varied considerably from day to day and from hour to hour; they were greater, on the average, during periods with southerly winds and high amounts of precipitable water overhead. Scheduling of observations also permitted an analysis of possible effects of cloud seeding in the area. The seeding utilized silver-iodide smokes from aircraft at distances of 25 to 45 miles from the nucleus counter. In the average, the seeded periods showed a slightly increased nucleus count at the ground, but the increase was small when compared with natural variations in the nucleus count. An indication was found that the slight increase in count during cloud seeding may persist into the day following that upon which the cloud seeding takes place. - Author's abstract.

26. Braham, Roscoe R., Jr. Phloroglucinol seeding of undercooled clouds. Chicago. University. Department of Meteorology, Technical Note No. 26. National Science Foundation Grant G-22419. April 1, 1963. 36 pp. DAS M74.1 C532te no. 26. Also issued in Journal of Atmospheric Sciences, 20(6): 563-568, November 1963. DAS M(05) A512j. Reprinted in Chicago. University. Department of Meteorology, Technical Note 28, Collection of Reprints VIII, April 1, 1964. DAS M74.1 C532te no. 28.

A series of twelve releases of phloroglucinol were made into stratus clouds at temperatures of -7C to -17C.

Showers produced by dry ice seeding were used to identify

particular spots in the layer clouds from which the exact locations of the phloroglucinol releases could be obtained by simple navigation. Visual observations of the cloud behavior and Formvar replicas of cloud and precipitation particles provided a means for judging the effects of the phloroglucinol seedings.

It is concluded that phloroglucinol will induce the formation of ice in undercooled clouds. However, in these experiments it was not nearly as effective as the dry ice in causing shower formation. - Author's abstract.

27. Cruette, D. Rendement d'un nouveau générateur de noyaux d'iodure d'argent: générateur à vortex. (Efficiency of a new silver iodide nuclei generator: the vortex generator.) Journal de Recherches Atmospherériques, Clermont-Ferrand, 1(4): 179-183, October - December 1963. French and English summaries p. 179. DAS M(05) J86jor 1: 1963.

To study AgI generator output author used freezing power analyzer developed by G. Soulage and P. Admirat. This apparatus allows the counting of freezing nuclei only when their number per liter of analyzed air is below 1,000. It is thus necessary to dilute the air seeded with silver iodide before it is introduced into the analyzer. This is done in metal vessels to avoid capturing on electrified walls. A parallel study was made of two generators, an old and a new one, to compare their output; the results show that the output of the new generator is at least equal to that of the old one. - MGA 15F-18.

28. Dukhin, S.S. Rol'diffuzionnykh i termoforeticheskikh sil v protsessakh pogloshcheniia iader kondensatsii i kristallizatsii v oblakakh pri aktivnykh vozdeistviiakh. (Role of the forces of diffusion and thermophoresis in processes of absorption of condensation and crystallization nuclei in clouds under active modification.)

Vsesoiuznoe Nauchnoe Meteorologicheskoe Soveshchanie, Leningrad, 1961, Trudy, 5: 114-122, issued 1963. DAS M(06) V985tr tom 5.

Temperature and vapor distribution around a cloud composed of droplets with diameters of the order of some tenths of microns or less is calculated; flows of heat and vapor are derived, and their effects upon thermophoretic and diffusional motions of aerosol particles are estimated theoretically. It is found that in conditions of supersaturation prevailing in cumulus clouds the forces of thermophoresis and diffusion do not play a significant role in particle capture by droplets, but that these forces may be significant in the case of seeding with cold substances.

- MGA 15F-22.

29. Fukuta, N. <u>Ice mucleation by metaldehyde</u>. Nature, London, 199(4892): 475-476, August 3, 1963. DAS P.

Experiments are reported in which it was shown that metaldehyde (CH3CHO), a cyclic tetramer of acetaldehyde, can be used as an ice nucleating material. Under suitable conditions ice crystals could be produced at temperatures as high as -0.4°C. At lower temperatures the metaldehyde was not quite as efficient as silver iodide smoke. The nucleating properties of the metaldehyde was found to be unaffected by its exposure to sunlight at temperatures below 33°C. At temperatures above 55°C the nucleating property was found to disappear quickly in sunlight. Metaldehyde is therefore considered to be a preferred material for cloud seeding studies. Possible explanations for the observed nucleating ability is sought in terms of the molecular and crystal structure.

- MGA 15F-28.

30. Harris, Franklin S., Jr.; Sparks, David C.; Layton, Richard G.

Nucleation of ice on lead iodide. Journal of the Atmospheric Sciences,

Boston, 20(2): 149-152, March 1963. DAS M(05) A512j.

A cold box was constructed to study ice crystal growth on single crystals of lead iodide. When the temperature of the PbI₂ substrate was slowly lowered past the temperature of the ice surface, crystal growth was observed first at the edges of the crystal and then at certain preferred sites on the PbI₂ surface. If water drops appeared on the crystals, there was a reduction in the number of active, nucleating sites. This was especially noticed at the edges of the crystal. It was noted that the threshold temperature for ice crystals growth, as determined by visual observation, was -6C. From the temperature-vapor pressure curve, it appears the PbI₂ acts as a freezing nucleus from -6C to about -12C to -14C and a sublimation nucleus at temperatures lower than -12C to -14C. - Authors' abstract.

31. Iartseva, N.N.; Bromberg, A.V.; Bychkov, N.V. Ob odnom kosvennom metode otsenki l'doobrazuiushchei aktivnosti reagentov. (Indirect method of evaluating the ice forming ability of seeding agents.)
U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy,
No. 145: 30-35, 1963. Russian summary p.30. DAS M(055) U581tg.

A method of evaluating the ice forming ability of seeding agents is described. The method is based on the interaction between the substance investigated and a supersaturated solution of AgI in a mixture of acetone and diglycol. - MGA 15F-38.

32. Langer, G.; Rosinki, J.; Bernsen, S. Organic crystals as icing nuclei.

Journal of the Atmospheric Sciences, Boston, 20(6): 557-562,

November 1963. DAS M(05) A512j.

Laboratory work showed that organic compounds have considerable promise as cloud-seeding agents. The following substances gave complete nucleation: phloroglucinol at -20, trichlorobenzene

at -12C, D(+)- Raffinose at -14C, trimesic acid at -15C, and melamine at -15C. Thirty-two organic compounds were investigated. The tests were conducted in a deepfreeze cloud chamber and a Bigg-Warner chamber. Field tests by the University of Chicago (Braham, 1963) confirmed the activity of phloroglucinol. Theoretical analysis indicates that activity of organic icing nuclei is determined by configuration of electric link-dipole moments in the molecule. - Authors' abstract.

33. Morris, Edward A. The public and weather modification. Western Snow Conference, 31st Annual Meeting, Yosemite National Park, California, April 17-19, 1963, Proceedings, pp. 116-121. Colorado State University, Fort Collins, Colorado, April 1963. DAS M(06) W527p 31: 1963.

The development of the science of weather modification is being retarded by public misunderstanding, lawsuits, insurance companies and non-uniform treatment and regulations in 50 different states.

34. Pruppacher, Hans R. The effects of electric fields on cloud physical processes. Zeitschrift für Angewandte Mathematik und Physik, Basel, 14(5): 590-599, 1963. German summary pp. 598-599. DAS P.

Presents a summary of studies reported in the literature on the effects of electric fields on "cloud physical" (sic) processes - on drop collision and coalescence, on the growth of ice particles, and on the ice nucleation in supercooled water. It is concluded that an external electric field is able to activate the ice-nucleation of a solid surface. It is unlikely that freezing can be initiated by electric fields in atmospheric clouds since the solid surfaces with which the drops have to be in contact during their deformation are not present in mature thunderstorm clouds. It would be possible to provide such surfaces artificially by cloud seeding. If such particles introduced into the cloud would also be highly charged they would initiate the icephase in the cloud by colliding with supercooled water drops even if no electric field is present in the cloud and even if the uncharged particles exhibit poor nucleation. - MGA 15.11-314.

35. Riehl, Herbert. On the origin and possible modification of hurricanes.
Science, Washington, D. C., 141(3585): 1001-1010, September 13, 1963.
DAS P.

Summarizes the important views of various workers on the subject and challenges the same by his own postulate that external cooling, rather than internal warming, is responsible as the initial accelerant mechanism of a hurricane, notwithstanding its maintenance largely by condensation heating. Modification of the postulate by rearranging a hurricane's energy was tested (based on Schaefer's experimental proof of controlled interference with

the condensation - precipitation process and Simpson et al.'s "depth charge" seeding producing an additional heat source). Although the results of the joint experiment of the U. S. Weather Bureau and U. S. Navy with depth charges somewhat off center of Hurricane "Esther," Sept. 16 and 17, 1961 gave no definite proof of the feasibility of asymmetrically rearranging the hurricane's energy, the experiment was encouraging. - MGA 15.12-263.

36. Simpson, R.H.; Ahrens, M. R., Decker, R.D. A cloud seeding experiment in hurricane Esther, 1961. U. S. National Hurricane Research Project Report no. 60. Washington, D. C., November 1962, Rev. April 1963. 30 pp. DAS M15.2 U5845r no. 60.

In September 1961 cloud seeding experiments were conducted in hurricane Esther on two consecutive days. The purpose was to determine whether artificial releases of latent heat of fusion and sublimation could be used to induce circulation instabilities leading to a reduction of maximum wind speeds. Pyrotechnic generators, dropped from aircraft in the tops of clouds, released vertical plumes of silver iodide which were subsequently spread downstream by the hurricane circulation. Results were monitored by research aircraft which maintained continuous radar coverage of a test area and measured changes in kinetic energy before and after seeding.

A marked reduction in reflectivity of 10-cm. radar energy was observed in the test area after the silver iodide was released. Also the kinetic energy diminished. However, the small magnitude of the change and limitations of the analysis restricted the conclusions which can be drawn on the basis of these initial experiments. - Authors' abstract.

37. Snelling, Hilda Jane. Production efficiency of different silver iodide ice-forming nuclei generators. June 1963. Thesis (M. Sc.) - Oregon State University. 30 pp. DAS M74.2 S671p.

Tests compared the production efficiencies of the following three silver iodide ice-forming nuclei generators: one burning charcoal soaked in a 2 per cent silver iodide acetone solution, one in which a jet of propane gas atomized a 2 per cent silver iodide acetone solution, and one in which a jet of compressed air atomized this same solution.

An optical pyrometer measured the generator operating temperatures. The United States Weather Bureau Bigg-Warner Type Ice Nuclei Counter provided counts of the number of effective ice nuclei produced by the generators at different temperatures. The tests occurred at these three temperatures of the ice nuclei counter, -12°C, -15°C, and -20°C.

The number of active nuclei produced per second of operation and

the number of active nuclei produced per gram of silver iodide used determined the efficiency of the generator. In all cases tested the acetone air generator had higher efficiency than either the charcoal generator or the propane generator. Both the acetone air generator and the propane generator had equal efficiency at the two operating temperatures tested. - Author's abstract.

38. Soulage, G. Augmentation du pouvoir glaçogène de l'air et diminution des dégats occasionnés par la grêle. (Increase of the atmospheric ice forming power and reduction of hail damage.) Journal de Recherches Atmosphériques, Clermont-Ferrand, 1(3): 69-76, July - September 1963. French and English summaries p. 69. DAS M(05) J86jor 1: 1963.

The influence of the atmospheric ice forming power upon the formation of hail can be determined on the one hand by investigating whether a constant difference exists between the ice forming power at the time of thunderstorms accompanied by hail and the ice forming power at the time of thunderstorms without hail, and on the other hand by examining whether a variation of the average ice forming power at the time of hailstorms is accompanied by a variation of the damage caused by these storms. Results obtained through the first method (comparison of the ice forming power at the time of thunderstorms either with or without hail) and derived from measurements carried out in 1957 and 1958 in the southwest of France and on the top of the Puy de Dôme show that hail forms as well with large values of atmospheric ice forming power as with small values. Observations made from 1960 to 1962 to compare the ice forming power and the hail damage show that an increase of the average ice forming power between -11° and -21°C at the time of thunderstorms is accompanied by a sensible reduction of the hail damage. - MGA 15F-110.

39. van den Berg, Piet. How to shoot down hail. Science Digest, Chicago, May 1963. pp. 42-45. "Condensed from Farmer's Weekly, Bloemfontein, South Africa." DAS M78.7 B493h.

Reports that in Swaziland when a hailstorm approached an area, and monks would start ringing heavy church bells—the hail turned "mushy." Rockets were subsequently used to destroy the hail before it did serious damage to crops. One theory considered to explain how hail can be made mushy is the cavitation theory which suggests that cavitation occurs when a sound wave from an explosion passes through a liquid and produces a great many small bubbles or cavities. In the case of hail, the ice becomes fragile. This, coupled with the fact that there is always a certain amount of natural internal melting taking place in hailstones, thus creating cavities containing liquid water inside the hailstone, may explain why an explosion in the air can lead to hailstones shattering when they strike the ground. The use of rockets for this purpose in Italy is also reported. - MGA 16.1-158.

Vernidub, I.I.; Zhikharev, A.S.; Medaliev, Kh. Kh.; Pravdun, N. S.;

Sulakvelidze, G.K.; Chumakova, G.G. Ol'doobrazuiushchikh svoistvakh
aerozolei iodistogo svintsa, poluchaemykh szhiganiem metallofodidnykh
sostavov. (Ice forming properties of aerosols of lead iodide obtained
by oxidation of metal iodide compounds.) Akademiia Nauk SSSR,
Izvestiia, Seriia Geofizicheskaia, No. 8: 1278-1284, August 1963.
Russian summary p. 1278. DAS P. Translated into English in the
corresponding issue of its Bulletin cof the Academy of Sciences USSR,
Geophysics Series, Washington, D. C. DAS P.

The results are described of a preliminary investigation, performed by the authors, of the crystallizing action of aerosol of lead iodide on supercooled fog. The aerosol was formed by burning of metaliodide compounds as a result of a chemical reaction between the highly dispersing lead powder and the various iodine-containing combinations. - MGA 15F-117.

Hurricanes and Stormfury. Mount Washington Observatory, Gorham, N.H., News Bulletin, 1(4): 10-13, December 1963. DAS M(06) M928n.

Reviews and comments on Origin and possible modification of hurricanes by Herbert Riehl (1963) and reports preliminary findings of cloud seeding experiments performed in Hurricane "Beulah" Aug. 1963 as part of Project Stormfury. The object of the experiments was to duplicate experiments begun in 1961 to seed hurricanes with AgI to see if the energy patterns in a hurricane could be changed. Although changes occurred, scientists cautioned that hurricanes often have similar changes without human interference. - MGA 16.1-156.

1964

Aksenov, M. Ia. and others. Razrobotka i issledovanie pirotekhnicheskikh sostavov dlia vozdejstvija na konvektivnye oblaka. (The development and study of pyrotechnical compounds for seeding convective clouds.) Vsesoiuznoe Nauchnoe Soveshchanie po aktivnym vozdejstvijam na gradovye protsessy, Tiflis, 1962, Trudy. Tiflis, 1964. pp. 341-346. DLC QC929.HIV9 1962.

The effectiveness of lead-iodide aerosols for controlling hail damages is established from experiments with various firework compounds consisting of silver- and lead-iodide. - WMSU.

Antonov, V.S.; Min-kan, Van; Polovina, I.P. Termodinamicheskie usloviia uspeshnosti vozdeistviia na sloistye pereokhlazhdennye oblaka steeliu vyzvaniia osadkov. (Thermodynamic conditions of successful seeding of supercooled stratus clouds for the purpose of causing precipitation.) Akademiia Nauk SSSR. Izvestiia, Seriia Geofizicheskaia, No. 12: 1885-1888, December 1964. DAS P. Translated into English by J. S. Sweet in the corresponding issue of its Bulletin of the Academy of Sciences U.S.S.R., Geophysics Series, issued Washington, D. C. DAS P.

Considers a means of finding a solution to the problem of effective seeding of supercooled clouds under conditions when their crystallization is caused by a reagent. The problem is seen in 2 parts: the evolution of the effectiveness of action of the reagent, and the computation of thermodynamic conditions of the changing of formed articles into raindrops. This paper deals with the latter as applicable to stratus clouds for which vertical movements of the air ~1 cm/sec are characterized. It was found that at the temperatures of the upper boundary of the clouds from -10° and lower, the necessary thickness for the formation of precipitation with the artifical inducement remains constant and is within limits of 350-400 m. _ MGA 17.1-151.

44. Appleman, Herbert S. Weather modification. U. S. Air Weather Service, Technical Report 177, July 10, 1964. Sections separately paged. DAS M(055) U58a 177.

The discussion includes not only well-verified facts but also theories that, while reasonable in view of available observations. cannot vet be considered as completely proven. Some of the conclusions are: the success of cloud seeding in increasing precipitation has not been proven, however, there is some evidence that under the right conditions light snow fall can be produced by seeding winter time supercooled orographic clouds; the use of dry-ice seeding from aircraft to dissipate supercooled stratus and fog has proved very effective when properly done; techniques for dissipating warm fog and stratus are also under study. but except for the FIDO system it appears that any success is still many years away: it will almost certainly be many years before a useful technique of modifying thunderstorms is achieved; the forecaster should be cautious neither to make nor accept claims of successful weather modifications unless supported by a valid verification program. - MGA 16.4-213.

45. Atmospherics, Inc., Fresno, Calif. Final report on cloud seeding in the County of Tulare, Calif., 1962-63 season. Submitted to Board of Supervisors, Tulare County. Prepared by Thomas J. Henderson. March 1964. Unpaged.

Reports on cloud seeding operations and results for purposes of increasing precipitation in Tulare Country, Calif., in 1962/63 season. The operation included the use of one aircraft equipped with both AgI and dry ice capabilities. The aircraft made 52 seeding flights. The AgI was used along the western border of the target area when complete overcast conditions prevailed prior to and during frontal passages. Dry ice was used during post-frontal activity when unstable conditions produced individual cumulus buildups over the foothill areas. An apparent increase of 14 per cent in precipitation within the target area is indicated. Precipitation data are included. - MGA 16.1-34.

46. Borovikov, A.M.; Kostarev, V.V.; Shupiatskii, A.B. Apparatura i metodika radilokatsionnykh nabliudennii evoliutsii moshchno-kuchevykh

i kuchevo-dozhdevykh oblakov. (Instruments and methods for radar observations of the evolution of cumulus congestus and cumulonimbus.) Vsesoiuznoe Nauchnoe Soveshchanie po aktivnym vozdelstviiam na gradovye protsessy, Tiflis, 1962, Trudy. Tiflis, 1964. pp. 210-216. DLC QC929.HLV9 1962.

Methods of radar analysis applied in 1961-1962 for studying cloud evolution and the effectiveness of hail suppression are described and discussed. - WMSU.

Borovikov, A.M.; Kostarev, V.V.; Shupiatskii, A.B. Nekotorye rezul'taty radiolokatsionnykh nabliudenii evoliutsii moshchno-kuchevykh oblakov i rezul'tatov vozdeistviia. (Some results of radar observations of the development of Cu cong clouds and the results of modification.) U.S.S.R. Tsentral'naia Aerologicheskaia Observatoriia, Moscow, Trudy, 57: 24-40, 1964. DAS M(055) U581tt. Translated into English through the support and sponsorship of U.S. Air Force. Cambridge Research Laboratories Research Translation T-R-510 by William J. Grimes and David Kraus. (American Meteorological Society Contract No. AF 19(628)-3880) 24 pp. DAS M(055) U581ttE no. 57 pp. 24-40.

Radar observations were made in 1961-62 in Georgia. There were experiments in modifying Cu cong and Cb to prevent hail. Information is given on the apparatus and methods employed, the hail content of Cb, and some criteria are proposed for determining the effect of artificial modification directed toward preventing hail damage. It is concluded that the modification apparently had a slight positive effect, as shown by the retardation of the development of clouds in a small area but it proved unsuccessful at greater distances, as evidenced by the fall of hail in the vicinity after modification. - MGA 17.12-183.

48. Budyko, M.I. Izmenenie klimata i puti ego preobrazovaniia. (Change of climate and ways of its transformation.) (In: Akademiia Nauk SSSR. Institut Geografii, Razvitie i preobrazovanie geograficheskoi sredy. Moscow, 1964. p.62-72.)

The significance of the thermal energy balance in climatological studies in particular the formation of climatic zones is discussed. The greater role of the ice cover in the formation of thermal zones of the Earth through its effect on the thermal balance than that of solar radiation is indicated and the use of energy balance to account for the origin of glaciation in general and in the tropics in particular is discussed briefly. The possibility of changing the climate of the Earth is considered in the light of the comparison between solar radiation energy reaching the Earth and the energy of onthropogenic origin and the possibility of a gradual transformation of climate as a result of the latter is pointed out. Various possibilities of altering the climate of the Earth are discussed. These include cloud seeding, modifying the underlying surface to produce more intense convection, modification of Arctic ice, etc. - MGA 16.12-487.

Bukhnikashvili, A.V., and others. Metodika aktivnykh vozdelstvii na gradovye protsessy i rezul'taty opytov, provedennykh v Alazanskoi doline. (Methods of modifying hail processes and results of experiments carried out in the Alazani Valley.) Vsesoiuznoe Nauchnoe Soveshchanie po aktivnym vozdelstviiam na gradovye protsessy, Tiflis 1962, Trudy. Tiflis, 1964. pp. 281-324. DLC QC929.HIV9 1962.

An outline of 187 hail-control experiments carried out from 1958-1962 is presented. - WMSU.

Bukhnikashvili, A.V. and others. Organizatsiia opytno-proizvodstvennoi zashchity gradobitii v Alazanskoi doline. (Organization of experimental protection of the Alazani Valley from hail damages.)

Vesoiuznoe Nauchnoe Soveshchanie po aktivnym vozdeistviiam na gradovye protsessy, Tiflis, 1962, Trudy. Tiflis, 1964. pp. 325-338.

DLC QC929.H1V9 1962.

The progress of controlling hail damage in the Northern Caucasian Area since 1959 is outlined. The area protected from hail reached 120,000 ha in 1963. - WMSU.

i protsessa ispareniia sukhogo l'da pereokhlazhdennykh oblakakh.

(Study of mechanism of ice particle formation and of the process of evaporation of dry ice in supercooled clouds.) Acta Meteorologica Sinica, Peking, 34(1): 87-93, February 1964. In Chinese. Chinese summary p. 87; Russian summary p. 93. DLC.

The mechanism of formation of ice particles during evaporation of dry ice is examined. The results agree with experimental data. - MGA 16.4-214.

52. Chattopadhyay, N.N. On the effect of continuous diffusion of salt muclei into the atmosphere on local rainfall. Indian Journal of Meteorology & Geophysics, Delhi 15(3): 381-392, July 1964. DAS M(05) 139i.

It is generally recognised that the presence of salt nuclei in clouds has a powerful influence on rain formation. It is with a view to find out whether continuous diffusion of salt nuclei into air from a powerful atomizer, placed at a height of 60 ft. above ground, which is fed by salt solution and worked by compressed air at 20 atmospheres would have any effect on local rainfall, that experiments were undertaken at the Jadavpur University in 1958 and 1959. The atmomizer was kept in continuous action throughout the day-light hours during April to October 1958 and during July to October of 1959.

During 1958 and 1959, West Bengal had deficient monsoon rainfall. The departures of rainfall from the normal in each of the months,

during which the experiments were done, were plotted and the lines of equal departures were drawn. These showed that the curves of least negative departures and in some cases highest positive departures were generally oval-shaped extending from north of Calcutta to a distance of about 100 miles towards the prevailing wind direction in all the months in which the experiments were done. This suggested that this oval-shaped area received more rainfall than the neighbouring areas. As this area came under the influence of the salt nuclei which permeated into the air and a fair proportion of which reached cloud levels after a travel of short distance from south Calcutta, it is considered that this factor may have contributed to the increase in rainfall. - Author's abstract.

Chuvaev, A.P.; Orenburgskaia, E.V.; Osipova, G.J.; Shvarts, V.T.

K metodike otsenki klimaticheskikh resursov iskusstvennogo
ubelicheniia osadkov iz konvektivnykh oblakov (na materialakh
basseina oz. Sevan). Evaluating climatic resources for artificial
increase of precipitation from convective clouds (using data from
the Lake Sevan Basin). U.S.S.R. Glavnaia Geofizicheskaia
Observatoriia, Leningrad, Trudy, 156: 101-117, 1964. Russian summary
p. 101. DAS M(055) U581tg.

On the basis of the interrelated analysis of network observations of clouds and precipitation in the Lake Sevan Basin, certain parameters are established which indirectly characterize the coefficient of the realization of water reserves of clouds in the form of natural precipitation during convective weather conditions. Considerations are expressed concerning the possibilities of increasing precipitation through artificial action on clouds during certain types of weather. - MGA 16.11-183.

54. Cot, Pierre D. Résultats opérationnels d'une méthode de dissipation des brouillards surfondus. (Operational results of a method for dissipating supercooled fog.) Académie des Sciences, Comptes Rendus, 258(12): 3337-3338, March 23, 1964. DAS P.

The research made by the author with a view to dissipating fog at airfields led to the erection, at the airfield at Orly, of an installation permitting the dissolution of supercooled fog; its efficiency was proved in Jan. 1964. The procedure consists of a scattering of ice germs which cause the crystallization of the supercooled water droplets. The device used at Orly enables the pulverization of liquid hydrocarbons from fixed locations. On Jan. 19, 20 and 21, 1964 a supercooled fog covered the Orly airport. The application of this fog dissipation method permitted 17 landings and 16 take-offs, on Jan. 19, 76 take-offs and 67 landings on Jan. 20-21. These results were obtained with a consumption of about 200 kg hydrocarbons an hour of working. Hence, the efficiency of this process was proved. - MGA 16.9-52.

55. Dessens, Henri and Dessens, Jean. Expériences avec le météotron au Centre De Recherches Atmosphériques. (Experiments with the meteotron at the Center of Atmospheric Research.) Journal de Recherches Atmosphériques, Clermont-Ferrand, 2(3): 158-162, July - September 1964. DAS M(05) J86jor 1: 2 année 1964.

Report on experiments made since 1961 with the meteotron set up on the Lannemezan plateau. The meteotron has been devised to induce showers in the equatorial zone. On the basis of the results from experiments made hitherto, the authors try to bring out what seems workable with a heat source of the order of 1 mill kwatt. The following experiments were conducted: intensifying of precipitation to leeward of the meteotron, production of rain by a combination of convection and NH3 seeding production of rain by convection and AgI seeding, experiment in modification of a stratocumulus layer, modification of a thunderstorm and guiding of lightning. The experimental results show that rain cloud experiments carried out in tropical regions cannot be reproduced in temperate regions. It is often impossible to form the smallest amount of cumulus. On the other hand, control of a thunderstorm forming in the vicinity of the meteotron seems possible providing that the action be initiated before the precipitation pattern gets organized. The authors define the situations in which important rainfall can be obtained through artificial convection. The investigation of these situations, characterized by strong instability beneath the cloud layers, could lead to new information on the process of rain formation. - MGA 16.4-215.

56. Dessens, Jean. Man-made thunderstorms. Discovery, London, 25(3): 40-43, March 1964. DAS MO9.6 D475ma.

The world's first meteotron has been designed and built at the Univ. de Clermont, France. By means of a hundred oil fired burners, convection currents can be induced in the atmosphere, giving rise to artificial clouds, rain, thunderstorms and even tornadoes. Work is going ahead in other parts of the world to produce really supermeteotrons. The meteotron has produced many artificial cumulus clouds, two of which gave rise to a substantial downpour. Dust devils have been located near the burners.

- MGA 16.7-223.

57. Elliott, Robert D. (Chairman of Panel). Weather modification.

American Society of Civil Engineers, Irrigation and Drainage Division,

Journal, 90(4): 73-84, December 1964. DAS P.

A discussion of the present status of knowledge and practice and statistical evaluation in weather modification with consideration of the economic aspects of cloud seeding to increase water supply. Legal and sociological aspects of weather modification are noted. Research needs are outlined: physical properties of ice, ice-forming processes; ice forming nuclei and seeding techniques;

seeding with condensation nuclei, lamp-black and other agents; electrification; and tracing techniques for cloud seeding. - MGA 16.11-181.

58. Gromova, T.N.; Krasikov, P.N.; Lenshin, V.T.; Shishkin, N.S. Opyty po vozdejstviju na pereokhlazhdennye oblaka kolloidnym rastvorom iodistogo serebra. (Modification of supercooled clouds with silver iodide in colloidal solution.) U.S.S.R. Glavnaia Geofizicheskaia Observatorija, Leningrad, Trudy, 156: 23-30, 1964. Russian summary p. 23. DAS M(055) U581tg.

Results are described of experiments on modification of supercooled clouds with AgI in colloidal solution which were conducted in 1960 at the A.I. Voeikov Main Geophys. Obs. - MGA 16.11-184.

59. Gusev, A.M. <u>K voprosu o preobrazovanii klimata.</u> (Modifying climate.)
(In: Akademiia Nauk SSSR, Institut Prikladnoi Geofiziki, Issledovaniia teploobmena atmosfere. Moscow, 1964, pp. 3-16.)

In connection with the problem of the modification of climate, the author presents a general discussion of the physical bases and theories of climate. This includes the solution of the equation of heat balance for the entire Earth - the surface of the Earth, the atmosphere and hydrosphere - the role of solar activity in the formation of weather and climate, the use of the methods of hydrodynamics and thermodynamics to investigate the atmosphere, the determination of the distribution of heat in the atmosphere including Defant's Shuleikin's and Kibel's approaches, etc. Also various methods of modifying climate are considered in the light of the role of underlying surfaces in the formation of climate, namely: the surface of the continents, the surface of seas and oceans, and surfaces of extensive glaciation. - MGA 16.12-492.

60. Howell (Wallace E.) Associates, Inc. Evaluation of cloud seeding for the P.H. Glatfelter Company, the Hanover Water Company and the New York Water Company, September - December 1963. Lexington, Massachusetts, 1964? 4 pp. DAS MO9.617 H859ev.

Following a summer of severe drought in central Pennsylvania, with water supplies becoming critically low, the Glatfelter Company sponsored rainfall stimulation operations over its watershed area near Spring Grove, Pennsylvania, as it had done on three previous drought occasions. This time, it was joined in the sponsorship by the water companies of the neighboring cities of Hanover and York.

The cloud seeding program was begun on 28 September 1963 and continued to the end of the year, except that the York Water Company dropped out at the end of November, when conditions there had been considerably alleviated.

During this time, an average of 10.47 inches of precipitation fell on the target. The expected precipitation was computed to be 9.47 inches, indicating an increase of 1.00 inches or 10.6 percent. Because of extremely wide deviations of the control rainfall from the monthly means, the usual tests of significance became almost meaningless, with the result that, according to these tests, the increase was quite likely to have been due to chance alone and no significance can be attached to the effect of the seeding in producing the increase.

Nearly half the rain that fell during the seeded period, 48 percent to be exact, came in two coastal storms on September 28-30 and November 8-9, while between these two dates the month of October was virtually rainless. Inspection of the rainfall amounts suggests that most of the indicated increase occurred in the November period, and that December showed comparatively poor results. - Author's summary.

61. Howell (Wallace E.) Associates, Inc. Report of rain stimulation in Fulton, Montgomery, Rensselaer, Saratoga and Washington Counties, New York, July 1964. Lexington, Massachusetts, December 1964.

4 pp. DAS M09.617 H859rep.

In June of 1964, a group of farmers in Fulton, Montgomery, Rensselaer, Saratoga, and Washington Counties banded together in an informal league to undertake cloud seeding in the hope that it might contribute to alleviation of the severe drought afflicting the region, with the County Farm Bureaus handling its administration on a volunteer basis. Operation was begun on 29 June. Two weeks of near-normal rainfall and slowness of contributions to the program led to its early termination on 17 July, though it turned out that the drought was far from over.

There were two showery periods, with cold fronts on the nights of July 3rd and 13th, but both times the centers of activity passed west of the target. Rain was extremely irregular and variable.

An evaluation was attempted, but because of the shortness of the period and the great variability of the rainfall, it failed to provide a reasonable test of the success or failure of the cloud seeding. - Author's summary.

62. Howell (Wallace E.) Associates, Inc. Resultados preliminares de las operaciones de estimulación de lluvia en la hoya del Río Anchicayá, Departmento del Valle, Colombia, para los períodos de verano entre Julio de 1963 y Abril de 1964. (Preliminary results of the operations of stimulation of rain in the watershed of the Anchicaya River, Department of the Valley, Colombia for the dry season periods between July 1963 and April 1964.) Lexington, Massachusetts, 1964. 20pp.

DAS MO9.617 H859re.

Evaluation of rainfall stimulation operations conducted in the watershed of the Rio Anchicaya, near Buenaventura, Colombia, from July to November 1963 and December to April 1964 is rendered extremely difficult by the scarcity of rainfall data and by the dependence of daily streamflow on antecedent conditions. However, a detailed study of maximum daily decrement of streamflow has permitted elimination of a large part of the variability due to antecedent conditions.

A formula expressing the maximum decrement is derived and the notion of equivalent precipitation is introduced, corresponding to the effect of a fictitious uniform precipitation over the watershed. The frequency distribution of this equivalent precipitation exhibits no important serial correlation, confirming elimination of most antecedent effects. However, even utilizing this equivalent precipitation, ordinary statistical comparisons are not practicable because of scarcity of adequate controls and great interannual variation. A mathematical expression is obtained for the frequency distribution of the equivalent precipitation, and the Bayes criterion is used to establish a lower limit of accumulated equivalent precipitation that would justify continuation of operations. Applied to the seeded period, this criterion recommends continuation of the operations. As confirmation, the same criterion applied to the previous 14 unseeded years recommends suspension in 9 years, and recommends continuation in two others by only a very narrow margin.

Finally, the specific raininess (defined as the average equivalent precipitation per rainy day, the latter taken as days with river flow 15 m³/sec) is relatively constant, and an excellent correlation is found between the number of rainy days and the accumulated equivalent precipitation. A regression equation is obtained that permits prediction of the accumulated equivalent precipitation as a function of the number of rainy days. Comparison of this prediction and its probable error with the actual river flow during the period of seeding indicates an increase of the order of 15 percent and the probability that this increase is due to chance appears to be less than one in 100. This increase corresponds to an increase of 2490 KW average power generation and to an economic return 5.8 times the cost of the seeding program.

Author's abstract.

63. Jiusto, James E. <u>Project Fog Drops:</u> investigation of warm fog properties and fog modification concepts. U. S. National Aeronautics and Space Administration, Contractor Report, CR-72, July 1964. 60 pp. DAS M(051) U585cr No. 72.

Considerable fog data were examined in order to quantitatively

model the structural, dynamic, and microphysical characteristics of warm fog. Laboratory experiments were conducted to determine the effect of surface active materials (fatty alcohol monolayers and ionic surfactants) on the growth and evaporation rate of droplets. These models and experimental findings were applied to the evaluation of various warm fog modification concepts. Regions of high frequency of supercooled fog in the United States were delineated and pertinent fog control considerations mentioned. - Author's abstract.

64. Kapoor, R.K. and Srivastava, R.C. A mock cloud seeding experiment at Delhi. Indian Journal of Meteorology & Geophysics, Delhi, 15(2): 271-276, April 1964. DAS M(05) I39i.

The results of what may be called "A mock seeding experiment" at Delhi for a period of 12 years are presented. On the basis of comparisons of target and control sector rainfalls during the period of the mock trial with those during actual seeding experiments at Delhi during five monsoon seasons, 1957 to 1961, certain interesting conclusions are reached about the significance of the seeding results obtained so far. - Authors' abstract.

65. King, A.R. Characteristics of a fire-induced tornado. Australian Meteorological Magazine, Melbourne, No. 44: 1-9, March 1964. DAS M(05) A938.

A cinematographic film of a tornado which formed over a severe bushfire in 1962 in Victoria has been analysed. Notable findings are that a flame rose in the core to a height of 260 feet, that the core velocities were up to 205 m.p.h, vertically, at least 20-30 m.p.h. horizontally and 15-30 revolutions per minute rotationally, that nearby parcels of air rose at up to 100 m.p.h. without spinning and that despite these conditions the ground winds were not strong enough to damage trees. - Author's abstract.

66. Koenig, L. Randall. Some chemical and physical properties of silveriodide smokes. Journal of Applied Meteorology, Boston, 3(3): 307-310, June 1964. DAS M(05) J86joa.

The aerosols, produced by several devices, used to provide silver iodide for cloud-seeding purposes have been studied by micro-chemical techniques which permitted the characterization of individual smoke particles. The water sorptive properties, the composition, and chemical uniformity of the particles were sought. Marked differences in the generator outputs were noted. Some effort has been made to relate the findings of this work to the suitability of the different aerosols to cloud-seeding tasks. - Author's abstract.

67. Krasnovskaia, L. I. <u>Fizicheskie osnovy iskusstvennykh vozde</u>istvii na

pereokhlazhdennye oblaka s pomoshch'iu khladoreagentov. (Physical bases of artificial modification of supercooled clouds by means of refrigerants.) U.S.S.R. Tsentral'naia Aerologicheskaia Observatoriia, Moscow, Trudy, No. 58, 1964. 79pp. DAS M(055) U581tt.

This monograph constitutes a theoretical and experimental investigation of the physical processes that take place when supercooled clouds are seeded with such cold reagents as solid CO2. The contents of this paper consist of the following, viz: a review of investigations of the modification of supercooled clouds and fogs with freezing reagents, including investigations of the possibility of modification with cold reagents up to and including the work of Langmuir and Schaefer, the value of formation of artificial ice crystals in clouds and natural ice crystals in the atmosphere, investigation of reagents for artificial modification of supercooled clouds; experimental investigation of processes of dispersing supercooled clouds during seeding with solid CO2 and theoretical methods for investigating the process of dispersion of supercooled clouds with the aid of solid CO2; formation of the ice nucleus phase during the introduction of solid CO2, in supercooled clouds including the formation of the solid phase at temperatures below -40°C, fundamental propositions of the theory of homogeneous condensation in supersaturated vapor, the temperature field of a granule of solid CO2 during different environmental temperatures and different air velocities, rate of fall of temperature in a temperature field of a granule in different conditions, application of condensation theory to the calculation of the rate of formation of nuclei of a new phase during seeding with solid CO2, the total amount of nuclei of the former per 1 gm of solid CO2 under different temperature conditions and analyses of the results of effective CO2 during different environmental conditions; propagation of ice crystals formed in a cloud layer as a result of modification, including the causes of the propagation of ice crystals formed in a cloud layer as a result of modification, including the causes of the propagation of crystals in a cloud, fundamental laws of the theory of turbulent diffusion in the atmosphere, the type of propagation source formed during the introduction of solid CO2 from an aircraft, and laws of variation of the width of a zone of propagation of crystals during different meteorological conditions; and experimental investigations of the process of propagation of crystallization zones in supercooled clouds, including a description of the experimental procedure, experimental errors and experimental results given in graphs and tables. - MGA 16.11-11.

68. Landsberg, H.E. Controlled climate (outdoor and indoor). In: Licht, Sidney and Kamenetz, Herman L. (eds.) Medical climatology. New Haven, Conn. Elizabeth Licht, 1964. pp. 663-701. DAS M86:610 L699m.

A discussion on controlled climate (outdoor and indoor) begins with definitions of terms that specify various domains of climatic

environment, and continues with consideration of the control macroclimate, mesoclimatic changes and controls modifications of microclimate, rest enclosures, cave climate, house climate, room climate, bed environment, vehicular environment, and therapeutic environments. Special mention is made of climatic chambers for therapeutic purposes. The manner in which man has affected the climate on a local scale by his activities is noted. Effects of deforestation, swamp drainage, irrigation, changes produced by cities, are pointed out. - MGA 16.4-489.

69. MacCready, Paul B., Jr. Weather modification and water resources.

Texas. Agricultural and Mechanical University, College Station,

Proceedings of the 8th Annual Conference on Water for Texas, Nov. 1820, 1963. Published 1964. pp. 46-48. DLC.

Presents survey on how the field of weather modification is evolving now and how it may develop in the future and then considers the Texas role in this area, and also legal aspects of the problem. Suggests that Texas can become intimably involved in the development of seeding research, in relation to larger government programs. - MGA 16.4-218.

70. Malkus, Joanne S. and Simpson, Robert H. Note on the potentialities of cumulonimbus and hurricane seeding experiments. Journal of Applied Meteorology, Boston, 3(4): 470-475, August 1964. DAS M(05) J86joa.

Outlines cumulus dynamics framework for evaluating past and proposed hurricane experiments and, using that framework to demonstrate that experiments in isolated cumulonimbus clouds in non-hurricane conditions offer a clearer, vastly cheaper and easier means of testing critical aspects of a wide class of hurricane modification possibilities. An estimate is made of the warming and D-value drop which could be produced by seeding an active cumulo-nimbus tower with AgI. The associated changes in vertical velocity and cloud top height are predicted. - MGA 16.5-343.

71. Meinel, Aden B. and Meinel, Carolyn P. Low-latitude noctilucent cloud of 2 November 1963. Science, Washington, D. C., 143(360): 38, January 3, 1964. DAS P.

Measurement of the filamentary noctilucent cloud of Nov. 2, 1963 yields a height of 56 km. Study of the motion and orientation of the cloud confirms the hypothesis that these unusual clouds appearing in the southwestern states are produced by the launching of rocket vehicles from the Pacific Missile Range. - MGA 15D-205.

72. Morgunov, S.P. and Shupiatskii, A.B. Otsenka effektivnosti iskusstvennykh vozdelstvii po poliarizatsionnym kharakteristikam ekho-signala.

(Evaluation of artificial - modification efficiency from the polarization characteristics of echo signal.) U.S.S.R. Tsentral'naia
Aerologicheskaia Observatoriia, Moscow, Trudy, 57: 49-54, 1964.

DAS M(055) U581tt. Translated into English through the support and the sponsorship of U.S. Air Force. Cambridge Research Laboratories, Research Translation T-R-514 by William J. Grimes. (American Meteorological Society, Contract No. AF 19(628)-3880) 10 pp. DAS M(055) U581ttE no. 57 pp. 49-54.

Reports that at Samsari in 1961-1962 field groups began research on the use of radar to evaluate the effectiveness of artificial modification of clouds in preventing hail. The use of the polarization method is discussed as one of the criteria for evaluating the effectiveness of cloud modification. A method is outlined for use of a radar with 1 movable antenna. The experimental results show clearly that the polarization method permits the phase changes produced by artificial modification in a cloud to be recorded. - MGA 17.12-190.

73. National Research Council. Committee on Atmospheric Sciences.

Scientific problems of weather modification. A report of the Panel on Weather and Climate Modification. National Research Council, Washington, D. C., Publication 1236, 1964. 56 pp. DAS MO9.6 N277sc.

This report on the present status of weather modification constitutes a review of scientific knowledge bearing upon weather modification, in particular rain making; the theoretical, meteorological and experimental basis of rain making, hurricane control, fog dispersion, etc.; and an examination of the needed scientific knowledge and effort for solving the problem of weather modification. The contents of this report include the following, viz: general evaluation of attempts at rain making, present knowledge of the physics of precipitation and further problems that must be solved; cloud modification, including continuous rain and rain from cumulus systems (rain making, hail by seeding, suppression of lightning, hurricane modification by seeding, seeding of individual tropical clouds); super-cooled clouds and fog and dissipation of warm clouds; surface modification as a means of stimulating convection, including the asphalt hypothesis; preliminary summary of the pertinent results of the Barbados study of island cloud and rainfall patterns; the general circulation of the atmosphere in relation to weather modification-observational aspects of the general circulation, numerical simulation of the general circulation and simulation of the general circulation by laboratory experiments; contamination or modification of the upper atmosphere - vertical eddy mixing, large scale circulation, removal of atmospheric impurities, etc. - MGA 16.9-36.

74. Ohtake, Takeshi and Isaka, Harumi. Determination of effectiveness of artificial stimulation of snow in Tohoku District, Japan. Sendai, Japan (Miyagi Prefecture) Tôhoku University. Science Reports, 5th Series: Geophysics, 15: 97-110, 1964. DAS P.

Every year in winter, cloud-seeding is conducted in the Tohoku District, northern part of Honshu, Japan for the purpose of

artificial snow making. Observations showed that cloud-seeding is effective in increasing snowfall amount from the following points of view: (1) High ice nucleus concentration was obviously observed at the ground in the target area 20 to 25 km away from the location of the AgI generator. (2) Average high freezing nucleus concentration which was observed in the fallen snow and an increase of snowfall amount agreed with each other in the target area. (3) Simultaneous observations of ice nucleus concentration in the air and freezing nucleus concentration in the fallen snow disclosed that the former was subject to the influence of the surface wind and the latter to the influence of the wind aloft. (4) The observation at Daishaka showed that ice nucleus concentration at the ground, and snow crystal forms and freezing nucleus concentration in the snow depended upon the temperatures and winds from the upper air to the ground. - Authors' abstract.

75. Osipova, G.I. and Fridman, Iu. S. K voprosu ob otsenke effektivnosti vozderstviia na oblaka s tsel'iu uvelicheniia osadkov. (Evaluating the effectiveness of cloud modification with the aim of increasing precipitation.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, 156: 31-45, 1964. Russian summary p. 31. DAS M(055) U581tg.

A statistical method is examined of evaluating the effectiveness of artificial action on clouds with the aim of increasing precipitation, and the conditions needed for setting up and conducting experiments which determine the reliability of using statistical evaluation methods. - MGA 16.11-186.

76. Page, Homer. There'll be a change in the weather. Think, N.Y., 30(3): 6-12, May/June 1964. DN-HO.

Discusses the Tiros satellites which keep watchful eyes on rain, sunshine, hurricanes and typhoons, and the possibilities and problems of made-to-measure weather. In discussing weather models, information is given on Stretch—one of the largest, fastest computers now available. The contributions and views of Robert M. White and Joseph Smagorinsky are introduced. MGA 16.1-463.

77. Pena, J.A.; Caimi, E.A.; Pena, R.G. de. Influence de la radiation ultraviolette sur l'activité glaçogène de l'aérosol d'iodure d'argent produit par différents générateurs. (Influence of ultraviolet radiation on the ice nucleating activity of silver iodide aerosol produced by various generators.) Journal de Recherches Atmosphériques, Clermont-Ferrand, No. 2: 87-93, April-June 1964. French and English summaries pp. 87-88. DAS M(05) J86jor 1: 2 année 1964.

Comparative experimental work has been carried out on the decay of the ice nucleating properties of AgI aerosols produced by 3 generators: "Skyfire," "Dessens" and charcoal, when these aerosols are exposed to ultraviolet radiation. Samples of aerosols

suitably diluted were lodged in a closed container of 10 l capacity and submitted to the ultraviolet light emitted by the core of a mercury discharge lamp, through a quartz window fitted at the base of the container and for a period of an hour. Decay curves show a dispersion which does not make it possible to establish differences of the behavior of AgI nuclei as function of their threshold (from —8 to —18°C). Average curves give (for one hour) a decay of more than one order of magnitude in the concentration of active freezing nuclei with respect to the initial concentration for the charcoal generator, nearly 2 orders for the "Skyfire" generator and 2 1/2 orders for the "Dessens" generator. — MGA 16.8-273.

78. Plank, Vernon G. Comments on "An Experiment on Fog Dispersion by the Use of Downward Air Current by the Fall of Water Drops." Reply by Choji Magono, Katsuhiro Kikuchi, Tsutomu Nakamura and Tadashi Kimura. Journal of Applied Meteorology, Boston, 3(2): 213-214, April 1964. DAS M(05) J86joa.

Plank commenting on Magono et al (see 15G-71, July 1964, Met. Abs.) notes that helicopter influences which they dismissed as being negligible are in fact significant. Plank suggests that aircraft have tremendous wakes, which, if the aircraft are flown anywhere in the near vicinity of clouds are capable of exerting an appreciable modification influence on clouds. In reply, Magono et al. confirm their belief that the falling water drops do have some effect on cloud dissipation. They add that the effect of the helicopter downdraft while larger than previously expected, still does not reach the ground surface when the helicopter is at 2000 ft. However, the falling water drops do reach the unstable air layer near the surface and the downdraft has some relation to dissipation of the fog layer.

- MGA 16.1-157.

79. Prikhot'ko, G.F.; Roev, L.M.; Tovbin, M.V. K voprosu ob ispol'zovaniji monomolekuliarnykh plenok dlia bor'by s tumanami tipa parenila. (Use of monomolecular films for protection against "steam" type fog.)

Meteorologiia i Gidrologiia, Moscow, No. 11: 27-29, November 1964.

DAS M(05) M589.

A report is given of some studies carried out in the Kol'skii Bay to determine the feasibility of reducing the risk of steam type fog using monomolecular films to reduce evaporation. By reducing the evaporation it would be expected that the water vapor content of the fog would be reduced. A theoretical discussion is given on the expected improvement of visibility by such a reduction in water content. It is pointed out that the conditions which give rise to "steam" fog, i.e., calm waters and light winds, are ideal for the use of chemical films and that the period for which the steam fog risk exists is limited. Most of the earlier estimates of the efficiency of chemical films in reducing evaporation have referred to high temperature conditions. Some results of new experiments carried out with water temperatures close to 0°C are reported. These show that the reduction is still effective at these temperatures and the conclusion is reached that the use of chemical films to reduce the risk of steam type of fog should be a practical proposition. -MGA 16.7-227.

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80. Rowland, S. Clark; Layton, Richard G.; Smith, David R. Photolytic activation of silver iodide in the nucleation of ice. Journal of Atmospheric Sciences, Boston, 21(6): 698-700, November 1964.

DAS M(05) A512j.

Clean, single crystals of silver iodide have been found to serve as a very poor nucleating agent for ice. The controlled introduction of impurities on the crystal surface by means of photolytic decomposition has been shown to greatly increase its nucleating ability. - Authors' abstract.

81. Simpson, R.H. and Malkus, Joanne S. Experiments in hurricane modification. Scientific American, N. Y., 211(6): 27-37, December 1964.

Vita, p. 20. DAS P.

Reports attempts to interfere in a critical area with the delicately balanced forces that sustain a mature hurricane. It involves seeding a certain cluster of clouds near the eye of the storm to release the latent heat energy of the clouds. Two experiments yielded interesting and useful results. Information is given on the eye of hurricane "Esther," radial pressure gradient, hurricane "Beulah" when seeded and after seeding and wind-speed curves are shown. Radar images and photographs illustrate the discussion. - MGA 16.7-225.

82. Simpson, R.H. and Malkus, Joanne S. Hurricane modification: progress and prospects, 1964: Report to U. S. Weather Bureau, Advisory Panel Project Stormfury and N.A.S.A. (Grant NsG481 to the University of California) Office of Naval Research (Contract no. 4071 with the Woods Hole Oceanographic Institution). August 1964. 53 pp. DAS M15.2 U587hm.

This report appears to be a general discussion of the nature of hurricanes and typhoons and of their destructiveness followed by a description of past experiments in hurricane modification beginning with Shaefer's (1946) experiment with dry ice and Project Cirrus. The authors state that as a result of the Weather Bureau Project, the hurricane is undoubtedly the most intimately exposed and best understood class of atmospheric circulations. The physical basis of the current hurricane experiments, the Stormfury hypothesis and the experiment on hurricane "Beulah" are discussed and illustrated. The results of the Aug. 24, 1963 seeding of "Beulah" are described and presented in charts. The authors stress that "it is of highest priority to determine the amount of supercooled water and the role of freezing in the unmodified situation, for upon this the course and prognosis of hurricane modification largely depends." Other potential approaches to hurricane modification including - numerical models, possible inhibition of the oceanic heat and moisture source and possible alteration of radiative processes in the high troposphere are considered. In conclusion the authors state interalia that the current Stormfury hypothesis is still hopeful,

but even if it is not successful in leading to practical modification, testing it has already added to hurricane knowledge and has suggested other experiments and alternative hypotheses. - MGA 16.8-233.

83. Sulakvelidze, G.K. and others. Metodika vozdelstviia na gradovye protsessy i resul'taty polevykh opytov. (Methods of controlling the hail processes and results of field experiments.) Vsesoiuznoe Nauchnoe Soveshchanie po aktivnym vozdelstviiam na gradovye protsessy, Tiflis, 1962, Trudy. Tiflis, 1964. pp. 256-261.

DLC QC929.HIV9 1962.

The effectiveness of hail control experiments carried out by the High-Mountain Geophysical Institute in Nalchik since 1961, is outlined. - WMSU.

84. Takeda, K. An evidence of effects of dry-ice seeding on artificial precipitation. Journal of Applied Meteorology, Boston, 3(1):111, February 1964. DAS M(05) J86joa.

Reports evidence of effects of dry ice seeding of a widespread cloud system from an aircraft. Six experiments were conducted March 8, 1963 at Hitoyoshi, Kyushu, Japan. The idea was to seed the clouds in a unique pattern and then to look for a corresponding pattern in the precipitation. In each case a precipitation pattern corresponding to the wind distorted seeding pattern was observed between 20 and 30 min later at a position downstream from the area seeded. - MGA 16.3-168.

85. U. S. National Science Foundation. Weather modification. Fifth Annual Report for fiscal year ended June 30, 1963. Washington, D. C., U. S. Government Printing Office, 1964. 40 pp. (NSF 64-19). DAS M09.67 U585we 1962/63.

The Fifth Annual Report on Weather Modification submitted to the Congress, describes the weather modification programs of the National Science Foundation, that of other Federal Government agencies, and non-federal weather modification activities. Appendixes provide names and identification of advisory panels and committees, listings of weather modification programs founded by the Federal Government for FY 1963, and a discussion of the physics of precipitation and its significance. - MGA 16.10-216.

86. Vernidub, I.I. and others. Sredstva vvedeniia reagentov v oblaka s ispol'zovaniem aviatsii. (Methods of reagent dispersion in clouds using aircraft.) Vsesoiuznoe Nauchnoe Soveshchanie po aktivnym vozdeistviiam na gradovye protsessy, Tiflis, 1962, Trudy. Tiflis, 1964. pp. 182-192. DLC QC929.HLV9 1962.

Various seeding techniques are outlined and the effectiveness of the seeding method patented by the authors (Soviet patent no. 134166) is discussed. - WMSU.

87. Vsesoiuznoe Nauchnoe Soveshchanie po Aktivnym vozdeietviiam na Gradovye Protsessy, Tiflis, Dec. 3-7, 1962, Trudy. (Transaction of the All-Union Scientific Conference on Active Modification of Hail Processes, Tiflis, Dec. 3-7, 1962) Tiflis, Institut Nauchno-Technicheskoi Informatsii i Propagandy, 1964. 345 pp. At head of title page: Institut Geofiziki AN Gruzinskoi SSR.

All important institutions of the Soviet Union engaged in hail control research activities were represented at the Conference; thus the 28 papers included in these proceeding provide excellent coverage of recent theoretical and experimental progress made in the U.S.S.R. on hail control as of 1962. More than 1/3 of the papers deal with hail control operations conducted in Georgia, in the Alazan Valley; the others deal with theoretical aspects of cloud microphysics and convective processes, effectiveness of various seeding techniques, observation of cloud evolution with radar, evaluation of seeding effectiveness, etc. - MGA 17.11-39.

88. Wyoming. University. Natural Resources Research Institute. Summary report cons Weather modification research. Its Information Circular, No. 26, April 1964. 21 pp. DAS M(051) W992in no. 26.

This report summarizes the work accomplished between Feb. 1963 and April 1964 in field studies of cap clouds. The current status of weather modification and the characteristics and experimental potentialities of cap clouds are discussed. Elk Mountain and the radar and the silver iodide seeding installations used in the experiments are described and shown in photographs and topographic maps. The results of field experiments conducted on seven days during Jan., Feb. and March 1964 are summarized in a table. The somewhat unexpected development of "white cells" is discussed and shown in four photographs. It is concluded that Elk Mountain's winter-time cap clouds consist of small supercooled water drops which do not naturally precipitate; can be induced by silver-iodide seeding to produce significant amounts of snowfall; and provide an exceptionally suitable opportunity for experimentally establishing definite quantitative relationships between the degrees and kinds of seeding and the amount of snowfall which can be produced from these and similar kinds of cap clouds. - MGA 17.8-215.

89. Zarea, St.; Diaconescu, Gh. I.; Căpuz, C. Problema insămințarii norilor și ceții in tara noastră. (Question of cloud and fog seeding in Rumania.) Rumania. Institutul Meteorologic, Bucharest, Culegere de Lucrări, 1962. Bucharest, 1964. pp. 199-208. Rumanian summary pp. 199-200; Russian and English summaries pp. 207-208. DAS M R936cu 1962.

Presents the analysis of 66 experiments on artificial stimulation of precipitation and fog dissipation with AgI carried out in Rumania during 1959-1962. The experiments were meant to verify the seeding technique (in view of establishing the minimum and optimum quantities of AgI required for acting upon clouds and fog from ground and by means of balloons), to set off the

favorable atmospheric conditions for the carrying out of these experiments and to ascertain the influence exerted by local factors. Experiments were performed on some isolated cumuliform clouds, on some cloud systems, as well as on fog, both in the plains (at the Baneasa Met. Obs.) and in the mountainous region (the Bucegi Mts.) in different seasons. The seedings were carried out at the soil surface, on mountain peaks (Omu, Postavaru and Caraiman), or with meteorological balloons, and consisted of volatilizing AgI by dint of smokeless powder. The correlation existing between the macrophysical conditions, the cloud type and the seeding results was established. The positive results of the experiments have been more obvious and conclusive in the case of isolated cumulonimbus clouds. The most significant experiment took place on Aug. 9, 1961 when it rained nowhere in Rumania but in the experimentation area. In cases of nephsystems, positive results were obtained with cold fronts and in the mountainous region, where the orographic element played a certain part. The fog dissipation experiments were carried out during the winter season and resulted in bettering visibility conditions at the Baneasa Airport. The experiments on the stimulation of precipitation and fog dissipation was in the nature of preparatory research for future organized and systematic activity. - MGA 16.11-182.

1965

90. Admirat, P. Contrôle de l'enrichissement de l'air en noyaux glaçogènes au-dessus de réseaux de générateurs terrestres d'iodure d'argent.

(Monitoring the enrichment of the air with ice nuclei over a ground based network of silver iodide generators.) Journal de Recherches Atmosphériques, Clermont-Ferrand, No. 4: 169-172, October - December 1965. DAS M(05) J86jor.

The author presents the results of observations made in order to determine the efficiency of AgI seeding from ground based generators. Measurement of the modifications of the ice forming power of air was performed both at the surface and aloft near the base of the clouds. It appeared clearly that the ground based network of AgI generators could not enrich the air with ice nuclei in a sensible, homogeneous and permanent manner. Under these conditions artificial modification of hail clouds cannot be expected, but the author suggests further investigation to determine the causes of AgI nuclei de-activation, and the use of coarser nuclei to increase the efficiency of ground-based seeding operations. - MGA 18.2-323.

91. Armagnac, Alden P. The weather: now we can do something about it.
Popular Science, New York, March 1965. pp. 80-84, 206. DAS M09.6
A727we.

Grand-scale plans are in the works for regional and global weather modification. Cloud seeding and artificial electrical charges are methods now used. Spreading lampblack over a polar ice cap, coating an ocean with an evaporation-preventing film, blanketing the Arctic with a vast artificial cloud and diverting ocean

currents are some of the suggestions being considered for altering the weather.

92. Atlas, David. Activities in radar meteorology, cloud physics, and weather modification in the Soviet Union (June 1965). American Meteorological Society, Bulletin, 46(11): 696-706, November 1965.

DAS M(05) A512b 46: 1965.

Report describing some of the activities in the fields of radar meteorology, cloud physics and weather modification in the U.S.S.R. based on discussion with a number of Soviet scientists and visits to 3 research establishments. The visit to the U.S.S.R. was primarily in connection with the International Colloquium on the Fine Scale Structure of the Atmosphere. Information is given on studies of angels, quantitative precipitation measurements by radar, radar calibration, polarization studies, doppler studies, hailstorm identification, cloud detection, weather modification, atmospheric electricity, etc. - MGA 17.3-67.

93. Bashkirova, G. M. and Pershina, T.A. O kharaktere zamerzaniia kapel' vodnykh rastvorov iodistogo svintsa. (Characteristics of the freezing of drops of aqueous solutions of lead iodide.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 176: 35-42, 1965. Russian summary p. 35. DAS M(055) U581tg.

The experimental procedure for investigating the process of freezing of droplets of a saturated solution of PbI2 is described and the results of freezing at temperatures of -9° to -19°C and also the results of freezing of drops in unsaturated PbI2 solution are presented. The freezing of drops of a saturated solution of PbI2 begins from within because of the recrystallization of particles of dissolved substance during cooling in the case of a relatively small degree of supercooling. The freezing of drops of a saturated PbI2 solution proceeds usually without explosion when the drops are blown intensely and for a long time. When the droplets are cooled rapidly they either divide in half or crevices form on their surface. When the drops freeze PbI2 particles are extracted from the surface. Particles of PbI2, can fly out from the drops when they freeze. - MGA 16.9-268.

94. Bashkirova, G.M. and Pershina, T.A. <u>O kristallizatsii pereokhlazhdennykh tumanov pri raspylenii v nikh nasyshchennogo rastvora iodistogo svintsa.</u> (Crystallization of supercooled fog by seeding saturated lead iodide solution.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 176: 43-50, 1965. Russian summary p. 43. DAS M(055) U581tg.

The authors describe the three series of experiments carried out in a small cold chamber in order to determine the process of crystallization of a supercooled water droplet fog when it is

seeded with drops of a saturated solution of PbI₂. The experiments involved the dispersion of a saturated PbI₂ solution at a temperature range of -13° to -24°C for the determination of—the form and dimensions of ice crystals formed; of ice crystals in a cold chamber in the absence of solution droplets; and the characteristics of crystals formed only as a result of sublimation of water vapor on condensation nuclei arriving during the introduction of PbI₂ drops into the chamber. It is shown that during the dispersion of saturated PbI₂ solution into supercooled fog formed in small cold chambers, ice crystals form a submicroscopic PbI₂ crystals ejected from the surface layer of drops of solution as they freeze.

MGA 16.8-168.

95. Battan, Louis J. Comments on "Note on the Potentialities of Cumulonimbus and Hurricane Seeding Experiments." Reply by Joanne Malkus Simpson and R.H. Simpson. Journal of Applied Meteorology, Boston, 4(3): 426-429, June 1965. DAS M(05) J86joa.

Battan notes that Malkus and Simpson should be commended for devoting their considerable talents to such a difficult but vitally important subject as cloud and weather modification. He points out that there are important uncertainties about the following aspects of the convective cloud study: the rate at which latent heat is released by natural processes; the concentration of active AgI ice nuclei at the critical temperatures between -4 and -7°C; the temperature and moisture structure of the atmosphere in the immediate vicinity of the test clouds; entrainment rates; and the quantity of retained liquid water in the clouds. In reply Malkus and Simpson suggest that the criticisms appear to be based partially on semantics and partially upon differing viewpoints on important aspects of cloud physics and dynamics. They encourage Battan and others with similar viewpoints to undertake Cu experiments like those made by "Stormfury" in any and all suitable areas. - MGA 18.3-264.

96. Battan, Louis J. A view of cloud physics and weather modification in the Soviet Union. American Meteorological Society, Bulletin, 46(6): 309-316, June 1965. DAS M(05) A512b.

This report deals only with the activity in the areas of cloud physics, weather modification and radar meteorology. Eight centers involved in such work in the Soviet Union were visited and brief summaries are given on their work. It is clear that Soviet scientists are concerned with the same cloud physics problems as those confronting the U. S. and indeed those in other parts of the world. Particularly impressive are the amount and scope of laboratory experiments. In view of the extensive program of translation and abstraction of foreign literature in the Soviet Union, it is relatively easy for Russian scientists to keep abreast of developments outside the Soviet Union and consequently to benefit from the work of others. A very ambitious program of weather modification is in progress. - MGA 17.7-366.

97. Beckwith, W. Boynton. Supercooled fog dispersal for airport operations. American Meteorological Society, Bulletin, 46(6): 323-327, June 1965. DAS M(05) A512b.

The capability of dissipating supercooled fogs by aircraft seeding has been recognized since Schaefer experimented in 1946. Except for some localized application of this weather control and some side effects of research aimed at precipitation increase, no organized program of airport weather improvement was established in the United States until 1963. Seeding of supercooled fogs by dry ice was organized during two winters for the purpose of increasing airline schedule reliability at airports subjected to this cold fog. Better than 80 per cent success was attained by this method, resulting in the operation of approximately 200 scheduled flights which would otherwise have been canceled. Typical examples of visibility improvement after less than an hour of seeding are illustrated. The direct benefits resulting from these programs outweigh the costs significantly and suggest that similar fog dispersal operations should be expanded to other areas of the United States which are subjected to supercooled fogs. - Author's abstract.

98. Bortell, P. and Hicks, J. Whiteout modification experiments using ground based systems. U. S. Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, Special Report 85, October 1965. 18 pp. DAS M(055) U586sp.

This report summarizes the research on whiteout dissipation systems carried out during the summer of 1964. The contents of the report consist of the following, viz.: a brief discussion of whiteout modification theory; a description of the procedure employed at Camp Century, Greenland; evaluation of the CRICKET (Cold Rocket Instrument Carrying Kit) system; evaluation of the solid-fuel rocket system; seeding experiments (propane, dry ice); rocket tracking procedure; and seeding experiment data sheets. It is recommended that in future operations of this type vehicles used in seeding tests be equipped with radio direction finders. - MGA 17.9-194.

99. Bouchet, R.J. Problèmes des gelées de printemps. (Problems of spring frost.) Agricultural Meteorology, Amsterdam, 2(3): 167-195, June 1965. English and French summaries pp. 167-168. DAS M(05) A278agr.

The problem of spring frost is studied schematically as to its physical or meteorological and biological aspects. The effects of frost, like relief, tillage or the vegetation coverage, are specified. Climatic prospection, by means of actinothermic data, is emphasized. In the investigation of biological data, independent of the role of the vegetation stage, the influence of dynamics of fall in temperature on the resistance of vegetation is accentuated. The study of the thermal balance in a zone which is protected against frost, permits the definition of the

means which should be employed to ensure protection. The principle, the effectiveness, the possible improvements of the active and passive fighting methods are studied. Heating and sprinkling appear to be the most valuable solutions, while smoke draws are certainly not advised in their present form. The fight against frost appears to be possible on rich cultures, despite heavy hindrances. The passive methods, being relatively less expensive, enlarge the efficiency and yield to the fight.

- MGA 17.2-147.

In: International Conference on Cloud Physics, Tokyo and Sappore, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 429-433.

DAS M74.1 I61p.

During the last 10 yrs there have been 6 cloud seeding experiments in which: a) AgI burners from aircraft were used; b) the seeding schedule was randomized; c) the intention was to discover the possible increase in precipitation which occurred over an extended area and d) the experiments lasted for more than 3 yrs. The results of these experiments were all inconclusive. This paper makes a post-hoc study of these experiments with the aim of arriving at alternative hypotheses which might be tested and to determine how future experiments should be designed. The analysis is conducted under 2 main headings. First the variation of the apparent result with time. The experiments tend to indicate that the effect of the seeding reduces with time, over a scale of years. This could be due to the statistical effect of the serial correlation of daily rainfall, to the persistence of AgI in the test area, or simply to the physical effects of the rain itself in producing a greater availability of moisture. The second consideration is that seeding may either increase or decrease precipitation. The cloud top temperature, when seeding commences, may have a crucial bearing on the total amount of rain that falls. Further there may be a change in the variance between the test area and the one used for comparison. Future Australian tests will be of 2 kinds. The first is a 3-area experiment in which I seeded area is flanked by 2 control areas. The central area is seeded or not seeded on a random basis. The second type will be a 4-area experiment in which 2 seeded areas are flanked by 2 control areas and the seeding areas seeded according to a random sequence. - MGA 17.6-161.

lol. Braham, Roscoe R., Jr. Project Whitetop, April 4, 1964 to April 3, 1965.
Chicago. University. Cloud Physics Laboratory, Grant NSF G-22419,
Final Report, October 25, 1965. 25 pp. DAS M74.1 B813p final.

Project Whitetop is concerned with research on basis and applied rain physics and weather modification, in particular the possible modification of precipitation processes in summer convective clouds of southern Missouri and the mechanism of warm air formation. This report consists of the following, viz: a summary of the 1964

Project Whitetop operation; a summary of Project Whitetop analysis activities—including statistical analysis of ground level echo cover data, the study of "plume rotation," etc.; a detailed presentation of the results of a 5-yr randomized cloud seeding study; and the use of urea in cloud seeding. The results of the seeding indicate that the amount of echo at ground level was increased by seeding for the region between seeding line and radar. This is supported by analysis of the rainfall data. "The fact that plume areas overlap both the positive and negative areas could account for the inconclusive nature of the statistical tests involving the plume and nonplume." Negative echo anomalies are apparently a result of seeding. Finally, urea was found to be an effective nucleant. - MGA 17.7-193.

102. Businger, J.A. Frost protection with irrigation. Meteorological Monographs, Boston, 6(28): 74-80, July 1965. DAS M(055) A512m v.6 no. 28.

The problem of frost protection is formulated by considering the energy budget of a typical horizontal leaf and of a spherical fruit. The energy that is transferred by radiation, convection, and evaporation is considered. In particular, the effect of sprinkling on the energy budget is examined and conclusions are drawn on the intensity of sprinkling required to prevent frost damage. The theory is compared with some experimental results. The possibility of intermittent sprinkling, the value of irrigating the soil prior to frost, and the desirable size of water drops are also examined. - MGA 17.1-143.

103. Cachera, P. <u>Difference of silver iodide activity in natural and artificial clouds</u>. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, eMay 1965. pp. 419-423. DAS M74.1 I61p.

In cloud seeding experiments it is difficult to determine whether any effects are due to the seeding or would have occurred naturally. The seeding of St. cloud is one exception where differing effects in seeded and nonseeded areas are apparent. was thought that in a similar way the seeding of rotor clouds could be used to demonstrate obvious effects. An experiment in seeding rotor clouds at Mont Ventoux in the south of the Alps near the Rhone Valley is reported. The cloud was seeded first for 30-min periods from AgI generators on the ground. No effects were observed. A second series of experiments was then carried out in which either dry ice or AgI was released by aircraft flying below the cloud. In both cases obvious cases of precipitation and break up of the cloud during seeding were observed. In the case of dry ice sometimes overseeding occurred and the seeding agents were carried back up to produce effects at the rotor downwind. Experiments in 1964 in the seeding of convective clouds in the west of France could not be satisfactorily evaluated. Further research effort must attempt the season by season study

of the statistical distribution of precipitation due to the Bergeron procedure and on laboratory experiments on the efficiency of seeding agents. - MGA 17.6-162.

104. Cachera, Pierre and Mace, Pierre. Précipitation artificielle d'un orographiques stationnaire. (Artificial precipitation from a stationary orographic clouds.) Académie des Sciences, Paris, Comptes Rendus, 260(26): 6959-6961. DAS P.

Description of the experiment of Feb. 15, 1965 during which, on account of very low temperatures, snow reaching the ground was induced by AgI seeding under stationary regime conditions. The authors proceed to a synoptic analysis of the weather characteristics on that day and comment on the procedure of the experiment. The satisfactory results that they achieved point to the stationary orographic clouds as "laboratory clouds" serving to test materials used in view of obtaining artificial precipitation. The ice-forming properties of AgI introduced directly in a very low temperature zone of a natural cloud are demonstrated. - MGA 17.4-146.

105. Crawford, Todd V. Frost protection with wind machines and heaters.

Meteorological Monographs, Boston, 6(28): 81-87, July 1965. DAS

M(055) A512m v.6 no. 28.

Discusses the principles of frost protection by heaters and wind machines, predicts the protection obtainable under different conditions and discusses combinations of heat and wind machines. Vertical cross sections of temperature responses produced by operating wind machines with and without heaters are shown.

- MGA 17.4-144.

106. Crozier, C. L. and Helland, J. D. Cloud seeding to influence rainfall:

its importance and present status. Canada. Meteorological Branch,
Circular 4337; TEC. 587, December 1, 1965. 40 pp. DAS M(06) C212c.

The present state of knowledge with respect to the effect of cloud seeding as a means of influencing rainfall is surveyed, with particular reference to Canada and Canadian conditions. The importance of water to the national economy and the advantages which would result from its control in the atmosphere are reviewed. The problems of cloud seeding and of the assessment cloud seeding experiments are presented, along with known theories of precipitation formation and their modification. The report concludes with a brief resume of cloud seeding experiments in several countries and an outlook for the future. - Authors' abstract.

107. Davis, L. G.; Booker, D. R.; Hosler, C. L. Observations of natural and artificial alteration of cumulus buoyancy. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 20-24. DAS M74.1 I61p.

A summary is given of some of the results of investigations carried out over the past few years in central Pennsylvania in which the

effects of topographical irregularities on cloud structures have been studied. The primary studies have consisted of radar observations of cloud echoes and balloon observations of environmental airflow. Aircraft observations have also been made. Mountain wave phenomena are familiar in the area; both the terrain and the general airstream are favorable. Topographic disturbances do occur repeatedly in particular areas. The small changes in buoyancy caused by mountain wave effects are important in the life cycle of clouds. A schematic diagram is used to illustrate these effects. Other terrain influences have been studied. When the circulation is strong air motions over ridges predominate. When circulation is weak thermal patterns generated by differential surface heating becomes more important. Cloud observations after seeding with CO2 pellets have been made. Rapid growth in the echo areas have been noted after seeding. Cloud changes take place with the release of latent heat and changes in buoyancy. These effects are also illustrated diagrammatically. More detailed studies of the effects of seeding are required for a fuller understanding. A current experiment is studying the belief that the release of latent heat by artificially glaciating the supercooled portion of the clouds would produce enough buoyancy to offset the loss of buoyancy in areas of subsiding motion caused by wave effects. Two aircraft are used in this experiment, one seeds the top of the cloud while the second makes runs at a lower level through the cloud before and after seeding to study any effects. - MGA 17.5-287.

108. DeBoer, H.J. Comparison of water vapour, water and water drops of various sizes, as means of preventing night frost. Agricultural Meteorology, Amsterdam, 2(4): 247-258, August 1965. DAS M(05) A278agr.

The problem of closing the atmospheric window by means of water drops in order to prevent night frost has been theoretically solved. Water spheres with radii of 7.5 up to 8.5 μ would appear to serve the purpose very well. An artificial cloud is required with 8.2 • 105 water-drops of that size in a vertical column with a cross-sectional area of 1 cm 2. Far less than 1 per cent of the long-wave radiation from the earth's surface is transmitted unhampered to outer space by a cloud of this kind. - Author's abstract.

109. Dessens, H. <u>Un Centre International de Physique des Nuages à Cuba</u>, (International Center for Cloud Physics in Cuba.) Journal de Recherches Atmosphériques, Clermont-Ferrand, No. 4: 173-174, October - December 1965. DAS M(05) J86jor.

Fidel Castro suggested to the Cuban Acad. of Sc. that it develop cloud physics research for increasing the precipitation amount for agricultural purposes. In Jan. 1966 the Academy invited the author and Soviet specialists to work on cloud modification in Cuba. Soviet meteorologists favored dry ice seeding in supercooled clouds by aircraft or shooting a bullet of PbI into a

moment of cloud insemination, the author suggested permanent seeding. Thus, a permanent generator of AgI was installed in Mimizan (Landes) with very good results. A meteotron was constructed in Jan. 1966 using liquid fuel fed by compression. It was decided to construct 2 AgI generators on the southern and northern shores of Cuba, and assess the results after a year of operation. Meantime, Cuba may become an international center of experiment meteorology, and the black sands of certain Cuban zones may serve as natural solar meteotrons. - MGA 17.10-215.

110. Dessens, Henri. Pourrons-nous modifier les climats? (Can we change the climate?) Monte Carlo, Monaco, Éditions du Cap, 1965. 99pp. (Diagrammes No. 100) Note: pp. 65-96, headed Actualité Scientifique, has no relation to above title of this monograph. DAS MO9.61 D475p.

In this popular booklet the author who has been a foremost proponent of cloud physics and weather modification in France for well over a decade, gives a concise summary of the history of weather modification, its scientific bases, the various means of achieving it and the different effects which can be achieved (small and large scale rainfall, snow, fog dispersal, air pollution control, hail prevention, tornado, hurricane, lightning and fire control). In addition to reviewing the effects of different cloud seeding techniques and the problem of evaluating such effects, the author describes the meteotron developed at his Centre de Recherches Atmosphériques on the Lannemezan Plateau. The meteotron is an assembly of 100 fuel oil burners producing convective currents and clouds, which can also be seeded. Preliminary results achieved with this method are indicated and other means of producing artificial convection by overheating of surfaces are discussed. Extravagant schemes which have been advanced for large scale modification of climate (creation of lakes in the Sahara, damming of the Bering Strait) are dismissed as impractical for the present and of doubtful value. While maintaining the necessity for further laboratory and field experimentation in cloud physics, the author also issued an urgent plea for consideration-and support, if justified-of any original idea which might contribute to the development of new weather modification techniques. - MGA 17.3-29.

Dubesset, G. Recherche d'une éventuelle influence des ensemencements sur le régime des pluies. (Study of a possible influence of seeding on rainfall regime.) Journal de Recherches Atmosphériques, Clermont-Ferrand, No.3: 97-98, July - September 1965. DAS M(05) J86jor.

The relative excess of rain during the seeding campaigns against hail from 1959-1965 in France from April-Sept. amounted to 51, 16, 15, 18, 17, 18, and 18 per cent, resp. It seems more and more that the abundant seedings in summer influence the rain regime in France. This fact led the author in March 1965 to risk a forecast of the relative rain distribution in France for the period April-Sept. 1965, establishing the mean chart of rain distribution for the

years 1959-64. The fictitious chart and the real chart are compared; they show a distinct resemblance. Sixteen stations received an excess of rain out of 24 stations where an excess was forecast and 12 stations showed an excess where it was not forecast. The actual region of relative excess was only somewhat shifted to the northeast in comparison to the fictitious region; this might be due to upper air winds. - MGA 17.10-216.

112. Dubois, E. Fog dispersal on runway approaches. Weather, London, 20(10): 313-315, October 1965. DAS M(05) R888w.

With the support of the Aeroport de Paris, Bertin and Co. has been conducting experiments in the use of jet engines to improve visibility on approaches to runways in fog. The heat and kinetic energy of jet engines is used to vaporize fog droplets. A blast of hot air is directed along the ground in front of the landing strips; it mixes with the ambient air, and lifts the fog near the end of the runway. Photographs taken at Melun Villaroche in March 1962 are reproduced here to illustrate the effectiveness of the method. In this experiment 15 jet engines were used to clear the region slightly above and beyond the downwind end of the runway. Three further jets were used to clear a shallow layer where the aircraft touches down. Initially the visibility was 100 yds, but the jets soon produced an improvement to 750 yds and the end of the runway could be seen from a point 240 ft above the ground.

- MGA 17.2-148.

113. Elliott, Robert D. Summary report on weather modification. By the Irrigation and Drainage Research Conference Panel no. 5, Robert D. Elliott, Chairman. American Meteorological Society, Bulletin, 46(6): 317-319, June 1965. "Extracted from complete report in American Society of Civil Engineers, Irrigation and Drainage Division, Journal, 90(4): 73-84, December 1964." DAS M(05) A512b.

Following introductory remarks, information is given on the present status of knowledge and practice and research needs. Consideration is given to economic aspects of cloud seeding to increase water supply and to legal and sociological aspects of weather modification. It is indicated that increased research efforts are needed in the following areas: physical properties of ice and ice-forming process in laboratory and field; natural and artificial ice-forming nuclei, and seeding techniques; electrification in weather modification; tracing techniques for cloud seeding; mesoscale structure and its role in weather modification; and winter seeding in mountain areas. - MGA 17.7-188.

114. Florida. Citrus Commission. Two days in December: a report on the Florida freeze of 1962. cl965? 93pp. DAS M24.37 F636tw.

This very costly and extravagantly printed and illustrated book is a report on the Dec. 12/13, 1962 freeze which caused the greatest loss in the entire history of Florida's agriculture. Seven of the 8 parts of this book are devoted to the effects of the freeze on by-products, on canning, on the fruit juice concentrate industry, and the like. Pt. 1 (constituting 3/4 of the

report) deals mainly with the horticultural aspects but contains also a paper on the weather in which the synoptic situation that resulted in the freeze is described and shown in a series of charts and tables. Recorded temperature minima, durations of critical temperatures, and related information is shown on maps (too small to read without magnification). Historic freezes in Florida are listed and the corresponding lowest temperatures are tabulated. Another short paper discusses the effectiveness of heaters, wind machines, and of sprinkler irrigation. With a sufficient number of heaters, heating is most effective. Wind machines failed to give protection during the windy night of Dec. 12 and morning of Dec. 13. Irrigation is fraught with dangers due to increase damage when the protection is not complete. — MGA 17.7-76.

115. Fukuta, N. Activated ice nucleation by sprayed organic solutions.

Journal of the Atmospheric Sciences, Boston, 22(2): 207-211,

March 1965. DAS M(05) A512j.

The ice-nucleating ability of certain organic materials may be further enhanced by spraying solutions of these materials in suitable organic solvents. By utilizing the evaporate cooling of the solvent, ice nucleation in clouds may be activated at temperatures approaching OC. The factors governing the suitability of various solvents are discussed. It is found that immiscibility with water is a desirable property. - Author's abstract.

116. Fukuta, Norihiko. Generation of metaldehyde smoke. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 405-409. DAS M74.1 I61p.

Various methods of fine particle generation are discussed and the properties of the particles obtained by the most promising method are described. The methods fall into 2 categories, dispersion methods, in which a substance of larger size is split into smaller particles and condensation methods in which smoke particles are produced by condensation or deposition from the vapor phase. Several dispersion methods were tried but there seems little hope that such methods could produce > 1010 particles/gm of metaldehyde (CH3CHO)1. The best method found was a condensation method in which hot vapor laden air was allowed to pass through an orifice and mix with atmospheric air. In the jet-cooling method, cooling is relatively gentle at first. Particles start to form at reasonably large separations and because they are unable to abstract much vapor, supersaturation persists and more particles are formed. Strong turbulent mixing of air into the jet reduces the rate of coagulation. A simple generator of this type was built and tested. In field work a mechanism for the continuous supply of (CH3CHO) pellets is required. - MGA 17.6-164.

117. Gabriel, K.R. Artificial rainfall stimulation experiment in Israel - some interim results. In: International Conference on Cloud

Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings Supplement. Tokyo, October 1965, pp. 163-166. DAS M74.1 I61p suppl.

At the end of three and a half seasons of experimental randomized cloud seeding in Israel, the amount of rainfall under seeding is found to have been about 18 per cent more than without seeding, a result whose significance is about 10 per cent. The experiment is continuing. - Author's abstract.

118. Gabriel, K.R. Expérience de pluie provoquée en Israël: quelques résultats partiels. (Artificial rain experiment in Israel: some partial results.) Journal de Recherches Atmosphériques, Toulouse, No. 1: 1-5, January - March 1965. French and English summaries pp. 1-2. DAS M(05) J86jor 2: 1965.

A randomized experiment of artificial rainfall stimulation has been carried out in Israel during the last three and a half rainy seasons. The experiment uses a cross-over design to compare rainfall amounts in the North and Centre of Israel, each day being randomly allocated for cloud seeding with silver iodide either in the North or the Centre, the other area serving as control.

The amount of rainfall under seeding is found to have been about 18 per cent more than without seeding. This result is significant at about the 10 per cent level. Detailed analyses suggest that the difference in rainfall due to seeding is particularly marked in marginal rainfall conditions, i.e., when there is little or no natural rainfall. The experiment is continuing. - Author's abstract.

119. Gaivoronskii, I.I. and Seregin, Iu. A. Ovvedenii reagentov v oblaka pri vozdeitvii na gradovye protsessy. (Introducing reagents into clouds during modification of hailstorm processes.) U.S.S.R.

Tsentral'naia Aerologicheskaia Observatoriia, Moscow, Trudy, No. 65: h8-66, 1965. Russian summary p.h8. DAS M(055) U581tt. Translated into English as U. S. Joint Publications Research Service, JPRS no. 37,551, September 13, 1966. DAS M(055) U581ttE no. 65.

This study on the optimum requirements of the means for introducing reagents into clouds in order to influence hail formation includes the following, viz: the physical basis of influencing hail processes and of effective methods of introducing reagents; a description of the structure and operation of the new antihail rocket "Oblako" developed in the U.S.S.R. and the principal results of the use. A table summarizing the results of the experiments with this rocket, which proved to be very effective in hail prevention; is presented. - MGA 17.6-166.

120. Gaivoronskii, I.I.; Leskov, B.N.; Seregin, Iu. A. Opyt reguliarnogo primeneniia metodov iskusstvennogo rasseianiia pereokhlazhdennykh oblakov i tumanov nad aerodromami. (Attempt at routine operations

of artificial dispersal of supercooled clouds and fogs over airfields.) U.S.S.R. Tsentral'naia Aerologicheskaia Observatoriia, Moscow, Trudy, No. 65: 3-8, 1965. Russian summary p. 3. DAS M(055) U581tt. Translated into English as U. S. Joint Publications Research Service, JPRS no. 37,551, September 13, 1966. DAS M(055) U581ttE no. 65.

The authors summarize the results of seeding of fogs and clouds over airports from the ground and air carried out in 1963 at Alma-Ata, Frunze, and Dzhambul. Solid carbon dioxide was used in seeding. The seeding procedure is described and the results and their economic effectiveness are discussed. In all 14 cases of seeding of fogs and low level clouds positive results were obtained. The authors discussed also the results of aircraft and ground seeding at Vnukovo: the effectiveness of these procedures is confirmed. - MGA 17.7-191.

121. Gaivoronskii, I.I. and Morachevskii, V.G. Soveshchanie po aktivnym vozdeistviiam na oblaka i tumany. (Conference on Cloud and Fog Modification.) Akademiia Nauk SSSR, Izvestiia, Fizika Atmosfery i Okeana, 1(7): 774-777, July 1965. DAS P. Translated into English in corresponding issue of its Izvestiya. Atmospheric and Oceanic Physics, issued Washington, D. C. DAS P.

The Conference on Cloud and Fog Modification held during Feb. 23-26, 1964 at the Principal Directorate of the Soviet Hydrometeorological Service dealt with problems of hail prevention, increase in precipitation, dissipation of clouds and stratus fogs, and cloud physics. Brief summaries of the important papers delivered at the Conference are presented. - MGA 17.3-177.

122. Gilman, Donald L.; Hibbs, James R.; Laskin, Paul. Weather and climate modification: a report to the Chief, United States Weather Bureau.

- Washington, D. C., Weather Bureau, July 10, 1965. 41 pp. DAS

M09.6 U587we.

A thorough review of the status and future prospects for modification of the weather, based on 19 yrs of research and activities along these lines by U. S. Weather Bureau and other scientists. The scientific aspects (heat and water vapor supply, clouds and precipitation, electrical balance, wind and windstorms) and research aspects; the social and economic aspects; the research activities; and the legal aspects are discussed in full in the 4 chapters. A 5-page bibliography is appended. The purpose of the retrospective review is to assess the prospects for future scientific progress or economic benefits along several lines—not only cloud seeding to produce rain or water supply, but hurricane or hail suppression, climate modification, etc.—and to indicate the kinds of programs needed. — MGA 16.9-35.

123. Godson, W.L.; Crozier, C.L.; Holland, J.D. <u>Cloud seeding evaluation</u>, <u>1959-1963: Precipitation Physics Project</u>. Canada. Meteorological Branch, Circular 4322; TEC-586, October 29, 1965. 22pp. DAS M(06) C212c.

During the period 1959-1963, a precipitation physics project aimed at discovering basic relationships in the chain of cause and effect in precipitation mechanisms was operated in the Laurentian Upland area of western Quebec province in Canada. As one method of study, randomized cloud seeding of synoptic scale weather systems was employed using a cross-over technique over two separated test areas. On suitable test occasions, silver iodide smoke was released from an aircraft into clouds which would pass over one of the test areas, chosen by a random selection, while the other area was kept free of silver iodide as a control. Comparison of storm rainfall in the two test areas measured by a dense network of raingauges was used to evaluate the effect of cloud seeding. Statistical tests of the relationship of liquid water equivalent and instability with the seeding effect were also conducted.

A small negative seeding index was computed and a slight positive correlation was found between both liquid water equivalent and instability and the seeding index ratio. However, none of these relationships was found to be statistically significant. The results did show with 95 per cent confidence that for the storms seeded the effect on rainfall would not lie outside ± 22 per cent. - Authors' abstract.

124. Godson, W.L.; Crozier, C.L.; Holland, J. D. Silver iodide cloud seeding by aircraft in Western Quebec, Canada, 1959-63. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 424-420. DAS M74.1 161p.

Cloud seeding by aircraft using AgI was conducted in Western Quebec, Canada, from 1959 to 1963 as part of a precipitation physics project aimed at discovering basic relationships governing precipitation mechanisms. This paper presents the results of istatistical analysis of the effect of the cloud seeding on the measured rainfall. Analysis of the data on rainfall from 45 storms seeded indicates a slight negative effect from the seeding. However the probability of obtaining the same result by chance if the seeding had no effect is very high. Hence the result must be regarded as inconclusive. There is slight evidence of a relationship between the individual seeding index ratio of a storm and the instability of the air and also between the individual seeding index ratio and the precipitable water. However, the correlation coefficients are low. There was no indication of a relationship between the individual seeding index ratio and the duration of the seeding relative to the duration of the storm. - MGA 17.6-167.

125. Gokhale, Narayan R. Comparison of ice-nucleating efficiencies of chemical aerosols in a supercooled cloud and in bulk water. In:

International Conference on Cloud Physics, Tokyo and Sapporo,
May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 176-180.

DAS M74.1 I61p.

Reports observations, enabling the comparison of the ice-nucleating

abilities of different inorganic compounds like AgI and CuS in a super-cooled cloud and in bulk water. The compounds were introduced either as smoke or as fine dust into a mixing cloud chamber and in distilled water in bulk. In the cold chamber experiments the technique used was similar in principle to that described by Schaefer. In the bulk water experiments droplets were formed on a film of liquid parafin and cooled until they froze. The median freezing temperature being taken as that when half the drops were crystallized. Artificial aerosols of given concentrations were introduced into the drops before cooling. Using the same apparatus particles from an AgI generator were allowed to fall on to super-cooled drops of distilled water. The results are tabulated. The author shows that even high concentrations of aerosol does not freeze distilled water drops at warmer temperatures. The ice-nucleating ability of such particles is reduced considerably in bulk water. The study confirms that nuclei from an AgI burner are by far the most effective in any process. - MGA 17.5-155.

126. Gromova, T.N. and Krasikov, P.N. <u>Issledovaniia l'doobrazuiushchikh</u>
svoistv rastvorov iodistogo serebra i iodistogo svintsa. (Study of
ice-forming properties of silver iodide and lead iodide solutions.)
U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy,
No. 176: 25-34, 1965. Russian summary p.25. DAS M(055) U58ltg.

The results of laboratory experiments on the ice forming properties of water solutions of AgI and PbI2 when dispersed in supercooled clouds are presented. The experimental apparatus and procedure are described. Water solutions of PbI2 cause crystallization of supercooled fog at temperature of -5°C, -7°C and lower. The number of ice crystals formed depends upon the concentration of the solution. The optimum concentration for modification is 0.06 per cent; the formation of ice crystals per 1 g of PbI2 occurring at a temperature of -10°C is 10¹2 and at a temperature of -15°C it is 10¹3. Solutions of PbI2 produce a somewhat smaller number of ice crystals than colloidal solutions of AgI; but because of the delay and prolongation of the ice forming properties of PbI2 in comparison with those of AgI, the laboratory experiments with solutions of PbI2 were somewhat low. - MGA 16.9-269.

127. Henderson, Thomas J. Cloud seeding on the Kings River Watershed. Final Report on the 1963-1964 Operations with Review of Results for Water years 1955-1963. Submitted to Kings River Conservation District, Fresno, California by Atmospherics Incorporated, March 15, 1965.

36 pp. Das Mog.617 H486cl.

This report summarizes in some detail the operation of the weather modification program in the Kings River watershed in California during 1963-1964 season and presents the results of the evaluation of cloud seeding for the period 1955-1964. The basic operating equipment used in 1963-1964 was a network of silver iodide ground generators, a Piper Apache twin-engine aircraft, a complete mobile

radar system, a radio communications network and a number of basic research tools used both on the ground and aboard the aircraft. A number of pyrotechnic seeding devices were also used. The aircraft serves as a movable generator for the dispersal of silver iodide particles and dry ice pellets. The analysis of this program has produced positive results.

128. Henderson, Thomas J. Final report on cloud seeding in the County of Tulare, California, 1963-64 season. Submitted to Board of Supervisors, Tulare County by Atmospherics Incorporated. Fresno, California, March 1965. 23 pp. DAS M09.617 H496fi.

The operational summary and results, the general operations and the evaluation of the cloud seeding project in Tulare County, California for the 1963-64 season are recorded. Recommendations for future cloud seeding operations are presented.

129. Hicks, J.R. Experiments on the dissipation of warm fog by helicopter - induced air exchange over Thule AB, Greenland. U. S. Cold Region Research & Engineering Laboratory, Hanover, New Hampshire, Special Report 87. August 1965. 7 pp. DAS M(055) U586sp 87.

Three approaches for clearing fog are briefly described. These approaches are (1) the "FIDO" system, (2) the replacement of the fog with warmer air from an inversion layer usually found above the fog, and (3) releasing water droplets from a helicopter above the fog causing sufficient air movement downward to dissipate the fog through the process of adiabatic heating by compression. The third technique is recommended for emergency use only.

130. Hicks, J.R. Recent advances in weather modification for improvement of airport operations. Eastern Snow Conference, 22nd, Hanover N.H., February 4-5, 1965, Proceedings, Vol. 10. Published 1965. pp. 11-24. DAS M(06) E13p v.10 1965.

The U. S. Army Cold Regions Research and Engineering Laboratory has succeeded in dissipating supercooled clouds over the Greenland Ice Cap near Camp Century by conventional methods, i.e., dry ice distributed over the cloud top by aircraft. The laboratory is now investigating several ground-based systems: tethered balloons, mortars, rockets and other devices to introduce seeding materials into clouds or fog. Dry ice is the principle reagent being used, but other chemicals: metaldehyde, propane and phloroglucinol are being investigated. - Author's abstract.

131. Hicks, J.R. Summary of whiteout studies. U.S. Cold Regions Research and Engineering Laboratory, Hanover, N.H., Technical Report 158, March 1965. 20 pp. DAS M78.4 U586r no. 158.

Previous whiteout work done by CRREL from 1954 to 1962 is outlined and field studies by CRREL in 1963, including instrumentation, seeding materials, and test procedures are discussed. The 1963 experiments were designed to test the feasibility of using

recently developed rockets (cold-propellant and solid-fuel types), continue the investigation of tethered balloon techniques, and field test the organic compound phloroglucinol, which was recently found to be an effective ice-nucleating reagent in the laboratory. A ground-based system for fog dispersal is feasible. Of the many systems tested, the CRICKET is the most promising. It can be moved easily to any suitable area, penetrate fog or clouds to heights of about 4000 ft, and is less expensive to buy and operate. It was concluded that better tracking and observing techniques are needed to determine if the seeding is effective. Monitoring a test from the ground in a dense low fog is difficult because (1) observers easily get lost, and (2) variable air movements make uncertain the drift of the seeded area. - Author's abstract.

132. Hoffer, Thomas E. and Ogne, Marshall L. A difference in the behavior of phloroglucinol and silver iodide nuclei. Journal of Geophysical Research, Washington, D. C., 70(16): 3857-3860, August 15, 1965.

DAS P.

Large particles of silver iodide and phloroglucinol, agents commonly used in weather modification, were subjected in the laboratory to a modeled condensation process to determine whether their ability to serve as ice-forming nuclei was altered. A difference was observed. After being wetted and redried at temperatures above OOC, silver iodide nuclei were observed to be less effective whereas phloroglucinol nuclei were more effective. The experimental techniques, equipment, and procedure are described. - Authors' abstract.

133. Howell, Wallace E. Cloud seeding against the 1964 drought in the northeast. W. E. Howell Associates, Inc., Lexington, Massachusetts, April 1965; 6 pp. DAS MO9.617 H859cl. Also in Journal of Applied Meteorology, Boston 4(5): 553-559, October 1965. DAS M(05) J86joa.

A short account is given of seven cloud-seeding programs conducted in the summer and autumn of 1964 for drought relief in the Northeast, and evaluations of six of them by target-control regressions of normalized monthly data are presented. The results indicate increases varying from one to sixty percent, averaging twenty-five percent, nominally significant at the one percent level. Circumstances such as non-randomization that compromise the evaluation are discussed. Note is also taken of an indicated fourteen percent rainfall increase in 1964 in a hail-suppression target area where operations were recently suspended on account of a state law prohibiting cloud seeding on the grounds that it contributes to drought. - Author's abstract.

134. Howell, Wallace E. Cloud seeding and the law in the Blue Ridge area.

American Meteorological Society, Bulletin, 46(6): 328-332, June
1965. DAS M(05) A512b.

Traces the development of opposition to cloud seeding and the meteorological notions on which it is based in a particular

instance, and suggests measures that may be taken in the future. The development of opposition in the Blue Ridge area is explained. Finally, the question of policy for the future is considered. While the situation described has been of principal concern to a single commercial weather modification program, it raises implications concerning professional conduct of weather modification for practical purposes of any sort, as well as questions relating to the legislative control of weather modification and the legal adjudication of disputes that may arise from it. There appears to be a failure of communication between the scientific community and a considerable segment of society. - MGA 17.7-194.

135. Howell, Wallace E. Twelve years of cloud seeding in the Andes of northern Peru. Journal of Applied Meteorology, Boston, 4(6): 693-700, December 1965. DAS M(05) J86joa.

A program of cloud seeding for rain stimulation has been carried on since September 1951, interrupted only by flood periods and the winter dry seasons, on the headwaters of the Rios Moche, Chicama and Jequetepeque and adjacent parts of the continental divide between about 7S and 8S, using mainly silver iodide seeding from the ground. The climate is one of winter drought and summer convective rain resulting from complex interactions between the Pacific marine layer and the overlying easterlies. Compared with seasonal averages for twelve seasons before seeding began, twelve seeded seasons indicate a rainfall increase estimated at 8 to 15 per cent. Conventional tests show significance at about the 2 per cent level but are rendered inconclusive by lack of prescribed experimental design and the fact that practical application is the primary mission of the program with experimental design having been subordinated. Criteria establishing the economic break-even point for continuance of the program are, however, amply exceeded. - Author's abstract.

Howell (Wallace E.) Associates, Inc. An evaluation of cloud seeding in the Connecticut Valley, summer 1964. Lexington, Massachusetts, March 1965. 5 pp. DAS M09.617 H859ecv.

At the height of a prolonged drought in central Connecticut, the Connecticut Potato Growers Industry Committee, seeing the probable effects of continued dryness on potato crops, made a grant to the Connecticut Weather Control Board with the understanding that the money would be used for experimentation in weather modification. The Control Board contracted with W. E. Howell Associates to conduct the project in the form of cloud-seeding with the primary objective of alleviating the intensity of drought in the principal potato-producing area. The target was defined as the region north of Manchester between the Connecticut River and Stafford Mountain. A secondary aim of the project was as a possible initial step in a long-range program of rainfall stimulation for agricultural purposes. Howell Associates had conducted a seeding project for the Connecticut Disaster Relief and Research Administration, Inc.,

in August 1952.

An intensive 15-day cloud seeding program was put into operation on July 26. Toward the end of this initial period, in view of continued general lack of sufficient rainfall, the program was extended until August 26th by a grant from the Shade Tobacco Growers Association.

An evaluation of rainfall amounts was made in the target and nearby control areas. The results indicated that an increase of 0.61 inches over an expected 2.03 inches occurred over the target area. This was an increase of 30 per cent. The odds are about three out of four that the indication of increase is not due to chance alone. - Author's summary.

Howell (Wallace E.) Associates, Inc. An evaluation of rainfall stimulation in Dutchess, Ulster and Columbia Counties, New York, summer 1964. Lexington, Massachusetts, January 1965. 5 pp. DAS MO9.617 H859eva.

On August 5th, 1964, a program of rainfall stimulation, carried out by W.E. Howell Associates, Inc., was initiated by the Dutchess County, New York, Farm Bureau. The goal was to alleviate the severity of the drought situation which had prevailed over much of the area since the beginning of the growing season. The program was later joined by sections of the Farm Bureaus of Ulster and Columbia Counties, which added parts of those counties to the target area. When the program ended on September 3rd, moisture conditions had improved considerably over most of the area.

