U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, Secretary
WEATHER BUREAU
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NATIONAL SEVERE STORMS PROJECT

REPORT No. 5

A Summary of Field Operations and Data Collection by the National Severe Storms Project in Spring 1961

by

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Washington, D. C.
March 1962

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1. INTRODUCTION

Between March 15 and June 4, 1961, field operations centered at Oklahoma City were carried out by the National Severe Storms Project (NSSP), a cooperative effort involving several agencies. These agencies are the U. S. Weather Bureau (USWB), the National Aeronautics & Space Administration (NASA), the Federal Aviation Agency (FAA), the U. S. Air Force's Aeronautical Systems Division (ASD), Geophysics Research Directorate (GRD), Air Defense Command (ADC), Air Weather Service (AWS) and Tactical Air Command (TAC), the U. S. Army Signal Corps (USASC) and the University of Chicago. In addition, the University of Oklahoma furnished space and facilities for the Weather Bureau Doppler radar. These groups were drawn together by their common interest in severe local storms and the opportunity for a unified effort in pursuing complementary objectives.

This project is an outgrowth of exploratory efforts in earlier years, which demonstrated the feasibility of utilizing aircraft along with ground based observational facilities for the detailed description of severe convective phenomena characteristic of the Great Plains area. An account of the Weather Bureau's earlier Tornado Research Airplane Project (1956-59) and National Severe Local Storms Research Project (a limited cooperative undertaking in 1960) are given in a separate report in this preprint series [1].

It is the purpose of the present report to provide a general summary of the Project during the Spring of 1961, and to make known what data are available as a result of the field operations. These operations have yielded a vast fund of data, much of which will be useful in studying the structure and behavior of severe thunderstorms and the environments in which they grow. A separate report to be issued later will summarize some of the broad-scale findings from the 1961 operations and certain of these will be treated in more detail in further Project reports and in the regular scientific journals.

2. PLANNING AND OBJECTIVES

At meetings of the NSSP Advisory Panel on October 24-25, 1960 [2] and at an operational conference on January 5-6, 1961, experience and research data from previous years were reviewed, and objectives and operational plans were laid out for the 1961 season. Lists of participants at these meetings are

given in Appendices IV and V. An Operational Guide [3] was prepared for use in the field operations and the objectives of the Project were described in the first report in this preprint series [4]. These objectives can be briefly stated as follows:

1. To investigate the structure and evolution of those parameters of cyclonic-scale disturbances which are responsible for the outbreak of severe convection.
2. To examine and describe the detailed structures of mesoscale and convective-scale systems so as to understand the mechanisms underlying the growth, movement, and dissipation of squall lines and severe weather cells.
3. To study the distribution and intensity of severe convective by-products (tornadoes, hail, turbulence, lightning, icing, surface gusts) relative to the cloud mass.
4. To develop a qualitative and quantitative classification of convective storms by means of ground-based and air-borne radar.
5. To study the energy budget of severe convective storms.
6. Eventually, to look into the feasibility of cloud modification methods which may apply to lessening the effects of severe convection.

Data to accomplish these objectives were gathered from regular and mobile upper-air stations, the normal reporting surface observation network supplemented by special research networks, Weather Bureau and military radar stations, a special pibal network, the sferics network, ground stereophotographic facilities, a Doppler radar, and instrumented aircraft.

3. FACILITIES

A. *Staging Area.*

The staging area for the 1961 season was at Oklahoma City. Operational headquarters were located in the National Guard Hangar at Will Rogers Field. Telephone, teletype, and facsimile equipment were installed and used in conjunction with information received from the Severe Local Storms Forecast Center in Kansas City and from the Extended Forecast Unit in Suitland, Maryland, in the planning and conduct of the operations. HF radio communications were used for air-ground exchange of meteorological information and flight following. At the WSR-57 radar site, VHF and UHF dual radio communications were used for aircraft control. The U. S. Weather Bureau Research Flight Facility (RFF) aircraft and the GRD C-130 were able to base at Will Rogers Field, Oklahoma City, while the other aircraft used Tinker Air Force Base.

B. *Radar.*

The WSR-57 at the Oklahoma City Weather Bureau station and a synchronized AN/MPX-7 IFF interrogator were used in control of the aircraft during cloud penetrations and during flights in range of the radar. Precipitation echoes and IFF and "skin paint" returns from aircraft were displayed jointly, along with a map of the high altitude airways, on a repeater scope utilized by FAA controllers assigned to NSSP. The same information, minus the airways map, was photographed on the WSR-57 scope. Use of radar in control of penetration aircraft is described separately [5].

Other radars (PPI and RHI) in the Oklahoma City area took part in a coordinated program designed for quantitative studies of precipitation intensities. Broad-areal coverage was provided by other Weather Bureau and military radar facilities (fig. 1). On selected days, those stations whose coverage extended into areas of expected convective activity were alerted and requested to provide scope photography. A separate report [6] summarizes the radar film available.

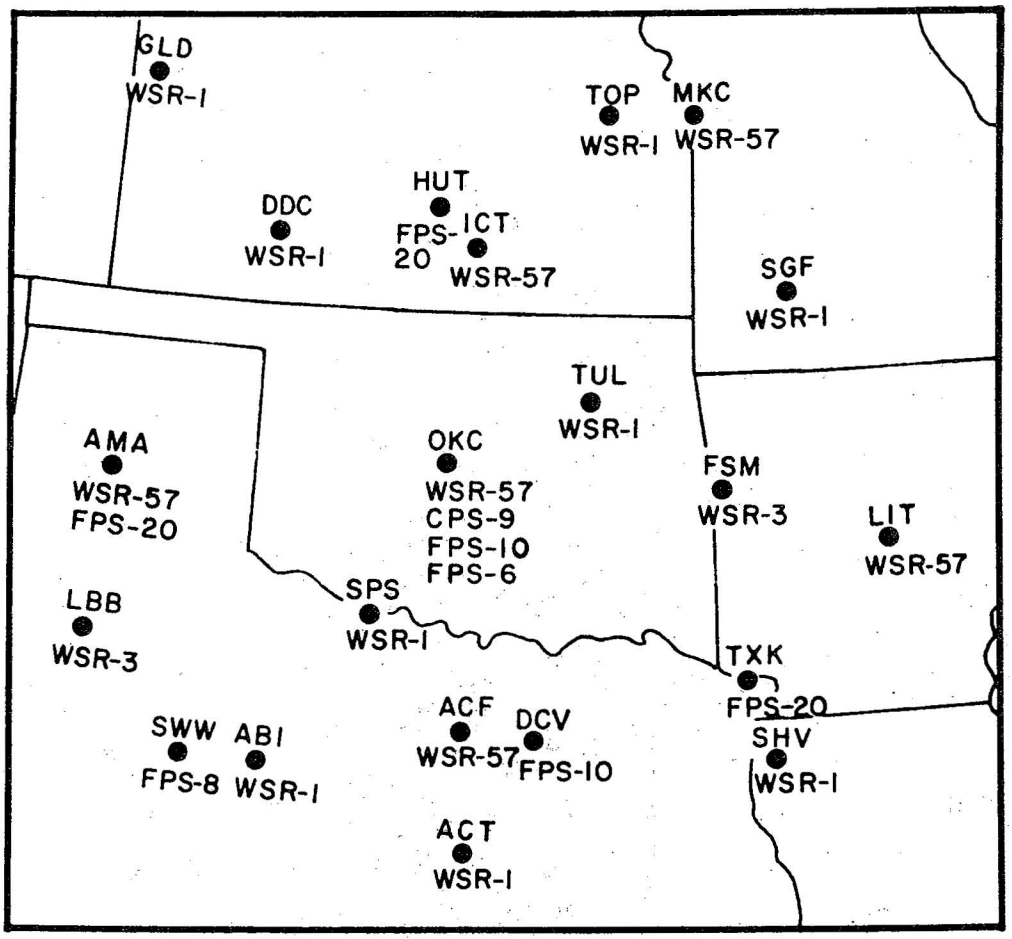

Figure 1.- Types and locations of radar where scope photography was available during 1961 operations of NSSP.

C. *Surface Networks.*

In addition to the regular surface observation reporting stations, two surface research networks were in operation. The "alpha" network consisted of about 200 stations approximately 30 miles apart (fig. 2). All stations are equipped with microbarographs and the majority of them have hygrothermographs and recording rain gages. Within the alpha network a "beta" network (fig. 3) was established with 36 stations 10 to 15 mi. apart. The beta network was equipped with wind recording instruments in addition to the parameters recorded at the alpha stations. Due to shortages of personnel and excessive maintenance and repair requirements, this network was not in full operation during the first part of the season. An index and maps of the surface networks, together with panoramic photographs of their surroundings, are published in a separate report [7].

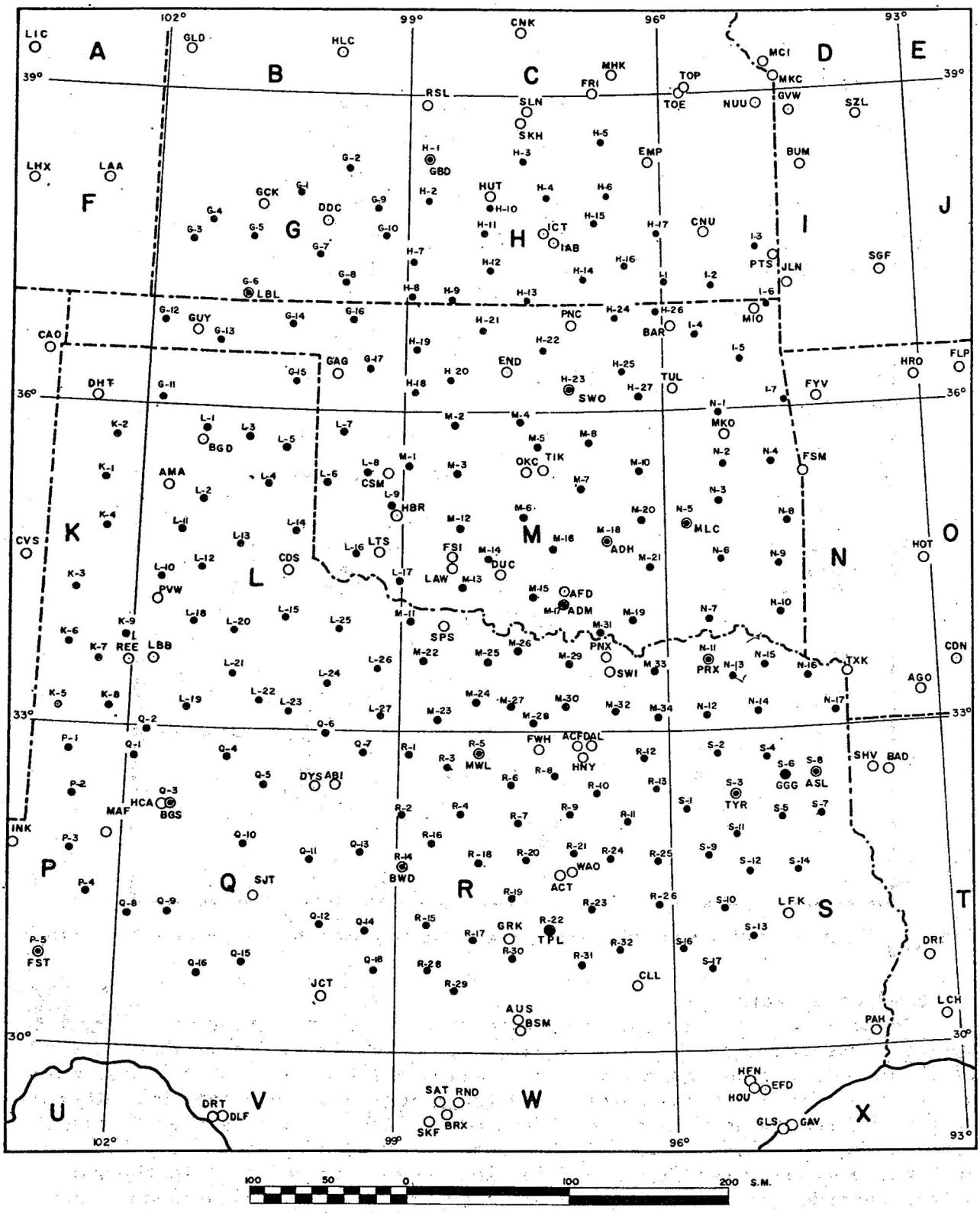

Figure 2. -NSSP Alpha network, 1961.

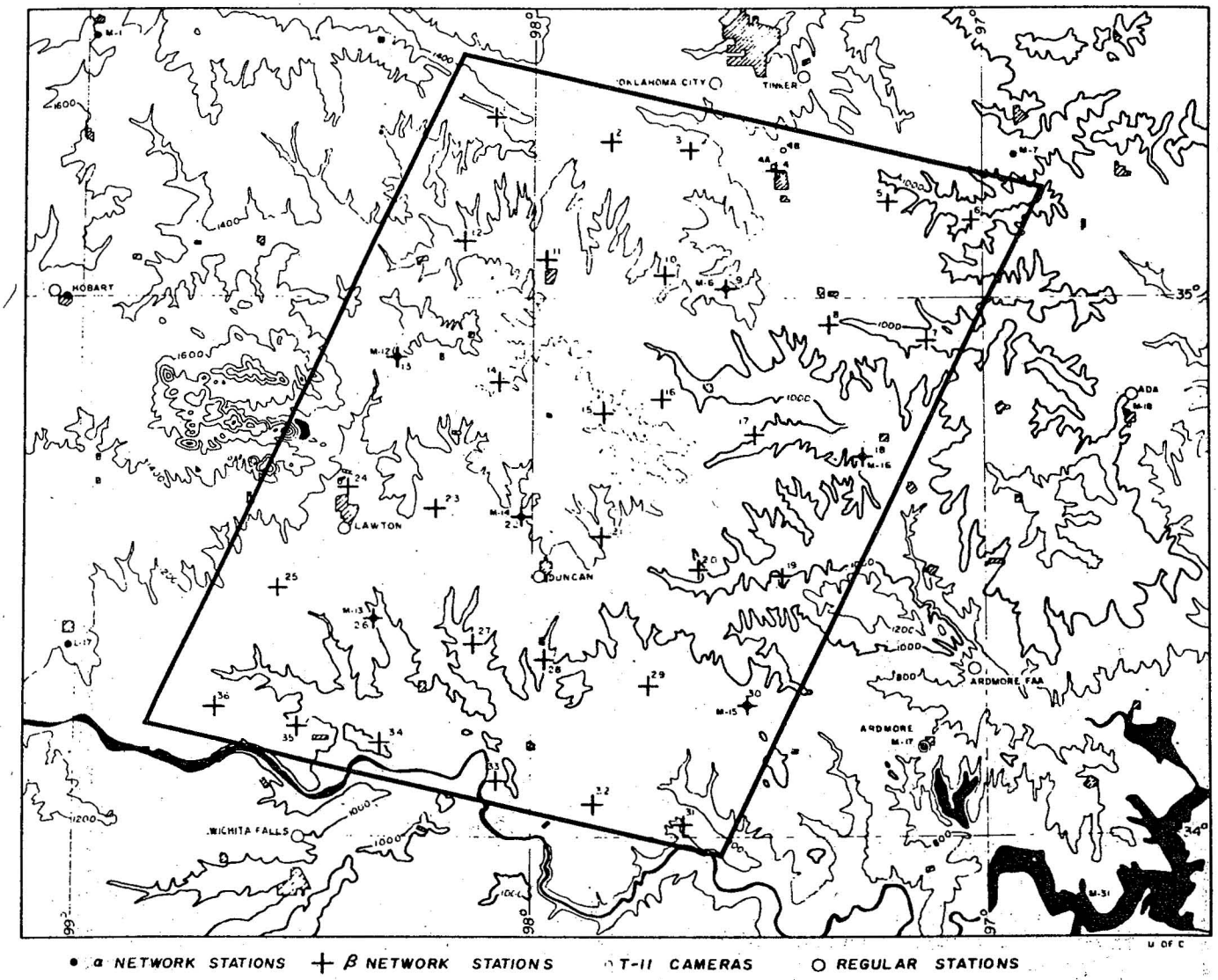

Figure 3. -NSSP Beta network, 1961.

D. *Upper-Air Network.*

At the rawinsonde network stations (fig. 4) the regular observations were supplemented by special (noon LST) and serial soundings on request. Approximately 500 serial rawinsonde observations made typically at 90-min. intervals for a 6-hr. period were obtained from 14 stations in the operating area during periods of squall line development and activity.

