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DEPARTMENT OF INTERIOR-DEPARTMENT OF TRANSPORTATION

BOMEX BULLETIN NO. 4

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BOMEX FIELD HEADQUARTERS • PARAGON HOUSE, BARBADOS

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1. Introduction

This, the fourth in the series of BOMEX Bulletins, places heavy emphasis on describing the overall experimental design for BOMEX, the major program areas and brief descriptions of the individual experiments. The operational or data-gathering phases of BOMEX are underway; the Field Headquarters was established in the Paragon House, Barbados on 27 April 1969 and the ships, aircraft and other observing platforms were on location on schedule on 1 May 1969. At the termination of the field observation phases, the BOMEX Project Office will return and continue at its Rockville location. Pending the establishment of a BOMEX Analysis Group within the ESSA Research Laboratories, the Project Office will continue to coordinate data handling, data exchange and the analysis of certain of the primary sea-air interaction experiments. We also anticipate the publication of an additional Bulletin which will describe our field experience.

2. Scientific Program

Objectives

BOMEX is designed to explore one of the key processes governing the physical behavior of atmosphere and oceans.

The energy received by the planet Earth from the sun in the form of short wave radiation is stored as heat primarily in the upper layers of the tropical oceans. In contrast, the earth loses heat rather uniformly at all latitudes by infrared radiation.

The resulting net gain of heat in tropical latitudes and net loss in polar latitudes is compensated by an energy flux from low to high latitudes which, strangely enough, is accomplished by the atmosphere rather than the oceans. Therefore, the heat stored in the oceans has to be transferred to the atmosphere.

This energy exchange may be visualized in three steps. In the first step energy from the upper ocean layers transfers by "sea-air interaction" to an atmospheric boundary layer of 5,000 to 6,000 feet depth, the so called tradewind layer.

In the second step, this energy finds its way into deeper layers of the troposphere by convective action.

The third step transports the redistributed energy from tropical to higher latitudes.

It is the first two steps which are the subject of the BOMEX Project.

Step one is notoriously difficult to observe. Although it is responsible for atmospheric circulations on the largest scale, the energy transfer from the sea surface occurs on the smallest scale, namely by turbulent action. The primary component of the turbulent energy flux is the latent heat of evaporation, but the exchange of sensible heat, momentum and other properties occurs at the same time and not always in the same direction. Many factors such as wind, sea state and air and sea temperature complicate this process. In the BOMEX Project the problem of sea-air interaction will be attacked by all technological and scientific methods at our disposal and the first two months of the project will be devoted primarily to this program.

Step two, the distribution of energy through deeper layers of the tropical atmosphere is even more obscure and will be explored in the third month (July 1969). It seems to occur in a spurt-like fashion in convective systems on the meso and synoptic scale. As seen from satellite pictures, tropical cloud systems of several hundred miles diameter form and dissipate, often within a day or two and accomplish this vertical transport transforming some of the latent heat into sensible heat by condensation and precipitation. The presence of a large fleet of aircraft will allow us to get some preliminary answers on the nature of these disturbances and to gain operational experience on the conduct of highly flexible long range flight operations based on real-time satellite information.

Otherwise, steps two and three will have to wait for the follow-on projects of the Global Atmospheric Research Program (GARP). BOMEX represents a start on GARP and can be expected to supply some vital lessons for future projects of similar or larger complexity. The scientific significance of BOMEX for GARP and the World Weather Program (which has been accepted by the nations of the World) lies in the fact that their primary goal, namely the extension of numerical forecasts to periods of one and two weeks cannot be accomplished without taking the basic energy sources of the atmosphere into account. Without any of these sources, friction would eliminate most atmospheric motions within the prediction period, while for short periods readjustments of the available potential and kinetic energy keep the atmosphere going. At present, the lack of a global observing network alone is sufficient to prohibit such extended forecast. Once the World Weather Watch corrects this deficiency, the results of experiments such as BOMEX will be required to supply the needed quantitative information on the energy sources and sinks over the tropical oceans. The earliest application of BOMEX results will be be in the choice of observational system parameters.

The details of the basic plan of BOMEX have been the work of the late Professor Ben Davidson whose untimely death in December 1968 caused a temporary crisis in the scientific direction of the project. His layout and his ideas have proved so sound that changes have been minimal.

BOMEX follows closely the recommendations of the Joint Panel on Sea-Air Interaction and the Panel on International Meteorological Cooperation of the National Academy of Sciences (1962). These panels pinpointed the problem of sea-air interaction as one of the most important, but also most difficult research problems of our time, requiring the close cooperation of the atmospheric and oceanographic scientific communities.

Such cooperation seems to have been achieved in BOMEX. Scientists from numerous universities, government agencies and industrial laboratories are joining and manning the many floating and flying research platforms available in this project (See Appendix 1).

The unprecendented participation by the scientific community (with more than 80 independent research projects) has made it necessary to group the projects into certain program areas, each of which represents a major effort. They are:

a) The Sea-Air Interaction Program

b) The Oceanographic Program

c) The Tropical Exploration Program

d) The Radiation Program

e) The Satellite Program

An additional group of projects has more specialized objectives.

The five major program areas are discussed in detail below. It should be pointed out that the Sea-Air Interaction Program remains the prime objective of BOMEX.

A. Sea-Air Interaction

The principal objective of the scientific program during the first three BOMEX periods is the determination of the flux of energy from the ocean to the atmosphere. This provides the rationale for the observational array and the scheduling of most of the observations.

The 500 km square represents the elementary finite-difference interval for synoptic meteorology and for numerical integration of the differential equations of dynamic meteorology. Conventional meteorological observations are made from fixed ships at the corners and at the central point. The variations of sea-air energy flux within the square will ultimately be related to these observations of wind direction, wind speed, temperature, humidity and barometric pressure at the surface and aloft and to their gradients.

The energy flux will be studied by keeping budgets of the following properties which are governed by rigorous conservation laws:

total mass

water substance

momentum

total energy

The budgets will be evaluated for an atmospheric volume extending vertically from sea level to a surface whose pressure is exactly 500 mb below sea level pressure and bounded horizontally by the square determined by the four outer fixed ship positions. Within the ocean the budgets will be evaluated for the volume extending downward to a depth of 500m. There are then three independently observable quantities which must be equal. These are the net upward flux of energy measured at the sea-air interface and integrated over the BOMEX area, the net loss from the oceanic volume, and the net gain by the atmospheric volume after all other gains and losses have been taken into account. These other gains and losses include internal source and sink terms, local rates of change ("storage"), and transfer through the other boundaries. A schematic 3-dimensional depiction of the atmospheric and oceanic volumes is shown in Figure 1.

At the sea-air interface itself, measurements will be made of short-wave radiation received from the sun, reflected short-wave radiation, long-wave (infra-red) radiative emission and net long-wave flux. The temperature gradient within the top millimeter of water, from which conductive heat flux can be calculated, will be measured by the University of California by means of aircraft mounted twin-wave-length infra-red sensors. Direct and indirect measurements of sea surface temperature, sea state and wave spectrum will provide boundary data for internal flux calculations in both fluids as well as direct evidence for estimation of surface stress.

Within the upper ocean, numerous vertical profiles of temperature, salinity (STD: Salinity Temperature Depth recorder) and current velocity together with eddy diffusion coefficients derived from less frequent turbulence measurements and radioactive tracer measurements (e.g. beryllium-7, radon) will permit estimates of the vertical flux of heat, momentum and salt. An attempt will be made to account for the horizontal flux divergence and local rate of change of heat so as to obtain a complete heat budget for the oceanic part of the BOMEX volume. This will be an important test since the upward heat flow to the sea-air interface must balance the total interface energy flux, including major transfers in the form of latent heat of vaporization and net long-wave radiation.

The most ambitious part of the BOMEX sea-air interaction program is that aimed at documenting all the terms in the atmospheric water vapor budget. These terms are:

(1) Upward flux in the first few tens of meters above the interface, determined by direct eddy-covariance methods on the FLIP and on the RFF, Woods Hole and NCAR aircraft, and by vertical profile ("Aerodynamic") methods using several different sensor systems on FLIP, TRITON and the basic ship array. Coefficients of eddy transfer will be estimated from those calculated for momentum from a large variety of stress measurements on several platforms, including eddy-covariance methods, dissipation and structure function (Kolmogoroff similarity) methods, the geostrophic departure method and others. Sensible heat flux will also be measured by several methods to be used both as a component of the energy budget in its own right and as a further source of eddy diffusivity coefficients. The sensible heat flux is expected to be very small on the average compared to the latent heat flux, but may become a significant term under some meteorological and oceanographic conditions.

Estimation of the area integrals of the vertical fluxes determined from the various local observations will be aided by aerial mapping of sea surface temperature and sea state, satellite cloud photography and aircraft meteorological observations as well as by detailed meteorological observations on all ships (Boom instrumentation as well as manual observations).

(2) Horizontal flux divergence measured by integrating the product of the specific humidity and the normal (outward) component of the wind over the area of the vertical boundaries along the sides of the BOMEX square. This integration will be carried out during seven selected periods of intensive observations. It will utilize the ship rawinsondes which will be launched 15 times per day, line integral aircraft flights twice a day, and continuous BLIP (Boundary Layer Instrument Package carried by captive balloons) time series at selected altitudes in the lowest kilometer during part of the observation period.

(3) Vertical flux through the top surface, which consists of two parts: that due to the mean or low-frequency vertical velocity and that due to small-scale eddies. This term is expected to be relatively small on the average. If on occasion, it should become significant, the mean component can be estimated by using the kinematic divergence of the horizontal wind, the sensible heat budget, or the vertical transport of natural radioactive tracers. The eddy component will not be directly measured in BOMEX and is expected to be very small compared to the other terms except in the case of widespread convection penetrating above the 6 km level. During the third BOMEX period, a series of LIDAR observations will be taken from C-130 aircraft to provide spatial patterns of aerosol concentration from which the scale and intensity of meso-scale turbulence, and the nature and amplitude of perturbations on the trade inversion, can be inferred.

(4) The rate of change of total moisture content of the BOMEX volume, determined from rawinsonde data supplemented by twice-daily sampling of the BOMEX volume by 8 dropsondes dropped from 20,000 feet by the U.S. Air Force C-130.

(5) Precipitation will be estimated by means of satellite visible light (NIMBUS, ESSA and ATS) and infra-red (NIMBUS) photographs several times a day, continuous radar coverage of part of the BOMEX area by X-band radars on Barbados and on the DISCOVERER, complete airborne radar photography coverage by Air Force B-47 once daily, nearly complete airborne radar coverage by Navy WC-121 each night, rain gage measurements on the five fixed ships, FLIP and TRITON, and special salinity profiles in the upper 15 m of the ocean at each ship during and following precipitation.

In addition, the measurements of beryllium-7 in the upper 100m of the sea will permit a good estimate of the average deposition rate of this 53-day half-life radionuclide which is formed naturally by cosmic-ray interaction with the upper atmosphere. Measurements of the vertical gradient of beryllium-7 concentration in the lowest few meters of the atmosphere, together with eddy transfer coefficients discussed above, will permit an estimate of the fraction deposited by turbulent transfer. The remainder is deposited by rain, and the measurement of concentrations in rain will permit an independent estimate of the average rainfall.

Each concentrated observation period will last 4 or 5 days. Serial rawinsondes and dropsondes will be taken throughout each period. Night line integral flights will be flown on 3 or 4 nights and day line integral flights employing 2 aircraft at a time will be flown on the 2 or 3 middle days of each period. BLIP observations will be continuous. RFF refractometer-gust probe flights will also be made during these periods. The periods tentatively selected for intenseive observations are:

May 3 - 6

May 10 - 13

May 25 - 28

May 31 - June 3

June 7 - 10

June 20 - 24

June 27 - July 1

Many of the atmospheric vertical-flux measurements, radar and satellite observations and conventional meteorological observations will continue during the other days of the BOMEX observational period. During those other days, 4 rawinsondes per day will be tracked to balloon bursting altitude to provide more information on the structure of the upper troposphere and lower stratosphere.

The Chief Scientist for the Sea-Air Interaction Program is Dr. J. Holland who is being assisted in developing the analysis plan by the following:

Mr. Robert Landis for the upper ocean heat budget.

Dr. Joseph Pandolfo for the evaluation and synthesis of vertical flux measurements.

Dr. James Rasmussen for the horizontal flux and volume integral computations.

Capt. Gerald Dittberner for the precipitation analysis.

Prof. Richard J. Reed for the analysis of synoptic and subsynoptic fields of meteorological variables.

Most of the investigators listed in Appendix I are participating in the Sea-Air Interaction Program except for those who are identified in the following Sections describing the remaining major programs.

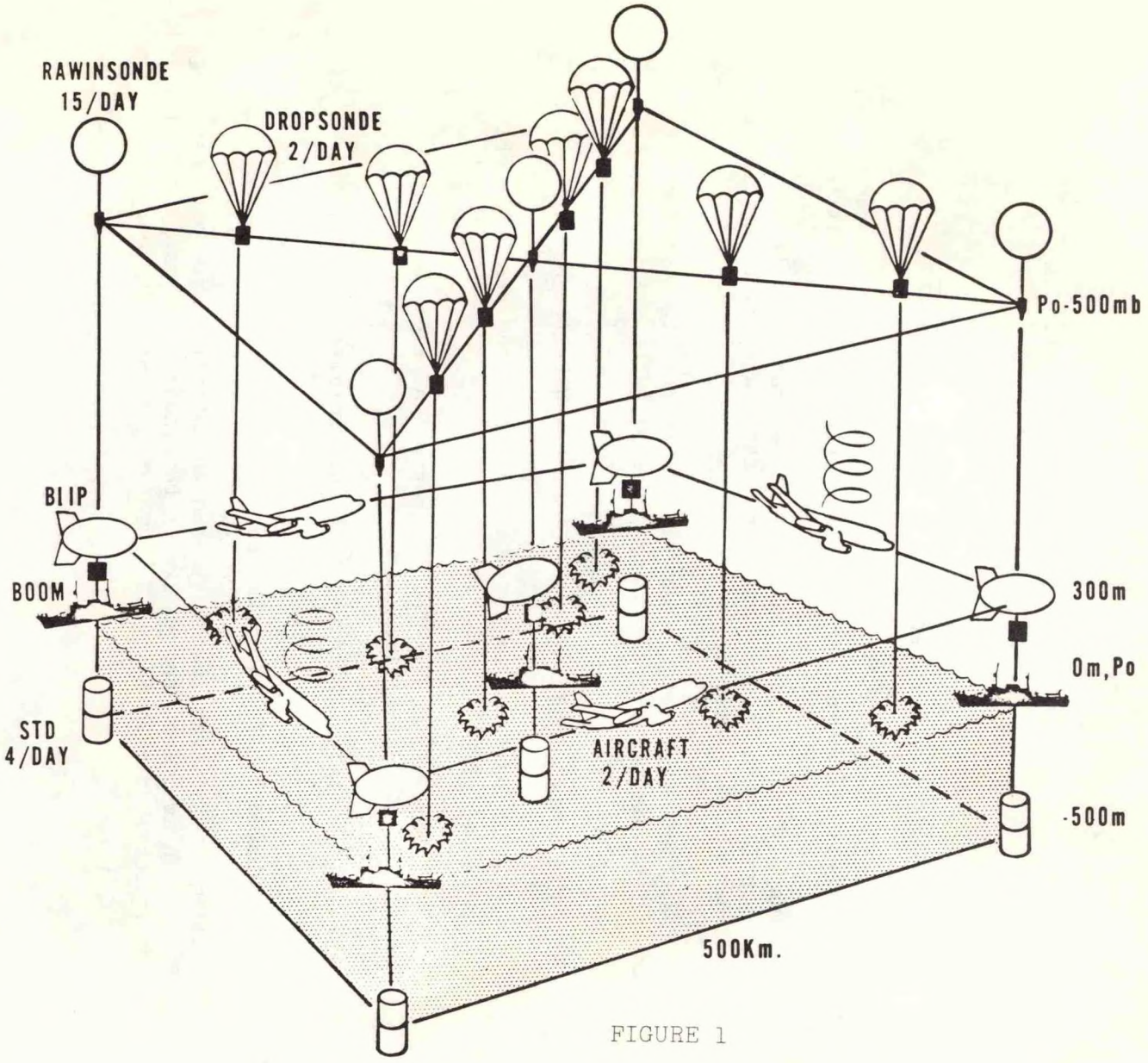

RAWINSONDE
15/DAY
DROPSONDE
2/DAY
Po-500mb
BIIP
BOOM
300m
0m,Po
STD
4/DAY
AIRCRAFT
2/DAY
-500m
500Km.

FIGURE 1

B. BOMEX Oceanographic Program

The Oceanographic Program of BOMEX, has been designed to satisfy a wide variety of objectives. These are related primarily to the dynamics and structures of the mixed layer in the upper ocean and to the transfer of energy and mass that takes place at the sea-air interface which is indeed, the very core of BOMEX.

Five distinct groups of oceanographic experiments are planned. The first group is concerned with the physics of the near-surface layers of the water, specifically with measurements of vertical shear, particle velocities in waves and turbulent motions.

The second group of experiments deals with the thermal structure of the ocean. Vertical temperature profiles and thermal pattern of the sea surface will be measured from aircraft and ships. The Sea-Air Interaction Program is dependent upon this group of experiments to provide data from which a complete heat budget of the upper ocean may be obtained.

Study of the generation and dynamics of surface and internal waves in the ocean comprises the third group of experiments. Wind-generated waves on the sea surface and baroclinic internal waves will be measured from ships, aircraft, and coastal stations using holographic techniques, airborne radar-wave-profilers, STD and tidegauges.

The fourth group of experiments is concerned with a study of ocean currents and their time and space variability. A line of moored-buoy stations will sense ocean current and temperature fields. Drifting drogue buoys will be radar-tracked to determine their trajectories and dispersions. The current-meter data will be analyzed to estimate vertically integrated water transport in the area.

The last group comprises projects concerned with the development of mathematical models of the ocean-atmosphere system. The data gathered will be utilized in oceanographic-prediction techniques.

Primary participants in the BOMEX Oceanographic Program are:

Naval Research Laboratories (Dr. D. Stilwell, Jr.)

NAVOCEANO (P.S. Deleonibus, Dr. R.W. James, Dr. P. Mazeika, L. Banchero)

Naval Underwater Research and Engineering Station (Dr. D.H. Shonting, G.S. Cook, A.T. Massey)

ESSA/Atlantic Oceanographic Laboratories (Dr. D.V. Hansen)

BOMEX Project Office (R. Landis)

Scripps Institution of Oceanography (Dr. D.D. McAlister, Dr. F.H. Fisher)

Woods Hole Oceanographic Institution (Dr. P.M. Saunders)

Massachusetts Institute of Technology (A. Leetma)

Yale University (Dr. T.D. Foster)

Isotopes Inc., Palo Alto Labs (Dr. D.R. Schink)

The BOMEX Oceanographic Program is coordinated by Mr. W. Maloney, NAVOCEANO.

C. Exploration of Tropical Convection Systems

The last operating period of the BOMEX Project during the month of July 1969 will be devoted to an exploration of large convective systems over the tropical Atlantic.

It is in these systems that most of the energy contained in the atmospheric boundary layer is transported to higher levels and distributed throughout the troposphere. Much of the latent heat of water vapor received from the ocean surface is transformed in these weather producing cloud systems to sensible heat.

For reasons not well understood at this time, convection over the tropical oceans takes place in large cloud clusters which are easily seen on satellite pictures and which form and die in a surprisingly short time in the general neighborhood of the Inter Tropical Convergence Zone (ITC). They may reach diameters of 300 to 500 miles, that is of the same order of magnitude as the whole BOMEX ship array.

Another type of tropical disturbance, the so called "Inverted V," is a synoptic disturbance of about 1,000 miles wave length with a characteristically shaped cloud pattern responsible for its name. Traveling westward from the African continent it sometimes "blows up" into a very large cloud cluster over the tropical Atlantic, and occasionally developes into a hurricane. A bulge in the ITC farther south usually travels along.

These and other types of tropical systems will be the subject of later projects of the Global Atmospheric Research Program over the Pacific. In the last month of the BOMEX Project, advantage will be taken of the presence of a highly instrumented fleet of aircraft to get some preliminary scientific information and to learn how to go about this highly flexible scientific flight operation based on real-time satellite inputs. For this purpose, the Hughes Satellite ground station will be installed on Barbados and will provide continuous daylight views from the ATS-III synchronous satellite stationed over the BOMEX operations area.

To increase the chance of intercepting the desired tropical disturbances, the ship array will be flipped south by moving the two most northerly ships to a position near latitude 6° to 7°N while keeping the center ship near 15°N (Figure 1). This will increase the latitudinal spread such that the ITC will be incorporated.

In case a sufficient number of convective disturbances does not pass through the BOMEX array, preparations have been made to operate on short notice from advanced bases in Brazil and Africa, such that group of at least 6 long range aircraft will be able to reach any point over the tropical Atlantic between Africa and Barbados with an operational flexibility of 2 hours over the target area (Figure 3).

The hypothesis that some of the tropical convection systems are products of a boundary layer phenomenon, namely a certain type of instability of the vorticity field, will be explored by Doppler wind measurements from a low flying formation of aircraft. Typical flight patterns for the cloud clusters (zig-zag track) and the synoptic disturbances (long distance triangular tracks) are shown in Figure 2. In addition, the height dependence of the horizontal divergence around large convective clouds will be measured. A vertical range from 500 to 60,000 feet will be covered by the available aircraft, listed in Table 1. Provisions are being made to satisfy requirements of the radiation program on the same flights.

Flights will be planned at the BOMEX Control Center in Barbados, but an airborne mission control director will provide additional flexibility during the flight mission. Longe range communications between aircraft and home base will be via satellite at predetermined times.

Primary scientific participants are:

Colorado State University (Dr. Riehl)

Massachusetts Institute of Technology (Dr. Charney)

University of Miami (Dr. Estoque)

ESSA (Mr. Frank, Mr. Hawkins, Dr. Kuettner)

Professor Charney will be Scientific Director of this program phase.

AVAILABLE AIRCRAFT FOR TROPICAL EXPLORATION PHASE

Agency	Over BOMEX Array	Over Atlantic
ESSA	DC-4	DC-4
	2 DC-6	2 DC-6
	B-57	
Air Force	WC-130	WC-130
	WB-47	
	WC-135 (?)	WC-135 (?)
	RB-57F	
Navy	WC-121	WC-121
NCAR	Buffalo	
	Queen Air	
NASA	990	990

TABLE 1

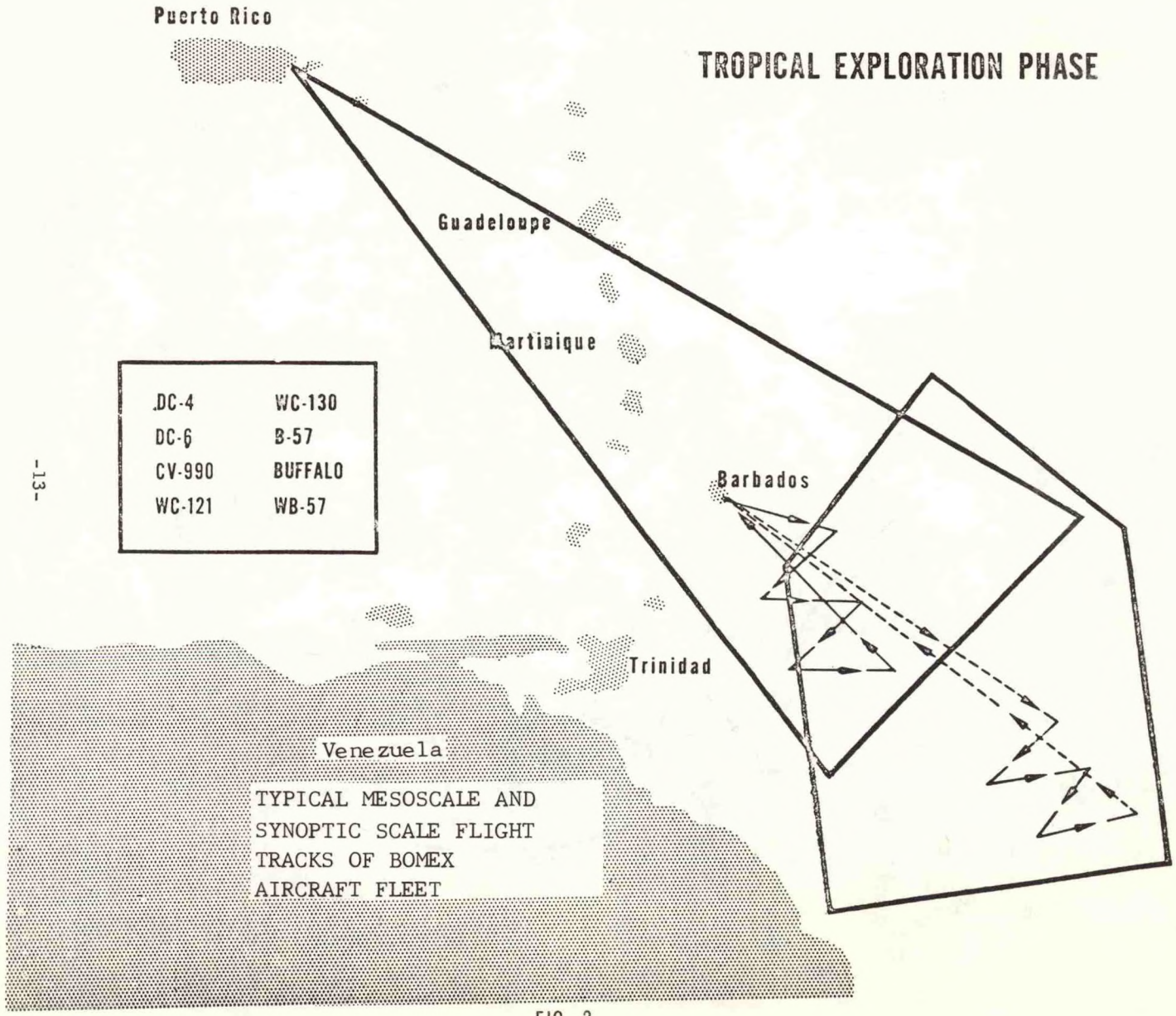

Puerto Rico
TROPICAL EXPLORATION PHASE
Guadeloupe
Martinique
DC-4
DC-6
CV-990
WC-121
WC-130
B-57
BUFFALO
WB-57
Barbados
Trinidad
Venezuela
TYPICAL MESOSCALE AND
SYNOPTIC SCALE FLIGHT
TRACKS OF BOMEX
AIRCRAFT FLEET

FIG. 2

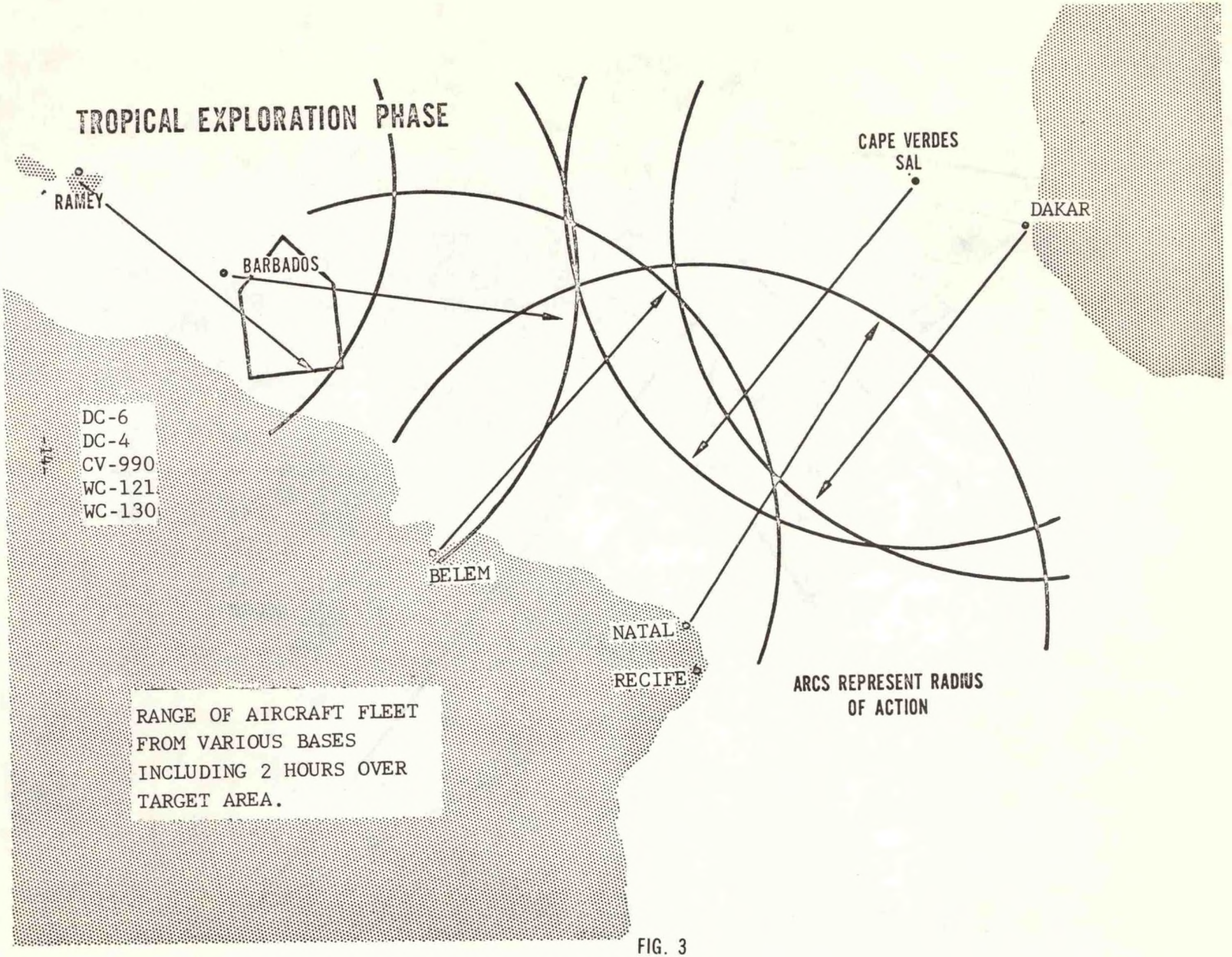

TROPICAL EXPLORATION PHASE
RAMEY
BARBADOS
CAPE VERDES
SAL
DAKAR
DC-6
DC-4
CV-990
WC-121
WC-130
-14-
BELEM
NATAL
RECIFE
RANGE OF AIRCRAFT FLEET FROM VARIOUS BASES INCLUDING 2 HOURS OVER TARGET AREA.
ARCS REPRESENT RADIUS OF ACTION

FIG. 3

D. BOMEX Radiation Program

The BOMEX radiation program is designed to determine the radiation budget over the BOMEX area from the ocean surface to the top of the atmosphere. This analysis is linked closely to the total energy budget of the sea-air interface.

