USWRP STORM-FEST • Operations Summary and Data

U.S. WEATHER RESEARCH PROGRAM

STORM-FEST

Operations Summary and Data Inventory

U.S. Weather Research Program Office
UCAR Office of Field Project Support

STORM

Fronts Experiment Systems Test

STORM-FEST

Operations Summary and Data Inventory

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Preface and Acknowledgements

The U.S. Weather Research Program, formerly called the STORM Program, conducted the first field experiment as part of USWRP, from 1 February through 15 March 1992. The experiment, called the STORM-FEST (Fronts Experiment Systems Test), focussed on studying the structure and dynamics of wintertime fronts and associated precipitation over the central United States, as well as being a research systems tests of the various new observational systems and operational procedures envisioned being used in future experiments. In conjunction with the field experiment there were special activities at Experimental Forecast Facilities at Kansas City, Missouri (at the National Severe Storms Forecast Center), Norman, Oklahoma (a joint activity supported by the Norman WSFO, NWS southern region, NSSL and the OSF) and at Boulder/Denver (a joint activity between FSL and Denver WSFO). Special numerical modeling activities were conducted at NMC with the Eta Ada model and at NCAR with the MM-4 model running every day in a semi-operational mode. Four Dimensional Data Assimilation (4DDA) data sets were generated using both the FSL MAPS and LAPS systems (the LAPS model domain was expanded to cover the entire STORM-FEST domain with analyses made every hour). High frequency data were collected from the ASOS/AWOS systems, as well as Archive II data from the WSR-88D radars that were within the experimental domain.

The USWRP data management system has evolved to the point were researchers can now have easy access to both operational and research data sets. The system provides researchers access to a distributed meteorological database held at geographically dispersed data centers. The system provides the means to identify data sets, the facilities to view the metadata associated with the data set, and the ability to automatically obtain data either via Internet or removable media.

An experiment of this type would not be possible without the help and dedication of so many people. It is virtually impossible to name every group or individual who helped make this experiment possible and/or who worked to make the data available. A special thanks to Dr. Donald Johnson and the members of the Cyclonic Storm and Fronts Working Group proposed and carried out the preliminary planning for the experiment. Thanks to Dr. Peter Hobbs and members of the Field Phase Steering Committee who developed the scientific objectives and the observational requirements for the experiment. Thanks to Dr. Stephen Koch and members of the Systems Integration Committee that developed the assessment plans for the systems test component of the experiment. Thanks also have to be extended to all the personnel at Richards-Gebaur Air Force Base who helped us so much throughout this experiment. A special thanks to all the facility support staff whose hard work made this experiment the success that it was.

A special note of thanks has to be made to NCAR's Research Data Program, who worked with us to develop the STORM-FEST CD-ROM and for providing the satellite photographs used in this document. Thanks also to NOAA's Climate Analysis Center and Meteorological Operations Division for use of the Daily Weather Map series.

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Air Force Office of Scientific Research
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National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration
National Science Foundation
U.S. Department of Agriculture
U.S. Geological Survey

FURTHER INFORMATION

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Introduction

1.0 Introduction

The STORM-Fronts Experiment Systems Test, STORM-FEST, investigated the structure and evolution of fronts, embedded precipitation and associated mesoscale phenomena in winter storms over the central United States. The field phase of STORM-FEST was from 1 February through 15 March 1992. This field effort provided the research background for the major Winter/Spring Multiscale Field Experiment planned for the mid-to-late 1990's and provided the experience with observational systems and other U.S. Weather Research Program (formally called the STORM Program) elements (4DDA, numerical modeling, data management, etc.) needed to insure success of other field experiments planned as part of the U.S. Weather Research Program.

1.1 Components of the STORM-FEST Field Project

The field phase of STORM-FEST was composed of three closely related components:

- A sharply focused investigation of the structures and evolutions of fronts and associated mesoscale phenomena in the central United States, with emphasis on precipitation and severe weather (referred to as "Frontal and Mesoscale Studies").

- A research assessment of new operational and research meteorological instrumentation, facilities, composite observational networks and other STORM elements (referred to as "Systems Tests").

- A study to begin to understand mesoscale prediction capabilities and limitations in active frontal regions (referred to as "Weather Prediction Studies").

