Operation and Data Summary for the Convection Initiation and Downburst Experiment (CINDE) held near Denver, Colorado from 22 June to 7 August 1987

A Joint Program Conducted by
the National Center for Atmospheric Research,
the National Oceanic and Atmospheric Administration,
the University of Wyoming,
the University of California at Los Angeles,
the University of North Dakota,
the Colorado State University,
and the MIT Lincoln Laboratory

Edited by Cathy J. Kessinger

March 1988

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CINDE Organization and Contributors to this Summary

A. Scientific Steering Committee

The CINDE Scientific Steering Committee was formed to ensure that research objectives and goals were adequately and equitably addressed during all phases of project planning and execution. Members were selected to represent each type of research objective and include: James Fankhauser (NCAR/MMM), Mark Hjelmfelt (NCAR/ATD), Cathy Kessinger (NCAR/ATD; Experiment Coordinator), Robert Kropfli (NOAA/WPL), Al Rodi (University of Wyoming), James Wilczak (NOAA/WPL), and James Wilson (NCAR/ATD; Chair)

B. Principal Investigators

Principal Investigators for each observing system included: V.N. Bringi (NCAR CP–2 Radar), James Fankhauser (NCAR King Air), Robert Kropfli (NOAA/C and /D Radars), Charles Knight (NCAR Photography), Al Rodi (UW King Air), Jeff Stith (UND Citation), Charles Wade (NCAR CLASS and Mobile Sounders, NCAR PAM), and James Wilson (NCAR CP–3 Radar).

C. Contributors

The following authors contributed to the writing of the CINDE Operations and Data Summary manual: James Fankhauser (NCAR King Air), Mark Hjelmfelt (SERI Tower), Cathy Kessinger (Introduction, TDWR Photography, Rocky Flats Towers, and Appendix A), Robert Kropfli (NOAA/C and /D Radars), Jeff Lew (CINDE Photography), Cindy Mueller (Daily Summaries, PAM and PROFS Mesonet Data), Jeff Stith (UND Citation), Rita Roberts (FL–2 and UND Radars, FLOWS Mesonet), Al Rodi (UW King Air), Ed Szoke (PROFS Datasets), Charles Wade (Sounding Systems), James Wilczak (BAO Tower), and James Wilson (Daily Summaries, NCAR CP–3 and CP–2 Radars). Cathy Kessinger edited the manual. Debbie Davis and Susan McClintock typed and assembled the manual to final form.

I. INTRODUCTION

A. Description of CINDE

The Convection Initiation and Downburst Experiment (CINDE) was designed to study the kinematic and thermodynamic properties of clear air, wind convergence lines in the planetary boundary layer that lead to the initiation of convective storms, to study the initiation and forcing of downburst downdrafts, and to investigate the structure and evolution of the mesoscale boundary layer. The field project was conducted near Denver, Colorado, from 22 June to 7 August 1987. The CINDE project was a joint venture with participating agencies from the National Center for Atmospheric Research (NCAR), National Oceanic and Atmospheric Administration (NOAA), the University of Wyoming (UW), the University of California at Los Angeles (UCLA), the University of North Dakota (UND), the Colorado State University (CSU), and the Massachusetts Institute of Technology (MIT) Lincoln Laboratory.

During the 47 day field experiment, a variety of weather phenomena were observed and documented in the 80 km $\times$ 50 km network. Initial figures indicate tornadoes occurred on 10 days; convergent lines were within the network on 35 days and produced storms on 27 days; and downbursts occurred on 22 days. Preliminary analysis shows that boundary layer convergence lines were instrumental in the initiation of convective storms, that significant differences in vertical profiles of moisture and temperature exist over small spatial and temporal scales and effect convective development, and that tornado–like vortices associated with convergent boundaries occurred frequently.

Facilities included in the field experiment phase of CINDE include: the NCAR CP–3 C–band Doppler radar, the NOAA/C and /D X–band Doppler radars, the UW King Air aircraft, the NCAR King Air aircraft, the UND Citation aircraft, five NCAR Cross–chain Loran Atmospheric Sounding System (CLASS) stations, three mobile sounding vans from NCAR and NOAA, 46 NCAR Portable Automated Mesonet (PAM II) surface stations, and an array of NCAR time–lapse movie and still camera equipment. Locations of CINDE facilities are shown in Fig. I.1.

B. Description of this Document

This document contains two main sections. Section II briefly describes the type of weather events or special data collections that occurred on each day, gives daily operations timetables for each facility, and then describes the "quick–look" products that have been produced for each day. The daily weather summary does not list every event that occurred on a particular day; more intensive study of the data are required. Section III contains short descriptions of each facility, summarizes the data collected including known problems, and lists contact people for acquiring data and/or software. Data catalogs and instrumentation lists have been placed in appendices. More exhaustive system descriptions were included in the CINDE Operations Plan that was written before the field project began.

Tables and figures are labeled with the section number and then a sequential number (II.1, II.2, etc.). Tables that are within appendices are first labeled with the letter corresponding to the appendix and then sequentially (A.1, A.2., etc.).

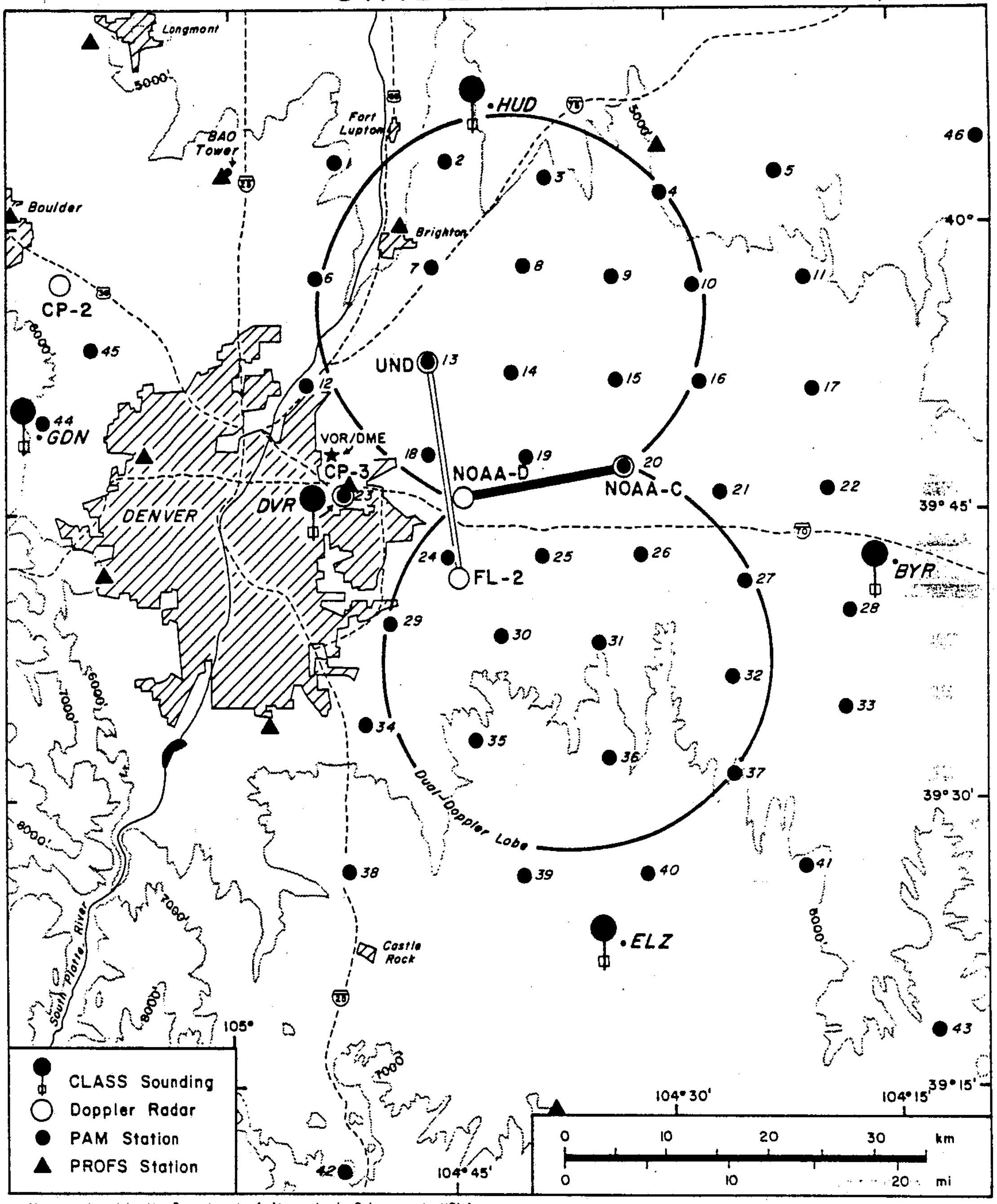
All phone numbers within the document use the Colorado area code (303) unless otherwise stated.

C. Data Policy

The CINDE data set is open to all institutions or individuals with two exceptions, described below. Reimbursement charges may be incurred for reproduction of data. This policy covers only basic, unanalyzed data and not analyzed data whose release is under the discretion of the investigator or institution involved.

The NOAA X–band radars used new, experimental instrumentation and techniques to collect dual-polarization and chaff flux measurements. Individuals who are testing

CINDE Network



Map produced by the Department of Atmospheric Sciences at UCLA.

Figure I.1. CINDE Surface Network.

and developing these instruments and techniques have proprietary use of these data. Other individuals who would like to use these data should expect to collaborate (i.e., co-authorship on papers) with those involved in the development and testing of the techniques.

D. Other Field Programs

The CINDE was complemented by the occurrence of three other field programs during the summer of 1987. These programs were: the Terminal Doppler Weather Radar (TDWR) Program, the Denver AWIPS–90 Risk Reduction and Requirement Evaluation (DAR^3E), and a precipitation and cloud physics study conducted by Prof. V.N. Bringi of Colorado State University (CSU). A high degree of cooperation between field programs was achieved with personnel participating in multiple field programs.

The TDWR Program is sponsored by the Federal Aviation Administration and is charged with testing and evaluating automated detection and warning of low–level weather hazards in the airport terminal environment. The field experiment was conducted from 18 May through 4 September. This program used the MIT Lincoln Laboratory FL–2 S–band Doppler radar and the University of North Dakota (UND) C–band Doppler radar to observe the area surrounding Denver Stapleton International Airport. A 30-station mesonet was contained within the western dual–Doppler lobe around Stapleton. Documentation and data acquisition of the TDWR radars and the mesonet are included within this document. A map of the radar and mesonet locations is shown in Fig. I.2.

The DAR^3E is an ongoing, real–time demonstration at the Denver National Weather Service (NWS) of the NOAA Program for Regional Observing and Forecast Services (PROFS) data processing and workstation concept for short period forecasting. The demonstration was begun in May 1987. The DAR^3E uses the following equipment: the NCAR CP–2 S–band Doppler radar, the 22 PROFS mesonet stations, five Profilers, and NWS rapid–scan satellite and synoptic data. Documentation of the CP–2 radar, the

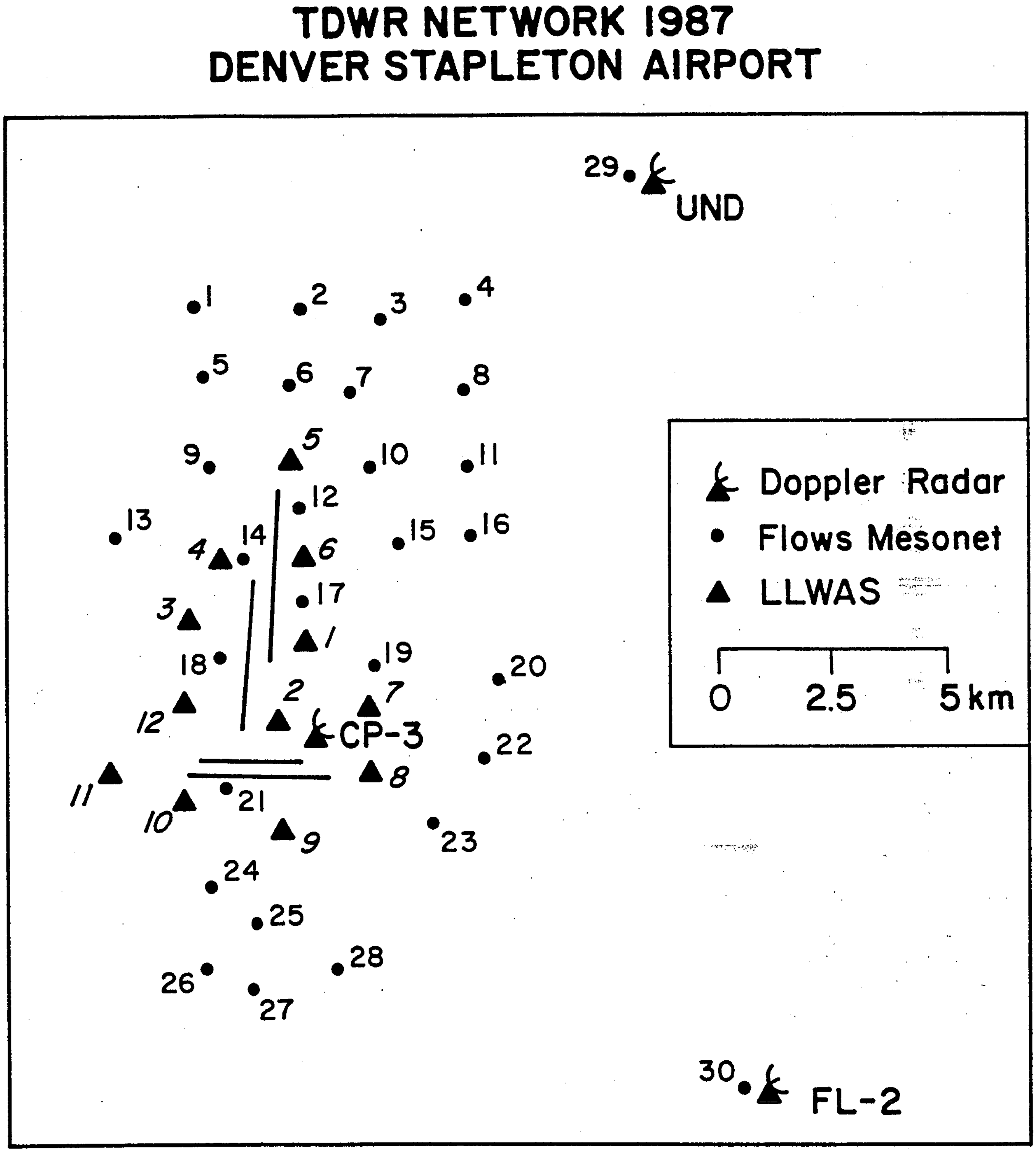
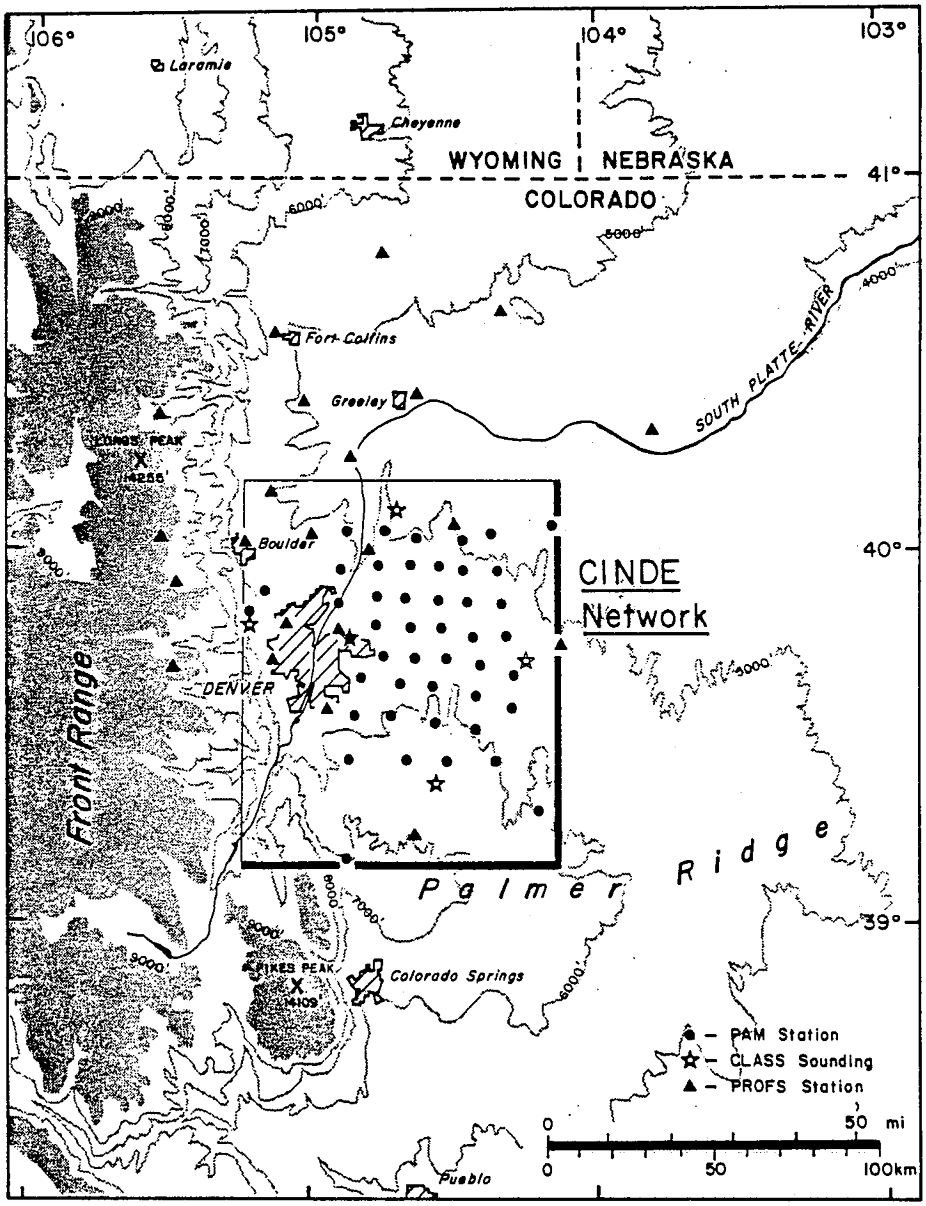


Figure I.2. TDWR Radar and Mesonet Locations.

PROFS mesonet, and data acquisition are included in this document. The PROFS network is shown in Fig. I.3.

Prof. V.N. Bringi operated the NCAR CP–2 S–band Doppler radar from 10 July–10 August to conduct multiparameter studies of heavy rain events over the TDWR dense mesonet at Stapleton Airport. He also investigated the possibility of multiparameter radar signatures contained within downburst downdrafts. Storms for study were frequently selected when they were within the CINDE network. Figure I.1 shows the location of the CP–2 radar.



Map produced by the Department of Atmospheric Sciences at UCLA.

Figure I.3. PROFS Mesonet Locations. The area covered by the CINDE network is also shown.

II. DAILY SUMMARIES

A. Daily Weather and Collection Summary

This section consists of Table II.1, which is a daily summary of weather events and field notes compiled by Jim Wilson. Table II.1 represents our present knowledge (March 1988) of events and should not be considered as all-inclusive, since a full search of the data has not been made. This table is based on field notes, "quick-look" data, and detailed studies on a few dates. The field notes should be used only as a quick-look guide to weather events and collections. By no stretch of the imagination are they complete. Microbursts, tornadoes, and convection initiation undoubtedly occurred on days not so indicated. The quality of data collections at the time the notes were taken could only be estimated.

Table II.1. Summary of CINDE Weather Events

	BOUNDARIES			PAM RAIN*		DOWNBURSTS		TORNADOES
Day	Stationary	Moving	Colliding	# Stations >1 mm	Max mm	<40dBZ	>40dBZ	
6/22		x		0	0			
6/23	x	x		26	17	x	x	
6/24	x	x		0	0			
6/25	x		x	5	16			
6/26				0	0			
6/27	x	x	x	1	1	x	x	
6/28	x	x	x	13	12		x	x
6/29				43	34			
6/30	x	x	x	14	14		x	x
7/1	x	x		0	0			
7/2	x	x	x	27	14	x	x	x
7/3	x	x	x	2	2			
7/4	x	x	x	14	14	x	x	x
7/5				2	3			
7/6	x	x	x	0	0	x		
7/7	x	x	x	14	8	x		x
7/8	x	x	x	24	36		x	x
7/9	x	x	x	1	5	x		
7/10	x	x	x	0	0	x		
7/11		x		12	3	x	x	
7/12				14	3		x	
7/13	x			0	0			
7/14				0	0			
7/15				0	0			
7/16	x	x	x	1	4	x		
7/17	x	x	x	18	18		x	x
7/18				0	0			
7/19	x	x	x	0	0			
7/20				0	0			
7/21	x	x		0	0			
7/22	x	x	x	8	8	x	x	x
7/23				0	0			
7/24	x	x	x	15	42		x	x
7/25	x			0	0			
7/26				0	0			
7/27	x	x		0	0			
7/28	x	x	x	25	15		x	x
7/29	x	x	x	17	18		x	x
7/30	x	x		0	0			
7/31	x	x	x	26	12		x	
8/1				0	0			
8/2	x	x	x	0	0	x		
8/3				0	0			
8/4	x			3	2			
8/5	x			0	0			
8/6		x	x	4	3	x	x	
8/7				19	21			

* From 1100 - 2000 mdt

Daily Field Notes

6/22

EVENTS

- Clear air mesocyclone on east edge of network.
- Cold front intersects field of Cu in network and initiates cells <30 dBZ. Stronger storms occur east of network.
- Possible low Z microbursts.

COLLECTIONS

- Soundings either side of cold front.
- NOAA radar data probably not useful.
- Aircraft practice.

6/23

EVENTS

- Stationary boundary initiates 60 + dBZ cells. Boundary just west and north of network.
- Tornado near Hudson and large hail in several locations.

COLLECTIONS

- CP-3 down until storms form. CP-2 may be O.K.
- Aircraft could do little because of storm intensity.
- Many problems with NOAA radars.
- Soundings may be good.

6/24

EVENTS

- Dry line from north dies in network, no storms occur in network.

COLLECTIONS

- Limited aircraft, no NOAA radars.
- Soundings either side of dry line.

6/25

EVENTS

- Denver cyclone made up of NE-SW and NW-SE convergence lines.
- Several 65 + dBZ storms initiate at the intersection of these convergence lines.
- Large hail near Bennett.

COLLECTIONS

- Aircraft flights prior to storm initiation.
- NOAA-D not available during initiation of storms.
- NOAA-C and CP-3 did some coordinated scanning on storm initiation.
- Good sounding placement.

6/26

EVENTS

- No boundaries or storms.

COLLECTIONS

- No special collections.

6/27

EVENTS

- Two moving and one stationary boundary initiate storms that produce strong outflows.
- Multiple collisions in south lobe produce additional storms.
- Many storms produce strong downbursts.

COLLECTIONS

- Complex situation, quality of data uncertain.
- NOAA radars, aircraft and soundings on moving gust front.

6/28

EVENTS

- Boundaries from early foothills convection collide and become stationary in the network. Secondary surges from the north strengthen convergence and initiate hailstorms, tornadoes and microbursts.

COLLECTIONS

- Good dual data on full life cycle of a storm from initiation to microburst.
- Soundings probably good.
- No aircraft.

6/29

EVENTS

- Heavy upslope rains.

COLLECTIONS

- One sounding and CP-3 until 1330.

6/30

EVENTS

- Denver convergence line produces 60 + dBZ storms with a tornado in north lobe and several microbursts. Explosion of activity associated with surge of wind of unknown origin from the northwest (good case).

COLLECTIONS

- No NOAA radars; CP-3 and FL2 coordinate low-level scanning, may have some good data on initiation.
- NCAR King Air has some good flights through convergence line.
- Many soundings should prove excellent.

7/1

EVENTS

- Three weak diffuse boundaries from the north and at least one from the west move into research area and produce no storms.

COLLECTIONS

- Good soundings document a null convection initiation case.

7/2

EVENTS

- Two convergence lines oriented NW-SE and SW-NE initiate original storms.
- Three tornadoes (1-large at UND), large hail and microbursts.

COLLECTIONS

- Good dual-Doppler data and photographic data on the full life cycle of a tornado.
- Good soundings.

7/3

EVENTS

- Weak Denver convergence line dissipates and produces no storms.
- Boundaries collide in north lobe but produce no echoes over 20 dBZ.

COLLECTIONS

- Many good soundings on dissipating convergence line, also on colliding boundaries.
- No NOAA-D data; NOAA-C and CP-3 may have good dual Doppler on colliding boundaries.
- Aircraft flights before boundary collision.

7/4

EVENTS

- > 50 mi long virga line streams off Mt. Evans, initiates three boundaries, produces numerous microbursts and two tornadoes.
- The above boundaries and an unknown moving boundary from the south initiate three 60 + dBZ storms in southern network.

COLLECTIONS

- Only CP-3 and mobile sounders available. However, soundings well placed.
- Good data for virga line study and boundary soundings for intense storms.

7/5

EVENTS

- No boundaries and no echoes exceeding 25 dBZ.

COLLECTIONS

- No special collections.

7/6

EVENTS

- At least six well-defined boundaries, all involved in collisions, produced only weak echoes (20 dBZ), one to 45 dBZ.
- A number of low Z microbursts.

COLLECTIONS

- Microburst aircraft flights with dual-Doppler coverage. One case is a microburst and the other case a null event.
- Many soundings on either side of moving and colliding boundaries.

—

7/7

EVENTS

- Stationary convergence zone intensified by outflow from foothills storms produced 60 + dBZ storms; hail, Castle Rock tornado, and microbursts.

COLLECTIONS

- NOAA dual-Doppler on initiation of two storms; one produces a microburst.
- Sounding on either side of convergence line.
- Aircraft have cloud physics data on low Z microbursts just outside of dual-Doppler range.

7/8

EVENTS

- Southern half of Denver convergence line, gust front, unknown moving, unknown stationary and mountain outflow, all interact initiating 50-60 dBZ storms with microbursts and tornadoes.
- Two moving boundaries created particularly strong convergence, that lifted stable air that produced a strong line of storms and evolved into a strong microburst line.

COLLECTIONS

- Good dual-Doppler on evolution of microburst line.
- Good soundings on multiple boundary collisions.
- Numerous aircraft flights through various boundaries.

7/9

EVENTS

- Collision of unknown stationary and unknown moving boundaries produced < 30 dBZ echoes.
- Virga line produces numerous microbursts.
- Collision of two moving boundaries produces a second line of low Z microbursts.
- Small plane forced down by microburst at Centennial Airport.

COLLECTIONS, 7/9 con't.

- Aircraft have good data on low Z microbursts.
- Aircraft and soundings through boundary collision.
- Dual-Doppler on colliding boundaries and low Z microbursts.

7/10

EVENTS

- Same boundaries of unknown origin observed previous day developed again. However, this time evolved into a large scale circulation with strong winds.
- 20-40 dBZ echoes produced some microbursts.

COLLECTIONS

- Good dual-Doppler history on low Z microbursts.
- Good sounding coverage on boundary evolution.
- Large dust devil documented.
- No aircraft data.

7/11

EVENTS

- Unknown moving boundary produces $\leq$ 20 dBZ cells.
- Virga line like 4 July produces weak divergence.
- Diverging line on north edge of north lobe and weak outflows in south lobe.
- Numerous 25-45 dBZ echoes with no obvious convection initiation reason; John Brown suggests symmetric instability may be the cause.

COLLECTIONS

- FL2 and UND collect dual data on virga line.
- Good soundings.
- No aircraft flights.

7/12

EVENTS

- Line of diverging showers in a saturated moist adiabatic lapse rate environment. Because of velocity signatures, the storm looked like a microburst line but hardly traditional.

COLLECTIONS

- NOAA radars collected some dual-Doppler on diverging line of showers.
- No other special collections.

7/13

EVENTS

- Convergence line on Palmer Divide. No storms.

COLLECTIONS

- Soundings either side of boundary.

7/14

EVENTS

- No boundaries or cells.

COLLECTIONS

- No special collections.

7/15

EVENTS

- Unknown stationary boundary SE of network produces a few storms.
- Weak gust front from south of network slowly moves north but produces no cells.

COLLECTIONS

- Two pair of soundings either side of unknown boundary.
- No other special collections.

7/16

EVENTS

- Numerous weak outflows mainly from mountain storms.
- Gust front from northwest becomes stationary in network. Does not produce storms.
- N-S unknown stationary boundary through network eventually associated with strong convergence after it collides with gust front. Produced < 30 dBZ echo.
- Few low Z microbursts.

COLLECTIONS

- Flight for Moti Segal on effects of vegetation variations on differential heating.
- Flights through gust front as it stalls in network, soundings also.
- Flights through potential low Z microbursts.
- FL2 and UND may have dual on low Z microbursts.
- Some good soundings either side of convergence lines that produced only weak or no cells.

7/17

EVENTS

- Synoptic scale N-S boundary through PAM eventually produces 60 + dBZ storms and three tornadoes near NOAA-C.
- Collision of gust front and strong surge from the SW lifts stable air that produces 55 dBZ echoes.

COLLECTIONS

- Excellent aircraft, sounding and photography on development of convection along N-S boundary. Quality of NOAA radar data for initiation of storms unknown.
- Excellent photography and single Doppler data on development of tornadoes also have proximity sounding.

7/18

EVENTS

- Strong clear-air velocity feature across southern PAM.
- No precipitation echoes.

COLLECTIONS

- Shelby Fritsch uses NOAA radars for his clear air turbulence study.

7/19

EVENTS

- Boundary from northwest, probably from mountain storms, produced a line of 30 dBZ cells with only weak outflows. Very marginal moisture.

COLLECTIONS

- Only CP-3 and soundings available. Soundings on either side of boundary.

7/20

EVENTS

- No boundaries or storms.

COLLECTIONS

- No special collections.

7/21

EVENTS

- Denver cyclone tried, but did not develop.
- Several ill-defined boundaries.
- No storms.

COLLECTIONS

- Numerous soundings associated with non-storm producing boundaries.

7/22

EVENTS

- 55 dBZ storms initiated along north side of network without an obvious pre-existing convergence line.
- Gust front from the northwest collides with another boundary just north of the airport; collision produced weak showers, then boundary continued to move through the network.

COLLECTIONS

- NOAA radars, soundings and profilers support clear air turbulence study.
- Sounding pairs on either side of gust front when producing storms and later when not. Also high resolution dual-Doppler when gust front not producing storms.
- Aircraft flew outside network, probably have good data for low Z microbursts.

7/23

EVENTS

- No boundaries and no storms.

COLLECTIONS

- No special collections.

7/24

EVENTS

- Cold front evolves into Denver convergence line that produces a line of 55 dBZ storms.
- Collision of gust front and initial boundary produces 60 dBZ storm.
- Major ring gust front moves out from the activity, producing scattered 45-65 dBZ storms, some with hail, as it intersects with other boundaries and mountains.
- PAM 9 records 33 m s^{-1} wind and hail. Other numerous strong downbursts with high Z storms.
- Two tornadoes occurred.
- One storm initiates in advance of gust front.

COLLECTIONS, 7/24 con't.

- Excellent soundings, aircraft flights and photography of the initial storm development along convergence line. No NOAA radars.
- Aircraft flights through circular gust front, NOAA radars obtain dual in same area.
- Dual-Doppler on history of moderate Z microburst storm.

7/25

EVENTS

- Decaying Denver convergence line produces no storms.
- Unknown stationary boundary with no storms.

COLLECTIONS

- Segal vegetation differential heating flight.
- Aircraft and soundings sample Denver convergence line.
- Soundings show significant difference on either side of unknown stationary boundary.

7/26

EVENTS

- No boundaries or storms, although mixing ratios 9 g kg^{-1} through deep layer.
- Many strong mountain storms, steering flow from the south.

COLLECTIONS

- Intercomparison soundings.
- Sounding in conjestus field late in the day.

7/27

EVENTS

- Large mountain outflow initiates cells < 45 dBZ.

COLLECTIONS

- Soundings in mountains and plains to examine moisture depth.
- Aircraft and soundings through mountain outflow.
- Horizontal roll study with aircraft and soundings.

7/28

EVENTS

- Palmer Divide storms produce anvils that generate convergence lines, and 40 dBZ storms.
- Colliding gust fronts produced 55 dBZ storms, downbursts and tornadoes.
- Gust front initiates 30 dBZ cells.

COLLECTIONS

- Segal vegetation differential heating flight with sounding support.
- Anvil study of convergence line initiation with soundings, photography, and NOAA radars.
- NOAA radars obtain dual data on several microburst storms, some with rotating downdrafts.
- NOAA radars obtain storm initiation data from colliding boundaries, also chaff updraft marker experiment.
- Aircraft flights through gust front that produces 30 dBZ echoes.

7/29

EVENTS

- NE-SW convergence line believed to be initiated by anvil and topography, produces 45 dBZ echoes.
- Anvil apparently produces second convergence line that collides with the one above and produces 45 dBZ echoes and one major cell over STP; also a small tornado. This big storm produces circular gust front that initiates a few more storms.

COLLECTIONS

- Sounding and aircraft sample circular gust front and NOAA dual-Doppler on a portion that produces only weak echo.
- Soundings either side of first boundary.

7/30

EVENTS

- Mountain outflow moves through Denver, produces two 45 dBZ storms. Apparently intersects with other boundaries.
- Anvil from storm over Palmer Divide quickly dissipates.

COLLECTIONS

- Soundings both sides of mountain outflow.
- Anvil study with soundings and aircraft; marginal success.

7/31

EVENTS

- Mountain outflow enhanced by convection it initiates. This boundary collides with several other boundaries (pseudo-Denver convergence line and gust fronts) and initiates numerous 50-65 dBZ storms some with hail and downbursts.
- Three boundaries interact in network initiating more storms.

COLLECTIONS

- Good soundings at various times on both sides of mountain outflow.
- Dual-Doppler on moderate to heavy storms, believe none produced downbursts.

8/1

EVENTS

- No storms or significant boundaries despite forecast of an active day by the progs.

COLLECTIONS

- No special collections.

8/2

EVENTS

- Mountain outflow from southwest reintensified by storms it produces, moves through the entire network. Several collisions occurred, producing 30-45 dBZ echoes.
- Number of microbursts, but relatively weak.

COLLECTIONS

- Good sounding and aircraft flights at several times during the life of the mountain outflow.
- Aircraft attempted anvil studies for low Z microbursts but microbursts did not materialize.
- Dual-Doppler on weak microbursts, one on top of a stable layer.

8/3

EVENTS

- Cold front passes early morning.
- Anvil from mountains transports high momentum air downward.
- No storms.

COLLECTIONS

- Soundings document evolution of inversion produced by cold front.
- Anvil study with sounders and NOAA radars.

8/4

EVENTS

- Early morning outflow from Kansas caused 4 mb pressure rise with 8-10° cooling to 600 mb.
- Later in day Denver convergence line develops but barely produces a cloud until after 1800, when one 60 dBZ cell develops.

COLLECTIONS

- Thermal capping study was started but terminated by the Kansas outflow.
- First echo study for Knight on a 10 dBZ echo just prior to 60 dBZ echo. NOAA radars have full history of 10 dBZ storm.
- Soundings with convergence line.

8/5

EVENTS

- Unknown boundaries produce $\leq$ 20 dBZ echoes.

COLLECTIONS

- Capping inversion study with soundings, aircraft and NOAA radars. Unfortunately cap did not develop.
- Soundings, aircraft and dual-Doppler of unknown boundaries, not a significant case.

8/6

EVENTS

- Two mountain outflows and a third unknown boundary collide and produce weak storms (one to 40 dBZ) and low Z microbursts.
- Two large dust devils documented.

COLLECTIONS

- Dual-Doppler on life history of microburst storm.
- Good soundings with boundaries.

8/7

<u>EVENTS</u>

- No significant weather. Shut down early for project party.

B. System Operation Timetables

The following tables (Tables II.2 - II.48) chronicle the operation times of all CINDE and TDWR equipment for each day. PAM, FLOWS, and PROFS mesonets are not listed, since they operate 24 hr/day.

C. Quick Look Products

The following quick look products are available for general use in Cindy Mueller's office (RL–3, Room A212). With a few exceptions, the products are available for each day of the project.

1. 5.5°PPI reflectivity plots for 35 and 50 dBZ_e contour levels at 5 min intervals
2. Notes taken during the operations by the operations director, radar analyst, scan optimizer, aircraft coordinator, and the nowcaster
3. Skew-T plots and listings from available soundings
4. Winds plots from the PAM mesonet and PROFS mesonet at 15 min intervals
5. Aircraft tracks for the NCAR King Air and UW King Air
6. Movies of CP–3 low-level velocity and reflectivity
7. Subjectively analyzed boundary locations

Contact Cindy Mueller (497–8805) or Bob White (497–8825) for assistance in using or copying the material.