Four distinct radiation experiments are planned over the BOMEX area, each measuring hemispheric upwelling and downwelling solar and infrared radiant emittance.

The first experiment involves measurement of the sea-air interface budget from solar and infrared surface radiometers on shipboard at the four corners and the center of the array. The second experiment, also from shipboard, involves vertical soundings by balloon-borne infrared radiometersondes. To complete the second experiment, aircraft will measure the divergence of solar radiation as a function of height within the troposphere. The third experiment addresses itself to the total radiation budget at the top of the BOMEX array. Measurements of the solar constant and reflected solar radiation from high flying aircraft, up and down welling infrared measurements by balloons flying to 100,000 feet and satellite observations in the visible and infrared spectral band conclude the very high altitude analysis.

There remains only an estimate of the variation of vertical radiant fluxes along the lateral boundaries of the array. For this the radiation program has to rely upon the "line-integral flights" around the array in which some of the radiometer equipped aircraft are participating.

Primary scientific participants of the radiation experiment are:

Florida State University (Prof. Garstang and Dr. Gille)

The University of Wisconsin (Dr. Cox and Dr. Hansen)

Texas A&M (Dr. Franceschini)

Woods Hole Oceanographic Institution (Dr. Bunker and Dr. Saunders)

Eppley Laboratories (Dr. Drummond)

ESSA/ERL (Dr. Kuhn)

Solar and infrared radiation directed upward and downward will be measured from ships, land stations, aircraft and balloons (See Table 1). In addition, one ship will measure the absorption of solar radiation in the oceans as a function of depth.

The radiation program will be coordinated by Dr. Kuhn (Surface and Balloon Program) and by Dr. Cox (Flight Program).

In the airborne radiation program seven aircraft equipped with short-wave radiometers (0.3 to 3.0) will be flown in two different modes of flight patterns. In the case of clear air, or when the cloud structure may be considered horizontally stratified, a single aircraft will make a vertical sounding. When the horizontally stratified assumption is not valid, up to five of the aircraft will operate in a near vertical stack between 1,000 and 40,000 feet altitude. From this the amount of short wave energy absorbed in each layer as well as the contribution to the albedo of each layer will be computed.

Flight measurements over and under tropical weather systems will be compared to simultaneously taken satellite pictures and will serve to "calibrate" these pictures with respect to their radiative information.

Additional sensors, including microwave radiometers carried by some of the BOMEX aircraft will be tested and provide "ground truth" for the developing of satellite sensors and are described under the "satellite program" of BOMEX.

TABLE 2

BOMEX RADIATION PROGRAM

Radiometers (Spectral Range) / Scientific Participants	AIRCRAFT						SHIPS				LAND	BALLOON
	NCAR		NASA	ESSA	CSU	WHOI	ESSA		COAST GUARD	NAVY		
PLATFORMS	QUEEN AIR	BUF-FALO	990	DC-4 DC-6	AERO CDR.	C-54G	RAINIER	DISCO-VERER	ROCKA-WAY	FLIP	BARBADOS	RADIOM. SONDES
Solar 1)	X	X	X 4)	X X	X	X	X	X	X	X	X	
Infrared 2)			X	X X			X	X	X	X	X	X
TOTAL 3)							X	X	X	X	X	
Univ. of Wisconsin	X	X	X	X X	X							
Florida State Univ.									X		X	X
Eppley			X									
ESSA			X				X	X	X			X
TEXAS A & M										X		
Woods Hole						X					X	

NOTES:
1) 2.5
2) 3.5 (multi-spectral)
3) 0.5 to 40
4) Multi-spectral

E. BOMEX Satellite Program

The BOMEX Satellite Program will serve multiple purposes:

(1) It will provide rather complete satellite coverage of the BOMEX area for operational purposes, primarily in flight planning. This information will be available on near real-time at the Barbados Control Center and will be vital during the 4th phase of BOMEX, the tropical exploration program, and for the conduction of radiation flights.

(2) It will provide scientific background information to be used in the analysis of many projects participating in BOMEX. It will be of special value to the sea-air interaction program in the determination of cloud cover and precipitation over the BOMEX array. Infrared measurements will serve to determine sea surface temperature and cloud heights.

(3) In the field of satellite meteorology, advance techniques of deriving winds and other parameters from satellite pictures will be compared with numerous direct measurements available from other platforms.

(4) It will support the development of satellite instrumentation by comparing remote sensing data from satellites and aircraft and direct measurements from ships and aircraft ("ground truth program").

(5) It will provide certain communication experiments with aircraft and ships via synchronous satellite for flight operations and future global weather and ocean systems.

Participants and primary users of the BOMEX Satellite Program are:

NASA, Goddard Space Flight Center (Miss Brennan, Dr. Conaway, Dr. Hovis, Dr. Nordberg)

NASA, Manned Spacecraft Center (Mr. Evans, Dr. Whitehead)

NASA, Langley Research Center (Dr. Lawrence, Jr.)

ESSA (Mr. Frank, Dr. Holland, Dr. Kuettner, Dr. McClain, Dr. Lettau, Dr. Wark)

U.S. Coast Guard (Cdr. Johnson)

University of Chicago (Dr. Fujita)

Colorado State University (Dr. Marlatt, Dr. Riehl)

Fairfield University (Dr. Callahan)

MIT (Dr. Charney)

University of Miami (Dr. Estoque)

University of Wisconsin (Dr. Cox, Dr. Hansen, Dr. Von der Haar, Dr. Suomi)

Research Triangle Institute (Dr. Vukovich)

A.D. Little, Inc. (Dr. Blau)

Among the platforms used in this program are the NASA Convair-990 and the P-3A, which carry numerous remote sensors over a wide spectral range (see Table 3) and the ESSA satellites 2, 6, 7, 8, 9, the Nimbus B-2 (to be launched in April 1969) and the ATS-III synchronous satellite. The latter will be moved during June to 47°W so as to be at the optimum position with respect to the BOMEX area during July 1969, in support of the tropical exploration phase of BOMEX. During this month, a Hughes ground station for ATS-III will be operated on Barbados to provide continuous high resolution views on real time.

Direct reception at Barbados from ESSA APT and NIMBUS, as well as WEFAX transmission via ATS-III, will provide excellent coverage during day and night (Figure 1). ESSA's National Environmental Satellite Center will send a special mosaic of 1000 x 1000 mi cetered over Barbados every evening via WEFAX to BOMEX Control. Personnel of the University of Wisconsin will be responsible for the satellite ground operation in Barbados. The total satellite coverage available at the BOMEX Control Center is described in Table 4. Archival data will be made available to all interested parties participating in BOMEX.

NASA AIRCRAFT

SATELLITE RELATED INSTRUMENTATION

	Convair 990		Lockheed P3A
1.	19.4 GHz Scanning Radiometer	1.	Dual channel infrared imager (0.3-5.5μ, 8.0-14μ)
2.	9.3 GHz Non-scanning Radiometer	2.	Infrared Spectrometer (6.5-13μ)
3.	MRIR (.2-4μ, 6.7μ, 10.5-11.5μ, 14.5-15.5μ, 20-23μ)	3.	Infrared radiometer (10-12μ)
4.	Cloud Radiometer (1.7 and 2.1μ)	4.	400 MHz Scatterometer
5.	Laser Nephelometer	5.	1.6 GHz Scatterometer
6.	13 GHz Scatterometer	6.	13.3 GHz Scatterometer
7.	Wave Profile Laser	7.	16.5 GHz Side-looking Radar
8.	Cirrus cloud radiometer (10-12μ, 3.5-31.0μ, 19-31μ, 2.6-2.8μ)	8.	Multiple Frequency Microwave Radiometer
9.	Aerosol Sampling	9.	RC-8 metric cameras (2)
10.	Photography - downward and side-looking	10.	Modified KA 62 camera cluster (4)

TABLE 3

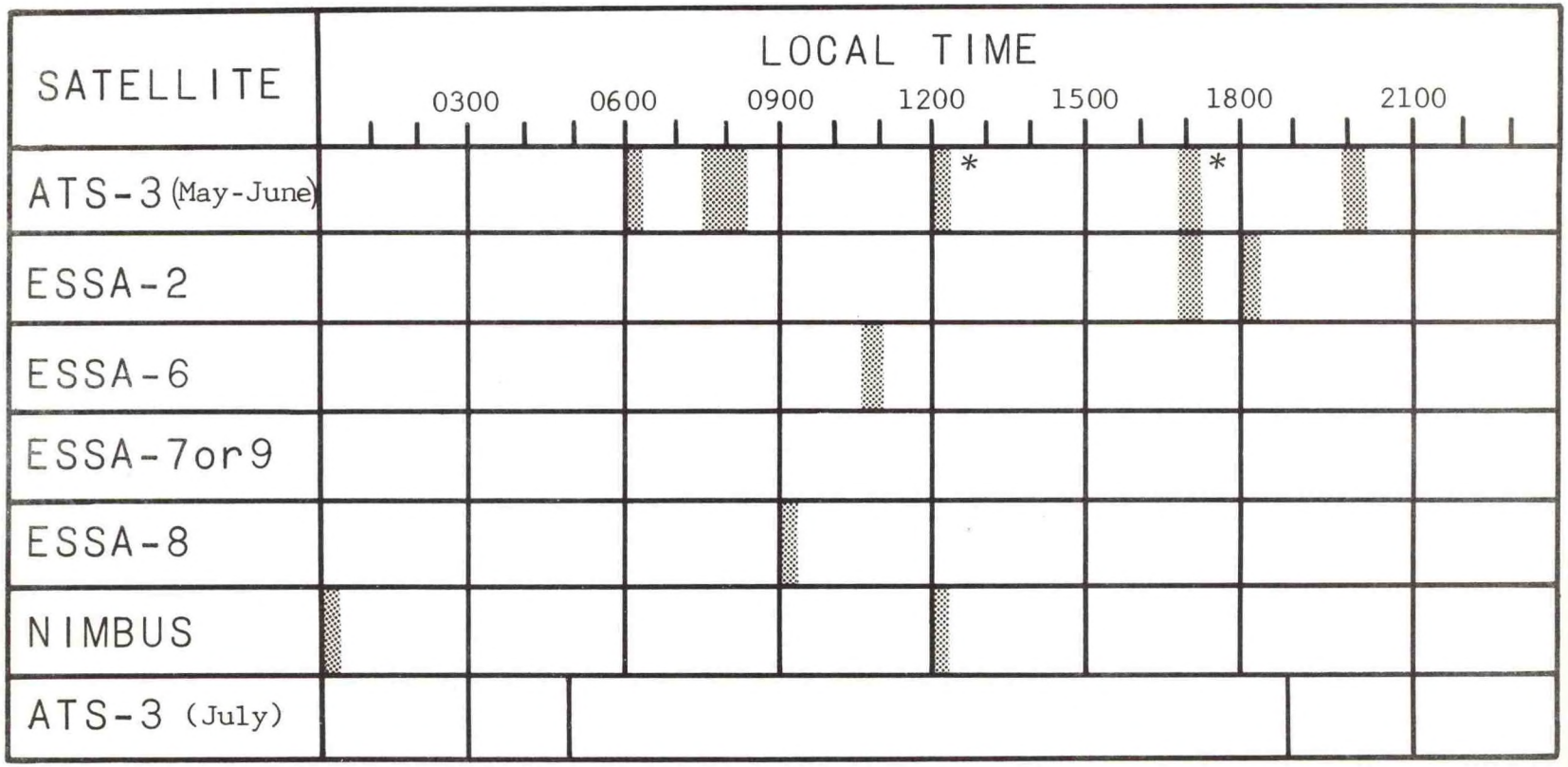
SATELLITE INFORMATION AVAILABLE AT BARBADOS

0600 Local time (May & June)	ATS 3	WEFAX
0745 to 0815 Local time	ATS 3	VHF Communication with aircraft and experimental interrogation of ship sensors
0800 Local time (May & June)	ATS 3	WEFAX
0900 Local time	ESSA 8	APT
1030 Local time	ESSA 6	APT (tilted)
1200 Local time	NIMBUS	DRID (2 mile resolution)
*1200 Local time (May & June)	ATS 3	WEFAX
1700 Local time	ESSA 2	APT
*1700 Local time (May & June)	ATS 3	WEFAX
1800 Local time	ESSA 2	APT
1945 to 2015 Local time	ATS 3	VHF Communication with aircraft and experimental interrogation of ship sensors
2100 Local time	ESSA 7 or 9	AVCS/WEFAX Mosaic 15^{o} x 15^{o} Data Time Approximately 1500 local
2400 Local time	NIMBUS	DRIR (4-5 mile resolution)
Day light - continuous (July)	ATS 3	Hughes Ground Station

* On a non-interference basis with APT

TABLE 4

DAILY SATELLITE DATA AVAILABLE



ON A NON-INTERFERENCE BASIS WITH APT

F. Summary of Scientific Participation

The following charts summarize the scientific participation in the BOMEX Project. The numbers in the boxes represent the number of experiments that will be pursued in the category indicated.

BOMEX SCIENTIFIC PARTICIPATION

Part 1

UNIVERSITY ORGANIZATION	SEA-AIR INTERACTION	TROPICAL CONVECTION	OCEA-NOGRAPHY	RADIATION	SATELLITE	OTHER
UNIV. OF BRITISH COL.	4					1
UNIV. OF CHICAGO						1
COLO. ST. U.	1	1			1	
FAIRFIELD U.					1	
FLORIDA S.U.	2			1		
LAMONT OBS.			1			
MIT		1				1
MIAMI U.		1				
UNIV. OF MICHIGAN	1					
OREGON S.U.	1					
RESEARCH TRI. INSTITUTE			1			
SCRIPPS	3		2			1
STANFORD RES. INSTITUTE						1
TEXAS A & M	1			1		
UNIV. OF WASHINGTON	1		1	1		
UNIV. OF WISCONSIN				1		
WOODS HOLE	1		1	1		
YALE UNIV.			2			

CHART I

BOMEX SCIENTIFIC PARTICIPATION

CHART I
Part 2

UNIVERSITY ORGANIZATION	SEA-AIR INTERACTION	TROPICAL CONVECTION	OCEA-NOGRAPHY	RADIATION	SATELLITE	OTHER
McGILL UNIV.						1
NCAR	1					
UNIV. OF NEVADA DESERT RESEARCH INSTITUTE	1					

BOMEX SCIENTIFIC PARTICIPATION

INDUSTRY ORGANIZATION	SEA-AIR INTERACTION	TROPICAL CONVECTION	OCEA-NOGRAPHY	RADIATION	SATELLITE	OTHER
BATTELLE N.W.	1					
EPPLEY LAB.				1		
ISOTOPES, INC.			1		1	
A.D. LITTLE, INC.						
THORNTHWAITHE ASSOCIATES	1					
TRAVELERS			1			

CHART II

BOMEX SCIENTIFIC PARTICIPATION

GOVERNMENT ORGANIZATION	SEA - AIR INTERACTION	TROPICAL CONVECTION	OCEANOGRAPHY	RADIA-TION	SATELLITE	OTHER
AEC ARGONNE	1					
BOMEX PROJECT OFFICE	8		2			
BUREAU OF COMMERCIAL FISHERIES			2			
ESSA ERL	2	1	1	1		
NESC					1	
WB						1
NAPCA						1
NASA GSFC					6	
LANGLEY						1
MSC			1			1
MTF	1					
NAVY NAVOCEANO	4		2			
NRL			1			
NUWR & ES			2			2
USAF AFCRL						1
U.S. COAST GUARD			1			1
U.S. GEOLOGICAL SURVEY	1					

CHART III

3. Project Management

The basic structure for the coordination and management of BOMEX was described in Bulletin No. 3. There has been no essential change in the basic structure; however, the scientific staff has been considerably strengthened as is shown in the organizational chart for BOMEX which is shown in Figure 5. Coordination meetings among the several special interest groups in addition to a general meeting of all of the principal investigators have been very largely responsible for the exceptionally smooth flow of BOMEX scientific activity thus far. The BOMEX Advisory Panel of the U.S. GARP Committee, National Academy of Sciences has reviewed the overall program and continues to provide scientific guidance.

The BOMEX Operation Plan 1-69 is the governing document for the execution of the BOMEX Field experiment during the period 1 May - 28 July 1969. Copies of the Operation Plan have been forwarded to Agencies and individuals concerned.

A Control Center, established in the BOMEX Field Headquarters, will exercise mission control of the participating units during the experiment to insure a coordinated control direction over all scientific observation programs and provide the scheduling, shore support and other assistance necessary to accomplish the field mission.

The Control Center will coordinate search and rescue operations, issue notices to mariners and airmen of BOMEX operations through appropriate channels, issue heavy weather bulletins and emergency evacuation plans, maintain display boards indicating current status and maintain communications with all elements of BOMEX.

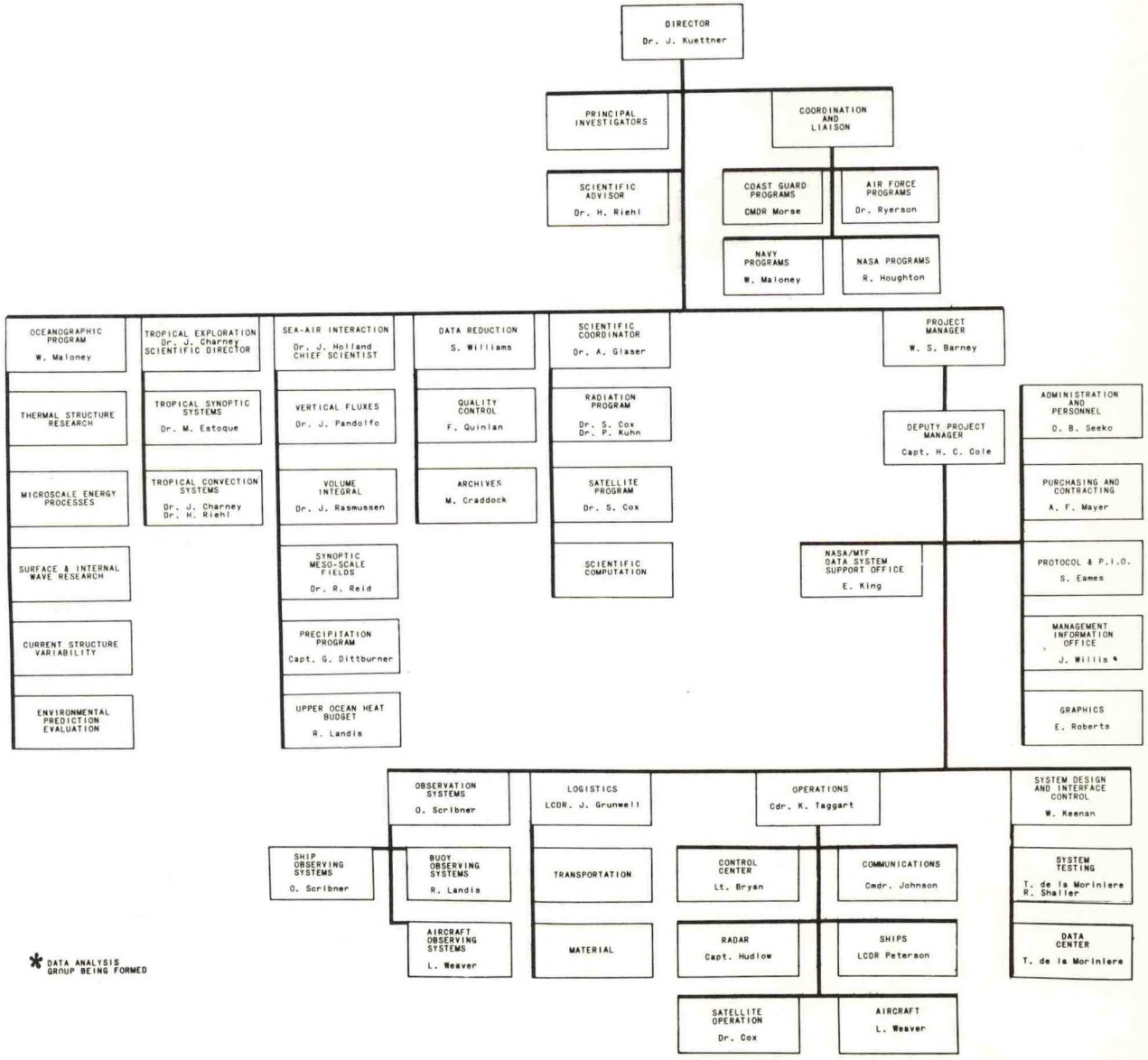
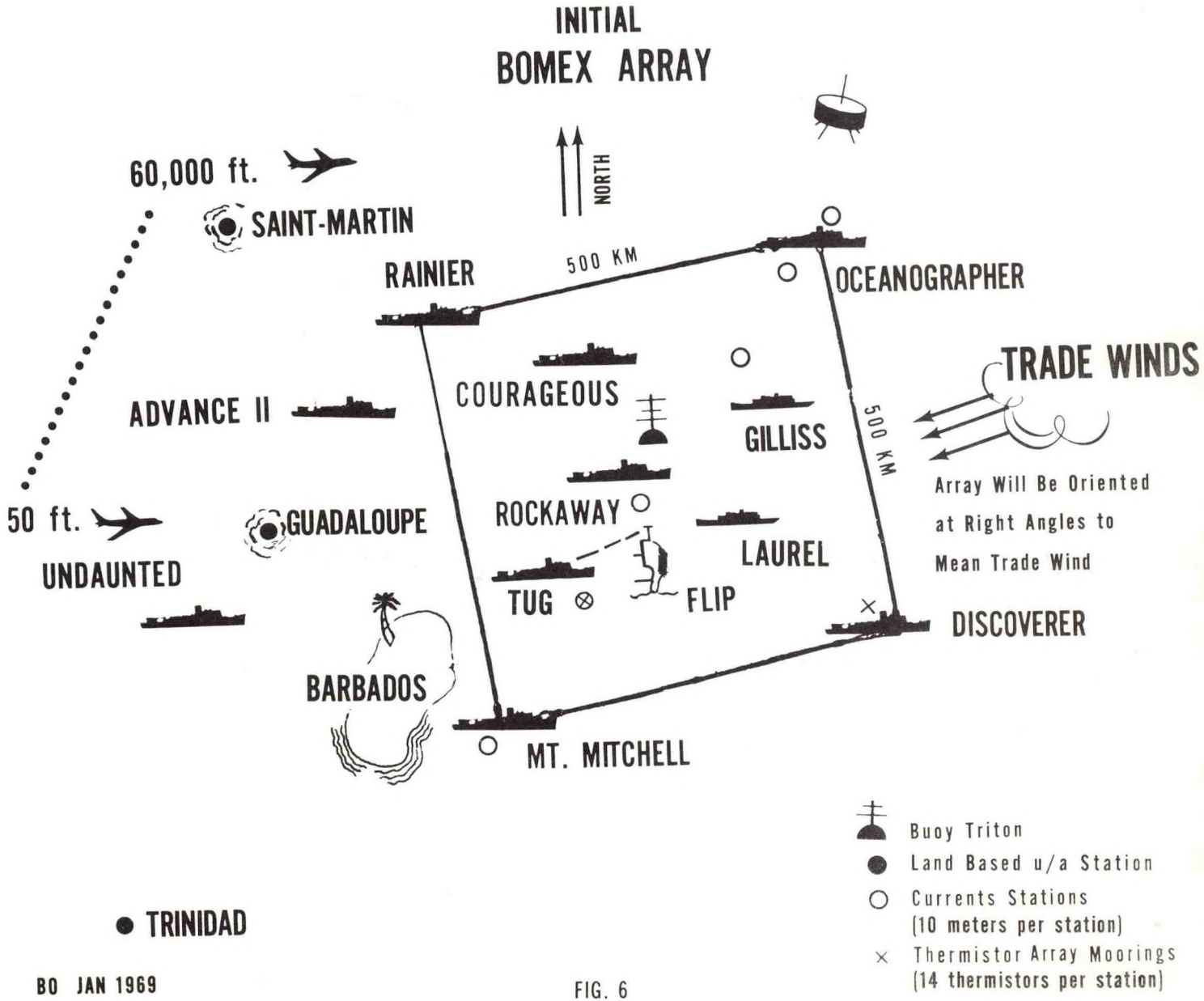

DIRECTOR
Dr. J. Kuettner
PRINCIPAL INVESTIGATORS
COORDINATION AND LIAISON
SCIENTIFIC ADVISOR
Dr. H. Riehl
COAST GUARD PROGRAMS
CMDR Morse
AIR FORCE PROGRAMS
Dr. Ryerson
NAVY PROGRAMS
W. Maloney
NASA PROGRAMS
R. Houghton
OCEANOGRAPHIC PROGRAM
W. Maloney
THERMAL STRUCTURE RESEARCH
MICROSCALE ENERGY PROCESSES
SURFACE & INTERNAL WAVE RESEARCH
CURRENT STRUCTURE VARIABILITY
ENVIRONMENTAL PREDICTION EVALUATION
TROPICAL EXPLORATION
Dr. J. Charney
SCIENTIFIC DIRECTOR
TROPICAL SYNOPTIC SYSTEMS
Dr. M. Estoque
TROPICAL CONVECTION SYSTEMS
Dr. J. Charney
Dr. H. Riehl
SEA-AIR INTERACTION
Dr. J. Holland
CHIEF SCIENTIST
VERTICAL FLUXES
Dr. J. Pandolfo
VOLUME INTEGRAL
Dr. J. Rasmussen
SYNOPTIC MESO-SCALE FIELDS
Dr. R. Reid
PRECIPITATION PROGRAM
Capt. G. Dittburner
UPPER OCEAN HEAT BUDGET
R. Landis
DATA REDUCTION
S. Williams
QUALITY CONTROL
F. Quinlan
ARCHIVES
M. Craddock
SCIENTIFIC COORDINATOR
Dr. A. Glaser
RADIATION PROGRAM
Dr. S. Cox
Dr. P. Kuhn
SATELLITE PROGRAM
Dr. S. Cox
SCIENTIFIC COMPUTATION
PROJECT MANAGER
W. S. Barney
DEPUTY PROJECT MANAGER
Capt. H. C. Cole
ADMINISTRATION AND PERSONNEL
D. B. Seeko
PURCHASING AND CONTRACTING
A. F. Mayer
NASA/MTF DATA SYSTEM SUPPORT OFFICE
E. King
PROTOCOL & P.I.O.
S. Eames
MANAGEMENT INFORMATION OFFICE
J. Willis *
GRAPHICS
E. Roberts
OBSERVATION SYSTEMS
O. Scribner
SHIP OBSERVING SYSTEMS
O. Scribner
BUOY OBSERVING SYSTEMS
R. Landis
AIRCRAFT OBSERVING SYSTEMS
L. Weaver
LOGISTICS
LCDR. J. Grunwell
TRANSPORTATION
MATERIAL
OPERATIONS
Cdr. K. Taggart
CONTROL CENTER
Lt. Bryan
RADAR
Capt. Hudlow
SATELLITE OPERATION
Dr. Cox
COMMUNICATIONS
Cmdr. Johnson
SHIPS
LCDR Peterson
AIRCRAFT
L. Weaver
SYSTEM DESIGN AND INTERFACE CONTROL
W. Keenan
SYSTEM TESTING
T. de la Moriniere
R. Shaller
DATA CENTER
T. de la Moriniere
* DATA ANALYSIS GROUP BEING FORMED

FIG. 5

4. BOMEX Ship and Buoy Array

The array of platforms and sensors which was illustrated in Bulletin No. 3 has been modified to indicate the participation of the U. S. Coast Guard Ship COURAGEOUS and the ATS-3 Satellite and is shown as Figure 6. Figure 7 is included to indicate the geographical coordinates of the fixed ships both during the first three phases and in dashed lines for the tropical exploration phase. The dates for the field phases have been given previously but will be repeated here for completeness:

a.	Phase 1	May 3 - May 15
b.	In Port	May 16 - May 23
c.	Phase 2	May 24 - June 10
d.	In Port	June 11 - June 18
e.	Phase 3	June 19 - July 2
f.	In Port	July 3 - July 10
g.	Phase 4	July 11 - July 28