There was nearly complete overlap in the observational requirements to meet the objectives in each of these three components. The frontal and mesoscale studies required data over the same time period and spatial scales as that required for making and verifying weather forecasts. The new observational systems will be evaluated on the bases of their contributions toward understanding mesoscale processes and helping to make and verify weather predictions. Similarly, the research assessment of new observing systems also required detailed measurements on the mesoscale as needed for the frontal and mesoscale studies.

1.2 Primary Objectives of STORM-FEST

Four primary objectives were identified for each of the three components of STORM-FEST. They are as follows:

For the Frontal and Mesoscale Studies:

- To begin to document the three-dimensional structures, kinematics and evolutions of the various types of fronts that affect the central United States.
- To begin to determine the dynamical and physical processes governing the structures and evolutions of fronts that affect the central United States.
- To begin to document the mesoscale organization and substructure of precipitation features associated with fronts in the central United States.
- To begin to determine the dynamical and physical processes governing the formation, maintenance, and dissipation of the mesoscale features associated with fronts in the central United States.

For the Systems Tests:

- To determine the utility of new observing systems, techniques and observation networks for mesoscale research, prediction, and warnings.
- To assess the ability to produce a four-dimensional mesoscale representation of the atmosphere, consistent with observations and model dynamics.

- To assess the effectiveness of Experimental Forecasting Facilities (EFF) as a mechanism for rapid transfer of technology and research results to operational mesoscale forecasting.

- To assess the ability of the STORM-FEST Data Management system to provide timely and flexible access to operational and research data sets.

For the Weather Prediction Studies:

- To begin to understand the capabilities and limitations of public forecast of hazardous winter weather in active frontal zones.

- To begin to understand the capabilities and limitations of aviation forecasts in active frontal regions.

- To begin to understand the capabilities and limitations of mesoscale model analyses and predictions in active frontal regions.

- To understand the capabilities and limitations of 6- to 48-h forecasts downstream of supplemental observations in active frontal regions.

1.3 STORM-FEST Data

To achieve the above objectives, the STORM-FEST experiment collected data sets from the operational, enhanced operational, and research observational systems (see Chapter 2 for further information on these data types and special composite data sets). Operational data and in several cases enhanced operational data were collected during the entire STORM-FEST period. Other enhanced data and research data were collected during Intensive Observation Periods, IOPs. During the approximate 45 days of STORM-FEST there were 20 IOPs. These are briefly presented in Table 1.1 and are the primary focus of Chapter 3, which presents an overview of the daily operations during STORM-FEST, including special data collected during the IOPs.

TABLE 1.1

STORM-FEST IOP LIST

IOP NO.	START, UTC (Date/Time)	STOP, UTC (Date/Time)	FOCUS
1	Feb 3/12	Feb 4/00	Weak dry front and K/A calibration flight
2	Feb 6/12	Feb 7/00	Dry cold front (IA and MO)
3	Feb 9/12	Feb 9/21	Stationary front (Freezing-rain) w/Wy K/A, convair
4	Feb 10/06	Feb 11/00	Dry cold front (IA)
* 5	Feb 11/00	Feb 12/12	Trough frontogenesis, dual doppler, A/C, precip
* 6	Feb 14/00	Feb 15/06	Structure of warm/cold fronts, dynamics of mesoscale rainbands
* 7	Feb 14/18	Feb 18/12	Structure and dynamics of fronts
8	Feb 19/12	Feb 19/21	Boundary layer (limited obs)
9	Feb 21/16	Feb 22/03	Boundary layer and frontogenesis
10	Feb 22/12	Feb 23/00	Structure of non-precipitating cold front
* 11	Feb 23/18	Feb 25/01	Cold front and rainband studies
12	Feb 25/12	Feb 26/00	Boundary layer
13	Feb 27/15	Feb 28/00	Boundary layer
14	Feb 28/23	Feb 29/04	Upper level jet dynamics
15	Mar 1/15	Mar 2/00	Boundary layer
* 16	Mar 3/18	Mar 5/12	Cyclogenesis, rainbands, cold front
* 17	Mar 5/12	Mar 10/14	Cyclogenesis, frontal passage, structure of major winter storm
18	Mar 10/16	Mar 11/00	Boundary layer
19	Mar 11/12	Mar 12/06	Upper level jet, rainbands, boundary layer
20	Mar 12/18	Mar 12/22	Boundary layer, systems test

**Major cyclonic events*

Data for STORM-FEST will be distributed primarily in two methods; an on-line data management system and a set of CD-ROMS.