Table II.2. System Operation Timetable for 22 June 1987

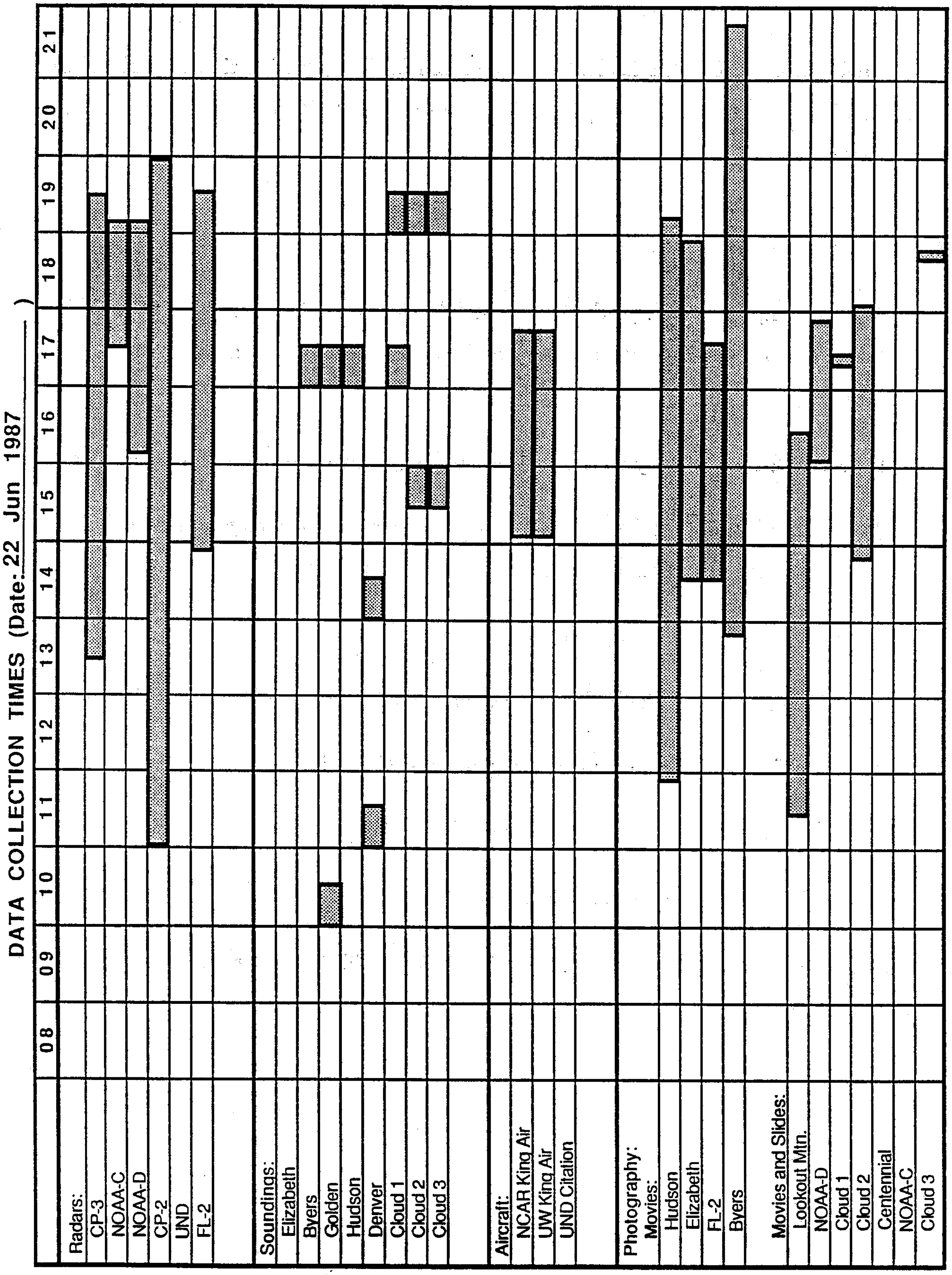


Table II.3. System Operation Timetable for 23 June 1987

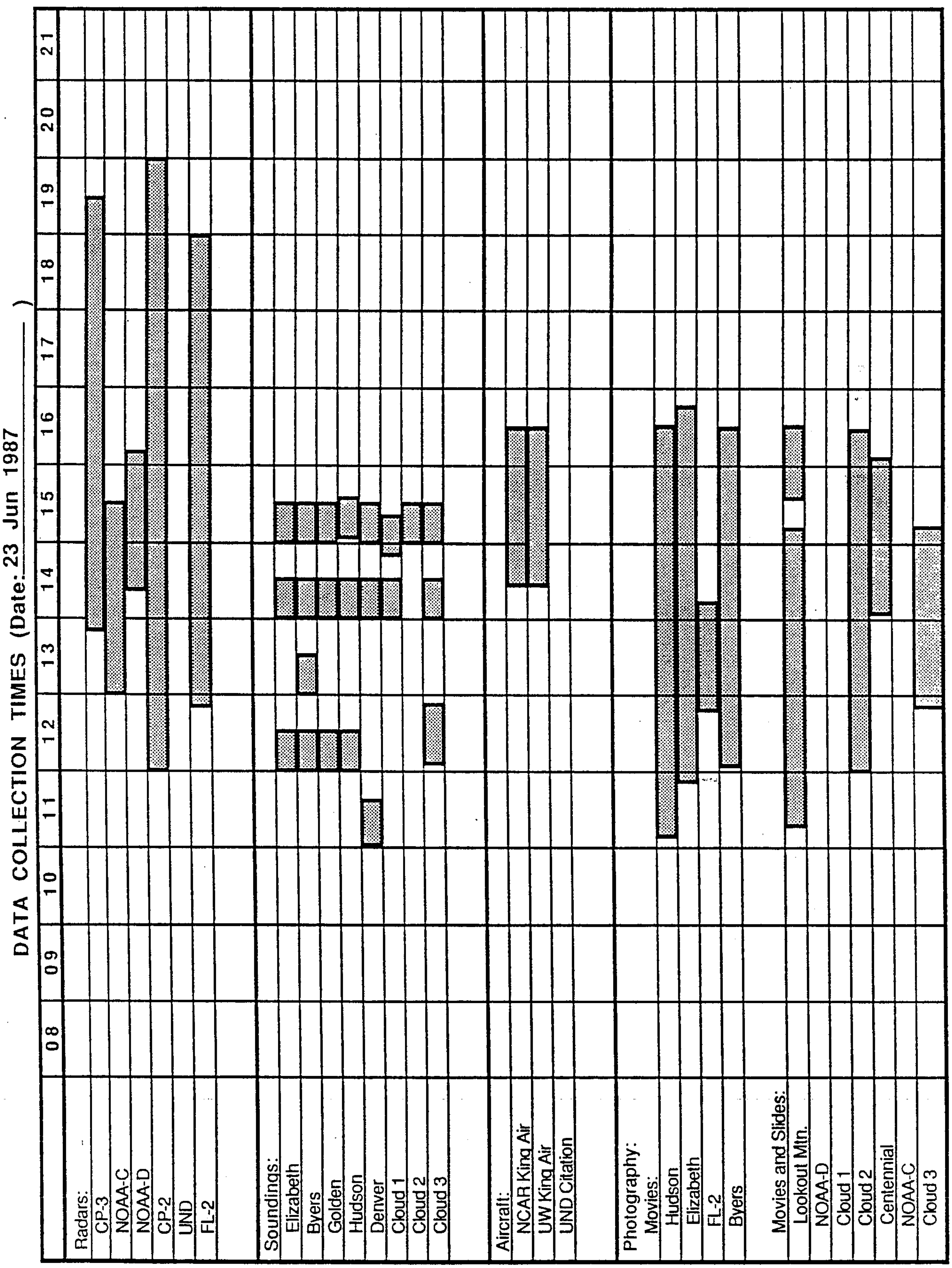


Table II.4. System Operation Timetable for 24 June 1987

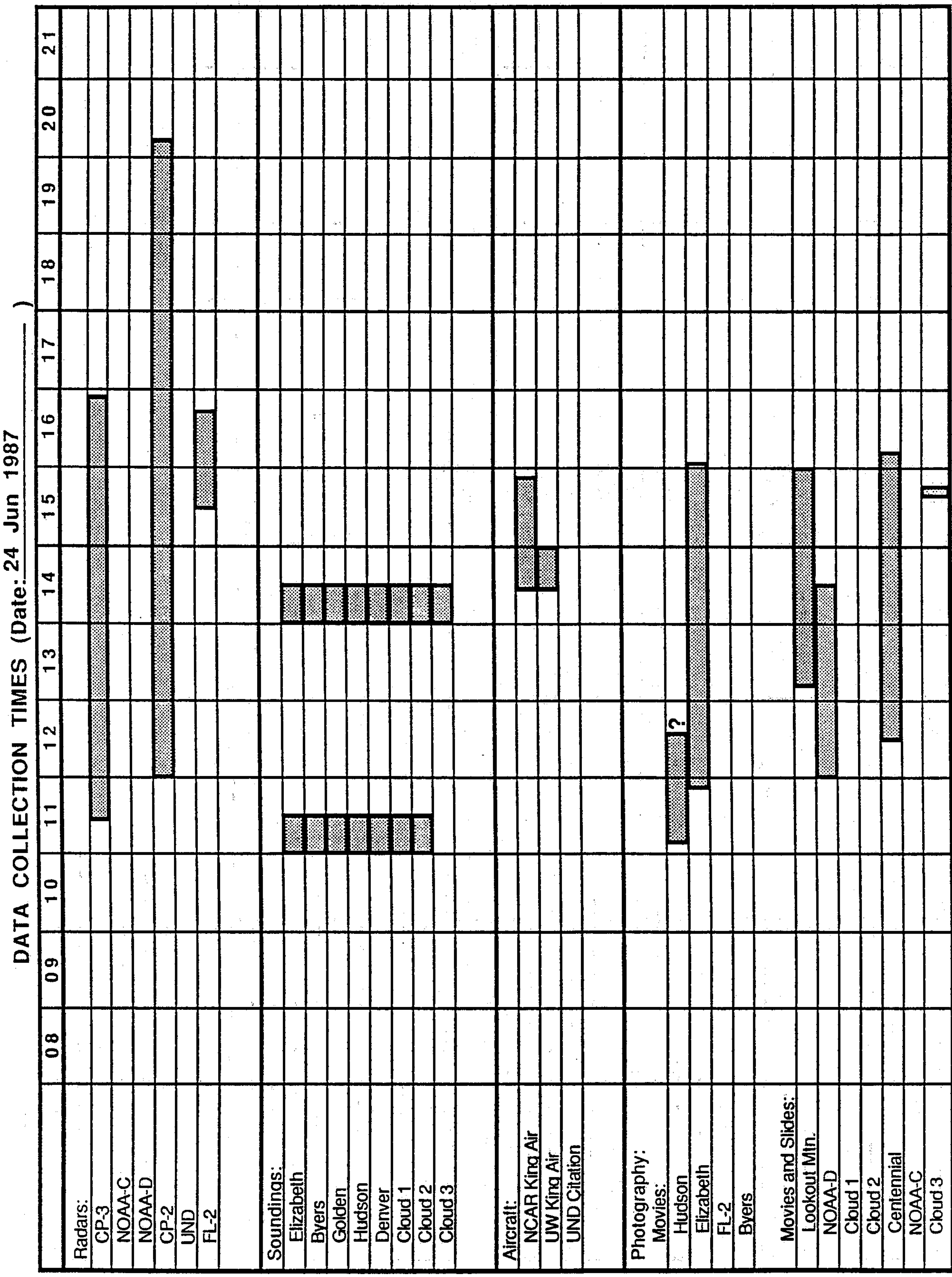


Table II.5. System Operation Timetable for 25 June 1987

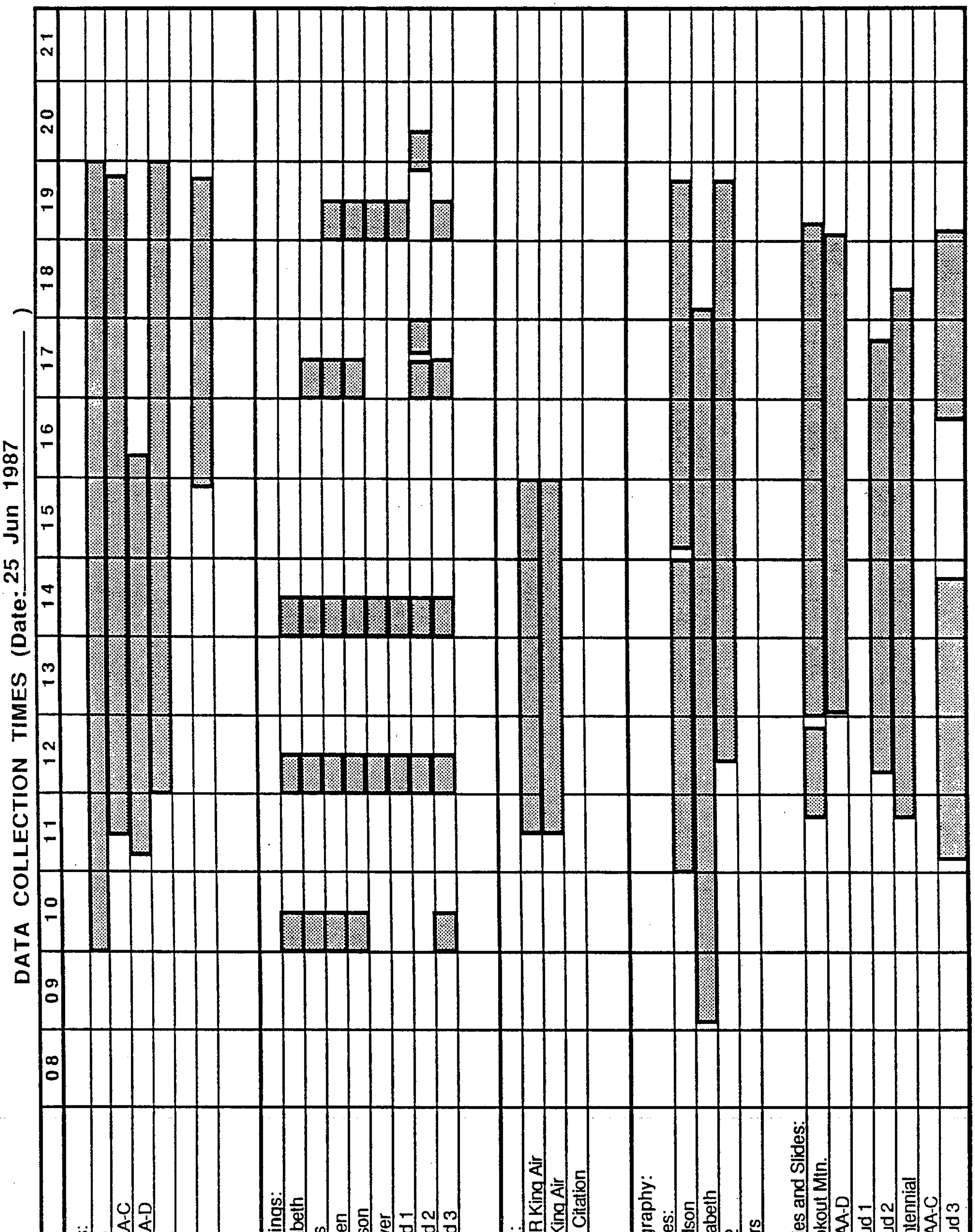


Table II.6. System Operation Timetable for 26 June 1987

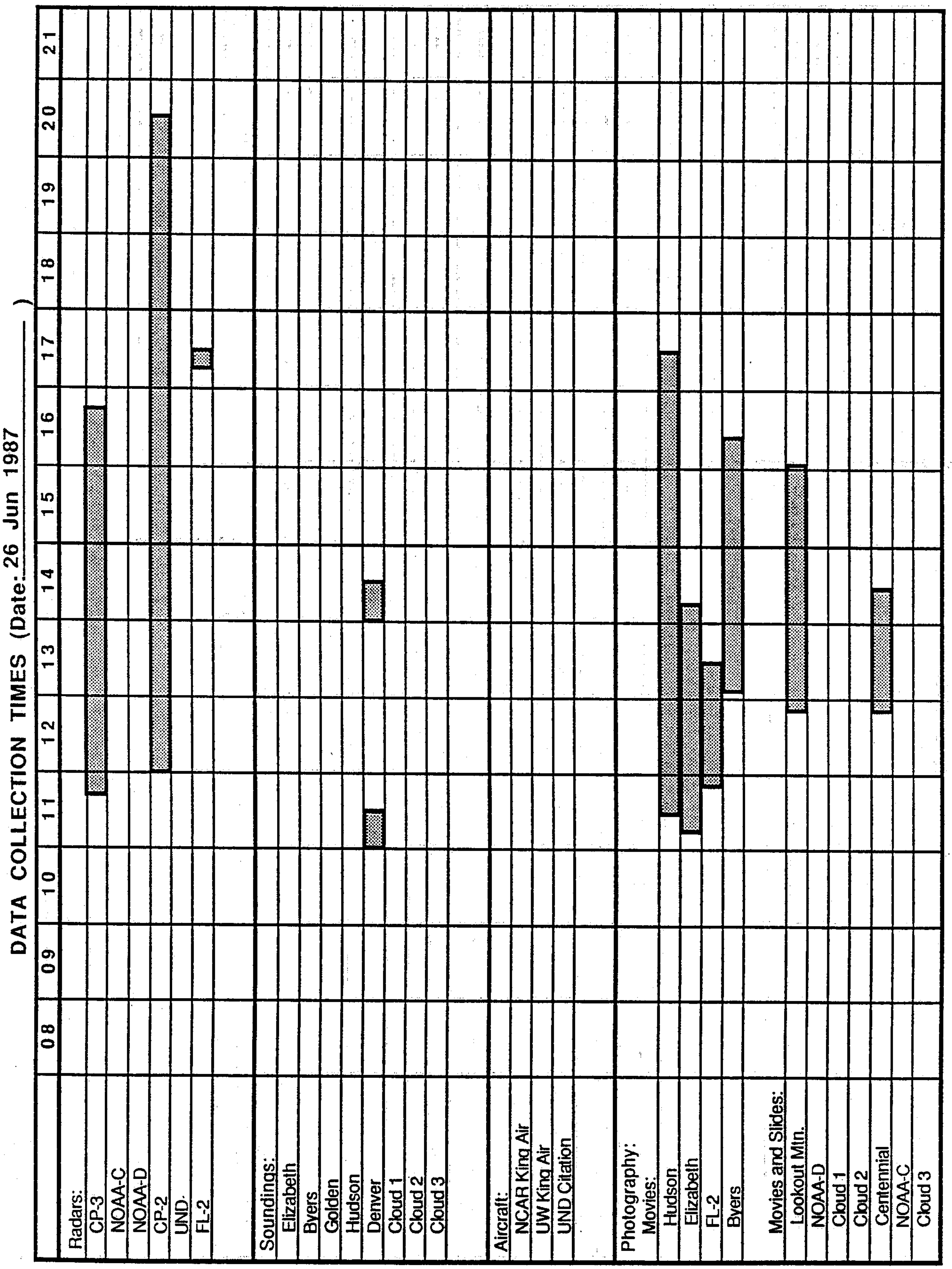


Table II.7. System Operation Timetable for 27 June 1987

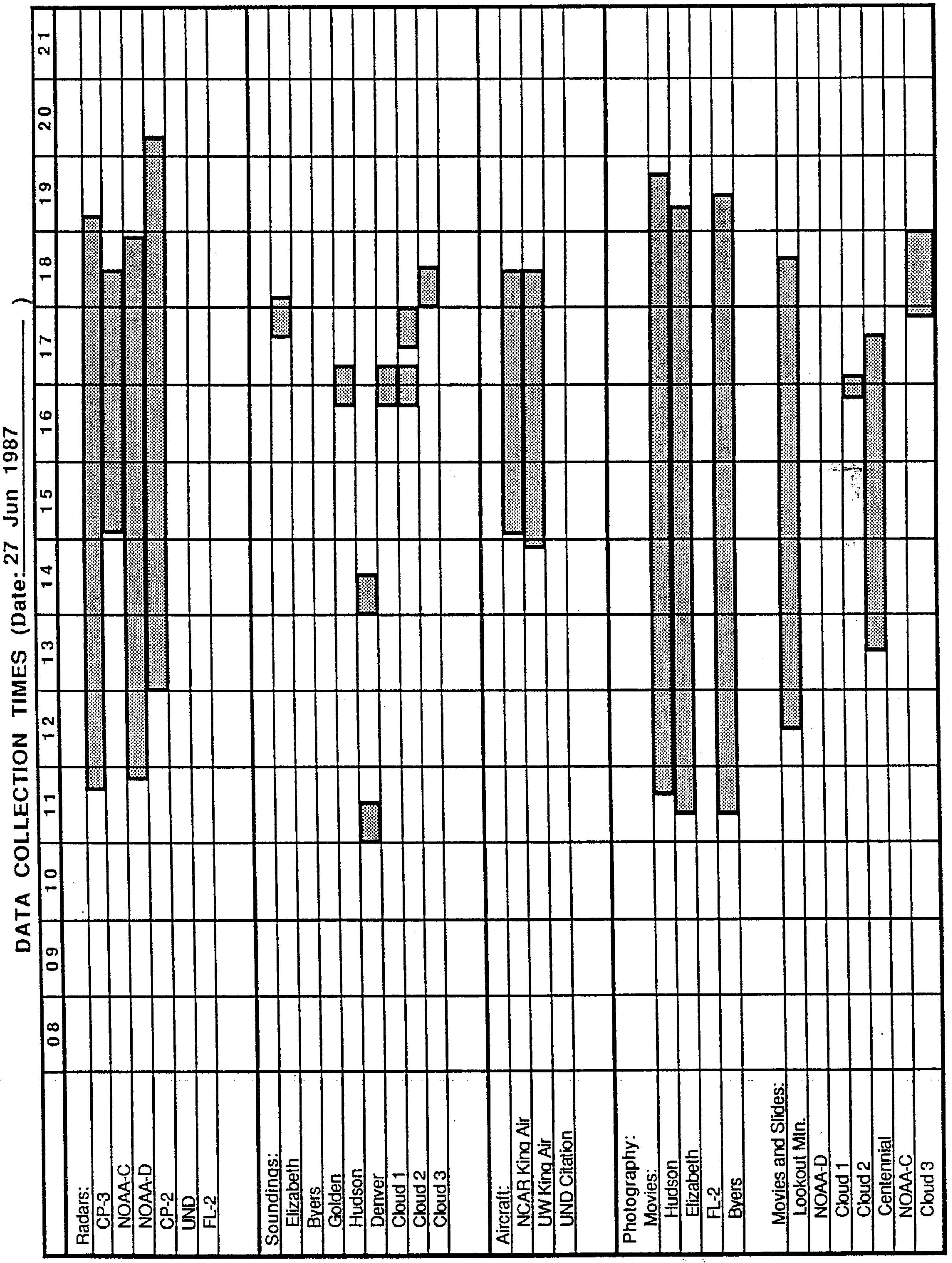


Table II.8. System Operation Timetable for 28 June 1987

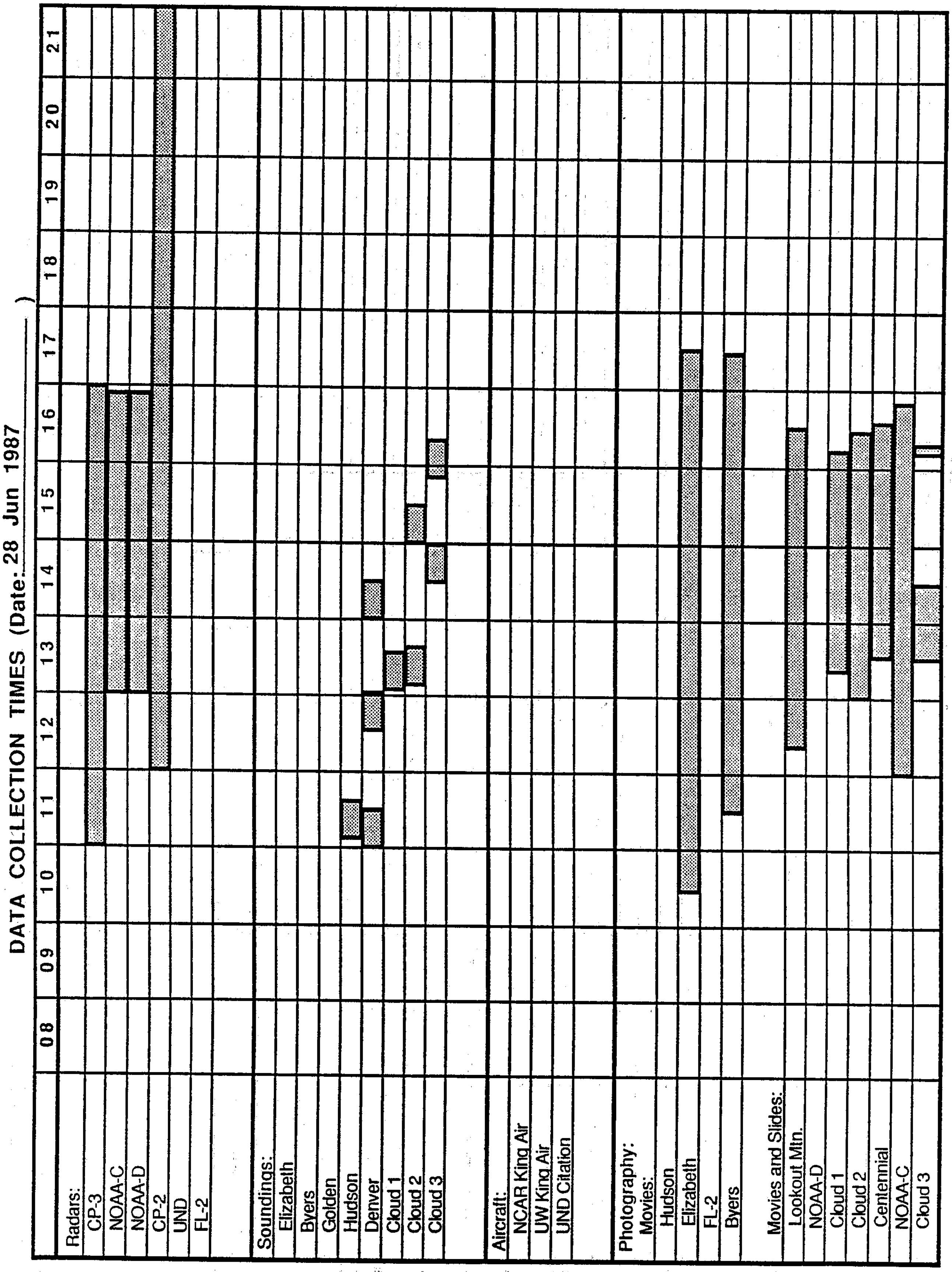


Table II.9. System Operation Timetable for 29 June 1987

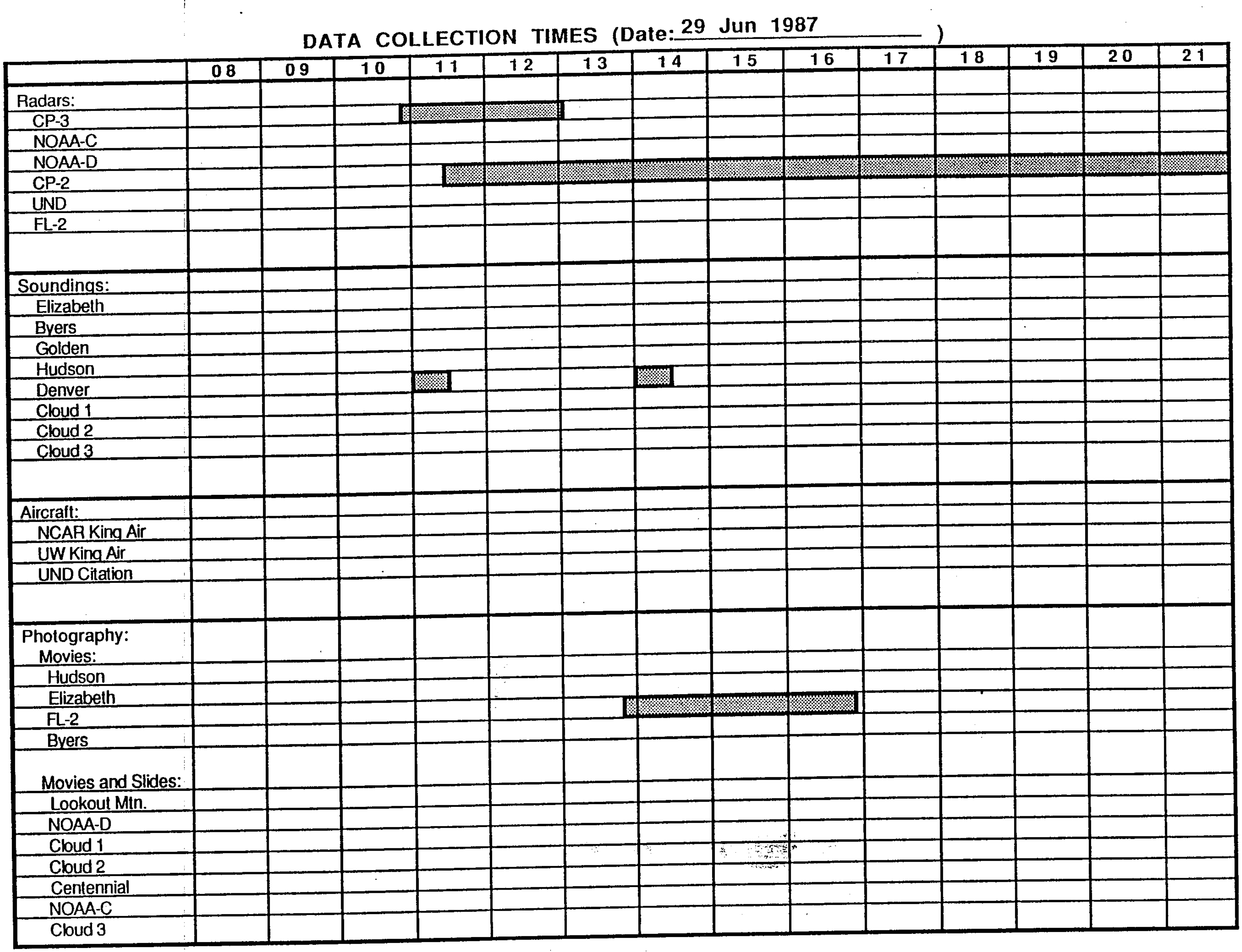


Table II.10. System Operation Timetable for 30 June 1987

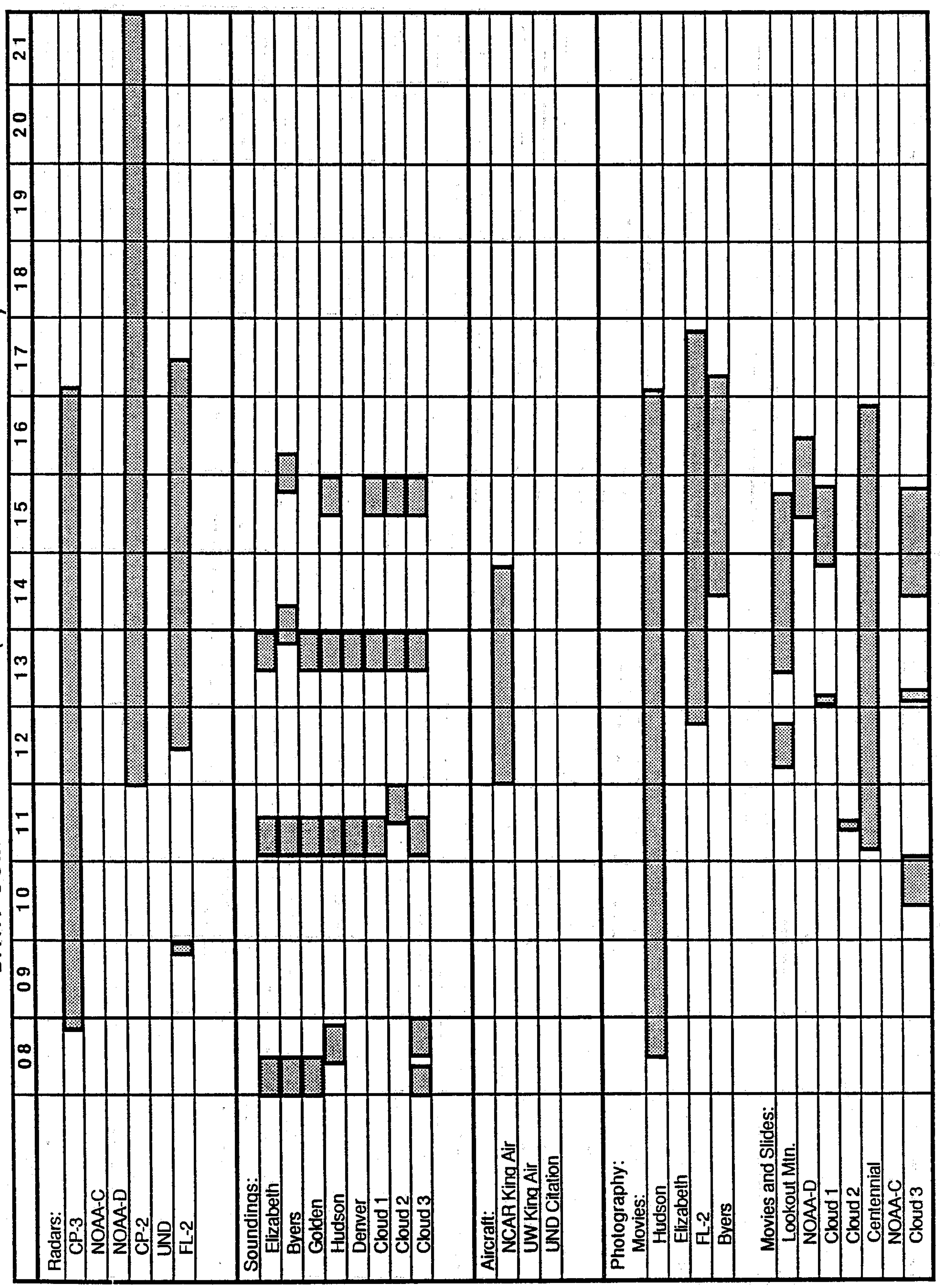


Table II.11. System Operation Timetable for 1 July 1987

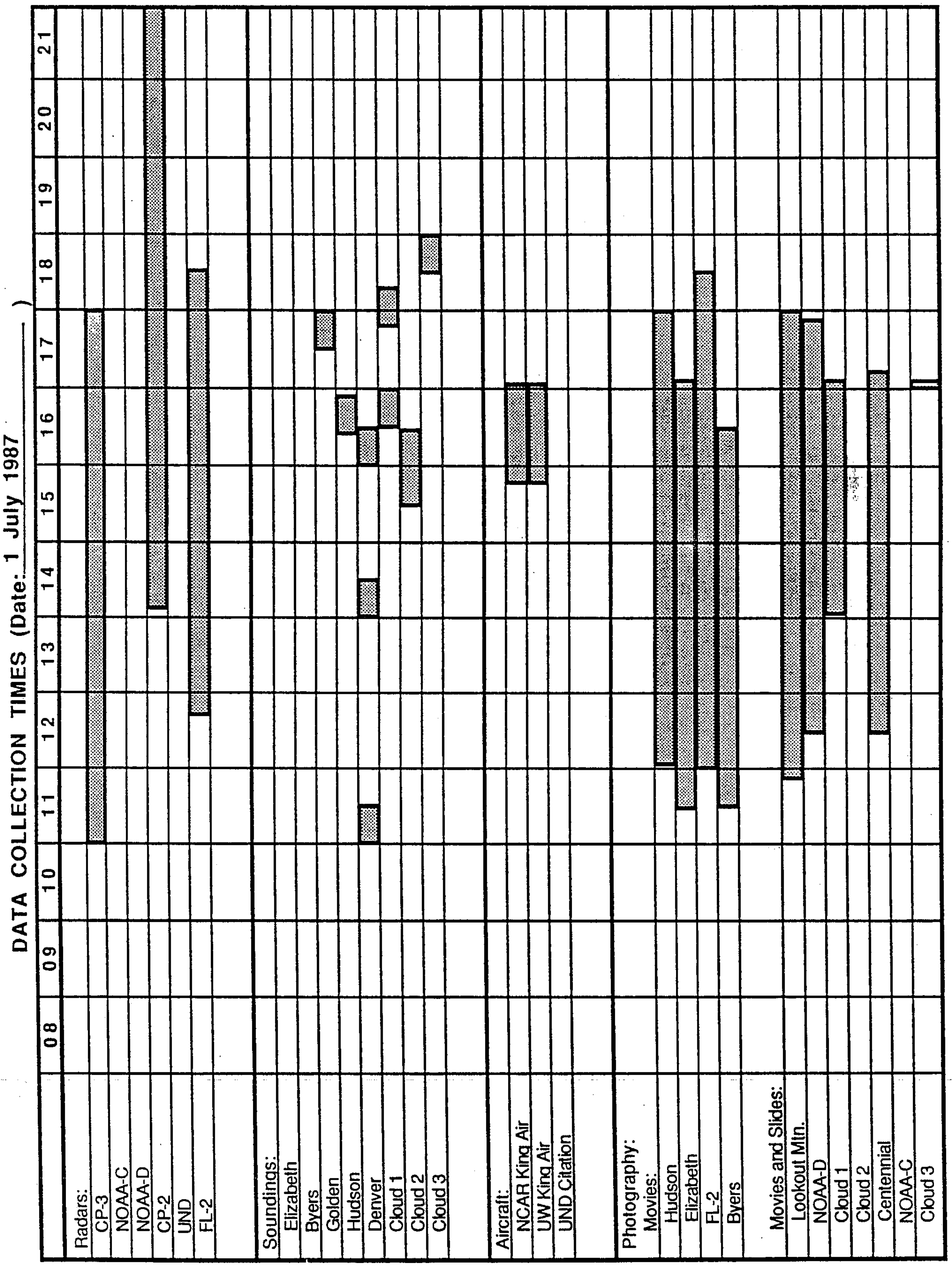


Table II.12. System Operation Timetable for 2 July 1987

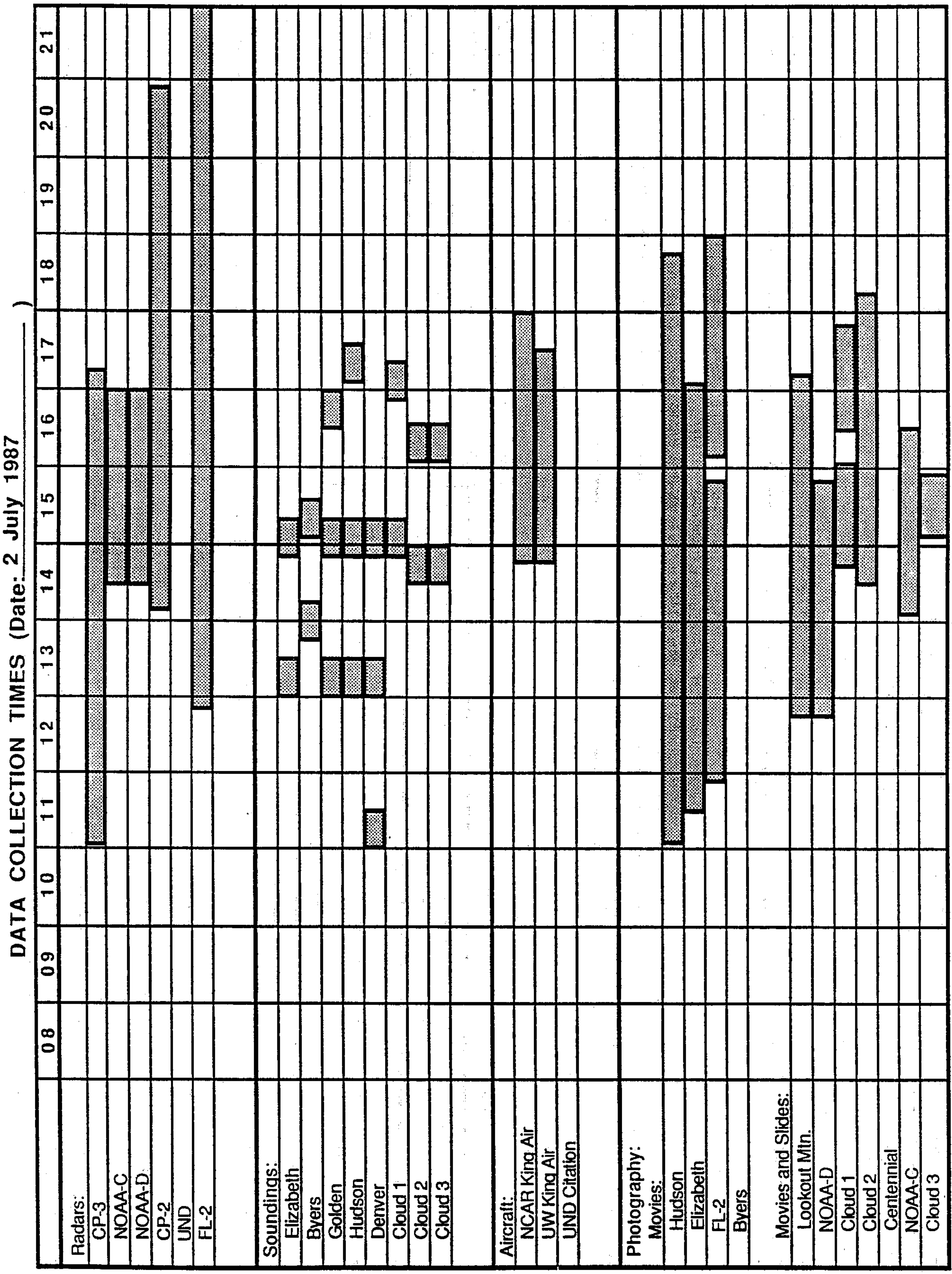


Table II.13. System Operation Timetable for 3 July 1987

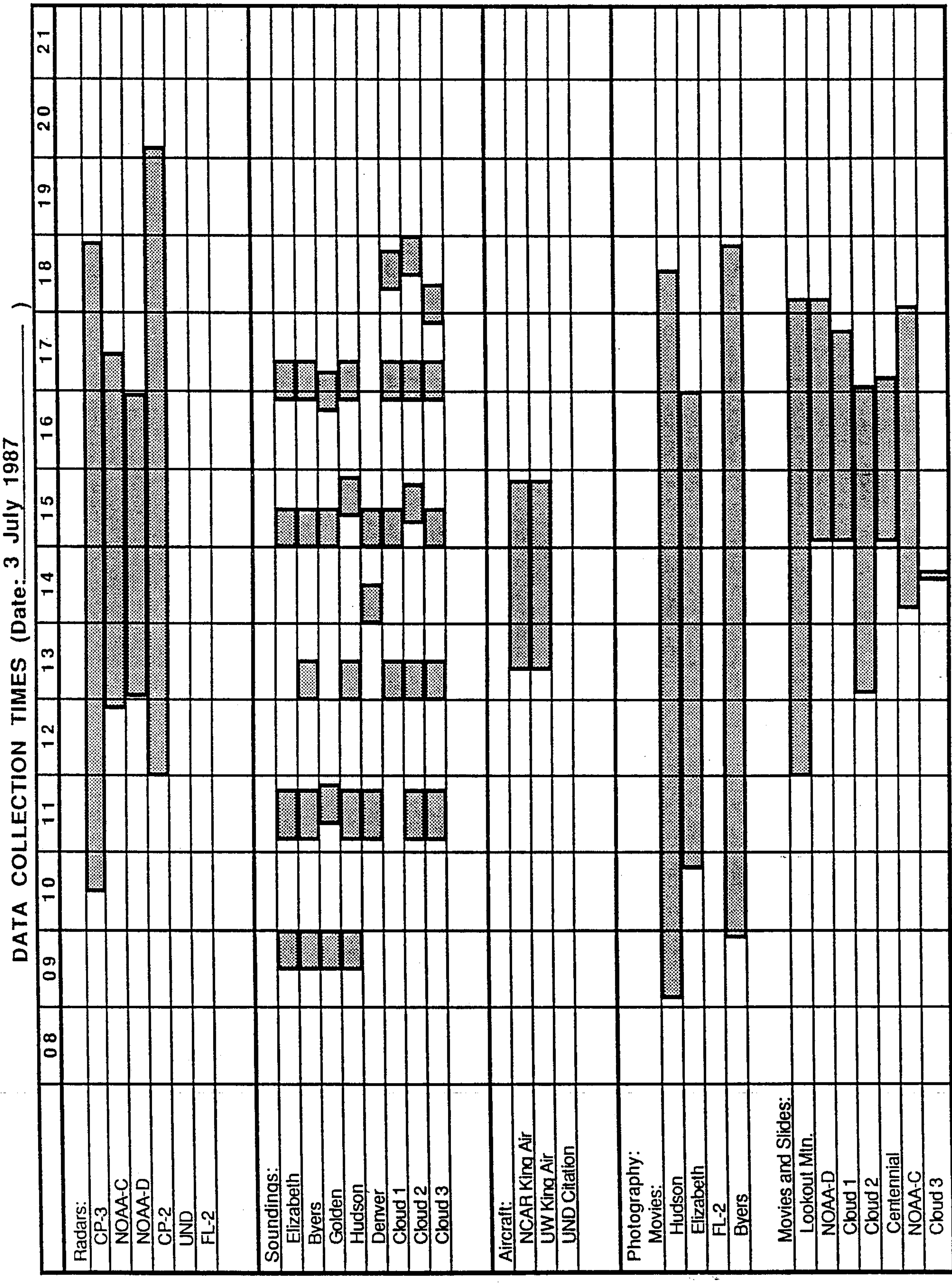


Table II.14. System Operation Timetable for 4 July 1987

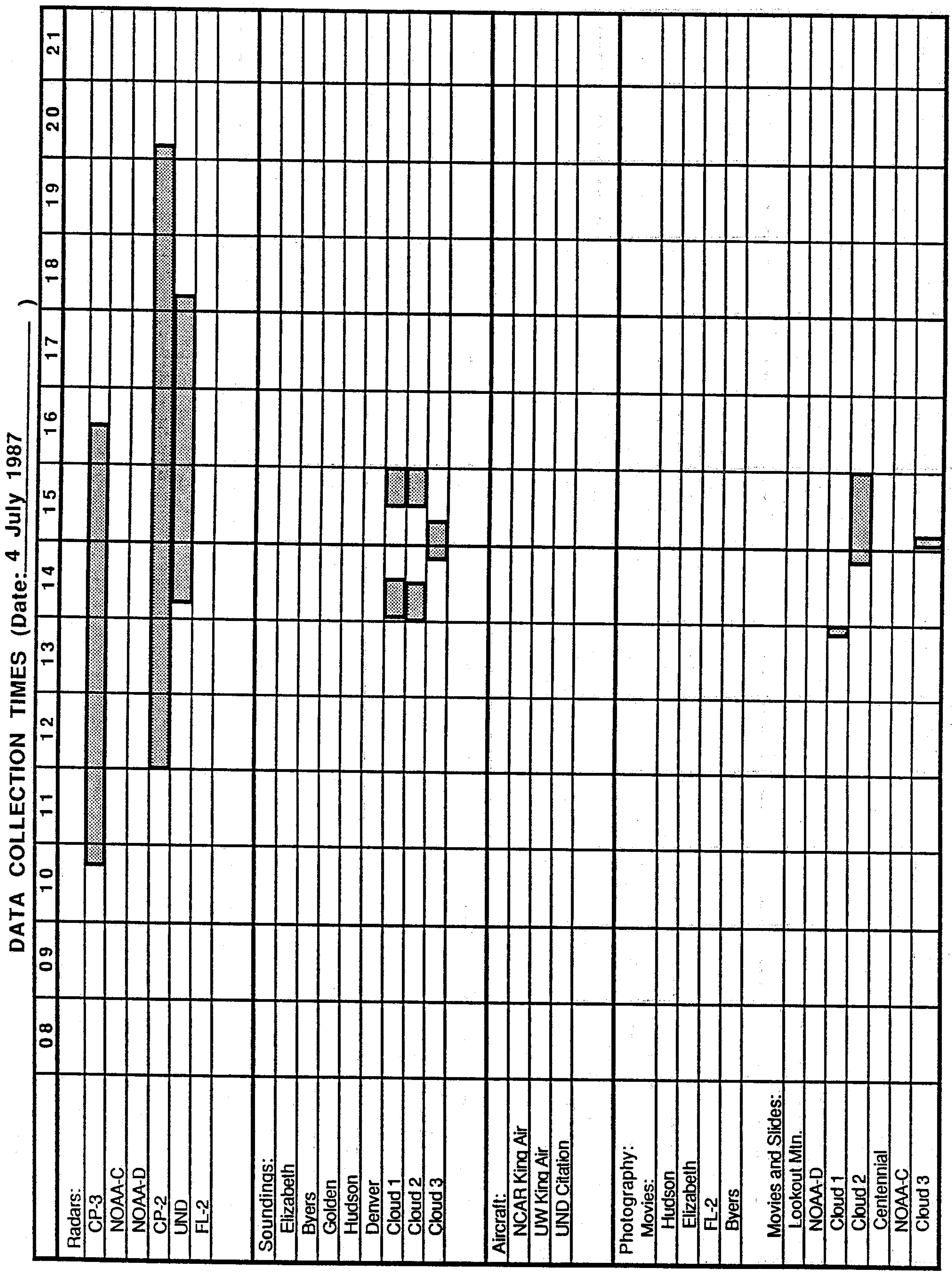


Table II.15. System Operation Timetable for 5 July 1987

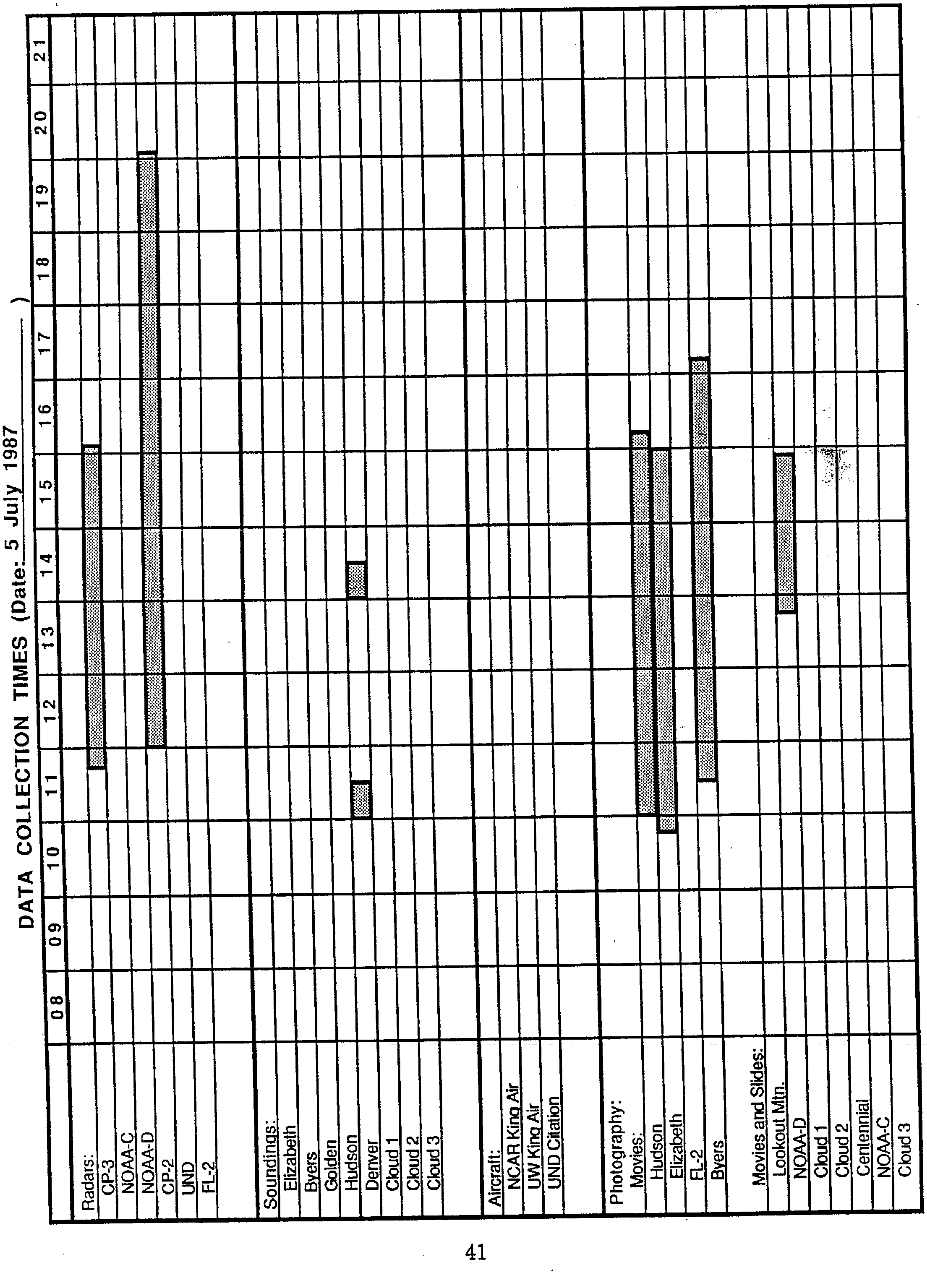


Table II.16. System Operation Timetable for 6 July 1987

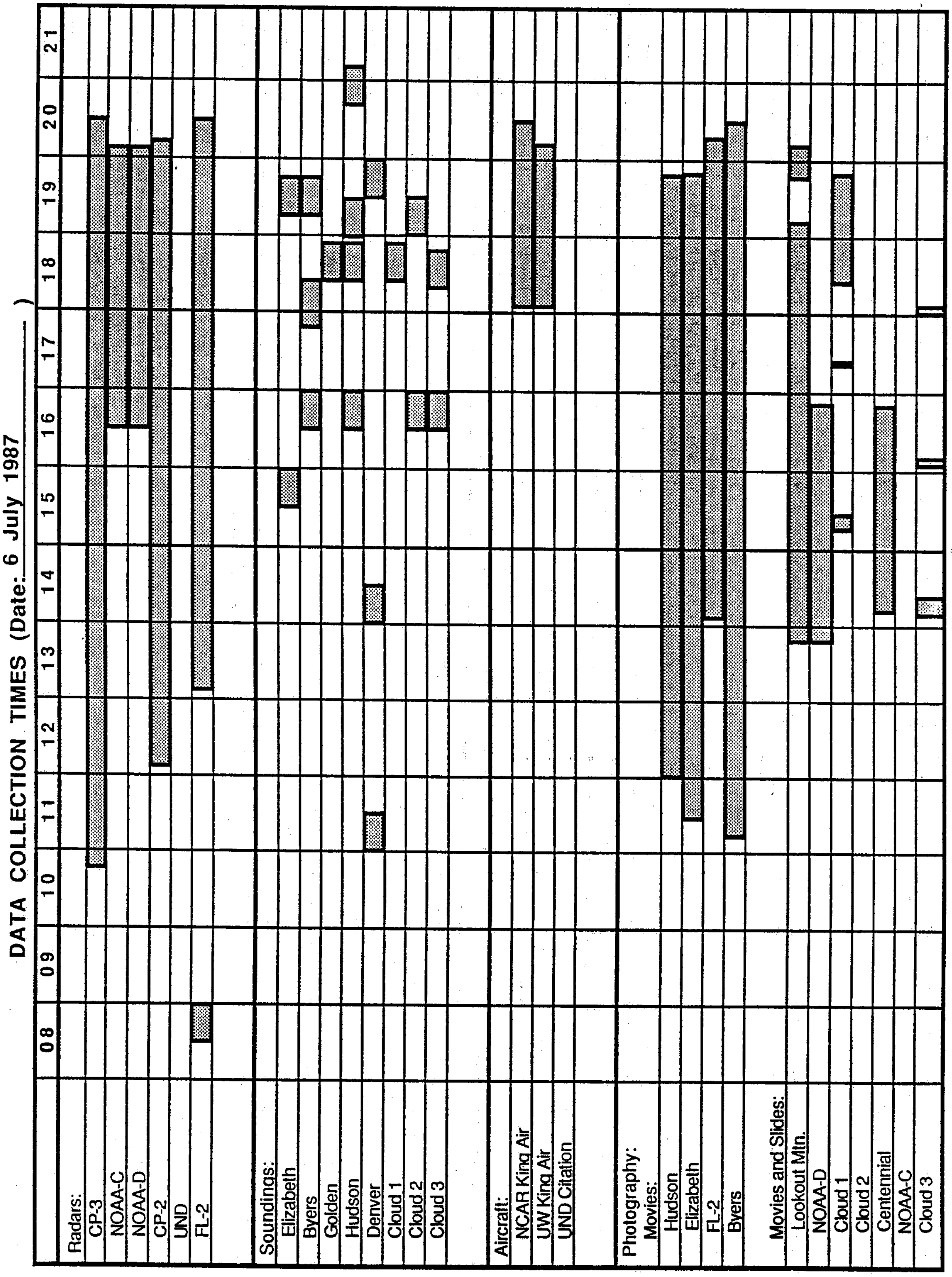


Table II.17. System Operation Timetable for 7 July 1987

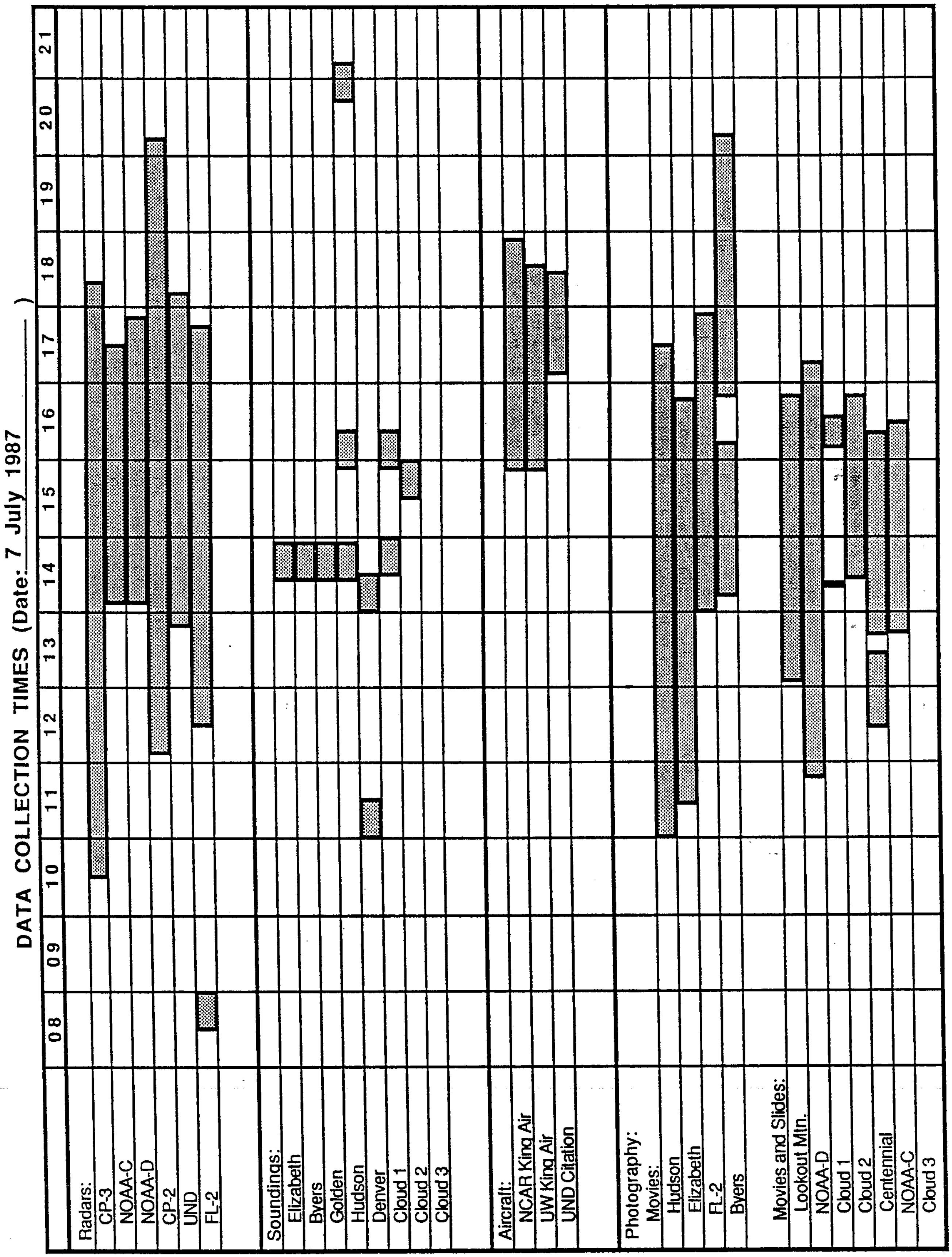


Table II.18. System Operation Timetable for 8 July 1987

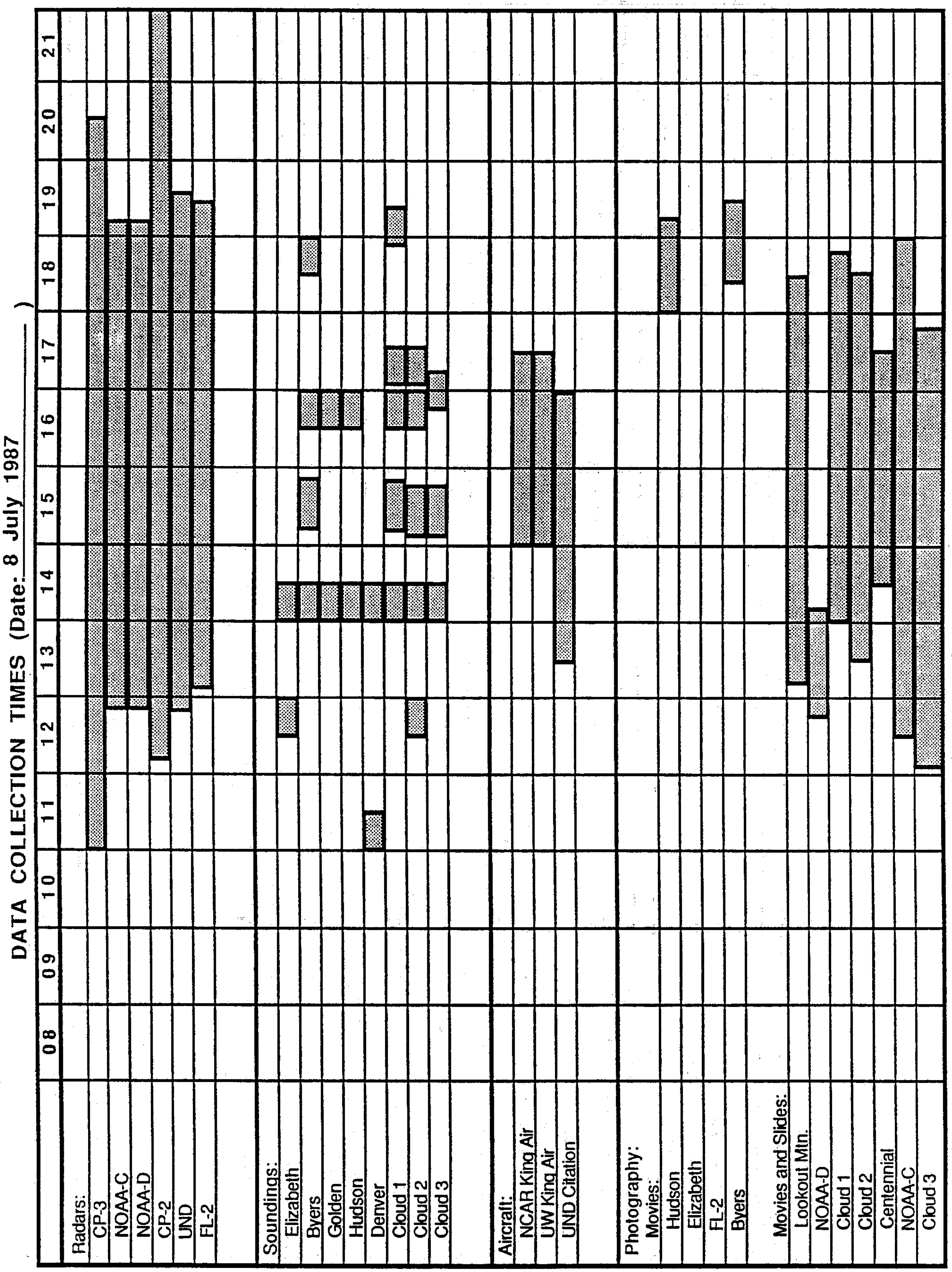


Table II.19. System Operation Timetable for 9 July 1987

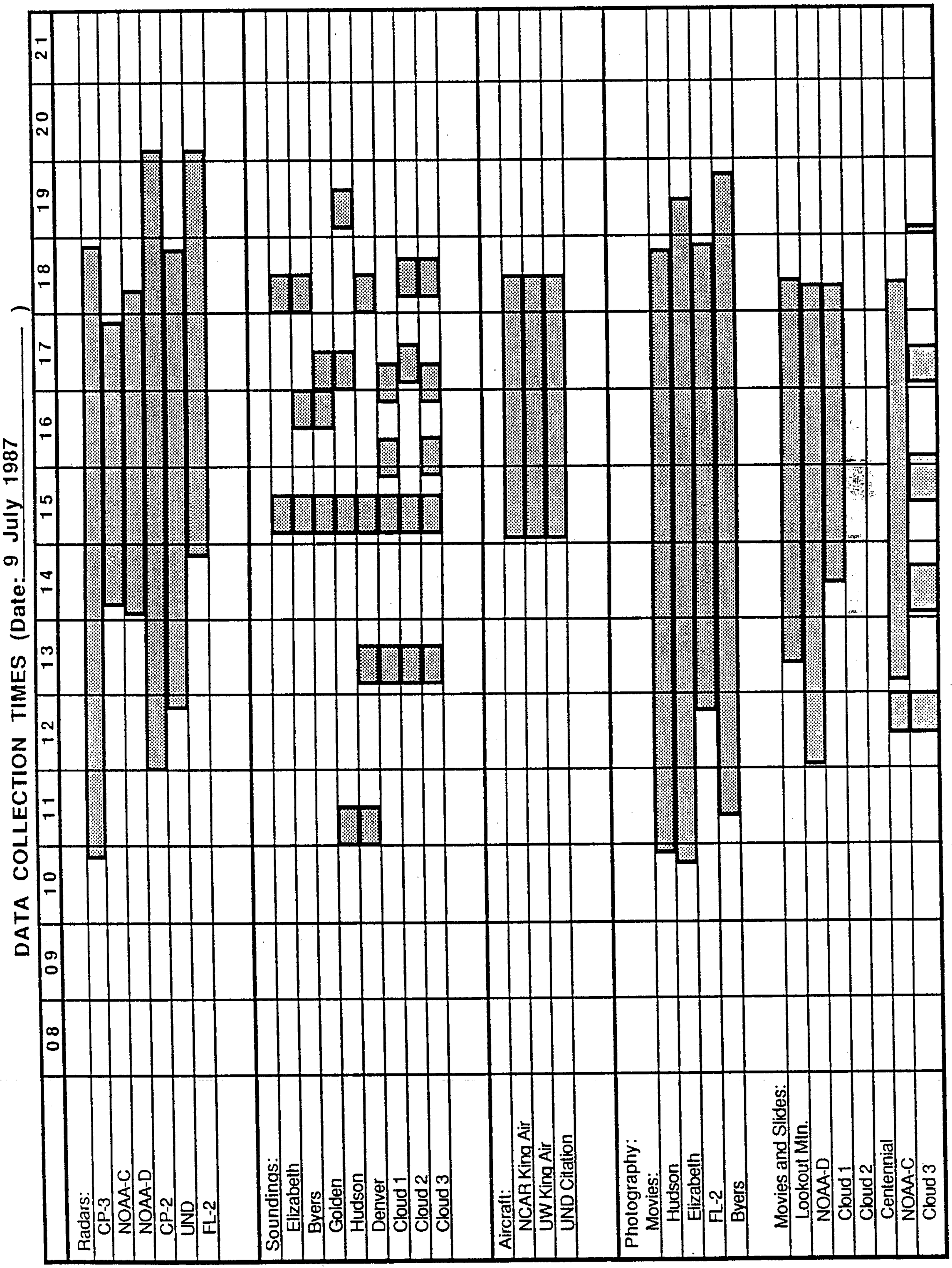


Table II.20. System Operation Timetable for 10 July 1987

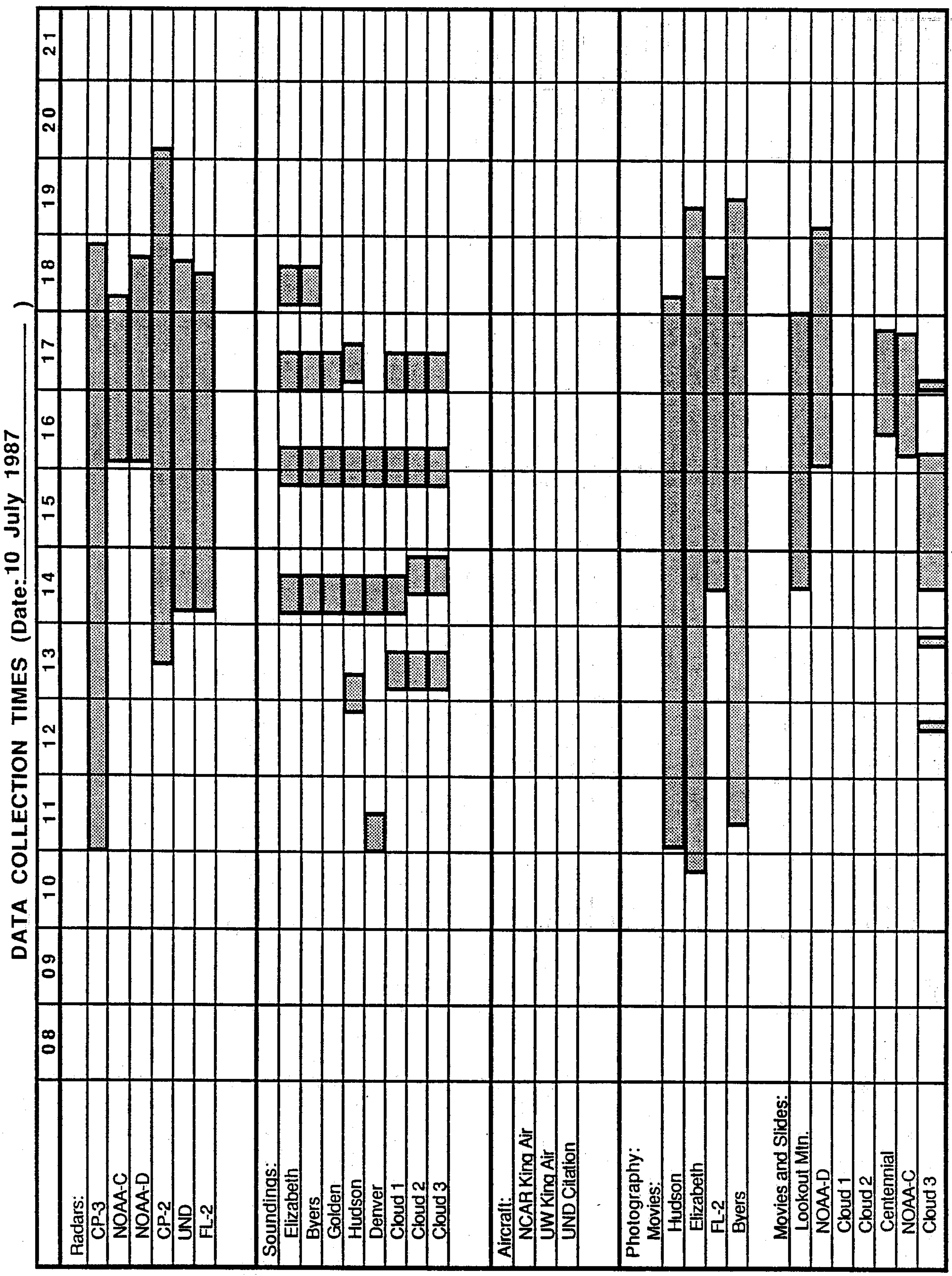


Table II.21. System Operation Timetable for 11 July 1987

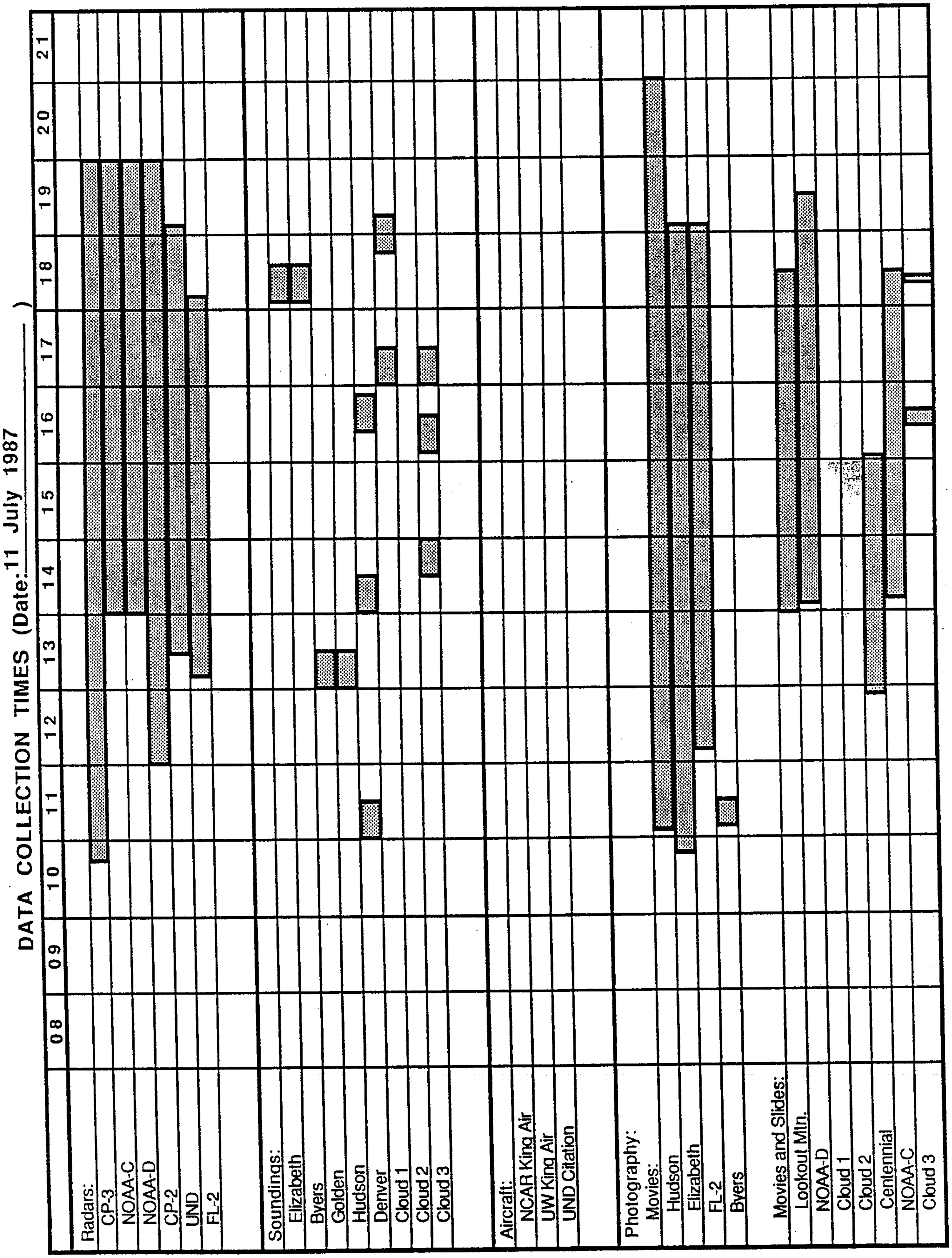


Table II.22. System Operation Timetable for 12 July 1987

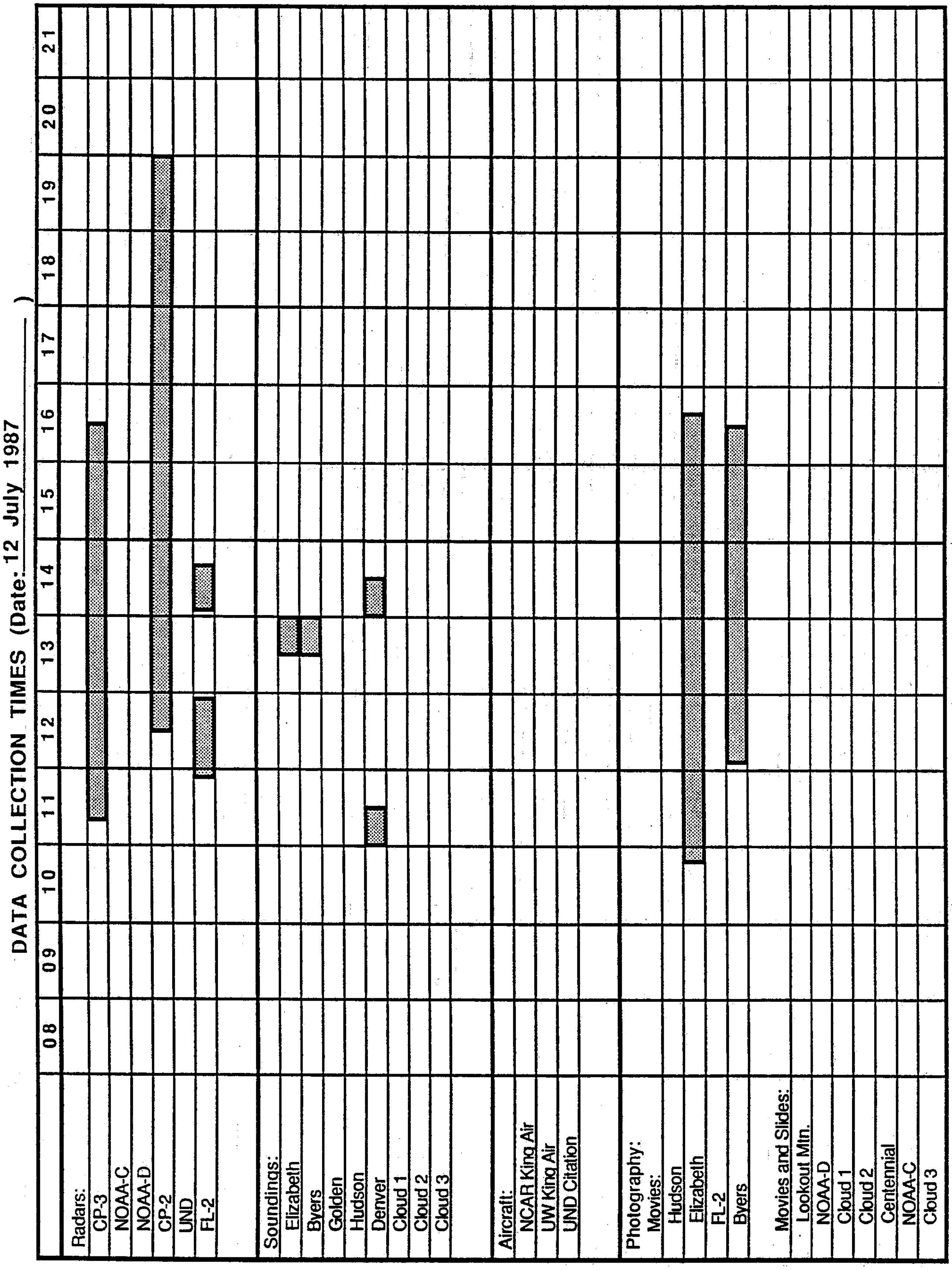


Table II.23. System Operation Timetable for 13 July 1987

DATA COLLECTION TIMES (Date: 13 July 1987)

	08	09	10	11	12	13	14	15	16	17	18	19	20	21
Radars:														
CP-3			■	■	■	■	■	■	■	■				
NOAA-C														
NOAA-D					■	■	■	■	■	■				
CP-2														
UND														
FL-2														
Soundings:														
Elizabeth									■	■				
Byers														
Golden														
Hudson														
Denver				■			■							
Cloud 1										■				
Cloud 2							■							
Cloud 3														
Aircraft:														
NCAR King Air														
UW King Air														
UND Citation														
Photography:														
Movies:														
Hudson				■	■	■	■	■	■					
Elizabeth			■	■	■	■	■	■	■	■	■			
FL-2					■	■	■	■	■					
Byers				■	■	■	■	■	■	■				
Movies and Slides:														
Lookout Mtn.														
NOAA-D														
Cloud 1														
Cloud 2														
Centennial														
NOAA-C														
Cloud 3														