BO JAN 1969

FIG. 6

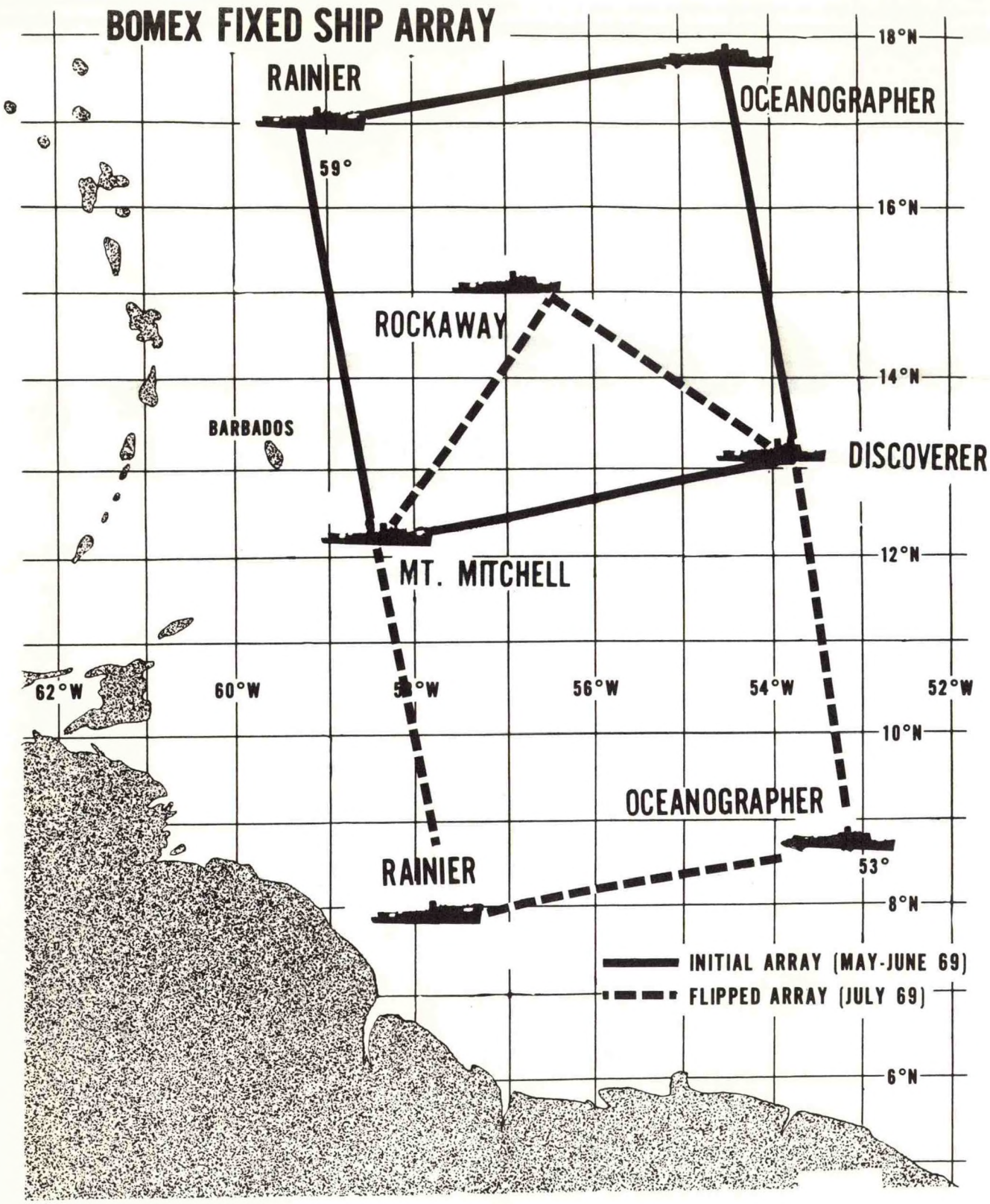

BOMEX FIXED SHIP ARRAY
RAINIER
OCEANOGRAPHER
ROCKAWAY
DISCOVERER
MT. MITCHELL
OCEANOGRAPHER
RAINIER
BARBADOS
18°N
16°N
14°N
12°N
10°N
8°N
6°N
62°W
60°W
56°W
54°W
52°W
59°
53°
INITIAL ARRAY (MAY-JUNE 69)
FLIPPED ARRAY (JULY 69)

FIG. 7

5. Aircraft Participation

ESSA's Research Flight Facility will operate four aircraft in support of BOMEX. Two DC-6 (ESSA 39C and ESSA 40C) and a DC-4 (ESSA 82) aircraft will fly special data-gathering missions as directed by daily operations order during the operational phases of BOMEX, between May 1 and July 28. In addition, one B-57 (ESSA 05) will be available after July 1.

USAF Air Weather Service will conduct weather reconnaissance missions in the BOMEX area during the operational periods, staging from Ramey Air Force Base, Puerto Rico. Sufficient aircraft will be positioned to conduct:

(1) Two WC-130B sorties daily
(2) Two WB-47 sorties daily (first and third periods)
(3) One WB-47 sortie daily (second period)
(4) One RB-57F sortie daily

Storm reconnaissance may interrupt the use of these aircraft.

U. S. Navy

(1) Weather Reconnaissance Squadron 4 will conduct weather reconnaissance missions with WC-121 aircraft in the BOMEX area during the operational periods, staging from Seawell Airport, Barbados. The resources to meet this requirement are those normally committed to fly the U.S. Weather Bureau KILO track and consist of one aircraft and one crew flying a mission every day. This resource will be subject to recall for U.S. Weather Bureau purposes in the event of intense storm activity for which reconnaissance is required.

(2) Antisubmarine Warfare Environmental Prediction Services (ASWEPS) aircraft (EC-121), staging at Seawell Airport, Barbados, will conduct oceanographic surveys of the BOMEX area according to the following schedule: May 24, 26, 28; June 18, 20.

(3) Navy Research Laboratory (NRL) aircraft (EC-121) will conduct oceanographic surveys of the BOMEX area, staging at Seawell Airport, Barbados, on May 24, 26, and 28.

BOMEX AIRCRAFT PARTICIPATION

AIRCRAFT	1 MAY-15 MAY	24 MAY - 10 JUNE	19 JUNE-2 JULY	11 JULY-28 JULY	REMARKS
DC-6 ESSA 39	X	X	X	X	WATER VAPOR, TURB., VERT. FLUX
DC-6 ESSA 40	X	X	X	X	WATER VAPOR, HORIZONTAL FLUX
DC-4 ESSA	X	X	X	X	WATER VAPOR, HORIZONTAL FLUX
B-57 ESSA				X	TROPICAL DISTURB., WIND FIELD
WC-121 NAVY	X	X	X	X	GENERAL SUPPORT, WIND FIELD
EC-121 ASWEPS		(X) 23-29 MAY	(X) 17-21 JUNE		OCEANOGRAPHIC EXPERIMENTS
EC-121 NRL		(X) 23-29 MAY			OCEANOGRAPHIC EXPERIMENTS
C-130 AWS	X	X	X	X	SAMPLING, DROPSONDE
B-57F AWS	X	X	X	X	SAMPLING, CLOUD PHOTOS.
B-47 AWS	X	X	X	X	SAMPLING, RADAR
CV990 NASA				X	MULTIPLE RADIATION EXPERIMENTS & NIMBUS III GROUND TRUTH DATA
P3A NASA		(X) 2-10 JUNE			MULTIPLE EXP., SATELLITE GROUND TRUTH
C-54 WHOI			23 JUNE-28 JULY (X)	X	TURB. VERT. FLUX
AERO. CDR. COLO. ST. U.			23 JUNE-28 JULY (X)	X	SUBCLOUD LAYER, OCEAN SURFACE
BUFFALO NCAR			X	X	TURB. VERT. FLUX
QUEEN AIR NCAR	X	X	X	X	MULTIPLE SUPPORT
DC-3 UNIV. OF CALIF.	1-30 MAY				VERT. TEMP. GROUND TRUTH OCEAN SURFACE

X = Full Time (X) = Part Time

FIG. 8

National Center for Atmospheric Research (NCAR)

(1) NCAR Queen Air N304D will conduct operations from Seawell Airport, Barbados, for the period May 1 - July 31. From May 1 to June 1, priority will be given to the Miyake sonic anemometer project.

(2) NCAR Buffalo N307D will conduct operations from Seawell Airport, Barbados, during the third and fourth period of the experiment.

National Aeronautics and Space Administration (NASA)

(1) The Goddard Space Flight Center will conduct operations with the Convair 990 in Barbados during the period July 8-31, to support NIMBUS III radiometer and spectrometer measurements and continue sea-state measurements.

(2) The Houston Manned Spacecraft Center will deploy a Lockheed Electra NP3A aircraft to Seawell Airport, Barbados, during the period June 2-10 to conduct remote-sensing missions within the BOMEX area.

Other Organizations deploying aircraft to conduct research flights within the BOMEX area are:

(1) Woods Hole Oceanographic Institution - C54G
June 20 - July 28

(2) Colorado State University - Aero Commander
May 28 - July 28

(3) University of California - DC-3
May 1 - May 30

6. Scard and Data Acquisition System Flow for Fixed Ships

NASA/MTF was given the responsibility for the design, fabrication and checkout of six (6) Signal Conditioning and Recording Devices (SCARD) and one decommutation unit (DECOMM). Five (5) SCARD units with boom signal conditioning units have been installed on the five (5) fixed ships for data acquisition from approximately 37 sensors that are being used for the BOMEX Experiment. The SCARD/DECOMM unit has been installed in the MTF/DAF facility, patched in to a Beckman 410 system in order to play back the recorded analog tape for digitizing and conversion to engineering units tape for use in scientific computations.

The BOMEX SCARD project from the start had two major constraints to overcome - TIME - 150 days to contract and deliver units for shipboard installation and limited budget.

With many of the sensor voltage outputs in the development stage and in order to accomplish the project within the time frame requirements, assumptions were made that all the sensors would input 150 MV minimum to a maximum of 5 volts DC with 200 HZ to 16 KHZ, and a requirement of 15 hours of data recording would be required. This established the criteria of obtaining an analog recorder with 1 7/8" IPS and a wide band capability of 16 KHZ. Due to manufacturers lead time in production, off the shelf developed electronic components were selected in the SCARD design.

A general description of the SCARD System is shown in Figure 8. There are two types of inputs to the system; those which are recorded continuously and those which are time and/or frequency miltiplexed and then recorded.

There are four inputs which are continuously recorded; of which three are obtained from the tethered balloon and the fourth is obtained from the STD probe. These inputs are channelized through the patch panel and onto the tape recorder tracks 3, 5, 6 and 7. The remaining 37 inputs are broken down as follows:

a) 6 inputs from radar and beacon

b) 2 inputs from ship timing

c) 10 operator originated events

d) 20 inputs of shipboard data

The six radar and beacon and one ship timing input are applied to the VCO calibrator and routed directly to the VCO's.

The ten "Events" inputs are originated by the SCARD operator and are applied to the time division miltiplexer with the twenty shipboard data inputs. These thirty channels appear as a pulse amplitude modulated wave-train at the time division miltiplexer output. This signal is then routed to its designated VCO in the frequency miltiplexer. There are ten VCO's as shown on the attached block diagram. These ten subcarrier outputs are divided into two frequency miltiplexes and recorded on tracks 1 and 2 of the recording device.

Included is a 5 volt power supply which provides the reference voltage for all the potentiometer type measurements. Its output is also applied to channels 1 and 2 of the miltiplexer from which a reference voltage and a frame synchronization are derived.

The Honeywell Tape Recorder, Model 7600, is a medium band, seven channel tape recorder on which channels 1 and 2 are used for the Data Frequency Multiplexer; channels 3, 5, and 6 are the boundary layer instrumentation outputs; channel 7 is the STD probe output; channel 4 is the reference track; and the edge track is the voice annotation channel.

The signal conditioning and recording device is housed in two rack assemblies and consists of the following equipment.

a) 1 Honeywell Model 7600 Medium Band 7 Channel

b) Tape Recorder

c) 2 VCO Summing Amplifiers

d) 10 Voltage Control Oscillators

e) 1 VCO Calibration and Data Distribution Unit

f) 1 30 Channel Time Division Miltiplexer

g) 1 Patch Panel

h) 1 5 VDC Power Supply

INSTRUMENTATION

SIGNAL INPUTS ACCEPTED BY SCARD:
ALL FM SIGNALS LEVEL 0-5V

	MEASUREMENT	SIGNAL OUTPUT	SIGNAL SOURCE
FREE BALLOON	TEMP. (DB) LOW MID REFERENCE	FM 200 HZ	RAWINSONDE
	RADIOMETER	FM 200 HZ	
	PRESSURE REFERENCE	FM 200 HZ	TRANSMITTER
	RELATIVE HUMIDITY REFERENCE	FM 200 HZ	
SHIP SYSTEMS	AZIMUTH		(RADAR) RAWINSONDE TRACKER
	20°	0-5V	
	360°	0-5V	
	SLANT RANGE	0-5V	
SHIP ATTACH-MENT	SEA SURFACE TEMPERATURE	-50MV TO 450 MV	BOOM
	TEMPERATURE DRY BULB	-50 MV TO 45 MV	
	TEMPERATURE WET BULB	-50 MV TO 450 MV	
	RELATIVE HUMIDITY	1.5V TO 5 VDC	INSTR.
	TRUE WIND VELOCITY	0-4V	
	TRUE WIND DIRECTION	0-3.75V	PKG.
	RADIATION		
	INCIDENT	0-10MV	
	NET	-0.15 TO 4MV	
SHIP SYSTEMS	RELATIVE WIND VELOCITY	0-5V	ANEMOMETER
	RELATIVE WIND DIRECTION	0-5V	VANE
	SHIP'S HEADING (TRUE)	0-5V	GYRO
	SHIP'S RELATIVE SPEED	0-5V	PITOT LOG
	SEA CURRENT (SURF.) VELOCITY DIRECTION	NOT TO BE RECORDED ON SCARD TAPE	
	SEA SURFACE TEMPERATURE	0-5V	BUCKET THERMOMETER
	TIME		TIME CODE GENERATOR
	IRIG - B1	0-5V	
	ARM - B1	0-5V	
TETHERED BALLOON	PRESSURE	FM	BLIP BOUNDARY LAYER INSTRUMENT PACKAGE
	TEMPERATURE (DB)	FM	
	TEMPERATURE (WB)	FM	
	REL. HUMIDITY	FM	
	WIND VELOCITY	FM	
	WIND DIRECTION	FM	
FISH FULLY INSTR. SUBMERS. HOUSING	DEPTH #1 SALINITY	FM	S.T.D. PROBE INSTRU. SYSTEM
	DEPTH #1 TEMPERATURE	FM	
	DEPTH #1 DEPTH	FM	
	DEPTH #1 SOUND VELOCITY	FM	
	DEPTH #2 SALINITY	FM	
	DEPTH #2 TEMP.	FM	
	DEPTH #2 DEPTH	FM	
	DEPTH #2 SOUND VELOCITY	FM	

SIGNAL COND.
SIGNAL COND.
SIGNAL COND.
SIGNAL COND.
SIGNAL COND.
SIGNAL COND.

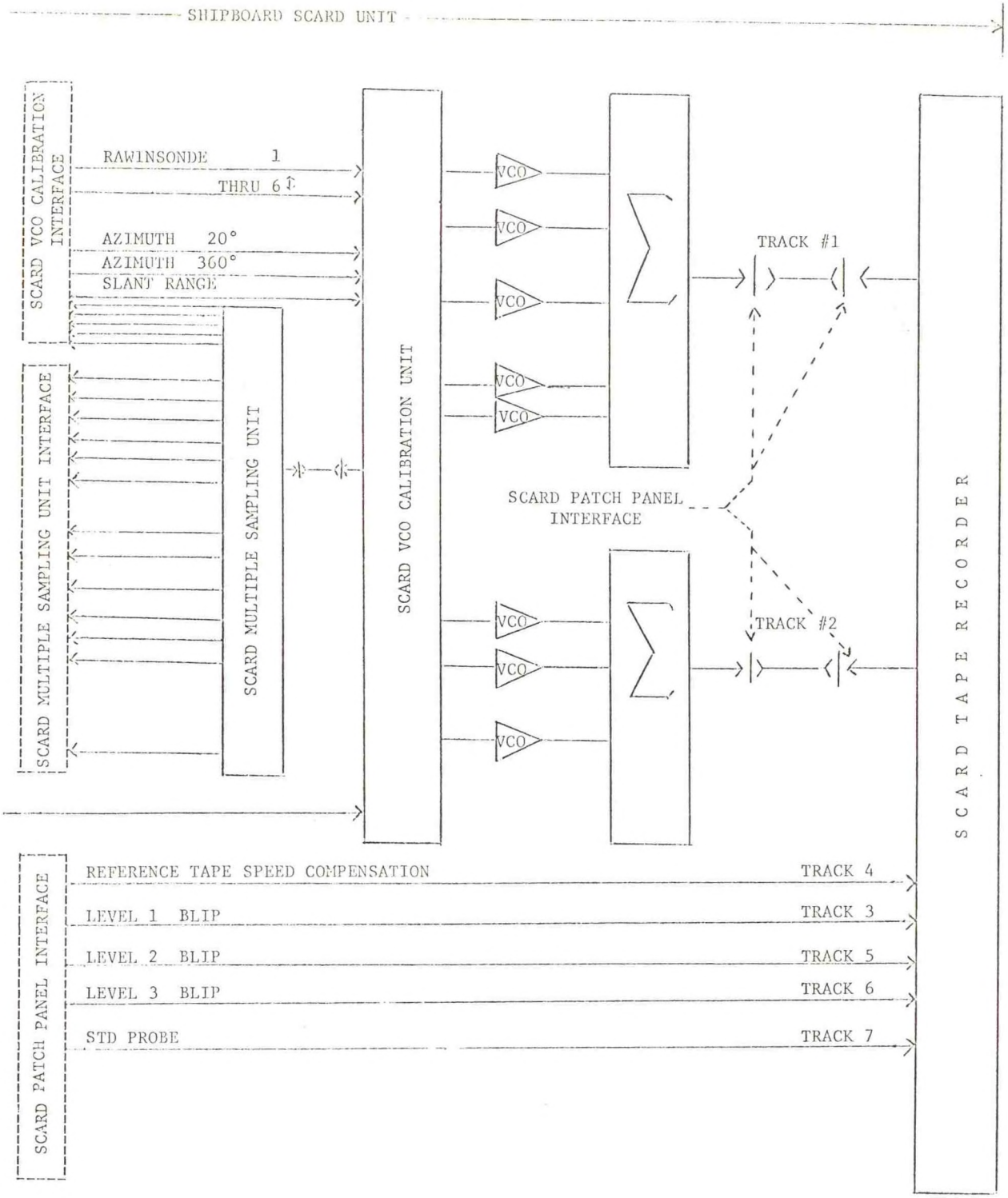
SCARD VCO CALIBRATION INTERFACE

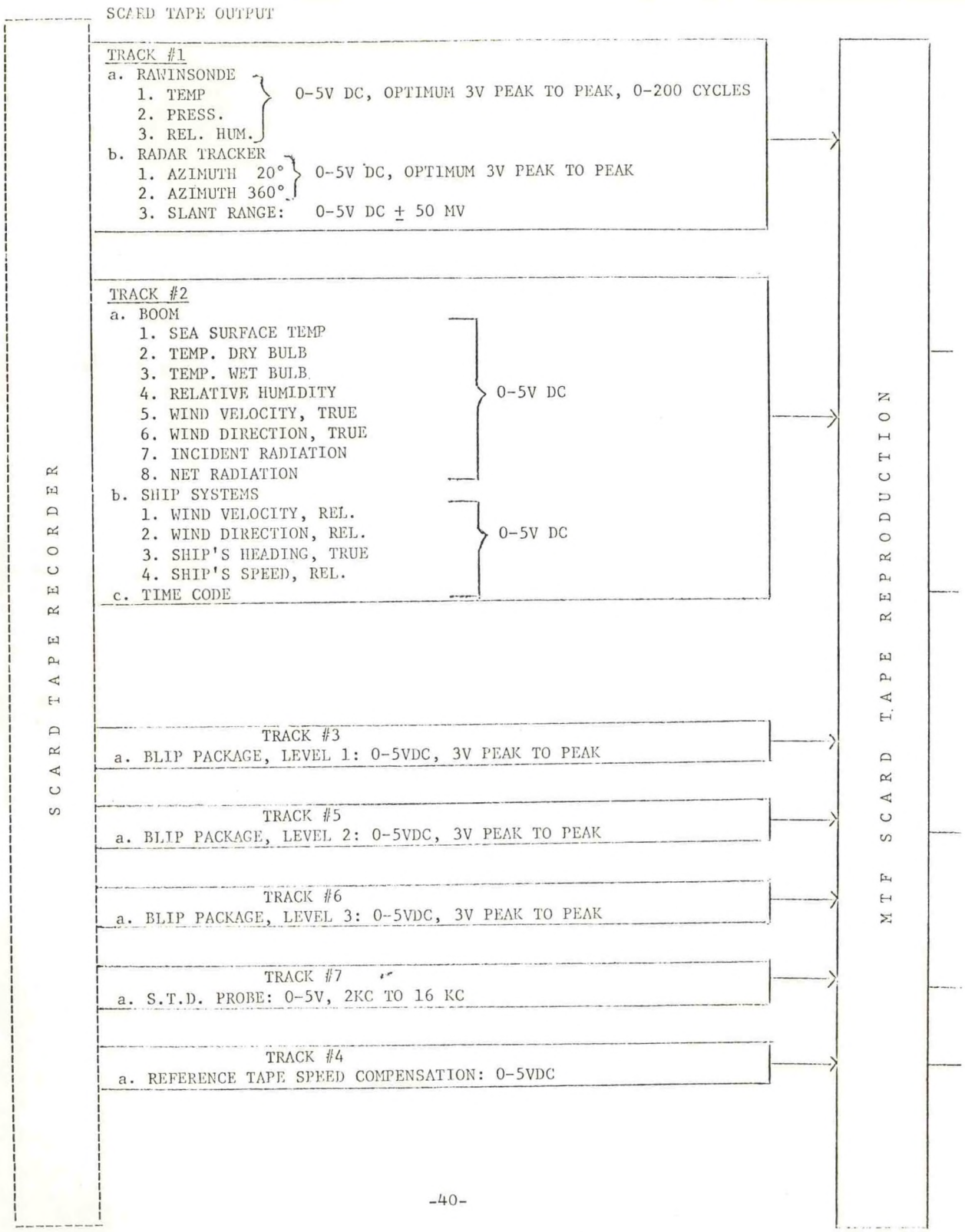
SCARD MULTIPLE SAMPLING UNIT INTERFACE

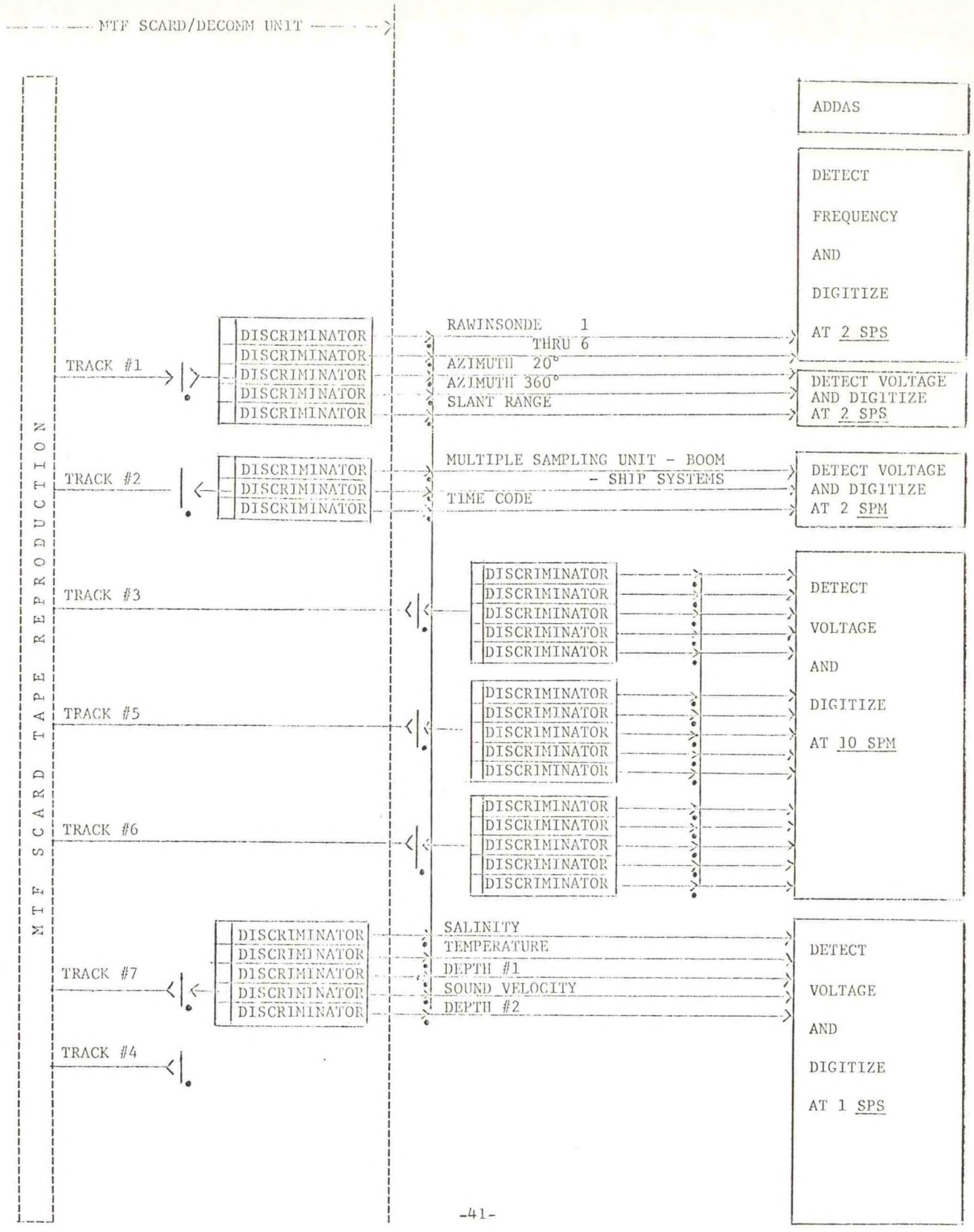
LEVEL 1 RECEIVER
LEVEL 2 RECEIVER
LEVEL 3 RECEIVER

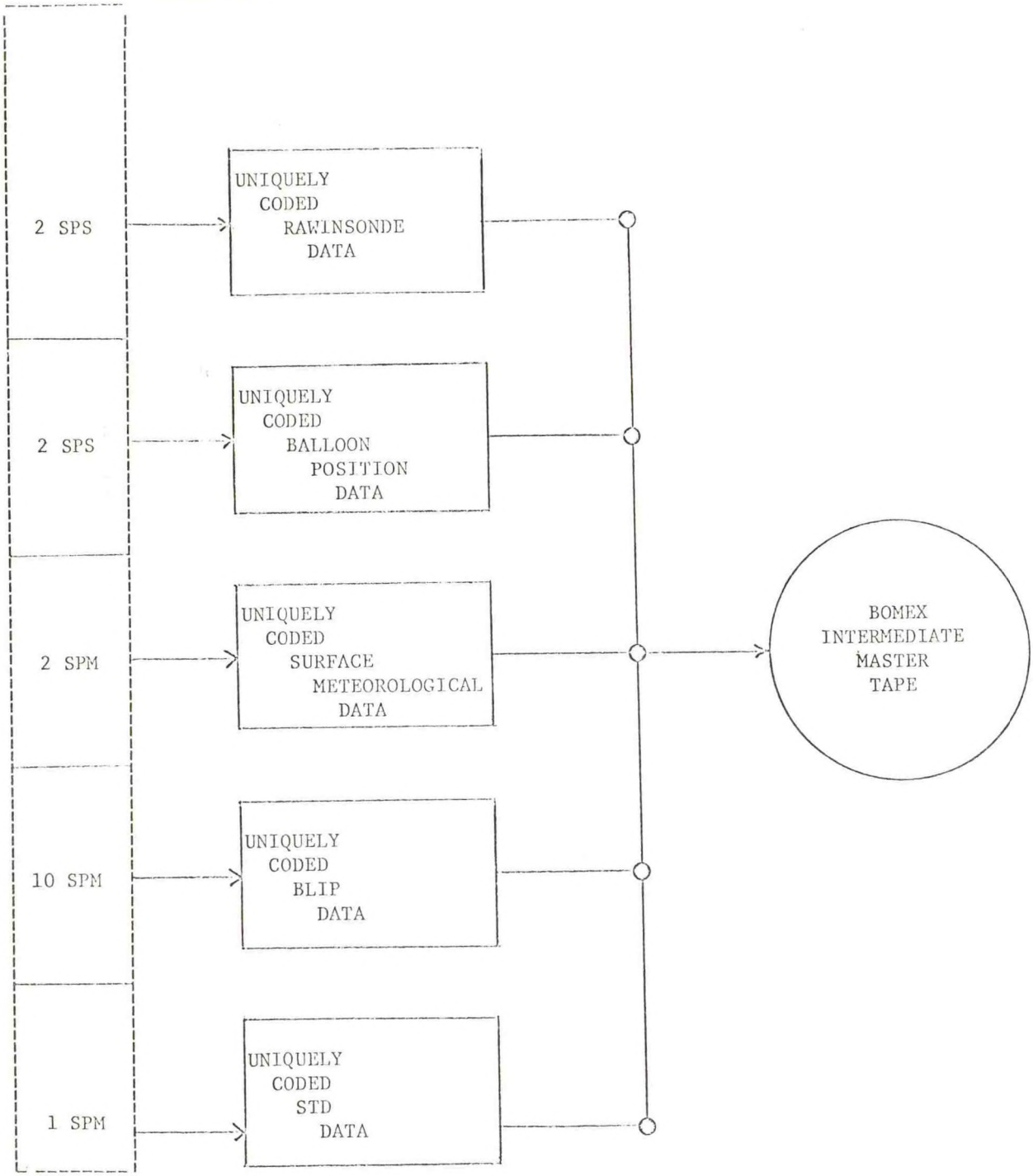
DEPTH 1
DEPTH 2

SCARD PATCH PANEL INTERFACE


SHIPBOARD SCARD UNIT
SCARD VCO CALIBRATION INTERFACE
RAWINSONDE 1
THRU 6
AZIMUTH 20°
AZIMUTH 360°
SLANT RANGE
SCARD MULTIPLE SAMPLING UNIT INTERFACE
SCARD MULTIPLE SAMPLING UNIT
SCARD VCO CALIBRATION UNIT
VCO
VCO
VCO
VCO
VCO
VCO
VCO
VCO
TRACK #1
TRACK #2
SCARD PATCH PANEL INTERFACE
SCARD TAPE RECORDER
SCARD PATCH PANEL INTERFACE
REFERENCE TAPE SPEED COMPENSATION
TRACK 4
LEVEL 1 BLIP
TRACK 3
LEVEL 2 BLIP
TRACK 5
LEVEL 3 BLIP
TRACK 6
STD PROBE
TRACK 7