For the 29-day period of the project, a statistical analysis of the observed rainfall indicates a rainfall increase of 0.64 inches or 50.4 per cent over the amount that would most probably have fallen if seeding had not been carried out. The likelihood that this increase might have occurred by chance is one in 66. - Author's abstract.

138. Howell (Wallace E.) Associates, Inc. An evaluation of rainfall stimulation in southern New Hampshire, November and December 1964.

Lexington, Mass., February 1965. 4 pp. DAS M09.617 H859enh.

After nearly a year of drought in southern New Hampshire, the State adopted a resolution to conduct rainfall stimulation in an effort to alleviate the situation. Upon approval by the Governor and Council, the firm of W.E. Howell Associates was called upon to conduct the program. The expressed expectation of the results was for a rainfall increase of approximately 20 per cent more than would fall naturally, but with the realization that the indicated result from a brief period of operation would probably not be sufficiently precise to be considered reliable. A similar program had been initiated by the State and carried out by Howell Associates in 1957.

An intensive cloud seeding program was planned and carried out over a period of 19 days from November 19, 1964 to December 7, 1964. Silver iodide smoke generators were used. A statistical analysis of Official Weather Bureau reports of rainfall amounts was completed. An evaluation of the results indicates an increase of 0.66 inches over an expected 3.44 inches of rainfall, or an increase of 19 per cent. The likelihood of an increase this size occurring by natural causes is one in four. — Author's summary.

139. Howell (Wallace E.) Associates, Inc., Lexington, Massachusetts.

Evaluation of cloud seeding in southern Puerto Rico, April - July
1965. Issued September 1965. 9 + 9 pp. In English and Spanish.

English and Spanish summaries. DAS MO9.617 H859evl.

The most severe drought on record, extending over 18 mos, was causing severe damage and hardship in Puerto Rico by the end of March. 1965. Several large private concerns and Government agencies with an interest in water decided that the emergency conditions and the immediate need for water greatly outweighted the uncertainties involved in cloud seeding, and collaborated to sponsor a program of rainfall stimulation. Operations of an emergency nature were begun on April 26, 1965, and continued until July 18, 1965. An analysis of the results was made by estimating the amount of rain that would have fallen if no seeding had been done, from the average rainfall per rainy day during a 19-yr historical (unseeded) period. This analysis indicated an increase during the 84-day seeded period of 2.69 in., equivalent to a 14 per cent increase, with just over 90 per cent certainty that the indication is not due to chance fluctuations. While no formal analysis of the economic consequencies is offered, rough estimates of the dependence of the aggregate agricultural product of the target area on rainfall suggests that the cloud seeding program returned value many times its cost, and hence justified the undertaking in the face of the uncertainties involved. - MGA 17.1-15.2.

140. Howell (Wallace E.) Associates, Inc. An evaluation of rainfall stimulation in the Fitchburg, Massachusetts, area, November and December 1964. Lexington, Massachusetts, February 1965. 4 pp. DAS MO9.617 H859efm.

During the last two months of 1964, a program of rainfall stimulation was conducted in the Gardner-Fitchburg-Leominster area to diminish the intensity of drought and to increase the supply of water for industrial uses and public consumption. The project was sponsored by the Cities of Fitchburg and Leominster, funded by contributions from industrial water users and others, and carried out by W.E. Howell Associates. The target area included the watersheds which supplied Fitchburg and Leominster and the areas served by their water systems.

Upon the issuance of a Certificate of Authority by the Massachusetts Weather Amendment Board, a vigorous program of cloud seeding was commenced on November 10th and continued through December 13th. The last week of the project was financed by the Weyerhauser Paper Company and operations for the last seven days were tailored to that company's watershed.

Results of a statistical analysis on rainfall figures indicates an increase of 0.44 inches over an expected 4.10 inches or a percentage increase of 11 per cent. - Author's summary.

141. Howell (Wallace E.) Associates, Inc. Report of cloud seeding in northern New Jersey, September - December 1964. Lexington, Massachusetts, April 1965. 3 pp. DAS M09.617 H859renj.

A program of precipitation stimulation that the Hackensack Water Company had carried on in two previous drought years was resumed on September 26, 1964, after a summer of severe drought, and is continuing. This report covers operation of this program through the end of 1964.

For a few days at its beginning, this program was supplemented under the sponsorship of the Palisades Interstate Park Commission to cover an area near Tuxedo Park and Sloatsburg, New York, where forest fires were burning. This period was too brief, however, to warrant a separate analysis of results.

From September 26, 1964, through the end of the year, run-off from the Hackensack River watershed, corrected for changes in storage and for diversions into the river from other sources, amounted to 3.24 inches. The amount due to natural rainfall, estimated by a covariance analysis of the Hackensack run-off in relation to that at Wanaque and Croton, was 2.03 inches. The covariance analysis indicates that the indicated increase of 1.21 inches, or 60 per cent has a probability of only 0.013 of occurring by chance alone; that is, only one chance in 77 that the indication of increase is due to chance alone. — Author's summary.

International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Sponsored by International Association of Meteorology and Atmospheric Physics of the International Union of Geodesy and Geophysics; World Meteorological Organization; Science Council of Japan. Tokyo, May 1965. DAS M74.1 I61p.

In his foreword to these impressive proceedings, H. Weickman quotes the oriental proverb: "You cannot tell how the flower looks if you know only the seed." He applies this saying to the case of weather modification where man tries to make or prevent rain or hail artificially without knowing the intermediate steps in the process leading from a cloud droplet or ice crystal to a

raindrop or hailstone. The two volumes at hand will go a long way toward advancing and disseminating such knowledge. They are the result of work contributed by many of the foremost authorities in the field, and contain well over 100 papers in which the latest developments and data are reported. The total number of conference participants was 338; this includes 94 scientists from countries other than Japan. In addition to the formal papers, the Proceedings also include the session summaries and discussions. The range of subjects covered is a wide one; it includes cloud dynamics, aerosols, air chemistry, cloud particles, atmospheric ice nuclei, ice nucleation and crystal growth, ice and snow crystals, precipitation physics, hail studies, radar meteorology, atmospheric electricity, atmospheric radioactivity, cloud modification (including artificial precipitation and hail prevention) and atmospheric electricity. - MGA 17.3-22.

143. Iribarne, Julio V. and Grandoso, Héctor N. Results of the five-year experiment on hail prevention in Mendoza (Argentina). In:

International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo May 1965. pp. 454-457.

DAS M74.1 I61p.

A report is given of an experiment to investigate the possible effect of cloud seeding with AgI on the hail damage sustained by vineyards in the Mendoza area, during the months November to March. The experimental area covers ~4000 m² of flat country to the east of the Andes. Seeding was made with AgI generators from the ground. The same area was used for control, on the basis of randomization. Hail damage statistics were obtained from information supplied by a state insurance institute. Test days were classified as frontal and other days, or as days with thunderstorms or days with hail. The results of the seeding on the whole population of test days was not statistically significant. Levels of significance varied from 8 to 20 per cent for the 2 groups, frontal and others. The computed effect of seeding showed a decrease in total damage of 70 per cent on frontal days and an increase of ~110% for other days. - MGA 17.6-168.

144. Johnson, Lyndon B. On weather modification. American Meteorological Society, Bulletin, 46(7): 401-402, July 1965. DAS M(05) A512b.

This is a letter of transmittal to the Congress of the 6th Annual Report on Weather Modification as submitted to the President by the Director of the NSF. It is stated in conclusion that "If the day is distant and dim when the benefits of weather modification will become real, tangible and universally enjoyed, it is no longer possible for any to argue justifiably that such a day is beyond the reach of man at all. Our knowledge must be enlarged and perfected, far beyond its present limits. But we can—and we do—believe that eventually these efforts underway now will succeed. That success will inure to the credit of the interest, initiative and understanding of the Congress in offering

encouragement and support to this worthy and important research." - MGA 17.7-189.

145. Kahan, Archie M. Evaluation of weather modification. Western Snow Conference, Thirty-third Annual Meeting, Colorado Springs, Colorado, April 20-22, 1965, Proceedings, pp. 97-99. Colorado State University, Fort Collins, Colorado. DAS M(06) W527p 1965.

The evaluation of cloud seeding by percentage of normal comparisons was not long in passing. The fault of the results in frequency analyses was the extreme insensitivity of the tests involved. Regression analysis proved a more powerful and impressive tool for estimating the amount of additional precipitation or streamflow resulting from cloud seeding. The statistical evaluation has been widely applied.

146. Kahan, Archie M. Importance of cloud physics to the atmospheric water resources program of the Bureau of Reclamation. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 446-448. DAS M74.1 I61p.

A review is given of the work in progress and planned by the Office of Atmospheric Water Resources of the Bureau of Reclamation at Denver, Colo. The Office was set up in 1961 by a grant from the U. S. Congress and now administers a large budget issuing contracts for research work to contractors drawn from the universities, private meteorological firms, and other government agencies. Programs underway briefly mentioned here include: the design and testing of nucleants and nucleation devices, the setting up of networks of snowfall measuring devices over areas planned for future seeding experiments, aircraft cloud physics studies, studies of the effects of seeding in lee wave clouds, and the physics of cap clouds. - MGA 17.6-169.

147. Kasemir, Heinz W. and Weickmann, Helmut K. Modification of the electric field of thunderstorms. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 519-523. DAS M74.1 I61p.

A method is proposed to limit the growth on the electric field of a thunderstorm by dispersing 50 to 100 lbs of chaff inside the cloud. This paper describes the first results with chaff seeding. The chaff was dispensed from a C-47 aircraft equipped with a standard chaff dispenser ALE 24 which was able to eject 1 package containing ~2 million chaff fibers every 1/2 sec; 50 to 60 packages were ejected on 1 run. A cylindrical field mill was used aboard the aircraft to measure the electric field. Five missions were carried out in which the aircraft searched a cloud for areas with a field strength above 20,000 V/m. After seeding in such an area the aircraft made successive runs over the same area recording any variations in field strength. On 3 runs, decreases in the electric field were observed after seeding, but the storm, then in its initial stage, continued to develop. It is concluded that there is not much doubt but that the chaff seeding can influence the electrical field in a thunderstorm. - MGA 17.6-156.

148. Kidney, John B. Winter 1965 field tests of urea, ion incorporated silica and hydrophobed silica as seeding reagents. Chicago. University. Cloud Physics Laboratory, Technical Note No. 31, October 1, 1965. 26 pp.

During the winter of 1965, a series of air-borne cloud seeding experiments was undertaken to field test the effectiveness of 3 new seeding agents: hydrophobed silica, ion incorporated silica, and milled urea. These materials were used in cold winter stratus clouds with varying degrees of success as described herein. All of the materials tested produced showers that could definitely be ascribed to seeding, with urea producing a shower on one occasion equal to or better than the best dry ice shower. The results of the experiments indicate that a certain minimum crystal concentration is necessary to trigger a cloud into precipitation. - MGA 17.3-180.

149. Knollenberg, Robert G. <u>Urea as an ice nucleant for supercooled clouds</u>.

Journal of the Atmospheric Sciences, Boston, 23(2): 197-201, March 1966. DAS M(05) A512j. Also issued as: Chicago University. Cloud Physics Laboratory, Technical Note No. 29, April 1, 1965. 15 pp. (Grant NSF G22419) DAS M74.1 C532te no. 29.

Urea was observed to have extraordinary ice nucleating properties in laboratory and natural clouds. Ice nucleation was induced in laboratory clouds at temperatures as warm as +6C. The nucleation mechanism involves the high endothermic heat of solution and high solubility of urea. Three field releases of urea in supercooled stratus resulted in marked visual transformation of the cloud and substantial snow showers. It is concluded that urea is an effective seeding reagent for supercooled clouds. In these experiments urea appeared to be equally effective as dry ice in causing shower formation. - Author's abstract.

150. Kopcewicz, Teodor et al. Wybrane zagadnienia z fizyki gradu i środków walki z nim: sprawozdanie z krajowego sympozjum walki z gradem.

(Selected problems of the physics of hail and means of combating hail: report on the Cracow Symposium on Combating Hail.) Przegląd Geofizyczny, Warsaw, 10(2): 171-209, 1965. DAS M(05) P973a. For English translation consult Translation 67-56085 from unidentified source.

1967. 63 pp. DAS M(05) P973aE 10: 1965 pp. 171-213.

Attempts were made to combat hail in Poland by making use of research in other western countries. The thermodynamic and synoptic conditions favoring the formation of hailstorms were described. The altitude and temperature of the upper boundary of clouds producing thunder and hailstorms, studied by radar echoes, are reproduced in curves. The structure and thermal balance of hailstones in various atmospheric conditions are given. The possibilities of hail prediction were discussed. - MGA 17.7-195.

151. Korzhov, V. A. <u>Nekotorye rezul'taty ispol'zovaniia radiolokatsionnykh</u>
nabliudenii dlia otsenki uspeshnosti iskusstvennykh vozdelstvil na
konvektivnye oblaka. (Some results of use of radar observations for

evaluating the success of artificial modification of convective clouds.) Akademiia Nauk URSR, Kiev. Mezhduvedomstvennyi Geofizicheskii Komitet, Geofizika i Astronomiia: Informatsionnyi Biulleten', No. 8: 103-105. DLC. Translated into English as U. S. Joint Publications Research Service, JPRS 35,792, June 1966.9 pp. DLC.

A method for processing radar observations is presented which gives criteria for detecting artificial precipitation centers and, thereby, makes it possible to evaluate the success of artificial cloud modification. In order to make this evaluation, consideration was given to cases for which the radar coordinates of the aircraft were known at the time of cloud seeding. In 11.5 per cent of the cases, seeding led to the formation of an earlier unobserved radar echoes were discovered; in 36 per cent of the cases, seeding occurred with radar echoes at the time or prior to the seeding; and in 7.5 per cent of the cases cloud seeding exactly coincided with the formation of radar echoes. - MGA 18.1-11/2.

152. Leonov, M. P. and Nerobeeva, T.D. Intensifikatsiia osadkov nad eksperimental nym meteorologicheskim poligonom zimoi 1963-64 g. (Intensification of precipitation over a weather experiment range in the winter of 1963-1964.) U.S.S.R. Ukrainskii Nauchno - Issledovatel skii Institut, Trudy, 47: 88-99, 1965. DAS M(055) U58ltu. Translated into English by Stuart W. Kellogg and produced by American Meteorological Society, Boston, Translation T-R-507, December 1967. DAS M(055) U58ltuE no. 47 pp. 88-99.

The authors present their results from 17 experiments on the intensification of natural precipitation conducted over a weather experiment range in the winter of 1963-1964. The positive effect of seeding is confirmed by the data of a precipitation-gauge network and by radar observations. - Authors' abstract.

153. Leonov, M.P. Nekotorye dannye ob opytakh po intensifikatsii zimnikh osadkov. (Some data on attempts to increase winter precipitation.)

Meteorologiia i Gidrologiia, Moscow, No. 1: 38-40, January 1965.

DAS M(05) M589 1965.

Practical experiments on the cloud seeding of winter clouds have shown that it is advisable to seed both those cloud systems already giving precipitation and also nearby systems in addition to "dry" front. It is necessary for the clouds to be of substantial vertical thickness with a substantial part of it consisting of supercooled droplets. The depth of the supercooled layer must be > 250-300 m and the minimum temperature in that layer $\leftarrow -4^{\circ}$. The trials reported were carried out through 4 winter seasons and aircraft ascents were made through the seeded clouds. Data from these trials are presented in this note.

- MGA 16.7-231.

154. Leonov, M.P. Opyty iskusstvennogo regulirovaniia osadkov. (Experiments in artificial control of precipitation.) Priroda, Moscow, No. 7: 61-64, July 1965. Russian summary p.61. DAS P.

The author discusses the atmospheric cloud and temperature conditions under which precipitation can be produced artificially by seeding with solid CO2 from an airplane and describes the results of a cloud seeding experiment carried out on Jan. 28. 1962 in the Experimental Meteorological Polygon, which is located on the steppe region of the Ukraine. It consists of 2 rectangular areas each of 50 by 75 km and separated from each other by 30 km. In this particular experiment the clouds of a disintegrating warm front were seeded with small solid ice grains released from an airplane. The clouds consisted of 3 layers: broken stratus at 350-700 m, stratonimbus at 900-1960 m, and altostratus at 2050-2330 m. The upper layer was seeded at temperatures of -14.30 to -16.50c. The cloud had a low water saturation -0.02 to 0.09 g/m³. The mean amount of precipitation in the experimental zone was 2.2 mm more than in the surrounding area. The increase in the height of the snow cover amounted to 2-5 cm above the increase in the surrounding area. It is concluded that it is possible to increase precipitation artificially over a plain either by producing it from clouds de novo or by intensifying precipitation that is already falling. An increase of 10-15 per cent may be attained both in winter and summer. - MGA 17.3-181.

155. Lopez, M.E. and Howell, W.E. Cloud seeding at Medellin Colombia, during the 1962-64 dry seasons. Journal of Applied Meteorology, Boston, 4(1): 54-60, February 1965. DAS M(05) J86joa.

Rapid growth in demand, doubling about every 12 years, led in 1961 to stringent rationing of hydroelectric power and potable water in Medellin, Colombia. After a preliminary study had shown that dry-season precipitation on the city's watersheds came principally from daytime convective clouds that showered only after surpassing the freezing level, and hence might be stimulated by silver iodide, cloud seeding was undertaken in the 1962, 1963 and 1964 dry seasons.

Evaluation by the usual target-control regression procedure indicated increases of 20 to 40 per cent, nominally significant at the one per cent level. A new approach to evaluation, based on the suggestion by Thom that seeding, if it increases rainfall, should affect mainly the scale parameter of the distribution, was developed and applied to one of the targets, deriving a separate estimate of 25 per cent increase, which falls slightly short of significance at the five per cent level.

Significance is compromised by some subjectivity, though this was minimized as much as possible, and by unavoidably imperfect randomization and lack of predetermined experimental design.

The cost of operations was equivalent to the economic return indicated from a 2 per cent increase in streamflow from the target watersheds. The indicated result overfulfilled the expectation established in advance of operations. - Authors' abstract.

Morachevskii, V.G.; Bartishvili, I.T.; Kokhanovitch, M.M. Experiments on control of the development of vigorous convective clouds with highly-dispersible nuclei of surface-active agents. Canada. Meteorological Branch, Meteorological Translation, No. 15: 11-15, 1968. Translated by A. Nurklik from original Russian in Problemy Fiziki Atmosfery, Leningrad, no. 3: 224-230, 1965. DAS M(055) C212me.

A discussion of Langmuir's (1948) "chain reaction" theory in the light of cited previous findings (Morachevskii et al., 1963) shows that it should be possible, by cloud seeding, to prevent the development of vigorous Cu clouds into the hail stage, and to increase precipitation from them. This paper presents narrative descriptions of the results of 5 experiments on controlling the development of convective clouds by seeding that were performed at the Samsari meteorological proving ground of the Transcaucasian Res. Inst. in 1963-64. Systematic upper air, hail, precipitation, and visibility observations were made, and a radar surveillance of clouds was kept over the periods of the experiments. The method of the experiment and the evaluation of the effectiveness were determined primarily by the actual synoptic situation. Changes in the appearance of seeded clouds and the radar echo patterns from them were photographed with time-lapse cameras. Samples of the photographs are shown. It is concluded that the results, in general, support the authors' suggestion that the development of cumulus clouds can be controlled by seeding them with surface-active nuclei. The authors state, however, that this conclusion must be considered tentative pending further experimental verification. - MGA 20.9-181.

Newton, O.H.; Riley, J.A.; Williamson, F.B. <u>Defoliation: controlled</u>
relative humidity in cotton fields. International Symposium on
Humidity and Moisture, Washington, D.C., May 1963, Humidity and
Moisture, Vol. 2 published 1965. pp. 103-105. DAS M71 I6lint v.2.

Examples of weather's control over crop development are many. Examples of man's influence over these controlling weather factors are few. Cotton field defoliation (the application of a chemical to insure leaf drop at a predetermined time) prior to harvest is one example of man's ability to achieve a desirable change in weather conditions in a field crop.

The moisture content of seed cotton holds the key to the quality of the harvested product. Wet cotton before harvest promotes fungal boll rot. If the moisture percentage at harvest time is above a critical level, bacterial action is accelerated and a number of other factors combine to cause a loss of value in the

harvested crop. A relative humidity of 50 per cent or less is equivalent to "safe" harvesting conditions.

Defoliation reduces obstruction of wind and light penetration into the plant zone. Experiments have shown twice as much sunlight within defoliated fields as compared with heavily leafed fields. Wind in the leafed field totaled only 25 per cent of the wind in the defoliated field. Evaporation averaged twice as much in the defoliated field. As a result of the complex of weather variables, relative humidity averaged 8 to 10 per cent lower in the defoliated field. This added an additional hour of safe picking time in the defoliated field. - Authors' abstract.

158. Oddie, B.C.V. The hail cannon: an early attempt at weather control.

Royal Meteorological Society, Weather, London 20(5): 154-156, May
1965. DAS M(05) R888w.

In 1896 Stiger in Austria revived interest in hail shooting. He devised an arrangement with a cannon surmounted by the smoke stack of an old locomotive which made a tremendous noise. He organized a network of shooting stations in his part of Austria and appeared to have great success. The practice spread and confidence grew. In 1902 the Austrian Government called an international conference which discussed the matter and decided to initiate trials. These trials, carried out at Windisch-Feistritz in Austria and at Castelfranco Veneto in Italy, proved quite convincingly the uselessness of the method. After these trials confidence was lost and interest rapidly waned. - MGA 16.8-172.

Ono, A. Studies on the process of ice-nucleation. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 185-188. DAS M74.1 I61p.

This paper reports some laboratory research on the freezing of aqueous solutions. The object was to know whether there are any chemicals which are water soluble and act as ice-nucleating agents. The experiments were conducted by spraying the aqueous solution by a nebulizer into a mixing cold chamber in which a cloud had been made. Ice crystals produced in the chamber are collected on glass slides placed at the bottom of the chamber. In the preliminary experiments the chemicals used were AgI, C6H3(OH)3.2H2O and alkaline halogen. AgI does not act as an ice-nucleating agent when dissolved completely in pure water, but does in the state of colloidal particles in aqueous solution. C6H3(OH)3 •2H2O does not act as an ice-nucleating agent in solution or in a state of colloidal particles. Small amounts of sodium halogenide added to aqueous solutions of AgI or C6H3(OH)3.2H2O have a tendency to reduce the ice-nucleating ability, this tendency increasing markedly with increasing concentration of solute. - MGA 17.5-323.

160. Oppenheimer, Jack C. Legal aspects of weather modification.

Western Snow Conference, Thirty-third Annual Meeting, Colorado

Springs, Colorado, April 20-22, 1965, Proceedings, pp. 88-93.

Colorado State University, Fort Collins, Colorado. DAS M(06) W527p

1965.

Some reasons for concern with the law of weather modification, present state laws of weather modification, present court decisions of weather modification, law-science-public policy are discussed in this paper.

161. P'iankov, V.P. Mamonty i zagadka klimata. (Mammoths and the riddle of climate.) Priroda, Moscow, No. 10: 86-94, October 1965. DAS P. Translated into English by E.R. Hope (Canada. Defence Research Board, Translation T 444 R, December 1965). DAS M83 P581m.

The change in the climate of the Arctic Ocean in Eurasia some 8000 yrs ago that led to the destruction of the mammoths is shown to be a result of the blocking of the Gulf Stream by the formation of a barrier preventing it from penetrating into the Kara Sea. As a result the penetration of moisture and warm air and their ameliorating effect on the Siberian anticyclone are abolished. In this paper the author discusses the present circulation of the Gulf Stream in the Arctic region and its blocking by Cape Kanin, the destruction of Chesha Bay which originally permitted passage of a branch of the Gulf Stream, the conversion of Kanin Is. into a peninsula, the role of the Gulf Stream in the warming of Europe, and the possible restoration of the Kara Current of the Gulf Stream by restoring Chesha Bay. He shows that the restoration of the flow would not bring about desiccation in southern Russian and Western Europe as a result of subsequent warming of the Arctic. - MGA 17.4-419.

Plaude, N.O. and Solov'ev, A.D. O primenenii chastits s bol'shoi udel'noi poverkhnost'iu dlia vozdelstviia na oblaka i tumany. (Use of particles with a large specific surface for modifying clouds and fogs.) U.S.S.R. Tsentral'naia Aerologicheskaia Observatoriia, Moscow, Trudy, No. 65: 30-47, 1965. Russian summary p. 30. DAS M(055) U581tt. Translated into English as U. S. Joint Publications Research Service, JPRS no. 37,551, September 13, 1966. DAS M(055) U581ttE no. 65.

The authors examine the problem of the use of particles with large specific surfaces —thin walled bubbles and disks—in order to disperse artificially clouds and fogs, and determine the optimum parameters of these particles under different conditions of activity. The contents of this paper include the following, viz: the calculation of the characteristics of particles with large specific surfaces; the use of bubbles and disks in seeding clouds and fogs including a comparison of the effectiveness of hygroscopic bubbles and drops in fogs with a thickness of 50 and 200 m; and experimental data on the

properties of bubbles and method for their production. - MGA 17.6-158.

163. Pletser, János and Radnai, Katalin. Öszibarackos Fagyvédelme. (Frost protection of peach orchards.) Hungary. Orságos Meteorologiai Intézet. Hivatalos Kiadványai, vol. 28, pt. 2, 1965. pp. 135-146. English and Russian summaries p. 135. DAS M(055) H936p. v.28.

The efficiency of field heating frost protection is discussed for a sandy peach orchard on the Hungarian Plain between the Danube and Tisza Rivers. Frost protections by wind machines and sprinkling were analyzed and on the basis of temperature gradient measurements, the wind machine method was appraised. In the orchard air temperature was measured by termistors up to 10 M. All of the methods studied are suitable for frost protection. The cost of each method is mentioned referring to the paper of F. Balázs, researcher of the Inst. for Agricultural Machine Experiments. - MGA 17.10-212.

Ponomarenko, I.N.; Koshenko, A.M.; Zabolotskaia, T.N. Kharakteristiki frontal'nykh oblakov, prigodnykh dlia intensifikatsii estestvennykh osadkov. (Characteristics of frontal clouds which are suitable for intensification of natural precipitation.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Leningrad, Trudy, No. 47: 79-87, 1965. Russian summary p.79. DAS M(055) U581tu.

Data on cloud phases in frontal zones over the Ukraine and the characteristics of frontal cloud systems susceptible to cloud seeding are reported. - MGA 16.12-435.

Prikhot'ko, G.F. O vozmozhnostiakh polucheniia iskusstvennykh osadkov iz konvektivnykh oblakov. (Possibilities of artificial precipitation from convective clouds.) Idojárás, Budapest, 69(6): 332-342, November - December 1965. Hungarian and English summaries p.332. DAS M(05) I21.

On the basis of theoretical and practical research, the author investigates the temperature ranges for the formation of solid cloud elements as well as determines the concentrations of ice nuclei necessary for the formation of precipitation. He concludes that in cumuliform clouds the precipitation forms as a result of coagulation-growth of larger ice crystals grown according to the Bergeron process (growth of ice crystals to the detriment of water drops). In rainmaking experiments carried out in the Ukraine cumuliform clouds were seeded by dry ice particles. According to a table, if the temperature of the seeded level was -12° C or lower in every case precipitation was given by the cloud (the vertical extent of the cloud was larger than 3.6 km). A figure gives the seeding temperature (T₃) and the thickness of the cloud (AH) in those 322 cases when seeding were

carried out. On the basis of these 2 parameters, 4 groups can be separated. Among them only those belonging to the first group have given precipitation in each case. For the first 3 groups a table gives the temperature of that level where the seeding was carried out. A figure presents the frequency of the seeded levels in general for convective (a) and for cumulonimbus clouds (b). According to the appraisal of data in the case of Cb clouds they succeeded in increasing the depth of precipitation by 5 per cent at the seeding level of -4°C, by 48 per cent between -4°C and -12°C, and by 47 per cent below -12°C. This surplus can be considered of great importance. - MGA 17.7-196.

Prikhot'ko, G.F. Opyt razrabotki priblizhennogo kriteriia opredeliaiushchego vozmozhnost' vyzvvaniia iskusstvennykh osadkov iz kuchevyky oblakov v USSR. (Attempt at establishing an approximate criterion for the potentiality of producing artificial precipitation from cumulus clouds in the Ukrainian SSR.) Meteorologiia i Gidrologiia, Moscow, No. 10: 36-38, October 1965. DAS M(05) M589. Translated into English as U. S. Joint Publications Research Service, JPRS, No. 33,250, December 9, 1965, pp. 39-43. DAS M(05) M589E No. 10 1965.

A report is given of the results of an analysis of data from 98 attempts to produce artificial rain from Cu cong cloud by seeding with solid CO2. The tests were made on isolated clouds not showing any signs of fibrous structure. Positive effects were attributed to each experiment which was followed by rain from the cloud which reached ground level. The limiting values of the temperature at the seeding level, the thickness of the cloud, the volume of the cloud and the volume of the supercooled portion of the cloud, for successful and unsuccessful attempts, are tabulated. A plot is made of those occasions, which were completely successful, those which gave weak precipitation not reaching the ground, and those which gave no precipitation, on a diagram with co-ordinates representing the temperature of the cloud at the seeding level and the thickness of the cloud. Three lines are drawn on the resultant diagram dividing the conditions into 4 groups. These groups included, conditions when seeding was always successful, 50 per cent, 10 per cent and conditions when absolutely no success was obtained. - MGA 17.2-149.

167. Rapp, R. Robert. Economic aspects of weather modification. Western Snow Conference, Thirty-third Annual Meeting, Colorado Springs, Colorado, April 20-22, 1965, Proceedings, pp. 83-87. Colorado State University, Fort Collins, Colorado. DAS M(06) W527p 1965.

The economic value of weather control might serve to eliminate unfavorable conditions — hail, lightning or severe storms. Or, it might produce something — more sunshine or increased amounts of precipitation. The job will be expensive. Even if the possibility of weather control is very small, the benefits which might be realized are certainly worth some investment in research.

168. Reichelderfer, F. W. Water: can cloud seeding help? Science, Washington, D. C., 150(3700): 1103, November 26, 1965. DAS P.

A letter suggesting the probability that advanced ACN techniques will yield worthwhile increments of precipitation from orographic clouds over certain mountain ranges; and the possibility of increasing yields from cumulonimbus clouds and in other favorable situations, should be thoroughly explored. The benefits not only to the understanding of the possibilities of weather modification but also to the advancement of weather prediction, and the solution of other atmospheric problems are ample justification for giving very high priority for such research. - MGA 17.4-148.

169. Ride, D. J. Convection from burning cornfields. Weather, London, 20(8): 238-241, August 1965. DAS M(05) R888w.

The corn harvest on Salisbury Plain is gathered mainly by combine harvester and the straw produced is frequently burnt in the field where it lies evenly distributed. During the harvest season of 1964 a watch was kept on burning fields from the Meteorological Office roof at Porton Down. Of 10 days on which burning off was observed, fire-formed cumulus was also observed on 7 days. These 7 occasions are listed and the weather conditions prevailing at the time are described. A photograph shows one of the more notable occurrences. On this occasion estimates were made of the dimensions of the vortex and attempts were made to establish the average velocity of the updraught in the thermal and its average degree of warming. These estimates suggest that the vortex was probably a concentration of some local, already existing vorticity rather than a correlation of vorticity associated with the Coriolis effect. It is pointed out that straw is normally lit when weather conditions are favorable for vortex formation - MGA 16.10-219.

170. Riehl, Herbert. Kann man einen Hurrikan abschwächen? (Can a hurricane be weakened?)

1965. German summary p. 385. DAS P.

The contents of this paper include a description of the structure of a hurricane, in particular of its wind regime; an analysis of the natural energy sources of a hurricane and the variation of the energy; the prediction of the intensity of a hurricane; the possibilities of experimenting with the modification of hurricanes by drying out the air in the hurricane, by operation of evaporation from the water surface, and by cloud seeding; the experiments of 1961 and 1963 which involved seeding clouds with AgI from an airplane; and experimental plan for 1965 involving seeding at intervals of 12-24 hrs. - MGA 17.2-202.

171. Roberts, Walter Orr. Atmospheric modification. American Meteorological Society, Bulletin, 46(12): 775-778, December 1965. DAS M(05) A512b.

In his speech at the AMS Conference on Cloud Physics and Severe

Local Storms, held Oct. 21, 1965 at Reno, Nev. the author philosophizes on the future of atmospheric modification, modification vs. research, need to distinguish between goals from promises, realism which comes by experimenting in nature against laboratory research etc. - MGA 17.4-142.

172. Rosinski, J. and Parungo, F. Freezing nuclei from photolytic decomposition of silver iodide. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965, pp. 171-175. DAS M74.1 I61p.

Ice nuclei data at Climax and Berthoud Pass (Colorado) and Mt. Washington (New Hampshire) have shown that ice nucleus concentrations on nonseeded days during seeded intervals have been substantially higher than during nonseeded intervals. This suggest a carry-over or residual effect from seeding with AgI. This effect could hardly be explained in terms of the re-entrainment of AgI particles deposited on the ground or on vegetation. The experiments reported here examined the photolysis of AgI particles deposited on vegetation to see if I compounds of resinous materials so formed might give rise to vapor which would activate an atmospheric aerosol particle as ice nuclei. Oils from different trees were collected, poured over AgI and subjected to unfiltered UV light. Additional heat was used to vaporize the oil. Oil vapors were then cooled and aerosol formed during an experiment filtered through a membrane covered with quartz sand. All the oil vapors show nucleation properties at temperatures higher than -15°C. When exposed to I large increases in the temperature of nucleation were observed for birch, Scotch pine, eucalyptus, and camphor. There was no change for the oil of cedars. AgI deposited on coniferous trees may cause higher than normal nucleation rates for some time and so areas which have been recently seeded should be excluded when observations are made of naturally occurring nuclei. - MGA 17.5-336.

173. Sansom, H.W. A hail suppression experiment at Kericho: first progress
report. East African Common Services Organization, Nairobi.
Meteorological Department, Memoirs, 4(1), 1965. 9pp. DAS M(055) El3me.

Following the publication of Vittori's (1960) report on the effects of explosions on hailstones, a hail suppression experiment was set up in the Kericho area (0°22'S, 35°17'E) by the African Highlands Produce Co., Ltd. A preliminary account of the first 18 mos of this experiment was given by Sansom (1965). The present report covers 26 mos of operation, from July 1963 to Aug. 1965. The experimental area and the location of a network of 13 rocket firing positions, ~ 400 yds apart, set up on the eastern half of Kitumbe Estate in the center of the area, are shown in a map. The rockets which are fired when hail is actually falling at or near the firing site are described. Average monthly loss of tea during the period of experiment compared to previous average, number of hailstorms and hail loss on all estates during the period of experiment, and duration of hailstorms and rate of

damage are tabulated and shown on maps. Visible effects of the rockets are listed. Frequency of reported hail diameters and time before hail melts on ground are given for 4 of the estates. It is concluded that while it cannot be stated categorically that the use of explosive rockets is causing a reduction of hail damage, there is very strong evidence that there has been an appreciable reduction of damage not only on Kitumbe Estate but also on the estates immediately adjacent to it. - MGA 17.10-219.

174. Sansom, H. W. A preliminary report on a hail suppression experiment in Kenya. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 449-453. DAS M74.1 I61p.

Some statistics are given of hail frequency and hail damage in in Kenya. An experiment undertaken from July 1963 onwards by the African Highlands Produce Co. is described. Italian anti-hail rockets were used which exploded 800 gm of TNT or cheddite at heights of 1500 or 2000 m. Thirteen launching sites, spaced 450 m apart, were used. Rockets were fired only when hail began to fall and firing ceased when the hail ceased. Hail damage data during 18 mos of firings were compared with data for the preceding 19 mos. Tea damage per acre amounted to 6.5 lbs during the control period and 6.2 lbs during the experimental period. There is a brief discussion on the interpretation of the results. While the results suggest an improvement due to the firings they cannot be considered to be conclusive. - MGA 17.6-170.

175. Schaefer, Vincent J. and Fuquay, James J. The detection of silver iodide in snow by neutron activation analysis.

Atmosphériques, Clermont-Ferrand, No. 2: 49-52, April-June 1965.
French and English summaries p. 49. DAS M(05) J86jor.

Laboratory and field samples of ice crystals grown on submicroscopic silver iodide aerosol particles have been collected and subjected to neutron activation analysis. The residue has been found to contain a concentration of silver more than an order of magnitude greater than samples from an area in the Colorado Rockies where silver iodide seeding has not occurred. This analysis technique may constitute a new approach to the physical evaluation of cloud seeding effects. - Authors' abstract.

176. Schaefer, Vincent J. Studies of cirrus-type clouds at ground level.

In: International Conference on Cloud Physics, Tokyo and Sapporo,
May 24-June 1, 1965, Proceedings. Tokyo, May 1965. pp. 414-418.

DAS M74.1 I61p.

A report is given of the results of some seeding experiments of Ci-type clouds which form at ground level in the Upper Geyser Basin area of Yellowstone Park where Old Faithful Geyser is situated. Here there is a combination of a rich moisture supply, stable air, a remoteness from pollution and temperatures in the range from O C to -50 C. Seeding operations are carried out by swinging

a wire mesh basket of dry ice, by hanging the same basket at a height of 2 m, or by releasing a vapor of AgI. During seeding experiments sampling sites to collect crystals formed were located 700 to 1500 m downwind of the seeding position. At these distances eddy diffusion had caused fairly efficient mixing of the seeding agents. The effects of the two types of seeding agent were found to differ. Dry ice produces a rapid reaction, quickly reaching a peak and then tapering off as the ice crystals produced diffuse, grow and fall out. AgI is much slower in reaching maximum concentration but is more persistent than dry ice. - MGA 17.7-395.

177. Schleusener, Richard A.; Marwitz, John D.; Cox, William L. Hailfall data from a fixed network for the evaluation of a hail modification experiment. Journal of Applied Meteorology, Boston, 4(1): 61-68, February 1965. DAS M(05) J86joa.

Hailfall data collected from a fixed network in northeastern Colorado during three seasons (1960-62) included the estimated impact energy, duration of hailfall, most common stone size, maximum stone size, and number of stones per square inch. These basic data, X, along with the transformations; $\ln X$, \sqrt{X} , and 1/X, were analyzed by computer methods to determine which parameters could be used in a statistical analysis of hail suppression experiment. The gamma distribution function was fitted to the hailfall data by the method of maximum likelihood. A chi-square goodness of fit test was applied to the data, and one transformation was tested using a sequential analysis technique.

All parameters except impact energy and number of hailstones per square inch were eliminated from the statistical analysis because of bias, non-homogeneity, or sparsity of samples. Transformations which produced the minimum mean coefficient of variation were logarithm of impact energy (lnE) and square root of the number of stones per square inch $(\sqrt{N_{1-6}})$. It was determined that a target-control analysis was not feasible for the analysis of hail suppression experiment. A period of 3 to 5 years is believed necessary to detect changes of 10 to 25 per cent in the hail parameters. The gamma distribution function fitted only the $\sqrt{N_{1-6}}$ data. From the results it was concluded that a sequential analysis test alone could not adequately evaluate the effectiveness of a hail modification experiment. - Authors' abstract.

Nachtfrost, seine Entstehung, Vorhersage und Abwehr, Band 2, Die

Praxis der Frostschadensverhütung. (Frost protection in the culture of plants: source book on night frost, its origin, forecasting and prevention, Vol. 2, Practices of frost damage prevention.) Munich, BLV Verlagsgesellschaft, 1965. 604 pp. DAS M24.37 S359fr Bd 2.

The first part of this book, dealing with frost damage prevention in the long view, consists of a 61 p. essay by M. Schneider on climatic factors and on influencing the frost danger by human activities, and 2 shorter articles by F. Schnelle on cultural practices and biological means of frost damage prevention in the long view (13 and 4 p., respectively). The major part of the book (p. 83-408) consists of 8 papers. Six of these papers by H. Aichele and 1 by H. Burckhardt deal with various methods of frost damage prevention - covering, making the air turbid (artificial fog and smoke, ventilation, heating, sprinkling, a combination of methods, flooding, setting the plants in motion, and other methods. The 8th paper (by both authors) is devoted to methods of measuring individual meteorological elements and to research methods in front protection apparatus and installations. remainder of the book discusses the organization of the first warning service and community frost protection. The 3 appendixes include a Memorandum on the need to consider preventive frost protection by landscape modification, land planning and farm consolidation and Guidelines for frost protection by heating and by sprinkling. The book contains a 3223 item bibliography compiled by Schneider and name and subject indices. - MGA 17.9-3.

179. Schwartz, Leonard E. <u>International relations and weather modification</u>. A report to the Special Commission on Weather Modification. Washington, D.C., Operations & Policy Research, Inc., April 1965. 100pp. Mimeo. Bibliographic footnotes, pp. 93 - 100. DAS M:341.5 S399i.

This is a treatment not so much of the avowed subject but of every conceivable related development (WWW of WMO, IQSY, IGY, COSPAR, the Tiros program, etc.). Little of the report is devoted specifically to weather modification. Evaluation of the scientific aspects of weather modification is not attempted. "Examination will be made instead of the more significant international programs in meteorology which shed light on the substantive. organizational and political factors confronting the current attempt to establish a large-scale program in weather modification." The report contains discussions of scientific rationale, technological framework, policy decisions, and of the following components of a World Weather System: research; global networks of meteorological stations; world, regional and national centers; communication facilities; meteorological satellites; skilled meteorologists; and regulation and control. Elsewhere in this report H. Houghton (MIT) is quoted to the effect that "International control of weather modification will be as essential to the safety of the world as control of nuclear energy is now." - MGA 18.2-161.

180. Serpolay, R. A ground-based device for dispersal of supercooled fogs.

In: International Conference on Cloud Physics, Tokyo and Sapporo,
May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 410-413.

DAS M74.1 I61p.

Since 1958 with the facilities at the Orly Airport, Paris, a method of dispersing fogs which can be used with fog temperatures below 0.5°C has been developed. About 60 regularly spaced propane sprayers, working at a height 2 m above the ground, are supplied by a number of tanks and set up along the periphery of the airfield at a distance of < 1.5 km from the group of principal runways. The spraying is operated by remote control and the rate of release can be varied. Downwind of the generators of the fog soon becomes icy, further downwind snow falls and visibility is improved, even further downwind a hole in the fog with good visibility appears. A number of experiments have been performed and the equipment has been used operationally with success. Sometimes the snowfall resulting from the seeding has been significant inasmuch as it has been necessary to sweep it from the runway. The snow fall on some occasions represents a significant fall of precipitation. This suggests that the method might be used with advantage to increase total precipitation amounts in mountain areas. - MGA 17.6-159.

181. Simpson, Joanne; Simpson, Robert H.; Andrews, Donald A.; Eaton, Max A.

Experimental cumulus dynamics. Review of Geophysics, Washington,
D. C., 3(3): 387-431, August 1965. DAS P.

Cumulus dynamics is approached as an experimental science. Its development since 1947 is briefly reviewed and the current convection models described, in particular models evolved from laboratory studies, such as the 'starting plume'.

A preliminary series of experiments on real tropical cumuli has been conducted as a method for testing and improving models and for assessing the range of applicability of the laboratory results. A silver iodide seeding technique was used in a joint U. S. Weather Bureau - U. S. Navy experimental program called Project Stormfury. Eleven tropical cumulus clouds were probed by instrumented aircraft on four days in August 1963. Six were seeded by dropping pyrotechnic silver iodide generators into their tops at intervals of 100 meters or less; five were studies as 'controls.' All control clouds died without further growth. Of the treated clouds, one was seeded by misunderstanding when its top was below 10,000 feet; it collapsed. The remaining five treated clouds grew. Of these, three were seeded at low enough elevations so that natural glaciation was unlikely; these are called the 'test' clouds. All three test clouds were observed to 'explode' in two phases. The first phase was a vertical growth of 10,000-20,000 ft, occupying 10-12 minutes; the second was a horizontal expansion, with the resulting giant cloud persisting more than 30 minutes. Using laboratory and theoretical results, we construct a dynamic model of the first growth phase and test it against the aircraft measurements and photographic data. The model predicts tower ascent rates, excess temperatures, and water contents, with environment and cloud base conditions as input. It predicts that unmodified clouds could not have attained the observed heights. Furthermore,

the postulated effects of seeding (fusion heating, expansion, and altered precipitation fallout) are incorporated into the model and are shown able to account for the excessive growth of the test clouds following treatment. A set of extensive control calculations shows that the main deductions are insensitive to the existing uncertainties in the input data and the modeling assumptions. Improved experiments are suggested to resolve some of the basic questions in cumulus dynamics, as well as seeding effects. - Authors' abstract.

182. Simpson, Joanne; Simpson, Robert H; Stinson, J.R.; Kidd, J.W. Stormfury cumulus seeding experiment 1965: preliminary summary. U. S. Environmental Science Services Administration and U.S. Navy, Project Stormfury Reports No. 1 - 65, November 1, 1965. 15pp. "A joint report." DAS M(055) U5885pr no. 1 - 65. Also slightly revised and issued in Journal of Applied Meteorology, Boston, 5(4): 521 - 525, August 1966 under the title Stormfury cumulus experiments; preliminary results 1965. DAS M(05) J86joa.

This paper is a preliminary summary of results of a tropical cumulus seeding experiment. Individual supercooled cumuli were seeded by silver iodide pyrotechnics and studied before and after by radar, photography and multi-aircraft penetrations. The choice of "seeded" versus "control" cloud was made from sealed instructions opened on the seeding aircraft.

Twenty-two cases were studied on nine days, with fifteen seeded and seven controls, largely in matched pairs. Two-thirds of the properly seeded clouds underwent marked vertical growth while six-sevenths of the controls did not. It is suggested that this and sequel experiments can delineate conditions under which seeding may have different effects upon clouds. - Authors' abstract.

183. Simpson, R. H. <u>Project Stormfury:</u> an experiment in hurricane weather modification. Geofisica Internacional, Mexico City, 5(2): 63 - 70, April 1, 1965. In Spanish and English. DAS P.

A brief account of the developments that led to the establishment of the project is followed by an outline of the present experimental design which looks to the release of latent heat of fusion in the chimney area by AgI seeding, and by a summary of results obtained on Sept. 16, 1961 with hurricane "Esther." A curve illustrating the increase in equivalent potential air temperature in the subcloud layer due to flux of latent and sensible heat from the ocean and curves indicating the difference in temperature of saturated rising parcels which release latent heat of fusion and those which do not are shown in a graph. Other illustrations include: radial wind profiles of several hurricanes; charts of surface and upper air conditions 1200 GMT Sept. 17, 1961; a series of concurrent 10 cm and 3 cm radar pictures before and after seeding; and mean wind and D-value profiles for "Esther." An experiment is planned in which very small plastic bubbles with high absorptivity to infrared radiation will be desseminated in an area near the cusp point in circulation over a hurricane. - MGA 17.10-210. 184. Smith, E.J.; Adderley, E.E.; Bethwaite, F.D. A cloud-seeding experiment in New England, Australia. Journal of Applied Meteorology, Boston, 4(4): 433-441, August 1965. DAS M(05) J86joa.

From 1958 to 1963 an experiment was conducted in the New England region of Australia, in which clouds were seeded with silver iodide smoke released from an aircraft. Clouds over two areas were seeded, with random choice of area. Rainfall measurements in the two areas suggest that seeding increased the rainfall during the first year, but no net changes in rainfall could be detected in subsequent years. The seeding appears to have increased the variability of rainfall. - Authors' abstract.

185. Solov'ev, A.D. Rasseivanie tumanov pri polozhitel'nykh temperaturakh vozdukha. (Fog dispersal under above-freezing air temperature conditions.) U.S.S.R. Tsentral'naia Aerologicheskaia Observatoriia, Moscow, Trudy, No. 65: 9-29, 1965. Russian summary p. 9. DAS M(055) U581tt.

The author reviews the investigations on fog dispersal during positive atmospheric temperatures carried out outside of the Soviet Union. The contents of this paper consist of the following, viz: the physical meteorological basis of methods of fog dispersal, namely methods of evaporation of fog droplets either by absorption of fog droplets at a constant temperature or by raising the atmospheric temperature at constant absolute humidity; the method of removing fog either by removing air together with the droplets; and methods of coagulation; and a description of the actual methods employed to disperse "warm" fogs, viz: FIDO, hygroscopic methods involving the use of CaCl₂ or NH_UNO₃ coagulation, by electric fields or by second waves; the use of ventilators to clean a volume; the use of surface active substances, etc. - MGA 17.6-160.

186. Soulage, G. A propos de la prévention de la grêle. (Hail prevention.)

Réponse à la note de G. Soulage "A propos de la prévention de la grêle." (Reply to the note by G. Soulage "Hail prevention.") by

Henri Dessens. Journal de Recherches Atmosphériques, Toulouse,

No. 1: 33-41, January - March 1965. DAS M(05) J86jor 2: 1965.

Recently Dessens suggested replacing the research and experiments in hail prevention, presently conducted over limited districts in southeast France, by an efficient large scale operation covering as wide a region as possible. Soulage advances arguments against this suggestion. He asserts that the present state of knowledge in the field of hail prevention may not justify extending the technique praised by Dessens (ground based AgI generators); other techniques (explosive rockets, AgI rockets, aircraft seeding) are summarily considered with valid objections as well as advantages and possibilities. The author concludes that research must still remain confined to small scale experiments since the proposed extension would undoubtedly hamper the

work on freezing nuclei and hinder further investigations on cloud modification and research in cloud physics. In his reply, Dessens maintains that results hitherto obtained by means of ground based AgI generators may be considered sufficiently conclusive to justify the extension of the method in view of reducing hail damage but, however, agrees with Soulage's opinion that active research is still very desirable in various related problems (concentration of nuclei required to avoid hail damage, possible de-activation of nuclei, efficiency of generators) and that he never meant to propose stopping the small scale experiments of various researchers engaged in this work. - MGA 16.11-187.

187. Sulakvelidze, G. K.; Bibilashvili, N. Sh.; and Lapcheva, F.F. Method and physical basis of the influence on convective clouds to prevent hail damage. In: International Conference on Cloud physics,
Tokyo and Sapporo, May 24 - June 1, 1965. Proceedings Supplement.
Tokyo, October 1965. pp. 167-173. DAS M74.1 I61p suppl.

The article deals with the physical basis of the methods of the influence on hail processes which come from some new notions concerning the hail formation mechanism. The values present our results of theoretical, laboratory and field experiments carried out at the State Alpine Institute of Geophysics (Naltchik U.S.S.R.). - Authors' summary.

188. Sulakvelidze, G.K.; Bibilashvili, N. Sh.; Lapcheva, V.F. Metodika i fizicheskie osnovy vozdeistviia na gradovye oblaka: obzor rabot, vypolnennykh v Vysokogornom geofizicheskom institute. (Method and physical principles of hailstorm cloud modification — a review of work carried out at the High Mountain Geophysical Institute.)

Meteorologiia i Gidrologiia, Moscow, No. 12: 45-49, December 1965.

DAS M(05) M589.

Research on shower clouds and hail have been carried out at the High-Mountain Geophys. Inst. in eastern Georgia since 1956. Studies on vertical currents have been made using constant-level balloons. The growth of particles by gravitational coagulation is discussed, and an expression showing the maximum height of ascent of a cloud particle is quoted. The process of the growth of hail particles by coagulation with supercooled drops is described. Zones of accumulation of large water drops are shown to be > 3 km in depth and each zone to produce precipitation for a period of 10 to 20 min. The "wet growth" of hail occurs between the 0° and -20°C isotherms in a depth 2.5 to 3.0 km. In order to reduce the risk of hail by artificial seeding operations seeding should be carried out in those parts of the cloud in which hail growth is most likely. Necessary conditions for successful seeding operations are: 1) a highly reliable method of forecasting hail conditions; 2) the seeding should eliminate the risk of the formation of cloud areas with high water content: 3) operational radars capable of delineating the zones where large drops are forming and detecting the zones of precipitation

and the form of the precipitation and 4) suitable means of seeding the clouds at the required heights. - MGA 17.6-171.

Sulakvelidze, G.K.; Bibilashvili, N. Sh.; Lapcheva, V.F. Obrazovanie osadkov i vozdejstvie na gradovye protsessy. (Formation of precipitation and hail control.) Edited by E.K. Fedorova and G.K. Sulakvelidze. Leningrad, Gidrometeoizdat, 1965. 264 pp. At head of title page; Glavnoe Upravlenie Gidrometeorologicheskoi Sluzhby pri Sovete Ministrov SSSR, Vysokogornyi Geoficheskii Institut. DAS M78.7 S9490.

This monograph presents the results of theoretical and experimental investigations on the process of formation and fall of shower precipitation and on the mechanism of hail formation carried out by the High Mountain Geophys. Inst. and the Lab. of Cloud Physics and Precipitation. Field experiments to influence hail processes carried out during 1961-1963 in the territory of the Kabardino-Balkar ASSR are also described. The contents of this book consist of the following: vertical currents in convective clouds including the calculations of the velocity of ascending currents in a stationary convective cloud, the radar method for determining the velocity of atmospheric currents in convective clouds, and the errors of measurement; distribution of velocity of ascending currents in a convective cloud on the basis of radar observations and comparison with computed data; the growth of drops and the formation of an accumulation zone in convective clouds including gravitational coagulation of cloud particles, the capture coefficient and its determination; calculation of the coagulational growth of cloud droplets in ascending currents with a consideration of the distribution of the velocity in ascending currents with height and calculation of maximum water content and amount of precipitation falling from convective clouds; the process of hail formation including the conditions of dry and wet growth of hail, temperature of natural crystallization, mechanism of hail formation in convective clouds and the most favorable temperature range for hail growth, downward movement of hail zones, rate of hail fall, hail paths, hail melting along path of fall; results of radar studies of clouds and precipitation; and method and results of action on hail processes including forecasting of hail phenomena from temperature stratification of the atmosphere with a consideration of advection and melting of hail below the zero isotherm, principle of action on hail processes, crystallization reagents, temperature threshold of crystallization and reagent dosage, methods of introducing the reagent into a cloud in order to prevent hail fall, organization of operations to influence hail processes, and experimental results of action of hail clouds. - MGA 17.8-29

190. Sutton, Graham. The resurgence of interest in the observational sciences. Weather, London, 20(6): 174-182, June 1965. DAS M(05) R888w.

By 'observational sciences' is meant those sciences which study naturally occurring events and use the measurements to formulate

theories that can be exploited by mathematical techniques to suggest other measurements or to predict future like events. The historical development of meteorological instruments is sketched very briefly with illustrations. Many ways of modifying the weather on a large scale have been suggested. The first steps must be towards encouraging more detailed observations throughout the world and to aim at solving the problems of the large-scale dynamics of the atmosphere; and the first step in this latter problem is to solve the problem of long-range forecasting. This article concludes with a discussion of the prospects for developing methods of modifying the weather or climate. The complexity of the atmospheric machine is described. - MGA 16.8-66.

191. Syono, S.; Isono, K.; Komabayasi, M.; Ono, A. Experiments of artificial rain-making in Japan. In: International Conference on Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965. Proceedings. Tokyo, May 1965. pp. 438 - 440. DAS M74.1 I61p.

The first Japanese experiments in the artificial stimulation of rain were made by Asada of Osaka Univ. in the spring of 1951. Since then the Tokyo Univ., the Japanese Met. Agency, and the Tokyo Electric Power Co. have formed a group to carry out experiments. Later other district research groups were formed and in 1952 the Committee on Rainmaking in Japan was formed. Seedings were carried out mainly from ground generators and occasionally with balloons, later on aircraft were used. Statistical investigations show an increase in the annual amount of rainfall due to seeding, but the result is not conclusive. - MGA 17.6-172.

192. Takeda, K. A quantitative determination of the amount of artificial precipitation in the case of dry-ice seeding. In: International Conference and Cloud Physics, Tokyo and Sapporo, May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 441 - 445. DAS M74.1 I61p.

A description is given of some results of seeding experiments carried out by the Kyushu branch of the Japanese Artificial Rainfall Corp. Dry-ice pellets of ~1 cm3 were dropped over clouds from an aircraft at the rate of ~1 kg/km for 20 - 30 km. A 3-cm radar was used. PPI and RHI patterns were continuously observed and fed to a computer to evaluate areal rainfall values which were compared with rain observations from a network of raingage stations. A particular experiment on March 6, 1964 is described fully. this calculations from the radar observations suggested an increase in point rainfall of 0.03-0.06 mm. This difference would be too small to be traced from raingage observations but would make a significant difference to the total areal rainfall. The curtain of artificial rainfall was effective for 100 km downwind. Repetitive seeding ~10 seedings in 2 hrs or so, would be expected to produce an increase of 100% in the point rainfall This is expected to be the upper possible limit of seeding. - MGA 17.6-173.

193. Todd, Clement J. <u>Ice crystal development in a seeded cumulus cloud</u>.

Journal of the Atmospheric Sciences, Boston, 22(1): 70-78, January
1965. DAS M(05) A512j.

A cumulus cloud was seeded by an aircraft flying 1780 meters below cloud base. An observation plane spiraled up through the cloud base and made replicas of the cloud particles while recording pressure altitude, temperature, mixing ratio, liquid water, and other factors. In the updraft below cloud base the temperature followed the dry adiabatic potential temperature curve. In the cloud, the temperature showed an increase above the pseudoadiabatic wet-bulb potential temperature. This increase corresponded to the development of ice crystals and was in the amount expected from the release of heat during freezing. The ice crystals were found slightly above cloud base, -9.50. The concentration increased in a manner which was consistent with the calibrated temperature activation curve of the AgI generator and the diffusion in the column of air above the seeding aircraft. The crystals were primarily unrimed hexagonal plates. - From author's abstract.

194. Tverskoi, N.P. <u>O rasseianii pereokhlazhdennogo tumana v akusticheskom pole</u>. (Dissipation of supercooled fog in an acoustic field.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 176: 51-59, 1965. Russian summary p. 51. DAS M(055) U581tg.

The apparatus and procedure for investigating the effect of sound oscillations upon a supercooled fog in an experimental chamber are described. The theoretical assumptions of the action of sound upon drops are discussed with the aid of König's equation describing the relationship between the degree of participation of particles in a sound field and the frequency of oscillation and the radius of the particles, and the equations for the acceleration acquired by droplets in a sound field and for the growth of mass and radius of the droplets. It is shown that the role of crystallization in a supercooled fog and the dissipation of the fog are determined by the following factors: the acoustical intensity of the radiator, the dimensions of the fog droplets and their water content, the magnitude of difference of the difference between saturated water vapor above the drops and over the ice crystals and the mean temperature of the fog. - MGA 16.8-169.

195. Uchevatkina, T.S. Raschety rosta kapel' i sfericheskikh ledianykh chastits v oblakakh pri estestvennom osadkroobrazovanii i pri aktivnykh vozdeistviiakh. (Calculations of the growth of drops and spherical ice particles in cloud during natural precipitation formation and during artificial modification.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 176: 3-12, 1965. Russian summary p.3. DAS M(055) U581tg.

Results of computations of the growth of drops and of spherical ice particles in clouds with uniform ascending currents during

natural processes of precipitation formation and during modification. The time of formation of processes after artificial modification and the dimensions of the particles of precipitation practically do not depend upon the initial dimensions of the ice nuclei when they vary from 10-0 to 10-4 cm. The duration of the process of precipitation formation during seeding at different heights (from 1.66 to 7.66 km above the base of a cloud) varies slightly from 12 to 14 min. The dimensions of cloud particles and the number of those falling as a result of seeding increase with a rise in the level of introduction of the reagents above the cloud bases. The minimum expenditure of the reagent ranges from 1.1 g/km² at a seeding level of 1.66 km (-4°C) to 0.3 g/km² at a seeding level of 2.66 km (-10°C). The limiting amount of precipitation falls after seeding may amount approximately to 1.6 and 4.0 mm. When the water content does not attain adiabatic values the amount of precipitation that may fall after modification decreases correspondingly. - MGA 16.8-353.

196. U. S. National Science Foundation. Weather modification. American Meteorological Society, Bulletin, 46(6): 294-308, June 1965. "Excerpts from the 6th Annual Report on Weather Modification, of the National Science Foundation." DAS M(05) A512b.

The Federal Government has responded vigorously to the heightened interest in weather modification as shown by a listing of its numerous activities. Guidelines are set for certain high-priority efforts, then divergent views on weather modification and the weather modification program of NSF for 1964 are reviewed. The highlights of basic research being conducted in the atmospheric sciences by various departments of the Federal Government are outlined. Notes are included on non-Federal weather modification activities. - MGA 17.7-187.

197. U. S. National Science Foundation. Weather modification. Sixth Annual Report for the fiscal year ended June 30, 1964. Its NSF 65-9, May 1, 1965. 68 pp. DAS M09.67 U585we.

This annual report on weather modification includes the following, viz: a summary of divergent views on weather modifications; the aims of the NSF Special Commission on weather modification and a list of the commission members; the weather modification program of the National Science Foundation for 1964 including the basic research in the atmospheric sciences, general circulation studies, turbulent interaction, aerosol chemistry, chemistry of true gases and atmospheric physics; the activities of the Dept. of Agric., the Dept. of Commerce, the Dept. of Defense (U. S. Air Force, U. S. Army and U. S. Navy), and the Dept. of the Interior in weather modification; Federal weather modification activities in the U.S. and activities in foreign countries; and a list of National Science Foundation grants and contracts for weather modification research in 1964. The various investigations are described and some of the results obtained are summarized. A table listing the weather modification programs funded by the

Federal Government in 1964 and a list of the advisory panels are presented. - MGA 16.10-217.

198. U. S. National Science Foundation. Special Commission on Weather Modification. Weather and climate modification; report of the Special Commission on Weather Modification. (NSF 66-3) 1965. 149pp.

DAS MO9.6 U5847we. Summary of the Report: in American Meteorological Society, Bulletin, 47(3): 166-183, March 1966. DAS M(05) A512b 47: 1966.

This report of the Special Commission on Weather Modification to the National Science Foundation contains the general results of the Commission's examination of the physical, biological, legal, social, economic and political aspects of weather modification and recommendations concerning future policies and programs. The contents of this report include the following, viz: the scientific basis of weather and climate modification, the present status of weather modification, accomplishments of the National Science Foundation and activities in foreign countries; the biological aspects of weather modification including the lines of investigation for predicting the consequences of weather modification, namely laboratory and computer simulation studies, predicted biological responses to weather modification such as crop yields, species extinction and disruption of natural communities, etc., statistical aspects of weather modification; precipitation oriented experiments; numerical modeling and simulation, and reports of the conference on statistical methodology, etc.; the human effects of weather and climate modification; legal and legislative aspects and weather modification and international relations, including international requirements of research, relation to U.S. foreign policy, international legal problems, etc; and the funding and administration of weather and climate modification activities. - MGA 17.7-19.

Voit, F. Ia. Raspredelenie vodnosti v Cu cong., podvergavshikhsia vozdelstvilam s tsel'iu vyzyvanila osadkov. (Distribution of moisture in Cumulus congestus which have been subjected to modification to induce precipitation.) U.S.S.R., Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Leningrad, Trudy, No. 47: 59-64, 1965. Russian summary p. 59. DAS M(055) U58ltu. Translated into English through the support and sponsorship of the U.S. Air Force. Cambridge Research Laboratories, Research Translation T-R-525, December 1965 by William J. Grimes. (American Meteological Society Contract no. AF 19(628)-3880. 12pp. DAS M(055) U58ltuE no. 47 pp. 59-64).

The relation of the vertical moisture distribution in Cu cong. to results of cloud seeding are discussed. Cu cong. layers 2200-3500 m deep are investigated. The results of investigations yielded information on moisture distribution in Cu cong. useful as a parameter in determining the value of reactions in rain production. - MGA 16.12-436.

200. Warburton, J.A. and Maher, C.T. The detection of silver in rainwater:

analysis of precipitation collected from cloud-seeding experiments.

Journal of Applied Meteorology, Boston, 4(5): 560-564, October 1965.

DAS M(05) J86joa.

Measurements were made of the concentration of silver in precipitation samples collected in areas of Australia where cloud seeding with silver iodide has occurred. Silver was detected in 41 of 63 'seeded' samples and in three of 23 'unseeded' ones. Values of concentration of the silver were between 3 x 10-12 gm ml⁻¹ and 4.8 x 10⁻¹¹ gm ml⁻¹. There is some evidence that silver is detected more frequently when the precipitation falls from seeded clouds which have top temperatures (<-150. - Authors' abstract.

201. White, Robert M. and Chandler, R. A. Project Stormfury: status and prospects. American Meteorological Society, Bulletin, 46(6): 320 - 322, June 1965. DAS M(05) A512b.

A report on the status and prospects of Project Stormfury. Its primary objective was to explore the structure and dynamics of hurricanes through a series of field experiments so that we may achieve a better understanding, improve prediction, and inquire into the feasibility of modifying some aspects of these destructive storms. It has been in progress since 1962. In 1963, Project Stormfury succeeded in carrying through a complex hurricane seeding experiment, as well as a series of tropical cumulus seeding experiments. The whole of 1964 was devoted to analysis of results. For 1965 Project Stormfury's plans were to improve as many as possible of the deficiencies of the 1963 experiments. An attempt was to be made to design and conduct the experiments in such a way that cause and effect can be clearly delineated. Although hurricane experimentation presents enormous potential rewards for the nation such experimentation is confronted with formidable obstacles, both scientific and logistic. - MGA 17.7-252.

202. Williams, Merlin C. Weather modification, University of Wyoming.
American Society of Civil Engineers. Hydraulic Division, Journal,
91(1): 93-104, January 1965. DAS P.

A general description is given of the weather modification research presently (1964) being conducted at the University of Wyoming. Completion of the second season of experimentation on April 1, 1964 verified rather interesting results obtained during the first season conducted in 1963. The experimental technique followed during the two-year period as well as the preliminary results obtained are briefly summarized herein. In addition, some indication of experimental area is given.

The results of the first two years of this project indicate that it may be possible to obtain definitive answers regarding weather modification effectiveness for a particular type of weather phenomenon. In view of the research progress to date, (1964),

indications of an expanded project for the future are also examined. Thus, an over-all picture of a continuing research project at the University of Wyoming is herein presented. - Author's abstract.

203. Yang, I.K. A preliminary survey for the seeding experiment in Korea.
In: International Conference on Cloud Physics, Tokyo and Sapporo,
May 24 - June 1, 1965, Proceedings. Tokyo, May 1965. pp. 434 437. DAS M74.1 I61p.

As a prelinary survey for a seeding experiment the following studies were undertaken. First, ice nucleus concentrations were studied to decide whether AgI seeding is an effective way to increase the amount of precipitation. The concentrations were measured in several ways. Concurrently, radioactivity of airborne dust and microscopic dust counts were also examined in order to investigate the origin of ice nuclei. On the other hand, for the purpose of confirming the effect of cloud seeding a network of 53 rain gage stations were set up in Seoul and its suburbs, this target area being selected for convenience sake, and the topographical influences on the fluctuation of daily amounts of precipitation were investigated. A direct method of detection of AgI in rainwater, developed by Isono and Warburton was also employed to check the scavenging efficiencies of water droplets falling through AgI aerosol. - MGA 17.6-174.

204. Yoshida, Sakumatsu. Evaluation of cloud seeding effect by statistical analysis of snowfall amount in the Tôhoku District, Japan. Sendai, Japan (Miyagi Prefecture) Tôhohu University. Science Reports, 5th series, Geophysics, 16(1): 37 - 47, February 1965. DAS P.

In every winter since 1953, ground-based seeding with silveriodide smokes has been carried out in the Tôhohu district,
northern part of Honshû, Japan, for the purpose of increasing
snowfall. The seeding effect which was evaluated by two ways of
statistical analysis of snowfall amounts, was as follows: (1)
From comparison of snowfall amounts for seeded and non-seeded
days under typical monsoon it was found that remarkable increase
of snowfall, reaching around 20 per cent on an average, occurred
50 to 100 km leeward of the seeding points on seeded days. (2)
Stochastic test for the ratio of ten day snowfall amounts at the
target points to those at the control ones on seeded periods
showed that the increased snowfall amount in the target area was
significant at the level of significance of 4 per cent. - Author's
abstract.

205. Zarea, St.; Căpuz, C.; Mija, Z. Experiente de stimulare artificială a precipitațiilor în bazinele unor centrale hidroelectrice. (Experiments in artificial stimulation of precipitation over the basins of certain hydroelectric power stations.) Rumania. Institutul Meteorologic, Bucharest, Culegere de Lucrări, 1963. Bucharest, 1965. pp. 227 - 238. Rumanian summary p. 227; Russian and English

Management, development and the main results of the stimulation of precipitation experiments carried out over the retention basins of the V. I. Lenin-Bicaz and Dobresti-Moroieni power stations, during 1963 are analyzed. Out of the 16 experiments carried out on the Omu and Piatra Craiului mountain peaks, within the area of the Dobresti-Moroieni power station, 8 can be considered successful, 5 inconclusive and 3 failures. Owing to the small number of seedings and to the conditions under which the experiments were carried out in the Bucegi massif, the results were not encouraging. Within the area of the catchment basin of the Bicaz power station 22 experiments were carried out on the Ceahlau -Toaca - Giumalau and Grințiesu mountain peaks. Out of these, 17 were successful, 4 inconclusive and 1 failed. Summing up, during 1963, 67% were successful, 22% inconclusive and 11% failed. As far as the experiments in the Bicaz area are concerned, satisfactory results call for several experiments in Rumania for a period 2 - 3 yrs which would bring a sufficient degree of certainty for the economic efficiency of the artificial stimulation of precipitation in view of increasing the output of electric energy of the hydroelectric power stations. - MGA 17.6-175.

206. Zarea, Ștefan. Orientări actuale în studiul și aplicarea technicii de stimulare artificială a precipitațiilor. (Present trends in the study and application of the technique of artifical precipitation stimulation.) Hidrotehnica, Gospodărirea Apelor, Meteorologia, Bucharest, 10(6): 316 - 322, June 1965. Russian, French, German and English summaries inside back cover. DAS M(05) H632.

The paper presents the systematization of the standpoints on the possibilities of the methods and on the importance of the results obtained during the last 2 decades in the experiments carried out for artificial influence upon certain meteorological elements. The experiments carried out in Rumania and abroad demonstrated that the mountainous zones in which there are reservoirs of power stations, represent the most adequate zone for an economic efficient application of the cloud insemination technique. In dissipating the clouds and the mist above the airports and hail control, carbon dioxide snow and silver iodide were used, good results being obtained. - MGA 16.11-188.

207. Zopf, David O. Engineering aspects of weather modification. Western Snow Conference, Thirty-third Annual Meeting, Colorado Springs, Colorado, April 20 - 22, 1965, Proceedings. pp. 100 - 108. Fort Collins, Colorado, Colorado State University. DAS M(06) W527p 1965.

The engineering aspects of a weather modification program are influenced to the greatest extent by the experimental plan -- which defines the purpose and methods to be used -- to a lesser extent by the variables to be measured and very seldom by the engineering state-of-the-art. The specific engineering expedients

adopted are a function of both scheduling and funding, but there is a very definite cross-over between the value of more time or more money in program start-up. Finally, the efficiency of the operation, while certainly dependent on the attitude and capabilities of the individuals involved is, we believe, a strong function of the original program planning and the options afforded the field organization in its day-to-day work. - Author's summary.

208. V uchrezhdeniiakh Gidrometeosluzhby. (In institutions of the Hydro-meteorological Service.) Meteorologiia i Gidrologiia, No. 2: 51, February 1965. DAS M(05) M589 1965.

The report includes information on experiments by the hydrometeorological institutions on weather modification in the area of TSelinograd and Tzans Ili Ala Tau. An increase of precipitation was observed at using lead iodide (in summer) and dry ice (in winter). - WMSU.

1966

209. Ackerman, Edward A. Economic analysis of weather: an ideal weather pattern model. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 61 - 75) (Chicago. University. Department of Geography, Research Paper No. 105: 61 - 75, 1966) DAS MO9.6 S989h.

The proposal for a design study for the economic analysis of weather modification proposed by the author in 1957 is summarized and a new design for a study of the economics of weather modification involving the investigation of the roles of weather inputs into the subsystems of economic production and consumption is proposed. For investigating the economics of weather inputs the concept of the ideal weather pattern model for geographical areas is proposed. Such a model is characterized by a particular zonal circulation and latitudinal pattern of insolation, specific quantitative and qualitative features of weather elements, selected economic and social components, and economic production and consumption elements. The uses of the ideal weather pattern model in the analysis of the economic effects of different weather patterns are examined. - MGA 17.11-205.

210. Anýz, František and Šrámek, Ladislav. Umělé zásahy do vývoje oblačnosti chemickými cinidly. (Artificial modification of cloud development by means of chemical agents.) Meteorologické Zprávy, 19(5): 139 - 146, 1966. Russian and English summaries p. 139. DAS M(05) M589me.

The most important stages of the development of the theory and practice of seeding supercooled clouds and fog in Czechoslovakia are examined. The methods of dispersion of AgI aerosol tested in the Inst. of Physics of the Atmosphere of the Czechoslovak Acad. of Sc. are described. Also the results of an experiment with a propane-butane generator in which an AgI solution was burned

in acetone are described in detail. Curves of size distribution of aerosol particles produced by means of the AgI generator and by pyrotechnic components serve to evaluate the methods for the dispersion. - MGA 18.6-238.

211. Appleman, Herbert S. Effect of supersonic aircraft on cirrus formation and climate. (Issued as AMS/AIAA Conference on Aerospace Meteorology, Los Angeles, California, March 28 - 31, 1966. AMS/AIAA Papers preprints, 66 - 369, March 1966. 10pp.)

It has been suggested that the proposed supersonic transports (SSTs), with their tremendously high fuel consumption and operating in the stable stratosphere, might produce such widespread and persistent Ci as to cause substantial changes in the radiation balance and eventually in the Farth's climate. This suggestion is examined in this note. It appears that a change in jet flight levels from the present 35,000 - 70,000 ft. would result in a large relative decrease in contrail frequency and in Ci resulting therefrom. There would be a sizable, but not necessarily significant, increase in water vapor and CO2 at 70,000 ft. Because of the greenhouse effect, some slight warming of the lower stratosphere would be expected. The degree of warming and the resulting effects on the circulation and climate, while probably small, cannot be ascertained without extensive study. - MGA 17.12-400.

212. Aujeszky, Lászlo and Kontur, G. The problem of artificial rainmaking.
U. S. Defense Intelligence Agency, Translation LN-552-66, September 25, 1966. 51pp. DAS MO9.617 A923p. "Translation of Das Problem der künstlichen Niederschlagerzeugung, issued as Hannover. Technical University, Report, Vol. 26, 1966."

The history of the developments in the U.S. and in Europe is briefly reviewed. The Weather Modification reports published annually since 1961 by the NSF are referred to. The basic knowledge of clouds including cloud formation, occurrence of ice crystals, and forming of precipitation, are discussed in Sect. 2 which also contains a survey of methods of cloud modification, i.e., nucleation of super-cooled clouds with CO2 and AgI, and spraying warm clouds with water and with hygroscopic materials. Sect. 3 describes the work in the U.S.S.R., U.S., Australia and 13 other countries including China where success was achieved in cloud transformation and not in producing precipitation. The practical (commercial) uses are treated in Sect. 4. The work of the Water Resources Development Corp., founded in 1950 by I. P. Krick, with central offices in Denver, Colo. and a special branch in Paris for European and African areas is discussed. successful Grand Coulee Dam operation is cited to indicate that cloud seeding with AgI is practical and economical on watershed areas several thousand km2 in size. The American Institute of Aerological Research established a corporation to evaluate its own results. North American Weather Consultants, of Goleta,

Atmospherics, Inc. of Fresno, and the Weather Modification Co. in San Jose, Calif. are mentioned. - MGA 18.4-236.

213. Barrows, J. S. Weather modification and the prevention of lightningcaused forest fires. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 169 - 182) (Chicago. University. Department of Geography, Research Paper No. 105: 169 - 182, 1966) DAS MO9.6 S989h.

Examines the characteristics of lightning-caused forest fires, the storms which produce them, and the role which weather modification may play in the overall program of lightning fire control with discussion of the following: the economic and social importance of forest fires caused by lightning in the U.S.; the nature of lightning storms and fires; the possible role of a successful weather modification program in reducing the very large number of lightning fires, in preventing lightning fires at critical places and in preventing lightning fires during periods of critical fire weather and high fire danger; a description of Project Skyfire; the research program aimed at the most critical features of the lightning fire problem including weather modification; a summary of the research results; and an outline of future research.

- MGA 17.11-209.

214. Bates, Marston. The role of weather in human behavior. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 393 - 407) (Chicago. University. Department of Geography, Research Paper No. 105: 393 - 407, 1966) DAS MO9.6 S989h.

The author discusses the interrelationship of climate and weather and man in the light of the concept of ecosystem. The discussion includes the following: microclimate, ecoclimate and geoclimate; the human environment and the human ecosystem; the relationship between climate and civilization; climate and psychology; climate and physiology; climate and race; the problem of atmospheric pollution; and the significance of weather control to man. The author is less than enthusiastic about extensive climatic modification. - MGA 17.11-462.

215. Battan, Louis J. Silver-iodide seeding and rainfall from convective clouds. Journal of Applied Meteorology, Boston, 5(5): 669 - 683, October 1966. DAS M(05) J86joa.

Summer convective clouds over a fairly isolated mountain range over southeastern Arizona were seeded by means of airborne silver-iodide generators. The selection of days to be seeded was made according to a randomization scheme involving the examination of pairs of days. After a program conducted during the period 1957 to 1960 failed to show that rainfall was increased, the experimental procedures were changed and a second set of tests were performed during 1961, 1962 and 1964.

This report deals with the analysis of rainfall measured by networks of recording rain gages over the mountain target. The data do not support a hypothesis that rainfall was increased as a result of the silver-iodide seeding. - Author's abstract.

216. Batten, E. S. The effects of nuclear war on the weather and climate.

The Rand Corporation, Santa Monica, California, Research Memorandum RM-4989-TAB, August 1966. 59 pp. bibl. pp. 55 - 59. DAS 507.2
R186r no. 4989 - TAB.

The possibility that the energy, the debris, or the radioactivity of nuclear detonations in large number may affect the climate and the weather is explored. Because of the complexity and the lack of thorough understanding of the interdependent meteorological processes, it is impossible today to predict the consequences of artificial atmospheric stimuli. This paper explores ways that the by-products of a nuclear war may interfere with the dynamical, hydrological, and radiational processes in the atmosphere.

The difficult problems of estimating quantitatively the weather and climatic changes are avoided except to emphasize the ambiguities of such estimates. The study indicates that the interference with the atmospheric processes in some cases can be sufficient to produce changes in them; however, it stresses that the nature, extent, and magnitude of the resulting anomalies in the weather and the climate are uncertain. - Author's abstract.

217. Beard, J. Taylor and Wiebelt, John A. Reflectance of a water wave surface as related to evaporation suppression. Journal of Geophysical Research, Washington, D. C., 71(16): 3843 - 3847, August 15, 1966.

DAS P.

An evaporation-reducing monolayer film on a water surface reduces the magnitude of the water waves. Such a reduction in the water waves also changes the reflectance of solar and sky radiation. If a sine wave contour for the water wave is assumed, theoretical values for reflectance can be determined as a function of the ratio of water wave amplitude to water wavelength and as a function of the angle of incidence. For diffuse irradiation, which would occur with a very overcast sky, presence of water waves decreases the theoretical reflectance up to 20%, depending on the ratio of the water wave amplitude to water wavelength.

- MGA 17.12-385.

218. Beckwith, W. Boynton. Impacts of weather on the airline industry:

the value of fog dispersal programs. (In: Sewell, W. R. Derrick

(ed.), Human dimensions of weather modification. Chicago, University

of Chicago Press, 1966. pp. 195 - 207) (Chicago. University.

Department of Geography, Research Paper No. 105: 195 - 207, 1966)

DAS MO9.6 S989h.

This paper includes the following: a historical account of airport fog dispersal attempts, data on the mean annual hours of super-

cooled fog with visibility <0.5 mi at 75 airports of the U.S., day ice seeding operations, analysis of seeding flights including a summary of supercooled fog seeding during the winter of 1963 - 64, the economies of airport fog dispersal, and expansion and refinement of airport fog dispersal. - MGA 17.11-220.

219. Beliaev, V.I.; Vial'tsev, V.V.; Pavlova, I.S. Opyt vozdeľstviia na pogodu pri zaseve tumana sukhim l'dom. (An experiment on weather modification by means of seeding of fog with dry ice.) Akademiia Nauk SSSR, Izvestiia. Fizika Atmosfery i Okeana, 2(6): 630 - 635, June 1966. Russian summary p. 630; English summary p. 635. DAS P. Translated into English in corresponding issue of its Izvestiya. Atmospheric and Oceanic Physics, issued Washington, D. C. DAS P.

The description and analysis of an experiment on weather modification by dispersing supercooled fog using dry ice from an airplane are presented. The analysis of the experiment shows that in southern regions of the U.S.S.R. it is possible to cause a considerable increase in the temperature of the air near the ground in this way. - MGA 17.11-221.

220. Berliand, M. E. Zashchita rastenii ot zamorozkov. (Protection of plants from frosts.) (In: Budyko, M.I. (ed.), Sovremennye problemy klimatologii. Leningrad, Gidrometeoizdat, 1966. pp. 412 - 434. Russian summary p. 412) DAS MB B927s.

An analytical treatment of the physical basis of the heating, smoking, fumigation, irrigation and sprinkling methods of plant protection, and of methods of forecasting frosts. Results of theoretical studies and data on the effectiveness of the methods are presented. A nomogram for readily computing the night minimum temperature at the instrument shelter level and instructions for its use are included. A graph of the decrease in the probability of frost damage with an increase in temperature shows that raising the temperature by 2.5-3° practically saves grapes in the European U.S.S.R. - MGA 18.12-172.

221. Bethwaite, F.D.; Smith, E.J.; Warburton, J. A.; Heffernan, K.J. Effects of seeding isolated cumulus clouds with silver iodide. Journal of Applied Meteorology, Boston, 5(4): 513 - 520, August 1966. DAS M(05) J86joa.

Isolated cumulus clouds with supercooled tops were seeded from an aircraft. Either a large (20 gm), small (0.2 gm) or zero quantity of silver iodide was used, with random choice of treatment. The amount of rain which fell from the cloud was measured at cloud base by means of an impactor on the seeding aircraft.

Clouds with tops -10C or colder which were treated with the larger quantity of silver iodide yielded significantly more rain than similar, untreated clouds. The mean rainfall from clouds seeded with the reduced treatment was also higher than that from the unseeded clouds, but the margin in this case was insufficient to demonstrate the statistical significance of the result. - Authors' abstract.

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222. Bowen, David. A new way of clearing fog. New Scientist, 32(524): 583, December 8, 1966. DAS P.

A description is given of a fog broom which has been successfully tested in laboratory conditions in New Jersey. A frame of Al, 2.5 ft wide, 4 ft in length and 2 in thick is wound in the direction of the longest dimension with monofilament nylon, .012" in dia., spaced at 10 strands/in, on the front and back faces of the frame, so that the strands in one plane are behind the spaces in the other. The fog broom rotates horizontally with the larger axis and the nylon strands in vertical orientation. The fog's moisture particles then collect on the fibres as a result of combined physical adhesion and electrostatic attraction. When they are heavy enough drops run down the strands and fall off the broom at the bottom. Outdoor experiments are planned to follow the successful laboratory trials. The idea originated from studies in Chile undertaken to examine the possibility of extracting moisture from fogs in desert areas. - MGA 18.5-179.

223. Bowen, E. G. The effect of persistence in cloud seeding experiments.

Journal of Applied Meteorology, Boston, 5(2): 156 - 159, April 1966.

DAS M(05) J86joa.

A basic assumption made in the design of most cloud seeding experiments is that each seeded period is independent of those which preceded it, i.e., that no cumulative effects are present. It now appears that this assumption is not entirely valid.

An investigation is made of the effect of persistence in a typical cloud seeding experiment and it is shown that one consequence is an apparent reduction in the result of seeding with time. There is reason to believe that this has actually occurred in many cloud seeding experiments.

A modified design of experiment is suggested which will indicate whether cumulative effects have occurred and will allow a more accurate assessment of the overall result of cloud seeding. - Author's abstract.

224. Boyko, H. Ancient and present climatic features in South - West Asia and the problem of the antique mounds of grapes ("Teleilat el - 'Anab") in the Negev. International Journal of Biometeorology, Amsterdam, 10(3): 223 - 231, December 1966. DAS M(05) I6lin.

The author examines in detail the hypothesis that the ancient grape mounds in the Negev were built in order to cultivate plants in such a way that the "subterranean dew" condensed therein in the cool morning hours could be used by the roots of the plants, chiefly grape vines. This hypothesis is then compared with the hypotheses that the mounds of stones resulted from excavations of pits in which grape vines were planted, or that they were left on slopes after cleaning in order to provide a better runoff with a greater influx of nutritive material to fields in the wadi.

Climatic data of 2000 yrs ago from various literary sources are compared with present climatic data and it is concluded "that neither the yearly course and amount of precipitation nor the course and degree of temperatures have significantly changed in our times since the beginning of the Christian era." If the higher frequency of thunderstorms in the 6-mo period from April to Sept. is taken as a sign of higher humidity then there is a possibility that dew formation was also more frequent and/or heavier than today, On the basis of examination of the structure of the mounds, of the heat capacity and conductivity of the stones and the possibility of their maximum heating by day and cooling by night so that they are ideal for dew condensation, and on the basis of experimental evidence of the amount of dew formation with such mounds, etc., the author concludes that the hypothesis that the mounds were used to further dew formation is more valid than the other hypothesis. - MGA 18.10-449.

225. Braham, Roscoe R., Jr. Project Whitetop, a convective cloud randomized seeding project. Chicago, University of Chicago, Department of the Geophysical Sciences, August 1966. 156pp. Part I. Design of the experiment. Part II. Summary of operations. "Consists of the first two of a series of reports describing and giving results from a cloud seeding experiment carried out by the University of Chicago under support from the National Science Foundation." DAS M74.1 B813pr.

Pt. 1 contains the following: the period and location of the research activity of Project Whitetop in Missouri, design of the cloud seeding experiments including selection of operational days and daily routine, definition of the seeding line, procedure for estimating the plume position, selection of time and altitude of seeding, characteristics of AgI generation and AgI solution, data for assessing the experimental results, radar and radar site, rain gage network, the measurement airplane, etc. Pt. 2 gives a chronological list of all calendar dates during which the project was in the field and the days selected for the randomized seeding tests and a summary of the basic research on cloud physics obtained during Project Whitetop. Appendices include the following: site selection study, definitions of criteria for "operational days," analysis of objective criteria used in cloud seeding research, examples of a daily flight log for the seeder pilot, and radar film data codes. - MGA 18.4-237.

226. Budyko, M.I.; Drozdov, O.A.; Iudin, M.I. Vliianie khoziaistvennoi deiatel nosti na klimat. (The effect of economic activity on climate.) (In: Budyko, M.I. (ed.), Sovremennye problemy klimatogii. Leningrad, Gidrometeoizdat, 1966. pp. 435 - 448. Russian summary p. 435) DAS M8 B927s.

Three leading climatologists of the U.S.S.R. discuss the effects of human activity (irrigation, deforestation, construction of reservoirs, urbanization, shelter belts, land drainage) which in the past affected only the local microclimate. With rapid industrialization and power production there are prospects of

changes of the climate over vast areas. To arrive at the possible effects the indexes of power production are compared with those of the energy of meteorological processes. An analysis of publish_ ed data (Budyko 1962, Budyko et al. 1962) shows a 4% annual rate of increase in power production or a doubling of power every 17 yrs. With such a rate the total power produced by man will equal the radiation balance in < 200 yrs; with an annual rate of 10%, (assumed by some authors) this will happen in <100 yrs. The heat generated by highly industrialized cities which if not removed by air currents could raise the temperature in them by tens of degrees, and other factors such as reduction in evaporation heat losses leading to additional heating of the air by increased turbulent heat emission, and air pollution are discussed. It is estimated that the actual increase in temperature of cities ranges from several tenths to 1-2°. The rise in temperatures and reduction in evaporation reduce the relative and absolute humidities. Wind speed is sharply reduced. Increased vertical air currents lead to increased summer precipitation in some cases. The effects of irrigation, and drainage and of shelter belts are discussed in considerable detail. The effects of the latter on the meteorological, hydrological regimes and on crop yields are illustrated in a block diagram. The effects of reservoirs are shown to be much greater in arid than in humid regions. - MGA 18.12-397.

227. Budyko, M.I. Vozmozhnost izmeneniia klimata pri vozdeistvii na poliarnye l'dy. (Possibility of climate-changing by modification of polar ice.) In: Budyko, M.I. (ed.), Sovremennye Problemy Klimatologii, Leningrad, Gidrometeoizdat, 1966. pp. 347 - 357. Russian summary p. 347. DAS M8 B927s. Translated into English as U. S. Joint Publications Research Service, JPRS, No. 43,482, November 28, 1967. 15pp. DAS M09.6 B927pos.

Discusses the stability of polar ice (PI) and its relation to the thermal regime of the Arctic. The possibility (in principle) of controlling the PI is considered. An analysis shows that lower summer temperatures at high latitudes (than at the equator) cannot be explained by lower total incoming total radiation Q. The annual courses of Qm and Qo and of absorbed radiation at 80°N and at the equator (Q_{∞}') , presented graphically, show the effect of high albedo of snow in the Central Antarctic. The enormous effect of the snow cover is illustrated by a computation showing that with snow and ice over the entire Earth its present average temperature (+15°C) would be reduced by ~100°, Northern Hemisphere charts for March and Aug. show good agreement between observed boundaries of floating ice and those computed by Zubenok (1963) using the method of successive approximations for determining the quantitative relationship between ice thickness and climatic factors. To arrive at the positive air temperature anomaly sufficient for complete destruction of perennial ice, the effect of PI on the thermal regime is determined by computing the temperature distribution in the absence of ice and comparing the results with the observed present distribution. The author's calculations (Budyko, 1961, 1962) based on simultaneous solution

of the heat balance and air mass transformation equations, and Rakipova's (1962), who used the general climatic theory equation, led to the conclusion that PI substantially reduces air temperatures in high latitudes. An additional example of a simple evaluation shows that PI reduces temperature of the Central Arctic by 30 - 35° in the winter and by 5° in the summer. With the presented method it was established that a positive summer temperature anomaly of only 2° is sufficient to destroy the perennial ice. It is concluded that the present land-sea area distribution results in a considerable instability of the ice regime which probably was one of the important causes of Quaternary glaciation. Without discussing the various possible ways of doing it the author states that with the technology of the near future, destruction of PI could become feasible. The discussed consequences of such destruction can, however, be both beneficial and harmful. - MGA 20.5-182.

228. Buikov, M. V.; Sigal, V.I.; Tarasiuk, V.K. <u>Kinetika obrazovaniia</u>

iskusstvennykh osadkov i rasseianiia <u>pereokhlazhdennykh sloistykh</u>
oblakov s pomoshch'iu tverdoi uglekisloty. (Kinetics of artificial
precipitation formation and of dissipation of supercooled stratus
by means of dry ice.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii
Gidrometeorologicheskii Institut, Trudy, No. 53: 3 - 94, 1966.
Russian summary p.3. DAS M(055) U581tu.

The problem of the action of particles of solid CO2 or of ice crystals introduced into supercooled stratified clouds is investigated. A system of equations describing the kinetics of the action are developed and a simplification enabling reduction of the problem to a solution of the problem of the growth of crystals in the case of constant supercooling is accomplished; with the aid of this solution it is possible to calculate the kinetics of precipitation and the temporal development of a region with zero water content (clearing). On the basis of a study of different models (without consideration of turbulence, with consideration of turbulence but with neglect of the fall of crystals, etc.) it appears that the decisive role in the formation of a clearing, in addition to condensation growth, is the horizontal turbulent transport and sedimentation of crystals; vertical turbulent transport plays a fundamental role in the duration of precipitation. Formulas are derived for the time of appearance of a clearing, its maximum width, the minimum number of crystals necessary for the formation of a clearing, and for the total amount of precipitation. The wind shear whose presence increases the discharge of the reagent is calculated. The influence of 2 seeding lines upon each other and also the influence of nonsimultaneous seeding are investigated. The effect of rotation of wind direction with height is examined for an infinite seeding line. The effectiveness of the number of crystals introduced into a cloud is determined on the basis of experimental data. The problem of the temperature threshold of the action of solid CO2 and of the influence of the shape of the crystals is discussed. - MGA 18.6-237.

229. Bulkov, M. V. and Fridman, A. M. O kinetike obrazovaniia iskusstvennykh osadkov iz pereokhlazhdennykh kuchevykh oblakov s pomoshch'iu tverdol uglekisloty. (Kinetics of artificial precipitation formation from supercooled cumulus by means of dry ice.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 53: 95 - 109, 1966. Russian summary p. 95. DAS M(055) U581tu.

The condensation and coagulation growth of particles in Cu clouds during seeding with solid CO2 is investigated. The fraction of nuclei introduced into the supercooled part of a cloud increasing to 50 µ is calculated as a function of the parameters of the cloud. The final dimensions of particles falling from a cloud and growing as a result of condensation and coagulation processes are calculated. The duration of artificial precipitation as a function of cloud parameters is computed. The kinetics of the action upon the cloud is calculated by taking into account turbulent transport in a horizontal direction. shown that a considerable portion of the crystals may be carried beyond the lateral boundaries of a cloud. It is concluded that some reserve of clouds suitable for seeding may be found among clouds of the 2nd, 3rd and 4th groups (as classified by G. F. Prikhot'ko) with small supercooled particles and great thicknesses. since the small dimensions of the supercooled particles can be compensated by the large dimensions of the crystals that are introduced. - MGA 18.6-240.

230. Bychkov, N.V.; Iartseva, N.N.; Bromberg, A.V. <u>Issledovanie</u>

l'doobrazuiushcheï aktivnosti aerozoleï metal'degida i florogliutsina.

(Investigation of ice forming activity of metaldehyde and phloroglucinol aerosols.) U.S.S.R. Glavnaia Geofizicheskaia

Observatoriia, Leningrad, Trudy, No. 186: 3 - 9, 1966. Russian summary p.3. DAS M(055) U581tg.

The chemical and physical properties of metaldehyde and phloroglucinol are described and their use in cloud seeding is reviewed. The method of preparing metaldehyde is described. This is followed by an investigation of the ice forming activity of metaldehyde and phloroglucinol obtained by thermal dispersion by sublimation in a current of hot air. Data on the production of ice crystals as a function of the temperature of a fog in a cloud chamber are given for metaldehyde and phloroglucine in a table and a graph. The curve lg N(T), where N= ice crystals and T= fog temperature, for phloroglucine has the slightly convex form with a steep drop towards higher temperatures characteristic of ice forming substances. Between temperatures —4 and 0°C the advantage is on the side of the metaldehyde aerosol. The activity of both aerosols is fully comparable to AgI smoke. — MGA 18.8-201.

231. Castle, Emery N. and Stoevener, Herbert H. The economic evaluation of weather modification with particular reference to agriculture. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 141 - 158)

(Chicago. University. Department of Geography, Research Paper No. 105: 141 - 158, 1966) DAS MO9.6 S989h.

The authors discuss economic evaluation such as increment analysis, benefit-cost analysis, production function analysis, and implied marginal analysis, both in general terms and with reference to weather modification. This is followed by an empirical analysis of the economic significance of precipitation and temperature in agriculture. The comparative values of irrigation water under alternative irrigation patterns and the cost and benefits of cloud seeding as compared with alternative means of meeting weather variability in the Great Plains, are discussed. The role of temperature in agriculture is examined with the aid of examples of animal production. - MGA 17.11-208.

232. Chuvaev, A.P. K issledovaniiu resursov iskusstvennogo uvelicheniia osadkov iz konvektivnykh oblakov v rajonakh nedostatochnogo uvlazhneniia. (Investigation of potentialities for artificial increase of precipitation from convective clouds in areas with insufficient moisture.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 186: 49 - 62, 1966. Russian summary p. 49. DAS M(055) U581tg.

An attempt is made to characterize the degree of development of the water supplies of large convective clouds under natural conditions on the basis of an analysis of network observations of clouds and precipitation at individual points in regions with insufficient moisture. Hourly observations on clouds and precipitation from 1954 - 1958 at the Kursk, Khar'kov, Donetsk, Rostov, Mineral'nye Vody and Aktubinsk stations were used. Similar data for Tiflis and for individual points of the basin of Lake Sevan were used for the purpose of comparison. The formation of these clouds and the precipitation associated with them are investigated with particular reference to the determining of the conditions and times of effective cloud modifications. Extensive data in tables and graphs are given on the precipitation and cloud regime. - MGA 18.8-407.

233. Clawson, Marion. The influence of weather on outdoor recreation. (In: Sewell, W.R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 183 - 193) (Chicago. University. Department of Geography, Research Paper No. 105: 183 - 193, 1966) DAS MO9.6 S989h.

The nature of outdoor recreation is examined. The effect of climate and weather, in particular the former, upon outdoor recreation activities is discussed. The possible effects of weather modification upon outdoor recreation and kinds of weather modification are considered. The discussion includes the possible effects of large scale regular and dependable modification, of small scale weather modification affecting timing of weather occurrences rather than their frequency or magnitude, effect of weather modification on concentration or peaking of outdoor activities, the regional effect of weather modification, etc.

234. Colón, José A. On the mechanisms for the production of rainfall in Puerto Rico.

Weather Bureau, Southern Region Technical Memorandum no. 15, June 1966. 12pp. DAS M(055) U587sot.

In this nontechnical talk presented at the Conference on Water Resources in Puerto Rico, held on March 23 - 24, 1966 in Mayaguez, P.R., the author describes the work of the USWB in P.R., reviews the rain making and other studies that have contributed greatly to the knowledge of rainfall processes in the tropics. This is followed by a discussion of the present status of artificial rain stimulation (which is still inconclusive); fundamental principles of the natural rainfall process; and of the rain-producing factors in P.R. It concludes with a discussion of rainfall distribution, the peculiarities of which require further study. A map of mean annual precipitation (1931 - 55) is appended. - MGA 18.1-141.

235. Cot, P.D. and Serpolay, R. Les recherches de dissipation thermique des brouillards réalisées à l'aéroport d'Orly. (Research on the thermal dispersal of fog at Orly Airport.) Journal de Recherches Atmosphériques, Clermont - Ferrand, No. 2 - 3, April - September 1966. pp. 171 - 177. English summary pp. 171 - 172. (International Symposium on Condensation Nuclei, 6th, Albany, N.Y. and University Park, Pa., May 9 - 13, 1966, Proceedings.) DAS M(05) J86jor Sec. 2.

The process of fog dispersal by the thermal method involves the heating up of the local atmosphere by mixing with hot gases emitted from generators. Taking into account the external temperature and the water produced by the burning of the fuel, calculations indicate that the theoretical heating increase ΔT needed for evaporating the cloud droplets in most "warm" fogs is between 1.6 and 2.5°C. At Orly Airport an experimental method of measurement has been developed for the purpose of delimiting simultaneously—the iso- ΔT surfaces in the volume disturbed by the mixing and the volume where the clearing-away is obtained. - MGA 18.9-203.

236. Crawford, Norman. Hydrologic consequences of weather modification:

case studies. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 41 - 57) (Chicago. University. Department of Geography, Research Paper No. 105: 41 - 57, 1966) DAS MO9.6 S989h.

The consequences of weather modification in hydrological regimes such as the volume and time distribution of flows in rivers and streams and in watershed moisture conditions in different geographical areas are examined. The methods used are digital simulation models representing natural watershed and calculating the results of modification of precipitation and evapotranspiration. The computational procedure is described briefly and the results of test simulated for points in Kentucky, California

and New South Wales, Australia, are presented in tables giving total changes in rainfall, potential, and actual evapotranspiration, runoff, and soil moisture. The trials reveal the sensitivity of streamflow to relatively small changes in regime. In order to modify overall response, changes in rainfall appear generally more effective than changes in potential evapotranspiration; but the effects resulting from changes in the latter are by no means small. - MGA 17.11-204.

237. Crozier, C. L. and Holland, J. D. Cloud seeding to influence rainfall:

its importance and present status. 1966? 40 pp. Bound with this:

Translated into French with title L'ensemencement des nuages comme moyen d'influer sur les chutes de pluie: son importance et son état actuel. (34pp.) At head of title page: Department of Transport,

Meteorological Branch. DAS MO9.617 C953cl.