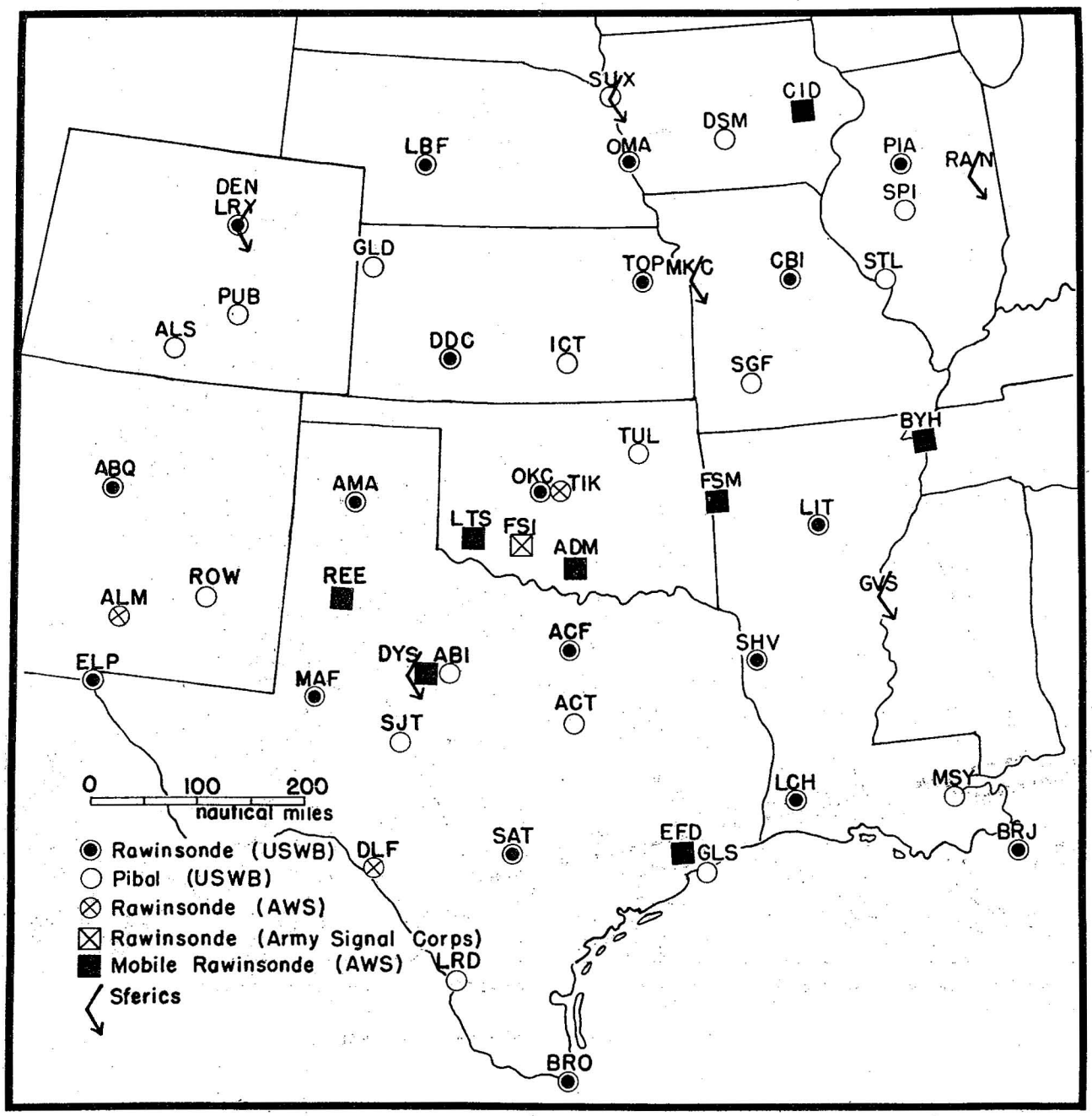

Figure 4. -Upper-air and sferics networks, 1961

A special pilot balloon network (fig. 5) was activated for two specific periods, April 20-29 and May 27 - June 2. On 5 selected days during these periods, hourly observations were made to 10,000 feet elevation at each station for a full 24 hours.

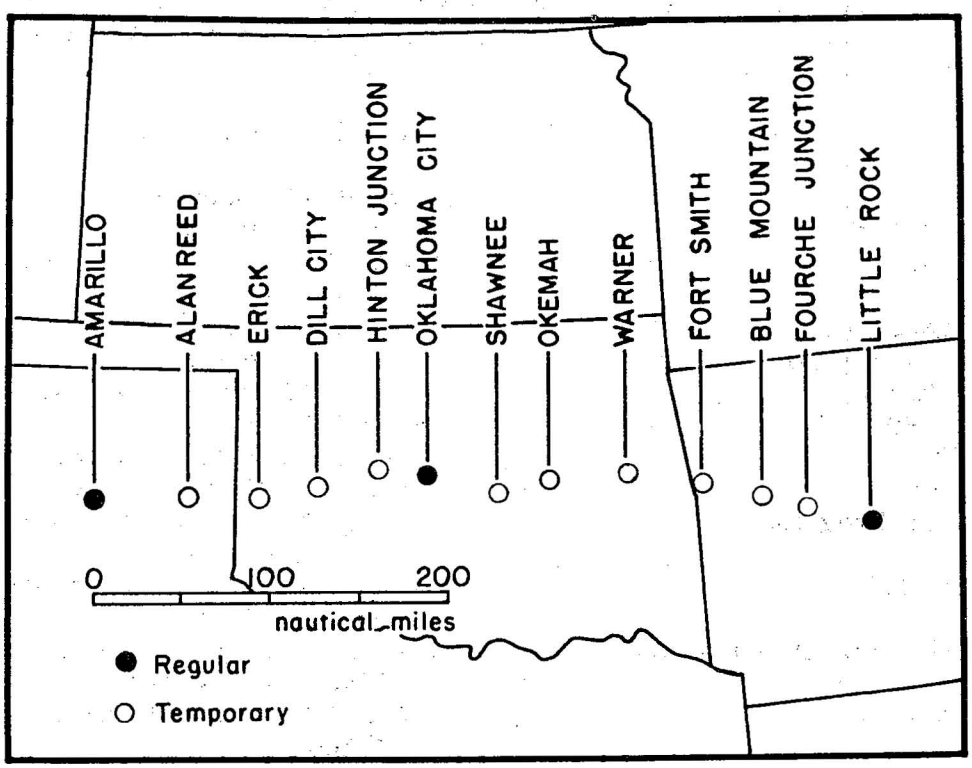

Figure 5. -Special pilot balloon network for study of low-level jet, 1961.

E. *Ground Stereophotography.*

A pair of stereophotography cameras was operated by GRD during the period April 26 to May 31. These cameras, located on the campus of the University of Oklahoma near Norman, were separated by a 13,200 ft. base line oriented 29° 24' east of north.

F. *Sferics Network.*

As in previous years, the sferics network (fig. 4) was operated by the Air Weather Service. Observations from the 5 stations, displayed on a central scope at Kansas City, were recorded by polaroid photography.

G. *Aircraft.*

Thirteen instrumented aircraft participated in the 1961 operation. A total of 107 flights was made on 31 days, involving anywhere from 1 to 9 aircraft on a given day. Table 1 is a listing of the aircraft, the period of operation, and the basic meteorological instrumentation. In general, the B-26 was used at lower altitudes, the DC-6's at medium altitudes, the C-130 at low, medium, and high altitudes, the jet aircraft at high altitudes above 30,000 ft., and the U-2 at the highest altitude.

4. OPERATIONS

The planned period for research operations extended from March 1 through June 15. Due to other commitments, not all aircraft and surface facilities were available for the complete period. Table 1 gives dates when the various aircraft were on station, and when ground observational facilities were operational or on call for NSSP purposes.

Table 1, Availability of Observing Facilities

B-26	March 15-June 15
DC-6 (40C) and B-57	March 15-May 31
DC-6 (39C)	March 29-May 31 (operational May 11-May 31)
F-106 (NASA-ASD)	April 19-June 4
B-66 & B-47 (ASD)	April 10-May 18
B-47 (GRD)	April 17-May 31 (on call)
C-130 (GRD)	April 20-May 19
U-2 (GRD)	April 17-May 31 (on call)
B-66 (TAC)	April 15-May 31 (on call)
OKC Radar Program	March 15-June 4 (operational April 18-June 4)
Doppler Radar	April 10-May 31 (operational April 29-May 31)
Stereophotographic Network	April 20-May 31 (operational April 27-May 31)
Pibal Network	April 20-April 29 & May 27-June 2
Sferics	March 15-June 30
Rawinsonde serials	March 15-June 30
Alpha network (surface)	March 1-June 30
Beta network (surface)	March 1-June 30 (only partial operation during early weeks)

Statistical studies of tornado and hail frequencies in Oklahoma [8] disclosed two distinct peaks of occurrence, centered near the end of April and near May 20. A related study of occurrences of the low-level jet stream [9] showed maximum frequencies near the same dates. The above table shows that periods of availability of facilities encompassed both maxima of occurrence.

In carrying out the observational program on a given day, the established procedure was: (1) decide on the area of concern; (2) decide on the objectives for flight aircraft; (3) coordinate aircraft flight patterns to meet objectives; and (4) alert the necessary supplemental facilities (radar, rawinsonde stations, etc.).

Appendix I, NSSP Flight Operations, is a list of dates on which the aircraft were flown and a brief summary of the flight objectives.

Appendix II is a list showing the individual aircraft and the days on which flights were made.

Appendix III is a list summarizing the operational log of the research activity indicating, among other things, the times the aircraft were flying, the times serial and special rawinsondes were made, and the hours when radar scope photographs were made.

5. DATA PROCESSING AND ARCHIVING

The over-all plan is to process data as rapidly as possible and to archive the data at the National Weather Records Center (NWRC) at Asheville, North Carolina. It is planned that users will obtain the data directly from NWRC. At the time of this report some of the data is still being processed. Following is a listing of the data gathered, its form, and its availability.

A. *Radar.*

Film from Weather Bureau radar stations is archived at NWRC. Film from ADC radar stations is in security storage at NSSP, Kansas City, Missouri. Aircraft radar film is presently archived at NSSP, Kansas City, Missouri. Data from a Doppler radar, which was operated at Norman, Oklahoma, is on magnetic tape and is being processed at the Weather Bureau Office, Evansville, Indiana.

B. *Surface Networks.*

Original barograms, hygrothermograms, wind recorder charts, and rain gage charts of the alpha and beta networks have been edited and bound by days and are archived at NWRC.

C. *Serial Rawinsonde Observations.*

Original forms WBAN-31 A, B, and C, and WBAN-20 (WB Form 610-12) are archived at NWRC.

D. *Special Pibal Network Observations.*

Raw data have been machine processed at the U. S. Weather Bureau's Office of Meteorological Research, Washington, D. C. Microfilm of the machine printouts will soon be available at NWRC.

E. *Ground Stereography.*

Film from the stereography cameras is currently being processed and evaluated by GRD.

F. *Sferics Data.*

Data of the AWS sferics network is now being copied, and will be provided NWRC.

G. *Aircraft Data.*

Most of the aircraft data have now been processed. Archiving of the data at NWRC will probably be delayed until such time as all of it is processed. Some of the data is temporarily archived at NSSP, Kansas City, Missouri.

Many of the aircraft crews maintained flight logs, made in-flight comments, or participated in debriefing sessions. Transcripts of these are on

file at NSSP, Kansas City, Mo. Specific additional data from the various aircraft are as follows:

(1) *NSSP B-26.* Visicorder and photopanel data are being digitalized at NSSP, Kansas City, Mo. Data are then machine processed to yield 10-second printouts of meteorological and navigational parameters. Copies of printouts will be provided NWRC. It is estimated that these will be complete and available by January 1, 1962. Radar film and nose camera film are archived at NSSP, Kansas City, Missouri.

(2) *RFF DC-6-39C, DC-6-40C, and B-57.* Digital data from these aircraft are being machine processed at Miami, Florida, to yield printouts of meteorological and navigational parameters. One set of printouts will be at 1-sec. intervals; another set will be at 10-sec. intervals. Copies of the printouts are expected to be available at NWRC by June 1, 1962. Radar film, and nose and side cloud camera film are archived at NSSP, Kansas City, Missouri.

(3) *ASD B-66 and B-47, and NASA-ASD F-106.* Data from these aircraft are being processed by ASD and NASA. The data will be studied by these agencies first, and will not be available for a year or more.

(4) *GRD U-2.* Flight logs and a portion of the film from the 180° sweep tracking camera are archived at NSSP, Kansas City, Mo. Additional film from this camera, nose camera film, and a limited amount of recorded meteorological data are still being processed by GRD.

(5) *GRD C-130.* A copy of the C-130 radar film is archived at NSSP, Kansas City, Mo. Meteorological data gathered by the C-130 have been retained by GRD. Not all of this data will be processed. Selected portions will be reduced as requested by NSSP.

(6) *GRD B-47.* Copies of the B-47 radar film, cloud camera film, and photopanel film are archived at NSSP, Kansas City, Mo.

(7) *TAC B-66's.* Dropsonde observations of these aircraft are archived at NSSP, Kansas City, Mo. Also on file are cloud camera film and in-flight hand written readouts of temperature, pressure and wind.

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4. Staff, National Severe Storms Project, "National Severe Storms Project Objectives and Basic Design," *NSSP Report No. 1*, U. S. Weather Bureau, Washington, D. C., March 1961. (Preprint).

5. Van Thullenar, C. F., "The Use of Radar in the Control of National Severe Storms Project Penetration Aircraft," *Proceedings, 9th Weather Radar Conference*, Kansas City, Mo., October 1961, pp. 199-205.

6. Coleman, H. L., "A Summary of Radar Data Obtained in NSSP Operations During the Spring of 1961," *Proceedings, 9th Weather Radar Conference*, Kansas City, Mo., October 1961, pp. 432-436.

7. Fujita, T., "Index to the NSSP Surface Network," *NSSP Report No. 6*, U. S. Weather Bureau, Washington, D. C. (To be published.) (Preprint).

8. Prosser, N. E., "Statistical Study of 10-Day Periods with Most Tornado and Hail Activity in Oklahoma," memorandum report, U. S. Weather Bureau, Kansas City, Mo., January 20, 1961. (Unpublished).

9. Sides, J. R., "Low-Level Jet Study," memorandum report, U. S. Weather Bureau, Kansas City, Mo., February 13, 1961. (Unpublished).

APPENDIX I

NSSP AIRCRAFT OPERATIONS

March 1 B-26 Rawinsonde Comparison flight.

March 28 B-26 and DC-6 (40C) completed severe weather investigation flight in a severe weather area in southern Oklahoma and northeast Texas. Hail up to 1 and 3/4 inches in diameter reported in cloud observed by aircraft radar.

March 30 B-57 made a jet stream and clear-air turbulence study in a tornado forecast area in southern Louisiana while on a ferry flight from Oklahoma City to Miami.

April 6 B-26 made a rawinsonde comparison flight.

April 10 B-26, B-57 and DC-6 (40C) made flights in western Texas, Oklahoma, and southwestern Kansas for dimensionalizing low-level jet and high-level jet stream.

April 11 B-26, B-57 and DC-6 (40C) flew severe weather mission in southern Oklahoma and northern Texas. Hail over one inch diameter reported in flight pattern. Tornado reported in area after aircraft flights.

April 14 B-26 and DC-6 (40C) made dropsonde comparison flight.

April 19 DC-6 (40C) and B-26 flew dry line investigation in northwestern Oklahoma and southwest Kansas.

April 20 DC-6 (40C), B-57, and B-26 made morning and afternoon flights over northwestern Oklahoma and southwestern Kansas in an area of anticipated squall line activity which did not develop. This was followed by individual cell sampling in squall line in southeastern Kansas by DC-6 and B-57. Tornadoes reported in area sampled within about two hours after aircraft departed.

April 21 DC-6 (40C), B-57, and B-26 investigated individual thunderstorm cell structure in a squall line in southeast Kansas. Tornado and one-inch hail reported from storm investigated.

April 24 DC-6 (40C), B-57, B-26, C-130, GRD B-47, and U-2 flew preactivity and activity patterns in western Oklahoma and Texas panhandle. B-57, ASD B-47, B-66 and F-106 performed individual thunderstorm cell sampling and penetrations in squall line near Ponca City, Oklahoma. Two-inch hail reported near Ponca City at 1908 CST.

April 26 C-130 flew cloud physics mission in southeastern Oklahoma.

April 28 The F-106 flew penetration missions in the vicinity of Fort Worth, Texas and Ardmore, Oklahoma. Hail was encountered in cell near Fort Worth.

April 30 The B-26 flew a pattern to study the kinematics of squall line environment just to the west of Oklahoma City. Several tornadoes and tornado funnels sighted by aircraft crew.

May 1 C-130, ASD B-47, and B-66 flew in an investigation of individual cell features and thunderstorm penetrations in southeastern Oklahoma. Penetration aircraft sustained hail and lightning damage.