SCARD TAPE OUTPUT
SCARD TAPE RECORDER
TRACK #1
a. RAWINSONDE
1. TEMP
2. PRESS.
3. REL. HUM.
0-5V DC, OPTIMUM 3V PEAK TO PEAK, 0-200 CYCLES
b. RADAR TRACKER
1. AZIMUTH 20°
2. AZIMUTH 360°
0-5V DC, OPTIMUM 3V PEAK TO PEAK
3. SLANT RANGE: 0-5V DC ± 50 MV
TRACK #2
a. BOOM
1. SEA SURFACE TEMP
2. TEMP. DRY BULB
3. TEMP. WET BULB
4. RELATIVE HUMIDITY
5. WIND VELOCITY, TRUE
6. WIND DIRECTION, TRUE
7. INCIDENT RADIATION
8. NET RADIATION
0-5V DC
b. SHIP SYSTEMS
1. WIND VELOCITY, REL.
2. WIND DIRECTION, REL.
3. SHIP'S HEADING, TRUE
4. SHIP'S SPEED, REL.
0-5V DC
c. TIME CODE
TRACK #3
a. BLIP PACKAGE, LEVEL 1: 0-5VDC, 3V PEAK TO PEAK
TRACK #5
a. BLIP PACKAGE, LEVEL 2: 0-5VDC, 3V PEAK TO PEAK
TRACK #6
a. BLIP PACKAGE, LEVEL 3: 0-5VDC, 3V PEAK TO PEAK
TRACK #7
a. S.T.D. PROBE: 0-5V, 2KC TO 16 KC
TRACK #4
a. REFERENCE TAPE SPEED COMPENSATION: 0-5VDC
MTF SCARD TAPE REPRODUCTION


MTF SCARD/DECOMM UNIT
MTF SCARD TAPE REPRODUCTION
ADDAS
DETECT FREQUENCY AND DIGITIZE AT 2 SPS
DETECT VOLTAGE AND DIGITIZE AT 2 SPS
DETECT VOLTAGE AND DIGITIZE AT 2 SPM
DETECT VOLTAGE AND DIGITIZE AT 10 SPM
DETECT VOLTAGE AND DIGITIZE AT 1 SPS
TRACK #1
TRACK #2
TRACK #3
TRACK #5
TRACK #6
TRACK #7
TRACK #4
DISCRIMINATOR
RAWINSONDE 1 THRU 6
AZIMUTH 20°
AZIMUTH 360°
SLANT RANGE
MULTIPLE SAMPLING UNIT - BOOM
- SHIP SYSTEMS
TIME CODE
SALINITY
TEMPERATURE
DEPTH #1
SOUND VELOCITY
DEPTH #2


2 SPS
2 SPS
2 SPM
10 SPM
1 SPM
UNIQUELY CODED RAWINSONDE DATA
UNIQUELY CODED BALLOON POSITION DATA
UNIQUELY CODED SURFACE METEOROLOGICAL DATA
UNIQUELY CODED BLIP DATA
UNIQUELY CODED STD DATA
BOMEX INTERMEDIATE MASTER TAPE

A P P E N D I C E S

APPENDIX 1

LIST OF EXPERIMENTS

I N D E X

AGENCY - INVESTIGATOR	EXPERIMENT DATES	EXPERIMENT NUMBER
ESSA/Environmental Research Laboratories		
Dr. B. Bean	3 May - 2 July	4
Dr. R. Crombie	2 July - 28 July	14
Dr. T. Carlson	3 May - 28 July	10
Dr. D. Hansen	3 May - 28 July	34, 50
Dr. H. Kasemir	3 May - 28 July	45
Dr. P. Kuhn	3 May - 28 July	46
Dr. B. Lettau	3 May - 28 July	53, 54
Dr. P. Ostapoff	3 May - 28 July	54
Mr. W. Shinners	3 May - 28 July	75
Dr. H. Weickmann	3 May - 28 July	84
ESSA/National Environmental Satellite Center		
Dr. E. P. McClain	3 May - 28 July	62
Dr. D. Wark	3 May - 28 July	83
ESSA/Weather Bureau		
Mr. N. Frank	19 June - 28 July	26
Fairfield University		
Dr. Callahan	3 July - 5 August	39
Florida State University		
Dr. M. Garstang	3 May - 28 July	31, 32
Dr. J. Gille	3 May - 28 July	32
Dr. Y. Hsueh	3 May - 28 July	40
Isotopes, Inc., Palo Alto Labs		
Dr. D. R. Schink	19 June - 2 July	74
Lamont-Doherty Geological Observatory		
Dr. W. Broecker	3 May - 11 June	7
Massachusetts Institute of Technology		
Dr. J. Charney	11 July - 28 July	11
Mr. A. Leetma	3 May - 11 June	52
Dr. Mollo-Christensen	pre-BOMEX	64
McGill University		
Dr. B. J. Garnier		30
Mee Industries, Inc.		
Thomas R. Mee		

AGENCY - INVESTIGATOR	EXPERIMENT DATES	EXPERIMENT NUMBER
NASA/Goddard Space Flight Center		
Miss B. Brennan	3 July - 5 August	6
Dr. J. Conaway	3 July - 5 August	12
Dr. W. Nordberg	3 July - 5 August	20
Mr. E. Hilsenrath	3 July - 5 August	36
Dr. Hovis	3 July - 5 August	39
NASA/ Manned Spacecraft Center		
Dr. D. Evans	3 July - 5 August	20
Dr. V. Whitehead	1 June - 21 June	85
NASA/Langley Research Center		
Dr. J. D. Lawrence, Jr.	19 June - 2 July	51
National Air Pollution Control Adm.		
Mr. H. C. Hamilton	19 June - 2 July	78
National Center for Atmospheric Research		
Dr. D. Lilly	15 June - 28 July	55
Naval Oceanographic Office		
Mr. L. Banchero	26 April - 5 August	2, 3
Mr. P. DeLeonibus	15 May - 2 July	16, 17
Mr. G. Hansen	17 May - 2 July	42
Dr. R. James	17 May - 2 July	42
Dr. P. Mazeika	18 May - 28 May	60
Naval Research Labs		
Dr. D. Stilwell	20 May - 28 May	80
Naval Underwater Research and Engineering Station		
Mr. G. Cook	11 July - 28 July	13
Mr. A. Massey	11 July - 28 July	59
Mr. D. Shonting	11 July - 28 July	76
Oregon State University		
Dr. S. Pond	3 May - 15 May	70
Research Triangle Institute		
Mr. J. R. Smith	19 June - 2 July	77, 78
Dr. F. M. Vukovich	19 June - 2 July	82

AGENCY - INVESTIGATOR	EXPERIMENT DATES	EXPERIMENT NUMBER
Scripps Institution of Oceanography		
Dr. R. E. Davis	2 May - 28 May	15
Dr. F. H. Fisher	2 May - 28 May	21, 22
Dr. C. H. Gibson	2 May - 28 May	33
Dr. D. D. McAlister	2 May - 30 May	61
Dr. W. A. Nierenberg	2 May - 28 May	66, 67
Dr. G. R. Stegen	2 May - 28 May	33
Stanford Research Institute		
Dr. W. Johnson	19 June - 2 July	44
Texas A & M University		
Dr. G. Franceschini	15 May - 28 May	24, 25
Travelers Research Center		
Dr. J. Pandolfo	2 May - 28 July	68, 69
U. S. Coast Guard		
Mr. A. Garcia	3 May - 2 July	29
Lt. Cdr. M. Johnson	3 May - 28 July	43
U. S. Geological Survey		
Mr. R. Alexander	1 June - 21 June	1
University of British Columbia		
Dr. M. Miyake	2 May - 30 May	63
Dr. R. Stewart	2 May - 15 May	79
University of Chicago		
Dr. T. Fujita	2 May - 28 July	28
University of Miami		
Dr. M. Estoque	11 July - 28 July	19
Dr. J. Prospero	3 May - 28 July	10
University of Michigan		
Dr. E. Monahan	19 June - 2 July	65
Dr. D. Portman	16 May - 28 May	71
University of Nevada Desert Research Institute		
Dr. J. Telford	15 June - 28 July	55

AGENCY - INVESTIGATOR	EXPERIMENT DATES	EXPERIMENT NUMBER
University of Washington		
Dr. R. Fleagle	2 May - 15 May	23
University of Wisconsin		
Dr. K. Hansen	3 May - 28 July	35
Dr. S. Cox	3 May - 28 July	35
Dr. V. Suomi	3 May - 28 July	35
Dr. T. Vonderhaar	3 May - 28 July	35
Woods Hole Oceanographic Institution		
Dr. A. Bunker	23 June - 28 July	9
Mr. R. Payne	1 July - 30 July	73
Dr. P. Saunders	1 July - 30 July	73
Yale University		
Dr. T. Foster	2 May - 28 July	21, 22

1. EXPERIMENT TITLE: Energy Exchange (Surface-Air Interaction)
PRINCIPAL INVESTIGATOR: Mr. R. Alexander, and Dr. R. Pease
AFFILIATION: U. S. Geological Survey
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: Relationships of remote sensing measurements to the study of surface energy environments and particularly to the energy transfers across the surface-air interface and to the changes induced in the local energy balance by changes in land use. To correlate remote measurements of outgoing long-wave radiation and reflected short-wave radiation with ground measurements of temperature, heat flux and reflectance at an already-established microclimatological research station in Barbados.
PRINCIPAL PLATFORMS AND SENSORS: P3A: PRT-5
SUPPLEMENTAL PLATFORMS AND SENSORS: All micrometeorological and radiation data from the Island of Barbados.

2. EXPERIMENT TITLE: Spectra of Vertical Motions as a Function of Space and Time
PRINCIPAL INVESTIGATOR: L. Banchero
AFFILIATION: NAVOCEANO
FUNDING SUPPORT: NAVOCEANO
EXPERIMENT DESCRIPTION: A spectral analysis will be conducted on two Navy temperature arrays consisting of 14 depths. The arrays will be recording over a 90-day period on a 15 to 20 minute interval.
PRINCIPAL PLATFORMS AND SENSORS: Navy Temperature Array
SUPPLEMENTAL PLATFORMS AND SENSORS: SHIPS: Surface Weather, STD's

3. EXPERIMENT TITLE: Spectra of Horizontal Motions as a Function of Space and Time to Determine Horizontal Current Scales.
PRINCIPAL INVESTIGATOR: L. Banchero
AFFILIATION: NAVOCEANO
FUNDING SUPPORT: NAVOCEANO
EXPERIMENT DESCRIPTION: The spectra of horizontal ocean currents will be determined in space and time diagonally across the BOMEX array using 6 current meter arrays of 10 current meters each. The sampling will be every 15 minutes for 90 days.
PRINCIPAL PLATFORMS AND SENSORS: Navy Current Meter Arrays
SUPPLEMENTAL PLATFORMS AND SENSORS: ALL PLATFORMS: Surface Weather; SHIPS: STD

4. EXPERIMENT TITLE: Water Vapor Flux Transport
PRINCIPAL INVESTIGATOR: Dr. Bean
AFFILIATION: ESSA/ERL
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To determine water vapor flux from an aircraft platform.
PRINCIPAL PLATFORMS AND SENSORS: DC-6: Gust probe; microwave refractometer
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

5. EXPERIMENT TITLE: Cloud Physics Experiment
PRINCIPAL INVESTIGATOR: Dr. H. Blau, Jr.
AFFILIATION: A. D. Little, Inc.
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: To make in situ measurements of cloud particle size with a laser nephelometer while flying through clouds and to then measure cloud reflectance of solar radiance at 1.7 and 2.1 microns while flying over the cloud. Results will indicate the extent to which cloud type may be determined by remote sensing from a meteorological satellite.
PRINCIPAL PLATFORMS AND SENSORS: CV-990: Nephelometer; cloud reflectance radiometer
SUPPLEMENTAL PLATFORMS AND SENSORS: All CV-990 data

6. EXPERIMENT TITLE: MRIR (Medium Resolution Infrared Radiometer)
PRINCIPAL INVESTIGATOR: Miss B. Brennan
AFFILIATION: NASA/GSFC
FUNDING SUPPORT: NASA/GSFC
EXPERIMENT DESCRIPTION: Study atmospheric interference with remote 10-11u IR surface temperature detection. Determine sea state from sun glitter to deduce surface winds. Provide 40,000 feet 10-11u measurements for BOMEX Radiation Project. Provide IR mapping for Nimbus III support and 19.4 GHz Scanning Radiometer.
PRINCIPAL PLATFORMS AND SENSORS: CV-990: Medium Resolution Infrared Radiometer (MRIR).
SUPPLEMENTAL PLATFORMS AND SENSORS: CV-990: Hygrometry

7. EXPERIMENT TITLE: Lamont Radon Experiment
PRINCIPAL INVESTIGATOR: Dr. W. Broecker
AFFILIATION: Lamont-Doherty Geological Observatory
FUNDING SUPPORT: AEC
EXPERIMENT DESCRIPTION: To measure rates of gas exchange (atmosphere-surface ocean) and rates of vertical mixing (surface ocean).
PRINCIPAL PLATFORMS AND SENSORS: ROCKAWAY: Nisken Samples and Radon Extraction system and scintillation counter
SUPPLEMENTAL PLATFORMS AND SENSORS: Wind velocity, sea state, and temperature profiles (air and sea) from ROCKAWAY.

8. EXPERIMENT TITLE: Test of Expendable Optic Dewpoint Hygrometer
PRINCIPAL INVESTIGATOR: Mr. F. Brousaides
AFFILIATION: AFCRL
FUNDING SUPPORT: AFCRL
EXPERIMENT DESCRIPTION: Side by side test with high quality conventional data sources, and to verify function in a tropical environment.
PRINCIPAL PLATFORMS AND SENSORS: Barbados: Special Rawinsondes
SUPPLEMENTAL PLATFORMS AND SENSORS: All BOMEX Grid Weather data and Rawinsondes.

9. EXPERIMENT TITLE: Trade Wind Structure and Mixing Processes During BOMEX
PRINCIPAL INVESTIGATOR: Dr. A. Bunker
AFFILIATION: WHOI
FUNDING SUPPORT: NSF/ONR
EXPERIMENT DESCRIPTION: To observe wind, temperature, humidity, clouds, turbulence, turbulent fluxes, and radiation in the boundary layer and to be analyzed in terms of the generation and dissipation of both mechanical and thermal turbulence, the transport of properties, and the modification of trade wind structure and ocean currents and structure by these transports.
PRINCIPAL PLATFORMS AND SENSORS: C-54Q: Microwave refractometer; vertical Gyro; Temperature bridge; turbulence bridge; dew point recorder, accelerometer; radiometers
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

10. EXPERIMENT TITLE: Measurements of Radon, Aitken Particles, Condensation and Freezing Nuclei
PRINCIPAL INVESTIGATOR: Dr. T. Carlson and Dr. J. Prospero
AFFILIATION: NHRL and U of Miami
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: To fix haze top altitude with respect to other meteorological parameters, especially the inversion. To determine if there is appreciable diffusion of radon out of haze layers. To measure concentration of Aitken, freezing and condensation nuclei above the haze layer.
PRINCIPAL PLATFORMS AND SENSORS: DC-6: Aerosol and Radon sampler
SHIPS: Ocean radon count
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

11. EXPERIMENT TITLE: Theory of Large Scale Atmospheric and Oceanic Processes
PRINCIPAL INVESTIGATOR: Dr. J. Charney
AFFILIATION: MIT
FUNDING SUPPORT: NSF, NCAR
EXPERIMENT DESCRIPTION: Part of a large scale study of tropical disturbance structure and the inter-tropical convergence zone will be made using the fourth BOMEX period. The ship array will be moved south 5 degrees of latitude.
PRINCIPAL PLATFORMS AND SENSORS: All ships: Rawinsondes; Blip, Boom; Islands: Rawinsondes; Aircraft: NCAR, RB-57 photos; B-47 photos, C-130 dropsondes, C121 Radar; DC-6 Weather data; Barbados: APT, WEFAX
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

12. EXPERIMENT TITLE: 19.4 GHz Scanning Radiometer and Wave Profilometer
PRINCIPAL INVESTIGATOR: Dr. J. Conaway
AFFILIATION: NASA/GSFC
FUNDING SUPPORT: NASA/ GSFC
EXPERIMENT DESCRIPTION: Mapping of microwave emission from the earths surface and atmosphere to determine, first, our ability to distinguish between precipitating and non-precipitating clouds over oceans and secondly, to determine our ability to infer the surface wind field from sea state measurements. To determine sea wave amplitude and wave length.
PRINCIPAL PLATFORMS AND SENSORS: CV-990: 19.4 HGz; Scanning Radiometer; wave profilometer (laser).
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

13. EXPERIMENT TITLE: Air-Sea Interaction: (1) Air flow over wind waves and swell; (2) Horizontal temperatures fluctuation in the surface layers of the ocean.
PRINCIPAL INVESTIGATOR: Mr. G. S. Cook
AFFILIATION: NUWR&ES
FUNDING SUPPORT: NAVY
EXPERIMENT DESCRIPTION: To determine the energy spectra and covariance function between current waves and wind while following the vertical motion of the waves. To determine the structure function between current waves and wind while following the vertical motion of waves.
PRINCIPAL PLATFORMS AND SENSORS: AESOP: Hot film anemometer; ducted meter system; wave staff system; crystal thermometer system.
SUPPLEMENTAL PLATFORMS AND SENSORS: BOMEX data of solar radiation; wind velocity, air temperature, free surface wave records, current velocity, STD, wet and dry bulb temperature.

14. EXPERIMENT TITLE: High Frequency Sea Scatter Experiment
PRINCIPAL INVESTIGATOR: Dr. D. Crombie and Mr. J. Watts
AFFILIATION: ESSA/ERL
FUNDING SUPPORT: DOD-ARPA
EXPERIMENT DESCRIPTION: To measure power spectrum, angular spectrum and phase velocities of sea waves having lengths between 100m and 7.5m by radio methods; compare the power and angular spectra with direct measurements of these quantities.
PRINCIPAL PLATFORMS AND SENSORS: BARBADOS: HF Radar
SUPPLEMENTAL PLATFORMS AND SENSORS: All platforms: sea state.

15. EXPERIMENT TITLE: Directional Spectra of Surface Waves
PRINCIPAL INVESTIGATOR: Dr. R. E. Davis
AFFILIATION: SIO
FUNDING SUPPORT: ONR
TYPE OF EXPERIMENT: Air Sea Interaction
EXPERIMENT DESCRIPTION: To obtain estimates of directional spectra of surface waves with periods between two and eight seconds. Of interest is the structure of the "fully developed" sea and the response of the sea state of variations in the wind.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Wave probe array and tiltmeters
SUPPLEMENTAL PLATFORMS AND SENSORS: Radio transmitted wave conditions from all platforms.

16. EXPERIMENT TITLE: Momentum Flux Measurements from a Ship
PRINCIPAL INVESTIGATOR: Mr. P. S. Deleonibus
AFFILIATION: NAVOCEANO
FUNDING SUPPORT: NAVOCEANO
EXPERIMENT DESCRIPTION: To compare momentum flux measurements made from the bow of a ship (USNS GILLISS) using the "Structure Function" approach against the momentum flux measurements using eddy correlation obtained from FLIP.
PRINCIPAL PLATFORMS AND SENSORS: GILLISS: 2 sensitive cup anemometers
SUPPLEMENTAL PLATFORMS AND SENSORS: FLIP: Momentum flux and Wave Height

17. EXPERIMENT TITLE: Profile of Steady-State Sea on Windward Side of Island and Limited Fetch State on Leeward Side
PRINCIPAL INVESTIGATOR: Mr. P. Deleonibus
AFFILIATION: NAVOCEANO
EXPERIMENT DESCRIPTION: A complete wave profile Map will be made of the ocean surrounding Barbados to study the effect of fetch lengths and a tropical island.
PRINCIPAL PLATFORMS AND SENSORS: ASWEPS C-121: Radar wave profiler
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

18. EXPERIMENT TITLE: Spectral Albedo Measurement Program, 180° Field of View
PRINCIPAL INVESTIGATOR: Dr. A. Drummond
AFFILIATION: Eppley Laboratory
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: Assembly of aircraft (CV-990) flight series of solar short wave incoming and outgoing flux measurements, with integral wavelength (λ>200 nm) values supplemented by filter components (λ>485, 530, 625, and 685 nm). This is a technique to separate the energy scattering effects, by gaseous molecules and aerosol from energy absorbing effects, mainly by water vapor, in the vertical atmospheric path between the aircraft observatory and the target. In this manner, the short-wave radiation budgets determined at the various aircraft locations will be augmented by the true albedo of the natural reflecting surface (in addition to that of the surface-air column system below the aircraft).
PRINCIPAL PLATFORMS AND SENSORS: CV-990: Eppley precision pyranometers model 2 (Two pair, one up, one down looking).
SUPPLEMENTAL PLATFORMS AND SENSORS: As complete information as possible of clouds above and below the aircraft and the nature of the underlying land or water surface, horizon to horizon.

19. EXPERIMENT TITLE: Study of Tropical Weather Systems During Project BOMEX
PRINCIPAL INVESTIGATOR: Dr. M. Estoque
AFFILIATION: University of Miami
FUNDING SUPPORT: NSF
EXPERIMENT DESCRIPTION: To make an observational study of the three dimensional structure of synoptic scale tropical perturbations. To use the observed data for an analysis of the budgets of energy, moisture, and other meteorological parameters. To determine from the observations the relationship between the synoptic scale perturbations and subsynoptic disturbances.
PRINCIPAL PLATFORMS AND SENSORS: AIRCRAFT: Wind Temperature, humidity, altitude, latitude, longitude, time, dropsondes; cloud photos: Radar precip; Aerosols. SHIPS: Surface Meteorology, Rawinsondes; radar precip; RN_{222}; ISLANDS: Surface Meteorology, Rawinsondes, cloud photos; Satellite: Cloud Photos
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

20. EXPERIMENT TITLE: NIMBUS III Study of Cross Section of Sea Surface Reflection
PRINCIPAL INVESTIGATOR: Mr. D. Evans, Dr. W. Nordberg
AFFILIATION: NASA/MSC, NASA/ GSFC
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: To collect data for developing satellite sensors for measuring sea surface reflection.
PRINCIPAL PLATFORMS AND SENSORS: CV-990: 13GHz Scatterometer
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

21. EXPERIMENT TITLE: Vertical Variations of Water Temperature and Sound Velocity
PRINCIPAL INVESTIGATOR: Dr. F. H. Fisher, Dr. T. D. Foster
AFFILIATION: SIO, Yale University
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: To measure profiles of temperature and sound velocity variations which will be correlated to surface conditions and surface weather.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Temperature-sound velocity profiles 0 - 2000 meters depth.
SUPPLEMENTAL PLATFORMS AND SENSORS: DC-3: IR sea temperature

22. EXPERIMENT TITLE: Vertical Variations of Current Profiles
PRINCIPAL INVESTIGATOR: Dr. F. H. Fisher, Dr. T. D. Foster
AFFILIATION: SIO, Yale University
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: The vertical variations of ocean current at a point will be determined by Doppler flow meter profiles to 300 meters. The data will be compared against other oceanographic and meteorological variability.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Doppler Flow meter from 0 - 300 meters
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

23. EXPERIMENT TITLE: Determination of the Turbulent Fluxes Near the Ocean Surface
PRINCIPAL INVESTIGATOR: Dr. R. G. Fleagle
AFFILIATION: NSF
EXPERIMENT DESCRIPTION: To measure mean profiles of wind speed, temperature and humidity in the lowest 10 meters of the atmosphere (at a fixed point). To measure direct measurements of fluxes of momentum, heat, and water vapor. To measure radiation temperature of the sea surface at the point where wave height measurements are made. Coupling between waves and wind and structure of the water surface in relation to waves and fluxes.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: roving probe of wind speed, wet and dry bulb temperature; fixed probe of wind speed, wet and dry bulb temperature; sonic anemometers, fast response thermocouple, Lyman α hygrometer, wave gauge, radiation thermometer.
SUPPLEMENTAL PLATFORMS AND SENSORS: All FLIP Data taken 2 - 16 May

24. EXPERIMENT TITLE: Radiation Balance, All-sky Photography, and Rainfall on FLIP
PRINCIPAL INVESTIGATOR: Dr. G. A. Franceschini
AFFILIATION: Texas A & M University
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: A determination of incoming and reflected solar radiation and net radiation. All-sky photographs will be taken during daylight at 1 frame per minute. Rainfall will be measured by gauge.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Upright and inverted solarimeters, and net radiometers; Kodak Super 8 camera; tipping bucket rain gauge.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

25. EXPERIMENT TITLE: Diurnal Variation of Momentum Flux
PRINCIPAL INVESTIGATOR: Dr. G. A. Franceschini
AFFILIATION: Texas A & M University
FUNDING SUPPORT: NSF
EXPERIMENT DESCRIPTION: To determine momentum flux by means of the structure function of turbulence using two hot-wire anemometers spaced 1 meter apart in the horizontal and a third centrally located hot-wire. Sensors mounted at a level approximately 10 meters above the surface.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Three hot-wire anemometers
SUPPLEMENTAL PLATFORMS AND SENSORS: Barograph

26. EXPERIMENT TITLE: Exploration of Inverted V Cloud Patterns in the Central North Atlantic Ocean
PRINCIPAL INVESTIGATOR: Mr. N. Frank
AFFILIATION: National Hurricane Center
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: (1) Determine the change in circulation structure of waves as they move westward across the Atlantic; (2) determine whether the cloud bands which form the Inverted V cloud pattern reflect the streamline pattern in the layer of maximum wave amplitude (around 10,000 feet); (3) determine the distribution of cloudiness and weather about the wave axis, and (4) determine whether satellite pictures can be used to assess changes in the shear velocity in the friction layer and to relate this to tropical storm development.
PRINCIPAL PLATFORMS AND SENSORS: Aircraft: Cloud Photos; Radar; Winds; Temperatures; Humidity.
SUPPLEMENTAL PLATFORMS AND SENSORS: Satellite pictures.