Table II.24. System Operation Timetable for 14 July 1987

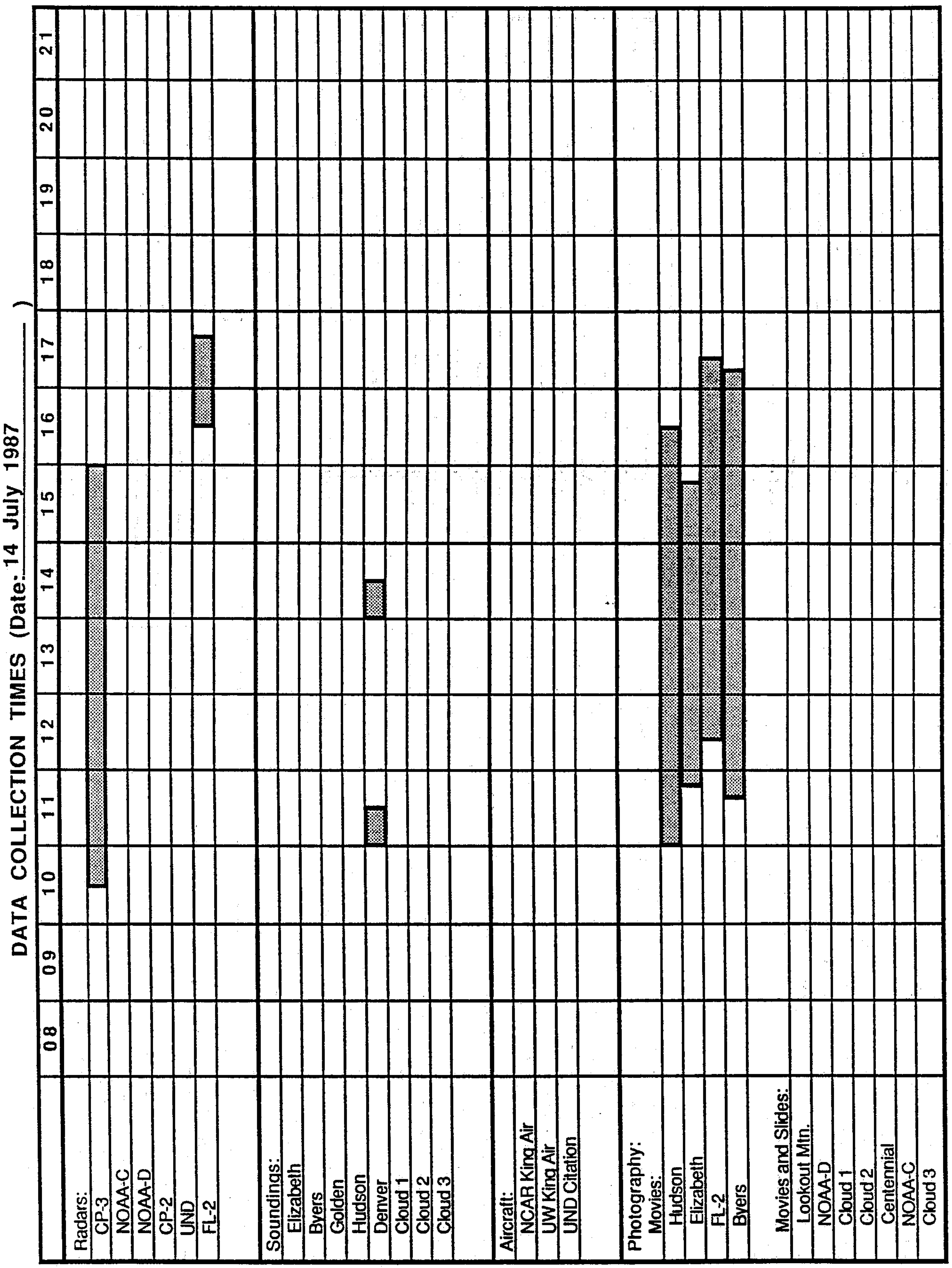


Table II.25. System Operation Timetable for 15 July 1987

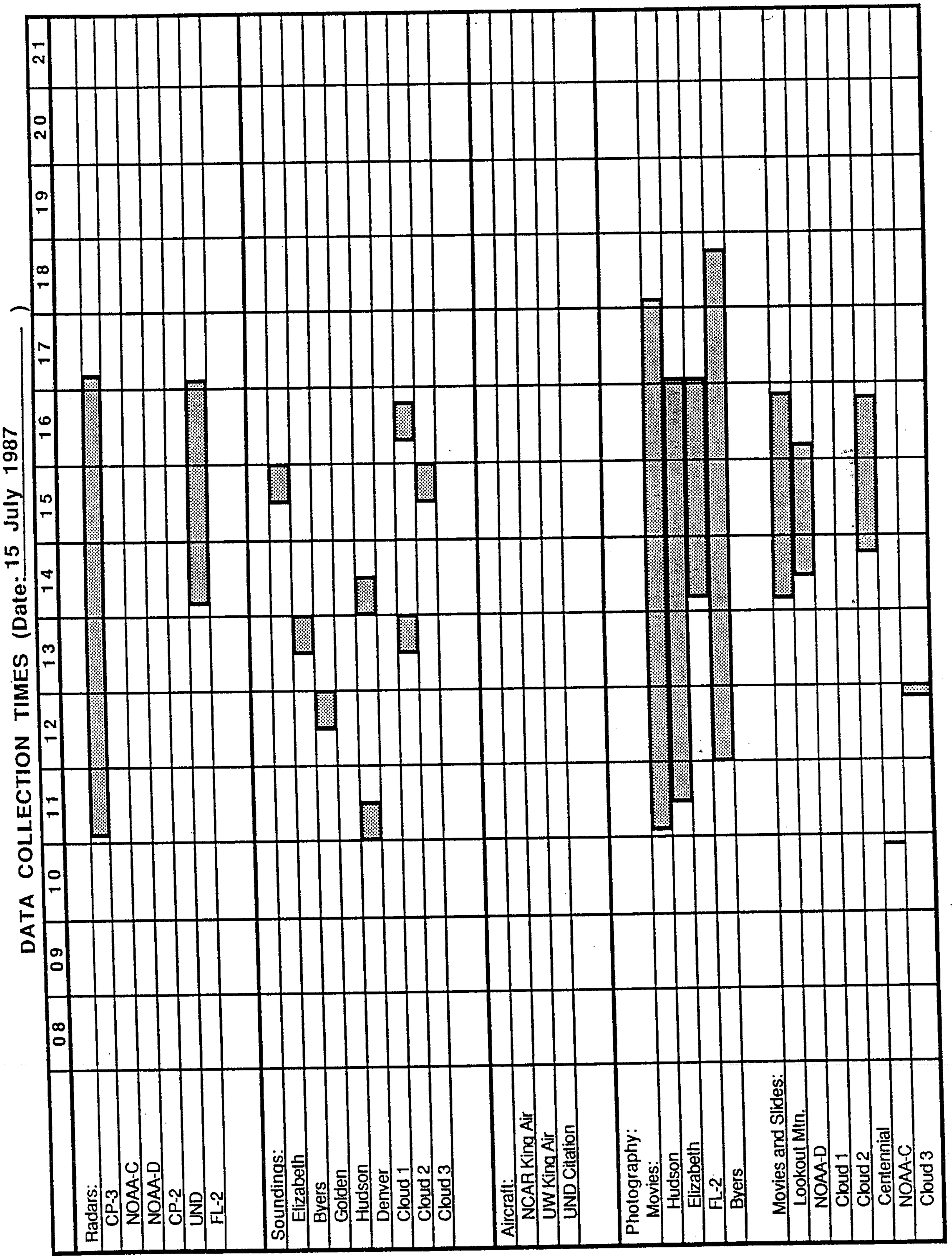


Table II.26. System Operation Timetable for 16 July 1987

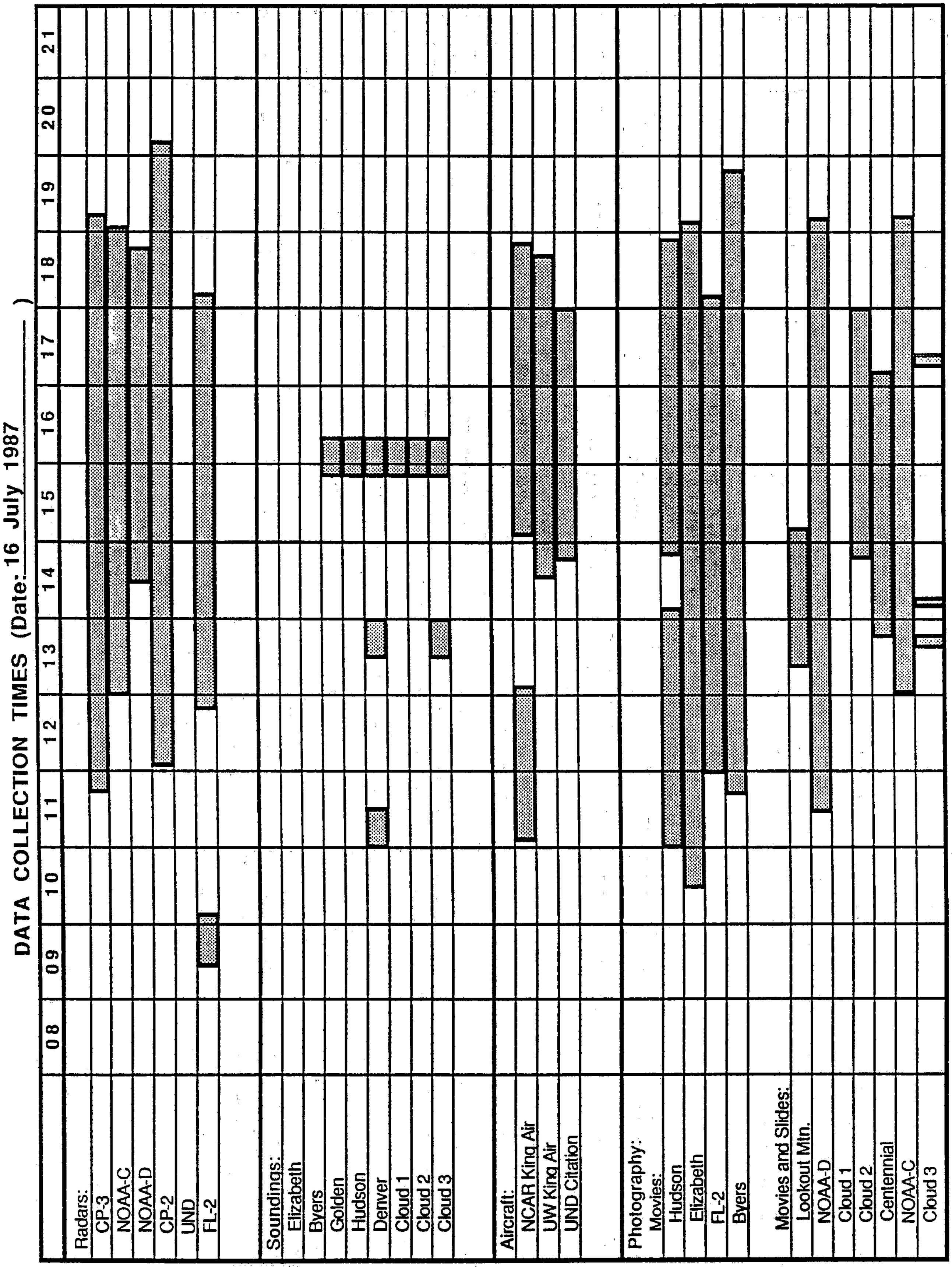


Table II.27. System Operation Timetable for 17 July 1987

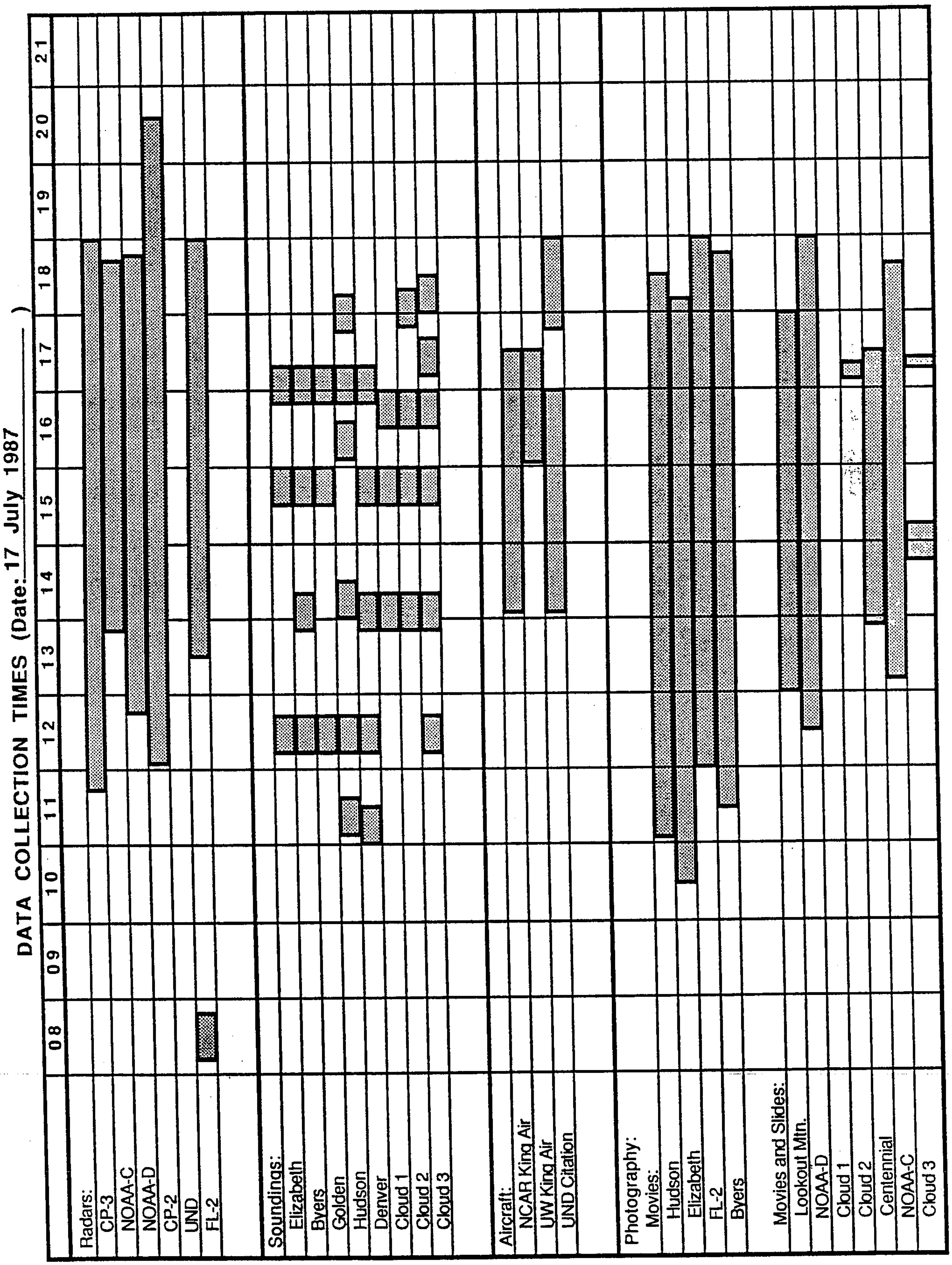


Table II.28. System Operation Timetable for 18 July 1987

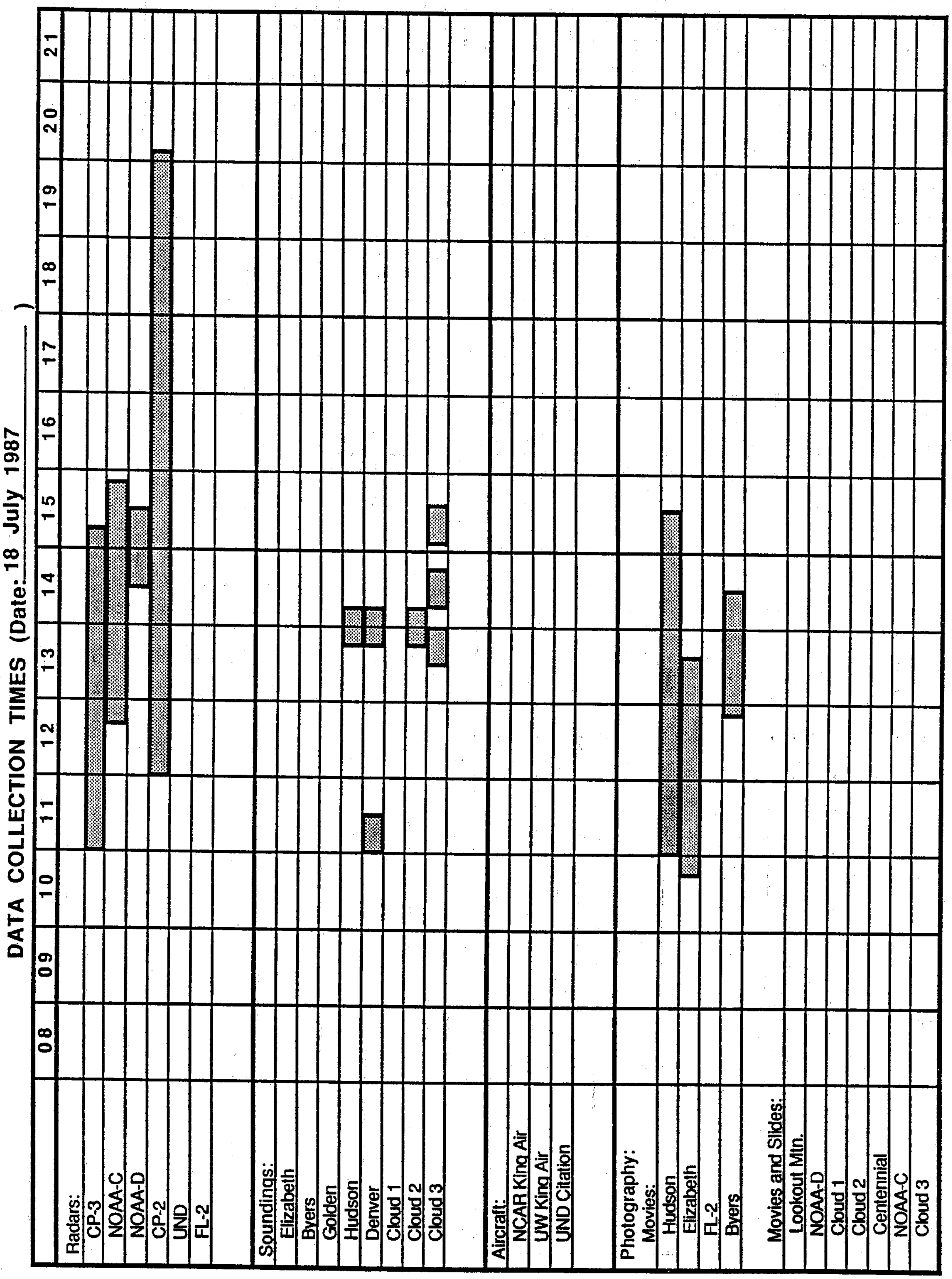


Table II.29. System Operation Timetable for 19 July 1987

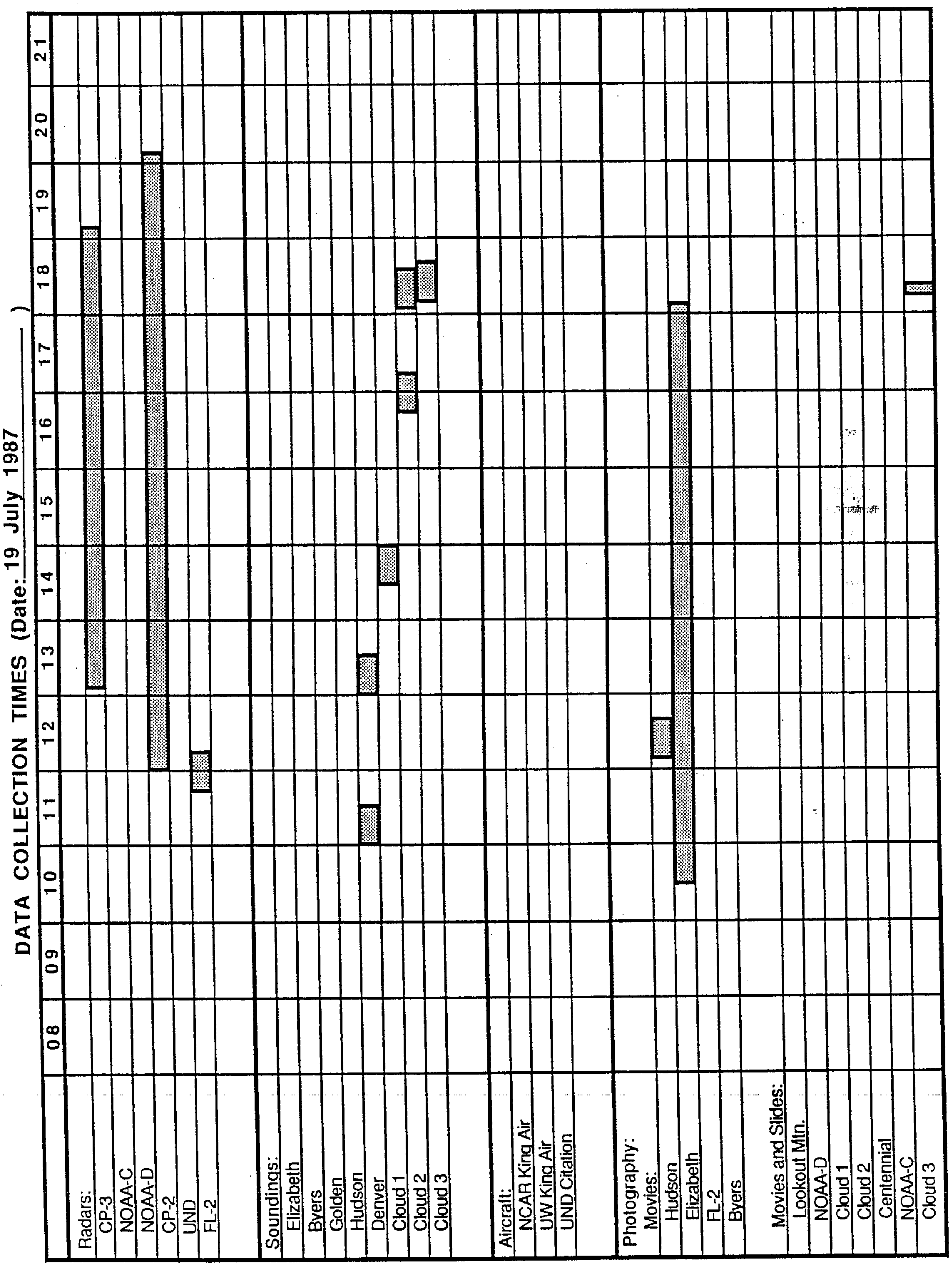


Table II.30. System Operation Timetable for 20 July 1987

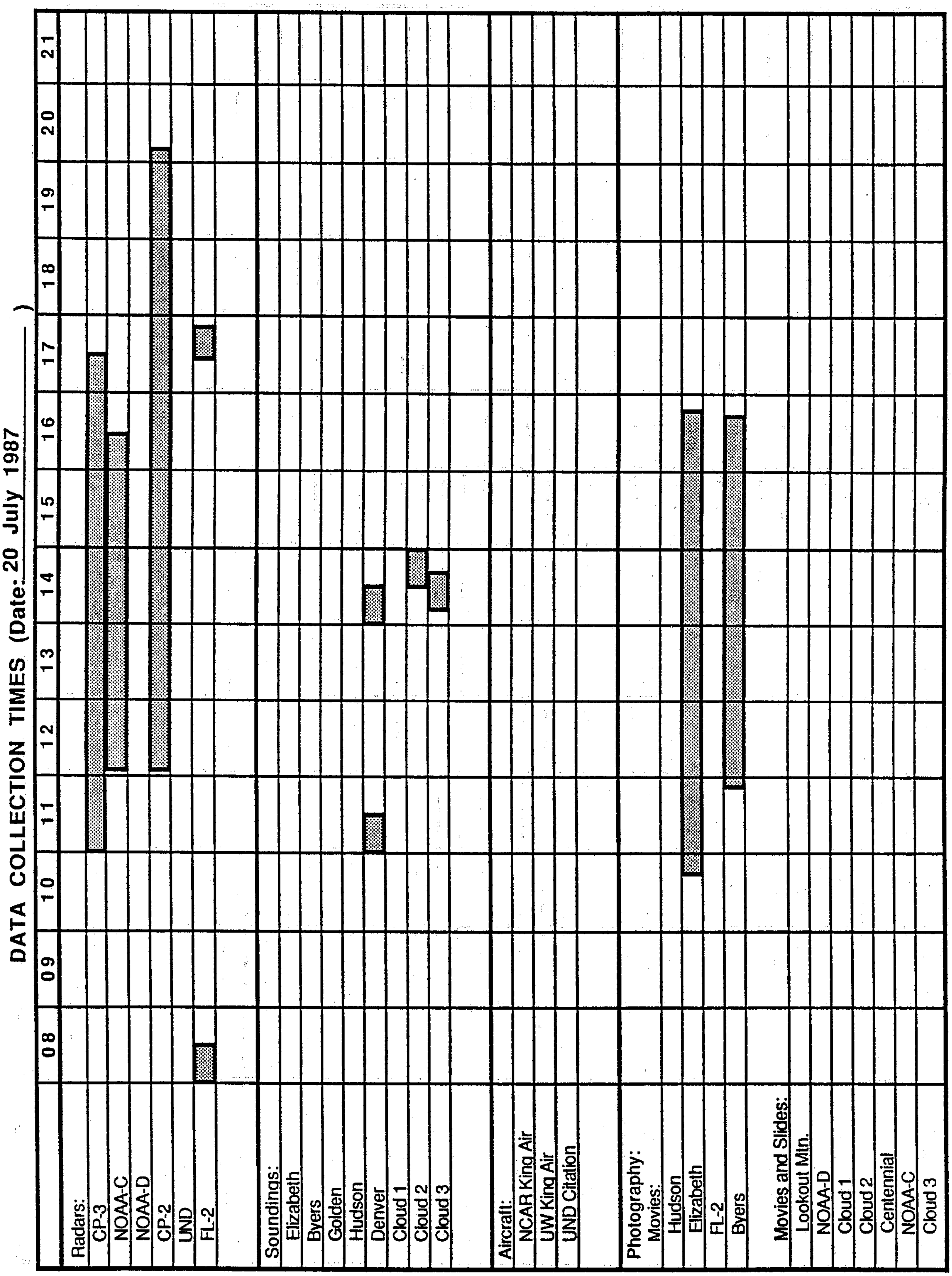


Table II.31. System Operation Timetable for 21 July 1987

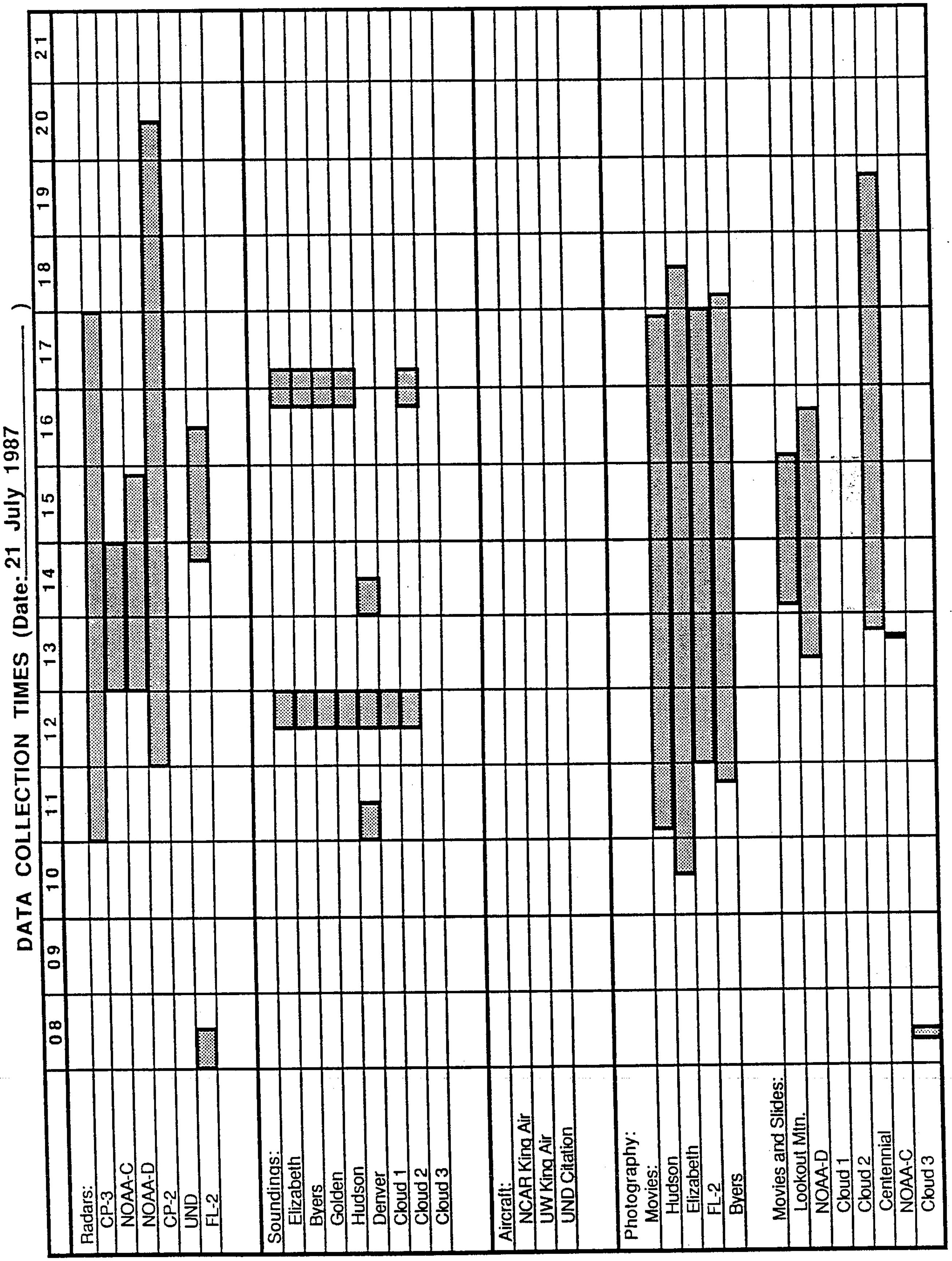


Table II.32. System Operation Timetable for 22 July 1987

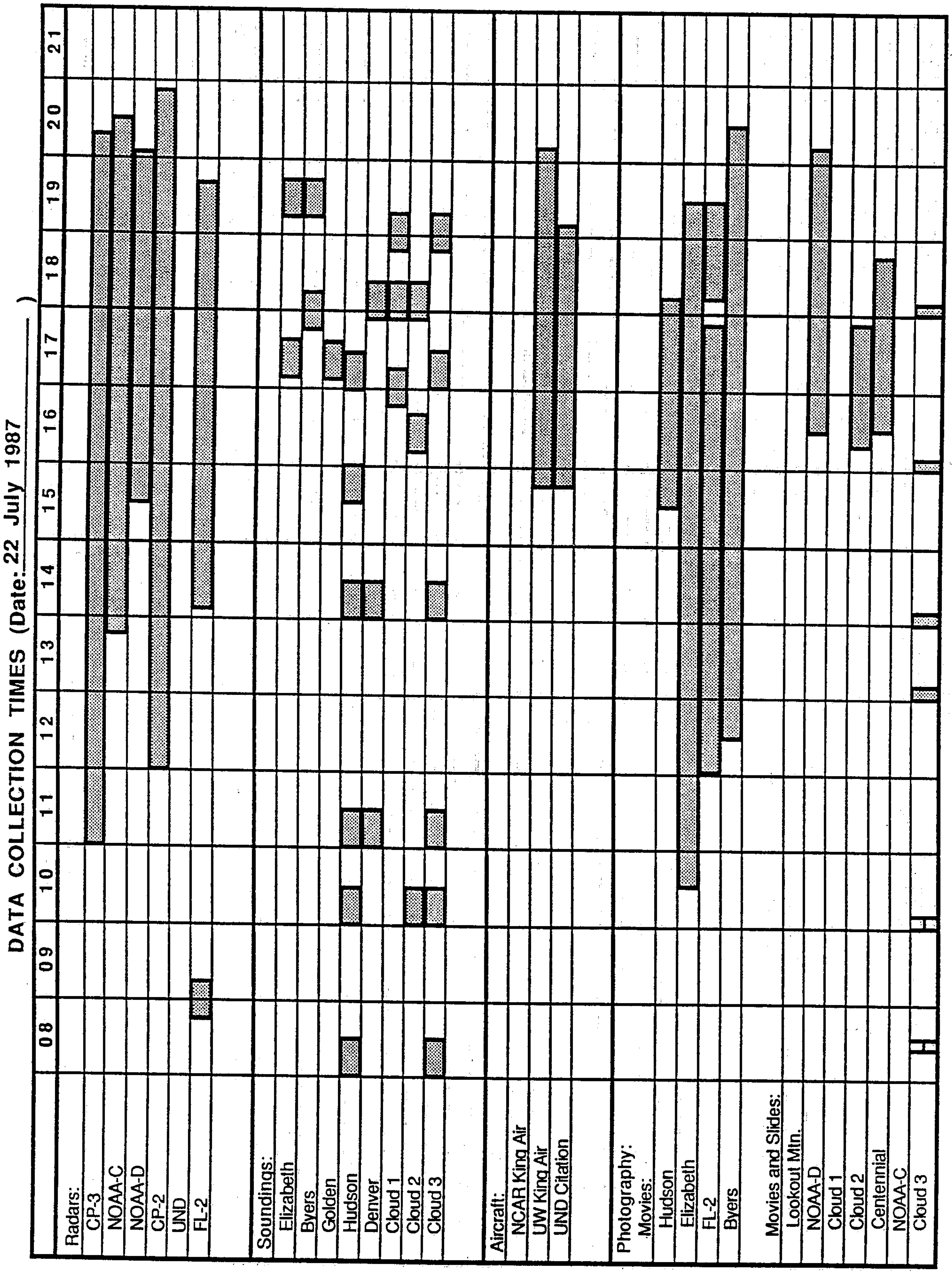


Table II.33. System Operation Timetable for 23 July 1987

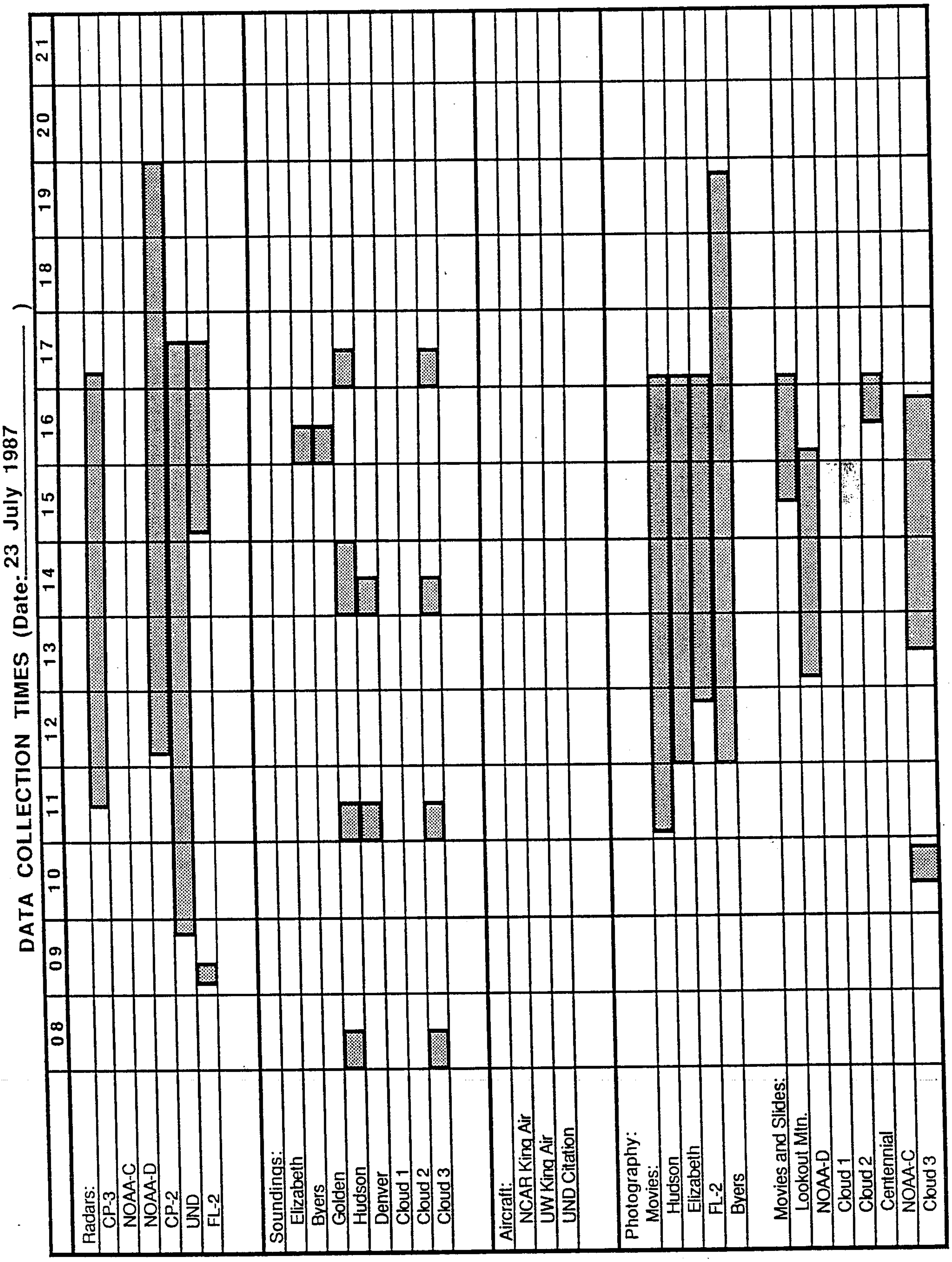


Table II.34. System Operation Timetable for 24 July 1987

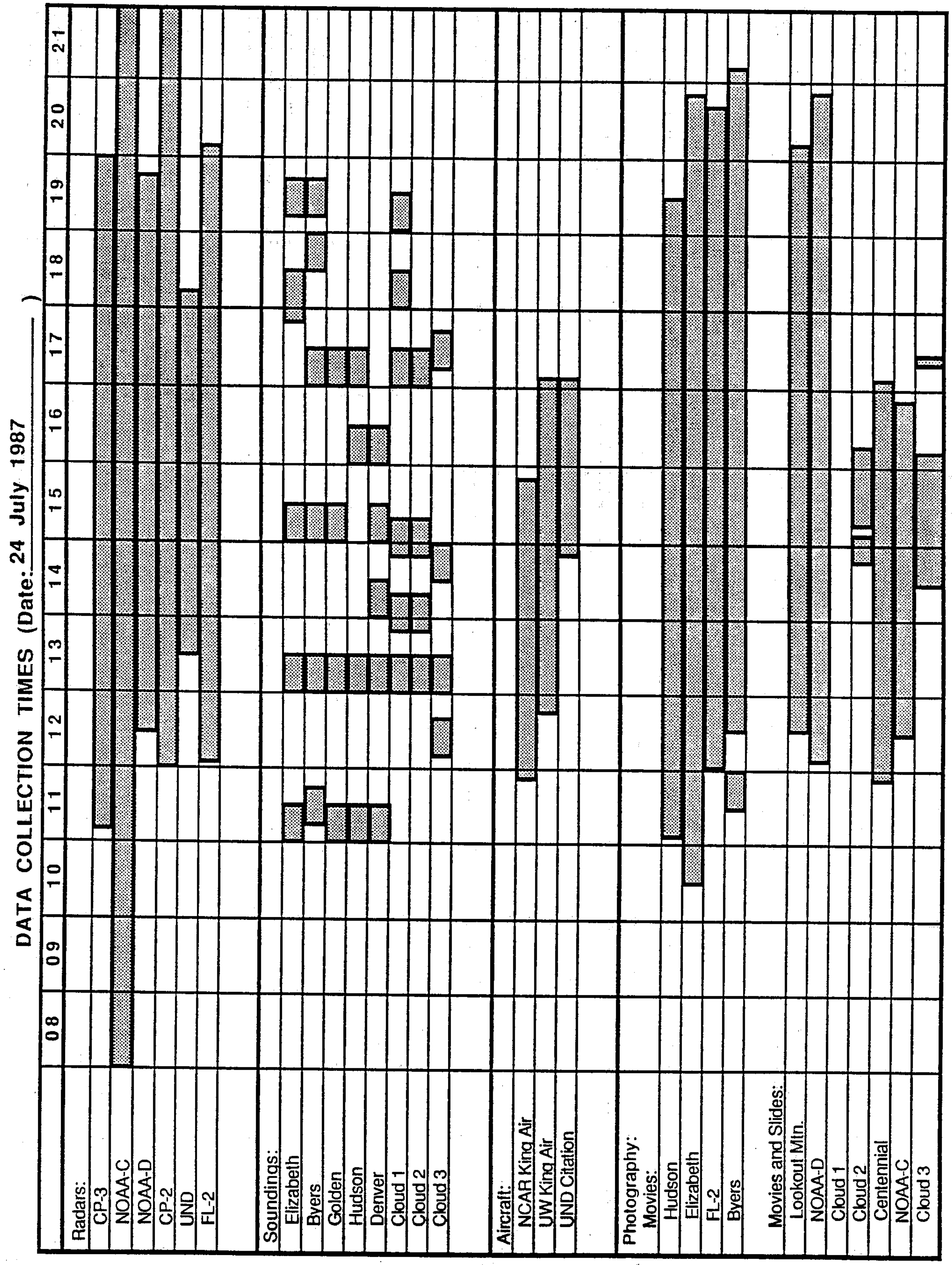


Table II.35. System Operation Timetable for 25 July 1987

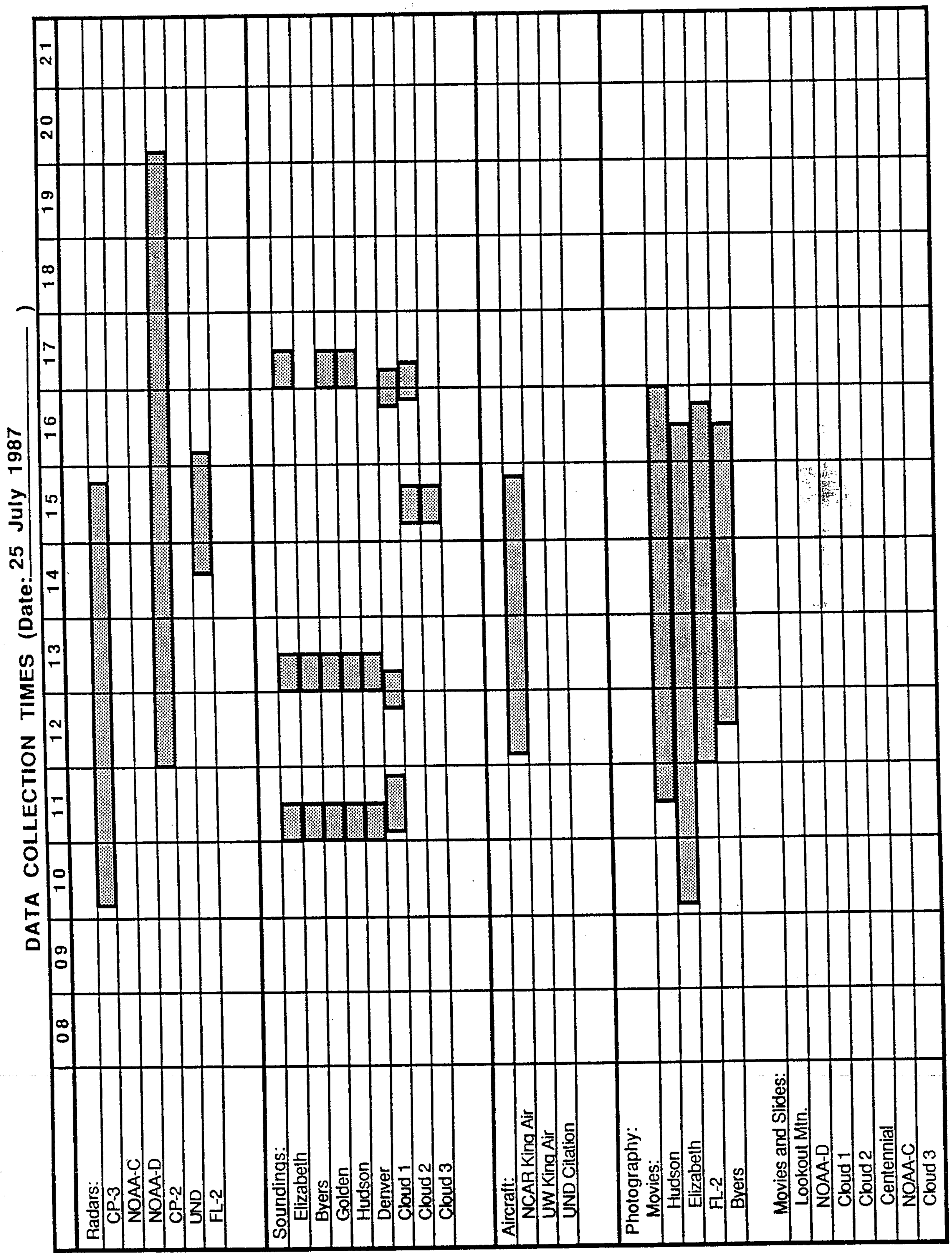


Table II.36. System Operation Timetable for 26 July 1987

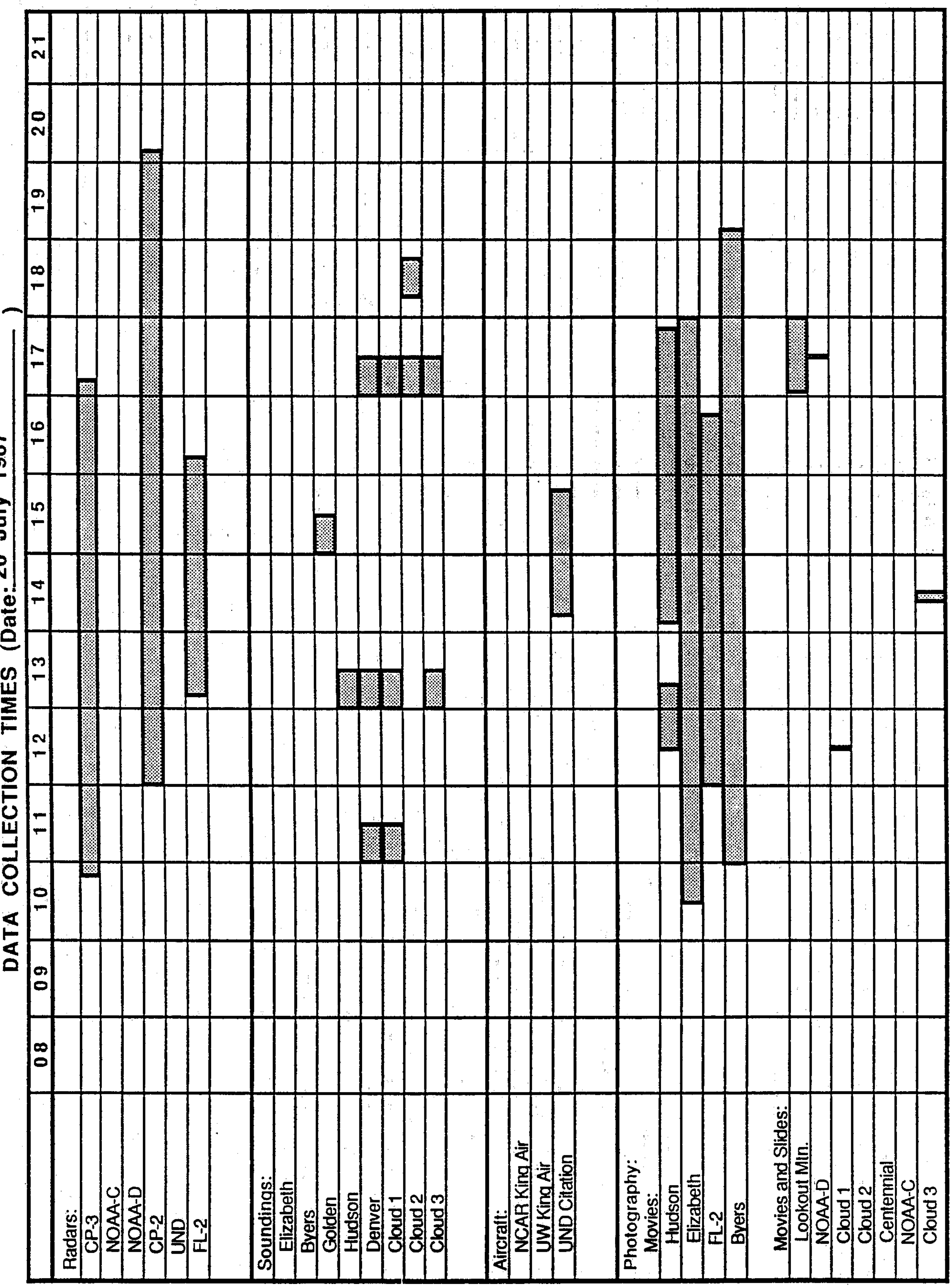


Table II.37. System Operation Timetable for 27 July 1987

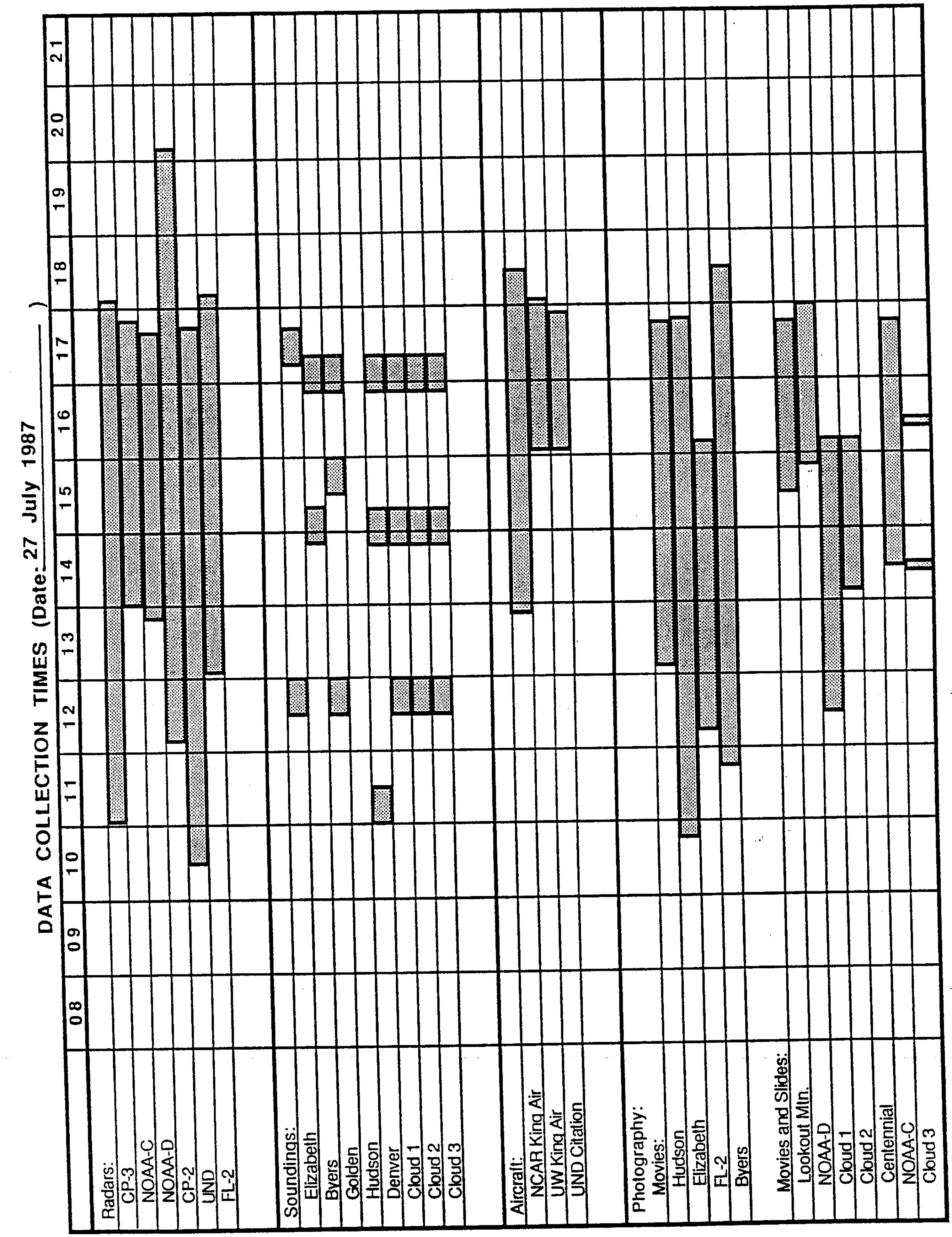


Table II.38. System Operation Timetable for 28 July 1987

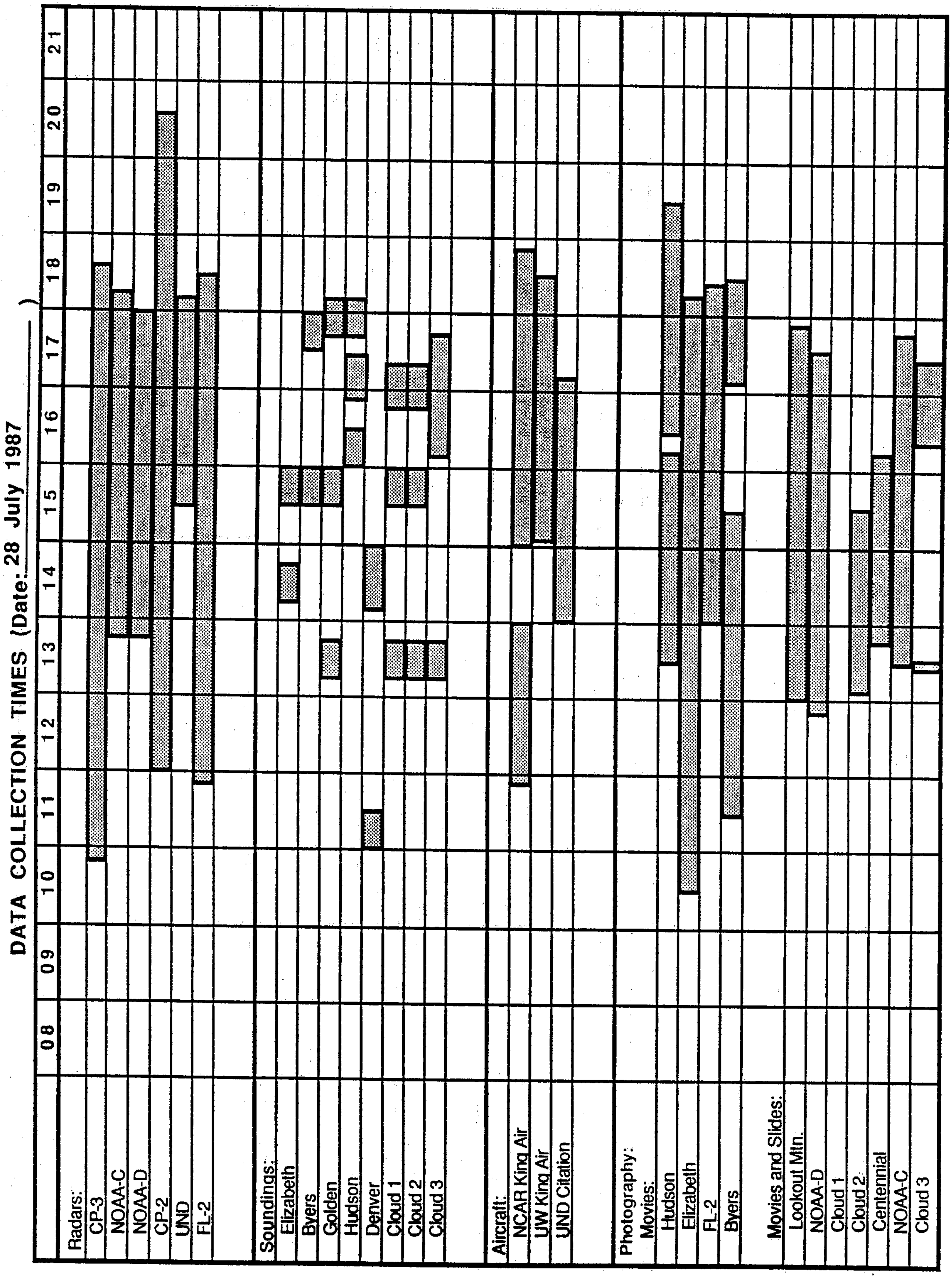


Table II.39. System Operation Timetable for 29 July 1987

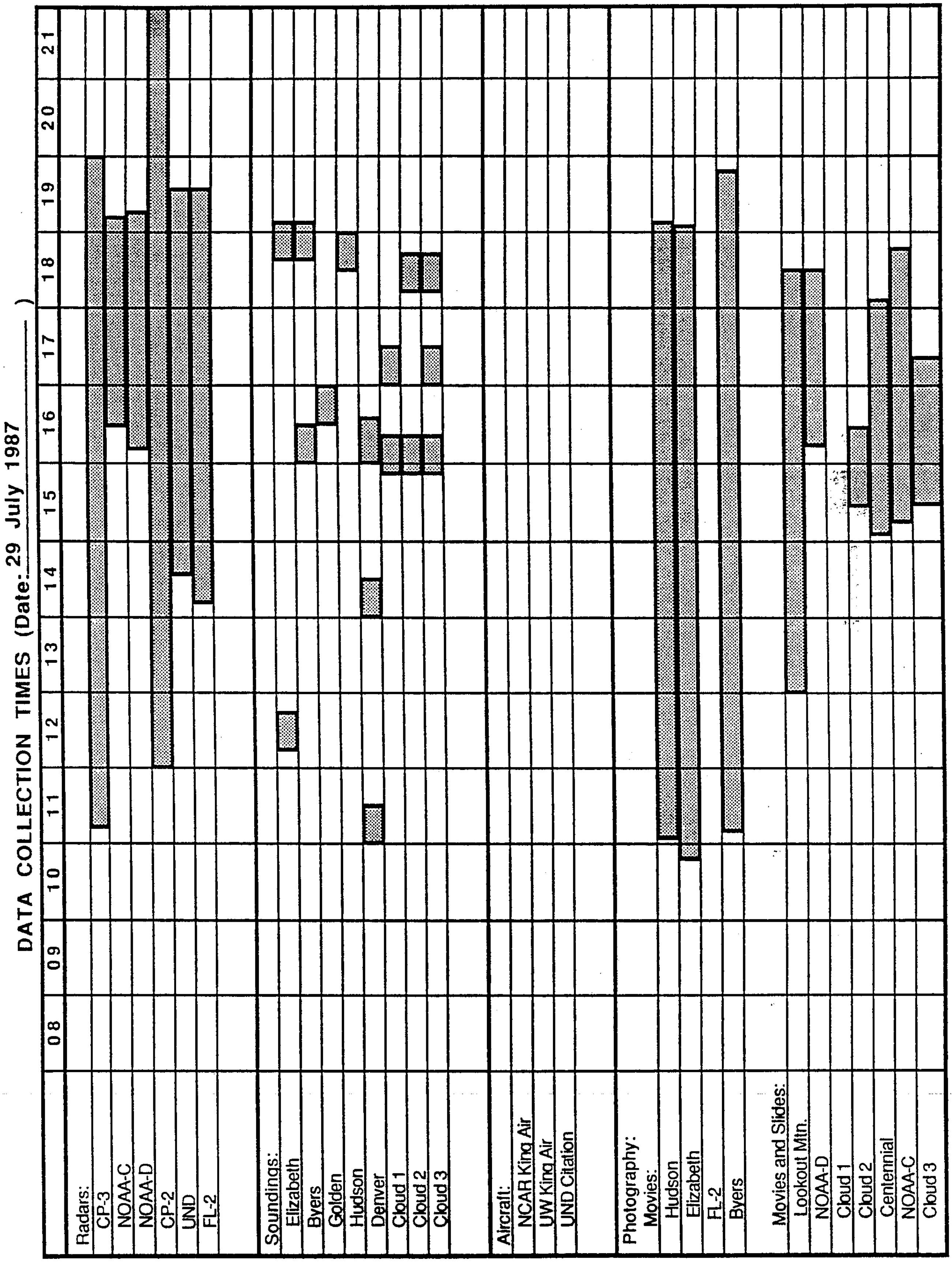


Table II.40. System Operation Timetable for 30 July 1987

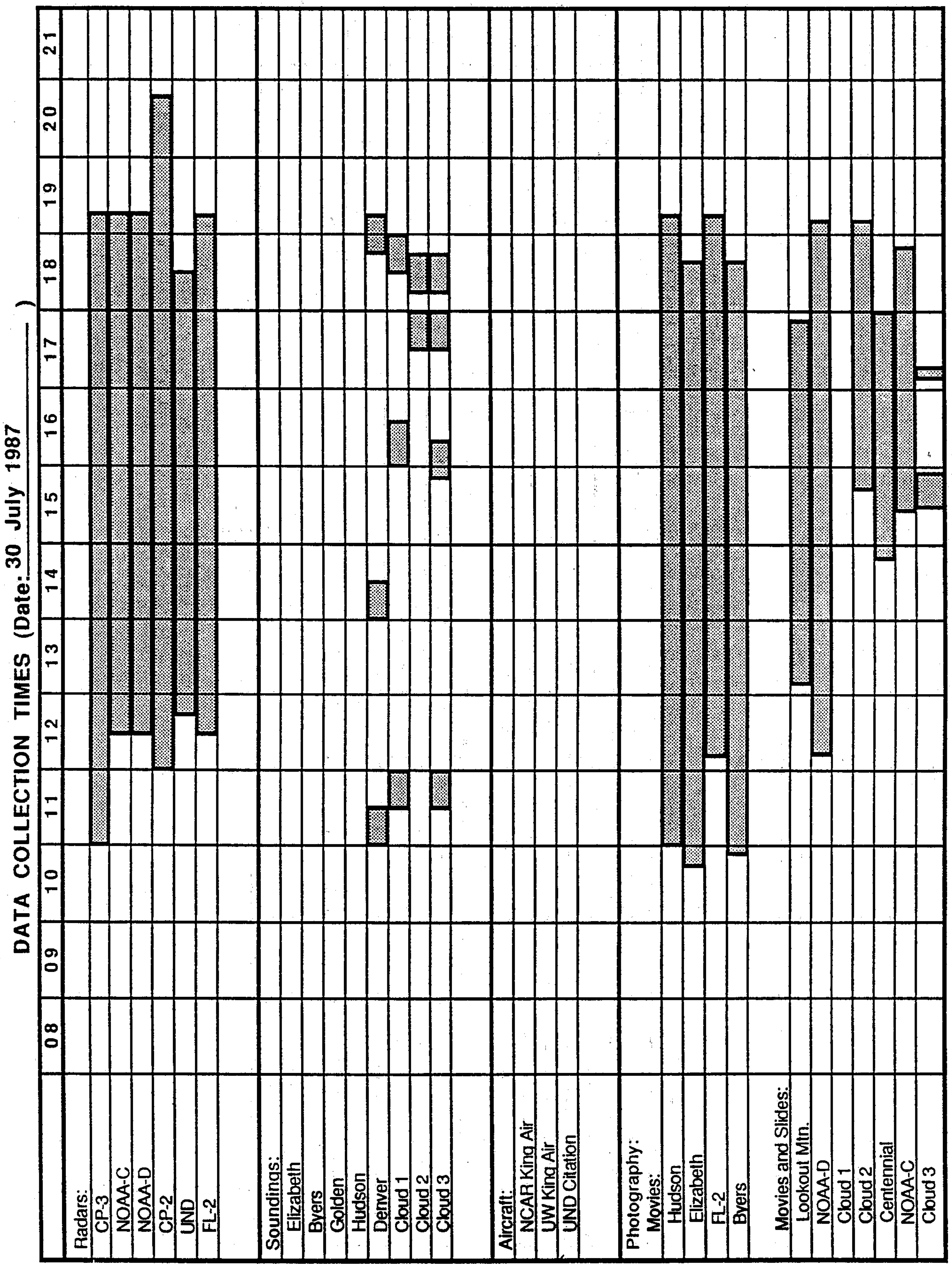


Table II.41. System Operation Timetable for 31 July 1987

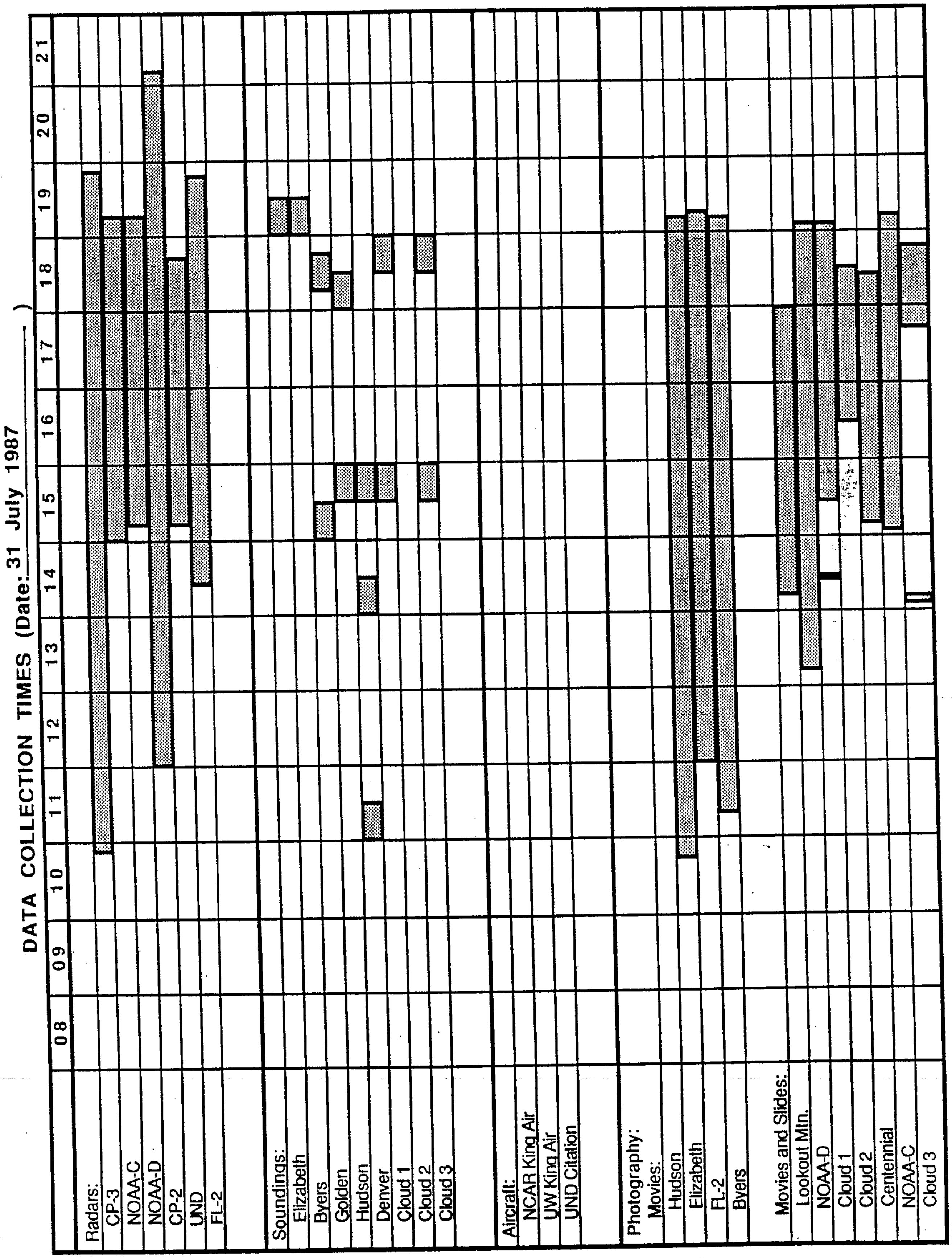


Table II.42. System Operation Timetable for 1 August 1987

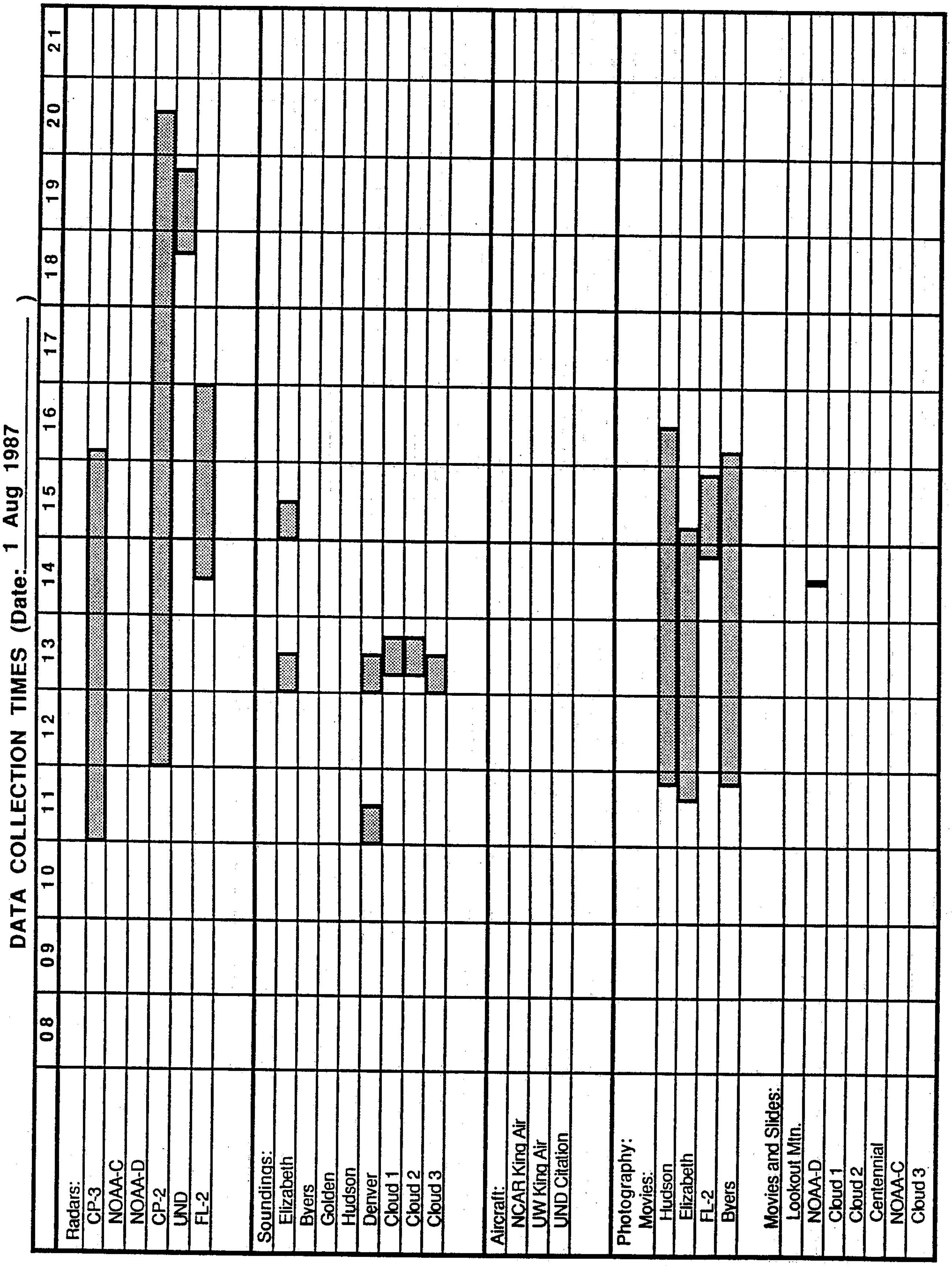


Table II.43. System Operation Timetable for 2 August 1987

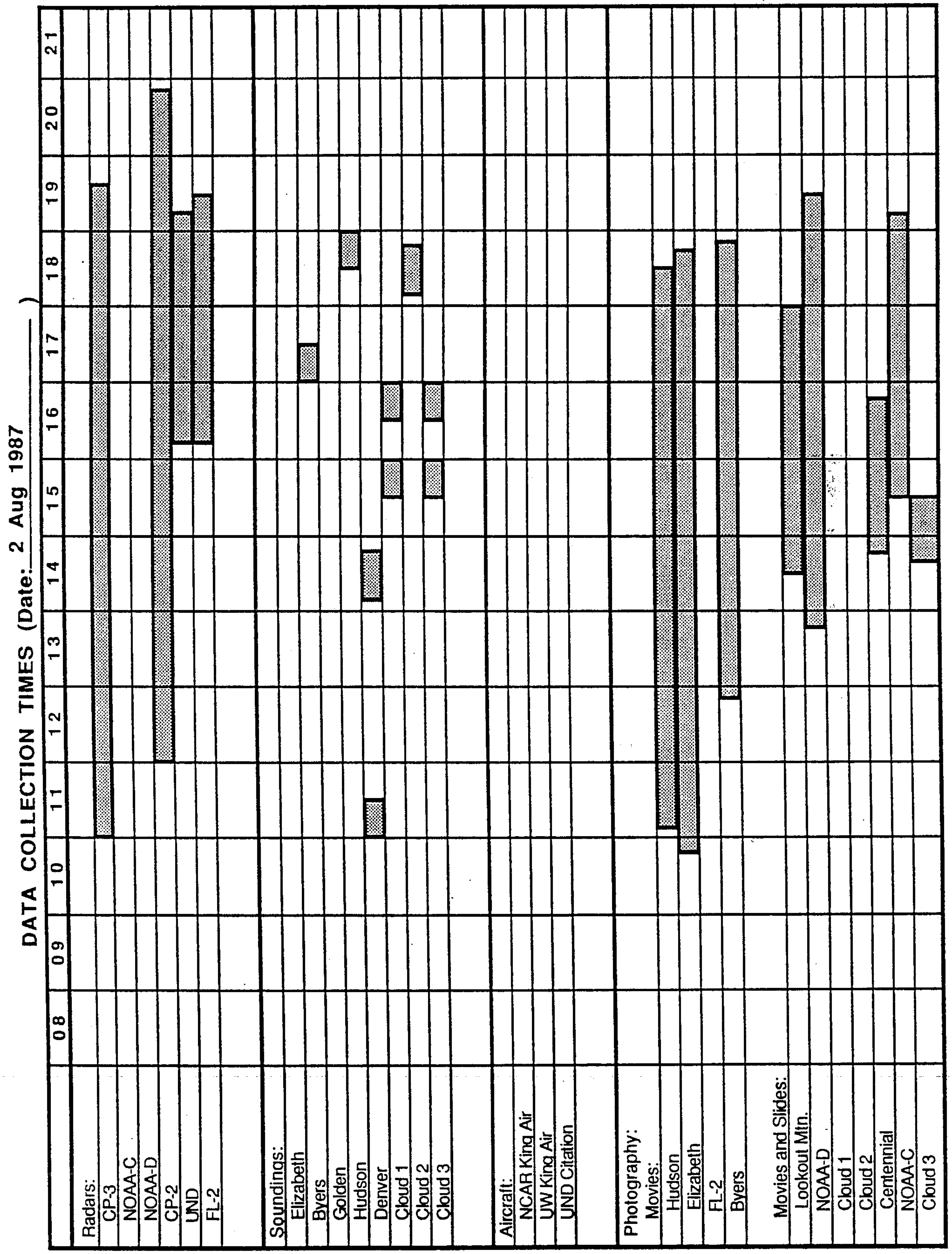


Table II.44. System Operation Timetable for 3 August 1987

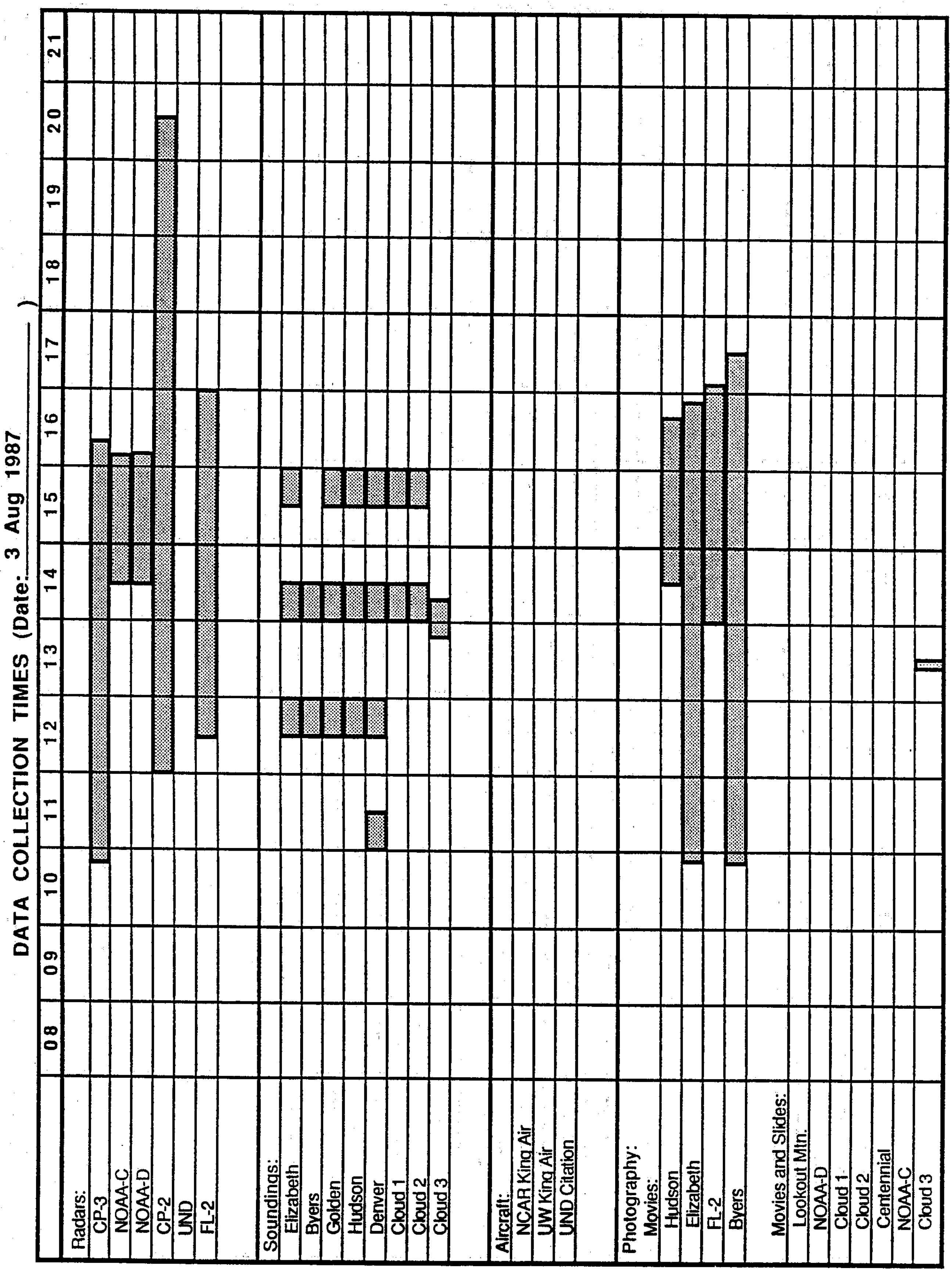


Table II.45. System Operation Timetable for 4 August 1987

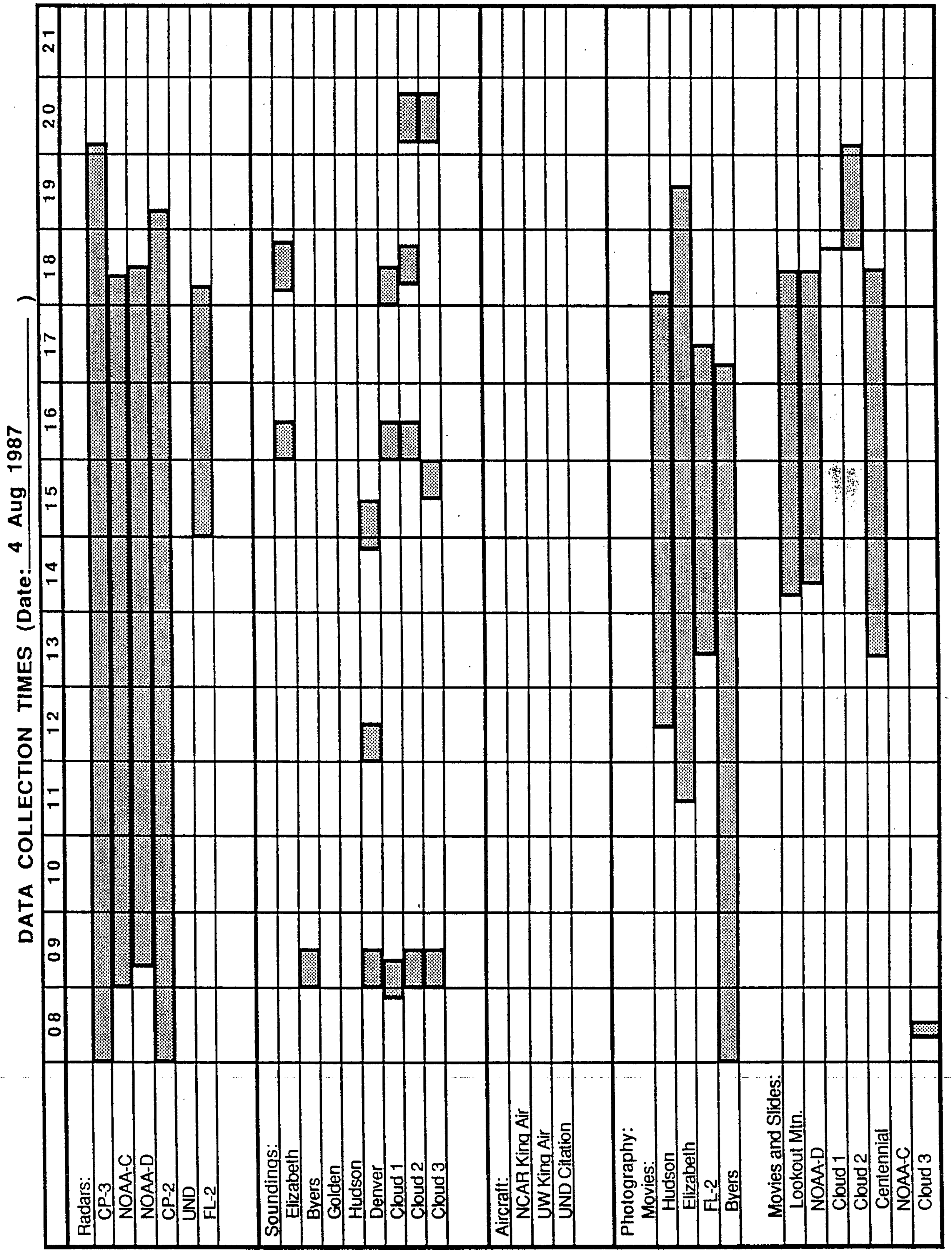


Table II.46. System Operation Timetable for 5 August 1987

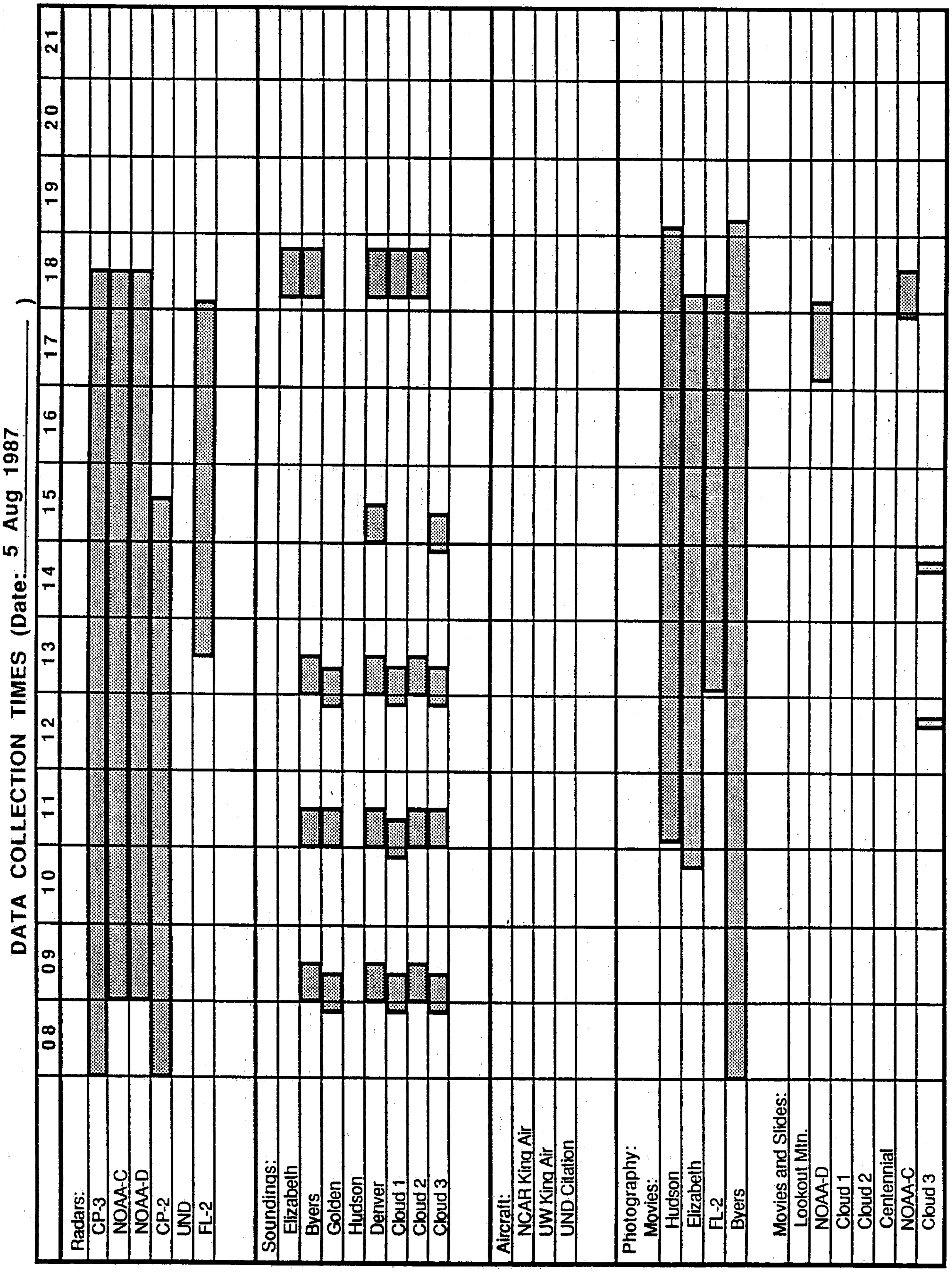


Table II.47. System Operation Timetable for 6 August 1987

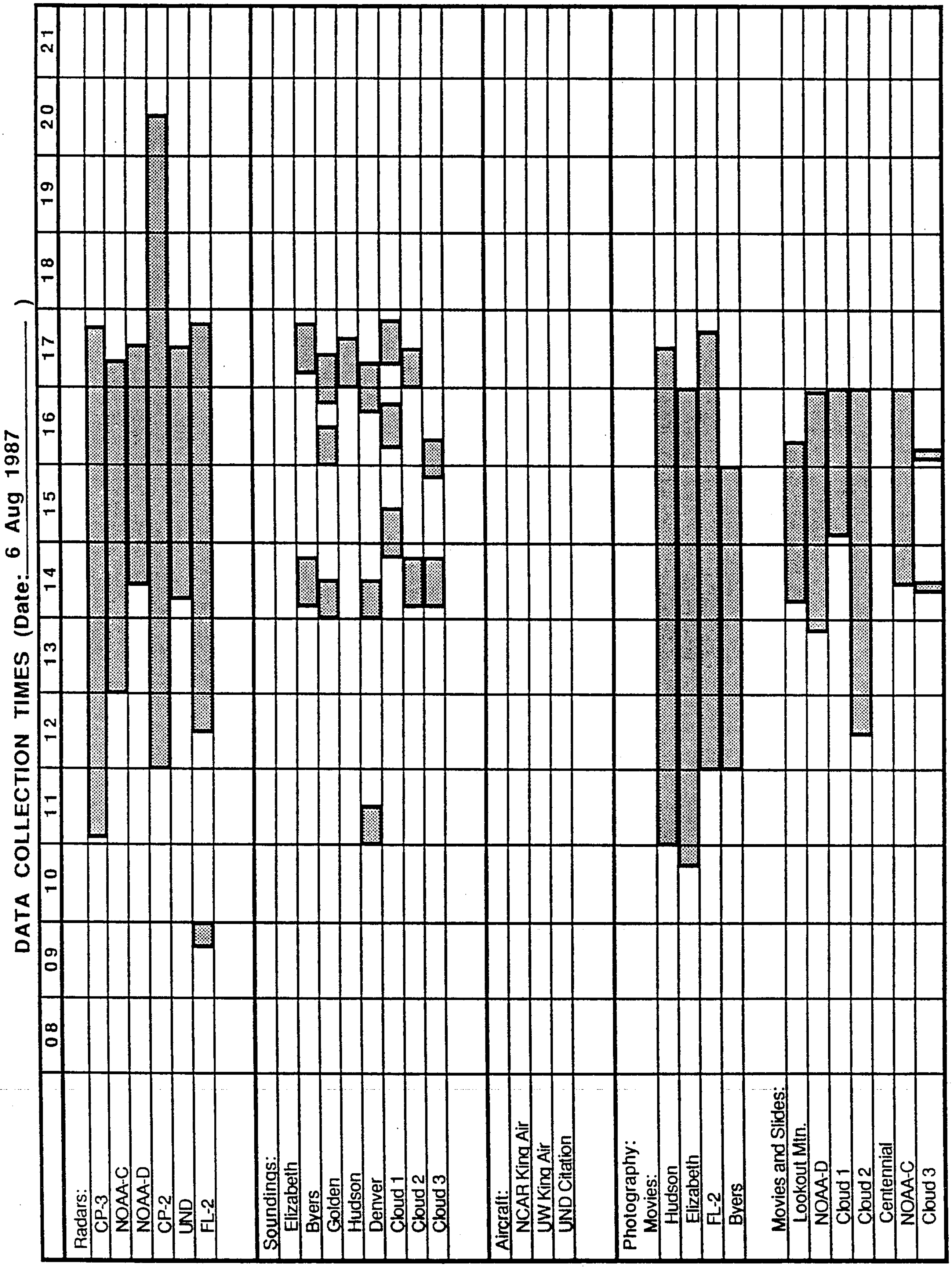
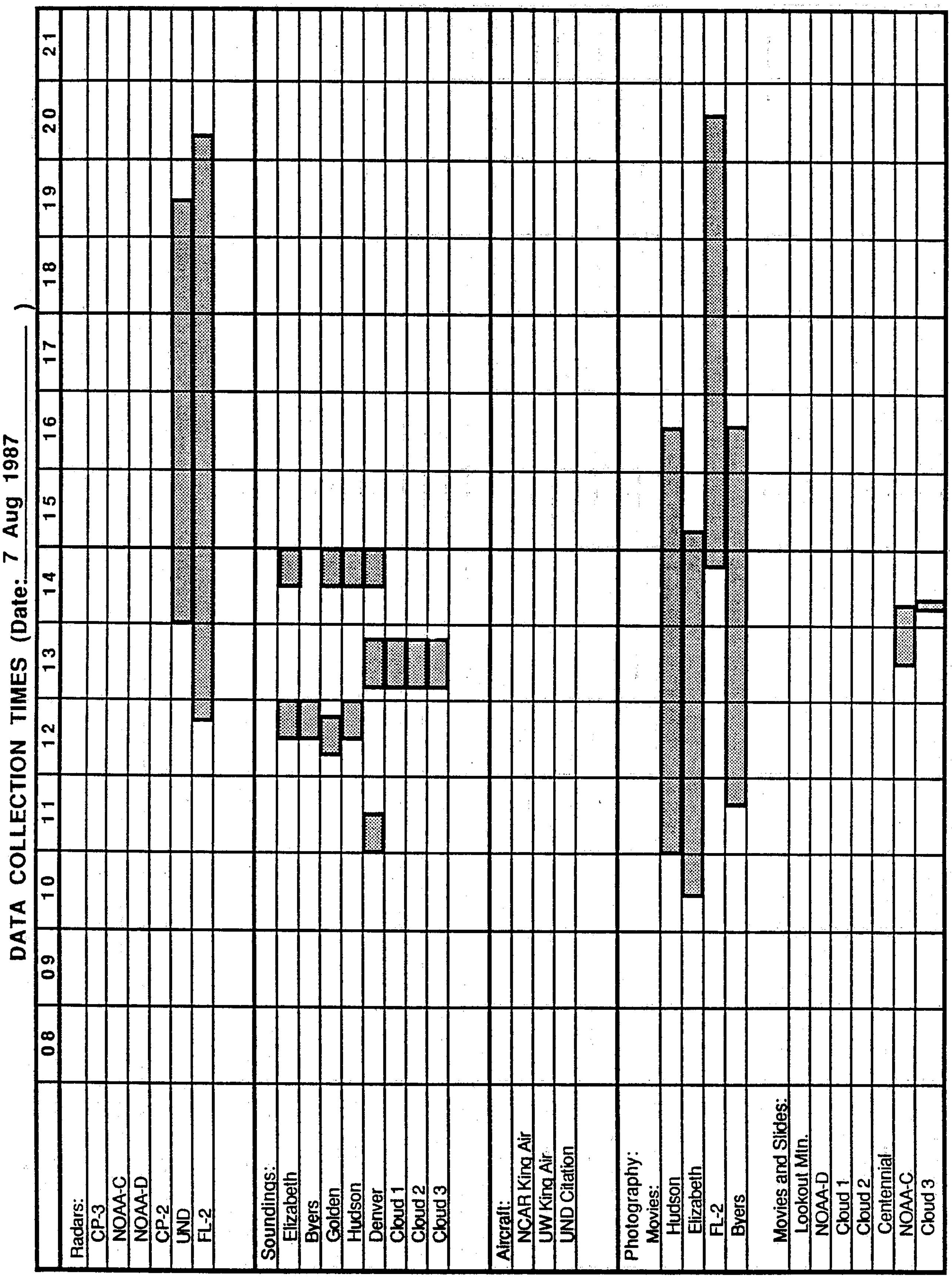


Table II.48. System Operation Timetable for 7 August 1987



III. OPERATING SYSTEMS

A. Radars

1. NOAA/C and NOAA/D Radars

a. *System Description*

The two NOAA/WPL X-band radars were separated by 15.9 km, as shown in Fig. I.1, to allow high resolution dual-Doppler measurements of microbursts and outflow boundaries. These radars have a similar antenna drive system and pedistal, digital processor, and radar control program. NOAA/C, however, has additional dual-circular polarization capability that is not currently available in NOAA/D.

The real-time digital processors used in both radars have the capability for a variety of processing modes that include the "partial sums" mode most often used for multiple Doppler radar operations. A data processing operation performed later computes estimates of Doppler spectral moments (reflectivity, velocity, and the Doppler second moment) in addition to circular depolarization ratio (CDR). Having these partial sums recorded in real-time rather than Doppler velocity allows for the removal of the DC spectral line from the estimates and reduces the velocity bias error in the presence of ground clutter and electronic biases. Other processor modes allow time series data to be taken when precise Doppler variance information is needed.

The digital processor also provides video sample gates and triggers to the radar transmitter. Range gates are under computer control and may be varied in number (up to 328), location, and spacing. A unique feature of this system is its ability to generate pairs of closely spaced transmitter triggers, separated by a somewhat longer period between each pair. The advantages of this double-pulse system include improved ability to recognize "second trip" echoes in real-time, improved Nyquist velocity, and constant av-

Table III.1. NOAA Radar Triggering and Range Gate Characteristics

Short period = SPD	$100\mu s \leq \text{SPD} \leq \text{LPD}/2$
Long period = LPD	$1300\mu s \leq \text{LPD} \leq 2000\mu s$
Number of gates = NRG2	$1 \leq \text{NRG2} \leq 320$
Gate spacing = SPC2	$0.25\mu s \leq \text{SPC2} \leq nX25\mu s$
	$n = 1, 2, 3, \ldots$
Delay to first range gate = DLAY	variable
Triggers per beam = NTRG	variable

Table III.2. NOAA Radar Operating Characteristics

Wavelength	3.22 cm
Peak Power	20 kW
Pulse Duration	0.75 μs
Average power	20 W
Pulse repetition period	450 μs (short)
	1600 μs (long)
Antenna diameter	3.1 m
System gain	44 dB
Beamwidth	0.8 deg
Noise power	-109 dBm
Minimum detectable reflectivity at 10 km range (velocity channel)	-18 dBZ

erage transmitted power over a wide range of operating parameters. Control of all processor functions and scan parameters is from a keyboard terminal input to an Eclipse S-120 mini-computer. Radar parameters and the range of values that are controllable from the Eclipse are given in Table III.1.

Parameters for approximately 1200 pre-programmed scans were stored at each radar for use in CINDE. Slight adjustments to these parameters were occasionally needed before these scans were used, a process taking just a few minutes. Table A.1 lists the radar locations for NOAA/C and NOAA/D during CINDE, and Table III.2 summarizes the operating characteristics for the NOAA radars.

b. *Data Description*

Nearly all NOAA radar data have been processed and are available in Universal Format (UF). The NOAA radar catalogues (Tables B.1 and B.2) provide tape numbers, dates, and times of data for each UF tape. Occasionally, there may be missing data from the end of the UF tape. In order to recover this data, a "special copy" of the original field tape must be made from which the complete UF tape can be generated. The contact person for accessing these tapes is Chris Mattson, 497-6837.

An azimuth pointing error was determined to exist for the NOAA/C radar. Details are contained within Table B.3.

2. NCAR CP-3 Radar

a. *System Description*

The CP–3 C–band radar was located on Denver's Stapleton International Airport beside the CINDE operations center (Table A.1). It routinely scanned in a surveillance mode, and project scientists directed field operations based on the displayed data. Typically, the radar began scanning by 1100 MDT each day and continued until the close of operations.

The two scan modes that were used are called pre-storm and storm. The pre-storm scan concentrated on low levels. However, it had sufficiently high altitude to monitor storm development over the mountains. The storm scan was employed when storms were within or near the CINDE network. Table III.3 lists the scan parameters for each mode. A complete volume required ~5 min.

Table III.3. CP–3 Scan Parameters for the Pre-storm and Storm Scan Types

	Pre-storm	Storm
PRF	1250	1250
Gate length (m)	150	150
No. gates	768	512
Samples	128	64
Scan rate (deg/sec)	8.5	15.7
Elevation angles (deg)	0.4	0.4
	0.9	0.9
	1.7	1.7
	2.6	2.6
	3.5	3.5
	4.5	4.5
	5.5	5.5
		6.5
		7.5
		8.5
		10.0
		12.0
		15.0

On several occasions when one of the NOAA radars was down, the CP-3 scanning was modified to provide dual-Doppler data. These occasions are noted in the Wilson field notes (Section II.A).

b. *Data Description*

A total of 360 FOF field format tapes were collected by CP–3 during CINDE. The tape numbers are V44200 through V44559 and are stored in RL-3, Room 246. These tapes can be read and displayed by NCAR's Research Data Support System (RDSS) using the Perusal and Editor programs. Before utilizing NCAR Cray computer programs, the tapes need to be run through the FOF catalogue program. Many of the more interesting days have already been catalogued and are listed in Table B.4 (current as of 14 March 1988). Those wishing additional days to be catalogued should contact Bob Rilling (497–8842). A data use document was prepared by the FOF data management group for CP–3 and CP–2 and is included in Table B.5. An error in the radar reflectivities was determined during the field project and is detailed in Table B.5, as are other corrections important for detailed studies.

3. NCAR CP-2 Radar

a. *System Description*

The NCAR CP–2 multi-parameter radar was located at the FOF field site near Marshall, CO (Table A.1). CP–2 is a dual-wavelength (3 and 10 cm) and dual-polarization (vertical and horizontal) radar. From 22 June to 10 July, it was operated for NOAA/PROFS using a scanning sequence similar to the CP-3 pre-storm and storm scans. From 10 July through 10 August, the radar supported a dual-polarization project for Colorado State University under the direction of Prof. V.N. Bringi. Typically, the radar collected high resolution, multi-parameter data in RHI and PPI mode while sectoring a particular storm. A 360° surveillance scan at 0.7° elevation was obtained every 5 min. The storm of interest was often selected over the CINDE network.

b. *Data Description*

FOF field tapes numbered V49550 through V49880 were collected during the CINDE project. These data are stored in RL-3, Room 246. They can also be displayed on the RDSS. Unlike CP-3, only a few field tapes have been catalogued (Table B.4). Requests for cataloging CP-2 tapes should be directed to Bob Rilling (497–8842). Data documentation is included in Table B.5.

4. FL-2 and UND Radars

a. *System Description and Operating Characteristics*

The FL-2 (S-band) and UND (C-band) radars are located at Buckley Air Force Base and 20.3 km almost due north of Buckley (Table A.1 and Fig. I.1), respectively, in support of the TDWR operational demonstration. The radars generally scanned in two modes during the summer. The NEXRAD surveillance mode, composed of 360° scans at elevation steps of ≈1°, was used prior to convection in the network or in the absence of weather over Stapleton International Airport. Several different surveillance scan tables were used during the summer. The second scan mode (TDWR), was composed of 120° sector scans, with uneven elevation steps (maximum elevation angle varied between 20° and 40°) usually centered over the airport. Maximum range of the radar was between 35-45 km. The TDWR scan sequence for FL-2 and UND are listed in Tables III.4 and III.5, respectively. Occasionally, a very limited scanning strategy was used in support of the UND Citation turbulence studies. For more information on these scans contact Mark Hjelmfelt (497-8786) or Rita Roberts (497-8780).

b. *Data Description and Summary*

The FL-2 and UND radars were operational from May 18 to September 4, and from July 4 to September 4, respectively. Fields stored onto tape are reflectivity, velocity, spectrum width and signal to noise ratio. Data are thresholded on the signal to noise ratio. FL-2 velocities near the signal to noise threshold are biased toward zero. The typical minimum thresholded value is -19 dBZ_e for FL-2. A clutter filter was used on the data throughout the summer. Most of the FL-2 and UND data collected during TDWR have been processed by Lincoln Laboratory and written to tape in Common Format (CF). One CF tape contains ≈2 hours of radar data. During TDWR, NCAR also wrote FL-2 data to tape in pseudo-FOF format. These tapes do not contain all of the information (such as the dBm field) or housekeeping identification numbers typically found on FOF field tapes, but they can be read by NCAR's Research Data Support System (RDSS). These tapes were also assigned V numbers for use on the CRAY.

An antenna position error arising from a conversion process in their old syncro-to-digital converter was found in FL-2 data prior to August 19th that also affects the data collected by NCAR. The effect of this error is that the center of a given beam does not always keep its same location depending on the direction the radar is scanning. For example, the position of the beam at 230° azimuth in the clockwise direction could be as

Table III.4. Scan Sequence for FL-2 TDWR PPI Only Mode

Volume	Tilt	Elevation	Azimuth Range	Time	Purpose
1	1	0.5	360	15	Wind shift/MB outflow
	2	2.2	120	8	Precursor
	3	4.5	"	8	"
	4	6.7	"	8	"
	5	8.8	"	8	"
	6	11.0	"	8 (55)	"
	7	0.4	"	8	MB outflow
	8	1.0	360	15	Wind shift
	9	13.1	120	8	Precursor
	10	15.6	"	8	"
	11	18.6	"	8	"
	12	21.9	"	8	"
	13	25.8	"	9 (64)	"
	15	0.4	"	9	MB outflow
	16	30.1	"	8	Precursor
	17	34.8	"	8	"
	18	39.9	"	10	"
	19	2.2	"	8	"
	20	4.5	"	8	"
	21	6.7	"	8 (58)	"
	22	0.4	120	8	MB outflow
	23	0.4	360	15	Low PRF
	24	8.8	120	8	Precursor
	25	11.0	"	8	"
	25	13.1	"	8	"
	25	15.6	"	8 (55)	"
	26	0.4	120	8	MB outflow
	27	18.6	"	8	Precursor
	28	21.9	"	8	"
	29	25.8	"	8	"
	30	30.1	"	8	"
	31	34.8	"	8	"
	32	39.9	"	10 (58)	"
Total				290 sec	

Notes:

1. Surface scan elevations may be adjusted at site.
2. Wind shift scans may be moved closer together in sequence.

Table III.5. UND TDWR Scan Sequence for PPI Only Mode

Storm	Tilt	Elevation	Az Rng	Time	Purpose
1	1	0.5	360		Wind shift/MB outflow
2	2	2.2	120		Precursor
	3	4.5	"		"
	4	6.7	"		"
	5	8.8	"		"
	6	11.0	"		"
	7	13.1	"		"
	8	0.4	120		MB outflow
3	9	1.0	360		Wind shift
4	10	15.6	120		Precursor
	11	18.6	"		"
	12	22.0(21.9)	"		"
	13	26.0(25.8)	"		"
	14	0.4	"		MB Outflow
	15	1.0	"		Precursor
	16	2.2	"		"
	17	4.5	"		"
	18	6.7	"		"
	19	0.4	120		MB Outflow
	20	9.0(8.8)	"		Precursor
	21	11.0	"		"
	22	13.0 (13.1)	"		"
	23	15.6	"		"
	24	0.4	120		MB Outflow
	25	18.6	"		Precursor
	26	22.0(21.9)	"		"
Total				5 min.	

much as 1.5° displaced in the counterclockwise direction. One of the major impacts of this error is on multiple Doppler wind analysis. An adjustment made to the FL-2 data early during the summer to correct for the antenna position error was later found to be incorrect. While a better correction was then found for the FL-2 data, the pseudo-FOF formatted tapes still have the incorrect adjustments on tape and there are no plans for correcting the problem.

For data prior to the 19th, the best correction Lincoln Laboratory personnel could make to the CF tapes is a mean delay of 20.2 milliseconds, which is equivalent to an angular error of .61° at a 30 deg/sec rate and 0.10° at a 5 deg/sec rate. After August 19th, the old converter was replaced with a new one, and an angle accuracy of 0.01° is assumed. No known problems exist with the UND data.

c. *Data Access*

Universal Format (UF) tapes of TDWR data can be obtained from Lincoln Laboratory for the cost of replacement tapes. Data requests should be made through Mark Isaminger, at the Lincoln Laboratory–Buckley radar site (363–0415). NCAR/RAP also has FL-2 and UND CF tapes for selected time periods during the summer. These tapes can be converted to UF tapes using the RAP computer and software. CINDE investigators wishing to access and convert some of this data should contact Rita Roberts (497-8780). RAP staff has top priority usage of the computer/workstation, and visitors should expect to work after peak hours. The pseudo-FOF field tapes are located in RL3, room A252 and can be signed out on the tape sign-out sheet next to the tape racks.

d. *Data Processing*

No software currently exists for perusing a CF tape, although work is progressing on this task and should be completed by April 1988. On NCAR/RAP's VAX computer, a CF tape can be read onto disk and converted into a Universal Format file. This file can then be accessed by a modified version of FOF's Perusal/Editor interactive software programs run on the RAP computer. The pseudo-FOF radar tapes can be examined in the same manner as regular FOF radar tapes on both the FOF and RAP computers.

e. *Operational Time Periods*

Table B.6 lists the time periods (MDT) that the FL-2 and UND radars were operational and data were collected. The time periods for FL-2 data collected on tape in pseudo-FOF format are shown in the fourth column.

B. Aircraft

1. University of Wyoming King Air (N2UW)

a. *System Description*

UW King Air instrumentation is listed in Table C.1. The discussion in the CINDE Operations Manual for the NCAR King Air also applies to the N2UW, with the following exceptions:

1) The gust measurements were made with a Rosemount 858 de-iced air sensing probe at the end of the noseboom.

2) Two video cameras were used: forward view and radar-scope. Full communications (VHF, FM, intercom) were recorded on video tape.

3) The Ophir radiometer was not onboard.

4) The NOAA chaff dispenser was onboard. During periods that the chaff dispenser was releasing chaff, an event was recorded on the data tape.

5) A Doppler navigation radar was flown. This data is backup to the INS and has the potential for velocity-damping of INS measurements.

6) The high altitude, high resolution radar altimeter (APN-159) was flown. This will facilitate pressure perturbation studies.