This survey of cloud seeding to influence rainfall, with particular reference to Canadian conditions considers the importance of water to the national economy, the potential value of cloud seeding, and the theories, methods and techniques behind cloud seeding attempts. Also discussed are the problems of the design of cloud seeding experiments and of their assessment, and the dual nature of cloud physics research—knowledge vs. application. A brief history of weather modification attempts by cloud seeding in Canada and other countries is given. The concluding section states that it has been demonstrated beyond any reasonable doubt that under certain atmospheric conditions, clouds can be modified to induce rain which would not normally have fallen and that there is considerable hope that with adequate research funds, personnel and time, the physics of precipitation mechanisms will be clarified and that positive weather modification techniques will be developed, tested and proven. - MGA 18.3-265.

238. Crutchfield, James A. Investment in weather modification research:

objectives, incentives and applications. (In: Sewell, W. R.

Derrick (ed.), Human dimensions of weather modification. Chicago,
University of Chicago Press, 1966. pp. 363 - 371) (Chicago. University. Department of Geography, Research Paper No. 105: 363 - 371,
1966) DAS MO9.6 S989h.

The theme of this economic analysis of weather modification research and application is as follows: scientific research on weather modification must be regarded as an investment decision comparable to other decisions to defer current output of goods and services in order to increase future productive capacity of society. It is argued that the very nature of weather modification procedures and their results are such that the normal market forces will not provide incentives for the proper kind of research even though the probability of beneficial results to society is high. A balanced program of weather modification research at an appropriate level will require a substantial degree of government participation. The balancing and compensation procedures must be undertaken by

a public agency since both benefits and damages are likely to be involved. The extensive nature of the impact of weather modification will require the creation of new administrative agencies for applying the results of measurements of benefits and losses. - MGA 17.11-218.

239. Curry, Leslie. Seasonal programming and Bayesian assessment of atmospheric resources. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 127 - 138) (Chicago. University. Department of Geography Research Paper no. 105: 127 - 138, 1966) DAS MO9.6 S989h.

The planning of seasonal farming activities influenced by soil moisture balance on the basis of statistical analysis of historical climatic data on precipitation evapotranspiration and soil moisture levels, is examined. The need for a statistical climatological model of the atmosphere for an understanding of the physical effects and economic consequences of cloud seeding, is stressed. The use of Bayer's theorem of a priori probabilities with empirical probabilities of climatological data (also including cloud seeding effects) is proposed. - MGA 17.11-223

240. Decker, Wayne L. and Schickedanz, Paul T. Project Whitetop, a convective cloud randomized seeding project, Part IV, a summary of the rainfall analysis. Chicago, University of Chicago, Department of Geophysical Sciences, October 15, 1966. 362pp. "Part IV of the Final Report on Project Whitetop." DAS 74.1 D295pro.

The objective of the research was to identify and isolate physical processes associated with the production of rain in summer convective clouds, and to study the ways in which these processes are modified by seeding with AgI. The experiment was conducted from 1960 through 1964 in a research area in southern Missouri enclosing a region within 60 mi of the radar site. The locations of the 49 recording rain gage (28 of U.S.W.B. and 21 of Univ. of Chicago) are shown and listed. The hourly rainfall is shown in the appendices. Presented analyses of the Chicago and Mo. plumes including "t" tests suggest a negative effect of the cloud seeding. An analysis of shower intensities showed that the difference between the in-plume and out-plume treated areas was not significant. - MGA 18.7-257.

241. Dennis A. S. and Kriege, D. F. Results of ten years of cloud seeding in Santa Clara County, California. Journal of Applied Meteorology, Boston, 5(5): 684 - 691, October 1966. DAS M(05) J86joa.

Ten seasons of commercial cloud seeding in Santa Clara County, California, are evaluated using target and control stations selected in 1955. Comparison of the linear regressions of target rainfall upon control rainfall, using seasonal totals, for the seeded winters and for ten immediately preceding ones gives evidence for a net increase in target precipitation. Examination of the rainfall distribution within the target area, which was

not a part of the original evaluation plan, shows that seeding effects are concentrated downwind of the highest part of the Santa Cruz Mountains, which form the southwestern boundary of the target area, and suggests that they are limited to periods of convective instability. - Authors! abstract.

242. Deveau, J. La lutte de l'homme contre la neige. (Man's fight against snow.) La Météorologie, Paris, Ser. 4, No. 79: 217 - 258, July - September 1965, issued 1966. French, English and Spanish summaries p.217. DAS M(05) M589v.

The purpose of the author is to delineate the basic principles of man's fight against snow, emphasis being on protection rather than on technical details, in view of the difficulties encountered in shielding practices and the removing of snow from roads, railways, airports, etc. Ch. 1 is devoted to snowdrifts and drift snow: terminology, snowdrifts and sand dunes, protective devices (preventive measures and various devices, i.e., Rudwicki's pyramids, removable fences of Wurzel, solid walls, tilted screens of Howic, continuous screens, lattice shields, forest belts, etc.). In Ch. 2 the author deals with avalanche danger; the numerous protective devices, i.e., the role of forests, protective walls, tunnels and galleries, fences, etc.; artificial setting in motion of avalanches; and a paragraph devoted to signaling devices and aid in case of catastrophes. In Ch. 3 the problems of clearing roads covered by snow are considered-static apparatus, dynamic apparatus, and other means. In his conclusions the author praises investigations made for a better knowledge of the properties of snow and its evolution, what should lead to new discoveries, and useful experimentation in the fight of man against snow. - MGA 18.6-456.

243. Droessler, Earl G. Atmospheric sciences and society. American Meteorological Society, Bulletin, 47(7): 518 - 521, July 1966. "Speech presented at the National Meeting of the AMS with the Pacific Division, AAAS, June 15, 1966, Seattle, Wash." DAS M(05) A512b.

Comments on the meeting of a small group of physical and social scientists to plan a pioneering study with the working title Human Dimensions in Weather Modification whose purpose is to establish ways to measure and predict the great variety of potential impacts on human activity that may be caused by weather modification. The author suggests that the fact that this group is undertaking this study underlines the growing belief that we are indeed on the threshold of great social usefulness for this area of knowledge we call the atmospheric sciences. The group concluded that in order to be able to measure the impact of weather modification, it is first necessary to devise techniques to measure the impact of weather itself on society and then to study the potential effects of all kinds of changes in man's interaction with the weather. - MCA 18.2-160.

244. Droessler, Earl G.; Howell, Wallace E.; Suomi, Verner E.; Weickmann, Helmut K. The role of the professional meteorologist and his society in a national program of weather modification. American Meteorological Society, Bulletin, 47(4): 279 - 286, April 1966.

DAS M(05) A512b.

Wallace E. Howell, Helmut K. Weickmann, and Verner E. Suomi discuss the role of the professional meteorologist in a national weather modification program, the role of the American Meteorological Society in such a national program, the role of the professional meteorologist in the American Meteorological Society, the contribution of the university meteorologists, etc. - MGA 17.11-199.

245. Drozdov, O.A. <u>Vozdeľstvie na vlagooborot</u>. (Modification of the hydrologic cycle.) (In: Budyko, M.I. (ed.), Sovremennye problemy klimatologii. Leningrad, Gidrometeoizdat, 1966. pp. 384 - 392. Russian summary p.384) DAS M8 B927s.

The possibility of increasing precipitation of a given area by influencing the moisture circulation is discussed. It is shown that both indirect and direct influences and a change in the moisture circulation are possible and even actually result from man's activity. It is noted that changes resulting from such influence may not always be desirable (for instance, melting of the Arctic ice). The effects of works of man such as afforestation or deforestation of large areas, reservoirs and others are too small to be noticed without special study. - MGA 18.12-177.

246. Duncan, A.D. The measurement of shower rainfall using an airborne foil impactor. Journal of Applied Meteorology, Boston, 5(2): 198 - 204, April 1966. DAS M(05) J86joa 5: 1966.

Size spectra of raindrops are deduced from samples of shower rainfall obtained at cloud base during the course of a cloud seeding experiment. Estimates are made of the errors to be expected when an aircraft impactor is used a) to sample rain by making one pass through it, and b) to derive the total flow of water from a cloud using measurements made during repeated passes through rain from the cloud and assuming a particular cloud model. The sampling error in the total flow of water from a cloud is found to be about 14 per cent for the smaller clouds, falling to about 3 per cent for the larger ones, which is satisfactory for cloud seeding experiments. - Author's abstract.

247. Dye, J.E. and Hobbs, P.V. Effect of carbon dioxide on the shattering of freezing water drops. Nature, London, 209(5022): 464-466, January 29, 1966. DAS P.

Reports experiments in which the effect of the presence of CO2 on the shattering process was investigated. Drops were frozen in an environment of ordinary air carrying out the nucleation, first with ice crystals or liquid nitrogen and then with solid

 ${\rm CO}_2$. Shattering took place only when ${\rm CO}_2$ was present. A second series of experiments was carried out in which definite concentrations of ${\rm CO}_2$ were introduced into the cloud chamber. The results show that the probability of shattering increases rapidly as the concentration of ${\rm CO}_2$ increases, that provided a liquid drop has been situated in an environment containing a relatively high concentration of ${\rm CO}_2$ shattering will take place even though the nucleating temperature is below $-5\,^{\circ}\mathrm{C}$, and that the shattering may be due to the fact that ${\rm CO}_2$ is more soluble with respect to liquid water than with respect to ice. It is suggested that cloud under natural conditions may never experience this shattering of drops, and that seeding experiment might be more effective if ${\rm CO}_2$ was introduced into the cloud before seeding. - MGA 17.8-412.

248. Eberly, Donald L. Weather modification and the operations of an electric power utility: the Pacific Gas and Electric Company's test program. (In: Sewell, W.R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 209 - 226) (Chicago. University. Department of Geography, Research Paper No. 105: 209 - 226, 1966) DAS MO9.6 S989h.

The test program initiated by the Pacific Gas and Electric Power Utility in order to determine whether modification by cloud seeding would be a better source of power than other possible alternatives is described. Also the factors that must be considered in evaluating the economic value of weather modification are examined. The contents of this paper are as follows: a discussion of the need for field testing of cloud seeding; the Lake Almanor, Calif., cloud seeding test including the selection of a suitable site control of the seeding; the experimental design and measurements; possible alternatives including improved efficiencies, possible delay of capitol expenditures and sources of energy; investigation of potential benefits from cloud seeding for different watersheds; factors influencing the values of benefits, namely variation in thermal fuel costs and optimization of the use of water; and cost/return ratios. - MGA 17.11-224.

249. Elliott, Robert D. Effects of seeding on the energy of systems.

Journal of Applied Meteorology, Boston, 5(5): 663-668, October 1966.

DAS M(05) J86joa.

Maps of hourly precipitation have been prepared for storms during the 1957-1960 Santa Barbara randomized seeding program. In non-seeded storms, they showed that approximately N-S oriented precipitation bands could be tracked eastward across the area. Similar maps for seeded cases showed that the bands were obscured by a strong stationary E-W oriented orographic band (the mountain range is oriented E-W).

Hourly station reports were arrayed in a table for each hour where row averages revealed the amplitude of the orographic effect and column averages that of the band effect. Row variance is related to the energy of the orographic precipitation-producing circulations, column variance to the band energy, and the residual variance, obtained by subtracting row and column variances from the total variance, to the energy of smaller-scale convective circulations. Attention was confined to the 7 hours of heaviest precipitation in each system.

In comparing seeded to non-seeded periods, the mean precipitation rate was almost five times as great. The proportion of the total variance in orographic form was more than double, the band variance was essentially the same, while the convective variance was less than a third of the non-seeded proportion.

It is concluded that the distribution of energy was shifted from smaller to larger scale circulation systems in going from non-seeded to seeded cases. The practical implications with respect to cloud seeding are discussed and illustrated by the results from two seasons of single generator tests made in the 1957-1959 period in the San Gabriel watershed near Los Angeles. - Author's abstract.

250. Fedorov, E. K. Nekotorye itogi i perspektivy nauchnykh rabot institutov Gidrometeorologicheskoi sluzhby (1965 - 1966gg.) (Some results and aspects of researches by institutions of the Hydrometeorological Service: 1965-1966.) Meteorologiia i Gidrologiia, No. 6: 3-11, June 1966. DAS M(05) M589 1966.

Weather modification is considered one of the most important problems in this report. Noticeable progress was reached in dispersion of supercooled fogs and clouds over the airports and in hail suppression by seeding. The area protected from hail damage in 1966 should be 800-900 thousand ha. The Central Geophysical Observatory and the Institute of Applied Geophysics continue theoretical researches on the problem of climate modification. - WMSU.

251. Fukuta, N. Experimental studies of organic ice nuclei. Journal of the Atmospheric Sciences, Boston, 23(2): 191-196, March 1966. DAS M(05) A512j.

The ability of 329 selected organic compounds to nucleate ice has been tested by three methods. Their activity was found to depend strongly on the method of preparation. More than 20 compounds were found to nucleate ice at temperatures above —50 when freshly ground. Some meta and para derivatives of benzene showed excellent activity. Particles prepared by condensation were less active, the only newly-discovered material effective above —50 being 1,5 dihydroxynaphthalene. Its use as a cloud seeding agent is suggested.

Crystals of effective materials generally have molecules which

display rotational symmetry. The role of molecular symmetry is discussed in connection with the formation of crystal planes with dense hydrogen bonding groups. The behavior of organic nuclei with nonsymmetrical molecules is also considered. - Author's abstract.

252. Fukuta, N.; Heffernan, K.J.; Thompson, W.J.; Maher, C.T. Generation of metaldehyde smoke. Journal of Applied Meteorology, Boston, 5(3): 288-291, June 1966. DAS M(05) J86joa.

A technique has been developed for generating fine particles of metaldehyde for possible use in nucleating ice in supercooled clouds. The number of particles effective as ice nuclei is 10¹² gm⁻¹ at -12C and 6 x 10⁹ gm⁻¹ at -4C.

Attention is drawn to the unusual rapidity with which concentrated metaldehyde smokes coagulate. The evaporation of the particles has also been studied. - Authors' abstract.

253. Garrison, W.I. Evaluation of consequences of modifications to weather and climate. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 77-90) (Chicago. University. Department of Geography, Research Paper No. 105: 77-90, 1966) DAS MO9.6 S989h.

The author discusses the ways in which knowledge of social and economic consequences might be used to formulate programs of modification of weather and climate. The approach is based upon a parallel between weather modification and transportation. The characteristics of the system to be modified are examined in terms of inputs, internal system relationships, outputs and control properties. The structure of a decision making scheme is described. - MGA 17.11-206.

254. Gel'mgol'ts, N. F. Oblachnye resursy Severnogo Kazakhstana primenitel'no k probleme iskusstvennogo vyzyvaniia osadkov. (Cloud resources of North Kazakhstan in connection with the problem of artificial production of precipitation.) U.S.S.R. Kazakhstan Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 25: 18-26, 1966. Russian summary p. 18. DAS M(055) U581tk.

The natural cloud resources of North Kazakhstan which may be used to produce supplementary precipitation by cloud seeding are investigated. The clouds regarded as resources are the following: (1) stratus clouds of the St-Sc type, 8-10 tenths in magnitude, not yielding precipitation; (2) strato-nimbus clouds (Ns), 8-10 tenths in magnitude, not yielding precipitation; and (3) cumulus clouds and shower clouds (Cu cong, Cb) in any magnitude not yielding precipitation. Data on the probability of the absence of precipitation from the clouds in North Kazakhstan, the number of days with clouds during the daylight hours, the number of days with convective clouds without precipitation as a function of height of a station above sea level, aerological characteristics

of clouds and on the structure and annual variation of cloud resources over North Kazakhstan and maps showing the territorial distribution of cloud resources and of annual precipitation amounts over North Kazakhstan are presented. The months with the least cloud resources are Jan. - March; Jan. is characterized by a large number of clear days and Feb. by intense snow storms. In these months cloud seeding is not promising. Oct. - Nov. are more promising for cloud seeding. The resources of these months are stratus clouds whose tops can be seeded from aircraft. - MGA 18.10-247.

255. Godson, W. L.; Crozier, C.L.; Holland, J.D. An evaluation of silver iodide cloud seeding by aircraft in western Quebec, Canada, 1960-1963.

Journal of Applied Meteorology, Boston, 5(4): 500-512, August 1966.

DAS M(05) J86joa.

A precipitation physics project aimed at discovering basic relationships in the chain of cause and effect in precipitation mechanisms was operated in western Quebec province, Canada, from 1959 to 1963 inclusive. In addition to many physical measurements taken from an aircraft and on the ground, randomized cloud seeding was employed as one method of study. Clouds over one of two test areas were seeded with silver iodide released from an aircraft during the passage of synoptic-scale weather systems, with the choice of area by a random selection. Comparison of storm rainfall in the two test areas measured by a dense network of raingages was used to evaluate the effect of the cloud seeding. Statistical tests of the relationship of precipitable water and instability with the seeding effect were also conducted. A small negative seeding index was computed and a slight correlation was found between both precipitable water and instability and the seeding index ratio. However none of these relationships was found to be statistically significant. - Authors' abstract.

256. Goyer, G.G.; Howell, W.E.; Schaefer, V.J.; Schleusener, R.A.; Squires, P. Project Hailswath. American Meteorological Society, Bulletin, 47(10): 805-809, October 1966. DAS M(05) A512b.

The principal aim of Project Hailswath sponsored by the NSF and the NCAR was to find out what practical and scientific problems are enountered in carrying out certain lines of hail modification activities in the field. The 23 separate organizations which participated in the project and their personnel are listed. The work of the project at Rand City was superimposed on the "Rapid" Project of the Inst. of Atm. Sc., sponsored by the U. S. Bureau of Reclamation. The work at Fort Collins, Colo. was superimposed on the hail research project of Colorado State University. The dual-Nike radar of the Inst. of Atm. Sc. near Rapid City was used to track the showers, direct and control the airplanes used for seeding and observation, and take data on the size and intensity of individual showers. The preliminary data showed the following: areal extent of hail in the seeded target was less than that in the nonseeded target on four days, greater on 1 day, tied on 1

day, and were zero in both areas on 4 days; total rainfall amounts averaged over the rain gages in the seeded areas was 0.46", and 0.30" in the non-seeded areas. - MGA 18.3-267.

257. Goyer, Guy G.; Grant, Lewis, O.; Henderson, Thomas J. The laboratory and field evaluation of Weathercord, a high output cloud seeding device. Journal of Applied Meteorology, Boston, 5(2): 211-216, April 1966. DAS M(05) J86joa.

Weathercord, a 40-grain detonating fuse containing about 20 per cent of silver iodide, has been evaluated as a cloud seeding nuclei generator in the laboratory, in the field, and in aircraft cloud seeding. Comparative data on the output efficiencies of several types of silver iodide generators are presented and show that, as a dispersal system, Weathercord provides in unit time and unit volume the highest concentration of nuclei available from any known source. The tests in supercooled fogs at Yellowstone National Park and two test cases of the seeding from aircraft of orographic cumuli are also described. Although of a preliminary nature these field tests suggest the effectiveness of the large concentrations of AgI nuclei, generated by Weathercord, in modifying relatively thin supercooled clouds. - Authors' abstract.

258. Grant, Lewis O. and Steele, Roger L. The calibration of silver iodide generators. American Meteorological Society, Bulletin, 47(9): 713-717, September 1966. DAS M(05) A512b.

A general method of calibration of AgI smoke generators, responsible for ice crystal nucleation in supercooled clouds is presented. Calibrations of generators using other materials than AgI for the same purposes is also considered. Testing procedures are summarized in flow charts and graphs. Samples of ice crystals produced by AgI smoke can be used to make reasonable calibrations of the nucleating characteristics of the smokes involving 10¹⁵ active particles/gm of AgI. A consideration of each phase of the process reveals no stage where the errors become unduly large. The repeatability of observations and comparison with closed volume experiments confirm the validity of generator testing procedures. - MGA 18.3-268.

259. Gromova, T.N.; Gliki, N.V.; Krasikov, P.N. <u>Vliianie primesei</u>
poverkhnostno-aktivnykh veshchestv na l'doobrazuiushchuiu effektivnost
rastvorov florogliutsina, Iodistogo serebra i Iodistogo svintsa.
(Effect of surface-active contaminants on ice-forming effectiveness
of solutions of phloroglucinol, silver iodide and lead iodide.)
U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy,
No. 186: 18-25, 1966. Russian summary p. 18. DAS M(055) U581tg.

The experimental procedure for investigating, under laboratory conditions, the effect of admixtures of surface active substances (SAS) upon the ice-forming activity of phloroglucinol (C₆H₃(OH)₃. 2H₂O), silver iodide (AgI) and lead iodide (PbI₂) when they are

dispersed in supercooled fog are described. The results presented in tables and graphs indicate the following: an addition of a SAS at a concentration of 1% lowers the freezing temperature of drops of solutions of ice-forming substances by an average of 4-7°C; in addition the threshold temperature of crystallization of fog is lowered by 3-8°C. The formation of ice crystals when solutions of AgI, PbI2 and C6H3(OH)3.2H2O are dispersed in a cloud chamber depends upon the concentration of surface active substances in the solution. When the concentration of SAS's is raised from 10-7 to 10-4% the formation of ice crystals declines from 2 x 10^{12} to 5 x 10^{10} g⁻¹. This is especially evident in the case of a colloidal AgI solution but is less marked for true solutions of PbI2, and C6H2(OH)2.2H2O. When any one of these solutions is dispersed into a supercooled fog whose temperature is considerably lower than that of the temperature of the dispersed drops their cooling and freezing proceeds rapidly with the accompaniment of the ejection of the admixture. Particles of active substances are seen to escape from the freezing drops. Such particles may serve as sublimation nuclei or, in the case of collision with fog droplets, as freezing nuclei. In addition there is always a propagation of nuclei since the number of dispersed solution drops is on the average of 2 orders of magnitude smaller than the number of ice crystals formed. - MGA 18.8-204.

260. Gutmanis, Ivars and Goldner, Lester. Evaluation of benefit-cost analysis as applied to weather and climate modification. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 111-125) (Chicago. University. Department of Geography, Research Paper No. 105: 111-125, 1966) DAS MO9.6 S989h.

The general theoretical applicability of benefit cost analysis in the evaluation of most public expenditures is discussed. The difficulties in the applicability of benefit-cost analysis to weather and climate modification are analyzed; they are the extensive geographical and functional scope of such programs, the difficulties in obtaining the necessary quantitative and qualitative data, the difficulty resulting from the availability of several possible technological approaches and the difficulty in integrating and supporting benefit-cost analysis with welfare-economic theory. The applicability of benefit-cost analysis to weather and climate modification, is shown to be possible by breaking up the comprehensive program into components that are much smaller in scope, require less data and involve considerably fewer interrelationships and secondary, tertiary, and other rounds of effects. - MGA 17.11-207.

261. Henderson, Thomas J. A ten year non-randomized cloud seeding program on the Kings River in California. Journal of Applied Meteorology, Boston, 5(5): 697-702, October 1966. DAS M(05) J86joa.

In 1954 a cloud seeding program designed to increase rainfall

and snowpack was initiated over the watershed of the Kings River in the Sierra Range of California. The project has been funded by the Kings River Conservation District, Fresno, California, and operated continuously each season during the 7-month October-April periods. At the end of the first three-year period, a multiple regression analysis was developed utilizing the unregulated historic flow of the Kings River and the flow of adjacent rivers presumed to be unaltered by cloud seeding activities. This statistical analysis has been applied to the flow of the rivers. During the ten-year seeded period 1954-1964, the analysis shows an apparent increase in flow amounting to 6 per cent of the total predicted by the regression analysis. The apparent increase is significant at the 0.005 level. - Author's abstract.

262. Hendrick, Robert L. and Friedman, Donald G. Potential impacts of storm modification on the insurance industry. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 227-246) (Chicago University. Department of Geography, Research Paper No. 105: 227-246, 1966)
DAS MO9.6 S989h.

The potential effects of some degree of weather modification on the insurance industry are examined in terms of the possibility of reducing the damage caused by storms producing wind, hail, and tornadoes. The possibilities of storm modification in terms of the parameters of intensity, frequency, and property exposure are examined. The contents of the paper comprise the following: the nature of potential storm controls including the effects of intensity modification of frequency, modification of path or area in the case of hurricane control and total effects of hurricane controls, tornado control, control of thunderstorm, hail and winds, control of extra tropical cyclones, and the combined effects of all controls; implications of marginal storm controls to the insurance industry; reduced storm damage hazards; improved weather forecasting; improved design standards; political implications; and insurance operations. - MGA 17.11-211.

263. Hicks, J.R. Improving visibility during periods of supercooled fog. U. S. Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, Technical Report 181, January 1966. 35 pp. DAS M78.4 U586r no. 181.

Six tests of dispersal systems using propane were conducted in Hanover, N. H. during winter 1964-65 and a like number in Greenland during summer 1965 mainly on supercooled fogs and in a few instances when air temperatures were within the lower 2 m at or slightly above freezing. Propane was introduced into the fog as a liquid aerosol to induce spontaneous nucleation either by cooling or by clathrate reaction which may be important in fog modification. The tests show that liquid propane will improve visibility in fogs, is safe to use, and no standby time is needed. The system may be permanently installed with either radio or manually controlled valve units, and is inexpensive, a cost of

\$20/hr estimated to keep an airport approach zone clear of fog. Details of the individual tests conducted are given. The dispensing apparatus, propane flammability tests, and the theory of formation, growth, and precipitation of ice crystals, thermal reaction, and the clathrate concept are discussed. - MGA 18.8-205.

264. Hindman, Edward E., II. The phase change in an artificial supercooled cloud upon heterogenous and homogeneous nucleation. Journal of Atmospheric Sciences, Boston, 23(1): 67-73, January 1966. DAS M(05) A512j 23: 1966.

A modified version of the Continuous Small Particle Sampler was used to obtain cloud particle samples of the phase change in a cloud chamber. The effects of silver iodide (AgI) and dry ice (CO₂) were studied under similar conditions. Nucleation by AgI produced evidence which followed heterogeneous nucleation theory and crystal growth-rate observations. The dry ice seeding, plus a comparison with natural samples, illustrated Mason's homogeneous nucleation theory. Finally, total water content balances were computed and depict the water content of ice, liquid water content, and water vapor content proportions for each seeding. - Author's abstract.

265. Hindman, Edward E., II. Theoretical investigation of techniques using dry ice for the dissipation of supercooled fogs —4C and warmer.

American Meteorological Society, Bulletin, 47(5): 445-449, June 1966.

DAS M(05) A512b 47: 1966.

Techniques have been developed for dissipation of supercooled fogs in the —40 to —200 range. However, no suitable methods have been devised to cover the OC to —40 range. Nucleation theories associated with dry ice and reports from the literature are applied to three dissipation techniques; tethered balloon, ground blower, and aircraft seeding. These techniques are theoretically subjected to the same fog condition in the OC to —40 temperature range. Resulting computations show that the aircraft technique is not operable in this fog case or the temperature range when using dry ice pellets. It was determined that the same mass of dry ice is needed for the dissipation of the fog in the remaining techniques. Computations associated with the dispersion of this mass into the fog are presented. A comparison of the dispersion operations show that the ground blower is the most feasible technique. — Author's abstract.

266. Hofmeyr, W. L. Klimaat en beskawing. (Climate and civilization.)
South Africa. Weather Bureau, Nuusbrief, No. 210: 161-165,
September 1966. DAS M(05) S726n 1966.

A review of the influence of weather on men and vice versa from historical times to the present. Answer to the question, "Why human control of large scale weather modification fails?" is in the negative at least at the present time. However, research into the various functions of the atmosphere and the improved

weather forecasting is promising, to which end the "Southerly Half-front Project" of the South African Weather Bureau is a worthy contribution. - MGA 18.8-200.

267. Howell, Wallace E. and López, Manuel E. Cloud seeding in southern Puerto Rico, April-July 1965. Journal of Applied Meteorology, 5(5): 692-696. October 1966. DAS M(05) J86joa.

With the most severe drought on record in its eighteenth month, causing severe damage and hardship in Puerto Rico, several large private concerns and government agencies interested in water decided that the immediate need for water greatly outweighed the uncertainties involved in cloud seeding, and collaborated to sponsor a program of rainfall stimulation. Operations of an emergency nature began 26 April and continued until 18 July 1965.

The result is evaluated by estimating the amount of rain that would have fallen if no seeding had been done, from the average rainfall per rainy day during a 19-year (unseeded) period. This analysis indicated an increase of 2.69 inches, equivalent to a 14 per cent increase nominally significant at the 10 per cent level.

No formal evaluation on the economic outcome is offered, but crop reports suggest that the cloud-seeding program returned value many times its cost, hence justifying the undertaking in the face of the uncertainties involved. - Authors' abstract.

268. Howell, Wallace E. Cloud seeding in the Catskills: a multi-faceted program. Notes for a Seminar of the Department of Meteorology and Oceanography, New York University, February 11, 1966. 11 pp. Reproduction of typescript. DAS MO9.617 H859clo.

The author discusses the hypothetical case of controlled experimentation with cloud seeding in order to establish empirically the relationships between cloud seeding and precipitation in an operational source. The difficulty and inefficiency of constructing and testing one hypothesis at a time is stressed and it is suggested that a multiplicity of hypotheses be framed and prescribed in advance. Various desirable ways of creating meaningful hypotheses are stated as for example, making each individual storm yield to its own "control information." In addition to the prime cause and intended consequence there are also unintended effects either in terms of meteorological or biological or economic consequences. Also the effects of experimental cloud seeding in its economic and legal aspects are considered. - MGA 18.2-163.

269. Howell, Wallace E. Conceptual models that guide applied cloud seeding.

American Meteorological Society, Bulletin, 47(5): 397-400, May 1966.

DAS M(05) A512b.

An essay on conceptual models that guide applied cloud seeding. In discussing the models the following are considered: dissipation

of quasi-static cloud, precipitation from small cumulus clouds, clouds with supercooled tops, seeding with dry ice or AgI, cloud electrification, precipitation from large cumulus becoming cumulonimbus, hail modification, field of competition model, local tempests, warm front clouds and, finally, orographic clouds. - MCA 17.11-200.

270. Howell, Wallace E. Effect on mean rainfall of artificially increased variance. Journal of Applied Meteorology, Boston, 5(1): 128-129, February 1966. DAS M(05) J86joa.

Taking an instance "where the distribution of monthly rainfall on a target has been normalized by a cube-root transformation and where the normalized distribution has a mean of 1.48 and a variance of 0.09," the author shows that doubling the variance results in a 10% increase in the mean rainfall. If seeding does increase the variance then statistical tests based upon an increase in the median alone underestimate the confidence that can be placed on the practical effectiveness of the seeding. A possible physical explanation for an increase in variance is that cloud seeding applied in a particular instance does not influence convective clouds smaller than some critical size but increases in effectiveness as the size of the clouds increases beyond this limit. - MGA 17.11-225.

271. Howell (Wallace E.) Associates, Inc. Evaluation of cloud seeding for The P.H. Glatfelter Company, August-October 1965. Lexington, Massachusetts, March 1966. 5pp. DAS MO9.617 H859egc.

With the northeastern drought in its fourth consecutive summer, the Glatfelter Company in August 1965 re-activated a rainfall stimulation program to help supply process water to its plants. This marked the fifth time in the last twelve years that operations have been carried on for this sponsor.

Cloud seeding began on August 1, 1965, and terminated on October 31, 1965. During this period a total of 9.96 inches of rain fell in the target area, compared with 9.39 inches expected by comparison with rainfall in a nearby control area, indicating an increase of 0.57 inches or 6.1 per cent.

In attempting to express the significance of this increase, reference was made to the review of the evaluation reports of previous operations on this target by the Panel on Weather and Climate Modification of the National Academy of Sciences and the referee recommendations of statisticians resulting from this review. A complete re-evaluation of past periods of operation, combined with that for the present period, and conducted in accordance with these recommendations, indicated an average increase of 12 per cent for the 20 months of operations, with approximately one chance in five that the increase indicated on the basis of this experience alone may have occurred from natural causes. When this probability

is combined with that indicated by similar operations also reviewed by the Panel, the conclusion is reached that, if these operations had been conducted as scientific experiments subject to appropriate controls, the increases would ordinarily be attributed to cloud seeding with a satisfactory degree of confidence. - Author's summary.

272. Howell (Wallace E.) Associates, Inc. Evaluation of cloud seeding for The P.H. Glatfelter Company, July-November 1966. Bedford, Massachusetts, 1966. 7pp. DAS MO9.617 H859egc 1966.

During the period July 19 to November 30, 1966, a precipitation stimulation program was carried on for the purpose of obtaining an additional supply of process water for the Glatfelter Company mill at Spring Grove, Pennsylvania.

A recently developed storm-by-storm evaluation scheme which fits a geometrical plane to the precipitation in a nearby control region and thus measures the trend of the rainfall, was used to estimate the expected precipitation over either the target or the control area during the period in question.

In the available 24 seeded storms, the target precipitation of 13.31 inches exceeded expectation by 2.68 inches of 25 percent, with odds of 89 to one against chance occurrence of such an increase.

Although the evaluation method was developed especially to avoid the need for comparing seeded storms with unseeded history (because changes may occur with time), as a matter of interest the identical evaluation procedure was applied to a series of six "dummy-seeded" storms, these six storms being the number of precipitation periods which were not seeded during this particular program. From these six "dummy-seeded" storms, target precipitation of 0.83 inches exceeded expectation by 0.05 inches or 6.3 percent, with better than even odds of chance occurrence.

By ordinary statistical standards, attribution of the increase to chance is strongly rejected for the seeded storms, while chance adequately explains the outcome of the "dummy-seeding". The power of this testing method offers promise for its use in distinguishing storms especially susceptible to seeding influence from the general run of storms. - Author's summary.

273. Howell, (Wallace E.) Associates, Inc., Lexington, Mass. A test of certain evaluation designs for cloud-seeding experiments. Contract Bureau of Reclamation 14-06-D-5962, Monthly Progress Report No. 6, October 31, 1966. 11pp. DAS M(051) H859mo no. 6.

Reports the completion of combining the Illinois rainfall data into 86 storms, obtaining the 700mb winds for this sample, and the encoding of these data on punched cards. The greater part of

this report is devoted to the deviation of the Υ and truncated Υ -distributions to be used in mormalization. Work planned for Nov. 1966 includes the "stormizing" of the Washita watershed data, the evaluation of the 700 mb winds for selected storms, and the completion of the tables and nomograms needed for fitting truncated rainfall samples with Υ -distribution. - MGA 18.6-241.

274. Huff, F. A. The effect of natural rainfall variability in verification of rain modification experiments. Water Resources Research, Washington, D. C., 2(4): 791-801, 1966. DAS P.

Data from four concentrated rain gage networks in Illinois were used to investigate the effect of natural rainfall variability upon verification of cloud seeding experiments in midwestern. warm season rainfall on areas of county size or less. Hypothetical seeding experiments were made on network data for seasonal periods of 1 to 5 months and for durations of 1 to 10 years. Both target-control and single-area randomized experiments were investigated, and the data were grouped into air mass storms and all storms combined. Results indicated that the single-area sampling experiments are influenced more by the effects of natural rainfall variability than the target-control type, but that the background interference is substantial in both cases. The study clearly illustrates the pitfalls in judging the results of cloud seeding on short-term experiments, and shows how verification may be affected by rain gage density and size of sampling area. - Author's abstract.

275. Huovila, Seppo and Valmari, Arvi. Experiments in the use of artificial ventilation for prevention of radiation frest. Geophysica, Helsinki, 8(4): 303-312, 1966. DAS M(055) G345.

Experiments were made on artificial ventilation during frost conditions, the apparatus used being a centrifugal cold air blower with a capacity of 75 m⁰min⁻¹. The heating effect due to air mixing, under conditions favorable for the method, was only some tenths of a degree at a distance of 5 m from the action center. The conclusion drawn, in accordance with earlier results, is that centrifugal ventilators are not effective mixers. Further, a fixed mounting and continuous operation of a wind machine are needed for useful purposes. - MGA 18.12-174.

276. Iudin, M. I. O vozmozhnostiakh vozdelstviia na krupnomasshtabnye atmosfernye dvizhenniia. (Possibility of controlling large scale atmospheric motions.) (In: Budyko, M.I. (ed.), Sovremennye problemy klimatologiia. Leningrad, Gidrometeoizdat, 1966. pp. 393-411.
Russian summary p. 393) DAS M8 B927s.

An analytical discussion of some corollaries of the present theory of atmospheric processes is followed by energy considerations and remarks on the stability of atmospheric motion which indicate that large scale motions can be affected most readily by influencing the ageostrophic wind field particularly in the field of vertical motion. The possibility of influencing the motion of cyclones is discussed. It is shown analytically that the intensity of a low cyclone can be reduced considerably in 8 hrs by producing descending motions of 3 cm/sec at the upper boundary of a mass $M \approx 3.5 \times 10^{14} \, \mathrm{kg}$. - MGA 18.12-169.

277. Kates, Robert W. and Sewell, W. R. Derrick. The evaluation of weather modification research. (In; Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 347-362) (Chicago. University. Department of Geography, Research Paper no. 105: 347-362, 1966) DAS MO9.6 S989h.

The contents of this paper on evaluating decisions of research funds for weather modification among physical and social and economic studies consist of the following: the special characteristics of weather modification research; the criteria for allocation of funds among research proposals for weather modification on the basis of economic efficiency; readiness of the field for exploitation and the readiness of the appropriate scientists to conduct competent research; the relationship between research and payoff in general and, as illustrated by the oceanographic research study, the weather satellite study, the Weather Bureau report on National effort on improved weather description and prediction for social and economic purposes; and a suggested relationship between weather modification research and payoff based on the Weather Bureau report. - MGA 17.11-217.

278. Kirkebride, John W. and Trelogan, Harry C. Weather and crop production:
some implications for weather modification programs. (In: Sewell,
W. R. Derrick (ed.), Human dimensions of weather modification.
Chicago, University of Chicago Press, 1966. pp. 159-168) (Chicago.
University. Department of Geography, Research Paper no. 105: 159168, 1966) DAS MO9.6 S989h.

The paper includes the following: a discussion of the importance of weather in agricultural production; research on the relationship between weather and crop production; forecasting crop yields from weather data as illustrated by simple correlation and multiple correlation studies; the use of graphic and multiple regression procedures utilizing reported conditions; reported yield, precipitation, and time as variations; studies on the immediate response of plants to their environment; estimation of yield from objective counts, measurements or weights, etc; and impact of weather modification on agricultural production. - MGA 17.11-72.

279. Knollenberg, Robert G. A note on a universal solid reagent seeding unit.

Journal of Applied Meterology, Boston, 5(6): 897-899, December 1966.

DAS M(05) J86joa.

The construction, operation, aircraft installation, and perfor-

mance of a solid reagent seeding unit are described. The unit, illustrated by a photgraph, includes a pulverizer, feeder, exhaust tube, and an aqua-lung tank and is capable of pulverizing and dispersing the solid chemicals into the airstream in a single operation. The results of field tests are presented. The advantages of this unit consist of control of particle size, freshness of the chemical seeding reagents (which often appear more active when fresh), elimination of clumping of the materials, and possiblility of using a wide range of reagents in a single seeding unit. It has the disadvantage that the output of the experimental unit falls short of the output of an average AgI burner by one or more orders of magnitude in terms of particles/sec. - MGA 18.6-242.

280. Koshenko, A. M. and Ponomarenko, I. N. O prigodnosti atmosfernykh frontov dlia intensifikatsii osadkov nad razlichnymi raionami Ukrainy. (Suitability of atmospheric fronts for stimulation of precipitation over various regions of the Ukraine.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologskii Institut, Trudy, No. 56: 78-85, 1966. Russian summary p. 78. DAS M(055) U581tu.

Data on the frequency of atmospheric fronts with conditions suitable for intensifying precipitation, on the characteristics of cloud layer and possible levels of active modification, are presented on the basis of 2649 aircraft soundings of network points in the Ukraine during the period 1957-1963 and special flights of "flying laboratories." In summer the suitability for seeding of atmospheric fronts is 2-4 times smaller than in winter. The most suitable areas for cloud seeding are the districts of Dnepropetrovsk-Krivoi Rog where 55% of the fronts passing during the the year are suitable for seeding. Next in order of suitability are the western districts of the Ukraine (49%), and the northeastern and eastern districts (47%); less suitable conditions are present in the extreme northern (36%), and southern districts (38%). Warm fronts in the Ukraine are most suitable for intensification of precipitation (49%); then follow occluded fronts (45%), and cold fronts (40%). Fronts suitable for modification are most rarely encountered during westerly processes. Fronts are essentially more suitable for modification during the passage of cyclones from the northwest, southwest and south. The mean thickness of suitable layers is 600-800 m. The predominant thicknesses in all districts of the Ukraine are layers of 300-600 m. Favorable conditions for seeding clouds in winter are present mainly at the levels 1-2 km (46-54%), in summer at levels 4-6 km (70-90%), in spring at levels 2-4 km (45-60%), and in fall almost equally likely at levels 2-4 km (45-51%), and 4-6 km (41-49%). - MGA 18.11-196.

281. Kozharin, V. S. O vozmozhnoù effektivnosti aktivnykh vozdeistvii na nizkie oblaka (tumany). Possible effectiveness of active modification of low clouds (fogs). U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 186: 104-112, 1966. Russian summary p. 104. DAS M (055) U581tg.

The author investigated the effectiveness of artificial modification of low stratus clouds (fog) by altering the hygrothermic state of the lower layer of the atmosphere from above and fulfilling the following conditions

$$\Delta(\gamma-\gamma_{\tau}) \geq 0$$
 in the case of $\Delta(t_0-\tau_0) \approx 0$.

The equations describing the development of lower boundary of clouds (fog) as a function of different factors are

$$(h + \Delta h)_{\Delta (t_0 - \tau_0)} = \frac{[(t_0 - \tau_0) + \Delta (t_0 - \tau_0)] h}{t_0 - \tau_0};$$

$$(h + \Delta h)_{\Delta (\gamma - \gamma_{\tau})} = \frac{(t_0 - \tau_0) h}{(t_0 - \tau_0) + \Delta (\gamma - \gamma_{\tau}) h}.$$

The dependence of the development of the lower boundary upon specific water content in the lower layer of the atmosphere is given by

$$(h + \Delta h)_{\Delta\delta} = \frac{2, 3 s_0 h (2 - \lg R_0)}{2, 3 s_0 (2 - \lg R_0) - \Delta\delta h},$$

In these equations h equals height of the lower cloud boundary; t_0 and τ_0 equal atmospheric temperature and dew point at the surface of the Earth, resp.; γ and γ equal mean vertical temperature and dew point gradients in the layer from the Earth to the upper boundary of the clouds; s_0 equals specific humidity of the atmosphere at the Earth; δ equals mean vertical gradient of specific humidity in the layer from the Earth to the upper cloud boundary and R_0 equals atmospheric relative humidity at the Earth. The equation for the amount of heat necessary for altering the thermal stratification of a column of air with a base of lm^2 is

$$\Delta q_1 = 1.15 \overline{\rho} s_0 \frac{(h + \Delta h) \Delta h}{h} (2 - \lg R_0).$$

The equation for determining the amount of moisture necessary for releasing the moisture content uniformly with height in an atmospheric column with a base of lm² is

$$\Delta q_2 = \Delta q_2 \left[\overline{\rho}, t_0, \frac{-(h+\Delta h)\Delta h}{h} (t_0 - \tau_0) \right].$$

The equation for calculating the amount of precipitation in the zone of rainfall is

$$I_1 = \frac{ln}{vb} \Delta q$$

where Δq equals variation of moisture content in a unit column of atmosphere from the surface of the Earth to the upper boundary of cloud that is necessary to dissipate it and n equals number of modifications in the zone. - MGA 18.8-206.

282. Kuntsevkii, P. G. and Roev, L. M. K voprosu o generatsii ledianykh kristallov. (Generation of ice crystals.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 53: 110-116, 1966. Russian summary p. 113. DAS M(055) U581tu.

A model problem of the formation of ice crystals on the boundary layer of a plane CO₂ granule is solved. A computation is carried out showing that a temperature of —1°C one gram, CO₂ generates 5.8 x 10¹¹ crystals of ice; the function of distribution of crystals by dimensions is determined. The assumption of the rate of crystal growth according to Maxwell raises somewhat the radius of crystals being formed. The formation and growth of crystals in an ice particle generator is computed. The distribution function of crystals at the generator outlet is determined and it is calculated that in the generator ~75% of the crystals formed grow to critical dimensions at a temperature of —1°C. — MGA 18.6-243.

283. Leonov, M. P. K voprosu ob istochnikakh vlagi iskusstvennykh osadkov pri
vozdelstviiakh na oblaka. (Sources of moisture for artificial
precipitation produced by cloud seeding.) U.S.S.R. Ukrainskii
Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy,
No. 53: 117-124, 1966. Russian summary p. 117. DAS M(055) U581tu.

In seeding experiments for the purpose of increasing precipitation over an experimental meteorological polygon the gaseous vapor which, in the supercooled droplet portion of a cloud, produced supersaturation in relation to ice was determined. As a result of a comparison with the observed drop phase of clouds there was established the possibility that the water supply exerts a considerable influence upon the fall of precipitation from such clouds. - MGA 18.6-244.

284. Leonov, M. P. Kolichestvennaia otsenka iskusstvennogo uvelicheniia osadkov kholodnogo polugodiia v Ukrainskoi stepi. (Quantitative estimate of artificial increase of precipitation in the cold half of the year in the Ukrainian steppe.) U.S.S.R. Ukrainskii Nauchno-Issledovatel skii Gidrometeorologicheskii Institut, Leningrad, Trudy, No. 61: 81-85, 1966. DAS M(055) U581tu. Translated into English as U. S. Joint Publications Research Service, JPRS: 43,549, December 4, 1967, 9 pp. DAS M09.617 L585qua.

With the intensification of precipitation in the cold half of the year it was discovered that the relative degree of its artificial

increment is dependent on the semidiurnal sums of natural precipitation: it increases with an increase of the latter. On the basis of this dependence, established using experimental data, and also on the basis of the frequency of recurrence of precipitation of different intensity in this region, the author has computed the possible effect of artificial cloud modification for obtaining precipitation. In the period November-March the additional precipitation may be 13-18% of the mean long-term sum of precipitation for this same period. - Author's abstract.

285. Leonov, M. P. Metodika i otsenka intensifikatsii osadkov kholodnogo polugodiia v Ukrainskoi stepi. (Method and estimation of intensification of precipitation during the cold half-year in the Ukrainian steppe.) Akademiia Nauk SSSR, Isvestiia. Fizika Atmosfery i Okeana, 2(4): 402-413, April 1966. Russian summary p. 402; English summary p. 413. DAS P. Translated into English in corresponding issue of its Izvestiya. Atmospheric and Oceanic Physics, issued Washington, D. C. DAS P.

A quantitative evaluation of an increase in precipitation by cloud modification is impeded by a large variability of natural precipitation which exceeds the artificial increase and by short duration of periods of cloud modification experiments. In studies carried out on the Experimental Meteorological Polygon (EMP) during a cold half-year period an experimental procedure was proposed to produce artificial precipitation over the given areas. For the quantitative estimation of the efficiency of modification it was found to be possible to compare precipitation over the modified area to that of adjoining plots of the same size. Radar observations of precipitation permitted precise determination of the distribution of artificial precipitation. Using such cases of precipitation over the EMP when their intensification was not carried out, for control purposes, and applying the same methods of calculation, the artifical increase in precipitation for the cold half-year period is estimated to be up to 20% of a norm, the significance level being from 1% to 20%. - MGA 17.10-217.

286. Leonov, M. P. Predvaritel'nye rezul'taty radiolokatsionnykh issledovaniš polos intensifitsirovannykh osadkov. (Preliminary results of radar investigations of zones of intensified precipitation.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometerologicheskii Institut, Trudy, No. 61: 86-93, 1966. Russian summary p. 86. DAS M(055) U581tu.

The use of a high potential radar to determine the principal parameters (time, appearance, width, etc.) of the zone of artificial precipitation and of the development with time is examined. Films of the screen of a circular survey indicator are presented and analyzed. The "Bol'shoi Ochag" radar in a series of cases did not detect the zones of artificial precipitation although the effect of seeding appeared in subsequent analysis

of the data of the precipitation network. This may be explained by insufficient sensitivity of the radar and by the light and comparatively distant precipitation. In general radar observations on precipitation permit: 1) the possibility of visual confirmation of the intensification of precipitation already falling, 2) obtaining the parameters of the zones of artificial precipitation necessary for carrying out mass seeding and for investigating the physics of precipitation formation, and 3) distinguishing the area of fall of intensified precipitation for which the effectiveness of seeding is determined quantitatively. - MGA 18.11-97

287. Leonov, N. G. and Marx, H. P. <u>Requirements and specifications for data-processing system</u>. World Meteorological Organization, World Weather Watch Planning Report, No. 8, 1966.23 pp. English, French, Russian and Spanish summaries, pp. VII - XXI. DAS M(06) W927w no. 8.

This report prepared jointly by Russian and American specialists contains specific recommendations on the data-processing, output products, collection and dissemination of meteorological informations, pre-processing, archiving and publication of data functions of the Meteorological Centers (MC) of the World Weather Watch (WWW) system. It also gives a tentative list of output products to be prepared by World and Regional MCs for international distribution and for use by National Meteorological Services (NMSs) and includes a short statement on research aspects of WWW in understanding of the mechanism of the general circulation, improvement of long range forecasts and modification of weather and climate. A map of the main features of the WWW telecommunication scheme is appended. - MGA 18.7-24.

288. Lieb, Herbert. Project Stormfury. ESSA World, Rockville, Maryland, ENO. 2: 4-7, October 1966. DAS M(05) E78es 1966.

A nontechnical description of Project Stormfury, ESSA's Research Flight Facility (RFF), and the Airborne Early Warning Squadron FOUR (also known as VW-4 or Navy Hurricane Hunters). Project Stormfury (Joanne Simpson, director) an interagency program of the ESSA and DOD, aim to achieve better understanding of storms, improve prediction, and investigate the possibility of modifying some aspects of these storms. In addition to the hurricane-eyewall experiments, the Project investigates the effects of seeding hurricane rainbands. Some 10 scientists work for the Project with some 17 aircraft. The RFF planes have flown hailstorm, air mass, and cloud photography study missions, also flew 115 missions and collected 1 million observations in connection with the studies of monsoons and general weather patterns in the Arabian Sea, the Indian Ocean, and the Bay of Bengal. The VW-4 based at Jacksonville, Fla. and in Puerto Rico, participate actively in Project Stormfury and have probed more than 350 hurricanes and tropical storms. - MGA 18.12-254.

289. Liniger, Ronald L. and Appleman, Herbert S. Project Cold Fog I.
U. S. Air Weather Service, Technical Report 188, November 1966.
pp. 65-70. DAS M(055) U58a no. 188.

Presents results of an AWS test program for 1965-1966. The basic program objective was to conduct operational tests of the AFCRL ground based techniques to dissipate supercooled fog and stratus, and to tailor these procedures to AWS resources, capabilities, and needs. All tests showed that a knowledge of the test site wonds at seeding altitudes is critical for useful positioning of the cleared zone. Seeding effects varied from formation of ice crystals and light to very light snow downwind of the seeding points to zones of improved conditions either near, or some miles, the runway. - MGA 18.7-254.

290. López, Manuel E. Cloud seeding trials in the rainy belt of western

Colombia. Paper prepared for presentation at the 47th Annual Meeting
of AGU, Washington, D. C., April 19, 1966. 21 pp. DAS MO9.617 1864c.
Also in: Water Resources Research, Washington, D. C., 2(4): 811-823,
1966. DAS P.

Evaluation of rain stimulation operation for the Río Anchicayá, near Buenaventura, Colombia, during "dry" seasons since 1963 was hampered by lack of rainfall data. Daily streamflow data were manipulated to remove serial correlation and derive a series of daily equivalent rainfalls by comparing each day's runoff with the maximum corresponding runoff decrement observed on rainless days. The Bayes criterion, applied to frequency distributions of equivalent daily rainfall before and during the seeding, consistently recommended continuation of the seeding. The total equivalent rainfall per month was found to correlate well with the number of days per month with equivalent rainfall above 2.5 mm, and comparison of the seeded period with the regression of equivalent rainfall per month on number of rainy days per month for unseeded history indicated an increase of 13 percent, with one chance in 8 of random occurrence, corresponding to 2.100 kw added power generation and about a sixfold economic return. - Author's abstract.

291. Lyden, Fremont J. and Shipman, George A. Public policy issues raised by weather modification: possible alternative strategies for government action. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 289-303) (Chicago. University. Department of Geography, Research Paper No. 105: 289-303, 1966) DAS MO9.6 S989h.

The role of government in weather modification is analyzed by classifying government action into particular forms which are identified by the source of the authority, initiation of the action, the standards governing action, administrative or judicial action, and the consequences of the action. The forms of action are self help (civil action), coercive (nondeterminative and determinative) and noncoercive. Each type of action is

described in detail and the appropriate combinations of the various action applicable to weather modification are discussed. - MGA 17.11-24.

292. MacCready, Paul B., Jr.; Smith, Theodore B.; Weinstein, Alan I. Analysis of Flagstaff data. Meteorology Research, Inc., Altadena, California, Contract DA 28-043-AMC-00406(E), Report no. 4, Final Report, November 1, 1964 - December 31, 1965, issued April 1966. 41pp. DAS M(051) M589rpr.

The continuous particle collector proved capable of yielding quantitative droplet distribution data and qualitative information on larger hydrometeors. In the Flagstaff convective clouds the droplet concentrations were high, 600 to 2000 per cm³ near cloud base, and some correlation was noted versus upcurrent strength. Drizzle-size drops grew in the cloud cores by coalescence, starting from large droplets (substantially larger than the small-droplet population) which were present even at cloud base in concentrations of 20 per liter. A possible source of such large droplets is considered to be giant salt particles, perhaps augmented from a maritime condensation nuclei distribution by coalescence effects in previous clouds. The growth rate of droplets on such nuclei is calculated for several parcel ascent rates. Graupel was encountered regularly at -5 and -6C, mostly outside cell cores, suggesting the rapid freezing and riming of the drizzle-size drops. -

The principles of cloud modification techniques are considered. They show that the transitory seeding methods used in 1962 and 1963 would not be expected to show large effects, and so techniques are suggested which consider diffusion effects and cloud seedability (especially buoyancy aspects). The quantitative basis is presented for buoyancy increases from seeding, considering all vapor, liquid, and solid water phases.

The convective wake phenomenon is reexamined, and a new concept for its occurrence is introduced: surface convergence and conditional instability released by the generation of a longitudinal vortex pair immediately downwind of the isolated peaks. - Authors' abstract.

293. Markovic, Radmilo D. <u>Statistical evaluation of weather modification</u> <u>attainments</u>. Colorado. State University, Fort Collins, Hydrology Papers No. 16, November 1966. 44 pp. DAS M(055) C719hy no. 16.

Three possible levels of control-- cloud phenomena, precipitation, and river flow--at which the evaluation of weather modification attainments may take place were considered. The river flow control level was found to be the most promising approach in discriminating the eventual change in water yield produced by weather modification experiments.

Six statistical (quantitative) evalution methods of weather modification were investigated at the river flow control level.

The annual river flow was the only variable, and its mean and variance were the main statistics used in discriminating the changes. Each of the methods investigated was designed for different sets of conditions, according to the available data and the expected changes in river flow produced by weather modification experiments.

The first two of these six methods of evaluation are characterized by the use of univariate distributions of annual river flows in a target basin, one method dealing with known and the other with unknown population parameters. The second two methods are characterized by the use of a joint bivariate distribution of annual river flows in a target and control basin, again one dealing with known and the other with unknown population parameters. The third two methods are characterized by the use of conditional distributions of annual river flows in a target basin given those in a control basin.

Four of the six methods were applied for the first time for this study, and one of them had been specially developed for application in the statistical evaluation of weather modification attainments. Each of the six methods applied for the evaluation of river flow change may be used under specified particular conditions.

The methods of statistical evaluation of weather modification, based upon the univariate distribution of target flows were found to be inferior to those based upon the joint target-control distribution. However, the latter were inferior to those based upon the conditional target-control distribution of river flows.

- Author's abstract.

294. Medaliev, Kh.Kh. <u>Iskusstvennaia kristallizatsiia krupnykh vodnykh kapel</u>. (Artificial crystallization of large water drops.) Nal'chik, U.S.S.R. Vysokogornyi Geofizicheskii Institut, Trudy, 3(5): 45-55, 1966. DLC QC851.E55.

Laboratory experiments of freezing supercooled drops with silver iodide are described and discussed. The better effect of convective cloud seeding was observed at temperature —5°C and below. - WMSU.

295. Meier, Richard L. <u>Urbanization and the new weather technology: problems, possibilities and institutional implications.</u> (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 261-276) (Chicago. University. Department of Geography, Research Paper No. 105: 261-276, 1966)

DAS MO9.6 S989h.

The author presents the theses that with increasing urbanization, water will be required mostly by cities which will be established near the shore line, that settlement of nearby seas will be attempted, and that weather modification will be most beneficial to cities. Research in marine technology enabling settlement of

the seas is summarized, and the possibility of continous occupation of the seas is argued. The prospective improvement of weather conditions for cities by climatic modification is regarded to be ill conceived; much more valuable would be the improvement in weather forecasting so that cities could adopt more readily to normal weather changes. The weather control efforts that would be most valuable are the prevention of catastrophes by the reduction of storms, the reduction of the range of variation of weather elements, etc. - MGA 17.11-212.

296. Mihara, Y. Frost protection by fog droplets coated with monomolecular films. Nature, London, 212(5062): 602-603, November 5, 1966. DAS

Attempts to prevent frost during calm nights by the creation of an artificial fog of water droplets have failed. The droplets evaporate rapidly in unsaturated air. The author overcame this difficulty by coating the droplet with a monomolecular film of a compound which inhibits evaporation, and has an appropriate hydrophylic and lipophilic balance. The commercial compound OED has the required qualities. Laboratory experiments have been carried out with 0.2% solutions of OED in water. The times for the decrease of the droplet from diameters of 30 to 5 \mu for pure water droplets and monolayer coated droplets have been measured under different temperature and humidity conditions. Field tests have been carried out in a hollow, using a steam sterilizer or a compressed air pump to spray an emulsion of 0.2% OED. Fog layers produced were not as thick or as dense as desired but had a marked effect in preventing the temperature from falling. The results suggest that larger scale use of this method may give frost protection. - MGA 18.5-178.

297. Mikhailenko, N. M. and Polovina, I. P. <u>K voprosu o prigodnosti dlia vozdeistvii frontal nykh oblakov, daiushchikh osadki.</u> (Problem of the susceptibility of precipitating frontal clouds to modification.)
U.S.S.R. Ukrainskii Nauchno-Issledovatel skii Gidrometeorologicheskii Institut, Trudy, No. 61: 94-100, 1966. Russian summary p. 94.

DAS M(055) U581tu.

On the basis of aircraft soundings carried out at 4 points in the Ukraine during the cold half year the authors investigated the frequency of favorable conditions for seeding in winter frontal clouds yielding precipitation. Owing to the imperfection of the method of microstructural observations the frequency of crystalline clouds is somewhat reduced, so that the data on the suitability of frontal clouds for intensification obtained by these observations are exaggerated. Direct microstructural determinations of the phase state of clouds at the points of the aircraft soundings may be rendered more accurate by observations on icing and by considering the type of falling precipitation. The mean frequency of cases with cloud layers suitable for modification over the Ukraine amounts to 35-40% except at Livov where it reaches 54%. Most

frequently (80.4% of the cases) the clouds suitable for seeding are on only one layer; in the remaining instances they are of two layers. In frontal clouds of considerable vertical thickness yielding steady precipitation the probability of icing is slight. With increase in the thickness of the cloud layer the probability of icing declines substantially. The lower boundary of cloud layers suitable for seeding lies in most cases at 3000 m. Relatively shallow layers (300-500 m) are comparatively frequent (~33% situated > 3000 m). - MGA 18.11-198.

298. Morris, Edward A. Institutional adjustment of an emerging technology:

legal aspects of weather modification. (In: Sewell, W. R. Derrick

(ed.), Human dimensions of weather modification. Chicago, University

of Chicago Press, 1966. pp. 279-288) (Chicago. University. Department of Geography, Research Paper No. 105: 279-288, 1966). DAS

MO9.6 S989h.

The legal and administrative aspects of weather modification and its consequences are reviewed. The author discussed some principles that should underlie laws on regulation of weather modification such as maximum social utility on negligence of the defendent; a discussion of law suits resulting from weather modification until 1965; legislation on weather modification passed and proposed in various states; federal legislation; a consideration of future legal and institutional problems of hurricane control, etc. - MGA 17.11-213.

National Research Council, Washington, D. C. Committee on Atmospheric Sciences. Panel on Weather and Climate Modification. Weather and climate modification: problems and prospects. National Research Council, Washington, D. C., Publication 1350, 1966. 2 vol. Vol. 1 (28 pp.) Summary and recommendations. Vol. 2 (198 pp.), Research and development. "This supersedes its Scientific problems of weather modification, issued as Publication 1236, October 1964" DAS MO9.6 N277we. Also: Excerpts from the Report. in American Meteorological Society, Bulletin, 47(1): 4-20, January 1966. DAS M(05) A512b. And: Carter, Luther J. Weather Modification: panels want greater federal effort. Science, 151(3709): 428-431, January 28, 1966. DAS P.

This report discusses comprehensively the possible modes of deliberate and inadvertent interference in weather and climatic processes and the principal scientific and technological problems that are involved in this activity. The contents consist of the following, viz: modification of clouds and storm systems, including precipitation stimulation and redistribution, operational experiences in stimulating precipitation, hail mitigation, suppression of lightning and electrical modification of clouds, modification of fog and stable cloud layers, modification of cloud dynamics, suppression of tornadoes and modification of hurricane; modification of weather and climate of large areas, including the question of climatic stability and theoretical aspects of large scale modification, numerical simulation of the general circulation and laboratory simulation of the general circulation; modification of local and regional climates, including modification of agricultural

microclimates and amelioration of desert conditions; inadvertent modification of atmospheric properties and processes involving the increase of COo in the atmosphere, the effects of urbanization such as air pollution and smog, urban climatic trends, effects of forestation and deforestation, effects of supersonic transport on the stratosphere, contamiation of the very high atmosphere, and possible indirect effects of weather modification experiments: the evaluation of weather modification projects, including statistical design studies and reporting procedures; instruments and techniques in cloud modification research and development; research in atmospheric water budgets: measurement of global weather parameters and of boundary layer processes; and the special problem of tropical meteorology, including convective processes in the tropics and the comprehensive investigation of hurricanes. Appendices contain the following special papers, viz: Preliminary study of meteorological effects on specific seeding trends, by R. R. Rapp and Schutz; Possible effects of optimal stopping in regression experiments by T. E. Harris; Statistical notes on cloud seeding projects by A. Madansky; and Statistical analysis of certain weather modification operations by G. W. Brier and D. B. Kline. - MGA 17.7-18.

300. Nevada. University. Desert Research Institute. Atmospheric water resources research, 15 December 1964 to 30 June 1966; final report. Bureau of Reclamation, contract 14-06-D-5410-1964. Reno, Laboratory of Admospheric Sciences, Desert Research Institute, University of Nevada, 1966? 41 pp. DAS M(051) N499atm.

The silver iodide seeding experiment and the dry ice seeding experiments in the Elko area are briefly described. Very little seeding was done because acceptable seeding conditions were limited. Fog dissipation experiments were conducted in the Mount Rose - Reno area in January 1965 with favorable results.

301. Newell, Homer E. A recommended national program in weather modification.

A report of the Interdepartmental Committee for Atmospheric Sciences.

U. S. Interdepartmental Committee for Atmospheric Sciences, ICAS
Report No. 10a, November 1966. 41 pp. & 6 separately paged appendices.

DAS M(055) U5838ic ICAS No. 10a.

The terms of reference for the proposed recommendations for a program of weather modification are the activities and plans of the Department of Agriculture (DA), Bureau of Reclamation (BR), the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the Environmental Science Services Administration (ESSA) and the Dept. of Defense (DOD). The principles underlying the recommendations are as follows: 1) there is sufficient potential payoff as a result of past research to justify further research on weather modification; 2) the potential dollar savings in reducing destructive effects of weather and the potential gains in beneficial effects are large enough to justify appreciable expenditures; 3) there is a need for a single agency to assume responsibility for research in

weather modification; 4) the maintenance of multiple agency approach is valuable, etc. The contents of the report include the following: the specific programs recommended for the DA, DI, NSF, & ESSA, coordination and reporting of these programs and international complications. Appendices include the following: membership and recommendations of the Panel on Weather and Climate Modification to the Committee on Atmospheric Sciences, National Academy of Sciences-National Research Council; Membership and Recommendations of the Special Commission on Weather Modification; National Science Foundation; Budget Recommendations, and Trends for a National Weather Modification Program, etc. - MGA 19.9-62.

302. Osipova, G. I. Nekotorye Kharakteristiki osadkov v sviazi s oblakami razlichnykh form v mae-iiune v Severnom Kazakhstane. (Some characteristics of precipitation in connection with various forms of clouds in May - June in northern Kazakstan.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 186: 63-73, 1966. Russian summary p. 63. DAS M(055) U58ltg.

Constitues a comprehensive analysis of the rainfall regime in northern Kazakhtan in particular in the months of May - June and its relationship to various clouds types. Data are given in tables on the mean long period precipitation amounts for each month of the year, the monthly amount of precipitation from May to Sept. greater than given limits of differing probability, the mean amount of precipitation and number of rains by day and night in each month from April - Oct. at the Tselinograd station, the number of days with precipitation producing clouds of 6/6 - 10/10 units in May - June, and probability of days with varying duration of precipitating clouds at the Balkashino station, etc. The significance of the precipitation regime to agriculture and the availability of clouds for seeding in May - June, which are the most important months for the grain harvest, are discussed. - MGA 18.8-414.

303. Pérez Siliceo, Emilio; Ahumada A., Aurelio; Mosiño, Pedro A. 16 años de operaciones de estimulación de lluvias en las Cuencas de Necaxa (Pue.) y Lerma (Mex.), 1949-1951, 1953-1965. (16 years of operation of artificial stimulation of rain in the Necaxa and Lerma watersheds, Mexico, 1949-1951, 1953-1965.) Mexico City., Compañía de Luz y Fuerza del Centro, S. A., Jan. 1966. 20 pp. Laid in: Long summary in English.

This report is very nearly the same version as that published earlier in 1963 but augmented with data for the years 1964 and 1965. The seeding technique is similar to that employed in the previous experiments. The evaluation methods involve as before, the use of a regression line and comparisons of daily departures from the normal of the ratio of the target rains to those of the control area during seeded days with those departures similarly calculated for the unseeded ones. This evaluation analysis is extended by the application of random seeding schedules for part of the years of operation including of the historical years. The fairly persistent

increase shown by the regression line and its tests of significance in particular the last 6 yrs, indicates a substantial gain in rainfall which can be estimated as 1.5 yr. of mean annual rainfall in the entire period of 16 yrs. The results obtained by comparison of seeded days with unseeded days after having chosen a consistent interval through 1961, have deteriorated during the last 5 yrs and even show slightly negative values entirely at variance with the regression line. There are indications that there is a delayed effect at least during 24 hrs after the first regular seeding. - MGA 18.1-143.

Pilié, Roland J. and Kocmond, Warren C. <u>Investigation of warm fog</u>
properties and fog modification concepts. Cornell Aeronautical
Laboratory, Inc., Buffalo, New York, CAL Report RM-1788-P-13, October
1966. 47 pp. (Contract NASr-156 Project Fog Drops, Third Annual
Summary Report) DAS M(051) C814rep 1788-P-13.

Surface measurements of drop size distribution and liquid water content made in advection fogs are shown to agree with characteristics of the fog model presented in earlier work. Comparisons are made of cloud and fog nucleus concentrations measured in Buffalo, Hawaii and central Pennsylvania. Analytic and experimental data show that the basic concept for minimizing degradation in radiation fog by preseeding with small concentrations of large hygroscopic nuclei is sound. Visibility improvements greater than a factor of 2 over unseeded fogs have been produced in the laboratory. The concept appears to have applicability only for radiation fog situations. Analytic and experimental investigations show that it is impractical to attempt to suppress fog at an airport by placing electric charge on fog droplets. Electrical forces that can be established by this means when practical droplet charging equipment is used are far too small to have significant influence on fog dissipation rate. - MGA 19.11-225.

305. Pilié, Roland J. Project fog drops: investigation of warm fog properties and fog modification concepts. U. S. National Aeronautics and Space Administration, Contractor Report, CR-368, January 1966. 71 pp. DAS M(051) U585cr no. 368.

Mathematical models have been formulated to describe the dynamic properties of warm fog. In the laboratory, experiments were conducted to determine the effects of ionic surfactant on droplet coalescence and to study the behavior of nuclei treated with fatty-alcohol monolayers. Daily measurements were made of the nuclei active at slight supersaturations characteristic of natural fog. The results of these measurements together with past analytical and experimental findings were used to generate new ideas for fog suppression and to evaluate previous concepts for altering warm fog. A climatological survey of fog frequency in the Continental United States describes those regions having frequent occurrences of dense fog, i.e. fog that limits visual range to 1/4 mile or less. - Author's abstract.

306. Piotrovich, V. V. Florogliutsin, kristallizator kapel' vody
pereokhlazhdennogo tumana i oblachnosti. (Phloroglucinol, a
crystallizing agent for water droplets in supercooled fog and clouds.)
U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy,
186: 10-17, 1966. Russian summary p. 10. DAS M(055) U58ltg.

The experimental procedures for sublimating phloroglucinol in a cloud chamber and for producing a supercooled fog are described, and the formula for calculating the effectiveness of a dispersion of phloroglucinol in producing ice crystals is presented. The effectiveness of phloroglucinol increases rapidly but its effectiveness declines rapidly as the temperature of the supercooled fog rises above -10°C . In the case of cloud seeding, clearings appeared in 5 out of 6 instances. The width of the clearings was usually not more than several hundred meters; this is considerably less than the width of clearings produced by solid 00_{2} . It is likely that the smaller clearings were the result of an insufficient amount of reagent. - MGA 18.8-203.

307. Polovina, I. P. Eksperimental'nye issledovaniia protsessa iskusstvennoi kristallizatsii v pereokhlazhdennykh sloistykh i sloisto-kuchevykh oblakakh. (Experimental investigations of the artificial crystallization process in supercooled stratus and stratocumulus clouds.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 61: 50-60, 1966. Russian summary p. 50. DAS M(C55) U581tu.

The results of experimental investigations on the laws of expansion of the crystallization zones in stratus and strato-cumulus clouds during seeding with solid carbon dioxide (CO2) are presented and analyzed. The characteristics describing the crystallization process include the rate of expansion of the zone, the time of formation of the processes (beginning of dispersion), the time of expansion and the maximum width of the crystallization zone (dispersion). During seeding the same cloud mass on increase in the dose of the reagent practically does not alter the laws of expansion of the crystallization zone; this conclusion is valid for CO2 doses exceeding the optimum. The time of formation of openings fluctuates from 11 to 35 min; on the average it is equal to 19 min and it increases with increase in cloud thickness. In the case of the same thickness an increase in dose causes a diminution in size of the openings. The rate of expansion of the zone is not constant in time but increases in approximately the first 10 min after seeding and then diminishes gradually to the end of the expansion process. The experimental data do not indicate that the rate of expansion of the zone depends upon wind speed but they show that during a temperature inversion in the clouds the rate of expansion decreases substantially. The time of expansion of the crystallization zone varied from 26 to 44 min; the average time was 33 min. The maximimum width of expansion (dispersion) varied from 1800 to 4200 m; the mean width was 3010 m, and the mean velocity of expansion was 1.5 m/sec. - MGA 18.11-189.

308. Polovina, I. P. O normirovanii raskhoda tverdoi uglekisloty pri
vozdelstvii na vnutrimassovye sloistye oblaka i tumany. (Regulation
of expenditure of solid carbon dioxide during modification of air
mass stratus clouds and fogs.) U.S.S.R. Ukrainskii NauchnoIssledovatel skii Gidrometeorologicheskii Institut, Trudy, No. 61:
h1-49, 1966. Russian summary p. 41. DAS M(055) U581tu.

The author presents the results of seeding supercooled stratus and strato-cumulus clouds and partial fogs in order to disperse them. The seeding procedure which involved the use of aircraft is described and the results are presented in tables giving data on seeding of clouds and fog with an intralayer temperature above -4°C, on the influence of wind speed, on the effectiveness of the dose of solid CO2, and on the results of seeding of Sc clouds during discharge of CO2 at different levels above the upper cloud boundary. The maximum vertical thickness of clouds which can be seeded effectively at a wind speed up to 6 m/sec is 650 m. In clouds with a thickness of 300 m it is possible to form a continous seeding zone at a wind velocity up to 12 m/sec. The temperature of -3°C (maximum for stratus clouds) may be taken as the temperature threshold of effective seeding with solid CO2. At a temperature above -4°C in the entire cloud layer complete seeding does not take place even at high CO doses. Complete cloud seeding with optimum doses was observed when ${\rm CO_2}$ was discharged from a height of 300 m above the upper boundary. But the width of the dispersion zone was reduced considerably in comparison with that obtained by introducing CO2 at the level of the upper boundary. - MGA 18.11-188.

309. Polovina, I. P. Parametry sloistykh i sloisto-kuchevykh oblakov,
daiushchikh osadki. (Parameters of stratus and stratocumulus clouds
which yield precipitation.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 61: 61-70, 1966.
Russian summary p. 61. DAS M(055) U58ltu.

Cloud parameters (temperature regime, thickness, height of the lower boundary) of Sc, which yield rain, were investigated on the basis of aircraft soundings at a network of stations in the Ukraine from 1951-1962 during the winter season (Nov. - March). Cases of single layer intramass St-Sc clouds were selected. The thickness of clouds yielding light snow, snow grains, and drizzle fluctuated within limits of 0.10-0.96, 0.15-1.15, and 0.27-1.55 km, resp.; the maximum probable values of the thickness for light snow and snow grains varied from 0.21 to 0.40 km, and for drizzle from 0.41 to 0.80 km. The temperature at the upper boundary of clouds yielding light snow lies within limits of -5 to -20.0°C; the maximum frequency is 10-15°C. The temperature at the upper boundary of clouds yielding drizzle varies from -10 to -13.0°C; and the frequency of values below -4°C is 33%. The height of the lower boundary of clouds yielding drizzle and snow grains in most cases does not exceed 400 m above the surface of the Earth. Light snow is often observed at a height of the lower boundary >1000

m and a thickness of 250-300 m. As a result of the investigation of the relationship between precipitation and the thickness of a cloud and its temperature, it was found that the probability of formation of precipitation increases with drop in temperature and for particular temperature intervals it increases with increase in the thickness of the cloud layer. At temperatures of —14°C the critical thickness of a precipitation producing cloud layer of Sc was equal to 100 m; at —5°C to 600 m. In winter the probability of different types of precipitation from intramass clouds is ~20% in relation to the general duration of the existence of clouds. The duration of precipitation in most cases does not exceed 5 hrs and very rarely reaches 10 hrs. The amount of precipitation for the period mentioned is between 0.0 and 0.2 mm. In almost all cases seeding of intramass clouds actually produces precipitation but does not intensify it. - MGA 18.11-394.

Ponomarenko, I.N.; Gaidai, L.I.; Koshenko, A. M. <u>Fazovoe sostoianie</u> oblakov v zonakh frontov nad Ukrainoi. (Phase condition of clouds in frontal zones over the Ukraine.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 56: 67-77, 1966. Russian summary p.67. DAS M(055) U58ltu.

The phase state of frontal clouds is examined from the point of view of evaluating their suitability for intensifying and stimulating precipitation by means of reagents used at present. The dependence of precipitation upon the phase state of clouds was investigated on the basis of 700 aircraft soundings of frontal clouds with 5350 measurements of their microstructure and water content at network points in the Ukraine during 1961-1963. The experimental flights were carried out according to 3 patterns: 1) frequent vertical sounding, 2) flight around the frontal cloud systems, and 3) aircraft expeditions with simultaneous flight of 2-3 aircraft at particular levels combined with vertical sounding at varying distances from the frontal line. The investigation of the phase state of clouds in the frontal zones involved frequency of phase of cloud elements in Ns-As, As, Ac, Sc, St and Fr nb and the frequency of phases of cloud elements for different temperature intervals. The phase state of clouds and fronts includes frequency of precipitation falling from frontal clouds of different phase states, and the relationship between precipitation and the meteorological parameters of clouds. Under the conditions of the Ukraine it is impossible adequately to distinguish clearly the conditions of the prevailing state of the phases on the basis of the temperature regime of the clouds. Thus the almost complete absence of crystallization in Sc and St clouds at temperatures below -8° and -12°C is associated with the fact that such a temperature is practically not observed within them. Precipitation reaching the Earth's surface falls from frontal cloud systems existing in the liquid phase in 18-30% of the cases. Precipitation from Sc and St is observed when their thickness exceeds 500 m. Also differences are observed in the thicknesses of Ns and Ns-As clouds yielding precipitation which reach and do not reach the Earth. MGA 18.11-397.

311. Prikhot'ko, G. F. and Furman, A.I. Eksperimental'nyi meteorologicheskii poligon. (The experimental meteorological area.) Meteorologiia i Gidrologiia, Moscow, No. 7: 52-54, July 1966. DAS M(05) M589.

An experimental meteorological area was created in 1959 by the Ukraine Scientific Res. Hydromet. Inst. for the purpose of determining the effectiveness of the artificial modification of clouds over a flat area. A description is given of the position and of the instrumentation of the area, of the stations set up and of the types of observation carried out. Additional studies have been undertaken including a wide range of agrometeorological studies initiated to examine problems of the inter-relationship between the weather and crop harvests. - MGA 18.3-269.

312. Prikhot'ko, G. F. Otsenka effektivnosti iskusstvennykh osadkov iz konvektivnykh oblakov. (Evaluation of effectiveness of artificially induced precipitation from convective clouds.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 61: 3-16, 1966. DAS M(055) U581tu. Translated into English as U.S. Joint Publications Research Service, JPRS, No. 43,528, November 30, 1967. DAS M(055) U581tuE no. 61 pp. 3-16.

Systematic experiments were carried out in the summers of 1960-1964 in the experimental meteorological polygon of the UkrNIGMI (Ukrainian Scientific Research Hydrometeorological Institute) for inducing additional precipitation from Cu cong. This article gives a quantitative evaluation of the results. The evaluation was made first by the direct method, that is, by determination of the quantity of artificial precipitation from strictly determined clouds, and then by the statistical method, by comparison of the monthly and seasonal sums of precipitation over the experimental and control areas. According to the statistical evaluation, the artificial increase of precipitation was about 15%. The probability of the result was 0.75. A further increase of the test period is required in order to increase the statistical significance of the evaluation. - Author's abstract.

313. Prikhot'ko, G. F. Sinopticheskie usloviia v dni s vozdeistviiami na konvektivnuiu oblachnost'. (Synoptic conditions on days when convective clouds are modified.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 61: 17-24, 1966. Russian summary p. 17. DAS M(055) U581tu.

The author presents data on the frequency of different types of synoptic processes distinguished by him during the period when convective clouds were formed above the experimental cloud seeding area in May-Aug. 1960-1962. The synoptic conditions at 1500 h on each day of this period were classified into 5 types and 15 subtypes. These are: 1-regions of high pressure or anticyclones (anticyclonic centers, southwesterly and southerly periphery of an anticyclone, northwesterly and northerly periphery of an anticyclone, northeasterly and easterly periphery of an anticyclone, and southeasterly and southerly periphery of an anticyclone):

2--eroded regions of high pressure (in the presence of fronts and without fronts); 3-regions of low pressure (centers and warm sectors of cyclones, the rear, northwesterly and northerly periphery of cyclones, the anterior easterly periphery of cyclones); 4-cols and eroded regions of high pressure (in the presence of fronts, without fronts); 5-troughs of low pressure (warm fronts, cold fronts, and fronts with waves). Data on the values of energy instability over the experimental polygon on an average day and on days with modification during the different synoptic processes, and on the mean values of instability during which convective clouds of different types developed are also presented. - MGA 18.11-399.

Pustina, Fratišek. <u>Umělé atmosférické srážky v ČSSR</u>. (Artificial precipitation in Czechoslovakia.) Vodní Hospodárství. Prague, 16(9): 363-365, 1966. Russian and English summaries in special section. DLC.

At the beginning of 1966, work on artificial rainfall was carried out in the Office of Water Management Development in Prague. A generator was developed which releases an AgI aerosol used to seed cumuliform clouds from the Earth and from aircraft. By the aviation seeding method, special wicks are burnt under the cumuliform base. The verifying tests were carried out in the basin of the Zbečno Reservoir on the Klíčava River. The results of the experiments were checked by visual and photographic observations of cloud development and by rain gauges. The tests were probably successful in \$_\delta \lambda \psi \psi \lambda \circ \text{to give an idea of the possibilities of applying artificially induced rainfall in water management in the CzechSSR, an estimate of the effect of modification within the rainfall system was determined. - MGA 18.5-182.

Rakipova, L. R. <u>Izmenenie zonal'nogo raspredeleniia temperatury atmosfery v rezul'tate aktivnykh vozdelstvil na klimat.</u> (Variation of zonal temperature distribution as a result of climate modification.) (In: Budyko, M.I. (ed.), Sovremennye problemy klimatologii. Leningrad, Gidrometeoizdat, 1966. pp. 358-383. Russian summary p. 358) DAS M8 B927s.

The theory of the zonal stationary distribution of temperature (Berliand, 1969) developed at the Voeikov Main Geophysical Obs. in which all principal physical factors are considered is presented in complete up-to-date form. This is followed by the application of the theory in computing the present distribution, and the distribution which could result from melting of the arctic ice (a reduction in the circulation index of 22% in summer and 42% in winter) and from dusting of the upper layers of the atmosphere. The tabulated results for the latter is said to be of the same order as those reported by Wexler. - MGA 18.12-175.

316. Roberts, Walter Orr. Peaceful uses of the Earth's atmosphere. Science, Washington, D.C., 152(3719): 159, April 8, 1966. DAS P.

The author discusses in this editorial the significance of the World Weather Watch. With the worldwide data and with improved computers, weather forecasting would be improved in quality and it might be possible to obtain 2-wk forecasts with an accuracy of 2-3 day forecasts. In addition, with the data of the World Weather Watch supplemented by an adequate computer and a global mathematical model it becomes possible to "perform" experiments on weather and climate modification numerically rather than in nature so that the consequences can be evaluated without any hazard. - MGA 17.10-75.

317. Ronne, Claude. Meteorological studies conducted by Contract NONR 4071
(00): Final Report. Woods Hole, Massachusetts, Oceanographic
Institution, Reference No. 66-5, February 1966. Unpublished Manuscript.
8 pp. DAS M(051) W894fin.

Weather modification studies as recorded photographically. During April and Aug. 1963 the Barbados Weather Modification Project made extensive use of whole-sky, time-lapse and conventional photography to investigate cloud and rain formation over tropical heat sources. These observations were made from land-based, ship-borne and aircraft stations. In July 1965 further photographic studies were carried out over the eastern Caribbean Sea to evaluate the effect of seeding cumulus clouds with AgI bombs. - MGA 17.8-218.

Saarinen, T. F. Attitudes towards weather modification: a study of Great Plains farmers. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 323-328) (Chicago. University. Department of Geography, Research Paper no. 105: 323-328, 1966) DAS MO9.6 S989h.

Using the questionnaire method, the author investigated the attitudes of farmers in areas ranging from the most arid to the most humid margins of the Great Plains to weather modification and their ideas on weather modification. The results indicate that farmers living in the more arid portions of the region were generally more convinced of the feasibility of modifying the weather than those in the more humid portions of the region. Farmers with a greater number of years of formal education and those who are interested in adopting new techniques are more favorably disposed to weather modification. - MGA 17.11-215

319. Sansom, H. W. The use of explosive rockets to suppress hail in Kenya. Weather, London, 21(3): 86-91, March 1966. DAS M(05) R888w.

Paper begins with a review of published accounts of theories and experiments concerning the use of explosive rockets to suppress hail. Although there is little official scientific approval of such experiments rockets are still used in many places, notably in northern Italy. Theories to explain their effect have included suggestions that the explosion breaks up eddies, that the explosive materials produce hygroscopic nuclei which increase the number of embryo hail particles so that none grow to any size, that these

same nuclei accelerate the production of rain thereby reducing the hail risk, or that the explosive shock wave cracks the surface of the hail making the stones soft and harmless. None of the theories have a great deal of support and all properly conducted experiments show inconclusive results. The tea crop in Kenya suffers heavily from hail damage and in 1961 the East African Meteorological Dept. was asked to cooperate in experiments using Italian explosive rockets. The rockets are launched from 13 launching sites, approximately 500 yds apart on a 1200 acre estate. The extent of hail damage at the estate on which the launching sites are based and on surrounding estates was assessed from farmers' reports and compared with the damage for earlier years. Less damage was recorded during the experimental period both on the trial estate and the surrounding estates. Maps of the distribution of the change in hail damage from the control period to the experimental period show a center of maximum change over the trial estate. It is not suggested that the rockets prevent hail formation. This cannot be so, since no rockets are fired until hail is actually falling. What appears to happen is that the firings change the hail from hard damaging hail to soft hail or rain. - MGA 17.10-220.

320. Sewell, W. R. Derrick (ed.) Human dimensions of weather modification. Chicago. University. Department of Geography, Research Paper No. 105, 1966. 423 pp. "Papers prepared in connection with a Symposium on the Economic and Social Aspects of Weather Modification, National Center for Atmospheric Research, Boulder, Colorado, July 1-3, 1965." (All articles abstracted separately.) DAS MO9.6 S989h.

The general topics covered in this Symposium include the following: approaches to the study of the human dimensions of weather modification; physical capacity to modify the weather including the state of the art and hydrological consequences; economic evaluation of weather modification; impacts of weather modification on various economic activities; impacts of weather modification on urban areas; institutional aspects of weather modification including legal aspects and government action; attitudes of farmers and industries to weather modification and to government involvement in the program; the social and economic evaluation of weather modification research; and the general implications of weather modification research to human behavior. A selected bibliography of papers on the human dimensions of weather modification that have appeared since 1957 is presented. - MGA 17.11-34

321. Sewell, W. R. Derrick and Day, J. C. Perception of possibilities of weather modification and attitudes toward government involvement.

(In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 329-344) (Chicago University. Department of Geography, Research Paper No. 105: 329-344, 1966) DAS MO9.6 S989h.

On the basis of a questionnaire technique, the authors investigated the following questions related to weather modification: 1) who believes that attempts to modify the weather are effective; 2)

to what extent is belief in the feasibility of weather modification influenced by the degree of aridity and by various socioeconomic characteristics; 3) which groups feel that the government should be involved in weather modification; 4) what kinds of government activity related to weather modification are supported and what kinds are opposed; and 5) how do attitudes toward government involvement vary with occupation and region. The procedure used in this study is described and the results of the study are presented in tables. - MGA 17.11-216.

322. Sewell, W. R. Derrick. The problem cof human dimensions of weather modifications in perspective. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. pp. 1-16) (Chicago. University. Department of Geography, Research Paper No. 105: 1-16, 1966) DAS MO9.6 S989h.

In this broad overall survey of the social and economic effects of weather modification by cloud seeding, the author discusses the extent, uses, and implications of weather modification: reviews briefly studies dealing with the economic and social consequences of weather modification; states the objectives of the present Symposium on the Economic and Social Aspects of Weather Modification, and summarizes the broad subjects of this symposium, namely, possible approaches to the study of the human aspects of weather modification, the physical capacity to modify the weather, economic and evaluation of weather modification projects and programs, impacts of weather modification on various economic activities, impacts on urban regions, attitudes to weather modification, the evaluation of the research effort on weather modification, implications of weather modification to primitive societies and to human behavior, and the institutional aspects of weather modification (legal aspects, government action). -MGA 17.11-201.

323. Simoi, Cornel. La pile héliothermique atmosphérique. (An atmospheric solar heat collector.) Journal de Recherches Atmosphériques, Clermont-Ferrand, No. 1: 13-18, January-March 1966. French and English summaries p. 13. DAS M(05) J86jor.

The utilization of dry clouds of carbon black to amplify and localize the absorption of sunlight in the atmosphere is purposed. Installed at high altitudes, these clouds can generate rising currents of convection and form cumulus clouds. In certain favorable conditions, it is possible to produce rain. - MGA 17.11-226.

Simon, A. Modification artificielle d'une couche d'altocumulus par des avions à réaction. (Artificial modification of an altocumulus layer by jet airplanes.) Journal de Recherches Atmosphériques, Clermont-Ferrand, No. 1: 36-38, January-March 1966. DAS M(05) J86jor.

Illustrated with very distinct photographs, the paper deals with

the observation made at Budapest on Oct. 11, 1965 of an Ac layer modification caused by the passage of jet planes. The author analyzes the evolution with time of the phenomenon in the light of the then prevailing weather conditions. A plausible explanation might be the dispersal of the clouds by the heat of the gases released, or more probably by the strong turbulence and acoustic field which form behind airplanes. It is suggested that these hypotheses be tested for possible artificial modification of clouds. - MGA 18.2-162.

325. Simpson, Joanne. Photographic and radar study of the Stormfury 5 August 1965 seeded cloud. Journal of Applied Meteorology, Ecston, 6(1): 82-87, February 1967. DAS M(05) J86joa 6: 1967. Issued by U. S. Environmental Science Services Administration as: Project Stormfury Reports no. 4-65, May 1, 1966. DAS M(055) U5885pr No. 4-65.

In the summer of 1965, a series of tropical cumulus cloud experiments was carried out by Project Stormfury, a joint program of the U. S. Navy and ESSA. Of 12 clouds seeded with tops colder than -5°C, 8 grew an average of 10,600 ft following seeding. This is a case study of one of these eight clouds; it was seeded at 25,000 ft (absolute altitude) and grew to about 36,000 ft. Four instrumented aircraft penetrated the cloud in a stack, at levels from cloud base to about 20,000 ft. A heavily radar equipped "Command" plane controlled the experiment, circling the cloud at a distance of about 25 mi. This paper documents the radar and photographic history of the cloud, mainly as determined from the command aircraft. It is intended to aid in interpretation of the cloud physics measurements provided by the penetrating aircraft, particularly that of the NRL. The NRL aircraft made repeated traverses through the cloud at 18,000 ft (absolute altitude; 17,000 ft pressure altitude) in the temperature range -3°C to -5°C. It measured temperature, humidity and hydrometeor structure, once before and several times after seeding. Conversion from largely water to largely ice was observed in a portion of the cloud together with some interesting temperature increases. This study attempts to relate the seeding effects and internal physical changes to the overall dynamic processes as deduced from radar and photography. - MGA 18.1-1/15.

326. Simpson, Robert H.; Simpson, Joanne; Stinson, J. R. Some aspects of hurricane modification. U. S. Environmental Science Services Administration and U. S. Navy, Project Stormfury Reports No. 2-65, March 1, 1966. 32 pp. DAS M(055) U5885pr No. 2-65.

Authors discuss and illustrate the objectives of the Stormfury modification effort; the eyewall hypothesis, current results and planned experiments, the organization, equipment logistics and problems, and other possible avenues of investigation such as the prevention of drop coalescence or the cooling of cloud particles. In summarizing, the authors state that no conclusion may be drawn now about the usefulness of the present Stormfury approach to

hurricanes. This must await operationally successful executions of the experiments planned for 1965. - MGA 18.1-140.

327. Simpson, Robert H. and Simpson, Joanne. Why experiment on tropical hurricanes? New York Academy of Sciences, Transactions, Ser. II, 28(8): 1045-1062, June 1966. DAS M15.2 S613w.

A discussion of the U. S. seeding experiment, Project Stormfury (which postulates instabilities which might be triggered by relatively small amounts of energy, introduced strategically) is followed by a description of an experiment which concentrates on the mature hurricane. The typical radial wind profile of a full hurricane "Daisy" (1958) is compared with that of a tropical storm "Frieda" (1957) and the question is posed as to whether a "Daisy" can be converted into a "Frieda" by the triggering of an instability. The manner in which cloud seeding is expected to work is described. Laboratory tests, the preliminary experiment run on hurricane "Esther" in 1961 and the experiments planned for 1965 and 1966 are mentioned. It is noted that cloud seeding may turn out not to be effective in hurricane modification. Other suggested approaches to cloud modification such as the prevention of drop coalescence or the cooling of the cloud particles by chemical means should in the author's opinion not be applied without construction of hypotheses and preliminary tests on Cu clouds. Alteration at high levels of the radiative balance in tropical cyclones and artificial restriction of the critical energy fluxes at the sea-air boundary which have been suggested aside from cloud modification are examined. It is concluded that in hurricane modification, the basic scientific questions remain unanswered; the question of "how" is not a matter of detail since the question of "whether" still looms unanswered -MGA 18.8-235.

328. Smith, E. J.; Adderley, E. E.; Bethwaite, F. D.; Warburten, J. A. <u>Cloud</u>
seeding experiment; annual report con. South Australia, 1957. Australia.
Commonwealth Scientific and Industrial Research Organization.
Division of Radiophysics. Sydney, August 1965. 11 pp. Also: ...1958.
November 1965. 7 pp. Also: ...1959. April 1966. 7 pp. DAS MO9.67

Describes cloud seeding experiments conducted over a 3-yr period in 2 rectangular (1000 mi² each) designated areas situated on the Mount Lofty Ranges 20-40 mi east of the coast in the vicinity of Adelaide, and separated by a 25 mi wide "neutral" (nonseeded) area. The experiments took place in the winter months during arbitrary periods of 10-12 days. The tests were to determine the amount of increased precipitation in seeded areas, by seeding the clouds with silver iodide smoke (released from aircraft), and to establish the regions and circumstances in which such seeding techniques could be effective. Detailed descriptions of the experiments are given as regards meterological conditions in and around the areas seeded—the areas seeded, topography, aircraft and flight plans, and total hours of seeding. Flight reports, summaries, and other relevant data are appended to each annual report. Conclusions show that the seeding operations conducted over the 3-yr period produced no demonstrable effects. - MGA 21.1-204.

329. Smith, E. J.; Warburton, J. A.; Heffernan, K. J.; Thompson, W. J.

Performance measurements of silver-iodide smoke generators on aircraft.

Journal of Applied Meteorology, Boston, 5(3): 292-295, June 1966.

DAS M(05) J86joa.

The performance of a silver iodide smoke generator, mounted on an aircraft, was measured in flight. The ice-nucleus output was 10^{11} per gram of silver iodide active at -150 and 10^{12} at -100. Considerable variations in the burner configuration and the solution which was burnt had little effect on the performance. - Authors' abstract.

330. Sommermeyer, I. E. and Beckwith, W. Boynton. <u>Success of super-cooled fog seeding for airline operations</u>. International Council of the Aeronautical Sciences, 5th Congress, London, September 12-16, Paper cunnumbered. 1966. 7 pp.

Discussion of the dispersal of supercooled fogs over airports of the northwestern U. S. by seeding them with crushed dry ice. The method considered is said to be operationally 80% reliable and to be economical, with cost-benefit ratios averaging about 1:5. The standard technique used in producing these weather modifications is described, and the advantages of aircraft seeding over ground seeding methods are outlined. Future cold- and warm-fog dispersal programs are considered. - MGA 18.4-235.

331. Srámek, L. Results of seeding experiments of supercooled fogs in cloud chambers by means of silver iodide atomized by means of pyrotechnic mixtures. Journal de Recherches Atmosphéricues, Clermont-Ferrand, No. 2-3, April-September 1966. pp. 377-382. French and English summaries p. 377. (International Symposium on Condensation Nuclei, 6th, Albany, N. Y. and University Park, Pa., May 9-13, 1966.

•Proceedings.) DAS M(05) J86jor Sec. 2.

Results of trials with AgI aerosels in a cold chamber where a supercooled cloud was produced are presented. The duration of an artificial cloud varied from 8 to 10 min and the ice crystal germ formation was registered with a photelectric cell and with the help of photographic observations. The critical temperatures for the different pyrotechnical mixtures were between —4°C and —9°C with the occurrence maximum at —6.5°C. — MGA 18.9-204.

332. Steele, R. L. and Krebs, F. W. Characteristics of silver icdide ice nuclei originating from anhydrous ammonia - silver icdide complexes:

Part I. Journal of Applied Meteorology, Boston, 6(1): 105-113,
February 1967. DAS M(05) J86joa. Also issued as Colorado. State University, Fort Collins. Department of Atmospheric Science,
Atmospheric Science Technical Paper no. 73, January 1966. 13 pp. (Mechanical Engineering Technical Paper 66-3).

Two methods of generating AgI ice nuclei were investigated. Neither employs thermal processing. A 3000 liter isothermal cloud chamber controllable over the range of 0 to -200 plus or mirus

O.1°C was designed and fabricated to study nucleation processes along with other support equipment. Anhydrous NH₃ as the AgI carrier was employed. In a simple system in which the complex is sprayed into ambient air via a commercial nozzle the results are negative, 10 to the 12th power nuclei per gram at -20°C. Another system, using Dautrebande's principle of obligatory filtration, shows promise. Performance at -13°C is 3 x 10 to the 1/1th power nuclei per gram. The electron microscope was used to study the effluents from both generators. The shape and physical characteristics of effective particles are quite different from those found in thermal generators. The marked difference in effectiveness between thermal and nonthermal systems is attributed to impurities. - MGA 17.12-191.

333. Steele, Roger L. Preliminary investigation of a new generator for silver iodide using isopropylamine as the carrier. Western Snow Conference, 3hth Annual Meeting, Seattle, Washington, April 19-21, 1966.

Proceedings. pp. 19-56. Fort Collins, Colorado, Colorado State University. DAS M(06) W527p 3h: 1966.

The author presents the advantages and disadvantages of using isopropylamine; describes the isopropylamine storage and handling, generator design and generator effectiveness; evaluates the results of the field test; gives conclusions. Distinct seeding effects were produced by the generator.

Sulakvelidze, G. K.; Biblashvili, N. Sh.; Lapcheva, V. F. Metodika i fizicheskie osnovy vozdejstviia na konvektivnye oblaka s tseliu predetvrashcheniia gradobitiia. (Methods and physical principles of convective cloud seeding for hail suppression.) Nal'chik, U.S.S.B. Vysokogornyi Geofizicheskii Institut, Trudy, 3(5): 215-220, 1966. DLC QC851.E55.

Theoretical, laboratory, and field data collected by the High-Mountain Geophysical Institute since 1956 are used for discussing the modified principles of hail suppression. - WMSU.

Sulakvelidze, G. K. Printsip i sredstva vozdelstvila na konvektivnye oblaka s tsel'iu predotvrashenila vypadenila grada, ispol'zovannye v rabotakh kavkazskof ekspeditsii. (Principles and means of convective cloud modification used in the work of the Caucasus Expedition, 1964-1965, with a view to preventing hail.) Nal'chik, U.S.S.R. Vysokogernyi Geofizicheskii Institut, Trudy, No. 5: 150-168, 1966. Russian summary p. 150. DLC. Translated into English as U. S. Joint Publications Research Service, JPRS, No. 43,546, December 4, 1967. 28pp. DAS MO9.616 S949pri.

The author discusses the mechanism of hail formation and proposes principles for the modification of hail-bearing clouds. The article also describes methods for the modification of hail processes, the method for injecting the reagent into a cloud and the results of experimental and practical work for modification of hail processes. Also considered are problems whose solution

is necessary for clarification of a number of problems involved in the modification of hail clouds. - Author's abstract.

336. Sulakvelidze, G. K. and others. Resul'taty Kavkazskoi Ekspeditsii po predotvrashcheniiu Gradobitiia (1964g). (Results of the Caucasian Expedition for hail suppression in 1964.) Nal'chik, U.S.S.R. Vysokogornyi Geofizicheskii Institut, Trudy, 3(5): 231-240, 1966. DLC QC851.E55.

A significant success in hail suppression was reached in Caucasus during 1961-1964. The area protected from hail increased from 30,000 ha in 1961 and 1962 to 50,000 ha in 1963, and more than 430,000 ha in 1964. Insurance payments in protected areas were 8 times lower than payments made during the previous 4-5 years. - WMSU.