27. EXPERIMENT TITLE: Energy Dissipation in the Boundary Layer
PRINCIPAL INVESTIGATOR: Dr. P. Frenzen
AFFILIATION: AEC - Argonne National Labs
FUNDING SUPPORT: AEC
EXPERIMENT DESCRIPTION: A stable operating platform will be used at various points in the BOMEX array for 1 to 2 day durations. Momentum Flux and Heat Flux will be computed from fluctuations of temperature, horizontal wind, and vertical wind.
PRINCIPAL PLATFORMS AND SENSORS: SAESOP: Two 6 cup anemometers, two wind propellars, two resistance thermometers.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

28. EXPERIMENT TITLE: Satellite and Terrestial Photogrammetric Study of Clouds over the Area of BOMEX
PRINCIPAL INVESTIGATOR: Dr. T. Fujita
AFFILIATION: University of Chicago
FUNDING SUPPORT: NSF, ESSA, NASA
EXPERIMENT DESCRIPTION: To study the formation and movement of nephsystems on and around the island of Barbados in mid summer. To study the relationship between cloud features and mesoscale characteristics of the atmosphere at the same time the vertical flux of momentum in relation to the cloud velocity will be classified by attempting to estimate the momentum flux from velocities of clouds with varying sizes and vertical extent. To determine the change in color of clouds near the terminator of sunrise and sunset. To study the effect of a relatively low island upon the natural modification of trade wind cumuli due mainly to the heating and cooling of the island.
PRINCIPAL PLATFORMS AND SENSORS: Barbados: ATS III: 2 16mm time lapse cameras with horizontal optical axis; 2 wide angle cameras 16mm time lapse vertical optic axis; 2 35mm teleophoto cameras; 2 infrared 35mm cameras.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

29. EXPERIMENT TITLE: Current Trajectories in BOMEX for Search and Rescue
PRINCIPAL INVESTIGATOR: A. Garcia
AFFILIATION: Coast Guard Oceanographic Unit
FUNDING SUPPORT: Coast Guard
EXPERIMENT DESCRIPTION: To determine the trajectories of a solely current driven drifting object and a quasi-current driven, wind influenced, free drifting object. An attempt will be made to ascertain the correlation between the velocities of the prevailing winds and surface currents present in the region and the trajectories of the drifting object.
PRINCIPAL PLATFORMS AND SENSORS: COURAGEOUS: Parachute drogues; survival craft, radar positions
SUPPLEMENTAL PLATFORMS AND SENSORS: SHIPS: Surface winds, Navy current meter array.

30. EXPERIMENT TITLE: Energy Budget of Barbados
PRINCIPAL INVESTIGATOR: Dr. B. J. Garnier
AFFILIATION: McGill University
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: To test the value of remote sensing apparatus and to try to improve knowledge of the spatial variations in the energy budget of Barbados.
PRINCIPAL PLATFORMS AND SENSORS: BARBADOS: Two 7 level thermistors, 4 net radiometers, two soil heat flux recorders, two Kipps, four bi-metallic actinographs, two mercury in steel distance thermographs, thermohygrographs, two PRT-5, two PRT-10.
SUPPLEMENTAL PLATFORMS AND SENSORS: All data from Barnes Engineering Aircraft.

31. EXPERIMENT TITLE: Synoptic Scale Energy Fluxes Between Tropical Oceans and Atmosphere
PRINCIPAL INVESTIGATOR: Dr. M. Garstang
AFFILIATION: FSU
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To determine the fluxes of momentum, heat and water vapor across the open tropical air-sea interface, the three dimensional wave spectra at a single open tropical ocean site, the turbulent structure of the sub-cloud layer at a single open tropical ocean site, and the surface current and direction at a single point in the open tropical ocean. To relate the energy fluxes at the interface to diurnal variations, the energy fluxes at the interface to turbulent processes in the sub-cloud layer, convective scale organization in the cloud layer to synoptic scale and planetary scale motions of the tropical atmosphere the energy fluxes as the interface to the generation maintenance and dissipation of wind wave fields and to correlate these with the time series of current measurements, the turbulent structure in the sub-cloud region to interface processes and to convective meso-, synoptic and planetary scales of motion, the energy fluxes through the interface and the sub-cloud layer to similar measurements being made within the BOMEX array to attempt to determine horizontal flux of energy through the sub-cloud volume; to utilize this information to attempt to obtain estimates of the dependence of the exchange coefficients for water vapor heat and momentum upon height, and the open ocean measurements to measurements based upon the island of Barbados with particular reference to the determination of the functional dependence of the exchange coefficient upon height.
PRINCIPAL PLATFORMS AND SENSORS: TRITON: Rain Gauge (11M), wind speed (2 and 10M) wind direction (10M) dry & wet bulb temperature (2&10M) wave HT, sonic anemometer (6M), water temperature (2M), water column pressure (3M), current velocity (10, 30, 50M), Buoy orientation, buoy inclination, Buoy acceleration. ROCKAWAY: SITS (BLIP) (100, 300, and 600M).
SUPPLEMENTAL PLATFORMS AND SENSORS: BOMEX BLIP, Gust Probe, and rawinsonde data.

32. EXPERIMENT TITLE: Radiative Balances and Fluxes in the Tropics
PRINCIPAL INVESTIGATOR: Dr. M. Garstang, Dr. J. Gille
AFFILIATION: FSU
FUNDING SUPPORT: NSF
EXPERIMENT DESCRIPTION: To obtain valid surface measurements of upward and downward short and long wave fluxes at location on land and sea. To determine whether heating rates as measured by thermometry can be equated theoretically and observationally to radiative heating in the boundary layer. To attempt to establish the heating rates in the free atmosphere.
PRINCIPAL PLATFORMS AND SENSORS: Barbados: Net radiometers, short wave and albedometers
SUPPLEMENTAL PLATFORMS AND SENSORS: Surface radiative measurements and radiometersondes from each ship.

33. EXPERIMENT TITLE: Direct Dissipation Measurement
PRINCIPAL INVESTIGATOR: Dr. C. H. Gibson - Dr. G. R. Stegen
AFFILIATION: University of California
FUNDING SUPPORT: ONR - Themis
EXPERIMENT DESCRIPTION: Precise inferrence of momentum flux. Test of log - normality theories of Kolomogoroff and yaglom. Extend previous dissipation profile measurements from FLIP. Reynolds stress measurement, heat flux, and structure function.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Linear constant temperature anemometer; Wave Probe; x wire probes; Thermistor: cold wires; separated hot wires, water measurements with hot film probes and thermistor.
SUPPLEMENTAL PLATFORMS AND SENSORS: FLIP: Cup Anemometer mean velocity.

34. EXPERIMENT TITLE: BOMEX STD Program
PRINCIPAL INVESTIGATOR: Dr. D. V. Hansen
AFFILIATION: ESSA/AOL
FUNDING SUPPORT: ESSA
TYPE OF EXPERIMENT: Oceanographic
EXPERIMENT DESCRIPTION: The variability in the oceanographic conditions, especially as they may be revealed as baroclinic planetary waves in the BOMEX study area.
PRINCIPAL PLATFORMS AND SENSORS: SHIPS: STD ISLAND: Tide gauges
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

35. EXPERIMENT TITLE: Wisconsin Atmospheric Radiation Divergence Study (Wards)
PRINCIPAL INVESTIGATOR: K. Hansen, Dr. S. Cox, Dr. V. Suomi, Dr. T. Vonderhaar
AFFILIATION: University of Wisconsin
FUNDING SUPPORT: ESSA, NSF
EXPERIMENT DESCRIPTION: To measure short wave and infrared radiation divergence in the atmosphere and ultimately parameterize the radiative divergence as a function of satellite - observed brighteners patterns.
PRINCIPAL PLATFORMS AND SENSORS: DC-4: 2 Pyranometers, DC-6's: 2 Pyranometers, Queen Air 150: 2 pyranometers, Buffalo: 2 Pyranometers
SUPPLEMENTAL PLATFORMS AND SENSORS: Aircraft: Cloud photography, position, speed, altitude, observer notes, temperature and moisture at aircraft level, liquid water content, ATS III: photography, SHIPS: Rawinsondes.

36. EXPERIMENT TITLE: In Situ Water Vapor Measurements by Means of an Aluminum Oxide.
PRINCIPAL INVESTIGATOR: Mr. E. Hilsenrath
AFFILIATION: NASA/GSFC
FUNDING SUPPORT: NASA/GSFC
EXPERIMENT DESCRIPTION: To evaluate a new type of hygrometer and support other BOMEX experiments with water vapor data.
PRINCIPAL PLATFORMS AND SENSORS: CV-990: AL_2O_3 Hygrometer
SUPPLEMENTAL PLATFORMS AND SENSORS: Synoptic Charts to 300 mb and Ships: Radiosondes

37. EXPERIMENT TITLE: Basic Synotpic Scale Water Vapor Budget
PRINCIPAL INVESTIGATOR: Dr. J. Holland
AFFILIATION: BOMEX Project Office
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: A water vapor budget will be computed from the amount of water vapor passing through the upper boundary, a volume integral of water vapor inside the ship array, precipitation into the sea, and evaporation from the sea.
PRINCIPAL PLATFORMS AND SENSORS: SHIPS: Rawinsonde, Radar, Boom, rain gauge; AIRCRAFT: Dropsonde, spiral soundings, radar cloud photographs
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

38. EXPERIMENT TITLE: Line Integral Method of Determining Water Vapor Divergence
PRINCIPAL INVESTIGATOR: Dr. Joshua Holland
AFFILIATION: BPO
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To determine the divergence of water vapor and heat from the BOMEX array area by application of line integration techniques.
PRINCIPAL PLATFORMS AND SENSORS: SHIPS: Rawinsondes, Blip; AIRCRAFT: Doppler, Thermometer, humidity sensor, dropsondes
SUPPLEMENTAL PLATFORMS AND SENSORS: Area precipitation estimates (Gauges, radar, visual, satellite, surface salinity, Be-7).

39. EXPERIMENT TITLE: NIMBUS III Study of Atmospheric Spectral Radiance in 8 to 16 Micron Region
PRINCIPAL INVESTIGATOR: Dr. Hovis, Dr. Callahan
AFFILIATION: NASA/GSFC, Fairfield University
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: To collect for development of satellite sensors for measurements of atmospheric spectral radiances.
PRINCIPAL PLATFORMS AND SENSORS: CV-990: Cyrogenic cooled detector.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

40. EXPERIMENT TITLE: Mesoscale Structures in the Boundary Layer
PRINCIPAL INVESTIGATOR: Dr. Y. Hsueh
AFFILIATION: FSU
FUNDING SUPPORT: DOD (Themis)
EXPERIMENT DESCRIPTION: To investigate the meso-scale structure of the tropical atmosphere in the absence of disturbances and to analyze the multi-scale scale structure of tropical atmosphere dynamics. To examine doppler wind and supporting meteorological measurements for evidence of meso-scale eddys in the planetary boundary layer geometry of the eddys with respect to the mean flow, variation of eddy characteristics with height, and correlation of the fluctuating winds to the large-scale wind shear will be examined.
PRINCIPAL PLATFORMS AND SENSORS: QUEEN AIR: Doppler wind; Temperature, humidity.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

41. EXPERIMENT TITLE: Ocean Environmental Effects on Surface Schooling Tuna
PRINCIPAL INVESTIGATOR: Dr. M. Ingham
AFFILIATION: Bureau of Commercial Fisheries
FUNDING SUPPORT: Bureau of Commercial Fisheries
EXPERIMENT DESCRIPTION: A survey will be conducted west of the Antilles and with the primary objective of defining the oceanic eddy field. A second survey will be undertaken to determine the relation of surface schooling tuna to the eddy field. Data will be collected to investigate the dynamics of the eddy field west of St. Vincent and St. Lucia.
PRINCIPAL PLATFORMS AND SENSORS: R/V UNDAUNTED, STD and standard surface meteorological sensors.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

42. EXPERIMENT TITLE: Oceanic Thermal Structure Prediction
PRINCIPAL INVESTIGATOR: Dr. R. W. James, G. L. Hansen
AFFILIATION: NAVOCEANO
FUNDING SUPPORT: NAVOCEANO
EXPERIMENT DESCRIPTION: Evaluate our ability to predict the oceanic thermal structure using present techniques for computing air-sea interface processes. To study microscale thermal structure pattern in vicinity of an island. To provide wave forecasts for BOMEX.
PRINCIPAL PLATFORMS AND SENSORS: ASWEPS C121 Aircraft: ART, AXBT. All Ships: synoptic STD and Surface temperature messages. Barbados: Weather Fax
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

43. EXPERIMENT TITLE: ATS III Meteorological and Oceanic Communications Experiment.
PRINCIPAL INVESTIGATOR: Lt. Cdr. M. R. Johnson
AFFILIATION: U. S. Coast Guard
FUNDING SUPPORT: Coast Guard - NASA - ESSA
EXPERIMENT DESCRIPTION: To measure field strength received at ROCKAWAY from ATS III VHF link in cooperation with NASA evaluation group. To test and evaluate remotely interrograted key board data entry set provided by the Weather Bureau. To test teletype transmission and to perform side by side comparison of error rates with direct HF transmission. To explore the use of satellite communications for future global meteorological and oceanographic experiments.
PRINCIPAL PLATFORMS AND SENSORS: ROCKAWAY: VHF transceiver, Keyboard data set, Radio teletype, voice terminal. Rosman, NC: Interrogation generator, Radio teletype, Voice terminal. Barbados: Radio Teletype, Voice terminal.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

44. EXPERIMENT TITLE: Lidar Measurements During BOMEX
PRINCIPAL INVESTIGATOR: Dr. W. Johnson
AFFILIATION: Stanford Research Institute
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: The experiment will attempt to document the from ruby lidar measurements, height and relative scattering profiles of the boundary haze layer.
PRINCIPAL PLATFORMS AND SENSORS: C-130: Mark V Lidar
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

45. EXPERIMENT TITLE: Atmospheric Electric Field and Current Measurement
PRINCIPAL INVESTIGATOR: Dr. H. W. Kasemir
AFFILIATION: ESSA/ERL
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: Determination of the global variation of atmospheric field and current over the ocean.
PRINCIPAL PLATFORMS AND SENSORS: DISCOVERER: Field mill and current screen mounted on flying bridge.
SUPPLEMENTAL PLATFORMS AND SENSORS: Meteorological measurements from shipboard, including wind and precipitation.

46. EXPERIMENT TITLE: Radiation Experiment, (Sea-Air Interface and Atmospheric)
PRINCIPAL INVESTIGATOR: Dr. P. Kuhn
AFFILIATION: ESSA/ERL
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: Determine solar, total and IR radiation budget at interface and in atmosphere as a function of weather systems, sky cover, sea state, daily cycle, corrective activity onset and suppression, and atmospheric stability. Part of the radiation experiment results are to be used in the core heat budget. Correlation with measurements made by NASA CV-990 near the tropopause.
PRINCIPAL PLATFORMS AND SENSORS: CV-990: Cirrus Cloud radiometer NIMBUS III: Cirrus Cloud radiometer, Ships: Radiometersonde, pyranometer, "bucket" temp., sea state, net radiometer, RFF: Radiometers, Barbados: Radiometers, pyranometer radiometersondes
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

47. EXPERIMENT TITLE: Tropical cloud Streets
PRINCIPAL INVESTIGATOR: Dr. J. Kuettner
AFFILIATION: BOMEX Project Office
EXPERIMENT DESCRIPTION: Observation of cloud streets from surface, air and space. Determination of circulation pattern, wind profiles, orientation and spacing.
PRINCIPAL PLATFORMS AND SENSORS: Photographs from ships, B-57F, ESSA, NIMBUS and ATS satellites. Vertical and horizontal wind measurements from RFF DC-6. Rawinsoundings from ships and spiral soundings from RFF aircraft.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

48. EXPERIMENT TITLE: Giant convection Cells in the Tropical Atmosphere
PRINCIPAL INVESTIGATOR: Dr. J. Kuettner
AFFILIATION: BOMEX Project Office
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: The generation and decay of giant convection cells over the tropical Atlantic will be studied based on high resolution continuous satellite pictures.
PRINCIPAL PLATFORMS AND SENSORS: ATS III spin camera and NIMBUS B-2 DRIR
SUPPLEMENTAL PLATFORMS AND SENSORS: Aircraft Doppler winds and cloud cameras

49. EXPERIMENT TITLE: Persistence of Tropical Ocean Heat Content in the Mixed Layer
PRINCIPAL INVESTIGATOR: R. Landis: BOMEX Project Office
AFFILIATION: THE MITRE Corporation
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To adequately measure the thermal structure of the tropical ocean in an area of net westerly transport in order to determine the amount of persistence of the ocean's heat content in the mixed layer. To relate changes in the ocean's thermal structure to meso and synoptic scale atmospheric disturbances. To determine the downstream long period heating of the tropical ocean during summer months. To compute geostrophic ocean currents and compare to movement of meso-scale ocean systems. To relate mixed layer depths to convective, meso and synoptic scale atmospheric systems. To determine areas of hurricane formation (deep hot spots) in the BOMEX area.
PRINCIPAL PLATFORMS AND SENSORS: SHIPS: STD's
SUPPLEMENTAL PLATFORMS AND SENSORS: Net solar radiation at sea surface and surface weather from all platforms.

50. EXPERIMENT TITLE: Basic Energy Budget
PRINCIPAL INVESTIGATOR: Mr. R. Landis, Dr. D. Hansen
AFFILIATION: BOMEX Project Office, AOL
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: Loss or gain of sensible heat in the upper layer of the ocean will be compared with net outgoing or incoming radiation. Corrections may be necessary for heat loss by evaporation and advection of heat by ocean currents.
PRINCIPAL PLATFORMS AND SENSORS: SHIPS: STD, Radiometers
SUPPLEMENTAL PLATFORMS AND SENSORS: Current meters on ships and buoys.

51. EXPERIMENT TITLE: Laser Radar Investigations of the Marine Atmosphere
PRINCIPAL INVESTIGATOR: Dr. J. D. Lawrence, Jr.
AFFILIATION: NASA/LANGLEY Research Center
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: To measure the spatial distribution of salt particles and other aerosols over the ocean, and to examine their effect on satellite measurements of sea surface temperature. To measure the reflectivity and transmissivity of cloud systems and this moisture layers over the ocean, and to examine their effect on satellite measurements of surface temperature. To measure the latitudinal distribution of stratospheric aerosol. To explore the feasibility of using laser radar to prove the ocean.
PRINCIPAL PLATFORMS AND SENSORS: ADVANCE II: Laser system with 60 inch collector and 12 inch collector, particle sampler.
SUPPLEMENTAL PLATFORMS AND SENSORS: Rawinsondes BOMEX grid, airborn particulate sampling.

52. EXPERIMENT TITLE: Near Surface Current Variations
PRINCIPAL INVESTIGATOR: Mr. A. Leetmaa
AFFILIATION: MIT
FUNDING SUPPORT: NSF
EXPERIMENT DESCRIPTION: To obtain measurements of velocity profiles in the oceanic Ekman layer of the trades.
PRINCIPAL PLATFORMS AND SENSORS: OCEANOGRAPHER: Two Braincon #252 Current Meters
SUPPLEMENTAL PLATFORMS AND SENSORS: OCEANOGRAPHER: STD, Wind Velocity

53. EXPERIMENT TITLE: Mesoscale Cloud System Study
PRINCIPAL INVESTIGATOR: Dr. B. Lettau
AFFILIATION: ESSA/SAIL
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To study the spatial distribution of cumliform clouds as a function of the sea surface temperature and the structure of the atmospheric boundary layer.
PRINCIPAL PLATFORMS AND SENSORS: P3A: IR Sea surface Scanner, cloud photography; RFF: IR Sea surface Scanner, photography
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

54. EXPERIMENT TITLE: Basic Large-Scale Energy Transfer
PRINCIPAL INVESTIGATOR: Dr. B. Lettau, Mr. F. Ostapoff
AFFILIATION: ESSA/SAIL
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To determine accurately the transfer of energy from the sea surface to the atmosphere, and to attempt to parameterize the magnitude of such transfers in terms of easily measured variables
PRINCIPAL PLATFORMS AND SENSORS: SHIPS: BOOM, BLIP, Rawinsondes, STD, Surface Weather
SUPPLEMENTAL PLATFORMS AND SENSORS: AIRCRAFT: Dropsondes, ISLANDS: Surface Weather

55. EXPERIMENT TITLE: Planetary Boundary Layer Turbulence Experiment
PRINCIPAL INVESTIGATOR: Dr. D.K. Lilly & Dr. J. Telford
AFFILIATION: NCAR & DRI
FUNDING SUPPORT: NSF
EXPERIMENT DESCRIPTION: To measure heat, momentum and moisture fluxes, and determine the nature of the large eddies in the planetary boundary layer to the extent possible with a newly installed platform and auxiliary equipment.
PRINCIPAL PLATFORMS AND SENSORS: BUFFALO: Rosemont Temperature probe; Tungsten resistance wire element (air temperature); dewpoint hygrometer; aircraft heading; GPL doppler APN-153V (Ground speed and drift angle); pace pressure transducer; ball variometer (Pressure change); air speed; angles of attack; wet and dry bulb thermistor (wet bulb depression); pyranometer (one up and one down).
SUPPLEMENTAL PLATFORMS AND SENSORS: Rawinsondes; DC-6 Gust probe; Queen Air sonic anemometer.

56. EXPERIMENT TITLE: NIMBUS III study of various environmental parameters
PRINCIPAL INVESTIGATOR: Dr. Marlatt
AFFILIATION: CSU
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: To collect data for development of satellite sensors for measuring various environmental parameters
PRINCIPAL PLATFORMS AND SENSORS: CV-990: Ambient temperature, altitude, heading, speed Doppler, and altitude deviation.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE.

57. EXPERIMENT TITLE: NIMBUS III study of Aerosol Distribution
PRINCIPAL INVESTIGATOR: Dr. Marlatt
AFFILIATION: CSU
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: To collect data for the development of s atellite sensors for measuring aerosols.
PRINCIPAL PLATFORMS AND SENSORS: CV-990: Aerosol sampler
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

58. EXPERIMENT TITLE: Measurement and Interpretation of the Sea-Surface and Air Temperature Gradients in the Sub-Cloud Layer During BOMEX
PRINCIPAL INVESTIGATOR: Dr. W. E. Marlatt, Dr. W. M. Gray
AFFILIATION: Colorado State University, CSU
FUNDING SUPPORT: NSF
EXPERIMENT DESCRIPTION: The experiment will be a micro and meso scale investigation of the variations of sea-surface and sub-cloud layer horizontal and vertical temperature gradients in relation to the Ekman or frictional veering of the wind in the sub-cloud layer.
PRINCIPAL PLATFORMS AND SENSORS: Aero Commander: IR sea temperature; air temperature; moisture; radar.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

59. EXPERIMENT TITLE: Measurements of Rate of Dissipation of Energy in the Ocean
PRINCIPAL INVESTIGATOR: A. T. Massey
AFFILIATION: NUWR&ES
FUNDING SUPPORT: NUWR&ES
EXPERIMENT DESCRIPTION: To determine the rate of dissipation of energy by viscosity as a function of depth in the mixed surface layer of the ocean.
PRINCIPAL PLATFORMS AND SENSORS: GILLIS: Current Meter, Bourns Potentiometer, Pitot Static probe.
SUPPLEMENTAL PLATFORMS AND SENSORS: GILLIS: Bucket Temperature, Sea State, XBT.

60. EXPERIMENT TITLE: Navy Ocean Variability Studies East of Barbados
PRINCIPAL INVESTIGATOR: Dr. P. Mazeika
AFFILIATION: NAVOCEANO
FUNDING SUPPORT: NAVOCEANO
EXPERIMENT DESCRIPTION: Time series measurements of currents and thermal structure will be used to investigate; (1) latitudinal and vertical variation of spectral properties, (2) relative amounts of spectral energy associated with tidal, inertial, and other frequencies, (3) correlation of horizontal and vertical kinetic energy spectra, (4) deep western boundary currents. Grid of oceanographic stations and current meter arrays will be used to: (1) estimate volume transport of various current systems and the net volume transport toward the Caribbean, (2) investigate approximation of computer geostrophic flow and of various approaches to determine a reference surface, (3) investigate piling up of water masses and slope distribution of isobanic surfaces, (4) study specific dynamic features (current reversals, compensation currents, etc.). By measurements and sampling at the oceanographic stations and by airborne instrumentation, studies will be made on: (1) physical property distribution, nutrients, upwelling, subsurface series of isopycnal layers, large scale horizontal turbulence, relation of surface temperature to the thermocline depth, thermal boundaries, synoptic surface thermal structure, etc.
PRINCIPAL PLATFORMS AND SENSORS: Navy Current Meter Array. Navy Temperature Array. GILLISS and ADVANCE II: STD, Nansen Casts, BT's, sea surface temperature sea surface salinometer, Pinger, Parachute drogues. ASWEPS C121: AXBT, ART.
SUPPLEMENTAL PLATFORMS AND SENSORS: All meteorological and oceanographic data of BOMEX.

61. EXPERIMENT TITLE: Sea temperature and Heat Flux
PRINCIPAL INVESTIGATOR: Dr. D. D. McAlister
AFFILIATION: S10
FUNDING SUPPORT: ONR, NAVOCEANO, NSF
EXPERIMENT DESCRIPTION: To measure from an airborne platform sea surface temperature at 25 and 75 micron depths and effective sky temperature and to deduce total heat flux versus environmental factors.
PRINCIPAL PLATFORMS AND SENSORS: DC-3: Twin wavelength radiometer (3.50 - 4.05 u) (4.45 - 5.10u); photography
SUPPLEMENTAL PLATFORMS AND SENSORS: BOMEX array data of sea temperature, air temperature, wind velocity, dew point, and sea state.

62. EXPERIMENT TITLE: Interpretation of Satellite Measured Sea Surface Temperatures
PRINCIPAL INVESTIGATOR: Dr. E. P. McClain
AFFILIATION: ESSA/MESC
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION : The comparison of satellite measurements of the surface temperature with the other measurements obtained from ships, buoys, and aircraft.
PRINCIPAL PLATFORMS AND SENSORS: All sea surface temperature measurements.
SUPPLEMENTAL PLATFORMS AND SENSORS: All surface meteorological and oceanographic observations at local noon and midnight.

63. EXPERIMENT TITLE: Turbulent Flux Measurements with Air-borne Sensors
PRINCIPAL INVESTIGATOR: Dr. M. Miyake
AFFILIATION: University of British Columbia
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To determine the air-sea transfers by measuring fluctuations of wind components relative to the aircraft, temperature, and humidity along with the motion of the aircraft, and study their variability with height and horizontal spacing.
PRINCIPAL PLATFORMS AND SENSORS: Queen Air 80 - Sonic anemometer; hot wire anemometer; air temperature sensor; Gyro and accelerometer; humidity sensor.
SUPPLEMENTAL PLATFORMS AND SENSORS: Temperature, wind data up to the height of 1.5 km from the BOMEX grid.

64. EXPERIMENT TITLE: Measured wind field around Flip
PRINCIPAL INVESTIGATOR: Dr. Mollo-Christensen
AFFILIATION: MIT
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: A small scale model of Flip was placed in a wind tunnel in order to determine the wind field deviation about super structures. Results have been tabulated and forwarded to Flip experimenters.
PRINCIPAL PLATFORMS AND SENSORS: FLIP Model, Laboratory Wind Data
MISCELLANEOUS: MIT has completed this study and the results are available to the Flip experimenters for sensor placement during BOMEX.

65. EXPERIMENT TITLE: Photographer Study of the Generation and Concentration of Oceanic White Caps
PRINCIPAL INVESTIGATOR: Dr. E. C. Monahan
AFFILIATION: University of Michigan
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: A photographic study of the generation and concentration of oceanic whitecaps as a function of wind speed, atmospheric thermal stability, and water temperature will be made from the OCEANOGRAPHER.
PRINCIPAL PLATFORMS AND SENSORS: OCEANOGRAPHER: Beattie Varitron automatic sequence camera.
SUPPLEMENTAL PLATFORMS AND SENSORS: OCEANOGRAPHER: Blip, Boom, STD

66. EXPERIMENT TITLE: Turbulence Measurements in the Open Ocean Atmosphere Boundary Layer
PRINCIPAL INVESTIGATOR: W. A. Nierenberg
AFFILIATION: SIO
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: Large and small scale properties of the boundary layer, spectra, correlations, intermittency, dissipation, flux.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Hot wire anemometers, cup anemometers, wave gauges.
SUPPLEMENTAL PLATFORMS AND SENSORS: Rawinsonde for stability estimates, homogeneity of large scale wind pattern from various ship observations.

67. EXPERIMENT TITLE: Phase Speed Measurements in Atmospheric Turbulence
PRINCIPAL INVESTIGATOR: Dr. W. A. Nierenberg
AFFILIATION: SIO
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: To obtain cross-spectral density measurements of the turbulence at two closely spaced locations in the high Reynolds number atmospheric boundary layer over the ocean. The measurements will be used to deduce the apparent phase speed of the turbulent Fluctuations.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: 2 linearized constant temperature hot wire anemometers
SUPPLEMENTAL PLATFORMS AND SENSORS: Daily weather forecasts

68. EXPERIMENT TITLE: A Numerical Model of the Atmosphere - Ocean Planetary Boundary Layer - Simulation with BOMEX Data
PRINCIPAL INVESTIGATOR: Dr. J. Pandolfo
AFFILIATION: Travelers Research Center
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To establish the minimum simulative capability of a detailed boundary layer numerical model using presently formulated interface flux-mean parameter relationships. To theoretically calculate supplementary physical quantities for the observation periods, e.g., radiative flux and flux divergence as a function of height and time within the boundary layer.
PRINCIPAL PLATFORMS AND SENSORS: SHIPS: Rawinsondes, Blip, STD, Boom, Precip, clouds; BUOYS: Temperature at depth, current at depth; AIRCRAFT: Dropsondes and Spirals
SUPPLEMENTAL PLATFORMS AND SENSORS: All turbulent and radiative flux Data.