7) VOR was recorded in addition to DME. DME switching is slightly different in strategy from NCAR methods.

b. *Data Description and Summary*

Tables C.2–C.4 show the order of the variables in the UW archive data format. Data are stored on 1600 bpi magnetic tapes in Laramie. Briefly stated, these tapes are in binary format, and values are stored in Hewlett-Packard (HP) floating point format. Conversion to scaled integer values is possible upon request.

The problems with the new N2UW data set known at this time are as follows.

1) A flaw in the radar altimeter algorithm occasionally causes 4,000 ft jumps.

2) The calibration used for the Lyman-α humidiometer is not correct (because of a malfunction). An updated calibration is available but has not been tested or incorporated into the processing at this time.

3) The post-project calibrations have not been used in the archived data, but we anticipate very little difference, if applied.

c. *Contact Point*

To obtain information or data contact:

Al Rodi
Box 3038
Laramie, WY 82071
(303)766–3245

d. *Available Software*

Software is available for the following:

1) Time series traces of any of the variables listed in Tables C.2–C.4

2) Time-height profiles for the airplane flights

3) Flight track plots

4) Soundings of airplane data

5) 2-DP and 2-DC images and special 2-D processing. These are archived in "raw" tape format.

Also, notebooks of 2), 3) and 4) have been compiled and may be duplicated. Flight tracks include the entire flight and 30-min segments with wind vectors. Soundings include a Skew-T, θ and θ_e vs. Z, and a hodograph.

e. *Start-Stop Times*

Table C.5 contains a record of each flight tape from the project. Listed are brief descriptions of the flight, as well as the start and stop times of each tape.

2. NCAR King Air (N312D)

a. *Flight Operations*

The NCAR King Air (N312D) participated in 30 flights during the 1987 CINDE summer research program. Of these, 21 were strictly research oriented (see Table C.6 for actual dates and flight periods), and 9 were devoted to instrument tests and calibrations (including pre– and post–season tower fly-bys and formation flights with other project aircraft for systems intercomparison). A total of 71.5 flight hours were used, amounting to 88% of the allocated flight time.

The research instrumentation package carried on the NCAR King Air during CINDE is listed in Table C.7.

Preliminary flight tracks, time–height profiles and soundings for all research flights have been plotted and are being compiled in the same manner as that provided for the UW King Air.

b. *Data summary*

The basic NCAR King Air research data base exists in two primary formats: a magnetic tape archive, and 35 mm microfilm with PMS images and plots of flight tracks and analog traces of all recorded and derived variables. The permanent archive of original microfilm output resides in the office of Principal Investigator (P.I.) J. Fankhauser (Room S276, RL–6, 3363 Marine Street, Boulder, Colorado). Copies are available for review and reproduction upon request.

Flight data tapes (G series in Table C.8) have been reprocessed by the Research Flight Facility (RAF) to 6250 bpi physical tapes (B series in Table C.8) that are accessible through the NCAR Scientific Computer Division's (SCD) Mass Storage Facility. SCD also provides a data processing package (called GENPRO) for basic data analysis. Calibrations applied by RAF in production of reprocessed data are identified on the header of each roll of microfilm. Users who require precise aircraft position and the best possible air motion accuracy are advised to consult principal investigators (J. Fankhauser and A. Rodi) for recommended data processing procedures.

Table C.9 is a video tape log giving on and off times for three on–board cameras: radar scope, forward–looking (black and white), and left side–looking (color). The forward looking film also has an audio record of all voice communication over aircraft radio and intercom channels.

RAF has provided the principal investigators with notebooks that compile their CINDE Project Documentation Summary. In addition to information in Tables C.8 and C.9 this document provides:

1) Summary logs for each research flight including:
   a) flight crew
   b) INS performance data
   c) air motion calibration maneuvers (if performed)
   d) a brief description of the flight mission

e) a review of instrument performance (including known malfunctions)

f) a record of changes in system components and/or calibrations.

2) Flight–by–flight record of the RAF Project Engineer's notes on instrument performance maintenance and data problems encountered

3) Processed data tape format listing

4) Summary of air motion calibration maneuvers

5) Summary of tower fly–by results

6) PMS calibrations

This project documentation and flight scientists' personal notes are available for review and reproduction upon request.

3. UND Citation

The instrumentation available on the Citation provides the following: meteorological state parameters, wind and turbulence components, and cloud microphysics measurements. Navigation data include INS and VOR/DME information. Detailed instrumentation specifications are included in Table C.10.

Most of the data are recorded at 24 Hz. Particle size information is recorded at 4 Hz. Additional information is provided by forward looking video, by hand held 35mm photographs, and by voice notes. A summary of the CINDE Citation Missions is provided in Table C.11.

Processed data are archived at UND. Data are available in several formats, including (a) archive tapes, (b) PMS tape format, (c) ASCII tape listings, and (d) special product tapes. For more information contact:

Dr. Don Burrows (Data Management)
Mr. Martin Brown (Software and tapes)
Dr. Jeff Stith
Box 8216, University Station
Grand Forks, ND 58202
(701)777-2791

C. Mesonetworks

1. PAM and PROFS Data

Station locations of the PAM and PROFS mesonet are given in Tables A.2 and A.3, respectively. Data from the PAM II stations of CINDE are currently accessible using the ROBOT program on the RDSS VAX and the CRAY computers. The data are also available on half inch magnetic tape in Common Mesonet Format (documentation available upon request). Instrumentation specifications are listed in Table III.6. The data were collected at one minute intervals. Fields available on CMF format and in ROBOT are listed in Table III.7.

The ROBOT software produces station plots, time plots, data listings and interpolated winds and contour plots. The following hardcopy outputs are available: slides, color plots, laser plots, and microfilm. Examples of interpolated winds and contour plots from the laser printer are shown in Figs. III.8–10. ROBOT will also combine the PROFS and FLOWS data sets with the PAM II data. Users interested in PAM data or ROBOT user manuals should contact Bob Rilling (497–8842), Chris Burghart (497–8836) or Cindy Mueller (497–8805).

The PROFS data are accessible on the RDSS VAX using the ROBOT program. The data are recorded as 5 min averages. Instrumentation specifications are listed in Table III.11. Fields accessible using the ROBOT software are listed in Table III.12. Because of the size of the data set, only requested days are on the RDSS disk. If you would like data staged onto the disk, contact Cindy Mueller (497–8805) or Bob White (497–8825).

Table III.6. PAM II Mesonet Instrumentation Specifications

Variable	Accuracy	Resolution	Sample Interval
Wind Speed			1 s
Wind Direction			1 s
Temperature	0.25°C	0.025°C	10 s
Wet Bulb Temp	0.50°C	0.025°C	10 s
Pressure	40 Pa RMS error	2 Pa	30 s
Rainfall		0.254 mm	

Taken from NCAR PAM User's Manual, available from NCAR/FOF.

Table III.7. PAM II Fields

Mnemonic	Meaning	Units
tdry	dry bulb temperature	°C
pres	pressure	mb
twet	wet bulb temperature	°C
wspd	wind speed	m s^{-1}
wdir	wind direction	m s^{-1}
u_wind	west wind	m s^{-1}
v_wind	north wind	m s^{-1}
wmax	maximum wind speed	m s^{-1}
raina	accumulated rainfall	millimeters
rainr	Rain rate (accumulated over sample time)	mm/minute
pt	potential temperature	°K
ept	equivalent potential temperature	°K
mr	mixing ratio	°K
rh	relative humidity	percent
dp	dewpoint	°C

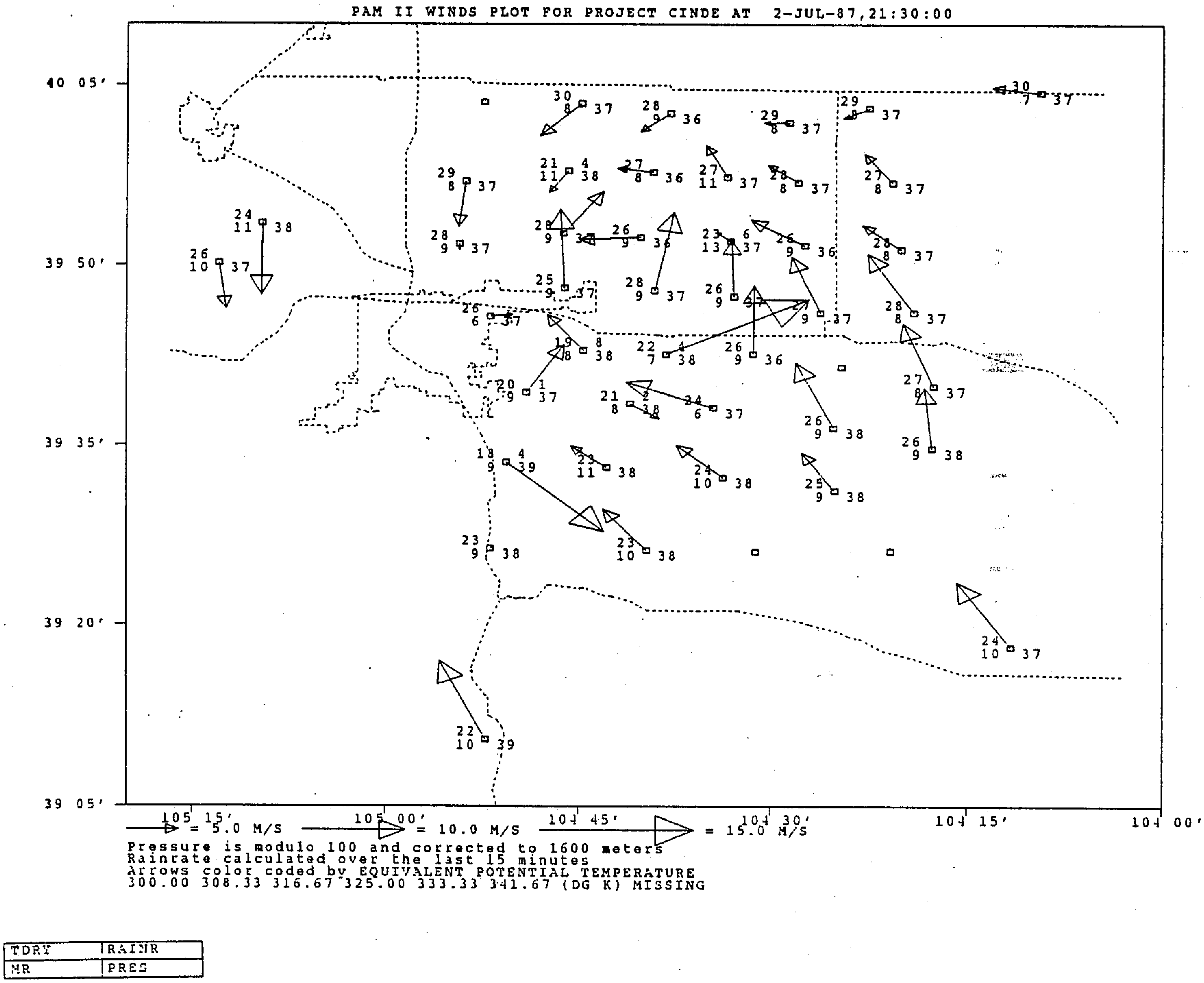


Figure III.8. Example of ROBOT Station Plot.

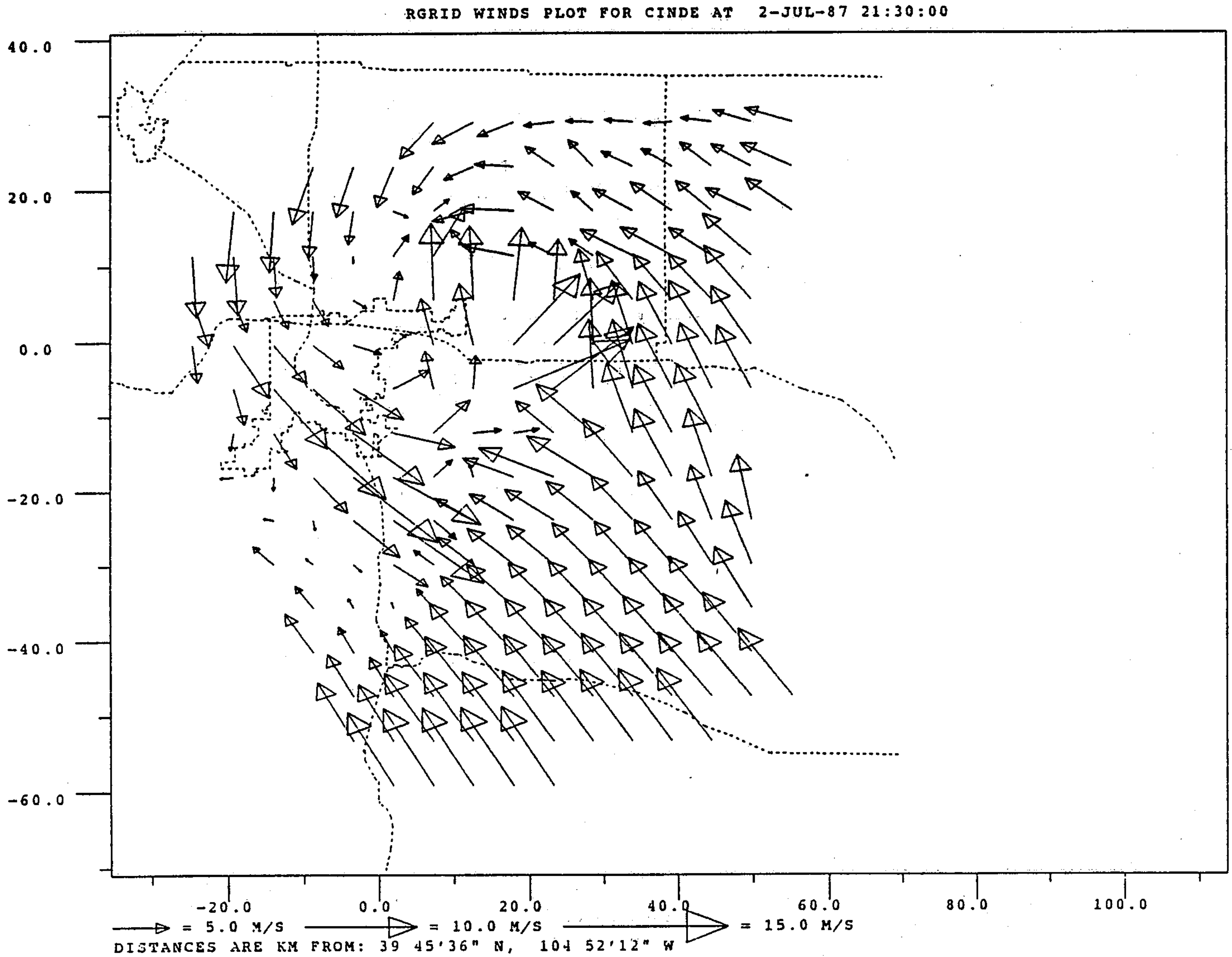


Figure III.9. Example of ROBOT RGRID Plot.

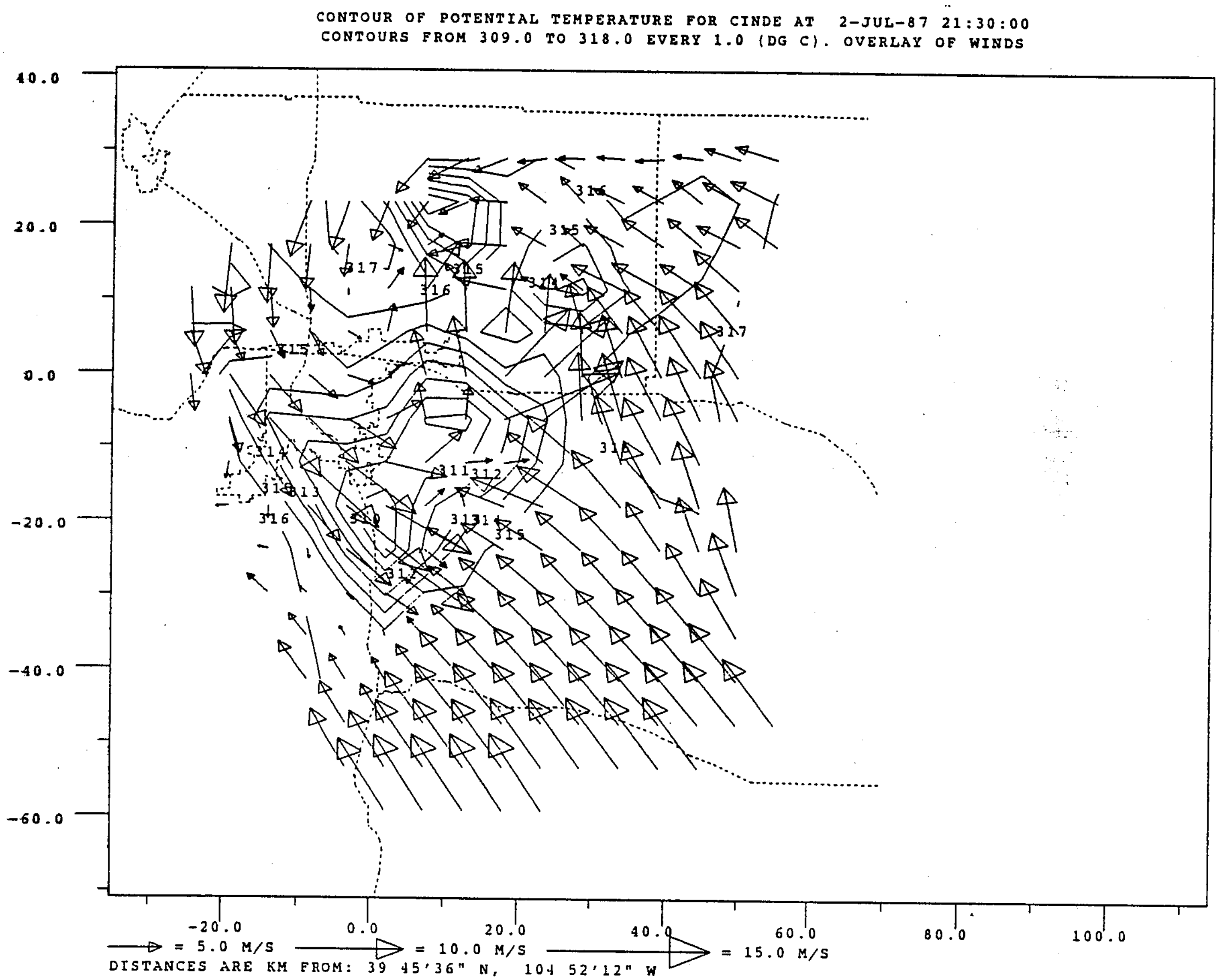


Figure III.10. Example of ROBOT RGRID and Contour Plot.

Table III.11. PROFS Mesonet Instrumentation Specifications

Variable	Height of Sensor	Sensor Operating Range	Sensor Accuracy	Signal Processing Accuracy
Wind Speed	10 m	1.5 to 90 m s^{-1}	0.3 m s^{-1} + 3% reading	0.05 m s^{-1}
Wind Direction	10 m	0 to 360°	4°	2°
Temperature	1.5 m	–50 to +50°C	0.4°C	0.1°C
Dew Point	1.5 m	–40 to +50°C	0.6°C	0.3°C
Pressure	1.5 m	620 to 920 mb	0.3 mb	0.2 mb
Insolation	8 m	20 to 1500 W m^{-1}	5% reading	1% reading
Visual Range	2 m	60 to 900 m	15% reading	15% reading
Accumulated Rainfall	0.6 m	0.25 to 100 mm h^{-1}	0.25 mm + 10% reading per event	0.25 mm

Pratte and Clark, 1983: PROFS Mesonet–Description and Performance, 5th Symp. on Meteor. Observ. and Instr., 303-307.

Table II.12. PROFS Fields Available in ROBOT

Mnemonic	Meaning	Units
tdry	dry bulb temperature	°C
pres	pressure	mb
wspd	wind speed	m s^{-1}
wdir	wind direction	m s^{-1}
rainr	Rain rate (accumulated over sample time)	mm/minute
dp	dewpoint	°C

2. FLOWS Mesonet

a. System Description and Operating Characteristics

Placement of the 30 surface weather stations comprising the FLOWS mesonet is shown in Fig. I.2 and listed in Table A.4. Each of these stations operated 24 hr/day, collecting 1 min averages of temperature, relative humidity, barometric pressure, wind speed and direction, and rainfall accumulation. The peak wind speed during each minute was also recorded.

b. Data Description and Summary

Lincoln Laboratory is providing NCAR with a complete set of FLOWS mesonet data in Common Mesonet Format (CMF). Unfiltered data have been sent to NCAR. A few of the stations were found to have intermittently faulty wind direction potentiometers that caused noisy data in the form of spikes or glitches in the pressure, temperature, relative humidity, and rainfall accumulation fields. The errors resulted when the wind direction crossed 360 °, causing spikes in the other field measurements. A filter is being used to correct for these bad data points. Once corrections are made, a complete set of filtered data will be sent to NCAR.

A problem was also found with the wind speed measurement at station 10. At the day and time periods listed in Table III.13, the average, instead of the peak, wind speed was recorded for peak wind speed. These peak wind speeds have been flagged as bad on the CMF tapes corresponding to the above time periods.

c. Data Access

Contact Rita Roberts (497-8780) to access NCAR's copies of the mesonet data. For data quality concerns, contact John DiStefano at Lincoln Laboratory, (617/863-5500 x 3452) or Chuck Curtis at the Buckley radar site (363-0415).

Table III.13. Bad Peak Wind Speed for FLOWS Station 10

PEAK WIND SPEED DATA FLAGGED BAD	
DAY (julian)	TIMES(UT)
229	0330–1400
230	1100–1400
231	1200–1300, 1530–1600
236	0200–2000
238	0040–0100, 0600–1200, 1800–2230
239	0000–1400
241	1200–1500
243	0730–1800

d. Data Processing

The tapes are written in CMF and are compatible with NCAR/FOF's ROBOT program.

e. Operational Time Periods

From 9 June to 8 July, the following 13 stations were operational: 1, 12, 13, 17, 18, 19, 20, 21, 22, 23, 28, 29, and 30. On July 1st, station 29 was removed from its location at the UND radar site and was not used the rest of the summer. After 8 July, the remaining 17 stations also became operational.

D. Sounding Systems

1. System Description

Two sounding systems were used to obtain temperature, humidity and wind profiles during the CINDE experiment. One system was the NCAR Cross–chain LORAN Atmospheric Sounding System (CLASS). Five CLASS sites were located within the CINDE project area shown in Fig. I.1. Table A.5 lists the latitude, longitude, elevation and radar relative locations for each of these sites and also shows the approximate total number of soundings obtained from each station. Each CLASS sounding provided an estimate every 10 sec of the temperature, pressure, relative humidity and the u and v components of the wind as the balloon ascended. Average ascent rate for the 200gm balloons was 4–5 m s^{-1}, which results in a vertical resolution in the data of about 40–50 m. The data were printed out in real time and were also collected on 3.5 inch diskettes. An example of the real time printout is shown in Table III.14. The Vaisaila radiosonde used by the CLASS system actually transmits new data to the ground station about every 3.4 sec. The 10 sec values shown in the listing, therefore, represent mean values derived by averaging the incoming data over 20 sec for the thermodynamic variables and 30 sec for the wind variables. The "Q" values listed next to each variable represent the standard deviation of the raw values over the respective time intervals. Large "Q" values flag bad data, as is shown in the pressure data on lines 1, 8, and 9. The original listings and diskettes for each CLASS sounding in CINDE are maintained by the NCAR ATD Surface and Sounding Systems office in RL–3.

Upper air soundings were also obtained from 3 mobile platforms that released AIR, INC 403MH_z radiosondes from various locations in and around the CINDE network. Two of the mobile units, referred to as Cloud 1 and Cloud 2, operated identical equipment and obtained temperature, pressure and relative humidity (using the VIZ carbon

Table III.14. Example of Real–Time Printout of CLASS Sounding Data

- NCAR / CLASS -

```
LAUNCH LOCATION ............ CINDE - DENVER,CO - DVR
LAUNCH DATE ................ 30 Jun 1987
LAUNCH TIME ................ 17:11:37 GMT
LAUNCH LATITUDE ............  +39°46'02"
LAUNCH LONGITUDE ........... -104°52'09"
```

Data	Alt (m)	Press (mb)	QP	Temp (°C)	QT	Tdew (°C)	Rhm (%)	QH	U (m/s)	QU	V (m/s)	QV
0	1608	841.1	0.0	22.0	0.0	14.4	62	0.0	2.2	0.0	0.0	0.0
1	2564	753.0	144.0	17.5	.8	11.6	56	1.7	.6	.1	-.6	.2
2	1708	832.5	.3	15.6	.2	8.8	64	1.6	.4	.1	-1.2	.1
3	1751	828.2	.2	15.1	0.0	8.9	67	.5	.5	.2	-1.9	.1
4	1790	824.4	.3	14.7	0.0	8.9	68	.3	.7	.2	-2.0	.1
5	1831	820.5	.2	14.3	.1	8.8	69	.3	1.0	.2	-2.0	.1
6	1875	816.3	.1	13.9	0.0	8.8	71	.3	1.3	.1	-1.8	.1
7	1921	811.8	.2	13.5	.1	8.8	73	.4	1.9	.1	-1.7	.1
8	3487	674.3	329.0	13.3	.1	8.6	73	.8	1.8	.2	-.3	.2
9	1628	840.9	289.0	13.0	.1	8.3	72	.6	.7	.2	.8	.2
10	2071	797.7	.5	12.6	.1	8.0	74	.4	.1	.1	1.3	.2
11	2124	792.7	.2	12.1	.1	7.9	75	.4	-.4	.1	2.1	.1
12	2177	787.7	.2	11.6	0.0	7.8	77	.4	-.6	.1	2.6	.1
13	2234	782.4	.3	11.1	.1	7.7	79	.4	-.5	.1	2.7	.1
14	2292	776.9	.2	10.6	.1	7.5	81	.3	-.3	.1	3.0	.1
15	2350	771.6	.3	10.2	.1	7.4	82	.3	0.0	.1	3.3	.1
16	2412	765.9	.2	9.8	0.0	7.1	83	.6	.1	.1	3.4	.2
17	2471	760.4	.3	9.4	.1	6.8	83	.6	.4	.2	4.5	.2
18	2528	755.2	.5	9.1	.1	6.6	84	.3	2.1	.3	5.9	.2
19	2586	750.0	.4	9.2	.3	6.2	80	2.2	2.8	.3	6.5	.2
20	2644	744.7	.2	9.6	.2	5.3	72	1.0	3.6	.2	6.4	.2
21	2699	739.8	.5	9.7	.1	4.2	66	1.3	4.5	.2	5.1	.1
22	2749	735.4	.3	9.4	.1	3.4	64	1.6	4.5	.2	4.5	.2
23	2796	731.2	.3	9.5	.2	2.6	60	1.2	4.3	.1	3.4	.2
24	2840	727.4	.2	9.8	.2	1.9	57	1.7	4.6	.1	2.4	.2
25	2879	724.0	.2	9.7	.1	1.7	57	.4	4.6	.1	1.0	.2
26	2916	720.8	.3	9.4	0.0	1.7	58	.3	5.0	.2	-1.8	.2
27	2954	717.5	.2	9.1	0.0	1.6	59	.3	5.0	.1	-1.6	.2
28	2989	714.4	.2	8.8	0.0	1.5	60	.2	4.5	.1	-1.3	.1
29	3026	711.2	.3	8.4	0.0	1.4	61	.3	4.3	.1	-.7	.1
30	3064	708.0	.1	8.1	0.0	1.4	62	.3	4.2	.1	-.6	.1
31	3101	704.9	.1	7.8	0.0	1.3	63	.4	4.1	.1	-.6	.1
32	3139	701.6	.1	7.5	0.0	1.2	64	.7	4.0	.1	-.2	.1
33	3178	698.3	.1	7.2	0.0	1.2	66	.7	4.2	.1	-0.0	.1
34	3217	694.9	.2	6.9	0.0	1.2	67	.8	5.7	.2	-.2	.1
35	3261	691.3	.3	6.5	0.0	1.1	67	.3	8.4	.4	-.2	.2
36	3308	687.3	.3	6.3	.1	.6	65	1.0	9.3	.4	-.8	.1
37	3354	683.5	.1	6.3	0.0	-.1	62	.7	9.3	.3	-1.3	.1
38	3396	680.0	.2	6.2	.1	-.7	60	.3	5.6	.3	-2.2	.1
39	3439	676.4	.2	5.9	.1	-1.0	60	.3	5.6	.3	-2.3	.1
40	3483	672.8	.1	5.6	0.0	-1.2	61	.2	6.3	.2	-2.6	.1
41	3528	669.1	.2	5.1	0.0	-1.4	62	.4	6.2	.1	-3.0	.1
42	3572	665.6	.5	4.7	.1	-1.5	63	.5	6.4	.1	-3.2	.1
43	3611	662.3	.2	4.4	0.0	-1.6	65	.6	6.4	.1	-3.7	.1
44	3648	659.4	.3	4.1	0.0	-1.6	66	.3	5.7	.1	-3.9	.1
45	3690	656.0	.3	3.7	.1	-1.7	67	0.0	5.0	.1	-4.0	.1

hygristor element) at 5 sec intervals. Average ascent rate was 4–5 m s^{-1}resulting in a vertical resolution of the thermodynamic parameters of 20–25 m. Winds were measured using an optical theodolite with azimuth and elevation angles recorded (manually) at 30 sec intervals. Cloud 3 was virtually identical to Clouds 1 and 2 with the exception that the wind angles were recorded automatically (using shaft encoders) at 30 sec intervals rather than manually. This feature enabled Cloud 3 to compute winds in real time. However, because of this additional processing, the thermodynamic parameters were only recorded at 10 sec intervals.