May 3 C-130 and U-2 flew investigations of preactivity and individual cloud samplings in western Oklahoma and Texas panhandle. Hail and tornadoes reported in above area after 1900 CST.

May 4 DC-6 (40C), B-26, ASD B-47, and U-2 flew missions in connection with squall line investigations in Texas panhandle and western Oklahoma. Numerous tornadoes and funnel clouds and baseball-size hail reported in area after 1400 CST.

May 5 B-57, B-26, C-130, ASD B-47, F-106, and GRD B-47 participated in preactivity and activity sampling of a squall line in central and western Oklahoma. Hail 2 and 1/2 inches in diameter reported in area.

May 8 C-130 flew photo reconnaissance of severe weather in northeast Oklahoma, and made cloud physics penetrations of small growing cumulus in eastern Oklahoma.

May 13 DC-6 (39C), DC-6 (40C), B-26, and C-130 flew dry line investigation and then cumulus cloud sampling to the west of Oklahoma City. B-57 flew a mission to study kinematic properties of jet stream over western Oklahoma and Texas panhandle. Tornado reported in the vicinity of Fort Sill at 1950 CST.

May 16 B-26 flew preactivity and individual cell patterns in western Oklahoma and Texas panhandle. ASD B-47 and B-66 flew penetration mission in northeast Texas panhandle. Tornado and hail reported in cell investigated by B-26.

May 16 DC-6 (40C), B-57, and U-2 flew Colorado hail study flight.

May 17 DC-6 (40C), B-57, B-26, C-130, ASD B-47, B-66, T-33, F-106, and U-2 flew preactivity and activity sampling and cell penetrations of a line just to the east and south of Oklahoma City. Small funnel cloud observed by B-26 vicinity of Norman.

May 18 F-106 and T-33 flew penetration mission 70 miles south of Oklahoma City.

May 19 B-26 flew a mission to study low-level inflow in vicinity of cells in south-central Oklahoma and northern Texas.

May 21 DC-6 (39C), DC-6 (40C), B-26, F-106 and T-33 flew squall line and individual cell investigation patterns in southwestern Oklahoma. Tornadoes and hail reported in area.

May 24 TAC B-66's flew high-level kinematics and dropsonde studies in thunderstorm activity area in Texas panhandle. 3/4 inch diameter hail reported in area.

May 24 DC-6 (39C), B-26, U-2, and GRD B-47 flew hail study pattern in northeast Colorado.

May 25 DC-6 (39C), B-26, U-2, GRD B-47, F-106, T-33, and TAC B-66's flew squall line and individual cell investigations and penetrations south and east of Oklahoma City. Tornado reported in area of TAC dropsondes approximately one hour after drop.

June 2 T-33 and F-106 made penetration flights west of Oklahoma City. B-26 made low-level investigation of individual cells in same area.

June 3 T-33 and F-106 made penetration flights to south of Oklahoma City. B-26 made low-level single cell investigation in vicinity of Red River, south of Oklahoma City.

June 13 B-26 flew incipient squall line investigation Wichita-Topeka area.

June 16 B-26 flew rawinsonde comparison flight near Topeka, Kansas.

APPENDIX II

INDIVIDUAL AIRCRAFT FLIGHT DAYS

DC-6-39C ..... *May* 11#, 13, 16+, 21, 24+, 25.

DC-6-40C ..... *March* 17, 28, *April* 10, 11, 14**, 19, 21, 21, 24, *May* 3, 4, 5, 11#, 13, 16+, 17, 21, 29.

B-57 ..... *March* 17, 25, 28, 30, *April* 10, 11, 20, 21, 24, *May* 5, 11#, 13, 16+, 17, 21, 24+, 25.

B-26 ..... *March* 1**, 17, 28, *April* 6**, 10, 11, 14**, 19, 20, 21, 24, 30, *May* 4, 5, 11#, 13, 16, 17, 19, 21, 24+, 25, 29, *June* 2, 3, 13, 16**.

C-130 (GRD) ..... *April* 24, *May* 1, 3, 5, 8, 11#, 13, 17.

B-47 (ASD) ..... *April* 24*, *May* 1*, 4, 5, 11#, 16*, 17*.

B-66 (ASD) ..... *April* 24, *May* 1, 16, 17.

F-106 (ASD) ..... *April* 24, 28, *May* 5, 17, 18, 21, 25, *June* 2, 3,

U-2 (GRD) ..... *April* 24, *May* 3, 4, 16+, 17, 24+, 25.

B-47 (GRD) ..... *April* 24, *May* 5, 24+, 25.

B-66's (TAC) ..... *May* 24 and 25.

T-33 (ASD) ..... *May* 17, 18, 21, 25, *June* 2, 3.

\# = Instrument Compatibility Flight.

\+ = Colorado State U. Hail Study.

* = ASD B-47 flew in support of penetration aircraft.

** = April 6 and June 16 Radiosonde compatibility flights. April 14 Dropsonde compatibility flight.

APPENDIX III

NSSP OPERATIONAL LOG

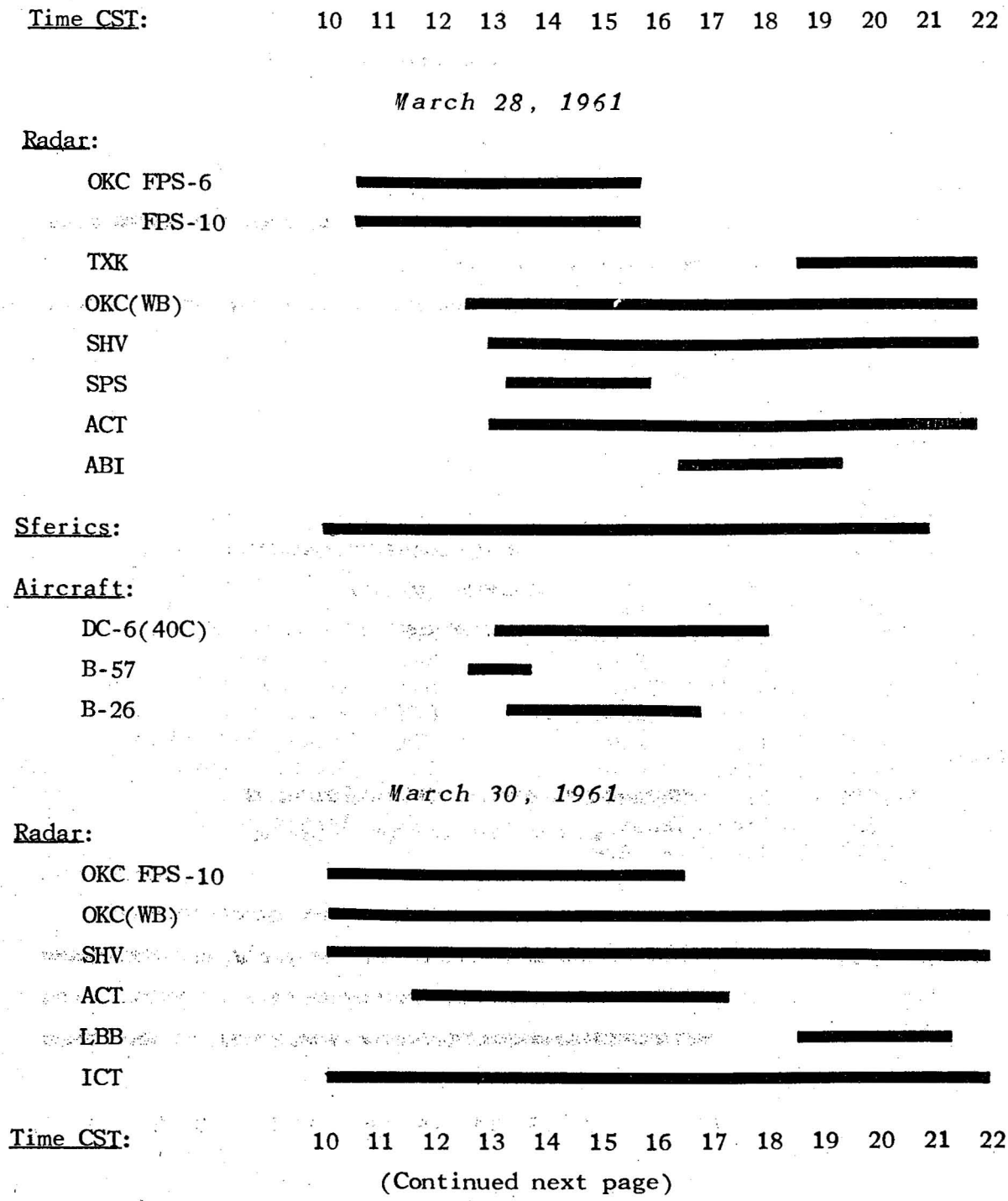
The data collected by NSSP during the spring of 1961 are summarized in the following pages. Even though some radar information was collected before 1000 CST and after 2200 CST, and an occasional aircraft was dispatched shortly before 1000 CST, these hours cover the bulk of irregularly collected data.

The following notes refer to specific types of data:

1. Where the origin of aircraft is not specifically mentioned it is understood they are operated by the U. S. Weather Bureau.
2. Aircraft origin.
   - ASD - Aeronautical Systems Division, U. S. Air Force
   - GRD - Geophysics Research Directorate, U. S. Air Force
   - NASA- National Aeronautics and Space Administration
   - TAC - Tactical Air Command, U. S. Air Force
   - RR - Rough Rider, Communications code name
3. Sferics. All sferics information available is through the U. S. Air Force.
4. Radar. No differentiation is made between Weather Bureau and military radar.
5. Serial and Special Rawinsondes. No differentiation is made between U. S. Weather Bureau and military observations.
6. Identification letters are as follows:

ABI - Abilene, Texas	LTS - Altus, Okla.
ACF - Fort Worth, Texas	MAF - Midland, Texas
ACT - Waco, Texas	MKC - Kansas City, Mo.
ADM - Ardmore, Okla.	OKC - Oklahoma City, Okla.
AMA - Amarillo, Texas	REE - Reese AFB, Texas
DCV - Duncanville, Texas	SGF - Springfield, Mo.
DDC - Dodge City, Kansas	SHV - Shreveport, La.
DYS - Dyess AFB, Texas	SPS - Sheppard AFB, Texas
FSI - Fort Sill, Okla.	SWW - Sweetwater, Texas
FSM - Fort Smith, Ark.	TIK - Tinker AFB, Okla.
GLD - Goodland, Kansas	TOP - Topeka, Kansas
ICT - Wichita, Kansas	TUL - Tulsa, Okla.
LBB - Lubbock, Texas	TXK - Texarkana, Ark.
LIT - Little Rock, Ark.	

NSSP OPERATIONAL LOG



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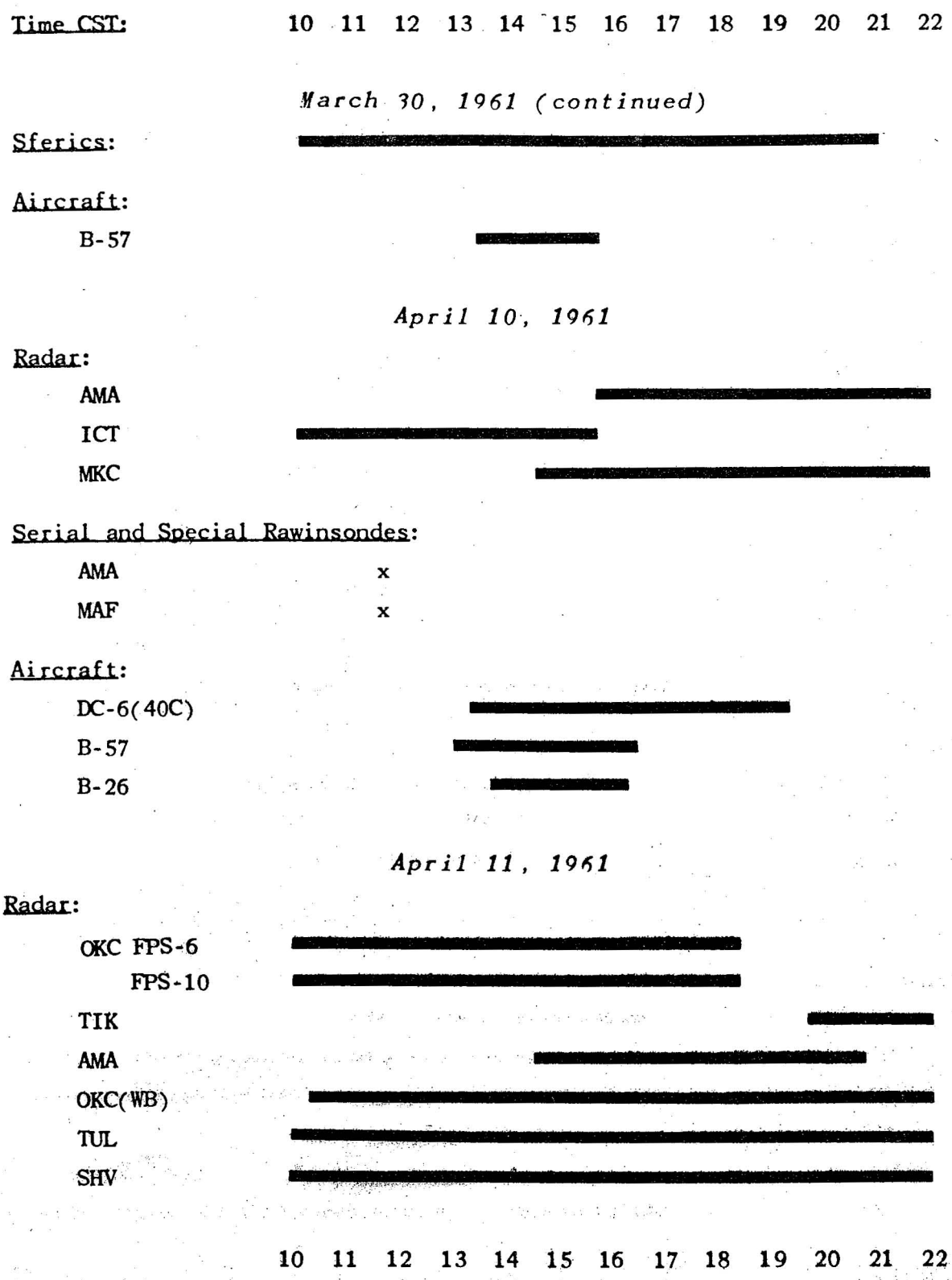