337. Sumin, Iu. P. Eksperimental nye issledovaniia kristallizatsii

pereokhlazhdennoi sloistoobraznoi oblachnosti pirotekhnicheskimi
sostavami s AgJ i PbJ2. (Experimental investigations of crystallization of supercooled stratus clouds by pyrotechnic compounds of AgI
and PbI2.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad,
Trudy, No. 186: 26-37, 1966. Russian summary p. 26. DAS M(055)
U581tg.

The results of field experiments carried out in winter on the crystallizing action of the flare cartridges 5-36 and 5-55 (containing, resp., 10 g of AgI and 15 g of PbI2) are presented. These proved to be effective in crystallizing supercooled clouds at temperatures of -7.5 and 8.7° C and lower, resp. The rate of propagation of a crystallization front increases with increase in wind speed but its importance for a point source is less than the values obtained by L. I. Krasnovskaia (TSAO, Trudy No. 14, 1962; see 15F-52, June 1964, Met Abs.) for a point source. Depending upon the state of cloudiness (diminution, maintenance or increase in thickness) the zone of crystallization either increases with time up to complete disappearence of the cloud layer or, attaining maximum value, it decreases in size because of the penetration of drops within it. On the average the dimensions of the crystallization zone produced in 1 hour by a flare cartridge may amount to 20-30 km² and even greater in individual cases. The more stable the cloudiness, the more rapid is the narrowing of the crystallization zone. The time of appearance of a clearing in a continuous layer of supercooled clouds is a function of the thickness of the layer and the wind speed within it. The empirical form of this relationship is

$$\tau_{pr} = \frac{\alpha \Delta II}{u^{\beta}},$$

when τ_{pr} = time of appearance of clearing in minutes, α and β

equal numerical coefficients equal, resp., to 0.0891 and 0.45; u equals wind speed at the level of the upper boundary in m/sec; and ΔH equals thickness of the cloud layer in kilometers. - MGA 18.8-207.

338. Sutcliffe, R. C. Control of weather and climate. Nature, London, 210 (5035): 459-460, April 30, 1966. DAS P.

In this report of the findings of the Committee of Atmospheric Sciences to the U. S. Natl. Acad. of Sc. on Weather and climate modification. Problems and prospect (Natl. Acad. of Sc., Wash., D. C., 1966) Sutcliffe makes a comparison between the U. S. and U.S.S.R. effort in the field of climate control and that of Great Britain. The British effort per head of population is lower by a factor of 10 than that of the U.S. It is suggested that international interest through many organizations may soon prompt a greater activity within Britain. Commenting on the Committee's findings regarding the efficiency of seeding operations for increasing rainfall, Sutcliffe points out that while no scientific step forward had been made there were many favorable signs worthy of further investigation. He considers that this favorable verdict was swayed by the feeling that after 20 yrs an expert body must do more than sit on the fence. Other recommendations in the Report are commented on but briefly. This review ends with a hint that the magnitude of the efforts in this field of both the Americans and the Russians may be prompted by the thought of weather control as a potential weapon. - MGA 17.10-211.

339. Taubenfeld, Howard J. Weather modification law, controls, operations:

a survey of responses to questionnaires of the Special Commission on Weather Modification of the National Science Foundation by states, research and experimental organizations, commercial operators and federal agencies. U. S. National Science Foundation, NSF 66-7, 1966.

73 p. DAS MO9.6. T222we. Certain parts of this are reproduced in the American Meteorological Society, Bulletin, 47(3): 184-193, March 1966. DAS M(05) A512b.

This report surveys the operations of present State laws with reference to weather modification research and commercial activities. The general topics considered consist of the following, viz: the scope of State regulatory statues and other applicable laws; licensing and registration standards; interstate relationships; uniform State statutes; Federal-State cooperation and Federal regulatory legislation; possible interference with a contamination of weather modification activities; liability, indemnification, and insurance with regards to damages which may result from weather modification activities. Appendices contain notes on case law and cases including specific law suits and court decisions, examples of ordinances and special statutes, etc. - MGA 17.8-30.

340. Thams, J. C.; Aufdermaur, A.; Schmid, P.; Zenone, E. <u>Die Ergebnisse des Grossversuches III zur Bekämpfund des Hagels im Tessin in den Jahren 1957-1963</u>. (Results of Project III for hail control in Tessin (Ticino), 1957-1963.) Switzerland. Schweizerische Meteorologische

Zentral-Anstalt, Veröffentlichungen, No. 2, 1966. 32 p. German, English, French and Italian summaries. DAS M(055) S9792ve No. 2.

In the summer half-years from spring 1957 to autumn 1963, a large scale hail suppression experiment was carried out in the Ticino. on the southern slopes of the Alps. The atmosphere was seeded with silver iodide (AgI) by means of a network of ground generators. To find out whether this seeding was successful or not the randomization principle was adopted, and two strictly comparable series of test days, the one with and the other without seeding, were obtained. The number of test days throughout the 7-yr period amounted to 292, on 145 of which seeding was carried out. Evaluation of the test has shown that seeding the clouds with AgI does not prevent hail formation but rather promotes it. This result is of course only valid for the special region in which the experiment was carried out and for the seeding and method employed. The rain stimulation test which was conducted parallel with the hail suppression investigation yielded the following result: under certain weather conditions, precipitation was considerably increased by seeding the clouds with AgI. The results of this test will be published later. - MGA 18.12-180.

3hl. Timofeev, M. P. <u>O regulirovanii intensivnosti zimnikh tumanov ispareniia.</u>
(Regulation of the intensity of evaporation fogs in winter.) U.S.S.R.
Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 187:
131-138, 1966. Russian summary p. 131. DAS M(055) U581tg.

The properties of winter evaporation fogs are analyzed, in particular the factors determining the stability of these fogs. The dependence of various characteristics of fogs upon the variability of parameters determining this function is examined. The possibility of altering the intensity of evaporation fogs by regulating initial air temperature by means of heat sources and by reducing evaporation by means of films of surface active substances is examined theoretically. - MGA 17.12-392.

3/12. Udall, Stewart L. Water resources in the sky. American Meteorological Society, Bulletin, 47(4): 275-278, April 1966. DAS M(05) A512b.

The Secretary of Interior discusses the activities of the Federal Government in conservation and development of water resources, and the possibility of weather modification. - MGA 17.11-198.

343. U. S. National Science Foundation. Weather modification. 7th Annual Report for fiscal year ended June 30, 1965. Its NSF 66-4, January 1966. 109 p. DAS MO9.67 U585we 1964/65.

The annual report on weather modification includes the following: a discussion of the general scope of a national weather modification program and of the scientific manpower problem; federal activities in weather modification including the Interdepartmental Committee on Atmospheric Sciences, the atmospheric water resources research program, the national Science Foundation (NSF) Special

Commission on Weather Modification, the USWB, etc; commercial cloud modification; evaluation of the state of the art of weather modification—including modification of fog and cloud, precipitation, lightning, severe storms and climate, and hail suppression; weather modification activities in foreign countries; weather modification program of the NSF; weather modification activities by the Dept. of Agr., Dept. of Comm., Dept of Def., Dept of the Int., Fed. Av. Agency, etc.; a list and description of NSF grants and contracts for weather modification research for 1965; the weather modification programs founded by the federal government in 1965; and a list of the advisory panels, committees, and commissions. — MGA 18.1-231.

3). U. S. Office of Atmospheric Water Resources. Plan to develop technology for increasing water yield from atmospheric sources: an atmospheric water resources program. Washington, D. C., U. S. Government Printing Office, November 1966. 56p. DAS M09.617 U586pl.

A comprehensive national plan of research and development, necessary to make weather modification an operational technique in water resources management, outlines the program approach for a national capability for "increasing" or 'redistribution' precipitation, required technical systems, schedules for accomplishing regional capabilities to enhance precipitation, and necessary relationships between governmental and other agencies. The 1966 special reports by the National Academy of Sciences-National Research Council and the National Science Foundation, which provided a substantial endorsement of the concept of increasing precipitation is quoted extensively. The plan provides that work will be done first in areas of major orographic effects (shown on a map). Research and development effort will include 50 experimental projects by 1975 and the establishment of ~20 pilot projects in the first 8 yrs of the program. - MGA 19.8-197.

347. Vickers, William W. and Church, James F. Investigation of optimal design for supercooled cloud dispersal equipment and techniques. Journal of Applied Meteorology, Boston, 5(1): 105-118, February 1966. DAS M(05) J86joa.

To determine optimal cloud-seeding techniques and optimal design specifications for a dry-ice seeding machine (the Cloudbuster), multiple strip seeding of stratiform decks was performed during which seeding rate, pellet size, and strip orientation with respect to wind were systematically changed from strip to strip. Concurrently, the physical properties of the cloud decks were measured and cloud response (i.e., hole size, growth rate, etc.) to the varying treatments was measured photogrammetrically. Results showed that both the dry-ice seeding rate and pellet size, as well as the cloud temperature, exerted a strong influence on cloud response. Seeding rate had an optimum of 8 to 9 lb per nautical mile of CO₂ pellets whereafter additional quantities failed to produce consistently any increase in response. Generally, clouds failed to respond to treatment at 1.9 lb per n mi. A

minimum recommended quantity of CO₂ pellets is 4 lb per n mi using a lxlxl-cm pellet of 0.6 gm cm⁻³ density. This CO₂ pellet has a fall distance of 1200 ft. When combined with other machine functions this seeding rate and pellet size allow an output of 10,500 pellets per n mi. Cloud response approximately doubles between -5 and -11C. A response failure point exists between -3 and -11C. Strips should be seeded across the wind. Seeding altitude for the aircraft should be coincident with the top of the deck for all but thickest decks (-1200 ft.). For thick decks, penetration into the top one-half to one-third of the cloud decks is recommended as well as enlargement of the seeded zone by a second seeding along the perimeter of the expanding ice crystal zones. - Authors' abstract.

346. Vogt, Evon Z. Some implications of weather modification for the cultural patterns of tribal societies. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. p. 373-392) Chicago. University. Department of Geography, Research Paper No. 105: 373-392, 1966) DAS MO9.6 S989h.

The potential effects of weather modification on 3 tribal societies, the Navaho, Zuni and Zinacanteco are discussed. The contents of this paper consist of the following: the general features of tribal societies; relationship of meteorological phenomena to cultural patterns, namely in cosmological beliefs, in ceremonies, and in ecological adaptation; hypothetical responses of the 3 tribal societies to weather modification in the cultural patterns; and an outline of suggested investigations in advance of weather modification programs affecting tribal societies. - MGA 17.11-219.

3/17. Volkov, A. D. and Mirmovich, L. A. Samoletnaia avtomaticheskaia doziruiushchaia ustanovka (SADU-1). Airborne automatic seeding apparatus (SADU-1). U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometecrologicheskii Institut, Trudy, No. 61: 118-122, 1966.

DAS M(055) U581tu. Translated into English as U. S. Joint Publication Research Service, JPRS, No. 43,400, November 21, 1967. DAS M09.616

Describes the design, construction, operation, control, circuitry, mounting, and employment of a device for modifying St clouds and mists in the winter months by means of automatic seeding. The airborne apparatus is capable of discharging granulated CO₂ evenly and discretly. Its major structural elements are illustrated. - MGA 20.7-168.

3h8. Vonnegut, Bernard. Further comments on "Note on the Potentialities of Cumulonimbus and Hurricane Seedings Experiments." Reply by Joanne and Robert H. Simpson. Journal of Applied Meteorology, Boston, 5(1): 13h-136, February 1966. For earlier comments by L. J. Battan, see Toid. h(3): h26-h29, June 1965. DAS M(05) J86joa.

The author points out that Langmuir treated the idea of the importance of the heat released by cloud seeding in a Project Cirrus

report (1947). Langmuir's statement that during cloud seeding there is another important source of heat besides cloud seeding is quoted. This other source of heat is the heat of sublimation of the extra amount of water which is converted from vapor into ice. The author criticizes Malkus and Simpson for failing to give details on "Alecto" pyrotechnic bombing method used in the Stormfury Project. With respect to the extra condensation heat due to vapor pressure difference between water and ice, Malkus and Simpson state that it is more consistent to assume saturation with respect to ice when freezing is complete and the fusion heating released. The extra condensation heat would contribute nearly 1°C more heating from seeding and would eliminate any need for side effects such as increased water fallout or expansion of the tower to explain cloud buoyancy and observed growth. Mottern cites references containing descriptions of the "Alecto" technique. MGA 17-11-282.

Walczewski, Jacek. Koncepcja wstępnych eksperymentów sztucznego oddzia/ywania na chmury. (Project for preliminary experiments in artificial cloud modification.) Poland. Państwowy Instytut Hydrologiczno- Meteorologiczny, Wiadomości S/uzby Hydrologicznej i Meteorologicznej, 2(2): 19-28, 1966. Russian and English summaries. DLC.

Contains proposed principles of artificial cloud modification experiments. The principles are related to Polish conditions and are based on the literature as well as on the results of practical work, performed in Poland with consideration of reagent type, form of reagent's injection, reagent's transport means, experiment verification methods and necessary weather conditions. A brief description is given of experimental balloon and rocket system for cloud modification, worked out in Polish Hydro-Meteorological Inst. - MGA 19.5-159.

350. White, Gilbert F. Approaches to weather modification. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago. University of Chicago Press, 1966. p. 19-23) (Chicago. University. Department of Geography, Research Paper No. 105: 19-23, 1966) DAS MO9.6 S989h.

Weather modification involves alteration in atmospheric, biologic, economic, and social systems. Its effects on human life can be investigated by 2 modes of approach. One is to assume a degree of atmospheric modification by a particular technique and to trace out the impacts in the life of the area involved; the other is to ignore weather probabilities initially and to consider the aspects of human life that are more directly related to weather. While weather modification is characterized by extreme uncertainty it has the virtue that, in comparison with other methods of modifying the environment, it has the advantages of low capital cost in relation to operating costs and anticipated benefits, and it is a flexible procedure. But there is the disadvantage that it may involve undesired effects in areas outside that under modification.

- MGA 17.11-202.

351. Woodley, William L. Computations on cloud growth related to the seeding of tropical cumuli. Bulletin of the American Meteorological Society, Boston, 47(5): 384-392, May 1966. DAS M(05) A512b.

A statistical study has been conducted investigating the possible cloud growth effects due to heat released when supercooled water is converted to ice. Calculations are made of the heights to which cloud tops would rise assuming that the supercooled water is converted to ice at -10C (the seeded case) or at -30C (the unseeded case). The clouds suffer a loss in buoyancy due to entrainment and the weight of the condensate. Sixty-two cases are treated for soundings from St. Martins Island during August of 1962. The results of this study are compared to those of a similar study for Flagstaff, Arizona, during the summers of 1961, 1962 and 1963. The results imply that spectacular height increases due to seeding can be expected, but that such cases are relatively infrequent. Specific observations of cloud growth due to seeding are noted, but can only be considered as consistent with these concepts rather than verifying them. The factors important for the seeding effect and the conditions which produce them are also examined. Despite the simplicity of the model, it is felt that the computed height differences qualitatively represent a reasonable measure of the potential for cloud dynamics changes from seeding. - Author's abstract.

352. Wycoff, P. H. Evaluation of the state of art cof the physical capacity to modify the weather. (In: Sewell, W. R. Derrick (ed.), Human dimensions of weather modification. Chicago, University of Chicago Press, 1966. p. 27-39) (Chicago, University. Department of Geography, Research Paper No. 105: 27-39, 1966.) DAS MO9.6 S989h.

The present state of scientific knowledge and of the technical art of weather modification is reviewed. The contents of the paper include the following: fog and cloud modification; precipitation modification; hail suppression; lightning suppression; severe storm modification—hurricanes and tornadoes; and modification of climate. - MGA 17.11-203.

353. Yoshida, Sakumatsu. Evaluation of cloud seeding effect by statistical analysis of snowfall amount in the Tôhoku District, Japan. Journal of Meteorological Research of Tohoku District, 18(3): 37-47, March 1966, Sendai, Japan. DAS M(05) J86jo.

In every winter since 1953, ground-based seeding with silver-iodide smokes has been carried out in the Tôhoku district, northern part of Honshû, Japan, for the purpose of increasing snowfall. The seeding effect which was evaluated by two ways of statistical analysis of snowfall amounts, was as follows: (1) From comparison of snowfall amounts for seeded and non-seeded days under typical monsoon it was found that remarkable increase of snowfall, reaching around 20 per cent on an average, occurred 50 to 100 km leeward of the seeding points on seeded days. (2) Stochastic test for the ratio of ten day snowfall amounts at the target points to those at

the control ones on seeded periods showed that the increased snowfall amount in the target area was significant at the level of significance of 4 per cent. - Author's abstract.

Zavertnev, M. P. and Khadzhiev, M. A. K voprosu o povtoriaemosti gradobitii na Severnom Kavkaze. (Frequency of hail damage in the Northern Caucasus.) Nal'chik, U. S. S. R. Vysokogornyi Geofizicheskii Institut, Trudy, No. 5: 178-190, 1966. Russian summary p. 178. DLC.

Frequency of hail damage and also probability of hail fall each year, and confidence of probability within limits of specific administrative districts of a series of regions, autonomous republics of the Northern Caucasus, etc. are examined on the basis of long period damage caused by hail in these areas. Tables on probability of hail fall per year, confidence of probability at various stations of the Northern Caucasus, and comparison of number of days with hail according to data of weather stations with those recorded by insurance agencies, etc are presented. - MGA 19.9-521.

Zavertnev, M. P. and Khadzhiev, M. A. Metodika i organizatsiia kontrolia rezul'tatov vozdeistviia na gradovye protsessy v ekspeditsiiakh VGI. (Methods of rating applied by expeditions of the High-Mountain Geophysical Institute for determining the effectiveness of hail suppression.) Nal'chik, U. S. S. R. Vysokogornyí Geofizicheskii Institut, Trudy, 3(5): 221-226, 1966. DLC QC851.E55.

The effectiveness of methods of hail suppression in Kabardian-Blakar ASSR developed by the Institute is discussed. A high rate of control was reached in 1963 when plants were protected from hail-storm damage in an area about 50,000 ha. - WMSU.

356. Zilitinkevich, S. S. Effekt rasseianiia tumana pri dinamicheskom vozdeistvii. (Effect of fcg dissipation due to dynamic impact.)

U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy,
No. 187: 217-220, 1966. Russian summary p. 217. DAS M(055) US81tg.

The author proposes a method for dispersing fog over a limited area based upon the dynamic and thermal effect of a local velocity field created by a special device pumping air in horizontal directions out of the area examined. The main factors of fog dispersal are the mechanical removal of warm moisture from the region of action and evaporation of drops by the heating of air compressed during its descent. The expected effect is computed on the basis of the theory of heat and moisture exchange in clouds and fogs. Instances in which atmospheric water exists only in gaseous and liquid phases are examined. The computational equations and results of computations are presented. - MGA 17.12-180.

357. Zykov, N. A.; Lenshin, V. T.; Morozova, T. I.; Shishkin, N. S.; Shkoda, G. I. O radiolokatsionnykh nabliudeniiakh za rezul'tatami vozdeľstviľ na moshchnye konvektivnye oblaka. (Radar observations of results of modification of thick convective clouds.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 186: 74-79, 1966. Russian summary p. 74. DAS M(055) U581tg.

The authors describe the results of ground radar observations on precipitation zones produced by seeding with PbI₂ a vigorous cumulus cloud in the region of the Valdai shower gaging network. Two experiments were carried out and a detailed account of the observations and diagrams of the radar echo for each of the experiments are given. The radar observations showed a good correspondence with the data of the pluviometric network. - MGA 18.8-208.

1967

358. Adámy, László and Mészáros, Ernő. A ködoszlatás lehetőségei

Magyarországon. (Possibilities of artificial dispersion of fog in

Hungary.) Időjárás, Budapest, 71(1): 28-33, January-February 1967.

English and Russian summaries p. 28. DAS M(05) I21 71: 1967.

Meteorological data available in the literature indicate that the dispersion of supercooled fog, particularly fog with a temperature below -3° C, is a solved problem. An analysis of 10 yrs of data of the Budapest-Ferihegy airport shows that in the winter months (Dec. - Feb.) an average of 197 hrs of fog occurs. In 68% of them temperatures are below 0°C; in 37% the temperature is below -3° C. Eighteen % of all cases with a temperature below -3° C are observed in the daytime. However there are strong variations around the mean value. - MGA 18.10-246.

359. Amelin, A. G. Theory of fog condensation. Jerusalem, Israel Program for Scientific Translations, 1967. 236 pp. Bibliography pp. 225-228. (Israel Program for Scientific Translation, Ltd., IPST Cat. No. 2186) Translation by Z. Lerman of Russian, 2nd rev. edition (edited by B. V. Deryagin) of Teoreticheskie osnovy obrazovaniya tumana prikondensatii para, issued Moscow, 1966. DAS M75 A498th.

Fundamental formulas are derived for the prediction and, possibly, prevention of fog. The basis research is reviewed, and the theoretical findings are substantiated by comparing them with experimental data. The different processes leading to the development of supersaturation are considered in some detail. This 2nd ed. includes the latest published data on formation of fog during vapor condensation. New theoretical and experimental data on rate of nucleation, critical supersaturation, rate of vapor condensation on droplets, etc., are included in Ch. 1. In Ch. 5 particular cases of industrial mists, e.g., in the manufacture of sulfuric acid, are considered in great detail in parallel with theoretical results and laboratory findings. Sulfuric acid was chosen because its particular properties make it ideally suited for the investigation of the general features of aerosol systems. Ch. 7 analyzes the effect of various factors on drop sizes and number densities of fogs, and describes techniques for controlling these

indices. Some practical examples of fog control are considered. Formation of supersaturated vapor and fog by adiabatic expansion and radiative cooling in turbulent mixing of gases, by molecular diffusion and thermal conduction, and as a result of chemical reactions of gases is treated in the remaining chapters. - MGA 19.2-1.

360. Australia. Commonwealth Scientific and Industrial Research Organization.

Division of Radiophysics. Cloud seeding experiment: annual report

con. Tasmania, 1964. Sydney, October 1967. 28 pp. DAS MO9.67

A938.

As the first in a series of reports, describes a cloud seeding experiment to determine 1) the amount by which seeding clouds with silver iodide smoke released from an aircraft can increase precipitation in a hydroelectric catchment area; 2) the circumstances under which the increase can be achieved; and 3) the duration of the effects. The experiment is described in detail and an account rendered of the operations conducted, and results obtained, during the period May 13 to Dec. 23, 1964. In this experiment, seeding takes place during alternate years over a total of 10 yrs-1964, 1966, 1968, are "on" years, but precipitation measurements are made in both "on" and "off" years. The method of operations, division of time into periods of 2 weeks each, areas seeded, control areas. and techniques of measurement and assessment are outlined. The general climate of the area is also described, noting yearround rainfall and other pertinent meteorological factors. Other major topics discussed include periods of suspension of the experiment (heavy local rainfall, strong winds); definition of suitable clouds: seeding equipment: aircraft employed, including navigation, aircraft and airfields; operational objectives (seeding of every suitable cloud in the target area); and seeding techniques. Other elements considered comprise historical rainfall comparisons: rainfall measurements; snow, airmasses, cloud observations, operations during "off" years; and methods of analysis of results. It was found on the basis of first year operations, that the rainfall figures obtained in the target area were consistent with seeding having increased precipitation. Extensive tabular data are appended. - MGA 21.1-265.

Bartishvili, I.T.; Bartishvili, G. C.; Gudushapi, Sh.L.; Lominadze, V.P.

K voprosu odnovremennogo (kombinirovannogo) vozdeľstviia na tepluiu
i pereokhlazhdennuiu chasti oblaka s tsel'iu predotvrashcheniia
vypadeniia grada. (Simultaneous (combined) action on the warm
supercooled parts of a cloud as a hail prevention measure.) U.S.S.R.
Zakavkazskii Nauchno-Issledovatel'skii Gidrometeorologicheskii
Institut, Trudy, 21(27): 56-82, 1967. Russian summary p. 56. DAS
M(055) U581tz no. 21.

The paper examines some results of hailcloud experiments made across the Samara high-mountain, scientific, and experimental meteorological polygon (2200 m asl, Georgian S.S.R.) between 1964 and 1965. Experiments were conducted by a new method of

simultaneous action, which uses treatment of both the warm and supercooled parts of the cloud by hygroscopic or surface-active and crystallizing substances. - MGA 20.6-179.

362. Battan, Louis J. <u>Cloud seeding and cloud-to-ground lightning</u>. Journal of Applied Meteorology, Boston 6(1): 102-104, February 1967. DAS M(05) J86joa.

During the summers of 1958 to 1962, convective clouds over a mountain range in southeastern Arizona were seeded by means of airborne silver-iodide generators. The data collected do not allow a conclusion that the seeding influenced the amount of cloud-to-ground lightning. - Author's abstract.

363. Battan, Louis J. Silver-iodide seeding and precipitation initiation in convective clouds. Journal of Applied Meteorology, Boston 6 (2): 317-322, April 1967. DAS M(05) J86joa.

Convective clouds on seeded and not-seeded days were observed by means of radar and a pair of high quality, ground-based cameras. Stereographic analysis allowed calculation of cloud-top heights. bearing, and distance from the radar set. Radiosonde data were used to convert cloud-top altitudes to summit temperatures. During the periods 1957 to 1960 (Program I) and 1961 to 1964 (Program II) the total number of clouds observed were 1249 and 522, respectively. The analyses indicate that on days when silver-iodide seeding was carried out from an airplane, a higher fraction of clouds developed precipitation echoes. When all the clouds in Program I with temperatures between -18 and -420 are considered, the effects of seeding were found to be significant at the 0.07 level according to the Mann-Whitney U test. When the data for both programs are combined, the same test yields a significance level of about 0.03 for clouds with summit temperatures between -18 and -42C. The results lead to the conclusion that airborne silver-iodide seeding may influence the precipitation-initiation process in convective clouds. - Author's abstract.

Battan, Louis J. Silver iodide seeding and radar echoes from convective clouds. Arizona. University. Institute of Atmospheric Physics, Scientific Report No. 23, October 15, 1967 11 pp. DAS MO8.21 A719s No. 23.

Summer convective clouds over a fairly isolated mountain range over southeastern Arizona were seeded by means of airborne silver iodide (AgI) generators. Selection of pairs of days to be seeded was made on randomization scheme. A 3-cm vertically scanning radar set was used to observe maximum echo height over the "target" area at 30-min intervals. Data were used to examine effects of seeding on vertical extent of the cloud echoes. Although there is a suggestion that AgI nuclei may have initiated precipitation in some clouds and caused small vertical echo growths, statistical analyses, for the most part, showed that observed differences could easily have been caused by chance. - MGA 19.8-202.

of a randomized cloud seeding project in Arizona. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21-July 18, 1965 and December 27, 1965-January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 29-33. DAS 519.9 S989pro 1965/66 v.5.

Presents a summary of results of a randomized cloud seeding project carried out during 1947-60 over the Santa Catalina Mts. in southeastern Arizona. The data summaries presented represent mean rainfall per station on seeded and not seeded days. AgI seeding was carried out by means of an airborne generator. The statistical tests indicate that the observed results could easily have occurred by chance, and thus the hypothesis that seeding had no effect cannot be reasonably rejected. It was found that the data do not support the idea that AgI seeding can increase precipitation at the ground. The observed differences suggest that if there were any effect at all it was to cause a reduction of rainfall. It is added that these results cannot be extrapolated to other techniques, other regions, or even other clouds of similar appearance elsewhere. - MGA 19.7-201.

Beliaev, V. I. and Vial'tsev, V.V. K voprosu o metodike rasseianiia oblakov na bol'shikh ploshchadiakh. (Methods of clouds dispersion over large areas.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, No. 202: 22-31, 1967. Russian summary p. 22. DAS M(055) U58ltg.

Approximate calculations were made of the expansion of crystallization zones generated by the action of solid carbon dioxide on layer clouds. Large scale turbulent diffusion was considered. Results were compared with experimental data. - MGA 20.2-171.

367. Benech, B. <u>Diffusion des noyaux d'iodure d'argent</u>. (Diffusion of silver iodide nuclei.) Association d'Etudes des Moyens de Lutte contre les Fléaux Atmosphériques, Toulouse, Rapport sur la campagnes, No. 15: 73-76, 1967. DAS MO9.6 A849ra.

Silver iodide nuclei were injected into a smoke plume and the formed cloud was analyzed with a mixture counter to determine the concentration of seeded nuclei. The samples taken in the smoke plume showed that an important part of seeding particles are located in the ascending chimney. However, the actual number of seedings proved to be lower than the theoretical amount. The experiments were considered tentative. - MGA 18.11-190.

368. Berg, T. G. Owe. <u>Nucleation and growth in cloud seeding</u>. Skywater Conference, lst, Denver, July 1967, Proceedings of Skywater Conference 1 con. Physics and Chemistry of Nucleation, Denver, Colo., U. S. Bureau of Reclamation, 1967, pp. 127-116. DLC.

Results of experiments with positively charged drops suspended in a nonuniform AC field at a high humidity and a low temperature, during which AgI particles of predominantly negative charge are introduced into the vessel, are discussed. It was found that ice particles may form chain structures of millimeter size, indicating that growth is promoted by charge and that charged particles may cause nucleation plus growth; a charged droplet attracts droplets of the opposite polarity and grows until the initial drop charge is neutralized. The experiment is discussed with relation to 1) condensation of water vapor; 2) nucleation in the cold chamber; and 3) the freezing mechanism of water. It is concluded that freezing may promote rain formation by lowering the vapor pressure and, perhaps, by promoting electrification and thereby, growth. Available evidence indicates that the freezing of cloud droplets occurs by condensation of vapor on the seeding agent and the formation of ice particles that in turn seed the droplets; further work is needed, however, with respect to the actual mechanism by which freezing occurs. Growth requires that the seeding agent be charged either by a natural process, e.g., condensation, or as a part of the dissemination process. - MGA 21.5-199.

369. Bernier, J. On the design and evaluation of cloud seeding experiments performed by Electricité de France. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21-July 18, 1965 and December 27, 1965-January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Ie Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 35-54. DAS 519.9 \$989pro 1965/1966 v.5.

Reports on the design and evaluation of cloud seeding experiments performed by Electricité de France. Deals specifically with experiments designed to obtain statistical evidence of increase in precipitation due to cloud seeding with AgI smoke released from ground based generators. The first part of the paper presents general remarks on statistical design and evaluation. The next part gives a survey of early experiments. A detailed description of the "randomized" Cere-Maronne experiment follows. Finally, comments are made on the basic elements of the problem of design and evaluation. It is concluded that the importance of an isolated experiment of the Cere-Maronne type is limited because its results are unavoidably tied to the special local meteorological, climatological, and geographical location. As to operational methodology, the value of seeding from ground based generators is open to question. - MGA 19.7-203.

370. Bilancini, R. L'intervento dell'uomo sui fenomeni meteorologici. (Intervention of man in meteorological phenomena.) Rivista di Meteorologia Aeronautica, 27(4): 84-88, October-December 1967. DAS M(05) R625.

An extended summary of the paper Report on artificial modification of meteorological processes presented by E. K. Fedorov at the 5th Congress of the WMO. The rainfall theories of Bergeron

and Findeisen, various procedures for artificial rain production, cloud modification, hail prevention and altering climate (such as the Dessens meteorotron) and various attempts at artificial rain production and climate modification carried out in the U.S.S.R. are discussed. At Dnepropetrovsk (Ukraine) there is in operation a polygon with control and experimental sectors each with an area of 50 x 75 km. Another polygon is in operation in the vicinity of Obinsk (the district of Moscow and Kaluga). Experiments on artificial rain have been carried out in northern Kazakhstan. In general the increments of 10-15% have been obtained with artificial seeding as compared with the control areas. Artificial seeding is more effective in redistributing rain rather than increasing it. The artificial production of snow has thus far not been particular successful in the U.S.S.R. so far as the large scale modification of climate is concerned. Fedorov does not believe that this will be attained within the next 20 to 30 yrs. - MGA 19.6-187.

371. Biswas, K.R.; Kapoor, R.K.; Kanuga, K.K.; Ramana Murty, Bh. V. Cloud seeding experiment using common salt. Journal of Applied Meteorology, Boston 6(5): 914-923, October 1967. DAS M(05) J86joa.

An experiment on artificial stimulation of rain using a warm cloud seeding technique was undertaken in three nearby climatologically similar regions, Delhi, Agra and Jaipur in northwest India. Analysis of the data from 18 experiment-seasons has suggested a positive trend of the result, which is found significant by statistical tests. - Authors' abstract.

Blanc, Milton L. <u>Influence of local physiographic features</u>. (In: Hagan, Robert M.; Haise, Howard R.; Edminster, Talcott W. (eds.), Irrigation of Agricultural Lands. Madison, Wisconsin, American Society of Agronomy, 1967. pp. 33-39) (Agronomy, Madison Wisconsin, no. 11) DAS 631.7 Hillir.

This chapter describes the manner in which "local physiography modifies the general weather pattern and affects water supply, water need and water use." The discussion comprises the following: effect of absolute and relative altitude and of topography (slope, exposure, height of mountain) on precipitation runoff and infiltration, role of small lakes, pond, etc., in increasing local shower activity and dew deposits; the role of local topography in weather modification; effect of altitude, topography, crainage and water bodies on water need and water use; and role of topography in frost protection. - MGA 19.7-193.

Borisov, P. M. Mozhno li upravliat' klimatom Arktiki? (Can we control the Arctic climate?) Priroda, Moscow, No. 12: 63-73, December 1967.

DAS P. Translation by E. R. Hope in Canada. Defence Research Board, Translation T498R, May 1968. 11pp. DAS MO9.6 B734can.

The possibility of modifying the climate of the Arctic by directing

the flow of warm Atlantic Ocean waters through the Arctic Basin into the Pacific Ocean is discussed on the basis of available knowledge of climate change. The author reviews the climate history of the Earth from the Cretaceous epoch to the present and the climate changes and fluctuations that have supervened and the possible causes and laws of climate change; the parameters of direct flow of Atlantic waters into the Arctic Ocean including the water exchange of the Arctic Ocean with adjacent seas, the water balance of the Arctic Ocean and its basin; the water temperature, salinity, and density of Atlantic and Arctic waters and the transformation of these parameters in case of direct flow; and possible climatic conditions and sequences that might result from the direct influx of Atlantic water into the Arctic Ocean. Four stages are identified: stage 1 is determined by the climatic conditions of the 10th cent. A.D.; stage 2 is determined by the level close to the climatic optimum existing on the Earth 4000 yrs ago; stage 3 is determined by the level of ecological conditions corresponding to the level of the McKulinsk and Lekhvinsk interglacials in the U.S.S.R.; and stage 4 is closest of all to the conditions of the middle Plicane. The effects on world temperature and ocean level are discussed; a diagram of a proposed dam across Bering Strait is presented. - MGA 20.4-211.

374. Bowen, E. G. Cloud seeding. Science Journal, London, 3(8): 69-73, August 1967. DAS P.

History of Australian cloud seeding work where special experiments were carried out in 2 similar neighboring areas. One or the other was seeded for periods of 10-12 days, seeding being switched from one area to another in random sequence. It was concluded that the effect of seeding was in some way persistent. It is now thought that the damping of the surface during the first seeded year effected the amount of dust nuclei present in the atmosphere during the subsequent years. New experiments in uncontaminated areas are underway. Experience has shown that conditions suitable for seeding are relatively common over the eastern part of Australia, except for the coastal fringe and the desert interior. State agricultural departments, forestry commissions and river authorities are now profiting. In forest areas, it is hoped that additional rain will reduce the frequency of forest fires; over wheat areas. significant improvements in harvest yield have been realized, and water storage schemes have profited. Costing assessments generally show that operations can be profitable. - MGA 19.8-203.

Bradley, W. E. and Semonin, R. G. The effect of artificially produced space charge on the electrification of clouds. National Conference on Weather Modification, 1st, Albany, New York, April 28-May 1, 1968, Proceedings. Boston 1968, pp. 114-121. DAS MO9.6 N277pr 1968. Also issued as: Illinois. Water Survey at the University of Illinois, Urbana, Illinois, NSF Grant-3479, Final Report, September 1, 1967. 24 p. DAS M(055) I29fief.

Summarizes the findings of 2 summer field investigations of the production of artificial atmospheric space charge and its effect on clouds and precipitation. Gridlike patterns were flown over the wire network at various altitudes to measure the areal distribution of the emitted space charge and the accompanying retential gradient perturbations. It was found that $\simeq 23\%$ of the clouds investigated downwind of the wire electrified. The analysis of the first echo formation downwind of the wire showed a higher frequency of first echoes within the plume of charge, but a similar study of the downwind rainfall revealed less in the plume than outside of it. The data suggest that charge did induce a development of radar-detectable particles aloft, but that this resulted in a possible reduction in the development of measurable rainfall at the ground. - MGA 19.11-520.

376. Braham, R. R., Jr. and Flueck, J. A. <u>Discussion on Professor Neyman's paper</u>. (This follows <u>Experimentation with weather control</u> by Jerzy Neyman.) Royal Statistical Society, London, Journal, Series A, 130(3): 316-326, 1967. DAS P. Also issued under title: <u>Discussion of experimentation with weather control</u> in Chicago. University. Cloud Physics Laboratory, Collection of Reprints, Vol. 12 (Technical Note no. 38) August 15, 1968. Reprint No. 7. 5 pp. DAS M74.1 C532te no. 38.

These detailed comments on Neyman's paper include: with reference to Project Whitetop some of the values used by Neyman are incorrect; the Missouri Plume reported by Decker is not contained within the Chicago Plume—rather it extends beyond the limit of the area of the research circle. Neyman's suggestions that the Whitetop experimenters seem to believe that precipitation in "Out of Plume could be affected by seeding" is incorrect. Neyman's conclusions that seeding resulted in rainfall decreases in the nonplume area is not accepted. Further comments are made on the statistical analysis of the data, etc. - MGA 20.5-180.

377. Braham, Roscoe R., Jr. Cirrus cloud seeding as a trigger for storm development. Journal of the Atmospheric Sciences, Boston, 24(3): 311-312, May 1967. DAS M(05) A512j 24: 1967. This is a shorter version of Chicago. University. Department of Geophysical Sciences, Cloud Physics Laboratory, Technical Note, No. 36, August 15, 1967. 11 pp. "Presented April 17, 1967 before the 4th Annual Meeting, American Geophysical Union, Washington, D. C."

From radar and instrumented airplane observations made during the summers of 1965 and 1966 at Bemidji, Minn., we have identified and documented a type of precipitation storm that results from cirrus seeding of disordered middle cloud convection. When fully developed, such storms have the outward appearance of small, dissipating thunderstorms. They differ markedly from the classical thunderstorm, however, since they are triggered from the top rather than from the bottom. Airplane collections of cirrus crystals give definite evidence that such particles can survive a fall of great distances in clear air in sufficient numbers to be important in nucleating the lower clouds. - MGA 19.1-129.

378. Brier, Glenn W.; Carpenter, Thomas H.; Kline, Dwight B. Some problems in evaluating cloud seeding effects over extensive areas. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21-July 18, 1965 and December 27, 1965-January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 209-221. DAS 519.9 S989pro 1965/66 v.5.

Reports results of analysis performed on 16 operational programs in 11 project areas in eastern U. S. involving a total of 62 seeded months. Difficulties in statistical evaluation of cloud seeding effects are discussed. It is estimated that by using the methods reported in this analysis, a total of 20 seeded months would be needed to give a 90% chance of detecting a 13% increase at the 5% significance level. A considerable improvement can be made on this by stratifying according to relevant meteorological parameters and by sharpening up the statistical estimates by multiple regression methods, data transformations, etc. - MGA 19.7-204.

Bryson, Reid A. and Baerreis, David A. Possibilities of major climatic modification and their implications: Northwest India, a case for study. American Meteorological Society, Bulletin, 48(3): 136-142, March 1967. DAS M(05) A512b.

On the basis of field observations and theoretical studies it is believed that the dense pall of local dust over northwestern India and West Pakistan is a significant factor in the development of subsidence over the desert. Archeological evidence derived from the northern documented plan, is directed toward improving and expanding existing Agricultural Weather portion of the desert within India suggests a pattern of intermittent occupation with the role of man being important in making the desert. As man has made the desert, so through surface stabilization can he reduce the dust and consequently modify the subsidence and precipitation patterns in the region. The social consequences of such climatic modification are briefly considered. - MGA 18.8-198.

380. Carr, John T., Jr. Control of weather modification activities. 1967.

15 pp. Typescript "Remarks made April 19, 1967 to a seminar of meteorologists at the University of Texas, Austin" DAS MO9.617 C311c.

Weather modification experiments and activities have increased rapidly since 1946. Legal problems and questions involving the rights of citizens and experimenters and the rights of commercial cloud seeders have kept pace with expanding activities in the field. At least 22 States now have Statutes bringing these activities under State control. The Federal Government has shown an ever increasing interest in weather modification control and a weather modification law at the Federal level. A comprehensive weather modification statute for Texas has been introduced and is now pending in the Texas Legislature. Its purpose is to bring weather modification operations in Texas under State control and to promote research and development in this important new science. Author's abstract.

Changnon, S. A., Jr. and Huff, F. A. The effect of natural rainfall variability in verification of rain modification experiments. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21-July 18, 1965 and December 27, 1965-January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 177-198. DAS 519.9 S989pro 1965/66 v.5.

Illustrates the magnitude of the natural variability in midwestern, warm season rainfall and the influence of this variability upon the interpretation of rain modification experiments. Rainfall data from 2 concentrated rain gage networks encompassing areas of 400 and 550 mi² in Illinois were used. Summer convective rainfall for periods of 5 to 10 yrs were involved in the experiment. Results showed that gage density is a highly important factor and that size of sampling area can materially influence the results in some cases. Indications are that sampling periods of 5 to 10 yrs. are inadequate to define rainfall changes of 10 to 20% resulting from cloud seeding efforts when verification is based upon analyses of surface rainfall. - MGA 19.7-205.

382. Chikirova, G. A. <u>Issledovanie kinetiki pogloshcheniia vlagi chastitsami ionoobmennykh smol v srede, nasyshchennoi vodianym parom, i v tumane.</u> (Study of the kinetics of moisture absorption by ion exchange resins in a medium saturated with water vapor, and in fog.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 202: 60-64, 1967. Russian summary p. 60. DAS M(055) U581tg.

Laboratory tests were made on the absorption of moisture by ion exchange resin particles exposed to fog or slow moving air (0.8 m/sec) saturated with water vapor. All types of ion exchange resins exhibited slower growth kinetics than hygroscopic particles. Therefore, ion exchange resins can not be recommended for cloud seeding. - MGA 20.2-172.

Chuvaev, A. P.; Orenburgskaia, E. V.; Shvarts, V. T. K kharakteristike polei konvektivnykh oblakov nad Ukrainoi (primenitel no k probleme iskusstvennogo uvelicheniia osadkov). (Characteristics of convective cloud fields over the Ukraine, as applicable to the problem of artificial increase of precipitation.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 202: 103-117, 1967. Russian summary p. 103. DAS M(055) U581tg.

A study was made of the frequency of convective summer clouds when in the field of vision of the observer Cb clouds are also present. The frequency of precipitation connected with the occurrence of Cb clouds was also studied. The study was based on the observations made over a period of 5 yrs by Ukrainian meteorological stations in Kiev, Kharkov, Donetsk, Dnepopetrovsk, Simferopol, and Odessa and by 4 stations in the adjoining territories in Minsk, Kursk, Rostov on Don, and Kishinev. It is shown that such studies are important for evaluating rain water resources which can

be released by cloud seeding. - MGA 20.2-404.

384. Colgate, Stirling A. <u>Tornadoes: mechanism and control</u>. Science, Washington, D. C., 157(3795): 1431-1434, September 22, 1967. DAS P.

If electrical energy is invoked to account for the high velocity of tornadoes, hydrodynamics restricts the possible mechanisms of energy exchange. In particular, the vortex is driven by a line sink of electrically heated air that must extend at least 5 km high. In those rare cases where heroic measures may be justified to protect a city in the path of a major tornado, some possible control measures are discussed in terms of the electrical heating mechanism. - MGA 18.12-262.

385. Compania de Luz y Fuerza del Centro, S. A. 17 anos de operaciones de estimulación de lluvias en las cuencas de Necaxa (Pue.) y Lerma (Méx.): informe anual, 1967. (17 years of operation of artificial production of rain in the basins of the Necaxa River (Puebla) and the Lerma River (State of Mexico): annual report, 1967.) July 1967. 22 pp. DAS MO9.67 C737op 1949-51, 1953-66.

This report on artificial production of precipitation in the basins of the Necaxa and Lerma Rivers (Mexico) is similar to that issued in 1966. It contains a statistical analysis of the data on artificial rain production based on 17 yrs of experimentation in Necaxa, 11 yrs in Lerma and especially the experiments of 1966. The seeding calendar and the statistical procedure for analyzing the results of seeding are described with the aid of graphs and tables, which include the data of 17 yrs of investigation. The statistical results for seeding in 1966, based upon regression analysis, and comparison of days with and without seeding show slight losses in precipitation. An appendix contains an analysis of 16 yrs. of cloud seeding experiments carried out in these basins; it is the same as that of the previous report. - MGA 19.10-182.

386. Corrin, M. L.; Nelson, J. A.; Cooley, B.; Rosenthal, B. The preparation of "pure" silver iodidie for nucleation studies. Journal of Atmospheric Sciences, Boston, 24(5): 594-595, September 1967. DAS M(05) A512j.

"Pure" silver iodide (AgI) is prepared by direct reaction between pure silver powder and iodine in high vacuum. Excess silver is removed by treatment with ammonia. The preparation involves 3 phases: namely, the reaction phase, filtration phase, and pump-off and storage phase. The AgI prepared has specific surface areas on the order of 0.5-1.lm²gm⁻¹ as determined by krypton adsorption. "It is a relatively poor ice nucleant. It is stable toward light and does not darken appreciably after prolonged exposure." "It is possible to 'dope' the pure material through the addition of various doping substances in liquid ammonia solution." - MGA 19.1-130.

387. Court, Arnold. Randomized cloud seeding in the United States.

Symposium on Mathematical Statistics and Probability, 5th, Berkeley,
California, June 21 - July 18, 1965 and December 27, 1965 January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited
by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of
California Press, 1967. pp. 237-251. DAS 519.9 \$989pro 1965/66 v.5.

Basic requirements, other than randomization of any experimental design, are discussed. The randomized cloud seeding experiments completed thus far are described in the light of these requirements. First discussed is the method of treatment, which is so variable and uncontrollable that the actual intensity of treatment cannot be specified even as to order of magnitude. The experiments are analyzed as tests of hypotheses. The hypotheses to be tested depend primarily on the intent of the experiment and also on all the other important foreseeable consequences of any effort to modify weather. It is concluded that no definitive experiment has yet been performed in the field. - MGA 19.7-194.

388. Crozier, C. L. and Holland, J. D. <u>Detailed storm acceptance and evaluation criteria</u>: Precipitation Physics Project. Canada Meteorological Branch, TEC 666, November 23, 1967. 27 pp. English and French summaries preceding text. DAS MO9.6 C954de.

During the summers 1959 to 1963, a project of cloud seeding combined with physical studies of precipitation mechanisms was operated in western Quebec. A major part of the project was devoted to the task of testing the effect of seeding synoptic scale weather systems with AgI using a randomized crossover technique with 2 separated test areas. This paper outlines the rules of the experiment as they were defined before commencement of the project. The sufficient conditions for cloud seeding are defined and their application in the field operations are discussed. The necessary conditions for acceptance of a seeded storm for the evaluation are also defined and their application discussed. Comments are made on some of the details of techniques required to meet the rules. Details of statistical and physical design, operation, and results of the evaluation are presented in other reports of this series. - MGA 19.11-232.

Davis, Charles I. and Steele, Roger L. Performance characteristics of various artificial ice nuclei sources. Journal of Applied Meteorology, Boston, 7(4): 667-673, August 1968. DAS M(05) J86joa. Also issued in: Conference on Severe Local Storms, St. Louis, Mo., 1967. Papers to be presented at Fifth Conference on Severe Local Storms, St. Louis, Mo., October 19-20, 1967. cSt. Louis, 1967. pp. 55-64. DAS M15.4 C748pa.

The effectiveness-temperature curves for various steady-state AgI generators and pyrotechnic type AgI generators are shown. It is concluded that, at the colder temperatures ($<-12^{\circ}$), the steady-state systems are, in general 1 order of magnitude more effective

than the pyrotechnics. At the warmer temperatures (>-12°C), however, the effectivenss of the pyrotechnics approaches and in some cases exceeds that of the steady-state systems. These conclusions are based on numerous tests made in the Colorado State Univ. isothermal cloud chamber. A discussion of the effect of AgI particle size on effectiveness is presented. The variation of effectiveness with air-fuel ratio is discussed. It is concluded that the maximum effectiveness occurs near the stoichiometric air-fuel ratios and that the AgI-isopropylamine (IPA) complex is more sensitive to changes in air-fuel ratios than the solution of AgI and NaI in acetone. It is suggested that this is due to the presence of unburned IPA vapor in the generator effluent. The variation of effectiveness with AgI burn rate is discussed for various pyrotechnic samples which were developed by a private concern for ESSA. It is concluded that the effectiveness decreases as the AgI burn rate is increased. The explanation for this occurrence is not at hand. - MGA 19.10-402.

390. Davis, L. G. and Hosler, C. L. The design, execution, and evaluation of a weather modification experiment. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 253-269. DAS 519.9 S989pro 1965/66 v.5.

Discusses the design, execution and evaluation of a weather modification experiment. Following a brief consideration of preceding studies, mountain wave influence, the execution of the experiment is reported. An example of the evaluation of the test precedes generalizations on weather modification experiments and speculations on weather control. It is suggested finally that the operational techniques that will be required to bring anything of economic value from weather modification are completely beyond the capabilities of any presently existing meteorologically oriented organization. - MGA 19.7-195.

391. Decker, Wayne L. and Schickedanz, Paul T. The evaluation of rainfall records from a five year cloud seeding experiment in Missouri.

Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 55-63. DAS 519.9 S989pro 1965/66 v.5.

Reports a 5-yr experiment in south central Missouri and north central Arkansas using AgI placed in the atmosphere from an aircraft. The experiment was designed to study the influence of seeding clouds which were formed by convective processes during summer. Only days during which instability showers were expected in the afternoon were included in the experiment. There was no evidence of increases in precipitation due to cloud seeding. The results appear to indicate that in spite of randomization, the no treatment days were meteorologically favored with rain.

Other analyses of these data are under investigation at both the Univ. of Missouri and the Univ. of Chicago. - MGA 19.7-206.

392. Dennis, A. S. A new look at weather modification. Journal of Soil and Water Conservation, Des Moines, Iowa, 22(1): 4-6, January-February 1967. DAS P.

The 6 conclusions of the Natl. Acad. of Sc. Panel (MacDonald, 1966) are listed. The progress made from 1957 to 1965 is reviewed. Results indicative of 5-30% increase in rainfall from cloud seeding reported from Australia, Israel, Mexico, and Switzerland are cited. Laboratory and theoretical research and simulation of cloud physics processes in computers are mentioned. It is pointed out that it is likely that for some years to come the only final answers to weather modification techniques will be found in nature's own laboratory—the out-of-doors. The pending legislation (Senate Bill 2916) which provides for a multi-agency, mission-oriented approach is discussed. It is concluded that despite the uncertainties which still exist, there are grounds for optimism concerning the future of weather modification. - MGA 18.8-199.

393. Dési, Frigyes. A jégeső elhárításának néhány kérdéséről (Some problems of hail prevention.) Időjárás, Budapest, 71(6): 367-369, November-December 1967. English summary p. 367. DAS M(05) I21.

In his presidential address to the 13th Annual Meeting of the Hungarian Meteorological Society (held at Sárospatak, Aug. 24-27, 1967), the author discussed some problems in hail prevention. The scientific as well as the economic importance of the problem was emphasized, disclosing that by utilizing the practical experiences gained by Soviet scientists, a network for hail prevention will be established soon in Hungary, and the first hail prevention station will be erected probably as soon as 1968. - MGA 19.12-140.

394. Dessens, Henri. La grêle et sa prévention. (Hail and its prevention.)
Association d'Etudes des Moyens de Lutte contre les Fléaux Atmosphériques, Toulouse, «Rapport sur la campagne», No. 15: 9-26, 1967.
DAS MO9.6 A849ra no. 15.

Destructive hail is the consequence of storage of large quantities of supercooled water in a storm cloud and the capture of this water by an amount of frozen elements. A natural process of hail prevention would be massive seeding with ice crystals of the supercooled part of the cumulonimbus by descending currents originating in the anvil cloud. However, for the time being, there is no practical means, other than AgI seeding by a vast network of generators on the ground. Experiments with rocket seeding were inefficient. - MGA 18.11-193.

395. Dessens, Henri. <u>Les resultats pratiques</u>. (Practical results.)

Association d'Etudes des Moyens de Lutte contre les Fléaux

Atmosphériques, Toulouse, Rapport sur la campagne, No. 15: 27-30,
1967. DAS MO9.6 A849ra no. 15.

The ratio R of compensation paid for harvest losses to guaranteed capital is the only official statistic of hail occurrences. The statistics started in 1944 before seeding. In 1955 a small amount of seeding was applied. In 1959 high efficiency generators were available and the seeding increased by 5-fold. The results are reported in 5 tables for the 13 departments of Aquitaine Basin. In 1965 losses due to hail were reduced to one half of the normal frequency. - MGA 18.11-191.

396. Dessens, Jean with the collaboration of P. Admirat, B. Benech, H. Dessens, M. Dessens and H. Sauvageot. Ensemencements à partir du sol d'altocumulus convectifs à 6400m d'altitude. (Ground-based seeding of convective altocumuli at 6400 m height.) Association d'Etudes des Moyens de Lutte contre les Fléaux Atmosphériques, Toulouse, Rapport sur la campagne, No. 15: 69-72, 1967. DAS MO9.6 A849ra no. 15.

It was investigated whether ground based silver iodide (AgI) seeding reaches convective altocumulus (Ac) at 6400 m altitude. Abundant frozen precipitation was observed from below the convective Ac on Aug. 11, 1966. On this day continuous emission of generators from 0645 hrs UT sent aloft 180 nuclei/1, active at —22°C. The radiosonde at Bordeaux at 1200 hrs UT indicated —15°C at 6400 m. The total congelation of the Ac at this temperature is an anomaly and should be attributed to seeding. Thus, it may be concluded that AgI nuclei from ground based generators are likely to concentrate at these levels of the atmosphere and they are not deactivated even for as long as a day. - MGA 18.11-192.

397. Deutsche Versuchsanstalt für Luft- und Raumfahrt e. V., München-Riem.

8. Bericht über die Hagelabwehrversuche im Landkreis Rosenheim.

(8th Report on hail prevention in rural area of Rosenheim.) Edited by H. G. Müller. Munich, 1967. 41 pp. DAS M(055) D486be 8. Bericht.

This report on hail prevention activities in the district of Rosenheim (Bavaria), which were begun in 1954, includes the following: description of the meteorological conditions in the Alpine foreland which are particularly favorable for hail occurrence, and a review of early attempts of hail prevention by cannon and rocket firings into clouds; theoretical basis for hail prevention by dispersion of AgI into hail clouds—increase in the number of ice nuclei in thunderstorm clouds and thereby increasing the number of ice nuclei and reducing the size and intensity of hail; description of the organization of the hail prevention attempts including the financing, the required mesometeorological requirements over the hail prevention area, the organization of the rocket firing system, surface generators,

airplane dissemination of AgI, the observational procedure, the hail warming systems, and report of rocket firings and the evaluation of the results; execution of individual experiments; a comparison of hail incidence and hail prevention activity in the period 1958-1966 (particularly 1964-1966). A comparison of the experimental period 1958-1966 with the period 1949-1957 shows a diminution in the annual number of days with hail in the Rosenheim area during the experimental period. In the control areas a similar result was obtained and it may be explained by the transport of AgI into them. The result was not statistically significant since the hail incidence is highly dispersed both temporally and areally so that the eventual effects of prevention are masked. A brief survey of hail prevention in Switzerland and France is given. - MGA 18.12-176.

398. Deyries, P. Compte rendu de la campagne 1966 d'essais de prévention de la grêle. (Report on the 1966 hail prevention experiments.)

Association d'Etudes des Moyens de Lutte contre les Fléaux

Atmosphériques, Toulouse, Rapport sur la campagne, No. 15: 35-66.

1967. DAS M09.6 A849ra no. 15.

The 235 experimental network stations in southwestern France were provided with a generator pattern nearly the same as that in 1965. All stations have vortex generators, designed by Dessens, based on his study of tornado mechanics. A table gives the weight of AgI diffused between 1959 and 1966, the number of network stations, and the amount of diluted solution in liters. A chronology of hail storms which occurred in southern France in 1966 is presented. - MGA 18.11-194.

399. Dolgushin, L. D. <u>O nauchnykh osnovakh iskusstvennogo regulirovaniia</u>
taianiia lednikov <u>Srednei Azii</u> (<u>Scientific principles of the</u>
artificial regulation of melting of glaciers in Central Asia.) (<u>In: Akademiia Nauk SSSR. Institut Geografi, Problemy preobrazovaniia prirody Srednei Azii. Moscow, Izdatvo Nauka, 1967. pp. 70-71).</u>

The results of some field observations on increasing the intensity of melting of glaciers by spreading ccal dust, scot, etc. upon their surfaces are discussed. The albedo of Central Asian glaciers varies in time and space from 15-40% on glacier tongues free from snow to 70-95% on firm basins and after snow fall. The low albedo on areas free from moraines are the result of contamination by air-borne dust. The blackening of glacier tongues with coal dust at an amount of 50-100 g/m2 increased ice melting by 20-45% (in July-Aug.) in spite of extensive surface contamination of the surface $(230-400 \text{ g/m}^2)$. This melting is twice as large as that on clean ice. The greatest effect with artificial dust cover was obtained in the first days; a gradual equalization of intensity on contaminated and control areas took place subsequently as a result of the washing off of the dust covered sectors by melt waters. However, the washing off of the blackening material by melt water will have less effect if entire glaciers are covered with dust. - MGA 18.12-173.

400. Dominick, Peter. An atmosphere of research. American Meteorological Society, Bulletin, 48(10): 763-764, October 1967. Also: 90th Congress, 1st Session, S.2058, June 29, 1967. Mr. Dominick introduced the bill. pp. 765-766. DAS M(C5) A512b.

A speech made at the dedication of the Atmospheric Science Building, Ft. Collins, Colo. on June 27, 1967. An announcement is made that a bill has been introduced on the floor of the U.S. Senate. This would provide one million dellars a year over a 3-yr period, for practical application of existing weather modification techniques to increase precipitation in the Upper Colorado River Basin. The text of the bill is included. - MGA 19.3-133.

lucion Dubesset, G. Recherche d'une éventuelle influence des ensemencements sur le régime des pluies. (Study of the possible influence of seeding on the rainfall regime.) Association d'Etudes des Moyens de Lutte contre les Fléaux Atmosphériques, Toulouse, Rapport sur la campagnes, No. 15: 67-68, 1967. DAS MO9.6 A849ra no. 15.

Charts of rain distributions in summer 1966 were studied to determine the effect of massive AgI seeding on the rainfall regime in France. Contrary to former years, an excess of rain, which bears no similarity to other years, has been established. However, the numerical value of the relative rainfall excess in the region amounts to 19% which seems to indicate that AgI seeding for hail prevention has some effects on rainfall, but other factors provoke excessive rainfall in the region. - MGA 18.11-195.

Levis H. Design and evaluation of randomized wintertime cloud seeding at high elevation. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 65-90. DAS 519.9 S989pro 1965/66 v.5.

AgI crystals were released in a controlled test on the Lake Almanor watershed (5000-6000 ft) in northeastern California. This report describes the operation, outlines the details of the test, and describes the analysis of the data collected in 1963. Results of the statistical analysis indicate a positive change was observed in the standard target area during seeding when the winds were from the west. No statistically significant result was detected from seeding clouds associated with southerly flow over the Lake Almanor watershed. - MGA 19.7-207.

403. Elliott, Robert D. and Lang, William A. Weather modification in the Southern Sierras. American Society of Civil Engineers. Irrigation and Drainage Division, Journal, 93(4): 45-59, December 1967. DAS P.

Presents an historical account of 15 yrs of continuous wintertime

cloud seeding to enhance snowpack in the upper San Joaquin watershed of the southern Sierra Nevada. The project was conducted by a private meteorological consultant firm for a large utility company interested in increased water resources for hydroelectric generation. The equipment employed to generate the artificial nuclei (AgI smoke) is described, and the evolution of the nuclei generator network into a partially radio controlled system is discussed. The evaluation of the results in terms of enhanced runoff suggests that the seasonal streamflow was increased by 8.5% - MGA 19.6-189.

404. Favreau, Roger F. and Goyer, Guy G. The effect of shock waves on a hailstone model. Journal of Applied Meteorology, Boston, 6(2): 326-335, April 1967. DAS M(05) J86joa.

The effect of explosively generated shock waves on ice cubes has been investigated in the laboratory. Impact tests on cubes previously exposed to shock demonstrate that the action of the latter weakens the cubes, the effect being markedly greater when the latter contain a water column. The phenomenon observed is discussed in terms of the theory of shock waves; the weakening of the ice cubes appears to be plausible on the basis of shock-induced cavitations within the water columns inside them. Insofar as ice cubes containing a water column very crudely simulate hailstones, the results observed suggest the possibility that explosive shock waves might similarly weaken actual hailstones. Thus, rocketborne explosive charges could conceivably be a practical way of reducing damage from hailstones. - Authors' abstract.

405. Fedorov, E. K. Aktivnoe vozdeľstvie na meteorologicheskie protsessy.

(Active modification of meteorological processes.) (In: Fedorov,
E. K. (ed.), Meteorologiia i Gidrologiia za 50 let Sovetskoľ vlasti:
sbornik stateľ. Leningrad. Gidrometeoizdat, 1967. pp. 215-226).

DAS M79 F29lmet.

The history of attempts at artificial modification of weather processes in the U.S.S.R., beginning with the first studies and attempts of V. N. Obolenskii and his co-workers in 1932, is surveyed. Extensive studies on convection at the Earth's surface have been carried out. The principle of artificial stimulation of convective currents has been utilized, and various types of meteorotrons (first developed by Dessens) were developed. The physical chemical processes of cloud development, condensation, and crystallization of particles have been investigated extensively. E. S. Selezneva (1966) studied particles acting as nuclei only during very high supersaturation, not observed in a real atmosphere. The first apparatus measuring concentration of condensation nuclei of diverse activity in a real atmosphere were developed by A. G. Laktinov (1965). The problems of stimulation or suppression of the activity of nuclei have been investigated. The role of turbulence phenomena, electrical charges, and other physical processes influencing the coalescence of small drops has been

investigated experimentally. A general theory of cloud development and precipitation for motion has been developed on the basis of studies of the dynamics of cloud formation and the physical-chemical nature of elementary phenomena producing clouds. The dissipation of low supercooled clouds and fogs and the use of the crystallization reaction for preventing hail is being investigated. Studies are being carried out on the effectiveness of cloud seeding in producing precipitation; in some areas precipitation over the experimental area was increased by 10-15%. The problem of whether cloud seeding produces additional precipitation or causes its redistribution has been studied by I. V. Litvinov (1967). Extensive studies have been carried out on the laws of the natural processes of precipitation formation in clouds. - MGA 20.4-212.

406. Fedorov, E. K. Weather modifications. World Meteorological Organization, WMO Bulletin, 16(3): 122-130, July 1967. DAS M(05) W927w 16: 1967.

The contents of this discursive paper on weather modification include the following: a brief history of cloud modification in particular the work carried out in the Soviet Union in the 1930's, the various methods of weather modification such as cloud seeding and induction of convection by the so-called "meteotrons," cloud and fog dispersion; hail prevention; increase in precipitation including some results obtained in the U.S.S.R.; and large scale weather modification. - MGA 18.12-171.

407. Filimonenko, I. S. Vliiaiut li meteornye potoki i iskusstvennye sputniki na pogodu? cand comments by: B. L. Dzerdzeevskii. (Do meteor streams and artificial satellites affect the weather?)
Priroda, Moscow, No. 5: 95-98, May 1967. DAS P.

In connection with Bowen's hypothesis on the relationship between meteoric dust and precipitation, the author considers the question whether both meteoric dust and the dust arising from the ever increasing number of disintegrating artificial satellites of the Earth have an influence upon weather. Dzerdzeevskii cites some papers favorable to and against Bowen's hypothesis and points out that a correlation without a physical basis is not meaningful. In particular, in most cases precipitation does not occur not because of an absence of condensation nuclei but owing to the absence of other conditions necessary for precipitation such as fronts. Also the constant 29-31 day interval between meteor streams and precipitation can be regarded as negative rather than positive evidence for Bowen's hypothesis considering that in each 30 day period, atmospheric processes are dissimilar, particularly in the Northern and Southern Hemispheres. Also if the products of disintegration of meteors always fall with the same velocity and reach the troposphere at the same time they must be large and cannot serve as condensation nuclei. A similar argument holds for the dust produced by disintegration of artificial satellites and precipitation anomalies cannot be attributed to this dust. Dzerdzeevskii calls attention to the possibility that rockets,

as a result of the fuel they burn, introduce into the upper atmosphere O2, CO2, Na, K, N, Cl and HNO3 and alter the concentration of these substances in the rarefied upper atmosphere. These effects produced by rockets may influence ultimately precipitation and weather in the troposphere. - MGA 18.11-200.

408. Fletcher, Joel E. Atmospheric water resources of the Wasatch Front,
Utah. Western Snow Conference, 35th Annual Meeting, Boise, Idaho,
April 18-20, 1967, Proceedings. Issued 1967. pp. 94-98. DAS M(06)
W527p 35: 1967.

An outline for research of Weather Modification experiments along the Wasatch Front, Utah, with the following objectives: 1) to determine feasibility of increasing water supplies by cloud seeding; 2) to develop more effective methods of cloud seeding; 3) to develop better equipment and methods of evaluating effects of cloud seeding; 4) to evaluate and delineate the area affected by cloud seeding under different synoptic conditions and generator placement locations; 5) to determine unique characteristics of storm systems and 6) to make the best possible estimate of the efficiency of precipitation mechanisms associated with these storms. Experimental work to be carried on relative to systems of telemetering of hydrologic data from various sensoring equipment, and new types of silver iodide generators, and a comparison with older types are planned. - MGA 19.8-195.

409. Fletcher, Joel E. Weather modification. Science, Washington, D. C., 158(3798): 276-277, October 13, 1967. DAS P.

In connection with the Symposium on Weather Modification in Arid Lands to be held at the 1967 meeting of the American Association for the Advancement of Science, the author reviews briefly the history of cloud seeding in the U. S. since 1952 and presents an outline of the present state of the science of weather modification. - MGA 19.2-123.

410. Fukuta, Norihiko. An airborne generator of metaldehyde smoke. Journal of Applied Meteorology, Boston, 6(5): 948-951, October 1967. DAS M(05) J86joa.

A high-output airborne metaldehyde smoke generator was designed for cloud seeding purposes and tested on the ground and in cumulus clouds.

The condensation method was employed for smoke production. Hot exhaust gas from the aircraft engine was diluted with air and used as the carrier gas for metaldehyde powder to evaporate and recondense. An output of 10^{12} nuclei sec⁻¹ was estimated, effective at -50. - Author's abstract.

411. Fuquay, Donald M. <u>Weather modification and forest fires</u>. Symposium on Ground Level Climatology, Berkeley, California, 1965, Ground Level Climatology, Robert H. Shaw (ed.) (American Association for the

Advancement of Science, Publication No. 86, 1967. pp. 309-325)
DAS M84.4 S989gr.

In the discussion of weather modification in relation to forest fires, consideration is given to forest fire conditions, lightning research, the characteristics of mountain thunderstorms, lightning modification, the identification of lightning discharges, and theoretical consideration for lightning suppression. Information from studies on mountain thunderstorms and fire-starting lightning discharges has been used to develop a 3-yr program to evaluate what effect seeding with AgI will have on the frequency and character of lightning discharges from mountain thunderstorms. Data from additional seasons hopefully will provide definite information on whether and how cloud seeding affects the frequency and character of lightning discharges and how these changes will influence forest fires caused by lightning. - MGA 19.7-209.

Gabriel, K. R. The Israeli artificial rainfall stimulation experiment:

statistical evaluation for the period 1961-1965. Jerusalem, 1965.

43 pp. DAS M09.617 Gll8i. Also revised slightly in: Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967.

pp. 91-113. DAS 519.9 S989pro 1965/66 v.5. Also his: The Israeli artificial rainfall stimulation experiment: statistical tables for the period 1961-1966. 18 pp. issued 1966. DAS M09.617 Gll8is.

A rainfall stimulation experiment is being carried out in Israel by seeding AgI from an aircraft in a randomized cross-over design. Results of four and a half seasons show 15% more rainfall with seeding than without, a result which is 5% significant. It is suspected that the excess precipitation has occurred mainly on a small number of days on which seeding apparently was very effective. It has not been possible to identify meteorological conditions particularly favourable to seeding effectiveness.

No evidence has been found that seeding effects persist beyond the day of seeding. - Author's abstract.

413. Gabriel, K. R. Recent results of the Israeli artificial rainfall stimulation experiment. Journal of Applied Meteorology, Boston, 6(2): 437-438, April 1967. DAS M(05) J86joa.

Reports that a randomized experiment of seeding clouds with AgI from aircraft has been in operation in Israel since 1961. Data for 5 1/2 seasons are summarized. Detailed study of the data suggests that seeding may have occasional very strong effects and little or no effect on most days. It is noted that use of a randomized test on the average S/NS ratio would have given more significant results. - MGA 18.9-206.

414. Gabriel, K. R.; Avichai, Y.; Steinberg, Raya. A statistical investigation of persistence in the Israeli artificial rainfall stimulation experiment. Journal of Applied Meteorology, Boston 6(2): 323-325, April 1967. DAS M(05) J86joa.

A number of tests of the data of the Israeli rainfall stimulation experiment have not shown any evidence of persistence of effects of cloud seeding, either from day to day, or within each season, or from season to season. - Authors! abstract.

415. Gaivoronskii, I. I. <u>Iskusstvennoe rasseianie oblakov i tumanov.</u>
(Artificial cloud and fog dispersion.) (In: Fedorcv, E. K. (ed.)
Meteorologiia i Gidrologiia za 50 let Sovetskoi vlasti: sbornik
statei. Leningrad, Gidrometeoizdat, 1967. pp. 243-249). DAS
M79 F294met.

The artificial dispersion of supercooled clouds and fogs was begun in the U.S.S.R. in 1947. The low temperature of a cold reagent leads to the cooling of cloud air saturated with water vapor and causes extensive supersaturation. Computations show that at all temperatures of the medium the process of nucleation begins and ends at a temperature that exceeds the temperature of the CO2 surface. The entire supply of water vapor in the cooled volume appears to be consumed and further temperature decrease does not produce any additional increase in the quantity of new phase media that are formed. The increase in the rate of flow about a CO2 granule increases the rate of temperature drop in the cooled volume so that the velocity of supersaturation is increased. On the basis of Sutlon's equations for turbulent diffusion, an equation was obtained describing the zone of propagation of crystallization. CO2 is most widely used in the dissipation of supercooled clouds and fogs, but new reagents (Freon, propane, butane, etc.) are being tested. The use of ground surface and aircraft devices for introducing cold reagents into clouds and fogs is discussed. - MGA 20.4-216.

416. Gaivoronskii, I.I.; Plaude, N.O.; Solov'ev, A.D. <u>Iskusstvennye</u>

l'doobrazuiushchie aerozoli. (Artificial ice-forming aerosols.)

Meteorologiia i Gidrologiia, Moscow, No. 10: 38-44, October 1967.

Russian summary p.38. DAS M(05) M589.

Discusses the state of research and ways of obtaining ice-forming aerosols for seeding supercooled clouds and fogs. Using Fletcher's theory, estimates are made of the maximum amount of active particles produced from a unit mass of a substance with various assumptions as to the characteristics and mechanisms of the ice-forming effect of the substance and its aerosols. - MGA 19.9-246.

417. Gokhale, Narayan. <u>Ice formation by contact nucleation</u>. Skywater Conference, lst, Denver, July 1967, Proceedings of Skywater Conference l con. Physics and Chemistry of Nucleation. Denver, Colo. U. S. Bureau of Reclamation, 1967, pp. 192-199.

Discusses the different mechanisms responsible for the nucleation and corresponding threshold temperatures. A review of the work of various investigators is followed by an account of the author's experimental studies of the mechanism of contact nucleation with a constant-rate cooling apparatus and with a specially constructed cold chamber. The two methods are described and their advantages and disadvantages are discussed. Histograms showing shifts in temperature with particle concentration and the effect of particle size on freezing temperature by contact are shown. If introduced in the region of supercooled drops (at least -5° C), AgI particles would be very effective and that more experimental work is needed in the 50-100 μ range. The extensive discussion (longer than the paper) dealt with the string and smoke AgI generators used in seeding, preactivation and other points brought up in the paper. - MGA 21.7-545.

Research, Boulder, Colorado, No. 4: 17-21, Summer 1967. DAS M(05) F11/7fa.

This article is an extended summary of the monograph by G. K. Sulakvelidze Results of the Caucasus Anti-Hail Expedition of 1965 (see 19.3-1, Met. Abs.). The hail storm model underlying the Soviet program, the verification of the model, and the hail suppression technicue are summarized. The discussion includes the following, viz: the determination of the vertical profile of the wind field in the updraft by using radar to track balloons fitted with corner reflectors; the accumulation zone concept, namely that droplets rising above the level of maximum updraft form an accumulation zone of liquid supercooled water, located slightly above the wind maximum; the detection of the accumulation zone with the aid of radar: measurement of hail size in the cloud by means of radar reflectivity; the characteristics of the final hail storm model; the microphysical principle of cloud seeding to increase the number of hail embryos; the use of silver iodide (AgI) as the seeding agent and the accompanying air temperature requirements; the suppression technique involving the use of one dual-wavelength radar and anti-aircraft guns firing shells containing 100 gm of AgI; the forecasting of conditions suitable for such gun-fire seeding; and the results of the program (tables and a graph are included). - MGA 19.4-171.

experiment at Climax, Colorado, 1960-65. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 115-131. DAS 519.9 S989pro 1965/66 v.5.

Reports on a randomized cloud seeding experiment at Climax, Colo. (1960-65). Deals primarily with the experimental design and

statistical analyses used in the detection of actual changes in precipitation. Data are given on ice nuclei observations, difference in precipitation between seeded and nonseeded cases during the accumulation of experimental cases, and differences with various temperature regimes. The preliminary analyses suggest both increases and decreases in precipitation may be occurring that, when considered together, give no change in the overall precipitation. However, consistently positive results might have been obtained if seeding had been carried out only when meteorological conditions were suitable. Residual effects of seeding must be given more attention before the results can be fully interpreted. - MGA 19.7-210.

420. Gromova, T. N. and Preobrazhenskaia, E. V. <u>Issledovanie l'doobrazuiush-chikh svoistv rastvorov organicheskikh veshchestv.</u> (Study of ice forming properties of solutions of organic substances.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 202: 41-59, 1967. Russian summary p. 41. DAS M(055) U58ltg.

Results on the laboratory studies of the properties of solutions of organic substances atomized into supercooled fog. The most detailed studies were made with solutions of phloroglucinol (1, 3,5- trihydroxy benzene) which exhibited a high ice forming activity. Data were obtained on the upper threshold temperatures of ice crystal formation and the ice forming efficiencies as functions of the concentration of the solution and the type of solvent. Results are also given of preliminary field experiments on the effect of ether solutions of phloroglucinol on supercooled clouds. The laboratory and the field tests were conducted in 1961-1962. - MGA 20.2-173.

421. Gromova, T. N. and Tverskoi, N. P. K vopresu o vozmozhnosti issledovaniia l'doobrazuiushchikh organicheskikh veschestv s pomoshch'iu elektronnogo mikroskopa. (Possibility of investigating ice forming organic substances by an electron microscope.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 202: 65-71, 1967. Russian summary p. 65. DAS M(055) U581tg.

The method by which a cloud seeding agent is dispersed, such as in form of powder by atomization ether, alcohol or water solution, or by direct sublimation with hot air, affects the size and shape of the seeding agent particles and thus its efficiency. It is shown that aerosols of phloroglucinol and methaldehyde can be studied by the electron microscope EM-5. It was found that the particles have characteristic shapes. The mean particle size obtained by thermal sublimation and other dispersion methods were determined. - MGA 20.2-175.

422. Henderson, Thomas J. <u>Tracking silver iodide nuclei under orographic influence</u>. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited

by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 199-207. DAS 519.9 S989pro 1965/66 v. 5.

Reports a program to establish the areal distribution of AgI downwind from ground generator sites and aircraft seeding flights. A study was made to establish freezing nuclei plume patterns. It was found that AgI freezing nuclei plumes dispensed from aircraft and ground generator sources are reasonably easy to track with a Portable Cold Box. Freezing nuclei plumes rarely conform to specific patterns and their dimensions in both time and space are unpredictable even when a given meteorological condition is similar to a previous experience. It would be risky to make assumptions about the distribution of AgI plumes if a field program were dependent upon the material reaching a given area at a particular time and in a certain concentration. - MGA 19.7-211.

423. Hicks, J. R. Improving visibility near airports during periods of fog. Journal of Applied Meteorology, Boston, 6(1): 39-42, February 1967. DAS M(05) J86joa.

Liquefied propane, released from ground-based dispensers, was used to seed twelve fogs during the period 6 October 1964 to 24 July 1965. Six of these tests were conducted at Camp Century, Greenland. Five were successful, i.e., glaciation of the supercooled droplets and subsequent precipitation occurred. The sixth test was made on an ice fog which was not amenable to this type of modification.

The remaining six tests were made in the Hanover-Lebanon, N. H. area. Five of these tests were successful. The sixth experiment, conducted under a low stratus cloud, yielded no reaction.

It is concluded that propane is safe and economical to use as a fog dispersing agent when used as described. - Author's abstract.

424. Hidy, G. M. Adventures in atmospheric simulation. American Meteorological Society, Bulletin, 48(3): 143-161, March 1967. DAS M(05) A512b.

Laboratory investigations of processes related to atmospheric behavior have long been a resource of fundamental knowledge to workers in meteorology. In fact the history of progress in laboratory simulation closely follows the development of a wide spectrum of key ideas and hypotheses about the atmospheric processes on scales ranging from molecular activity to planetary circulation. This paper presents a very brief survey of the exciting wealth of information evolving from an ever increasing variety of laboratory experiments devoted to atmospheric phenomena. - MGA 18.7-253.

425. Hilst, Glenn R. On the propsects for controlled modification of the natural environment. American Meteorological Society, Bulletin, 48(4): 258-261, April 1967. DAS M(05) A512b.

The prospects for controlled modification of the environment

on significant scales of time and space are sufficiently high that we must prepare for the far reaching decisions which their implementation will require. The development of the basis for assessing the social and economic desirability of complex changes must go forward parallel with the development of the scientific and technologically feasible ways of accomplishing these changes. - MGA 18.11-184.

426. Holland, J. D. and Crozier, C. L. Statistical design for cloud seeding evaluation - precipitation physics project. Canada. Meteorological Branch, TEC 657, August 21, 1967. 49 pp. English and French summaries in front. DAS MO9.6 H735st.

Clouds of synoptic scale weather systems were seeded by aircraft with AgI during the summers of 1959 to 1963 in western Quebec. Rainfall in the target area was compared statistically with rainfall in the control area to obtain an evaluation of the effect of the cloud seeding. This paper presents the design of the statistical analysis of the project, its relationship to the physical design, and the methods used to meet the difficulties normally encountered in statistical analysis of cloud seeding experiments. A brief review of some of the general problems in analysis of cloud seeding experiments is given, some of the most frequently used techniques are discussed briefly, and the general features desired in analysis techniques are summarized. The physical design and operation of the project and the results of the statistical analysis of the effect of the cloud seeding have been presented earlier in this series. - MGA 19.7-212.

427. Howell (Wallace E.) Associates, Inc. Report and evaluation of precipitation stimulation for the Hackensack Water Company, September 1964 - April 1966. Lexington, Massachusetts, 1967? 7 pp. DAS MO9.617 H859reh.

Cloud seeding for mitigation of drought was carried on over the watersheds of the Hackensack River and nearby Saddle River from September 1964 through February 1967 with a three-month suspension beginning in May 1966. A storm-by-storm evaluation scheme, fitting a geometrical plane to the precipitations measured in a control region nearby outside the target area to estimate the expected precipitation on the target, was applied to all storms that gave a tenth of an inch or more precipitation on both the target and the control area for the period from the beginning of the program through the end of April 1966.

From the 75 seeded storms, the target precipitation of 51.8 inches exceeded expectation by 8.2 inches or 19 percent, with odds better than a million to one against chance occurrence of such an increase.

Although the evaluation method was developed especially to avoid the need for comparing seeded storms with unseeded history (because changes may occur with time), as a matter of interest the identical evaluation procedure was applied to the series of "dummy-seeded" storms obtained by working backward from the initial date of the project to the beginning of 1964. From the 31 dummy-seeded storms, target precipitation of 22.7 inches exceeded expectation by 1.3 inches or 6 percent, with even odds of chance occurrence.

By ordinary statistical standards, attribution of the increase to chance is strongly rejected for the seeded storms, but is not rejected at all for the dummy seeding. The great power of the testing method offers promise for its use in distinguishing storms especially susceptible to seeding influence from the general run of storms. - Author's abstract.

1428. Iakovlev, B. R. Primer ispol'zovaniia meteorologicheskoi radiolokatsionnoi stantsii dlia nabliudenii za rasseianiem frontal'noi oblachnosti
v period rabot po iskusstvennomu vozdelstviiu. (An example of using
a meteorological radar station to observe the scattering of a frontal
overcast during artificial seeding.) U.S.S.R. Glavnaia Geofizicheskaia
Observatoriia, Leningrad, Trudy, No. 217: 65-68, 1967. DAS M(055)
U581tg. Translated into English for U. S. Army Foreign Science and
Technology Center by Techtran Corporation, Technical Translation
FSTC-HT-23-438-68, April 30, 1969. 5 pp. DAS M(055) U581tgE no. 217
p. 65-68.

A meteorological radar station may be used successfully to control and correct active seeding operations of supercooled clouds. The accumulation of materials similar to those presented may render substantial aid to refine the methodology of scattering operations. The seeding effect is short-lived when there is a strong wind and a frontal overcast. The cleared zone closes in almost simultaneously with the termination of seeding. (In the case described, only 7 min passed between termination of seeding and complete elimination of the effect.) It is feasible to seed a frontal overcast only when two aircraft which have a maximum amount of carbon dioxide onboard and which alternate with each other take part in this operation. - MGA 21.7-115

James, Barry R. On Pitman efficiency of some tests of scale for the Gamma distribution. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman.

Berkeley, University of California Press, 1967. pp. 389-393. DAS 519.9 S989pro 1965/66 v.5.

Considers a 2-sample testing problem which has arisen in connection with weather control. A comparison is made of several 2-sample rank tests for scale change in γ distributions. A test is studied, the exponential scores test, which offers greater Pitman efficiency than some standard tests when the

shape parameter γ is small. The efficiency results imply that in the interval of relevance to the cloud seeding experiment, the exponential scores test is asymptotically almost as good as the IMP rank test S γ , and apparently offers an improvement over the L test. The performance of the Wilcoxon test is found to be poor. - MGA 19.7-213.

430. Kahan, Archie M. An atmospheric water resources research program.

American Society of Civil Engineers. Irrigation and Drainage
Division, Journal, 93(4): 15-24, December 1967. DAS P.

A progress report of the Bureau of Reclamation's Atmospheric Water Resources Research Program of practical application of weather modification techniques for improving the water supply of the nation is presented. The program is divided into 3 categories:

1) field experiments, 2) field support, and 3) laboratory studies. Descriptions of each of the projects and some of the important results are presented. Field experiments involve investigations of orographic and convective clouds during winter and summer in 6 major river basins of the West. Field support of various types is provided by 3 government agencies. The variety of problems studied in the laboratory include instrumentation, cloud physics, and evaluation techniques. Many studies are conducted in conjunction with field experiments. - MGA 19.6-188.

131. Kessler, Edwin. On the continuity of water substance. U. S. National Severe Storms Laboratory, Technical Memorandum TERTM-NSSL 33, April 1967. 125 pp. (Institutes for Environmental Research, Technical Memorandum TERTM-NSSL 33). DAS M(055) U582re no. 33.

In the first paper, Model circulations with microphysical processes, principles of continuity are applied with simple models of airflows and microphysical processes. Associations among the distributions of water substance, the microphysical processes, and the air motion are described. A model illustrates the dependence of an onset-time parameter on the strength of cloud autoconversion and accretion processes, and on the ratio of these processes. Distributions of water substance in 2-dimensional circulation models 6 km deep are considered. In the model, the circulation depth, intensity, and duration, and the initial water content, rather than microphysical parameters such as the distribution of raindrop sizes, are the principal regulators of precipitation amounts. Problems of weather modification and global climate are considered in the light of this study. The 2nd paper is a short note discussing the gravitational separation of raindrops of different sizes. The 3rd paper presents an interpretation of radar weather data, based on the theory discussed in the 1st paper. Radar echo coverage calculated on several days of two stormy periods in central Oklahoma and compared with the distribution of echo intensity near the Earth's surface indicate that the vertical profiles reflect the intensity of convection and that marked infra-diurnal changes of the fractional area covered by precipitation are not attended by marked changes in the character of the weather. The 4th paper is a reprint of an article which appeared in the Monthly Weather Review (see 14.9-712, Sept. 1963, Met Abs.). - MGA 19.1-13.

Kocmond, Warren C. and Jiusto, James E. Project Fog Drops; investigation of warm fog properties and fog modification concepts. Cornell Aeronautical Laboratory, Inc., Buffalo, New York, Contract NASr-156, Quarterly Progress Report for Period ending March 31, 1967. April 15, 1967. 15 pp. (CAL Report RM-1788-P-15) Also: Cuarterly Progress Report for period ending June 31, 1967. July 15, 1967. 22 pp. (CAL Report RM-1788-P-16) DAS M(051) C814rep.

The 1st paper deals with the testing and evaluation, in the 750 m³ chamber of the CAL Ordnance Lab., of the preseeding and desiccation concepts of fog dissipation. In the former, large hygroscopic nuclei are used to inhibit the formation of dense fog; in the latter, the atmosphere is seeded with hygroscopic particles after fog has formed. The paper includes a discussion of the preseeding and desiccation concepts, equations for calculating the preseeding and desiccation concepts, equations for calculating the size attained by giant hygroscopic nuclei after falling through a given depth of fog, and time required for growth and fallout of droplets during desiccation experiments. Also included: a description of the test chamber instrumentation and of the seeding experiments and graphs showing the results of seeding as indicated by visibility and drop size spectra. The desiccation tests show the following: after seeding is completed, visibility in the seeded fog improves rapidly from 500 to 3600 ft, then levels off for several minutes. Visibility in the fog was improved because of 2 processes related to the net change in size distribution: sizes attained by droplets, growing on the larger artificial sizes attained by droplets, growing on the larger artificial nuclei, were sufficient to cause fallout of some water from the fog between the time the NaCl nuclei were introduced into the fog and the time that visibility improvements were noted; and the change of drop size distribution from many small droplets to a few large ones caused an improvement in visibility in the same manner as in preceding trials. The investigation of atmospheric nuclei at subsaturated humidities is discussed. An appendix contains a description of the construction and operation of the particle classifier and disseminator used for fog seeding experiments. 2nd paper contains the following: a summary of visibility improvement attained in laboratory fog seeding experiments involving preseeding with NaCl nuclei to inhibit formation of dense natural fog; discussion concerning seeding an atmosphere in which fog already has formed but was dissipating and seeding an atmosphere in which a persistent fog had formed; an analysis of the processes responsible for visibility improvement and the results obtained from seeding existing fog. The physical characteristics (drop size distribution, liquid water content, and visibility) of both control and seeded fog at the time of seeding were characteristic of dense natural radiation fogs; they altered rapidly even in the control fogs. In one type of experiment, rapid natural drying was causing the fog to dissipate; in the other experiments, abnormally high cooling rates were causing an increase in liquid content. In view of the fact that visibility improvement in the first 5 min due to drop size distribution was of a factor of 3 for the dissipating fog and 2.6 for the fog of increasing liquid water content, the initial rate of visibility improvement to be expected in natural fog is associated with the vicinity of these values. The visibility improvements observed at later times were strongly influenced by the increased precipitation rate. The maximum

improvement in visibility that might be expected solely from the drop size distribution modification in deep fog appears to be on the order of a factor of 5 to 6. - MGA 19.9-247.

433. Konovalov, V. G. <u>Izmenenie teplovogo balansa abliatsii i svoistv</u>
deiatel'noi poverkhnosti l'da i firna pod deistviem iskusstvennogo
zacherneniia. (Changes in the heat balance of ablation and in the
properties of the active surface of ice and firm under the action
of artificial blackening.) U.S.S.R. Sredneaziatskii NauchnoIssledovatel'skii Gidrometeorologicheskii Institut, Leningrad, Trudy,
30(45): 51-57, 1967. Russian summary p. 51. DAS M(055) U581ts
vyp. 30.

The manner in which the properties of the active surface of a glacier and the heat balance of ablation are altered by spreading coal dust upon the ice surface or firm layer is investigated. additional absorbed short wave radiation, ΔQ , depends upon the flux of global solar radiation, Q, and on the extent to which the natural reflecting capacity of ice (AE) or firm is reduced; this is expressed by $\Delta Q = Q(A_E - A_B)$ where $A_B =$ albedo of a coal-dust covered surface. There are presented data from the published literature on the effect of different concentrations of dust upon albedo; the dependence of albedo upon concentration of dust is examined. The effective action of dust increases much more slowly than the increase in the concentration of the dust. The coal dust spread on a glacier surface also alters the long wave radiation balance and influences the intensity of heat and moisture flux. The process of evaporation-condensation on the ice or firm surface is examined; the thermal equivalent of this process during the daytime is calculated by formulas given in the text. The effect of coal dust upon the intensity of moisture and heat exchange is examined with the aid of these equations. There is also demonstrated the fact that variation in the height of the microstructure in the coal dust layer influences the heat and moisture exchange in the surface layer. - MGA 19.12-772.

434. Koyama, Michiyoshi and Sasaki, Harumi. Frost heave of roads in Hokkaido and its countermeasures. (In: International Conference on Low Temperature Science, Sapporo, Japan, August 14-19, 1966, Proceedings, Vol. I, Physics of Snow and Ice, Part 2. Sapporo, Japan. Hokkaido University, Institute of Low Temperature Science, 1967. pp. 1323-1331) DAS M74.1 I6lpr v.1 Pt 2.

For preventing frost damage to paved roads in Hokkaido, the so-called replacement method has been adopted with the aid of the current specifications provided by the Hokkaido Development Bureau. However, there still remain some problems to be solved to obtain the rational design criteria for paved roads, i.e., frost preventing effect and load carrying capacity in thawing period. This paper contains the following: 1) frost heaving of roads in Hokkaido, 2) replacement method in Hokkaido, 3) research outline on this subject, and 4) Bibi frost heave test road. - MGA 19.11-219.

435. Landers, John N. and Witte, K. <u>Irrigation for frost protection</u>.

(In: Hagan, Robert M.; Haise, Howard R.; Edminister, Talcott W. (eds.), Irrigation of Agricultural Lands. Madison, Wisconsin, American Society of Agronomy, 1967. pp. 1037-1057) (Agronomy, Madison, Wisconsin, No. 11) DAS 631.7 HILLIER.

This comprehensive review of the rationale and use of irrigation in frost protection involves a discussion of the following: I) characteristics of advection and radiation frost and the atmospheric conditions attending their formation; II) a) environmental and crop factors influencing the thermal heat exchange between plants and the atmosphere during a frost by means of radiation, evaporation and convection, b) effect of volumetric heat capacity and thermal conductivity of the soil and plant cover upon surface temperatures, and frost occurrence; c) critical temperature below which frost damage occurs for various crops, and the ability of plants to supercool, d) heat balance of the scil-plant-atmosphere at night; III) methods of utilizing irrigation for frost protection a) during frost such as overhead sprinkling, ground (undertree) sprinkling and surface irrigation methods such as flooding or furrow irrigation, b) use of irrigation prior to frost (advance or pre-irrigation); and IV) selection and design for overhead and ground sprinkling, and surface and furrow irrigation in frost protection. - MGA 19.7-200.

li36. Lenshin, V. T. and Shishkin, N. S. <u>Vozdeistviia vodnymi rastvorami</u>
iodistogo svintsa na pereokhlazhdennye konvectivnye oblaka v raione
<u>Valdaiskogo livnemernogo kusta</u>. (Action of aqueous lead iodide
solutions on supercooled convective clouds in the area of the Valdai
shower measurement center.) U.S.S.R. Glavnaia Geofizicheskaia
Observatoriia, Leningrad, Trudy, No. 202: 32-40, 1967. Russian
summary p. 32. DAS M(055) U581tg.

Experiments are described in which large cumulus clouds were seeded by aqueous lead iodide (PbI₂) solutions sprayed from aircraft. The experiments were conducted by the A. I. Voelkov Main Geophys. Obs. in summer 1961. Temperature threshold and the mechanism involved in the action of PbI₂ solutions were defined more accurately. Statistical evaluations of the effect of cloud seeding were calculated from data obtained by the rainfall station network with increased measurement frequency. MGA 20.2-176.

437. Leonov, M. F. and Perelet, G. I. Aktivnye vozdelstviia na oblaka v kholodnoe polugodie. (Stimulation of clouds during the cold half-year.) Leningrad, Gidrometeoizdat, 1967. 151 pp. DAS MO9.6 L585ak.

Summarizes results of field experiments on producing artificial precipitation in the Ukraine from stratiformis. Previous work on stimulation of supercooled clouds is reviewed and the experimental meteorological base and its cloud regime are described in the first ch. Cloud characteristics from the standpoint of their artificial

stimulation are the subject of ch. 2. Methods of stimulation and an analysis of results of individual experiments are given in ch. 3. In ch. 4, synoptic conditions favorable for stimulation are analyzed together with data on water content of clouds. A statistical evaluation of the effectiveness of stimulating winter clouds is made in the last ch. Following are some of the principal conclusions. With stimulation of supercooled clouds, winter precipitation can be increased by ~15% over limited areas. Data were obtained on parameters of cloudiness suitable for stimulation. The water resources were determined sufficiently accurately for Sc-St and provisionally for Ns. - MGA 19.11-10.

438. Litvinov, I. V. Otsenka otnositel'noi shkaly dozirovok pri vozdeistvii kristallizuiushchimi reagentami na pereokhlazhdennuiu oblachnost'.

(Evaluation of the relative scale of dosage for modification of supercooled clouds with crystallizing reagents.) Akademiia Nauk SSSR. Institut Prikladnoi Geofiziki, Trudy, No. 9: 83-86, 1967. Russian summary p. 83. DAS M(055) A313trp v.9.

The number of particles such as hailstones, graupel and snow falling in precipitation of varying intensity and the distribution of particles in snowfall of varying intensity by diameter are given as graphs. In the formation of different kinds of precipitation the number of precipitating elementary particles differs almost by 3 orders. The smallest number of particles falls in the case of hail, the largest in the case of granular snow. Hence for modifying natural precipitation formation by increasing the number of growing hail or snow particles the dosage of crystallizing reagent per unit cloud area should be almost 3 times less in the former than in the latter. The dosage in the case of graupel occupies an intermediate position. Since the area of hail fall is many times smaller than the area occupied by snowfall, the total amount of reagent necessary for modifying a cloud yielding snow should be 4-5 orders of magnitude greater than that in the case of modification of a hail producing cloud. - MGA 19.6-191.

439. Litvinov, I. V. Pereraspredelenne osadkov pri vozdežtvii na oblaka khladoreagentami. (Redistribution of precipitation during cloud seeding with a cold reagent.) Meteorologiia i Gidrologiia, Moscow, 9:48-51, September 1967. DAS M(05) M589. Translation by A. Nurklik into English in Canada. Meteorological Branch, Meteorological Translations No. 15: 26-31, 1968. DAS M(055) C212me.

Results of cloud seeding from airplanes carried out in the European U.S.S.R. in order to verify the artificial decrease of precipitation simultaneously with the increase during cloud seeding and to verify the hypothesis proposed for this phenomena. The results show that during seeding a zone of increase in precipitation is followed by a zone of decrease in precipitation and that the total effect of seeding is close to zero, i.e., the increase in precipitation is substantially equal to the decrease. The significance of the results obtained was analyzed statistically with the aid of the coefficient of precipitation redistribution,

the computations of which show that the hypothesis that the observed decrease in precipitation at random is unacceptable and that there is a high probability that during seeding of clouds yielding rainfall, regions occur with diminution in precipitation amount simultaneously with regions with increase in precipitation.

- MGA 19.5-160.

MacCready, Paul B., Jr. and Skutt, Roger F. Cloud buoyancy increase due to seeding. Journal of Applied Meteorology, Boston, 6(1): 207-210, February 1967. DAS M(05) J86joa.

Considers quantitative aspects of cloud buoyancy alterations and offers a nomogram technique for the calculation of both parcel temperature and buoyancy alterations. It is shown that the heat of sublimation effect can be either an increase or decrease of temperature and buoyancy. The computational procedure is set forth. Complete glaciation of parcels with liquid water contents, will add materially to the local buoyancy. A temperature increase of 2.5°C at 250°K corresponds to a buoyancy yielding an extra vertical acceleration of 1% of gravity, or 10 cm sec 2. Within a few minutes such an acceleration can be expected to have a marked effect on the dynamics of some clouds. - MGA 18.6-432.

441. Malone, Thomas F. Weather modification: implications of the new horizons in research. Science, Washington, D. C., 156(3777): 897-901, May 19, 1967. DAS P.

A review of weather modification is followed by implications of the new horizons in research. Considers the way in which man is "tinkering" with the physical environment, in particular with artificially produced changes—deliberate or inadvertent, transient or permanent—in the composition and behavior of the atmosphere. The author examines the scientific problem and the developments that are currently transforming it, summarizes briefly the state-of-the-art, reviews the issues, and closes with discussion of the implications. - MGA 19.2-122.

Markovic, Radmilo D. Control levels for quantitative evaluation of weather modification attainments. Water Resources Research, Washington, D. C., 3(2): 423-431, 1967. DAS P.

There are three basic control levels from which the quantitative (statistical) evaluation of weather modification (cloud seeding) attainments can be considered, corresponding to three particular stages in the general hydrologic cycle: cloud phenomena, precipitation, and river flow control levels. The cloud phenomena level of control is suitable for qualitative (physical) rather than for quantitative (statistical) evaluation of weather modification attainments. The precipitation level of control may be used for both qualitative and quantitative evaluations. However, the inaccuracy involved in single measurements of precipitation under different environmental conditions and in the determination of

mean areal precipitation makes this level of control unreliable for the quantitative evaluation of weather modification attainments at present. The river flow control level has been shown to be suitable and promising, accurate, and reliable for practical purposes, and it is, therefore, highly recommended for use in the quantitative evaluation of weather modification attainments. — Author's abstract.

Marlatt, William E. The effect of weather modification on physical processes in the microclimate. Symposium on Ground Level Climatology, Berkeley, California 1965. Ground Level Climatology, Robert H. Shaw ed. American Association for the Advancement of Science, Washington, D. C., Publication No. 86, 1967. pp. 295-308. DAS M84.4 S989gr.

The purpose of this paper is to point out some of the possibilities, limitations, and ramifications that certain techniques of weather modification will have directly and indirectly on microclimate. In conclusion it is stated that each activity of man may be considered a weather modification of the microscale environment. Research in cloud physics on the mesoscale indicates that weather modification to increase precipitation may become practical and economically feasible. There is no doubt that either modifying amounts of precipitation received or modifying the distribution of rainfall will affect the microclimate of a region, but to what extent is unknown. Indirect modification by man's activities is probable. The air pollution menace may have more far-reaching ramifications on the microclimate than anything man could do to the weather on purpose. Because the microclimate is easily modified by many types of activities on many scales, immediate and concentrated research is essential, so that we may know in advance how our purposeful or accidental weather modification will change the microclimate. - MGA 19.7-196.

444. Marwick, Charles. Beating the weather in Minnesota. New Scientist, London, 36(573): 549-550, November 30, 1967. DAS P.

Plans are afoot in the U.S. to build a fully enclosed town, within which environmental conditions can be strictly controlled. The latest plan provides for an entire town to be enclosed in a series of domes 2 mi in diameter. Each dome is to be 1 mi high at its apex and 6 of the domes will accommodate about a quarter of a million people. The dome city is planned for upper Minnesota, an area becoming rapidly depressed through depopulation resulting from hard winters. The note briefly outlines the main features of the proposed city. - MGA 19.5-158.