2. Data Processing, Format and Availability

Scientists interested in analyzing the CINDE soundings may examine the data in a number of formats. The real time CLASS listings and diskettes are available through the NCAR ATD Surface and Soundings office, as described above.

Limited software has been developed to display the sounding data on the H–P computers in that organization. The original mobile sounding listings can also be obtained from Chuck Wade (NCAR) for Cloud 1 and 2, and Dan Wolfe (NOAA) for Cloud 3.

The data have also been merged into a common format, as illustrated in Fig. III.15, so that the RSANAL package (available on the NCAR Cray) can be used to display and analyze the data.

A document describing the RSANAL package is available. At present the common format files reside on the RDSS VAX. They can be processed on the NCAR CRAY using the RSANAL software package (contact Sandra Henry [497–8950] or Cindy Mueller [497–8805] for information on the use of this software).

A "first–look" product has been created using the RSANAL software. Examples of the plotted thermodynamic and wind vector data are shown on a skew–T diagram in Fig. III.16. Interpolated data at 10 mb intervals have also been produced for each sounding and are illustrated in Table III.17. Contact Chuck Wade (487–8977) or Cindy Mueller (497–8805) for questions regarding the availability of this "first–look" data.

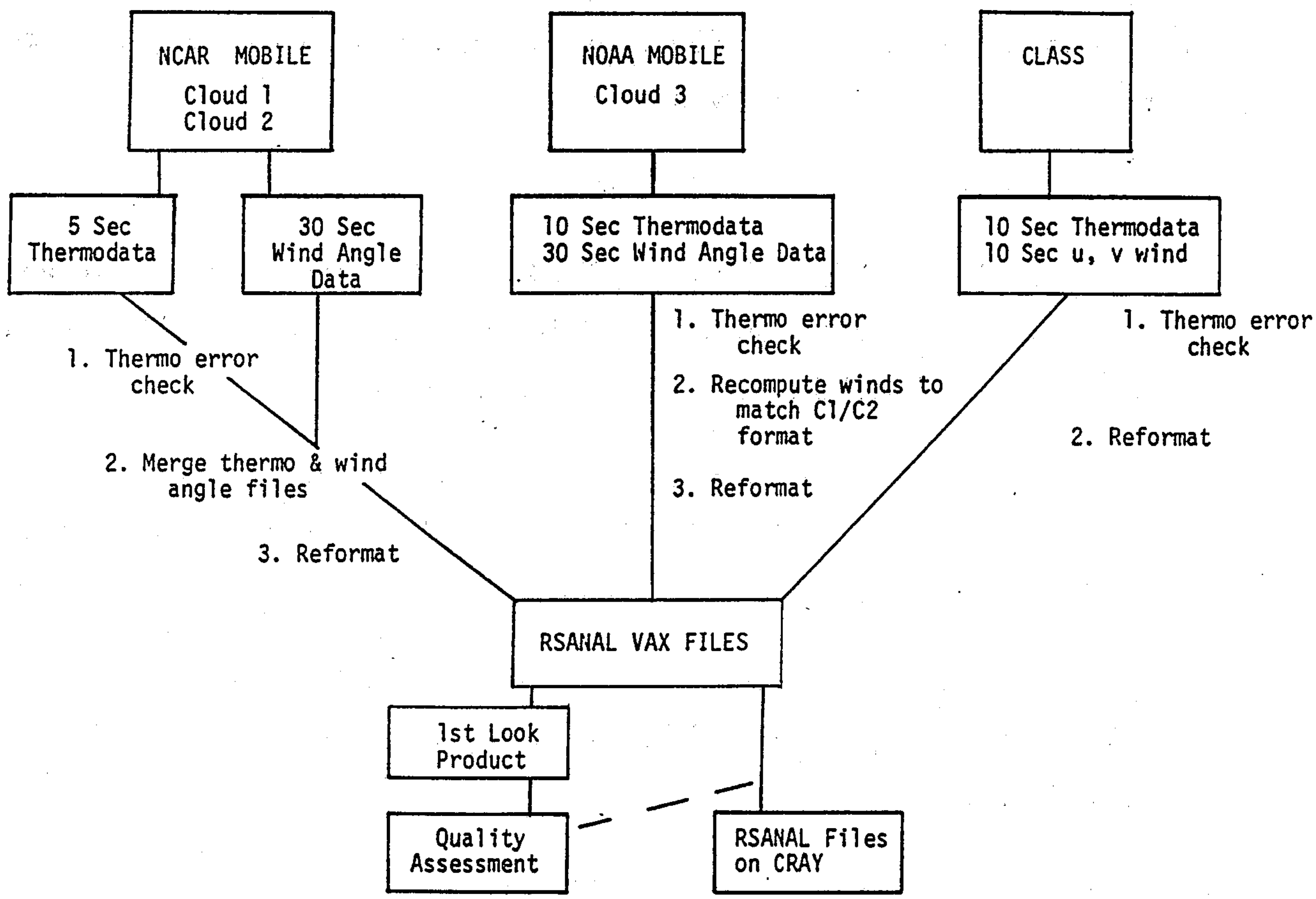


Figure III.15. Flow chart showing the merger of CLASS and mobile sounding data into the RSANAL format.

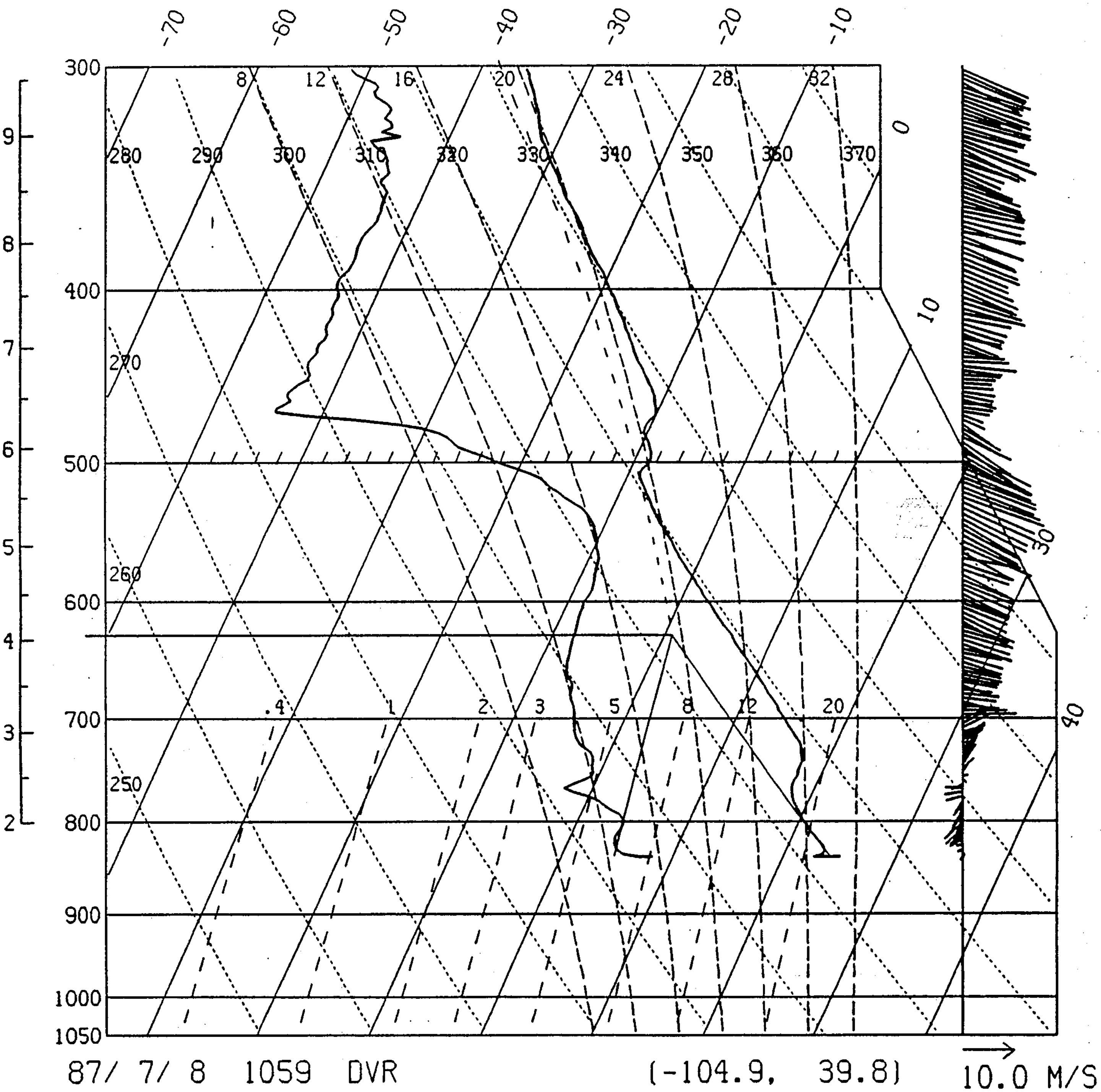


Figure III.16. Example of CINDE CLASS sounding plotted on a Skew-T diagram using RSANAL software.

Table III.17. Example of Interpolated Data Listing at 10 mb Intervals Using RSANAL Software

7/ 8/87 1059 MDT DVR HGT. (MSL)= 1608. M. INTERPOLATED REPORTS STANDARD TEMPERATURE ANALYSIS

PRES MB	HGT KM	TEMP DEG C	DWPT DEG C	RELH P-CNT	MIXR G/KG	TVIR DEG C	POT DEG K	EPOT DEG K	TSAT DEG C	PLCL MB	TLCL DEG C	ZLCL KM	SPD M/S	DIR DEG	TIME MIN
836.5	1.608	25.0	8.1	34.1	8.1	26.5	313.8	339.3	12.5	653.0	4.6	3.717	0.9	22.5	0.00
830.0	1.676	23.4	4.8	30.0	6.5	24.6	312.8	333.4	12.2	631.5	1.1	3.993	0.7	58.6	0.47
820.0	1.782	22.5	4.1	30.1	6.3	23.7	313.0	332.8	11.8	625.3	0.5	4.075	2.3	63.5	0.80
810.0	1.888	21.4	4.1	32.1	6.4	22.6	312.9	332.9	11.3	627.2	0.7	4.049	3.2	45.5	1.20
800.0	1.995	20.5	4.1	34.0	6.4	21.6	313.0	333.4	10.8	627.8	0.8	4.042	4.5	37.8	1.57
790.0	2.104	19.6	2.9	32.9	6.0	20.7	313.2	332.2	10.3	616.4	-0.4	4.191	4.3	32.2	1.94
780.0	2.213	18.8	1.2	30.8	5.4	19.7	313.4	330.5	9.8	600.9	-2.2	4.399	2.7	34.2	2.31
770.0	2.324	18.2	-1.6	26.1	4.4	19.0	314.0	328.2	9.3	573.7	-5.3	4.770	3.5	82.6	2.68
760.0	2.436	17.9	-1.5	26.6	4.5	18.7	314.8	329.4	8.7	568.8	-5.3	4.839	1.0	37.2	3.09
750.0	2.549	17.9	-0.7	28.4	4.9	18.7	316.0	331.7	8.2	569.0	-4.2	4.836	2.6	219.4	3.55
740.0	2.664	17.8	-1.1	27.7	4.8	18.6	317.1	332.6	7.6	558.3	-4.7	4.987	4.9	213.3	4.00
730.0	2.780	17.3	-1.9	26.8	4.5	18.1	317.8	332.6	7.1	547.8	-5.6	5.137	5.4	223.9	4.43
720.0	2.897	16.5	-3.3	25.4	4.2	17.3	318.2	331.8	6.5	534.7	-7.1	5.327	5.2	233.8	4.85
710.0	3.016	15.5	-4.0	25.8	4.0	16.2	318.3	331.5	6.0	530.0	-7.7	5.398	5.4	247.5	5.27
700.0	3.136	14.5	-4.5	26.5	3.9	15.1	318.5	331.4	5.4	526.4	-8.1	5.451	5.8	251.5	5.68
690.0	3.257	13.4	-5.0	27.3	3.8	14.1	318.6	331.2	4.8	522.8	-8.5	5.503	7.6	272.7	6.12
680.0	3.380	12.3	-5.8	27.8	3.6	12.9	318.7	330.8	4.1	517.7	-9.1	5.580	6.9	275.9	6.57
670.0	3.504	11.1	-6.1	29.2	3.6	11.8	318.8	330.7	3.5	516.1	-9.3	5.605	6.7	288.5	7.03
660.0	3.629	10.0	-7.1	29.3	3.4	10.6	318.9	330.1	2.9	509.7	-10.2	5.701	7.8	281.7	7.55
650.0	3.755	8.8	-7.5	30.8	3.3	9.3	318.9	330.0	2.2	507.6	-10.5	5.733	8.1	287.6	8.01
640.0	3.883	7.5	-7.8	32.8	3.3	8.1	318.9	329.9	1.5	507.0	-10.6	5.742	7.9	282.9	8.45
630.0	4.013	6.3	-8.0	35.0	3.3	6.9	319.0	330.0	0.9	506.3	-10.6	5.752	9.5	287.5	8.88
620.0	4.144	5.0	-8.2	37.7	3.3	5.6	318.9	329.9	0.2	506.4	-10.6	5.752	9.5	289.1	9.32
610.0	4.276	3.8	-8.4	40.4	3.3	4.3	319.0	329.9	-0.5	505.8	-10.7	5.761	10.2	295.6	9.77
600.0	4.410	2.5	-8.6	43.7	3.3	3.1	319.1	330.0	-1.3	505.9	-10.6	5.759	9.6	291.3	10.23
590.0	4.546	1.3	-8.4	48.4	3.4	1.8	319.1	330.5	-2.1	508.2	-10.2	5.724	10.3	293.2	10.68
580.0	4.683	0.0	-8.8	51.6	3.4	0.5	319.2	330.4	-2.8	506.7	-10.4	5.747	10.0	294.7	11.15
570.0	4.822	-1.4	-9.0	55.8	3.4	-0.8	319.2	330.4	-3.6	506.1	-10.4	5.757	9.8	286.3	11.54
560.0	4.963	-2.6	-9.7	58.3	3.3	-2.1	319.3	330.1	-4.4	502.0	-11.0	5.819	13.5	294.3	11.95
550.0	5.106	-3.9	-10.3	61.0	3.2	-3.4	319.5	330.0	-5.3	497.7	-11.5	5.885	12.2	297.8	12.33
540.0	5.250	-5.3	-11.3	62.6	3.0	-4.8	319.5	329.4	-6.1	491.6	-12.4	5.982	13.4	298.5	12.76
530.0	5.397	-6.5	-12.9	60.1	2.7	-6.1	319.8	328.7	-7.0	478.9	-14.1	6.183	15.4	294.4	13.20
520.0	5.546	-7.6	-15.5	53.0	2.2	-7.2	320.2	327.6	-7.9	459.2	-16.9	6.506	16.0	289.9	13.67
510.0	5.696	-8.8	-17.8	47.8	1.8	-8.5	320.5	326.8	-8.8	442.1	-19.4	6.797	15.2	290.7	14.18
500.0	5.850	-8.7	-22.2	32.4	1.3	-8.4	322.5	327.0	-9.8	403.5	-24.4	7.485	14.6	295.9	14.75
490.0	6.006	-9.2	-26.4	23.1	0.9	-9.1	323.7	327.0	-10.8	372.8	-29.1	8.068	11.9	305.4	15.34
480.0	6.166	-10.4	-29.5	19.0	0.7	-10.2	324.2	326.7	-11.9	351.4	-32.8	8.496	8.6	300.2	15.92
470.0	6.328	-10.0	-42.1	5.2	0.2	-10.0	326.6	327.3	-12.9	276.6	-47.0	10.172	4.7	285.7	16.55
460.0	6.493	-10.8	-43.6	4.7	0.2	-10.8	327.6	328.2	-14.0	267.1	-48.6	10.408	6.5	283.1	17.26
450.0	6.662	-12.1	-43.0	5.5	0.2	-12.1	328.1	328.8	-15.2	269.4	-47.7	10.350	6.1	273.2	17.94
440.0	6.833	-13.6	-43.4	6.0	0.2	-13.6	328.2	328.9	-16.3	268.0	-47.9	10.386	9.6	274.1	18.61
430.0	7.007	-14.9	-43.2	6.8	0.2	-14.9	328.7	329.5	-17.6	268.2	-47.6	10.381	7.3	289.7	19.25
420.0	7.185	-16.3	-43.2	7.6	0.2	-16.3	329.1	329.9	-18.8	267.5	-47.4	10.399	8.7	286.6	19.91
410.0	7.366	-17.8	-43.5	8.4	0.2	-17.8	329.5	330.3	-20.1	266.1	-47.5	10.433	12.6	285.1	20.51
400.0	7.550	-19.3	-43.8	9.3	0.2	-19.3	329.9	330.7	-21.5	264.4	-47.6	10.477	11.1	292.6	21.08
390.0	7.737	-20.9	-43.6	10.8	0.2	-20.9	330.2	331.0	-22.9	265.3	-47.2	10.456	9.5	292.1	21.66
380.0	7.929	-22.7	-43.7	12.7	0.2	-22.7	330.3	331.1	-24.4	266.0	-47.0	10.437	11.0	292.1	22.26
370.0	8.124	-24.2	-43.4	15.0	0.2	-24.2	330.8	331.6	-25.9	266.8	-46.5	10.416	12.0	283.5	22.91
360.0	8.323	-26.1	-43.2	18.1	0.2	-26.0	331.0	331.8	-27.5	268.3	-46.0	10.380	12.0	281.6	23.61
350.0	8.526	-27.9	-43.9	19.8	0.2	-27.8	331.2	332.0	-29.1	265.3	-46.6	10.455	11.5	288.8	24.36
340.0	8.733	-29.7	-44.5	22.0	0.2	-29.7	331.5	332.3	-30.8	262.8	-47.0	10.519	10.0	286.2	25.17
330.0	8.945	-31.5	-46.6	20.7	0.2	-31.5	331.8	332.5	-32.6	253.1	-49.2	10.769	13.5	289.6	26.02

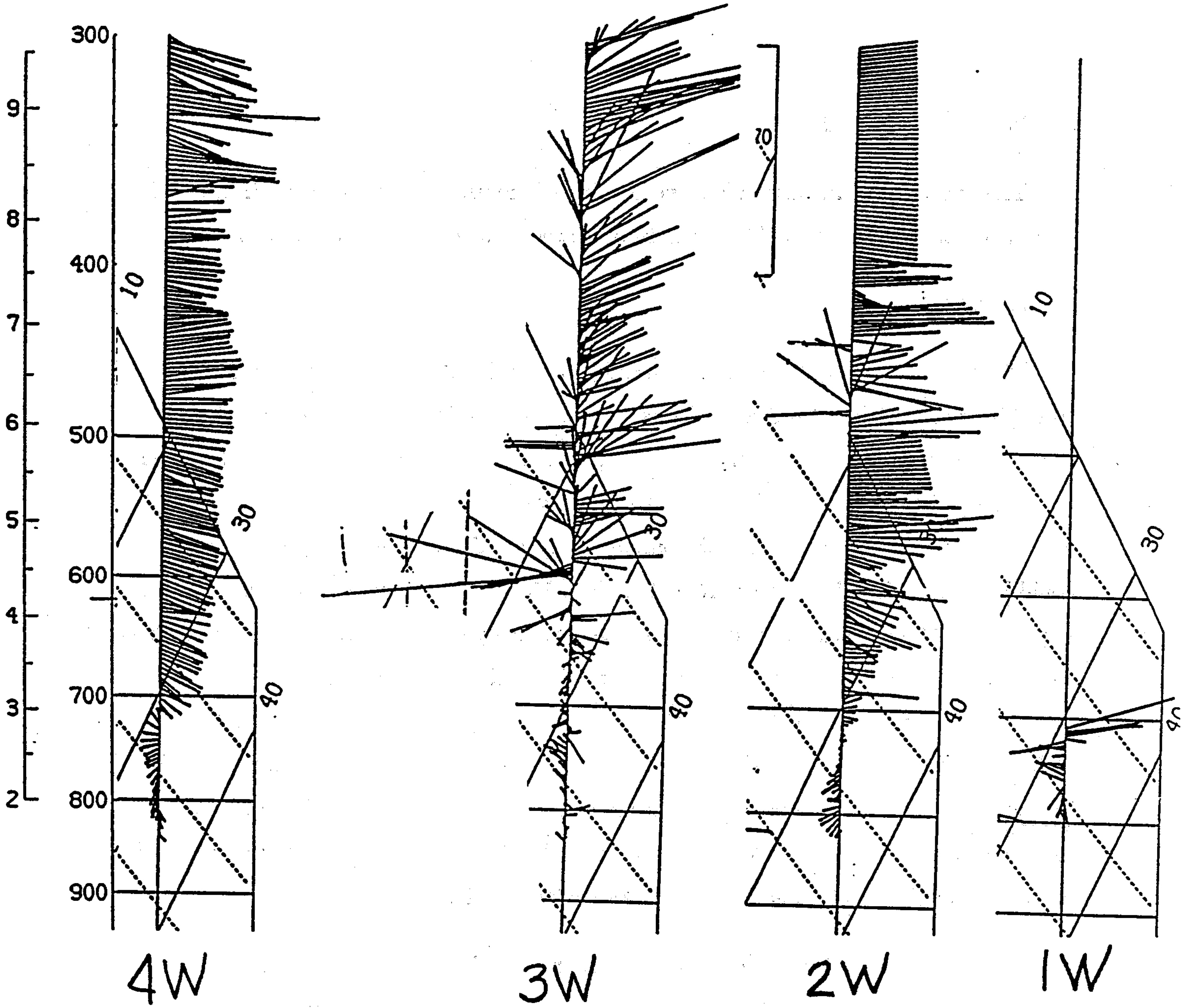
3. Problems in the Data

The purpose of this section is to note a few of the problems which exist in the CINDE sounding data set. These problems fall into 5 categories addressed individually below.

a. *CLASS Winds*

CLASS winds are obtained using LORAN navigational signals. In Colorado and throughout the northern and central Great Plains, the LORAN signals are relatively weak, since the LORAN transmitting stations are located primarily near coastal regions. As a result, there was a broad range in the quality of wind data obtained in CINDE. Examination of more than 400 CLASS soundings suggested that the quality of wind data could be summarized in four general categories. These four categories are illustrated in Fig. III.18. The 4W winds are generally of good quality with relatively little noise. The 3W winds have considerably greater noise, which should be removed from the data before being analyzed. The category 2W winds have considerable gaps in the winds (insufficient LORAN data to establish the u and v components), although there may still be useful winds over portions of the sounding. The category 1W winds have very little useful wind data. The table at the bottom of the figure summarizes the number and percentage of the winds in each category for each of the five sounding sites.

A technique for filtering the wind data has been built into the RSANAL software and is illustrated in Fig. III.19. The top portion of the figure shows a wind profile for one of the Hudson soundings on 22 July 1987. The u component of the wind from this sounding is plotted as a function of altitude in the bottom panel. It shows varying degrees of noise, particularly in the range of 4 to 7 km. To the right of the unfiltered trace, the filtered wind is shown, displaced 10 m s^{-1}. The analyst has the ability to control the degree to which the data is filtered.



	DVR		GDN		HUD		BYR		ELZ		Total	
4W	49	38%	34	50%	46	61%	42	57%	5	8%	176	43%
3W	30	23%	22	32%	12	16%	11	15%	3	5%	78	19%
2W	46	36%	8	12%	14	19%	20	27%	19	31%	107	26%
1W	3	2%	4	6%	3	4%	1	1%	34	56%	45	11%
	128		68		75		74		61		406	

Figure III.18. Examples of CLASS winds showing the 1W, 2W, 3W, and 4W classifications.

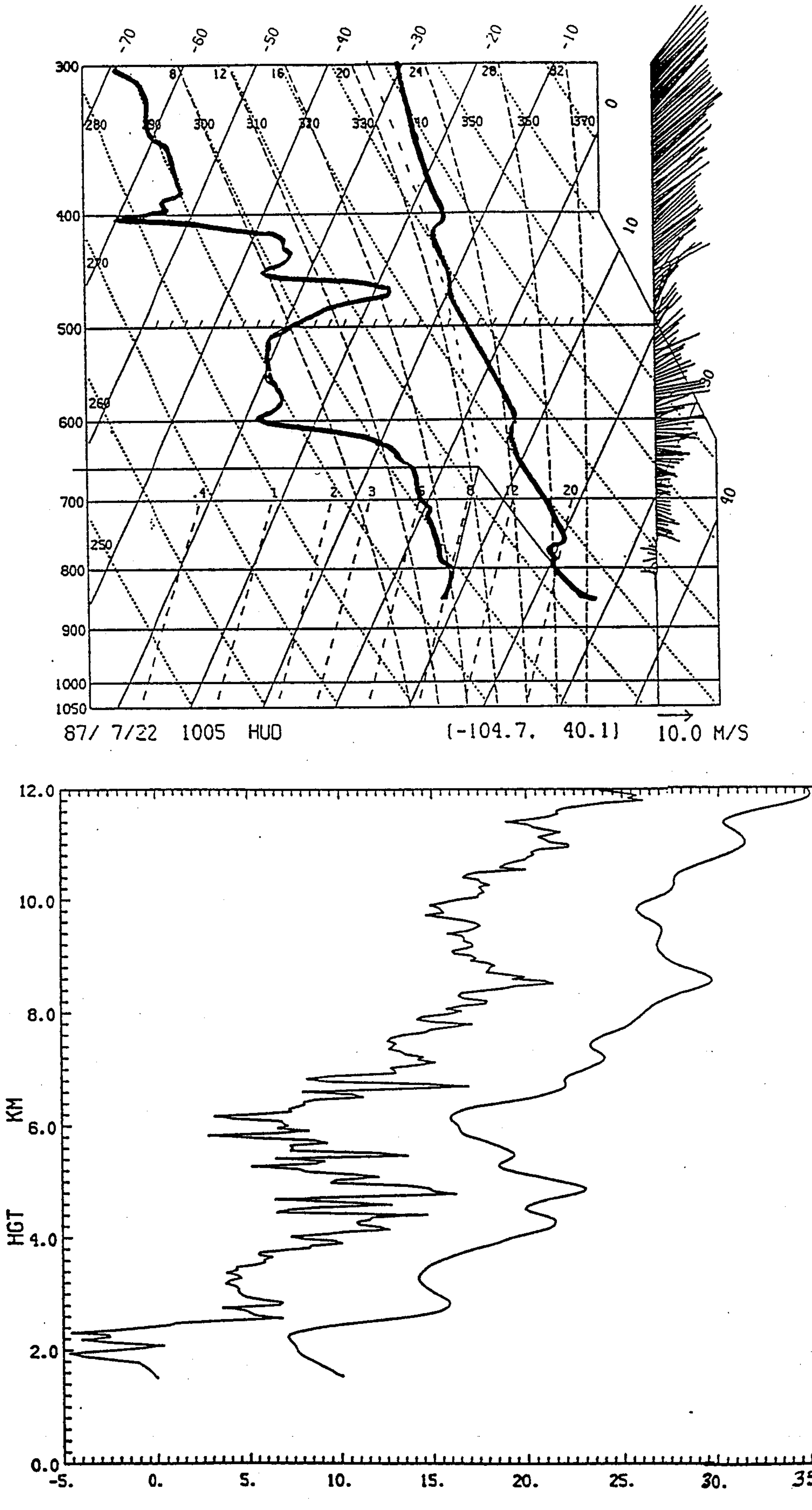


Figure III.19. Illustration of wind filtering capability included in the RSANAL package.

b. *CLASS Surface and Low Level Thermodynamic Data*

The CLASS surface measurement of temperature and relative humidity was obtained from instruments that were not properly ventilated. As a result, the surface data often disagrees with the sounding data obtained just above the surface. This is illustrated in Fig. III.20 for a Golden sounding taken on 27 July. A second factor that complicates this problem is the fact that the CLASS sondes are released from within a trailer, which is often air-conditioned on hot summer days. Since the temperature data are averaged over a 20 sec period, the first level or two after release are contaminated by this somewhat cooler air in the trailer. This artifact in the data can be seen in the Golden sounding for approximately 5 to 10 mb above the surface. Correction of these two problems is left to the discretion of the analyst. Mesonet data from nearby PAM stations may be useful in adjusting the data.

c. *CLASS Relative Humidity Problem*

A few of the CLASS soundings (most notably those taken at the BYERS site) show unusual dewpoint traces when plotted on a thermodynamic diagram. As shown in Fig. III.21, these traces are characterized by layers of unrealistically dry air and mixing ratios that increase with height in a well mixed boundary layer. We believe that the problem can be traced to preflight calibration activities, when the BYERS crew improperly calibrated the relative humidity sensor prior to launch. Unfortunately, no station log was maintained so there is no record of these activities. In general, no calibration adjustment for the humidity sensor was necessary. However, if a humidity offset was entered, it would affect all humidities equally, i.e., a correction in humidity of 10% would offset all humidities by the same amount. In the example shown, an increase in RH of 7–8% would increase the mixing ratio in the boundary layer to a value of about 2 g/kg, which is very realistic based on nearby soundings taken on this day. Therefore, the solution for the BYERS humidity problem is based on a judgment of what the boundary layer humidity profile should look like on a given day. This judgment can be obtained from aircraft, mesonet, or other CINDE soundings. A humidity offset can then be added to

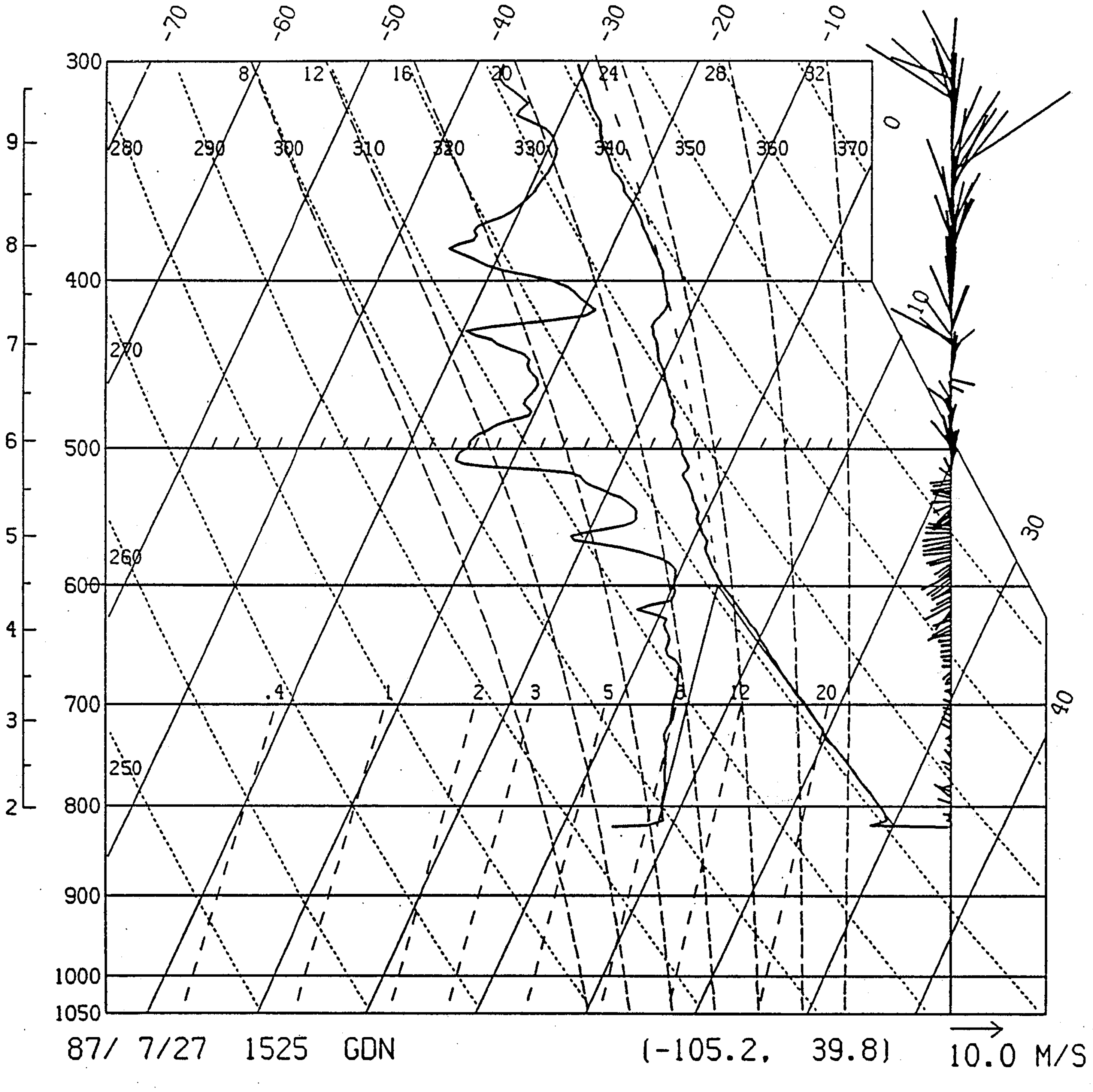


Figure III.20. Illustration of CLASS surface and low–level temperature and relative humidity errors.

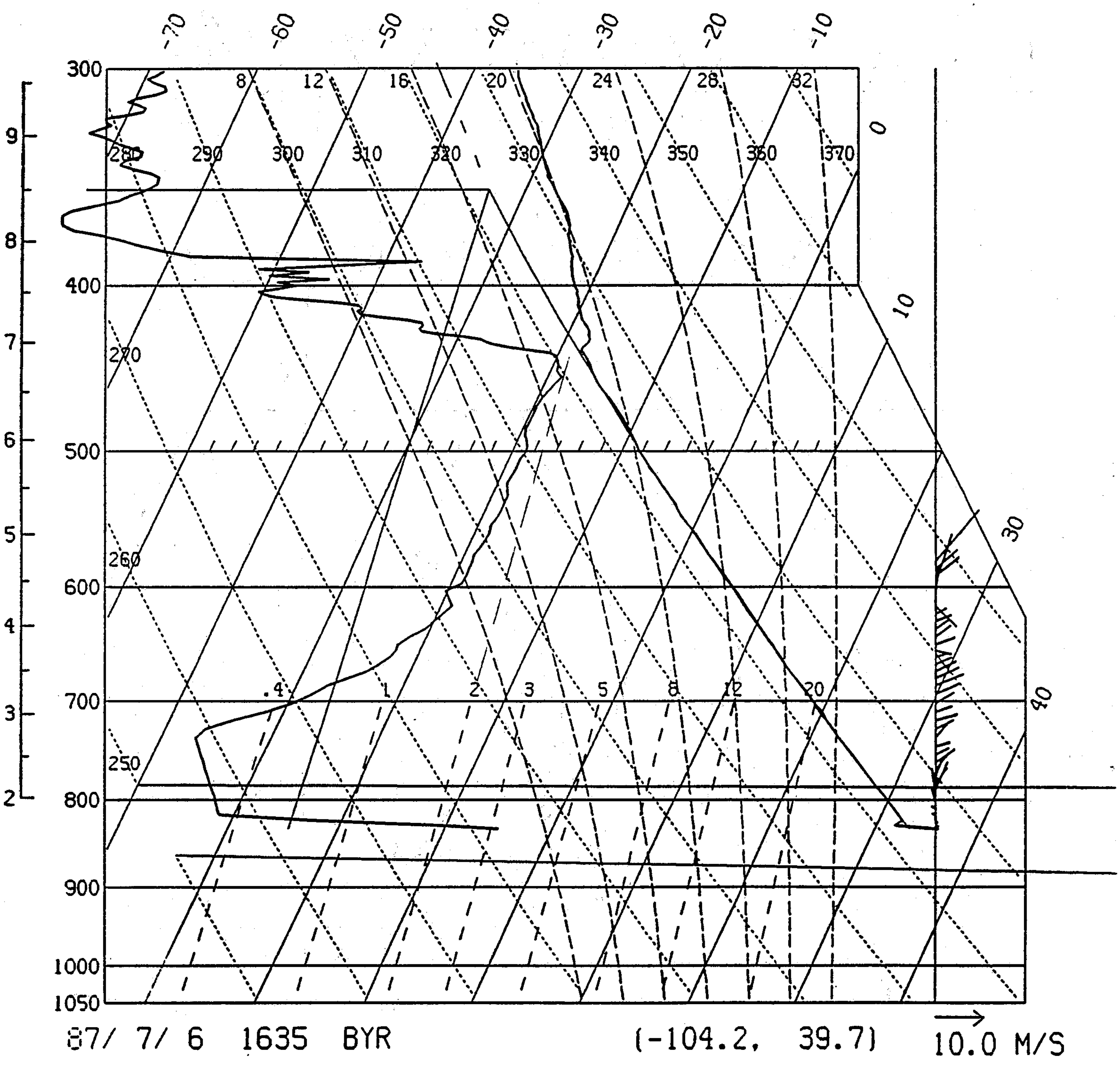


Figure III.21. Byers CLASS sounding showing an apparent error in the dewpoint trace.

all humidities for the sounding until the proper humidity profile is obtained. While this procedure is tedious, it may help to salvage what would otherwise be useless humidity data.

d. *Humidity Problem for the Mobile Sounders*

The mobile sounders also experienced a relative humidity problem that is tied to the VIZ Acculoc carbon hygristor elements used. The sounding shown in Fig. III.22 illustrates the nature of the problem. The temperature trace shows a well mixed boundary layer that extends up to near 490 mb, and the light winds (plotted on the right hand side of the figure) suggest that there is relatively little horizontal advection occuring. The dewpoint trace, however, shows considerable variation in mixing ratio in this layer. If we assume that the mixing ratio should be nearly constant throughout this region (approximately 3.6 g/kg based on its value for the layer between 40 and 65%), then the humidity is underestimated for the layer between 20 and 40% and overestimated for the layer below 20%. This type of behavior was observed throughout the CINDE experiment on all of the mobile soundings that were released in a warm, dry environment. We believe that the problem is tracable to the calibration curves furnished to us from the VIZ Corporation. VIZ calibrates their elements at selected intervals starting at 20% (i.e., 20, 33, 50, 70, 90 and 95%). The elements are not calibrated below 20% and the calibration curve that was furnished to us from VIZ suggests a linear extrapolation for humidities below 20% based on the calibration points above 20%. If our assumption of a nearly constant mixing ratio in the well mixed boundary layer is valid, it suggests a rather sudden change in the shape of the calibration curve for humidities below about 21%. This behavior was so consistent from one sounding to another, taken on different days, that a recalibration curve has been generated (Fig. III.23) that will allow the user to adjust the humidities below about 35% if he or she desires. The ordinate in the figure represents the current observed relative humidity and the abscissa is the estimated new or corrected humidity. The diagonal line running from lower left to upper right in the figure is the "zero error" line between the two axes and helps to illustrate the magnitude of the error between the old and new humidity calibrations. The dashed lines running parallel to this line represent the 2% error bounds for the premium Acculoc hygristor used in CINDE. It is interesting to note that the recalibration curve lies within 1% of the VIZ calibration curve at 20 and 33%. We are working with VIZ to get their impression of these results. In the meantime, users of the mobile sounding data should be aware of this potential problem in the humidity data.

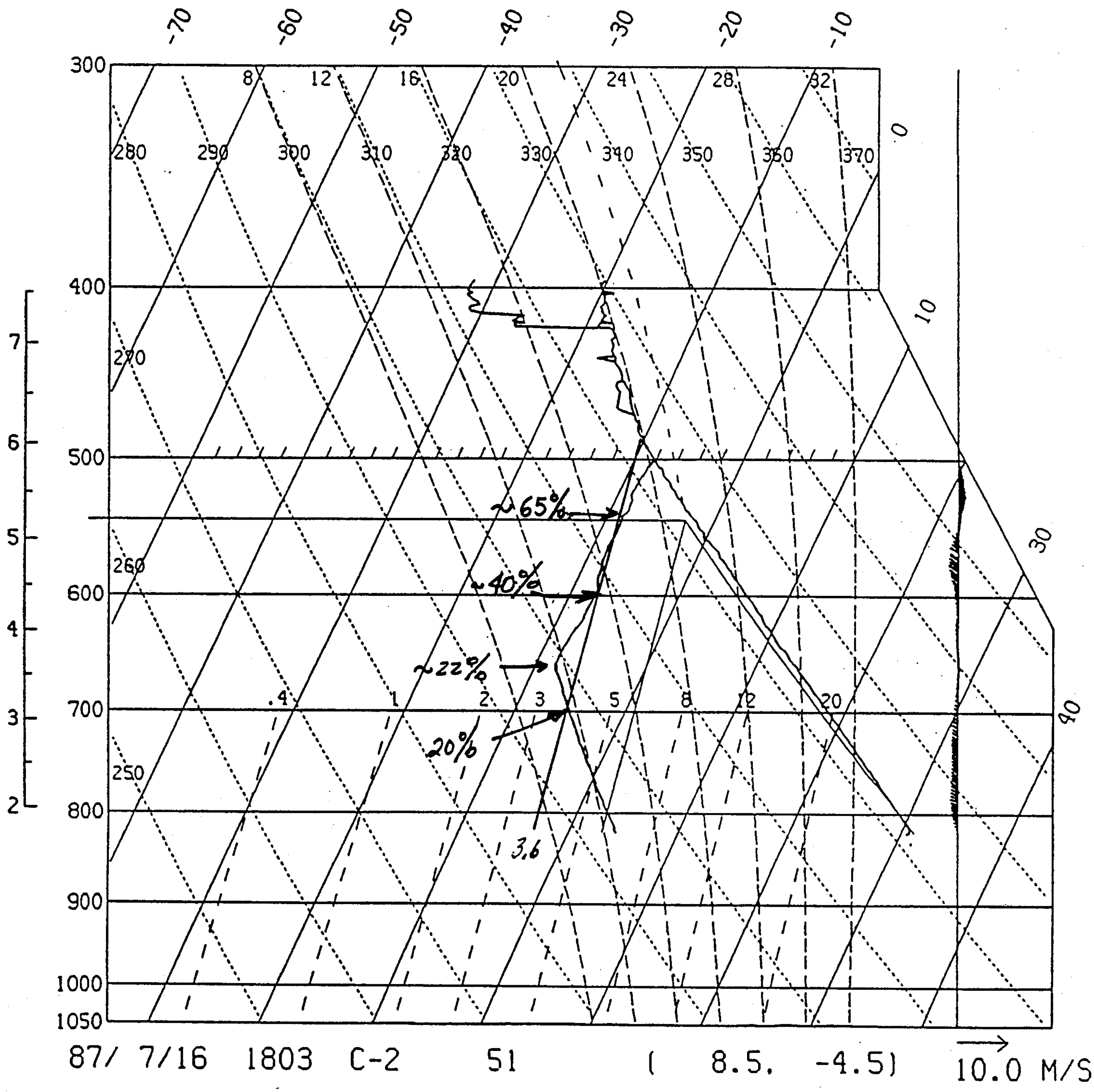


Figure III.22. Illustration of humidity problem for a mobile sounding using the VIZ carbon hygristor element.

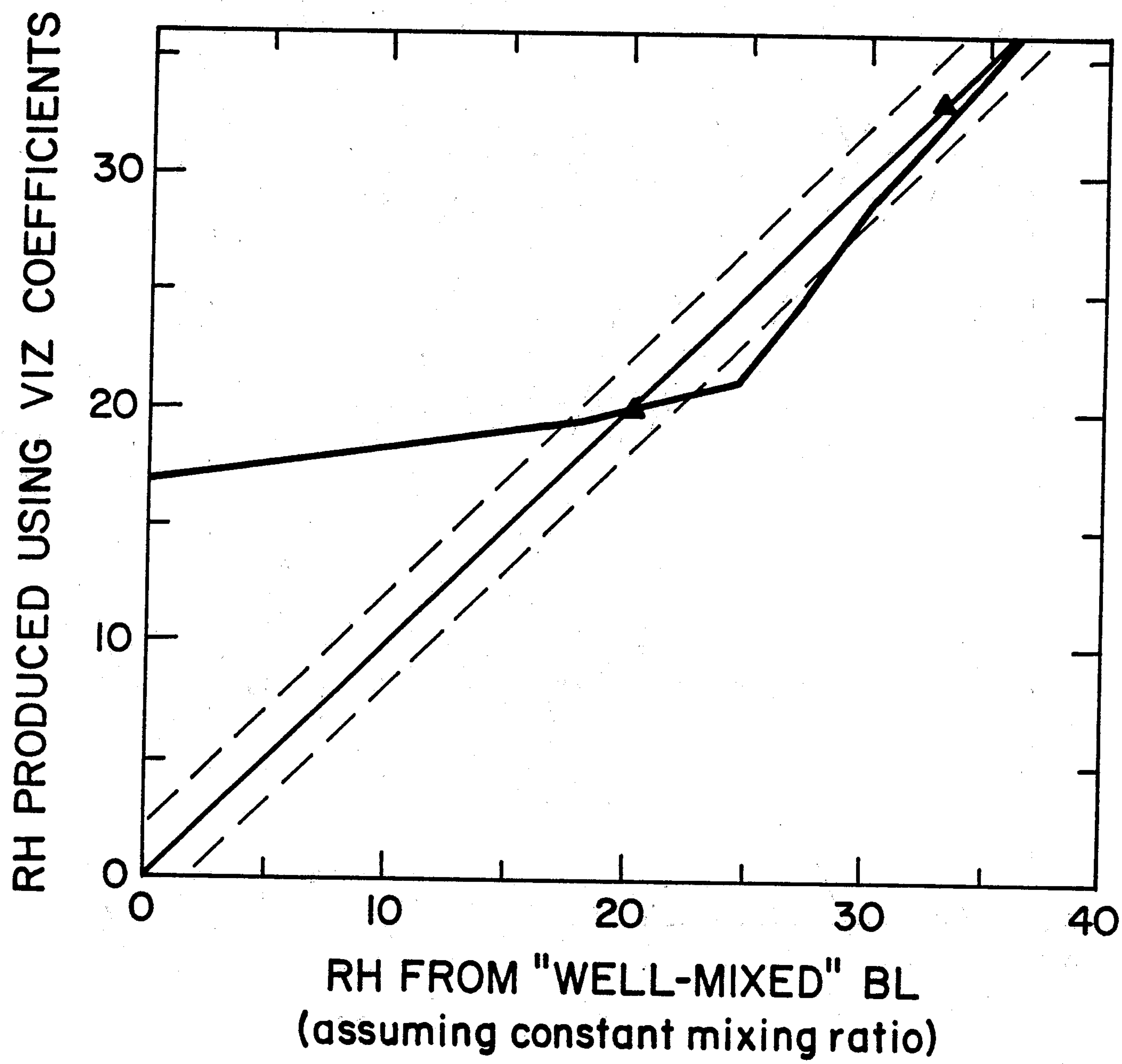


Figure III.23. Relative humidity recalibration curve for mobile soundings.

e. *Potential Wind Error Problems with the Mobile Sounders*

Winds for the mobile sounders were obtained by tracking the balloons with optical theodolites. Obtaining winds in this manner is an imprecise science. Some of the potential errors are listed below.

1) Misalignment of theodolite

2) Changing lenses

3) Mis-reading angles

4) Mis-recording angles

5) Mis-entering angles when typing

6) Error in thermodynamic calculations – so that heights are off – or "noisy" pressure sensor

7) Merging wind angles with thermodynamic data

8) Losing track when sonde passes overhead

9) Losing track near sun

10) Losing sync on sonde – beeper gets off

11) Using average $\Delta t \approx 29.0$ sec when actual varies by up to ± 1 sec – results in $\pm 3\%$ wind speed error

12) Low wind angles: resolution is currently a tenth of a degree in elevation; for angles below 20° this produces "noise" in wind speeds. Wind speed is very sensitive to small changes in elevation angle.

Clouds 1 and 2 are more likely to have errors 3–5 since they manually read, recorded and entered the wind angle data. These errors, however, generally stand out in the final wind data as sudden and short lived departures in the wind direction or speed.

It is impossible to know whether or not the theodolites were properly aligned. An error in alignment to true north will result in a constant wind direction offset. An error in leveling the theodolite will induce a variable offset in both wind speed and direction. At times the two lenses on the theodolite will get out of adjustment. Switching from the wide angle lense to the telephoto lense may cause a slight offset in wind direction and speed. Close examination of the raw azimuth and elevation angles may show this offset and may also help in correcting "estimated" angles when the sonde passed directly overhead or near the sun.

When the elevation angle of the sonde falls below about 20 degrees, the computed winds become increasingly sensitive to small changes in this angle. Smoothing these angles may help to smooth out the noise in the wind data for these cases.

Finally, wind speeds are obtained by computing the horizontal distance traversed by the sonde and dividing by the time interval between wind angle measurements. This interval is typically about 29 sec, but varies between 28 and 30 sec during the flight. To simplify the data processing, an average time interval for the flight is computed and is used in all wind speed computations. Since this value may differ from the true value by about 1 sec the computed wind speeds may be in error by up to 3% (1/30). If this type of error is significant, contact Chuck Wade for a procedure that can eliminate this problem.

4. Listing and Status of CINDE Soundings

Table D.1 summarizes all soundings taken in CINDE between 22 June and 7 August 1987. The soundings are listed by date and time, and locations are in Statute miles from CP–3. The summary is being updated daily; contact Sandra Henry (NCAR/MMM, 497–8950) for questions regarding the status of a particular sounding.

E. Photography

1. CINDE Photography

a. *System description*

Time-lapse films show evolution of convective cloud features in the network. Movie cameras were located as follows (Fig. III.24):

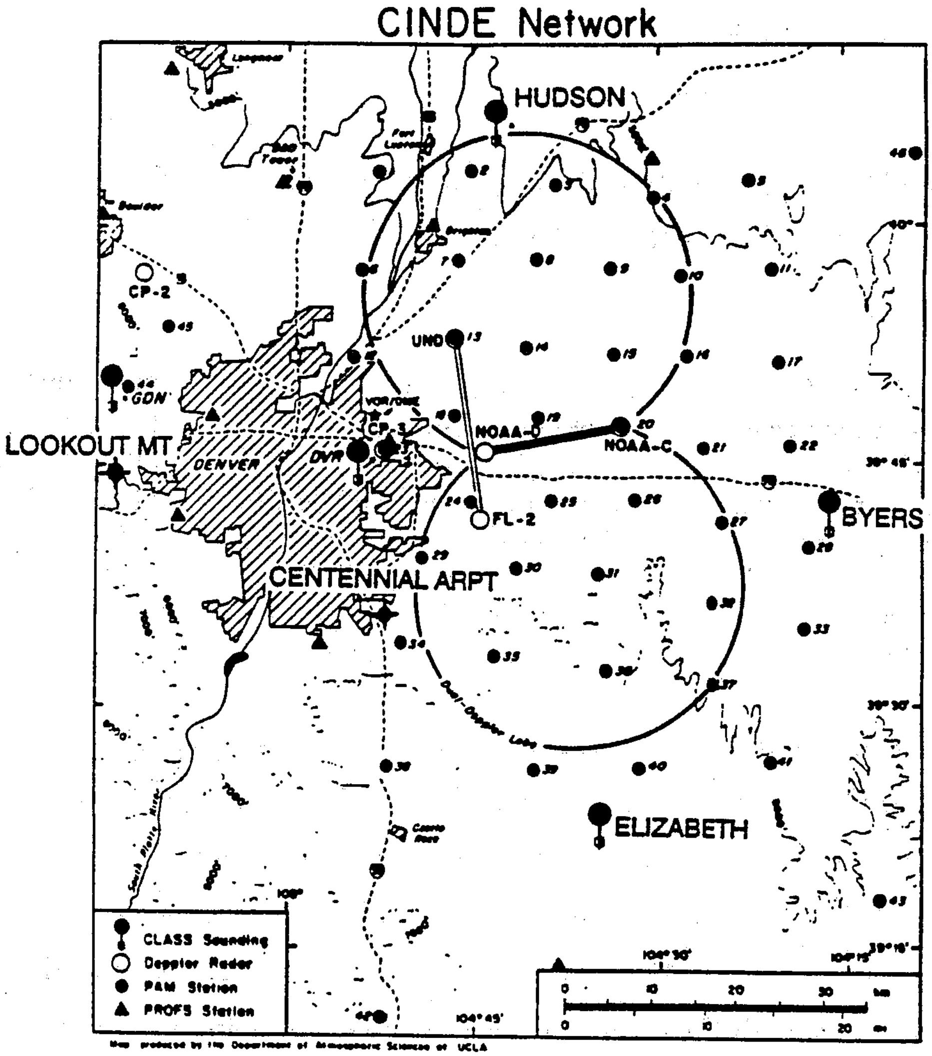
Site, film format	Scan strategy	Location (lat., long.)
Byers CLASS (Super-8)	looking westward	39°42'32" 104°14'54"
Elizabeth CLASS (Super-8)	looking northward	39°22'31" 104°33'35"
Hudson CLASS (16mm)	looking southward	40°06'32" 104°41'53"
Centennial Airport (16mm)	close-in, scanning all points	39°35'44" 104°51'13"
Lookout Mt. (Super-8)	scan all eastward directions	39°44'32" 105°14'19"
NOAA–C (Super-8, after 7/24)	close-in, scanning all directions	39°47'24" 104°32'59"
NOAA–D (Super-8, after 7/1)	close-in, scanning all directions	39°45'50" 104°43'59"
CLOUD–1, 2 (Super-8)	from sounding locations	————

Super-8 cameras were not equipped with time-imprinting devices, but operators were expected to photograph time hacks for reference. The 16mm cameras continuously photographed an analog clock. The CLASS site cameras were fixed in viewing direction as noted above. The NOAA radar cameras were usually aimed in the general direction of the radar scans. Centennial Airport and Lookout Mt. cameras were aimed toward developing cloud towers, with Centennial Airport providing close-in views and Lookout Mt. providing wide, overall views of the network.

Standard 35mm color slides were taken with cameras that had time-imprinting equipment. These were used at the continuously-manned sites, by the CLOUD vehicles, and by both King Airs:

Centennial Airport	CLOUD–1, 2
Lookout Mt.	CNDE–1, 2
NOAA–C, D	

The 35mm cameras were used during the same time periods as the time-lapse cam-



Approximate locations of stationary photography sites.

Figure III.24. Map showing the CINDE stationary photography locations.

eras. Slides were taken in the same general direction as the movie cameras in order to provide high-quality images of what was being recorded on the time-lapse films. Also, when cloud development was widespread, multi-frame semi-panoramas were taken to supplement the views from the time-lapse cameras. Most of the 35mm photography was done with moderately-wide-angle lenses. Normal and telephoto lenses were used at Lookout Mt. at times because of the distance from the network.

In order to determine the viewing azimuth angles from the photographs, 360° level panoramas were taken at each stationary site (including CLASS sites). The azimuth angles for various landmarks have been photogrammetrically determined from these panoramas. Contact Jim Wilson (NCAR/ATD, RL-3/A244, 497–8818) or Roger Wakimoto (UCLA, 213/825–1751) for information on photogrammetric panoramas of some of the mobile sounding sites.

b. *Other Sources of Photographic Data*

In addition to the CINDE/NCAR Photography database just described, there are other sources of photographic materials taken during the project. Contact the representatives below for more information, or see the appropriate section in this document.

Description	Contact
35mm slides from CP–3 radar site	Cathy Kessinger (NCAR 497–8781)
Time-lapse TDWR films from FL–2 radar site	Cathy Kessinger (NCAR 497–8781)
35mm slides from CLOUD–3 mobile sounding van	Dan Wolfe (NOAA 497–6204)
35mm slides from CNDE–3 aircraft (UND Citation)	Jeff Stith (UND 701/777–2791)
Videotape from both King Airs (forward and side-looking cameras)	Jim Fankhauser (NCAR 497–8981) or Al Rodi (UWyo 307/766–4945)
Videotape following radar dish at NOAA–C and D	Chris Mattson (NOAA 497–6238)
Videotape from PROFS Chase Teams	Jim Wilson (NCAR 497–8818)

c. *Catalog Status*

All primary time-lapse films are cataloged and appear in Tables E.1 - E.6. Slides are filed by site, date, and time but are not cataloged due to the large number of slides. In general, slides were taken during the same time periods as the time-lapse movies for a particular site. In addition, daily logs from all sites detail start-stop times, changes of viewing azimuth angles, descriptions of cloud development and severe weather phenomena, etc.

d. *Problems in the Dataset*

1) Super-8 time-marking is not continuous. Exact time must be inferred from frame counts. Some Super-8 films and Hudson's films before 7/13 have illegible time marks.

2) A few time-lapse films are unusable for quantitative analysis due to camera problems (usually, weak batteries). These films are identified in the catalog.

3) Virtually all 35mm slides have exact times imprinted. However, some of the slides taken by mobile sounding personnel lack adequate photo-documentation of date and site.

4) No CNDE-1 slides after 7/9. CNDE-2 slides from 7/2 to 7/9 are overexposed but still usable for some purposes.

5) NOAA-C slides before 7/2 are missing time imprints, but approximate time of exposure can be estimated.

6) While Lookout Mt. provides good views of the overall development of clouds over the network, this site's distance from the network means that images are often degraded by atmospheric haze.

7) Preliminary analysis on films and slides show that projection of the originals should be avoided whenever possible. Original time-lapse films should be viewed

with editors, and original slides should be viewed on light boxes. There may be some delay before users are allowed to view certain materials because they must be duplicated first.

e. *Accessing the Photographic Database*

1) The restrictions on availability and use of photographic data are intended to prevent deterioration and loss of the original images without having to unnecessarily duplicate the entire set. Thus, for example, projection of movie films is discouraged.

2) Requests to view CINDE photographic materials should be made to Charlie Knight (NCAR/MMM, RL-6/E121, 497–8940). *It is expected that users will view the materials in RL-6; if materials are needed for long periods of time or for analysis, the requesters should make duplicates or prints for themselves.*

3) Requesters are responsible for all reproduction costs. Reproduction orders must be sent to Charlie Knight or Fran Huth (NCAR/MMM, RL-6/E141, 497–8931) so that the location of originals can be traced. Some special services (such as B/W or color internegatives/prints, contact sheets, Super-8-to-16mm transfers) may be planned or have already been performed for analysis purposes; inquire for availability.

4) Some materials will be unavailable at times because they are out for duplication. Please call first to establish availability.

5) Off-site users will have to make special arrangements to use the materials, since shipping of originals will be avoided as much as possible.

f. *Using Super-8 and 16mm Time-Lapse Films*

1) Local users may view films with our Super-8 and 16mm editors in RL-6. Projection of original films is discouraged in order to prevent dye fading and physical damage. If demand for certain films is high enough, we may temporarily hold all requests and make duplicates for viewing.

2) Individual frames can be enlarged to 35mm format (B/W internegatives only; availability of color depends on the number of requests) and/or printed; inquire. Certain frames will have been enlarged and time-imprinted for analysis purposes; inquire for availability of duplicates.

3) Continuous time-marking is not available. If you need specific times or timing information, ask for assistance.

g. *Using 35mm Slides*

1) Slides are filed by site, date, and time in file pages, so requests for specific sets are easy to fill. Slide pages are also boxed by site for portability. A light table for viewing slides is available in the Mesoscale Data Analysis Room (RL-6/C138).

2) Projection of original slides for very short periods of time may be approved on an individual basis. Kodachrome dyes may fade significantly after only $1\frac{1}{2}$ hours of cumulative projection time!

3) Black and white internegatives and prints of certain slides may have been made for analysis purposes; inquire for availability of duplicates.

4) Requests to use NOAA-C slides for 6/22–7/2, 7/9, 7/17, and 8/4 should be made to Roger Wakimoto (Dept. of Atmospheric Sciences, Univ. of California, Los Angeles CA 90024; 213/825–1751). Requests to use *original* CNDE-2 (Wyoming King Air) slides should be made to Al Rodi (Dept. of Atmospheric

Science, Univ. of Wyoming, Laramie WY 82071; 307/766–4945). A duplicate set of the CNDE-2 slides is available for viewing at NCAR/MMM.

h. *Time-Lapse Film Catalog*

Tables E.1-E.6 contain a list of all primary time-lapse films with dates and start-stop times. Notations after times denote problems with the film for that particular time period: "batt."=weak batteries caused intermittent shutter problems, thus timing is non-uniform; "dbl"=film is double-framed, so frame counts must be halved to get correct timing; "intv"=unknown frame interval or non-uniform frame interval used; "timing"=problem with timing, possibly due to non-uniform frame interval or incorrect time hacks.