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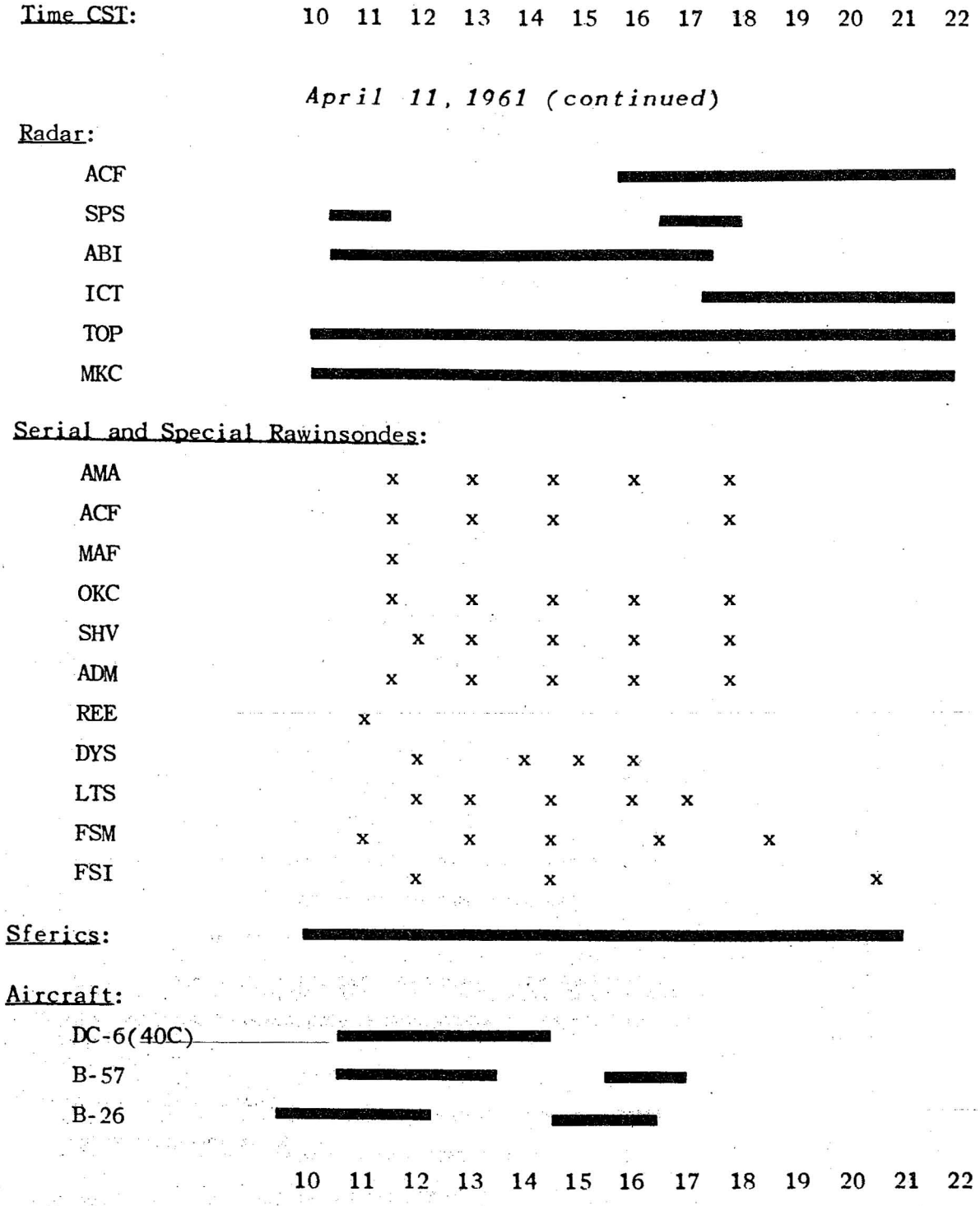
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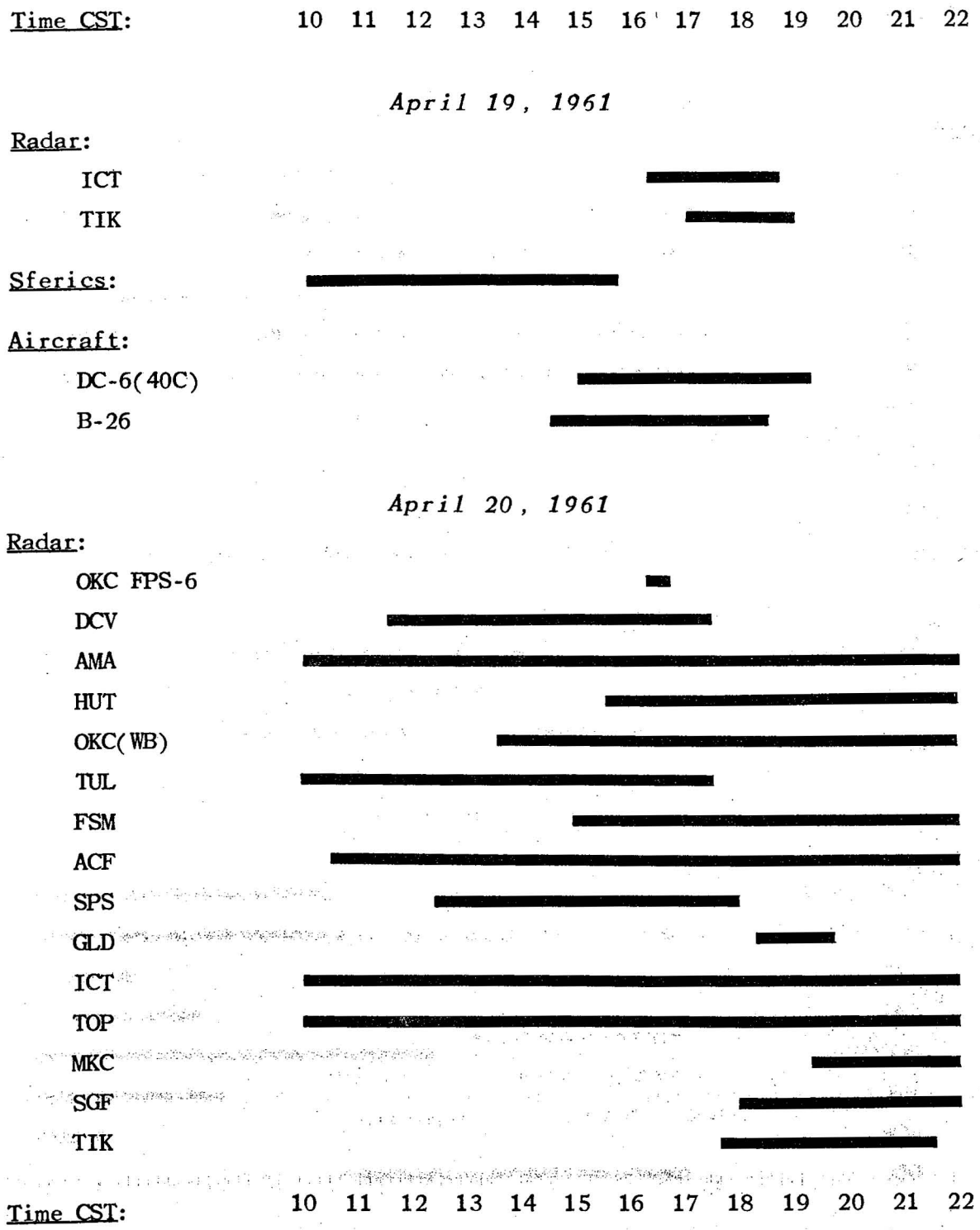

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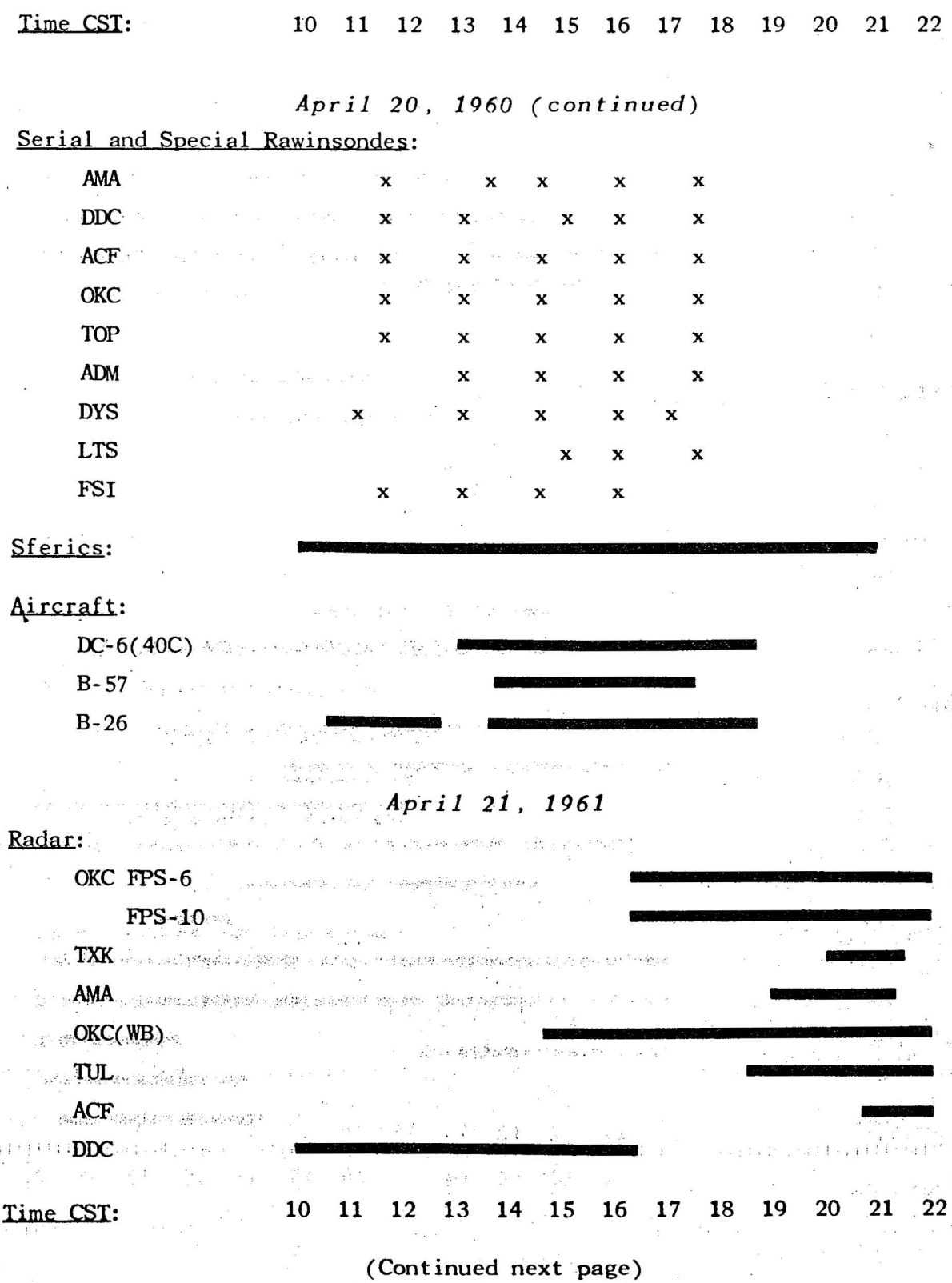

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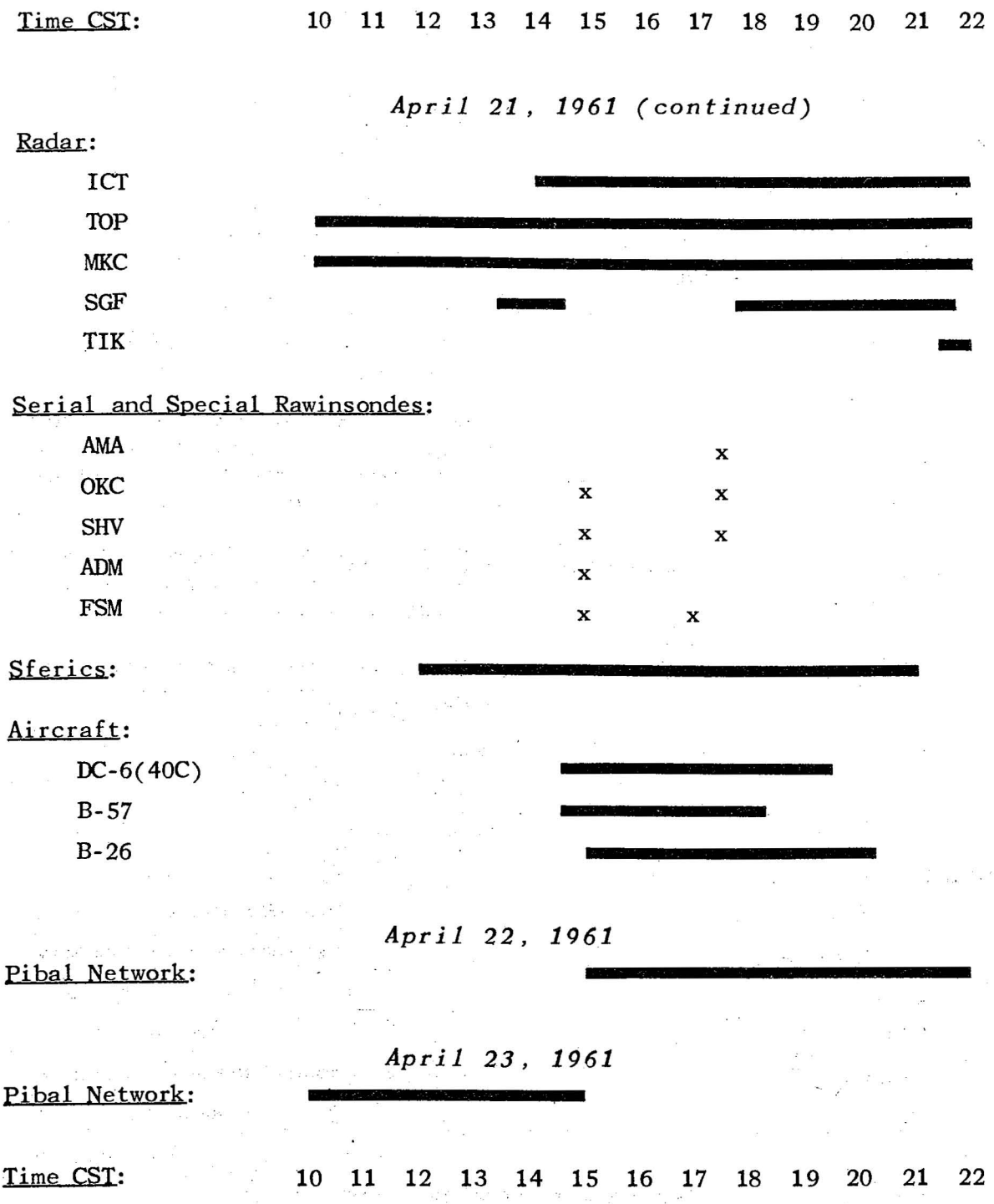

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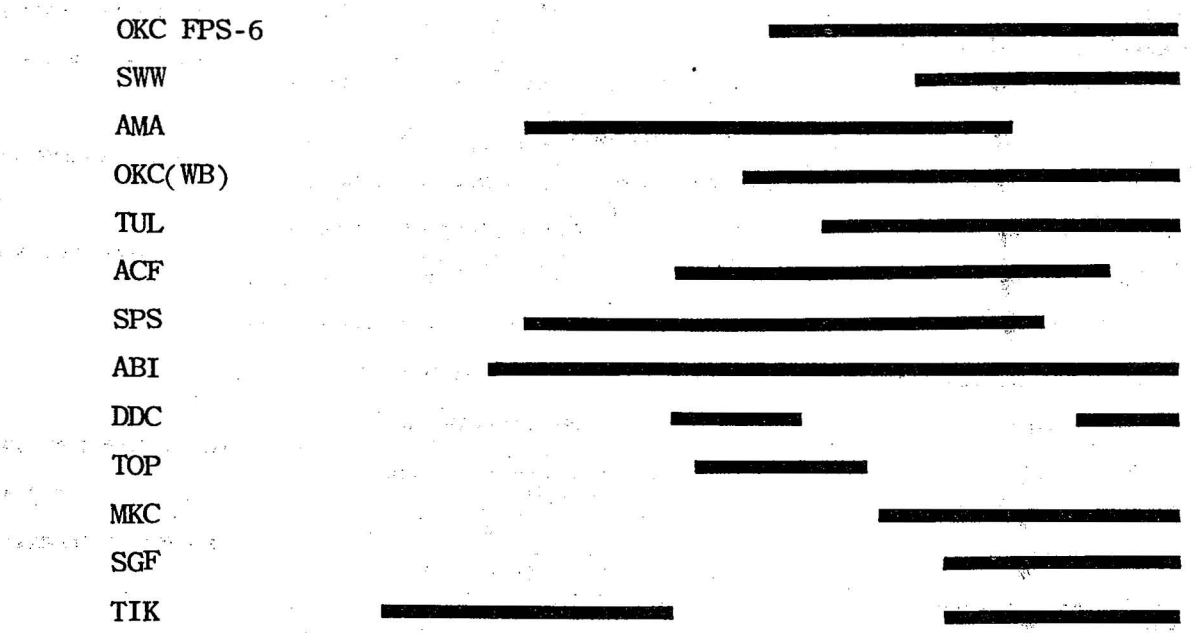
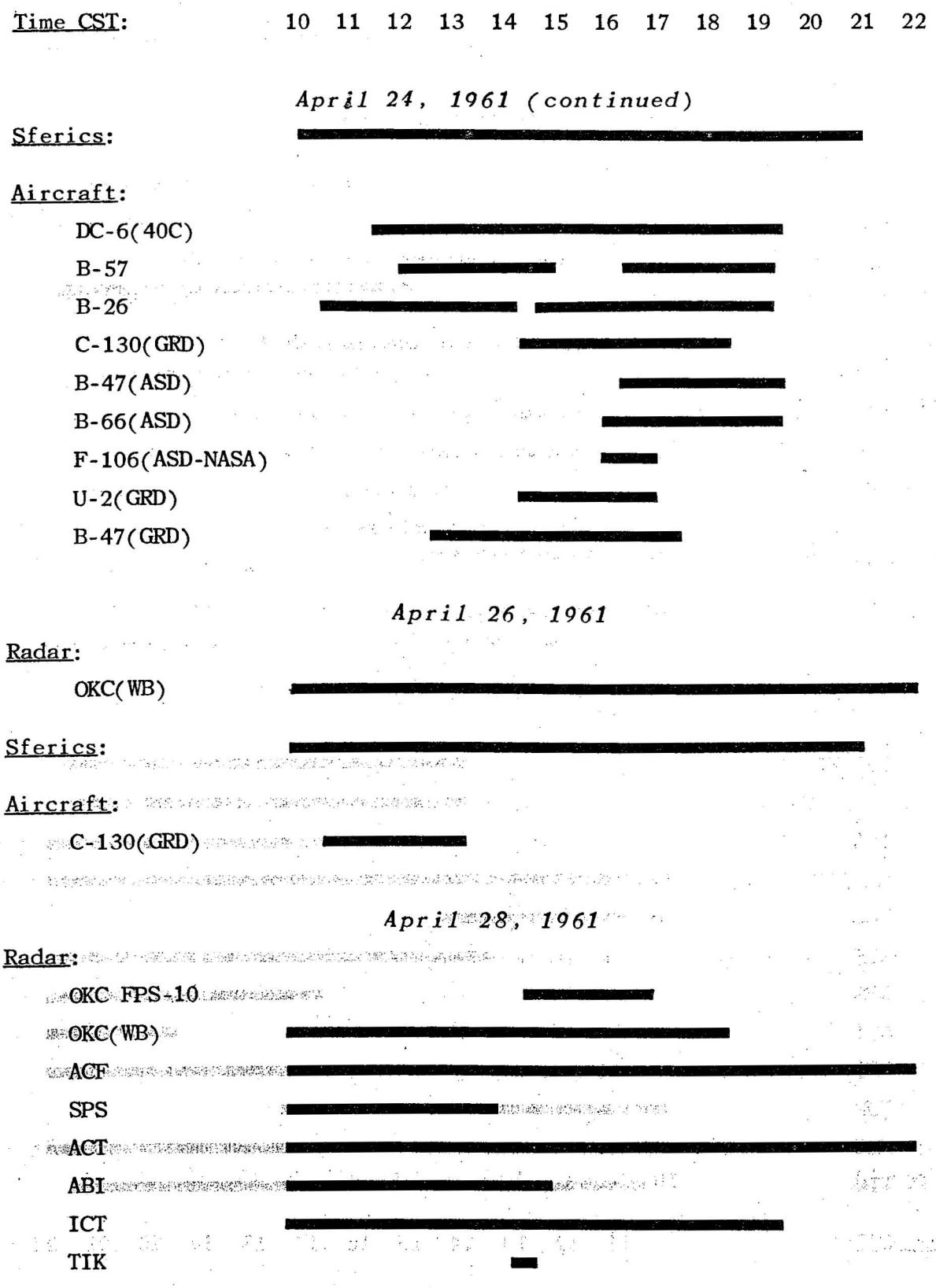
April 24, 1961