69. EXPERIMENT TITLE: Flux Computations by the Aerodynamic Profile Method
PRINCIPAL INVESTIGATOR: Dr. J. Pandolfo
AFFILIATION: TRC
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To compute momentum, heat, and vapor flux from profiles at each fixed ship position in BOMEX
PRINCIPAL PLATFORMS AND SENSORS: FIXED SHIPS: Boom, Blip
SUPPLEMENTAL PLATFORMS AND SENSORS: FIXED SHIPS: Rawin

70. EXPERIMENT TITLE: Measurement of Humidity fluctuations and Turbulent Transport of Latent Heat
PRINCIPAL INVESTIGATOR: Dr. G. S. Pond
AFFILIATION: Oregon State University
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: The measurements of absolute humidity fluctuation will be made with an alfa-Lyman absorption device aboard Flip
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Alfa-Lyman absorption device
SUPPLEMENTAL PLATFORMS AND SENSORS: FLIP: Wind velocity and temperature fluctuations from University of British Columbia instrumentation on Flip.
MISCELLANEOUS: Measurements will be recorded on analog tape (1" 14 channel IRIG standard). Analog to digital conversion and digital time series analysis will be used. Some analog analysis may be done as well.

71. EXPERIMENT TITLE: Measurements of Turbulence, turbulent Transports and Wave Heights from FLIP
PRINCIPAL INVESTIGATOR: Dr. D. J. Portman
AFFILIATION: The University of Michigan
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: To measure u', v', w', and T' at two heights together with wave heights. To determine the vertical Reynolds fluxes of momentum and sensible heat. To study the structure of turbulence and turbulent transfer processes in relation to wind and temperature profiles and wave conditions.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Hot film Anemometers (2 & 4 meters); linearized constant temperature probe (2 & 4 meters); liquid level wave height sensor; water surface temperature; water temperature in first few meters; wind direction; platform accelerations; wind and temperature profiles.
SUPPLEMENTAL PLATFORMS AND SENSORS: FLIP: Net radiative exchange; total incident and reflected solar radiation

72. EXPERIMENT TITLE: Exploration of the Planetary Boundary Layer in the rain areas of tropical Disturbances
PRINCIPAL INVESTIGATOR: Dr. H. Riehl
AFFILIATION: Colorado State University
FUNDING SUPPORT: DOD
EXPERIMENT DESCRIPTION: A study will be made to determine the structure of various synoptic scale weather phenomena in the tropics.
PRINCIPAL PLATFORMS AND SENSORS: 3 level aircraft; vertical pressure structure; vertical structure of humidity. High altitude aircraft: cloud photos; outflow measurements.
Barbados: APT, WEFAX
SUPPLEMENTAL PLATFORMS AND SENSORS: All synoptic meteorological data

73. EXPERIMENT TITLE: Ocean Albedo Measurement
PRINCIPAL INVESTIGATOR: Dr. P. M. Saunders
AFFILIATION: WHOI
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: Determination of two quantities: (a) Albedo of ocean surface as a function of surface roughness and lighting conditions (b) relation between solar radiation flux and diffuse components.
PRINCIPAL PLATFORMS AND SENSORS: ISLAND: Pyranometers
SHIP: Pyranometers
SUPPLMENTAL PLATFORMS AND SENSORS: SHIP: Wind velocity

74. EXPERIMENT TITLE: Rn/Ra Measurements to Determine Vertical Mixing and Air Sea Gas Exchange Rates (Project BODON)
PRINCIPAL INVESTIGATOR: Dr. D. R. Schink
AFFILIATION: ISOTOPES PALO ALTO LABS
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: To obtain measurements of radon and radium in the near surface water. From radon depletion, the coefficient of vertical mixing and exchange rate of gas across the air-sea interface may be determined as a function of wind velocity and water density structure.
PRINCIPAL PLATFORMS AND SENSORS: ROCKAWAY: Samples with water radon stripping
SUPPLEMENTAL PLATFORMS AND SENSORS: ROCKAWAY: STD, Surface Weather; Boom; sea state; turbulence

75. EXPERIMENT TITLE: Shipboard Buoy Rainfall Measurements
PRINCIPAL INVESTIGATOR: Mr. W. Shinners
AFFILIATION: SAIL
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: Quantitative rainfall measurement comparison of shielded and unshielded gauges.
PRINCIPAL PLATFORMS AND SENSORS: SHIPS & BUOYS: Raingauges
SUPPLEMENTAL PLATFORMS AND SENSORS: SHIPS: Wind Velocity

76. EXPERIMENT TITLE: Eddy Thermal Diffusion and Wind Shear Studies
PRINCIPAL INVESTIGATOR: Dr. D. H. Shonting
AFFILIATION: NUWR&ES
FUNDING SUPPORT: NAVY: NATO
EXPERIMENT DESCRIPTION: To measure vertical heat flux associated with the interaction of turbulent rotational wave motions with the near surface temperature gradient. To evaluate wind stress at the sea surface by attempting to measure wind generated current shear in the upper 10 - 20 meters of the ocean.
PRINCIPAL PLATFORMS AND SENSORS: AESOP: 3 ducted impeller meters; 3 thermistors
SUPPLEMENTAL PLATFORMS AND SENSORS: GILLISS: wind velocity; STD wave spectra; solar radiation; air temperature

77. EXPERIMENT TITLE: Ocean Station, Salinity, Temperature and Depth Measurements
PRINCIPAL INVESTIGATOR: Mr. J. R. Smith
AFFILIATION: Research Triangle Institute
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To compare classical geostrophic techniques with oceanic measurements.
PRINCIPAL PLATFORMS AND SENSORS: ADVANCE II: STD, Nansen Bottles, BT, Bead Thermistor at sea surface, surface salinometer, wind, air temperature, humidity.
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

78. EXPERIMENT TITLE: Air Pollutant Concentration in an Ocean Environment
PRINCIPAL INVESTIGATOR: Mr. James R. Smith and Mr. H.L. Hamilton
AFFILIATION: Research Triangle Institute and National Air Pollution Control Administration
FUNDING SUPPORT: Public Health Service
EXPERIMENT DESCRIPTION: To observe and analyze the concentration of certain trace constituents, normally used as measures of air quality in an ocean environment. Measurements in the atmosphere include O_3, NO, NO_2, SO_2, CO, CO_2, CH_4, $SO_4^{=}$, NO_3^{-}, selected metals and organics and particulates. Measurements of trace constituents in the sea include CO, CO_2, CH_4, $SO_4^{=}$, NO_3^{-}, and selected metals and organics.
PRINCIPAL PLATFORMS AND SENSORS: ADVANCE II: Bubbler system with a sequential sampler for NO, Chemiluminescent ozone meter; NO_2 and SO_2, Charlton Integrating Nephelometer, Gelman Hurricane air sampler, moving slide impactor, Nansen Bottles
SUPPLEMENTAL PLATFORMS AND SENSORS: BOMEX grid sea surface temperature, rawinsondes.

79. EXPERIMENT TITLE: Reynolds Flux Measurements from FLIP
PRINCIPAL INVESTIGATOR: Dr. R. W. Stewart
AFFILIATION: University of British Columbia
FUNDING SUPPORT: ONR
EXPERIMENT DESCRIPTION: To determine directly the air-sea transfers by measuring fluctuations of all wind components, temperature, and humidity near the sea surface and to relate them to external conditions such as mean wind, sea surface condition, and air temperature and humidity.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: 3-D sonic anemometer-thermometer (5 meter level); 1-D wettable sonic anemometer (surface).
SUPPLEMENTAL PLATFORMS AND SENSORS: Surface Synoptic Weather data and temperature vs. ocean depth data in the BOMEX grid.

80. EXPERIMENT TITLE: Sea Photo Analysis
PRINCIPAL INVESTIGATOR: Dr. D. Stilwell, Jr.
AFFILIATION: NRL
FUNDING SUPPORT: NRL
EXPERIMENT DESCRIPTION: To study the energy spectrum of the sea from photographs
PRINCIPAL PLATFORMS AND SENSORS: NRL C-121: CA-38 9" aerial camera
SUPPLEMENTAL PLATFORMS AND SENSORS: Wavepole records and quantitative information of the wave field

81. EXPERIMENT TITLE: EDDY Flux and Profile Measurements from FLIP
PRINCIPAL INVESTIGATOR: Mr. W. J. Superior
AFFILIATION: C. W. Thornthwaite Associates
FUNDING SUPPORT: NAVOCEANO
EXPERIMENT DESCRIPTION: Microscale measurements of eddy fluxes of momentum, and heat together with profile measurements of wind, temperature, and water vapor obtained from FLIP, will provide the essential "reference" measurements with which to correlate the meso-scale measurements of parameters obtained from the ships and aircraft participating in BOMEX.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Heat Flux (6 meters); Momentum Flux (6 meters); Air Temperature (7 levels); wet bulb temperature (7 levels); wind speed (7 levels); Net radiation, water temperature (2 levels), platform movement.
SUPPLEMENTAL PLATFORMS AND SENSORS: FLIP: Wave Height

82. EXPERIMENT TITLE: A Study to Determine the Effect of Physical Noise on NIMBUS Sea Surface Temperature Analysis
PRINCIPAL INVESTIGATOR: Dr. F. M. Vukovich
AFFILIATION: Research Triangle Institute
FUNDING SUPPORT: NESC
EXPERIMENT DESCRIPTION: To determine the effect of absorption of sea spray; and scattering by lower and upper level aerosols, including invisible cirrus, on the sea-surface temperature pattern as viewed by NIMBUS HRIR; and to theoretically investigate the effect of cloud cover which partially fills the field of view of the radiometer.
PRINCIPAL PLATFORMS AND SENSORS: ADVANCE II: Barney IR radiometer
SUPPLEMENTAL PLATFORMS AND SENSORS: ADVANCE II: Laser system, Aerosol samples

83. EXPERIMENT TITLE: Ground Truth for NIMBUS IIB Atmospheric Sounder
PRINCIPAL INVESTIGATOR: Dr. David Wark
AFFILIATION: ESSA/National Environmental Satellite Center
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To compare the atmospheric temperature profiles determined from the Nimbus IIB Satellite Infrared Spectrometer (SIRS) with radio soundings from all ships.
PRINCIPAL PLATFORMS AND SENSORS: Radiosonde and surface data from all ships.
SUPPLEMENTAL PLATFORMS AND SENSORS: Sea surface temperature measurements from aircraft, cloud heights and sea state from all ships.

84. EXPERIMENT TITLE: Nuclide Aerosol Counts
PRINCIPAL INVESTIGATOR: Dr. Weickmann
AFFILIATION: ESSA/ERL
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: To measure concentration of Aitken particles, condensation nuclei, and freezing nuclei.
PRINCIPAL PLATFORMS AND SENSORS: DC-6: Aerosol Nuclide Counter
SUPPLEMENTAL PLATFORMS AND SENSORS: NONE

85. EXPERIMENT TITLE: Classification of Environments About Tropical Cumuloform Clouds
PRINCIPAL INVESTIGATOR: Dr. V. S. Whitehead
AFFILIATION: NASA/MSC
FUNDING SUPPORT: NASA
EXPERIMENT DESCRIPTION: The experiment consists of studying the environment about cumulus clouds over warm oceans, including the temperature pattern on the sea surface, with the goal of categorizing the environment about cumulus in varying stages of development or of differing visual characteristics.
PRINCIPAL PLATFORMS AND SENSORS: P3A: Pallet consisting of foresighted felter wheel spectrometer radiometer and camera; air temperature indicator, dew point indicator. PRT-5 radiation thermometer, camera (wide angle), scatterometer, infrared scanner (RS - 14), multichannel microwave radiometer.
SUPPLEMENTAL PLATFORMS AND SENSORS: SHIPS: Rawinsondes, Surface weather, sea surface temperature

86. EXPERIMENT TITLE: Basic Synoptic Scale Reynolds stress Using the Geostrophic Departure Technique
PRINCIPAL INVESTIGATOR: Mr. S. Williams
AFFILIATION: BOMEX Project Office
FUNDING SUPPORT: ESSA
EXPERIMENT DESCRIPTION: Difference between mean observed wind and mean geostrophic wind for the array will be computed for various levels to the top of the friction layer.
PRINCIPAL PLATFORMS AND SENSORS: SHIPS: Rawinsondes, Boom
SUPPLEMENTAL PLATFORMS AND SENSORS: Ships Barometer

87. EXPERIMENT TITLE: Measurement of Air-Sea Exchange Rates with Fallout Radioisotopes
PRINCIPAL INVESTIGATOR: Dr. N. A. Wogman
AFFILIATION: Battelle Memorial Institute
FUNDING SUPPORT: AEC
EXPERIMENT DESCRIPTION: Determine the rate of exchange across the air-sea interface using cosmic-ray-produced ^{7}Be and other radio-nuclides as tracers.
PRINCIPAL PLATFORMS AND SENSORS: FLIP: Air Samples ^{7}Be (0-10-20-30-70 feet); water samples ^{7}Be (0-30-60-100-150-200-270 feet); Rainfall. ROCKAWAY: Air Samples ^{7}Be (0-10-20-30-70- feet); water samples ^{7}Be, Rainfall.
OTHER FIXED SHIPS: Air Sample 1 level ^{7}Be; Rainfall.
AIRCRAFT: Nuclide Samplers
SUPPLEMENTAL PLATFORMS AND SENSORS: Horizontal and vertical mean wind velocity and variance at all levels of FLIP, TRITON, and ROCKAWAY. All atmosphere humidity profiles. All temperature profiles in air and ocean (STD, Rawinsonde). Wave spectra from FLIP & ROCKAWAY. All measurements of radiative flux divergence.

APPENDIX 2

AIRCRAFT FLIGHT PATTERNS

ESSA Research Flight Facility (RFF)

During the first three BOMEX operational periods, missions will be flown to provide data to be used in computing the horiziontal flux divergence by integrating the product of the specific humidity and the normal (outward) component of the wind over the area of the vertical boundaries of the BOMEX array. These missions are designated "line integral" flights and will be accomplished both at night and during the day. The line integral - day track is as shown in Figure 2-1 and is designed to provide for a comparison of the measurements from two aircraft on that portion of the flight between positions HOTEL and CHARLIE, both on the outbound and the inbound legs. The legs around the box will at times be flown at the lowest altitude possible commensurate with obtaining good Doppler wind data. A spiral ascent and descent sounding will be made at each of the indicated positions between 100 feet and 10,000 feet. Climb rate will be 350 feet per minute and descent rate will be 500 feet per minute. Mission duration will be approximately 10 hours.

Also during the first and second operational periods, low-level water vapor flux missions will be flown every other day on tracks to be selected by the Scientific Director. These missions will average six hours' duration and will employ everal patterns involving operation of the vertical gust probe and microwave refractometer at 500 feet altitude or less. An example, shown in Figure 2-2, is designed to obtain a sample of records over a range of spatial positions and meteorological conditions. Other patterns are designed for FLIP fly-by, profiling the vertical water vapor flux through the entire boundary layer, and sampling water vapor flux during line integral flights.

U.S. Air Force (AWS)

Two daily WC-130 sampling and synoptic sorties, 12 hours apart, will be flown over the BOMEX array at altitudes from 1,000 to 20,000 feet. On each flight, dropsonde observations will be taken at locations 1, 2, 3, 4, 5, 6, 7, and 8 (See Figure 2-3), to collect temperature, pressure, and humidity data between the aircraft and the sea surface. In addition to observations at each of the four corners of the array, samplings and spot wind data will be taken at 1000-foot intervals when climging or descending near the array and midway between BRAVO and JULIETT, over JULIETT, and midway between JULIETT and ECHO.

The WB-47s will be employed during the first and third phases of the project, flying one daily sampling sortie between 20,000 and 30,000 feet over DELTA, KILO, ECHO, JULIETT, BRAVO, INDIA, and ALPHA (See Figure 2-4). These observations will be made near the same altitude whenever possible, based on level for sampling requirements. An additional WB-47 mission will be flown during the first three operational periods to obtain radar observations of the precipitation areas within the array (see Figure 2-5).

During the first phase of the BOMEX project, the RB-57Fs will fly a daily sortie six days a week and two sorties on the seventh day (see Figure 2-6). The route will be over DELTA, abreast of KILO, over ECHO, abreast of JULIETT, over BRAVO, abreast of INDIA, and over ALPHA. In addition to synoptic and sampling missions, these aircraft will obtain high-level (40-50 thousand feet) color photographs of cloud formations over the project area. Timing is crucial for this task as the aircraft must be over a specified point at solar noon to minimize shadow contamination of photographic products due to sun angle. After the initial phase, the RB-57Fs will fly daily photo missions and one sampling sortie per week at 60,000 feet.

All aircraft will make radar observations and take radarscope photographs every five minutes whenever a precipitation return is observed.

Atmospheric particulate sampling for Beryllium 7 will be conducted daily duringthe first and third experiment periods. Samples will be obtained in the near vicinity of the four corner ships at 1,000, 5,000, 10,000, 20,000, 30,000, 40,000, 50,000, and 60,000 feet. The 60,000-foot flights will be weekly and over two ships only.

U.S. Navy

The WC-121 from Squadron 4 will fly a line-integral night pattern (Figure 2-7). These aircraft will obtain weather observations including special soundings and radar scope photography.

ASWEPS EC-121 will fly patterns for oceanographic missions as shown in Figures 2-8 and 2-9. Its missions are designed for: (1) radar wave-profiling to check and verify the concept of a "steady state" or "fully developed" sea on the windward side of Barbados and to observe sequences of limited fetch on the leeward side; and (2) to obtain sea-surface temperatures, thermal structure, and wave profile data within the BOMEX array.

The NRL EC-121 will conduct missions to obtain photograph wave spectrum data.

During the fourth operational period, missions will be flown on the above-mentioned tracks as required to obtain basic BOMEX data. In addition, special missions will be flown in conjunction with other aircraft to investigate meteorological occurrences of interest to the Scientific Director. These missions will be flown in a vertical stack or horizontal line abreast formation with a minimum of three aircraft and will use radar control when flying through disturbed areas.

Other Aircraft

The remaining aircraft participating in BOMEX will fly special data-gathering missions in support of experiments. Principally these are:

a. National Center for Atmospheric Research
   (1) Queen Air - Flight test of a 3-dimensional sonic anemometer for aircraft flux measurements.
   (2) Buffalo - Gust probe data and study of tropical disturbance structure within the intertropical convergence zone.

b. National Aeronautics and Space Administration
   (1) Convair 990 - Nimbus III correlative measurements and determination of the variation of sea-surface brightness temperature at microwave frequencies under varying ocean and atmospheric conditions.
   (2) Lockheed P3A - Classification of tropical maritime cumulus.

c. Woods Hole Oceanographic Institutions - C-54G - The trade wind structure and mixing processes are to be determined by various flux calculations from aircraft data.

d. University of California - DC-3 - Determining total heat flux from the sea surface.

e. Colorado State University - Aero Commander - Determination of sea-surface and air temperature gradients in the sub-cloud layer.

This section contains flight patterns designed to support BOMEX Phase 4 (Tropical Exploration Program).

FLIGHT PATTERN "A"

(CHARNEY/RIEHL)

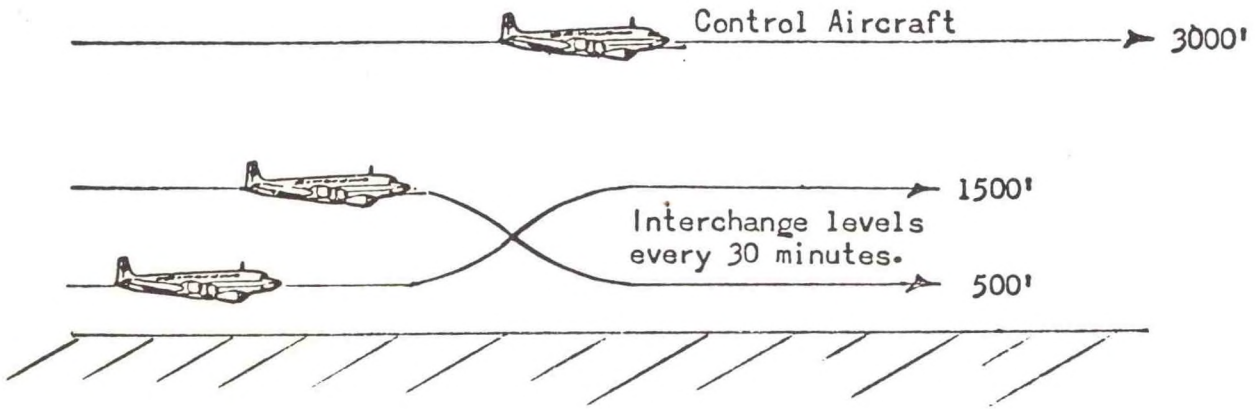
Flight Pattern enroute to cloud system

1. Enroute to area to be investigated, RFF aircraft will fly the following altitudes:

a)	DC-6	3000 Feet
b)	DC-6	1500 Feet
c)	C-54	500 Feet

2. Enroute pattern will be flown VFR. The 500 ft. aircraft and the 1500 ft. aircraft will change altitudes every 30 minutes.

3. Aircraft will maintain staggered vertical stack visually, with the DC-6 at 300 feet acting as control aircraft.



FLIGHT PATTERN "B"
(CHARNEY/REIHL/COX)

Pattern to be flown through cloud system

1. Aircraft will rendezvous at 3000 feet under control of designated DC-6 at a point approximately 50 NM from cloud system selected for investigation.

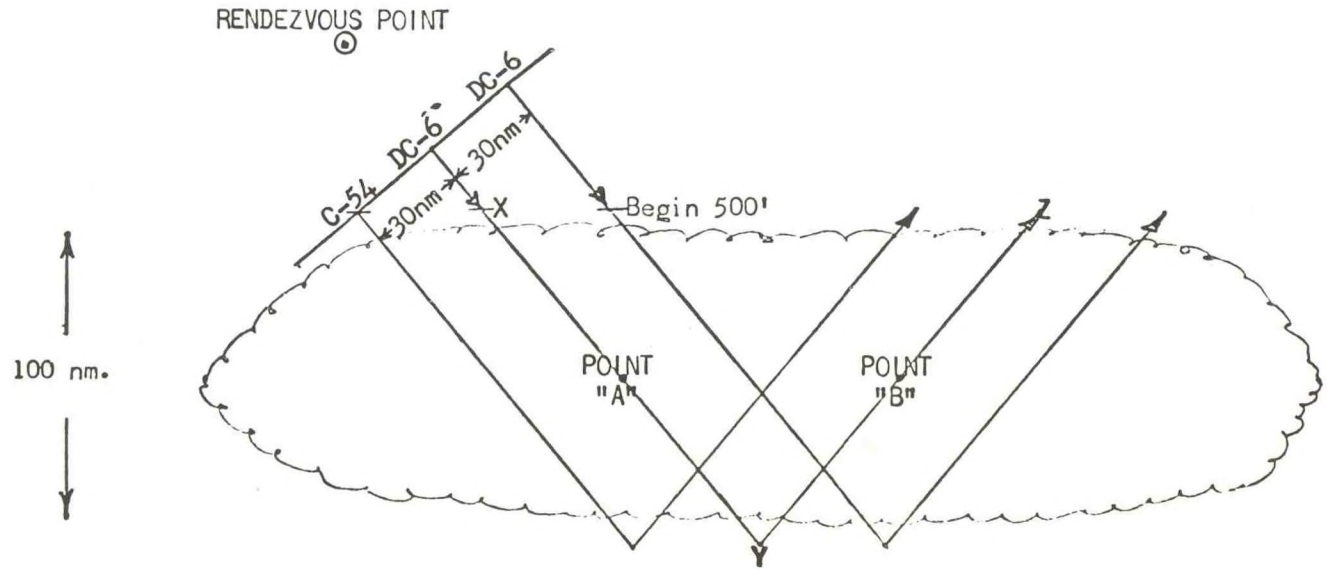
2. For ZIG-ZAG pattern through cloud system descend to 500 feet. Horizontal separation of 30 NM. will be established between aircraft with center DC-6 acting as control aircraft.

3. Control aircraft through the Project Scientist on board will designate the starting point, track, control points, and turning point in the pattern.

4. Max. duration at 500 feet will be two hours.

5. VERTICALLY stacked aircraft will fly tracks X-Y and Y-Z such that ALL aircraft overhead positions A and B coincident with the control aircraft (RFF DC-6).

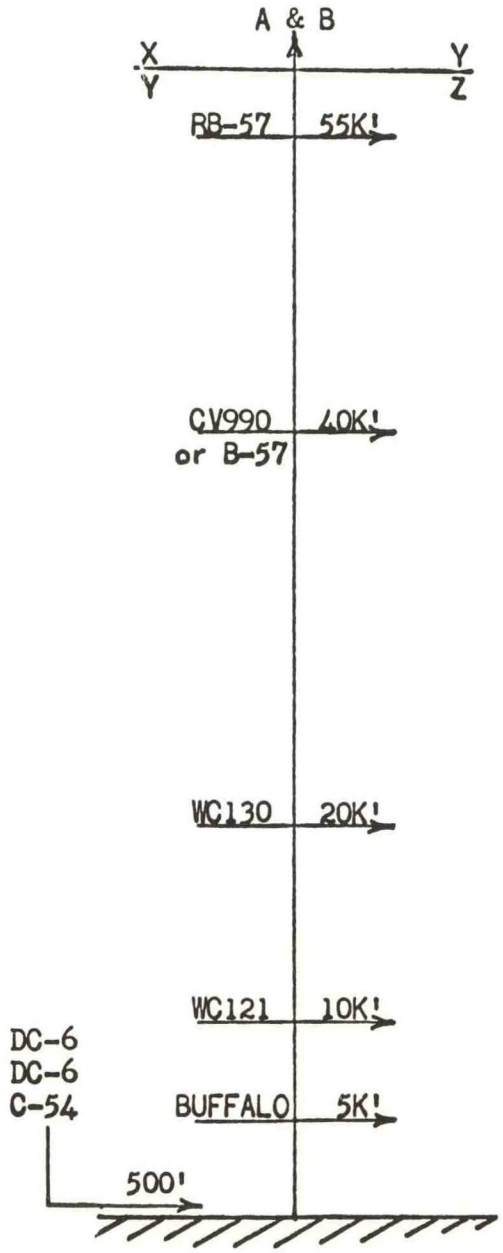
6. During the ZIG-ZAG pattern control aircraft will record the relative position of other aircraft in the formation by means of radar scope photography.



FLIGHT PATTERN "B"

PROFILE OF VERTICALLY STACKED AIRCRAFT

Vertically stacked aircraft will fly tracks X-Y and Y-Z so that all aircraft overhead control positions A and B coincident with the control DC-6 aircraft (See Flt. Pattern "B" Horizontal View).

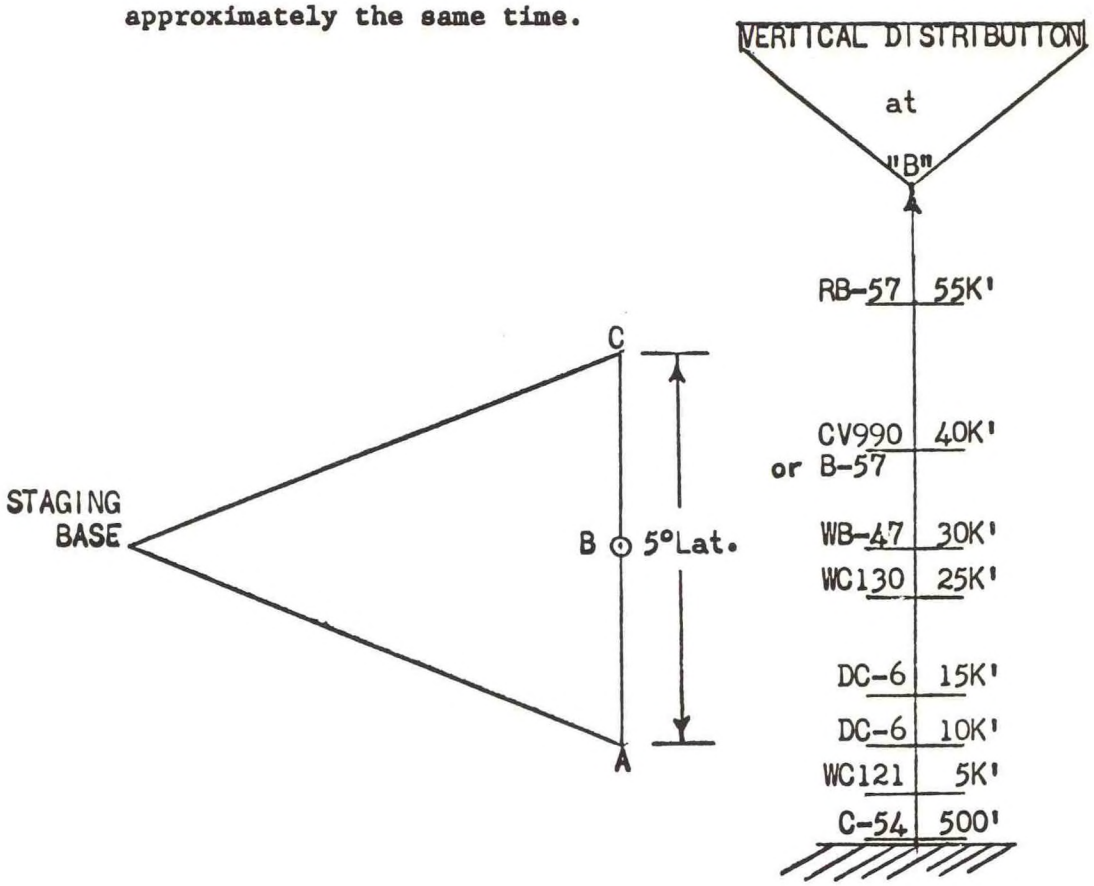


FLIGHT PATTERN "C"

Estoque

Project Scientist will designate Initial Point "A", Control Point "B" and Final Point "C".