Meteorology Research, Inc., Altadena, California. Arizona weather modification research program. Final report for FY 1965, 1966, and 1967. Its MRI 66, FR-407r, April 30, 1967. 62 p. + separately pages appendixes. "Twelve additional special reports with individual authors are issued in a companion volume, entitled: Arizona Weather Modification Research Program: Research Reports for FY 1965, 1966 and 1967." DAS M(051) M589fia.

The program included a small investigation of seeded and nonseeded summer storms in 1965, a brief winter field project early in 1966, a major program in the summer of 1966 and the associated planning, technique developments and evaluation. The conduct and results of the 3 field projects are presented. Case studies of some of the seeding events are described with some definite results, some tentative results, and some speculations based on the observations. The overall results show some distinct effects which are consistent with the predictions of physical models. A list of special topics includes development of a simplified computer model of cumulus dynamics and precipitation and of an airborne dispensing system for metaldehyde smoke, an organic nucleating material which has several potential advantages over silver iodide. - MGA 18.11-185.

Morachevskii, V. G. Ob aktivnosti chastits AgJ v kachestve

l'doobrazuiushchikh iader. (Activity of AgI particles as ice-forming
nuclei.) Akademiia Nauk SSSR, Izvestiia. Fizika Atmosfery i Okeana,
3(1): 105-107, January 1967. DAS P. Translated into English in
corresponding issue of its Izvestiya, Atmospheric and Oceanic Physics,
issued Washington, D. C. DAS P.

Studies of the efficiency of AgI particles as nuclei for ice formation were carried out in a cold chamber at temperatures down to -35°C. The results are presented in graphs. Preliminary conclusions state that in the choice of a reagent as an initial stimulator of epistatic growth of the solid phase, most attention should be paid to the elecktrokinetic potential distribution. If an adsorptive layer of the highest degree of homogeneity, as in semiconductors, is desired, a crystalline priming tagged with \$\textit{g}\$-emitters is suggested. - MGA 18.9-411.

447. Morgan, G. M., Jr. and Rosinski, J. A field technique for detecting silver iodide in snow. Journal of Applied Meteorology, Boston, 6(4): 656-661, August 1967. DAS M(05) J86joa.

A field technique was developed to detect silver iodide seeding agent in snow samples. The technique consists of collecting snow during a snow storm, forming liquid drops by melting pellets made from the snow, and refreezing the drops. A histogram of frequency of drop freezing plotted against temperature indicates the presence or absence of silver iodide in snow. - Authors' abstract.

Miller, Hans Gerhard. Weather modification experiments in Bavaria. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 223-235. DAS 519.9 S989pro 1965/66 v.5.

Reports an experiment using AgI released from rockets, as well as from ground generators to obtain information about possibilities of suppressing hail by seeding hail clouds in the Rosenheim district of the Bavarian Plains. It was concluded that an 8-yr

period does not provide significant data on weather phenomenon as infrequent as hail. The chosen target area was found to be too small compared with the variability of the weather situation.
- MGA 19.7-215.

449. Myers, J. N. The use of vegetation in the control of shallow radiation fog. Weather, London, 22(7): 289-291, July 1967. DAS M(05) R888w 22: 1967.

A brief account of some reported studies of the visibility distribution in the Bald Eagle and Nittany Valleys during radiation fog conditions. These studies serve to illustrate the marked effect that vegetative cover has on visibility on such occasions, and leads to the suggestion that appropriate landscape-gardening could be used in the vicinity of airports to reduce the fog risk. Its principal effect would be to control air drainage. It might also enhance the efficiency of other fog preventive measures that might be used in that it would reduce the wind speed in the lower layers, and thereby decrease the volume of air to be cleared in unit time, and would decrease slightly the liquid-water content in the lower layers of fog through the capture of fog droplets by the vegetation. - MGA 19.1-49.

450. Neiburger, M. Physical factors in precipitation processes and their influence on the effectiveness of cloud seeding. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 1-27. DAS 519.9 S989pro 1965/66 v.5.

The paper provides a background to the studies which follow in this volume. It presents a summary of the physical factors in precipitation processes and their influence on the effectiveness of cloud seeding. Following a qualitative description of precipitation processes the following are summarized: condensation and the formation of clouds, growth by collection, growth of ice crystals in supercooled clouds, and dynamics of clouds and precipiation. - MGA 19.8-205.

451. Neyman, Jerzy. Experimentation with weather control. Royal Statistical Society, London, Series A(General), 130(3): 285-326, 1967. DAS P.

Brief historical sketch: woes of citizens as a source of inspiration for, and a cause of difficulties in, weather control experimentation. Three consecutive hail-prevention experiments in Switzerland. Reports of the U. S. National Academy of Sciences-National Research Council Panel on Weather and Climate Modification: commercial cloud-seeding and randomized experiments as sources of information. Two points of view: (i) effect of cloud seeding vs (ii) varying effects of cloud seeding. Original evaluation of 19 known randomized experiments and hopelessness of (i). Evidence of positive as well as negative effects of cloud

seeding on precipitation. Need for a reorientation of purposes of experiments. Accessibility vs availability of data on completed experiments with weather control. Extension of analysis of variance for random effects: optimal $C(\alpha)$ tests for the presence of random effects. - Author's abstract.

Neyman, Jerzy and Scott, Elizabeth L. Note on techniques of evaluation of single rain stimulation experiments. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 371-384. DAS 519.9 S989pro 1965/66 v.5.

Summarizes the techniques developed in the Statistical Lab. The formulas and some extensions are presented. All the techniques are asymptotic. The normal distributions of the test criteria were obtained under a passage to the limit as the number N of observations is indefinitely increased. The whole problem of statistical methodology of evaluating rain stimulation experiments is not considered completely solved and the techniques indicated constitute a progress report. Practically all the techniques are based on the assumption that the possible effect of seeding on rainfall is multiplicative. This assumption requires verification. - MGA 19.8-206.

Project. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 351-356. DAS 519.9 S989pro 1965/66 v.5.

This note provides information on the Weather Bureau ACN Cloud Seeding Project. The project experimental areas was in the states of Washington and Oregon. Cloud seeding was done with dry ice dispensed from aircraft flying across the direction of the advancing winter type storms, which are usually from the west. The intention was to seed only cloud systems that were "ripe for seeding." Using 3 types of target, 6 different evaluations of effectiveness of seeding were performed. The numerical results are tabulated and discussed. The 6 methods of evaluation differed in the way the normal precipitation for a given rain gage and the given test period was estimated, some of them very complicated and all raising questions. - MGA 19.8-207.

Neyman, Jerzy and Scott, Elizabeth L. Planning an experiment with cloud seeding. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 327-350. DAS 519.9 S989prc 1965/1966 v.5.

Reviews the problem of planning an experiment with cloud seeding as a whole and calls attention to subproblems of particular importance. Consideration is given to: 1) meteorological aspects of planning, 2) the statistical aspects of planning, 3) the statistical theoretical background, and 4) number of experimental units required to attain the preassigned precision of a planned experiment. Numerical illustrations are based predominantly on data collected by Project SCUD (Spar, 1957). - MGA 19.8-208.

Neyman, Jerzy and Scott, Elizabeth L. Some outstanding problems relating to rain modification. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 293-326. DAS 519.9 S989pro 1965/66 v.5.

Two aspects of the problem of rain modification by cloud seeding are dealt with: the meteorological aspect, concerned with the rainfall itself and with the possibility of its being affected by cloud seeding, and the statistical aspect, concerned with the methodology particularly suitable for the treatment of the meteorological problem. An analysis was made of 5 major American rain stimulation experiments and of a Swiss hail suppression experiment, Grossversuch III. - MGA 19.8-209.

456. Nikandrov, V. Ia. Aktivnye vozdefstviia na oblaka i tumany. (Cloud and fog modification.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 218: 251-260, 1967. DAS M(055) U581tg no. 218.

In this short review, the author manages to present an amazingly complete account of the theoretical and practical weather modification work in the U.S.S.R. Investigations in experimental meteorology began in 1919 at the Main Physical Obs. (now GGO, Main Geophys. Obs.) with studies of supercooling of water and of formation of ice nuclei. In the thirties, laboratory studies were made in a 110 m³ adiabatic fog chamber. Special aircraft expeditions were conducted. The work of the 1934-1936 high mountain expeditions of the Leningrad Inst. of Experimental Meteorology (LIFM), which became a part of GGO in 1942, is particularly noteworthy. In weather modification experiments during this period, electrical methods were used to determine the possibility of cloud and fog modification by artificial ionization. In postwar years, the GGO continued theoretical and experimental studies of atmospheric physics. Five lines of research which contributed greatly to the scientific substantiation of methods of weather modification and the leaders of this research are listed. Present methods of modification at negative temperatures are based on the instability in the supercooled state. Field experiments with CO2 played a deciding role in determining the possibility of controlling clouds and fogs at

negative temperatures. Modification methods at positive air temperatures are based on the colloidal instability of a system composed of hygroscopic particles and cloud droplets. Present methods of combating hail are based on preventing the precipitation formation of large hail on relatively sparse natural nuclei. Four of the several methods used in evaluating the effectiveness of rainmaking are listed. The results are still inconclusive but there are reasons to assume an increase of 10%. Three possible methods of preventing anomalous heavy downpours are listed. Along with the work in weather modification, theoretical studies are being conducted in the modification of climate. - MGA 20.1-164.

157. O'Connor, James F. Crystal ball on the clouds. Panhandle Magazine, Kansas City, Missouri, 2(2): 16-20, Winter 1967-68. DAS P.

Explains in nontechnical language and illustrates pictorially the problems involved in both short and long range weather forecasting. The efforts being made in solving these problems and in improving the reliability of forecasts including the meteorological satellite program and use of computers are discussed. The limited experimentation in rain making and hurricane seeding which so far produced inconclusive results are referred to. The success claimed by the Russians in hail suppression is mentioned. The author concludes that, because results of tampering with natural forces can not be predicted, attempts at large scale weather control may not be possible before the end of the century. - MGA 19.12-102.

458. O'Mahony, G. Cloud seeding in Wimmera-Mallee, Victoria, 1966.

Australian Meteorological Magazine, Melbourne, 15(3): 133-147,

September 1967. DAS M(05) A938.

Cloud seeding was conducted in the Wimmera-Mallee during the months of August, September and October 1966 and claims have been made and publicised that the wheat yield in the seeded area was increased significantly as a direct result.

The claims have been investigated here by comparing rainfalls in the seeded or 'target' area with those of an unseeded 'control' area. Two types of tests were employed, the first being distribution free, and the second was based on the assumption of Normality of the relevant distributions. The same data were used in each and so obviously the tests were not independent.

The results showed a rather remarkable uniformity of rainfall anomaly over the target and control areas for the seeded period. This uniformity was highlighted by the fact that the 1966 value of the ratio of target to control rainfalls was located at the median of the relevant 42 term series.

From this evidence it would appear there is no justification for claims that rainfall has been affected by the cloud seeding. However, the additional point has been brought out that because

the rainfall has such large inherent variability, it appears to be practically impossible to substantiate such claims based on a test sample of only one member, that is on only one set of seeded data. - Author's abstract.

osadkov v voprosakh iskusstvennykh vozdeistvii na oblaka. (Considering breakdown of the sums of semi-diurnal and diurnal precipitation in problems of artificial cloud modification.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 202: 118-124, 1967. Russian summary p. 118. DAS M(055) U58ltg.

In evaluating the effect of cloud seeding, daily averages of precipitations are usually considered which is inadequate when seeding is carried out only during the daytime. Separate evaluation of precipitations during day- and nighttimes showed that for daytime seeding, the effect should be assessed only from daytime precipitation. To obtain an improved effect around the clock, seeding should be carried out by aircraft, rockets and other means. - MGA 20.2-177.

460. Pena, R. G. de and Caimi, E. A. Hygroscopicity and chemical composition of silver iodide smoke used in cloud seeding experiments.

Journal of the Atmospheric Sciences, Boston, 24(4): 383-386, July 1967. DAS M(05) A512j 24: 67.

The aerosol produced by a commercial device used for cloud seeding experiments was studied by electron microscopy, electron diffraction, chemical analysis and a replica method to test the hygroscopicity of the particles. The electron micrographs obtained from the aerosol when applying the replica method showed the hygroscopic nature of the aerosol particles.

We deduced from chemical analysis that the aerosol is composed of silver and potassium iodides in the ratio of approximately 2:1.

From an electron diffraction pattern and other considerations, the formation of a double salt or a solid solution is indicated; its nature should be considered in further work. - Authors' abstract.

461. Penner, Edward. Experimental pavement structures insulated with a polyurethane and extruded polystyrene foam. (In: International Conference on Low Temperature Science, Sapporo, Japan, August 14-19, 1966, Proceedings, Vol. I, Physics of Snow and Ice, Part 2. Sapporo, Japan. Hokkaido University, Institute of Low Temperature Science, 1967. pp. 1311-1322) DAS M74-1 I6lpr v.1 pt. 2.

The purpose of insulating roads in areas of seasonal frost is to attenuate frost penetration and thus permit the design pavement thickness to be reduced. For satisfactory operation the requirements are that the insulating material must retain a high thermal resistance during the lifetime of the installation despite a varying moisture regime in the surrounding material. Also, it should not interfere significantly with the stability of

the pavement structure either because of the flexible nature of the insulation or by creating an unfavorable water condition in the other components of the road bed. Early indications from actual use are that polystyrene insulation will meet these requirements. Two 100-ft (32.8-m) sections of street were constructed in Sudbury, in Sept. 1964 using 0.610 by 1.200-m by 5.08-m sheets of extruded polystyrene insulation in the pavement structure at a depth of 0.106 m. During the first winter of operation (1964-1965) the air freezing index was 2600 deg day below 32°F (11,41, deg day below 0°C). The maximum frost penetration was 1.65 m in the center of the road in the control area, and 0.76 m in the insulated area, that is, the insulation attenuated frost penetration by 17.5 cm/cm of insulation. Benkelman beam deflections were somewhat higher in the insulated areas but the amount of heaving was considerably retarded. In the summer of 1955 2 additional insulated road sections were constructed in Ottawa. Two types of insulation and methods were used. Extruded polystyrene boards were placed by hand (the same at at Sudbury) at the desired elevation. Polyurethane was foamed in place by spraying the chemicals on the road bed with a specially constructed self-propelled spraying machine. This paper discusses the relative merits of the different methods of insulating roads and, in a broader context, the protection against freezing of underground utilities, such as water mains and sewers. - MGA 19.11-220.

h62. Pérez Siliceo, E. A brief description of an experiment on artificial stimulation of rain in the Necaxa watershed, México. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 133-140. DAS 519.9 S989pro 1965/66 v.5.

A brief description is given of an experiment on artificial stimulation of rain in the Necaxa watershed, Mexico. This report is a continuation of earlier description of the project, and extends the evaluation by using the method of historical years and applying to them the random seeding schedules used in the later years of experimentation. Carryover effects of seeding were also studied. While 2 statistical methods give discordant results they do agree in that both methods yield many more values above the normal than below. Analysis of the unseeded day following each seeding period shows that there probably is an effect for more than one day, although less than 2 days, from the rain stimulation. The results point to the necessity for a physical investigation to detect any presence of AgI nuclei on the days following seeding, and to see if they reach the control zone during disturbed weather. - MGA 19.8-211.

463. Phillips, B. B. Hail suppression concepts. Conference on Severe Local Storms, St. Louis, Mo., 1967. Papers to be presented at Fifth Conference on Severe Local Storms, St. Louis, Mo., October 19-20, 1967. St. Louis, 1967. pp. 10-13. DAS M15.4 C748pa.

A discussion is given of the concept of hail suppression and hail mitigation. The cloud structure and the role of the water accumulation in upper levels of the cloud are described. The seeding requirements for experimentation are outlined. The model and concept leading to hail mitigation are similar to that described for successful Russian hail control experiments. - MGA 19.11-242.

464. Pilié, Roland J.; Kocmond, Warren C.; Jiusto, James E. Warm fog suppression in large-scale laboratory experiments. Science, Washington, D. C., 157(3794): 1319-1320, September 15, 1967. DAS P.

Visibility in warm fog produced in a 600 m³ chamber was increased by factors of 3 to 10 by seeding with carefully sized sodium chloride particles. As little as 1.7 mg of salt/m³ was effective. Extrapolation of these results indicates that clearing a suitable landing zone for aircraft would not involve prohibitive amounts of seeding material. - MGA 19.2-125.

465. Pleszczyńska, Elżbieta. <u>Statistical study of hail suppression experiments</u>. Acta Geophysica Polonica, Warsaw, 15(1): 39-47, 1967. English summary p. 39; Polish summary p. 47. DLC.

The effectiveness of hail suppression methods ought to be verified statistically on the basis of a properly planned experiment. However, special features of hail make most standard methods unapplicable. This paper contains a discussion of problems and some suggestions of suitable planning and interpreting the results of an experiment. The Monte-Carlo method of evaluating of the required experiment duration time is also described. These problems are illustrated by hail data gathered in Poland. The paper also contains some critical remarks on the methods adopted by some experimenters working abroad in this field. - MGA 18.10-248.

466. Prikhot'ko, G. F. Evaluation of effectiveness of artificially induced precipitation from convective clouds. Washington, U. S. Joint Publications Research Service, 1967 (JPRS 43,523). 21 pp. From Trudy Ukrainskogo Nauchno-Issledovatel'skogo Gidrometeorologicheskogo Instituta (Transactions of the Ukrainian Scientific Research Hydrometeorological Institute), No. 61, Leningrad, 1966, pp. 3-16. DAS M(055) U581tuE. no. 61. p. 3-16.

Systematic experiments were carried out in the summers of 1960-1964 in the experimental meteorological polygon of the UkrNIGMI (Ukrainian Scientific Research Hydrometeorological Institute) for inducing additional precipitation from Cu cong. This article gives a quantitative evaluation of the results. The evaluation was made first by the direct method, that is, by determination

of the quantity of artificial precipitation from strictly determined clouds, and then by the statistical method, by comparison of the monthly and seasonal sums of precipitation over the experimental and control areas. According to the statistical evaluation, the artificial increase of precipitation was about 15%. The probability of the result was 0.75. A further increase of the test period is required in order to increase the statistical significance of the evaluation. - Translation of author's abstract.

H67. Riehl, Herbert. Les efforts de prévention de la grêle dans le Sud-Ouest de la France. (Hail prevention efforts in southwestern France.)

Association d'Etudes des Moyens de Lutte contre les Fléaux Atmosphériques, Toulouse, Rapport sur la campagne, No. 15: 3-8, 1967. DAS MO9.6 A8h9ra no. 15.

Hail formation and hail prevention methods were investigated by the author during his visit at the French Center of Atmospheric Research in Lannemezan. A physical model of hail formation envisioned warm and humid air ascending to 10 km height where it met temperatures between —35° and —40°C. The rising water vapor first condenses, then freezes into snowflakes which may act as nuclei in hail formation. A long, anvil shaped cumulonimbus, expanding rapidly in strong upper air currents, may be an efficient hail producer for hours. It is suggested that hail may be prevented by injecting a large amount of nuclei into the ascending warm air current, contributing to small ice particle formation, which, however, will never reach hail size. - MGA 18.11-199.

468. Roberts, Walter Orr. The Global Atmospheric Research Program. American Meteorological Society, Bulletin, 48(2): 85-88, February 1967. DAS M(05) A512b 48: 1967.

An overall view of the Global Atmospheric Research Program (GARP) indicates that the goal of GARP is to promote a vastly improved understanding of the general circulation of the global atmosphere, not only for the sake of understanding, but for its relevance to practical goals. GARP should provide a research resource that can be exploited to simulate such global weather modification processes—and to do so harmlessly in a computer—in order that we may know just how far we can go deliberately, or may go inadvertently, in changing weather and climate. - MGA 18.11-38.

469. Ruskin, R. E. Measurements of water-ice budget changes at -5C in AgI-seeded tropical cumulus. Journal of Applied Meteorology, Boston, 6(1): 72-81, February 1967. DAS M(05) J86joa.

During the 1965 Project Stormfury experiments a combination of six cloud physics aircraft instruments were used to measure the changes in the water-ice budget in a large tropical cumulus which had been seeded. Pyrotechnic "Alectos" were used to produce an estimated 180 AgI nuclei per liter effective at -50 in the seeded area. Measurements showed an 80 per cent conversion to ice at the

-5C level (17,000-ft pressure altitude) in a 1 km region of the cloud 5 min after seeding, together with a 1.5C rise in temperature. At the same time the adjacent unseeded region of the same cloud decreased in percentage ice at that level, but increased about the same amount in temperature, probably because of increased updraft induced by the heat of fusion energy released in the seeded region.

On two passes 10 min apart a 300-m length of "wisp" visible outside the main cloud produced many 10-20 μ replicas of ice particles in air which had a measured 75 to 90 per cent relative humidity, including the moisture from the cloud particles which were vaporized in an instrument which measures the cloud total water content. - Author's abstract.

L70. St. Amand, Pierre. Nucleation by silver iodide and similar materials.

Skywater Conference, 1st, Denver, July 1967, Proceedings of Skywater Conference 1 con. Physics and Chemistry of Nucleation. Denver, Colo., U. S. Bureau of Reclamation, 1967. pp. 305-353. DLC.

The paper discusses the nucleation process, Fletcher's theory, and the recent tests at Colorado State University that show some of the properties of nucleants and suggests a way to proceed toward recognition of the need for a particular type of nucleant, the meteorological conditions under which they are to be employed and subsequent application of nucleation theory. Seeding from the ground is considered ineffective, unless performed in mountains. - MGA 21.6-562.

471. Sargent, Frederick, II. A dangerous game: taming the weather. American Meteorological Society, Bulletin, 48(7): 452-458, July 1967. DAS M(05) A512b.

The implications and possible consequences to the ecosystem arising from current and planned attempts to change weather and climate are discussed. The concept of ecosystem and man's role within it, his use of the ecosystem as a natural resource, and the changes in the ecosystem due to man's activity are considered. Particular attention is given to the creation of a "heat island" in the urban area, the role of CO2 in the recent warming of the atmosphere, etc. Various plans to modify weather so as to reduce the risks due to weather phenomena and to increase man's control of his environment are reviewed. These involve increase in precipitation, dissipation of fog, control of storms and hurricanes, etc. Some of the ecological risks that may result from such control are reviewed. These include the disturbance of the relationship between organisms and their environment, such as the change in the range of species or even their extermination, the possible interference in moisture transport by the modification of storms or hurricanes, etc. - MGA 19.1-128.

472. Schleusener, Richard A. Evolution of uses of cloud-seeding technology.

American Society of Civil Engineers, Irrigation and Drainage Division,

Journal, 93(3): 187-197, September 1967. DAS P.

The evolution of uses of cloud seeding technology is reviewed to determine the factors responsible for introduction of this new technology into operating systems for water resources management. There is a time lag between recognition of the possibility of beneficial use of this technology and its general acceptance. Factors promoting this time lag include not only physical and economic evaluations of the technology, but also the attitudes of management and its willingness to innovate. In contrast to attitudes of the recent years, a consensus now exists on the importance of cloud seeding as a tool in management of water resources This portends substantial increases in weather modification activity, and attempts to evolve operational systems of weather modification to further exploit the technology as a water resources management tool. Experience to date indicates the importance of providing latitude for innovators in developing the technology. - MGA 18.12-178.

473. Schleusener, Richard A. Lessons from Project Hailswath. Conference on Severe Local Storms, St. Louis, Mo., 1967. Papers to be presented at Fifth Conference on Severe Local Storms, St. Louis, Mo., October 19-20, 1967. St. Louis, 1967. pp. 24-27. DAS M15.4 C748pa.

Project Hailswath was a cooperative pilot experiment in hail suppression research, conducted in South Dakota and Colorado during the summer of 1966. The project provided observational data on seeded and unseeded thunderstorms and provided an environment for an active exchange of views among the participants. The lessons learned from Project Hailswath which are applicable to future field programs of hail suppression research may be categorized by principles involving technology, organization, design, and socioeconomic application. - MGA 19.11-248.

1474. Schleusener, Richard A. and Grant, Lewis O. Weather variation and modification. (In: Hagan, Robert M.; Haise, Howard R.; Edminister, Talcott W., (eds.), Irrigation of Agricultural Lands. Madison, Wisconsin, American Society of Agronomy, 1967. pp. 40-50) (Agronomy, Madison, Wisconsin, No. 11) DAS 631.7 Hlllir.

The present status of short and long-period weather forecasting and of weather modification is reviewed. Contents of this paper comprise the following: I) effects and magnitude of weather variation in agriculture—progress in forecast periods of 24-48 hrs., of 2-7 days, and long-range forecast periods of 7 days to a few years, prospects for improved forecasts through 7 days and beyond 7 days; II) a brief historical review of weather modification—importance of the atmosphere as a source of water, physical basis for weather modification including the ice crystal process, the coalescence process, the changes in cloud dynamics, weather modification and supplementary water supplies directly from the atmospheric water vapor source; III) current status of the use of cloud seeding—for increased precipitation, storm abatement, supercooled cloud

dispersal, statistical verification of weather modification including, target vs. control precipitation relationship, randomization, demonstrated phases, and the uncertain phases of the seeding process; and IV) outlook for the scientific and economic aspects of weather modification. - MGA 19.7-197.

475. Schmid, P. and Thams, J. C. Results of a large-scale rain stimulation experiment on the southern slopes of the Alps. Archiv für Meteorologie, Geophysik und Bioklimatologie, Serie A, Vienna, 16(2-3): 226-241, 1967. English, German and French summaries pp. 226-227. DAS M(05) A673a.

The large scale Experiment III conducted in Ticino (southern slope of the Alps) in 1957-1963 for the suppression of hail was also used to investigate the problem of rain stimulation. Based on a randomization principle, the experiment showed that the number of days on which rain fell was not increased by seeding the clouds with silver iodide (AgI) but that the amount of rainfall on test days with precipitation was augmented. The increase on thundery days with cold fronts was up to 60%, and in thundery barrage situations even amounted to 100%, while on days with local thunderstorms no significant differences were recorded, and on days with changing weather conditions the differences in some cases carry the opposite sign. Statistical evaluation consequently showed that seeding clouds with AgI was in certain cases effective. - MGA 19.3-134.

176. Schmid, Paul. On "Grossversuch III," a randomized hail suppression experiment in Switzerland. Symposium on Mathematical Statistices and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 141-159. DAS 519.9 S989pro 1965/66 v.5.

Reports on a randomized hail suppression experiment, "Grossversuch III," conducted in Switzerland 1957-1963 to study whether it is possible to prevent hail by releasing large amounts of AgI smoke from ground based generators. The first 3 sections of this final report give a brief account of the design, execution, and hail results of the experiment. Rainfall records are summarized and discussed. AgI has sometimes increased rain by large amounts. The hail results are not as conclusive as the rain results. Nevertheless, at least the differences are significant for the number of hail days in the total test area. It is concluded that the seeding operations have been effective in the wrong way. - MGA 19.8-212.

477. Schmieschek, U. Fog dispersal over airport runways by a mechanical method. (Nebelbeseitigung über Landebahnen auf Flugpläten mit Hilfe eines Mechanischen Entnebelungs - Verfahrens.) Royal Aircraft Establishment, England, Library Translation 1257, October 1967.

11 pp. DAS MO9.325 S354 fog.

Following a description of a fog dispersal procedure employing rotary sieves and after a brief résumé of fog dispersal experiments in the laboratory, a mobile plant for dispersing fog on airfield runways is described. Fog dispersal experiments were carried out under natural fog conditions and proved successful in considerably increasing the visibility. - Author's abstract.

1478. Simmons, James N. and Hirsch, John H. Rapid recall of data from field experiments in weather modification. Conference on Severe Local Storms, St. Louis, Mo., 1967. Papers to be presented at Fifth Conference on Severe Local Storms, St. Louis, Mo., October 19-20, 1967. cSt. Louis, 1967. pp. 65-68. DAS M15.4 C748pa.

Describes a rapid data recall system devised to collect field data secured by radar, aircraft, and other sources; reproduce it; and present it as a clear, composite picture following an operational day of weather modification field experiments. Suggestions on equipment and examples of data that could be presented are given. - MGA 19.11-210.

179. Simpson, Joanne. An experimental approach to cumulus clouds and hurricanes. Weather, London, 22(3): 95-114, March 1967. DAS M(05)

R888w 22: 1967. Also issued as Appendix B to Project Stormfury; annual report 1966 by Naval Weather Service and Environmental Science Services Administration, March 1967. DAS M(05) U587pro.

An account is given of an experimental program focused on convective clouds and their role in larger scale circulations. Current work can be divided under three headings. "Before and after" measurements on full scale atmospheric systems where attempts have been made at artificial modification designed to be predictable and controllable. "Stormfury" Cu cloud studies and hurricane seeding come under this heading as are detailed observations upon situations where nature herself is performing a partially controlled experiment, i.e., studies of the alterations of airflow and convective patterns caused by heated islands: and numerical experiments based on solutions of the hydrodynamic equations backed up with observations, including those from aircraft. Descriptions are given of the progress of certain experimental programs under the headings - hurricane studies, Cu studies, prediction of "seedability" and case studies. Results up to the present show that: seeding with Alecto pyrotechnics can enhance the vertical cloud growth under certain specifiable initial and environmental conditions; the present "Stormfury" Cu model predicts heights and buoyancies of seeded and unseeded tropical clouds very well despite an assumption of fallout being a fraction of the condensed water; that strong control is exerted by the environmental temperature and moisture structure upon the vertical growth of tropical Cu clouds; and, since seeding effects on Cu vary with varying conditions, so must seeding effects on precipitation vary. - MGA 18.7-260.

480. Simpson, Joanne. Hurricane modification experiments. (In: American Society for Oceanography. Publication Number 1. Papers. Hurricane Symposium, Houston, Texas, October 10-11, 1966. Edited by Sidney A. Stubbs. pp. 255-292. published 1967. DAS M(055) A5123pu no. 1.

After stating that the scientific reasons for hurricane modification experiments are at least equally as compelling as the practical reasons, the philosophy on which Project Stormfury is based is explained. Evidence is set forth to support the view and the hope that hurricanes may eventually be modified. The significance of various experiments is suggested. Actual modification experiments are now possible and have been carried out on the full scale hurricane and on some parts of its machinery separately. The relation between convective processes and natural variations may well be a key to modeling and, eventually, controlling the tropical hurricane. Hurricane modification experiments are an imperative next step in hurricane research. - MGA 19.9-342.

481. Simpson, Joanne. Photographic and radar study of the Stormfury 5

August 1965 seeded cloud. Journal of Applied Meteorology, Boston, 6

(1): 82-87, February 1967. DAS M(05) J86joa.

In the summer of 1965, a series of tropical cumulus cloud experiments was carried out by Project Stormfury, a joint program of the U. S. Navy and Environmental Science Services Administration. Of twelve clouds seeded with tops colder than —5C, eight grew an average of 10,600 ft following seeding. This is a case study of one of these eight clouds; it was seeded at 25,000 ft (absolute altitude) and grew to about 36,000 ft.

Four instrumented aircraft penetrated the cloud in a stack, at levels from cloud base to about 20,000 ft. A heavily radar equipped "Command" plane controlled the experiment, circling the cloud at a distance of about 25 mi. This paper documents the radar and photographic history of the cloud, mainly as determined from the command aircraft. It is intended to aid in interpretation of the cloud physics measurements provided by the penetrating aircraft, particularly that of the Naval Research Laboratory. N.R.L. aircraft made repeated traverses through the cloud at 18,000 ft (absolute altitude; 17,000 ft pressure altitude) in the temperature range -3 to -5C. It measured temperature, humidity, and hydrometeor structure, once before and several times after seeding. Conversion from largely water to largely ice was observed in a portion of the cloud together with some interesting temperature increases. This study attempts to relate the seeding effects and internal physical changes to the overall dynamic processes as deduced from radar and photography. - Author's abstract.

482. Simpson, Joanne (Starr). Project Stormfury. Oceanology International, Beverly Shores, Indiana, 2(1): 24-26, January _ February 1967. DLC.

Seeding experiments are being conducted by an interagency program called Project Stormfury. The experiments require 10 to 15 specially equipped aircraft to document before and after structure. Field experiments on the full-scale hurricane must be backed and guided by laboratory and theoretical numerical experiments, and by the development of modification techniques and their delivery systems. It is added that the ocean certainly is involved in hurricane history, hence we must use every opportunity to learn more of how the air and sea interact and affect each other. - MGA 18.6-234.

Simpson, Joanne; Brier, Glenn W.; Simpson, R. H. Stormfury cumulus seeding experiment 1965: statistical analysis and main results.

Journal of Atmospheric Sciences, Boston, 24(5): 508-521, September 1967. DAS M(05) A512j.

A randomized seeding experiment was carried out on 23 tropical oceanic cumulus clouds on 9 days in the summer of 1965 as part of the joint Navy-ESSA Project Stormfury. Following instructions in sealed envelopes, an aircraft seeded 14 of the clouds with 8-16 pyrotechnic silver iodide generators called Alecto units. Each unit releases about 1.2 kg of silver-iodide smoke. The nine remaining clouds were studied in an identical manner as controls, using the same stack of four instrumented aircraft to penetrate the cloud before and after the seeding run. Cloud growth was documented by aircraft, radar and photogrammetry. The seeded clouds grew vertically an average of 1.6 km more following the seeding run than did the control clouds; the difference is significant at the 0.01 level.

A numerical model of cumulus dynamics was specified in advance of the field program. This model integrates the equation for the vertical acceleration of an entraining cumulus tower, predicting top heights of unseeded and seeded clouds as a function of ambient sounding and horizontal tower dimension. Seedability is defined as the predicted difference between the seeded and unseeded top of the same cloud. Effect of seeding is defined as the difference between the observed top and the predicted unseeded top of the same cloud. Both parameters are computed and graphed for all 23 clouds. Seeded and unseeded clouds separate into distinct populations. This statistical analysis demonstrates that 1) seeding has a clear effect on cumulus growth under specifiable conditions and 2) the model has considerable skill in predicting the amount of growth and in specifying the conditions.

Sources of subjectivity and bias are shown to be small and not to affect the results. The sensitivity of the model predictions to variations in input data is investigated with two examples, one each of large and of negligible cloud growth following seeding. Some possible effects of natural glaciation are examined with the model and future phases of the program are described. - Authors' abstract.

484. Skywater Conference, 1st, Denver, July 10-12, 1967, Proceedings of Skywater Conference 1 cons Physics and Chemistry of Nucleation.

Denver, Colo., U. S. Bureau of Reclamation, July 1967. 419 pp. On t-p: Water Resources Program. DLC.

Contains a welcoming address by the chief engineer of the Bureau of Reclamation, two panel discussions on problems and direction of nucleation research and the 12 papers and discussions (many longer than the papers) presented at the conference. The preface states that a consensus was reached that effective nucleants now exist, but it is not clear whether silver iodide or other nucleating agents, as they are now produced, are nearly as efficient as they could be. Doubt was expressed as to whether any material now in existence is suitable for a large-scale operational precipitation management program. The need for alternatives to the use of large amounts of silver in an operational precipitation management program was stressed. - MGA 21.4-266.

485. Smith, E. J. and Adderley, E. E. <u>Cloud seeding experiment; annual report cons</u> Tasmania, 1964. Australia. Commonwealth Scientific and Industrial Research Organization. Division of Radiophysics. Sydney, October 1967. 28 pp. DAS MO9.67 A938 1964 Tasmania.

As the first in a series of reports, describes a cloud seeding experiment to determine 1) the amount by which seeding clouds with silver iodide smoke released from an aircraft can increase precipitation in a hydroelectric catchment area; 2) the circumstances under which the increase can be achieved; and 3) the duration of the effects. The experiment is described in detail and an account rendered of the operations conducted, and results obtained, during the period May 13 to Dec. 23, 1964. In this experiment, seeding takes place during alternate years over a total of 10 yrs-1964, 1966, 1968, are "on" years, but precipitation measurements are made in both "on" and "off" years. The method of operations, division of time into periods of 2 weeks each, areas seeded, control areas, and techniques of measurement and assessment are outlined. The general climate of the area is also described, noting year-round rainfall and other pertinent meterological factors. Other major topics discussed include periods of suspension of the experiment (heavy local rainfall, strong winds); definition of suitable clouds; seeding equipment; aircraft employed, including navigation, aircraft and airfields; operational objectives (seeding of every suitable cloud in the target area); and seeding techniques. Other elements considered comprise historical rainfall comparisons; rainfall measurements; snow, airmasses, cloud observations; operations during "off" years; and methods of analysis of results. It was found on the basis of first year operations, that the rainfall figures obtained in the target area were consistent with seeding having increased precipitation. Extensive tabular data are appended. - MOA 21.1-265.

black. Smith, E. J. Cloud seeding experiments in Australia. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 161-176. DAS 519.9 S989pro 1965/66 v. 5.

Experiments in Australia make it appear that cloud seeding with AgI has considerable potential for modifying the rainfall. However, the effects are not simple and early experiments appear to have been confused by effects of seeding which persisted after the seeding stopped, and were sometimes positive and sometimes negative. Experiments of improved design will be necessary to reveal the full possibilities and limitations of the technique. - MGA 19.8-213.

487. Smith, E. J. and Heffernan, K. J. The trajectory of silver iodide smoke. Reply by Paul Willis. Journal of Applied Meteorology, 6(6): 1126, December 1967. DAS M(05) J86joa.

Smith notes that results presented by Langer et al. (see 18.6-175, Met. Abs.) are in agreement with those of a set of measurements made by Smith et al. (1954, 1955, and 1956). It was concluded that in Australian conditions silver iodide (AgI) smoke should be released from aircraft and should not be released from the ground. In reply, Paul Willis agrees that persons who release AgI from the ground would be wise to find out where it goes. Willis concludes that aircraft seeding is necessary under some conditions but is definitely not under other conditions. - MGA 19.4-172.

N88. Sokol, G. P. Nekotorye rezul'taty otsenki effektivnosti aktivnykh vozdejstvij na gradocpasnye oblaka v Gissarskoj doline. (Some results of an evaluation of hail cloud control in the Gissar Valley.)
Meteorologija i Gidrologija, Moscow, No. 1: 36-39, January 1967.

DAS M(05) M589.

The experimental procedure employed to test the effectiveness of modification of hail producing clouds is described with the aid of a map, and data are presented on the frequency of hail phenomena observed at the meteorological network in the Gissar Valley since 1947, on the frequency of hail falls since 1951, on the areas damaged by hail, and on the ratio of damaged areas to total sown area. The results of a comparison of experimental with control areas show that in the former, where hail prevention was carried out, the losses due to hail amounted to 10% of the expected losses. - MGA 18.9-208.

489. Squires, Patrick. Cloud physics — prose or poetry? American Meteorological Society, Bulletin, 48(6): 400-403, June 1967. DAS M(05) A512b.

A keynote talk given at the American Meteorological Society meeting at the University of Michigan, Ann Arbor, 20th March 1967: some thoughts on trends in cloud physics and weather modification studies. - Author's abstract.

Stalevich, D. D. and Uchevatkina, T. S. Ob optimal nykh raskhodakh l'doobrazuiushchikh reagentov pri vozdeistvii na oblaka s tsel'iu vyzyvaniia iz nikh osadkov. (Optimum doasage of ice forming agents used in cloud seeding to produce precipitation.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 202: 13-21, 1967. Russian summary p. 13. DAS M(055) U581tg.

An analysis was made of the growth of particles of ice forming agents introduced into clouds to induce precipitation. Turbulent diffusion of these particles inside the cloud and also their successive washout from the cloud by precipitations were considered. Relationships were determined between the amount of precipitation and the temperature during seeding and the amount of the introduced ice forming agent. On the basis of these relationships optimum dosages of different ice forming agents and the ranges of the precipitation zones were calculated. - MGA 20.2-178.

491. Stinson, J. Robert. Project Skywater: The Bureau of Reclamation!'s Atmospheric Water Resources Program. Western Snow Conference, 35th Annual Meeting, Boise, Idaho, April 18-20, 1967. Proceedings. Issued 1967. pp. 85-93. DAS M(06) W527p 35: 1967.

A report on practical application of weather modification techniques for improving water supply of the U. S. Operational research program, increased 40 times since 1961, is divided into 3 categories: 1) field experiments, 2) field support and 3) laboratory studies. Descriptions of each of the projects and some of the important results are presented. Field experiments involve investigations of orographic and convective clouds during winter and summer in 6 major river basins of the West. Field support of various types is provided by 2 Government agencies. Problems being studied in the laboratory, include instrumentation, cloud physics and evaluation techniques, many in conjunction with field experiments. - MGA 19.8-196.

492. Strauch, Edward. Warunki meteorologiczne razpraszania mgie/ w Polsce.

(Meteorological conditions of the artificial fog dissipation in Poland.) Poland. Państwowy Instytut Hydrologiczno - Meteorologiczny, Prace, No. 92: 17-23, 1967. Polish summary p. 17; Russian and English summaries p. 23. DAS M(055) P762p no. 92.

The author presents a detailed analysis of the meteorological conditions with respect to artificial fog dissipation in Poland. The following characteristics of fog formation in Poland

were computed: the number of hours with fog in each month, the number of hours with supercooled and warm fog, the characteristics of fog temperature, the monthly mean number of fog, and the duration of supercooled and warm fog. The above characteristics were computed on the basis of observational data for years 1955-1959 published in the meteorological yearbooks of the National Inst. for Hydrol. and Met. Expected results of artificial dissipation of supercooled fog were considered. - MGA 20.4-218.

193. Strodtbeck, Fred L. Weather modification as an uncertain innovation.

(In: Garnsey, Morris E. and Hibbs, James R. (eds.), Social Sciences and the Environment. Conference on the Present and Potential Contribution of the Social Sciences to Research and Policy Formulation in the Quality of the Physical Environment, University of Colorado, 1967. pp. 103-124) DAS 300 C748cc.

The author sets forth the details and conclusions of the Hailswath Project that was a man-environment experiment in the small community of Hermosa, S. Dakota. In the Great Plains area of the U. S., man is unusually conscious of the weather and his relation to land and its reference to water. Weather modification projects and experiments proved unacceptable to the ranchers. The study concludes with varied reactions of the community to the scientist's approach to the human behavioral sciences as they are related to the sophisticated atmospheric sciences. appended discussions by John W. Bennett and Dwight Kline focus on the emphasis of the behavioral findings in which they caution the author and his associates to be careful in considering the ecological contexts of attitudes in their findings as well as the culture context. The subject of public response to the problems of weather modification that was undertaken appeared more complex than anticipated. The social scientist and the physical scientist have to span a great gap in communication if experiments such as the Hailswath Project can find full meaning. - MGA 20.10-133.

194. Sulakvelidze, G. K. Bor'ba s gradobitiiami. (Hail control.) (In: Fedorov, E. K. (ed.), Meteorologiia i Gidrologiia za 50 let Sovetskoi Vlasti: sbornik statei, Leningrad, Gidrometeoizdat, 1967. pp. 227-242. DAS M79 294met.

Reviews the theoretical and practical aspects of hail prevention in the U.S.S.R. and discusses the following: investigations of the mechanism of hail processes; the principles and methods of their modification; the protection of small areas against hail fall; the protection of large areas; and evaluation of the effectiveness of modification. Equations associated with the theoretical aspects of hail formation and hailstone growth are presented, and the effectiveness of anti-hail measures is calculated. - MGA 20.4-222.

Loss. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966. Proceedings, Vol. 5. Weather modification. Edited by Lucien M. Le Cam and Jerzy Neyman. Held with the support of University of California, National Science Foundation, National Institutes of Health, Air Force Office of Scientific Research, Army Research Office and Office of Naval Research. Berkeley, University of California Press, 1967. 451 pp. (All articles on weather modification abstracted separately.) DAS 519.9 S989pro 1965/66 v.5.

The papers in Vol. 5 of the Proceedings are grouped in sections on physical background, large randomized experiments, relevant climatological studies, nonrandomized operations, methodological discussions, and observational data. In the preface, Le Cam, Neyman, and Scott suggest that the inspiration of fresh statistical research, and also an advance in the understanding of the complex reactions of the weather to external stimuli, depend on ready availability of observational data which could serve for verification of various tentative hypotheses that may be formulated. Thus, an effort was made to assemble a substantial collection of experimental results on rainfall and on some collateral factors. This collection is appended to this volume. - MGA 19.7-12.

196. U. S. Environmental Science Services Administration. Weather and the hand of man. Washington, D. C., U. S. Government Printing Office, April 1967. 15 pp. DAS M09.6 U5885we.

Problems basic to successful modification of the weather are reviewed in nontechnical terms; the role of the Environmental Science Services Administration (ESSA) in the acquisition of a fuller understanding of atmospheric processes and their ultimate modification is emphasized. Major topics discussed include 1) past efforts in weather modification; 2) the new promise of advances in science and technology during the past decade; 3) the rationale of the ESSA approach—its capabilities and responsibilities within the federal structure; 4) precipitation modification, its possibilities and consequences; 5) hurricanes, tornadoes and severe local storms; 6) hail and its prevention; 7) lightning and its centrol; 8) fog dissipation and low cloud problems; 9) effects of pollution on the weather; and 10) the future of weather modification and related scientific, technical, legal, social, and economic problems. - MGA 21.4-34.

497. U. S. National Science Foundation. Weather modification. 8th Annual Report for fiscal year ended June 30, 1966. Its NSF 67-9, June 1967. 132 pp. DAS MO9.67 U585we.

The contents of this report comprise the following: a summary of the report of the Panel on Weather and Climate Modification of the National Academy of Sciences (1966), a summary of the report of the NSF Special Commission on Weather Modification, U. S. Senate hearings and bills including the bills introduced by Senators Magnuson and Anderson, the Project Hailswarth for hail

suppression, the Project Stormfury and the Line Islands Experiment; Weather Modification Program of the NSF including the study of the prolonged drought in the Northeastern U. S., hail suppression cloud electrification, socio-economic studies on the impact of weather and climatic modification, and cloud seeding activity reports; federal government weather modification activities by the Dept. of Agr. (lightning suppression, weather modification research planning), by the Dept. of Commerce (Project Stormfury evaluation of commercial seeding), by the U. S. Air Force (cold fog and stratus modifications, warm fog modification, cumulus cloud physics and dynamics), by the U. S. Army (atmospheric electricity, dissipation of cold fog), by the U. S. Navy (Project ACF-weather modification and control), by the Dept. of the Interior (Colorado River activity, the Univ. of Wyoming activity, interior basin program, Pacific Northwest program, etc.), and by the Federal Aviation Administration; NSF grants and contracts for weather modification research for fiscal year 1966; and appendices containing descriptions of the advisory panels committees and commissions, on excerpts from Weather and Climate Modification report of the NSF Special Commission on Weather Modification, and an excerpt from Weather and Climate Modification -Problems and Prospects - report of the National Academy of Sciences panel on Weather and Climate Modification; and NSF regulations for reporting weather modification activities. - MGA 18.12-49.

No. S. Panel on the World Food Supply. The world food problem; a report of President's Science Advisory Committee. Vol 1-2.

Washington, D.C., U. S. Government Printing Office, May 1967. 127 + 772 pp. "Vol. 1 is a general description of the problem and study recommendations of the Panel and summaries of subpanel reports. Vol. 2 is a compilation of the subpanel reports of the study."

Two chapters of most interest in Vol. 2 are: Water and land, pp. 405-469 and Tropical scils and climates, pp. 471-500. DAS 338.19 U58wo.

The summary of the report of the subpanel on water and land includes the following salient points. The area of potentially arable land on the Earth is -3 times the area actually harvested in any given year; more than half of it is in the tropics, with 34% in semiarid or arid tropics; the largest areas are in Africa and South America. The present technology for agricultural production is inadequate for the humid and subhumid tropics. Water management and use of water in combination with other inputs in the arid and semiarid regions should also be The needs for hydrologic and engineering given high priority. data and for highly-trained specialists who can analyze and plan such projects are most pressing. The panel on tropical soils and climates deliberately excluded regions subject to frost or regions which have a mean monthly temperature of 2 55°F; its classification of tropical climates was based on amount and seasonal distribution of rainfall. The principal points brought out in the summary of this report are: Deficiency of knowledge of

tropical soils and of practical soil and crop management systems needed for sustained high yields and deficiency of technological and economic inputs now available in temperate regions are 2 major deficiencies which must be overcome to realize the vast unused potential for food production in the tropics. Tropical soils range from highly-leached to alkalisaturated; from rich volcanic soils of Java through alluvial soils of the Nile delta to impoverished soils of the Ancient uplands. - MGA 20.1-7.

499. Voronov, G. S.; Gaivoronskii, I. I.; Leskov, B. N.; Seregin, Iu. A.

Opyt protivogradovoi zashchity v Moldavskoi S.S.R. (Report on hail
preventive measures in the Moldavian S.S.R.) Meteorologiia i
Gidrologiia, Moscow No. 7: 29-36, July 1967. DAS M(05) M589.

Translation into English by A. Nurklik in Canada, Meteorological
Branch, Meteorological Translations no. 15: 16-25, 1968. DAS
M(055) C212me.

A report of a series of trials of hail prevention methods carried out in the Moldavian S.S.R. during 1964-1966. The normal observing network was supplemented by the setting up of a number of new voluntary observing posts, where reports of hail, cloud movement, precipitation, and other weather parameters were kept. Tracking of hail centers and the assessment of hail damage was carried out by helicopters. Radar was also used to track hail centers. A combined index incorporating observed radar parameters and temperature values was used to ascertain the hail risk of particular clouds. Hail prevention was attempted in chosen clouds by firing rockets which released lead iodide. area was a circular region of some 100,000 acres centered on Korneshty. Two control areas were used for comparison purposes, one was a similar circular area some distance away, while the other encompassed the trial area and was delimited by administrative boundaries. Tabulations of the frequencies of damaging hail in the test and control areas suggest a high degree of success. In fact, a reduction of the frequency of damaging hail to ~10 of its previous value is claimed. - MGA 20.5-198.

500. Washicek, Jack N. and McAndrew, Donald W. Snow measurement accuracy in high density snow course network in Colorado. Western Snow Conference, 35th Annual Meeting, Boise, Idaho, April 18-20, 1967, Proceedings. Issued 1967. pp. 43-49. DAS M(06) W527p 35: 1967.

A progress report on the Park Range Atmospheric Water Resources Program of the North Central Rocky Mts., Colo. This project was initiated by the U. S. Bureau of Reclamation to determine if the natural precipitation in the form of snow or rain could be increased in significant amounts by weather modification processes to evaluate the benefits derived economically. Location of snow survey courses, pressure pillows, soil moisture and rain gages are shown on a location map. Discussion of procedures, schedules of measurements and results obtained during 1964-66 are included, with tables showing data collected. Some analysis of data

are included. Automatic recording pressure pillows are used in collecting data on water content of the snow pack. - MGA 19.8-198.

501. Wells, J. M. and Wells, M. A. Note on Project SCUD. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M.Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 357-369. DAS 519.9 S989pro 1965/66 v.5.

Project SCUD originated at New York Univ. in May 1952 as an attempt to discover quantitative effects of cloud seeding on cyclones developing in the east coastal region of the U.S. The experiment was designed to test the hypothesis that cloud seeding in areas of cyclogenesis has no measurable effect on the development of storms there. The idea was that seeding during an early stage of a cyclone would be more effective than using the later stages. Although 2 variables were observed: precipitation and pressure change, this account is concerned only with precipitation. Seeding was done with AgI released from 17 ground based generators and with dry ice dispensed from aircraft. Observational data are given and evaluated. - MGA 19.8-215.

502. Whittaker, R. H. Ecological implications of weather modification. Symposium on Ground Level Climatology, Berkeley, California, 1965, Ground Level Climatology, Robert H. Shaw (ed.) (American Association for the Advancement of Science, Publication no. 86, 1967. pp. 367-384) DAS M84.4 S989gr.

The logic of an ecologist's reservations regarding weather modification must be considered in relation to phenomena on 2 levels: that of particular natural communities which may be affected by weather modification and that of man's own ecology, or relation to his environment. It is concluded that the effects of weather modification on natural communities may be detrimental. Because of the relation of weather modification to complex atmospheric and ecological processes, the longer range effects on man's own environment are to some extent unpredicatable and may be disadvantageous. Research on effects of weather modification is needed, but ecological considerations suggest a policy of caution and restraint. - MGA 19.7-198.

Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 395-397. DAS 519.9 S989pro 1965/66 v. 5.

Suggests that when given concomitant observations on various physical and meteorological phenomena, the results can be examined to see whether, singly or jointly, they influence the results. Short term and long term effects should be separately

examined. It is noted that once standard errors are given it is possible to combine estimates from different experiments, or from different parts of the same experiments, in whatever way appears appropriate, without reference back to the original data. Methods of estimation are also discussed. Once the variance law has been established, a suitable transformation can be used. The use of a transformation implies that the data conform, at least approximately, to the associated variance law. An alternative approach is to work with ratios directly. - MGA 19.7-216.

Yevdjevich, Vujica M. Evaluation of weather modification as expressed in streamflow response. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 283-292. DAS 519.9 S989pro 1965/66 v.5.

Discusses evaluation of various aspects and results of weather modification as expressed in stream flow response. Consideration is given to the selection of variables and of their parameters for weather modification evaluation and to the maximization of river flow response. Some current methods of evaluating weather modification attainments are discussed. A comparison is then made of precipitation and runoff phenomena used for evaluation. - MGA 19.7-199.

23. bis 31, Mai 1967 in Washington.) (International Conference, Water for Freedom May 23-31, 1967, Washington.) Die Wasserwirtschaft, Stuttgart, 57(11): 403-404, November 1967. DLC.

Account of the aims, proceedings and activities of the Conference. The subjects considered were the following: 1) technique of water supply, 2) basis for water management, 3) organization problems, 4) education and training, 5) planning and execution, and 6) finance problems. The papers dealt with water desalination, weather modification, reuse of water, evaporation, water management over entire precipitation regions, ground water, water conveyance, prediction of water amounts, possibilities for conserving the water resources, water quality, purity problems, international and national authorities, water associations, water legislation, international programs of water, etc. The preparation of the German section of the Conference is described and the German contributions are listed. - MGA 19.9-812.

506. Zikeev, Nikolay T. and Doumani, George A. Weather modification in the Soviet Union, 1946-1966: a selected annotated bibliography.

Washington, D. C. Science and Technology Division, Reference Department, Library of Congress, 1967. 78 pp. DAS M(016) U584we.

This bibliography lists 503 items that have appeared in Russian publications during the period 1946-66. Each entry is accompanied by a very brief descriptive annotation. The following topics are

covered: physics of clouds and fog-theoretical and experimental research; seeding of clouds and fog; atmospheric electricityeffect on modification; hail suppression; radar applications; reagents-dispersion properties, equipment and methods; and climate modification. The introduction gives a brief historical account of the development of weather modification studies in the U.S.S.R. since 1919 and a list of reports on weather modification activity since 1951. Tables listing field experiments of the Inst. of Experimental Meteorology, Leningrad, experiments with dry ice and experiments on the use of silver iodide for seeding supercooled fog and clouds are presented. Each table lists the investigator, subject, method and the results. Appendices contain lists of Russian scientific serials containing material on weather modification, names of Soviet specialists active in research on weather modification, and addresses of Soviet institutions active in weather and climate modification. - MGA 19.3-29.

A collection of observational data. Symposium on Mathematical Statistics and Probability, 5th, Berkeley, California, June 21 - July 18, 1965 and December 27, 1965 - January 7, 1966, Proceedings, Vol. 5 (Weather modification). Edited by Lucien M. Le Cam and Jerzy Neyman. Berkeley, University of California Press, 1967. pp. 399-451. DAS 519.9 S989pro 1965/66 v.5.

Presents a collection of raw data from 5 major rain stimulation experiments conducted in 5 different countries. In all cases, rainfall data are accompanied by some collateral observations. Also gives information as to other data that is available and accessible. The experiments are from U. S. (Arizona), Australia, France, Israeli and the Swiss Hail Prevention Experiment ("Grossversuch III" 1957-1963). - MGA 19.7-202.

508. Project Stormfury; annual report, 1966. By Naval Weather Service and Environmental Sciences Services Administration. Sections separately paged. March 1967. DAS M(05) U587pro 1966.

Consists of the report proper, a map showing the Stormfury Hurricane Experimental Area. Recommendations of Advisory Panel, a paper entitled Experimental approach to cumulus clouds and hurricanes by Joanne Simpson, and a statistical evaluation of the 1965 experiments by G. W. Brier. It is reported that forces were assembled at the Roosevelt Roads Naval Base staging area for very successful dry runs and also on the occasion of hurricane "Faith." However, neither the eyewall nor a rainband of "Faith" seeding (specified as first and second priorities for 1966) were carried out because the storm never entered the prescribed seeding area. Monitoring of the unseeded storm by the assembled aircraft resulted in the recording of valuable data on the hurricane mechanism and structure. Research activities using 1965 Cu experiment data continued throughout the year. Results of this work are reported in the appended papers. The statistical evaluation (Appendix C) shows that a physical cloud model developed by the ESSA Experimental Meteorclogy Branch predicted growth which correlated highly (0.973) with observed and measured growths of seeded tropical Cu clouds. The conclusion of Simpson's paper are: 1) Seeding with Alecto pyrotechnics has been shown to cause enhanced vertical cloud growth under certain conditions.2) The Stormfury Cu model predicts heights and buoyancies of seeded and unseeded tropical clouds very well. 3) Conclusion 2 implies a strong control exerted by the environment temperature and moisture structure upon the vertical growth of tropical Cu when natural or seeded. 4) Seeding may have different effects upon precipitation. - MGA 19.4-169.

509. Project Stormfury 1967. American Meteorological Society, Bulletin, 148(9): 663; 689, September 1967. DAS M(05) A512b 48: 1967.

Brief note on Project Stormfury 1967. The 1967 experiments give first priority to multiple seeding of the eyewall clouds over an 8-hr period in an appropriate hurricane. Another experiment calls for seeding spiral rainbands to determine whether their modification will cause a measurable change in the storm's mechanism. Specially instrumented aircraft of the Navy, ESSA and Air Force will monitor the area for about 17 hrs; from 3 hrs before the first seeding until 6 hrs after the final one, in order to record changes in storm characteristics. - MGA 19.3-132.

1968

510. Adderley, E. E. Cloud-seeding in Western Victoria in 1966. Australian Meteorological Magazine, Melbourne, 16(2): 56-63, June 1968. DAS M(05) M938.

In August, September and October 1966 the Victorian Department of Agriculture carried out a cloud-seeding operation in Western Victoria. G. O'Mahony of the Central Office, Bureau of Meteorology made an assessment of the operation and concluded: "There is no evidence in the present case which points to the rainfall having been affected in any way by the silver iodide". The results of the original assessment and a closer examination of O'Mahony's assessment show that this conclusion is invalid. - Author's abstract.

511. Adderley, E. E. Rainfall increases down-wind from cloud seeding projects in Australia. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 42-46. DAS MO9.6 N277pr 1968.

An examination of the rainfall downwind from 2 areas in Australia over which cloud seeding operations were carried out in 1966 and 1967. Three figures show that increases downwind of the target area have occurred for distances to 200 mi. It seems that increases from artificial stimulation of precipitation extends considerably farther downwind than the area at which the operation

is aimed and in the Australian experience, at least, there is no suggestion of decreases downwind. The downwind increases may be due to a continuing effect of silver iodide in spite of its measured photolytic decay in clear air, but it is also likely that they are due to a dynamic interaction between the environment and the seeded clouds, about which little is actually known. - MGA 19.11-226.

512. American Meteorological Society. AMS statement on weather modification. Weatherwise, Boston, 21(3): 100-101; 113, June 1968. DAS M(05) W362.

Defines efforts directed toward weather and climate modification as a means of achieving great potential good for all peoples through the deliberate production of beneficial changes, but notes that man's present capabilities in this field are still very limited. A greatly expanded research effort to enhance our present fund of meteorological knowledge, conducted over an extended period, may be expected, however, to lead to attainment of these goals. Although the methods by which climate may be modified over wide regions of the Earth are still speculative, there have been significant but perhaps partly inconclusive results in local attempts to modify precipitation. Primarily through techniques of cloud seeding, the 1966 findings by the National Academy of Sciences on silver-iodide seeding of winter orographic storms, and in other seasons and areas, are cited, but it is noted that many crucial problems requiring intensive field and laboratory study for further progress remain unresolved. Problems of hail and lightning suppression, dissipation of "ccld" and "warm" fog, modification of hurricanes and other large storms, and computer modeling of atmospheric systems will require a continued and intensive research effort to achieve success. International cooperation is stated to be a natural essential to large scale weather and climate experimentation. In view of our current lack of an adequate understanding of the legal consequences of weather modification, the AMS cautions against detailed legislation which might inhibit rather than further the proper development of this science for the benefit of mankind. - MGA 20.4-203.

American Meteorological Society. Statement on weather and climate modification, October 27, 1967. Its Bulletin, 19(3): 272-273, March 1968. DAS M(05) A512b.

Following a statement on the objectives of weather and climate modification, it is indicated that large scale experiments aimed at weather and climate modification will, of their nature, be international in character and will, therefore, require international consultation and cooperation. The legal consequences of weather modification can be foreseen in part, but, until greater understanding is gained through research, no definite statement can be made on this important aspect of the problem. The American Meteorological Society cautions against detailed

legislation which might inhibit instead of encourage the proper development of weather modification to the benefit of all people. - MGA 19.9-214.

Ammons, R. L. and Benjamin, R. B. Rocketborne dispersion system for support of weather modification techniques. National Conference on Weather modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 522-531. DAS MO9.6 N277pr 1968.

Reports a study to consider use of a rocket delivery system to enable the use of newly developed methods in the pyrotechnic production of AgI smoke. Consideration is given to the preliminary design concepts and the basic equations of motion; a vehicle performance summary is presented. It is concluded that the use of near-vertically fired projectiles for weather modification applications is definitely within the state of the art. It is recommended that both the single-stage rocket and rocket-boosted projectile concepts be pursued further and that detailed performance, dynamics, cost, and safety studies be conducted to arrive at a final vehicle configuration. - MGA 19.11-227.

515. Antonov, V. S. Nekotorye voprosy iskusstvennogo vozdelstviia na pereokhlazhdennye sloistoobraznye obalaka. (Some questions of artificial action on supercooled layer clouds.) Akademiia Nauk SSSR, Izvestiia. Fizika Atmosfery i Okeana, 4(2): 236-240, February 1968. DAS P. Translated into English in corresponding issue of Academy of Sciences, USSR, Izvestiya. Atmospheric and Oceanic Physics. DAS P.

Author examines, with the aid of the relevant formulas, the calculation of the time of formation of the zone of action of artificial modification of a St cloud, the width of the seeding zone of a cloud as a function of time and mean wind speed, the time of maximum expansion of the crystallization zone, and the influence of the dosage of the cold reagent introduced into a cloud on the crystallization process in a cloud. The time of formation of the zone of the effect is shown to depend substantially on the mean wind speed in the layer of seeded clouds, upon the stratification of the atmosphere, and upon the distance between adjacent seeding areas. The effect of the productivity of the source and of the frontal concentration is insignificant. For the same experimental conditions the maximum widening of the seeding zone is directly proportional to the dosage. - MGA 20.5-187.

Appleman, Herbert S. The Air Weather Service weather-modification program. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston 1968.

Describes the Air Weather Serv. (AWS) weather modification program including information on its projects: Cold Fog I, II and III; Cold Cowl; Cold Wand; Cold Horn; Cold Fan; and Warm Fog. The AWS weather modification program is designed to make operational, and then implement, those techniques within the scientific state-of-the art which are potentially applicable to the AWS mission. - MGA 19.11-211.

517. Appleman, Herbert S. First report on the Air Weather Service weathermodification program, April 1968. U. S. Air Weather Service, Technical Report 203, May 1968. 14 pp. DAS M(055) U58a no. 203.

The Air Weather Serv. has recently inaugurated a program to field test those weather modification techniques within the scientific state-of-the-art and of potential value to the Air Force in order to bring them to a state of operational readiness. A group of cloud physicists at Hqtr. Air Weather Serv. designs the field tests, then assigns them for implementation to appropriate sites selected from its worldwide network of weather stations. Initial efforts are concentrated primarily on developing an economical and reliable capability to disperse supercooled fog over runways, both because of its importance as an Air Force problem and because of previously demonstrated feasibility. - MGA 20.5-181.

518. Appleman, Herbert S. The operational dissipation of supercooled fog:

Project Cold Cowl 1967-1968. U. S. Air Weather Service, Technical
Report 205, April 1968. 10 pp. DAS M(055) U58a no. 205.

This paper is a report of the first operational weather modification program carried out by the Air Weather Service at Elmendorf Air Force Base, near Anchorage, Alaska. A weather reconnaissance aircraft was used to seed supercooled fog with dry ice. A prescribed flight path was flown a specified distance upwind from the target and crushed dry ice was disseminated at rates of 12.5 or 25 lbs/mi. It was found that a clearing generally occurred in 30 to 45 min. The only real failure occurred in a case that may have been an ice fog; in addition, proper positioning of the hole proved a major problem throughout the program. An estimated 200 successful takeoffs and landings were made with the aid of artificially produced clearings. In addition, airborne liquid CO2 dispensers and AgI flares were tested in fog dispersal. The procedure is described. It appears that both substances offer promise of success provided the aircraft can be flown through the fog. - MGA 19.11-221.

519. Atkinson, Bruce W. The weather business: observation, analysis, forecasting, and modification. London, Aldus Books, 1968. 192pp.

(Aldus Science and Technology Series) DAS M A875we.

This beautifully illustrated up-to-date book is a lucid narrative on observations, analysis, forecasting, and modification of the world's weather. Special emphasis is placed on numerical forecasting, and weather modification. The last chapter on prospect contains an illustrated description of the World Weather Watch and a discussion of GARP and of the U.S.-N.Z. GHOST project. The book discusses and illustrates the latest development including the lidar, automated analysis, use of rockets and satellites. The theory and practice of numerical prediction, and the statistical physical and synoptic methods of long-range forecasting. The illustrated instruments employed in surface observations are those used in the U.K. - MGA 21.6-127.

520. Auer, August H., Jr.; Veal, Donald L; Marwitz, John D. <u>Plume tracking studies associated with orographic and convective situations</u>.

National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 404-413.

DAS MO9.6 N277pr 1968.

Presents results of the 1st year's plume detection studies carried on at the Elk Mountain research facility of the Univ. of Wyo. Studies relating to the detection of seeding material during summertime convective situations in western South Dakota are also described. Experimental data are presented in tabulated form and implications are set forth. It seems entirely possible that many convective cloud systems are indeed not really seeded by means of ground generators; the top of the layer of air which contains the seeding nuclei is rarely tapped by the updraft core of the cloud system. - MGA 19.11-228.

521. Australia. Commonwealth Scientific and Industrial Research Organization. Radiophysics Laboratory. The Radiophysics Laboratory, C.S.I.R.O., 1965-1968. £1968. 28pp. DAS 523.016 A938ra.

On pages 25-27 rainmaking in Australia is described. The earlier trials of cloud-seeding methods were carried out on isolated clouds. Results obtained from many of these experiments showed an increase in rainfall. Conclusion from large-scale experiments indicate seeding with silver iodide can increase precipitation in certain areas. Down-wind effects of seeding are discussed. - MGA 20.11-520.

Bakhanova, R. A.; Solianek, E. G.; Terziev, F. S. Rezul'taty opytov po bor'be s tumanami ispareniia v Kol'skom zalive zimoi 1966-1967g. (Results of experiments on struggle against evaporation fog in the Kola Bay in winter of 1966-1967.) Meteorologiia i Gidrologiia, Moscow, No. 10: 39-43, October 1968. Russian summary p. 39; English summary p. 43. DAS M(05) M589.

The authors report on experiments made (since 1964) in the laboratory and in the field, on the possibility of dispersing evaporation fog over the waters of Kola Bay by using films of surface active agents. It is a practical proposition to clear evaporation fog over areas in the order of 3 km² producing visibilities in the order of 10-12 km, where the visibility in fog had been from 100-200 m. In the experiments, fatty alcohols were used as a 3% solution in kerosine. Conditions for successful clearance were that the temperature of the solution when applied should be above 0°C, the solution should be applied in a dispersed form (i.e., as a spray jet), the winds should be light (winds in excess of 8-12 m/sec dispersed the film too quickly), and the surface of the water should be free of ice. The drift of the film is controlled mainly by current. There is an urgent need for the study of currents in the bay. To disperse fog over a large area, several tons of the reagent would be required. There is a need for studies to find an optimum reagent. - MGA 20.8-22/.

523. Battan, Louis J. Some problems in changing the weather. Weatherwise, Boston, 21(3): 102-105; 120, June 1968. DAS M(05) W362.

Reviews the major problem areas in weather modification, with emphasis on cloud seeding techniques by means of dry ice, silver iodide (AgI), and lead iodide (PbI). It is conceded that such seeding does dissipate "supercooled" clouds and fogs, but that the degree of effectiveness of such techniques in increasing or redistributing precipitation has not yet been established. Efforts to suppress hail are discussed. The Soviet techniques in the Caucasus are cited. Claims of successful efforts to suppress lightning by very heavy cloud seeding with AgI are said to be premature, while cloud seeding in severe storms has led to inconclusive results due to lack of knowledge of the natural mechanisms of such atmospheric systems. - MGA 20.4-204.

Baum, Werner A. Congressional action on weather modification. American Meteorological Society, Bulletin, 49(3): 234-237, March 1968.

"Paper presented at the AAAS Symposium on Weather Modification, New York, December 30, 1967." DAS M(05) A512b 49: 1968.

A consideration of congressional action on weather modification includes a discussion on why legislation such as House Bill 9212 should be enacted. It is referred to as the Weather Modification Act of 1967 and consists of 4 titles: Declaration of policy and definitions, Federal coordination and planning, Weather modification, and General. The HB 9212 now pending takes a much broader view of weather modification responsibilities within the Federal government than did previous bills, and assigns functions to 5 departments and the NSF. One very important advantage of this legislation would be to bring about the consideration of weather modification as a topic, rather than as a development of separate plans operated by separate agencies. Greater progress per dollar will almost certainly result from such a topical approach. - MGA 19.9-245.

Baum, Werner A. ESSA program in weather modification. (In: Taubenfeld, Howard J. (ed.), Weather Modification and the law. Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 22-30.) DLC.

ESSA aims at the broad spectrum of weather modification possibilities having the most general responsibility in the field of meteorology. The ESSA Program is closely coordinated through ICAS with the programs of other federal agencies concerned. Primary responsibility for work in weather modification currently lies in the ESSA Res. Labs. The major problem areas within ESSA's scope are: modification of precipitation techniques; moderation of tropical disturbances and hurricanes; modification of severe local sterms (thunderstorms, tornadoes); mitigation of hail and lightning: modification of climate; and exploration of socio-economic, legal, and ecological aspects of weather modification. Active field projects include development of techniques to modify severe snowstorms along southern shores of lakes Erie and Ontario, study of tropical storms in the continuing program of Project Stormfury (U. S. Navy-ESSA), based on seeding of supercooled clouds near edge of storms, and exploration and analysis of these storms. Moderation of hail damage and lightning remain significant objectives, also, investigation of tornadic storms. A National Hail Modification Res. Plan (NHMRP) is under preparation as a multiagency program. Together with the U. S. Army, ESSA is experimenting with "chaff" -metalized nylon needles-to "short circuit" lightning. Studies of inadvertent climate modification include micromeasurements of "clean" air at Mauna Loa Obs. to establish a "bench mark," and the development of complex numerical models of the atmosphere. Other general problems resulting from experimentation in, or actual modification of climate are also being investigated. - MGA 20.4-205.

526. Beckwith, W. Boynton. An analysis of airport fog dispersal operations.

National Conference on Weather Modification, 1st, Albany, New York,
April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 361-371.

DAS MO9.6 N277pr 1968.

Reports 2 new field projects important in the development of measures to combat airport fog—both warm and cold. The dry ice method and liquid propane method are described and the economics of warm fog dispersal is discussed. Preliminary results are noted. - MGA 19.11-222.

527. Berry, Edwin X. Modification of the warm rain process. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 81-88. DAS MO9.6 N277pr 1968.

In a cloud which has a limited lifetime governed by the mesoscale circulation, the initial rate of droplet growth may make the difference between rain and no rain. It is concluded that computer simulation of the initial phases of droplet growth by collection can be summarized in a simple formula containing the

important parameters of the condensation produced spectrum. This leads to a new equation to express autoconversion rate. - MCA 19.11-118.

528. Betts, Sherman W. Weather modification in the USA. New Scientist, London, 37(578): 20-23, January 1, 1968. DAS P.

The U. S. Government is considering spending about \$1/4 million this fiscal year on weather modification projects. The proposed program has been outlined recently in Report No. 11 of the Interdepartmental Committee for Atmospheric Sciences. The program is outlined in this article together with some introductory comment. Researchers in methods of increasing precipitation have been claiming some degree of success; strong claims were being put forward for larger scale studies. In 2 recent reports, one by a committee of the National Academy of Sciences and the other by a commission set up by the National Science Foundation, the possibilities of successful modification of certain weather factors were recognized and increased research programs were recommended. The areas in which both the reports recognized the need for further work are listed. The suggested appropriations for the various fields of study are listed. Brief notes are given on the main program being supported under each of the headings: precipitation modification, hail suppression, inadvertent modification, hurricane modification, lightning modification, cold fog dissipation, warm fog dissipation and severe storm modification. - MGA 19.5-157.

529. Bowen, E. G. Review of current Australian cloud-seeding activities.
National Conference on Weather Modification, 1st, Albany,
New York, April 28 - May 1, 1968, Proceedings. Boston, 1968.

pp. 1-7. DAS MO9.6 N277pr 1968.

A review on current Australian cloud seeding activities with respect to the effects of persistence in cloud seeding experiments and the practical operations in progress. When rain falls over a comparatively large tract of continental interior, 2 phenomena can occur: namely, an increase in water vapor flux and a decrease in condensation nucleus count (both of which are conducive to more rain); however, the heat flux could either increase or decrease, dependent on the amount of cloud cover. - MGA 20.1-168.

Braham, Roscoe R., Jr. One finger on the throttle of nature's weather machine. Weatherwise, Boston, 21(3): 106-109, June 1968.

DAS M(05) W362.

Discusses problems inherent in gaining influence over precipitation development and suggests that present day knowledge is too fragmentary to permit effective operation of the weather control "throttle," involving deliberate adjustments of energy input into the atmospheric weather machine. The rationale and operations of cloud seeding are analyzed; several hitherto unresolved problems of artificial production of precipitation

from convective clouds are listed. Results of "Project Whitetop" (between 1960 and 1964) are discussed, with the conclusion that seeding of summer clouds in Missouri actually decreased the anticipated rainfall. Other observations with respect to downwind conditions are noted. The reaction of the seeded clouds is believed to have depended largely on regional and unexpected meteorological factors. A flow diagram of precipitation processes is provided. - MGA 20.1-206.

Bromberg, A. V.; Bychkov, N. V.; Voronov, G. S.; Gaivoronskii, I. I.; Gromova, T. N.; Nikandrov, V. Ia.; Seregin, Iu. A.; Iartseva, N. N. O vozmozhnosti primeneniia sernistoi medi v raketakh dlia vyzyvaniia osadkov. (Possibility of using cuprous sulfide in rockets to produce precipitation.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Trudy, No. 224: 135-149, 1968. Russian summary p. 210. DAS M(055) U581tg no. 224.

Copper sulfide was tested in search for other substances that induce precipitation. It is easily available, the manufacturing technology is simple, the substance is nontoxic, etc. Laboratory experiments indicated that the threshold temperature of ice-producing activity of CuS is —3°. After introducing the powder into a supercooled large-droplet fog in the experimental chamber, the number of produced ice crystals per gram of reagent was 2.10 ¹¹ at —10°, 1.5.10 ¹¹ at —8°, and 3.10 ¹⁰ at —5°. Field experiments also confirmed the valuable ice-producing properties of CuS. The efficiency of seeding convection clouds with CuS was assessed by hail-prevention rockets. The results of field experiments are evaluated in detail. - MGA 20.9-178.

Brown, Keith J. and Elliott, Robert D. <u>Large scale dynamic effects of cloud seeding</u>. National Conference on Weather Modification, 1st, April 28 - May 1, 1968, Albany, New York, Proceedings. Boston, 1968, pp. 16-25. DAS MO9.6 N277pr 1968.

The study of large scale dynamic effects of cloud seeding was divided into 3 phases: a statistical phase, a physical phase, and a test development phase which would lead to a field program to test the hypotheses. This report deals primarily with the statistical phase and also includes the preliminary hypothesis regarding the physical explanations for the observed results. The evidence presented gives strong support to the hypothesis that long term operational cloud seeding programs in the western U. S. have not just increased precipitation in the intended target areas, but have also increased precipitation over a large area $\simeq 100$ mi downwind from the targets. The downwind effects of seeding on airflow and precipitation are considered in some detail. - MGA 19.11-229.

Pudilova, E. P.; Kornienko, E. E.; Lenshin, V. T.; Stalevich, D. D.

Naturnye ispytaniia smesi NaCl s tsementom v kachestve reagenta dlia

vozdelstviia na moshchnye kuchevye oblaka. (Field experiments

with a mixture of NaCl and cement as a reagent for modifying large
cumulus clouds.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia,

Leningrad, Trudy, No. 224: 23-36, 1968. Russian summary p.204. DAS M(055) U581tg no. 224.

Sixty-three experiments with seeding convective clouds and inducing precipitations in them were made in 1966. Sodium chloride mixed with cement was used as the reagent. Prior to mixing, the salt was ground to obtain particles with a radius of $5-7\mu$; it was mixed with cement at the ratio of 4:1 (by weight). The experiments were made in an airborne laboratory II -1) with equipment for dosing and dispersing the reagent. The reagent was dosed in accordance with the geometrical parameters and dynamic characteristics of the clouds (1-4 kg/cloud). The results of seeding operations were observed from the aircraft in combination with ground radar stations and the raingage pluviograph ic network. The analysis showed that precipitation was observed in 71% of all experiments. In 57%, precipitation occurred as rain, ranging from weak to medium. As a rule, the precipitation was observed 12-18 min after seeding, and it continued usually for 15-30; in particular cases, even 1 hour and longer. - MGA 20.7-192.

Bulkov, M. V. and Polovina, I. P. O sravnenii teorii rasseianiia pereokhlazhdennykh oblakov s pomoshch'iu tverdoi uglekisloty s eksperimental'nymi dannymi. (Comparison of the theory of supercooled cloud dispersion by means of dry ice with experimental data.) U.S.S.B. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 74: 3-10, 1968. Russian summary p. 135. DAS M(C55) U581tu no. 74.

The authors present a theoretical explanation of the observed phenomena of the dissipation of stratus clouds by means of solid carbon dioxide. It is demonstrated that the existence of optimum standards of seeding (elevation of the standard above the optimum does not intensify the observed effect) is explained by a weak (logarithmic) dependence of the maximum width of the clearance upon the seeding standard. According to theoretical and experimental data, the time of appearance of an opening declines with an increase in the seeding standard; but theory gives a more rapid decrease. This is explained by the fact that according to theory, the moment of appearance of a cloud opening corresponds to its width, equal to zero; while in an experiment, the moment of formation of an opening is identical with the appearance of visibility from the Earth (i.e., the opening has some finite width). dependence of the time of appearance of the opening upon the thickness of the cloud cover is explained by unevenness of seeding in width. Theory gives a diminished maximum width of the opening with decrease of cloud thickness; this agrees qualitatively with the experiment. In a series of experiments made at a temperature above -4°C, the theoretical criterion was verified of formation of an opening, and a correlation was observed between the effects of modification and the magnitude of the criteria parameter. are compared theoretical and experimental curves for minimum expenditures of solid carbon dioxide necessary for dispensing a cloud layer. - MGA 20.8-226.

Buikov, M. V. and Tkachenko, A. V. Otsenka vozmozhnosti bor'by s sukhoveiami s pomoshch'iu uvlazhneniia prizemnogo sloia vozdukha. (Evaluation of the possibility of sukhovei control by means of humidifying the atmospheric layer near the ground.) U. S. S. R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 74: 119-129, 1968. Russian summary p. 143. DAS M(055) U581tu no. 74.

The method of control of sukhovei winds by evaporating a sufficient amount of dispersed water into the layer of the atmosphere near the ground is evaluated. This problem is solved by the means of the theory of transformation of an air mass of finite thickness; wind speed and the coefficient of vertical exchange are expressed in the form of power function. Horizontal motion is disregarded. The process of dispersion of water and of evaporation of drops is not examined; it is assumed that the evaporation of water drops proceeds sufficiently rapidly. The solution of the problem yields formulas enabling determination of the distribution of absolute and relative humidity and of temperature in the zone of modification; all the calculations with these formulas were made for an altitude of 1 m (zone of the plant habitat). There was calculated the maximum distance at which the result of modification can be considered still effective, i.e., the prevision of satisfactory meteorological conditions for plant (relative humidity 40%). Since for sukhovei winds with an air temperature of 25°C, wind velocity of 5 m/sec, and relative humidity of 30%, it is necessary to evaporate 5.35 g of water in a cubic meter, the maximum effectiveness of modification is 2.64 km when a layer of 50 m is humidified and 0.48 km when a layer of 100 m is humidified (in the latter case the stratification is considered unstable). Proceeding from statistical data on the duration of sukhovei winds in July-August in the southern Ukraine, the authors conclude that this method of control of sukhovei requires about 4000 tons of water/ha/yr. - MGA 20.9-175.

Butchbaker, Allen F. Evaluation of a hail suppression program in southwestern North Dakota. National Conference on Weather Medification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 503-512. DAS MO9.6 N277pr 1968.

It was possible to use radar to make a rough distinction between thunderstorms which were producing hail and those which were not. Hailfall energy in the target and control areas had a skewed distribution with $\simeq 80\%$ of the hailfalls having energies <10 ft $1b/ft^2$ and 95% of the hailfalls <30 ft $1b/ft^2$. It is probable that cloud seeding did suppress some of the hail and that cloud seeding for hail suppression did not appreciably alter precipitation in the area. - MGA 19.11-230.

537. Colifornia. Department of Water Rescurces. Weather modification operations in California, October 1, 1966 - September 30, 1967. Bulletin no. 16-67. August 1968. 31 pp. DAS M09.61 C153we 1966/67.

Eight California licensees conducted nine cloud-seeding projects during the 1966-67 water year. The projects were conducted mainly to increase surface storage for municipal and irrigation uses, for use in recreational facilities, and for use in hydroelectric installations. Additional purposes for precipitation increase were ground water storage and applied research. Five project target areas were in Central California, three in Southern California, and one in the northern Sierra Nevada.

Excluding electric discharge operations, 15,704 hours of cloud seeding were logged from ground-based equipment and 225 hours from aircraft. Seven licensees used silver iodide, dispersed from ground-based generators or aircraft, as a nucleation agent. In addition to silver iodide, one licensee dispersed 155 pounds of dry ice. One licensee used the electric discharge method, in which ions discharged from stainless steel wires act as a nucleation agent. This unit was operated during 235 days of the 1966-67 season. - Author's abstract.

Chamberlain, A. R. and Grant, Lewis O. Weather modification and its relationship to environment. Western Resources Conference, 9th, University of Colorado, July 5-7, 1967, Man and the quality of his environment: Western Resources Papers. Boulder, University of Colorado Press, 1968. pp. 69-79. DAS 301.3 W527ma.

Discusses in broad outline the problems of restoring and maintaining the quality of the atmosphere as a limited rescurce. The present apparent status of the biological and social sciences, and of the law, with relation to technical knowledge of the physical aspects of weather modification as a specific part of the interrelationship between the quality of life and the atmosphere, is interpreted as indicating an urgent need for increased research in these and associated disciplines. One sector of weather modification, that concerned with modification of precipitation, is formulated by the authors into a theoretical structural model permitting meaningful research by the disciplines cited. This model divides precipitation modification into changes of intensity, duration, spatial distribution, and temporal redistribution. Each element is discussed. Knowledge of the physical science aspects of weather modification has progressed to the point where further advances will require investigations of the implications of weather modification for the biological and social environment. - MGA 20.12-157.

Changnon, Stanley A., Jr. Evaluation of data to verify hail modification efforts. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 513-521. DAS MO9.6 N277pr 1968.

A study made to evaluate the major types of data either being employed or being considered for future projects in the Great Plains or Midwest of the U. S. Consideration is given to the

sources of data that are assessed. All of the listed data sources have significant advantages as well as disadvantages. It is suggested that a network of recording hail gages would be the best data source for experiments involving single storm or random daily designs. Two suitable and 4 nearly suitable data sources are available for continuous seed experiments; the selection of data source will likely depend on geographic and cost limitations. For random daily seeding experiments, recording hail gage networks are considered to be the most suitable source. The only limiting feature of the recording hail gage is a lack of historical record, but if current research proves its data is correlated with the degree of crop loss, the historical insurance loss experience could be substitued. - MGA 19.11-231.

5h0. Chicago. University. Cloud Physics Laboratory. Collection of Reprints, Vol. 12, August 15, 1968. 11 reprints with original pagings and format. (Technical Note No. 38) (All articles on weather modification abstracted separately.) DAS M74.1 C532te no. 38.

Papers by outstanding authorities on the following subjects: Meteorological bases for precipitation development. Cirrus crystals in clear air. Thermoelectric power of single ice crystals. Camera and cloud measurements. Cumulus entrainment. Airborne cloud particles replicator. Experimentation with weather control. Project Whitetop precipitation data. Precipitation cloud echo and thunderstorms. Partitioning of water between cloud drops and precipitation particles in cumuli. Project Whitetop data in comparison of seeded and not-seeded convective cloud depth. - MGA 20.5-13.

5hl. Crozier, C. L. Weather radar facilities and observations: Precipitation Physics Project. Canada. Meteorological Branch, Canadian Meteorological Research Reports CMRR 8/68, October 9, 1968. 5h pp. DAS M(055) C212cam CMRR 8/68.

From 1959 to 1963, the Precipitation Physics Project conducted field experiments of cloud seeding in organized synoptic scale weather systems with silver iodide dispensed from an aircraft in Western Quebec province from May to September. A 3 cm. MR-75 modified Decca Radar System with a programmed antenna and photographic recording system was installed in 1960 at an elevated site about halfway between two 32 mile square test areas separated by 32 miles. This report details the radar facilities, the radar program, the recorded data format and the inventory of film record. The quality and use of the data is discussed and examples of the data illustrated for typical cloud systems of interest to the Project. Theoretical calculations on the radar power of weather target detectability are included. The basic principles of radar in the weather role are briefly outlined as an introduction to provide information and an appreciation of the general nature of the observations and the data collected and allow some assessment to be made of the value of the data for the possible support of

other associated studies. - Author's abstract.

Crutchfield, James A. The economics of weather modification. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 181-189. "Abridged version of a paper presented before the Public Policy Seminar of the University of Washington, January 30, 1967." DAS MO9.6 N277pr 1968.

In discussing the economics of weather modification, it is suggested that evaluation of weather modification must involve calculation of costs and benefits much more comprehensive than those with which the private operator could or should be concerned. Author points out the questions that must be asked to insure inclusive evaluation, in general terms and with reference to specific areas in which weather can be expected to produce significant economic "outputs." - MGA 19.11-212.

Culnan, David E. Project Skywater: The Bureau of Reclamation's Atmospheric Water Resources Program. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law. Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 44-55) DLC.

The Bureau of Reclamation program was commenced in 1961 to improve the U. S. water supply and to learn how to induce rain or snow to fall where optimally beneficial. Primary study areas include identification of problems; instrumentation; cloud and precipitation processes; cloud treatment systems; and social, economic, ecological, and legal aspects of weather modification. Field experiments are being conducted in the Colorado, Missouri, and Rio Grande River basins, the Great Basin, the Pacific Northwest, and the southern Sierras. Plans include development of a region-by-region water enhancing capability, particularly in critical areas. A selected area capability in the western mountain area is anticipated by 1975. Current funding (as of 1966) is

\$\times \frac{\pi_1}{500,000}\$. - MGA 20.5-189.

544. Davis, L. G. and Weinstein, A. I. Modification studies directed toward isolated cumulus clouds. 13 pp. "Presented at the First National Conference on Weather Modification, Albany, New York, April 28 - May 1, 1968." DAS MO9.617 D262mod.

A brief review of experiments, in which single clouds, in both seeded and unseeded situations, were investigated to determine the effect of seeding rate on the microphysics and dynamics of clouds, is presented. This is followed by a discussion of the Flagstaff 1967 experiment on the influence of seeding on the development of precipitation from isolated supercooled cumulus clouds. The numerical model uses the environmental temperature and humidity lapse rate; the cloud base height and an assumed temperature for natural and artificial nucleation are basic inputs. The operation of the model, the aircraft and radar procedures, the analysis and evaluation procedures, the computa-

tion of optimum seeding rates and the operational criteria are presented. The experiments demonstrate conclusively that the vertical extent of supercooled, isolated currents can be increased (about 25%) by proper cloud seeding techniques. The duration of precipitation is increased (about 50%) as is the rainfall at cloud base (about 300%). - MGA 20.10-136.

Davis, L. G.; Kelley, J. I.; Weinstein, A.; Nicholson, H. Weather modification experiments in Arizona. Pennsylvania. State University. Department of Meteorology, NSF Grant GA-777, Report 12A and Final Report, November 1968. 129pp. DAS M(051) P415rp no. 12A.

Penn State's role in northern Arizona studies prior to 1967 dealt with the development of a steady-state cumulus model and field techniques to investigate the dynamics and microphysics of cumulus clouds and with establishing the seeding concept to alter the dynamics through the release of latent heat of fusion. Some investigations resulted in a microphysical description of cumulus clouds and an application of power spectrum analysis to cumulus dynamics.

During the summer of 1967, randomized seeding experiments were conducted with nine isolated cloud pairs (on control, one test cloud) utilizing radar and aircraft. Results showed increases of cloud top heights by 25%, of precipitation duration by 45%, and of rainfall at cloud base by 350% with seeding. These experiments represented judicious seeding with the aid of the model prediction of the most susceptible cloud size; the results were statistically significant at less than the 1-5% level.

A mesoscale seeding concept to organize convective cloud motions was proposed and tested. The concept is to seed individual clouds in an area so that their combined dynamics "force" larger scale circulation through the baroclinity developed by the rainfall and evaporative cooling in the sub-cloud layer. Six exploratory trials were made. Results showed two trials were successful, one moderately successful, and three inconclusive due to operational difficulties.

Data from a five year randomized seeding program in southern Arizone which showed no significant change in rainfall with seeding were reanalyzed with the application of the steady-state model. It was shown that the model is best used on individual clouds rather than a cloud population. Data were stratified according to rainfall amounts and cloud top heights. Results showed that seeding should have produced significant increases in cloud top height and rainfall for shallow clouds, but no change in cloud top height and a decrease in rainfall for deep clouds. These deductions may help to explain the inconclusive results frequently obtained from analyses of average precipitation increases from cumulus cloud seeding. - Authors' abstract.

Davis, Ray Jay. New wine in old bottles: weather modification legal analogies. Western Resources Conference, 9th, University of Colorado, July 5-7, 1967, Man and the quality of his environment: Western Resources Papers. Boulder, University of Colorado Press, 1968. pp. 91-104. DAS 301.3 W527ma.

Affirms that little U. S. regulatory law exists in the U. S. directly concerned with weather modification; that no significant body of precedents can be found in the few judicial decisions reached hitherto; and that what law is applicable is constructed by analogy to preexisting legal norms drawn from other areas of the law. Current weather modification law has borrowed extensively from several fields including water law, liability law, and administrative law. A number of litigations, and the judicial decisions reached, involving weather modification and modifiers, are cited. Questions of trespass, nuisance, negligence, strict liability causation, and immunity, are discussed. Other related problems considered are concerned with administrative procedures in reporting, licensing, and issuing permits. A number of potential legal analogies are suggested. It is warned, however, that such parallels must be used with care in the development of a body of weather modification laws and its interpretation. MGA 20.12-158.

547. Davis, Ray Jay. Special problems of liability and water resources law. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law. Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 103-140) DLC.

Links the traditional legal approach with regard to liability of weather modifiers with water law issues. The latter comprise the legal aspects of increasing available supplies through weather modification: the law of water distribution as applied to such increases; and the financing of water so produced. Existing approaches to these legal problems may perhaps be adapted to meet legal complications resulting from weather modification. The vital role of the concepts of factual and proximate cause involved in the legal consequences of the application of the techniques of increasing water supplies through weather modification is stressed and illustrated by the author, together with the question of "reasonable foreseeability" and its application to this problem. The distribution of water supply has been the source of numerous other legal complications, many involving various private rights of ownership and use of land and water. The author discusses problems of state allocation of water use; acreage limitations; and direct and indirect costs in financing. The legal problems of liability of weather modifiers and water resources law are viewed by the author as "inextricably attached." An extensive listing of reference materials is appended. - MGA 20.3-228.

548. Decker, Fred W. Cloud seeding comes "of age." Weatherwise, Boston, 21(2): 76-77, April 1968. DAS M(05) W362 21: 1968.

Reviews briefly the first "landmark" experiment, on April 4, 1947, in weather modification by cloud seeding. In the 21 yrs which have elapsed since the earliest experiments, other attempts have been made to overcome some of the problems of observation and verification which perplexed these pioneers. Yet, the "coming of age" has not utterly removed the doubts about the readiness of cloud seeding for routine application. - MGA 19.11-233.

Depietri, C. and Rosini, E. <u>Inseminazione mediante aereo con una miscela urea-bentonite di nubi cumuliformi.</u> (Aircraft seeding of cumulus clouds with urea-bentonite mixture.) Associazione Geofisica Italiana, 16th, Naples, May 22-24, 1967, Atti, issued 1968. pp. 481-487. Italian and English summaries p. 486. DAS P.

Seeding of Cu in the Modena area in connection with experiments on hail phenomena are discussed. The urea was pulverized first into particles with a mean diameter of 70 μ . To prevent aggregation of the crystals into compact masses, bentonite crystals with a mean diameter of about 3 μ were mixed with the urea particles. The bentonite crystal is more volatile, chemically inert, and not capable of growth. Photographs definitely show the dissolution of Cu clouds that began about 15 min after seeding. - MCA 20.8-231.

Dessens, Henri. Influence sur la pluviométrie d'une émission continue de noyaux d'iodure d'argent. (Influence on pluviometry of the continuous emission of silver iodide nuclei.) Académie des Sciences, Paris, Comptes Rendus, Ser. B, 267(6): 1/27-1/32, August 5, 1968.

DAS P.

Since 1965 a silver iodide (AgI) ground generator has been operating practically continuously on the Atlantic Coast of Landes at Mimizan. The AgI solution contains 17 g of AgI/1; the output is 0.8 1/hr and the number of ice-producing nuclei active at -21°C is 1.5 X 10¹²/sec. In the 3 years of operation, 1965-1967, there was observed an excess of rainfall centered at ~ 30 km downwind from the generator. In 1965 an excess of 50% over the regional rainfall was observed; 18% of this excess is attributable to the generator. In 1966 and 1967 the excess was less pronounced but still amounted to 20%. A comparison of the annual mean rainfall for 1921-1950 with the mean rainfall for the 3 yr seeding period demonstrates the effectiveness of seeding, but the increase in effectiveness appears to diminish with time. - MGA 20.5-191.

Dessens, Henri. La maitrise des climats. (Climate control.) Paris, Presses Universitaires de France, 1968. 159 pp. (La Science Vivante). DAS MO9.61 DL75ma.

The physical and dynamic atmospheric processes underlying the

formation of clouds and precipitation, the formation of thunderstorms and various catastrophic weather phenomena, and methods of climatic control are discussed in a nontechnical manner. The book contains numerous diagrams, photographs, and a few simple equations. The contents include the following: solar energy and the hydrologic cycle including the energy of clouds and evaporation, condensation and precipitation, the formation of cloud drops, the processes of vapor condensation including formation of condensation nuclei, droplet growth, etc.; the formation of snow flakes, the dynamics of clouds; rain, snow, and hail; cloud catastrophes including devastating storms, hail and wind storms, lightning, ball lightning, tormadoes, cyclone formation, tropical cyclones and extratropical cyclones: passive defense against bad weather including the prescientific period, Espy's proposal for producing artificial clouds by heating the ground, the relationship between bombardment, precipitation, and cloud seeding; the techniques of weather modification and some of the results obtained; and various practical suggestions for experimental production of precipitation and weather modification. - MGA 20.8-5.

552. Dessens, Jean and Pham, Van Dinh. <u>Le générateur à vortex</u>. (Vortex generator.) Journal de Recherches Atmosphériques, Clermont-Ferrand, 3(1-2): 215-221, January - June 1968. French and English summaries p. 215. (International Workshop of Cloud Nuclei, Lannemezan, France, September 8-23, 1967, Communications). DAS M(05) J86jor.

This vortex generator has been improved since the first silver iodide (AgI) aerosol generator designed by H. Dessens (1961). This vortex generator is more convenient for ground seeding experiments, because no power supply is needed. The AgI-acetone solution is supplied from a pressurized tank, injected into a chimney after the fine breakur by a nozzle and burned in the chimney by which the air is sucked forming a vortex. Measurements of ice nucleus concentrations per 1 gm of AgI were made for different concentrations of the solutions. - MGA 20.5-190.

Deutsche Versuchsanstalt für Luft- und Raumfahrt e.V., Munich. 9.

(Abschluss-) Bericht über die Hagelabwehrversuche im Landkreis
Rosenheim. (9th and Final Report on hail in the rural area of
Rosenheim.) Munich, 1968. 32 pp. DAS M(055) D186be 9. Bericht.

This final report on hail prevention in the district of Rosenheim comprises the following: meteorological conditions of hail fall; empirical data on cloud physics as a basis for hail prevention experiments in particular cloud seeding experiments with silver iodide, using antiaircraft guns as reported by Prof. Federov; organization of hail prevention experiments in the Rosenheim district including a description of the experimental design, the warning system, rocket and protection organization, ground generators and evaluation procedure, and a detailed account of the individual hail prevention experiments

in 1967. The statistical evaluation of the results shows that the number of days with hail damage in the Rosenheim district in 1958-1965 was 27% fewer than in 1948-1957, and the number of hail damage days was reduced also in the surrounding districts, particularly to the east of Rosenheim the reduction is statistically significant. An experimental area of about 800 km² is too small in the climatic area of the Rosenheim district for obtaining a maximum effect by using silver iodide rockets to a height of 1500 m and silver iodide ground generators) The size of a hail prevention area must be suited to the speed of air flow and the weather development, an area of \$1000 to 6000 km² would satisfy this requirement. Data are presented in tables. - MGA 21.6-155.

Douglas, William J. Toxic properties of materials used in weather modification. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 351-360. DAS MO9.6 N277pr 1968.

Precipitation samples were analyzed for silver (Ag); in precipitation samples from storms which were not seeded, the Ag content measured was up to 20 X 10⁻¹² gm of Ag/ml of precipitation. The content measured in precipitation from storms seeded with AgI varied from 20 to 200 X 10⁻¹² gm of Ag/ml. This is a concentration of 0.02 to 0.2 parts/billion, which is so low that it is far beyond the limit of the human metabolic system to feel. Reconcentration through biological or botanical processes is not considered. - MGA 19.11-234.

555. Edwards, G. R. and Evans, L. F. <u>Ice nucleation by silver iodide: III.</u>

The nature of the nucleating site. Journal of the Atmospheric Sciences, Boston, 25(2): 249-256, March 1968. DAS M(05) A512j.

On an AgI surface, the number of ice nucleating sites capable of nucleating ice by the freezing mechanism is found to be about 100 times the number which nucleate ice by sorption at water saturation. This phenomenon has been explained by taking into account the nonuniform electrical properties of the AgI surface. The relevance of this work to cloud seeding by pure and impure AgI aerosols is discussed. - MGA 19.7-208.

National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 423-432.

DAS MO9.6 N277pr 1968.

Sets forth a design for an orographic cloud seeding test program with points illustrated by specific examples, many of which are drawn from a design study performed for the southern Sierra. This kind of program should use serial rawinsondes and rabals during seeding tests. A weather radar and any aerial observations would provide information of value. The key parameter, however,

is the surface precipitation, as measured by heated gages or snow pillows. - MGA 19.11-235.

557. Fedorov, E. K. Können wir das Wetter ändern? (Can we change the weather?) Die Umschau, Frankfurt a. M., 68(1): 9-12, January 1, 1968. DAS P.