2. TDWR Photography

a. *System Description*

Cloud photography was accomplished at the FL–2 radar site using a 16 mm time-lapse movie camera and a 35 mm still camera with a zoom lens. The movie camera was run with commercial or generator power and had a clock placed on a boom such that it was photographed in each frame. The still camera imprinted time (hours, minutes, seconds) on the slide film. A second 35 mm camera (personal camera of Cathy Kessinger) put the day, hours and minutes on the slide film (no seconds). The second camera roamed between radar sites with its owner.

Two filming sites were used at FL–2 due to viewing blockage caused by equipment locations. Figure III.25 shows the approximate layout of the FL–2 site with the western and eastern filming sites noted. The movie camera was placed at the site appropriate for the cloud location. Using a theodolite, colored poles were placed in a circle around the filming site at 15° intervals. These positions should be considered only approximate since photogrammatic analysis requires better accuracy. Poles at 0°, 90°, 180°, and 270° are white with red stripes. Poles at 45°, 135°, 225°, and 315°are red with blue stripes.

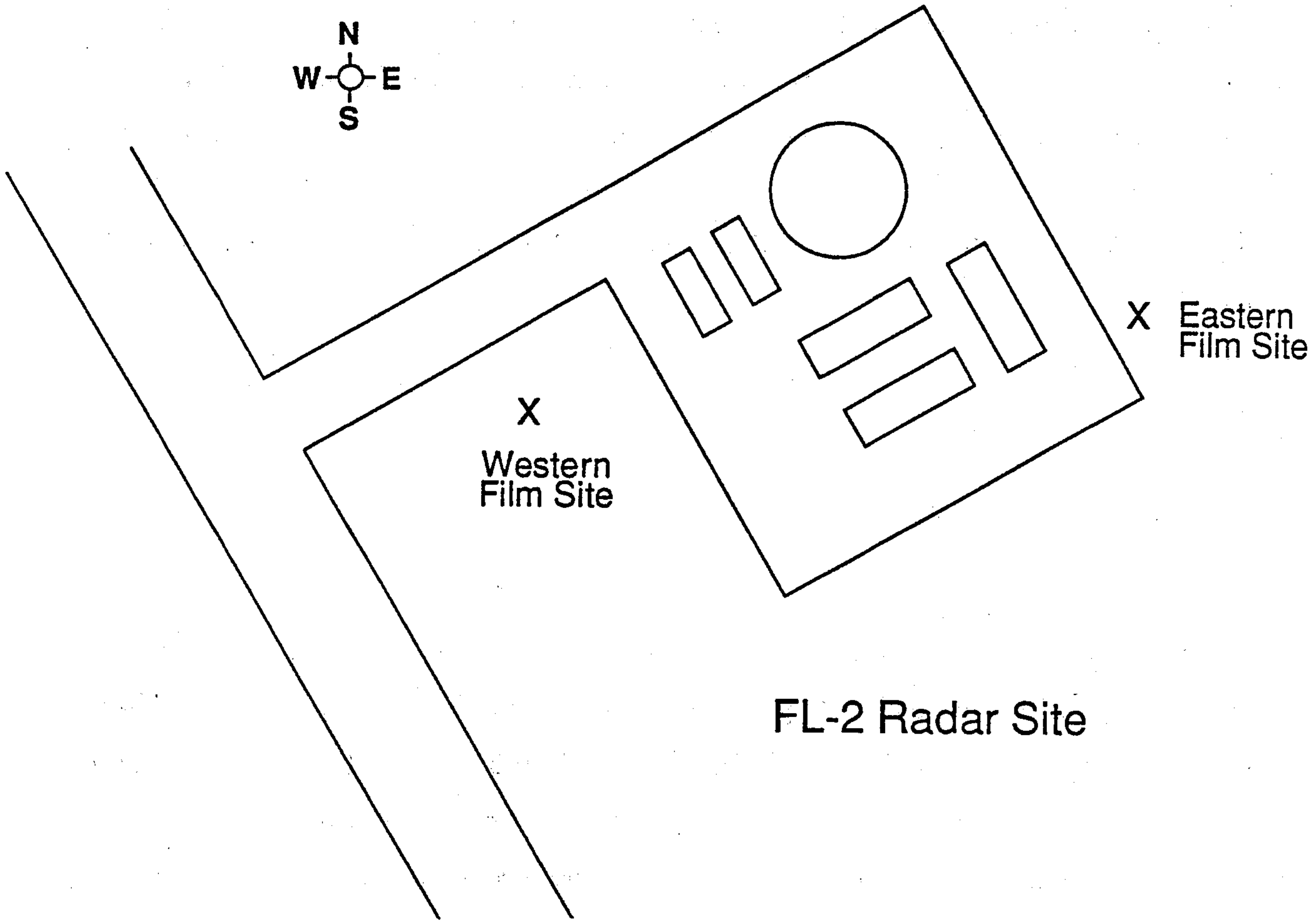


Figure III.25. Map showing the eastern and western TDWR photographic sites and FL-2 (not to scale).

Poles at intermediate locations are solid red on the southern quadrant and solid blue on the northern quadrant.

b. *Data Description*

The movie camera was pointed at an area of interest that the radar was scanning. Different frame rates were used depending on conditions. During active conditions, a rate of 1 frame/5 seconds was used, and at other times, a rate of 1 frame/20–60 sec was used. A catalog of dates and start/stop times is contained in Table E.7. A limited number of still photographs were taken as opportunity allowed and not in any systematic manner. The locations of the still cameras are noted in Table E.7. In general, the slides were taken within the same time interval as the movie cameras. Catalogs of the slides are available.

Tungsten negative film was used in the movie camera. The negative is kept on file. To obtain a copy of a movie, the negative must be printed. Both Kodachrome and Ektachrome films were used in the still cameras.

c. *Problems with the Data*

Problems with the movies are mainly exposure (both over and under) since the camera aperature had to be adjusted manually. Earlier movies are particularly bad due to inexperience. Occasionally, slides do not have time imprinted on them.

d. *Data Acquisition*

The TDWR movie films, slides and slide logs are maintained by Cathy Kessinger (NCAR/ATD/RAP, P.O. Box 3000, Boulder, CO, 80307, 497–8781). For local viewing, slides and movies may be checked out. However, if they are needed for a considerable length of time, it is preferable that duplicates be made. Reproductions can be obtained, with the requester assuming all costs.

F. PROFS Datasets

1. General Information

For the summer of 1987, including the entire CINDE operational time, all data sets that PROFS received were saved on tape. The data are available to users by basically three methods. The user can request copies of the data, and PROFS will make copies on user-supplied tapes of the raw data. PROFS can also supply hard copies of certain data, i.e. SAO, mesonet, or profiler data. Alternatively, one can look at the data on the PROFS systems (RL-3, 2nd floor, either the SERS system [like the system in the CINDE Operations Center] or the DAR^3E system [a more complete system than was in the CINDE Operations Center]). In order to examine a case, one needs to first speak to PROFS regarding the data wanted. PROFS operators will then create a disc pack containing the data, which can then be viewed on the PROFS systems. The PROFS systems are excellent for quickly viewing lots of data and data of different types, as well as being able to loop the images. In addition, there are a number of application programs that can be used (different analyses, for example). The process of creating the data pack can take more than a week, because the packs can only be created off-hours. The contact with PROFS should be through Ken Heideman (497-6618).

2. Data Descriptions

Types of data available from PROFS include:

- Satellite data; IR, Visible, Water vapor imagery (6.7 μ, precipitable water, low-level, and derived bouyancy). Scales include Northern Hemisphere (NH), North America (NA), Regional (R), State (S), and Local (L) (the size of the PROFS mesonet), on .5 to 2 mile resolution. Images are available every 30 minutes, except every one hour for NA scale, and every three hours for NH scale.

- Radar data; CP-2 reflectivity and velocity data at 0.2°, 0.7°, and 3.7°, on the L and S scale, and 0.2° on the R scale. While this is not nearly the amount of data available by using the NCAR RDSS system, there is the advantage of easy looping and very rapid perusal. Data from the Weather Service radars at Limon, Colorado and Cheyenne, Wyoming are also available: one low-level scan every five minutes.

- Surface observations; PROFS mesonet data every five min, SAO data every hour with plots on S and R scale.

- Profiler data; time series of one-hour averaged profiler winds from Denver/Stapleton, Platteville, Fleming, and Flagler, Colorado. Radiometric data from Denver/Stapleton.

- Sounding data; any sounding from the U.S. can be plotted, as well as the CLASS soundings. A sounding applications program is available to perform parcel calculations.

- Upper-level synoptic data are available, as well as an analysis of numerous fields using the PROFS/MAPS programs.

- Numerical model data from the NGM, LFM, MRF and "Spectral" models. NGM output is available as analysis of the grid point data, and thus output of a number of fields not normally seen, and at 6-hour intervals, is possible.

G. Instrumented Towers

1. BAO Tower

The Boulder Atmospheric Observatory (BAO) is a NOAA research facility designed for continuous measurements of the planetary boundary layer. Its location is shown in Fig. I.1 and listed in Table A.5. The focal point of the BAO facility is a 300 m tower instrumented with eight levels of both fast and slow response sensors that provide turbulent moment and mean quantity measurements. These sensors consist of:

sensors	measured variables
prop-vane anemometers	u, v
sonic anemometers	u, v, w
platinum wire (fast response) thermometer	T'
quartz crystal (slow response) thermometer	T
dew point hygrometers	T_d

In addition to the tower, the BAO also operates supporting instrumentation consisting of:

sensor	measured variables
monostatic sodar	back scattered power (fascimile records)
optical triangle	u, v, convergence
pyranometer	solar radiation
microbarograph array	perturbation pressure

The data from these sensors are measured and recorded continuously, both day and night. The times during which the BAO was recording data during CINDE are listed in Table III.26, where hour of the day is given in Mountain Standard Time (MST); a 1 means data was recorded, a zero means no data was recorded.

Data from the BAO are archived on tape in three different modes: 20 min mean values (also available in hard copy form); 10 sec average values; and once per 100s grab samples of very high frequency data. Extensive computer programs exist for accessing, processing and plotting these data.

Additional information on the BAO can be found in: "The Boulder Atmospheric Observatory", *Journal of Applied Meteorology*, Vol. 22, No. 5, May 1983, pp. 864-880, by J. C. Kaimal and J. E. Gaynor. Data from the BAO can be obtained by contacting:

Jim Wilczak
Wave Propagation Laboratory
325 Broadway
Boulder, CO 80303
303/497-6245

Table III.26. BAO Tower Data Catalog during CINDE

ARCHIVED DATA SINCE 870622., OF KIND A 04-NOV-87 07:54

DATE	HOUR 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
870622.	000	000	000	000	000	000	111	111	111	111	111	111	111	111	110	111	111	111	111	111	111	111	111	111
870623.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870624.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870625.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870626.	111	111	111	111	111	111	111	111	110	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870627.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870628.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	000	000	000	000
870629.	000	000	000	000	000	000	111	100	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870630.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870701.	111	111	111	111	111	111	111	111	111	111	111	110	011	111	111	111	111	111	111	111	111	111	111	111
870702.	111	111	111	111	111	111	110	111	111	111	111	100	000	000	011	111	111	111	111	111	111	111	111	111
870703.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870704.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870705.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870706.	111	111	111	111	111	111	111	111	111	000	000	000	000	110	001	111	111	111	111	111	111	111	111	111
870707.	111	111	111	111	111	111	111	111	100	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
870708.	000	000	000	000	000	000	011	111	000	000	000	000	111	111	111	001	111	111	111	111	111	111	111	111
870709.	111	111	111	111	111	111	111	111	000	011	111	111	111	000	011	111	111	111	111	111	111	111	111	111
870710.	111	111	111	111	111	110	110	001	111	111	111	111	111	111	001	111	111	111	111	111	111	111	111	111
870711.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870712.	111	111	111	111	111	111	111	100	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000	000
870713.	000	000	000	000	000	000	110	111	100	000	000	000	000	000	011	111	111	111	111	111	111	111	111	111
870714.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870715.	111	111	111	000	000	000	011	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870716.	111	111	111	111	111	111	100	010	000	000	011	111	111	000	001	111	111	111	111	111	111	111	111	111
870717.	111	100	000	000	000	000	110	000	000	000	000	000	011	111	111	111	111	111	111	111	111	111	111	111
870718.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870719.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870720.	111	111	111	111	111	110	011	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870721.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870722.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870723.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	011	111	111	111	111	111	111	111	111	111
870724.	111	111	111	111	111	111	111	111	111	111	111	111	011	111	111	110	000	000	000	000	000	000	000	000
870727.	000	000	000	000	000	000	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870728.	111	111	111	111	111	101	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870729.	111	111	111	111	111	110	111	111	111	110	111	111	111	111	111	111	111	000	000	000	000	000	000	000
870730.	000	000	000	000	000	001	111	100	000	011	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870731.	111	111	111	111	111	111	111	111	111	111	111	111	111	110	111	111	111	111	100	000	000	000	000	000
870803.	000	000	000	000	000	000	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870804.	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870805.	111	111	111	111	111	111	111	111	111	111	111	111	111	011	111	100	011	111	111	111	111	011	111	111
870806.	111	111	111	111	111	110	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
870807.	111	111	111	111	111	111	111	111	111	111	111	111	101	111	111	111	111	111	111	111	111	111	111	111

Table III.27. SERI Tower Data

Ht(m)	wind speed	wind direction	wind σ	max gust	temp	dew point	pressure
5	x	x	x	x	x	x	x
10	x	x	x	x			
20	x	x	x	x			
50	x	x	x	x			
50m–5m windspeed and temperature difference							

2. SERI Tower

Data from the Solar Energy Research Institute (SERI) wind energy research program tower (location given in Table A.5) has been made available to CINDE for the period 14 June to 14 August 1987. Data were collected at four heights at 2 minute intervals. Data available are shown in Table III.27. These data are available on one 6250 BPI tape in an easy-to-read ASCII format. The data will also be converted to Common Mesonet Format (CMF) so that it can be input into ROBOT and made available through CINDE.

3. Rocky Flats Towers

Two 10 m towers operated at Rocky Flats during July and August. The data will be made available to CINDE users. No documentation is available at press time. Contact Cathy Kessinger (497-8781) to obtain data.

Appendix A. Latitude and Longitude of CINDE Facilities.

Table A.1. Radar Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation of feed/beam (m)	CP–3 as Origin X (km)	CP–3 as Origin Y (km)	FL–2 as Origin X (km)	FL–2 as Origin Y (km)
NOAA C	39°47’22”	–104°33’02”	1676	27.6	2.5	16.6	10.4
NOAA D	39°45’50”	–104°43’58”	1665	12.0	–0.2	1.0	7.7
CP–3	39°45’53”	–104°52’23”	1620	0.0	0.0	–10.9	7.9
FL–2	39°41’41”	–104°44’39”	1725	11.0	–7.9	0.0	0.0
UND	39°52’38”	–104°45’47”	1604	9.5	12.4	–1.4	20.3
CP–2	39°57’00”	–105°11’41”	1750	–27.2	20.9	–38.2	28.8
FAA Parker	39°35’40”	–104°41’34”		15.3	–19.1	4.3	–11.2
STP VORTAC	39°48’00”	–104°53’12”		–1.1	3.9	–12.1	11.8

Table A.2. PAM Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation (m)	CP-3 as Origin X (km)	CP-3 as Origin Y (km)	FL-2 as Origin X (km)	FL-2 as Origin Y (km)
1	40°03'33"	−104°52'41"	1555	−0.1	32.7	−11.1	40.6
2	40°03'28"	−104°45'05"	1582	10.7	32.5	−0.3	40.4
3	40°02'40"	−104°38'08"	1551	20.5	30.9	9.6	38.8
4	40°01'55"	−104°28'51"	1509	33.7	29.5	22.7	37.3
5	40°03'06"	−104°22'39"	1499	42.5	31.6	31.5	39.5
6	39°57'01"	−104°54'05"	1612	−2.2	20.7	−13.2	28.5
7	39°57'53"	−104°46'05"	1564	9.2	22.2	−1.8	30.0
8	39°57'45"	−104°39'36"	1600	18.4	21.8	7.4	29.7
9	39°56'55"	−104°35'10"	1588	24.7	20.2	13.7	28.1
10	39°56'55"	−104°28'10"	1551	34.6	20.2	23.7	28.1
11	39°56'55"	−104°20'50"	1558	45.0	20.1	34.1	28.0
12	39°51'49"	−104°54'35"	1555	−3.0	11.0	−14.0	19.0
13	39°52'41"	−104°46'31"	1600	8.5	12.5	−2.5	20.4
14	39°52'20"	−104°40'28"	1641	17.1	11.8	6.1	19.7
15	39°52'00"	−104°33'30"	1644	27.0	11.1	16.0	19.0
16	39°51'20"	−104°27'39"	1602	35.3	10.4	24.3	17.7
17	39°51'20"	−104°20'11"	1586	45.9	9.8	35.0	17.7
18	39°48'07"	−104°46'25"	1631	8.5	4.1	−2.4	11.9
19	39°47'55"	−104°39'25"	1667	18.5	3.6	7.5	11.5
20	39°47'25"	−104°33'16"	1673	27.2	2.6	15.9	10.5
21	39°46'04"	−104°26'30"	1667	36.9	0.1	25.9	8.0
22	39°46'05"	−104°19'16"	1623	47.2	0.1	36.2	7.9
23	39°45'45"	−104°52'09"	1617	0.3	−0.3	−10.6	7.6

Table A.2, continued. PAM Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation (m)	CP–3 as Origin X (km)	CP–3 as Origin Y (km)	FL–2 as Origin X (km)	FL–2 as Origin Y (km)
24	39°42'55"	–104°44'57"	1699	10.5	–5.6	–0.4	2.3
25	39°42'36"	–104°38'31"	1744	19.7	–6.3	8.6	1.6
26	39°42'38"	–104°31'45"	1728	29.4	–6.3	18.4	1.6
27	39°41'32"	–104°24'52"	1731	39.2	–8.3	28.2	–0.5
28	39°39'50"	–104°17'42"	1710	49.4	–11.5	38.4	–3.7
29	39°39'25"	–104°49'20"	1740	4.2	–12.0	–6.7	–4.1
30	39°38'29"	–104°41'19"	1783	15.7	–13.8	4.7	–6.0
31	39°38'08"	–104°34'52"	1830	24.9	–14.6	13.9	–6.7
32	39°36'28"	–104°25'31"	1774	38.2	–17.7	27.3	–9.8
33	39°34'47"	–104°18'16"	1742	48.5	–20.9	37.5	–13.0
34	39°33'35"	–104°50'53"	1791	1.9	–22.8	–9.0	–14.9
35	39°33'09"	–104°43'08"	1890	13.0	–23.7	2.0	–15.8
36	39°32'19"	–104°34'09"	1922	25.8	–25.3	14.9	–17.5
37	39°31'13"	–104°25'29"	1841	38.2	–27.5	27.3	–19.6
38	39°26'21"	–104°52'06"	2018	0.1	–36.2	–10.9	–28.3
39	39°26'14"	–104°40'04"	2025	17.3	–36.6	6.3	–28.7
40	39°26'03"	–104°31'04"	1975	30.1	–37.0	19.2	–29.1
41	39°26'41"	–104°21'00"	1852	44.6	–35.9	33.6	–28.0
42	39°10'30"	–104°52'30"	2182	–0.8	–65.6	–11.8	–57.7
43	39°18'10"	–104°12'13"	1918	57.1	–51.7	46.1	–43.8
44	39°50'10"	–105°13'15"	1818	–29.6	8.3	–40.6	16.2
45	39°53'30"	–105°09'51"	1756	–24.7	14.4	–35.6	22.3
46	40°04'25"	–104°09'33"	1491	61.1	34.0	50.1	41.9

Table A.3. PROFS Mesonet Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation (m)	CP–3 as Origin		FL–2 as Origin	
				X (km)	Y (km)	X (km)	Y (km)
Arvada	39°48'4"	–105°05'53"	1643	–19.2	4.3	–30.1	12.1
Aurora	39°46'27"	–104°52'08"	1625	0.4	–1.0	–10.6	8.9
Boulder	40°00'48"	–105°15'03"	1628	–31.9	28.0	–42.8	35.9
Briggsdale	40°38'	–104°20'	1483	46.4	96.3	35.5	104.1
Brighton	40°00'03"	–104°48'16"	1518	6.1	26.2	–4.9	34.1
Byers	39°44'28"	–104°07'39"	1554	63.7	–3.0	52.8	4.9
Elbert	39°13'55"	–104°38'06"	2146	19.9	–59.4	9.0	–51.5
Erie	40°02'	–105°00'	1584	–10.6	30.0	–21.5	37.9
Estes Park	40°22'00"	–105°33'38"	2377	–57.6	67.7	–68.5	75.6
Fort Collins	40°35'18"	–105°08'48"	1609	–22.2	91.8	–33.2	99.7
Fort Morgan	40°19'42"	–103°48'10"	1387	91.3	62.3	80.4	70.2
Greeley	40°25'25"	–104°38'38"	1414	20.1	73.1	9.2	81.0
Idaho Springs	39°40'43"	–105°29'35"	3505	–53.1	–8.9	–64.1	–1.0
Keensburg	40°04'09"	–104°30'32"	1521	31.3	33.6	20.3	41.5
Lakewood	39°41'50"	–105°08'43"	1832	–23.4	–7.2	–34.3	0.6
Littleton	39°34'08"	–104°57'21"	1750	–7.3	–21.7	–18.3	–13.8
Longmont	40°09'53"	–105°09'22"	1533	–23.6	44.7	–34.6	52.6
Loveland	40°24'35"	–105°02'18"	1483	–13.3	71.9	–24.2	79.7
Nunn	40°48'15"	–104°45'21"	1634	11.0	115.5	0.0	123.4
Platteville	40°15'34"	–104°52'07"	1457	–83.9	56.3	–10.0	62.9
Rollingsville	39°54'35"	–105°29'25"	2749	–52.5	16.8	–63.4	24.7
Ward	40°02'07"	–105°32'30"	3048	–56.6	30.8	–67.6	38.7

Table A.4. FLOWS Mesonet Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation (m)	CP-3 as Origin X (km)	CP-3 as Origin Y (km)	FL-2 as Origin X (km)	FL-2 as Origin Y (km)
1	39°51'02"	-104°53'38"	1564	-1.7	9.6	-12.6	17.4
2	39°51'03"	-104°52'15"	1577	0.3	9.6	-10.7	17.5
3	39°50'57"	-104°50'43"	1595	2.5	9.4	-8.5	17.2
4	39°51'03"	-104°49'16"	1588	4.5	9.5	-6.4	17.4
5	39°50'11"	-104°54'00"	1580	-2.2	8.0	-13.2	15.9
6	39°50'08"	-104°52'10"	1588	0.4	7.9	-10.6	15.8
7	39°50'08"	-104°51'10"	1585	1.8	7.9	-9.1	15.7
8	39°49'52"	-104°49'17"	1595	4.5	7.3	-6.5	15.2
9	39°49'02"	-104°53'39"	1580	-1.7	5.9	-12.7	13.7
10	39°49'05"	-104°50'49"	1594	2.3	5.9	-8.7	13.8
11	39°49'04"	-104°49'12"	1602	4.6	5.9	-6.4	13.7
12	39°48'32"	-104°52'09"	1594	0.4	4.9	-10.6	12.8
13	39°48'15"	-104°54'58"	1579	-3.6	4.4	-14.6	12.3
14	39°47'58"	-104°53'25"	1591	-1.4	3.9	-12.4	11.8
15	39°48'01"	-104°50'39"	1607	2.5	3.9	-8.4	11.8
16	39°48'15"	-104°49'07"	1612	4.7	4.3	-6.3	12.2
17	39°47'30"	-104°52'11"	1606	0.3	3.0	-10.6	10.9
18	39°46'44"	-104°53'21"	1600	-1.4	1.6	-12.3	9.5
19	39°46'40"	-104°50'38"	1626	2.5	1.4	-8.4	9.3
20	39°46'51"	-104°49'08"	1632	4.6	1.7	-6.3	9.6

Table A.4, continued. FLOWS Mesonet Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation (m)	CP–3 as Origin X (km)	CP–3 as Origin Y (km)	FL–2 as Origin X (km)	FL–2 as Origin Y (km)
21	39°45'14"	–104°53'17"	1618	–1.3	–1.2	–12.2	6.7
22	39°45'27"	–104°49'01"	1632	4.8	–0.8	–6.2	7.0
23	39°44'44"	–104°49'40"	1638	3.8	–2.2	–7.1	5.7
24	39°43'52"	–104°53'29"	1631	–1.6	–3.7	–12.6	4.2
25	39°43'25"	–104°52'39"	1642	–0.4	–4.6	–11.4	3.3
26	39°42'48"	–104°53'28"	1646	–1.6	–5.7	–12.6	2.2
27	39°42'33"	–104°52'33"	1655	–0.3	–6.2	–11.2	1.7
28	39°42'50"	–104°51'20"	1669	1.4	–5.7	–9.5	2.2
29	39°52'45"	–104°46'21"	1598	8.7	12.6	–2.2	20.5
30	39°41'30"	–104°44'22"	1717	11.4	–8.2	0.4	–0.3

Table A.5. CLASS and Instrumented Tower Locations

Station	# Soundings Taken	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation (m)	CP–3 as Origin X (km)	CP–3 as Origin Y (km)	FL–2 as Origin X (km)	FL–2 as Origin Y (km)
Golden	74	39°49'11"	-105°13'07"	1783	-29.4	6.5	-40.4	14.3
Hudson	84	40°06'34"	-104°41'54"	1510	15.2	38.2	4.3	46.1
Elizabeth	67	39°22'28"	-104°33'35"	2000	26.5	-43.6	15.6	-35.7
Byers	77	39°42'25"	-104°14'53"	1612	53.4	-6.8	42.4	1.2
Denver	131	39°46'02"	-104°52'09"	1608	0.3	0.3	-10.6	8.2
BAO (300 m)		40°03'01"	-105°00'12"	1572	-10.8	31.9	-21.7	39.7
SERI (50 m)		39°54'47"	-105°13'53"	1848	-30.4	16.8	-41.3	24.7
Rocky Flats (10 m)								
Rocky Flats (10 m)		39°53'20"	-105°11'44"		-27.4	14.1	-38.3	22.0

Table A.6. Low Level Wind Shear Alert System (LLWAS) Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation of Anemometer (m)	CP–3 as Origin X (km)	CP–3 as Origin Y (km)	FL–2 as Origin X (km)	FL–2 as Origin Y (km)
1	39°46’55”	–104°51’58”	1626	0.6	1.9	–10.3	9.8
2	39°45’51”	–104°52’21”	1629	–0.0	–0.1	–10.9	7.8
3	39°47’06”	–104°53’29”	1616	–1.5	2.3	–12.5	10.2
4	39°47’56”	–104°53’21”	1590	–1.3	3.8	–12.3	11.7
5	39°49’11”	–104°52’17”	1599	0.2	6.1	–10.7	14.0
6	39°47’56”	–104°52’02”	1614	0.5	3.8	–10.4	11.7
7	39°46’03”	–104°50’54”	1632	2.1	0.3	–8.8	8.2
8	39°45’16”	–104°50’50”	1636	2.2	–1.2	–8.8	6.7
9	39°44’33”	–104°52’22”	1651	0.0	–2.5	–11.0	5.4
10	39°44’52”	–104°53’52”	1654	–2.1	–1.9	–13.1	6.0
11	39°45’26”	–104°55’08”	1644	–4.0	–0.8	–14.9	7.1
12	39°46’05”	–104°53’54”	1633	–2.2	0.4	–13.1	8.3

Table A.7. Profiler Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation (m)	CP–3 as Origin X (km)	CP–3 as Origin Y (km)	FL–2 as Origin X (km)	FL–2 as Origin Y (km)
Platteville	40°10'48"	–104°43'48"	1523	–12.6	46.1	1.7	53.9
Stapleton	39°46'12"	–104°52'48"	1611	–0.6	0.6	–11.5	8.5
Fleming	40°37'48"	–102°56'24"	1336	164.1	96.4	153.1	104.3
Flagler	39°07'12"	–103°05'24"	1463	153.1	–71.6	142.2	–63.8

Table A.8. Boulder Wind Network Locations

Station	Latitude (deg,min,sec)	Longitude (deg,min,sec)	Elevation (m)	CP–3 as Origin X (km)	CP–3 as Origin Y (km)	FL–2 as Origin X (km)	FL–2 as Origin Y (km)
Table Mountain	40°07'32"	–105°14'35"	1698	–31.1	40.5	–42.0	48.4
North Broadway	40°03'39"	–105°16'55"	1710	–34.5	33.3	–45.4	41.2
RL–3 Roof	40°00'47"	–105°15'10"	1637	–32.1	28.0	–43.0	35.9
DOC/NBS	39°59'35"	–105°15'31"	1649	–32.6	25.8	–43.5	33.7
Marshall	39°57'00"	–105°11'41"	1732	–27.2	20.9	–38.2	28.8

Appendix B. CINDE/TDWR Radar Summaries.

Table B.1. NOAA/C Radar Data Catalog.

CINDE 1987
NOAA/C

TAPE #	DATE	START	END
001	6/22	17:39:00	18:01:00
002	6/22	18:13:00	18:13:00
003	6/22	18:33:00	18:48:00
005	6/22	19:05:00	19:10:00
006	6/23	13:04:00	13:55:00
007	6/23	14:18:00	14:21:00
008	6/23	14:25:00	14:56:00
009	6/23	15:06:00	15:27:00
010	6/23	15:39:00	15:39:00
011	6/25	11:30:00	11:43:00
012	6/25	11:50:00	12:14:00
013	6/25	12:20:00	12:35:00
014	6/25	12:48:00	13:04:00
015	6/25	13:04:00	13:19:00
016	6/25	13:28:00	13:40:00
017	6/25	13:41:00	13:56:00
018	6/25	13:57:00	14:12:00
019	6/25	14:20:00	14:35:00
020	6/25	14:44:00	1 volume
021	6/25	15:04:02	15:22:38
022	6/25	15:23:00	15:25:00
023	6/25	15:44:00	15:50:00
024	6/25	16:03:00	16:03:00
025	6/25	not processed	
027	6/25	16:50:00	17:02:00
028	6/25	17:14:00	17:28:00
029	6/25	17:29:00	17:39:00
030	6/25	17:58:00	18:12:00
031	6/25	not processed	
032	6/25	18:13:38	18:29:24
033	6/25	18:32:00	18:43:00
034	6/25	18:46:00	19:00:00
035	6/25	19:15:49	19:29:59
036	6/25	19:32:57	19:44:17
037	6/27	15:07:00	15:22:00
038	6/27	15:23:00	16:19:00
039	6/27	15:20:00	16:35:00
040	6/27	16:35:00	16:50:00
041	6/27	16:52:00	17:07:00
042	6/27	17:08:00	17:22:00
043	6/27	17:24:00	17:39:00
044	6/27	17:40:00	17:55:00
045	6/27	17:56:00	18:10:00
046	6/27	18:11:00	18:37:00
047	6/27	18:39:00	18:55:00
048	6/28	13:02:00	13:38:00
049	6/28	13:39:00	14:01:00
050	6/28	14:03:00	14:26:00

CINDE 1987
NOAA/C

TAPE	DATE	START	END
051	6/28	14:27:00	14:44:00
052	6/28	14:45:00	15:06:00
053	6/28	15:08:00	15:27:00
054	6/28	15:28:00	15:47:00
055	6/28	15:48:00	16:11:00
056	6/28	16:12:00	16:31:00
057	6/28	16:32:00	16:50:00
058	7/02	14:35:00	15:08:00
059	7/02	15:08:00	15:30:00
060	7/02	15:31:00	15:51:00
061	7/02	15:51:00	16:10:00
062	7/02	16:12:00	16:31:00
063	7/02	16:32:00	16:52:00
064	7/02	16:53:00	17:01:00
065	7/03	12:56:00	13:20:00
066	7/03	13:20:00	13:50:00
067	7/03	13:50:00	14:20:00
068	7/03	14:20:00	14:51:00
069	7/03	14:56:00	15:14:00
070	7/03	15:16:00	15:55:00
071	7/03	16:00:00	16:30:00
072	7/03	16:30:00	17:00:00
073	7/03	17:00:00	17:27:00
074	7/03	17:29:00	17:44:00
075	7/03	17:44:00	17:58:00
076	7/03	18:01:00	18:04:00
077	7/06	16:30:00	16:45:00
078	7/06	16:45:00	17:01:00
079	7/06	17:01:00	17:17:00
080	7/06	17:17:00	17:33:00
081	7/06	17:33:00	17:48:00
082	7/06	17:48:00	18:04:00
083	7/06	18:04:00	18:17:00
084	7/06	18:20:00	18:33:00
085	7/06	18:36:00	19:00:00
086	7/06	19:04:00	19:23:00
087	7/06	19:24:00	19:46:00
088	7/06	19:47:00	1 volume
089	7/06	19:53:00	20:12:00
090	7/06	20:13:00	20:15:00
091	7/07	14:10:00	14:37:00
092	7/07	14:40:00	14:58:00
093	7/07	14:59:00	15:17:00
094	7/07	15:18:00	15:35:00
095	7/07	15:37:00	15:50:00
096	7/07	15:53:00	16:06:00
097	7/07	16:09:00	16:25:00
098	7/07	16:27:00	17:35:00
099	7/07	17:43:00	17:53:00

TABLE B.1, continued. NOAA/C Radar Data Catalog.

CINDE 1987
NOAA/C

TAPE	DATE	START	END
100	7/08	12:50:00	13:40:00
101	7/08	13:40:00	14:05:00
102	7/08	14:07:00	14:20:00
103	7/08	14:23:00	14:36:00
104	7/08	14:38:00	14:52:00
105	7/08	14:54:00	15:07:00
106	7/08	15:10:00	15:24:00
107	7/08	15:25:00	15:42:00
108	7/08	15:44:00	16:02:00
109	7/08	16:02:00	16:17:00
110	7/08	16:18:00	16:43:00
111	7/08	16:44:00	17:01:00
112	7/08	17:02:00	17:18:00
113	7/08	17:19:00	17:47:00
114	7/08	17:48:00	18:06:00
115	7/08	18:07:00	18:28:00
116	7/08	18:28:00	18:51:00
117	7/08	18:52:00	19:11:00
118	7/08	19:13:00	1 volume
*119	7/09	14:02:00	14:44:00
*120	7/09	14:45:00	15:26:00
121	7/09	15:26:00	15:52:00
122	7/09	15:52:00	16:09:00
123	7/09	16:10:00	16:28:00
124	7/09	16:30:00	16:54:00
125	7/09	16:55:00	17:18:00
126	7/09	17:47:00	18:06:00
127	7/09	18:06:00	18:22:00
128	7/10	16:45:00	17:08:00
129	7/10	17:11:00	17:27:00
130	7/10	17:27:00	17:45:00
131	7/10	17:46:00	18:01:00
132	7/10	18:01:00	18:29:00
133	7/10	18:29:00	18:39:00
134	7/11	14:27:00	14:55:00
135	7/11	14:56:00	16:01:00
136	7/11	17:05:00	17:19:00
137	7/11	17:21:00	18:40:00
138	7/11	17:42:00	18:17:00
139	7/11	18:19:00	18:26:00
140	7/11	18:45:00	19:03:00
141	7/11	19:05:00	19:23:00
142	7/11	19:25:00	19:55:00
143	7/12	12:13:00	12:26:00
144	7/16	13:00:00	13:34:00
145	7/16	13:36:00	13:39:00
146	7/16	14:45:00	15:00:00
147	7/16	15:02:00	15:17:00
148	7/16	15:18:00	15:40:00

TABLE B.1., continued. NOAA/C Radar Data Catalog.

CINDE 1987
NOAA/C

TAPE	TAPE	START	END
149	7/16	15:45:00	16:35:00
150	7/16	16:35:00	17:11:00
151	7/16	17:11:00	17:31:00
152	7/16	17:33:00	18:02:00
153	7/16	18:04:00	18:28:00
154	7/16	18:29:00	18:47:00
155	7/16	18:47:00	19:00:00
156	7/17	13:50:00	14:15:00
157	7/17	14:16:00	14:35:00
158	7/17	14:37:00	14:51:00
159	7/17	14:53:00	15:07:00
160	7/17	15:10:00	15:23:00
161	7/17	15:26:00	15:50:00
162	7/17	15:50:00	16:15:00
163	7/17	16:18:00	16:33:00
164	7/17	16:36:00	16:53:00
165	7/17	16:53:00	17:12:00
166	7/17	17:13:00	17:31:00
167	7/17	17:33:00	17:55:00
168	7/17	17:54:00	18:14:00
169	7/17	18:15:00	18:24:00
170	7/18	12:47:00	13:35:00
171	7/18	14:38:00	15:32:00
172	7/18	15:34:00	16:11:00
173	7/19	13:12:00	13:47:00
174	7/20	12:04:00	12:24:00
175	7/20	not processed	
176	7/20	" "	
177	7/21	" "	
178	7/21	" "	
179	7/21	" "	
*180	7/22	12:04:00	14:10:00
*181	7/22	14:11:00	14:55:00
*182	7/22	15:01:00	15:56:00
183	7/22	15:57:00	16:30:00
184	7/22	16:34:00	16:55:00
185	7/22	16:56:00	17:14:00
186	7/22	17:15:00	17:34:00
187	7/22	13:34:00	17:57:00
188	7/22	17:59:00	18:16:00
189	7/22	18:17:00	18:28:00
190	7/22	18:33:00	18:47:00
191	7/22	18:49:00	19:03:00
192	7/22	19:05:00	19:19:00
193	7/22	19:21:00	19:40:00
194	7/22	19:41:00	19:59:00
195	7/22	20:00:00	20:03:00
196	7/22	20:32:00	22:44:00
197	7/22 7/23	23:30:00	2 :02:00

TABLE B.1, continued. NOAA/C Radar Data Catalog.

CINDE 1987
NOAA/C

TAPE	DATE	START	END	
198	7/22	12:05:00	13:43:00	
199	7/22	13:55:00	15:22:00	
200	7/22	16:01:00	17:00:00	
201	7/24	17:04:00	18:35:00	?7/23
202	7/24	02:29:00	03:59:00	
203	7/24	12:02:00	12:24:00	
204	7/24	15:27:00	15:43:00	
205	7/24	15:45:00	16:02:00	
206	7/24	16:06:00	16:37:00	
207	7/24	16:43:00	17:03:00	
208	7/24	17:04:00	17:22:00	
209	7/24	17:23:00	17:42:00	
210	7/24	17:43:00	18:35:00	
211	7/24	18:36:00	18:56:00	
212	7/24	18:58:00	19:20:00	
213	7/24	19:24:00	19:40:00	
214	7/24	19:42:00	19:49:00	
215	7/27	not processed		
216	7/27	not processed		
217	7/27	16:10:00	16:44:00	
218	7/27	16:45:00	17:02:00	
219	7/27	17:03:00	17:23:00	
220	7/27	17:24:00	17:44:00	
221	7/27	not processed		
222	7/28	13:45:00	14:22:00	
223	7/28	14:24:00	14:43:00	
224	7/28	14:43:00	15:06:00	
225	7/28	15:07:00	15:24:00	
226	7/28	15:23:00	15:50:00	
227	7/28	15:50:00	16:06:00	
228	7/28	16:70:00	16:23:00	
229	7/28	16:24:00	16:43:00	
230	7/28	16:44:00	17:03:00	
231	7/28	17:05:00	17:17:00	
232	7/28	17:24:00	17:27:00	
233	7/28	17:45:00	17:59:00	
234	7/28	18:01:00	18:15:00	
235	7/29	not processed		
236	7/29	" "		
237	7/29	" "		
238	7/29	" "		
239	7/29	17:52:00	18:12:00	
240	7/29	18:13:00	18:27:00	
241	7/29	18:29:00	18:32:00	
242	7/29	not processed		
243	7/29	" "		
244	7/30	" "		
245	7/30	" "		

TABLE B.1, continued. NOAA/C Radar Data Catalog.

CINDE 1987
NOAA/C

TAPE	DATE	START	END
246	7/30	not processed	
247	7/30	" "	
248	7/30	" "	
249	7/30	" "	
250	7/31	15:25:00	15:47:00
251	7/31	15:49:00	16:06:00
252	7/31	16:07:00	16:25:00
253	7/31	16:38:00	16:42:00
254	7/31	17:00:00	17:02:00
255	7/31	17:18:00	17:35:00
256	7/31	17:37:00	17:58:00
257	7/31	18:00:00	18:19:00
258	7/31	18:24:00	1 volume
259	7/31	18:47:00	19:05:00
260	7/31	19:07:00	19:26:00
261	7/31	19:26:00	19:28:00
262	8/2	not processed	
263	8/2	" "	
264	8/2	" "	
265	8/2	" "	
266	8/2	" "	
267	8/2	" "	
268	8/2	" "	
269	8/2	" "	
270	8/2	" "	
271	8/3	" "	
272	8/4	09:14:00	10:42:00
273	8/4	11:04:00	12:19:00
274	8/4	12:23:00	13:24:00
*275	8/4	not processed	
*276	8/4	" "	
*277	8/4	not processed	
*278	8/4	not processed	
*279	8/4	" "	
280	8/4	18:02:00	18:18:00
281	8/4	18:21:00	18:35:00
282	8/5	09:02:00	10:07:00
283	8/5	10:20:00	11:12:00
284	8/5	11:39:00	12:49:00
285	8/5	12:58:00	1 volume
286	8/5	14:17:00	15:32:00
287	8/5	15:35:00	16:37:00
288	8/5	16:54:00	1 volome
289	8/5	17:59:00	18:18:00
290	8/5	18:18:00	18:33:00
291	8/6	14:31:00	14:48:00
292	8/6	14:50:00	15:08:00
293	8/6	15:09:00	15:26:00
294	8/6	15:26:00	15:42:00

CINDE 1987
NOAA/C

TAPE	DATE	START	END
295	8/6	15:42:00	15:55:00
296	8/6	15:59:00	16:14:00
297	8/6	not processed	
298	8/6	16:41:00	17:01:00
299	8/6	17:01:00	17:17:00
300	8/6	17:17:00	17:34:00

* Time series experiments

Table B.2. NOAA/D Radar Data Catalog.

CINDE 1987
NOAA/D

TAPE	DATE	START	END
001	6/22	16:21:00	16:37:00
002	6/22	17:50:00	17:58:00
003	6/22	18:13:00	18:28:00
004	6/22	18:35:00	18:35:00
005	6/22	19:03:00	19:10:00
006	6/23	14:25:00	14:44:00
007	6/23	15:04:00	15:23:00
008	6/23	15:27:00	15:54:00
009	6/23	15:56:00	16:18:00
010	6/25	11:22:20	11:40:31
011	6/25	11:50:00	11:52:00
012	6/25	not processed	
013	6/25	12:02:00	12:14:00
014	6/25	12:48:00	12:58:00
015	6/25	13:03:00	1 volume
016	6/25	13:17:00	13:31:00
017	6/25	13:33:00	13:43:00
018	6/25	13:53:00	13:59:00
019	6/25	14:08:00	1 volume
020	6/25	14:21:00	14:32:00
021	6/25	14:42:00	14:51:00
022	6/25	14:51:00	15:04:00
023	6/25	15:06:00	15:19:00
024	6/25	15:19:00	15:54:00
025	6/25	15:55:00	16:13:00
026	6/25	16:13:00	16:22:00
027	6/27	11:50:00	12:00:00
028	6/27	12:28:00	12:59:00
029	6/27	13:00:00	13:31:00
030	6/27	13:57:00	15:10:00
031	6/27	15:10:00	15:25:00
032	6/27	15:26:00	16:21:00
033	6/27	16:27:00	16:42:00
034	6/27	16:42:00	16:56:00
035	6/27	16:58:00	17:14:00
036	6/27	17:14:00	17:28:00
037	6/27	17:30:00	17:44:00
038	6/27	17:47:00	18:00:00
039	6/27	18:02:00	18:15:00
040	6/27	18:18:00	18:46:00
041	6/27	18:48:00	18:55:00
042	6/28	13:06:00	13:30:00
043	6/28	13:31:00	13:52:00
044	6/28	13:54:00	14:12:00
045	6/28	14:14:00	14:32:00
046	6/28	14:34:00	14:51:00
047	6/28	14:53:00	15:11:00
048	6/28	15:13:00	15:32:00

CINDE 1987
NOAA/D

TAPE	DATE	START	END
049	6/28	15:34:00	15:52:00
050	6/28	15:54:00	16:14:00
051	6/28	16:14:00	16:33:00
052	6/28	16:35:00	16:51:00
053	7/2	14:30:00	14:55:00
054	7/2	14:56:00	15:26:00
055	7/2	15:28:00	15:48:00
056	7/2	15:49:00	16:09:00
057	7/2	16:09:00	16:27:00
058	7/2	16:28:00	16:50:00
059	7/2	16:50:00	17:03:00
060	7/3	12:56:00	13:20:00
061	7/3	13:25:00	13:55:00
062	7/3	13:57:00	14:30:00
063	7/3	14:30:00	14:59:00
064	7/3	15:01:00	15:20:00
065	7/3	15:21:00	16:05:00
066	7/3	16:06:00	16:36:00
067	7/3	16:36:00	16:50:00
068	7/6	16:35:00	16:51:00
069	7/6	16:51:00	17:04:00
070	7/6	17:06:00	17:19:00
071	7/6	17:22:00	17:35:00
072	7/6	17:38:00	17:51:00
073	7/6	17:53:00	18:07:00
074	7/6	18:09:00	18:22:00
075	7/6	18:23:00	18:42:00
076	7/6	18:42:00	19:06:00
077	7/6	19:06:00	19:32:00
078	7/6	19:33:00	20:00:00
079	7/6	20:02:00	20:10:00
081	7/7	14:40:00	14:58:00
082	7/7	14:58:00	15:17:00
083	7/7	15:17:00	15:35:00
084	7/7	15:36:00	15:50:00
085	7/7	15:52:00	16:06:00
086	7/7	16:07:00	16:25:00
087	7/7	16:26:00	17:42:00
088	7/7	17:43:00	17:56:00
089	7/8	12:50:00	13:35:00
090	7/8	13:37:00	14:05:00
091	7/8	14:07:00	14:20:00
092	7/8	14:23:00	14:36:00
093	7/8	14:38:00	14:52:00
094	7/8	14:54:00	15:07:00
095	7/8	15:10:00	15:24:00
096	7/8	15:26:00	15:42:00

TABLE B.2, continued. NOAA/D Radar Data Catalog.

CINDE 1987
NOAA/D

TAPE	DATE	START	END
097	7/8	15:44:00	16:04:00
098	7/8	16:05:00	16:20:00
099	7/8	16:21:00	16:38:00
100	7/8	16:40:00	16:59:00
101	7/8	16:59:00	17:21:00
102	7/8	17:22:00	17:38:00
103	7/8	17:38:00	18:03:00
104	7/8	18:05:00	18:23:00
105	7/8	18:25:00	18:44:00
106	7/8	18:45:00	19:05:00
107	7/8	19:06:00	19:17:00
*108	7/9	14:02:00	14:48:00
*109	7/9	14:48:00	15:36:00
110	7/9	15:36:00	15:54:00
111	7/9	15:54:00	16:00:00
112	7/9	16:20:00	16:48:00
113	7/9	16:48:00	17:07:00
114	7/9	17:08:00	17:47:00
115	7/9	17:48:00	18:06:00
116	7/9	18:06:00	18:22:00
117	7/10	16:40:00	17:16:00
118	7/10	17:16:00	17:33:00
119	7/10	17:33:00	17:39:00
120	7/10	17:53:00	18:18:00
121	7/10	18:19:00	18:37:00
122	7/10	18:38:00	18:38:00
123	7/11	14:00:00	14:25:00
124	7/11	14:30:00	14:55:00
125	7/11	14:56:00	17:05:00
126	7/11	17:08:00	17:21:00
127	7/11	17:23:00	18:00:00
128	7/11	18:02:00	18:25:00
129	7/11	18:25:00	18:30:00
130	7/11	18:48:00	19:08:00
131	7/11	19:44:00	20:00:00
132	7/11	19:08:00	19:42:00
133	7/16	14:22:00	14:41:00
134	7/16	14:42:00	15:00:00
135	7/16	15:06:00	15:15:00
136	7/16	15:25:00	16:00:00
137	7/16	16:00:00	16:57:00
138	7/16	16:59:00	17:17:00
139	7/16	17:18:00	17:53:00
140	7/16	17:53:00	17:57:00
141	7/16	18:12:00	18:33:00
142	7/16	18:36:00	18:52:00
143	7/16	18:54:00	19:08:00
144	7/17	13:50:00	14:15:00

TABLE B.2, continued. NOAA/D Radar Data Catalog.

CINDE 1987
NOAA/D

TAPE	DATE	START	END
145	7/17	14:17:00	14:35:00
146	7/17	14:38:00	14:51:00
147	7/17	14:54:00	15:07:00
148	7/17	15:09:00	15:23:00
149	7/17	15:26:00	15:45:00
150	7/17	15:47:00	16:15:00
151	7/17	16:17:00	16:33:00
152	7/17	16:35:00	16:52:00
153	7/17	16:52:00	17:12:00
154	7/17	17:12:00	17:34:00
155	7/17	17:34:00	17:55:00
156	7/17	17:55:00	18:14:00
157	7/17	18:15:00	18:40:00
158	7/17	18:42:00	1 volume
159	7/18	14:27:00	15:04:00
160	7/18	15:04:00	15:36:00
161	7/18	15:39:00	15:52:00
162	7/21	13:03:00	13:40:00
163	7/21	13:41:00	14:00:00
164	7/21	14:15:00	14:20:00
165	7/21	14:40:00	15:20:00
*166	7/22	13:45:00	14:29:00
*167	7/22	14:30:00	15:26:00
*168	7/22	15:26:00	16:17:00
169	7/22	16:20:00	16:44:00
170	7/22	16:46:00	17:05:00
171	7/22	17:06:00	17:06:00
172	7/22	17:26:00	17:45:00
173	7/22	17:47:00	18:11:00
174	7/22	18:11:00	18:26:00
175	7/22	18:27:00	18:42:00
176	7/22	18:43:00	18:57:00
177	7/22	18:50:00	19:13:00
178	7/22	19:15:00	19:35:00
179	7/22	19:36:00	19:57:00
180	7/22	19:58:00	20:05:00
181	7/24	13:24:00	13:55:00
182	7/24	13:55:00	14:25:00
183	7/24	14:25:00	14:51:00
184	7/24	14:53:00	15:06:00
185	7/24	15:08:00	15:24:00
186	7/24	15:24:00	15:41:00
187	7/24	15:43:00	16:05:00
188	7/24	16:05:00	16:39:00
189	7/24	16:39:00	17:01:00
190	7/24	17:02:00	17:20:00
191	7/24	17:22:00	17:40:00
192	7/24	17:42:00	18:31:00
193	7/24	18:83:00	18:51:00

TABLE B.2., continued. NOAA/D Radar Data Catalog.

CINDE 1987
NOAA/D

TAPE	DATE	START	END
194	7/24	18:53:00	19:20:00
195	7/24	19:23:00	19:40:00
196	7/27	19:41:00	19:49:00
197	7/27	11:46:00	14:28:00
198	7/27	14:46:00	15:01:00
199	7/27	15:56:00	16:35:00
200	7/27	16:36:00	16:56:00
201	7/27	16:58:00	17:16:00
202	7/28	13:45:00	14:20:00
203	7/28	14:22:00	14:40:00
204	7/28	14:41:00	14:58:00
205	7/28	15:00:00	15:18:00
206	7/28	15:19:00	15:36:00
207	7/28	15:37:00	15:59:00
208	7/28	16:01:00	16:17:00
209	7/28	16:18:00	16:44:00
210	7/28	16:45:00	17:06:00
211	7/28	17:07:00	17:22:00
212	7/28	17:23:00	17:38:00
213	7/28	17:39:00	17:54:00
214	7/28	17:55:00	17:59:00
215	7/29	16:30:00	16:52:00
216	7/29	16:53:00	17:12:00
217	7/29	17:12:00	17:31:00
218	7/29	17:31:00	17:47:00
219	7/29	not processed	
220	7/29	not processed	
221	7/29	18:22:00	18:36:00
222	7/29	18:38:00	15:54:00
223	7/29	not processed	
224	7/30	" "	
225	7/30	" "	
226	7/30	" "	
227	7/30	" "	
228	7/30	" "	
229	7/30	" "	
230	7/30	19:00:00	19:06:00
231	7/31	15:25:00	15:35:00
232	7/31	15:41:00	1 volume
233	7/31	16:01:00	16:18:00
234	7/31	16:20:00	16:40:00
235	7/31	16:41:00	17:02:00
236	7/31	17:03:00	17:21:00
237	7/31	17:21:00	17:35:00
238	7/31	17:36.00	18:06:00
239	7/31	18:11:00	18:24:00
240	7/31	18:32:00	18:51:00
241	7/31	19:00:00	19:19:00

TABLE B.2., continued. NOAA/D Radar Data Catalog.

CINDE 1987
NOAA/D

TAPE	DATE	START	END
242	7/31	19:24:00	19:31:00
243	8/2	16:12:00	16:42:00
244	8/2	not processed	
245	8/2	" "	
246	8/2	" "	
247	8/2	" "	
248	8/2	" "	
249	8/2	" "	
250	8/2	" "	
251	8/2	" "	
252	8/3	" "	
253	8/4	" "	
254	8/4	" "	
255	8/4	10:10:00	11:15:00
256	8/4	11:29:00	12:20:00
*257	8/4	not processed	
*258	8/4	not processed	
*259	8/4	not processed	
*260	8/4	" "	
*261	8/4	" "	
262	8/4	17:51:00	18:07:00
263	8/4	18:09:00	18:24:00
264	8/4	18:26:00	18:35:00
265	8/5	09:09:00	10:14:00
266	8/5	not processed	
267	8/5	" "	
268	8/5	" "	
269	8/5	14:23:00	15:39:00
270	8/5	not processed	
271	8/5	17:00:00	17:17:00
272	8/5	17:49:00	18:09:00
273	8/5	18:09:00	18:29:00
274	8/5	not processed	
275	8/5	not processed	
276	8/6	14:31:00	14:48:00
277	8/6	14:49:00	15:05:00
278	8/6	15:07:00	15:23:00
279	8/6	15:25:00	15:39:00
280	8/6	15:41:00	15:55:00
281	8/6	15:57:00	16:11:00
282	8/6	16:13:00	16:35:00
283	8/6	16:36:00	16:56:00
284	8/6	16:57:00	17:12:00
285	8/6	not processed	
286	8/6	17:31:00	17:34:00
287	8/10	not processed	
288	8/10	not processed	
289	8/10	not processed	

TABLE B.2., continued. NOAA/D Radar Data Catalog.

CINDE 1987
NOAA/D

TAPE	DATE	START	END
290	8/10	not processed	
291	8/11	16:08:00	18:52:00

* Time series experiments

Table B.3. NOAA Radar Coordinates and NOAA/C Azimuth Pointing Error.

MEMORANDUM

TO: CINDE Personel
FROM: B. W. Orr/WPL
DATE: 2/18/88
SUBJECT: NOAA Radar Coordinates

Over the last several months there has been some controversy as to the positions of the N.O.A.A. radars during the CINDE experiment of last summer. Several independent methods have been applied using measurements from topographic maps, ground truth measurements, aerial photographs and radar clutter target locations. Based on these results a new set of coordinates has been determined. The most significant change has been the need for a 1.1 degree counter-clockwise rotation in the data obtained from NOAA/C, i.e. all azimuths must have 1.1 degrees subtracted from them. The change in physical location was minor, amounting to only 30 meters in either direction. For data processing using the N.O.A.A. radars the following coordinates should be used:

NOAA/C: 39 47' 22'' - with a 1.1 degree counter-
104 33' 02'' clockwise rotation.

NOAA/D: 39 45' 50''
104 43' 58''

or in cartesian coordinates relative to NOAA/C:

NOAA/C: (0,0,0) -with a 1.1 degree counter-
clockwise rotation.

NOAA/D: (-15.62,-2.83,0)

The accompanying plots indicate the importance of these changes, especially when small spatial scales are involved.

TABLE B.3, continued. NOAA Radar Coordinates and NOAA/C Azimuth Pointing Error

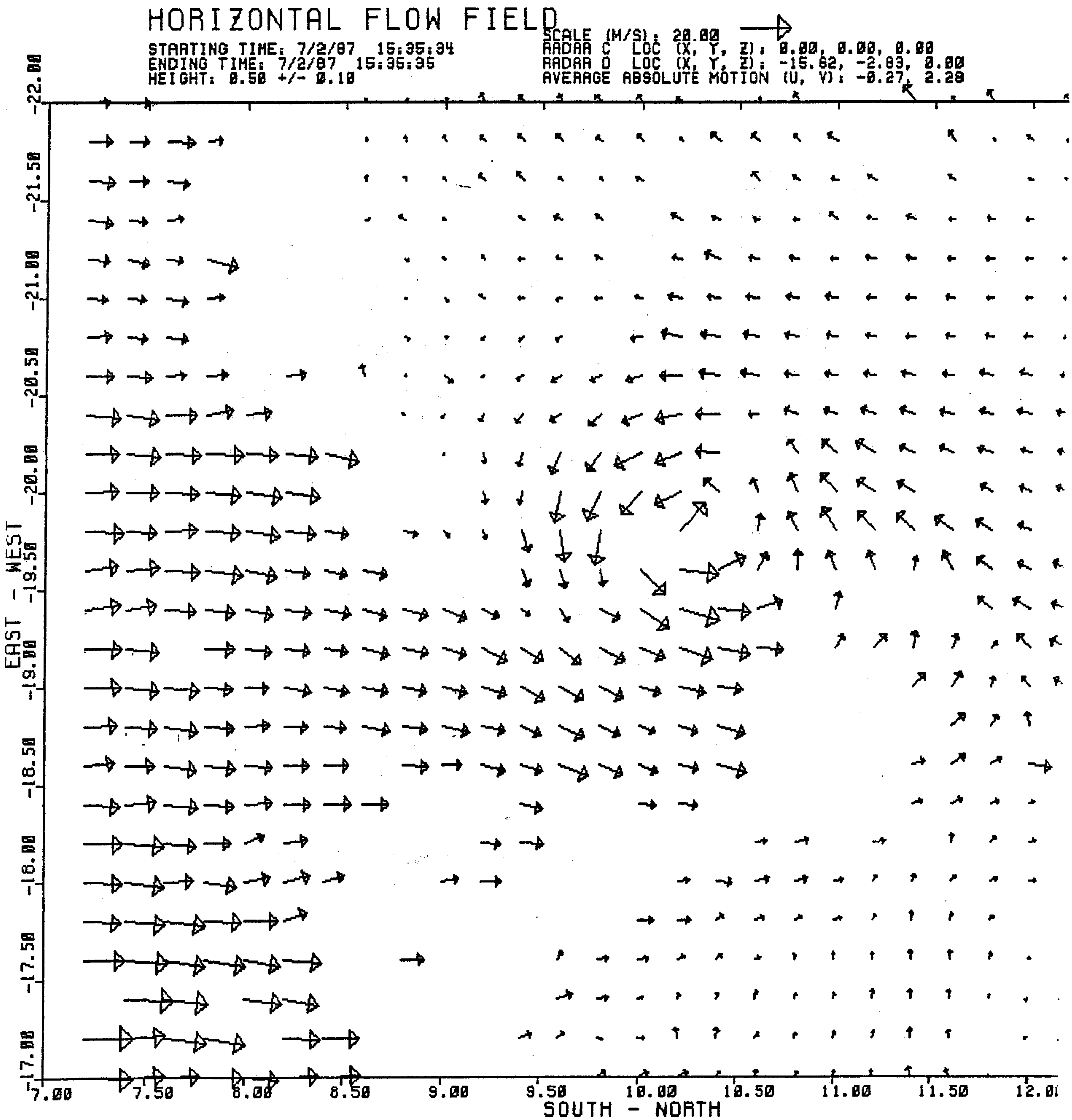


TABLE B.3, continued. NOAA Radar Coordinates and NOAA/C Azimuth Pointing Error.

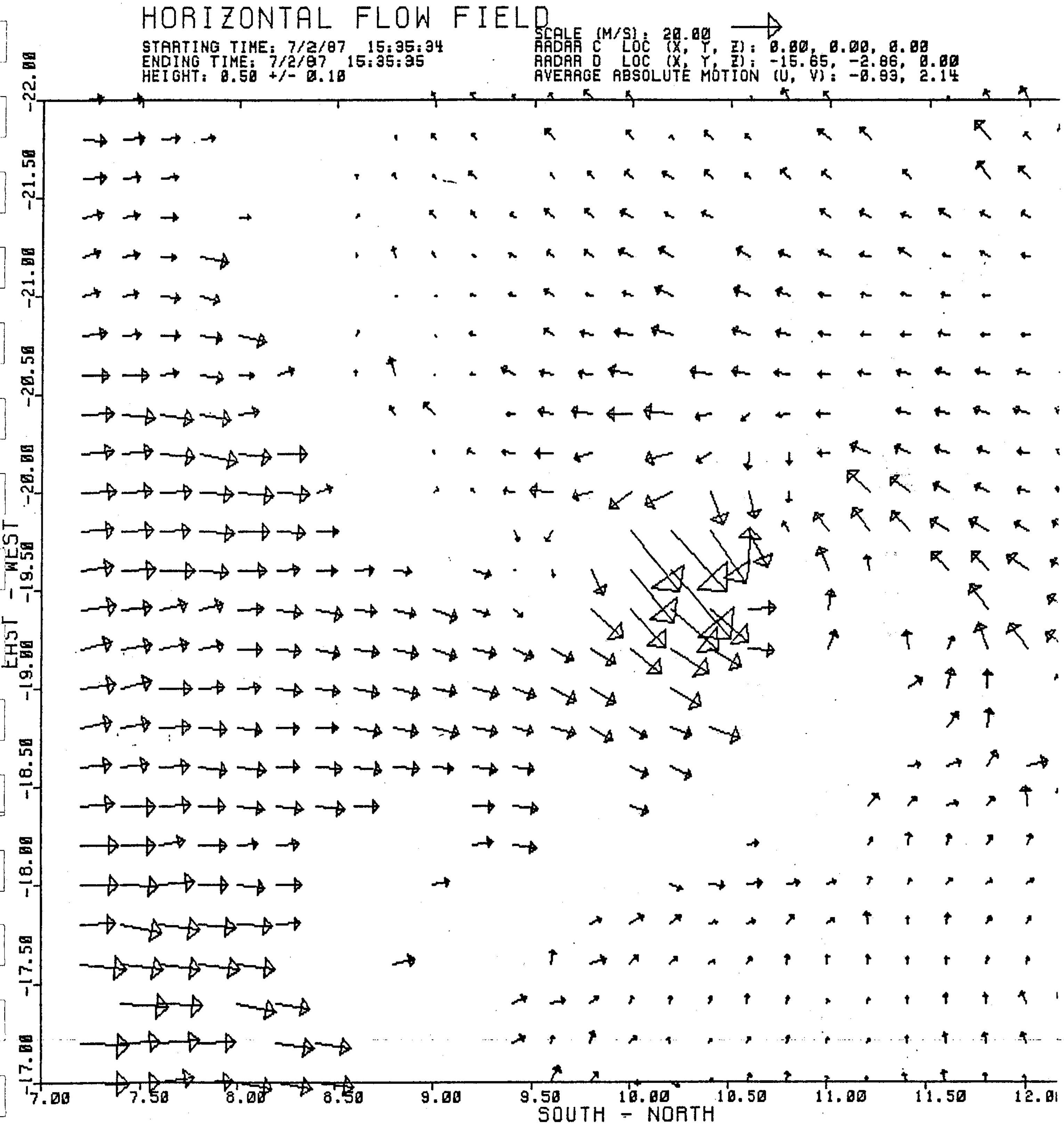


Table B.4. CP–3 and CP–2 Radar Data Catalog on NCAR Cray.