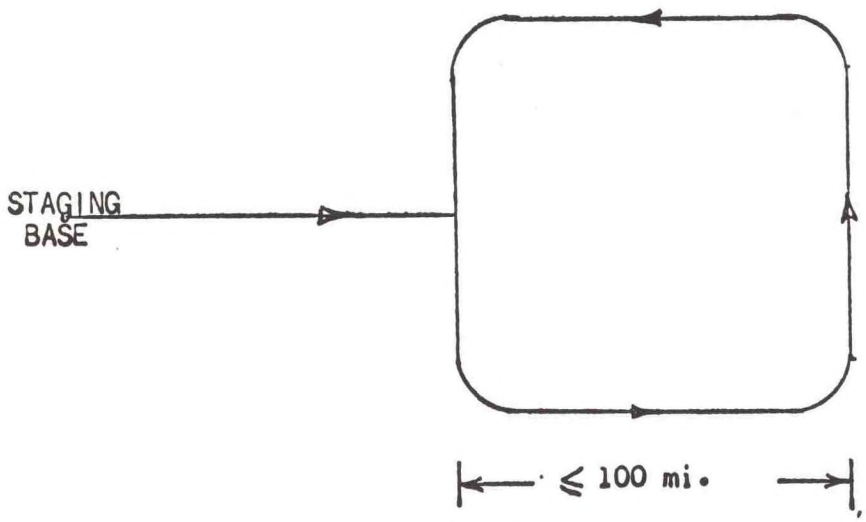
Aircraft departure times should be established based on TAS so that all aircraft will arrive over Control Point "B" at approximately the same time.



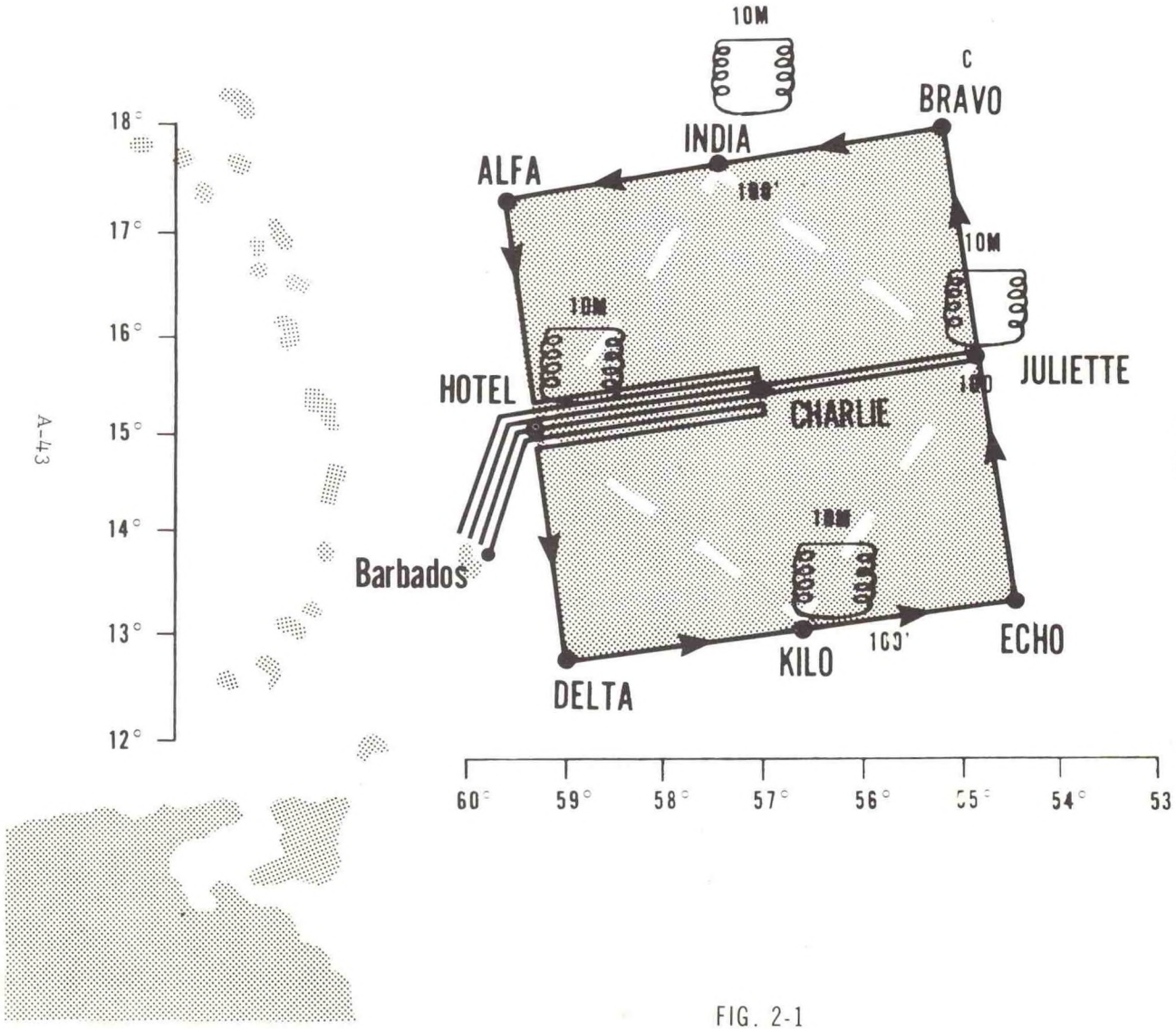
FLIGHT PATTERN "D"

(REIHL - CONVERGENCE PATTERN)

1. Pattern to be flown as directed by the Project Scientist at selected altitudes by available aircraft.



LINE INTEGRAL-DAY TRACK



AIRCRAFT TYPE

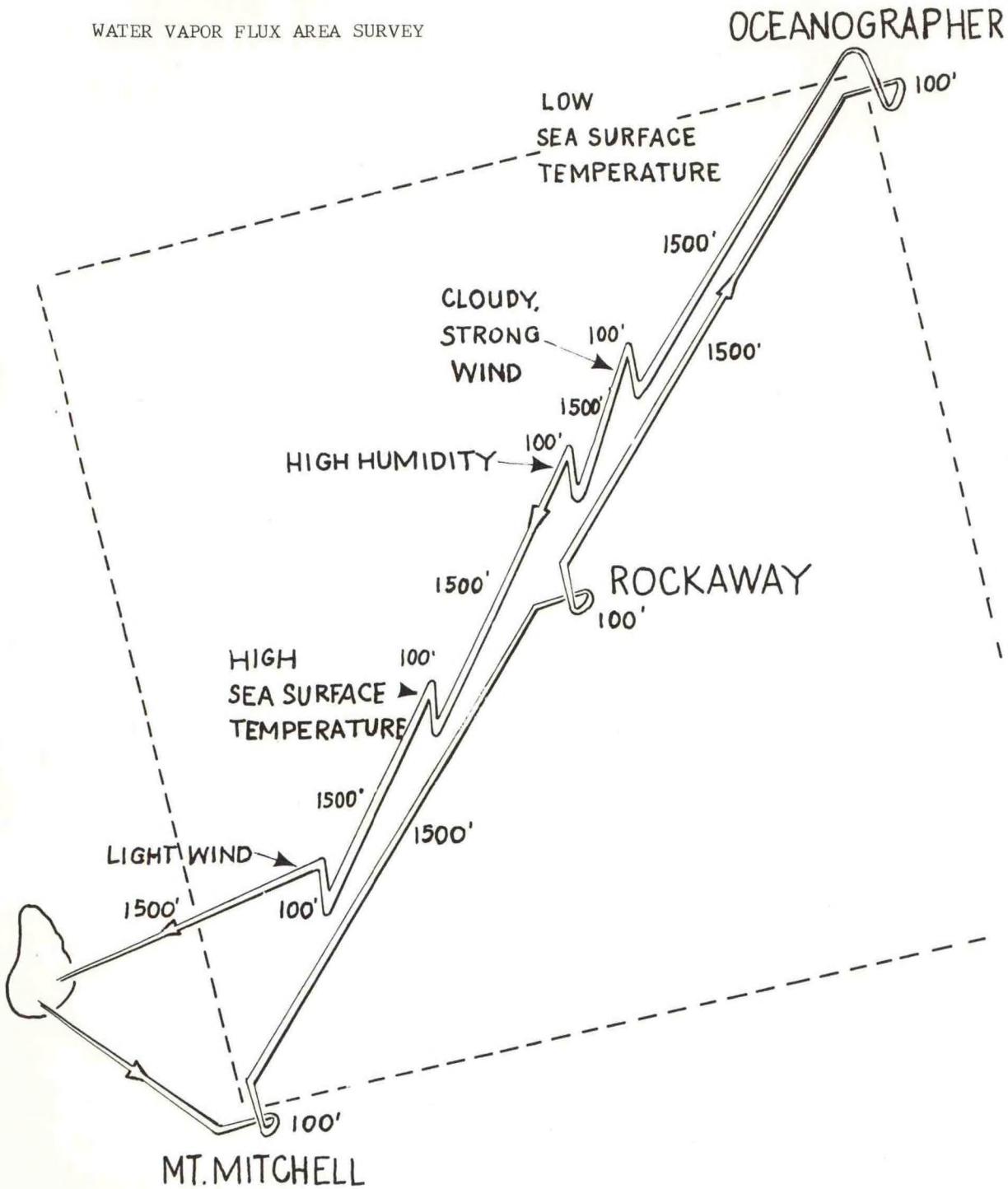
DC-6
DC-4

NOTE: BOTH AIRCRAFT FLY TO CHARLIE POSITION TOGETHER AND RETURN TOGETHER FOR INTER - COMPARISON OF MEASUREMENTS.

FIG. 2-1

FIGURE 2-2

WATER VAPOR FLUX AREA SURVEY



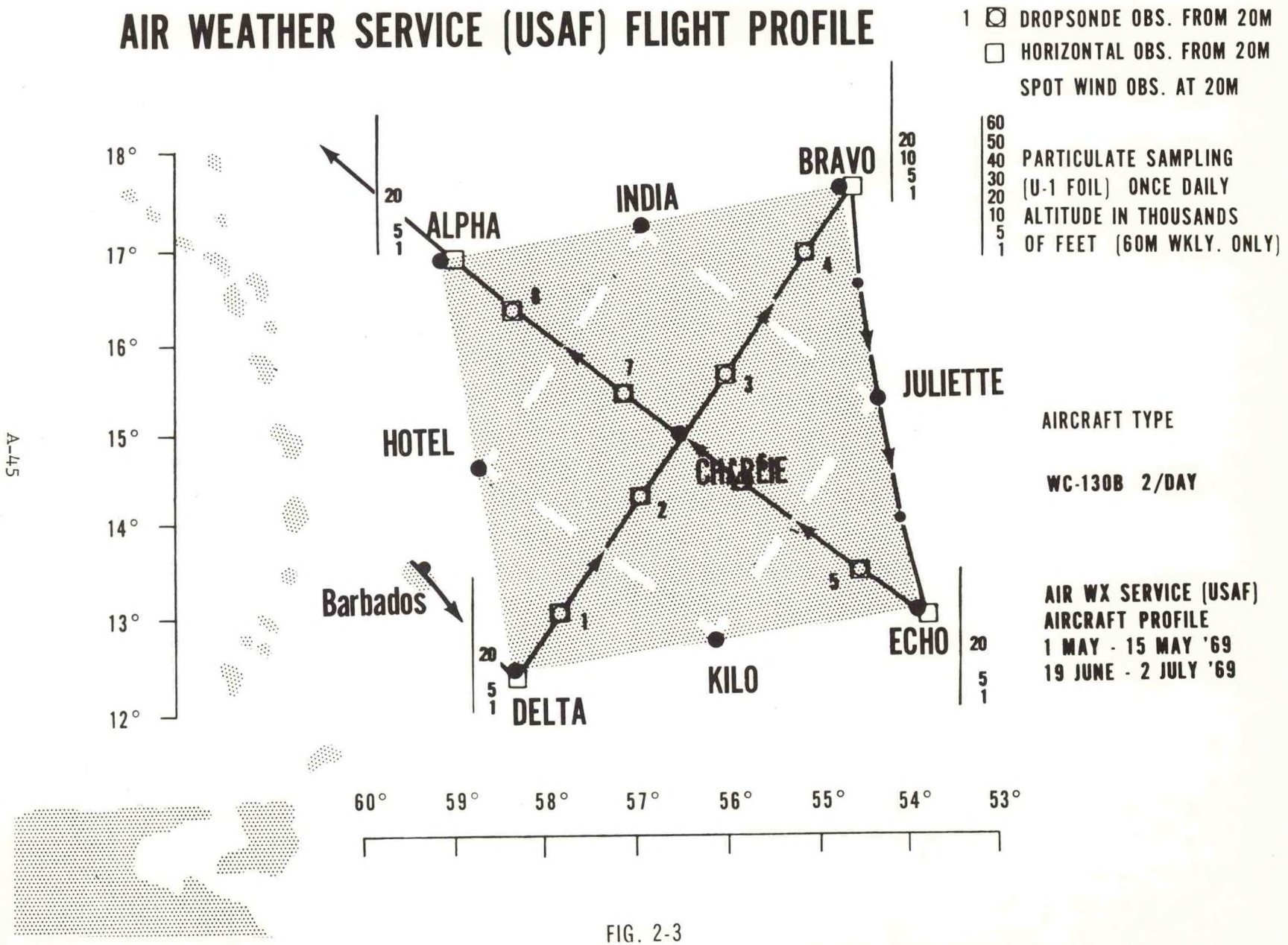

AIR WEATHER SERVICE (USAF) FLIGHT PROFILE
1 DROPSONDE OBS. FROM 20M
HORIZONTAL OBS. FROM 20M
SPOT WIND OBS. AT 20M
60
50
40
30
20
10
5
1
PARTICULATE SAMPLING
(U-1 FOIL) ONCE DAILY
ALTITUDE IN THOUSANDS
OF FEET (60M WKLY. ONLY)
18°
17°
16°
15°
14°
13°
12°
ALPHA
BRAVO
INDIA
JULIETTE
HOTEL
CHARLIE
ECHO
KILO
DELTA
Barbados
20
10
5
1
AIRCRAFT TYPE
WC-130B 2/DAY
AIR WX SERVICE (USAF)
AIRCRAFT PROFILE
1 MAY - 15 MAY '69
19 JUNE - 2 JULY '69
60°
59°
58°
57°
56°
55°
54°
53°

FIG. 2-3

AIR WEATHER SERVICE (USAF) FLIGHT PROFILE

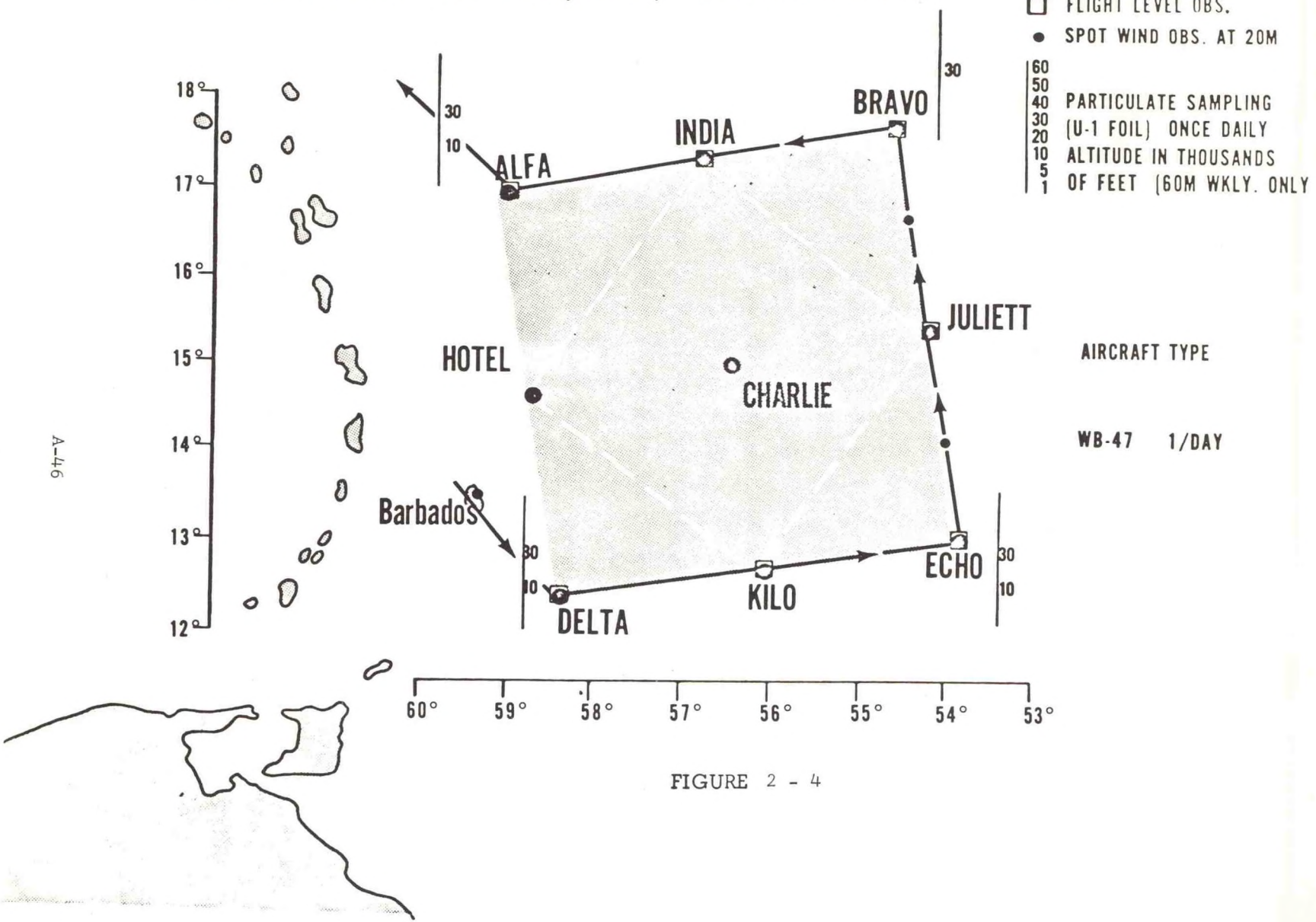


FIGURE 2 - 4

AIR WEATHER SERVICE (USAF) FLIGHT PROFILE

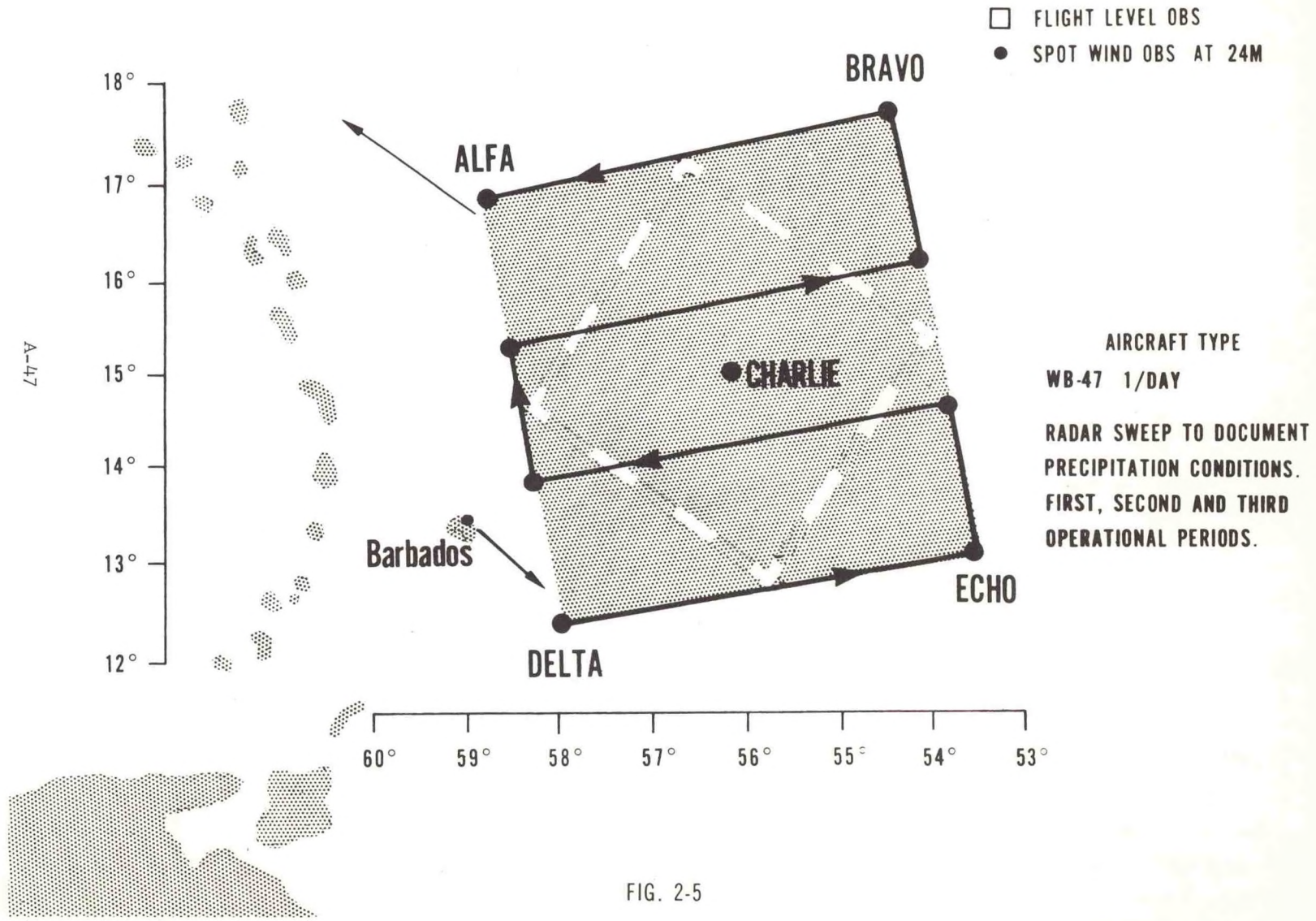


FIG. 2-5

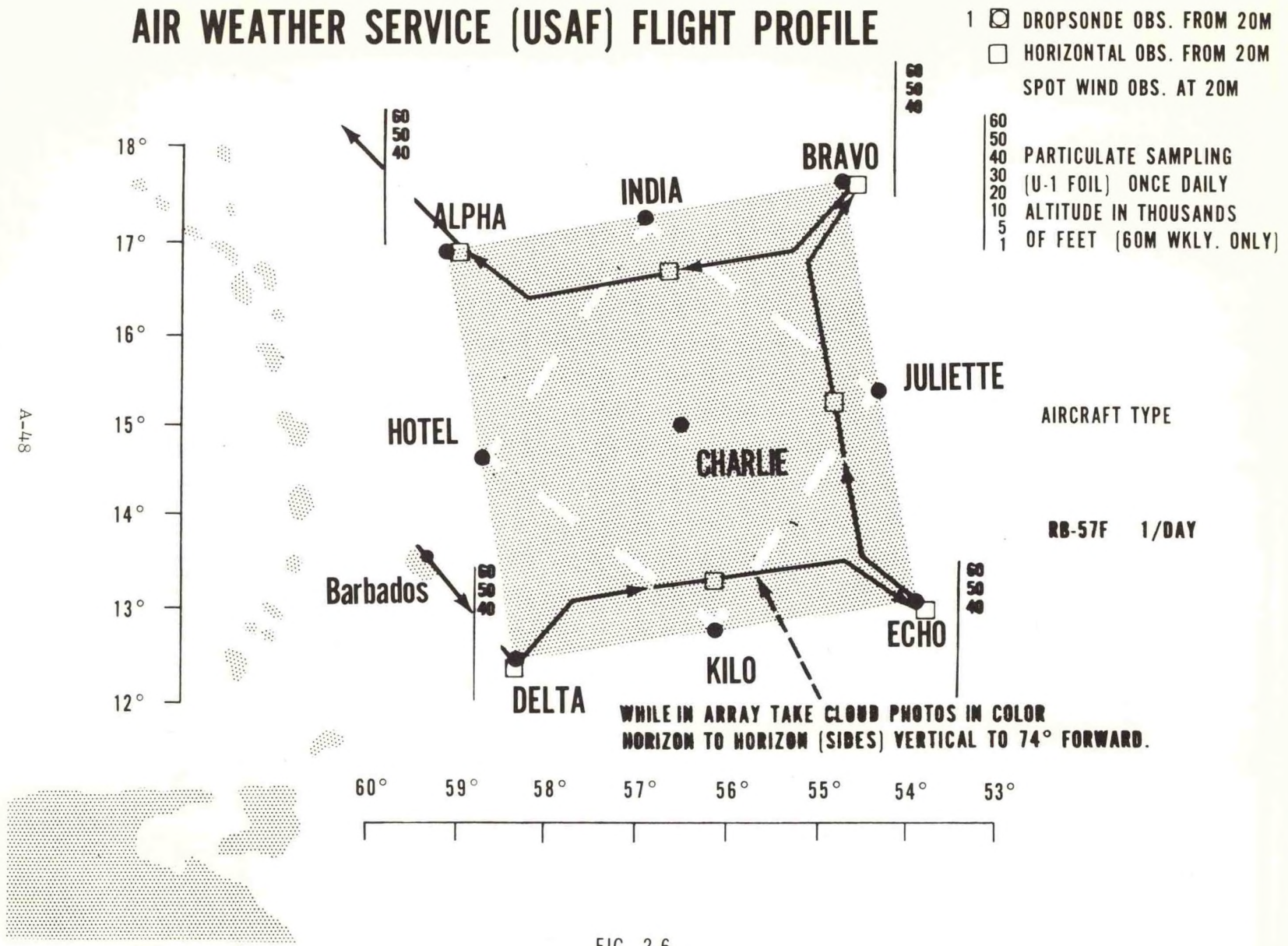

AIR WEATHER SERVICE (USAF) FLIGHT PROFILE
1 DROPSONDE OBS. FROM 20M
HORIZONTAL OBS. FROM 20M
SPOT WIND OBS. AT 20M
60
50
40
30
20
10
5
1
PARTICULATE SAMPLING
(U-1 FOIL) ONCE DAILY
ALTITUDE IN THOUSANDS
OF FEET (60M WKLY. ONLY)
ALPHA
BRAVO
INDIA
JULIETTE
HOTEL
CHARLIE
Barbados
ECHO
KILO
DELTA
AIRCRAFT TYPE
RB-57F 1/DAY
WHILE IN ARRAY TAKE CLOUD PHOTOS IN COLOR
HORIZON TO HORIZON (SIDES) VERTICAL TO 74° FORWARD.
18°
17°
16°
15°
14°
13°
12°
60°
59°
58°
57°
56°
55°
54°
53°