1.3.1 The STORM-FEST Data Management System

The STORM-FEST Data Management System called the Cooperative Distributed Interactive Atmospheric Catalog System (CODIAC) provides a new concept in data access for the mesoscale investigator. The system was developed by the USWRP Project Office, the Forecast Systems Laboratory, and the National Climatic Data Center to provide researchers access to a distributed meteorological database held at geographically dispersed data centers. CODIAC offers investigators the means to identify data sets of interest, the facilities to view metadata associated with the data sets (including inventory information normally included in the Operations Summary), and the ability to automatically obtain data via either removable media or Internet file transfer.

CODIAC SYSTEM FEATURES

The CODIAC system provides a variety of functions and features. A brief description of the major components (or modules) is provided below:

Data Set Guide

The data set guide provides descriptions of the various data sets supported by the system. The descriptions includes such aspects as the data set title, abstract, spatial and temporal resolution, archive center, level of quality control, type of observing system or network used to collect the data set, and the name and other contact information for the curator of the data set.

The data set guide may be searched by a number of different methods, such as project, time, area, and observing system or network. Key word search of the abstracts is also provided.

Project Information

The project information module provides a description of field experiments (projects) whose data are managed by the system. This includes a brief overview of the project, including a description of scientific objectives, and the spatial and temporal domain of the project. Additional information on the timing and facilities deployed during individual IOP's and operations logs for the various platforms involved in the project, such as radars, aircraft, and satellite schedules will be available by mid-1993. Researchers can search this information to identify IOPs of interest, and use the dates and times found to search for data sets.

Station Information

This module provides detailed descriptions of the observing platforms utilized to collect the data. Information such as station location, name, parameters observed, identification numbers, and times in operation are included in the description. This information may be searched by a number of criteria.

Order Entry/Data Delivery

The Order Entry/Data Delivery module provides the user with the ability to obtain data. This module is composed of two parts: one which allows users to request delivery of data on removable media such as 9-track or Exabyte tape, and one which allows users connected to the Internet to download data that are on-line directly to their workstation or personal computer.

On-line data is provided at no charge through a cooperative agreement between the USWRP Office and the other data centers involved. STORM-FEST investigators will also receive data on off-line media, free of charge, although the availability of this service from the NCDC is contingent upon sufficient funds available in a special account set up for this purpose. In either case, the system will compute and display the price for the desired data.

Inventory Information

The inventory module provides detailed information for each data set, and specific times that data are in the archive. In most cases, this information is produced from the archived data files and is very accurate. The information is currently presented in table form although a graphical display module should be available by Summer 1993.

Data Set Notes

This module is an experimental implementation. It offers any scientist using the system the ability to attach comments to a data set. For example, if a researcher found a portion of a data set to be questionable, they could attach a note to the data set describing the time period or stations that were suspect. Other investigators who use the data set later may then review the notes and become immediately aware of potential problems.

Reference Contacts

This is another experimental module. When a researcher obtains data through the Order Entry/Data Delivery system, they will be asked if they are willing to volunteer as a reference contact for the data set. If they agree, the system will ask them to characterize their familiarity with the data set, and then their name and contact information (address, phone number, etc.) will be made available to other users who request it. It is hoped that this facility will provide a way for users and potential users of a given data set to network with scientists that are experienced in using the data set.

Daily Weather Maps

On-line daily weather maps provide another resource for identifying research cases of interest. The daily weather maps for each day of STORM-FEST have been digitized, and stored in the database. Researchers running an X-windows software can specify the day of interest, and the weather map for that day will be displayed in a window. This feature will be available in late 1993.

TO ACCESS THE SYSTEM

The CODIAC system may be accessed by two methods: Internet and dial-up. Each of the methods is described below. However, access via Internet is preferred, as it provides the only means to support the X-terminal emulation required to utilize the full capabilities of the system. Access into the system is provided by the examples given in Figures 1.1-1.4. Commands to be entered by the user are indicated in **bold type**.

Access Via Internet

To fully utilize the system across Internet, users should have some knowledge of the configuration of the local system they are using. In particular, users must know the information listed in Figure 1.1.

Once questions in Figure 1.1 have been answered, users follow the sample dialogue given in Figure 1.2 (X-Window users), or Figure 1.3 (non-X-Window users). Note that editorial comments are contained between the < > symbols, and that user entries are in **bold** print.