Presents a general review of the state and achievements of weather modification and the possibility and prospects of climatic modification. The discussion includes: physical principles underlying cloud modification, development of cloud modification, development of cloud modification in the U. S. and the U.S.S.R., various seeding reagents for seeding warm and supercooled clouds, seeding technique and effectiveness of cloud modification; hail prevention; experiments carried out in the U.S.S.R. to increase precipitation including a discussion of cloud dynamics and the results of such experiments; and modification of climate including a brief summary of various theories of climatic change, various possible methods of modifying climate such as change in the temperature of the water surfaces of large ocean areas, acceleration or retardation of melting of the snow cover, modification of the Earth's relief and reclamation. - MGA 20.1-163.

558. Fletcher, J. O. Changing climate. Rand Corporation, Santa Monica, California, Paper, P-3933, September 1968. 27 pp. Bibliography pp. 24-27. DAS M(055) R186p no. 3933.

This summary statement is an individual contribution to a more comprehensive review of weather and climate control by The RAND Corporation. Questions are discussed as regards the global climate pattern and its changes, causes, influences, man-made modification and international interest and reciprocity in the exchange of data. The factors of progress (observation, understanding, prediction and control is achieving the degree of control) over climatic processes are becoming much less limited and restricted. This is because of sophisticated instrumentation, satellite and shape probe advancements, improved networks, and computerized data. -MCA 21.4-33.

Fletcher, J. O. Climatic change and the ice extent on the sea. The Rand Corporation, Santa Monica, California, Paper P-3831, April 1968. 22 pp. "Paper prepared for presentation at the First National Conference on Weather Modification, Albany, New York, April 28 - May 1, 1968." DAS M(C55) R186p no. 3831.

Discusses fluctuations in extent of polar ice packs as a sensitive climatic lever which is capable of amplifying the effects of small changes in global heating and, hence, may be considered a possible tool for the deliberate modification of climatic processes. The author relates quantitative assessments of the annual variations of the Arctic and Antarctic heat budgets to annual variations in the general atmospheric circulation.

Physical effects of an ice cover are analyzed and presented graphically. Natural variations in the extent of Arctic pack ice, atmospheric heat loss over Antarctic regions, variations in Antarctic pack ice extent, seasonal changes, and the relationship of Antarctic cooling and global circulation are considered. It is suggested that, in addition to annual fluctuations, large long term budget variations also occur in both polar regions, and that these shifts are closely related to the variable extent of ice in the sea. The report presents quantitative estimates of the long term variations in the intensity of the polar heat sinks and dicusses their possible significance for explaining changes in global climate. - MGA 20.4-213.

560. Flueck, John A. A statistical analysis of Project Whitetop's precipitation data. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 26-35. DAS MO9.6 N277pr 1968.

Presents a portion of the statistical analysis of the precipitation data of a 5-year, 1960-64, randomized, summertime cloud seeding experiment conducted in southern Missouri by the Cloud Physics Lab. of the Univ. of Chicago under the name of Project Whitetop. The negative treatment effect was generally more strongly supported by comparison of the plumes than by the comparison of non-plumes or K areas. The design of the experiment was such that any classical statistical inferences drawn from the analysis refer only to the nonseeded subset of the operational days. - MGA 19.11-236.

Fukuta, Norihiko. Production of organic nucleants. Conference on the Production and Delivery of Cloud Nucleating Materials, Denver, February 1/1-16, 1968, Project Skywater, Proceedings: Skywater Conference III. pp. 9-28. DAS M09.617 C748pro Conf. III.

The process of organic smoke particle formation and the theoretical limit for the production of a maximum number of particles are discussed. The past and present methods of organic ice nuclei generation are described and some suggestions are presented for their future improvement and development. - Author's abstract.

562. Garrett, William D. Künstliche Veränderungen der Grenzfläche Ozean/ Atmosphäre? (Are artificial modifications of the air-sea interface possible?) Die Umschau, Frankfurt a. M., 68(18): 568-569, August 29, 1968. DAS P.

Outlines basic characteristics of monomolecular sea surface films most frequently observed in biologically active coastal waters; describes several modes by which the film material reach the surface, and notes various dispersive forces acting upon the adsorbed film. Modifications of the microscale properties of the air-sea interface through surface-active materials are discussed: damping of the capillary wave spectrum; small wave attenuation: inhibition of microconvectional cells; air bubble bursting;

and other effects. A number of useful modifications of the air-sea interface through artificially applied, monolayer-forming substances are considered, with reference to reflected light, surface wind drag, wave reduction, and other parameters. The geophysical effects of an artificial surface film are summarized in tabular form. - MGA 20.6-185.

(Verification of the effectiveness of hail prevention measures.)
Idöjárás, Budapest, 72(2): 79-84, March-April 1968. Hungarian and
Russian summaries p. 79. "Presented at 13th Congress of Hungarian
Meteorological Society, August 24-27, 1967, Sárospatak, Hungary."
DAS M(05) I21.

Reviews briefly and discursively various methods of verifying hail prevention experiments (particularly with the use of surface generators). The methods vary with the size of the seeding area. The method involving the comparison in a chronological series of values on hail damage obtained before and after cloud seeding and the use of a statistical test and the analysis of variances is described with the aid of an example. Another method involves the analysis of the spatial distribution of hail damage in relation to the emplacement of generators. A better method consists of comparing a target area with a control zone which is protected against the seeding operation in the target zone; the regression between the 2 series of values during an unseeded period is determined and the events occurring during hail prevention operations in the target area are described. These methods suffer from the fault that it is difficult to be certain that other factors except the counter-hail measures have been excluded in the comparison. A method providing a homogeneous series is that using random selection of the seeding event as utilized in Switzerland and Argentina. This procedure can be employed properly only with the satisfactory prediction of synoptic hail situations. The conditions of the use of this latter method and its use in cloud seeding with AgI are discussed. - MGA 20.1-169.

Gentry, R. Cecil and Edelstein, Max W. Project STORMFURY, a hurricane modification experiment. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings.

Boston, 1968, pp. 296-305. DAS MO9.6 N277pr 1968.

Discusses Project Stormfury—the various experiments being planned and the hypotheses involved, specific problems associated with the experiments and what is being done about them, plans for the 1968 hurricane season, and the data collection effort of Project Stormfury. Stormfury seeks to modify hurricanes by using silver iodide crystals to cause freezing of supercooled water drops and the release of latent heat in selected volumes of the hurricane. The experiments are designed to provide data not only for evaluation but for increased understanding of the energy processes of a hurricane which will lead to improved and more sophisticated experiments as stepping stones to modification success. — MGA 19.11-213.

565. Gerdel, R. W. Note on the use of liquefied propane for fog dispersal at Medford-Jackson Airport, Oregon. Journal of Applied Meteorology, Boston, 7(6): 1039-1040, December 1968. DAS M(05) J86joa.

Reports that 25 fogs were treated with liquefied propane at the Medford, Oreg., Airport during the 1967-68 winter. Operational minima of 0.5 mi horizontal visibility and 200-ft ceiling were attained in 15 of the 25 treatments. In 8 treatments, sufficient modification occurred to improve horizontal visibility from 500 to several thousand ft. The author concludes that, although the natural variability in ceiling and horizontal visibility during the winter fog period has not been evaluated, the transmissometer trace showed a return of the fog and reduction in visibility with a few minutes of cessation of the propane treatment in all but 2 fog events, and substantiates the effectiveness of liquefied propane as a fog dispersal agent. - MGA 20.6-178.

566. Gokhale, Narayan R. and Goold, James, Jr. <u>Droplet freezing by surface nucleation</u>. Journal of Applied Meteorology, Boston, 7(5): 870-874, October 1968. DAS M(05) J86joa.

Droplet freezing by surface nucleation has been observed during the course of studies of ice nucleation in our laboratories. A constant rate of cooling apparatus and a specially constructed cold chamber were used for this study. Silver iodide particles sprinkled on supercooled, millimeter-size water drops are effective in freezing the drops at -5°C. Particles of naturally occurring silicates were found to be effective in the range -7 to -1°C. Thus, the ice nucleating ability of such dry particles is much greater by the surface contact mechanism than when particles are embedded in the drops.

The importance of the surface nucleation mechanism in forming solid hydrometeors in cumulus clouds is assessed. - Authors' abstract.

567. Goyer, Guy G. The use of explosive nuclei generators in the study of cumulus clouds. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 122-128. DAS MO9.6 N277pr 1968.

Recent advances in the development of explosive generators of freezing and condensation nuclei and the design of safe delivery systems provide a new versatile research tool. The test results were spectacular. Most noticeable was a very rapid and extensive growth of the seeded clouds. This type of generator is unique in producing a very large number of nuclei in a very short time in a very small volume. The delivery systems permit an accurate control of the location, the temperature, and the time of nuclei generation. These features permit the study of effects of freezing and condensation nuclei, of the latent heat of condensation and solidification, and of the shock waves generated on the subsequent visual and radar development of the seeded clouds. These instantaneous high output point sources of nuclei are ideal for the study of

the diffusion of nuclei in clear air or in clouds. A few examples of definite questions of critical importance which may be answered with this new type generator have been proposed. - MGA 19.11-237.

Grant, Lewis O.; Chappell, Charles F.; Mielke, Paul W., Jr. The recognition of cloud seeding opportunities. National Conference on Weather Modification, 1st, April 28 - May 1, 1968, Albany, New York, Proceedings. Boston, 1968, pp. 372-385. DAS MO9.6 N277pr 1968.

Presents the results of an attempt to delineate some of the more critical relationships that influence the potential for modification of the cloud system. The investigations discussed are relevant to the cold orographic clouds forming over the central Colorado Rockies. A few specific findings apply only to this region. The results, in general, are consistent with current orographic cloud seeding theory and offer a crude verification of its basic tenets. The study shows that the application of discriminate and variable seeding techniques in the central Colorado Rockies will result in substantial increases in snowfall. - MGA 19.11-238.

Greiner, Edward C. Department of Water Resources activities in weather modification. Western Snow Conference, Thirty-sixth Annual Meeting, Lake Tahoe, Nevada, April 16-18, 1968, Proceedings. cl968?apr. 77-83. Colorado State University, Fort Collins, Colorado. DAS M(06) W527p 36: 1968.

A review and evaluation of Weather Modification projects and activities contiguous to the State of California Central Valley Water Project through the Department of Water Resources. Reference is made to the Department's Bulletin No. 16 series entitled "Weather Modification Operations in California". These bulletins list all licensed operators, and projects descriptions occurring during one years time. Current operations in weather modification show a marked improvement in methods through the use of advanced meteorological information that is analysed and processed for cloud seeding operations. - Author's abstract.

570. Gromova, T. N. and Lenshin, V. T. <u>O nekotorykh osobennostiakh rezul'tatov vozdeľstviia na moshchnye kuchevye oblaka l'doobrazuiushchimi reagentami</u>. (Some peculiarities of the results of modifying large cumulus clouds with ice-forming reagent.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 224: 150-156, 1968. Russian summary pp. 210-211. DAS M(055) U581tg no. 224.

Results are presented of experiments with seeding supercocled convection clouds with silver iodide, lead iodide, copper sulfide and fluoroglucin. The peculiarities of the effects of these reagents under laboratory conditions and in field experiments are described. The specific nature of soluble and insoluble substances was assessed in dependence of the relative air humidity in the cloud (fog). The amount of the produced ice particles decreases

by 1-3 times with decreasing relative humidity in the cloud (fog). The amount of the produced ice particles decreases by 1-3 times with decreasing relative humidity of the fog from 100 to 90%. This relationship, which differs for various ice-forming substances and their method of introduction becomes weaker with decreasing temperature. The results obtained permit a better selection of reagents for optimum utilization in seeding large cumuli with the aim of producing large-volume precipitation or their dispersion. - MGA 20.8-227.

571. Gromova, T. N. and Sumin, Iu. P. O primenenii sernistoi medi dlia vozdeistvii na pereokhlazhdennye konvektivnye oblaka. (Using copper sulfide for modifying supercooled convective clouds.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 224: 43-61, 1968. Russian summary p. 205. DAS M(055) U581tg no. 224.

The results of natural experiments with copper sulfide during the summer period of 1966 are evaluated. The action was directed toward large cumuli in various stages of development, without any signs of natural crystallization, and without precipitation. The effects of powder reagents on convective clouds are described including the action of 26-mm cartridges containing 7 or 1/1 g of copper. The analysis of 32 experiments showed that successful action (precipitation) is possible at the temperature of -6°C at the level of action and the vertical magnitude of clouds exceeding 2.5 km. In case of smaller clouds, the action usually results in their break-up. - MGA 20.8-232.

Gryts'kiv, I. V. et al., Opyt zaseva oblakov v tsentral'nom rajone

Evropeiskoi territorii Sovetskogo Soiuza s tsel'iu pereraspredeleniia

zimnikh osadkov. (Cloud seeding in the central region of the
European U.S.S.P. with the objective of re-distributing winter
precipitation.) Leningrad. Institut Eksperimental'noi Meteorologii,
Trudy, No. 3: 3-25, 1968. Russian summary p. 107.

Describes the method and organization of experiments made in the cold time of the year in the center of the European territory of the Soviet Union to determine the possibility of redistributing precipitation by influencing clouds with crystallizing reagents. A description of 11 experiments and detailed information on the parameters of the clouds that were influenced are given. The change in the precipitation field caused by the influence is analyzed. An increase in precipitation with a 99.9% significance level and a decrease with 97.5% significance level take place. The region with a decreased amount of precipitation lies along the wind behind the zone with an increased amount of precipitation.

- MGA 20.12-159.

573. Haas, J. Eugene. Social and political aspects of planned weather modification. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 202-209. DAS M09.6 N277pr 1968.

Discusses social and political aspects of planned weather

modification with consideration for the following: need for development of theory; knowledge for policy formation; relevant concepts; weather modification and disasters; a view of weather modification agencies; and needed research. - MGA 19.11-21/L.

57/1. Halacy, D. S., Jr. The weather changers. New York, Harper & Row, 1968. 246 pp. DAS MO9.6 H157we.

An interesting nontechnical but exhaustive popular book which polarizes the various angles on weather modification. Basic concepts like difference between weather and climate, and statistical, numerical and analog (Krick) weather predictions are clarified and the points on the consequent debate as to which system is better are divulged. Developing the theme of the book, "Everybody talks about the weather but nobody does anything about it," the author retraces the history of artifical rain making from the times of Veraart, Bergeron, Findeisen, Langmuir, Schaefer, to the present time, and describes their experiments on freezing of water vapor on ice crystals in clouds, formation of ice crystals in humid air, dry ice, and AgI cloudseeding, etc. In FY 1965, work on some 79 weather modification projects (mostly privately financed) listed in the Magnuson Report included: increasing precipitation; hail suppression; dissipating supercooled fog; rainfall stimulation for watersheds, etc. "Weather Chasers," viz: fog-, hurricane-, tornado-seeding techniques are described and illustrated. Climate modification; modification by accident, i.e., by the influence of cities, smog, CO2; climatic warfare; psychological considerations; legal aspects of weather modification, etc., are among other topics of the book. - MGA 19.3-12.

Hannaford, Jack F. and Williams, Merlin C. Regional hydrologic area study as an analysis tool in weather modification. Western Snow Conference, Thirty-sixth Annual Meeting, Lake Tahoe, Nevada, April 16-18, 1968, Proceedings. c1968. pp. 67-76. Colorado State University, Fort Collins, Colorado. DAS M(06) W527p 36: 1968.

Weather modification projects representing a wide range of effort and capability have been conducted in California and central Sierra Nevada since the late 19h0's. Data from many of these projects is collected and analysed not to their effectiveness or to evaluate rainfall or streamflow; instead, to analyse (1) outline areas of increased runoff resulting from seeding, and magnitude, (2) to identify changes in runoff in term of target areas, (3) to investigate possible downwind or side effects and possible interproject effects of major magnitude which might exist in the area of regional analysis. This work was accomplished through facilities of the Bureau of Reclamation's Project Skywater. - Authors' abstract.

576. Henderson, Thomas J. Commercial prospects and problems for weather modification activities. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law, Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 65-75) DLC.

Recognizes the entry of business interests into present and future weather modification programs and outlines prospects for commercial operations and research. Current operating activities include precipitation stimulation, hail and wind suppression, and cold fog dissipation. Commercial funding shows a significant decrease over the 1950's, but universities, public agencies, industry, and private groups, are calling upon commercial organizations for assistance. Airlines are heavily involved in fog dissipation. Support for long term rain stimulation has come from private interests, especially in western regions. Problem areas include organization and implementation, operations evaluation, legal affairs, and public relations in weather modification. - MGA 20.4-214.

577. Henderson, Thomas J. An operational hail suppression program near Kericho, Kenya, Africa. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 474-483. DAS MO9.6 N277pr 1968.

In this report, the preliminary results are presented and are said to be encouraging enough to warrant further research activities as the program moves through its initial 18-mo experimental period. The design of the program includes the attempt to increase the concentration of freezing nuclei in the accumulation zone to $\simeq 10^5~\text{m}^{-3}$ by injection in the strong updraft zones. Pyrotechnic seeding devices which disperse 70 grams of silver iodide in 1.5~min and develop efficiencies of $\sim 10^{13}~\text{nuclei/gram}$ effective at -5°C and $10^{15}/\text{gram}$ at -20°C appear to satisfy this design. - MGA 19.11-240.

National Conference on Weather Modification, 1st, Albany, New York,
April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 241-250.

DAS M09.6 N277pr 1968.

The objective of this study was to formulate a simple framework within which any proposed modification of weather can be subjected to a preliminary desirability evaluation in terms of economic consequences, sensory and phychic satisfactions, and ecological fitness. - MCA 19.11-215.

Hibbs, James R. and Cumberland, John H. Society, environment, and technology: challenge and opportunity. Western Resources Conference, 9th, University of Colorado, July 5-7, 1967, Man and the quality of his environment: Western Resources Papers. Boulder, University of Colorado Press, 1968. pp. 3-15. DAS 301.3 W527ma.

Proposes a multidisciplinary approach to the central problem of man's relation to his environment, and affirms the need to view man and his surroundings within the same total system. As a case in point, the various interlocking sets of disciplines involved in achieving an understanding of the effects of weather modification on man are cited. The present dilemma of atmospheric

pollution, and further human abuses of water, Earth, and other natural resources are said to constitute a deterioration of the environment that poses the greatest threat to man's continual existence on Earth. The nature of this ominous trend is examined from the economist's viewpoint; the extent to which society can modify the basic elements of economic activity, industrial growth, and population explosion without suffocating in his own wastes, is then considered. Among other requirements, the current technological linkages between industrial activity and environmental pollution must be modified. For example, the global nature of water sheds, wind sheds, ocean currents, and atmospheric phenomena must be recognized and knowledge thereof applied to meet man's needs through international agreements. The development of multidisciplinary institutes addressed to man, environment research and analysis, is then discussed; a number of basic, formulative ideas are presented; and a proposal for such a multidisciplinary institute is set forth, including a prototype budget. It is concluded, among other findings, that such an investment will cost less than 1% of current and foreseeable federal expenditures caused by our deteriorating environment. - MGA 20.12-166.

580. Hindman, Edward E., II. <u>Numerical simulation of supercooled fog</u>
dispersal. National Conference on Weather Modification, 1st, Albany,
New York, April 28 - May 1, 1968, Proceedings. Boston, 1968,
pp. 396-403. DAS M09.6 N277pr 1968.

Presents a numerical simulation for the growth and precipitation of ice crystals. Computed results are compared with observed supercooled fog dispersal data to demonstrate the realism of the simulation. The comparison of the computed fog clearing times and those actually observed produced little correlation, but indicated which physical parameters are critical. It appears that a variation of an order of magnitude affects the clearing times significantly. Variations in the temperature and LWC of fogs affect the clearing times to a lesser degree. The computed fog clearing times and distances were compiled, illustrating the concentrations of crystals which may cause an underseeded or overseeded condition. - MGA 19.11-223.

581. Hitschfeld, Walter. Comments on "Cirrus Cloud Seeding as a Trigger for Storm Development." Reply by Roscoe R. Braham, Jr. Journal of the Atmospheric Sciences, Boston, 25(3): 530-531, May 1968. DAS M(05) A512j.

Comments on Braham's 1967 work in which he indicates that crystals can fall through clear air and retain their seeding properties over long vertical distances. The author asks whether the wintertime snow generating cells occurring in widespread frontal stratus clouds could be caused by the same kind of cirrus (Ci) cloud seeding which Braham has established for summer cumulus. In reply, Braham does suggest that it is quite logical to speculate that the wintertime snow generating cells result

from Ci cloud seeding in a manner entirely analogous to our summertime observations. He distinguishes between 2 different modes of Ci seeding. Cirrus uncinus and related clouds may develop large ice crystals capable of surviving an extended trajectory through clear air. Such crystals are capable of infecting middle level stratified layers. Cirrostratus and ice shield layers probably consist of small ice crystals which are not capable of long clear air trajectories. In this case, convective towers must penetrate or come very close to the ice cloud for appreciable seeding to occur. - MGA 19.9-248.

582. Hoffer, T. E. and Perthel, R. <u>Characteristics and laboratory uses of a spray type generator</u>. Journal de Recherches Atmosphériques, Clerment-Ferrand, 3(1-2): 203-206, January-June 1968. (International Workshop on Cloud Nuclei, Lannemezan, France, September 8-23, 1967, Communications). DAS M(05) J86jor.

The construction and operation of a spray-type generator for generating mixed nuclei are described. A diagram is included, and a graph shows the number of effective nuclei produced per sec as a function of temp. (phloroglucinol nuclei compared to AgI and Metaldehyde generators). A table gives the number of nuclei produced per sec with a large and a small spray generator. The average radius of the individual droplets is close to 2 μ , provided that a large amount of mass is not transported in large droplets. Droplet production is sharply peaked in the 1-3 μ range. - MGA 20.5-183.

583. Hollomon, J. Herbert. Reflections on the consequences of social and technological change. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law. Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 206-214) Also his: Statement before the Senate Committee on Commerce, on S.23 and S.2915, regarding weather modification, Feb. 25, 1966. pp. 215-228. DLC.

In an analysis of the consequences for man of our present advances in science and technology, the author raises questions of society's moral responsibility in decision making and in affecting change in a highly interdependent world. Of particular concern is the question as to whether it is morally responsible to seek to effect weather and climate change without specification of advance controls for dangers that may be unleashed by such activities. Other fundamental issues arising from technological progress and its consequences for society are discussed, together with the types of decision society is making with regard to them. A major role in dealing with unresolved problems of a technocracy is assigned by the author to "the University." In his statement before the Senate Committee on Commerce of Feb. 25, 1966, the author presented his views on weather modification and on 2 bills on this subject before the Congress. He expressed support for authorization for the Secretary of Commerce to conduct a weather modification program. The statement included general comments on weather modification; the need for redirection

of the national effort in this field; a discussion of the scope of such a program; ouestions of information gathering; non-interference with federal projects; public safety and indemnification aspects; and the need for international cooperation in weather modification activities. The role of ESSA as a regulatory body is discussed, together with weather modification activities of other agencies. The author concludes with proposals for coordination of the national effort, and makes legislative recommendations to meet our goals. - MGA 20.3-224.

584. Hosler, C. L. Of wizardry, witches, and weather modification. Weatherwise, Boston, 21(3): 110-113, June 1968. DAS M(05) W362.

Suggests failure in the educative process as a critical element in poor public response to weather modification experiments, as exemplified by the laws of Pennsylvania curbing such activities, but emphasizes continued need for experimentation in environmental manipulation within carefully controlled limits in order to improve the technology. Various approaches to weather modification and its problems are discussed in broad terms, and the techniques involved, including applications of the techniques of cloud seeding and regulation of heat flow are enumerated. - MGA 20.4-207.

585. Houghton, Henry G. On precipitation mechanisms and their artificial modification. Journal of Applied Meteorology, Boston, 7(5): 851-859, October 1968. DAS M(05) J86joa.

Natural precipitation processes are re-examined on the basis of accumulated knowledge of the microphysical aspects and field observations, with particular attention to the implications for cloud seeding. It appears that the active lifetime of a convective cell is much the same as the time required to grow precipitation particles and, therefore, that artificial nucleants should be inserted during the inception of the cell. The accretion process appears to be dominant in convective precipitation and there is evidence that the effectiveness of the sweeping action could be enhanced in many cases by adding more precipitation particles. The dominant precipitation mechanism in the stratiform systems characteristic of extratropical cyclones is the ice crystal process. It is proposed that the uniformly high precipitation efficiencies of such systems, in the face of the great variability of the concentration of natural ice nuclei, result from the exponential increase in active ice nuclei with decreasing temperature. It is suggested that opportunities exist for redistributing some of the precipitation by seeding if the nucleants are released into the proper cloud layer at the correct time. Orographic precipitation often involves convective clouds as well as forced uplifting and the characteristic synoptic features and topography of the particular region are of major importance. It is believed that opportunities exist for reducing the loss of condensate in the downslope flow by seeding upwind of the barrier. It is concluded that opportunities exist for the modification of each of the three general types of precipitation

considered, but that their realization depends on much more complete observations and a more quantitative approach than have been typical of past cloud seeding experiments. - Author's abstract.

586. Howell, Wallace E. Management of snow pack by weather modification.

Eastern Snow Conference, 25th, Boston, February 8-9, 1968, Proceedings, 1968. pp. 1-5. DAS M(06) E13p v.13 1968.

The article reviews the shift in the U. S. national policy toward weather modification since 1957 as regards increasing snowpack to augment water resources. Results of various national and foreign cloud seeding projects to date are summarized. There is a need to validate current weather modification techniques for particular modifications, for particular needs. Progress in these areas is reported and illustrated. The most important task lies in the field of technological innovation to actually put weather modification to work in the management of snowpack. - MGA 20.8-233.

587. Huff, F. A. Area-depth curves: a useful tool in weather modification experiments. Journal of Applied Meteorology, Boston, 7(5): 940-943, October 1968. DAS M(05) J86joa.

The area-depth curve provides a simple mathematical expression of the spatial distribution of rainfall within a rain-gaged area. It can also provide a measurement of time variation in the spatial distribution as a storm progresses; this may provide clues on how seeding is affecting treated cloud systems. Analyses of the area-depth curves could reveal tendencies for seeding to intensify or decrease the average rainfall gradient in treated storms and, consequently, indirectly provide information on modification of the physical processes in the treated cloud system. - MGA 20.4-208.

588. Hurley, Patrick A. Augmenting Colorado River by weather modification.

American Society of Civil Engineers, Irrigation and Drainage Division,

Journal, 94(4): 363-380, December 1968. DAS P.

An overall perspective on the promising potential for increasing winter precipitation over mountains of the upper Colorado River basin is presented in an engineering context for water development planners. The resulting augmented spring runoff, regulated by existing reservoirs, can provide additional water to meet growing demands for the region where present water supplies are becoming critically short. Increasing the Nov. through April precipitation by 15% over 14,200 mi² of target areas generally located at elevations above 9500 ft will yield an average additional runoff of 1,870,000 acre-ft annually. This practical capability to enhance the winter snowfall should be developed by the mid-1970's through the outlined \$25,000,000 applied research field program. Exclusive of initial research costs, regular production costs by weather modification are

estimated at \$1.00 to \$1.50 an acre-ft for the new water. Average additional benefits are estimated to be 20 to 25 million annually, for a highly favorable benefit-cost ratio of about 10 to 1. - MGA 21.3-673.

Jiusto, J. E.; Pilié, R. J.; Kocmond, W. C. Fog modification with giant hygroscopic nuclei. Journal of Applied Meteorology, Boston, 7(5): 860-869, October 1968. DAS M(05) J86joa. Also issued as reprint in: Symposium on Progress of Research on Warm Fog Properties and Modification Concepts, Performed by Cornell Aeronautical Laboratory under NASA Contract Washington, D. C., February 6, 1969, Papers March 1969. DAS M75 S989pa.

Analytic and experimental investigations were conducted to examine the concept of modifying fog with hygroscopic material. An approximate equation was derived that is useful in estimating the feasibility of such applied problems. The combined results show that it is possible to improve visibility in warm fog by seeding with micron-size salt particles (NaCl). The visibility in laboratory fog produced in a 600-m³ chamber was increased by factors of 3-10, with as little as 1.7 mg m-3 of NaCl being effective. Only a modest reduction (< 1%) in ambient relative humidity by the giant salt particles is necessary to cause substantial evaporation of the fog droplets. Extrapolation of these results suggests that clearing a suitable landing zone for aircraft should not involve prohibitive amounts of properly sized seeding material. - Authors' abstract.

Johnson, Ralph W. <u>Iegal implications of weather modification</u>. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law. Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 76-102) DLC.

Describes general activity in weather modification law and outlines the roles being developed by the courts, legislatures, and administrative agencies concerned. Reviews the legal literature, pertinent legislation of the various states, and the probable parameters of the court centered common law system applied. Difficulties are especially notable in establishing cause-effect relationships. Some common law analogies are suggested and a number of topics cited requiring further legal and other research. Court decisions serving as precedents are cited. The report to the U. S. Senate Committee on Commerce, "Weather Modification and Control," of April 22, 1966; the NSF report of 1966; and other publications are stated to provide good coverage of the legal consequences of weather modification. The available body of case law is very limited. To date, only 8 states have created weather control administrative boards. While Texas favors action in weather modification, Pennsylvania practically precludes all work in this area -- Maryland prohibits it. Analysis of several cases demonstrates the extreme difficulty of presenting cause and effect proof. Current severe limitations on the efficacy of the courts in dealing with problems resulting

from weather modification have contributed to the establishment of regulatory agencies. Relevant analogous legal concepts may perhaps be derived from concepts of "reasonableness" in nuisance and riparian rights cases; also from principles involved in strict liability, trespass, and negligence. An extensive reference bibliography and case source is appended. - MGA 20.3-225.

Jones, D. M. A.; Stout, G. E.; Mueller, E. A. Raindrop spectra for seeded and unseeded showers in Arizona. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 99-106. DAS MO9.6 N277pr 1968.

Concerns a study made at Flagsteff, Ariz. in 1966 and 1967 to determine the differences, if any, that exist between the drop-size distributions of more humid climates and those of the dry plateau climate of north-central Arizona. Data on surface drop-size distributions, surface and upper air winds, radiosonde observations, surface temperature and relative humidity, precipitation, freezing nuclei, and chloride particles were collected. concluded that at least 4 mechanisms were operative in the production of the high concentration of drops associated with the summer storms in Flagstaff. These were: 1) artificial nucleation of the clouds to produce glaciation, 2) natural seeding by ice crystals falling from the anvils of earlier or nearby thunderstorms into the clouds, 3) the self-glaciation of the stable rains falling from decaying thunderstorms, and 4) seeding from the burning of large masses of tree products. The data did not reveal a case of artifically seeded rain with which hail was observed to fall. - MGA 19.11-461.

592. Kahan, Archie M. The place of government programs in weather modification. American Meteorological Society, Bulletin, 49(3): 242-246, March 1968. "Paper presented at AAAS Symposium on Weather Modification, New York, December 30, 1967. DAS M(05) A512b.

Activities grouped together as "weather modification" cover a wide range and have important differences and similarities. Many governmental agencies in pursuing long standing interests in the relation of the atmosphere to their missions, have become involved in individual weather modification programs. Study of the details of what is going on provides little evidence that serious empire building or duplicative efforts are the rule. Cooperation and coordination exist between Federal agencies but should be improved particularly in the areas of planning for the future and attracting the participation of the additional skilled people. - MGA 19.8-200.

593. Kahan, Archie M. and Eddy, Richard L. Weather modification: a progress report. In: International Conference on Water for Peace, Washington, D. C., May 23-31, 1967, Water for Peace. Washington, D. C., U. S. Printing Office, 1968, Vol. 2: 401-409. French and Spanish summaries pp. 408-409. DAS 333.91 I61wa v.2.

A report on Project Skywater, an expanding research and engineering effort of the U. S. Bureau of Reclamation to develop a practical technology for increasing water supply through weather modification. The activities include field experiments conducted in Colorado, Missouri and Rio Grande river basins; the Interior Basin, Pacific Northwest; and in Southern Sierra to find out how to apply available knowledge to uncover new knowledge and to develop and test new techniques and procedures. Field support by other Federal agencies such as the WB, GS, Forest Service and the SCS and laboratory research, conducted by contractors such as state universities and private institutions, that requires carefully controlled conditions are discussed. Future plans call for the development of a "practical reliable capability in selected western mountain areas by about 1975." - MGA 21.8-126.

Western Resources Conference, 9th, University, July 5-7, 1967, Man and the quality of his environment: Western Resources Papers. Boulder, University of Colorado Press, 1968. pp. 81-89. DAS 301.3 W527ma.

Explores some of the effects of intentional weather modification on the human environment. A definition of weather modification is also provided. Data are presented comparing silver concentrations in treated air and in the precipitation following cloud seeding, with acceptable levels. These concentrations are of several orders of magnitude lower than maximum tolerance levels for both air and water. Relative concentrations of other seeding materials are also considered. Fog dispersal techniques employed near Orly Airport. France, produced light snow but icy road warning signs effectively reduced accidents. It is contended that careful monitoring of seeding activities reduces, rather than increases, flood hazards. Evidence suggests that no significant downwind decrease in precipitation is likely; on the contrary, an increase may be anticipated. It is believed that operations for lightning suppression in areas susceptible to forest fires will have little effect on precipitation; high suppression activities. however, may actually increase precipitation. Results of hail suppression efforts are inconclusive. Progress in moisture management can result only from much careful study and experimentation. - MGA 20.12-161.

Kocmond, Warren C. Investigation of warm fog properties and fog modification concepts. Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., CAL Report RM-1788-P-18, January 15, 1968. 10 pp. (Contract no. NASr-156, (Project Fog Drops), Quarterly Progress Report). DAS M(051) C81/4rep 1788-P-18.

Describes progress made in first quarter of 5th contract year in l_4 major areas: 1) theoretical modeling of fog modification by seeding with hygroscopic nuclei; 2) a climatic survey of fog frequency in the Buffalo, N. Y., area; 3) large scale lab.

experiments to test different size distributions of sodium chlorime nuclei and effectiveness of seeding fogs with urea crystals; plans and preparations for field testing of the proposed seeding concept in spring of 1968 are presented. A computer program has been developed to simulate the response of natural and artificial fogs to the seeding techniques described, and the results are compared with those of earlier experiments. Computed visibility is presented in graphic form as a function of time. The experimental findings are analyzed, the techniques employed are described, and details of the numerous tests are provided. Pertinent features of visibility improvement, including seeding mass and model diameter of particle distribution, are discussed and presented in tabular form. Future research plans are outlined. - MGA 20.4-217.

596. Kondratova, A. V. Otsenka vodozapasov pereokhlazhdennykh oblakov sloistykh form ne daiushchikh osadkov. (Evaluation of the water content of supercooled stratiform clouds which do not yield precipitation.) Leningrad. Institut Eksperimental noi Meteorologii, Trudy, No. 3: 44-54, 1968. Russian summary p. 109.

Presents evaluated data of average quantities of additional precipitation from supercooled St, Sc, and Ac clouds, and from Ns-As clouds that do not yield precipitation under natural conditions. Additional precipitation could be obtained on the European territory of the Soviet Union as a result of its systematic artificial accumulation during the cold half of the year. The maximum contribution of additional precipitation does not exceed 5% of annual normal or 13% of the winter normal. - MGA 20.12-162.

597. Kornienko, E. E.; Tovbin, M. V.; Furman, A. I. <u>Issledovanie metoda</u> vozdeľstviia na konvektivnye oblaka pri pomoshchi poverkhnostno-aktivnykh veshchestv. (Studying convective cloud modification techniques employing surface-active agents.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorclogicheskii Institut, No. 74: 99-104, 1968. Russian summary p. 143. DAS M(055) U581tu no. 74.

The authors present a method of artificial production of precipitation from convective clouds by introducing into the cloud surface-active substances that reduce the surface tension of the water drops. The surface-active substance leads to participation in the chain process of fractionation of a larger number of drops than during the natural development of clouds. The calculation of critical dimension of fractionating drops is made by the formula of V. G. Levich, namely $r_0 = A\sigma/\rho v^2$, where r_0 is critical radius of drop fractionation, v is velocity of fall of drops, ρ is atmospheric density, σ is surface tension at the liquid air boundary, and A is a constant. The reagent was introduced into a cloud with the aid of an aircraft liquid device. The experiments were carried out in the summer of 1966 on 15 Cu long clouds with a thickness of 20h km. The effect was evaluated by comparing

precipitation from the experimental clouds and control clouds. The parameters of the experimental clouds and the results of modification by a surface active reagent, the frequency of the values of the parameters in the control and experimental clouds and the frequency of cases with precipitation of varying intensity from experimental and control clouds are presented. Precipitation was produced by modification, but the quantity was extremely small. - MGA 20.7-193.

Kornienko, E. E. Statisticheskaia otsenka effektivnosti vozdeistvii na konvektivnye oblaka s tsel'iu uvelicheniia osadkov. (Statistical evaluation of the effectiveness of convective cloud modification to increase precipitation.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Leningrad, Trudy, No. 74: 90-98, 1968. Russian summary p. 141. DAS M(055) U581tu No. 74.

The author presents the results of evaluation of the effectiveness of modification of convective clouds carried out on the Experimental Meteorological Polygon of the Ukrainian Hydrometeorological Inst. situated in the steppe region of the Ukraine. experiments were conducted during the period of May-Aug. 1965. The monthly precipitation totals of the experimental and 2 control plots were compared. The statistical evaluation was made by means of the regression equation of experimental or control areas, Student's criterion, and the Wilkinson and Van der Waarden criteria. The increase of precipitation on the experimental plot amounts to 5.5-8.4 mm a month or 13-20% of the monthly totals with a probability of randomness of 9.1-18.7%. In months with precipitation amounts of 10-100 mm, the increase amounts to 17-24%. The association between the experimental and control areas is disturbed substantially during the period of modification; this also indicates the effect of modification on precipitation. In view of the high probability of the randomness of the observed increase of precipitation, it is not possible to determine the magnitude of the artificial supplement caused by mcdification, even in the course of a series of years. - MGA 20.8-234.

Koscielski, Alexander and Dennis, A. S. A randomized seeding experiment in South Dakota. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 47-54. DAS MO9.6 N277pr 1968.

Rapid Project was established to test the hypothesis that rainfall over extended areas can be increased by artificial nucleation of supercooled convective clouds. Since 1966, a randomized crossover design with target areas of ~700 sq mi each has been used. The experiment is randomized by days and test days are stratified (typed) in advance in accordance with meteorological conditions. Operations are controlled from a radar facility located east of Rapid City. Six radar sets are used to control project aircraft, record aircraft tracks, and provide data on precipitation cells. Seeding is carried out primarily by an aircraft equipped with

2 silver iodide generators and 2 racks carrying up to 14 pyrotechnic devices (flares) each. Seeding is carried out below cloud base with the aim of introducing 1-10 ice nuclei/1 effective at —10°C into the updraft air. Aircraft probes show that contamination of the unseeded target area occurs on some days but that it is possible to maintain consistently higher ice nuclei counts in the target area designated for seeding. Rainfall data for the 67 test days of 1966 and 1967 have been evaluated using covariance analysis and two rank tests. With southwest flow aloft, seeding produces statistically significant rainfall increases in parts of the predesignated target areas. With northwest flow aloft, the results are conflicting and not statistically significant. — MGA 19.9-249

600. Krasnogorskaia, N. V. Elektrichestvo teplykh oblakov. (Electricity of warm clouds.) Doklady Akademii Nauk SSSR, 181(5): 1111-1114, 1968. DLC. For translation into English consult the corresponding issues of its Doklady of the Academy of Sciences of the U.S.S.R., Earth Science Sections, issued Washington, D. C. DAS P.

In an attempt at an electrical approach to the problem of precipitation forming in warm clouds, experiments were conducted in 1966 on the distribution of charges of cloud particles and on the potential gradient of the electrical field in natural warm Cu and Sc clouds up to 1 km thick. The measurements made from an aircraft and the determination procedures are described. The two types of distribution of charged particles revealed by the measurements (symmetrical and skewed on the negative side of the spectrum) are shown graphically. The average particle charge was found to be greater in the part of the cloud where the charge distribution is skewed. Electrical fields in clouds are small; the potential gradient \Rightarrow 30 v/cm. The measurements confirmed the author's previous conclusion (Krasnogorskaia, 1960, 1965) that along with mixed charges there are parts of clouds with predominantly unmixed charges. The author therefore investigated the effect of electrical forces in natural clouds on coagulation and on collision and merging of droplets. In conclusion, if, as a result of natural or artificial intervention, particles with sufficiently large charges appear in a natural cloud, the enlargement of particles will begin in the region of sizes that are too small for gravitational growth. Electrical coagulation combined with gravitational growth can lead to sudden, strong downpours often observed in the development of Cu-rain and thunderstorm clouds. - MGA 20.7-491.

601. Kudriavtseva, S. K. and Polovina, I. P. <u>O nekotorykh voprosakh metodiki vozde</u>istviia na pereokhlazhdennye sloistoobraznye oblaka s tsel'iu ikh rasseianiia. (Methods of modifying supercooled stratiform clouds to achieve their dispersion.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 74: 18-31, 1968. Russian summary p. 135. DAS M(055) U581tu no. 74.

On the basis of a series of experiments on the dispersal of supercooled stratiform clouds with solid carbon dioxide, the authors examine such problems as the number of seeding lines, the intervals between seeding lines, the cloud characteristics, etc. Data are presented on experimental determinations of the intervals between seeding lines and on the character of the variation of seeding in the experiments. In the course of comparatively small time intervals, there may occur substantial variations in the characteristics of the cloud layer, particularly thickness and water content. The possible interval between seeding lines, during which complete cloud dispersal in the zone of seeding can be achieved, is determined, above all, by the stage of the life of the cloud. The time of widening and the width of the dispersal zones of individual lines is larger in cloud layers tending to disintegration, as indicated by a decrease in thickness or water content. In the case of intensification of the clouds (increase in thickness and water content), the conditions for dispersal deteriorate, since in this case the dispersal process is retarded by extending the dispersal zone laterally as a result of turbulent diffusion and the inflow of moisture because of vertical moisture exchange. The latter effect is particularly evident near nonseeded sectors of clouds, which serve, as it were, as centers of reconstitution of the cloud mass. - MGA 20.8-228.

602. Kumai, Motoi. Fog modification on the Greenland Ice Cap. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 414-422. DAS MO9.6 N277pr 1968.

The USA CRREL Cloud Physics Group modified supercooled fog by liquid propane seeding on the Greenland Ice Cap during the 1965 summer months. This paper describes the nuclei of supercooled fog before and after seeding by liquid propane and discusses the nucleation process. It was found that giant sea salt nuclei are moving inland over the Greenland Ice Cap. It was concluded that a snow crystal is formed by epitaxial growth on clay minerals and that ice nucleation of supercooled fog by liquid seeding occurs by thermal effect. - MGA 19.11-224.

603. Kyriazopoulos, B. D.; Livadas, G. C.; Angouridakis, V. E. Olympus

Cumulus Project, Part I. Artificial draining of summer-clouds:

preliminary report. Thessalonike. Panepistemion. Ergasterion

Meteorologias, Meteorologika, No. 9, 1968. 36 pp. English, Greek,

French and German summaries pp. 5-7. DAS M(055) Thildpu no. 9.

Cases and "days" of water yielding ground clouds without rain $(N_{\,G}^{\,+})$ outnumber cases and days of rain (R). In most cases of rain there is a coexisting water yielding cloud on the ground. Rain clouds occur mostly around the level of the Met. Station. The importance of the cloud catcher has been confirmed; by its exposure the frequency of atmospheric water grounding has been increased as well as its duration, and also the amounts of

atmospheric precipitation and the intensity of rain in the presence of ground clouds (Rg) have increased. The total amount of water collected from clouds (cloud drip) without rain is ($N_{\rm d}^+$) almost equal to the amount of rainfall (R). Quota of vertical to horizontal precipitation, maximum amounts, and maxima of intensity are noted. The frequency spectra for the duration of vertical and horizontal precipitation, and the frequency spectra of their daily amounts, show a tendency towards higher values of the frequency maximum when the water collection is wholly due to clouds. The frequency of cloud cover on the ground (ground clouds) and the hourly amounts of vertical and horizontal precipitation, tend to decrease during the day and increase at night. There is proof of a high frequency of alternation among the different types of liquid atmospheric precipitation R, Rg and $N_{\rm d}^+$. - MGA 20.1-166.

604. Lee, Jean T. and Kessler, Edwin. Aerial cloud photography as a technique for observing cloud growth and development. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 343-349. DAS MO9.6 N277pr 1968.

Photography from aircraft flying above 60,000 ft provide high resolution data concerning the growth and development of convective clouds over a wide area. Such data might be used to monitor the effects of attempts to modify cloud growth, although the view from above may occasionally be obstructed by clouds higher than those it is desired to observe. Photographs taken from U-2 and RB-57F aircraft operating in the NSSL program, at high altitudes during 1962-1967, show an area of tens of thousands of square kilometers corresponding to the cameras' 180° x 45° field of view. Stereographic analysis of consecutive photographs determines the distribution of cloud tops above selected levels, as well as growth rates of individual towers. Small scale phenomena are also clearly observed. - MGA 19.9-499.

605. Litvinov, I. V. and Ruzheinikova, Iu. V. <u>Povtoriaemost'v Podomskov'e oblakov, prigodnykh dlia iskusstvennogo preobrazovaniia</u>. (Frequency of clouds in the Podmoskov'ye area suitable for artificial modification.) Leningrad. Institut Eksperimental'noi, Meteorologii, Trudy, No. 3: 35-43, 1968. Russian summary p. 107.

Aircraft atmospheric sounding data at the Vnukovo airport and precipitation measurement results at 8 precipitation measuring posts provide estimates of the number of clouds suitable for modification by seeding with crystallizing reagents in the Moscow region. In the cold part of the year, 25 days with cloudiness suitable for scattering are observed in Podmoskov'e (environs of Moscow). The more precipitation the clouds give naturally, the less the possibility of their artificial modification. The maximum additional precipitation amount that can be obtained over a significant area lies within 10-40% of the normal precipitation for the considered period. By precipitating on a

limited area all the cloudiness suitable for modification, it is possible to double the natural amount of precipitation. All computations are made with the assumption that all the accumulated super-cooled cloudiness can be precipitated. - MGA 20.12-163.

606. Lóry Manuel E. Project Aguanube, 7 November 1967 through 31 October 1968; final report. Submitted to: Lluvia Artificial Inc. Bollay (E) Associates, Inc., Technical Report. December 2, 1968. 29 pp. DAS M09.617 B691pr.

The disastrous drought conditions which prevailed in Puerto Rico during late 1964 and 1965 prompted the formation of Lluvia Artificial Incorporada, a non-profit corporation established by local private concerns and Government agencies interested in water problems and created specifically to sponsor a rainfall stimulation program. An intensive seeding operation was conducted on a crash basis for the whole of the South coast of Puerto Rico from late April to mid-July when the sponsors considered that the emergency was over. Although ample rains fell during the operating period and the agricultural drought was terminated by late June, the climatological drought had been only partially relieved and the ground water deficit was still great.

Similar severe drought conditions recurred during 1967 and Lluvia Artificial, again considering that the likelihood of gain greatly outweighed the risk of loss, decided to undertake another stimulation program. This time, however, in view of the catastrophic coincidence of two great droughts almost back to back, it was reasonable to expect that the need for additional water would extend over a long interval. Consequently, operation AGUANUBE was conceived, to serve the immediate purpose of alleviation of the drought, but to be conducted over a sufficient period of time so it could provide adequate inputs for a future study of the economic implications of present-day stimulation techniques. The present report covers the first season of a planned five-year program. The target area was to be the whole of the South Coast up to and including the reservoirs along the Central Cordillera: the Loiza watershed and the extreme northeastern part of the island.

The seeding program was designed to be flexible, both in response and techniques, and to profit as much as possible from experience and new innovation. Thus, although climatological considerations had suggested planning full-scale operations starting in May to optimize the available funding, the additional emergency created by the dwindling water supply for the city of San Juan dictated a localized effort for the Loiza watershed during March and April. - Author's summary.

607. McCarthy, John. Computer model comparisons of seeded and not-seeded convective cloud depth using Project Whitetop data. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1,

1968, Proceedings. Boston, 1968, pp. 270-279. DAS MO9.6 N277pr 1968.

Reports a computerized study made by the Cloud Physics Lab. of the Univ. of Chicago to investigate the seeding effect on summertime cumulus congestus clouds occurring over the Project Whitetop experimental area in southern Missouri during the summers of 1960-64. From 171 operational days, the vertical convective cloud depth was calculated for a hypothetical test cloud, using the Project Stormfury model applied to a variety of assumed glaciation levels. It was found that the overall seedability decreases when the level of natural glaciation becomes successively warmer. Differences were found in seedability of clouds of different radii. The greatest seedability occurred with mean lapse rate between 7 and 8 deg km⁻¹ while the magnitude of the seedability fell off sharply in both directions from this range of values. - MGA 19.11-241.

608. MacCready, P. B., Jr. and Baughman, R. G. The glaciation of an AgI - seeded cumulus cloud. Journal of Applied Meteorology, Boston, 7(1): 132-135, February 1968. DAS M(05) J86joa.

Records from an airborne continuous cloud particle collector showed distinct differences in particle characteristics between an unseeded and a seeded cumulus cloud. The unseeded cloud consisted primarily of supercooled water droplets and the seeded cloud entirely of ice particles at the observed levels.

Complete glaciation was achieved by AgI seeding even at the relatively warm temperature of -7C. The AgI acted as efficient ice nuclei even though introduced through a warm cloud base with temperatures above OC. The observed concentration of crystals was considerably larger than would have been predicted from the standard AgI generator calibration data.

Large crystals were observed clustered together in the fully glaciated seeded cloud. - Authors' abstract.

609. MacDonald, Gordon J. F. How to wreck the environment. (Unless peace comes, Pt. 4). New Scientist, London, 38(594): 180-182, April 25, 1968. Excerpt from: Calder, Nigel, (ed.), Unless peace comes. Penguin Press, 1968. DAS P.

At present, success in weather modification is limited. It is possible to clear fog locally, on airfields, for instance, and there is some possibility of increasing precipitation in certain favorable areas. Future development of meteorological science may, however, open up a number of possible ways in which weather, or climate, modification might be used to gain a strategic advantage over an enemy. Methods discussed briefly here include; controlling the development and movement of hurricanes; changing the radiation balance of the atmosphere by planting radiation absorbents in the upper atmosphere; reducing precipitation over

a chosen area by seeding upwind; making local, temporary, holes in the ozone layer to permit ultraviolet radiation to penetrate; triggering instabilities on the Sun; and the manipulation of ice fields, either by altering the radiation balance of their surface using a covering of radiation absorbent material, or by initiating the "Wilson" mechanism by exerting gravitational pressure on the ice cap causing them to advance into the sea. - MGA 19.11-216.

610. MacDonald, Gordon J. F. Weather modification. Science Journal, 4(1): 39-44, January 1968. DAS P.

Weather modification efforts must be directed at releasing instabilities in the Earth's atmosphere. Theory of precipitation formation, developed by American researchers from the Bergeron - Findeisen mechanism, is described. Results of experiments in America and Australia are recounted briefly. Active research on hail suppression in U.S.S.R., the National Science Foundation's support on new studies in South Dakota, and studies of lightning suppression in the U.S. under Project Skyfire are in progress. - MGA 19.8-201.

611. McQuigg, James D. Bibliography for NSF Project GA-1110. Revised edition December 17, 1968. 175 pp. DAS M(016) M173bib.

Pages 1-26 contain weather modification references under the following headings: bibliography; general; cloud and fog modification; hail and snow modification; hurricanes modification.

612. Mallinger, William D. A view from mariners of Project Stormfury.

Mariners Weather Log, Washington, D. C., 12(4): 111-113, July 1968.

DAS M(05) U587ma.

Reports that Project Stormfury forces will be on the alert to modify tropical storms and hurricanes this coming season. The seeding seasons runs from Aug. 1 to Oct. 15. The most likely scene of staging operations is the Naval Station at Roosevelt Roads, Puerto Rico. Some hurricanes could be seeded from bases in Florida. Benefits to the mariner are indicated. A decrease in wind strength near the center of the storm with attendant decrease of sea and swell would permit faster and smoother sailings, resulting in reduced ship and cargo storm damage. - MGA 20.5-184.

613. Mann, Dean E. Proposals for federal control of weather modification activities. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law. Dobbs Ferry, N. Y., Oceana Publications, Inc. 1968. pp. 141-162) DLC.

Assesses current thinking with regard to federal legislation of weather modification activities, summarizes pertinent recommendations in reports by various federal commissions, and cites specific bills introduced in, but not acted upon by the Congress. Although there is a considerable agreement on the goals sought to be achieved by federal regulation, differences of opinion center

on the most efficient means of achievement, priorities of allocation of available resources, and proper timing of legislation. It is widely agreed that control of weather modification is, by nature of the elements involved and on constitutional grounds, a responsibility of the federal government. State legislation is potentially restrictive. Federal legislation should include licensing of private weather modifiers. the WMA has taken steps to establish qualifications. Recommendations of the special commission on weather modification (SCWM) are discussed with regard to coordination of research and development programs. The WMA's work in formulating model state regulation and the so called Magnuson bill, the latter containing important restrictive conditions, are cited. Further problem areas involve the assignment of roles and missions among implementing agencies; establishment of "lead" responsibilitity (possibly in the Dept. of Commerce); and basic organization for research and operations, avoiding duplication of effort. The organization for regulation, its character, the possible role of ESSA as regulatory agency, problems of indemnification and private endeavor, international relations in weather modification, and the size of the federal effort are discussed. The author warns against precipitate action. - MGA 20.3-226.

614. Mann, Dean E. The Yuba City flood: a case study of weather modification litigation. American Meteorological Society, Bulletin, 49(7): 690-714, July 1968. DAS M(05) A512b.

In Dec. 1955 a severe tropical storm caused severe flooding throughout northern California with damage exceeding \$200,000,000. One area suffering large scale flooding was at Yuba City, at the confluence of the Feather and Yuba Rivers. The levees broke and consequent damage was in the magnitude of \$65 million. Property-owners sought recompense through suits brought in the Superior Court of Sutter County against the State of California, Pacific Gas and Electric Company (PG&E), and North American Weather Consultants (NAWC). The suit was begun in 1958 and concluded in 1964. The judge ruled that neither PG&E nor NAWC was liable. In accordance with an agreement among the parties no appeal was taken. Plaintiffs were successful, however, against the State, basing their claim for damages on the doctrine of inverse condemnation which holds that the State must recompense for damages incurred in the lawful exercise of its powers-in this case, the construction of levees. The litigation raises important questions of public policy as regards weather modification. - MGA 20.6-183.

615. Markovic, Radmilo D. Statistical evaluation of weather modification:

target two-sample run method. International Association of Scientific Hydrology, Publication no. 76, 1968. pp. 426-435. (IASH, General Assembly of Bern, 25 Sept. - 7 Oct. 1967, Commission of Surface Waters: Hydrological Aspects of the Utilization of Water). DAS M(06) I6llg S Hyd. no. 76.

The distribution-free run method, devised for solving non-parametric problems of testing whether two continuous distributions are identical, was employed for statistical evaluation of weather modification at the river flow control level. The practical application of this two-sample method to the sequences of runs of ordered nonseeded and seeded annual river flows drained from a target basin indicated that the method is sensitive to differences both in shape and in mean between two distributions.

- Author's abstract.

616. Mason, B. J. Weather modification. In: International Conference on Water for Peace, Washington, D. C., May 23-31, 1967, Water for Peace, Washington, D. C., U. S. Government Printing Office, 1968. Vol. 2: 389-393. French and Spanish summaries pp. 392-393. DAS 333.91 I6lwa v.2.

The controversial nature of the subject is alluded to. A review of the results of "rain making" is preceded by a discussion of major and quasi-permanent changes in the general circulation implied in widespread changes in the weather. It is noted that although the 1883 Krakatoa explosions and the 1963 eruption at Bali caused widespread and marked reduction in direct insolation, corresponding changes in temperature and in circulation were small and difficult to detect. The main assumptions on which "rain making" is based are stated. Many hundreds of trials have shown that seeding may often induce light showers and very occasionally a heavy local shower and clear large areas of fog. The important question is whether changes in rainfall can be produced on an economically useful scale. Randomization of cloud seeding experiments is discussed. Perhaps the most disappointing feature of the last 15 yr is not so much the failure to produce rain, but that little advance has been made in cloud-modification technology and methodology, and that relatively little effort has been devoted to mechanisms. The problems probably lie more in the realm of atmospheric dynamics than in the microphysical processes of particle growth and aggregation. - MGA 21.8-119.

617. Maunder, W. J. and Sewell, W.R.D. Adjustments to the weather: choice or chance? Atmosphere, Toronto, 6(3): 93-96; 105-108; 115, 1968.

In this paper are examined some aspects of meteorological science which the Canadian Meteorological Society in its first years might well encourage, thereby usefully serving the purposes for which it was founded. The authors state that, knowing the impact of weather, one can hardly know how much to modify it and surely should not modify it without knowing what the results of such modification will be. The use of weather information, economics and social aspects of meteorology, weather forecasting, and weather sensitive activities are discussed. When weather forecasting programs are properly evaluated, when those engaged in weather-sensitive activities operate more efficiently, and when economics of weather modification can be determined more precisely adjustments to the weather will be less of a chance (as they are today), and more a

matter of choice. To make weather a matter of choice, the authors believe that meteorology must broaden its vision by actively encouraging research in the social and economic aspects of the profession. - MGA 20.9-141.

618. Medaliev, Kh. Kh. and Kazankova, Z. P. Issledovanie uslovii obrazovaniia iskusstvennykh zarodyshei gradin. (Studying the conditions for the formation of artificial hailstone nuclei.)

Nal' chik, U.S.S.R. Vysokogornyi Geofizicheskii Institut, Trudy,
No. 8: 32-40, 1968. Russian summary p. 169. DLC.

Artificial hail nuclei arise in two ways: freezing of cloud drops 0.0-1.0 microns in diameter as a result of collision with ice crystals formed by crystallization nuclei, and transformation of ice crystals growing by sublimation to dimensions of 100-150 \$\mu\$, into artificial hail nuclei as a result of coagulation of a liquid-drop fraction. Computations show an inequality in the initial growth stage. With increase in the dimensions of growing particles, the role of the coagulation processes increases, and beginning with large crystal dimensions an inequality is present. The results demonstrate that the formation of ice crystals proceeds in two stages: at first, water drops from an undissolved nuclei by condensation of water vapor and then they freeze under the influence of the nucleus. The expenditure of reagent necessary for artificial modification of the hail process amounts 70-100 g/km 3. - MGA 20.9-498.

619. Mee, Thomas R. Airborne seeding. Conference on the Production and Delivery of Cloud Nucleating Materials, Denver, February 14-16, 1968, Project Skywater, Proceedings: Skywater Conference III, pp. 3-6. DAS MO9.617 C748pro Conf. III.

This discussion covers two aspects of airborne seeding; a summary of instruments and techniques that are available, and a brief discussion of how typical seeding techniques might be applied in an isolated cumulus cloud. - Author's abstract.

620. Mikhailenko, N. M. K otsenke prigodnosti sloistoobraznykh oblakov dlia aktivnykh vozdeistvii v raione Kieva. (Evaluation of the suitability of stratiform clouds for active modification in the area of Kiev.)

U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 74: 85-89, 1968. Russian summary p. 141. DAS M(055) U581tu no. 74.

A preliminary assessment of the suitability of supercooled clouds for modification on the basis of aircraft soundings of the atmosphere carried out in the Kiev district during 1954-1965. Liquid drop clouds with a thickness greater than 300 m and with a maximum temperature in the layer less than —4°C are considered as suitable for modification. Because of the temperature conditions considerable part of frontal and intramass clouds are not suitable for modification. Middle level and Sc clouds possess conditions that are considerably more suitable for seeding. In intramass clouds of the middle level and of small thickness Ns-Sc clouds,

there are more suitable conditions for modifying the phase state. The cold period is the most favorable time of the year for modification; in the warm period conditions for modification are practically nonexistent because of the high level of the location of the cold phase. - MGA 20.8-235.

Mihailenko, N. M. and Polovina, I. P. <u>Prigodnost' oblakov k aktivnym vozdelstviiam na razlichnykh rasstoianiiakh ot fronta</u>. (Suitability of clouds for active modification at various distances from a front.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 74: 78-84, 1968. Russian summary p. 141. DAS M(055) U58ltu no. 74.

Frequency of conditions favorable for modifying frontal clouds to increase precipitation from a front was determined on the basis of network aircraft soundings over the Ukraine. Suitable clouds were considered those with a layer thickness > 300 m containing the liquid drop phase, with a maximum temperature in the layer of warm and cold fronts is practically independent of the position of the sounding in relation to the frontal line at the surface, but in occluded fronts with waves the frequency decreases substantially with increase in distance from the front. The mean values of the thickness of clouds suitable for modification are for all types of fronts, except stationary ones, quite close and vary from 0.96-1.10 km. The clouds most suitable for modification, 85-90%, are Ns and As clouds with mean temperature that is, in most instances, > -12°C and the mean water content is equal to 0.15-1.17 g/m³. - MGA 20.8-236.

622. Mitchell, J. Murray, Jr. Is man's industry upsetting world weather?
ESSA World, Rockville, Maryland, 3(4): 4-7, October 1968. DAS
M(05) E78es 1968 v.3.

The author notes the two contradictory views: one maintaining that atmospheric vagaries are nothing new, and the other ascertaining that Man's activities may be upsetting the delicate natural balance to bring about new weather hazards and tries to answer the question whether both can be right. He dismisses the abomic influence fears by noting that "The bomb tests came and went. Atmospheric radioactivity waved and waned. Still the weather seemed to go on behaving as usual-which is to say, unusual." He then considers the striking changes in the Earth's surface brought about by clearing forests, creating huge artificial reservoirs, irrigation, and paving large areas; and the 10-15% increase in the CO2 content of the atmosphere in the last century. These he states have not yet had much impact on large scale weather, but are almost certain to have in the future. Another factor discussed is atmospheric pollution other than by CO2. Dust and nucleating particles in jet aircraft are believed to trigger initial ice crystal formation but the author believes that there is little basis as yet for supposing that the supersonic

fleets of tomorrow will upset world climate. He concludes that if man is capable of influencing the climate "he can ill afford to forge into the future without a clear understanding of his impact upon it." - MGA 20.8-242.

Mohnen, V. and Vonnegut, B. Weather modification and air pollution.
National Conference on Weather Modification, 1st, Albany, New York,
April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 228-240.
DAS MO9.6 N277pr 1968.

Outlines some of the interrelationships between weather modification and air pollution. It is said that aerosol and gaseous contaminants are affecting the heat balance of the atmosphere by their effects on incoming and outgoing radiation. The carbon dioxide theory suggests that, in the present century, man is unwittingly raising the temperature of the Earth by his industrial activity. - MGA 19.11-254.

Mooney, Margaret L. and Lunn, George W. The area of maximum effect resulting from the Lake Almanor randomized cloud seeding experiment.

Journal of Applied Meteorology, Boston, 8(1): 68-74, February 1969.

DAS M(05) J86joa. Also in: Western Snow Conference, 36th, Lake Tahoe, Nevada, April 16-18, 1968, Proceedings. pp. 54-59. DAS M(06) W527p 36: 1968.

A randomized cloud seeding experiment was conducted on the Lake Almanor watershed near Mt. Lassen, Calif., during five winter seasons, 1962-1967. The target area extended approximately 20 mi east-west and 15 mi north-south, and ranged in elevation from 4500-6400 ft. MSL. Silver iodide was released from groundbased. acetone solution generators which were located between 6000 and 7400 ft MSL. Silver iodide releases were made for 12-hr periods, these seeding periods being subsequently divided into four weather categories, depending on wind direction and temperature. In three of these categories, which together produce approximately 85% of the total precipitation, no response to the seeding was observed in the target area. In the remaining category, characterized by westerly winds and cold temperatures, the increase peaked at approximately 57% between 5 and 11 mi downwind, and averaged 37% throughout the 21-mi distance. Both results were statistically significant at the 5% level. - Authors' abstract.

625. Morachevskii, V. G. and Shiniaev, B. M. Effect of the departure of vapour pressure of aqueous solutions of the surface-active agents from Raoult's law. Canada. Meteorological Branch, Meteorological Translations No. 15: 7-10, 1968. Translation by A. Nurklik of original Russian in Problemy Fiziki Atmosfery, Leningrad, No. 3: 218-220, 1965. DAS M(055) C212me.

The mathematical expression of Raoult's law for a 2-phase one-constituent system given in previous work is referred to in which it was found that $P*=P_p+dP_p$, where P* is the quasi-equilib-

rium vapor pressure over solutions of surface active agents and dPn is the departure from Raoult's law. A series of direct measurements of P showed that $dP_p = 0.2$ to -0.3 mb for $C_{vol} = 1$ -5%, which coincides with the value of supersaturation of vapor for large ($r \geqslant 1 \mu$) drops of solutions of surface-active agents. Reported herein are the results of a study of the growth of droplets of aqueous solutions of different surface-active agents in a dust-free medium, saturated with water. The device consisting of a compressor, heating chamber, humidifier, refrigerator, aerosol filter, glass threads, and a binocular stereoscopic microscope used in the measurement of the condensation growth of droplets is described and illustrated in a diagram. The condensation growth of droplets of alkalibenzylsulfonates and of 3% NaCl solutions is shown graphically. The following conclusions are drawn: Droplet size of surface-active solutions increases at concentrations \leq 3\(\). The growth rate may be described by Maxwell's law, taking into account dP. At high concentrations, the molecules of dissolved substances do not represent a mono-layer but penetrate into the droplet and the effect approaches that of an ideal solution. -MGA 20.7-194.

626. Morachevskii, V. G. and Shiniaev, B. M. Study of fog properties in a cloud chamber. Canada. Meteorological Branch, Meteorological translations No. 15: 1-3, 1968. Translation by A. Nurklik of original Russian in Problemy Fiziki Atmosfery, Leningrad, No. 3: 215-217, 1965. DAS M(055) C212me.

The cloud chamber of the Univ. of Leningrad and the procedures used in a study of the effect of various surface-active seeding nuclei on simulated fogs are described and illustrated in a diagram. In the reported experiment, fog was seeded with a number of surface-active nuclei, in particular with powders of alkylbenzosulfonates. Graphic results show clearly an increase in fog droplet size and a more rapid fallout after seeding. It is noted that the cloud chamber can be used also with liquid nuclei, which will be employed in further experiments. - MGA 20.6-389.

627. Morris, Edward A. Preparation and trial of weather modification litigation. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law. Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 163-184) DLC.

Provides background of, describes preparations for, and analyzes the longest and most complicated weather modification trial ever held. The record breaking floods of northern Calif. at Christmas, 1955, were involved, causing loss of life and multimillion dollar damage. Plaintiffs were some 170 ranch owners; defendant, the Pacific Gas & Electric Co., which had employed a member of the North American Weather Consultants to undertake cloud seeding activities in an area of the Sierra Mts. where the P. G. & E. maintained over 50 dams. These efforts were considered moderately successful in increasing precipitation, to the

financial benefit of the P.G. & E. The pre-flood weather conditions, the collapse of the city of Yuba levees, and the resultant severe flooding are described. Preparation for litigation occupied many years and involved complex legal questions. including the state of the law of absolute liability, and numerous technical matters in weather modification. It was ultimately agreed to try the case without a jury, since costs would have been prohibitive. The counsel for defense describes in detail the studies made, the assertions by the plaintiffs, and the opinions of experts called to testify, including Dr. Vincent Schaeffer. The court found that the plaintiffs could not recover against the P.G. & E., having failed in their burden of proof. and that no significant increase in rain or snow had resulted outside of the Lake Almanor watershed. Hence, the P.G. & E. was not responsible for the breaking of the laws and resultant flooding. - MGA 20.3-231.

628. Mossop, S. C. and Tuck-Lee, C. The composition and size distribution of aerosols produced by burning solutions of AgI and NaI in acetone.

Journal of Applied Meteorology, Boston, 7(2): 234-240, April 1968.

DAS M(05) J86joa.

The Warren-Nesbitt generator is widely used in Australia and other countries for producing a cloud seeding aerosol by burning a solution of AgI and NaI in acetone. It is found that the particle size distribution follows a log probability law with median diameter $0.085~\mu$ and standard deviation factor 1.47. Electron diffraction examination of the particles shows that they consist of beta AgI and NaI. The available evidence indicates that each particle is probably a mixture of these 2 constituents. - MGA 19.7-214.

629. Mueller, Eugene A. and Changnon, Stanley A., Jr. A recording hailgage for use in hail modification projects. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 494-502. DAS MO9.6 N277pr 1968.

The evolution of the design criteria for the Illinois hailgage is discussed; the construction, testing, and operation of the developed gage are described; and data collected from the first sampled hailstorm are presented. Some of the design criteria finally evolved were: the gage had to measure and record against time the size and momentum of individual hailstones, the recovery time between individual stone measurements had to be ≤ 1.5 sec, time of occurrence of each hailstorm event should be recorded to the nearest minute, the record of individual stone data should be continuous over a 10-min period, stone sizes ranging from 6 mm to 7 cm in dia. should be measured, all desired hail data for 3 separate 10-min periods should be separately recorded before servicing was necessary, the gage should be easily installed and serviced, and no external source of 110-v power could be included. - MGA 19.11-155.

630. National Conference on Weather Modification, 1st, Albany, New York,
April 28 - May 1, 1968, Proceedings. Boston, 1968. Conference
sponsored by the American Meteorological Society at the State
University of New York at Albany. 532 pp. All articles on weather
modification abstracted separately. DAS MO9.6 N277pr 1968.

A collection of papers which constitute the Proceedings of the first National Conference on Weather Modification. Field programs and projects were described in 12 papers; 7 papers dealt with warm rain and warm cloud modification; five papers were concerned with large scale climate modification; 9 papers, with inadvertent modification and social and legal aspects to weather modification; 7 papers, with cumulus modeling and cumulus seeding; 6 papers, with instruments and techniques for weather modification; 9 papers, with fog, stratus and winter orcgraphic cloud modification; and 9 papers treated the subject of hail suppression. A statement on weather and climate modification by the American Meteorological Society is included. - MGA 19.11-29.

631. Neumann, J.; Gabriel, K. R.; Gagin, A. Cloud seeding and cloud physics in Israel: results and problems. In: International Conference on Water for Peace, Washington, D. C., May 23-31, 1967, Water for Peace. Washington, D. C. U. S. Printing Office, 1968. Vol. 2: 375-388. French and Spanish summaries pp. 386-388. DAS 333.91 I6lwa v.2.

The paper deals with randomized experiments that began in Feb. 1961. As of Jan. 1967, six seasons of seeding and research were completed. The physical problems relating to the effectiveness of AgI smoke used as a seeding agent are reviewed. The regional mechanism of rain formation is discussed. Typical daily average count of ice nuclei in Jerusalem and their average concentration as a function of time are shown graphically. The growth of solid precipitation elements is discussed qualitatively. Temperature profiles are shown for groups of days with different daily rainfall amounts. Ice nuclei have a marked influence on initiation of The winter cumuli of Israel appear to form their precipitation. precipitation through an ice-crystal mechanism. For shower formation, the tops of Cu must be colder than -15°C. necessary to use seeding agents which produce nucleation at a relatively high temperature. The dependence of daily precipitation on temperature is probably due to the fact that the colder the atmosphere, the lower the -14°C level. As shown by the statistical analysis, the precipitation increase is very large on some and small or negligible on most seeding days. This is probably due in part to the presence or absence of sufficiently high amounts of precipitable water and/or nuclei in the atmosphere and the presence or absence of certain stability conditions, or, rather, potential instability conditions in the atmosphere. - MGA 21.8-127.

632. Odencrantz, F. K. Modification of the ice nucleation efficiency of pyrotechnically produced AgI smoke by atmospheric contamination.

Journal of Applied Meteorology, Boston, 7(5): 955-956, October 1968.

The results for 0.02 gm/m³ of dimethylamine are not shown, since the measured nucleation efficiency was less than 109 active nuclei/gm AgI for all temperature > -10°C. It was found that ammonium hydroxide, hydrogen sulfide, and sulfur dioxide contaminants, which enhance the production of positively charged ice crystals, increase the nucleation efficiency. Contaminants that enhance the production of negatively charged ice crystals decrease the nucleation efficiency. In all cases, crystals decrease the nucleation efficiency, and a decrease in the amount of contaminant reduced the magnitude of the change. - MGA 20.4-219.

of the Department of Defense. (In: Taubenfeld, Howard J. (ed.),
Weather modification and the law. Dobbs Ferry, N. Y., Oceana
Publications, Inc., 1968. pp. 31-43) DLC.

Discusses major interests of DOD in the current national weather modification program aimed at the solution of operational military problems, largely fog and cloud modification with special emphasis on severe weather systems. The 3 major areas of interest are: cold fog and clouds; warm fog and clouds; and convective cloud systems. Programs include Project Cloudbuster and other Air Force seeding operations: Army's use of propane gas to modify whiteout conditions in the north; joint Army-Navy supercooled fog modification field research; AWS Project Cold Fog II (ground based dissipation); and contrail suppression. Warm fog research is supplemented by USAF project "Catfeet": other work in warm fog study is underway under USN-USAF auspices. USAF project in Florida is investigating cumulus clouds in relation to missile tracking systems. An extensive atmospheric electricity and cloud physics field program is underway under joint auspices of DOD and several other agencies, including ESSA. Project Stormfury, a joint DOD-DOC undertaking in hurricane modification is described, and the current techniques of repetitive seeding are discussed, together with planned further investigations in this area. Numerical modeling of fogs has commenced under AFCRL. Other field experiments of Army and Navy are noted and the AFCRL's improvements in data gathering techniques are cited. The Naval Weapon Center's activities are described, together with Navy weather modification programs in the international area. DOD's weather modification program in forests is characterized as "mission-oriented." -MGA 20.7-187.

634. Panzram, H. Niederschlagsbeeinflussung in Kalifornein. (Precipitation modification in California.) Naturwissenschaftliche Rundschau, Stuttgart, 21(6): 256-257, June 1968. DAS P.

Discusses briefly the 1955-65 rain modification experiments in the Santa Clara Valley and the adjacent mountain chain. The mean rainfall of all stations in the control area was 390 mm; in the

target area it was 475 and 435 mm for 1955 and 1965 resp., an increase over the unmodified 1945-54 period when it was 405 and 365 mm resp. The artificial increase varied between 10% (1945) and 15% (1954) in the control area, but analysis by individual years rather than by means shows that in years with low rainfall, when an increase in rainfall would have been desirable, there was no increase in the target area. Maps show that the maximum of precipitation occurred northeast of the target concentration of generators in an area into which silver iodide was carried by southwesterly winds aloft. Artificial rain cannot be produced under unfavorable atmospheric conditions, but precipitation can be increased when naturally favorable prerequisites are present. (This is a summary of the article in Germany (Federal Republic). Deutscher Wetterdienst, "Berliner Wetterkarte, Beilage 163/67, So 56/67"). - MGA 20.4-220.

635. Peterman, William A. <u>Hygroscopic treatment of warm cloud precipitation</u>.

National Conference on Weather Modification, 1st, Albany, New York,
April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 107-113.

DAS M09.6 N277pr 1968.

Presents preliminary results of numerical investigations conducted at the Navy Weather Research Facility to study the warm rain process and the modification of this process by the introduction of hygroscopic particles to the distribution of naturally occurring condensation nuclei. The development of cloud droplet distributions undergoing condensation and coalescence within closed parcels has been shown to be significantly altered by the addition of hygroscopic treatment nuclei, and the type and magnitude of the alteration is dependent upon the size and amount of treatment used. - MGA 19.11-449.

636. Picca, R.; Gasc, H.; Mailhes, R. La production de cristaux de glace dans une chambre a détente. (Production of ice crystals in an expansion chamber.) Journal de Recherches Atmosphériques, Clermont-Ferrand, 3(3): 245-252, July - September 1968. French and English summaries p. 245. DAS M(05) J86jor.

The concentration of ice crystals produced by an adiabatic expansion of natural air or air polluted with silver iodide is measured. The influence of the minimum temperature reached during the expansion and that of the expansion ratio are studied. The experimental results are compared with those given by a mixing chamber.

As to the air polluted with silver iodide, we find that when it is diluted with fresh air, the decrease of the concentration of active nuclei is less than that of the theoretical value.

The produce of a Vortex generator is measured and compared with the one given by a cloud chamber and also with the one given by direct observation of silver iodide nuclei with an electronic microscope. - Authors' abstract. 637. Podgurskaia, V. N. and Polovina, I. P. Radiolakatsionnye issledovaniia polos iskusstvennykh osadkov. (Radar investigation of zones of artificial precipitation.) Vsesoiuznoe Soveshchanie po Radiolokatsionnol Meteorologii, 3rd, Dolgo-Prodnaya, USSR, April 1966, Trudy. Moscow. 1968. pp. 166-172. Russian summary p. 254.

Radar observations on precipitation produced by seeding supercooled clouds are examined. The position of the seeding lines was determined by means of radar tracking of the aircraft. Appropriate observations of the radio echo zone were made on a three cm radar and the results were recorded by photographing the screen of the indicator of the circular field of view. Zones of developing precipitation were tracked from the moment of appearance to disappearance. In four experiments with 136 seeding lines it was found that precipitation formation takes place in from 12 to 16 minutes and the rate of descent of the precipitation zone is about 1.5 m/sec. These data agree satisfactorily with aircraft observations made in individual experiments. The mean width of the zones in the layer near the ground varies from 1.55 to 2.10 km and the maximum width attains 2.5 km. The duration of zones of artificial precipitation in the layer near the ground does not exceed 30-35 min. In addition from the radar echo data it was possible to determine and compare also the width of the crystallization zone and the width of the precipitation zone. - MGA 21.1-120.

638. Podgurskaia, V. N. and Polovina, I. P. Radiolakatsionnye issledovaniia polos iskusstvennykh osadkov, obrazuiushchikhsia pri vozdelstvii na sloistye oblaka. (Radar investigations of artificial precipitation bands forming during modification of stratiform clouds.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 74: 44-54, 1968. Russian summary p. 137. DAS M(055) U581tu no. 74.

Material of radar observations, including more than 3000 photographs of the screen of radar plan position indicator, has been used to determine the different characteristics of zones of artificial precipitation produced by seeding intramass clouds. Analysis of the material shows that on the average, precipitation formed in 14 min after introduction of solid carbon dioxide. The rate of descent of precipitation zones, which was determined from the difference between the time of their appearance at the maximum angle and an angle of 1 degree and also from the difference between these altitudes, was ~ 90 m/min (1.5 m/sec). The mean width of the zones of artificial precipitation in the layer near the ground varied from 1.55-2.10 km; the maximum width was 2.5 km. The duration of the existence of these precipitation zones in the layer near the ground was determined as the difference of time between appearance and disappearance of the same zone at an angle of 1 degree. It did not exceed 30-35 min. The time of existence

of precipitation zones in the layer near the ground, determined from the position of outermost zones visible on the radar screen at an angle of 1 degree, proved to be of the same order. The radar observations enabled a study to be made of the vertical profiles of precipitation zones from the moment of appearance until their disappearance. It was found that the zones of artificial precipitation are formed in the center of the cloud thickness, hence, in the course of 25 min after seeding they spread with a velocity of ~ 1.5 m/sec. In 30-35 min after seeding, the upper boundary of the zones begins to descend and their width decreases sharply. - MGA 20.6-184.

639. Poland, Fred. Melting the Arctic ice. New Scientist, London, 39(608): 244, August 1, 1968. DAS P.

A recent Priroda article crystalizes proposals put forward by some Russian scientists for ameliorating the climate of the Arctic. Engineering designs have been published for building a series of barriers which would dam the Bering Strait. Cold Arctic water would then be pumped into the Pacific permitting warmer Atlantic water to flow across the Arctic basin. It is expected that it would take 3 yrs for the Arctic sea ice to disappear; temperatures in the northern regions would rise by some 30° to 35° and permafrost would vanish. The cost of the scheme would be immense and international cooperation would be required to fund it. Canadian meteorologists, and even some Russians, have doubts as to whether the scheme would work. They point out that the flow of warmer water into the Arctic basin would cause a huge fog to develop over the area with an increase in precipitation producing a greater supply of snow to increase the ice caps of Greenland and Canada's Arctic areas. - MGA 20.4-215.

640. Polovina, I. P. Nekotorye osobennosti raspredeleniia vetra v St-Sc i uchet ikh pri aktivnykh vozdeltviiakh. (Some characteristics of the distribution of wind in St-Sc and allowance for them in actual modification operations.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Institut, Trudy, No. 74: 68-77, 1968. Russian summary p. 139. DAS M(055) U581tu no. 74.

On the basis of 1620 parallel aircraft and radiosonde ascents the author investigated the characteristics of wind distribution (velocity and direction) in stratus and stratocumulus clouds as a function of the thickness and height of the lower boundary of the clouds. Maximum magnitude of variation of wind direction in cloud layers is observed at a lower boundary height up to 400 m and attains 150-170°. Frequency of large variations in wind direction within the limits of individual height intervals declines with increase in cloud heights and with decrease in the cloud thickness. In the case of cloud layers situated at a height > 1000 m maximum value of the variation in wind direction does not exceed 65°. Frequency of the values of variations of wind speed of 3 m/sec and greater at a lower boundary height of up to 200 m amounts to

46.4% and at a height > 1400 m to 15.1%. In cloud layers with a thickness of 100-200 m, frequency of variation in wind speed of 3 m/sec and higher is 6.5%, and in clouds with a thickness of 700-800 m it is 31.7%, in the case of maximum variations of 14 m/sec. Mean value of wind shear is 54 m/min for clouds with a thickness of 100-200 m and 175 m/min for clouds with a thickness of 600-700 m. Magnitude of mean gradients of wind speeds and the frequency of values exceeding them diminished with increase in height and thickness of the clouds. In cloud layers with a lower boundary height up to 200 m, the mean gradient is 0.70 and at a height > 1400 m -0.31 1/sec. For clouds with a thickness of 110-300 m and >700 m, the mean gradient was resp. 0.59 and 0.821/sec. In cloud modification of intramass clouds the wind shear influenced the course of crystallization. This effect manifested itself in that the widening of the crystallization zone at the moment of its maximum development exceeded the width of the dispersal zone of the clouds (visibility of the Earth) in incividual cases by > 1000 m. - MGA 20.6-393.

641. Polovina, I. P. O rezul'tatakh rabot po rassenianiiu pereokhlazhdennykh oblakov i tumanov i vozmozhnostiakh provedeniia ikh nad aeroportami Ukrainy. (Results of supercooled cloud and fog dispersion operations and possibilities of carrying them out over airports in the Ukraine.)
U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologischeskii Institut, Trudy, No. 74: 32-43, 1968. Russian summary p. 137.
DAS M(055) U581tu no. 74.

Results of dispersion of supercooled clouds and fogs carried out in the winter season of 1964-65 over several airports in the Ukrainian S.S.R. are presented and analyzed. On the basis of 11 yrs of observations made at 9 stations in the Ukraine there were obtained data on the duration of supercooled fogs and low clouds, their daily variation and the wind speeds. Fogs and low clouds suitable for seeding are observed during Nov. to March with a maximum in Dec.-Jan. The mean number of hours with such fogs varies in winter from 13 (Odessa) to 96 (Donets) and the number of hours with fogs and low clouds at these points varies from 25-234. Duration of fogs and low clouds suitable for dispersion does not exceed 6 hrs in most cases; but the duration of fogs only may reach 2 days (Donets). The maximum frequency of fog and low clouds (about 40%) is between 6 and 10 hrs and the minimum between 14 and 19 hrs. Fogs suitable for dispersion are observed in 50-60% of the cases during wind velocities up to 2 m/sec. The frequency of wind speed of 5 m/sec and above, except for special points, is 10-15%. Low clouds and fogs suitable for dispersion are characterized by large wind shear. Extensive data are presented in tables. - MGA 20.8-225.

642. Polovina, I. P. Predvaritel'nye rezul'taty opytov po opredeleniiu koeffitsienta realizatsii vodozapasov. (Preliminary results of experiments on the determination of the coefficient of potential water supply.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii

Gidrometeorologicheskii Institut, Trudy, No. 74: 55-67, 1968. Russian summary p. 139. DAS M(055) U581tu no. 74.

There are presented the results of ll experiments of modification intramass stratiform clouds in order to determine the coefficient of realization of water supplies. The latter term is defined as the relationship between the actual amount of artificial precipitation and that calculated on the basis of data on the supplies of liquid drop moisture in clouds; it is expressed by the equation $k = (R/R_c) 100\%$; where R is the total amount of artificial precipitation over the entire area, and R_c is the computed (possible) amount of precipitation. The parameters R and R_c are determined by the equations:

$$\bar{R} = \sum_{i=1}^{n} R_i S_i / \sum_{i=1}^{n} S_i$$
, and $R_e = \frac{Q}{S}$,

where s is the area of precipitation fall, Q is the amount of moisture transported through a line of seeding; and Q is determined by

$$Q = PvtL_m$$

where P is water supply of a cloud layer, v is rate of transport of clouds taken as equal to wind speed, t is time of modification, and L_m is length of the modification line. In calculating the length of the line of modification, in which complete crystallization penetrating the cloud layer is to be produced as a function of the rate of transport of the cloud and given intervals between the lines of seeding, it is necessary to account for the seeding aircraft turning time (1). The time the aircraft spends on the seeding line (t_L) is given by $t_L = (L_{kr}/\nu) - t_r$, where L_{kr} is width of the crystallization zone or interval between seeding It has been established that the most favorable conditions for carrying out experiments to compute the coefficient of realization of water supplies exist at wind speeds of 5-10 m/sec. In the case of small velocities there is realized a momentary water supply of a cloud layer that frequently does not yield a measurable amount of precipitation. In the case of wind speeds greater than 10 m/sec it is impossible to completely crystallize a cloud mass, and to produce the maximum realization of its water supply without using aircraft with a velocity greater than that of the IL-14. The possibility of calculating the amount of artificial precipitation is rendered difficult by the fall of natural precipitation up to and after the experiments. insignificant number of experiments does not permit final conclusions on the practically real values of the coefficients of realization of water supply. On the basis of preliminary experiments, they vary within the limits of 60-80%. - MGA 20.7-195.

643. Polovina, I. P. Rezul'taty sopostavleniia eksperimental'nykh i rasschitannykh znachenii shiriny zon kristallizatsii. (Results of comparison of experimental and computed values of the width of the crystallization zone.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 74: 11-17, 1968.
Russian summary p. 135. DAS M(055) U581tu no. 74.

The author compares experimentally and theoretically calculated values of the width of the crystallization zone formed in the case of seeding of supercooled stratus clouds. To verify the possibility of calculating the width of the crystallization zone by means of a theoretical formula of turbulent diffusion, there are necessary data on the values of the coefficient of horizontal exchange in intramass clouds. Calculations are not feasible with V. V. Nikandrov's formula, $L = 4\sqrt{kt}$ (L is width of the crystallization zone at a definite moment after modification, k is coefficient of turbulent diffusion, and t is time elapsed after seeding), taking into account the coefficient of turbulent exchange; they do not yield data similar to experimental results. The values of the coefficient of turbulent exchange determined from optimum data lie within the limits of 1.41-5.28 X 102m 2/sec with a mean value of 2.68 X 102 m²/sec. In the case of wind speeds up to 5 m/sec the values of the width obtained experimentally are on the average equal to those computed with L. I. Krasnovskii's formula:

$$L = 2C(u\tau)^{m/2} \sqrt{\ln \frac{Q \cdot 10^3 \operatorname{erf}\left(\frac{x_0}{2C(u\tau)^{m/2}}\right) \operatorname{erf}\left(\frac{z_0}{2C(u\tau)^{m/2}}\right)}}$$

where c is vertical coefficient of turbulent exchange, u is wind speed, τ is time after modification, m is factor determining thermal stratification in a cloud, Q is productivity of the source, x_0 is length of the seeding zone, and z_0 is vertical thickness of the cloud. In the case of speeds greater than 5 m/sec the computed values at 1000-2000 m exceed the experimental ones. - MGA 20.7-196.

644. Preobrazhenskaia, E. V. O vzaimodelstvii melkodispersnykh poroshkov ionoobmennykh smol s vodnym aerozolem i vodianym parom. (Interaction of finely dispersed powders of ion exchange resins with water aerosol and water vapor.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 224: 157-168, 1968. Russian summary p. 211. DAS M(055) U581tg no. 224.

The paper presents results of experiments on the effect of high-molecular compounds (ionites) on the stability of water aerosol at 18-20° in a large-volume experimental cloud chamber. Ion-exchange resins of twelve manufacturers were used and some were chemically treated. According to powder grain, the substances were divided into two fractions: fraction I with particle mean diameter between 5 and 10 μ , and fraction II with mean particle diameter 40 and $60\,\mu$. Silicagel was tested. The

effect of ionite and silicagel seeding on the fog in the chamber was weak. Acceleration of fog dispersion by seeding in comparison with natural dispersion of the fog in the chamber was 10-15% and only in some cases amounted to 20-30%. In order to compare seeding with high-molecular compounds with the effect of hygroscopic substances on the stability of water aerosol at positive temperatures, the author conducted experiments with sodium chloride. It appeared that all ionites and silicagel do not compare favorably with NaCl. - MGA 20.7-188.

Preobrazhenskaia, E. V. Opredelenie sledov medi v osadkakh pri
vozdelstviiakh sernistol med'iu na konvektivnye oblaka. (Detection
of copper traces in precipitation in cases of cuprous sulfide
modification of convective clouds.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 224: 169-175, 1968.
Russian summary pp. 211-212. DAS M(055) U581tg no. 224.

Results are presented of the chemical analysis of the copper content in precipitation produced by seeding convection clouds with CuS. The experiments were conducted near the Central Aerological Observatory of the Moldavian S.S.R. in summer 1966. The reagent was introduced into the supercooled portion of the cloud by means of hail-prevention rockets. Four experiments with CuS, during which subsequent precipitation sampling was performed, are described. - MGA 20.7-197.

646. Prikhot'ko, G. F. <u>Iskusstvennye osadki iz konvektivnykh oblakov.</u>
(Artificial precipitation from convective clouds.) Leningrad,
Gidrometeozdat, 1968. 175 pp. bibliography pp. 162-172. DAS MO9.6
P95lis.

The author of this monograph, the late Director of the Ukrainian Hydrometeorological Res. Inst. paid particular attention to investigations in active stimulation and modification of clouds, precipitation, and fog. To study methods of artificial stimulation of precipitation, a 7000 km² experimental meteorological base was established under the author's direction in the Dniepropetrovsk Region in 1958. This base, equipped with radar installations, consists of two 50 X 75 km (3750 km²) areas 30 km apart, one of which is used for the experiments while the other serves as the control. In 1960-62, 300 rainfall stations (1 per 11-12 km²) operated on the experimental area and 270 on the control: of these 25, were recording gages (on each area). In addition to describing the experimental base and analyzing the results, the author briefly reviews previous investigations and discusses the physical basis of stimulation of convective clouds for rainmaking. In conclusions, the author states that, for Cu clouds with a life of 3 hrs and a transport velocity of 30 km/hr, the experimental area should be > 100 X 100 km and must be radar equipped. Up-to-date aircraft must be used in seeding. Following are some of the conclusions drawn from the presented analysis of the results obtained on the smaller areas. In plane relief, artificial stimulation does not reduce total rainfall in the

region. Evaluation by comparing total amounts shows some additional rainfall on treated areas; such additional rainfall for a month or a season cannot be considered certain. The probability of artificially producing precipitation from Cu cong can be determined with the obtained $T_8-\Delta H$ criterion $(T_8-\Delta H)$ temperature at the seeding level, ΔH -cloud thickness). - MGA 19.10-3.

647. Rabbe, Asmund; Hoppestad, Sverre; Eriksen, Bjørn. Cold fog occurrence at Oslo airport, and methods of artificial dissolution. Meteorologiske Annaler, Oslo, 5(1): 31-43, 1968. DAS M(05) N892.

If the authors discard the fog periods which last <5 hrs, there remain $\simeq 10$ fog periods every winter (Oct.-April). Since Fornebu Airport is closed for all traffic during the night ($\sim 1/4$ of the time), and since the cold fogs of Oct., April, and (in part) March appear mainly during the night or early morning hours, $\sim 40\%$ of cases may be neglected. On the average, 6 periods lasting >5 hrs remain, suitable for seeding. Some last so long that several seedings are needed, but we should not in general expect >5-10 seedings each winter. It is hard to decide whether dry ice seeding from a plane or propane seeding from a fixed installation is preferable. However, meteorologists and airline managers seem to favor the former for physical reasons, the latter for economic reasons. - MGA 20.2-399.

648. Ramana Murty, Bh. V. and Biswas, K. R. Weather modification in India.

Meteorological Society of Japan, Tokyo, Journal, 46(3): 160-165,

June 1968. DAS M(05) M589sj. Also in: National Conference on

Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968,

Proceedings. Boston 1968, pp. 71-80. DAS M09.6 N277pr 1968.

Experiments on artificial stimulation of clouds using warm cloud seeding technique have been conducted, on randomized basis, from ground for 4 monsoon periods at Jaipur, 6 monsoon periods at Agra and 9 monsoon periods at Delhi, in North India. The seedings were also conducted from aircraft, during one monsoon period at Delhi. Orographic clouds have been seeded for two summer seasons at Munnar in South India.

Results have been evaluated on the basis of rainfall amounts obtained from raingauges in the respective target and control sectors in each region. Evaluation has also been done on the basis of data obtained by high power microwave radar in the case of a few series of trials conducted at Delhi.

A net increase in precipitation was suggested in each area as a result of seeding. The percentage increase in rainfall as a result of ground-based seeding varied from 18.6 to 58.5 according to the area. Statistical evaluation indicated that the results obtained could be significant. - Authors' abstract.

649. Rand Corporation, Santa Monica, California. Weather-modification progress and the need for interactive research. By the staff of Weather Modification Research Project, Research Memorandum RM-5835-NSF, October 1968. DAS 507.2 R186r no. 5835 NSF. Also issued in: American Meteorological Society, Bulletin, 50(4): 216-246, April 1969. DAS M(05) A512b.

A review of the status of weather modification research, with emphasis on progress since 1966. The authors stress that (1) the possibility of inadvertent weather or climate modification is rapidly becoming a probability, as human effects on the atmosphere and the surface of the planet grow at an increasing rate; (2) progress in weather modification research continues to be hampered by the prevalent lack of cohesive effort by both theoreticians and experimenters; (3) computers of advanced design and increased capacity will handle atmospheric models of considerably greater sophistication than in the past; and (4) this is a not-to-beneglected opportunity for interactive research -- constant two-way feedback from theory to experiment to theory, with dynamic atmospheric models facilitating each advance. General and specific recommendations are appended concerning areas most urgently requiring research and instrumentation most drastically needing development. - Authors' abstract.

650. Reedy, William W. and Hurley, Patrick A. Making weather modification a working partner in water resources development. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 65-70. DAS MO9.6 N277pr 1968.

Following information on the Atmospheric Water Resources Program, there is a discussion of the acceptance of precipitation modification in making economic decisions. It is indicated that the technology of precipitation modification is rapidly developing to a point of widespread operational application. It is essential now that the water resources planners begin to consider ways in which precipitation modification can be brought into the analyses as a significant and realistic alternative, recognizing its characteristics of costs, effects, and reliability. It is also incumbent on the scientist engaged in weather modification research to develop those data that will be needed by the planner comparing this alternative with other plans for multiple-purpose water resource development. - MGA 19.11-244.

651. Reinking, Roger F. and Grant, Lewis O. The advection of artificial ice nuclei to mountain clouds from ground-based generators. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 433-445. DAS MO9.6 W277pr 1968.

Reports a study on the advection of artificial ice nuclei to mountain clouds from ground-based generators. Information is

given on data and instrumentation, and ice nuclei concentrations. The advection of nucleants from ground-based generators to target mountain cloud systems has been shown to be dependent upon storm pattern as related to topography and parcel instability in air masses passing through the target area. The imposed interrelationships induce significant differences in the delivery of seeding material and in the resultant seeding effects. - MCA 19.11-245.

652. Rhea, J. Owen. An attempt to explain variations of seasonal mesoscale target-to-control area precipitation ratios. National Conference on Weather Modification, 1st, Albany, New York. April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 446-554. DAS MO9.6 N277pr 1968.

In this presentation, tabulated data reveal a rather organized change in precipitation ratio values with change in average wind direction. It was found that while the very rough averaging processes used herein still allow good qualitative agreement with expected orographic effects, it is likely that more stable seasonal precipitation ratios could be derived by performing the laborious task of tabulating the type of surface map feature in combination with 700 mb and 500 mb patterns versus precipitation ratios. - MGA 19.11-246.

653. Rinehart, Ronald E. and Staggs, Donald W. <u>Use of radar to delineate</u>
surface hail areas in weather modification experiments. National
Conference on Weather Modification, 1st, Albany, New York, April 28 May 1, 1968, Proceedings. Boston, 1968, pp. 464-473. DAS MO9.6
N277pr 1968.

Reports on an evaluation of the ability of a 3-cm radar operated in a step-gain, step-tilt mode to delineate the areal extent of surface hail in a 400 mi² area of central Illinois. In the April-Sept. 1967 period, 83 hailstreaks occurred during radar operational periods; various results comparing point and area hailfalls with radar reflectivities at different levels at and above the surface are presented. It appears that any attempts to measure the area of small hail at the surface, based on high reflectivities at the surface, will be unsuccessful unless some other parameter detectable by radar or a combination of radar and synoptic parameters can be found which will significantly improve the accuracy. One parameter to be reconsidered is the ratio of areas of reflectivity at different values near the maximum reflectivity detected for each day. The negative correlation between this ratio and the hail area is sufficiently good to warrant further investigation of the various possible relationships which might exist. - MGA 19.11-120.

654. Roberts, Walter Orr. State of the art in weather modification. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law.

Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 1-21) DLC.

Present day techniques include cloud seeding to increase precipitation, using dry ice or silver iodide. itation, using dry ice or silver iodide. "Orographic seeding" is widespread in areas favorable to supercooled cloud formation, but experiments in seeding cumulus clouds in summer have been inconclusive. In the U.S.S.R., efforts to modify storm systems to avert hail are reported to have had significant results. In the U. S., the Forest Service is sponsoring lightning suppression research. Other projects underway aim to discover means of suppressing or steering hurricanes. Fog dissipation techniques have been successful, but only under favorable conditions. In the field of large scale atmospheric modification. empirically discovered persistence trends are of greater importance in long range weather forecasting than the results of theoretical research into the complex factors involved. Adequate global meteorological data are not yet available. A major worldwide attack on the problem of large scale circulation modification is being currently formulated under the joint auspices of WMO and ICSU in the Global Atmospheric Research Program (GARP). The effects of high altitude nuclear tests, the increase in CO2 in the atmosphere, and of other air pollutants, are discussed. need for greater financial support in weather modification research, the social, moral, and legal problems to be anticipated, and the proper allocation of responsibility for future work in this field are stressed. - MGA 20.2-171.

655. Robertson, Charles E. Evidence of pulsed seeding as measured in the air and snow. National Conference on Weather Modification, 1st,

Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 326-335. DAS MO9.6 N277pr 1968.

Discusses ways in which analyses of pulsed seeding are made in air and snow. Following details on the geography and basic instrumentation is information on artificial ice nuclei observations. The design characteristics of the Park Range Atmospheric Water Resources Program are reviewed. The data from the nuclei counter do show a relationship between the nuclei concentration at Rabbit Ears Pass and the wind velocity at the generating site. Evidence of pulsing is found. No pulses were observed in crystal structure or degree of riming as indicated by replicas, although a unique small hexagonal plate with detailed internal structure was recognized. - MGA 19.11-247.

656. Sansom, H. W. A report on hail suppression experiments in Kenya.

East African Community, Proceedings of the Fourth Specialist Meeting on Applied Meteorology in East Africa held at the University College, Nairobi, Kenya 26-27 November 1968. 3 pp. DAS M(055) Ellpro.

Hail damage causes an average annual loss of tea in the Kericho area of over 700,000 kg. Evidence from earlier work on hail suppression by explosive rockets suggests that this is an effective technique. Since Oct. 1967, a more conventional

method of seeding hail clouds with freezing nuclei has been used in the Kericho and Nandi Hills area. This method may not be as effective as explosive rockets, although a much greater area is protected. It is difficult to reach firm conclusions because of variability in efficiency of reporting storms and the absence of any proper control area. Number of hailstorms studied, location of rocket sites, and average damage per hailstorm are displayed in charts. - MGA 21.10-130.