FIG. 2-6

LINE INTEGRAL-NIGHT TRACK

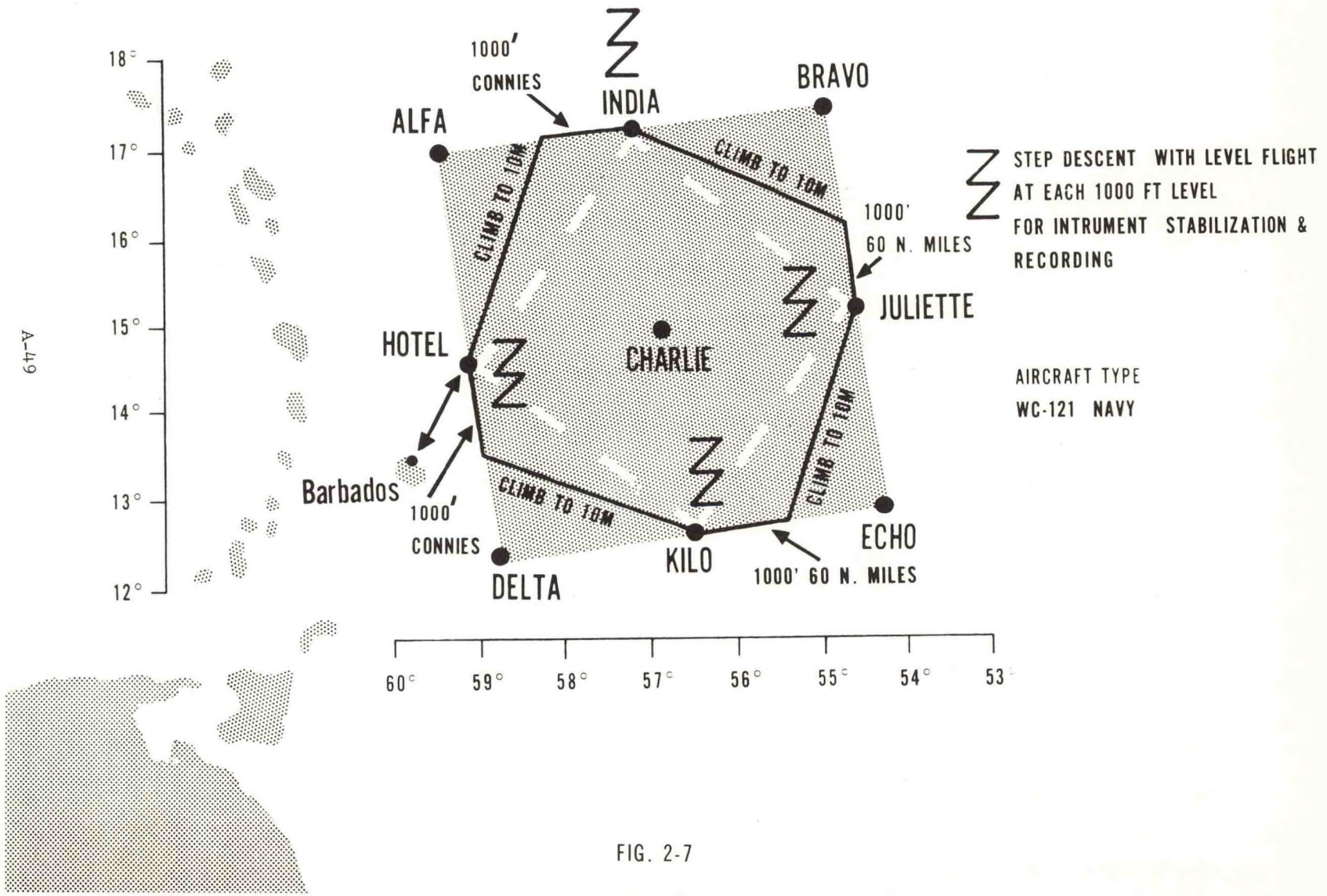
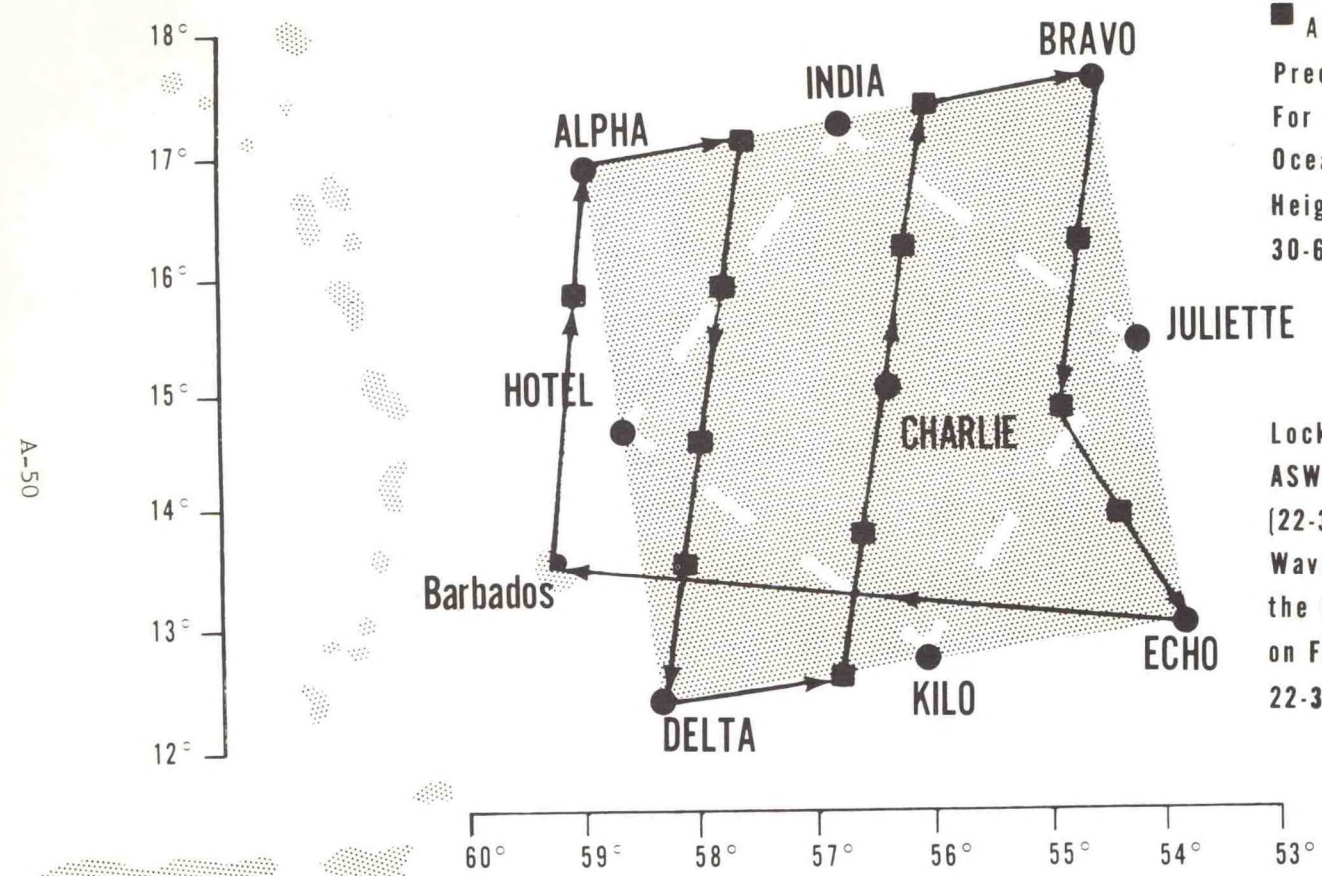


FIG. 2-7

ASWEPS (US NAVY) FLIGHT GRID A



Continuous ART Measurements
8-13 Micron Infrared
■ AXBT Bathythermographs
Precise Radar-Ranging
For Profile Mapping of the
Ocean Wave Structure, Wave
Heights 0.3-15 Meters
30-600 Meters in Length

AIRCRAFT TYPE

Lockheed Super Constellation
ASWEPS FLIGHT GRID A
(22-30 May 1969) (16-22 June 1969)
Wave Data Will be Taken in Support of
the Momentum Flux Measurements
on FLIP and USNS Gilliss
22-30 May 1969

FIG. 2-8

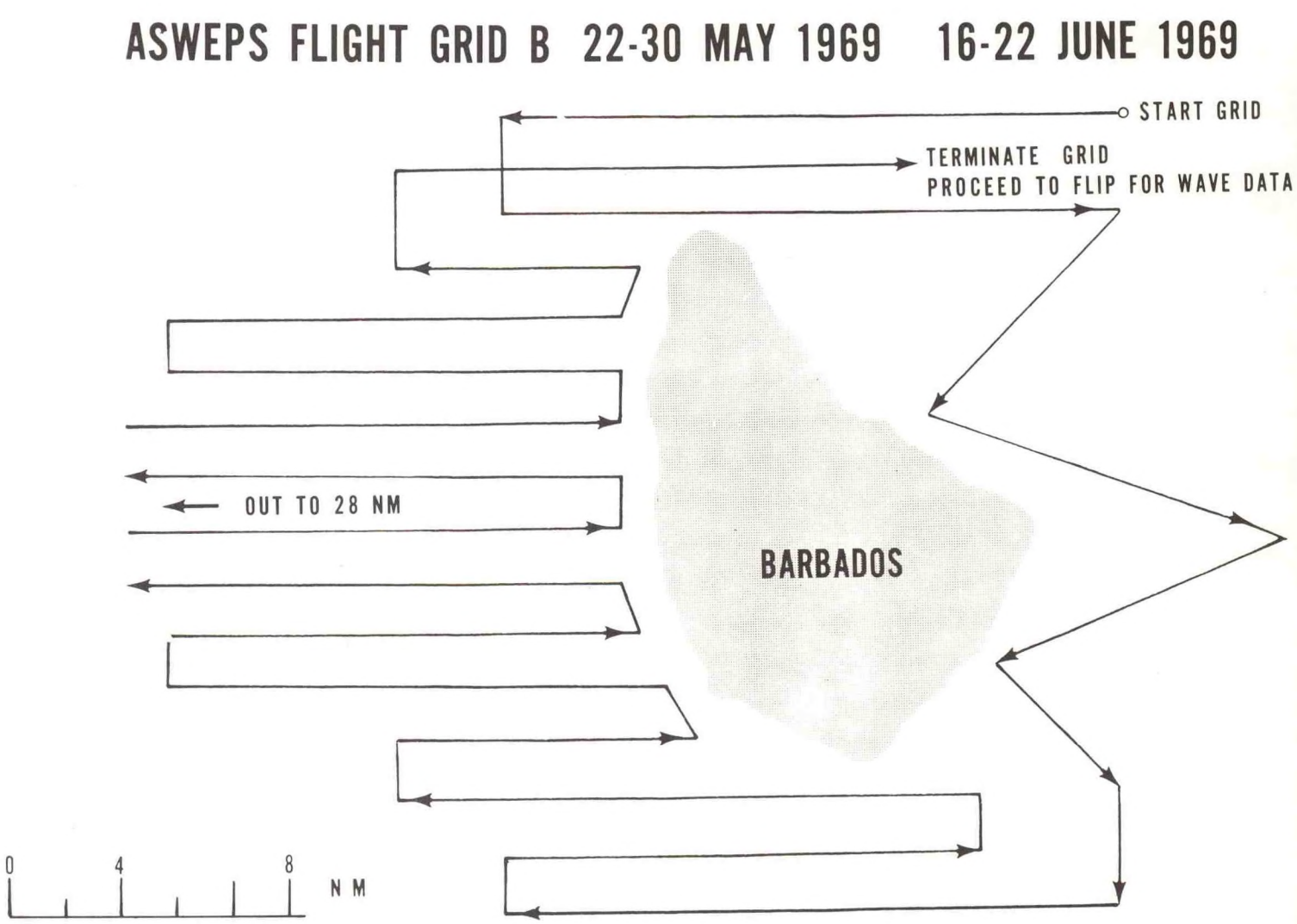

ASWEPS FLIGHT GRID B 22-30 MAY 1969 16-22 JUNE 1969
START GRID
TERMINATE GRID
PROCEED TO FLIP FOR WAVE DATA
OUT TO 28 NM
BARBADOS
0
4
8
N M

FIG. 2-9

APPENDIX 3

LOGISTICS

1. Staging

The primary staging area for the ships scheduled to occupy the fixed locations in the BOMEX array has been Gulfport, Mississippi. Modifications to the ships necessary for the installation of the observing and data handling subsystems were accomplished by a local contractor, under the guidance of a team from the BOMEX Project Office. Expendables and supplies such as helium, radiosondes, balloons etc., were pre-positioned at the U.S. Naval Construction Battalion Center at Gulfport, prior to loading on the ships. Installation and check-out of the Signal Conditioning and Recording Device and associated equipment was accomplsihed by NASA, Mississippi Test Facility. Installation and testing of the observing and data recording subsystems took place for all ships during the period 4 March - 24 April 1969.

2. Airlift

The National Guard Bureau is supporting BOMEX airlift requirements to the maximum extent practicable through Air National Guard units. The Air National Guard units are operated by the individual states and coordinated by the National Guard Bureau. The logistics flights provided by the Air National Guard units have played and are playing a significant role in insuring the success of BOMEX. The following is a schedule of the currently approved flights.

AIR NATIONAL GUARD
PROJECT BOMEX TRANSPORTATION REQUIREMENTS, MONTH OF APRIL 1969

Item	Routing	Date	Equipment Description, weight, cubes, remarks
			(USAF)
A1	Tinker AFB to Gulfport, Miss	4/09	40 USAF personnel. Contact: SGT Parker, telephone 405-732-7321 x2370
			(MTF, RFF)
A2	Gulfport, Miss to Barbados	4/14	NASA generator sets, equipment, and personnel from Mississippi Test Facility (Gulfport). Generators are trailer mounted, two in number. Dimensions 14 x 8 x 9 feet and 11 x 5 x 6½ feet (length-width-height). Weight 17,000 pounds, volume 1500 cu ft. Three (3) men. Contact: Dan Blenis, telephone 601-688-3541. Research Flight Facility (Miami) has two ground power units, 100 pounds @54 cu ft and 1800 pounds @120 cu ft for loading at Miami (Miami International requested); also 2 wheels for DC-6 and 2 wheels for DC-4, weight 1000 pounds. Contact: Mr. Callahan, telephone 305-350-5607. Miami loading requested for 15 April.
			(FSU)
A3	Tallahassee, Fla to Barbados	4/15	Florida State University TRITON buoy parts and ancillary equipment, plus 15 personnel. Battelle Northwest equipment staged at Tallahassee. Total weight 34,439 pounds, 2434 cu ft. Contact: COL Petersen, telephone: 904-599-2526.
			(Hq, USCG, Lamont Labs)
A4	Andrews AFB to Barbados	4/18	USCG communications equipment and personnel. BOMEX Headquarters files and equipment. AFCRL instrumentation. Total weight about 3500 pounds, 400 cu ft. Five USCG men. Contact: LCDR Michael Johnson, telephone 202-964-5054

AIR NATIONAL GUARD
PROJECT BOMEX TRANSPORTATION REQUIREMENTS, MONTH OF APRIL 1969

Item	Routing	Date	Equipment description, weight, cubes, remarks
A5	Seattle, Wn to Barbados via Detroit, Mich and Millville, N.J.	4/18	(FLIP) Equipment for FLIP experiments from U of Washington, U of British Columbia and Oregon State University at Seattle (approximately 5500 pounds, 200 cu ft); Equipment for FLIP from U of Michigan at Ann Arbor (approximately 500 pounds, 30 cu ft); and equipment for FLIP from C.W. Thornthwaite Associates in Centerton, N.J. (1130 pounds, 165 cu ft). Contacts: In Seattle, Leonard Lang, telephone 206-543-4586; In Ann Arbor, Donald Portman, telephone 313-764-0597; In Centerton, William Superior, telephone 609-358-2350 or 609-691-4549. NOTE: Desirable dates and fields are: Boeing Field, Seattle on 18 April; Willow Run Airport near Detroit on 19 April; and Millville Municipal Airport, New Jersey on 20 April . . . thence to Seawell Airport, Barbados.
A6	Tinker AFB to Barbados	4/24	(USAF) One USAF rawinsonde station, generator set, four Jamesway huts, air conditioners, and 17 USAF personnel. Total weight 16,000 pounds, volume 1500 cu ft. Contact: SGT Parker, telephone 405-732-7321 x 2370, 137th Wing Oak City.
A7	Buckley AFB to Barbados	4/25	(NCAR) National Center for Atmospheric Research van, 19 x 7 x 8 feet (4460 pounds, 1301 cu ft); generator trailer (1390 pounds, 200 cu ft); two-wheel trailer, 15 x 7 x 6 feet (7000 pounds, 696 cu ft); miscellaneous equipment (3750 pounds). Total weight 16,600 pounds, volume approximately 2300 cu ft. Contact: COL Walter Records, telephone 303-444-5151 x 550

AIR NATIONAL GUARD

PROJECT BOMEX TRANSPORTATION REQUIREMENTS, MONTH OF MAY 1969

Item	Routing	Date	Equipment description, weight, cubes, remarks
			(U of Wisconsin)
B1	Madison, Wis to Barbados	5/01	University of Wisconsin automatic picture transmission equipment, peripheral equipment, 3 personnel. Total weight 2250 pounds, volume 152 cu ft. Contact: Mr. Jerry Sitzman, telephone 608-262-5938.
			(MTF)
B2	Gulfport, Miss to Barbados	5/09	Logistics airlift between Washington and Barbados. Contacts:
B2a	Barbados to Gulfport	5/11	Mr. O. E. Scribner, telephone 301-496-8646 at ESSA HQ; CDR Grunwell, telephone 8442 at BOMEX HQ in Barbados.
B3	Andrews AFB to Barbados	5/16	(Logistics airlift between Washington and Barbados) Personnel to
B3a	Barbados to Andrews AFB (via Tallahassee and return)	5/18	Tallahassee on return flight. Contacts: Mr. O.E. Scribner, telephone 301-496-8646 at ESSA HQ; CDR Grunwell, telephone 8442 at BOMEX HQ in Barbados.
B4	Barbados to Gulfport, Miss	5/21	(Data Courier flight) Approximately 1600 pounds magnetic tape in shipping containers, volume 30 cu ft. Plastic bottles containing water samples for Battelle Northwest (AEC). Contact CDR Grunwell, telephone 8442, BOMEX HQ in Barbados. NOTE: Pickup of one man in Tallahassee on the way down to Barbados would be appreciated. Contact Col Petersen, 904-599-2526
B5	Andrews AFB to Barbados	5/30	(Logistics airlift between Washington and Barbados) Contacts:
B5a	Barbados to Andrews AFB	6/01	Mr. O. E. Scribner, telephone 301-496-8646 at ESSA HQ; CDR Grunwell, telephone 8442 at BOMEX HQ Barbados.

AIR NATIONAL GUARD

PROJECT BOMEX TRANSPORTATION REQUIREMENTS, MONTH OF JUNE 1969

Item	Routing	Date	Equipment description, weight, cubes, remarks
C1	Buckley AFB to Barbados	6/02	(National Center for Atmospheric Research equipment) Weight 1800 pounds, volume 148 cu ft. Contact: COL Records, 303-444-5151 x550
C1a	Barbados to Van Nuys, Calif.	6/04	(Equipment of FLIP experimenters) from U of Washington, Oregon State University, University of British Columbia. Not over 8,000 pounds.
C2	Tallahassee, Fla to Barbados	6/08	(FSU equipment and personnel) including 3 small vehicles and 35 people. Weight 29,000 pounds, volume 1800 cu ft. Contact: COL Petersen, Telephone 904-599-2526.
C3	Andrews AFB to Barbados	6/14	(Logistics airlift between Washington and Barbados) Contact: Mr. O.E. Scribner, telephone 301-496-8646.
C3a	Barbados to Gulfport, Miss	6/16	(Data courier flight) Approximately 1600 pounds magnetic tape plus plastic bottles containing water samples. One man. Contact: CDR Grunwell, telephone 8442, BOMEX HQ in Barbados.
C4	Amarillo AFB to Barbados See Note -----	6/21	(Helium gas) not to exceed 10 pallets 36" x 44" x 48", each containing 16 flasks, total weight 22,000 pounds, volume approximately 460 cu ft. NOTE: This requirement is contingent on rate of use of helium. If flight is necessary, confirmation will come by message or phone on or about 12 June. Contact: Mr. Herb Gerstner, Bureau of Mines Helium Activity, Amarillo, telephone 806-376-7304
C8	Moffett Field to Barbados	6/23	(NASA Aircraft Support Equipment)
C5	Barbados to Amarillo AFB (only if C4 is required)	6/22	(Empty helium cylinders) on pallets, not to exceed 10 pallets. Contact: CDR Grunwell, telephone 8442 BOMEX HQ in Barbados.
C6	Andrews AFB to Barbados	6/27	(Logistics airlift between Washington and Barbados) Contact: Mr. O.E. Scribner, ESSA HQ telephone 301-496-8646; CDR Grunwell, BOMEX HQ in Barbados, telephone 8442.
C6a	Barbados to Andrews AFB	6/29	
C7	El Segundo, Cal to Barbados	6/27	(Hughes Aircraft satellite tracking equipment) folding dish antenna, some personnel. Details not yet available.

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Item	Routing	Date	Equipment description, weight, cubes, remarks
D1	Barbados to Gulfport, Miss	7/08	(Data courier flight) Appriximately 1600 pounds magnetic tapes volume 300 cu ft. Also plastic bottles containing water samples for Battelle Northwest. One man. Contact: CDR Grunwell telephone 8442 in Barbados NOTE: Pickup of one man in Tallahassee, Fla requested on way down to Barbados. Contact: COL Petersen, telephone 904-599-2526
D2 D2a	Andrews AFB to Barbados Barbados to Andrews AFB via Tallahassee	7/18 7/20	(Logistics airlift between Washington and Barbados) Contact: Mr. O.E. Scribner, telephone 301-496-8646, ESSA HQ; CDR Grunwell, telephone 8442, BOMEX HQ in Barbados.
D3	Barbados to Tinker AFB	7/31	(USAF ground weather station) generator, 4 Jamesway huts, 2 or 3 rawinsonde sets, ancillary equipment, 59 USAF personnel and equipment. Weight approximately 38,000 pounds, volume approximately 2000 cu ft. Contact: CDR Grunwell, telephone 8442, BOMEX HQ in Barbados.

AIR NATIONAL GUARD

PROJECT BOMEX TRANSPORTATION REQUIREMENTS, MONTH OF AUGUST 1969

Item	Routing	Date	Equipment description, weight, cubes, remarks
E1	Barbados to Andrews AFB	8/01	(USCG communications equipment and personnel) BOMEX HQ equipment and files. Perhaps other items for transport to Washington area at that time not to exceed total weight of 15,000 pounds. Contact LCDR Johnson, BOMEX HQ Barbados, telephone 8442.
E2	Barbados to Gulfport, Miss via Miami, Fla	8/03	(Data courier flight to Mississippi Test Facility) plus NASA generators, equipment and 14 personnel. Generators are 14 x 8 x 9 feet and 11 x 5 x 6½ feet. Two ground power units for Research Flight Facility in Miami, plus 4 aircraft tires and wheels. Total weight 22,000 pounds. volume 1725 cu ft. Contact: CDR Grunwell, BOMEX HQ Barbados, telephone 8442.
E3	Barbados to Tallahassee, Fla	8/10	(FSU equipment and 10 personnel) Includes TRITON buoy components and shipboard equipment. Weight 22,500 pounds, volume
E4	Barbados to Buckley AFB	8/02	(NCAR van) 19 x 7 x 8 feet; generator trailer; miscellaneous equipment. Approximately 16,000 pounds, 2,000 cu ft. Contact: COL Walter Records Telephone 303-444-5151 x550.
E5	Barbados to Caracas, Venez or Barcelona, Colombia	8/02	(NCAR equipment) 7000 pounds, 900 cu ft. Contact: COL Walter Records, telephone 303-444-5151 x550.
E6	Barbados to Tallahassee, Fla	8/25	(FSU equipment and personnel) Weight 22,500 pounds, volume 10 passengers.
E7	Barbados to Tallahassee, Fla	8/28	(FSU equipment and personnel) Weight 22,500 pounds, 10 passengers
E8	Barbados to Tallahassee, Fla	8/31	(FSU equipment and personnel) Weight 23,750 pounds, 15 passengers

AIR NATIONAL GUARD

PROJECT BOMEX TRANSPORTATION REQUIREMENTS, MONTH OF AUGUST 1969

Item	Routing	Date	Equipment description, weight, cubes, remarks
E9	Barbados to El Segundo, Cal	8/01	Hughes Aircraft satellite tracking equipment) folding dish antenna, personnel. 22,150 pounds, 3400 cu ft. One crate is 5 x 5 x 30 feet; another is 10 x 15 x 15 feet. The latter crate can be disassembled into smaller components if required. Contact: Mr. Dorfman, telephone 213-648-3346 or Mr. Winnek, telephone 213-648-4724.
E10	Barbados to Moffett Field	8/05	NASA/AMES Aircraft support equipment

3. Local Transportation in Barbados

In general, scheduled transportation will be provided by the BOMEX Field Headquarters for those activities based on Barbados. This will include a shuttle bus service between the Field Headquarters at Paragon House and major hotels, shuttle service from ships' berthing to the harbour gate, mail runs and staff cars as required to perform administrative duties.

APPENDIX 4

MISCELLANEOUS

1. Locations of Centers of BOMEX Activity in Barbados

Figure 4-1 is a map of Barbados on which the locations of the BOMEX Field Headquarters (Paragon House), the Barbados Hilton Hotel, the Caribbean Meteorological Institute and the AN/MPS-34 Radar site have been indicated.

2. Living Accommodations

U. S. Government quarters are not available in Barbados; however, no problem is anticipated in securing adequate commercial accommodations at rates compatible with per diem allowances. Some hotels, including the Barbados Hilton have made special arrangements for BOMEX personnel. The BOMEX Project Office and the Field Headquarters will assist in procuring housing for personnel involved in the Experiment insofar as is practicable without incurring U. S. Government responsibility or liability.

3. BOMEX Identification Cards

The Government of Barbados, through its Ministry of Home Affairs has made arrangements for the provision of identification cards for personnel participating in BOMEX. Participants and official visitors should request these cards from the BOMEX Field Headquarters.

4. Mailing Address and Telephone Numbers for BOMEX Field Headquarters

Telephone numbers for the Field Headquarters in Barbados are 88359 and 87395. The mailing address is:

BOMEX Field Headquarters
Paragon House
Barbados, W. I.

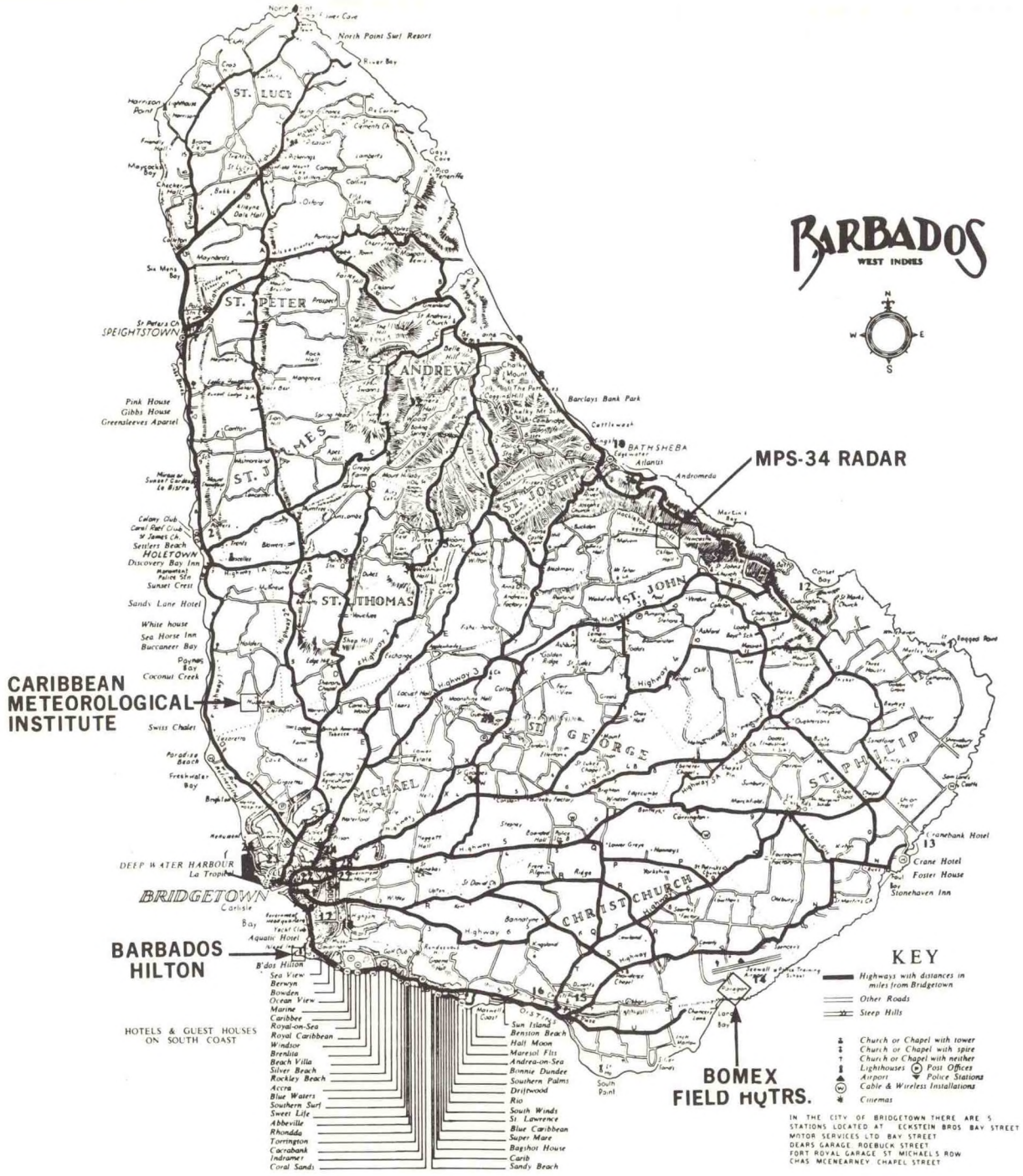
BARBADOS
WEST INDIES
MPS-34 RADAR
CARIBBEAN METEOROLOGICAL INSTITUTE
BARBADOS HILTON
BOMEX FIELD HQTRS.
BRIDGETOWN
SPEIGHTSTOWN
HOLETOWN
ST. LUCY
ST. PETER
ST. ANDREW
ST. JAMES
ST. JOSEPH
ST. JOHN
ST. THOMAS
ST. GEORGE
ST. PHILIP
ST. MICHAEL
CHRIST CHURCH
DEEP WATER HARBOUR
HOTELS & GUEST HOUSES ON SOUTH COAST
KEY
Highways with distances in miles from Bridgetown
Other Roads
Steep Hills
Church or Chapel with tower
Church or Chapel with spire
Church or Chapel with neither
Lighthouses
Post Offices
Airport
Police Stations
Cable & Wireless Installations
Cinemas
IN THE CITY OF BRIDGETOWN THERE ARE 5 STATIONS LOCATED AT
ECKSTEIN BROS BAY STREET
MOTOR SERVICES LTD BAY STREET
DEARS GARAGE ROEBUCK STREET
FORT ROYAL GARAGE ST MICHAEL'S ROW
CHAS MCENEARNEY CHAPEL STREET

FIG. 4-1

5. Mr. Valti Powell, Headquarters Liaison Officer of the BOMEX Project Office, will remain at the Rockville, Maryland location to insure continuity and to provide such support as may be required during the field phases.