Serial and Special Rawinsondes:

	10	11	12	13	14	15	16	17	18	19	20	21	22
AMA		x		x		x		x		x			
DDC				x		x		x		x			
ACF		x											
LIT		x											
OKC		x		x		x		x		x			
TOP		x		x		x		x		x			
ADM				x		x		x		x			
REE		x		x		x		x		x			
LTS		x			x		x						
FSM		x		x		x		x					
FSI		x		x		x							
Time CST:	10	11	12	13	14	15	16	17	18	19	20	21	22

(Continued next page)



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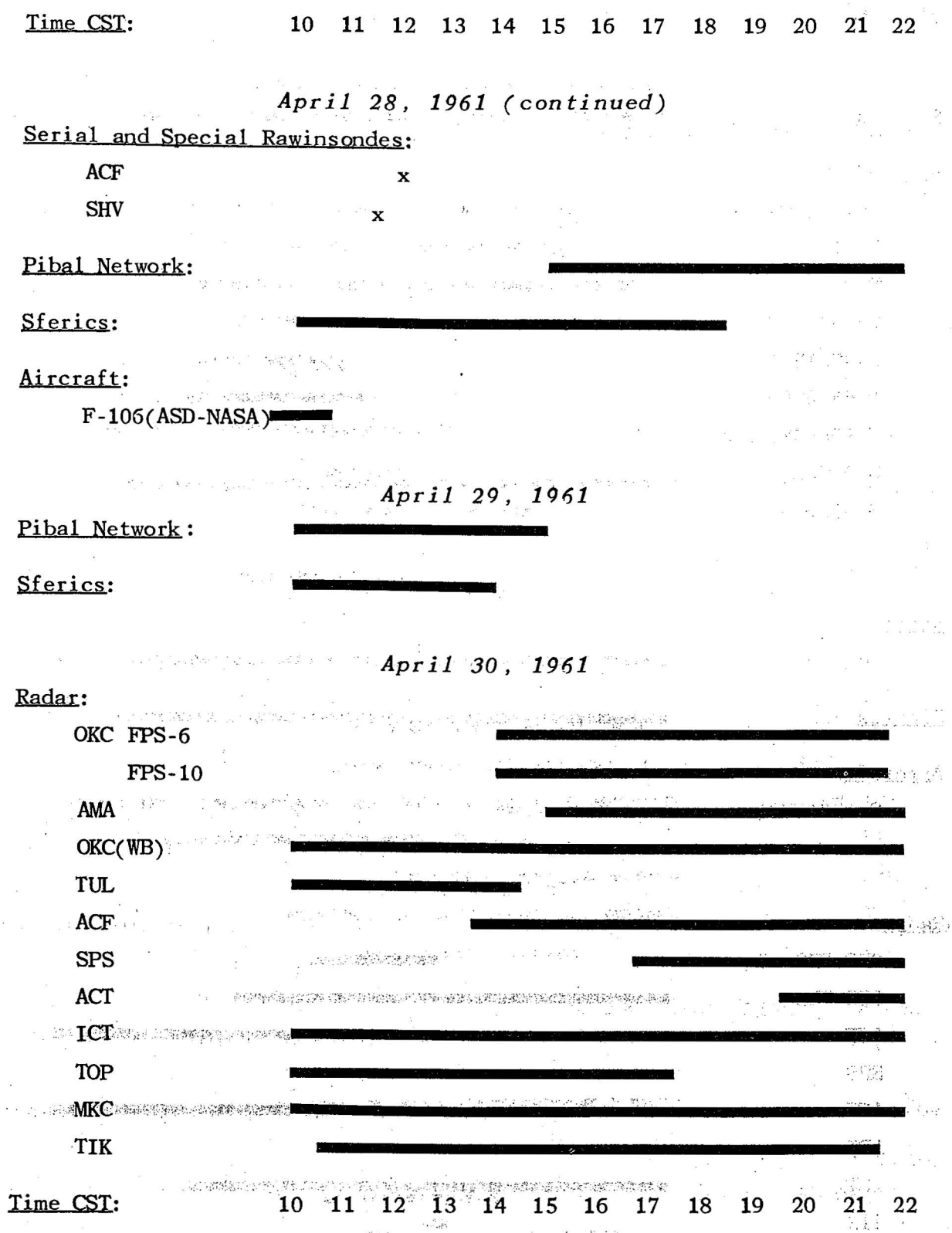


(Continued next page)

Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22

April 30, 1961 (continued)

Serial and Special Rawinsondes:

AMA	x
DDC	x
ACF	x
OKC	x
DYS	x

Stereo-Photography (GRD):

Doppler Radar:

Sferics:

Aircraft:

B-26

May 1, 1961

Radar:

OKC- FPS-6

FPS-10

OKC(WB)

SPS

ICT

MKC

TIK

Serial and Special Rawinsondes:

DYS x

Sferics:

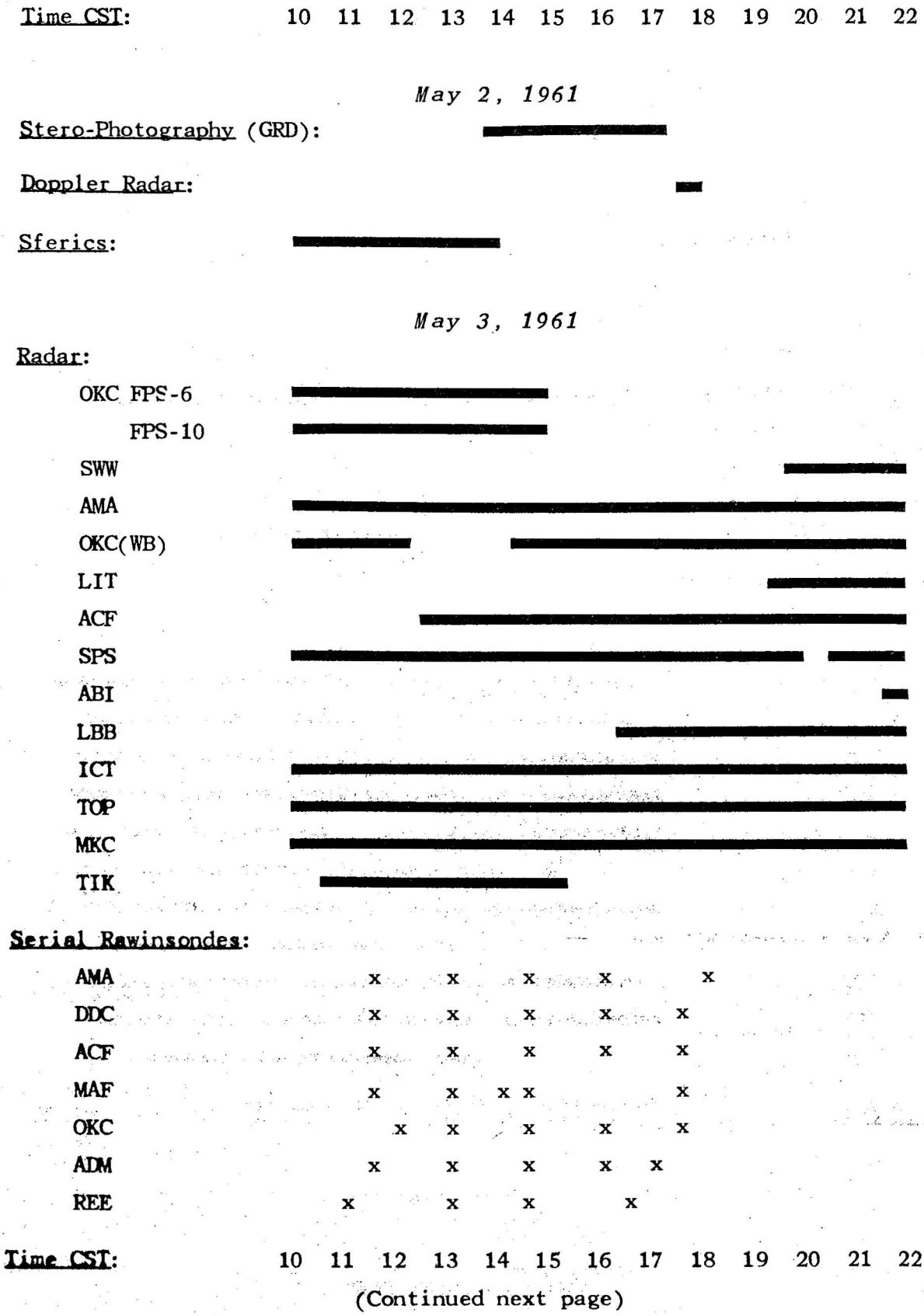
Aircraft:

C-130(GRD)

B-47(ASD)

B-66(ASD)

Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22



(Continued next page)

Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22

May 3, 1961 (continued)

Serial and Special Rawinsondes:

DYS			x			x		x		x		x	
LTS			x			x			x	x		x	
FSM				x		x		x		x			x
FSI				x	x		x		x		x		x

Doppler Radar:

Sferics:

Aircraft:

C-130(GRD)

U-2(GRD)

May 4, 1961

Radar:

OKC FPS-6

FPS-10

SWW

AMA

OKC(WB)

FSM

LIT

SHV

ACF

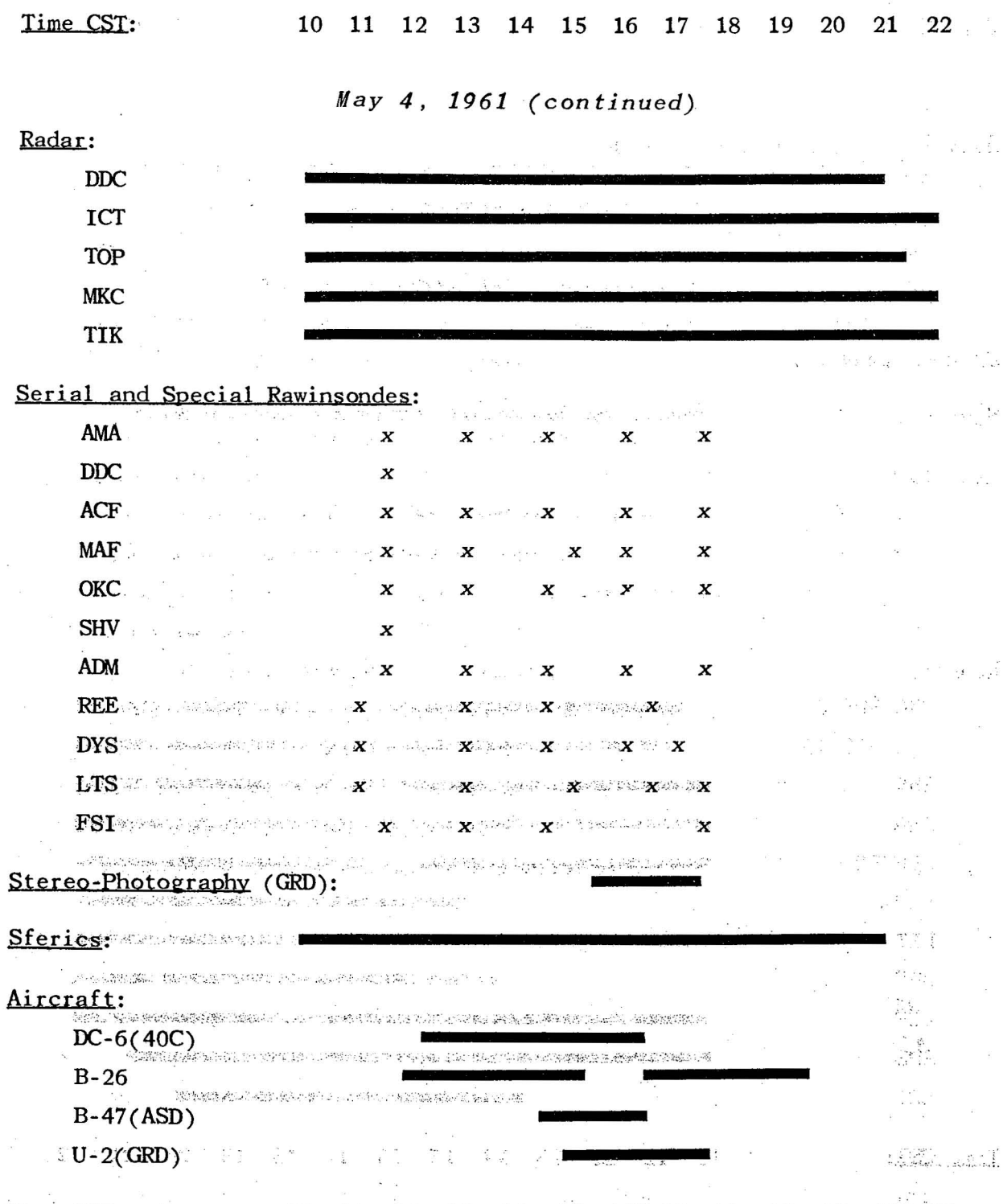
SPS

ABI

Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22

(Continued next page)

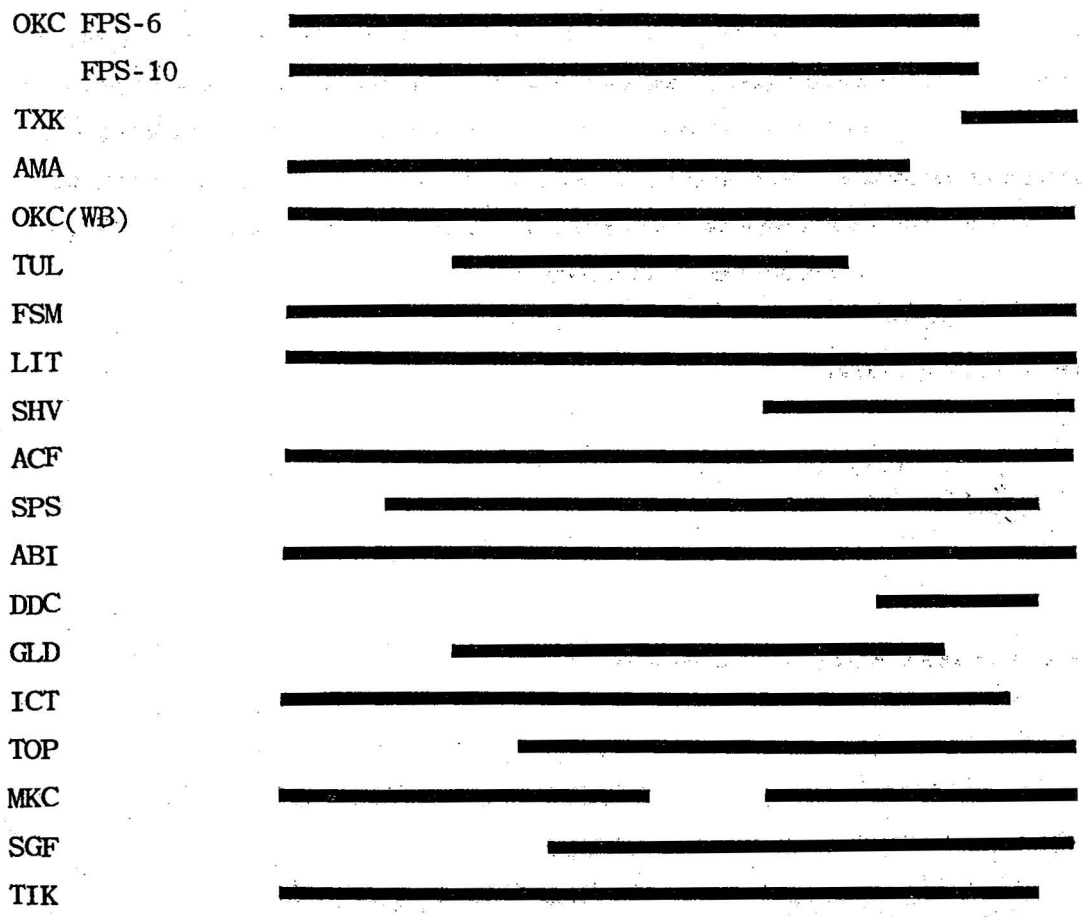
May 4, 1961 (continued)



Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22

May 5, 1961

Radar:

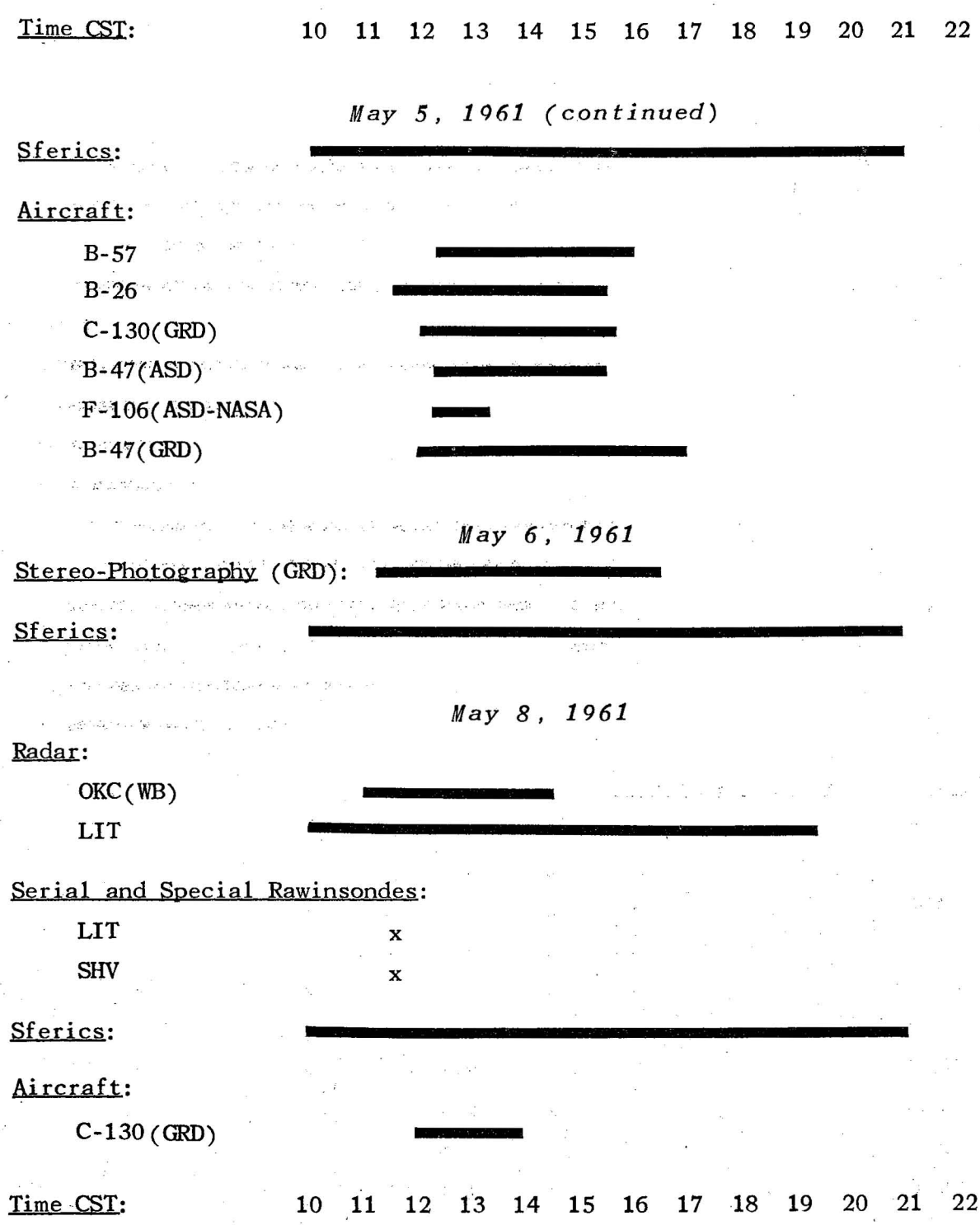


Serial and Special Rawinsondes:

	10	11	12	13	14	15	16	17	18	19	20	21	22
AMA		x											
DDC		x											
ACF		x											
OKC		x		x		x		x		x			
TOP											x		
ADM		x		x		x		x		x			
REE		x											
LTS		x											
FSI		x	x	x	x	x		x					

Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22

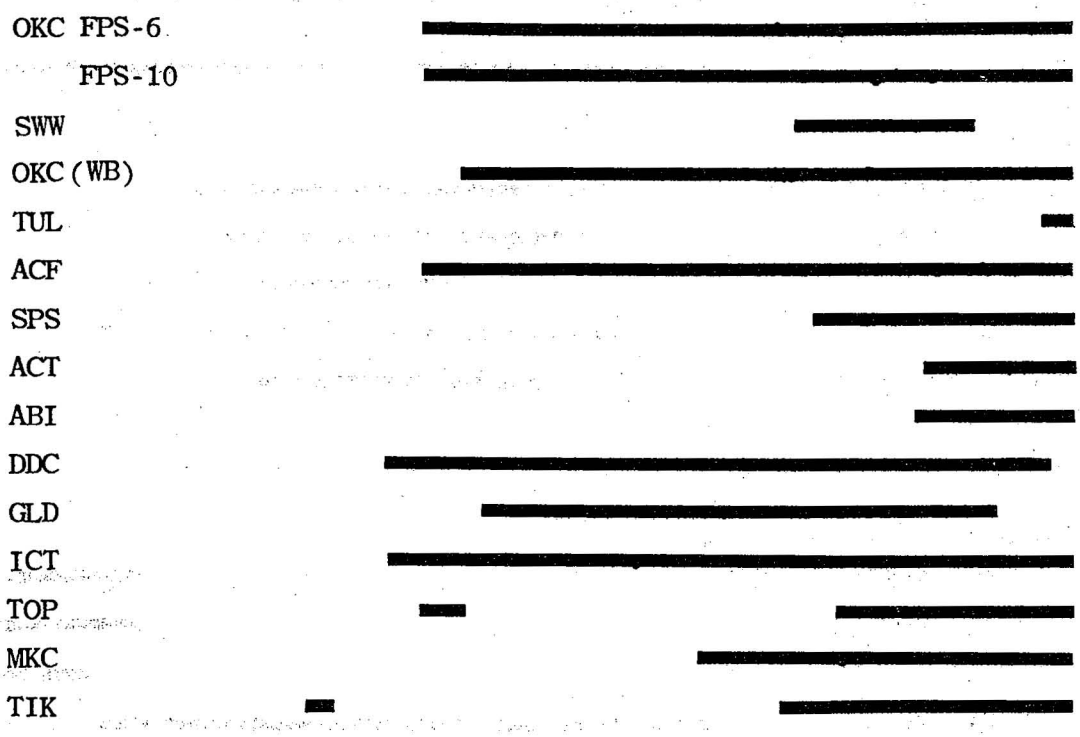
(Continued next page)


Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22
May 5, 1961 (continued)
Sferics:
Aircraft:
B-57
B-26
C-130(GRD)
B-47(ASD)
F-106(ASD-NASA)
B-47(GRD)
May 6, 1961
Stereo-Photography (GRD):
Sferics:
May 8, 1961
Radar:
OKC(WB)
LIT
Serial and Special Rawinsondes:
LIT x
SHV x
Sferics:
Aircraft:
C-130(GRD)
Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22

Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22

May 13, 1961

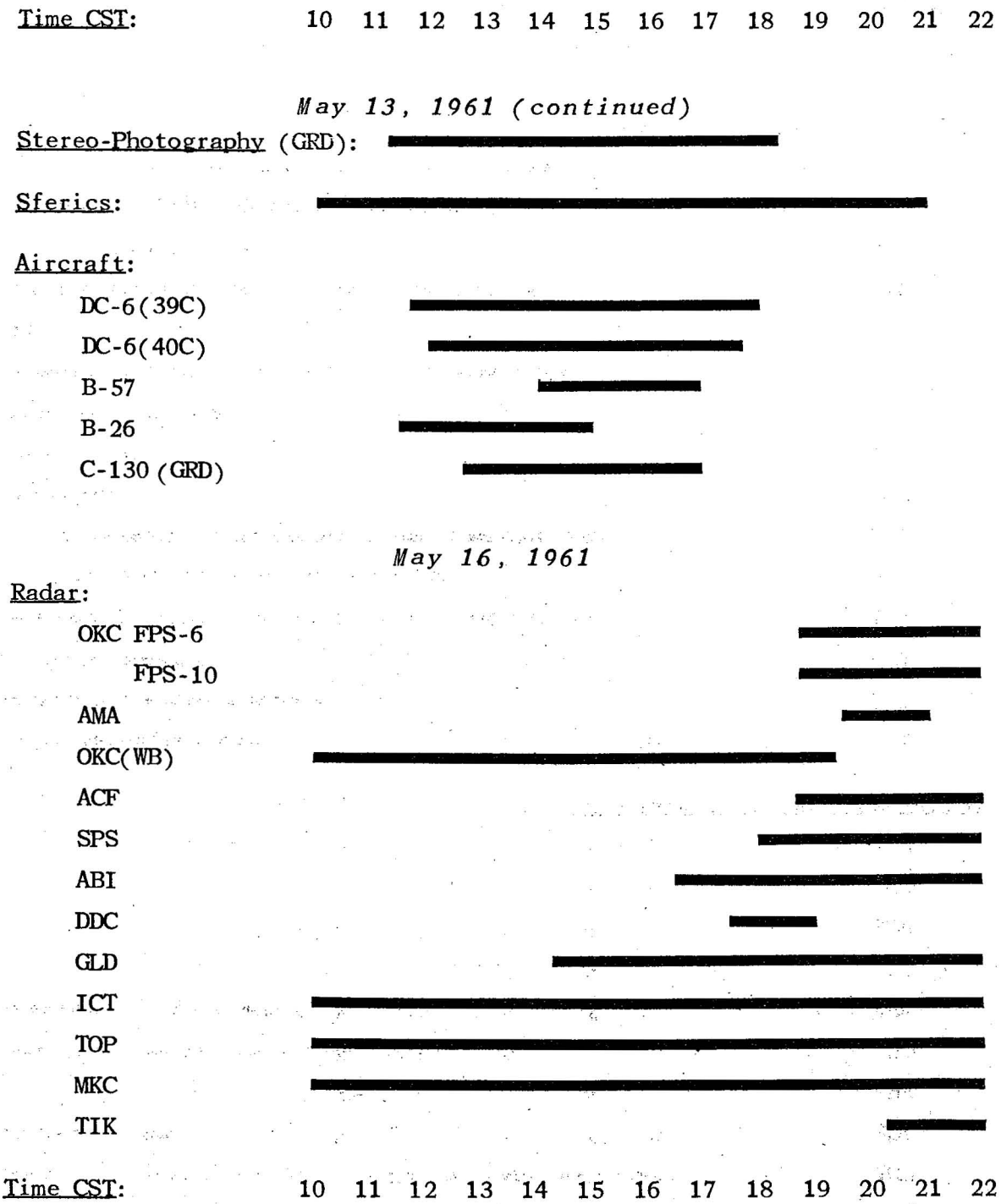
Radar:



Serial and Special Rawinsondes:

	10	11	12	13	14	15	16	17	18	19	20	21	22
AMA			x			x	x						
DDC			x		x		x	x	x				
ACF			x		x		x	x	x				
LIT			x		x		x	x	x				
MAF			x		x		x	x	x				
OKC					x		x	x	x				
SHV			x		x		x	x	x				
TOP			x		x		x	x	x				
ADM				x	x		x		x				
DYS			x		x		x	x					
LTS			x			x	x				x		
FSM			x		x		x	x					
FSI					x		x		x		x		
Time CST:	10	11	12	13	14	15	16	17	18	19	20	21	22

(Continued next page)



(Continued next page)

Time CST:	10	11	12	13	14	15	16	17	18	19	20	21	22

May 16, 1961 (continued)

Serial and Special Rawinsondes:

AMA			x		x		x		x		x		
DDC			x										
ACF			x										
MAF			x		x		x		x		x		
REE		x			x	x			x		x		
DYS		x											
LTS		x											

Doppler Radar:

Sferics:

Aircraft:

DC-6(40C)
B-57
B-26
B-47(ASD)
B-66(ASD)
U-2(GRD)

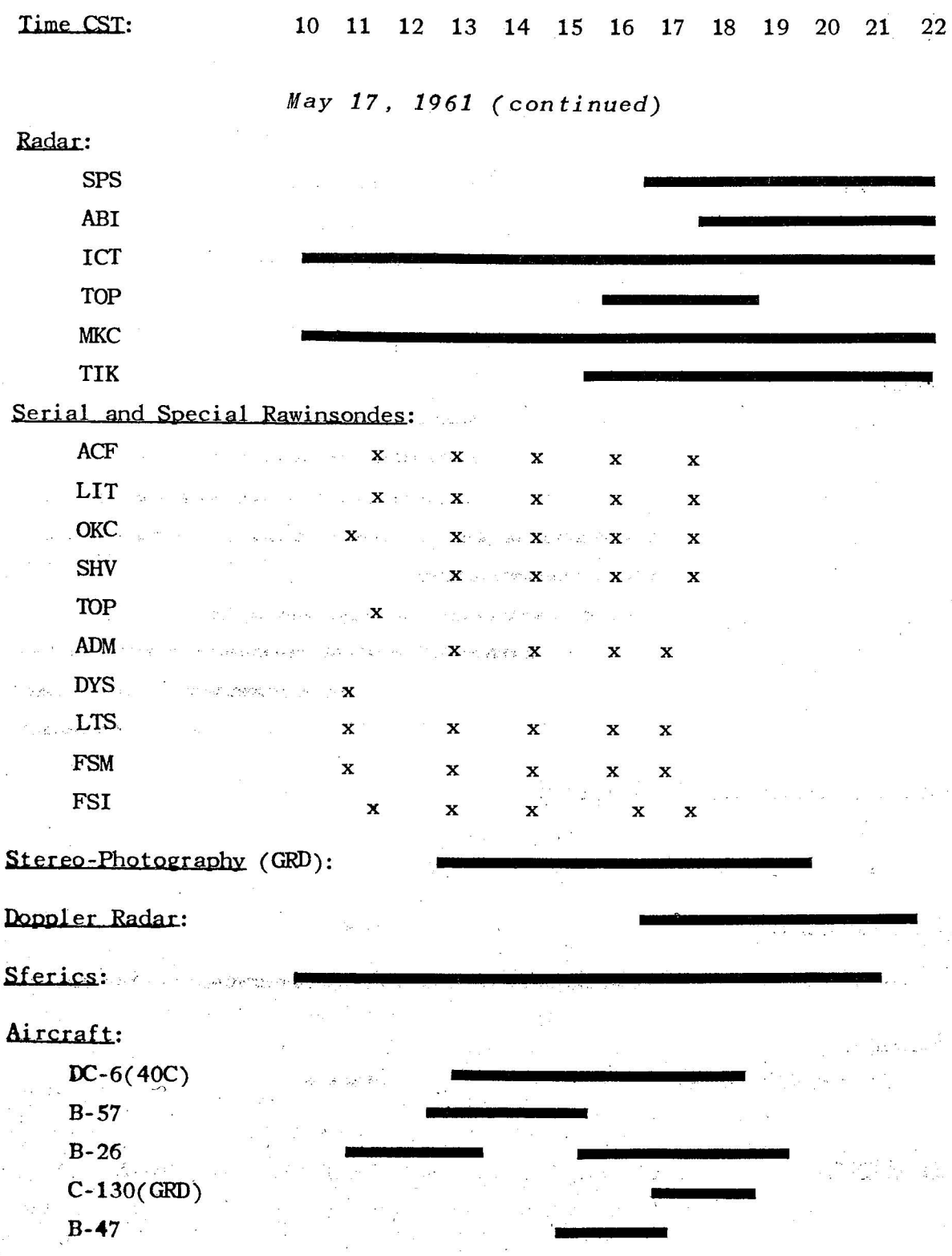
May 17, 1961

Radar:

OKC FPS-6
FPS-10
DCV
SWW
OKC(WB)
LIT
ACF

Time CST:	10	11	12	13	14	15	16	17	18	19	20	21	22

(Continued next page)



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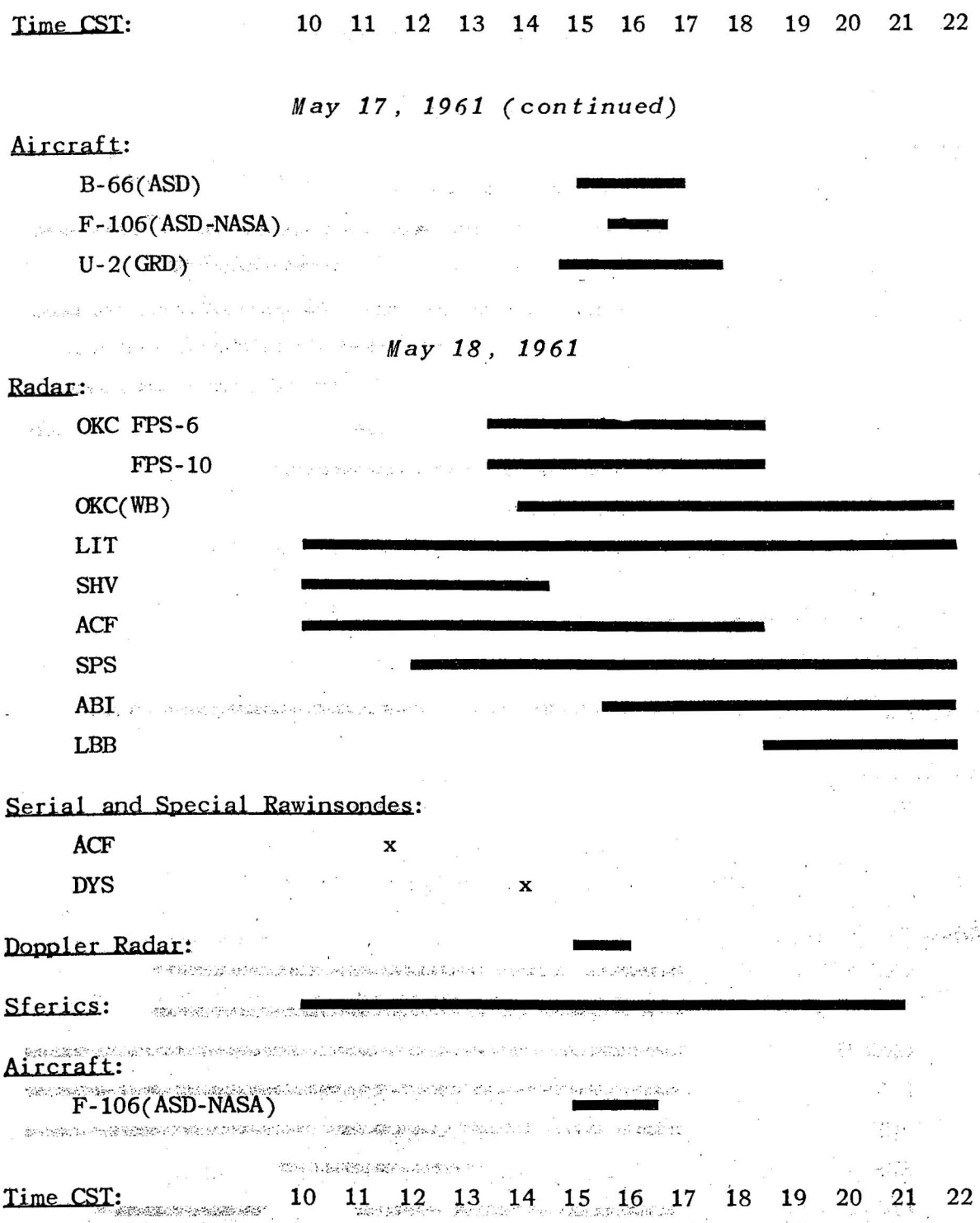
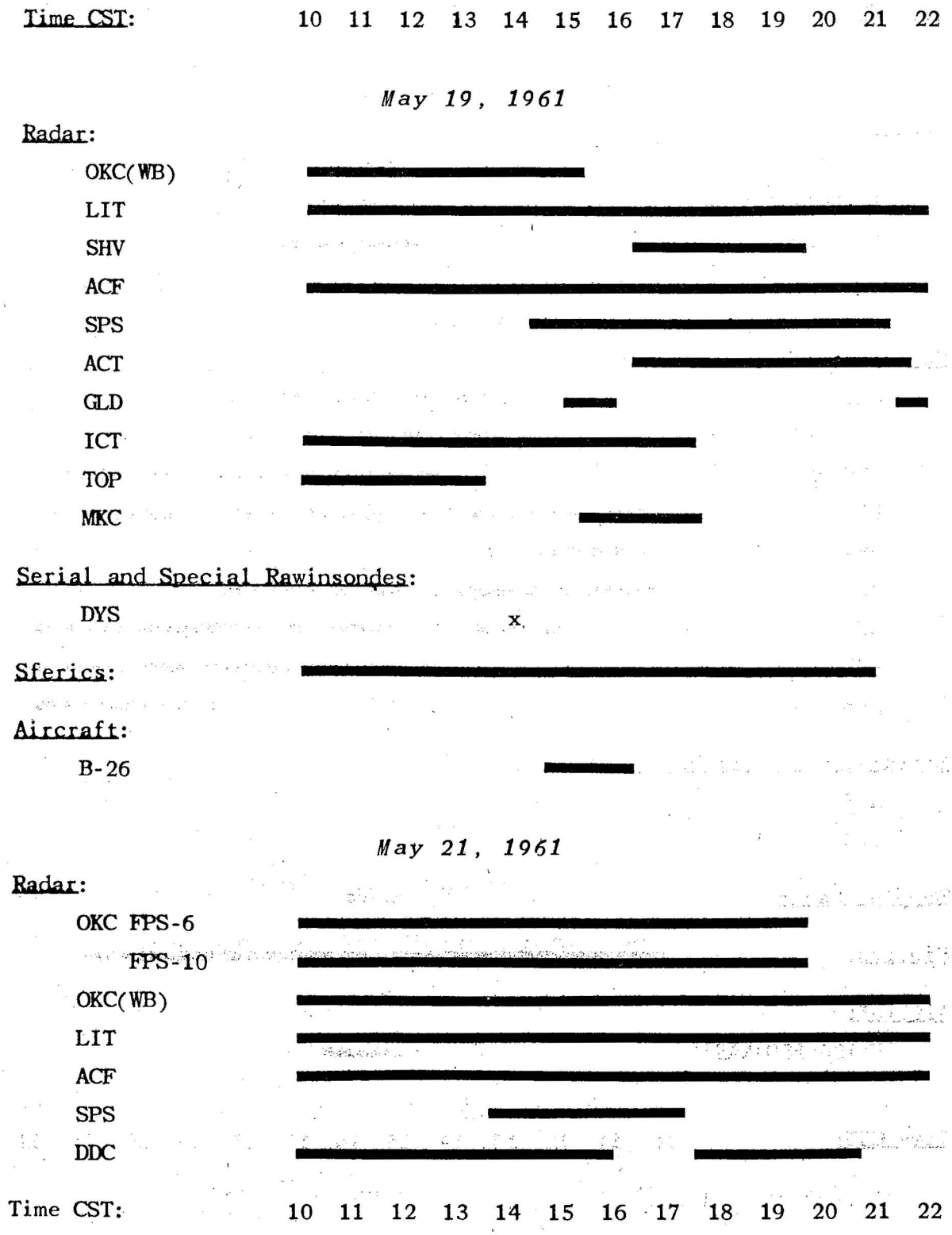

Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22
May 17, 1961 (continued)
Aircraft:
B-66(ASD)
F-106(ASD-NASA)
U-2(GRD)
May 18, 1961
Radar:
OKC FPS-6
FPS-10
OKC(WB)
LIT
SHV
ACF
SPS
ABI
LBB
Serial and Special Rawinsondes:
ACF x
DYS x
Doppler Radar:
Sferics:
Aircraft:
F-106(ASD-NASA)
Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22



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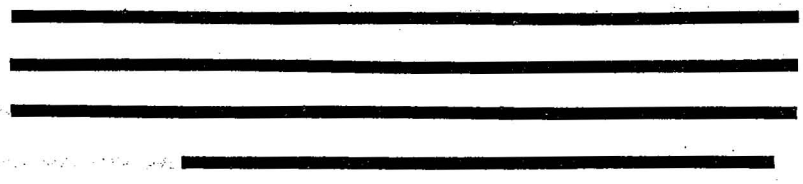
Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22

May 21, 1961 (continued)

Radar:



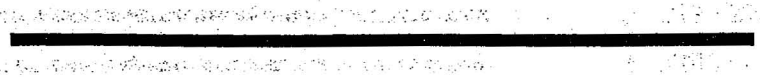
Serial and Special Rawinsondes:

	10	11	12	13	14	15	16	17	18	19	20	21	22
DDC				x		x		x	x				
ACF			x						x				
MAF									x				
OKC		x		x		x		x		x			
TOP			x										
ADM			x	x		x		x	x				
REE				x		x		x	x				
DYS		x		x		x		x	x				
LTS		x		x			x	x					
FSM				x		x		x	x				
FSI			x	x			x		x	x			

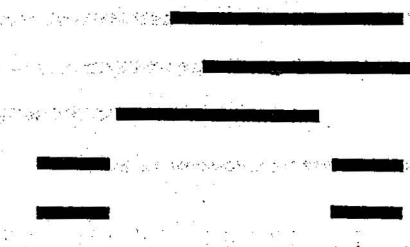
Stereo-Photography (GRD):

Doppler Radar:

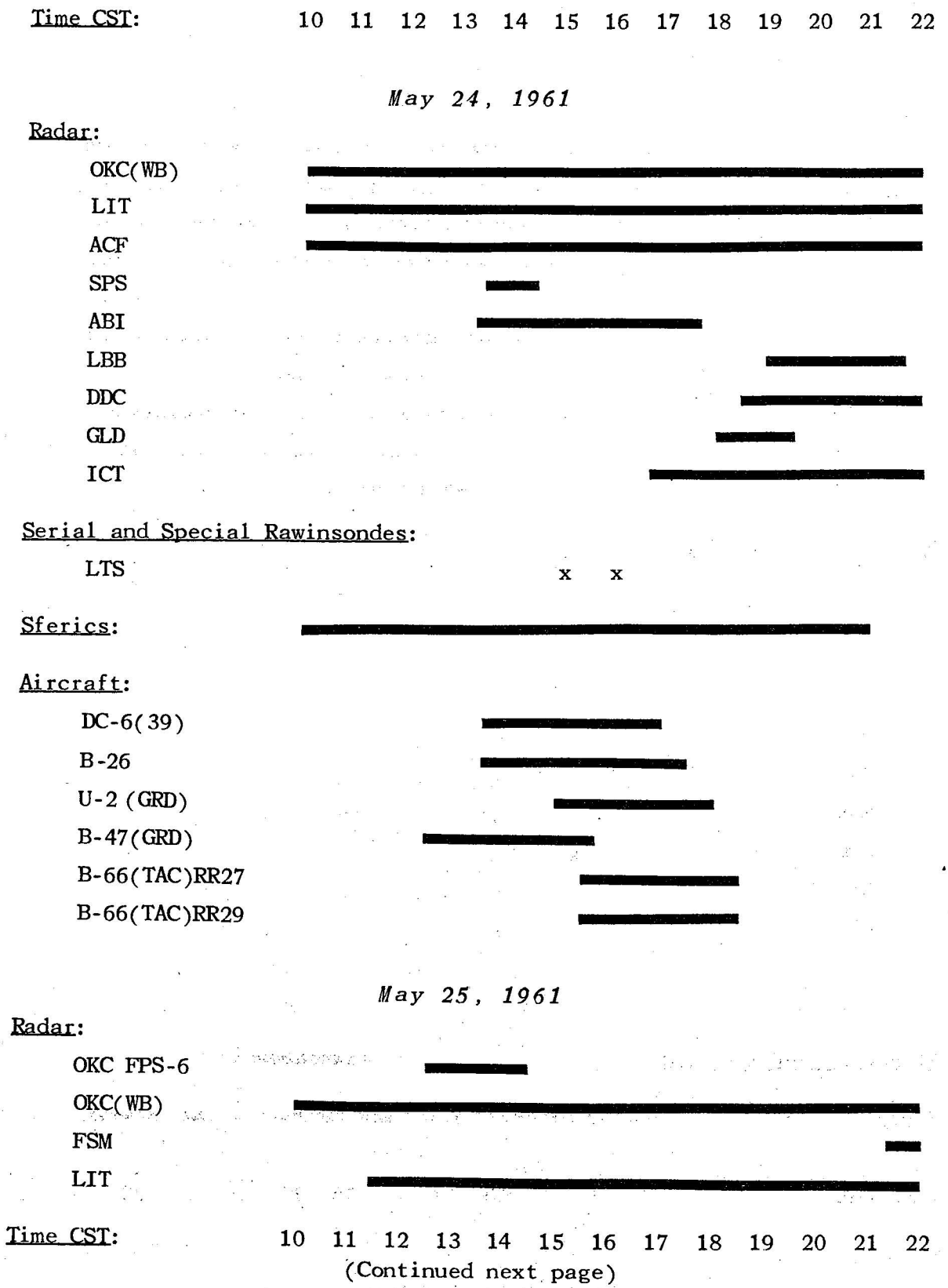
Sferics:



Aircraft:



Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22



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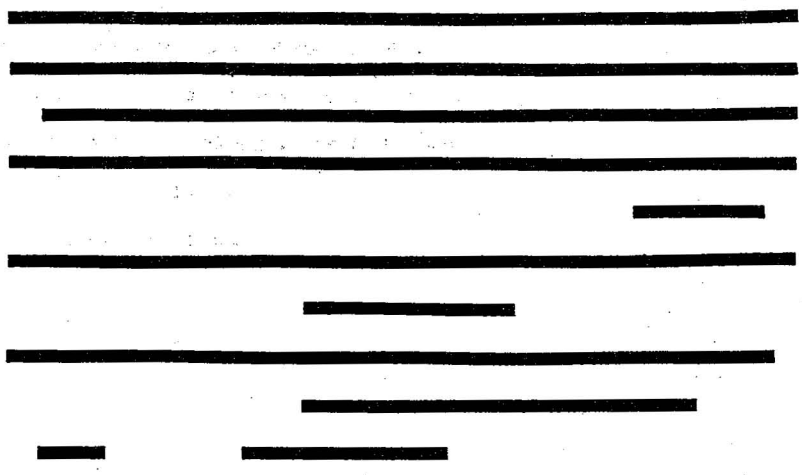
Time CST:	10	11	12	13	14	15	16	17	18	19	20	21	22

May 25, 1961 (continued)

Radar:



Serial and Special Rawinsondes:

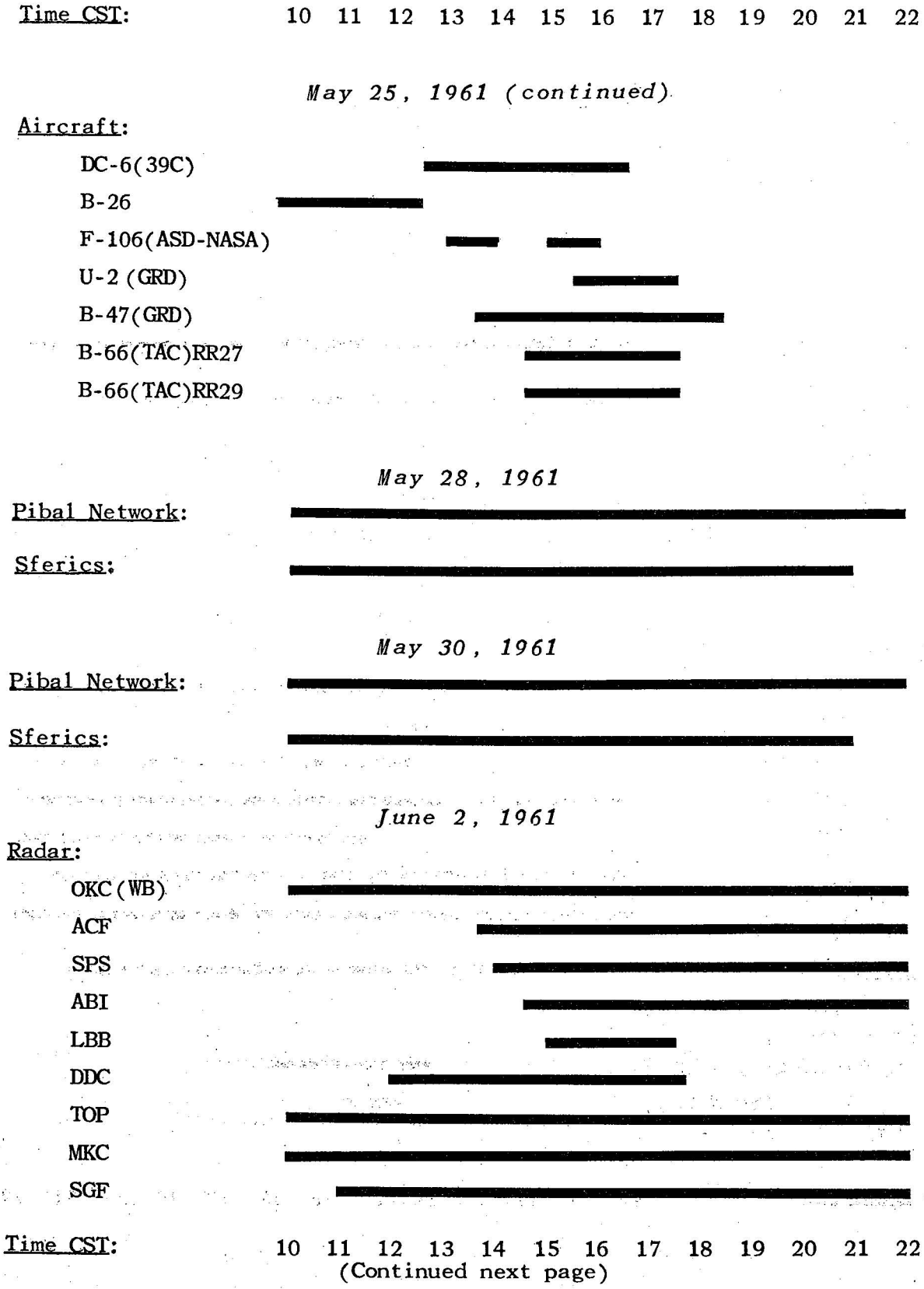
AMA				x		x		x		x			
DDC				x		x		x		x			
ACF				x		x		x		x			
LIT		x											
MAF				x		x			x	x			
OKC				x		x		x		x			
SHV				x		x		x		x			
ADM		x		x		x		x	x				
DYS				x		x		x	x				
LTS				x		x		x		x			
FSM				x		x			x				
FSI		x	x		x		x		x				

Stereo-Photography(GRD)

Sferics:

Time CST:	10	11	12	13	14	15	16	17	18	19	20	21	22

(Continued next page)



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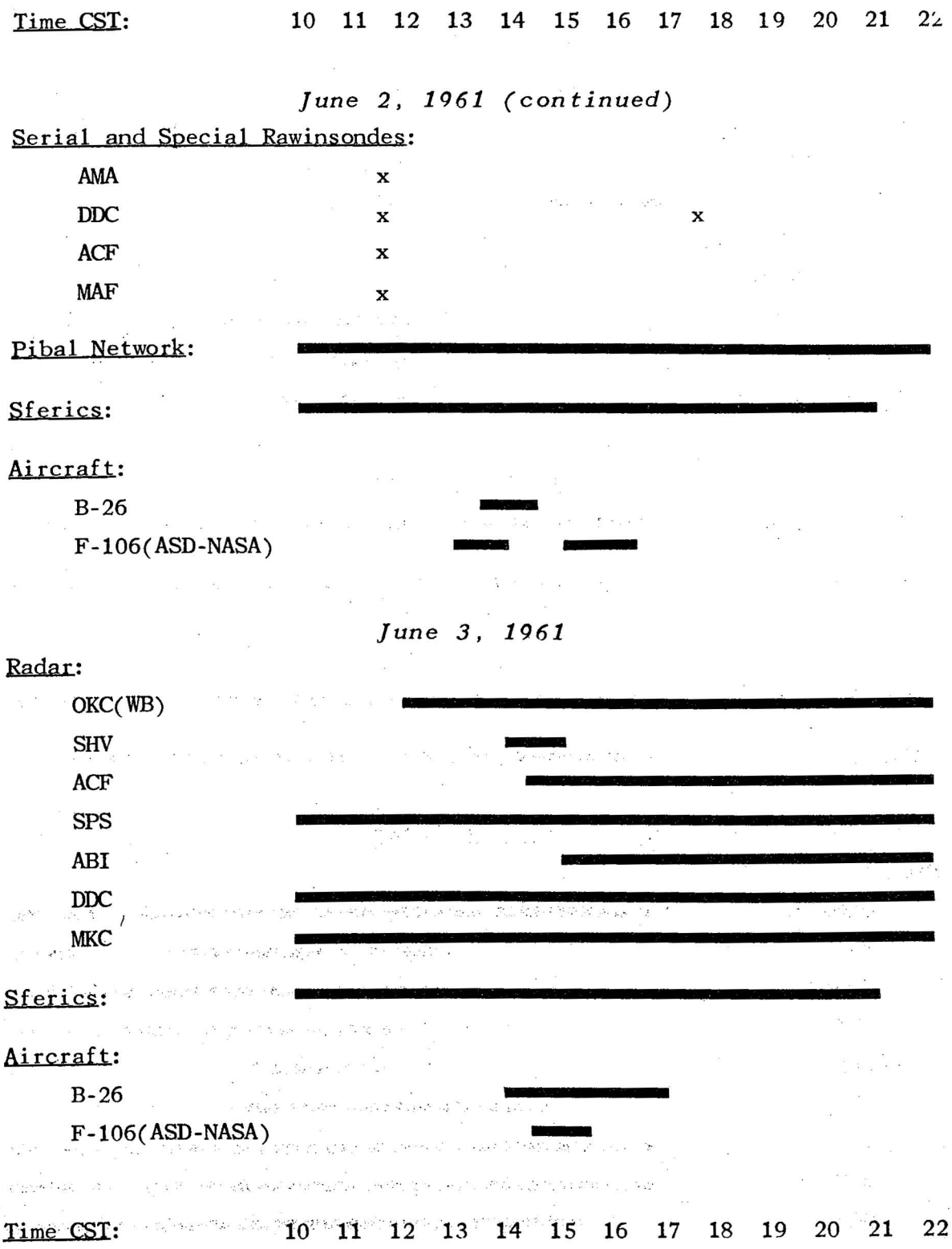
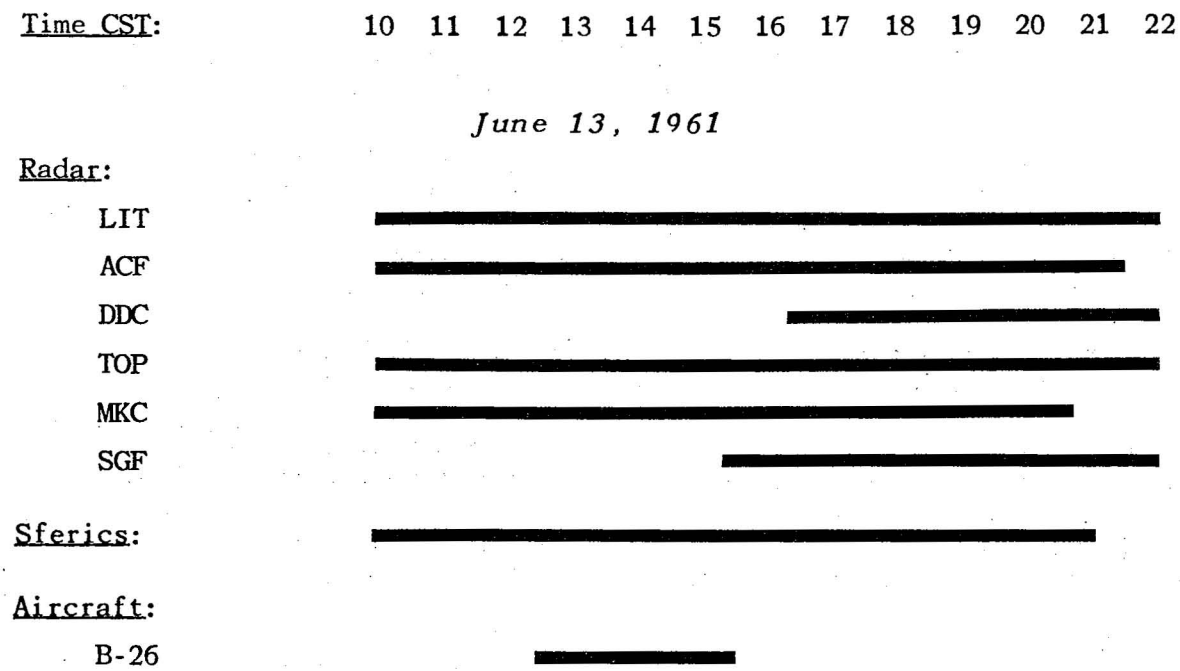

Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22
June 2, 1961 (continued)
Serial and Special Rawinsondes:
AMA
DDC
ACF
MAF
Pibal Network:
Sferics:
Aircraft:
B-26
F-106(ASD-NASA)
June 3, 1961
Radar:
OKC(WB)
SHV
ACF
SPS
ABI
DDC
MKC
Sferics:
Aircraft:
B-26
F-106(ASD-NASA)
Time CST: 10 11 12 13 14 15 16 17 18 19 20 21 22



DROPSONDES

DATE	TIME(CST)	LATITUDE	LONGITUDE	(mb.)
May 24, 1961	1620	36.5N	101.5W	200 mb.
24	1700	34.3N	104.6W	214 mb.
24	1712	35.8N	103.1W	220 mb.
24	1733	36.9N	103.0W	214 mb.
May 25, 1961	1514	35.0N	95.3W	200 mb.
25	1556	34.1N	94.4W	188 mb.
25	1606	34.5N	95.9W	192 mb.
25	1630	32.9N	96.4W	188 mb.
25	1655	32.7N	95.9W	220 mb.

APPENDIX IV

ATTENDEES AT ADVISORY PANEL MEETING, OCTOBER 24-25, 1960.

(*Member of Advisory Panel)

Dr. Charles E. Anderson
U. S. Air Force

*Dr. Louis J. Battan
University of Arizona

Mr. Norman L. Canfield
U. S. Weather Bureau

Mr. Charles F. Chow
National Severe Storms Project

Mr. James M. Cook
Contract Pilot, U. S. Weather Bureau

Maj. Albert Ehrlich
U. S. Air Force

Dr. Tetsuya Fujita
University of Chicago

Mr. Brent B. Goddard
National Severe Storms Project

Mr. William E. Hardy
National Severe Storms Project

*Mr. Henry T. Harrison
United Air Lines

*Dr. Glenn R. Hilst
The Travelers Insurance Company

Mr. Donald C. House
U. S. Weather Bureau

*Dr. Joachim P. Kuettner
Army Ballistic Missile Agency

Mr. Jean T. Lee
National Severe Storms Project

Mr. E. L. McGuire
U. S. Weather Bureau

*Prof. James E. Miller
New York University

Dr. Chester W. Newton
University of Chicago

Mr. R. J. Petitte
Federal Aviation Agency

Mr. Gene D. Prantner
U. S. Navy

Mr. Norman E. Prosser
National Severe Storms Project

Mr. Robert M. Rados
U. S. Air Force

Mr. Carl M. Reber
U. S. Weather Bureau

Dr. Herbert Riehl
Colorado State University

*Dr. Walter J. Saucier
University of Oklahoma

Dr. R. A. Schleusener
Colorado State University

Mr. Paul W. Schumacher
U. S. Air Force

Mr. Robert H. Simpson
U. S. Weather Bureau

Mr. Roy Steiner
National Aeronautics & Space Administration

Mr. James Thompson
Federal Aviation Agency

Mr. C. F. Van Thullenar
National Severe Storms Project

Dr. Harry Wexler
U. S. Weather Bureau

Mr. Dansy T. Williams
National Severe Storms Project

APPENDIX V

ATTENDEES AT OPERATIONAL MEETING NSSP, JANUARY 5 - 6, 1961

Mr. Robert L. Ammons
New Mexico State University

Dr. Charles E. Anderson
U. S. Air Force

Mr. L. E. Anderson
Federal Aviation Agency

Dr. David Atlas
U. S. Air Force

Capt. R. W. Banks
U. S. Air Force

Mr. Kenneth M. Barnett
U. S. Army

Lt. Col. W. W. J. Barrios
U. S. Army

Lt. Col. D. C. Barrow
U. S. Air Force

Dr. F. C. Bates
University of Kansas

Mr. Robert G. Beebe
Midwest Weather Service

Capt. T. I. Bell
U. S. Air Force

Mr. S. G. Bigler
U. S. Weather Bureau

Mr. E. T. Binckley
U. S. Air Force

Maj. R. T. Brown
U. S. Air Force

Mr. J. A. Browne
Trans World Airlines

Mr. R. C. Chamberlain
Federal Aviation Agency

Mr. Charles F. Chow
National Severe Storm Project

Mr. F. E. Christensen
U. S. Weather Bureau

Dr. William H. Clayton
A & M College of Texas

Mr. H. L. Coleman, Jr.
National Severe Storm Project

Mr. James M. Cook
Contract Pilot, U. S. Weather Bureau

Mr. H. G. Corwin
Trans World Airlines

Mr. J. T. Dooley
National Severe Storm Project

Mr. W. E. Cunningham
American Airmotive Corporation

Lt. Col. Robert Durbin
U. S. Air Force

Mr. A. T. Erickson
Federal Aviation Agency

Dr. D. R. Fitzgerald
University of Chicago

Mr. J. V. Flanagan
Federal Aviation Agency

Mr. H. E. Foster, Jr.
U. S. Weather Bureau

Mr. Roy L. Fox
U. S. Weather Bureau

Dr. Tetsuya Fujita
University of Chicago

Capt. R. E. Gabosch
U. S. Air Force

Mr. Abraham Golden
U. S. Army

Mr. J. R. Gray
U. S. Air Force

Lt. Col. A. F. Gustafson
U. S. Air Force

Mr. William E. Hardy
National Severe Storm Project

Maj. C. L. Hasseltine
U. S. Air Force

Mr. Donald C. House
U. S. Weather Bureau

Dr. Rex Inman
University of Oklahoma

Mr. C. S. Kent
Federal Aviation Agency

Maj. John J. Knight
U. S. Air Force

Mr. G. K. Langford
Federal Aviation Agency

Mr. Duane A. Lea
U. S. Navy

Mr. Jean T. Lee
National Severe Storm Project

Mr. C. H. Lynch
Federal Aviation Agency

Mr. E. L. McGuire
U. S. Weather Bureau

Mr. E. J. Minser
Trans World Airlines

Mr. C. B. Moore
Arthur D. Little, Inc.

Mr. H. H. Murphy
Federal Aviation Agency

Dr. Chester W. Newton
The University of Chicago

Mr. Robert H. Nolen
U. S. Weather Bureau

Mr. R. J. Petitte
Federal Aviation Agency

Mr. Norman E. Prosser
National Severe Storm Project

Lt. Col. P. J. Quinlan
U. S. Air Force

Mr. R. M. Rados
U. S. Air Force

Mr. Carl Reber
U. S. Weather Bureau

Dr. Sasaki Yoshikazu
University of Oklahoma

Mr. R. A. Schleusener
Colorado State University

Dr. W. J. Saucier
University of Oklahoma

Mr. P. W. J. Schumacher
U. S. Air Force

Mr. Robert H. Simpson
U. S. Weather Bureau

Mr. E. W. Sims
Federal Aviation Agency

Mr. Robert W. Smith
National Severe Storm Project

Mr. Roy Steiner
National Aeronautics and Space Administration

Mr. Glenn E. Stout
Illinois State Water Survey Division

Mr. J. L. Thomas
New Mexico State University

Mr. W. L. Thompson
U. S. Weather Bureau

Mr. J. K. Thompson
Federal Aviation Agency

Mr. C. F. Van Thullenar
National Severe Storm Project

Mr. Wm. O. Viavant
University of Oklahoma

Mr. Neil B. Ward
National Severe Storm Project

Mr. Walter L. Watts
U. S. Weather Bureau

Mr. K. E. Wilk
Illinois State Water Survey Division

Mr. Dansy T. Williams
National Severe Storm Project

Mr. A. W. Youmans
U. S. Weather Bureau

USCOMM-WB-DC