657. Sargent, Frederick, II. Weather modification and the biosphere.
National Conference on Weather Modification, 1st, Albany, New York
April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 173-180.
DAS MO9.6 N277pr.

Considers the interactions between weather modification and the biosphere. It is advised that, to deal with the problems both inadvertent and conscious weather modification pose for the biosphere, one must understand the transactions and flows that take place between organisms and their habitat. It is concluded that taming the weather can be a dangerous game. There may be gains for human welfare from achieving some control over the weather. At the same time there are some imponderable ecological risks. Man must undertake ecological studies that will allow him to anticipate the consequences and implications of conscious weather modification for the biosphere. - MGA 19.11-217.

658. Schaefer, Vincent J. The early history of weather modification.

American Meteorological Society, Bulletin, 49(4): 337-342, April 1968. DAS M(05) A512b.

Reviews briefly certain aspects of weather control prior to 1946 and then attempts to provide an accurate historical chronology of the significant advances which occurred during the early period of this new phase of atmospheric science. The control of weather within our global atmosphere has been a dream of man for many centuries. In its earliest phases this ambition was limited to the rain needed for a tiny patch of corn or some similar local and immediate need. As man's knowledge of the atmosphere increased and his needs became more urgent and widespread, his approach to such problems was increasingly directed toward a scientific consideration of the possibilities as well as limitations of changing atmospheric processes. Prior to 1946, all of the proposals advanced toward doing something about modifying atmospheric processes failed to consider the massive nature of the atmospheric and the need to depend on triggering mechanisms to utilize the latent energy which develops from some of the physical reactions and interactions which occur in clear and cloudy skies. - MGA 19.11-209.

659. Schaefer, Vincent J. What about the next twenty years? Weatherwise, Boston, 21(3): 114-117, June 1968. DAS M(05) W362.

Reviews cloud seeding experiments, including tests of the Jan. 1968 Yellowstone Expedition to compare standard with newer seeding materials; stresses the cost benefit ratio of increasing precipitation from unstable clouds by seeding; and cites efforts abroad in large scale cloud seeding, in contrast to lagging U. S. efforts. Hail suppression programs are said to be active in several parts of the world. The role of inadvertent weather modification as an air pollution byproduct, particularly downwind of large industrial areas, is emphasized. Responsibilities of government, industry, and education in the field of weather modification are reviewed, and socioeconomic political, legal, and international implications are summarized. - MGA 20.4-209.

660. Schickedanz, Paul T. and Decker, Wayne L. The determination of optimum design and minimum duration of cloud seeding experiments. National Conference on Statistical Meteorology, 1st, Hartford, Connecticut, May 27-29, 1968, Proceedings. Boston, American Meteorological Society, 1968. pp. 124-132. DAS MO9.314 N277pr 1968.

Information is given on the basis of generating data for a synthetic rain gage network and a method for simulation of rainfall records. The method described applies only to daily observations and was used for testing a single area in which 1/2 of the days are seeded and the other half are nonseeded. - MGA 19.12-141.

661. Schleusener, Richard A. Hailfall damage suppression by cloud seeding:

a review of recent experience. National Conference on Weather

Modification, 1st, Albany, New York, April 28 - May 1, 1968,

Proceedings. Boston, 1968, pp. 484-493. DAS MO9.6 N277pr 1968.

Evaluation of experience to date indicates that seeding with silver iodide at rates of < 1000 gm/hr/storm may stimulate convection and increase the number of individual hail events, but that heavier seeding at rates of 2000-3000 gm/hr/storm is effective in reducing the total impact energy. - MGA 19.9-250.

662. Schleusener, Richard A. Hailfall damage suppression by cloud seeding:

a review of the evidence. Journal of Applied Meteorology, Boston,

(6): 1004-1011, December 1968. DAS M(05) J86joa.

Extant physical models allow the hypothesis that seeding may produce either increases or decreases in hailfall. Present technology for delivery of seeding materials permits seeding with higher concentrations and greater accuracy of placement with airborne equipment than is possible with ground equipment.

Evaluation of experience to data supports the hypothesis that seeding at rates of less than 1000 gm hr⁻¹ per storm may stimulate convection and increase the number of individual hail events, but that heavier seeding at rates of 2000-3000 gm hr⁻¹ per storm is effective in reducing hailfall damage by reducing the total impact energy from hailfalls.

Limited observational evidence suggests that the effects of cloud seeding on hailfalls may extend to clouds not directly affected by the seeding material. - Author's abstract.

663. Schleusener, Richard A. A perspective on weather control. American Society of Civil Engineers, Irrigation and Drainage Division, Journal, 94(1): 73-78, March 1968. DAS P.

Consideration is given to weather control on 3 scales: local weather systems, cloud and storm systems, and the global circulation system. It is noted that weather control can be accomplished on local weather systems by forceful intervention, such as construction of greenhouses or local frost-prevention measures. In cloud and storm systems, physical changes can be accomplished by using existing knowledge and available cloud-seeding technology. However, the effects of these changes are imperfectly understood, and for larger storm systems the effects are only the subject of speculation. Proposals for modification of the global circulation suffer the disadvantage that the possible deleterious effects of such actions create an unacceptable risk in the absence of adequate information on the probable results. - MGA 20.3-223.

664. Sewell, W. R. Derrick. Emerging problems in the management of atmospheric resources: the role of social science research. American Meteorological Society, Boston, Bulletin, 49(4): 326-336, April 1968. DAS M(05) A512b.

The emergence of 3 major problems has given rise to growing public concern about the atmosphere and an increasing desire to manage it like other natural resources. These problems relate to the mounting volume of air pollution, the rising toll of losses due to extreme weather events, and man's increasing ability to modify the weather. Such problems have brought into sharp focus the fact that our knowledge of the human impact of atmospheric variations is still quite limited, and has emphasized the need for a considerable acceleration in research relating to the economic, social, institutional, and ecological aspects of the management of atmospheric resources. This article outlines types of research that are most urgently required in this connection and offers suggestions as to possible means of stimulating an expansion in the present research effort in this field. - MGA 19.10-181.

665. Sewell, W. R. Derrick; Kates, Robert W.; Phillips, Lee E. Human response to weather and climate: geographical contributions. The Geographical Review, N. Y., 58(2): 262-280, April 1968. DAS P.

The focus of geographical inquiry into the human dimensions of the atmosphere appears to be changing, partly as a result of the development of new concepts and techniques in the field of geography as a whole, and partly as a result of the fact that means have been found to alter the atmosphere in purposeful ways. A consequence of the latter development has been the elevation of the atmosphere to the status of a resource. A number of public policy issues concerned with the management of atmospheric resources have arisen, but most of them remain unresolved. In particular, debate continues as to the circumstances under which man should attempt to modify the weather. Several scientific and Congressional committees have pointed out that a considerable expansion in research is needed before the problems of managing atmospheric resources can be dealt with satisfactorily. The authors of the present article suggest that geographers could make an important contribution to this effort, and they outline 4 major lines of inquiry that might be pursued.

- MGA 20.2-72.

666. Shulepov, Iu. V. Rasseianie tumanov pri vvedenii kontsentrirovannykh rastvorov s Zemli. (Fog dissipation by means of seeding with concentrated solutions from the ground.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 74: 105-118, 1968. Russian summary p. 143. DAS M(055) U581tu no. 74.

On the basis of the solution of a system of equations for functions of dimensional distribution of particles introduced in clouds, the water content of a fog, the density of water vapor, and temperature, the author concludes that there exist optimum values of the concentration and dispersal of particles introduced in clouds at which the height, extent of the clearing, and visibility in the fog are a maximum. There are devised formulas for calculating the length on which a clearing forms, the shape of the clearing, and the visibility within it, etc. The parameters of a clearing in fog during the introduction of calcium chloride particles are calculated. It is shown that in the case of a reagent expenditure of 12 kg/min, there is obtained a clearing at a distance of about 1.3 km that is 60 m high and extends 600 m; the visibility in the clearing is improved in comparison with a a fog by 5.6 times. - MGA 20.7-189.

667. Simpson, Joanne; Wiggert, Victor; Mee, Thomas R. Models of seeding experiments on supercooled and warm cumulus clouds. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 251-269. DAS MO9.6 N277pr 1968.

Numerical "modification" experiments are now being performed on a hierarchy of scales of simulated atmospheric circulations. It is indicated that cumulus clouds are well suited for the joint experimental-numerical approach described. Information is given on: the background and philosophy of cloud modeling for modification experiments; the dynamic aspects of the EMB cumulus model; the cloud physics aspects of the EMB cumulus model; the testing of of EMB 67 model with radar observations; tests of EMB 67 with aircraft studies of natural clouds; design of supercooled seeding subroutines for EMB 67: tests with Stormfury

1965 seeded clouds; and warm cloud experiments. It is concluded that the cumulus model described here is, at best, a highly parametrized 1-dimensional treatment of the rising phase of an isolated cumulus tower of prescribed horizontal dimension. - MGA 19.11-249.

668. Soulage, G. and Admirat, P. Mesure du pouvoir glaçogène et modification des nuages. (Measurement of nucleating properties and cloud modification.) Journal de Recherches Atmosphériques, Clermont-Ferrand, 3(1-2): 141-145, January - June 1968. French and English summaries p. 141. (International Workshop on Cloud Nuclei, Lannemezan, France, September 8-23, 1967, Communications) DAS M(05) J86jor.

Meaurements of ice power under the basis of clouds seem absolutely necessary to compute the probability of modifying cumulus in releasing ice nuclei on the ground. They can furnish a list of meteorological conditions fit and unfit for such trials. - MGA 20.3-429.

669. Spar, Jerome. Design study for a cloud seeding experiment in the northeastern United States. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 55-58. DAS MO9.6 N277pr 1968.

Presents a preliminary version of experimental design for a weather modification experiment for the northeastern U. S. The design study is to devise an experiment that will answer the question: How much can precipitation be increased through AgI seeding, either from the ground or from aircraft? The basic experiment is a randomized, 2-area, crossover design using aircraft seeding. This is supplemented by a 1-area, randomized ground level seeding experiment and a nonrandomized ground level seeding operation. General objectives and design features are set forth. - MGA 19.11-250

670. Spar, Jerome. Design study for a weather modification experiment in the Northeastern United States. New York University, Department of Meteorology and Oceanography, Geophysical Sciences Laboratory Report TR-68-11, August 1968. 86pp. (Grant No. E22-112-67(G) ESSA, Final Report) DAS M(051) N532rpo TR-68-11.

The establishment of a randomized-operational type ground-level silver iodide seeding experiment for year-round precipitation augmentation in central New York State is recommended. An experimental design is proposed in which the basic unit is a 24-hour "seedable day", and seeding is restricted to two weather types. A method for estimating expected target area precipitation by pattern fitting and extrapolation from upwind control area data is described, and a procedure is outlined for the use of these estimates in evaluation of the experiment. - Author's abstract.

671. Stalevich, D. D. and Uchevatkina, T.S. K voprosu ob optimal'nykh raskhodakh l'doobrazuiushchikh reagentov pri vozdeistvii na oblaka s tsel'iu vyzyvaniia iz nikh osadkov. (Most effective quantities of ice-forming agents used in cloud modification to produce precipitation.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 224: 10-17, 1968. Russian summary p. 203. DAS M(055) U581tg no. 224.

The optimum quantities of seeding agents introduced into the upper portion of a cumulus are determined by means of linear or point sources. The effect of seeding on clouds of vertical magnitude of 2.00, 2.34, and 2.66 km with temperatures at the upper boundary of -6, -8, and -10°C is discussed. For these clouds, the curves of growth of the reagent particles, introduced into the upper portions of the cloud, were constructed. The distribution of the reagent particle concentration under the effect of turbulent transfer in the active zone is determined, and the width of active zone and the possible precipitation volume are indicated. The optimum quantities were calculated for a reagent with ice-forming activity of 10^{12} particles per gram. A method for determining the optimum consumption of specific reagents is proposed. - MGA 20.7-198.

672. Stinson, J. Robert. <u>Project Skywater planning conferences</u>. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. <u>Boston</u>, 1968, pp. 36-41. DAS M09.6 N277pr 1968.

Project Skywater is a code name for the program management research conducted by the Bureau of Reclamation's Office of Atmospheric Water Resources. Its goal is to develop technology for putting extra water on the ground in the most efficient and effective manner. It is hoped that planning conferences will establish: the status of a problem or problems, what needs to be expanded or improved that is now being done, what needs to be done that is not being done, and priorities to help achieve accomplishment of possible or appropriate approaches to problems. Secondary objectives include the exchange of information between the various participants and the dissemination of the results of the conferences to the interested scientific and industrial communities. - MGA 19.11-251.

673. Stinson, P. J. <u>Design and evaluation in Project Skywater</u>. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 59-64. DAS MO9.6 N277pr 1968.

Presents a brief summary of 11 papers presented at the Skywater Conference on the Design and Evaluation of Weather Modification Experiments held at Denver, Oct. 1967. There seems to be little doubt that seeding convective clouds with a few grams of silver

iodide smoke stimulates precipitation to fall. The physical process, similar to that originally postulated for natural rain, is fairly well known. There still exists confusion and controversy as to whether or not there is a net increase in rainfall due to continued seeding in a specified geographic area. The confusion appears to be concerned with several factors relative to research design and statistical evaluation of data. - MGA 19.11-252.

674. Sulakvelidze, G. K. Printsipy metoda bor'by s gradobitiiami i rezul'taty rabot po predotvrashcheniiu vypadeniia grada. (Principles of hail damage control and results of hail prevention measures.)
Nal'chik, U.S.S.R. Vosokogornyi Geofizicheskii Institut, Trudy,
No. 11: 215-254, 1968. Russian summary pp. 283-284. DAS M(055)
A3131tud vyp. 11.

The principle of active modification of a Cu rain cloud for hail prevention consists of the creation of artificial hail embryos with a concentration that exceeds their natural concentration 10 to 10^3 fold in the hail center that is located by a two-channel radar station ($\lambda=3.2$ and $\lambda=10.0$ cm). This is accomplished by introducing crystallizing reagents PbI₂ and AgI into the zone of hail growth. The methodology of active modification, results of experimental verification, and the methodology of criteria control of effective modification work are described. The use of the described criteria in an analysis of protective results of large agricultural areas (1-1.5 million ha) from hail damage during 1963-1966 shows that the method of modification can be recommended for operational protection of crops from hail damage. - From MGA 20.11-368.

675. Sumin, Iu. P. Metodika rasseianiia pereokhlazhdennykh tumanov pirotekhnicheskimi sostavami s iodidami serebra i svintsa. (Methods of supercooled fog dispersion by pyrotechnic compounds with silver iodide and lead.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Trudy, No. 224: 37-42, 1968. Russian summary p. 204. DAS M(055) U581tg no. 224.

The dispersion of supercooled fog and low clouds by pyrotechnical charges (containing AgI and PbI₂ as the active reagent) is discussed. The relationships are established between the rate of crystallization and wind speed, and between the time in which the crystallization zone becomes maximum and fog temperature. The mean wind speed and temperature in the fog permits determination of the required location of seeding lines, number of points of seeding and the distance between them, and the time lapse between individual firings. Graphs were plotted for establishing the indicated parameters. - MGA 20.9-177.

676. Takeda, K. Some recent results of weather modification activities in Japan. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 8-15. DAS MO9.6 N277pr.

This brief note describes the results of two silver iodide cloud seeding experiments in Kyushu, Japan. The first experiment was conducted on February 23, 1965 about 50 km west of Hitoyoshi and the second was on March 1, 1966 at about 30-40 km NW of Hitoyoshi. Weather conditions during each experiment are recorded. The conclusion is that artificial precipitation depends largely on weather conditions. There probably exist certain adequate weather conditions when natural precipitation does not fall that artificial precipitation will fall. An outline of the experiment in Kwanto is presented.

677. Taubenfeld, Howard J. and Taubenfeld, Rita F. The law and weather modification. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. Boston, 1968, pp. 190-201. DAS M09.6 N277pr 1968.

The potential benefits of weather modification for mankind must be assessed in the context of possibly substantial direct losses for some or many. Reference is made to legal ouestions that involve conflict of laws: those of jurisdiction and amenability. It is suggested that, in time, a Federal approach would seem appropriate to: a uniform system of licensing, an explicit allocation of legal responsibility for damages caused, and a system of penalities for noncooperation. - MGA 19.11-218.

678. Taylor, Dee F. Weather modification and agriculture and forestry. (In: Taubenfeld, Howard J. (ed.), Weather modification and the law.

Dobbs Ferry, N. Y., Oceana Publications, Inc., 1968. pp. 56-64)

DLC.

Establishes weather modification missions of the U. S. Dept. of Agric. (USDA) and Forest Service. Goals of the USDA and State Agriculture Experiment Stations (SAES) include increased food and fiber production, protecting man's environment, and enhancing forest and range water resources. Major dimensions of the program comprise development of techniques for direct weather modification; understanding of biological, economic, and social aspects; and decision making. USDA's long-term research project, "Skyfire," aims to suppress lightning. Field and laboratory work include development of efficient instrumentation in knowledge of the characteristics of lightning strikes and storms; suitable instrumentation; and operational systems for forest fire control agencies. Hail suppression, a high cost element in farm insurance, is a major area of interest. USDA-SAES research, in cooperation with other agencies, seeks to ensure ultimate benefits to agricultural and forest areas. Other major concerns are the biological consequences of weather modification and their monitoring; micrometeorological effects; and the development of an adequate scientific basis for decision making in weather modification. The speaker emphasizes the qualifications of the USDA in these problem areas. - MGA 20.4-210.

679. Temple, Joann. To find a ghost. ESSA World, Rockville, Maryland, 3(2): 20-21, April 1968. DAS M(05) E78es 1968 v.3.

Describes the joint ESSA-NASA Airborne Lab. search for high atmosphere "invisible" cirrus, and ESSA's Atmospheric Physics and Chemistry Lab. (APCL) investigation of Earth's greenhouse for variations in roof thickness, holes, or other modifications. It was determined that, when cirrus exists, it is visible and that no invisible cloud layer in the upper atmosphere exists. Greenhouse "roof" pollution through disintegration products of returning space vehicles and the invisible haze effects due to high altitude supersonic flights are under study by the APCL as possible contributors to inadvertent long term weather modification. - MGA 20.4-224.

680. Temple, Joann T. Hail: scourge of the centuries. ESSA World, 3(4): 24-25, October 1968. DAS M(05) E78es 1968 v.3.

A brief account of a recently completed 6-wk intensive study of summer hail storms on Colorado's high plains made by the ESSA Atm. Phys. & Chem. Lab. in (APCL) in which a specially instrumented DC-6 aircraft was used. The most important observation was that these storms apparently suppress their own hail formation mechanism by natural ice formation. According to Weickmann, APCL director, the still qualitative observation confirms that seeding can suppress hail. It is noted that in an average year hail costs the U. S. some \$300 million and that if the recently published Russian claims are right, the returns from hail suppression outweigh the costs by 30 to 1. - MGA 20.9-499.

681. Todd, Clement J.; Peterman, William A.; Schertz, Donald C. Climatology of the potential for modifying convective clouds with ice-phase seeding. National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968, Proceedings. pp. 280-286. DAS M09.6 N277pr.

With the surging interest in developing applied weather modification, there is a crucial need for a climatology of the potential of ice-phase modification of convection. Our knowledge of the critical factors in this process is still in a state of flux so that any study accomplished now will surely be obsolete soon. Yet, if a preliminary study can be conducted that will give insight into the seasonal and areal distribution of the frequency and intensity of these modification effects without being unduly misleading, it will be worth many times its cost.

The Navy Weather Research Facility has developed a computerized model for obtaining such a climatology, and has, at this time, processed much data towards this end. Some of the output is illustrated here, but in order to develop an interpretation of this output or to learn how to change it to be more meaningfully related to natural processes, broad cooperation is needed. Computer produced analyses of atmospheric seedability

from historical radiosonde data can be made available to those involved in making detailed evaluations of weather modification experiments. It is believed that such cooperative effort will lead to a continually improving climatology of weather modification potential. - Authors' abstract.

682. Tverskoi, N. P. Primenenie teplovogo metoda vozgonki organicheskikh soedinenii na samolete. (Using the thermal method of organic compound sublimation from an airplane.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 224: 121-129, 1968. Russian summary p. 209. DAS M(055) U581tg No. 224.

The possibility of applying a thermal sublimation method for methaldehyde and phloroglucin is studied. The model of airborne equipment is described, the service regimes are characterized, and the method of introducing the substance into the cloud is given. The temperature at the outlet of the equipment can vary within 120 to 240 deg and the air discharge rates between 390 and 1250 1/min. The air is preheated. The graphs of the dependence of outlet temperature on equipment parameters are plotted. The maximum output of ice-producing particles is 20-25 g/km of flight. Results are presented of experiments with methaldehyde and phloroglucin dispersion by the thermal method with the purpose to modify stratified winter clouds. In all experiments at temperatures below -10°C, crystallization in the clouds took place with subsequent gap formation. This indicated the possibility of applying thermal sublimation for aircraft dispersion of clouds. - MGA 20.7-191.

683. U. S. Air Force. Cambridge Research Labs. Use of helicopters to dissipate warm fog. By Meteorology Lab. U. S. Air Force. Office of Aerospace Research, Research Review, 7(11): 15, Nov. 1968. DLC.

Describes the use of a helicopter to dissipate warm fog. A helicopter hovers at 100 ft. above the cloud or fog until an initial opening appears, then ascends until the maximum clearing width is observed. The helicopter slowly accelerates across the cloud of fog until an optimum clearing rate is attained. The relative humidity of the drier air should be 90% or less. If the air above the cloud or fog layer has a higher humidity, the mixing might actually deepen the fog. - MGA 20.10-134.

684. U. S. Air Weather Service. Final Report on the Air Weather Service
FY 1968 Weather Modification Program. Volume 1, Projects Warm Fog,
Cold Fog III, Cold Wand, Cold Horn and Cold Fan. Its Technical
Report 209, Vol 1, November 1968. 57 pp. Each Project Report
has an individual summary. DAS M(055) U58a no. 209 v.l.

This report includes final reports of 5 separate fog-dispersion tests conducted by AWS personnel during the winter of 1967-68. One project (WARM FOG) involved fog temperatures > 32°F; 4 projects (COLD FOG III, COLD WAND, COLD HORN, and COLD FAN) dealt with supercooled fogs. Each project is reported separately with

conclusions and results summarized for all except Project COLD FOG III. A sixth project will be covered by Vol. 2 of this technical report at a later date. - MGA 20.7-190.

685. U. S. National Science Foundation. Weather modification. 9th Annual Report for fiscal year ended June 30, 1967. Its NSF 68-21, 1968.

101 pp. DAS M09.67 U585we.

Describes progress in developing a weather modification capability and in acquiring insight into its uses. Federal activities are presented according to type of weather modification, showing total federal involvement for each major area. Highlights of important actions during fiscal 1967 are summarized in an appendix. Planning and consideration of weather modification, social economic, legal, and ecological aspects, and weather modification research and field testing are reviewed. Weather modification research abroad, and the role of congressional activities are also noted. Main subjects of discussion are: the modification of precipitation characteristics: hail suppression; fog dissipation; cloud electricity, lightning, and severe storms, including tornadoes and hurricanes; and mathematical models of atmospheric processes. Various interagency, research task force, and other committees concerned with weather modification are listed in the appendices. - MGA 20.4-5.

Annual Report. Washington, D. C., Government Printing Office,

January 1968. 2 vols. Vol. 1: Summary (79 pp.) Vol. 2:

Contractor Reports (each report repaged). At head of cover:

Atmospheric water resources program. These Reports are from the following institutions: Colorado State University. University of Denver. Fresno, California State College. Montana State University. University of Nevada. New Mexico State University. South Dakota School of Mines and Technology. University of California, Los Angeles. Utah State University. University of Wyoming. Aerometric Research, Inc. T. G. Owe Berg, Inc. E. Bollay Associates, Inc. W. E. Howell Associates, Inc. Meteorology Research, Inc. North American Weather Consultants. Washington State Department of Water Resources. U. S. Weather Bureau. DLC.

The Project is designed to solve the growing water problems of the world by developing weather modification and precipitation management technology. The goal is to develop the techniques for putting more of the atmosphere's water on the ground and in storage facilities where it is available for man's use. The approach is restricted only to altering of the precipitation processes. Vol. 1 summarizes: the historical development of the Project since 1961, its activities and accomplishments in weather modification during July 1, 1966 through June 30, 1967, present status, and the program for the future. It also includes the experimentation, instrumentation development, evaluation, etc. Vol. 2 contains the annual reports from the 19 research contractors. The reports are printed as received. - MGA 20.3-23.

687. U. S. Research Flight Facility. ESSA Florida cumulus seeding project, 1968. Its Operations Plan 2-68, May 1, 1968. 41 pp. On cover: ESSA/RFF OPS Plan 2-68. DAS M(055) U5889op 2-68.

The purpose of the project is to provide microphysical data on Florida clouds; demonstrate in Florida Cu the causal relationship between AgI seeding and Cu growth that has been established elsewhere; to conduct concentrated cloud seeding and to determine its effect on cloud precipitation physics; and to test and refine the dynamical Cu model (EMB-67). Also covered are the participating agencies and their contributions. A brief discussion of the primary mission of the aircraft that will conduct the airborne research operations is given. Operational concepts, flight plans, communications, the various parameters to be measured (data monitoring and processing), and related operations are outlined in a discussion on meteorological measurements. The responsibilities of RFF Chief of Operations, of the Chief Meteorologist and of other directors of the project are given. Appendixes contain descriptions, routings, charts of operational areas, flight patterns, and forms to be used by the project. - MGA 20.8-240.

688. U. S. Research Flight Facility, Miami, Florida. Project Hail Storm, 1968. Its Operations Plan 3-68, June 1, 1968. 39 pp. On cover: ESSA/RFF OPS Plan 3-68. DAS M(055) U5889op 3-68.

The Atmospheric Physics and Chemistry Laboratory and the Wave Propagation Laboratory of the Environmental Science and Service Administration in cooperation with the National Center for Atmospheric Research and the Colorado State Univ. were to conduct a Hail suppression experiment in northeast Colorado during June 11 - July 20, 1968. The project was designed, essentially, to study the kinematics and structure of hail storms through the use of instrumented research aircraft, ground-based radar, and data collection stations. The basic objectives are briefings, etc.; a description of the meteorological measurements of the communications and of the logistics. - MGA 20.10-139.

Vul'fson, N. I. and Levin, L. M. O vozmozhnosti stimulirovaniia rosta vnutrimassovykh kuchevykh oblakov. (Possibility of the stimulation of development of intermass cumuli.) Akademiia Nauk SSSR, Izvestiia. Fizika atmosfery i Okeana, 4(5): 499-507, May 1968. Russian summary p. 499; English summary p. 507. DAS P. Translated into English in corresponding issue of its Academy of Sciences, USSR, Izvestiya. Atmospheric and Oceanic Physics. DAS P.

The main characteristics of the stable layers which prevent cumuli formation or their development into the rain stage near Moscow for summer months of 1957-1964 are given. The problem of convective current velocity above the stationary thermal and momentum source at the neutral, stable and unstable stratifications is considered approximately. Parameters of the installation (on the basis of gas turbine engine) for artificial vertical ascent currents capable of penetrating most of the inversion

observed near Moscow during the period mentioned above are estimated. - MGA 20.3-232.

690. Vul'fson, N. I. and Levin, L. M. Razrushenie razvivaiushchikhsia kuchevykh oblakov iskusstvenno sozdannymi niskhodiashchimi potokami. (Destruction of developing cumuli by artificially produced downward currents.) Doklady Akademii Nauk SSSR, 181(4): 855-857, 1968. DLC. For translation into English, consult the corresponding issue of its Doklady of the Academy of Sciences U.S.S.R., Earth Sciences Sections, issued Washington, D. C. DAS P.

The authors have shown (Vulifson and Levin, 1964) that in unstable atmospheric layers there can arise spontaneously ascending stationary jet streams and descending ones. In the present paper. an expression is derived for the ratio of air speeds in descending and ascending jet streams. Tabulated ratios computed with this expression for various values of ρ (0, 1/8, 1/4 . . . , 2, 7/3) show that if the intensity of the ascending streams is such that adiabatic cooling of the arising air ensures sufficient condensation of water vapor, then the development of descending motions in such a cloud will occur with a sufficient or greater speed than is required to evaporate all the drops in the jet stream. This was verified in 9 field tests in which downward pulses of speed within Cu (up to 5000-6000" thick) were created by jet planes flying through them. In all tests, the clouds broke up, substantially lowered their upper boundary, or disappeared entirely. The tests confirmed also that the more intensively developing clouds are destroyed more completely and more quickly. - MGA 20.8-

691. Vul'fson, N. I. and Kondratova, A. V. <u>Vozdeistvie</u> na kuchevye oblaka iskusstvennymi vertikal'nymi voskhodiashchimi struiami. (Effect of artificially produced vertical jets on cumulus clouds.) Meteorologiia i Gidrologiia, Moscow, No. 9: 22-27. September 1968. Russian summary p. 22; English summary p. 27. DAS M(05) M589.

Discusses the possibility of stimulating the formation of cumulus clouds, using artificially created vertical jets. An apparatus is described and illustrated in which 4 jet engines are linked so that their exhausts are all directed to provide a vertical upward jet. Some theoretical estimates of the possible extent of a jet formed in this way are given and confirmed by experimental tests. During June - July 1966 and 1967, 20 separate experiments were carried out, showing that it was possible to locally intensify convective activity using an apparatus of this type. Further trials will use more powerful apparatus, involving 10 jet engines. - MGA 20.8-230.

692. Warburton, J. A. and Young, L. G. Evidence of persistence or crosscontamination in cloud seeding experiments. Western Snow Conference, 36th, Lake Tahoe, Nevada, April 16-18, 1968, Proceedings. pp. 60-66. DAS M(06) W527p. 36: 1968.

One hundred and fifty samples collected during 1966-67 have been analyzed for silver content using thermal neutron activation

methods. The samples were collected in five separate regions of the western United States. In two of the locations where extensive randomized silver iodide seeding was occurring, with seeding periods of one day, there is evidence of persistence of silver in the atmosphere in unseeded situations. Silver, in relatively high concentrations, was present in specific storms which yielded precipitation in an unseeded region, It is speculated that this silver originated in cloud-seeding regions upwind of this unseeded area. Results also provide evidence that silver iodide released from the ground in one mountainous seeding area is not arriving in the target area precipitation. This is in strong contrast to results in two other similar seeding projects where high concentrations of silver are observed. - Authors! abstract.

693. Warner, J. A reduction in rainfall associated with smoke from sugar-cane fires: an inadvertent weather modification? Journal of Applied Meteorology, Boston, 7(2): 247-251, April 1968. DAS M(05) J86joa.

An examination of 60 years of rainfall during three months of the cane-harvesting season has shown a reduction of rainfall at inland stations coinciding with increasing cane production; no such reduction occurred at a "control" station upwind of smoke from the cane fires. The reduction is consistent with the hypothesis that through their activity as condensation nuclei the smoke particles result in great increases in concentration and consequent reduction in the size of cloud droplets, thereby hindering the coalescence process of rain formation. However, the possibility that other factors caused the particular climatic changes observed cannot be eliminated, and it is suggested that other areas of the world should be examined to see if similar effects can be found.

Author's abstract.

Weickmann, Helmut K. The artificial modification of atmospheric water resources. In: International Conference on Water for Peace, Washington, D. C., May 23-31, 1967, Water for Peace. Washington, D. C., U. S. Government Printing Office, 1968. Vol. 2: 394-400. French and Spanish summaries pp. 399-400. DAS 333.91 I6lwa v.2.

The author estimates the 1949 water vapor inflow into the North American Continent as 18,824 and the outflow as 11,770 million ft3. Considering that the discharge of the Mississippi River ranges from 0.135 to 1.806 million ft3, he concludes that the water lost through the atmosphere amounts to a river equivalent of from 6.5 (flood state) to 87 times the size of the Mississippi. He states that one can thus talk about "rivers in the atmosphere" that might be tapped, but that the processes through which the water can become available occur over a hugh scale of atmospheric phenomena. At present, human interference is possible only with the microscale mechanisms. This paper reviews the accomplishments in cloud dissipation, artificial cloud formation, rainfall from convective clouds, hail suppression, augmentation of continuous rain, and redistribution of precipitation. - MGA 21.8-120.

695. Weickmann, Helmut K. The Program on Weather Modification of the Environmental Science Services Administration (ESSA). Part I. Cloud dissipation. Idöjárás, Budapest, 72(2): 65-78, March - April 1968. Hungarian and Russian summaries p. 65. "Presented at the 13th Congress of the Hungarian Meteorological Society, August 24-27, 1967, Sárospatak, Hungary." DAS M(05) I21.

The author surveys the cloud dissipation research carried out by the U. S. Weather Bur. and presents some of the results obtained. The discussion includes the following: the physical and theoretical bases of cloud dissipation by means of seeding, including the formation of condensation nuclei as a result of seeding, formation of stratocumulus clouds, the equations for calculating the rate of condensation of a cloud, the rate of vapor diffusion from water drops to a dendritic ice crystal, the process of cloud glaciation, and the process and rate of dissipation of a seeded cloud; secondary phenomena following seeding such as release of heat of fusion; cloud formation following seeding; artificial cloud formation; artificial rain from convective clouds; and the establishment of a "Seedability Index." - MGA 20.1-167.

696. Weickmann, H. K. Program on Weather Modification of the Environmental Science Services Administration (ESSA), Part 2, Hail suppression. Időjárás, 72(3): 133-139, May - June 1968. DAS M(05) I21.

The 2nd article of this series on weather modifications deals with methods of hail suppression. First, the formation mechanisms and the geometry of hailstones are described. Two types of hailstorms are considered: the air mass type hailstorm and the traveling storm. The 1st method of hail storm suppression involves the prevention of the formation of hail embryos through massive seeding. The 2nd suppression method is based on the addition of just enough freezing nuclei at the right time and right level to produce more embryos which can grow and deplete the cloud water content. The 1st method is considered to bring certain success while the 2nd is critically linked with timely discovery of the hail forming process. In Russia, the latter method is carried out by means of radar surveillance and radar controlled discharge of cannon shells containing AgI. Aircraft seeding is considered more adequate for U. S. conditions. An experimental program includes pre-seeding storm analysis by an aircraft borne mesometeorological system in a command aircraft. One aircraft circles the storm and measures the divergence and vapor flux through the storm. From these data, the seeding rate and location are computed. After aircraft seeding, the success is determined by airborne IR radiometry. - MGA 20.4-223.

697. Weickmann, H. K. The Program on Weather Modification of the Environmental Science Services Administration (ESSA), Part 3. Augmentation of continuous rain and lightning suppression. Időjárás, Budapest, 72(4): 219-232, July - August 1968. DAS M(05) I21 72: 1968.

The discussion of the augmentation of continuous rain is concerned mainly with extratropical cyclones. It includes an examination of the principles underlying the designing of a randomized rain augmentation program, the numerical model for determining whether an increase in the number of precipitation particles will increase precipitation developed by Wexler and Atlas, and an example of the calculation of actual increase in precipitation by cloud seeding. The redistribution of precipitation is examined on the basis of an analysis of the energy of a storm passing over the Great Lakes. The modification of colloidal stability within clouds by seeding with condensation nuclei is discussed on the basis of a review of Sources and Twomey's work on the seeding of maritime clouds with a mixture of chlorosulphuric acid and the work of Gillespie and Johnson on warm fog dissipation. The concept and theory of lightning suppression are outlined with the aid of relevant equations. Some studies of inadvertent modification such as produced by air pollution are discussed, with particular reference to the atmospheric increase in CO2 as measured at the Mauna Loa Obs. and the possible effect of CO2 increase on the Earth's surface temperature. - MGA 20.8-241.

698. Weickmann, Helmut K. Symposium: the weather modification program of the Atmospheric Physics and Chemistry Laboratory. Collected from staff and contractors reports. Boulder, Colorado, September 1968. 54 pp. DAS MO9.6 Wh15sym.

Summary and critical review of the results of 15 U. S. and foreign projects. In the introduction great emphasis is placed on both the physical and statistical design of cloud modification experiments. The 5 sections deal with the following types of projects: modification of storm patterns, convective clouds and severe storms, radiation parameters in weather modification, and secular measurements of atmospheric constituents. It is indicated that "The Atmospheric Physics and Chemistry Laboratory research related to inadvertent modification of weather and climate will center in the future around several Primary Geophysical Monitoring Observatories where selected atmospheric pollutants and related phenomena will be monitored on a continuing basis." The appendix contains a short preliminary report on hailstorm modification research project, June 5 - July 18, 1969. - MGA 20.9-174.

699. Willis, Paul T. <u>Diffusion in an orographic environment</u>. Skywater Conference, 3rd, Denver, Colorado, February 14-16, 1968, Proceedings of Skywater Conference 3 con. Production and delivery of Cloud Nucleating materials. Denver, Colorado, Bureau of Reclamation, 1968. pp. 193-215. DAS MO9.617 S629pro conf. III.

Several cases of a series of tests in the Park Range Area (in Colorado) illustrate several categories of behavior typical of aircraft tracked in this area. The topography of the area dominated by the north-south oriented Park Range and the equipment used in the tests are described. U. S. Radium Corp. No. 2267 zinc cadmium sulfide tracer material (2 μ mean diameter) of approximately 2 x 10^{10} particles per gram was aerosolized using a dry system.

The 8200-ft Emerald Mt. is the release site for most of the tests. A comparison is made showing the greater sensitivity of the AgI nuclei system over the ZnS system. Seven cases are described and nuclei counts are shown graphically. Following are some of the conclusions. Trapping by low-level inversions extending thousands of feet above a valley floor severely limits effective tar-getting with ground-based generators. The complex flow patterns in mountainous terrain make diffusion modeling difficult. The discussion by a number of participants concerned effects of temperature inversions, tracking and the work of the counters in clouds. - MGA 21.10-146.

700. Zarea, St. and Căpuz, C. <u>Unele rezultate ale experimentării in laborator a metodei acustice de disipare a ceții</u>. (Some results from a scund method of fog dissipation tested in laboratory.) Rumania. Institutul Meteorologic, Culegere de lucrări, 1966. Bucharest, 1968. pp. 221-231. Rumanian summary p. 221; Russian and English summaries p. 231. DAS M R936cu 1966.

Laboratory experiments were made at the Meteorological Institute in Bucharest of fog dissipation by an acoustic field. A dependency link was developed between fog dissipation speed and the intensity of the acoustic field. Optimal frequencies for the tests are 5000-15,000 Hz. - MGA 21.10-125.

701. Zaverina, M. V. and Mikhel', V. M. Klimaticheskie kharakteristiki oblakov v zone nedostatochnogo uvlazhneniia Evropelskol territorii SSSR. (Climatic characteristics of clouds in the zone of insufficient moisture in the European territory of the U.S.S.R.) U.S.S.R. Glavnaia Geofizicheskaia Observatoriia, Leningrad, Trudy, No. 219, 1968. 111 pp. Bibliography pp. 108-111. DAS M(055) U581tg.

The results of a detailed study of the principal characteristics of low level clouds in the moisture deficit zone of the European territory of the U.S.S.R. are presented and the suitability of seeding these clouds in order to produce precipitation is evaluated. The contents of this study comprise the following: climatic characteristics of stratus clouds in the zone of moisture deficit including relative and absolute frequency, daily march of the frequency of stratus clouds, the duration of continuous clouds, natural precipitation from stratiform clouds, height of the lower boundary and thickness of cloud layers, water content, microstructural characteristics and temperature of clouds, moisture generating capacity of clouds and climate evaluation of the possible effectiveness of seeding stratiform clouds; climatic characteristics of stratonimbus and stratocumulus clouds including the frequency of Ns, Fr nb, Ci, and Cb clouds, duration of existence and thickness of clouds and precipitation, comparative climatic characteristics of clouds forms of the lower layer, and climatic evaluation of the probability of effective artificial increase of precipitation from Ns clouds in the cold time of the year; and characteristics of the distribution of clouds and precipitation in dry periods including spatial-temporal distribution of Fr nb, Ns and Cb clouds, spatial-temporal variability of precipitation fields in years of catastrophic droughts and of abnormally large precipitation, and causes of unfavorable conditions for artificial production or

intensification of precipitation in dry periods. Extensive data are presented in tables, graphs, and maps. - MGA 19.12-343.

702. New directions in hail suppression research. Facilities for Atmospheric Research, Boulder, Colorado, No. 7: 2-7, December 1968.

Describes and illustrates the summer 1968 Hail Suppression Research Program which was influenced by the recent disclosure of a successful Russian hail suppression program in which artillery shells were fired into clouds to prevent large hailstone growth. Reference is made to Sulakvelidze's report, Results of the Caucasus Anti-Hail Expedition of 1965. Included in the description are airborne, lightning, and radar studies which were discussed with Sulakvelidze, who visited NCAR briefly following the Toronto International Cloud Physics Conference. A photograph shows an electronic hail pad built to obtain information on hail arriving at the ground by recording impact data on a tape recorder. Cloud seeding systems are discussed. American researchers agree that artillery or rocket delivery of the cloud seeding agent into the proper temperature zone of the hail cloud is probably more effective than relying on natural convection processes to carry the seeding nuclei into clouds from ground or aircraft generators. Colorado State Univ. cloud seeding rockets with wing mounted launch pad on a Lockheed T-33 jet aircraft are shown in an annotated photograph. - MGA 20.9-179.

703. Steel mills: new rain producers. Industrial Research, Beverly Shores, Indiana, 10(5): 11, May 1968. DAS P.

For the last several years LaPorte, Ind. averaged 31% more rainfall than nearby areas; had 84 days of hail between 1951 and 1960—compared to only 43 days for other communities within a radius of 160 km; and thunderstorms that have increased by 38% with several occurring in early morning. This article refers to Changnon, a climatologist for the Illinois State Water Survey Dept., whose investigations show a substantial relationship between hazy conditions over the steel-producing Calumet area near Chicago's South side and Gary and the strange weather in LaPorte. His explanation as quoted is that the heat maintained throughout the night in the industrial-urban area causes greater vertical air motions and that pollution particles account for more rapid growth of raindrops. - MGA 19.11-253.

1969

704. Appleman, Herbert S. An introduction to weather modification. Air Weather Service (MAC), Technical Report 177 (Revised). September 1969. 38 pp. DAS M(055) U58a 177rev 1969.

Weather modification techniques are explained and Air Weather Service activities in cloud-seeding and fog-dissipation experiments are discussed. Technical Report 177 issued 10 July 1964 is updated. - Author's abstract.

705. Appleman, Herbert S. The operational dissipation of supercooled fog. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. **Toronto, 1969?** pp. 708-712. DAS M74.1 I61p 1968.

A report is given of some operational tests of the dissipation of supercooled fogs made at Elmendorf AFB near Anchorage, Alaska. A four-engined aircraft was loaded with dry ice blocks and a dry ice crusher capable of crushing the blocks at the rate of 75 lb/min to sizes ranging from sugar to 3/8 in diam. Thirty seven operational missions were flown. A standard seeding configuration was used-five parallel lanes, each 2 mi long and 1 mile apart, seeded with 12.5 or 25 lb/mi of crushed dry ice, and displaced the proper distance upwind from the target area. Twenty-five missions successfully cleared the target area in three cases, a hole was cut but missed the target. The failures all occurred on the same day when the state of the fog was doubtful. In addition to the operational tests, a separate supplemental test program was undertaken. Seeding at the lower rate of 12.5 lb/mi rate was more successful when seeding was made from within the fog. Successful clearing was achieved with dry ice powder, $1/l_1$ inch pellets, or a mixture of sizes. Successful clearances were also obtained with silver iodide flares attached to the aircraft, but a somewhat lower temperature was required than with dry ice. This had to be done within the fog. ful clearances were obtained when the aircraft flew through the fog dispensing liquid CO2 through a fire extinguisher type of This produces dry ice snow at a rate of 40 lb/mi. Failure resulted when the aircraft skimmed the top of the fog and no horn was used. - MGA 21.9-290.

706. Appleman,, Herbert S. Second annual survey report on the Air Weather Service weather-modification program (FY 1969). U. S. Air Weather Service, Technical Report 213, June 1969. 16 pp. DAS M(055) U58a no. 213.

This report does not provide technical details for specialists, it is intended to inform the AWS community of the current status of its rapidly changing capabilities in weather modification. Five fog-dissipation projects initiated in the winter of 1968-1969 are discussed. The equipment and procedures are described and illustrated. The results are summarized as follows: Airborne techniques for dissipating supercooled fog using dry CO₂ and AgI can be considered fully operational. The propane technique is far too cumbersome for routine use in a mobile configuration. Use of sized NaNO₃ in warm-fog dissipation offers a possible, but costly, solution of the problem. - MGA 21.3-297.

707. Aynsley, Eric. How air pollution alters weather. New Scientist, London, 44(670): 66-67, October 9, 1969. DAS P.

Air pollution can cause changes in climate. The earth's temperature could increase from increases in carbon dioxide levels, continual accumulations of atmospheric aersols could increase the atmospheric dustiness or turbidity, excessive dustiness can initiate cloud formation, atmospheric dusts provide excellent nuclei for cloud condensation and fires can modify cloud formation.

708. Bakhanova, R. A. and Solianek, E. G. On the application of surfaceactive agents to prevent water evaporation fogs over the unfreezing
water basins in winter season. In: International Conference on
Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings.
Toronto, 1969? pp. 688-693. DAS M74.1 I61p 1968.

A report is given of laboratory and field trials to evaluate the possibilities of using surface active agents to reduce the rate of formation of evaporation fog. Over the Kola Basin, evaporation fogs form with water temperatures ranging from 0 to 40°C and air temperatures -10°C and below. Laboratory trials using C18 -C23 higher fatty alcohols dissolved in kerosine were first undertaken. The film efficiency depended upon the concentration of the reagent in the kerosine, with the maximum efficiency attained with solution concentrations 3-6%. There was a time lag between the time of application of the solution and the maximum effectiveness of the film. This depended upon the temperature of the solution prior to its application. For optimum results, this temperature should be 20°C. Field tests were done in the Kola Basin where the reagent solution was prepared aboard ship and pumped through a hose with a contracting nozzle to give a pulverized jet. Tests were made for various air and water temperatures and varying water current and wind conditions. On many occasions, application of the film resulted in immediate clearance of fog, the area of clearance spreading as the film itself spread. It was obvious that the clearance was due to the film since distinctive patterns of film application were also present in the areas of the clearance. With water temperatures varying between 0 and 15°C, the retarding effect of the film on fog formation was marked. This effect decreased progressively with increasing temperatures above 15°C, until with temperatures above 40°C, the effect of the film was negligible. - MGA 21.6-538.

709. Bánkövi, György and Wirth, Endre. Csapadékkeltési kísérletek tervezése és értékelese. (Planning and evaluation of experiments on artificial stimulation of precipitation.) Idöjárás, 73(6): 358-366,
November - December 1969. English and Russian summaries p. 358.

DAS M(05) I21.

In the last two decades, numerous rain-making experiments have been performed all over the world. Nevertheless the results have remained ambiguous. In this paper, the authors analyze the causes of this ambiguity and examine the historical development of statistical methods of evaluating cloud-seeding trials. Some possibilities of further improvements of evaluating the results are noted. There is proposed a method of evaluating the effectiveness of seeding for determining the optimum duration of experimentation, which is generally an important and difficult problem in planning. The method is based upon the artificial increase of precipitation data, random sampling, and the use of regression between the target and some control areas. - MGA 21.10-127.

710. Battan, Louis J. Comments on silver iodide seeding and hailfall damage suppression. Reply by Richard A. Schleusener. Journal of Applied Meteorology, Boston, 8(3): 466-469, June 1969. DAS M(05) J86joa.

In criticism of Schleusener's results of hailstorm seeding projects, Battan comments on the following: the conclusions that greater quantities of AgI are more effective than small quantities in suppressing the fall of damaging hail seems possible, but Schleusener does not make a good case supporting it. The suggestion that whether or not hail is decreased depends on seeding at 2000 gm hr per storm rather than 900 is not proved by the data in Schleusener's paper or by his analysis thereof. Sulakvelidze initially seeded at rates of about 500 gm km⁻³ of cloud, but states that the results of the first experiment showed that this amount could be reduced by a factor of about 10. Further study showed that the maximum amount of the agent required to produce the desired modification was about 20 gm km⁻³ of hail center. In reply, Schleusener comments that the fuel use rates represent the closest approximation that can be made to the more desirable statistic of concentration of ice nuclei in a cloud. The seeding rates do not differ by a "factor of 2 or 3" but by more than two orders of magnitude. The maximum seeding rate per storm was defined to represent the approximate maximum rate of silver iodide ingestion into a given storm at any one time. Its significance lies in that it represents an upper limit of the rate of seeding in a single storm that might have been used by the operation of the various projects. A direct comparison between the Russian seeding rates, which involved shooting material into the storms and the other rates involving release of seeding material into the bases of storms is inappropriate. Schleusener did not conclude that "whether or not hail is decreased depends on seeding at 2000 gm hr -1 rather than at 900 . . . and would agree that a factor of 2 or 3 in the maximum seeding rate per storm is unlikely to be critical in determining success or failure of seeding for hail suppression." The important fact is that the available evidence supports the hypothesis that increases in hail may be caused by relatively light seeding rates and that decreases in hail can be the result of heavier seeding rates. MGA 21.1-266.

711. Battan, Louis J. Harvesting the clouds: advances in weather modification. Garden City, N. Y., Doubleday & Company, Inc., Anchor Books, 1969. 148 pp. (American Meteorological Society, Science Study Series S61) DAS M09.616 B335ha.

This booklet is one of a series of monographs within the Science Study Series developed for secondary school students and laymen by the American Meteorological Society. It deals with weather and climate modification—one of the scientific frontiers "in need of much greater investigation and exploitation." The first section deals with violent storms, droughts, and other phenomena that make it desirable to change the weather; in concluding this section the author states that in the last 20 years there has been considerable research on influencing rain, snow, hail, lightning, thunderstorms, hurricanes, cyclones and even the weather over the entire country. In the following chapters he examines the past, present, and future work in this field. The short last section titled "Postscript" contains the following statement: "We should be able to exert greater control over the atmosphere than we do today. It follows natural laws, as does every other physical system. As our knowledge of the atmosphere increases, so will our ability to manipulate it." - MGA 21.2-43.

712. Battan, Louis J. Weather modification in the U.S.S.R. - 1969. American Meteorological Society, Bulletin, 50(12): 924-945, December 1969.

DAS M(05) A512b.

Presents detailed discussions of the scientific programs at various institutes visited by the U. S. delegation on weather modification during the period May 6 - June 3, 1969 in the Soviet Union. In summary, the author notes that there has been a striking expansion, since 1964, in projects devoted to the practical application of hail-suppression techniques. The general reaction of the author is that in the 5-yr period since 1964, the overall program on weather modification has not increased very much. An appendix describes airport weather modification operations in the Soviet Union. - MGA 21.7-107.

713. Benton, George S. <u>Some general comments on meteorological and weather modification activities in the Soviet Union</u>. American Meteorological Society, Bulletin, 50(12): 918-922, December 1969. DAS M(05) A512b.

The U. S. delegation on weather modification were guests of the Soviet Union as part of the Cultural Exchange Program during the period May 6 - June 3, 1969. The author offers general comments concerning activities in weather modification, and more broadly in meteorology within the Soviet Union. The availability of personnel in all categories is notable and is matched by the availability of funds for growth. Interesting programs underway are antihail activity and various models were constructed to explain the success of seeding in reducing damaging hail. Other programs commented on include cloud physics, precipitation augmentation, and fog dissipation. - MGA 21.7-108.

714. Bergeron, T. Cloud physics research and the future fresh-water supply of the world. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. **Toronto, 1969?** pp. 744-757. DAS M74.1 I61p 1968.

Fresh water is a necessary condition for any land-based food production. If this is to keep up with the population increase over the next 10 to 20 yrs; there is a necessity to increase available supplies. The amounts of untapped ground water are small in comparison to the need. Increased utilization of surface water will soon reach its natural limits; pollution is narrowing these limits and methods of conservation are impracticable on a sufficiently large scale. The desalting of sea water is now a practicable proposition on a small or medium scale, but is still excessively expensive on the large scale. The only other possibility is artificial weather and climate modification. Increasing the yield of the atmospheric water cycle could be attempted by heating the air at sea in the subtropics, by accelerating the rise of moist air in convective cells and systems, at fronts and over orographic obstacles or by increasing the output of precipitation release from clouds. Local increases in the water cycle are possible, but these may be at the expense of other regions. - MGA 21.8-367.

715. Bigg, E. K.; Brownscombe, J. L.; Thompson, W. J. Fog modification with long-chain alcohols. Journal of Applied Meteorology, Boston, 8(1): 75-82, February 1969. DAS M(05) J86joa.

The growth of water drops on condensation nuclei in a supersaturated environment can be greatly retarded by the presence of long-chain alcohols which form monomolecular layers on the liquid surface. The possibility that a fog could be significantly modified using this priniciple is examined quantitatively, and it is shown that by dispersing practical amounts of long-chain alcohols it might be possible to produce useful changes of visibility in volumes of the order of 1 km³.

Field trials are then described in which about 200 kg of a hexadecanol-octadecanol mixture was released as a finely divided smoke into a valley where fog was expected. In each case, the results were consistent with a modification of the fog throughout a larger volume than expected, but it cannot be claimed that this was not due to natural causes. Assessment of the value of the method is likely to be as difficult as with other forms of cloud seeding. - Authors' abstract.

716. Blair, Donald N. and Davis, Briant L. Aging of silver iodide-sodium iodide generator effluent in moist and dry air. Journal of Applied Meteorology, Boston, 8(4): 551-555, August 1969. DAS M(05) J86joa.

The effect of storage of AgI-NaI aerosol particles in moist and dry air upon the efficiency of nucleation of such particles

has been investigated. Samples were obtained from a standard solution generator and tested in an optical cold stage at -15C under a controlled atmosphere. The "wet" and "dry" samples were paired and studied together in the optical cold chamber to eliminate several environmental variables. In 16 out of 21 runs the aerosol aged under dry conditions showed a higher nucleation efficiency, there also being a possible weak positive correlation of the ratio of efficiencies of dry to wet samples with time. Differences between these results and those of other workers can best be explained by differences in aging treatment. - Authors' abstract.

717. Bulkov, M. V. and Polovina, I. P. Nekotorye zakonomernosti
rasprostraneniia iskusstvennoi kristallizatsii v pereokhlazhdennykh
sloistykh oblakakh. (Some regularities in propagation of artificial
crystallization in supercooled stratus clouds.) U.S.S.R. Ukrainskii
Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy,
No. 82: 61-76, 1969. Russian summary p. 154. DAS M(055) U581tu.

The paper is devoted to the analysis of data of observations of the propagation of zones of artificial crystallization when stratus clouds are seeded with solid CO2. The experiments were carried out on the experimental grounds of the UkrNIGMI (Ukrainian Hydrometeorological Research Institute) during 1962-1968; a total of 35 experiments were selected for analysis. The analysis was based on a simplified theory of artificial crystallization of supercooled clouds which takes into account three main factors: condensation growth of crystals, turbulent diffusion of crystals, and their dropping out under the action of gravity. The zone of crystallization is defined as the region where the water content of the cloud is zero; the appearance of a clearing in the cloud is connected with improved visibility through the cloud layer. It was found in the theory that expansion of the crystallization zone follows the law: $x_h = A (t-t_0)^{0.68}$ where width of the crystallization zone, t is the time and A and are empirically determined parameters used for finding the turbulent diffusion coefficient and the number of crystals introduced per unit area of the seeding plane. These values were not measured directly in the experiment. Experimental values of the width of the crystallization zone at two instances were used in finding A and t_0 . The found values of the turbulent transport coefficient in the horizontal was ~ 103 m2 /sec, number of crystals introduced per cm² of the seeded area $\sim 10^4$ cm⁻², yield of crystals per gram of CO₂ was $\sim 10^{11}$ g⁻¹. With the thus determined parameters A and to the theoretical curves for the width of the crystallization zone agree well with the experimental. The first four moments of the crystal distribution function were found; it is shown that on the boundary of the crystallization zone the concentration of crystal does not remain constant but drops in the course of time. The total crystal surface is approximately constant. The effect of crystal shape on coordination of the procedure for analyzing experimental

data is discussed. The law of propagation of crystallization in thick columns is closely found to agree with that found for spherical crystals. The visibility range through a seeded area of a cloud layer was computed. The appearance of a clearing depends principally on some parameter; so that when its value is small the clearing appears at the edge of the crystallization zone and that when large it appears in its center. - MGA 21.10-126.

718. Bulkov, M. V. O regulirovanii osadkov iz frontal nykh oblakov. (The control of precipitation from frontal clouds.) Meteorologiia i Gidrologiia, Moscow, No. 8: 60-66, August 1969. Russian summary p. 60; English summary p. 66. DAS M(05) M589.

The problem of artificial regulation of precipitation from frontal clouds is studied. The dimensions of zones with intensified and weakened precipitation using the conventional method of seeding are estimated. A new method of seeding rain-bearing clouds based on intensive introduction of ice nucleating agents into the same cloud volume is suggested. - MGA 21.5-200.

719. Cantù, V. L'uomo nell'equilibrio della natura. (Man and the equilibrium of the natural environment.) Rivista di Meteorologia Aeronautica, Rome, 29(4): 43-46, October-December 1969. DAS M(05) R625. Resume of article by M. Pavan in Collana Verde of the Italian Ministry of Agriculture and Forests. DLC.

The author discusses the following: the increasing atmospheric pollution, in particular the increasing CO_2 content, the resulting warming of the climate, and the consequent melting of the Arctic ice and reduction of rainfall in Europe: the climatic effects of the proposed construction of barriers across Bering Strait and the Straits of Gibraltar; and the proposal to cut down the Apennines near Passo Giov to reduce the atmospheric pollution and smog in the Padnan plain. The project is based on the principle that warm air rises and from the level of the Tyrrhenian Sea, it would rise to the colder zone of the Apennines; as it finds a passage the flow of the Tyrrhenian would be reversed in the Po Basin dissolving clouds and smog. The proposal is invalid meteorologically; it fails to consider the Milan Sea and the existence of horizontal pressure gradients, etc. - MGA 21.8-117.

720. Changnon, Stanley A., Jr. Hail evaluation techniques. Illinois.
Water Survey, University of Illinois, Urbana, Grant NSF GA-482, Final
Report - Part 1, April 1969. 97pp. DAS M78.7 I29fin pt. 1.

The entire project comprised the following three interrelated studies: 1) a climatological investigation of historical hail data; 2) collection of highly detailed surface hail data unavailable in historical format; and 3) study, development, and evaluation of new instruments and techniques for better or

easier measurement of hail. This report deals primarily with the second and third studies and includes the installation and development of six data networks, collection of ensuing data, and the subsequent analysis involved in the first study and with the evaluation of 3-cm radar and with the development and evaluation of new surface instruments for remote measurements of hail involved in the second study; the names of personnel who were involved in the operational and/or research phases; the scientific and technical publications from the research, and the related information produced for public dissemination. Conclusions related to the design of an optimum future experiment and recommendations for future research some of which have already been partially realized are presented. An optimum design for a hail suppression experiment in Illinois is discussed in detail. It is hoped that the results will serve as recommendations for hail research elsewhere. - MGA 21.11-299.

721. Changnon, Stanley A., Jr. Hail measurement techniques for evaluating suppression projects.

596-603, August 1969. DAS M(05) J86joa.

Collection of hail data that will provide meaningful measures of the results of hail suppression projects varies according to five factors, including the geographical-climatic site, the statistical design, and the goal of the project. Eight possible techniques of collecting hail data are evaluated with respect to their use in different areas, availability of historical data, and with different project designs. Each technique provides data that have distinct limitations. However, the two data collection techniques rated best for projects having a continuous seeding (on all hail days) design are networks of passive hailpads and raingages, and crop-hail damage records. The best technique for use in projects utilizing a single-storm seeding design or a random daily seeding (single area) design is a network of recording hailgages. - Author's abstract.

722. Changnon, Stanley A., Jr. and Schickedanz, Paul T. <u>Utilization of hail-day data in designing and evaluating hail suppression projects</u>.

Monthly Weather Review, Washington, D. C., 97(2): 95-102, February 1969. DAS: M(05) U587m.

Historical hail-day records of U. S. Weather Bureau first-order stations and cooperative substations are the only long, objective records of hail occurrence available throughout the United States. Although hail-day data are limited in areal density and are not necessarily the most desired measure of seeding effects, they are the only data available to obtain a measure of the areal-temporal variability of hail for most areas of the United States. Consequently, hail-day data from Illinois have been employed in a pilot project to determine the time required to obtain statistically significant changes in hail-day frequencies over various

sized areas. Four statistical designs were investigated using the historical hail-day data for five areas in Illinois. The results show that the optimum design for hail-day data is the continuous seeding (seeding on all days likely to have hail) over an area. The optimum test is the sequential test involving the Poisson and Negative Binomial distributions. Detection of a 20-percent reduction in summer hail days would require, on the average, a continuous seeding program ranging from 13 to 37 yr, depending on the level of precision desired, and the size and location of the seeded area. Major reductions, those in excess of 60 percent, would require experiments of only 1- to 3-yr length. - Authors' abstract.

723. Chapmen, Douglas G. Statistical aspects of weather and climate modification. In: Fleagle, Robert G. (ed.), Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 56-68. DAS MO9.6 W362wea.

The author reviews the reasons for the doubts of statisticians about the evidence for the claim of increased precipitation by cloud seeding in the report of the NAS Panel on Weather and Climate Modification. An introductory discussion leads the author to state that the whole problem of statistical evaluation is whether or not observations can be accepted as being random and independent and whether or not a simple model of the control and target areas can be established. Randomization in designed cloud experiments and commercial operations, and future evaluations are considered. The author points out that, when all the variables (including the possible operational variables) are provided for, a research program to evaluate weather modification can be a very expensive proposition. He does not favor large scale operational tests by a federal agency. The overall conclusion is that an outsider who does not have access to all the data must accept the panel's optimistic conclusions even though he might well wish that the arguments were more direct and the possible loopholes had been plugged more tightly. - MGA 20.10-131.

724. Chaterjee, R. N.; Biswas, K. R.; Ramana Murty, Bh. V. Result of cloud seeding experiment at Delhi as assessed by radar. Indian Journal of Meteorology & Geophysics, Delhi, 20(1): 11-16, January 1969. DAS M(05) I39i.

Based on measurements made by a high power microwave radar on areal echo coverage and echo height of rain cells within 100 km around Delhi, the result of cloud seeding experiment conducted in the area during the 5 experiment years, 1961 and 1963 to 1966, has been evaluated. The trend of result has been found positive on the basis of areal echo coverage, and negative on the basis of mean echo height. The implication of the suggested trends of result is discussed. -Authors' abstract.

725. Chisholm, John; Berry, Ed; Pranger, Maarten. Aspects of weather modification experiments in mountainous terrain. Nevada.

University. Desert Research Institute. Laboratory of Atmospheric Physics, Project Report No. 9, January 1969. 43 pp. (NSF Grant GA-908 and Bureau of Reclamation Contract 1406-D-6632-1968) DAS M(055) N4992pr no. 9.

Based on 1966 airborne cloud seeding experiment results, the design of limited operations during the winter of 1967-68 is described, focussing on key aspects of a successful airborne wintertime operation. These aspects are the availability of a suitable aircraft, an efficient radar display system, and effective radar location. Details of their use are considered in the report. Objective of the operation is to seed orographic storms from within the cloud at a specific level and position, such that the radar echo produced by the artificially made ice crystals terminates upon a preselected mountain top. The task implies development of an integrated delivery system consisting of a mobile airborne cloud laboratory, a groundbased radar and computer system, and a silver iodide tracing technique. The discussion centers on 1) the applicable general operational procedures; 2) selection of a suitable operational area and associated radar site; 3) data transmission to and from the various project facilities; 4) airborne and radar measurements; 5) preprocessing radar reflectivity data; 6) relaying radar data; 7) radar selection, with special consideration of "chirp" radar; and 8) a real time sensor for cloud particles. - MGA 21.6-151.

726. Chorley, R. J. and More, Rosemary J. The interaction of precipitation and man. (In: Chorley, Richard J. (ed.), Water, earth and man. London, Methuen & Co., Ltd, 1969. pp. 157-166) DAS M79 C551wa.

A discussion of the various possible artificial weather modifications illustrated in a sketch showing points of human intervention in the world hydrologic cycle is followed by a more detailed treatment of rainmaking. In summarizing the authors point out the limited range of natural conditions in which precipitation can be produced, increased or conserved artificially. The difficulty of determining if significant increases in precipitation resulted from human efforts and the legal problems involved in cloud seeding are noted. Hurricane suppression by seeding and spreading oily material on the sea ahead of the storm is mentioned. It is noted, however, that a large part of the rainfall is in many places derived from hurricane circulation (fully 40% of the September rainfall at Atlantic City). Sprinkler irrigation is discussed as an alternative method of precipitation modification. The authors point out that game theory has been used to show how an unconscious perception of climatic probabilities has been employed by primitive farmers to maximize their possibilitity of continual survival against nature by always planting a balanced range of crops with differing responses to deficiency or abundance of rainfall. Crop insurance as practiced in the U.S. is cited as still another partial answer to

climatically controlled variations in agricultural returns. - MGA 21.1-267.

727. Colorado. State University, Fort Collins. Department of Atmospheric Sciences. Comments on the Northeast Brazil Project by the 1969 class in "The Atmosphere and the Water Cycle." Its: Weather Disturbances over Tropical Continents and their Effects on Ground Conditions, Report No. 3. March 1969. 21 pp. DAS M(051) C719ret no. 3.

Northeastern Brazil has been chosen as the site for a large meteorological observing program by the World Meteorological Organization and Brazil for the purpose of studying and predicting the very low precipitation to which the area is often subjected.

In this report scientific objectives and methods of analysis of the network data are discussed with respect to four problems:

- (1) Quantitative description of the physical processes leading to the observed mean climatic state.
- (2) Prognoses on the time scale of one day upward, as far ahead as possible, for operational purposes.
- (3) Prediction of aperiodic rainfall fluctuations on longer time scales, such as the whole rainy season.
- (4) Potential of cloud modification to increase precipitation.
 Authors' abstract.
- 728. Cooper, Charles F. and Jolly, William C. Ecological effects of weather modification: a problem analysis. Michigan. University, Ann Arbor. School of Natural Resources. Department of Resource Planning and Conservation, Contract No. 14-06-D-6576, cunnumbered Reports, May 1, 1968, issued May 1969. 160 pp. Bibliography pp. 150-159. DAS M(051) C776eco.

If deliberate modification of weather can be achieved, the structure of plant and animal communities will be altered through shifts in rates of reproduction, growth, and mortality of weather sensitive species. Ecological changes will generally require several years to become fully evident. Weather modification may interact with other ecological stresses such as air pollution and pesticide application to produce changes greater than the sum of the individual effects. The fallacious argument is rejected that because the change anticipated from weather modification is smaller than the normal variability of weather, weather modification will have little or no biological effect. Catastrophic outbreaks of weeds or insect pests are unlikely as a result of weather modification, but not impossible. Big game animals could be adversely affected if snow accumulation is significantly increased on winter range. Somewhat

different effects are anticipated in semiarid and in humid regions. There does not appear to be an immediate serious threat of environmental contamination from silver iodide or other seeding agents. A global environmental monitoring system is urgently needed but adequate planning for such a system has not yet been done. A monitoring system should deal with all forms of environmental change, not weather modification alone. No research dealing specifically with ecological effects of weather modification has yet been reported. Agencies sponsoring research and development in the technology of weather modification have an obligation, which they have so far not adequately met, to support research to determine the social and biological consequences of this technology. Institutional arrangements may have to be altered to require such research support. The report includes sections on anticipated kinds of weather modification; effects in semiarid climates and in humid climates; pests and diseases; direct effects of seeding agents; biology of lakes and streams; fog, hail, lightning, and hurricane modification; environmental monitoring programs; inferences from ecological theory; recommended research; and recommended premodification field surveys. - MGA 21.4-32.

729. Crutchfield, James A. Economic evaluation of weather modification.
In: Fleagle, Robert G. (ed.), Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 105-117. DAS MO9.6 W362wea.

The long delay between weather modification (WM) research outlay and payoff, the tremendous variability of weather patterns, the inability of the private operator to collect for all benefits, and the difficulty of identifying and charging him for external costs associated with his operation are given as reasons why any evaluation of WM must involve calculated social cost and benefits much more comprehensive than those with which the private operation could or should be concerned. This paper indicates the questions that must be asked to insure this kind of an inclusive evaluation with reference to agriculture, forestry, hydrosystems, fog dispersal, fisheries, and storm modification. Uncompensated negative benefits raise serious questions of economic equity and general welfare for which neither theory nor practice provide satisfactory answers. - MGA 20.11-165.

730. Dennis, A. S.; Davis, B. L.; Donnan, J. A.; Orville, H. D.; Smith, P. L., Jr. Increasing water supplies for the northern Great Plains through cloud modification. South Dakota, School of Mines and Technology, Institute of Atmospheric Sciences, Report 69-12, July 1969. 85 pp. DAS M(055) S726re 69-12.

This report describes a program of theoretical, laboratory and field experiments directed toward increasing usable water supplies for the northern Great Plains through weather modification.

Significant results described include the documentation of changes in rainfall associated with cloud seeding, the development of radar facilities including an on-line computer to support field experiments, the construction of a wind tunnel/cloud chamber facility for testing seeding devices, and the development of a numerical model of cumulus clouds forming over a heated mountain ridge. The firmest evidence of changes in rainfall associated with cloud seeding have come from the Rapid Project, a randomized crossover experiment involving fixed target areas of approximately 700 sc mi each. The results indicate that rainfall can be increased on days with isolated showers but that there may be rainfall decreases associated with seeding on days with widespread convective storms. The radar facilities now include an on-line computer to compute radar reflectivity factors and display these in real time. The wind tunnel/cloud chamber facility is being used for rapid testing of ice nuclei generating devices and is available for basic research in nucleation processes. The numerical model of cumulus clouds has advanced to the point where simulated weather modification experiments can be conducted upon it.

Advances in cloud seeding technology under the program have involved aircraft control procedures, methods of delivery of seeding materials, and statistical design and evaluation of field experiments.

Relationships between the program and other research in weather modification and the probable future evolution of the program are discussed briefly.

Further information on the field experiments conducted, on the numerical models developed, and on results of laboratory experiments on silver iodide crystals, as well as listings of staff members, papers and reports prepared under the contract, and data available from the various experiments are included in appendices. - Authors' abstract.

731. Dennis, A. S. and Musil, D. J. The North Dakota Pilot Project. Part

1: Work plans. South Dakota. School of Mines and Technology,
Rapid City. Institute of Atmospheric Sciences, Report 69-9,
April 1969. 39 pp. (U. S. Department of the Interior, Bureau of Reclamation, Contract No. 14-06-D-6660) DAS M(055) S726re 69-9.

The North Dakota Pilot Project is set up to verify the apparent seeding effects noted in the Rapid Project. Target area is McKenzie County, North Dakota. One objective is to reduce damaging hail and increase average rainfall. Another is to verify the findings of the Rapid Project concerning effects of silver iodide seeding upon average rainfall over an area on showery days and on stormy days as an aid in making decisions regarding implementation of operational precipitation

management projects in the Northern Great Plains. Finally, it is hoped to develop additional hypothesis concerning the effects of silver iodide seeding upon rainfall and hailfall at the ground as a function of seeding method, nature of underlying terrain, and meteorological conditions. The work plans to serve as guidelines in project operations are presented in this publication. - MGA 21.8-124.

732. Dennis, A. S. and Koscielski, Alexander. Results of a randomized cloud seeding experiment in South Dakota. Journal of Applied Meteorology, Boston, 8(4): 556-565, August 1969. DAS M(05) J86joa.

A 3-year randomized crossover seeding experiment has been conducted in South Dakota to test effects of artificial nucleation upon supercooled convective clouds of spring and early summer. The associated rainfall observations have been analyzed by several statistical techniques. The principal conclusions are: (1) on days with isolated showers, rainfall has been heavier in the seeded target area than in the unseeded target area; 2) on days with widespread convective activity and southwesterly winds aloft, rainfall has been lighter in the seeded target area than in the unseeded target area, except for the regions 10-20 miles east of the Black Hills; and 3) on days with widespread convective activity and northwesterly winds aloft, rainfall has been lighter in the seeded than in the unseeded target area. - Authors' abstract.

733. Dessens, Henri. Expérience de pluie provoquée par ensemencement ininterrompu à partir du sol. (Experiment in artificial precipitation by continuous seeding from the ground.) In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. Toronto 1969? pp. 719-723. DAS M74.1 I61p 1968.

Since the beginning of 1965, a ground silver iodide generator has been in operation, almost continuously, at Mimizan in southwestern France. To study its effects, the normal network of rainfall stations was supplemented by additional stations. Comparison of rainfall records for the three years of operation of the burner, 1965-1967, with long term means suggest a marked increase in precipitation in the area affected by the burner. The rainfall distribution patterns during each of the three years also appear to indicate the effectiveness of the burner in increasing precipitation with a center of high rainfall in the region. - MGA 21.5-204.

734. Dessens, J. Expérience de suppression de la grêle dans le sud-ouest de la France. (Hail suppression experiment in southwest France.)

In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. Toronto, 1969? pp. 773-777. DAS M74.1 I61p 1968.

A brief report is given of a 6-yr experiment in hail suppression made in southwest France from 1959 to 1966. Each year, over

four tons of silver iodide was dispensed from a network of 240 generators spaced over an area of 70,000 km². Seeding was done from all generators 4 to 6 hr prior to the expected formation of hail storms. The frequency of damaging hail was compared to the mean frequency of damaging hail during the years 1944-1958. An apparent reduction in occasion of damaging hail of 22.6% was obtained. - MGA 21.7-117.

735. Dumas, Andre J. and Morel-Seytoux, Hubert J. Statistical discrimination of change in daily runoff. Colorado State University, Fort Collins, Hydrology Papers no. 34, August 1969. 29 pp. DAS M(055) C719hy no. 34.

The purpose of this study was the development of a technique for rapid detection of the occurrence of a suspected hydrologic change in high mountain watersheds. A method has been developed that uses a sequence of independent daily flows.

This procedure is superior to previous ones based on seasonal or yearly flows. The results of this investigation show the use of daily, instead of seasonal flow, data in a Student t-test reduces the number of necessary years of data for detection by an average of five in 14 out of the 20 cases studied, or by an average of three for the 20 cases. All of the cases come from the Upper Colorado River Basin. The study is particularly relevant to the planned cloud seeding operations of the Bureau of Reclamation in high elevation areas of the Colorado Rocky Mountains.

The statistical procedure of detection relies on the Target Control concept and the application of a conditional Student t-test, a test of the difference between the adjusted means obtained by the regression lines between Target and Control for the seeded and non-seeded periods. - Authors' abstract.

736. EC&G, Inc., Boulder, Colo. Park Range Atmospheric Water Resources
Program. Contract (Bureau of Reclamation of Atmospheric Water Resources) 15-06-D-5649. Final Report, July 1, 1964 - June 30, 1969. 385 pp.

The procedures and results of a five-year program of cloud seeding to increase orographic precipitation in the Park Range of Colorado are presented. Winter precipitation systems were seeded with silver iodide from ground generators and aircraft. Measurements in the seeding target area included total snowfall, snowfall rate, freezing nuclei counts, type of snow crystals, and concentration of silver in snow as well as radar and rawinsonde observations. As part of the investigation, diffusion tests were conducted to study the transport and dispersion of seeding agent, and a numerical model was developed to predict location and rate of snowfall as functions of observed wind, temperature, and stability. During the first years of the program, the experimental design called for pulsed seeding at 1 cph frequency. Power

spectra of snowfall rate were computed in an effort to show significant differences in the time histories of snowfall rate for pulse-seeded and natural snow days. Though seeding effects were evident in some observations from individual cases, the approach was not successful, largely due to the natural variability of snowfall rate and of seeding agent dispersion in the atmosphere. On the basis of climatological analysis and the results of this program it is concluded that a combination of ground and airborne seeding, used whenever forecast cloud temperatures are appropriate, could, on an operational basis, produce cumulative seasonal snowfall increases of approximately 25% in the Park Range. - MGA 21.9-113.

737. Eadie, William J. Computer simulation of fog seeding experiments. U. S. National Aeronautics and Space Administration, Washington, D. C., NASA SP-212, Progress of NASA Research on Warm Fog Properties and Modification Concepts, Proceedings of a Symposium held at NASA Headquarters February 6,1969, in Washington, D. C., pp. 75-85. DAS 629.1388 U585na Sp-212.

Describes the computer model (developed to simulate the response of natural and artificial fogs to seeding with hygroscopic nuclei) used in conjunction with the field experiments on Project Fog Drops. Computer modeling does play an important role in the optimization of seeding techniques for a wide variety of warm fog situations. - MGA 21.5-194.

738. Edmondson, W. T. Ecology and weather modification. (In: Fleagle, Robert G. (ed.), Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 87-93) DAS MO9.6 W362wea.

The paper begins with a definition of ecology and a discussion of the effects of physical factors on organisms to show that any program for significantly modifying the environment will interest ecologists and that use of ecological techniques and concepts will be required in the evaluation of effects of weather modification. It is pointed out that weather involves more than rain. Examples of effects of and changes in environment such as elevation, sunshine conditions, and patchiness of forests due to hurricane damage are presented. The subtlety and delicacy of the "balance of nature" should not be overemphasized since a great deal of self-regulation has been built into natural systems by natural selection. - MGA 20.11-166.

739. Edwards, G. R.; Evans, L. F.; Hamann, S. D. <u>Nucleation of ice by mechanical shock</u>. Nature, London, 223 (5204): 390-391, July 26, 1969. DAS P.

A report is given on a study of the effect of shock waves on supercooled cloud droplets suspended in a cold chamber, essentially a cylindrical vessel of capacity 80 l with walls which could be maintained at subzero temperatures. The shock waves were formed by detonating 0.3-0.7 g of pentolite (50/50 PETN/TNT) at the apex of a steel funnel that intensified the shocks and directed them vertically into the open top of the chamber. Experiments at —10° and drop sizes of <20 µm and 2 mm were undertaken, and on freezing was recorded. Supercooled water is not induced to freeze either by the passage of a weak shock or by the mechanical disruption caused by an air blast (the larger drops shattered with the passage of the shock). On the other band, there is evidence that mechanical shock can induce freezing when the supercooled water is in contact with certain solid surfaces. This was confirmed by experiments in which a drop of water sandwiched between films of "polythene" or "teflon" was exposed at —5°C to a shock wave of the same intensity as used in the other experiments. — MGA 21.7-543.

740. Elliott, R. D. Computer determination of cloud seeding area of effect.
Western Snow Conference, Salt Lake City, Utah, April 15-17, 1969,
Proceedings, 37: 69-74. DAS M(06) W527p 37: 1969.

Based on existing knowledge about mountain air flow, plume dispersal, cloud physics and water budget, a satisfactory computerized engineering-type numerical model for predicting the area of effect of cloud seeding can be developed.

741. Ershova, N. G. Vliianie ul'trafioleta na l'doobraziushchuiu aktivnost' aerozolia florogliutsina. (Ultraviolet radiation effect on the nucleating activity of phloroglucinol aerosol.) U.S.S.R. Tsentral'naia Aerologicheskaia Observatoriia, Moscow, Trudy, No. 89: 65-70, 1969. English summary p. 70; Russian summary p. 101. DAS M(055) U581tt.

The variation of ice nucleating properties of phloroglucinol aerosols under ultraviolet irradiation is investigated. After one hour, the ice forming ability decreases by a factor 2.2. - MGA 21.6-156.

742. Fabre, R. Phénomènes optiques provoqués par ensemencement d'um brouillard surfondu à température voisine de -6°C. (Optical phenomena resulting from seeding of a supercooled fog at a temperature of about -6°C.) Journal de Recherches Atmosphériques, Clermont - Ferrand, 4(2): 101-103, April - June 1969. French and English summaries p. 101. DAS M(05) J86jor.

During fog dispersal at -6°C, several optical phenomena were observed, i.e., a 22° halo, left and right parhelia, and solar cross. - MGA 21.6-152.

743. Fleagle, Robert G. <u>Background and present status of weather modification</u>. In: Fleagle, Robert G. (ed.), Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 3-17. DAS MO9.6 W362wea.

Using the removal of ice from the Arctic Ocean as an example, the author points out the need for an interdisciplinary discussion of weather modification (WM) by experts in the physical and biological sciences, statistics, economics, law, and political science. This introductory paper reviews some of the history of WM which accounts for present opportunities and limitations and describes the recent actions of scientific bodies, government. states, and private operators. The author notes that the increased optimism reflected in the Anderson bill (1966) and the Magnuson bill passed by the Senate in 1967, new agency plans, and new plans and activities of commercial operators were based on the report of NAS Panel. To use the academy recommendations to support large and expensive operations aimed at economic objectives while ignoring the qualifications is dubious wisdom. In the discussion of the scope of WM, it is pointed out that the papers in this volume will be concerned with modification of clouds and storm systems especially through cloud seeding. It is emphasized, however, that the atmosphere is a single complex system in which interactions are both subtle and far reaching. - MGA 20.11-167.

7ld. Fleagle, Robert G. Implications for public policy. In: Fleagle, Robert G. (ed.), Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 138-142. DAS MO9.6 W362wea.

In this short summary, the author distinguishes between such small-scale, near-at-hand projects as fog dispersal and large scale, perhaps visionary, projects as the steering of hurricanes. The several papers on cloud modification are briefly reviewed. He expresses the belief that with further study it should eventually become possible to distinguish much more sharply between positive and negative effects. In each of the disciplines representedscience, statistics, economics, law, and ecology-there are gaps between hypothesis and proof. With this in view, the author discusses the following implications for public policy: Can the available technology and manpower be relied on to increase rather than to decrease precipitation under operational conditions? What should be the administrative management and budget allocations? The author states that the over-riding factor should be the need for further research and evaluation and that "an agency devoted exclusively and monopolistically to weather modification would be irrational, ineffective, and dangerous." A third set of central issues discussed is regulation and new legislation; last, but not least important, are the possible international ramifications. - MGA 20.11-168.

745. Fleagle, Robert G. (ed.). Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. 147 pp. (all articles abstracted separately). DAS MO9.6 W362wea.

Weather modification, an important example of the growing number of activities concerned with the deliberate intervention of man

into his environment, presents a complex set of problems requiring not only scientific and technological competence, but also new techniques in management, economic analysis, legal innovation, and political wisdom of a high order. To analyze the problems and possibilities of weather modification, the University of Washington Graduate School of Public Affairs, in the academic year 1966-1967, sponsored a series of interdisciplinary seminars featuring noted scholars in the fields that influence weather modification. It was recognized that weather modification includes both small-scale, near-at-hand projects such as fog dispersal, and large-scale visionary projects such as hurricane steering. Special emphasis was directed to the controversial subject of cloud seeding. Contributors included Robert J. Fleagle, P. V. Hobbs, Douglas G. Chapman, W. T. Edmondson, James H. Crutchfield, Robert Hunt from the Univ. of Wash .: James C. McDonald from Univ. of Ariz .: Gordon J. F. McDonald from the Univ. of Calif., Santa Barbara; W. R. Derrick Sewell from the Univ. of Victoria, B. C. - MGA 20.11-26.

746. Fukuta, Norihiko. Some remarks on ice nucleation by metaldehyde.
In: International Conference on Cloud Physics, University of
Toronto, August 26-30, 1968, Proceedings. Toronto, 1969? pp. 194198. DAS M74.1 I61p 1968.

A simple metaldehyde generator using the vapor activation method was devised and tested in the supercooled fog of Yellowstone Park, Jan. 1968. Seedings cleared the supercooled fogs and produced sun dogs and showers of ice crystals. Ice crystals produced by the seeding were replicated by the Formvar method and their shapes studied. Two groups of ice crystals of unusual shape were observed in very high concentration. The first group consisted of two or more hexagonal plates placed eccentrically parallel. The second consisted of hexagonal plates with vanes attached onto them, mostly perpendicular to the base plates. The ice crystals produced by a metaldehyde seeding are thus considerably different from others, and suitable care has to be taken in the estimation of their behavior in cloud. - MGA 20.15-135.

747. Gagin, A. Studies of the nature of precipitation mechanisms for the physical evaluation of cloud seeding experiments. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. eToronto, 1969? pp. 730-734. DAS M74.1 I61p 1968.

Israeli cloud seeding experiments, like others in Australia and Arizona, were aimed at stimulating or initiating an assumed rain-forming mechanism by effecting the phase instability of the cloud hydrometeors. AgI seeding was done within the clouds from aircraft. Most of the clouds were associated with low pressure systems and were predominantly cumuli. Comparisons were made of rainfall within seeded and unseeded areas. Increases

in winter precipitation of 18-19% were recorded. This note examines the results and compares them with those from the Australian and Arizona experiments, where the techniques were basically similar, in an attempt to discover the physical factors effecting variations in the reported results. Parameters examined were total precipitable water, ice nuclei, cloud nuclei, liquid water content of clouds, atmospheric stability, and vertical stratification of the atmosphere. The higher rainfall amounts observed were considered to be the higher effective ice nuclei concentrations activated at various levels in the cloud and the existence of conditions favoring faster and more extended growth processes within the cloud. The temperature properties of the atmosphere are more important than the moisture properties. This is in direct conflict with Battan's conclusions based upon the Arizona experiments. The nature of the mechanism leading to rain formation in summertime cumulus in Arizona are completely different from those of Israeli winter clouds. - MGA 21.7-118.

7/18. Gaivoronskii, I. I.; Krasnovskaia, L. I.; Solov'ev, A. D. Artificial

low cloud and fog dissipation. In: International Conference on

Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings.

Toronto, 1969?, pp. 700-706. DAS M7/4.1 I61p 1968.

Even with the full development of automatic landing systems it will still be more economical at certain airfields to use certain fog dispersal techniques as opposed to installing automatic landing equipment. All methods of artificial fog dissipation may be classified according to the physical process involved. The three basic processes are evaporation of fog droplets, for droplet withdrawal, and coagulation. The methods may be further divided according to the modification method and finally by the means. Nineteen different fog modification techniques are classified in this way. The different techniques are then compared by examining the minimum energy requirements for effective fog dispersal by each of the methods. For warm fog modification, thermal techniques are to be preferred. For supercooled fogs, seeding with an ice-nucleating reagent appears the most profitable. Investigations in the laboratory and in the field are reported in which dry ice was used as the reagent. Operations at airports in the Moscow region between 1964 yield of five times the cost of the seeding experiments. - MGA 21.6-153.

749. Gaivoronskii, I. I.; Seregin, Iu. A.; Voronov, G. S. Investigations of hail processes and their artificial modification in flat regions of the USSR. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. Toronto, 1969? pp. 760-767. DAS M71.1 IGIP 1968.

Since 1964, hail prevention experiments were made in the central part of the Moldavian S.S.R., a flat plain region. Detailed studies of hailstorm structure indicated that hail cells developed with a

cycle of from 15 to 30 min in the rear part of the cloud relative to the direction of motion. Analysis of radar and upper air sounding data made it possible to specify critical values of a number of cloud parameters for the formation, or nonformation, of hail. These were combined to produce a formula giving the percentage probability of hail. It was found convenient in judging the probability of hail forming to calculate differing critical parameters for different seasons and cloud types. Modification experiments were based upon the principle that the introduction of large number of hail embryos into that part of the cloud where hail formation was taking place would result in the formation of large numbers of smaller, less damaging hail and would reduce the risk of large hail formation. Rockets were used to deliver dry ice or lead iodide particles into the cloud. A description is given of the Oblako rocket specially developed for this purpose. The potentially hazardous cloud volumes were identified using radar. Tabulated results of the experiments are given. The parameter used to measure the rate of success was the ratio of hail damaged area in the test region with the area in a similar control region. Significant reductions in hail damage were obtained. - MGA 21.7-119.

750. Gaivoronskii, I. I. <u>Issledovannia v oblasti vozdelstvii na oblaka i tumany</u>. (Investigation in the field of cloud and fog modification.)

U.S.S.R. Tsentral naia Aerologicheskaia Observatoriia, Moscow,
Trudy, No. 90: 56-72, 1969. English summary p. 72; Russian summary
p. 79. DAS M(055) U581tt.

Results of the theoretical and experimental studies on the mechanism of supercooled cloud and fog modification by means of ice-forming agents are reported. Results of a number of practical methods developed for supercooled cloud and fog dispersal and for thunderstorm and hailstorm control to prevent hail are given. - MGA 21.3-298.

751. Gaïvoronskii, I. I. and Voronov, G. S. Some results of artificial modification of hail processes. Idojárás, Budapest, 73(6): 321-327, November - December 1969. Russian and Hungarian summaries. DAS M(05) I21.

The results of radar studies of hail processes in the Moldavian S.S.R. are discussed. In 75% of the cases, hail (in Moldavia) was associated with the passage of primary and secondary cold fronts. Radar observations show that two or three large drop cells can be distinguished within hail clouds and of these only one is hail-bearing. The hail cell is found in the rear of the cloud and its development cycle averages 15 or rarely 30 min. Its average size is 14 to 16 km³. Formation of disintegration of clouds is accompanied frequently by the lamination of radar echo zones. The evolution of seeded hail clouds shows a rapid

increase of radar parameters 8-10 min after seeding; later, the radar parameters decrease rapidly as compared to their variation during seeding. During seeding, the hail cells disintegrate at a high rate. Seeded hail clouds do not show a tendency towards resumption of cloud development, and no precipitation of solid particles was ever detected. After merging with unseeded clouds, they generally start to grow rapidly and the values of the main radar parameter simultaneously increase. Hail danger can be assessed on the basis of a combination of the following radar and thermal parameters: 1) maximum height of radar echo; 2) vertical thickness of echo; 3) ratio of radar echo for negative and positive air temperature; 4) maximum radar reflectivity; 5) peak of maximum radar reflectivity; 6) vertical thickness of high reflectivity zone differing from maximum radar reflectivity; 7) air temperature at the top of the radar echo; and 8) air temperature at the upper level of the high reflectivity zone. The cloud parameters for rain and hail clouds in Moldavia are tabulated. An analysis of 10-day monthly averages of radar echo and temperature parameters of clouds has established three periods of variation of the parameters: 1) May and first half of June; 2) second half of June and July; and 3) Aug. and Sept. The use of the "Cblako" hail rocket as an antihail measure and the extent of hail damage over protected and control areas are discussed. - MGA 21.9-334.

752. Gentry, R. Cecil. Project Stormfury. American Meteorological Society, Bulletin, 50(6): 404-409, June 1969. DAS M(05) A512b. Also in World Meteorological Organization, WMO Bulletin, 18(3): 146-15h, July 1969. DAS M(05) W927w.

Project Stormfury is a project of the Commerce and Defense Dept. for experimenting on the modification of hurricanes. Justification for the work is based on recent discoveries about hurricanes and the high potential benefit to cost radio of the experiments. Evidence is presented that two approaches for modifications should be considered—clouds seeding, and inhibiting evaporation from the ocean. The scientific aspects and logistic problems of both approaches are reviewed. The program and goals of the project Stormfury are discussed. - MGA 21.3-299.

753. Greenfield, S. M. Weather modification research: a desire and an approach. Rand Corporation, Santa Monica, California, Paper 4027. February 1969. 15 pp. DAS M(055) R186p no. 4027.

The history of weather modification (cloud seeding) activities (since Langmuir's experiments in 1946) is reviewed in which the necessity of understanding the atmospheric environment in depth as a prime requisite for weather modification is discussed and followed by an examination of the problem. A diagram of atmospheric interaction shows that the energy in the cloud-size, vertical-instability portion of the spectrum must contribute, in part, to the horizontal instability that results in the larger weather

phenomena, and hence, probably through an organizational process involving feedback, move up-scale. A graph of atmospheric available kinetic energy distributions shows two forms of instability that represent the basic driving forces in the atmosphere, and probably provide the most fruitful approach to possible weather modification. The author notes that unfortunately the atmosphere is not so simply described either energetically or dynamically, which makes it necessary to resort to modeling. With enough time and computer power, adequate atmospheric models would result, and then weather modification research would proceed quickly. This appears to be a simple approach and the apparent need for numerical models is one that calls for a growing interplay between numerical, laboratory, and field experimentation. A recent Rand report is quoted in which 3 basic categories of application of modeling to weather modification research were identified, and emphasizes that if weathermodification research is to proceed at all expeditiously, the numerical modelers and the theoreticians must be brought into close cooperative contact with the laboratory and field experimenters. The funding of research and experimentation and other problems including the lack in the U. S. of a supported group charged with the total problem of weather modification are discussed. - MGA 21.8-121.

754. Harris, Dale R. Beat the big freeze. ESSA World, Rockville, Maryland, 4(2): 32-35, April 1969. DAS M(05) E78es.

Describes the central role played by USWB's Western Region Fruit-Frost Service in protecting the fruit trees, fruits, and vegetables in the western states and in saving growers millions of dollars in labor costs. The author states that the hydrometric formula still serves as a guide in making the temperature estimates. The several illustrations show smudge pots, frost damage, and wind machines used in protecting trees from frost damage. - MGA 21.2-46.

755. Hastay, Millard and Gladwell, John S. Statistical evaluations of a cloud-seeding program at streamflow control level. Journal of Hydrology, Amsterdam, 9(2): 117-135, October 1969. DAS P.

During the winters of 1962-63 and 1963-64 cloud-seeding operations were undertaken on the Skagit River (Washington) watershed. Conditions required that the statistical evaluation be made at the streamflow control level.

A combination of least squares regression with principal components analysis is developed. This requires preliminary screening of variables using a liberal (0.10 level of significance) critical region, followed by the orthogonalization procedure of principal components. Final stepwise regression analysis using the principal component scores and the 0.05 level of significance follows. Tests are consistent with treating the residuals as Gaussian, homoscedastic, and non-autocorrelated.

The analysis is replicated in various ways. Without exception, the excess of actual over predicted flows for the full period of the experiment was significant at 0.01 "or higher" level. However, whereas the excess in 1964 is invariably significant at the 0.005 "or higher" level, the 1963 excess would not be judged significant by itself at the 0.05 level. This is explained by a five-fold increase in seeding between 1963 and 1964.

Two years subsequent to the period of seeding are analyzed: observed flows fail to show significant deviations from expected flows. Estimates indicate at least 15 percent runoff increase from seeding. - Authors' abstract.

756. Hildebrand, Peter H. An examination of a cumulus cloud width-height measure under the effects of seeding. American Meteorological Society, Bulletin, 50(1): 10-14, January 1969. DAS M(05) A512b.

A width-height measure of cloud shape is used to investigate possible effects of seeding cumulus clouds with silver iodide. Evidence is presented to show that seeding may cause decreases in the width-height ratios of cloud echoes and that these effects may extend beyond the region of silver iodide transport. - Author's abstract.

757. Hobbs, P. V. The scientific basis, techniques, and results of cloud modification. In: Fleagle, Robert G. (ed.), Weather Modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 30-42. DAS MO9.6 W362wea.

Summarizes the major elements and problems involved in cloud modification, and describes in detail 2 methods of inducing precipitation artificially: 1) introduction of large hygroscopic particles or liquid water droplets into a cloud to initiate rainfall production through the coalescence mechanism, and 2) production of ice crystals in a cold cloud by introducing artificial ice nuclei or other suitable material, thereby triggering the Bergeron-Findeisen mechanism. Chief topics discussed in this context are 1) seeding of warm clouds; 2) seeding of cold clouds; 3) hail suppression; 4) lightning suppression; 5) modification of cloud dynamics; and 6) modification of hurricanes. Verification of results remains a central problem in cloud-modification experiments because of natural variability in the behavior of clouds and the amount and distribution of rainfall; statistically significant results can be obtained only by the conduct of random experiments over fairly long periods of time. - MGA 20.12-160.

758. Hogan, A. W.; Robertson, C.; Edwards, C. P. Application of an inert tracer to an AgI seeding experiment. Journal of Applied Meteorology, Boston, 8(1): 169-171, February 1969. DAS M(05) J86joa.

Results of experiments involving simultaneous seeding with AgI and Li stearate carried out in the Park Range during Jan. and Feb. 1968. In addition to measurement of amount and rate of precipitation there were attained crystal replicas and precipitation samples. In earlier experiments where AgI and Li. stearate aerosols were generated simultaneously, it was found that a "square wave" pulse of seeding material could be stretched into a pseudo-continuous source by local meteorology and topography and that the meteorologically inert tracer could easily be sensed in the large area at time when no proportional rise occurred in active ice nucleus concentration. "The hypothesis of Robertson was that this was due to the silver iodide nuclei being consumed by the precipitation processes in the cloud above the receiving station." The hypothesis of Robertson is confirmed and it is concluded that frequent or continuous observation of precipitation, crystal size and type in conjunction with an inert tracer launched simultaneously with the seeding material can be of great value in deciding whether the target area has been seeded. - MGA 20.6-182.

750. Howell, Wallace E. <u>Discussion of "An examination of a cumulus cloud</u> width-height measure under the effects of seeding." Reply by Peter H. Hildebrand. American Meteorological Society, Bulletin, 50(6): 1143-1444, June 1969. DAS M(05) A512b.

Howell states that probably Hildebrand arbitrarily assigned zero value of his width-height measure, $T_{k_{\perp}}$, to echoless sweeps, even though the physical meaning, infinitely tall skinny echoes, is inappropriate, and zero value for the numerator of his expression combined with the nonzero values for both factors of the denominator is absurb. He then notes the differences in T between seeded and nonseeded days and concludes that Tb is greatly affected by dispersion characteristics of echo size as well as by width-height ratio. He considers it regrettable that Hildebrand did not treat explicitly the echo height that is of key physical importance. He concludes that if the dynamic effect on echo-height variance is capable of propagation in time and space, Hildebrand's observation of later and more widespread decrease of T related to seeding thus might be partly explained. In his reply, Hildebrand agrees that the use of a zero value for the widthheight measure, T, in the case of no echoes is misleading, but not for the seasons given by Howell. He then states that his choice of T=0 for nonecho sweeps was based upon a consideration only of the case of dissipating convective echoes and the T=0should not have been included in the tables. He does, however, demonstrate that removal of the zeros from the data does not significantly change the difference between the seeded and the nonseeded samples. A further analysis is presented leading to the conclusion that the maximum possible dispersion of echo heights was the same on seeded and nonseeded days for the sample used, and that the only way that seeding could have increased the dispersion of echo heights would have been to produce taller echoes on seeded days and this was not observed. The author presents

the result of his calculations of the mean echo diameter for seeded and nonseeded days. It is reasonable to expect the echo of a convective cloud to retain its shape, thus it is possible that an improved width-height measure might provide the strongest tool for investigating the effects of cloud seeding on the shape of radar echoes. - MGA 21.3-309.

760. Huff, F. A. Climatological assessment of natural precipitation characteristics for use in weather modification. Journal of Applied Meteorology, Boston, 8(3): 401-410, June 1969. DAS M(05) J86joa.

A study has been made of the climatological characteristics of storm precipitation on a point and areal basis through the use of two sets of data. One is from a 12-year operation of a dense raingage network on 400 mi2 in central Illinois, and the other is the long-term point rainfall records of daily precipitation from U. S. Weather Bureau climatic stations throughout the state. The detailed network data were used to investigate effects of storm intensity and duration, precipitation type, synoptic weather type, wet and dry periods, and other factors upon storm distribution characteristics. Frequency distributions of both rainfall depth and number of storms were determined for various classifications, and these distributions were evaluated with respect to implications in weather modification during the critical growing season (May-September) and the water-supply replenishment period (October-April). Nomograms were developed from the climatological distributions to facilitate the evaluations. By relating areal to point distributions, a method was devised for deriving similar information for less dense network areas. - Author's abstract.

761. Huff, F. A.; Shipp, W. L.; Schickedanz, P. T. Evaluation of precipitation modification experiments from precipitation rate measurements.

Illinois. Water Survey, Contract INT 14-06-D-6575, Final Report, April 30, 1969. 122 pp. DAS M(051) I29re final.