CINDE Date	CP-2: Time (MDT)	Tape Nos.	Req. By/Dt	Current Proc/Test	Send To / Date	Comments
7-09	1200-2010	V49705-10	VB F	DNE REV	VB 2-23-87	Not de-glitched
6-28	1101-1701	V49600-07	VB F	DNE REV	VB 2-23-87	
7-06	1044-2028	V49677-81	VB F	DNE REV	VB 2-23-87	
7-07	1035-1816	V49682-88	VB F	DNE REV	VB 2-23-87	
7-08	1058-1937	V49692-00	VB F	DNE REV		
7-24	1116-1937	V49776-81	VB F	DNE REV		
6-25	1200-2011	V49576-85	JT G	STAGED	---	Stage only!
7-17	1210-2131	V49737-42	JT F	DNE REV		Stage only
7-10	1102-1853	V49711-14	VB F	DNE REV		
7-19	1324-1910	V49749-54	VB F	DNE REV		
8-4	1806-2045	V49853-54	TT H	STAGED	---	Stage only!
CINDE CP-3:						
6-23	1355-1940	V44211-16	N E	DNE REV	CKn 12-30-87	Not de-glitched
6-30	0858-1701	V44255-63	N A	DNE REV	CKM 9-1-87,RW 11/10	Not de-gl
7-09	1207-1850	V44327-33	N A	DNE REV	CKM 9-1-87	Not de-glitched
7-17	1142-1855	V44386-93	N A	DNE REV	CKM 9-1-87,RW 11/10	Not de-gl
7-02	1104-1721	V44270-75	N B	DNE REV	CKM 9-24-87,RW 11/10	Not de-gl
7-24	1116-1937	V44434-44	N B	DNE REV	CKM 9-24-87	Not de-glitched
7-07	1035-1816	V44308-15	N B	DNE REV	CKM 10-27-87	Not de-glitched
8-04	0720-2010	V44524-36	N D	DNE REV	JW 10-21-87	Not de glitched
7-22	1057-2021	V44416-28	N B	DNE REV	CKM 10-27-87	Not de-glitched
7-06	1044-2028	V44296-07	N B	DNE REV	CKM 10-27-87	Not de-glitched
7-8/9	1058-1207	V44316-26	N B	DNE REV	CKM 10-27-87	Not de-glitched
6-22	1327-1930	V44206-10	N B	DNE REV	CKM 10-12-87	Not de-glitched
6-25	1000-1952	V44223-31	N B	DNE REV	CKM 10-12-87	Not de-glitched
7-10	1102-1853	V44334-41	N B	DNE REV	CKM 10-12-87	Not de-glitched
7-11	1047-1957	V44342-53	N B	DNE REV	CKM 12-30-87	Not de-glitched
7-16	1141-1919	V44378-85	N B	DNE REV	CKM 10-27-87	Not de-glitched
7-19	1324-1910	V44398-03	N B	DNE REV	CKM 10-12-87	Not de-glitched
7-15	1109-1715	V44372-77	N B	DNE REV	CKM 10-12-87	Not de-glitched
7-27	1108-1800	V44457-64	N B	DNE REV	CKM 10-12-87	Not de-glitched
7-28	1047-1835	V44465-73	N B	DNE REV	CKM 12-30-87	Not de-glithced
7-29	1114-1923	V44474-82	N B	DNE REV	CKM 10-27-87	Not de-glitched
7-31	1054-1952	V44492-01	N B	DNE REV	CKM 10-27-87	Not de-glitched
7-30	1100-1915	V44483-91	N B	DNE REV	CKM 10-27-87	Not de-glitched
6-27	1049-1919	V44237-45	N C	DNE REV	CKM 10-26-87	Not de-glitched
6-28	1101-1701	V44246-52	N C	DNE REV	CKM 10-26-87	Not de-glitched
7-01	1107-1811	V44264-69	N C	DNE REV	CKM "	
7-03	1024-1854	V44276-84	N C	DNE REV	CKM "	
8-02	1102-1932	V44507-17	N C	DNE REV	CKM "	
8-06	1104-1740	V44548-55	N C	DNE REV	CKM "	
8-25		TDWR01		DNE, UF	UF TO WES WILSON 9-29-87	
8/11-28		TDWR02		DNE, UF	"	
8/10-14		TDWR03		DNE, UF	UF TO LARRY 10-08-87	

Processes: STG, FIX, CAT, NFX, REN, PRT, IND, DNE Tests: REV, UF, BSC
Requestors: U = University PI's, N = NCAR PI's.
Recipients: CKM=Cindy Mueller JW= Jim Wilson RW=Roger Wakimoto
CKn=Charlie Knight,VB=V. Balaji,JT=J. Tuttle, TT=Tuttle&Turk(CSU

Request A=7-24-87, B=9-1-87, C=9-17-87,D=10-8-87,E=12-1-87
F=2-01-88,G=2-24-88,H=3-3-88

Table B.5. CP-3 and CP-2 Data Documentation.

17 January 1988
FOF Data Management Group

RDSS Access to NCAR
Radar Data from CINDE and PROFS 87-88

1. Perusing Radar Data on the RDSS

a. Verifying Radar Parameters

The perusal program prompts the user for input or correction of "Radar" parameters, which are necessary to insure proper calculation of measured fields. At present, it is up to the user to confirm that the proper radar parameters have been entered at the outset of each perusal session. Table A summarizes the values to be used.

Table A: Radar Parameters.

Values in brackets require correction by the user throughout most of the project period.

Radar Parameter Name	CP-2 S-band	CP-2 X-band	CP-3
Wavelength (cm)	10.67	3.20	5.45
Avg. Trans. Pwr. (dBm)	59^	43^	57-59^
Beam Width (deg)	[0.98]	[0.96]	[1.11]^^
System Gain (dB)	[41.8^^^]	[44.5]	[37.6^^^] (thru 7/16) [39.1^^^] (7/17) [42.1^^^] (7/18 & later)
Zdr Bias Correction(dB)	[0.4]		
Approx. Sys Noise Pwr (dBm)	-107	-112	-106.8 (thru 7/17) -111.4 (7/18 and later)
Pulse Duration (ms)	0.001	0.001	0.001
Site Latitude (deg,min,sec)	39 57 00		39 45 53
Site Longitude	-105 -11 -38		-104 -52 -23
Site Elevation (m)	1743		1620

^ Correct values are automatically recorded on tape. No user correction should be necessary.
^^ The CP-4 antenna and pedestal was used for this project.
^^^ These values contain hidden factors. See Attachment 2 for explanation.

b. Accessing Power Calibration Data

Power calibrations for each radar and each day of operation have been checked and archived on the RDSS disk. To access these calibrations, the user should select the menu option labeled

"Use the DMG Verified Calibration",

currently listed as option 0 of the calibration file menu. The proper calibration will then be automatically entered into the perusal program.

We suggest that users avoid collecting calibration files in their own directories, since FOF staff will be unable to update and/or correct calibrations scattered among individual directories.

c. Verifying Field Parameters

The perusal program prompts the user for input or correction of "Field" parameters, which are necessary to insure proper range and pointing accuracy for each individual field recorded on tape. At present, it is up to the user to confirm that the proper field parameters have been entered at the outset of each perusal session. Table B summarizes the values to be used.

Table B: Field Parameters

Field Parameter Name	CP-2 S-Band	CP-2 X-Band	CP-3
MTERM: Reflectivity and power fields derived from log receiver.	-2	-2	-1
All velocity fields	-2		0
S-band Zdr, Spectrum width	-2		
X-band LDR.		-2	
Normalized coherent power	-2		
Reflectivity and power fields derived from linear receiver.	-2		
EOERROR (see Note below)	0.02	0.02	-0.02
GSERROR, AZERROR	0	0	0
ELERROR (deg)	0	0	0

Note: EOERROR values are only valid for gate spacing of 150 m on CP-3.

2. Editing Radar Data on the RDSS

a. Verifying Radar and Field Parameters

The FOF editor utilizes Radar and Field parameters (or their equivalent) at the time data is initially "read in" to the program. This information must be properly specified at that time for range, gate alignment and data values to be correct in editor data files.

The user is first prompted to review and correct (if necessary) the gate spacing used. Next, the user reviews the range to the first good gate on tape. Values given in Table C should be used in this step.

Table C: Range to Center of First Good Gate on Tape (in km)

Gate Spacing (km)	CP-2	CP-3
0.15	0.095	0.205
0.20	0.145	

For each data field to be read in, the user must supply the gate number to be taken as the "first good gate on tape" for that data field. The proper gate numbers are given in Table D below.

Table D: Gate Number for First Good Gate

Field	CP-2 S-Band	CP-2 X-Band	CP-3
Reflectivity and power fields from log receiver.	3	3	3
All velocity fields.	3		2
Zdr, Spectrum width	3		
LDR		3	
Normalized coherent power (NCP)	3		
Reflectivity and power fields from linear receiver.	3		

b. Accessing Power Calibration Data

The automatic calibration access routine described in Section 1.b is not available in the Radar Editor program. When reading radar data into the editor, the user is prompted to select power calibrations. At this time, the user should opt to read in (from the RDSS disk) the proper calibration, designated as

ddmmmyyid.cal

where ddmmmyyid is the calibration file name. A list of the appropriate calibration names for CINDE and PROFS 87-88 is given in Attachment 1.

c. Scratch Disk Management

The FOF scratch disk is automatically purged on a weekly basis. Therefore any data left on the disk for 7 days will be deleted. Data may be written out to magnetic tape in Universal Format using the tape output process within the Editor program.

Users are allocated 500,000 blocks on the scratch disk. This should be sufficient to meet most needs. However, it is important to delete files after they have been written to tape (and the tape has been checked), or when they are no longer needed. To look at the files that are on the scratch disk, exit the FOF programs and after the $ sign prompt type

dir/size/date dt:

To delete a file named xyz.red, type

delete dt:xyz.red;*

This will delete all the versions of the file xyz.red.

3. Special Notes Concerning Data Fields

o Linear averaging has been implemented for MIST on CP-2 S-band log channel quantities (reflectivity, received power, differential reflectivity). This eliminates positive bias in average power measurements and reduces variance of Zdr statistical fluctuations.

o Differential reflectivity measurements contain a small bias which must be removed for proper display. A small correction for noise power contributions to Zdr must also be made. In perusal, bias and noise corrections are specified during initialization of the ZD field. The editor has no provision for "reading in" corrected Zdr values. Instead, bias and noise corrections must be carried out using processes 432 and 340, respectively.

o Proper display and calibration of linear power data from CP-2 is not yet implemented on the RDSS.

o For proper calculation of linear depolarization (LD field), the field parameters for X-band horizontal and vertical power (XM and XL) must be correctly set before the LD field is initialized. Since each RDSS plot parameter table stores field parameters for XM and XL whether or not these fields have been initialized and reviewed, the user must initially confirm (by displaying each field) that the stored values correspond to those in Table B. If not, the correct values should be entered, and the revised plot parameter table saved on disk. In the editor, it is necessary to properly enter the information relevant to X-band power fields in Tables C and D to insure proper calculation of LD.

TABLE B.5., continued. CP-3 and CP-2 Data Documentation.

Attachment 1
17 January 1988
P. Herzegh

CINDE and PROFS 87-88

Recommended Log Channel Calibrations

CP-2 S-Band Calibrations

Date of Observations	VAX Cal File Name
15 Feb - 26 Mar	20FEB87C2.CAL
27 Mar - 14 Apr	9APR87C2.CAL
15 Apr - 1 Jul	25MAY87C2.CAL
2 Jul -	2JUL87C2.CAL

CP-2 X-Band Calibrations

Date of Observations	VAX Cal File Name	
15 Feb - 26 Mar	2MAR87XH.CAL	2MAR87XV.CAL
27 Mar - 14 Jul	28MAY87XH.CAL	28MAY87XV.CAL
15 Jul -	23JUL87XH.CAL	23JUL87XV.CAL

CP-3 Calibrations

Date of Observations	VAX Cal File Name
20 Jun - 14 Jul	28JUN87C3.CAL
15 Jul	15JUL87C3.CAL
16 Jul	16JUL87C3.CAL
17 Jul	17JUL87C3.CAL
18 Jul	18JUL87C3.CAL
19 Jul	19JUL87C3.CAL
20 Jul - 6 Aug	21JUL87C3.CAL

TABLE B.5., continued. CP-3 and CP-2 Data Documentation.

Attachment 2
October 8, 1987

MEMO TO: Cindy Mueller, Jim Wilson

FROM: Paul Herzegh

SUBJECT: CINDE Data

My memo of 30 July details 'fudged' gain values to account for a variety of signal losses known to exist for CP-3 during CINDE. These values could be applied incorrectly, however, since the memo does not properly reflect the fact that the off-frequency transmission problem for CP-3 was solved in two stages over July 17 and 18. Furthermore, the gain value cited in the memo for use after July 18 doesn't account for the minor correction needed for receiver bandwidth loss.

The table below summarizes the use of 'fudged' gain values for CP-3. Should better information quantifying the off-frequency loss become available, we'll need to amend these figures. As of today, Cray access accounts for the losses as shown below. Before today, July 17 data accessed through the Cray would have been about 3 dB high.

Date	Fudged CP-3 Gain	Problems Accounted for in Fudged Gain
July 16 and before	37.6	9.1 dB loss due to off-frequency problem 1.7 dB loss due to receiver bandwidth
July 17	39.1	6.1 dB loss due to off-frequency problem 1.7 dB loss due to receiver bandwidth
July 18 and later	42.1	1.7 dB loss due to receiver bandwidth

As before, use of a CP-2 S-band gain of 41.8 for all dates accounts for linear averaging and receiver bandwidth losses.

END OF MEMO

Table B.6. FL–2, UND, and Pseudo–FOF Radar Catalog.

Date	FL-2	UND	Pseudo-FOF
June 22	14:56-19:37		16:01-19:40
23	12:51-19:00		13:41-19:09
24	15:33-16:37		15:38-16:36
25	15:56-19:44		11:45-20:00
26	17:14-17:33		12:54-16:30
27			
28			
29			
30	09:55-10:00		12:22-17:40
	12:27-17:29		
July 1	14:40-18:28		13:45-18:29
2	12:55-22:36		13:19-18:56
3			
4		14:20-18:19	
5			
6	08:35-08:58		14:17-20:29
	13:15-20:27		
7	12:35-17:47	13:56-18:10	13:25-17:50
8	13:10-19:30	14:49-19:42	12:36-19:30
9	14:51-20:20	12:46-18:47	13:20-19:25
10	14:15-18:34	14:11-18:44	12:27-18:33
11	13:17-19:11	13:31-19:04	12:43-19:14
12	11:56-12:55		12:08-16:37
	16:05-16:38		
13		12:51-17:15	
14	16:35-17:45		12:30-17:25
15	14:15-17:06		14:24-17:08
16	09:32-10:04	13:04-18:16	12:46-18:21
	12:51-18:16		
17	08:12-08:44	11:58-14:35	13:27-18:59
	13:35-18:59		
18			
19	11:42-12:13		12:00-15:27
20	08:03-08:33		
	17:33-17:45		

TABLE B.6., continued. FL-2, UND, and Pseudo-FOF Radar Catalog.

Date	FL-2	UND	Pseudo-FOF
July 21	07:50-18:30		12:18-18:02
	14:46-16:35		
22	08:48-09:17		13:29-19:30
	14:12-19:39		
23	09:10-09:13	09:44-17:28	
	15:10-17:26		
24	12:05-20:10	13:24-18:20	11:47-19:40
25	14:46-16:02		
26	13:15-16:13		13:45-16:43
27	13:06-18:05	10:27-17:43	12:00-18:03
28	11:54-18:34	15:39-18:12	12:30-18:30
29	07:46-07:55	14:37-19:28	13:07-19:27
	14:10-19:35		
30	12:25-19:15	12:47-18:34	13:20-19:08
31	14:30-19:41	15:10-18:42	12:56-19:40
August 1	14:29-16:59	18:42-19:40	13:54-15:54
2	13:29-18:12	14:29-17:56	13:25-18:05
3	12:37-16:57		12:26-17:04
4	14:57-17:14		15:26-17:36
5	13:28-18:10		12:48-18:05
6	09:40-09:53	14:19-17:27	12:08-17:41
	12:28-17:50		
7	12:45-20:20	14:00-19:26	15:00-19:40

Appendix C. CINDE Aircraft Summary.

Table C.1. Aircraft Instrumentation on the Wyoming King Air.

Parameter Measured	Instrument Type	Manufacturer and Model Number	Range	Accuracy	Useable Resolution*	Sampling Rate(Hz)
Temperature	Platinum Resistance	Rosemount Engr. Co. 5108 amplifier Model 102 Probe	±50°C	±0.5°C	0.1C	10
Temperature	Platinum Resistance Reverse Flow	NCAR Probe Minco, Inc. Element	±50°C	±0.5°C	0.1C	10
Dewpoint	Peltier cooled mirror	Cambridge System, Incl Model 137C3	±50°C	±0.5°C>0°C ±1.0°C<0°C	0.3C	10
Heading	Magnetic	King Radio Corp. KPI 553 & Sperry C14-43	0-360°	±1°	0.1°	1
Altitude	Total Pressure	Rosemount Engr. Co. Model 1201FA1B1A.	0-15 psia (0-1034 mb)	0.25%	0.004 psia (0.3 mb)	10
Indicated Airspeed	Differential Pressure	Rosemount Engr. Co. Model 831 CPX	0-1.6 "Hg (0-54 mb)	Adjustable for zero & span	3x10⁻³"Hg (0.1 mb)	10
Rate of Climb	Differential Altitude	Rosemount Engr. Co. Model 1241-A-4BCDE	±6000 fpm (±30.5 m/s)	1% to 15,000' 2% to 25,000' 5% to 30,000'	~50 fpm (0.25 m/s)	10
Position - Azimuth	VOR	King Radio Corp. KNR 615	0-360°	1.5°		1
Position - Distance	DME	King Radio Corp. KDM 705A	0-200 n mi	0.2 n mi	0.1 n mi	1
Vapor Density	Reverse Flow Lyman-α	In-house design	0-10 g m⁻³		.005 g m⁻³	50
Liquid Water Content	Hot Wire	Bacharach Inst. Model LWH (J-W)	0-3 g m⁻³	0.26 g m⁻³	0.1 g m⁻³	50
Liquid Water Content	Hot Wire	In-house CSIRO design	0-3 g m⁻³	(-)	(-)	50
Aircraft Latitude	Inertial Nav. Sys.	Litton LTN-51***	±90°	±0.066°**	0.001°	1
Aircraft Longitude	Inertial Nav. Sys.	Litton LTN-51	±180°	±0.066°**	0.001°	1
Aircraft Ground Speed	Inertial Nav. Sys.	Litton LTN-51	0 to 400 m/s	±1 m/s**	0.04 m/s	10
Aircraft Vertical Vel.	Inertial Nav. Sys.	Litton LTN-51	±50 m/s	±0.10 m/s	0.012 m/s	10
Aircraft True Heading	Inertial Nav. Sys.	Litton LTN-51	0 to 360°	±0.05°	0.001°	5
Aircraft Pitch Angle	Inertial Nav. Resolver	Litton APD 917055	45°	±0.008°	0.005°	10
Aircraft Roll Angle	Inertial Nav. Resolver	Litton APD 197055	45°	±0.008°	0.005°	10
Inertial Platform Hdg.	Inertial Nav. Resolver	Litton APD 917055	45°	±0.05°	0.005°	10

b) Table 1 cont.

Parameter Measured	Instrument Type	Manufacturer and Model Number	Range	Accuracy	Useable Resolution*	Sampling Rate(Hz)
Aircraft Pitch Angle	Vert. Stab Gyroscope	Humphrey Model SA-09-0502-1	±50°	0.2°**	(-)	10
Aircraft Roll Angle	Vert. Stab. Gyroscope	Humphrey Model SA-09-0502-1	±50°	0.2	(-)	10
Aircraft Vert. Acceleration	Vert. Stab. Accelerometer	Humphrey Model SA-09-0502-1	±0-2 g	0.002 g	.004g	10
Aircraft Ground Speed	Doppler Radar	Singer Model SKK-1000	0-1000 kts	0.17% ±.35 kt	0.5 kt	1
Aircraft Drift Angle	Doppler Radar	Singer Model SKK-1000	±40°	0.2°	0.1°	1
Aircraft Side-slip Angle	Differential Pressure	Rosemount Model 858AJ28 and 831CP8SC2	±10°	0.2°	.003°	10
Aircraft Angle of Attack	Pressure Probe	Rosemount Model 848AJ28, 831CP35C1 and 831CP4SC3	±10°	0.2°	.003°	10
Eddy Dissipation Rate	Pressure Fluctuations	Meteorology Research Model 1120	0-10 $cm^{2/3}s^{-1}$	10%	0.1 $cm^{2/3}s^{-1}$	10
Filter Sequencer Manifold Pressure	Differential Pressure	National Model LX 1602D	0-15 psid (0-1034 mb)	3%	(-)	1
Cloud Droplet Spectrum	Laser Spectrometer	Particle Measuring Systems	.5 to 45 μm	(-)	Selectable 0.5, 1, 3μm	50 (strobes) 10 (spectrum) (~15 cm^3/sec sample vol)
Cloud Droplet Spectrum	Optical Array (1D)	Particle Measuring Systems	12.5 to 187.5 μm	(-)	12.5 μm	10 (~0.5 L/sec sample vol.)
Hydrometeor Spectrum	Optical Array (2D)	Particle Measuring Systems	25-10,000 μm	(-)	25 μm	(~5 L/sec sample vol.)
Hydrometeor Spectrum	Optical Array (2D)	Particle Measuring Systems	200-10,000 μm	(-)	200 μm	(~168 L/sec sample vol.).

*Values quoted are estimates of overall useable resolution which can be expected for actual flight conditions. In several cases, indicated by (-), we have insufficient experience to estimate the useable resolution or accuracy. Theoretical resolutions are one part in 4095 for all the above parameters.

**The indicated values are means for flights of four-hour duration; longer flights will result in degraded accuracy without external update.

***NCAR system.

Table C.2. University of Wyoming King Air Archive Data Format (Slow).

```
C SLOW RECORD ARCHIVE FORMAT #40  (FIRST WITH FORMAT CODE STORED, WD128)
C   WORD    VALUE    NAME   DEFINITION                   UNITS
C    1-2      1      YMD    YYMMDD - DATE
C    3-4      2      HMS    HHMMSS - TIME                CUT
C    5-6      3      PMB    PRESSURE                     MB
C    7-8      4      RLWC   LIQUID WATER CONTENT FROM R. ICING PROBE
C    9-10     5      AIAS   INDICATED AIRSPEED           KTS
C   11-12     6      TS     TEMPERATURE, ROSEMOUNT       DEG.C
C   13-14     7      TR     TEMPERATURE, REVERSE FLOW    DEG.C
C   15-16     8      TDP    DEW POINT                    DEG.C
C   17-18     9*     HEAD   HEADING (MAGNETIC)           DEG. MAG.
C   19-20    10*     GS     GROUND SPEED                 M/SEC
C   21-22    11*     DA     DRIFT ANGLE (+ IS RIGHT)     DEG.
C   23-24    12      DIFCNT DECELERATOR                  SEC.
C   25-26    13*     G      VERTICAL ACCELERATION        M/S**2
C   27-28    14*     PITCH  PITCH (POS. IS UP)           DEG.
C   29-30    15*     ROLL   ROLL  (POS. IS RIGHT)        DEG.
C   31-32    16      ALPHA  ANGLE OF ATTACK              DEG.
C   33-34    17      BETA   YAW ANGLE (POSITIVE IS R.)   DEG.
C   35-36    18      VOR    VOR (ANGLE FROM STATION)     DEG. MAG.
C   37-38    19      DME    DME (DIST. FROM STATION)     KM
C   39-40    20      ROC    RATE OF CLIMB                M/S
C   41-42    21      TORQUE ENGINE TORQUE (LEFT)         FT-LBS
C   43-44    22      APIPCNT APIPS RELEASE VALVE         COUNTS
C   45-46    23      RALT1  RADAR ALTIMETER 1            M
C   47-48    24      TURB   INDICATED TURBULENCE         IT UNITS
C   49-50    25      TWODC  2-D CONCENTRATION, 2D-C      /LITER
C   51-52    26      TWODI  2-D DEPOL. CONC.             /LITER
C   53-54    27      CONC   FSSP DROPLET CONC.           /CM**3
C   55-56    28      ALWC   LIQ WATER CONTENT,FSSP       G/M**3
C   57-58    29      WC     LIQUID WATER CONTENT, JW     G/M**3
C   59-60    30      TWODP  2-D CONCENTRATION, 2D-P      /LITER
C   61-62    31      ONEDC  1D-C CONC (GT 25 UM)         /LITER
C   63-64    32      ANUC   NCAR ICE NUCLEUS COUNTER     #/LITER
C   65-66    33      XRR    A/C POSITION, E. OF CP3 (KM) --updated with DME
C   67-68    34      YRR    A/C POSITION, N. OF CP3 (KM) --updated with DME
C   69-70    35      CLWC   CSIRO LWC                    G/M**3
C   71-72    36*     WW     VERTICAL VELOCITY            M/SEC
C   73-74    37      XPNTR  LOCATION OF POINT WRT CP3    KM EAST
C   75-76    38      YPNTR  LOCATION OF POINT WRT CP3    KM NORTH
C   77-78    39      RHOLA  LYMAN-ALPHA VAPOR DENSITY,   G/M**3
C   79-80    40      Z      ALTITUDE                     M
C   81-82    41      TAS    TRUE AIRSPEED                M/SEC
C   83-84    42      WKI    CSIRO IWC METER POWER        WATTS
C   85-86    43      THETAE EQUIVALENT POTENTIAL T.      DEG.K
C   87-88    44*     HWDIR  HORIZ WIND DIRECTION         DEG. TRUE
C   89-90    45*     HWMAG  HORIZONTAL WIND SPEED        M/SEC
C    91                     PILOT EVENTS (BINARY)
C    92                     COPILOT EVENTS (BINARY)
C    93                     TECH. EVENTS (BINARY)
C    94                     DME SELECT FREQUENCY
C   (94)                    FILTER EVENTS (BINARY) : 1 -> CLOSED
C                           (1-PURGE;2-BACK AISLE;3-BACK WALL;

C                            4-FRONT; 6-ROT FILTER,OVERRIDE;
C                            7-ROT FILTER, STOP AT CAM; 8-INPUT OPEN)
C******C    95              NRIPS  ACCUMULATED TRIGGERS FROM R.I.P.
C    95              THUMBWHEEL EVENT
C    96              SCPP STATUS CODE FROM REAL-TIME PROGRAM
C   97-109           ONED   1D SPECTRUM, 13 CHANNELS    (#/LITER)
C    110             IVREJ  % ACCEPTED BY VEL REJ, FSSP
C    111             ACT    FSSP ACTIVITY FRACTION      (% THIS SEC)X10
C    112             IRNGA  FSSP RANGE (1 IS RANGE 3-31 UM)
C   113-127          FSP    FSSP SPECTRUM               (#/CM**3/UM)*10
C    128             FLAG   100*(ARCH. FMT CODE-40) + FIXED ZERO, SLOW-REC ID
C                           (*-INERTIAL DATA IF FMT CODE-41)
C
```

Table C.3. University of Wyoming King Air Archive Data Format (2D).

```
C   -----------2D ARCHIVE RECORDS-----------
C
C    1-2       1     YMD     YYMMDD - DATE
C    3-4       2     HMS     HHMMSS - TIME RECORDED
C    5-6       3     STIME   START TIME FOR RECORD*100.
C    7-8       4     ETIME   END TIME FOR RECORD *100.
C     9              NICE    NO OF ACCEPTED PARTICLES     TOTAL NO.
C    10              NWAT    NO PARTICLES SPHERICAL       TOTAL NO
C    11              NSTREK  NO REJECTED AS STREAKERS     TOTAL NO
C    12              IOL     OVERLOAD FLAG FOR 2D         0/1
C   13-14      7     TAS     TRUE AIRSPEED, 2-D           M/SEC
C   15-16      8     CONCI   AVE CONC, ALL PART.          /LITER
C   17-18      9     DCONCI  ERROR IN CONC, ALL PART      /LITER
C   19-20     10     CONCW   CONC OF SPHERICAL PART.      /LITER
C   21-22     11     DCONCW  ERROR IN SPH. PART CONC      /LITER
C   23-24     12     DBZI    DBZ AS IF C1G ICE XLS        DBZ
C   25-26     13     DBZG    DBZ AS IF SPH. GRAUPEL       DBZ
C   27-28     14     DBZW    DBZ AS IF WATER              DBZ
C   29-30     15     RRI     RAINFALL RATE IF SPH. GRPL   MM/HR
C   31-32     16     RR      RAINFALL RATE IF WATER       MM/HR
C   33-34     17     AIWC    ICE WATER CONTENT, C1G       G/M**3
C   35-36     18     AGWC    GRAUPEL WATER CONTENT        G/M**3
C   37-38     19     ARWC    RAIN WATER CONTENT           G/M**3
C   39-40     20     SVOL2   SAMPLE VOLUME FOR RECORD     LITERS
C   41-42     21     CONCD   DEPOL SIGNAL CONCENTRATION   /LITER
C   43-82            ICON    NO PARTICLES/SEC FROM STIME, BY SECONDS.
C   83-84     42     CONCAG  CONCENTRATION AGGREGATES     /LITER
C    85              NAGG    AGGREGATES, TOT #
C    86              NZERO   ZERO-AREA IMAGES, TOT #
C    87              NDEPOL  NUMBER OF DEPOL-SIGNAL PARTICLES
C   88-107           NSZI    20 SIZE CLASSES, ALL PRTCLS  TOT #
C  108-127           NSZW    20 SIZE CLASSES, SPH PRTCLS  TOT #
C    128             IPROB   PROBE FLAG, 1=C, 2=P
C
```

Table C.4. University of Wyoming King Air Archive Data Format (Air Motion).

```
C  -----------AIR MOTION SENSING ARCIVE RECORD -------
C
C   WORD    VALUE    NAME    DEFINITION                          UNITS
C   1-2       1      YMD     YYMMDD - DATE
C   3-4       2      HMS     HHMMSS - TIME RECORDED
C   5-6       3      PMB     PRESSURE                           MB
C   7-8       4      ROC     PRESSURE RATE OF CLIMB             M/S
C   9-10      5      AIAS    IDICATED AIRPSEED                  KTS
C  11-12      6      WCUNC   JW UNCORRECTED                     G/M**3
C  13-14      7      RALT2   RADIO ALTITUDE (FINE)              M
C  15-16      8      THI     TRUE HEADING (INS 5 HZ)            DEG.TRUE
C  17-18      9      HEAD    HEADING (MAGNETIC)                 DEG.MAG
C  19-20     10      GS      GROUND SPEED (DOPPLER)             M/S
C  21-22     11      DA      DRIFT ANGLE (+ R, DOPPLER)         DEG
C  23-24     12      GSI     GROUND SPEED (INS 1HZ)             M/S
C  25-26     13      G       VERTICAL ACCEL (GYRO)              M/S**2
C  27-28     14      PITCH   PITCH(+ UP) (GYRO)                 DEG
C  29-30     15      ROLL    ROLL (+ RIGHT)  (GYRO)             DEG
C  31-32     16      ALPHA   ANGLE OF ATTACK                    DEG
C  33-34     17      BETA    SIDESLIP ANGLE (+RIGHT)            DEG
C  35-36     18      VOR     VOR (ANGLE FROM STATION)           DEG. MAG.
C  37-38     19      DME     DME (DIST. FROM STATION)           KM
C  39-40     20      ACZ3    VERTICAL ACCEL (INS)               M/S**2
C  41-42     21      PITCHI  PITCH (INS)                        DEG
C  43-44     22      ROLLI   ROLL  (INS)                        DEG
C  45-46     23      THF     HEADING (INS, FINE RESOLV)         DEG.TRUE
C  47-48     24      WAI     PLATFORM WANDER ANGLE (INS)        DEG.TRUE (CCW, TRUE)
C  49-50     25      GSF     GROUND SPEED (10 HZ, INS)          M/S
C  51-52     26      DAI     DRIFT ANGLE (10 HZ, INS)           DEG
C  53-54     27      WGG     VERTICAL SPEED (GYRO)              M/S
C  55-56     28      WP3     VERTICAL SPEED (INS)               M/S
C  57-58     29      ALATI   LATITUDE (INS)                     DEG(POS. NORTH)
C  59-60     30      ALONI   LONGITUDE (INS)                    DEG(POS. EAST)
C  61-62     31      TKI     TRACK ANGLE (1 HZ, INS)            DEG.TRUE
C  63-64     32      TKF     TRACK ANGLE (10 HZ, INS)           DEG.TRUE
C  65-66     33      WK      CSIRO LWM POWER                    WATTS
C  67-68     34      TWIRE   CSIRO LWM WIRE TEMP                DEG. K
C  69-70     35      WI      VERTICAL WIND SPEED (INS)          M/S
C  71-72     36      WW      VERTICAL WIND SPEED (GYRO)         M/S
C  73-74     37      PITCHC  CORRECTED PITCH (GYRO)             DEG
C  75-76     38      A1      Y-INT FOR Re-Nu RELATION
C  77-78     39      B1      SLOPE FOR Re-Nu RELATION
C  79-80     40      TOVEN   ALTITUDE #1 OVEN TEMP              C
C  81-82     41      TAS     TRUE AIRSPEED                      M/S
C  83-84     42      HWDIRI  HORIZ WIND DIRECTION (INS)         DEG.TRUE
C  85-86     43      HWMAGI  HORIZ WIND MAGNITUDE (INS)         M/S
C  87-88     44      HWDIR   HORIZ WIND DIRECTION (DOPPL)       DEG.TRUE
C  89-90     45      HWMAG   HORIZ WIND MAGNITUDE (DOPPL)       M/S
C   91                       PILOT EVENTS    (BINARY)
C   92                       COPILOT EVENTS  (BINARY)
C   93                       TECH. EVENTS    (BINARY)
C   94                       DME SELECT FREQUENCY (E.G.11320)
C   95                       INS EVENTS (BINARY)
C   96                       INS STATUS (BINARY)
C   97                       INS LAST FRAME NUMBER

C   98                       SYNC TIME (MS*10)
C  99-100    50      DLAT    LATITUDE (LORAN)  DECIMAL, NORTH POSITIVE
C 101-102    51      DLON    LONGITUDE (LORAN) DECIMAL, EAST POSITIVE
C 103-104    52      MVAR    MAGNETIC VARIATION (LORAN), EAST POSITIVE
C  105               STATL   STATUS (LORAN), 0-9 (9 BEST)EAST POSITIVE
C  106               VALID   DATA VALIDITY (LORAN) 0-OK, 1-??, 2-BAD
C 107-127            SPARES
C  128               FLAG    100*(ARCH.CODE-40)+ 3
C
C
C--------------------------------------------------------------------
```

Table C.5. University of Wyoming King Air Data Tape Statistics.

Backup Tape Number	Raw Tape Number	Date	Number of Records on Raw Tape	Start Time	Stop Time	Brief Flight Description	Tape # of Total # Tapes for Flight
1	6142	870619	3398	71807	81418	TOWER FLYBY/INTERCOMPARISONS	1/ 3
1	6143	870619	3569	81421	91338		2/ 3
1	6144	870619	2864	91341	100116		3/ 3
2	6145	870622	3545	150823	160705	SHAKEDOWN-C2/C3/M1	1/ 3
2	6146	870622	3554	160707	170555		2/ 3
2	6147	870622	2049	170558	173951		3/ 3
2	6148	870623	3515	143519	153315	SEVERE STORMS/C2 PATTERNS	1/ 3
3	6149	870623	3521	153318	163040		2/ 3
3	6150	870623	302	163043	163542		3/ 3
3	6151	870624	2251	142418	150141	INTERCOMPARISONS/CP3 DOWN	1/ 1
3	6152	870625	3520	113211	123041	CI / TRIANGLE PATTERNS	1/ 5
4	6153	870625	3568	123044	132955		2/ 5
4	6154	870625	3493	132958	142754		3/ 5
4	6155	870625	3553	142756	152651		4/ 5
4	6156	870625	2198	152654	155853		5/ 5
5	6157	870627	3401	145617	155009	M1 PATTERNS / GUST FRONT	1/ 5
5	6158	870627	2841	155011	161838		2/ 5
5	6159	870627	3141	161839	170131		3/ 5
6	6160	870627	3546	170133	180016		4/ 5
6	6161	870627	1625	180018	182703		5/ 5
6	6162	870701	3467	154806	164420	M1 PATTERN PRACTICE/CLEAR AIR	1/ 2
6	6163	870701	1145	164422	170320		2/ 2
7	6164	870702	3476	144605	154339	CI/TORNADO FLIGHT	1/ 4
7	6165	870702	3542	154342	164221		2/ 4
7	6166	870702	3364	164224	173515		3/ 4
7	6167	870702	160	173518	173756		4/ 4
8	6168	870703	3488	132412	142209	CI/PRECURSOR C1/C2/C3	1/ 3
8	6169	870703	3551	142211	152107		2/ 3
8	6170	870703	1403	152109	154418		3/ 3
8	6171	870706	3056	181315	185520	MICROBURST EXPERIMENT	1/ 3
9	6172	870706	3447	185521	194936		2/ 3
9	6173	870706	1625	194939	201518		3/ 3
9	6174	870707	3464	154506	164218	MICROBURST / TORNADO SIGHTED	1/ 6
9	6175	870707	2752	164220	170631		2/ 6
10	6176	870707	2523	170633	172336		3/ 6
10	6177	870707	2530	172337	173827		4/ 6
10	6178	870707	2976	173830	181726		5/ 6
10	6179	870707	1620	181728	184113		6/ 6
11	6180	870708	3131	150206	154419	M1--ABOVE CLOUD BASE	1/ 4
11	6181	870708	2828	154422	161217		2/ 4
11	6182	870708	3001	161219	164946		3/ 4
11	6183	870708	2545	164948	173023		4/ 4
12	6184	870709	3314	151215	160320	MICROBURST MISSION	1/ 6
12	6185	870709	3008	160321	163906		2/ 6
12	6186	870709	2868	163909	171050		3/ 6
13	6187	870709	2949	171051	174409		4/ 6
13	6188	870709	2630	174410	180430		5/ 6
13	6189	870709	2251	180431	183548		6/ 6
13	6190	870716	3511	143732	153550	C1 & M1 PATTERNS	1/ 8
14	6191	870716	2796	153552	160246		2/ 8
14	6192	870716	3005	160247	163944		3/ 8
14	6193	870716	3055	163945	171716		4/ 8
15	6194	870716	2585	171717	173558		5/ 8
15	6195	870716	2908	173559	180657		6/ 8
15	6196	870716	2727	180658	183131		7/ 8
15	6197	870716	688	183132	184215		8/ 8
16	6198	870717	3487	160704	170417	CONVERGENCE LINE FLIGHT	1/ 2
16	6199	870717	1950	170419	173636		2/ 2
17	6201	870722	2934	154424	162047	M1: NORTH AND SOUTH EXCELLENT	1/14
17	6202	870722	2938	162048	165312		2/14
17	6203	870722	2723	165315	171816		3/14
18	6204	870722	2356	171818	172850		4/14
18	6205	870722	2314	172851	173542		5/14
18	6206	870722	2315	173543	174149		6/14
19	6207	870722	2673	174150	180352		7/14
19	6208	870722	151	180354	180622		8/14
19	6209	870722	2590	180919	182802		9/14
19	6210	870722	2548	182805	184412		

TABLE C.5., continued. University of Wyoming King Air Data Tape Statistics.

Backup Tape Number	Raw Tape Number	Date	Number of Records on Raw Tape	Start Time	Stop Time	Brief Flight Description	Tape # of Total # Tapes for Flight
							10/14
20	6211	870722	2474	184413	185738		11/14
20	6212	870722	2574	185740	191447		12/14
20	6213	870722	2753	191448	194012		13/14
20	6214	870722	1638	194014	200650		14/14
21	6215	870724	3527	65426	75303	TOWER FLYBY/INTERCOMPARISON	1/ 3
21	6216	870724	3558	75305	85212		2/ 3
21	6217	870724	365	85215	85817		3/ 3
21	6218	870724	3489	124431	134229	C1 MOISTURE MAXIMIUM	1/ 6
22	6219	870724	3550	134232	144130		2/ 6
22	6220	870724	3426	144132	153644		3/ 6
22	6221	870724	315	153647	154134		4/ 6
22	6222	870724	3506	154511	164326		5/ 6
23	6223	870724	1375	164329	170608		6/ 6
23	6224	870727	3495	161206	171010	DUAL DOPPLER GUST FRONT	1/ 2
23	6225	870727	3348	171012	180548		2/ 2
24	6226	870728	3480	150303	160052	MI+C2 IN GUST FRONT	1/ 5
24	6227	870728	3031	160054	163719		2/ 5
24	6228	870728	2814	163721	170641		3/ 5
25	6229	870728	3486	170642	180239		4/ 5
25	6230	870728	1839	180242	183311		5/ 5

Table C.6. Summary of NCAR King Air Research Flight Operations in CINDE.

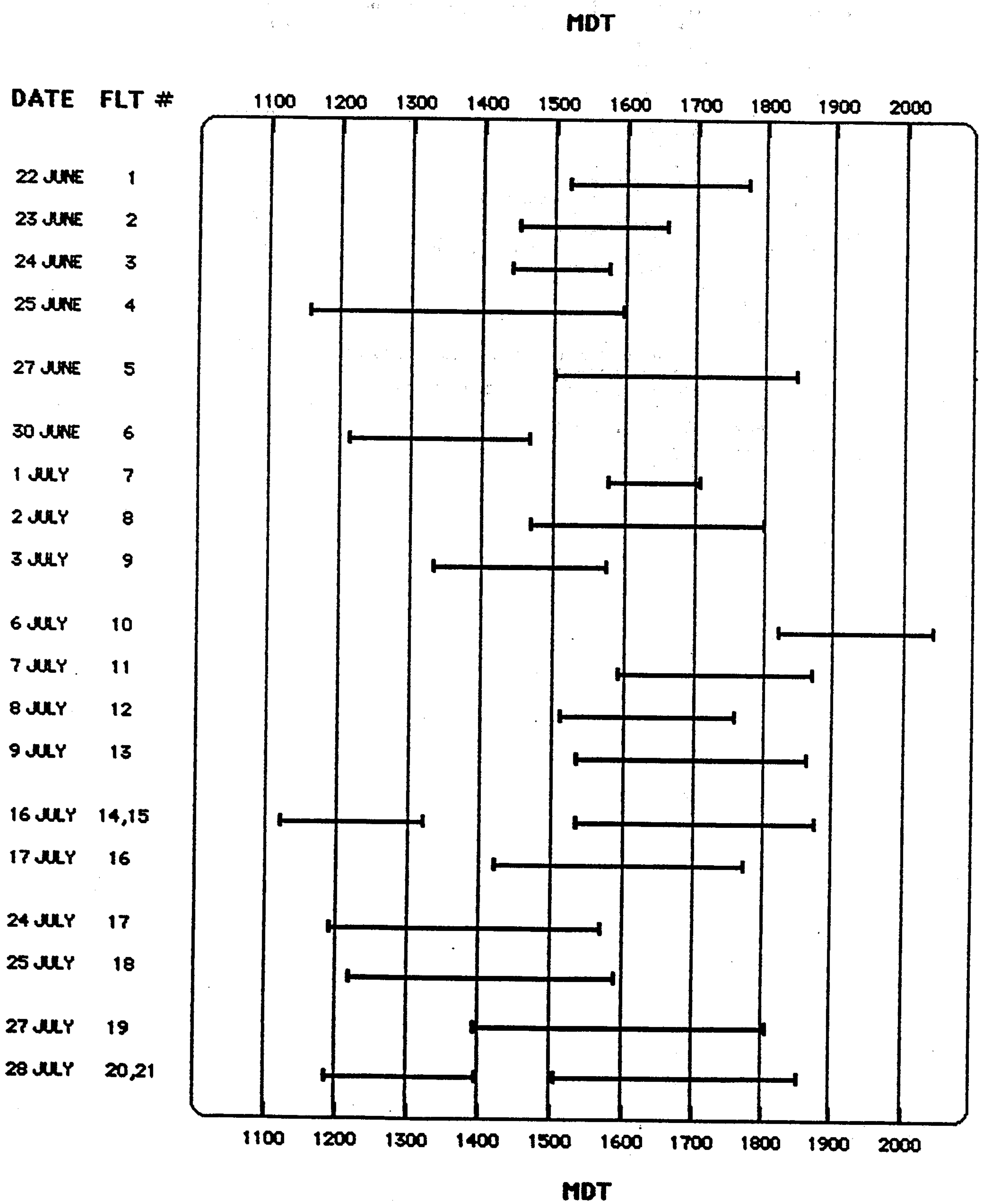


Table C.7. NCAR King Air Research Instrumentation.

RAF-Supplied Instrumentation:

I. Airborne Data System.
  A. Acquisition: King Air ADS (Motorola 68000 based), Kennedy Model 9800 Tape Drives. (2 units).
  B. Display: Hewlett-Packard Model 2113E Computer (1000 Series), HP Model 9885M Floppy Disk Drive, HP Model 9876A Printer, HP 85 Terminal, and Panasonic Model WV-5362 Twin Video Monitors, (2 units).

II. Aircraft Position, Velocity, and Attitude.
  A. Litton LTN-51 INS (Inertial Navigation System) located in the cabin. SN-877.
  B. LORAN C, Advanced Navigation Inc., ANI-7000.
  C. DME KDM-7000.

III. Static Pressures.
  A. Rosemount Model 1501 Digital Pressure Transducer - Fuselage Port (PSFD). SN-36.
  B. Rosemount Model 1201F1 Pressure Transducer - Right Wing Tip (PSW). SN-1510.

IV. Dynamic Pressures.
  A. Rosemount Model 1221F1VL (starboard wing tip). SN-1380.
  B. Rosemount Model 1221F (radome differential pressure). SN-1382.

V. Air Temperatures.
  A. Rosemount Type 102 Non-deiced Sensor -- Rosemount Model 510BF Amplifier (radome instrument ring mount). SN-2933.
  B. NCAR Reverse Flow Minco Sensor -- Rosemount Model 510BF. Amplifier (starboard wing tip). SN-86.
  C. Fast Response Temperature Probe, NCAR Built, (Sensor on Radome Extension).

VI. Dew Point and Humidity.
  A. EG&G Model 137-C3 Dew Point Hygrometers (2 units in Fuselage Mount (DPT, DPB). SN-1001, 641.
  B. NCAR Model LA-3 Lyman-alpha Hygrometer - Radome Mount (VLA1). Standard spacing (.5 cm) VMG 4-7-87.

VII. Flow Angle Sensors, Radome.
  A. Attack - Rosemount Model 1221FVL Differential Pressure Transducer (ADIFR). SN-1071.
  B. Sideslip - Rosemount Model 1221FVL Differential Pressure Transducer (BDIFR). SN-1093.
  C. Total Pressure - Rosemount Model 1201F Transducer (PTR). SN-1598.

VIII. Radio Altitude.
  A. Collins ALT-55 Radio Altimeter (HGM)

IX. Photography.
  A. Forward looking from cockpit: PULNIX Model TM-34K black and white camera, time and date superimposed. Images recorded on VCR in VHS format. Audio recording from copilots position.
  B. Radar photography. GE Model 1CVK 5032A color camera, time and date superimposed. Images recorded on VCR in VHS format.
  C. Left side view, color system.

X. Cloud Physics.
  A. Particle Measuring System/King Liquid Water Sensor.
  B. JW/Cloud Technology Liquid Water Sensor.
  C. Particle Measuring Systems Model Wing Mounted, 2D-C and 2D-P.
  D. Particle Measuring Systems Model FSSP Droplet Size Distribution, Wing Mounted, Range 3 to 45 μm and Resolution 3 μm.
  E. PMS 260X.

XI. Radiation Fluxes.
  A. Visible Radiation. Eppley Model PSP Pyranometer. Radiation Band .285 to 2.8 μm. Two Units: Top (SWT) and Bottom (SWB).
  B. Infrared Radiation. Eppley Model PIR Pyrgeometer. Radiation Band 4 to 45 μm. Two Units: Top (IRT) and Bottom (IRB).
  C. Surface Temperature. Barnes PRT-5, Downward Looking.
  D. Sky Temperature. Barnes PRT-5, Upward Looking.

XII. Miscellaneous.
  A. Event Recording from Cabin.

XIII. A. Ophir Air Temperature Radiometer.

XIV. A. Prototype Thermometer (Lawson).
  B. Wetted Thermometer System (Lawson).

XV. A. NATS - Test Evaluation Mode.

XVI. A. Engine Torque (A. Cooper) calibration available after flight #1.

Table C.8. NCAR King Air Data Tape Log.

O U T P U T   T A P E   L O G   DATE : 09 NOV. 1987

PROJECT NO TYPE : 282-HRT
AIRCRAFT : 312
SCIENTIST : FANKHAUSER

PROJECT NAME : CINDE
PROGRAMMER : GH
TAPE COPY : REIKO RAESE

TAPE TRACK : 9
TAPE DENSITY : 6250 BPI

	HEADER FILE	DATA FILE
# OF LOG. REC. PER PHYS. REC. :	10	1
TOTAL # OF BITS PER PHYS. REC. :	6400	66176
# OF PHYS. REC. IN HEADER FILE :	76	XXXX

NOTE: THE FIRST FILE OF EACH FLIGHT IS ALWAYS A HEADER FILE WHICH HAS 76 RECORDS.
THE FILE NUMBER OF THE HEADER OF EACH FLIGHT ON THE OUTPUT TAPE IS THE FIRST FILE NUMBER SHOWN ON THAT FLIGHT MINUS ONE.

FLT NO.	FLT DATE	START TIME	END TIME	INPUT VSN	FILE NO	OUTPUT TAPE	FILE NO	NO. OF RECORDS
1A	22JUN87	15: 6:27	16:55: 6	G55846	2	R00109	2	7519
1B	22JUN87	17: 1:21	17:42:38	G55847	2	B00109	4	2476
2	23JUN87	14:29: 4	16:36: 5	G55848	2	B00109	6	7621
3	24JUN87	14:22:49	15:40:53	G55850	2	B00110	2	4665
4A	25JUN87	11:53:10	12:14:15	G54579	2	B00242	2	1265
4B	25JUN87	12:28: 7	15:56:50	G55853	2	B00242	4	12523
5A	18JUN87	15: 6:45	16:27:50	G55872	2	B00116	2	4865
5B	25JUN87	16:28:15	18:27:17	G55873	2	B00116	4	7142
6A	26JUN87	12:17:32	14:03:31	G54892	2	B00119	2	7359
6B	01JUN87	14:06:23	14:43:17	G55877	2	B00119	4	2214
7	01JUL87	15:42: 7	16:59:19	G55878	2	B00119	6	4632
8A	02JUL87	14:53:36	16:40:49	G54893	2	B00121	2	6433
8B	02JUL87	16:42:24	17:56: 5	G55880	2	B00121	4	4421
9	03JUL87	13:20:56	15:41:29	G55881	2	B00122	2	9433
10	06JUL87	18:11:39	20:15:09	G55886	2	B00122	4	7410
11A	07JUL87	15:51:55	17:23:12	G55898	2	B00128	2	5478
11B	07JUL87	18:21: 1	18:41:49	G55990	2	B00128	4	1249
12A	08JUL87	15: 2:39	16:24:35	G55891	2	B00128	6	4925
12B	08JUL87	16:26:12	17:29:47	G54548	2	B00128	8	3815
13A	09JUL87	15:15:27	17:45:23	G55894	2	B00140	2	8996
13B	09JUL87	17:54:20	18:34: 5	G55896	2	B00140	4	2386
14A	16JUL87	12:22:23	13:05:35	G55903	2	B00140	6	322
14B	16JUL87	13:28:05	13: 5:35	G55903	2	B00140	8	2250
15	16JUL87	15:13:59	18:45:37	G55904	2	B00162	2	12698
16A	17JUL87	14: 8: 9	15:55: 0	G55895	2	B00200	2	6411
16B	17JUL87	15:56:48	17:32: 0	G55912	2	B00200	2	5712
17	24JUL87	11:54:43	15:38:44	G55915	2	B00218	2	13441
18	25JUL87	12: 5:14	15:50:26	G55918	2	B00224	2	13512
19	27JUL86	13:51:31	18: 2:12	G55921	2	B00232	2	14981
20	28JUL86	11:50:19	13:57:55	G55924	2	B00235	2	8656
21	28JUL86	15: 2: 4	18:14: 0	G55926	2	B00236	2	11516
T08	16JUL86	6:52:31	9:13:19	G55913	2	B00245	2	8449

Table C.9. NCAR King Air Video Tape Log.

CINDE #7-282

VIDEO TAPE LOG

TIME: MDT

DATE	FLIGHT#	RADAR	FORWARD	LEFT SIDE
22 June 1987	R1	15:08-17:38	15:30-17:30	15:09-17:38
23 June 1987	R2	14:45-16:35	14:53-16:35	14:53-16:35
24 June 1987	R3	14:27-15:42	14:34-15:42	14:27-15:42
25 June 1987	R4	11:35-15:57	11:35-15:57	11:35-15:57
27 June 1987	R5	15:04-18:27	15:04-18:27	15:04-18:27
30 June 1987	R6	12:17-14:43	12:17-14:43	12:17-14:43
1 July 1987	R7	15:40-17:01	15:40-17:01	15:40-17:01
2 July 1987	R8	14:47-17:57	14:47-17:57	14:47-17:57
3 July 1987	R9	13:19-15:43	13:19-15:47	13:19-15:47
6 July 1987	R10	18:08-20:14	18:08-20:14	18:08-20:14
7 July 1987	R11	15:52-18:43	15:52-18:43	15:52-18:43
8 July 1987	R12	15:03-17:28	15:03-17:28	15:03-17:28
9 July 1987	R13	15:16-18:34	15:16-18:34	15:16-18:34
16 July 1987	R14	11:18-13:07	11:18-13:07	11:18-13:07
16 July 1987	R15	15:14-18:45	15:14-18:45	15:14-18:45
17 July 1987	R16	14:09-17:35	14:09-17:35	14:09-17:35
24 July 1987	T8	-----------	06:52-09:13	06:52-09:13
24 July 1987	R17	11:55-15:38	11:55-15:38	11:55-15:38
25 July 1987	R18	12:03-15:49	12:03-15:49	12:03-15:49
27 July 1987	R19	13:51-18:05	13:51-18:05	13:51-18:05
28 July 1987	R20	-----------	11:52-13:57	-----------
28 July 1987	R21	15:02-18:32	15:02-18:32	15:02-18:32

NOTE: The time listed is the actual ADS clock for the start and stop for each video are not necessarily the displayed video time as is the case for the radar data for R11 and R12; in each case the displayed clock is in error, 8 hours slow, due to IRIG decode hardware failure. In the same vein, the Julian day on the radar video for R6-R13 = Julian day-80; on R1-R3 the Julian data is positioned such that it is difficult read, this was corrected on R4.

R14, the forward video being analyzed by Wendy.
R15, the lens zoom was not used on the radar camera.
R18,R20 forward video sent to Moti Segal at CSU (1-491-8533) prior to the end of CINDE.

Table C.10. UND Citation Instrumentation Specifications.

Parameter Measured	Instrument Type	Manufacturer and Model No.	Range	Response Time	Accuracy	Resolution
Temperature	Platinum Resistance	Rosemount Model 102 Probe 510B Signal Conditioner	-65°C to +50°C	1 sec nominal	±0.5°C	0.03°C
Reverse Flow Temperature	Platinum Resistance	Minco element Rosemount 510BF Signal Cond.	-65°C to +50°C	1 sec nominal	±0.5°C	0.03°C
Dew Point	Cooled Mirror	EG&G Model 137	-50°C to +70°C	2°C/sec max heating or cooling	±0.5°C 0° to 70°C ±0.6°C -30° to 0°C ±1.1°C -50° to -30°C	0.03°C
Static Pressure	Absolute Pressure	Rosemount 1201F1	0 to 1.0×10^5 nt/m^2	15 msec	300 nt/m^2	2.5nt/m^2
Altitude	INS and Static Pressure	Litton LTN-76 858AJ	0 to 13.7 km	-	uncertain due to lack of standard	2m
Attack Angle and Sideslip	Differential Pressure	Rosemount 1221F1, 858AJ	±3.45 nt/m^2	10 msec	±1.3 nt/m^2	1.7 nt/m^2
Indicated Airspeed	Differential Pressure	Rosemount 1221F	0 to 1.7×10^4 nt/m^2	0.3 msec	55 nt/m^2	2.1 nt/m^2

(continued)

TABLE C.10., continued. UND Citation Instrumentation Specification.

Parameter Measured	Instrument Type	Manufacturer and Model No.	Range	Response Time	Accuracy	Resolution
Heading	Inertial Nav System	Litton LTN-76 (with dual speed resolvers)	0-360°	42 msec update	±12 arc min	6 arc min
Pitch, Roll	INS	Litton LTN-76	-90° to +90°	42 msec update	±2 arc min	0.25 arc min
Vertical Accleration	INS	Litton LTN-76	30 to -10 m s^2	42 msec	0.1 m/s^2	0.01 m/s^2
Ground Speed	INS	Litton LTN-76	0 to 500 m/s	42 msec update	±0.5 m/s	.05 m/s
Position	INS	Litton LTN-76	±90° Lat ±180° Long	42 msec update	1.8 km per hour of Nav time (without update)	18 m
	and VOR DME	2 each Collins VIR30A and DME 40	0 to 360 deg	1 sec	±2 deg (VOR)	1 deg
			0 to 554 km		±0.4 km (DME)	0.2 km

(continued)

TABLE C.10., continued. UND Citation Instrumentation Specification.

Parameter Measured	Instrument Type	Manufacturer and Model No.	Range	Response Time	Accuracy	Resolution
Cloud Photographs	16 mm cameras	L-W International (Automax)	--	--	--	--
Liquid Water Content	Johnson-Williams Liquid Water Detector	Cloud Technology Inc.	0-9 g/m^3	1 sec	20%	0.05 g/m^3
Cloud Droplet Spectrum	Forward Scattering Spectrometer Probe	Particle Measurement Systems	0.5-47 μm	0.1 sec (counting interval)	±1 count	1 count
Ice crystals and water drops	Optical Array Probe 2D-C	Particle Measurement Systems	35-1100 μm	0.1 sec (counting interval)	±1 count	1 count
Large Particles	Optical Array Probe 200Y	Particle Measurement Systems	300-4500 μm	0.1 sec (counting interval)	±1 count	1 count
Icing Rate	Vibrating Cylinder	Rosemount Model 671FA	0-0.0251 cm before recycle	7 sec recycle	±.013 cm	0.003 cm

(continued)

TABLE C.10., continued. UND Citation Instrumentation Specification.

Parameter Measured	Instrument Type	Manufacturer and Model No.	Range	Response Time	Accuracy	Resolution
Time	Quartz Crystal Oscillation	Perkin-Elmer	24 hours	--	±1 sec/day	0.001 sec
Engine Fan Speed	Tach Generator	TRW GEU-7/A	0-105%	1 sec	±1.0%	0.025%

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Table C.11. Summary of UND Citation CINDE/FL–2 Missions.

Date	Time (Local)	Mission Type	Flight Patterns	Data Quality Observations	Comments
7 July	1718 1839	Test Flight	Intercomparison with King Airs		
8 July	1338 1702	CINDE + FL2	C-3	No 2D-C. Data interruption at 1631, otherwise good data.	Initial point 130/16. Initial heading 290 2 mi legs second point 105/20, 360 IH 3 min. legs. Good observations of outflow first part. Good measurements on intersecting boundaries, with storm developing overhead.
9 July	1511 1824	CINDE + FL2	C-2, Microburst	Good No-2DC	Cut short C-2 pattern for low level (1,000" AGL) microburst sampling over 20 penetrations through microbursts.
14 July	1631 1742	FL2		Good	Test FL2 Scan strategy.
16 July	1445 1757	CINDE + FL2	C-1 (2), M1	One data gap at 1527	IP 360/12 IH 030 (C-1) IP 350/10 IH 030 (C-1) Through boundary feature in light turbulence. IP 116/15.3 (M-1). No microbursts found.
17 July	1406 1700	CINDE + FL2	C-3	Good	3 C-3 patterns with observed wind shift and turbulence.
17 July	1749 1904	FL2		Good	Light to moderate turbulence in cloud turrets and rain shafts.
22 July	1545 1910	CINDE + FL2	M-1	Good	IP 330/25 and 329/32.6 Downdrafts up to 10 m/s.
24 July	0638 0904	CINDE + FL2	Tower fly by + intercomparison	Good	
24 July	1453 1708	CINDE + FL2	Cloud top and gust front	Data interruption at 1540	045/5 for cloud tops 120/8 for gust front
26 July	1415 1541	FL2	Investigate turbulence	Good	Mostly light turbulence.
27 July	1604 1757	CINDE + FL2	C-2	Good	IP 150/18 weak feature IP 110/20
28 July	1356 1712	CINDE + FL2	C-3 + microburst and turbulence	Good	IP 135/20 IH 260° MB waypoints 103/25, 134/27, 92/16. Moderate turbulence 86/22.3 in microburst.

TABLE C.11., continued. Summary of UND Citation CINDE/FL-2 Missions.

Date	Time (Local)	Mission Type	Flight Patterns	Data Quality Observations	Comments
29 July	1636 1923	CINDE + FL2	Gust front penetrations	Good	IP 345/15 IH 120°
30 July	1506 1746	FL2	Investigate turbulence	Good	Light to moderate turbulence.
31 July	1610 1801	CINDE + FL2	Cloud base investigation of microbursts	Good	Unable to get to location of best microburst due to high reflectivities.
1 August	1546 1709	FL2	Investigate turbulence	Good, except for brief gap at 1700	IP 157/35 and 155/33.5 Little turbulence observed.
2 August	1602 1840	CINDE + FL2	C-3	Gap at 1800 for 5 min.	NE-SW cloud line feature IP 135/20, 090/21, 100/20.
5 August	0946 1200	CINDE + FL2	Vertical cross section 8,000' to 21,000'	Good	Upper level warming experiment.
5 August	1737 1823	CINDE + FL2	Investigate turbulence	Good	Not much to work - returned early.

Appendix D. CINDE Sounding Summary.

Table D.1. Status of CINDE Soundings as of 19 November 1987.

Abbreviations for SOUNDING STATIONS are:

BYR - Byers Class
DVR - Denver Class
ELZ - Elizabeth Class
GDN - Golden Class
HUD - Hudson Class
C1.# - NCAR mobile sounding unit 1 followed by the launch number
C2.# - NCAR mobile sounding unit 2 followed by the launch number
C3.# - NOAA mobile sounding unit followed by the launch number.

A sounding preceeded by * indicate it has not been processed as of now.
Soundings preceeded by ** indicate they will NOT BE PROCESSED.

TIME listed is the actual release time to the nearest minute.

LOCATIONS are given in x,y coordinates and are measured in STATUTE MILES from CP-3.

COMMENTS contains information regarding thermodynamic and wind quality, and tells the status of soundings not yet processed.
The Class sites have codes describing the quality of the winds.
The following list gives the code name and it's definition.

4W - Good quality winds, no gaps. Weak filter may be required to eliminate minor glitches.

3W - The winds are significantly noisier than 4W winds and a stronger filter will be required to clean up the data.

2W - Significant gaps or missing winds.

1W - Virtually no useful wind data were recorded.

TABLE D.1., continued. Status of CINDE Soundings as of 19 November 1987.

22 JUNE 87:

STN	TIME	LOC (X,Y)	COMMENTS
GDN	0959		4W
DVR	1103		2W.
DVR	1410		1W.
C3.1	1534	7.9,-10.8	WINDS TO 540 MB.
C2.1	1535	7.3,-26.0	WINDS TO 480 MB.
BYR	1656		2W TO 550 MB - NO WINDS ABOVE. RH CALIB. PROBLEM.
HUD	1659		4W TO 560 - NO WINDS ABOVE
GDN	1700		4W TO 490 MB - NO WINDS ABOVE.
C1.1	1701	15.0,7.0	WINDS TO 490 MB.
C1.2	1900	15.0,6.0	WINDS TO 510 MB.
C2.2	1901	15.0,-8.0	WINDS TO ABOVE 300 MB. NOISY THERMO ABOVE CLOUD BASE.
C3.2	1903	0.25,0.25	WINDS TO 370 MB.

23 JUNE 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1058		4W.
* ELZ	1157		DIFFICULTY PRODUCING SOUNDING.
GDN	1159		3W.
BYR	1200		4W. RH CALIB MAY BE TOO LOW. SFC T,RH?
HUD	1200		4W. SFC T,RH?
C2.3	1201	0.0,0.0	LOST SIGNAL AT 700 MB.
* C3.3	1216	17.0,1.5	DISK FILE LOST. DATA NEEDS TO BE ENTERED BY HAND.
BYR	1301		4W. RH CALIB?
ELZ	1358		4W.
DVR	1359		2W. LARGE GAPS IN THE WINDS.
BYR	1400		3W. RH CALIB? SFC T,RH?
C3.4	1400	17.0.1.5	WINDS TO 470 MB. SIGNAL LOST AT 470 MB.
** GDN	1400		SONDE FAILURE - NO DATA AVAILABLE.
C1.3	1401	0.0,0.0	SIGNAL LOST AT 700 MB.
HUD	1402		1W. SFC T,RH? LOST SIGNAL AT 370 MB.
C1.4	1447	0.0,0.0	LOST SIGNAL AT 650 MB.
C3.5	1457	17.0,1.5	LOST SIGNAL AT 620 MB.
BYR	1500		1W. SFC T,RH? LOST SIGNAL ~ 500 MB.

	STN	TIME	LOC (X,Y)	COMMENTS
	ELZ	1500		1W. SFC T,RH?
	GDN	1500		1W (FEW WINDS 820-720 MB).
	DVR	1503		2W TO 450 MB - NO WINDS ABOVE.
*	C2.4	1505		DATA NEEDS TO BE ENTERED FROM DISK OR BY HAND.
	HUD	1510		2W TO 500 MB - NO WINDS ABOVE. SFC T,RH?

24 JUNE 87:

	STN	TIME	LOC (X,Y)	COMMENTS
	BYR	1059		2W TO 480 MB - NO WINDS ABOVE. RH CALIB?
	DVR	1059		4W.
	GDN	1059		4W.
	HUD	1100		3W TO 500 MB - NO WINDS ABOVE. SFC T,RH?
	C1.5	1103	8.0,-3.0	SIGNAL LOST AT 715 MB.
*	C2.5	1103	8.0,-3.0	NEED WIND DATA FROM DISK.
**	ELZ	1105		BAD SONDE - NO DATA AVAILABLE.
	ELZ	1358		1W. THERMO GAP 350-450 MB.
	DVR	1359		4W. SFC T,RH?
	BYR	1400		4W TO 540 - NO WINDS ABOVE.
	C1.6	1400	7.0,-25.0	SIGNAL LOST AT 600 MB.
	GDN	1400		4W TO 550 - NO WINDS ABOVE.
*	HUD	1400		DIFFICULTY PRODUCING SOUNDING..
	C2.6	1402	-4.0,15.0	WINDS TO 710 MB. SIGNAL LOST 490.
	C3.6	1403	17.0,1.5	SIGNAL LOST ~ 650 MB.

25 JUNE 87:

	STN	TIME	LOC (X,Y)	COMMENTS
	ELZ	0959		4W. SFC T,RH?
	BYR	1000		4W. SFC T,RH?
	HUD	1000		4W. SFC T,RH?
	C3.7	1001	0.5,0.0	NOT A GOOD SOUNDING - THERMO PROBLEMS. LOST SIGNAL 625 MB.
	GDN	1001		4W TO 450 MB - SIGNAL LOST AT 450 MB.
	ELZ	1158		4W TO 350 MB - NO WINDS ABOVE. SFC T,RH?
	BYR	1200		4W. WINDS TO 630 MB - NO WINDS ABOVE.
	C1.7	1200	17.0,2.0	WINDS TO 710 MB (CLOUD BASE).
*	C2.7	1200		DIFFICULTY READING THERMO DISK FILE.
	C3.8	1200	-9.6,1.5	WINDS TO 700 MB (CLOUD BASE).
	DVR	1200		4W.
	GDN	1200		4W. SFC T,RH?
	HUD	1200		2W. NO WINDS ABOVE 670 MB. SFC T,RH?

DVR	1359		4W.
BYR	1400		2W. NO WINDS ABOVE 500 MB. RH CALIB?
C1.8	1400	17.0,1.5	WINDS TO 660 MB (CLOUD BASE).
C3.9	1400	-11.2,-14.5	WINDS TO 700 MB (CLOUD BASE). SIGNAL LOST AT 350 MB.
ELZ	1400		1W. SIGNAL LOST AT 600 MB.
GDN	1400		3W. GAP - ALL DATA ~ 600 MB.
HUD	1400		4W. SFC T,RH?
C2.8	1402	16.0,-14.0	WINDS TO 560 MB.
HUD	1659		4W. SFC T,RH?
BYR	1700		4W. SFC T,RH?
C1.9	1700	17.0,1.5	SIGNAL LOST AT 710 MB.
GDN	1700		3W.
C2.9	1701	16.0,-14.0	SIGNAL LOST AT 710 MB.
C3.10	1701	-10.0,-13.5	WINDS TO 550 MB.
C2.10	1728	16.0,-14.0	SIGNAL LOST AT 710 MB.
C3.11	1900	6.0,-20.0	WINDS TO 650 MB.
C1.10	1900	17.0,1.5	WINDS TO 620 MB.
DVR	1900		3W.
* GDN	1900		POWER FAILURE - DATA NEEDS TO BE ENTERED BY HAND.
HUD	1900		4W. SFC T,RH.
* C2.11	1956		DIFFICULTY PRODUCING SOUNDING.

26 JUNE 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W. SFC T,RH?
DVR	1400		4W.

27 JUNE 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1059		4W.
DVR	1400		3W.
C1.11	1640	14.0,14.0	WINDS TO 510 MB (CLOUD BASE).
HUD	1641		1W.
* C2.12	1641		DIFFICULTY PRODUCING SOUNDING.
* C2.13	1734		DIFFICULTY PRODUCING SOUNDING.
ELZ	1742		1W. FEW WINDS SFC-660 MB.
C3.12	1758	15.3,-9.0	WINDS TO 550 MB.

TABLE D.1., continued. Status of CINDE Soundings as of 19 November 1987.

28 JUNE 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1059		3W. SFC TEMP.
HUD	1110		4W. SFC T,RH?
DVR	1235		2W. GLITCHES T,RH.
C1.12	1301	15.0,-9.0	WIND TO 430 MB.
C2.14	1310	16.8,1.8	JITTERY-PSBL WIND GLITCH ~ 480 MB.
DVR	1400		3 W. SFC T,RH?
C3.13	1430	15.3,-9.0	WIND TO 430 MB.
C2.15	1459	15.0,7.0	WIND TO 360 MB. INTERFERENCE ~350 MB.
C3.14	1551	13.1,-9.0	WIND TO 500 MB. INTERFERENCE < 340 MB.

29 JUNE 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		2W. GLITCHES
* DVR	1400		POWER FAILURE - DATA NEEDS TO BE ENTERED BY HAND.

30 JUNE 87:

STN	TIME	LOC (X,Y)	COMMENTS
* ELZ	0759		POWER FAILURE - DATA NEEDS TO BE ENTERED BY HAND.
* HUD	0759		DIFFICULTY PRODUCING SOUNDING.
C3.15	0800	17.0,1.5	NO WINDS DUE TO LOW OVERCAST. T,RH TO 390 MB.
GDN	0800		3W. GAP IN DATA 510-610MB. SFC T,RH?
BYR	0807		4W.
DVR	0823		2W. SFC T,RH?
C3.16	0834	17.0,1.5	T,RH,WINDS TO 530 MB. FEW GLITCHES
BYR	1109		4W. SFC T,RH?
ELZ	1109		2W. GAP 520-370 MB.
GDN	1110		4W. GAP IN WIND 470-570 MB. SFC T,RH?
HUD	1110		4W.
DVR	1111		4W. SFC T,RH?
C3.17	1112	17.0,1.5	WIND TO 530 MB.
C1.13	1114	-7.0,19.0	WIND TO 790 MB.
* C2.16	1126		DIFFICULTY READING THERMO DISK FILE.
ELZ	1329		1W. SFC T,RH?

GDN	1329		4W. SFC T,RH?
HUD	1329		3W. GAP IN WINDS 300-360 MB. GLITCH 600 MB. SFC T,RH
C1.14	1330	-7.0,19.0	WIND TO 790 MB.
C2.17	1330	27.0,22.0	WIND TO 700 MB.
DVR	1330		2W. GAP IN WINDS 410-660 MB. GLITCH 650 MB.
C3.18	1332	17.0,1.5	GAP IN DATA 570-690 MB. T,RH TO 495 MB.
BYR	1350		LOST SIGNAL AT 675 MB. 4W UP TO THAT POINT.
HUD	1529		4W. SFC T,RH?
C1.15	1530	-1.0,6.0	WIND TO 550.
C3.19	1530	17.0,1.5	NOISY THERMO. WINDS NEED WORK.
C2.18	1531		WIND TO 500. T,RH TO 330 MB.
BYR	1544		4W. SFC T,RH?

1 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W. SFC T,RH?
DVR	1400		4W.
* C2.19	1527		DIFFICULTY READING DISK, MAY NEED TO BE ENTERED BY HAND.
DVR	1603		2W.
C2.20	1605	-2.0,6.0	T,RH GOOD ONLY TO 700 MB, WIND TO 750 MB.
HUD	1623		4W. RH GLITCH 610-620 MB. SFC T,RH?
C1.16	1633	-7.0,19.5	WIND GLITCH 350 MB.
GDN	1734		3W. THERMO GLITCHES 600-650 MB.
C2.21	1742	5.0,7.0	WINDS UP TO 450 MB, T GLITCH 330 MB.
** C3.20	1832		VERY BAD SIGNAL - NOT WORTH PROCESSING.

2 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W. SFC T,RH?
ELZ	1259		4W ABOVE 630 MB - PROBLEMS BELOW.
HUD	1259		4W. SFC T?
DVR	1300		4W.
GDN	1300		4W TO 680 MB, 1W ABOVE. SFC T,RH?
BYR	1340		4W.
C2.22	1435	-6.8,19.3	WIND TO 490 MB. NOISY THERMO TRACE.
* C3.21	1435		DATA NEEDS TO BE ENTERED BY HAND.
DVR	1443		4W. RH GLITCH 470 MB.

HUD	1449		4W. RH GLITCH 470 MB.
GDN	1451		4W TO 450 MB, 1W ABOVE. IT'S LIKELY IT JUMPED TO ANOTHER SONDE ABOVE 450 MB.
ELZ	1452		1W. T TRACE OK - NO RH, NO WIND.
C1.17	1456	9.0,-2.0	LOST SIGNAL AT 785 MB.
BYR	1511		4W WINDS TO 500 MB, THEN LOST LORAN, NO WINDS ABOVE 500 MB.
* C2.23	1605		DIFFICULTY PRODUCING SOUNDING.
* C3.22	1605		DATA NEEDS TO BE ENTERED BY HAND.
GDN	1628		4W TO 650 MB - NO DATA ABOVE. T,RH GLITCHES BUT OK.
C1.18	1655	12.0,7.0	WIND OK TO 510 MB.
HUD	1711		2W LOST SIGNAL ABOVE 720 MB.

3 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
HUD	0929		4W. SFC T,RH?
ELZ	0930		2W. SFC T,RH?
GDN	0930		4W.
DVR	0935		4W. FEW GLITCHES IN TEMP
BYR	0936		4W.
ELZ	1114		2W. SFC T,RH?.
BYR	1115		4W. SFC T,RH?
C3.23	1115	9.2,-1.7	LOST SIGNAL AT 700 MB; WINDS TO 715 MB.
DVR	1115		4W. T GLITCH 580 MB.
HUD	1115		4W. SFC T,RH? RH GLITCHES 690-715 MB.
C2.24	1119	-1.8,6.5	LOST SIGNAL ABOVE 730 MB - NO WINDS.
GDN	1123		4W (3W 470-610 MB). THERMO GLITCHES.
HUD	1300		4W EXCEPT 440-520. SFC T,RH?
C1.19	1304	24.0,21.0	EXCELLENT DATA - MINOR WIND GLITCH ~ 350 MB.
BYR	1305		4W. SFC T?
C3.24	1305	17.0,1.5	GOOD WINDS TO 320 MB.
C2.25	1306	6.8,14.6	LOST SIGNAL AT 730 MB - OK BELOW.
DVR	1400		4W. SFC RH?
* ELZ	1459		DIFFICULTY PRODUCING SOUNDING.
BYR	1500		4W TO 400 MB - 2W ABOVE.
GDN	1500		4W. SFC RH? RH GLITCH 570 MB.
C1.20	1501	26.0,21.0	OK TO 350 MB-LOST SIGNAL-NOISY ABOVE 450 MB.
C3.25	1502	17.0,1.5	LOST SIGNAL ABOVE 550 MB, OK BELOW.
DVR	1505		4W EXCEPT 550-680 MB. FEW T GLITCHES.
* C2.26	1518		DIFFICULTY PRODUCING SOUNDING.
HUD	1524		4W TO 590 - NO WINDS ABOVE. SFC T,RH?
GDN	1644		4W. FEW T GLITCHES. SFC T,RH?

STN	TIME	LOC (X,Y)	COMMENTS
ELZ	1649		4W. RH GLITCH 720 MB.
BYR	1650		4W.
HUD	1650		4W. SFC T,RH?
C2.27	1651	-5.5,16.8	LOST SIGNAL AT 350 MB.
* C3.26	1651		WIND DATA NEEDS TO BE ENTERED FROM DISK OR BY HAND
C1.21	1652	23.0,22.0	NO THERMO DATA FROM 695-780 MB. WINDS OK TO 450 MB.
C3.27	1750	24.0,6.0	WINDS TO 370 MB - INTERFERENCE ABOVE 340 MB.
C1.22	1815	23.0,22.0	WIND GLITCH AT 450 MB.
C2.28	1827	6.8,14.6	LOST SIGNAL AT 430 MB - GOOD WINDS TO 440 MB.

4 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
C2.29	1358	-8.0,0.5	WINDS TO 500 MB; JITTERY THERMO.
* C1.23	1408		DIFFICULTY PRODUCING SOUNDING.
C3.28	1449	13.0,8.0	WINDS TO 550 MB. NOISY RH TRACE.
* C2.30	1530		THERMO DISK FILE CONTAINS NO DATA.
C1.24	1531	8.0,-8.5	LOST SIGNAL AT 630 MB; WINDS TO 650 MB.

5 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W.
DVR	1400		4W. SFC RH?

6 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W. SFC T,RH?
DVR	1400		3W. FEW GLITCHES IN THERMO DATA.
ELZ	1530		1W. SFC T,RH?
BYR	1635		4W TO 580 MB. MAJOR PROB WITH RH (TOO LOW).
HUD	1635		4W. SFC T,RH? FEW RH GLITCHES.
C2.31	1635	35.0,-12.0	WIND GLITCH ~ 390 MB - WINDS GOOD TO ABOVE 300 MB.
C3.29	1637	24.5,16.0	EXCELLENT SOUNDINGS. WINDS TO ABOVE 300 MB.
BYR	1745		4W TO 400 MB - NO WINDS ABOVE.

STN	TIME	LOC (X,Y)	COMMENTS
			MAJOR RH PROBLEM.
C3.30	1818	11.3,14.3	LOST SIGNAL AT 510 MB. WINDS TO 680 MB.
GDN	1820		3W TO 500 MB - 1W ABOVE. MAJOR RH GLITCHES ABOVE 500.
** HUD	1824		BAD SONDE - NO DATA AVAILABLE.
C1.25	1826	5.0,7.0	LOST SIGNAL BETWEEN 650-780 MB. WINDS GOOD TO ABOVE 300 MB.
HUD	1845		4W EXCEPT MISSING DATA 410-710 MB. SFC T?
C2.32	1905	15.5,-8.5	WINDS TO 450 MB.
ELZ	1919		1W - NO WINDS. SFC T?
BYR	1921		3W, EXCEPT 1W 510-620 MB. T GAP 580-620 MB. RH MAY BE LOW.
DVR	1932		3W TO 450 MB; 1W 450 TO 320 MB.
HUD	2040		3W. SFC T,RH? RH GLITCH 490-510 MB.

7 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1059		4W.
DVR	1400		4W EXCEPT BIG GAP 340-640 MB.
HUD	1423		4W. SFC T,RH?
BYR	1425		4W (3.5W). SFC T? RH MAY BE LOW.
ELZ	1426		3W TO 560 - NO WIND ABOVE. SFC T,RH? NOISY THERMO ABOVE 550.
GDN	1426		3W. SFC T,RH?
C1.26	1431	8.0,-1.0	WINDS TO 490 MB. GLITCHY RH 630-690 MB.
C2.33	1527	10.5,6.3	WINDS EXCELLENT TO ABOVE 300 MB.
C1.27	1554	8.0,-1.0	EXCELLENT WINDS TO 300 MB. GLITCHY IN WINDS ~ 370 MB. RH TRACE IN BL LOOKS FUNNY.
HUD	1555		4W TO 450. SFC T,RH?

8 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W.
ELZ	1229		3W. SFC T,RH?
C2.34	1231	2.0,-8.0	WINDS TO 360 MB. GLITCH IN WIND AT 440 MB.
ELZ	1359		1W. THERMO TO 410 MB. NO WINDS. T GLITCH 650 MB.
BYR	1400		4W. RH MAY BE LOW.
C2.35	1400	2.0,-8.0	WIND ONLY TO 760 MB. JITTERY THERMO DATA.
DVR	1400		4W.

GDN	1400		2W. RH GLITCHES. SFC T,RH?
HUD	1400		4W. ONE RH GLITCH ~ 715 MB. SFC T,RH?
C1.28	1401	25.0,10.0	THERMO TO 360 MB. WINDS TO 530 MB.
C3.31	1404	16.0,-13.5	THERMO OK TO 390 MB. WINDS TO 710 MB.
C2.36	1509	2.0,-8.0	WINDS TO 500 MB. GLITCHY T,RH.
C3.32	1512		
BYR	1520		2W - WINDS MISSING FROM 370-610 MB. T GLITCH 630-650 MB.
C1.29	1521	25.0,10.0	LOST SIGNAL AT 530, WINDS TO 530. NOISY R.H
BYR	1635		2W. RH GLITCH 490 MB.
C1.30	1635	25.0,10.0	LOST SIGNAL AT 680 MB.
HUD	1635		2W. LOST SIGNAL ~ 600 MB.
C2.37	1636	7.1,4.3	LOST SIGNAL AT 605 MB.
GDN	1637		1W. NO DATA BETWEEN 360-520 MB.
C3.33	1645	16.0,13.5	LOST SIGNAL AT 700 MB.
C2.38	1704	7.1,4.3	GOOD TO 450 MB - JITTERY.
C1.31	1706	25.0,10.0	GOOD TO 540 MB. NOISY RH.
BYR	1829		1W. NO WINDS.
C1.32	1851	15.0,6.0	NOISY THERMO. WINDS GOOD TO 660 MB.

9 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W.
* HUD	1100		POWER FAILURE - DATA NEEDS TO BE ENTERED BY HAND.
DVR	1315		4W. SFC T,RH?
* C2.39	1316		DIFFICULTY READING DISK.
C3.34	1317	6.0,10.5	WINDS TO 510 MB.
C1.33	1324	27.8,28.0	WINDS TO 410 MB. SFC T,RH?
ELZ	1514		2W.
BYR	1515		3W. BAD RH CALIB.
DVR	1515		4W.
GDN	1515		4W. SFC T,RH?
HUD	1515		2W. THERMO GLITCHES BELOW 530 MB.
C1.34	1516	8.0,16.3	WINDS TO 480 MB.
C3.35	1516	5.5,8.0	WINDS TO 460 MB. THERMO TO 340 MB.
* C2.40	1521		DIFFICULTY READING DISK.
C1.35	1549	8.0,16.3	LOST SIGNAL AT 680 MB.
C3.36	1554	5.5,8.0	LOST SIGNAL AT 500 MB.
C3.37	1652	5.5,8.0	WINDS GOOD TO 490 MB.
C1.36	1657	8.0,16.2	WINDS GOOD TO 500 MB.
GDN	1700		3W. GLITCHY T,RH. SFC T,RH?
HUD	1705		3W - SOME WINDS MISSING. RH GLITCHES.

* C2.41	1708		DIFFICULTY READING DISK.
DVR	1800		2W.
ELZ	1800		1W.
BYR	1806		2W. BAD RH CALIB.
* C2.42	1818		DIFFICULTY READING DISK.
C3.38	1818	15.5,-9.0	WINDS GOOD TO 390 MB.
* HUD	1915		DISK NOT READABLE - DATA NEEDS TO BE ENTERED BY HAND.

10 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W.
HUD	1252		4W. SFC T?
C1.37	1257	26.5,26.5	WINDS GOOD TO 390 MB.
C3.39	1258	24.5,6.0	EXCELLENT WIND AND THERMO DATA.
C2.43	1259	6.2,2.5	LOST THERMO AT 710MB. LOST WINDS AT 730 MB.
HUD	1414		3W.
BYR	1415		3W. BAD RH CALIB.
C1.38	1415	26.5,26.5	WIND ANDLE GLITCH ~ 450 MB.
DVR	1415		3W.
ELZ	1415		2W. RH SEEMS LOW.
GDN	1415		4W. SFC T,RH.
C3.40	1424	16.3,6.4	WINDS TO 460 MB.
C2.44	1427	8.6,-11.2	WINDS TO 400 MB. JITTERY THERMO
C1.39	1545	26.5,26.5	WINDS TO 550.
C3.41	1545	16.3,6.4	WINDS/THERMO TO 500.
DVR	1545		2W. FEW THERMO GLITCHES.
GDN	1545		4W. SFC T,RH?
HUD	1545		3W.
C2.45	1547	8.6,-11.2	WINDS TO 500 MB.
ELZ	1546		4W.
BYR	1549		2W. LOST SIGNAL AT 390 MB. BAD RH.
C1.40	1700	26.5,26.5	WINDS TO 480 MB.
C2.46	1700	8.6,-11.2	EXCELLENT; WINDS/THERMO TO ABOVE 300 MB.
C3.42	1702	16.3,6.4	WINDS TO 370 MB.
GDN	1704		1W. JUMPED TO ANOTHER SONDE AT 730 MB.
ELZ	1706		3W.
BYR	1707		3W. BAD RH.
HUD	1714		1W. NOISY RH. NOT A GOOD SOUNDING.
BYR	1804		3W. BAD RH.
ELZ	1807		2W TO 500 MB - NO WINDS ABOVE.

11 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
* DVR	1100		NEED DATA FROM DISK.
GDN	1300		4W.
HUD	1302		4W ABOVE 500 MB, 1W BELOW. GAP IN THERMO 510-730 MB. SFC T,RH?
DVR	1400		2W - WINDS TO 520 - NONE ABOVE. THERMO OK.
C3.43	1430	17.0,1.5	WINDS TO 680 MB. THERMO OK.
C3.44	1609	17.0,1.5	WINDS TO 620 MB. THERMO NOISY ABOVE 550 MB.
DVR	1618		1W, NO WINDS. THERMO OK.
C1.41	1700	7.0,14.5	WINDS TO 600 MB. NOISY THERMO.
* C3.45	1702		THERMO DATA NEEDS TO BE ENTERED FROM DISK OR BY HAND.
ELZ	1806		2W - WIND TO 600 MB - NONE ABOVE.
BYR	1810		2W - WINDS OK ABOVE 430 MB - NONE BELOW.
C1.42	1843	7.0,14.5	WINDS TO 600 MB.

12 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W.
ELZ	1334		1W. THERMO TO 380 MB.
BYR	1338		4W.
DVR	1400		4W.

13 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1106		2W TO 650 MB - 4W ABOVE.
DVR	1400		2W.
C3.46	1407	17.0,1.5	WINDS TO 600 MB.
ELZ	1654		3W.
C2.47	1659	15.0,-40.0	WINDS AND THERMO TO 420 MB.

14 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1059		3W.

DVR	1400		2W.

15 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		2W.
GDN	1230		4W. SFC T,RH?
BYR	1329		4W. RH BAD.
* C2.48	1337		DIFFICULTY PRODUCING SOUNDING.
DVR	1400		2W - VERY NOISY WIND.
ELZ	1529		2W.
** C3.47	1537		BUSTED LAUNCH - NO FILE!
* C2.49	1620		DIFFICULTY PRODUCING SOUNDING.

16 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		3W.
DVR	1330		3W.
C3.48	1331	3.5,15.5	WINDS TO 400 MB. RH PROBLEM.
HUD	1549		4W TO 500 MB - NO DATA ABOVE.
* C1.43	1550		NEED WIND FILE FROM DISK.
C2.50	1550	-0.5,21.5	WINDS TO ABOVE 300 MB; FEW WIND GLITCHES.
C3.49	1550	3.5,15.5	LOST SIGNAL AT 490 MB; OTHERWISE, GOOD WIND AND THERMO.
DVR	1550		3W.
* GDN	1550		POSS. POWER FAILURE - DATA MAY NEED TO BE ENTERED BY HAND.
C1.44	1705		CAN'T READ THERMO.
C2.51	1805	8.5,-4.5	WINDS TO 500 MB.
* C1.45	1808		NEED WIND FILE FROM DISK.
C3.50	1811	5.0,6.5	LOST SIGNAL AT 520 MB; WINDS TO 520 MB.
BYR	1823		4W. BAD RH.

17 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W. FEW THERMO GLITCHES.

HUD	1115		3W. NOISY RH TO 600 MB.
DVR	1215		2W. WIND GAP 600 TO 480 MB.
GDN	1215		3W TO 560 MB - NO WINDS ABOVE.
HUD	1215		2W. SEVERAL GAPS IN WIND. RH GLITCH 780 MB.
C3.51	1218	17.0,1.5	WINDS TO 350 MB
BYR	1219		4W. BAD RH.
ELZ	1220		1W. BAD SONDE - NO USEFUL DATA; JUMPED TO ANOTHER SONDE.
BYR	1345		2W. SEVERAL GAPS IN WIND AND THERMO.
C1.46	1345	23.0,-11.0	EXCELLENT WINDS AND THERMO TO ABOVE 300 MB.
DVR	1345		2W. BIG WIND GAP 670-390 MB.
C3.52	1347	17.0,1.5	EXCELLENT WINDS AND THERMO TO ABOVE 300 MB.
C2.52	1358	29.8,3.2	LOST SIGNAL AT 480 MB. WINDS TO 520 MB.
HUD	1400		4W.
BYR	1530		4W. RH QUESTIONABLE.
DVR	1530		2W - NO WINDS ABOVE 600 MB.
GDN	1530		2W - BIG GAP IN WINDS 580-350 MB.
C3.53	1531	17.0,1.5	LOST SIGNAL ~ 500 MB.
C2.53	1532	10.8,14.8	JITTERY DATA; OTHERWISE, GOOD THERMO AND WINDS TO ABOVE 300 MB.
C1.47	1533	24.0,13.0	WINDS TO 650 MB. THERMO TO 440 MB.
* ELZ	1533		SFC DATA INCORRECT - NEEDS WORK.
HUD	1612		3W TO 500 MB. LOST SIGNAL AT 500 MB. SFC T,RH?
C2.54	1635	10.8,14.8	WINDS TO 550 MB. RH GLITCHES. THERMO GAP 530-420 MB.
C1.48	1638	24.0,13.0	SIGNAL LOST AT ~ 630 MB.
C3.54	1638	17.0,1.5	WINDS/THERMO TO 360 MB. NO RH DATA.
HUD	1640		4W. SFC T,RH? FEW T,RH GLITCHES.
DVR	1642		2W. WIND GAP 500-380 MB. T,RH GLITCHES.
GDN	1644		3W TO 520 MB - NO WINDS ABOVE.
ELZ	1647		1W - NO WINDS. THERMO TO 480. NOT A GOOD SOUNDING.
BYR	1656		DATA NEEDS TO BE ENTERED INTO VAX BY HAND.
C3.55	1709	17.0,1.5	THERMO TO ~ 485 MB. WINDS TO ~ 650 MB. T,RH GLITCHES.
HUD	1745		4W TO 600 MB - NO WINDS ABOVE. T,RH GLITCHES.
C2.55	1747	11.0,14.8	WINDS TO 610 MB (CLOUD BASE). THERMO A BIT NOISY.
C3.56	1801	17.0,1.5	WINDS TO 640 MB (CLOUD BASE); NOISY ABOVE.

18 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		3W.

C3.57	1326	17.0,1.5	NO PROBLEMS, WINDS TO 300 MB.
DVR	1345		4W.
HUD	1345		4W. SFC T?
C2.56	1346	32.0,4.0	WINDS TO 400 MB.
C3.58	1409	17.0,1.5	WINDS TO 300 MB.
* C3.59	1507		DIFFICULTY PRODUCING SOUNDING.
C3.60	1525	17.0,1.5	WINDS TO 300 MB.

19 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1059		4W.
DVR	1300		3W.
C1.49	1425	24.5,-5.3	WINDS TO 400 MB.
C2.57	1640		CAN'T READ THERMO FILES.
C2.58	1804		CAN'T READ THERMO FILES.
C3.61	1816	0.5,15.5	WINDS TO 500 MB.

20 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		2W.
DVR	1400		2W. RH GLITCHES.
C3.62	1410	14.0,1.5	WINDS TO 300 MB.
C2.59	1437	-28.0,-3.0	WINDS TO 490 MB (CLOUD BASE).

21 JULY 87

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		3W.
GDN	1229		3W TO ~ 560 MB - NO WINDS ABOVE. SFC T,RH?
* HUD	1229		DIFFICULTY PRODUCING SOUNDING.
DVR	1230		2W TO ~ 570 MB - NO WINDS ABOVE. NOISY T,RH.
BYR	1231		2W. WIND GAP 400-550 MB. PSBL RH PROBLEMS.
ELZ	1231		2W. BIG WIND GAP 750-450 MB.
C2.60	1239	15.6,6.8	WINDS TO 300 MB. NOISY T,RH.
C1.50	1241	16.0,-16.0	LOST SIGNAL AND WINDS AT 420 MB.
DVR	1400		3W - WIND GAP ABOVE 400 MB.

GDN	1644		3W. SFC T,RH?
BYR	1645		3W. RH PROBLEM.
HUD	1645		4W. SFC T,RH?
C2.61	1646	17.1,1.9	WINDS TO 300 MB.
ELZ	1646		1W. SFC T,RH?

22 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
HUD	0800		4W. SFC T,RH?
C3.63	0804	FLAG. PROF.	WINDS TO 340 MB.
HUD	1005		4W. I/C WITH C1 AND C2.
C1.51	1006		I/C WITH C2 AND HUD.
C2.62	1006	9.5,21.5	I/C WITH C1 AND HUD.
DVR	1100		2W.
HUD	1100		4W.
* C3.64	1102	FLAG. PROF.	DATA NEEDS TO BE READ FROM DISK.
C3.65	1400	FLAG. PROF.	WINDS TO 600 MB.
DVR	1400		2W.
HUD	1400		4W.
HUD	1531		4W.
C2.63	1621	15.4,19.0	WINDS TO 400 MB.
C1.52	1653	5.0,8.0	WINDS TO 580 MB.
C3.66	1659	FLAG. PROF.	WINDS TO 300 MB. T GLITCH 330 MB.
HUD	1700		4W TO 500 MB - MISSING ABOVE.
GDN	1711		2W. SFC T,RH?
ELZ	1712		1W. FEW NOISY WINDS 800-750 MB.
BYR	1747		4W. RH PROBLEM (CALIB. TOO LOW).
C1.53	1755	-6.0,8.0	WINDS TO 420 MB (NEED WORK ABOVE 520). MISSING THERMO DATA 520-440 MB.
DVR	1755		3W.
C2.64	1756	8.3,-1.5	WINDS TO 400 MB.
C2.65	1847	8.3,-1.5	WINDS TO 600 MB.
DVR	1853		2W - WINDS TO 550 MB - NONE ABOVE.
BYR	1916		2W. BIG GAP IN WINDS 680-380 MB. RH PROBLEM.
ELZ	1918		2W ABOVE 550 MB - NO WINDS BELOW.

23 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
C3.67	0800	FLAG. PROF.	WINDS TO ABOVE 300 MB.
HUD	0800		4W. SFC T,RH?

	C3.68	1059	FLAG. PROF.	WINDS TO ABOVE 300 MB. THERMO GLITCH 500 MB.
	DVR	1100		2W. MISSING WINDS 590-510 MB.
	HUD	1100		4W. SFC T?
	C3.69	1400	FLAG. PROF.	WINDS TO 430 MB.
	DVR	1400		4W.
**	HUD	1400		BAD SONDE - NO GOOD DATA AVAILABLE.
*	HUD	1425		DIFFICULTY PRODUCING SOUNDING.
	GDN	1605		4W. SFC T,RH?
	BYR	1615		4W. RH CALIB TOO LOW.
	C3.70	1700	FLAG. PROF.	WINDS TO ABOVE 300 MB.
	HUD	1700		4W. LOST SIGNAL (THERMO AND WINDS) AT 610 MB.

24 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
GDN	1059		3W. THERMO GLITCHES ~ 550 MB. SFC T,RH?
DVR	1100		3W.
ELZ	1100		2W. WIND GAP 680-410 MB.
HUD	1100		4W. SFC T,RH?
BYR	1115		4W. RH APPEARS TO BE OK.
C3.71	1218	17.0,1.5	WINDS TO 300 MB.
C2.66	1226	15.0,-9.0	WINDS TO 300 MB.
BYR	1300		4W. RH CALIB. TOO LOW.
C1.54	1300	1.0,-11.0	SIGNAL LOST AT 690 MB.
GDN	1300		3W.
HUD	1300		2W. WIND GAP 690-480 MB.
DVR	1301		2W. SFC T,RH?
ELZ	1301		2W. WINDS - VERY NOISY TO 540 MB - NONE ABOVE.
C3.72	1304	17.0,1.5	LOST SIGNAL AT 760 MB.
C2.67	1306	15.0,-9.0	LOST SIGNAL AT 550 MB. PROBLEMS WITH THERMO DATA.
C1.55	1345	1.0,-11.0	WINDS TO ABOVE 300 MB.
C2.68	1345	15.0,-9.0	LOST SIGNAL 510 MB. WINDS TO 560 MB.
C3.73	1426	5.0,6.5	WINDS TO 500 MB. THERMO GAP 500-400 MB.
C2.69	1452	10.0,-9.0	WINDS TO 650 MB.
C1.56	1454	-5.0,-13.5	WINDS TO 420 MB.
BYR	1500		2W - GAP 690-550. RH CALIB. TOO LOW.
DVR	1500		4W.
ELZ	1500		2W. FEW WINDS 750-650. SFC T,RH?
GDN	1500		2W. VERY NOISY WIN. THERMO OK.
DVR	1558		2W. FEW VERY NOISY WINDS TO 500 MB - NONE ABOVE.

HUD	1605		2W. FEW VERY NOISY WINDS. THERMO GAP 530-390 MB.
GDN	1703		3W TO 450 - NO WINDS ABOVE. SFC T,RH?
BYR	1710		4W. RH CALIB. PROBLEM.
C1.57	1710	16.0,-14.0	SIGNAL LOST AT 705 MB.
C2.70	1712	10.0,-9.0	SIGNAL LOST AT 475 MB.
HUD	1716		3W.
C3.74	1721	-7.9,15.4	SIGNAL LOST AT 610 MB.
ELZ	1749		2W - VERY NOISY WITH GAPS. SFC T,RH?
C1.58	1801	10.5,-13.0	WINDS TO 560 MB.
BYR	1830		2W. RH CALIB PROBLEM.
C1.59	1906	10.0,-13.0	WINDS TO 540 MB.
BYR	1917		3W TO 510 MB. NO THERMO OR WIND DATA ABOVE 510 MB. RH CALIB. PROBLEM.
ELZ	1921		1W. FEW WINDS 750-690 MB.

25 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
BYR	1100		3W. RH CALIB. PROBLEM.
DVR	1100		3W.
ELZ	1100		1W. RH CALIB. PROBLEM.
GDN	1100		4W.
HUD	1100		3W. WIND GAP 630-560 MB.
C1.60	1109	17.0,2.0	WINDS TO 380 MB. MAJOR THERMO GLITCHES.
C1.61	1246	17.0,2.0	WINDS TO 430 MB - LOST SIGNAL AT 430 MB.
BYR	1300		3W. RH CALIB. PROBLEM.
ELZ	1300		1W. RH CALIB. PROBLEM.
GDN	1300		3W - GAP 650-450 MB. NOISY THERMO DATA.
HUD	1300		3W.
DVR	1301		4W.
C2.71	1510	-11.5,10.5	WINDS TO 300 MB. AZ, EL GLITCHES - NEED REPAIR. MAJOR WIND ANGLE PROBLEM.
C3.75	1516	-19.0,15.5	WINDS TO 650 MB.
C1.62	1645	23.5,-4.5	EXCELLENT SOUNDING. WINDS ABOVE 300 MB.
C2.72	1655	-18.0,4.0	WINDS TO 350 MB - GLITCHES. THERMO GAP 620-520 MB.
ELZ	1700		2W. SFC T,RH?

26 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
C1.63	1100	0.25,0.25	EXCELLENT SOUNDING. I/C WITH DVR.

DVR	1100		3W.
C1.64	1303	0.25,0.25	I/C WITH DVR.
C3.76	1300	0.25,0.25	WINDS TO 450 MB. I/C WITH DVR.
HUD	1300		4W TO 450 MB - NO WINDS ABOVE.
DVR	1302		2W. I/C WITH C1.
GDN	1507		4W.
* C2.73	1704		NEED WIND FILE FROM DISK.
DVR	1703		4W. I/C WITH NWS, C1, AND C3.
C3.77	1704	0.25,0.25	PRESSURE OFFSET NEEDS CORRECTING. I/C.
C1.65	1706	0.25,0.25	LOST SIGNAL AT 700 MB. I/C.
* C2.74	1808		RERELEASED AT 1821
* C2.75	1821		NEED WIND FILE FROM DISK OR ENTER BY HAND.

27 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1059		2W - WINDS GAP - 540-350 MB.
ELZ	1229		1W. NO WINDS.
C1.66	1230	-40.0,0.0	WINDS TO 510 MB.
GDN	1230		4W. NOISY THERMO DATA.
C2.76	1234	0.25,0.25	WINDS TO 450 MB. THERMO GAP 650-780 MB. I/C.
C3.78	1234	0.25,0.25	WINDS TO ABOVE 300 MB. I/C.
BYR	1450		4W TO 550 MB - LOST SIGNAL; REGAINED AT 330 MB. RH CALIB PROBLEM.
C2.77	1450	25.5,-1.9	WINDS TO ABOVE 300 MB. I/C.
DVR	1450		2W. FEW WINDS BELOW 500 MB.
* C1.67	1452		DIFFICULTY PRODUCING SOUNDING.
C3.79	1452	29.0,-2.7	WINDS TO ABOVE 300 MB. I/C.
GDN	1525		4W. SFC T,RH?
GDN	1654		2W. LARGE GAP IN WIND AND THERMO DATA.
BYR	1655		4W. RH CALIB PROBLEM.
C1.68	1655	20.5,-0.5	WINDS TO 300 MB - NEED WORK.
C2.78	1655	12.7,-2.0	WINDS TO 550 MB.
C3.80	1655	18.2,-0.8	WINDS TO 450 MB.
DVR	1655		3W.
ELZ	1709		1W. NO WINDS. SFC PRESSURE ENTERED WITHOUT DECIMAL POINT.

28 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		2W - NOISY WINDS - BIG GAP.
C1.69	1315	9.0,40.0	WINDS TO 500 MB.
C2.79	1318	14.0,49.5	WINDS TO 500 MB.
C3.81	1325	17.2,59.1	WINDS TO 450 MB.
GDN	1325		3W. SFC T,RH?
ELZ	1412		1W. FEW WINDS 800-700 MB. THERMO GLITCH 650-690 MB.
DVR	1416		2W. LOST SIGNAL 630 MB.
DVR	1439		2W. PROBLEM WITH RH TRACE 450-610 MB.
C1.70	1530	24.0,-11.0	WINDS TO 550 MB. NOISY THERMO ABOVE CLOUD BASE.
C2.80	1530	11.0,-8.8	WINDS TO 600 MB.
BYR	1540		2W. RH CALIB PROBLEM.
GDN	1540		2W. NOISY THERMO.
ELZ	1541		1W. NO WINDS.
HUD	1604		3W - LOST SIGNAL ~ 600 MB.
C3.82	1617	5.5,8.0	WINDS TO 620 MB.
C1.71	1637	22.0,6.0	WINDS TO 510 MB.
C2.81	1639	8.4,-1.8	BAD SOUNDING - LOUSY DATA.
C3.83	1644	5.5,8.0	LOST SIGNAL AT 640 MB. WINDS NEED WORK.
* HUD	1652		NEED DATA FROM DISK OR ENTER BY HAND.
C3.84	1708	5.5,8.0	WINDS TO 600 MB.
BYR	1731		2W - NO WINDS ABOVE 610 MB. RH CALIB PROB.
HUD	1747		2W - LARGE GAP 600-350 MB.
GDN	1749		4W. SFC T,RH?

29 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W.
ELZ	1222		3W.
DVR	1400		2W.
C1.72	1550	5.0,8.0	WINDS TO ABOVE 300 MB.
C3.85	1550	10.0,-9.0	WINDS TO 520 MB.
C2.82	1555	-11.5,-14.5	WINDS TO 500 MB.
BYR	1600		4W. RH CALIB FINALLY FIXED.
DVR	1600		3W.
GDN	1630		3W.
C1.73	1702	-2.0,13.5	LOST SIGNAL AT ~ 485 MB.

TABLE D.1., continued. Status of CINDE Soundings as of 19 November 1987.

			AZ/EL GLITCH IN WINDS ~ 620 MB.
C3.86	1702	5.0,8.0	LOST SIGNAL AT ~ 550 MB.
C2.83	1817	17.5,-8.8	WINDS TO 580 MB (CLOUD BASE). DATA ABOVE 450 MB QUESTIONABLE.
C3.87	1817	8.0,-2.0	WINDS TO 600 MB.
HUD	1830		WINDS TO 620 MB. SIGNAL LOST AT 415 MB.
ELZ	1839		1W. NO WINDS.
BYR	1841		4W. GOOD RH.

30 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		3W.
C1.74	1131	0.0,0.0	I/C WITH C3 AT CP-3 - ONE SONDE.
C3.88	1131	0.0,0.0	I/C WITH C1 AT CP-3 - ONE SONDE.
DVR	1400		4W.
C3.89	1555	-2.5,-15.5	WINDS TO 500 MB.
C1.75	1602	16.0,-14.0	WINDS TO 600 MB.
C2.84	1732	-14.0,4.0	WINDS TO 550 MB (CLOUD BASE).
C3.90	1733	-4.5,-13.5	WINDS TO 590 MB.
C2.85	1815	-14.0,4.0	WINDS TO 500 MB. SIGNAL LOST AT 370 MB.
C3.91	1815	-4.5,-13.5	WINDS TO 400 MB. THERMO GLITCHES.
C1.76	1831	5.5,8.5	SIGNAL LOST AT 480 MB. WINDS TO 500 MB. THERMO GLITCHES.
DVR	1841		4W. WINDS TO 350 MB. SIGNAL LOST AT 350 MB.

31 JULY 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W.
DVR	1400		2W. WINDS GOOD TO ~ 600 MB.
GDN	1500		4W.
C3.92	1532	-4.5,16.0	LOST SIGNAL AT 390 MB.
C1.77	1533	5.0,8.0	WINDS TO 420 MB. AZ/EL GLITCH ~ 550 MB.
DVR	1538		3W.
HUD	1538		4W. LOST SIGNAL AT 540 MB. SFC RH?
C2.86	1617	3.5,-9.0	WINDS TO 600 MB (CLOUD BASE).
C2.87	1700	7.0,-9.0	WINDS TO 600 MB (CLOUD BASE).
C1.78	1728	16.0,-14.0	WINDS TO 430 MB.
C3.93	1739	6.0,14.0	WINDS TO 570 MB. THERMO GLITCHES.

HUD	1759		4W TO 560 MB - NO WINDS ABOVE.
GDN	1814		1W. NO WINDS. THERMO DATA STOPS AT 450 MB.
C1.79	1828	16.0,-14.0	WINDS TO 560 MB. WINDS NEED WORK.
C3.94	1832	17.0,13.0	WINDS TO 580 MB.
BYR	1903		4W.
ELZ	1903		1W. NO WINDS.

1 AUG 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		3W.
C3.95	1300	0.25,0.25	I/C WITH DVR. WINDS TO 380 MB.
DVR	1300		4W. I/C
ELZ	1300		1W.
C2.88	1322	-2.3,6.8	WINDS TO 400 MB.
C1.80	1329	3.0,32.0	WINDS TO ABOVE 300 MB.
ELZ	1500		1W.

2 AUG 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		2W. GAP 510-350 MB.
DVR	1410		2W.
C3.96	1532	-9.0,-15.0	WINDS TO 400 MB.
C1.81	1533	-1.0,-14.0	WINDS TO 500 MB.
C1.82	1637	-1.0,-14.0	WINDS TO 520 MB (CLOUD BASE).
C3.97	1639	5.0,-11.5	WINDS TO 550 MB (CLOUD BASE).
ELZ	1659		1W. THERMO PROBLEMS BELOW CLOUD BASE.
C2.89	1812	17.0,1.5	WINDS TO 350 MB. THERMO GAP 480-420 MB.
HUD	1839		3W.

3 AUG 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		4W.
BYR	1230		4W.
DVR	1230		4W.
ELZ	1230		1W.
GDN	1230		4W. SFC T,RH?.

	HUD 1230		4W.
*	C3.98 1350		NEED DATA FROM DISK OR ENTER BY HAND.
	C2.90 1359	-7.3,-25.3	WINDS TO 505 MB.
	BYR 1400		2W. GAPS IN WIND.
	C1.83 1400	-40.0,0.0	WINDS TO 500 MB.
	DVR 1400		2W. GAPS IN WIND.
	ELZ 1400		1W.
	GDN 1400		3W. SFC RH?
	HUD 1400		3W TO 400 MB - NONE ABOVE.
	C1.84 1530	-40.0,0.0	WINDS TO 490 MB.
	DVR 1530		2W.
	ELZ 1530		1W.
	GDN 1530		3W. NOISY THERMO DATA.
	HUD 1530		4W.
	C2.91 1536	-7.3,-25.2	WINDS TO 550 MB.

4 AUG 87:

	STN	TIME	LOC (X,Y)	COMMENTS
	C1.85	0651	-55.0,-5.0	WINDS TO ABOVE 300 MB. WIND GLITCH ~450 MB.
	BYR	0700		3W TO 390 MB - NO WINDS ABOVE.
	C3.99	0700	1.7,1.5	WIND PROBLEMS.
	GDN	0700		4W TO 395 MB - NO WINDS ABOVE.
	C2.92	0702	-33.0,-1.0	EXCELLENT - NO PROBLEMS.
	DVR	0702		4W.
	C1.86	0851	-55.0,-5.0	EXCELLENT - NO PROBLEMS.
	BYR	0900		4W.
	C2.93	0900	-33.0,-1.0	WIND GLITCH 350 MB - OTHERWISE NO PROBLEMS.
	C3.100	0900	1.7,1.5	NO WINDS (LOW OVERCAST).
	DVR	0900		2W. ONLY WINDS ARE BETWEEN 360-550 MB.
	GDN	0900		3W TO 400 MB - NO WINDS ABOVE.
	DVR	1205		4W.
	DVR	1449		4W.
	C3.101	1528	1.7,1.5	EXCELLENT DATA.
	C2.94	1606	-7.8,-13.5	WINDS TO 600 MB.
	ELZ	1609		1W.
	C1.87	1611	6.0,-16.0	LOST SIGNAL AT 390 MB.
	C1.88	1812	6.0,-16.0	EXCELLENT.
	ELZ	1815		2W.
*	C2.95	1820		NEED THERMO FILE FROM DISK OR ENTER BY HAND.

C2.96 2008	23.8,-0.5	WINDS TO 400 MB.
C3.102 2011	-12.5,5.5	WINDS TO 500 MB.

5 AUG 87:

	STN TIME	LOC (X,Y)	COMMENTS
	C1.89 0650	17.5,2.0	WINDS TO 530 MB.
	C3.103 0658	-54.5,-6.0	EXCELLENT.
**	BYR 0700		BAD SONDE. NO DATA AVAILABLE.
	GDN 0700		3W.
	DVR 0702		3W.
	C2.97 0704	-60.0,0.0	WINDS TO 480 MB.
	BYR 0733		4W.
	C1.90 0851	17.5,2.0	WIND GLITCH 400 MB.
	C3.104 0855	-54.5,-6.0	SFC WIND?
	GDN 0858		4W.
	DVR 0900		4W.
	BYR 0901		4W.
*	C2.98 0904		DIFFICULTY PRODUCING SOUNDING.
	C1.91 1050	17.5,2.0	WINDS TO 300 MB.
	C3.105 1059	-54.5,-6.0	WINDS ARE A LITTLE NOISY.
	BYR 1100		4W.
	C2.99 1100	-60.0,0.0	LOST SIGNAL AT 640 MB, WINDS TO 680 MB.
	DVR 1100		4W. RH SEEMS LOW.
	GDN 1101		4W. SFC T,RH?
	C1.92 1253	17.5,2.0	LOST SIGNAL AT 600 MB.
	GDN 1254		4W.
	C3.106 1257	-54.5,-6.0	WINDS TO 450 MB.
	BYR 1300		4W.
	DVR 1300		3W.
	C2.100 1301	-60.0,0.0	WINDS NEED WORK - NOISY, GLITCHES.
	C3.107 1456	-54.5,-6.0	WINDS TO 370 MB.
	DVR 1500		3W.
	BYR 1815		4W.
	C1.93 1815	4.0,-12.0	WINDSTO 480 MB.
	DVR 1815		2W.
	ELZ 1815		1W. FEW WINDS 800-650 MB.
*	C2.101 1819		NO WIND DISK FILE - ENTER BY HAND.

6 AUG 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1100		3W (2W BELOW 550; 4W ABOVE).
GDN	1403		4W.
DVR	1409		3W.
BYR	1415		3W. SIGNAL LOST AT 525 MB, NO DATA ABOVE.
C2.102	1417	25.3,21.5	WINDS TO 525 MB.
C3.108	1418	-4.5,-13.5	WINDS TO 550 MB.
C1.94	1457	15.0,10.0	WINDS TO 485 MB.
C3.109	1543	-1.5,-16.0	WINDS TO 550 MB (CLOUD BASE).
GDN	1556		3W. SFC T,RH?
C1.95	1620	8.5,-0.5	WINDS TO 580 MB (CLOUD BASE). TEMP ERROR 630-580 MB.
DVR	1639		2W.
GDN	1648		2W TO 490 MB. SIGNAL LOST 440 MB. SFC T,RH?
HUD	1700		2W. MISG WINDS ~ 600-400 MB.
* C2.103	1702		NEED THERMO FILE FROM DISK OR ENTER BY HAND.
BYR	1710		2W - NOISY PLUS GAPS.
C1.96	1712	9.5,-8.0	WINDS TO 550 MB.

7 AUG 87:

STN	TIME	LOC (X,Y)	COMMENTS
DVR	1108		3W.
GDN	1220		4W. SFC T,RH?
HUD	1229		4W.
BYR	1230		4W.
ELZ	1230		1W. FEW NOISY WINDS SFC-690 MB. NONE ABOVE.
C1.97	1308	0.3,0.3	EXCELLENT SOUNDING. I/C.
C2.104	1308	0.3,0.3	SERIOUS PRESSURE PROBLEM. I/C.
C3.110	1308	0.3,0.3	NO WINDS. I/C.
DVR	1308		2W.
GDN	1425		4W.
HUD	1429		4W.
DVR	1430		1W.
ELZ	1430		1W.

Appendix E. CINDE/TDWR Photographic Summary.

Table E.1. Catalog of Byers Time–Lapse Movies.

6/22	134507–214637
6/23	121141–162855
6/24	——
6/25	——
6/26	130853–162553
6/27	112159–203131
6/28	112335–171802
6/29	——
6/30	143738–171958
7/1	113436–162436
7/2	——
7/3	095848–185043
7/4	——
7/5	112658–171558
7/6	111603–203336 (batt.)
7/7	141547–162557 (batt.)
	165243–201908 (dbl)
7/8	112743–170431
	173542–192532
7/9	113307–194501
7/10	112201–193451
7/11	111347–122517
7/12	120656–163356
7/13	111931–171733
7/14	114139–172241
7/15	120046–184046 (batt.)
7/16	114322–170654
	171326–195155
7/17	113859–184927
7/18	125313–143543
7/19	——
7/20	115517–164448
7/21	114455–181958
7/22	123433–203835
7/23	120109–194712
7/24	113516–115116
7/24	122306–200808
7/25	123227–164459
7/26	105904–190834
7/27	114533–141933
7/27	142929–182855
7/28	113901–152931
7/28	171103–183333
7/29	110615–194817
7/30	105622–184754
7/31	112359–191729
8/1	115150–160750
8/2	125725–185247
8/3	105602–173303
8/4	063107–171807
8/5	062633–191616
8/6	120052–160122 ? (batt.)
8/7	114827–163029

Table E.2. Catalog of Centennial Airport Time–Lapse Movies.

	8mm
6/23	141349–152309
	153357–160842
6/24	123808–161230
6/25	114039–175533
	180457–182342
6/26	—
6/27	133702–174914
6/28	133559–162750
6/29	—
6/30	112200–161100
	162250–165150
7/1	122700–171600
7/2	—
	16mm
7/3	151542–171828
7/4	—
7/5	—
7/6	142002–164813
7/7	122817–133237
	134704–162200
7/8	142930–173000
7/9	144551–
7/10	163140–174840
7/11	125621–160308
7/12	—
7/13	—
7/14	—
7/15	144124–164654
7/16	134947–160722
	163150–171215
7/17	135556–172906
7/18	—
7/19	—
7/20	—
7/21	134432–143732
7/22	163046–184526
7/23	163330–170430
7/24	115451–171342
7/25	—
7/26	—
7/27	—
7/28	134245–161414
7/29	150247–180407
7/30	145120–175630
7/31	151847–175957
8/1	—
8/2	144354–164205
8/3	—
8/4	142302–183140
8/5	—
8/6	—
8/7	—

Table E.3. Catalog of Elizabeth Time–Lapse Movies.

6/22	143150–185221
6/23	105025–164345
6/24	104700–160338
6/25	091220–181250
6/26	102335–141435
	142809–153808 (intv?)
6/27	112220–191455
6/28	103825–172915 (intv?)
6/30	?
7/1	113325–171230
7/2	102704–170800
7/3	104930–135715
7/3	140350–182420?
7/5	104020–160150
7/6	102401–194450
7/7	102320–154240
7/8	?
7/9	104443–193408
7/10	104105–192615
7/11	111610–191610
7/12	104412–164010
7/13	103045–180715
7/14	114930–164000?
7/15	103405–133905
7/16	103930–191030
7/17	104325–182010 (timing?)
7/18	105340–134210
7/19	103605–180232
7/20	104105–165220
7/21	103515–183320
7/22	103745–153115
7/23	110130–171230
7/24	103410–195010 (batt.)
7/25	100810–162720 (162640?)
7/26	103950–175810 (175650?)
7/27	?
7/28	?
7/29	110700–190100
7/30	103815–183810 (183645?)
7/31	104415–191325 (191215?)
8/1	103925–152025
8/2	104450–183705 (batt.)
8/3	105615–165608 (batt.)
8/4	103710–194030 (batt.)
8/5	104325–182255
8/6	104315–170130 (batt.)
8/7	103415–150820 (batt.)

Table E.4. Catalog of Hudson Time–Lapse Movies.

6/22	115028–192535
6/23	111655–163536
6/24	110622– ?
6/25	110055–150040
	152009–194919
6/26	112728–1726xx
6/27	113856–194733
6/28	(bad focus)
6/29	——
6/30	083410–171401
7/1	(clock out of view)
	1204xx–1800xx
7/2	111035–184159 ?
7/3	090730–182607
7/4	——
7/5	110000–162005
7/6	105949–194200
7/7	110034–?
	1635xx–173340
7/8	180005–191502
7/9	105500–184348
7/10	110542–1820xx ?
7/11	110241–141615
	142705–? (dark)
7/12	——
7/13	111045–172020
7/14	110156–163041
7/15	110456–180450
7/16	110000–141034
	145610–185444
7/17	110516–183113
7/18	110001–153640
7/19	121618–123549
7/20	——
7/21	1108xx–175442 ?
7/22	153635–181837
7/23	110602–170506
7/24	110530–182936
7/25	112500–165905
7/26	123400–132001
	140532–175605
7/27	130705–174603
7/28	133000–162035
	164146–192749
7/29	110630–191109
7/30	110001–191709
7/31	111530–190537
8/1	115029–162502
8/2	110443–183050
8/3	143800–164101
8/4	122759–181705
8/5	110700–190507
8/6	110000–173236
8/7	110000–163005

Table E.5. Catalog of Lookout Mountain Time–Lapse Movies.

6/22	112830–162530
6/23	112400–151515
	153500–163040
6/24	131630–160130
6/25	114200–125400
	130025–175315
	175810–192030
6/26	125500–161100
6/27	123000–152400
	152910–184000
6/28	122730–140210
	140745–163000
6/29	——
6/30	121230–153000
	153540–165200
7/1	115030–164500
	164800–180000
7/2	124700–172230
7/3	122000–181837
7/4	——
7/5	——
7/6	135000–185202 (batt.)
7/7	130400–164516
7/8	131800–154300
	154705–183331
7/9	132500–164800
	165100–183300
7/10	142700–175800
7/11	140230–183802
7/12	——
7/13	——
7/14	——
7/15	141930–165131
7/16	132930–152245
7/16	152600–175031
7/17	130000–162251
	162535–1800xx? (batt., trauma)
7/18	——
7/19	——
7/20	——
7/21	141000–160300
7/22	——
7/23	153700–170700
7/24	122900–153501
	153800–191001
7/25	——
7/26	170730–175335
7/27	153400–174431
7/28	130100–163746
	164030–175230
7/29	130030–174802
	175130–182400
7/30	131700–175301
7/31	141800–180101
8/1	——
8/2	143000–180001
8/3	——
8/4	142100–152500
	152830–183801
8/5	——
8/6	142100–162400
8/7	——

Table E.6. Catalog of NOAA/D Time–Lapse Movies.

6/22	—
6/23	—
6/24	—
6/25	—
6/26	—
6/26	—
6/27	—
6/28	—
6/30	—
7/1	130700–175520
7/2	124130–141555
	142200–~1540 (tornado)
	(no time–tornado) (batt.)
7/3	150759–181945
7/4	—
7/5	134110–155511
7/6	—
7/7	114322–125837
	131900–172715
7/8	124730–140210
	141410–190255
7/9	124500–170240 (dbl)
7/10	161815–190715
7/11	140600–193140
7/12	—
7/13	—
7/14	—
7/15	—
7/16	113600–150425 (dbl)
	150955–191220
7/17	123430–190120
7/18	—
7/19	—
7/20	—
7/21	133430–152100
7/22	163615–200705
7/23	135600–161100
7/24	120630–150645
	151335–195215
7/25	—
7/26	—
7/27	160400–175825
7/28	125500–164355
7/29	125624–? (no time)
7/30	(no time)
7/31	?–1909xx (no time)
8/1	—
8/2	134900–165930
8/3	—
8/4	?–1838xx (no seconds)
8/5	1702xx–1803xx (no seconds)
8/6	1440xx–1728xx (no seconds)
8/7	—

Table E.7. Catalog of FL–2 Time–Lapse Movies and Slides.

Date	Time Period	Slides Location	Date	Time Period	Slides Location
4 June	1310–1556	–	16 July	1200–1815	–
5 June	1223–1703	–	17 July	1200–1900	FL–2
6 June	1221–1829	–	20 July	–	CP–3
7 June	1205–2023	–	21 July	1200–1800	CP–3
8 June	1219–1816	–	22 July	1200–1930	CP–3
9 June	1419–1759	–	23 July	1255–1710	CP–3
10 June	1300–1817	–	24 July	1200–1940	NOAA–D
11 June	1247–1933	–	25 July	1200–1545	–
12 June	1203–1916	–	26 July	1200–1645	–
13 June	1232–1830	–	27 July	1215–1615	–
14 June	1106–1853	–	28 July	1400–1820	FL–2
15 June	1212–1706	–	29 July	1200–1930	FL–2
16 June	1244–1825	–	30 July	1215–1915	FL–2
17 June	1524–1827	–	31 July	1200–1920	FL–2
18 June	1258–1912	–	1 August	1445–1554	CP–3
19 June	1318–1733	–	2 August	1426–1803	CP–3
20 June	1212–1756	–	3 August	1400–1705	–
21 June	1210–1701	–	4 August	1330–1732	CP–3
22 June	1428–1738	–	5 August	1305–1808	CP–3
23 June	1244–1800	–	6 August	1159–1741	CP–3
24 June	1419–1625	–	7 August	1450–2028	–
25 June	1236–1947	CP–3	8 August	1320–1645	–
26 June	1151–1337	CP–3	9 August	1200–1805	–
28 June	–	CP–3	10 August	1320–1720	–
29 June	1357–1651	CP–3	11 August	1345–1930	–
30 June	1244–1750	CP–3	12 August	1315–1745	–
1 July	1201–1831	FL–2	13 August	1330–1740	–
2 July	1155–1542	FL–2	14 August	1400–1830	–
2 July	1615–1900	FL–2	15 August	1200–1700	–
3 July	–	NOAA–D	20 August	1715–2000	–
5 July	–	NOAA–D	21 August	1230–1900	–
6 July	1410–2020	–	21 August	1230–1900	–
7 July	1400–1755	FL–2	27 August	1300–1845	–
8 July	?–1915	CP–3	28 August	1400–2000	–
9 July	1242–1850	CP–3	30 August	1200–1730	–
10 July	1431–1834	–	1 September	1200–1815	–
11 July	1217–1907	CP–3	2 September	1230–1830	FL–2
12 July	1240–1715	–	3 September	1300–1630	–
13 July	1240–1715	–	4 September	1330–1730	–
14 July	1234–1723	–			
15 July	1420–1710	FL–2			