An investigation of the natural time and space characteristics of 1-minute rainfall rates in warm season storms of the Midwest was made. The potential applicability of rate distributions in the verification of cloud seeding effects was evaluated from the analytical results within the limits permitted by the statistical sample. Analyses were based upon a 50-storm sample of 1-minute amounts collected with two dense networks of raingages during 1951-1953. Attention and 100 mi² on areas of 60 mi² was given to the effects of rain type, synoptic storm type, and other meteorological parameters on the time-space distributions. Time characteristics were defined primarily through the development of storm time distribution models, calculation of sequential variability, and determination of lag correlation relations. Spatial distribution characteristics were based largely upon studies of area-depth relations, spatial correlation patterns, and relative variability calculations. Statistical theory and testing were applied to the data to obtain estimates of sampling time required to verify cloud seeding effects through use of three experimental designs and two statistical test, and based upon various assumed changes in rainfall rate resulting from seeding. Overall, it was concluded that rainfall rate may be one of several useful rainfall measurement tools in weather modification evaluations, but that, by itself, it is not very effective unless pronounced changes in the rate structure are produced by seeding. - Authors! abstract.

762. Hunt, Robert S. Weather modification and the law. (In: Fleagle, Robert G. (ed.), Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 118-137) DAS MO9.6 W362wea.

This philosophical legal paper discusses the "ownership" of clouds, for which neither riparian nor prior appropriation principles provide answers, and the law of torts, which the author considers probably the most helpful source of principle by analogy. He states that whether weather modification (WM) would fall within the concept of strict liability may depend upon the kind of activity undertaken, hurricane diversion certainly would. The laws of trespass and of private nuisance as they may apply in WM are discussed. The author cites the decisions in seven lawsuits against WM operations and concludes that, until some better system is devised, the courts will decide the cases and shape the law of WM along traditional principles. A discussion of the inadeouacy of traditional doctrine and procedures and of existing legislation in some 23 states dealing with WM leads the author to conclude that if a workable system of regulation of weather modification in the U. S. is an agreed-upon goal, the present situation is intolerable. In the last section dealing with future trends, the author expresses the view that federal regulation is the only ultimate solution; "At the very least certain varieties of WM can and will be regulated only by the federal government. Hurricane diversion is the most dramatic example." - MGA 20.10-132.

763. Jiusto, James E. Some principles of fog modification with hygroscopic nuclei. U. S. National Aeronautics and Space Administration, Washington, D. C., NASA Sp-212, Progress of NASA Research on Warm Fog Properties and Modification Concepts, Proceedings of a Symposium held at NASA Headouarters February 6, 1969, in Washington, D. C., pp. 24-39. DAS 629.1388 U585na Sp-212.

Calculations and experiments indicate that the visibility in warm fog can be substantially improved by seeding with giant salt (NaCl) particles. By absorbing water vapor from the air, the larger saline drops grow at the expense of the natural fog droplets. In order to avoid impractical salt mass requirements, particle size and concentration must be carefully prescribed. Calculations indicate that, for typical radiation fogs, 5 to 10 $\,\mu\text{-}\,\mathrm{radius}$ salt nuclei in concentrations of a few mg m $^{-3}$ of air are desired.

Excessive drying of the air (i.e., more than a per cent or two lowering of the relative humidity) is neither desirable nor practical. In advection fogs with strong winds, thereby dictating large payloads, the technique appears to be of limited value.

The choice of hygroscopic material is less dependent on small variations in water absorbing capacity than on milling (sizing), agglomeration, cost and corrosion factors. Of the salts, sodium chloride appears to be the best choice. Its only potential deficiency -- a possible but as yet undetermined corrosion problem at airports -- suggests that substitutes continue to be investigated. - Author's abstract.

764. Jones, Douglas M. A. Raindrop distributions near Flagstaff, Arizona. Illinois. State Water Survey at the University of Illinois, U. S. Army Grant DA-ARO-D-31-124-G-937, Final Report. January 1969.

50 pp. DAS M77.1 J76rai.

The Illinois State Water Survey raindrop camera was operated from 9 July through 19 August 1967 at the Fort Valley Experimental Forest near Flagstaff, Arizona, before, during, and after a period of cloud seeding. Drop-size distributions were determined for showers which were seeded and unseeded and showers with and without the occurrence of hail. It was found, on the average, that seeded showers and natural showers forming in more humid air masses have fewer large drops and more drops per cubic meter for the same rainfall rate than have showers accompanied by hail and unseeded showers forming in relatively dry air masses. The increase in the relative number of drops at rainfall rates greater than 30 mm hr⁻¹ was investigated and found to be the result of the breakup of drops larger than 2.0 mm diameter.

It is concluded that the peculiarity of the Flagstaff distributions lies in the extraordinary number of very large drops which fall in showers forming in relatively dry air and that these large drops do not break up easily because they are the remnants of hailstones. - Author's abstract.

765. Kahan, Archie M.; Stinson, J. Robert; Eddy, Richard L. Progress in precipitation modification. American Meteorological Society, Bulletin, 50(4): 208-214, April 1969, DAS M(05) A512b.

Progress in weather modification is assessed with special emphasis on precipitation modification. Although assessment of progress on a current basis is difficult, an attempt is made to accomplish this on both a problem and a component scale. Much work is being conducted which should significantly improve our ability to increase precipitation in specific targets and minimize risks associated with modification activities. - Authors' abstract.

766. Kartsivadze, A. I. Modification of hail processes. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. **Toronto, 1969?**, pp. 778-788. DAS M74.1 I61p 1968.

A theoretical treatment of adding hail embryos into cloud is given as a physical basis of modifying the hail development process. First, the average decrease in size of hail particles caused by the presence of additional embryos is considered. Then, the influence of the embryos on the droplet size distribution is discussed. Laboratory experiments have indicated that 1/500 - 1/1000 part of the total ice nuclei active at a given temperature can produce pellets comparable in size with hailstone embryos after 5-10 min. All these calculations show that when seeding with AgI or PbI aerosols an increase of concentration of active crystallization nuclei up to 104 -105 m-3 is necessary for efficient results. Special studies of hail and shower clouds were made to determine the correlation between the probability of hail and certain values of various cloud parameters. A radar technique for locating areas of probable hail formation was devised. The nucleating agents are delivered to the cloud by means of specially developed rockets or artillery shells. A report is given of the result of operational trials made in the Alanzi valley of the Georgian S.S.R. These began in 1958. The area protected increased during later years, until, in 1967, its total area reached 320,000 ha. Rocket sites were set up throughout the area. An operational center plots the areas where a hail risk exists and controls the firing program. To check the efficiency of the technique, comparison is made to control areas. The results are summarized in tabular form. A marked decrease in hail occurrence and in crop damage was recorded in the test areas. - MGA 21.7-120.

767. Kelley, Neil D. A digital telemetry system for weather modification research. Report No. 14 to the National Science Foundation. NSF Grant GA-3956. Pennsylvania, State University, Department of Meteorology, May 1969. 121 pp. DAS M(051) P415rp no. 14.

This report gives the results of the comparison and evaluation of four types of telemetry modulations, namely: frequency modulation (FM), pulse-amplitude modulation (PAM), pulse-duration modulation (PDM), and pulse-code modulation (PCM) as transmitted over a frequency modulated radio link. The author concludes that the PCM would provide proper data links and would significantly improve field experiments in weather modification. Although this system is the most complex and most expensive of the techniques its great flexibility and efficiency counteracts these drawbacks.

768. King, Palmer. Legal aspects of weather modification. American Society of Civil Engineers, Irrigation and Drainage Division, Journal 95(3): 403-408, September 1969. DAS P.

Weather modification activities produce some interesting legal problems: liaibility, asserting ownership to increased runoff, and the role of the government. The claimant has thus far been unable to prove that whatever damages he may have suffered resulted from weather modification. However, liability is an ever-present threat to the weather modifier. Existing laws give the additional water to whoever expends his time and means to create the increased runoff. The problem is establishing with reasonable certainty the amount of increased water supply attributable to the modifier's efforts. The Federal Government has broad authority under the Commerce Clause of the Constitution to legislate with regard to weather modification. Because of the unique nature of the weather modification science, existing legal analogies generally appear deficient in one way or another. - MGA 21.3-300.

769. Kiriukhin, B. V. and Morachevskii, V. G. O vozmozhnosti ispol'zovaniia poverkhnostnoaktivnykh veshchestv v tseliakh vozdeistviia na konvektivnye oblaka. (The possibility of using surface active substances for influencing upon convective clouds.) Meteorologiia i Gidrologiia, Moscow, No. 6: 30-38, June 1969. Russian summary p. 30; English summary p. 38. DAS M(05) M589.

Conditions for initiation of a chain process (according to Langmuir) are examined when precipitation is formed from large cumulus clouds with regard to changes of upward airflow velocities with height. The article presents a study of the fragmentation process of water droplets and surface active agents by the method of high-speed photography; the size of resulting aeroscls and their spectral distribution are given. The possibility for artificial stimulation of the chain process with the help of surface active substances in experiments on the generation of additional precipitation from cumulus clouds is discussed. - MGA 21.5-206.

770. Kocmond, W. C.; Pilié, R. J.; Jiusto, J. E. Warm fog suppression with giant hygroscopic nuclei. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. eToronto, 1969? pp. 694-699. DAS M71.1 I61p 1968.

A report is given of laboratory tests undertaken to determine the improvement in visibility that could be achieved by seeding warm fogs with hygroscopic nuclei of carefully controlled size, to determine the minimum amount of seeding material required to produce that visibility improvement, and to compare the results to theoretical predictions. The experiments were conducted in a large cloud chamber 30 ft in diam. and 30 ft high. Twenty seven experiments were run. NaCl and, occasionally, urea nuclei of controlled sizes were used with initial visibilities ranging from 200 to 300 ft and in some cases of 700 ft. Three tests were run to examine the effects of reseeding fogs several minutes after initially injecting nuclei into the fog. All tests

resulted in some significant visibility improvement except one. During the experiments, droplet samples were obtained on gelatin coated slides automatically exposed to the fog. The experiments demonstrated that it is possible to improve significantly visibility in warm fog with carefully sized hygroscopic particles. Two processes effect the visibility change. Initially, after injecting nuclei into the fog, increased visibility results from a favorable shift in drop-size distribution towards fewer. larger drops. Only slight changes occur in fog liquid water content for several minutes after seeding. As time progresses, precipitation of saline droplets promotes further dissipation of the fog and additional visibility improvement. Estimates suggest that for a hypothetical airport fog, a landing zone 100 m high, 500 m wide, and 2 km long might be opened with 200 to 300 kg of properly sized salt particles. Ten u-diam. NaCl particles appear optimum. Visibility improvement factors greater than 10 can be expected. - MGA 21.7-111.

771. Kocmond, Warren C. <u>Dissipation of natural fog in the atmosphere</u>.

U. S. National Aeronautics and Space Administration, Washington, D. C.,
NASA SP-212, Progress of NASA Research on Warm Fog Properties and
Modification Concepts, Proceedings of a Symposium held at NASA
Headouarters February 6, 1969, in Washington, D. C., pp. 57-74.

DAS 629.1388 U585na Sp-212.

During the late summer and early fall months of 1968, 31 fog seeding experiments were conducted at the Chemung County Airport near Elmira, N. Y. The primary objective of these experiments was to determine the effects of seeding dense natural fog with carefully sized hygroscopic particles. Our intent was to evaluate the concept by seeding fogs from the ground, and if necessary, perform aerial seeding experiments during the latter part of the fog season. A total of 25 experiments were conducted with ground seeding apparatus during the period May - September 1968. Six aerial seedings of dense valley fog were performed during a three week period in October 1968. Data collected during several of these experiments have now been analyzed and the results are presented here. - Author's summary.

772. Kocmond, Warren C. and Pilié, Roland J. Investigation of warm fog properties and fog modification concepts. Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., CAL Report No. RM-1788-P-22, February 15, 1969. 19 pp. (Contract NASr-156, Quarterly Progress Report). DAS M75 S989pa.

Summarizes the results of field experiments and subsequent data analysis in connection with evaluating the effects of seeding dense natural fog. The experiments were conducted during the late summer and early fall of 1968 near Elmira, N. Y., using carefully sized hygroscopic particles; fogs were seeded from the ground, and also aerially. Instrumentation and equipment employed in

these studies are described and illustrated; mobile seeding techniques, aircraft, and transmissometers were employed. Fog characteristics were analyzed for drop size, vertical temperature distribution, and fog depth, and are presented in comparative tabular form. Mechanisms of the formation of valley fog are considered. Results of ground seeding experiments are reported as successful in improving visibility; aerial seedings with 700 lbs of sodium chloride (size range 10-30 μ in diam.) produced fully cleared areas for about 30 min. Data analysis indicates 60% of the visibility improvement was the result of the decrease in fog liquid water caused by precipitation of the large saline droplets after seeding. - MGA 20.9-176.

773. Kocmond, Warren C. Laboratory experiments with seeding agents other than NaCl. U. S. National Aeronautics and Space Administration, Washington, D. C., NASA SP-212, Progress of NASA Research on Warm Fog Properties and Modification Concepts, Proceedings of a Symposium held at NASA Headquarters February 6, 1969, in Washington, D. C., pp. 86-96. DAS 629.1388 U585na Sp-212.

These initial experiments in which various types of sized phosphate chemicals were used to improve visibility in dense laboratory fog have been encouraging. Refinements in sizing of materials and tests with other seeding agents are planned. The results of our laboratory tests with sized polyelectrolytes suggest that these materials are ineffective as seeding agents. Stress-corrosion cracking experiments will be conducted to determine the corrosive effects of various seeding agents on several types of metals. Once we have isolated one or two of the most promising non-corrosive chemicals in the laboratory we plan to evaluate the seeding agents in a series of field experiments. It is our intention to conduct field evaluations of these chemicals during the later summer and early fall of 1969. - Author's conclusions.

774. Koenig, L. R. <u>Numerical experiments pertaining to warm-fog suppression</u>.
Rand Corporation, Santa Monica, California, Research Memorandum
RM-6159-PR, October 1969. 49 pp. DAS 507.2 R186r no. 6159-PR.

As part of a continuing study of micro-physical aspects of weather processes, an attempt has been made quantitatively to assess the prospects for modifying warm fogs by seeding them with condensation nuclei. This has been done by calculating the time-dependent changes in the sizes and concentrations of fog droplets that are predicted by the ordinary equations of diffusion of water vapor to and from the surface of droplets, taking into account their size, molality, and ambient water-vapor density.

Initial conditions consist of a homogeneous volume of air of specified height and aerosol content. An external cooling rate and seed dosage are specified. The effects of various combinations of cloud height, seed properties (such as size, mass density, and rate of injection) on the metamorphosis of the fog-droplet population are examined. The cloud-forming process (in which

temperature decreases with time) is allowed to continue after seeding has been accomplished, and tentative conclusions are drawn regarding the ranges of seed dosages that might result in successful and nonsuccessful efforts to suppress warm fog.

A discussion of the basis of calculations of the meteorological range is included. - Author's abstract.

775. Kornienko, E. E.; Leskov, B.N.; Polovina, I.P. Results of seeding clouds with solid CO₂ aimed at the stimulation of precipitation over the Ukraine. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. Toronto, 1969? pp. 724-729. DAS M74.1 I61p 1968.

This paper presents the results of artificial cloud seeding experiments made in the Ukraine (1959-1967) over a region where a special meteorological observing network had been set up. Seeding was done by aircraft using solid carbon dioxide as the reagent. The results of seeding St or Sc layers with depths of 250-300 m and mean temperatures below -4°C showed that over an area of 300-500 km² precipitation could be increased from 5-10%. Seeding of cyclonic As-Ns was done over areas from 300 to 1000 km2. With slight rain increases, precipitation from 60 to 150% could be achieved; for moderate and heavy rain, the equivalent increase was 30 and 20%, accounting for the frequency of occurrence of seedable cloud and other factors. With the increases from St Sc seeding, an overall increase of 15-20% in rainfall is possible. Experiments in seeding cumulus clouds were begun in 1960. While apparent increases in rainfall were observed. the statistical interpretation of the results was difficult. Seeding of clouds chosen at random was attempted and similar clouds, randomly chosen but not seeded, were also observed. The number of seeded clouds that produced rain was in excess of the unseeded ones. Estimates of the volumetric increase in precipitation resulting from the seeding are attempted. - MGA 21.7-121.

776. Kraght, Peter E. Warm cloud modification. Shell Aviation News no. 375: 16-23, 1969. DAS P.

The composition of fog, classification of fog, physics of warm fog modification, Bollay Associates investigations in California, and Texas, World Weather, Inc. projects, MRI's (Meteorology Research Incorporated) conclusions and significance and problems of ground dispensing of seeding agents are discussed.

777. Kumai, Motoi. Fog modification studies on the Greenland Ice Cap.
U. S. Cold Regions Research & Engineering Laboratory, Hanover, New
Hampshire, Research Report 258. March 1969. 9 pp. DAS M78.4
U586re no. 258.

During the summer of 1965, the CRREL cloud physics group carried out a study of fog modification by propane and dry ice seeding

on the Greenland Ice Cap, an area with one of the lowest concentrations of atmospheric pollution on earth. The nuclei of supercooled fog droplets before seeding were observed using electron microscopy and electron diffraction methods. The nuclei of ice crystals formed by dry ice and propane seeding were also observed using the same technique. The nuclei of the supercooled fog droplets and the ice crystals formed by seeding were found to be hygroscopic sea salt particles that were easily distinguished from the clay mineral nuclei of natural snow crystals. The sublimation temperature of carbon dioxide is -78.5C. The boiling point of liquid propane is -44.5C at 1 atm pressure. It is concluded that the ice nucleation of supercooled fog by dry ice and liquid propane seeding is due to thermal effects. - Author's abstract.

778. Kumai, Motoi. Formation and reduction of ice fog. U. S. Cold Regions
Research & Engineering Laboratory, Hanover, New Hampshire, Research
Report 235, March 1969. 21 pp. DAS M78. U586re no. 235.

During January and February of 1962, 1963 and 1964, Fairbanks, Alaska, and vicinity was the site of a series of studies dealing with ice fog and ice crystals. This report presents the results of an investigation of the amount and extent of air pollution and ice fog in the area with special emphasis on reducing ice fog by decreasing the water vapor being emitted into the atmosphere. The major sources of water vapor at the two military installations in the region, Fort Wainwright and Eiclson AFB, are the heating and power plants and their associated cooling ponds. In the populated areas around Fairbanks, a high aerosol concentration of about 105 particles/cm3 exists, whereas in the uninhabited areas the concentration is extremely low (about 300 particles/cm³). Much of the high concentration is due to the burning of coal for heat and power. Because the coal is of low grade it also emits about 350,000 kg of water vapor into the atmosphere on a day when the temperature is -40C. This water vapor condenses on the aerosols and produces ice fog. Anthracite or semi-bituminous coal would reduce the water vapor output to only 1/5 of the amount produced by the low grade coal. Water vapor from cooling ponds can be reduced by freezing the surfaces of the ponds. - Author's abstract.

779. Layton, R. G. Comments on "Ice Nucleation Behavior of Silver Iodide Smokes Containing a Soluble Component." Reply by N. H. Fletcher. Journal of Atmospheric Sciences, Boston, 26(4): 774-775, July 1969. DAS M(05) A512j.

Layton, on the basis of findings of Edwards and Evans (1962), indicates that any drop which is formed by NI should be rather resistant to ice nucleation by AgI. There should be very little activity at temperatures > -16C. This would profoundly change the results of Fletcher's calculations to the point that it may be seriously questioned if this process can be at all important

in the actual nucleating of a supercooled cloud by a silver iodide smoke. In reply, Fletcher recognizes that the ionic absorption effect discovered by Edwards and Evans (1962) is important, and he agrees that it must be included in any really comprehensive theory. The apparent existence of active sites for nucleation is important. The next generation of nucleation theories must begin to take account of these effects. - MGA 21.1-269.

780. Layton, R. G. and Lavign, M. The decay and rejuvenation of silver iodide surfaces. Journal de Recherches Atmosphériques, Clermont-Ferrand, 4(3): 113-114, July - September 1969. French and English summaries p. 113. DAS M(05) J86jor.

The ice nucleating ability of single crystals of silver iodide was found to decay upon exposure to the atmosphere and the development of hygroscopic patches on the surface was noted. The decay was evidenced by an increase in the supersaturation required for nucleation, a decrease in the number of crystals nucleated, and in a change in crystal type. The hygroscopic patches were not the areas favored for ice nucleation. Several different washing techniques succeeded in restoring activity at the original supersaturation, but the original density of active sites was not restored.

781. Layton, R. G. and Steger, John. <u>Nucleation of ice on silver iodide</u>.

Journal of the Atmospheric Sciences, Boston, 26(3): 518-521, May 1969. DAS M(05) A512i.

A constant nucleation rate implies a nearby constant supercooling. This is confirmed experimentally by observing the nucleation of ice and water on single AgI crystals. The experimentally determined supercoolings for condensation and deposition, when plotted on a T vs log P graph, allow the determination of the threshold for deposition ($\sim -5^{\circ}\text{C}$ at $\sim 3\%$ supersaturation). The threshold for deposition at water saturation is found to be -9°C . Three nucleation threshold temperatures are of interest. The first is when transition from condensation to deposition occurs, the second is when deposition first occurs at water saturation, and the third is when liquid water in contact with the nucleus freezes. Only the first two are considered in this paper. - MGA 20.9-382.

782. Leonov, M. P. Ob otsenkakh vozdejstvij na pereokhlazhdennye oblaka (Estimates of influence upon supercooled clouds.) Meteorologija i Gidrologija, Moscow, No. 6: 39-46, June 1969. Russian summary p. 39; English summary p. 46. DAS M(05) M589.

The article presents the estimation of six-year study on the intensification of widespread precipitation in the Ukraine. The shortcomings of the study methods and estimates in other similar experiments are discussed. - MGA 21.3-310.

783. Leskov, B. N.; Polovina, I. P. <u>Nekotorye rezul'taty issledovaniia</u>
protsessa rasprostraneniia <u>kristallzatsii</u> po vertikali v
sloistoobraznykh oblakakh. (Some results of research into the
propagation of crystallization along the vertical in stratiform
clouds.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 82: 77-83, 1969. Russian summary
p. 155. DAS M(055) U58ltu.

Results are presented of experiments on the speed of propagation of the crystallization process in the vertical and horizontal directions when inner mass stratiform clouds are being modified. The investigation was based on data of 12 modification experiments in which seeding of clouds with solid CO2 was carried out on the upper and near the lower boundaries. The average speed of propagation of the crystallization process in the vertical was 1.05 m/sec. An increase in the speed of vertical propagation with an increase in cloud thickness is noted. The speed along the horizontal with the seeding along the upper boundary was 0.69 m/sec; with seeding near the lower boundary it was 0.98 m/sec. These differences are explained by the simultaneous influences of the vertical and horizontal exchanges on the crystallization process when the seeding was near the lower boundary. The conducted experiments indicate the need for a new theoretical approach to the evaluation of the number of the generated crystals in relation to the weight of the introduced reagent. - MGA 21.10-123.

784. Leskov, B. N.; Polovina, I. P. <u>O metodike provedeniia opytov i tochnosti izmereniia zon iskusstvennoi kristallizatsii.</u> (Experimental construction methods and precision in measuring artificial crystallization zones.) U.S.S.R. Ukrainskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Trudy, No. 82: 84-91, 1969. Russian summary p. 155. DAS M(055) U58ltu.

Specially designed experiments serve as a basis for this paper's discussion of errors in measurement of the width of the crystallization zone. It was established that the maximum relative error does not exceed 5-80%. Parallel measurements of the zone width by change in cloud-layer structure and by "lower" Sun give the same results if the line of action is oriented in the direction of the Sun. The line of action must be perpendicular to the wind direction at the upper boundary level or along the wind. In case of orientation of the line at some angle to the wind, errors will occur because of turning of the zone. In as much as wind in the cloud layer can have diverse orientations in relation to the Sun, the possibility of measuring crystallization zones by "lower" Sun is substantially limited. In measurements of zone widths, oriented normal, to the direction toward the Sun by the "lower" Sun method, their dimensions can be substantially exceeded especially with small solar declinations. In the first 5-15 min this error can reach 100% which exceed by more than one order the possible maximum measurement error

785. Levin, L. M. and Vulf'son, N. I. Modification of convective clouds with the help of artificially created vertical jets. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. Foronto, 1969? pp. 820-827. DAS M74.1 I6lp 1968.

Development of cumulus clouds is often restricted by stable atmospheric layers. The application of vertical updrafts of sufficient intensity to penetrate such stable layers should stimulate cumulus development. Obsolete gas turbine aircraft engines were used to create the upward jet. Calculations of probable effects of one or more such engines operating were first made. The first experiments were made using only one engine, but in later experiments, four engines were used. Preliminary tests showed that small cumuli could be created particularly when highly active condensation nuclei were used. If vertical jets could be used to create cumulus development, then it might also be possible to damp cumulus development using downward pointing jets. Calculations showing the orders of magnitude of the energies required are reported. Experiments in which jet aircraft were flown through cumulus clouds at high pitch angles appeared to give successful results. - MGA 21.7-116.

786. Lovasich, Jeanne L.; Neyman, Jerzy; Scott, Elizabeth L.; Smith, Jerome A. <u>Timing of the apparent effects of cloud seeding</u>. Science, Washington, D. C., 165(3896): 892-893, August 29, 1969. DAS P.

The average hourly precipitation amounts, on 96 experimental days without cloud seeding in the Whitetop experiment, show a marked maximum between 4 and 7 o'clock in the afternoon, presumably reflecting the convection activity caused by heating of the ground occurring during an earlier period. No such maximum is observed on the 102 days with seeding. The hypothetical explanation presupposes that seeding with silver iodide creates early general cloudiness, which prevents ground temperatures from rising to levels usually attained on days without seeding. This hypothesis may explain not only the mechanism of the loss in rain in the Whitetop experiment, apparently induced by seeding, but also may explain certain phenomena noticed in the Grossversuch III experiment. - Authors' abstract.

787. Lovasich, Jeanne L.; Neyman, Jerzy; Scott, Elizabeth L.; Smith, Jerome A. Wind direction aloft and effects of seeding on precipitation in the Whitetop experiment. National Academy of Sciences, Proceedings, 64(3): 810-817, November 15, 1969. DAS P.

The subdivision of all the experimental days of the Whitetop project into two approximately equal groups, group W with predominantly westerly winds aloft and group E with frequent easterly winds, shows a remarkable difference in the apparent

effect of seeding. On W days there was no detectable effect of seeding on rainfall. On E days with seeding, the average 24 hour precipitation in an area of about 100,000 square miles was significantly less than that without seeding by 46 per cent of the latter. The decrease resulted from a "decapitation" of the usual afternoon rise in rainfall. It may be significant that the afternoon maximum of natural precipitation on E days occurs some two hours later than on W days. If the actual cause of the differences in rainfall was seeding, then the loss of water resulting from operational, rather than experimental, seeding would have averaged eight million acre-feet per summer. - Authors' abstract.

788. Low, Richard D. H. A comprehensive report on nineteen condensation nuclei. Part 1. Equilibrium growth and physical properties. U. S. Army Electronics Command, Fort Monmouth, New Jersey, ECOM-5249, May 1969. 553 pp. DAS M(055) U5812ec ECOM-5249. Also his: A theoretical study of nineteen condensation nuclei. Journal de Recherches Atmosphériques, Clermont-Ferrand, 4(2): 65-78, April June 1969. English and French summaries p. 65. DAS M(05) J86jor.

The theoretical study of condensation nuclei has been hampered by the fact that one must know the van't Hoff i-factors for a particular nucleus at different concentrations; as a result, only sodium chloride has been studied extensively. In this report, a generalized expression for the solution effect on droplet growth is used, thus simplifying the study of the growth behaviors of a large number of promising condensation nuclei under equilibrum conditions. Tables are compiled to present their equilibrum growths and their physical properties, and a few graphs comparing these properties are included to illustrate how the data in these tables may be used. It is believed that the information presented herein will facilitate an intelligent selection of the proper artificial nuclei for the modification of warm fogs and clouds, when combined with adequate measurements of the pertinent environmental parameters. Author's abstract.

789. Lumb, Alan Mark. Hydrologic effects of rainfall augmentation.
Stanford University, Stanford, California. Department of Civil Engineering, Technical Report No. 116, November 1969. 114 pp.

This is a study of the hydrologic consequences of increasing precipitation. The Stanford Watershed Model was selected to simulate the land phase of the hydrologic cycle and a special statistical model was written to simulate the increase in hourly rainfall resulting from augmentation. Increase in annual streamflow varies from 0 to 106% of the added precipitation. Higher moisture levels are maintained in the soil from a 10% precipitation increase. Increases in annual streamflow, evapotranspiration, and soil moisture for rainfall increases of 5 or 15% may be assumed proportional to the increases in streamflow from the 10% increase in precipitation. - MGA 21.10-128.

790. MacDonald, Gordon J. <u>Die Veränderung der Erde durch den Menschen</u>.

(Modification of the Earth by man.) Die Umschau, Frankfurt am Main, 69(15): 486, July 17, 1969. German summary p. 486. DAS P.

Between 1880 and 1940 the mean annual atmospheric temperature rose by about 0.4°C; in the past 25 yr it has dropped by about 0.2°C. Human activity can alter the atmospheric heat balance, and hence climate, in six ways: increasing the atmospheric CO2 content, reducing atmospheric transparency by aerosols, reducing atmospheric transparency of haze, direct warming of the atmo-sphere altering the albedo of the Earth's surface, and altering the exchange rate of thermal energy and the impulse between sea and atmosphere. The decrease in temperature in last two decades cannot be attributed to the ${\rm CO}_2$ content of the atmosphere since its concentration is continuing to increase. Pollution caused by cities and agriculture can overcompensate the temperature increase due to increase in CO2 concentration; the temperature can be reduced by 0.4°C. Thermal pollution at present appears inconsequential. An increase in albedo by 1% can reduce surface temperature by 1°C. The modification of the Earth's surface involving the release of elastic energy built up by tectonic forces over geological periods and seismic disturbances resulting from various constructions, such as dams, are discussed briefly. - MGA 21.3-559.

791. MacDonald, Gordon J. F. Federal Government programs in weather modification. In: Fleagle, Robert G. (ed.), Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 69-86. DAS MO9.6 W362wea.

The author begins this rather extensive review with brief mention of Dyrenforth's unsuccessful attempt in 1891 (financed by USDA) and of PL 79-691(1946) used later by the Chief of the Weather Bureau as his authority to conduct and support research in weather modification. Recent legislative history is traced to PL 510 that singled out the NSF for special responsibility in an area that involves basic research and its application, and the 1955 and 1956 Public Works Appropriation acts that made the USDI the largest supporter of weather modification research within the federal government. Activities of various agencies are reviewed and summarized in two tables showing a marked increase in funding (from \$4.97 million in 1965 to 7.26 and 8.77 in 1966 and 1967). Attempts at coordination, the review of individual agencies' plans by the ICAS, the role of the Office of the General Coordinator of Meteorological Services and of several external advisory committees are discussed. The question of a natural program is considered as regards weather modification that will prosper only in a new independent agency is given primary responsibility for promoting research in environmental prediction and modification. - MGA 20.11-169.

792. McDonald, James E. Evaluation of weather modification field tests.

In: Fleagle, Robert C. (ed.), Weather modification: science and public policy. Seattle, Washington, University of Washington Press, 1968, issued January 1969. pp. 43-55. DAS MO9.6 W362wea.

The author concerns himself with whether or not we can really modify any weather element to a useful degree. In discussing what he calls the bugaboo of evaluation he stresses and illustrates atmospheric variability. One entire section is devoted to the "antistatistics" viewpoint of meteorologists. The antistatisticians are classified as Type 1, who want no part of statistics and condemn those who use it, and Type 2, claim that the effects can be seen without it. The author concludes his discussion of antistatistics by expressing the wish that Type 1 would stop scorning those working at practical questions of the moment and that Type 2 would face up to the harsh facts of atmospheric variability. In concluding his discussion of evolution of evaluation methods, the author expresses his belief that the wide variability and dangers of unconscious bias speak strongly for randomization at this stage of our knowledge of weather processes. He seems alarmed and disturbed by the overwhelming response, especially in Congress, to the report of the NAS Panel on Weather and Climate Modification which he discusses at some length. Everything should be done to insure that substantial amounts of federal funds to be made available will be spent on pinning down more conclusively the actual potential for useful modification of atmospheric processes. -MGA 20.11-170.

793. Mann, Dean E. Public policy issues in weather modification. American Society of Civil Engineers. Irrigation and Drainage Division, Journal, 95(3): 375-384, September 1969. DAS P.

Weather modification is a relatively new technique of environmental control promising important benefits but significant disbenefits as well. As such it is the proper subject for public regulation. Numerous public policy approaches are considered here. Because experimentation and action programs are desirable, the imposition of controls should be carefully planned and phased to promote careful experimentation and protect ecological values. Public regulation presently is principally a state responsibility but federal involvement will be both necessary and desirable. The federal and state governments must regulate to prevent contamination of projects and prevent projects from interfering with each other. Licensing and setting of scientific qualifications for researchers and practitioners is called for, probably at the state level. Projects of appropriate size must be mounted to maximize scientific results while not endangering biological communities. Several federal agencies are involved in weather modification and appropriate roles and missions must be assigned each. An appropriate administrative mechanism must be found for regulating weather modification. Serious questions of indemnification and international relations remains unanswered. MGA 21.3-301.

794. Milly, George, H.; Ball, John T.; Spiegler, David B. A numerical experiment on the spatial distribution of cloud seeding nuclei. Journal of Applied Meteorology, Boston, 8(1): 83-91, February 1969. DAS M(05) J86joa.

An examination is made of the hypothesis that the inconclusive or marginal effects of many cloud seeding operations are due, at least in part, to an inhomogeneous distribution of freezing nuclei resulting in great ranges of concentration and extensive areas of overseeding and underseeding over the target region. Distributions of silver iodide nucleus concentrations arising from ground based generators were computed using a Gaussian plume diffusion model. Meteorological conditions and the number, locations, and yield of ground based generators were varied in a series of numerical experiments which bracketed conditions typical of many cloud seeding operations. The results indicated that effective seeding concentrations of nuclei can be achieved over a significant portion of the target area only by carefully considering initial atmospheric conditions as they affect nucleus diffusion and activity, and by accordingly designing and deploying the system of silver iodide generators. - Authors' abstract.

795. Mooney, Margaret L. and Lunn, George W. The area of maximum effect resulting from the Lake Almanor randomized cloud seeding experiment.

Journal of Applied Meteorology, Boston, 8(1): 68-74, February 1969.

DAS M(05) J86joa.

A randomized cloud seeding experiment was conducted on the Lake Almanor watershed near Mt. Lassen, Calif., during 5 winter seasons, 1962-1967. The target area extended approximately 20 mi east-west and 15 mi north-south, and ranged in elevation from 4500-6400 ft MSL. Silver iodide (AgI) was released from ground-based, acetone solution generators which were located between 6000 and 7400 ft MSL. AgI releases were made for 12-hr periods, these seeding periods being subsequently divided into 4 weather categories, depending on wind direction and temperature. In 3 of these categories, which together produce approximately 85% of the total precipitation, no response to the seeding was observed in the target area. In the remaining category, characterized by westerly winds and cold temperatures, the increase peaked at approximately 57% between 5 and 11 mi downwind, and averaged 37% throughout the 21-mi distance. Both results were statistically significant at the 5% level. - MGA 20.5-194.

796. Morachevskii, V. G. and Kiriukhin, B. V. On the artificial control of the chain process of raindrop growth in clouds. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings, Foronto, 1969? pp. 683-687. DAS M74.1 I61p

Recent antihail experiments in the U.S.S.R. in which volatile surface-active material was introduced into the lower part of cumulus cloud by rockets have led, in some instances, to cloud dispersal in some 10 to 15 min, sometimes accompanied by the falling of drizzle or showers. The principle underlying the experiments was that the surface-active material, by altering the surface tension on drop surfaces, caused a reduction in the critical radius at which growing drops break up. The authors discuss conditions for the occurrence of the Langmuir chain process in cumulus clouds to explain the mechanism more fully. When variations of vertical velocity throughout the cloud depth are considered conditions for the Langmuir process to operate will occur in well developed cumulus just above the level of maximum vertical velocity. In clouds that are not yet fully developed, the situation is different and conditions for the Langmuir process to operate may never materialize. In such cases the introduction of surface active material may then be effective in creating the necessary conditions. If this is so, then it would be expected that immediately upon the introduction of the material there might be an outfall of large drops. Later, within 10 to 15 minutes after the Langmuir process began to operate, a fallout of drizzle-sized droplets occurred. This is consistent with observations. Results of a series of high speed photographs of the drop splitting process (up to 2000 stills/sec) are given. The results of these were qualitatively similar to the results reported by Mason. - MGA 21.6-613.

797. Mueller, Marti. Hurricane seeding: a quest for data. Science, Washington, D. C., 165(3897): 990, September 5, 1969. DAS P.

R. Cecil Gentry, Director of the National Hurricane Research Laboratory in Miami, and head of Project Stormfury, explains that the purpose of the seeding of hurricane "Debbie" was to acquire data on the nature of and changes in hurricane structure and position. Evaluation of recorded film and magnetic tape collected in the seeding operation takes at least 2 mos. Changes observed in clouds, and in the storm's mechanisms, can occur naturally. - MGA 21.4-30.

798. Mullaney, G. J.; Christiansen, W. H.; Russell, D. A. A study of fog clearing using a CO₂ laser. Boeing Scientific Research Laboratories, Seattle, Washington Document D1-82-0848, April 1969. 25 pp. DAS M(055) B671doc D1-82-0848.

It has been suggested that haze and fog may be dissipated by using a $10.6\,\mu$ laser beam. This radiation is strongly absorbed by liquid water but only weakly absorbed by water vapor. Thus, the laser selectively deposits its energy in the water droplet, ultimately evaporating it. In this paper, the physics of fog removal by a CO_2 laser is explored and the possibility of clearing

airport runways is evaluated. While initial estimates of the power required to clear a runway, 10^6 to 10^7 watts, are large for present-day laser devices, they may not be excessive requirements for future systems. - Authors' abstract.

799. Namias, Jerome. The labile Gulf of Alaska cyclone: key to large-scale weather modification elsewhere. (In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. **Toronto 1969?** pp. 735-743. DAS M74.1 I61p 1968.

The Gulf of Alaska is an area characterized by great variability in atmospheric pressure. It is the seat of one of the more important centers of action influencing large-scale wind and weather systems elsewhere, notably over the U.S. It is postulated here that variations in the sea surface temperature generated over the North Pacific in summer affect the distribution of atmospheric pressure over the Gulf of Alaska in the subsequent fall. Departures from normal of from 2 to 6°F over areas 1/3 of the North Pacific are common. Such variations lead to variations in the degree of cyclogenesis during those seasons when cyclone waves traverse an area of abnormal sea temperatures and this in turn would affect the circulation and pressure over the Bering Sea and Alaska. To illustrate this, the circulation during the summer and fall of 1967 is examined and discussed. It is then possible that by controlling the water temperature of a substantial area of the Pacific surface water it might be possible to alter the weather over a large area. Order of magnitude estimates of the amount of energy required to do this suggest that with present day day technological capabilities the required energies are not realizable. - 21.7-110.

800. Neiburger, M. and Chin, Ho-chih. The meteorological factors associated with the precipitation effects of the Swiss hail suppression project.

Journal of Applied Meteorology, Boston, 8(2): 264-273, April 1969.

DAS M(05) J86joa.

During 1957-63 a randomized experiment to test the efficacy of cloud seeding to suppress hail in the southern Alps was conducted using ground-based silver iodide generators. While the results from the standpoint of hail suppression were negative, there appears to have been a definite overall effect in increased precipitation on days with seeding. Further, Neyman and Scott discovered that the precipitation effect was strongly positive on days selected for the experiment by one forecaster, and somewhat negative on those selected by another. This paper is an attempt to identify the factors responsible for this difference.

An analysis of the meteorological conditions associated with the experiment showed that, in general, the conditions favoring convective precipitation, i.e., southerly flow and upper-level

instability, were also associated with positive seeding effects. To some extent the difference between forecasters referred to above was due to accidental differences in the random selection of seeding opportunities among cases of southerly and northerly flow. Not all the difference was explained in this way.

The conditions favoring large amounts of precipitation and large seeding effects were studied. For instance, the experimental days were typed according to surface pressure pattern, and in two of the weather types strong positive seeding effects were present.

The necessity of caution in attributing to seeding differences which might be due to other factors is discussed in the light of the possibility of the process of random selection producing unequal samples from meteorological types having widely different physical characteristics. - Authors' abstract.

801. Neiburger, Morris. Artificial modification of clouds and precipitation. World Meteorological Organization, Technical Note No. 105. (Revised version of Technical Note No. 13). WMO publication no. 249. TP 137. English, French, Russian and Spanish summaries. Published 1969. DAS M(06) W927p 249.

In Chapter I the nature of the problem of weather modification is discussed and the present (end of 1968) status of the subject reviewed. In a way this chapter presents a summarization of the rest of the report. Chapter II explains in physical terms the reasons why cloud seeding may be expected to have an effect on cloud and precipitation, and why the effect on precipitation may in some instances be an increase, in others a decrease. The methods by which attempts to increase precipitation may be evaluated are reviewed in Chapter III, and the results of a number of such attempts are presented there. In Chapter IV attempts to reduce fog, hail and lightning are reviewed. Chapter V presents the recommendations which are drawn as consequences of the information presented in the previous chapters.

References to source material in the literature are made where pertinent, but these references are by no means exhaustive. A list of general references and bibliographies is appended for those desiring to investigate more thoroughly any of the aspects of weather modification, and also lists of recent publications by Japanese and Russian investigators, furnished by the members of the working group from those countries. - Author's abstract.

802. Neyman, J.; Scott, E. L.; Wells, M. A. Statistics in Meteorology. California University, Berkeley, Statistical Laboratory, ONR 9. Technical Report to the Office of Naval Research. Presented at the European Meeting of Statisticians, Amsterdam, September 1968. Reprinted from Review of the International Statistical Institute, 37(2): 119-148, 1969. DAS M(051) C153on ONR 9.

The expository part of the paper draws attention to the fact that the advent of experimentation with weather control caused a revolutionary change in statistical problems of meteorology, calling for novel developments in experimental design and in statistical inference. The inordinately long time needed for a single experiment, perhaps five years, and the difficulties of testing more than one treatment at a time bring to the fore the use of tests for which power can be easily computed. Also, design problems call for power orientation more than in other domains.

The nonexpository part of the paper is given to a particular aspect of the problem of designing an experiment with rain stimulation through cloud seeding. As shown by P.A.P. Moran. of the commonly used designs, the so-called crossover design is the most efficient. However, this conclusion is based on the hypothesis that cloud seeding over a particular target area would not affect the rainfall over another area at a moderate distance from the first. Two major experiments were analysed to evaluate the spread of the effects of seeding, the Whitetop experiment in the state of Missouri and Grossversuch III performed in Switzerland. In both cases it was found that the effects of seeding, negative in one case and positive in the other, appear to have spread to surprisingly large distances, in excess of 100 miles. Thus, it appears that the crossover design involves an inconvenience: contamination of one of the two alternative targets by seeding over the other may ruin the experiment.

803. Neyman, Jerzy; Scott, Elizabeth; Smith, Jerome A. Areal spread of the effect of cloud seeding at the Whitetop experiment. Science, Washington, D. C., 163(3874): 1445-1449, March 28, 1969. DAS P.

With reference to arguments that weather modification technology is sufficiently advanced for the federal government to finance cloud-seeding operations as a means of alleviating water shortages. an analysis of the Whitetop rain stimulation experiment was performed. The average 24-hr precipitation in six concentric regions up to 180 mi from the center of the target on 102 days of cloud seeding was less than that on the 96 experimental days without seeding. For distances less than 30 mi, the apparent loss of rain from seeding was 32%. With the increase in distance, this apparent loss decreased to a minimum of 9% for gages between 120 and 150 mi from the center. However, the 48 gages at distances between 150 and 180 mi showed a 22% apparent loss of rain from seeding. The estimated average loss of rain within the whole region of about 100,000 mi² was 21% of what would have fallen without seeding. When a 5-yr experiment, expected to produce a 5- to 10% increase, shows a 20% decrease in rainfall, the relevant technology does not appear reliable enough for practical use. - MGA 20.10-137.

804. Nicodemus, M. Lawrence and McQuigg, James D. A simulation model for studying possible modification of surface temperature.

Journal of Applied Meteorology, Boston, 8(2): 199-204, April 1969. DAS M(05) J86joa.

A simulation model is presented which hopefully is consistent with known physical and statistical properties of atmospheric events, and consistent with criteria that might be applied in the management of actual experiments in the atmosphere. The process being simulated is the possible modification of daytime surface temperatures during the summer in central Missouri through the generation of contrail cirrus clouds. Monte Carlo techniques are used in the model to allow for the likelihood of failure of the experiment on any particular day, and to allow for variations in the degree of success on days when the experiment is considered to not be a failure.

The model is applied to an observed time series (1946-1965) of surface and upper air observations from Columbia, Mo. Estimates of the results are based on analysis of the relationship between temperatures on cirrus and cirrus-free days. If it can be assumed that it is possible to create enough contrail cirrus to reduce the per cent of possible sunshine from 15-35%, it appears that it might be possible at reduce daily maximum temperatures by from 3-5F on about half of the days when soil moisture values are below "desirable" levels or when temperatures are expected to be above some "critical" level.

This is a relatively inexpensive way to estimate the order of magnitude of the effect of weather modification, compared to the cost of conducting an actual experiment over a long period of time. - Authors' abstract.

805. Odencrantz, F. Kirk. Freezing of water droplets: nucleation efficiency at temperatures above —50. Journal of Applied Meteorology, Boston, 8(3): 322-325, June 1969. DAS M(05) J86joa.

Numerical values obtained in laboratory studies of nucleation effectiveness of pyrotechnically produced smokes are strongly dependent on experimental conditions. Contact nucleation is shown to be relatively important at warm temperatures, when the nuclei are produced in a supercooled cloud of high liquid water content. Thus, pyrotechnics designed to produce nuclei in supercooled clouds should be tested under appropriate conditions. - Author's abstract.

806. Osmun, William G. Airline warm fog dispersal program. Weatherwise, Boston, 22(2): 48-53; 87, April 1969. DAS M(05) W362.

The warm fog dispersal program by fog seeding from an aircraft carried out in Sacramento, Los Angeles and Nantucket, is described and the results obtained are discussed. Vaporized salt brine was used in Sacramento. The tests at Sacramento indicated that dispensing of certain chemicals into dense fog to

change droplet size thereby increasing visibility had been proven. The materials used were effective in dispersing both warm and cold fog. The reaction produced when seeding materials were introduced by ground machine appeared similar to the reaction produced by aerial seeding. Also finely milled particles of salt or salt flour were used in seeding and positive and negative results were obtained. "Polyelectrolytes and surfactants are more effective and seeding runs need not be as precisely conduced as in operations which dispense salt." - MGA 21.1-262.

807. Parker, W. J. Polarographic analogues for dispersing fogs. Nature, London, 222 (5194): 655, May 17, 1969. DAS P.

Two new techniques for dispersing natural fogs have emerged from studies of disperse-phase diffusion phenomena in gaseous media and of analogous behavior at polarographic electrodes in liquid media. The first method involves the displacement of the fog by creating a stable disperse-phase diffusion layer at the interface between the fcg base and a thin layer of dry air at lower temperature injected on to the runway. The dry air is produced by the evaporation of liquid air through heated directional louvers on either side of the runway and could displace fog to a height of 40 m above an aircraft runway 100 m wide to a required safe takeoff length. The second method is based on the precipitation of the fog by exposure to a large area of surface cooled to a very low temperature by liquid air. This technique might well be effective on aircraft carriers where a cooled surface at the bow of the carrier might be effective in clearing fogs approaching at relative speeds of up to 40 kts. - MGA 21.2-48.

808. Parungo, Farn P. and Robertson, Charles E. Silver analysis of seeded snow by atomic absorption spectrophotometry. Journal of Applied Meteorology, Boston, 8(3): 315-321, June 1969. DAS M(05) J86joa.

An experimental weather modification program using silver iodide as the cloud seeding agent is being conducted over the Park Range in northwestern Colorado. The measure of silver content in target area precipitation can be used as an aid in tracking the silver iodide plume and evaluating seeding results.

The ultramicroquantities of silver in snow samples are concentrated by a solvent-extraction technique with an organic complexing reagent, and silver content is then determined by atomic absorption spectrophotometry. This analytical method is capable of detecting silver iodide activities in seeded snow. The results obtained using this technique on Park Range target area snow samples are discussed. - Authors' abstract.

809. Pilié, Roland J. A review of Project Fog Drops. U. S. National Aeronautics and Space Administration, Washington, D. C., NASA SP-212, Progress of NASA Research on Warm Fog Properties and

Modification Concepts, Proceedings of a Symposium held at NASA Headquarters, February 6, 1969, in Washington, D. C. pp. 1-23. DAS 629.1388 U585na Sp-212.

The purpose of Project Fog Drops is to investigate basic warm fog properties and dynamics and to evaluate suggested methods for suppression of warm fog. The high points of the program reviewed includes a study of concentrations of fog and haze nuclei, descriptive models, inhibition of droplet growth, investigation of effects of ionic surfactants on coalescence, investigation of electrical means for fog dispersal, and a method for prevention of dense radiation fog. - MGA 21.4-268.

810. Pilié, Roland J. Verification in laboratory seeding experiments.
U. S. National Aeronautics and Space Administration, Washington,
D. C., NASA SP-212, Progress of NASA Research on Warm Fog
Properties and Modification Concepts, Proceedings of a Symposium
held at NASA Headquarters February 6, 1969, in Washington, D. C.
1969. pp. 40-56. DAS 629.1388 U585na Sp-212.

The results of experiments aimed at laboratory verification of the fog dispersal concepts are compared with those obtained by Jiusto. The experimentally determined requirements are approximately twice the theoretical values in experiments when secondary expansion was not used. The author achieved visibility improvements ranging from 4 to 7 times with as little as 1.6 mg m⁻³ of the 4-µ diameter mode NaCl but found no improvement with the 0.8 mg m⁻³. - MGA 21.5-198.

811. Plank, Vernon G. Clearing ground fog with helicopters. Weatherwise, Boston, 22(3): 91-98, 126, June 1969. DAS M(05) W362.

A brief discussion of the manner in which fog can be dissipated by the downwash action of helicopter rotors and reference to previous trials are followed by an illustrated description and discussion of the Nov. 3-27, 1968 tests at Smith Mountain Lake, Va. The location of the man-made lake in a natural depression is described. The fog experienced in Nov. varied in depth from about 50 to 400 ft. The several illustrations (photgraphs of clearing fog) include a schematic drawing of the helicopter vortex circulations involved in the fog-clearing process. A ground witness to the clearing experiment of Nov. 17 stated that "the whole valley and hollow were cleared, just the same as snapping on a light." The evidence leads the author to conclude that helicopters can create operationally-useful clearings in particular types of ground fog of shallow depth and relatively small liquid water content. A helicopter of the CH-3E type (22,000 lbs gross weight) should be able to accomplish effective clearing of such fog to depths of some 300 ft or so. Partial clearing, or visibility enhancement, might be achieved with fog layers as deep as 500 ft. - MGA 21.2-254.

812. Plank, Vernon G. and Spatola, Alfred A. Cloud modification by helicopter wakes. Journal of Applied Meteorology, Boston, 8(4): 566-578, August 1969. DAS M(05) J86joa.

Helicopter wake effects on stratus and stratocumulus clouds are described. Holes and troughs were created in such clouds with dimensions several hundred feet across. The velocities and penetration distances of the downwash flow beneath the HH-53B helicopter employed in the experiments were investigated by the release of a "tracing agent" from the helicopter and by hovering at various altitudes above the water surface of a Florida bayou. The downwash velocities were as large as 100 ft sec, near the rotor, and the downwash extended some 1300 ft beneath the helicopter (under near dry adiabatic conditions).

A suggestion is made that helicopters might be employed operationally to clear radiation-type ground fog from airfield runways. The cloud clearing capabilities of the HH-53B helicopter are discussed in support of this suggestion, by reference to observational data and to the theory of Hohler. - Authors' abstract.

813. Plaude, N. O. <u>Ice-nucleation properties of silver iodide</u>. In:
International Conference on Cloud Physics, University of Toronto,
August 26-30, 1968, Proceedings. Toronto, 1969?, pp. 174-177.

DAS M74.1 I61p 1968.

A report is given of experiments designed to test Fletcher's theory of heterogeneous nucleation on small particles, which states that a substances nucleating ability can be completely described by the minimum particle size that is still active at a given supercooling in water cloud. Silver iodide was applied in liquid form on to a small section of metal wire. This was heated in the lower part of a vertical quartz tube. The AgI vaporized and then condensed to form a cloud at the bottom of the tube, a stream of gas through the tube carried this upwards to a hotter part of the tube where the AgI evaporated again to recondense as aerosol crystals on emergence from the upper nozzle of the quartz tube where it was cooled by another cooler stream of gas. The nucleating ability of the aerosol produced varied with the rate of evaporation from the wire, the rate of cooling and the shape and size of the tube nozzle. It was found that the smaller the mean size of the particle produced the more homogeneous was their size distribution and the closer the number of active nuclei produced came to the theoretical maximum. Some results of the experiments are shown graphically and compared with estimates using Fletcher's theory. The experimental number of ice-forming nuclei are found to be in excess of those estimated by the Fletcher theory while below the maximum values possible under the sublimation process of ice embryo formation. - MGA 20.9-182.

814. Rhea, J. Owen and Davis, Larry G. Airborne seeding techniques applied to winter orographic clouds. Western Snow Conference, Salt Lake City, Utah, April 15-17, 1969, Proceedings, 37: 75-81. DAS M(06) W527p 37: 1969.

The authors present the advantages of airborne release of cloud seeding material in winter orographic clouds over ground-based seeding, the procedures for determining the seeding track for the seeder aircraft, the techniques used to evaluate the results and a summary of all airborne seeding operations.

815. Rinehart, Gayle S. Fog drop size distributions: measurement methods and evaluation. U. S. Army Electronics Command, Ft. Monmouth, New Jersey, ECOM-5247, April 1969. 39 pp. DAS M(055) U5812ec ECOM-5247.

In connection with evaluating fog modification efforts, several published methods of measuring the size distribution of fog droplets were reviewed. An evaluation cast doubt on the validity of the gelatin, Formvar, and polyvinyl alcohol, and oil collection media for recording droplets less than $4\,\mu$ diameter. Efficiency of several collection methods appeared to be poor for less than $4\,\mu$ diameter droplets when lack of drop size distribution correlation with visibility measurement was considered.

During a fog dispersal test, pyrotechnically produced hygroscopic reagents were observed to cause an increase in the number of concentrations of the small sized droplets of a natural fog.

During nonfog conditions, several types of pyrotechnic flares containing different hygroscopic reagents were tested for usefulness as fog modification agents. Measurement of drop and particle size distributions downwind from the ignition point of these pyrotechnics revealed that the effect of small droplet sizes in decreasing visibility in air of high humidity would negate the improvement made by removal of large size drops. - Author's abstract.

816. Robertson, Charles E. Continuous ice nuclei measurements made during pulsed cloud seeding. Journal of Applied Meteorology, Boston, 8(4): 579-584, August 1969. DAS M(05) J86joa.

In a cloud seeding program, it is necessary to know what meteorological conditions are controlling the travel of artificial ice nuclei. While it is obvious that they will travel with the air currents, it is difficult to determine if the currents will travel to the desired area, and how much time is taken to transport the nuclei from the generator to the target area. Silver iodide particles were generated in a cyclic manner from ground-based generators, while continuous observations of ice nuclei were made on the surface in the target area. Observa-

tions show the surface wind velocity at the generator site to be the primary factor controlling the particle travel. However, nuclei concentrations have been observed to remain low even though the wind velocity was favorable for detection. This may be due to the silver iodide particles nucleating the cloud to form ice crystals, which do not enter the nucleus counter. - Author's abstract.

817. St. Louis, Paul T. and Steele, Roger L. <u>Certain environmental effects</u>
on silver iodide ice nuclei. In: International Conference on
Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. <u>**Toronto*</u>, 1969? pp. 178-182. DAS M74.1 I61p 1968.

The influence of water vapor and ultraviolet radiation on an aerosol of silver iodide from a Skyfire type type generator was examined. This paper outlines the experimental procedures and discusses the results. Comparison is also made with the work of other investigators. The experiments assessed the influence of water vapor and ultraviolet irradiation on the nuclei effectiveness of a single source of silver iodide at -20°C. Water vapor has no effect at 25°C until the vapor pressure is 12 mm Hg. It then increases the nucleation effectiveness to three times that of the dry sample at 25 mm Hg vapor pressure at 25°C. Ultraviolet irradiation causes a decrease in effectiveness by a factor of 6/hr, independent of water vapor pressure. - MGA 20.9-183.

818. Sansom, H. W. A four year hail suppression experiment using explosive rockets. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. Toronto, 1969?, pp. 768-772. DAS M74.1 I61p 1968.

A brief review is given of a hail suppression experiment made at Kericho, Kenya from July 1963 to Sept. 1967. Hail damage was assessed in terms of "made tea" lost caused by hail. These estimates were made by the tea estate managers. The experiment began with a network of 13 firing positions. Four other stations were installed at a later date. No rockets were fired until hail had commenced falling. The rockets contained explosive TNT only and exploded at 2000 to 2400 m above ground level. There seems little doubt from the results that the use of the rockets resulted in an appreciable reduction in hail damage over the estate on which the launching sites were located and on neighboring estates. There are doubts as to the process whereby the explosive rockets affect hail. Those discussed here are the mechanical effect of shock waves (cavitation), shock-induced freezing, freezing from adiabatic expansion, introduction of ice nuclei or introduction of hygroscopic nuclei. - MGA 21.5-209.

819. Sansom, H. W. and Gichuiya, S. <u>Hailstorms in the Kericho area</u>. Conference on Severe Local Storms, 6th, Chicago, April 8-10, 1969,

Preprints of papers presented at the Conference. (Boston, American Meteorological Society), 1969. pp. 326-331. "Unpublished ms." DAS M15.4 C748pre.

Hailstorms occur on about 80 days per annum throughout the year at Kericho, in western Kenya, at an altitude of about 2000 m above sea level. Since the start of a hail suppression experiment in July 1963, hail reports have been submitted regularly by some 35 tea estates covering an area of approximately 400 sq. Km. The storms are convective in origin, and usually of small extent, with hailstone sizes ranging from 3 to 25 mm. but occasionally larger. Extensive damage to tea is caused. Over quite small distances the incidence of hail at a point varies from 3 to 12 storms per annum.

Hailstorms are produced by convergence between the Lake Breeze from Lake Victoria and the prevailing easterly flow; the intensity of the Lake breeze circulation is an indication of the likelihood of severe hail. - Authors' abstract.

820. Satterlund, Donald R. Combined weather and vegetation modification promises synergistic streamflow response. Journal of Hydrology, Amsterdam, 9(2): 155-166, 1969. DAS P.

The potential effect of simultaneous application of cloud seeding and vegetation modification of target watersheds was tested using Thornthwaite water balance models. Combining practices often produces a synergistic interaction that increases runoff from treated woodland watersheds over the sum of the two practices applied separately. The synergistic gain appeared in 29 of 30 tests, using climatic data from wooded areas of the United States. Increased runoff attributable to synergistic interaction ranged from 0 to 43 mm annually, with quantitities exceeding 25 mm annually appearing commonly from wooded regions of the dry Southwest. The validity of the tests and significance of the results are discussed, with the conclusion being reached that water-short nations cannot afford to overlook this potential for increasing their water supply.

Author's abstract.

821. Sax, Robert I. The importance of natural glaciation on the modification of tropical maritime cumuli by silver iodide seeding. Journal of Applied Meteorology, Boston, 8(1): 92-104, February 1969.

DAS M(05) J86joa.

In order to determine if natural glaciation proceeds rapidly or extensively enough in tropical maritime cumuli to influence attempts to modify their dynamical behavior by seeding with silver iodide, a detailed study was made of the clouds observed during the 1965 Project Stormfury experiments. From photographic coverage, notes on visual observations, and instrumentation on-board penetrating aircraft, data were compiled on cloud

liquid water content, volume-median drop size, in-cloud temperature profile, and the dynamical life histories of both seeded and non-seeded clouds. The validity of applying Koenig's numerical splintering model to tropical maritime cumuli, as well as an assessment of the effectiveness of silver iodide seeding, were determined by comparing the dynamical behavior of paired seeded and non-seeded clouds with glaciation times predicted by the model. Dynamical studies were initiated on two independently developed parametrized numerical cumulus models, and an excellent correlation between predicted and observed cumulus growth was found if no natural glaciation at temperatures > -150 was assumed.

The results of this study suggest that natural glaciation does not proceed rapidly and/or extensively enough in the critical cloud updraft areas to alter the effectiveness of modifying tropical maritime cumuli by causing artificial glaciation with silver iodide. - Author's abstract.

822. Schickedanz, Paul T. and Decker, Wayne L. A Monte Carlo technique for designing cloud seeding experiments. Journal of Applied Meteorology, Boston,8(2): 220-228, April 1969. DAS M(05) J86joa.

The design of a field experiment in rainfall augmentation requires prior estimates of the duration of the experiment and the density of raingages. A "Monte Carlo" method was developed to generate synthetic climatological rainfall data for various time periods and densities of raingages. The method was applied to a hypothetical cloud seeding experiment. Rainfall data for reporting networks were simulated and the resulting data were used to estimate the change in error variance induced by varying the density in a raingage network and the length of the experiment. The "t" test was applied to the simulated nontransformed data which were skewed and to data normalized by a transformation. In addition, the generalized likelihood ratio test was used to test for differences in location parameters of the seeded and nonseeded gamma distributions having a common shape factor.

The applicability and limitations of the method are discussed. With proper consideration of the limitations and with additional research on the problems encountered, it should be possible to obtain a preliminary estimate of the error variance of a proposed experimental design for many areas and various conditions. - Authors' abstract.

823. Schickedanz, Paul T.; Changnon, Stanley A., Jr.; Lonquist, Carl G.

A statistical methodology for the planning and evaluation of hail suppression experiments in Illinois. Illinois. State Water Survey, University of Illinois, Urbana, Illinois, GRANT NSF GA-482, (Hail evaluation techniques). Final Report, Part 2, April 14, 1969.

11/10 pp. DAS M78.7 I29fin pt. 2.

The phase of the project concerned with the use of historical hail data in Illinois to determine the necessary length of hail suppression programs to detect significant seeding effects is described. The paper develops a statistical methodology for the planning and evaluation of hail modification experiments in Illinois (and areas of similar hail climate) involving three sources of data and nomograms of the sample size required for the detection of various reduction levels for various sizes and locations of data areas, for various seasons and combinations of experimental designs, and for various statistical tests. Presents analyses of Weather Bureau hail-day data, crop-hail insurance data, the network hailstreak data. The various statistical tests, designs, and data sources are compared and the application of the methodology are discussed. Following are some of the conclusions and recommendations: The methodology appears to be adequate for obtaining useful estimates of the time required to detect an effect of seeding with specified power and is applicable to other climatic areas provided the appropriate historical record and theoretical distribution functions are used. For similar research on other areas adjustment factors should be developed for removing the effect of temporal changes in farming practices and in liability from insurance data. MGA 21.5-639.

824. Schleusener, R. A.; Koscielski, A.; Schock, M. R. Recent data on hail suppression by cloud seeding in South Dakota. Conference on Severe Local Storms, 6th, Chicago, 8-10 April 1969. Preprint of Papers presented. pp. 338-339. Unpublished manuscript. DAS M15.4 C748pre.

Results are presented from two cloud seeding projects during 1968 in South Dakota. The Rapid Project shows lower hail impact energy on seeded days than unseeded days, using moderate seeding rates below cloud base ahead of updraft areas. Results from the Grand River Project, which involved heavier seeding by a variety of techniques, are mixed, and show that such heavy seeding is not a sufficient condition for stopping all damaging hail. - Authors! abstract.

825. Schneider, T. Wind and nightfrost in young forest plantations.
Archiv für Meteorologie, Geophysik und Bioklimatologie, Serie B,
Vienna, 17(2-3): 229-238, 1969. English and German summaries
p. 229. DAS M(05) A673ab.

The effectiveness of a frost prevention method in connection with reafforestation is considered. The danger of an existing vegetation around the young trees is demonstrated with the results of measurements carried out near Smilde. Differences in air temperature between bare soil and grassy areas up to 3°C are found. The possibility of frost protection by clearing the planting area of all scrub and grass is shown by the measurements at Emmen. Air temperature differences up to 5°C

are found between treated and untreated areas. The difference in overall clearing costs between wholly and partially clearing is shown to be small at this site. - Author's abstract.

Senn, Harry V. and Courtright, Charles I. Radar hurricane research,

1 September 1968 to 31 August 1969. Rosenstiel School of Marine
and Atmospheric Sciences, University of Miami, Final Report to
ESSA Contract No. E22-27-69(N), November 1969. 28 pp. DAS M(051)
M618rad.

Planning for the EML experiments in the spring of 1970 is reviewed. Changes in equipment and data gathering techniques are planned so that more accurate positioning of aircraft with respect to the experimental clouds is obtained; and so that data on the current modes of operation of the 10-cm radar are more automatically and accurately documented on the film.

Participation in all phases of Project Stormfury continued, including the operational aspects of the cloud line and hurricane Debbie modification experiments. - From the authors' abstract.

827. Serpolay, R. and Fabre, R. <u>Détermination expérimentale in situ de la température limite d'efficacité du dispositif de dispersion des brouillards surfondus installé sur l'aéroport d'Orly. (Experimental determination, in situ, of the temperature efficiency threshold of the eground-based device for supercooled fog dispersion installed at Orly Airport.) Journal de Recherches Atmosphériques, Clermont-Ferrand, 4(2): 79-83, April-June 1969. French and English summaries p. 79. DAS M(05) J86jor.</u>

Fog dispersal conducted at Orly Airport in exceptional conditions confirmed that O°C is the efficacy threshold for a groundbased device working with liquid propane sprayers. - MGA 21.6-154.

828. Serra, A. Sui più recenti tentativi di modificare artificialmente le condizioni atmosferiche. (Recent experiments in artificial weather modification.) Rivista di Meteorologia Aeronautica, Rome, 29(2): 77-79, April-June 1969. DAS M(05) R625.

This is an extended summary of New chemical engineer's role:
Weathermaker, which appeared in Chemical Engineering May 6, 1968
and which summarizes some of the most recent attempts at
weather modification carried out in the U.S. The discussion
includes the following: the various seeding substances used
in controlling atmospheric precipitation and their methods of
use; cloud dissipation experiments; the suppression and fragmention of hail; and suppression of lightning. - MGA 21.2-44.

829. Sewell, W. R. Derrick. Weather modification: when should we do it and how far should we go? In: Fleagle, Robert G. (ed.), Weather modification: science and public policy. Seattle, Washington,

University of Washington Press, 1968, issued January 1969. pp. 94-104. DAS MO9.6 W362wea.

The author notes the enthusiasm for weather modification (WM) which in the U. S. is spurred on by desire for innovation and change, desire to put new discoveries into practical use, and the fear that the Russians will get there first. This paper considers first whether WM should be done at all, and, if so when, where, and how far we should go. The obvious benefits in reducing hurricane, tornado, lightning, flood, and drought losses, some of the recreational and other benefits from increased rain and snow, health and psychological benefits of WM, and the difficulties of measuring the impact of WM are pointed The case of Quebec Hydro. is cited to show that, when followed by any major departure from normal, WM may arouse public opposition. In discussing how far we should go, legal, economic, and political (local, state, federal, and international) aspects are considered. The danger of military use of WM in combination with chemical warfare is noted. Possible consequences of altering the track of the 1964 Hurricane "Cleo," and of the proposed damming of the Bering Strait are discussed. Implications of inadvertent WM, like particles of the Los Angeles smog being swept across Arizona, are pointed out. The author believes that large scale WM could have really disastrous consequences, more attention should be given to social consequences, and legal and administrative devices are needed which will permit research but will safeguard against side effects of commercial and government-sponsored operational programs. - MGA 20.11-171.

830. Shishkin, N. S. Some problems of the theory of natural and artificial precipitation. In: International Conference on Cloud Physics, University of Toronto, August 26-30, 1968, Proceedings. Toronto, 1969? pp. 804-814. DAS M74.1 I61p 1968.

The formation of precipitation involves three processes: condensation or sublimation of water vapor, coagulation of particles, and phase transformations. The first section of this paper reviews the development of techniques for calculating the theoretical growth of liquid particles in natural clouds, based mainly on Russian work. Next, the various studies at the Main Geophysical Observatory and elsewhere on the transition processes from snow to graupel and then to hail are described. Finally, the results of the studies show application to the calculation of the optimum norms of the amounts of reagent required for the artificial stimulation of precipitation. - MGA 21.6-158.

831. Simpson, Joanne; Woodley, William L.; Friedman, Howard A.; Slusher,
Thomas W.; Scheffee, R. S.; Steele, Roger L. An airborne pyrotechnic
cloud seeding system and its use. Boulder, Colo., Atmospheric
Physics and Chemistry Laboratory, ESSA Technical Memorandum ERLTMAPCL 5, February 1969 (U. S. ESSA Research Laboratories, Technical
Memorandum ERLTM-APCL 5). 44 pp. DAS M(055) U5835te ERLTM-APCL 5.

The development, testing, and use of an airborne pyrotechnic cloud seeding system is described. Pyrotechnic flares producing 50 g of silver iodide smoke each were developed by two industrial corporations and laboratory tested for nucleation effectiveness in the Colorado State University cloud chamber. A delivery rack and firing system were developed, under ESSA supervision, and installed on its B-57 jet aircraft. Night flight tests were made of reliability, burn time and flare trajectory.

The flare system was used in a Florida cumulus seeding experiment in May 1968 conducted jointly by ESSA and the Naval Research Laboratory, with the participation of the U. S. Air Force, the University of Miami Radar Laboratory and Meteorology Research, Incorporated. A randomized seeding scheme was used on 19 supercooled cumuli, of which 14 were seeded and 5 were studied identically as controls. Of the 14 seeded clouds, 13 grew explosively. Seeded clouds grew 10,900 ft higher than the controls, with the difference significant at better than the 1/2 percent level. Rainfall from seeded and control clouds was compared by means of calibrated ground radars. Large increases in rainfall were found from seeded clouds, but unfortunately not at a satisfactory significance level. A single successful repeat of the experiment could result in rainfall differences significant at the 3 percent level. - Authors' abstract.

832. Simpson, Joanne and Woodley, William L. <u>Intensive study of three seeded clouds on May 16, 1968</u>. U. S. Environmental Science Services

Administration, Research Laboratories, Atmospheric Physics and Chemistry Laboratory, Boulder, Colorado, May 1969. ESSA Technical Memorandum ERLTM-APCL 8. 42 pp. DAS M(055) U5835te ERLTM-APCL 8.

Three cumulus clouds were seeded over the south Florida peninsula on a day ideally suited for a cloud modification experiment. Following seeding, one of these clouds dissipated without growth, while the other two grew explosively. Of these two, the first exhibited rapid growth of the tower that was tallest at the seeding time, the second underwent "hesitation" growth of a later tower, with dissipation of the tower that was tallest at seeding time. This paper analyzes the history of each cloud with aircraft and ground radar observations and with a parameterized numerical model.

Cloud measurements were made by four aircraft. Observations from the ESSA DC-6 and B-57 are described here. These consisted of quantitative photography and of in-cloud records of temperature, humidity, and water content. Photogrammetry with the airborne cameras was performed to obtain the heights and sizes of the clouds as a function of time.

The numerical model predicts the rise rate, cloud and precipitation water contents, and radar echo intensity of a rising cloud tower. The calibrated ground radars were use in conjunction with the aircraft penetrations to test the model predictions. The model was found to predict all parameters effectively in the case of liquid clouds. Complete data for a similar test for frozen clouds are still lacking.

The model results showed that the first cloud that failed to grow had (due to narrow width) zero seedability or growth potential. The second cloud was shown able to grow with little tower expansion, while the third cloud required significant tower expansion to reach observed heights, thus explaining the "hesitation" growth. - Authors' abstract.

833. Sinclair, Peter C. and Marion, Frank C. <u>Hailstorm modification</u>. In:
International Conference on Cloud Physics, University of Toronto,
August 26-30, 1968, Proceedings. <u>Toronto</u>, 1969? pp. 789-795.
DAS M74.1 I61p 1968.

Cloud base seeding of potential hailstorms in northeastern Colorado with aircraft equipped with only two Loshe AgI seeding generators does not have any apparent hail suppression effect. The reasons for this apparent negative result are twofold: 1) the cloud selection criteria required that the cloud be of such proportions and intensity that a severe storm with hail was a high probability, and 2) calculations indicate that seeding with two cloud-base AgI generators requires a seeding period much longer than the average storm life. For effective cloud base seeding, it appears that two aircraft, each with ten Loshe type of generators, are required. However, a direct-injection technique appears to offer the most promise. An airborne rocket delivery system now under development for deployment and tests during the summer of 1968 is designed to deliver approximately 0.5 lb of seeding material to the hail genesis volume. The seeding nuclei are produced from a pyrotechnic creation of iodides in which a wide range of formulations can be precisely tailored to react all iodine to iodide, as well as create the desired degree of dispersion for the point of reaction. - MGA 21.7-638.

834. Skywater Conference, 5th, Denver, Colo., February 1969. Proceedings of Skywater Conference 5 cons Scientific Review Plans and Design of the Colorado River Basin Pilot Project. Denver, Colo., U. S. Bureau of Reclamation, Feb. 1969. 235 pp. On title page:

Atmospheric Water Resources Program. DLC.

Contains the same 25 brief talks and comments, including an introduction by Kahan of the Bureau of Reclamation (BR), presented at a one-day meeting of engineers and scientists. Previous conferences that led to several major modifications of the overall plan and design are reviewed in the preface. The subsequent studies and decision made by the BR are summarized in the Appendix. The summary states that the scientific merit for the project is based largely on the evaluations of positive results obtained by Colorado State University at Climax and Wolf Creek, Colo., experiments. Remote operated generators and a telemetered meteorological observation network were needed for best seeding of the large areas proposed. The project areas to be seeded by seasons would be selected on a strictly random basis. Yearly randomization was favored for hydrological evaluation using stream gages. Further study of the exact form of randomization was recommended. The state of the art has advanced to where a full-scale, scientifically evaluated, test project is justified. More effective seeding could be made by air seeding. However, the proven ground-seeding techniques would be employed on the first pilot project. Criteria for restricting seeding under conditions potentially damaging to public well being would be included in the final plan. - MGA 21.5-211.

835. Soulage, G. and Admirat, P. <u>Limits of efficiency of silver iodide</u>
ground burners to seed clouds. In: International Conference on
on Cloud Physics, University of Toronto, August 26-30, 1968,
Proceedings. <u>Toronto</u>, 1969? pp. 713-718. DAS M74.1 I61p 1968.

The conditions for the dispersal of silver iodide smoke generated by ground burners are discussed. The effects of relief, the network of burners, and weather conditions are each considered. The summarized conclusions from the results of many experimental measurements made in France with differing networks at various times between 1957 and 1968 are presented. Since silver iodide nuclei deactivate with time, there is no noticeable increase in the concentration of the nuclei on the ground as a function of seeding. Results are reported where nuclei concentration increased during the first half hour of seeding and then remained constant. Seeding at a time well in advance of the storm formation will be ineffective. Relatively homogeneous concentrations of artificial nuclei some 100 to 1000 times in excess of natural concentrations can be obtained with a regular mesh of burners in the whole region above which clouds are to be seeded, a mesh of some kilometers (about 5 km), and a burner output equal to 10^{12} nuclei effective at -12°C/sec. The transfer of air from ground to cloud occurs only for a short period, about one hour above a certain point, when storms are forming and only above a limited region, with an area not yet determined. Effective seeding from the ground must therefore be concentrated in the regions and at the moment in which storms form. - MGA 21.7-124.

836. Stinson, P. J. Experimental design and statistical evaluation of weather modification experiments. Final report to the U. S. Bureau of Reclamation, Office of Atmospheric Water Resources, Contract No. 14-06-D-6151. Denver, Colorado, Denver Research Institute, University of Denver, September 15, 1969. 98 pp. DAS M(051) S959exp.

This report summarizes the accomplishments of the Denver Research Institute, University of Denver toward the fulfillment of the objectives of the Bureau of Reclamation contract entitled, "Experimental Design and Statistical Evaluation of Weather Modification Experiments" during the contractual period, 1 April 1967 to 1 September 1969.

The general objective of the project was to develop experimental design criteria and statistical methods to evaluate the attainments of the Bureau's Atmospheric Water Resources Programs. In order to achieve this general objective, accomplishment in four specific objectives or methods of procedure were pursued: critical evaluations of past weather modification experiments, special analyses and studies, development of design criteria for field experiments, and the development of statistical computer programs and analytical techniques.

The prevailing thesis throughout this report is that (1) there are some very serious problems of research design and statistical evaluation that need to be considered relevant to weather modification experiments, (2) experiments can be performed within operational weather modification programs, (3) traditional statistical and analytical techniques are neither appropriate nor adequate to evaluate much of the data collected from operational weather modification programs, and (4) new approaches, such as some of the techniques or models used in operations research, are more appropriate to evaluate or optimize the attainment of the goals of operational weather modification programs. - Author's abstract.

837. Stow, C. D. On the prevention of lightning. American Meteorological Society, Bulletin, Boston, 50(7): 514-520, July 1969. DAS M(05) A512b.

The destructive nature of cloud-to-ground lightning strokes is well known. Loss of life and damage to buildings and other man-made structures may to a large extent be prevented by the judicial use of lightning conductors and screens but no comparable protection may be offered to expanses of agricultural crops or forests. According to Fuquay (1967) lightning is the greatest single cause of forest fires in the western United States: during the period 1946-1962, 140,000 such fires occurred causing severe losses of timber, wildlife, watershed, and recreational resources. Comparable losses occur regularly in other parts of the world. The only solution is the suppression

or modification of cloud-to-ground lightning discharges. Methods of suppression are described, some of which may turn out to be practical ways of achieving this aim. - Author's abstract.

838. Sulakvelidze, G. K. On the principles of hail control method applying in the USSR. In: International Conference on Cloud Physics,
University of Toronto, August 26-30, 1968, Proceedings. Toronto,
1969? pp. 796-803. DAS M74.1 I61p 1968.

This paper first discusses the general principles and method developed for hail suppression in the U.S.S.R. and then reports the results of a series of experiments made in the Caucasus region with emphasis on agricultural crops. Studies consider the main requirements for hail modification methods. They must interfere in convective clouds to eliminate the growth of large hailstones in areas of high concentration of supercooled water. Radar must be efficient enough to locate areas in clouds where large drops are occurring and where there should be means of delivering crystallizing reagents to large-drop areas that occur where the temperatures lie between 0 and -20°C. It is only necessary to treat the hail formation centers with volumes of The formation of an additional 10^{12} - 10^{14} hail nuclei 15 km³. are recuired in these areas for efficient hail suppression. is necessary to deliver about 10 gm of reagent within a period that does not exceed two min. In the Caucasus, antiaircraft shells were used. Preliminary tests made during 1961-1963 over a limited area yielded positive results; thus, more extensive trials over an area of 0.5-1.0 million ha were undertaken. These trials (from 1964) were successful with hail being prevented in most cases. Some hail damage did occur, but on most occasions it occurred because in some technical regions the firings were aborted because of the presence of civil aircraft. Some attempt was made to cost the trials during the 1964-1966 period and to compare their cost with the economic savings resulting from higher agricultural harvest. This indicates a positive economic value. - MGA 21.7-125.

839. Symposium on Progress of Research on Warm Fog Properties and Modification Concepts, Performed by Cornell Aeronautical Laboratory under NASA Contract, Washington, D. C., February 6, 1969, Papers. March 1969. Each section repaged. Two papers abstracted separately are: Jiusto, J. E.; Pilié, R. J.; Kocmond, W. C. Fog modification with giant hygroscopic nuclei. Kocmond, Warren C. and Pilié, Roland J. Investigation of warm fog properties and fog modification concepts. DAS M75 S989pa.

Presents theoretical and practical investigations centering on techniques of dispersal and modification. Major topics discussed include modification of fog with giant hygroscopic nuclei; warm fog dispersal, including theoretical considerations, laboratory experiments, field evaluation, and computer simulation of fog seeding; and laboratory testing of additional seeding agents. An extensive discussion of the papers presented is appended. - MGA 20.11-27.

840. Taubenfeld, Rita F. and Taubenfeld, Howard J. The international implications of weather modification. Bulletin of the Atomic Scientists, Chicago, 25(1): 43-45, January 1969. DAS P.

Presents results of a study to determine the nature of potential international problems arising from future control of weather resources; 2 analogous cases of potential gravity are analyzed comparatively: 1) the pollution use, and diversion of international rivers, a problem considered directly relevant to inadvertent weather modification by air pollution, and 2) experiments in outer space. Current practices in coriparian mutual restraints are discussed; it appears likely that similar patterns may emerge for national weather modification activities among states sharing the same watershed, but there are grave hazards in such quasi political cooperation involving costs and benefits among other parameters. Security considerations may also be involved in weather modification operations conducted over other nations' sovereign territory. Climatic "threat" is discussed, noting crises over diversion of the waters of the River Jordan. Space research analogues include problems of space "cluttering" (project West Ford's copper needles experiment), high altitude nuclear tests, and the various proposed limits and accepted U. N. resolutions, noting particularly the Outer Space Treaty of Jan. 1967 and its provisions. Application of the analogues cited leads to the conclusion that despite solid evidence of international cooperation in world weather observation and research, the international control of national programs of scientific experimentation on weather modification promises to be difficult to achieve in a climate of high security consciousness of sovereign and jealous nations. - MGA 20.8-223.

841. Temple, Joann. A weapon against the weather. ESSA World, Rockville, Maryland, 4(2): 8-11, April 1969. DAS M(05) E78es.

A general discussion of weather modification and experimental meteorology is followed by an account of two cloud-seeding research projects conducted in 1968 by the Atmospheric Physics and Chemistry Laboratory (APCL) of ESSA. In one on seeding Florida cumuli conducted on May 14, 19 studied clouds were seeded and 5 served as controls. Woodley, who described this work before a recent AMS meeting, is quoted as follows "There was one obvious effect of seeding on Florida cumulus which needed no analysis. Seeding caused explosive cloud growth-both vertical and horizontal of a magnitude never observed in any cloud-seeding experiment." In concluding the discussion of this research, the author quotes Joanne Simpson, Director of the Project as follows: "With data from the 1968 project, we hope to design a new model which will account correctly for the effects of seeding." In the second project on Great Lakes Snow APCL scientists seeded cloud lines to study the feasibility of inhibiting the massive snowfalls due to the "lake effect" that may create as much as 100" of snow a year. The author reports

that tests of the basic seeding hypothesis were made during three periods of short-lived cold air outbreaks which were accompanied by light natural snowfall. Seeding effects on clouds were observed from aircraft, on radar, or on the ground. A thorough analysis of all data collected will be made to reveal the response of the cloud to the treatment. - MGA 21.2-45.

842. Tribus, Myron. Everybody talks about the weather, but... Science, Washington, D. C., 164(3886): 1341, June 20, 1969. DAS P.

This was written in response to the report by Neyman, Scott and Smith (Ibid., 163(3874): 1445-1448, March 28, 1969), on the effect of cloud seeding in the Whitetop Experiment. The conclusion of Neyman et al. that man can affect the weather is valid—but not to be considered as derived solely from the data from Whitetop. Tribus believes there was overseeding in Whitetop. The important issued facing us is whether we have enough information on hand to attempt to schedule operational weather activities. We are closer to this state of knowledge than Neyman indicates. - MGA 21.1-261.

843. U. S. Air Force. Cambridge Research Labs. Bedford, Mass. Helicopter technique for clearing warm fog and clouds. By the Meteorology Lab. U. S. Air Force. Office of Aerospace Research, Research Review, 8(3): 10, May/June 1969. DLC.

A description of a technique and procedure with which warm fog layers 200 ft thick were repeatedly cleared by using helicopter rotors to force dry air above the fog into the moisture laden air below. For optimum effectiveness, twin-engine helicopters with gross weights of about 20,000 lb are prescribed. The progressive enlargement of a hole in a cloud as a helicopter circles above it is shown in a series of photos. - MGA 21.1-263.

844. U. S. National Aeronautics and Space Administration. Progress of NASA
Research on warm fog properties and modification concepts. Proceedings of a Symposium, Washington, D. C. February 6, 1969. Its
Special Publication No. 212, 1969. 122 pp. All 6 papers abstracted separately. DAS 629.1388 U585na Sp-212.

A collection of papers and notes discusses the progress of NASA research on warm fog properties and modification concepts. The objective was to provide results of recent warm fog seeding experiments at the Chemung County Airport, Elmira, N. Y., and laboratory experiments at the Cornell Aeronautical Laboratory facility. - MGA 21.6-576.

845. Van Valin, Charles C. and Allee, Paul A. Silanes as cloud stabilizers.
U. S. Environmental Science Services Administration, Technical Report
ERL 105-APCL 6, April 1969. (U. S. Atmospheric Physics and Chemistry
Laboratory, Boulder, Colorado, Technical Report ERL 105-APCL 6)

(U. S. ESSA Research Laboratories, Technical Report ERL 105-APCL 6)
DAS M(055) U5885te ERL 105-APCL 6. Also slightly revised in National
Conference on Weather Modification, 2d, Santa Barbara, California,
April 6-9, 1970, Preprints of papers. Boston e1970 pp. 129-133.
"Unpublished papers." DAS MD9.6 N277pre. Abstract in American
Meteorological Society, Bulletin, 51(1): 97, January 1970. DAS
M(05) A512b.

Silanes (alkylchlorosilicon compounds) are effective in stabilizing cloud droplets against evaporation. Among compounds tested, the alkyltrichlorosilanes proved most efficient in this role. The mode of action is apparently a reaction of the silane with water at the surface of a droplet to form a silicone polymer film that lowers the water vapor pressure over the surface. The reduction of vapor pressure was demonstrated by experiments, which showed that the dewpoint is lowered in a silane-treated cloud and over a silane-treated plane water surface. Substances that are effective as cloud stabilizers were also found to be effective in preventing the nucleation of ice crystals by AgI ice nuclei in a supercooled cloud. - Authors' abstract.

846. Volkova, S. S. and Ovchinnikova, E. N. Kristallizuiushchaia sposobnost'
zolei iodistogo serebra. (The crystallizing activity of silver
iodide sols.) U.S.S.R. Tsentral'naia Aerologicheskaia Observatoriia,
Moscow, Trudy, No. 89: 84-89, 1969. English summary p. 89;
Russian summary p. 101. DAS M(055) U581tt.

Crystallizing ability of silver iodide colloid solutions of various concentration prepared by different ways is studied. Temperature dependence of pure water and diluted silver iodide sol crystallizing ability is given. Due to the variation of the dispersed consistency of the silver iodide colloid solution, the crystallizing ability does not vary proportionally to the weight and to partial concentration. As supercooling increase, the difference between the crystallizing activity of pure water of heteorgeneous impurities disappears. - MGA 21.6-160.

847. Vonnegut, Bernard; Blanchard, Duncan C.; Cudney, Robert A. Structure and modification of clouds and fogs. New York. State University.

Research Foundation, Annual summary report No. 1, Project Themis, 12 September 1967 through 11 September 1968. AFCRL-68-0627. Issued January 1969. DAS M(051) N5327pro.

A wide range of field and laboratory investigations is described. They include studies of the formation and detection of ice crystals, the effects of charge and electric fields on fog, the electrical properties of lake storms and tornadoes, the global electrical budget, the generation and significance of giant particles in the atmosphere, and the development and use of a large vertical wind tunnel. These studies are primarily experimental. Theoretical work has been done on the interaction

of gravity waves with warm fronts, and on the dynamic stability of the tornado funnel.

Strong electric fields have been found to induce ice crystal formation in supercooled fogs. The formation of ice crystals in clear air at high altitudes has been demonstrated by carrying dry ice aloft with balloons.

A stable vortex of over a meter in height has been produced by electrical discharges. As the vortex becomes stable, the sparks change into a glow discharge. An analogy is made to tornadoes and electrical storms.

Giant particles have been found in continental air in sufficient quantity to suggest that they may play a role in the formation of warm rain. The generation of particles from bulk water surfaces (both giant and in the Aitken range) has been studied.

A 5-foot diameter vertical wind tunnel has been constructed and is being used to study the interaction between suspended large water drops. - Authors' abstract.

848. Weickmann, H. K. and Schuman, Elmer. The hailstreak fallacy. 1969?
13 pp. DAS MO9.617 W416ha.

The mesoscale structure of hailswathes into individual hailstreaks as discovered by Changnon (1968) affects markedly the analysis of hail suppression experiments. It may have contributed to serious errors in the evaluation of the pilot test program in hail suppression in the Soviet Union conducted 1961-1963. - Authors! abstract.

849. Weinstein, A. I. and MacCready, P. B. Jr. An isolated cumulus cloud modification project. Journal of Applied Meteorology, Boston, 8(6): 936-947, December 1969. DAS M(05) J86joa.

A randomized seeding experiment was conducted in Flagstaff, Ariz., in July and August of 1967 wherein the heights, rainfall amounts and rainfall durations of isolated cumuli were measured. Twenty-one clouds were studied, 10 seeded and 11 not seeded, on 11 days. On nine days there were paired seed and no-seed events. The choice of the test clouds and much of the analysis was performed with the aid of a simple numerical model of cumulus dynamics and microphysics. The project aims were to show distinct effects of seeding on cloud-top height, rainfall and duration; to verify and/or improve the model; and to use the model to interpret the importance of the seeding effect.

For the 21 test clouds, the average increases in radar tops, precipitation and duration were 5900 ft, 2.00 mm and 10 min, respectively, with student's t-test significance

values being 96, 92 and 81%, respectively. On the nine days of paired seed and no-seed events, the t-test significance exceeded 98% for the three variables quoted above. On every one of the nine days, the seeded clouds showed increased height, rainfall and duration.

Using the model after it was calibrated against the 11 control clouds, it was found that the seeding increased the 10 cloud-top heights by an average of 6000 ft, with a maximum of 21,500 ft. The student t-test significance value for this increase was 96%.

Using the calibrated model on all of the 21 test clouds showed how much benefit could have been derived from seeding all of the clouds. The average potential increase in cloud-top height was 6500 ft. This represents a 52% increase assuming bases at 13,000 ft. Comparison with observations showed an rms prediction error of 3341 ft. The corresponding rainfall and duration increases were +2.86 mm (up from 2.99 mm) and 7 min (up from 11 min), respectively. These hypothetical increases are comparable to the observed values. - Authors' abstract.

850. Weinstein, Alan I. A numerical model of cumulus dynamics and microphysics. Pennsylvania. State University. Department of Meteorology,
NSF Grants GA-3956 and GA-777, Report No. 13, January 1969. 75 pp.
DAS M(051) P415rp no. 13.

The evolution of Cu, a complicated phenomenon resulting from the interaction of numerous subphenomena, can be best understood by simulating the subprocesses on a computer or in the laboratory. A numerical model was developed to explore the interaction between the thermodynamics, dynamics, and microphysics of cumulus clouds, and to investigate the roles of evaporation, freezing, and precipitation development of these clouds in their growth. The model can be used in basic research to gain some insight into the interactions of the various processes taking place in Cu; in applied research to suggest improved cloud modification procedures, and in the field to guide daily operations. The numerical calculations utilize forward-time integration and upstream-space differencing to obtain one-dimensional solutions of the first law of thermodynamics, the third equation of motion, and a series of equations describing the conservation of water substance. The thermodynamic and dynamic solutions, Eulerian analogs of the standard parcel method with entrainment, were made more realistic by simulating evaporation of precipitation below the cloud base and freezing of supercooled water by the introduction of artificial ice nuclei. The moisture balance equations were improved by parameterizing the transformation of condensed water from small cloud droplets into hydrometeors. The conclusions of the investigation are: 1) evaporation caused by vertical and horizontal mixing produces the life

cycle of small Cu; 2) the interaction between the cloud dynamics and microphysics of large cumuli controls the growth of these clouds; 3) the time at which condensed water starts its transformation into hydrometeors is more important to the production of rain than is the rate of transformation; 4) subcloud evaporation causes cooling and strong downdrafts below the cloud base; 5) increases in cloud-top height alone are not sufficient parameters to use in the evaluation of ice-phase seeding to augment rainfall; 6) the precise ice-nucleation temperature of the seeding agents and the conditions under which the nucleation temperature can change must be better known in order to optimize the ice-phase seeding procedures presently in use; 7) the best time to induce artificial freezing in Cu is during the cloud's most active growing stage. - MGA 21.1-595.

851. White, William C. et al. <u>Project Tule fog:</u> an investigation of warm fog dispersal using hygroscopic solutions. U. S. Naval Weapons Center, China Lake, Calif., NWC Technical Publication, 4766, November 1969. 16 pp. DLC.

Hygroscopic solutions dispensed from an aircraft were tested for their warm fog dispersal potential over the Naval Air Station, Lemoore, Calif., in the San Joaquin Valley. Because of unfavorable weather, only four tests were conducted during the test period, Jan. 6 to Feb. 28, 1969. Effects caused by seeding were observed on at least one of the tests. The most significant difference between this and the other three tests was the dispensing rate, 200 gal/min and 100 gal/min, respectively.

- MGA 21.10-124.

852. Woodley, William L. Precipitation results from a pyrotechnic cumulus seeding experiment. U. S. Environmental Science Services Administration, ESSA Technical Memorandum ERLTM-AOML 2. Miami, Atlantic Oceanographic and Meteorological Laboratories, August 1969. 50 pp. DAS M(055) U5887tem ERLTM-AOML 2. Also see Journal of Applied Meteorology, Boston, 9(2): 242-257, April 1970. DAS M(05) J86joa.

In an attempt to specify the changes in precipitation produced by alteration of cloud dynamics, airborne seeding with silver iodide pyrotechnics was carried out in South Florida during May 1968. Emphasis was placed on altering cloud dynamics and on increasing precipitation as a by-product of the dynamic alteration. Nineteen clouds were studied; 14 were seeded and 5 unseeded (controls) as dictated by the randomized seeding instructions. Each of the 14 clouds received approximately 1 kg of silver iodide smoke. Seeding was found to be effective in promoting increased cloud growth; the average growth difference between the seeded and control clouds was 11,400 ft, significant at the 1 percent level. The induced growths took many forms and in many cases were produced in clouds containing significant amounts of natural ice.

A 10-cm radar with iso-echo contouring was used to infer changes in precipitation. Analysis indicates that seeding increased rainfall an average of 100 to 150 acre-feet 40 min after the seeding pass, an increase of over 100 percent. The result is changed little by using an alternate analysis scheme or by including 5 additional control clouds selected after the program. The rainfall increases would probably have been greater if calculations had been possible for entire cloud lifetimes. Because of heavy natural rains during the program, the rainfall computations must be viewed with reservation. The significance of the rainfall results ranged between 5 and 20 percent based on two-sided statistical tests.

Comparison between radar and rain gage rainfall demonstrates that the rainfall calculations are probably underestimates by no more than 30 percent. The Z-R relation used in the rainfall calculations was equally valid for the seeded and control clouds. The amount of rain from the seeded clouds was positively correlated with the maximum top growth following seeding. The seeded rainfall increases were apparently the result of larger and more lasting clouds that were the by-product of the dynamic invigoration; there is no evidence that they were produced by improved efficiency of natural precipitation processes through disturbance of stability of supercooled drops. The natural glaciating behavior of the experimental clouds would appear to preclude the "colloidal stability" approach to rainfall augmentation from Florida cumuli. - Author's abstract.

853. Workman, E. J. The possible role of ammonia in thunderstorm electrification. In: International Conference on Cloud Physics, University
of Toronto, August 26-30, 1968, Proceedings. Foronto, 1969?
pp. 653-656. DAS M74.1 I61p 1968.

A revised model of thunderstorm electricity, proposed by the author involves the transfer of negative charge from water to ice when new ice layers form on cold atmospheric ice particles struck by splashing drops of supercooled cloud water. paper reports the results of experiments in which supercooled water drops (1.67 mm diam.) were allowed to fall through a cold space and strike a small piece of cold ice. The water drops cooled to a temperature of -4 to -8°C and struck the ice at a speed of a 365 cm/sec. The experiments were made for a number of drop forming solutions. Drops of distilled water, rainwater, tap water, pond water, melted hail, and NaCl solution all left negative charges of varying sizes on the ice. Solutions of ammonium compounds demonstrated a more complex behavior. For weak solutions the drops deposited a negative charge, however, the size of the charge diminished with increasing concentration up to about 4 X 10 -5 M. At this point, the charge deposited becomes zero and with further increase in concentration the deposited charge is positive. It should be pessible to modify

the electrical behavior of thunderstorms by dosing clouds with some ammonium solvent. Anhydrous ammonia would appear to be the best choice of reagent. To reduce the charge, a dosage of 18 kg for a typical cloud should be sufficient. A larger dosage might even cause a reversal of polarity. - MGA 21.7-715.

854. Yamashita, A. Uncommon ice crystals observed in a large cold room.

Meteorological Society of Japan, Tokyo, Journal, 47(1): 57-58,
February 1969. DAS M(05) M589sj.

The paper describes and illustrates the water droplets and ice crystals of uncommon shapes produced by dry-ice seeding in a 300 m³ wooden building in a mountain village in Gumma Prefecture. The crystals were formed on a cold Feb. day in 1966 when the outside temperature was —17°C and the temperature inside was kept at —5°C by hot water (+35°C) in a large container. When a dry-ice pellet was exposed briefly in the house, filled with supercooled droplets, numerous ice crystals appeared. The growth rate of these ice crystals is shown in a diagram. — MGA 21.7-550.

855. Camille batters U. S. mainland; Stormfury seeds Hurricane Debbie.

ESSA News, Rockville, Maryland, 5(34): 1-2, August 22, 1969. DAS.

"Camille" lashed the southeastern edge of Louisiana with a force greater than that of "Beulah" in the Gulf Coast in 1967. The Weather Bureau and Civil Defense officials distributed life-saving warnings. The WB station at Boothville, La., especially constructed to withstand hurricane free winds, survived, but the staff was marooned for 24 hr. The station's ground equipment for upper-air soundings was destroyed; WB personnel lost automobiles and personal effects; all homes were destroyed from Empire south to the gulf. Seeding of the immediately following "Debbie" was done to determine whether the violence of such a storm can be lessend. ESSA, Navy, and Air Force aircraft, scientists, and crews participated in the project. - MGA 21.3-460.

No. 25: £4-73, November 1969. DAS M(05) N277n no. 25.

The project aims 1) at describing hailstorms in northeastern Colorado, 2) at testing systems for detecting hailstorms and techniques for measuring hailfall intensity and mapping hailswaths and 3) at testing of techniques of hailfall suppression by silver iodide seeding of potential hail clouds. The method of hail prediction based on the prediction of an afternoon temperature profile developed by Edwin F. Danielsen, the computer model of an imaginary air parcel with the predicted base and height of afternoon clouds and associated updraft velocities and the results of prediction are discussed. Although impossible to determine accurately the size of the updraft parcels that will

form, there is generally a correlation between large updraft radii and approaching pressure troughs; apparently its related large-scale convergence helps to organize large updrafts. It is possible to predict the hail probability within the Rayner region in Northeastern Colorado by combining standard weather forecasts with computer model information. The network of three 3-cm Doppler radars developed by Roger L'Hermitle and the Northeastern Colorado Hail Experiment for hail suppression is described. - MGA 21.4-300.

857. Secretaries Stans and Chafee report on Project Stormfury; 1969 seeding results hailed as potential breakthrough. ESSA News, Rockville, Maryland, 5(49): 1-2, December 5, 1969. DAS.

After being seeded by Project Stormfury last summer Hurricane "Debbie" (1969) weakened measurably, enhancing hopes for ultimate hurricane modification. Details of the history of "Debbie" and its seeding are given. Stormfury scientists estimate that if Federal hurricane modification research continues at the present level for a decade, and if, in that time, one severe hurricane such as "Camille" can be weakened so that its damage is reduced as little as 10%, the investment will have been returned tenfold. - MGA 21.5-210.

858. Warm fog dispersal passes airport tests. Environmental Science and Technology, Washington, D. C., 3(7): 617-618, July 1969. DAS M(05) E6len.

Low visibility ceilings at two California airports were subject to weather modification tests. At Los Angeles and Sacramento airports, warm fog banks were seeded to provide an increase in visibility. Test results showed improved seeding techniques and increased airport use and efficiency. The California tests were directed at warm fogs that are most troublesome to airline operations. The basic techniques used in these tests can be applied to fog dispersal over harbors, canals, freeways, etc. - MGA 21.3-305.

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