Access Via Modem

Access via modem is provided by the NCAR modem bank. To obtain the toll-free number for access to NCAR, contact the Consultant On Duty (COD) at (303) 497-1278. After obtaining the number, follow the dialogue in Figure 1.4. Note that modem access supports character terminals only.

```
Does the machine that you are using support the X-Window windowing
system?

If yes:

     What is the internet (IP) address of the machine that you are
     using?

     What type of keyboard does your machine have?

     Keyboards that are supported under the X-Window system are:

          PC/AT               DEC Stations
          HP 9000/300         IBM System/6000
          SUN3                SUN4

If no:

     What terminal type are you running or does your software emulate?

     Terminal types that are supported are:

          VT100, VT220, etc.       PC running PC/TCP (VT100)
```

Figure 1.1. Information needed to access the CODIAC System.

```
xhost +storm.ofps.ucar.edu

telnet storm.ofps.ucar.edu
Trying 128.117.90.53 ...
Connected to 128.117.90.53.
SunOS UNIX (storm.ofps.ucar.edu)

login: storm
Password: research

      <Introductory text deleted to save space>

Are you running X-windows?[y/n/quit]->y

Enter the internet ADDRESS of your X-server->999.999.99.99
999.999.99.99 is alive

Select your KEYBOARD type by number:

   1)  PC/AT keyboard                5)  SUN3 Keyboard
   2)  DEC Keyboard                  6)  SUN4 Keyboard
   3)  HP 9000/300 Keyboard          7)  Exit
   4)  IBM System/6000 Keyboard

Enter the number of your choice->6
Emergency exit key = CTRL/C

      <The X-Window should now appear on your display>
```

Figure 1.2. A CODIAC System login session for an X-Window system user.

```
telnet storm.ofps.ucar.edu
Trying 128.117.90.53
Connected to 128.117.90.53
SunOS UNIX (storm.ofps.ucar.edu)

login: storm
Password: research

      <Introductory text deleted to save space>

Are you running X-windows?[y/n/quit]->n
Emergency exit key = CTRL/C

Select your terminal type by number:

   1)  vt100, vt220, etc.
   2)  PC running an vt100, vt220, etc. emulation (PC/TCP v2.05)
   3)  SUN Console
   4)  exit

Enter the number of your choice->1

  <The CODIAC System Window should now be displayed on your terminal>
```

Figure 1.3. A CODIAC System login session for a non X-Window system user.

```
NCAR Host Connection Account
US Govt Property: Unauthorized use is a Federal Offense.
 ++++++++++++++++++++++++++++++++++++++++
 +    NCAR Host Connection Account      +
 +   (ONLY NCAR HOSTS MAY BE REACHED)   +
 +                                      +
 +     Enter the hostname, or IP #      +
 ++++++++++++++++++++++++++++++++++++++++

What host do you want to connect to --> storm.ofps.ucar.edu
Checking name via domain name system.....

     Enter destination host login name: storm
     Enter password: research

trying 128.117.90.53...
Connected to 128.117.90.53.
Escape character is '\377'.

<At this point you will be connected to the CODIAC System.
 Follow the session transcript shown in Figure 2.>
```

Figure 1.4. Connection to the CODIAC System using a modem.

1.3.2 STORM-FEST CD-ROMS

A CD-ROM set containing STORM-FEST data was produced by the NCAR/Research Data Program, UCAR/Office of Field Project Support, and NCAR/Research Aviation Facility. The CD-ROM set contains the following data: NCAR King Air, University of Wyoming King Air, University of Washington C-131, NOAA P-3, NOAA Profilers, Soundings (CLASS, NWS, L2D2, and AES), NCAR ASTER, Surface composite data and Precipitation composite data in NetCDF format, GOES satellite, WSI NOWRAD, and CP4 in Zeb Image format.

The Zeb and WINDS software packages were also included on the CD-ROMs. These software packages provide versatile interactive displays. Zeb is a comprehensive integration and display program that has been used in real-time and post-processing analysis. Zeb provides a variety of displays including surface plots, vertical cross-sections, Skew-T, X-Y graphs, and Profiler time-height plots. In addition, the Zeb software provides access routines that allow data to be moved between a user's analysis package and Zeb. The WINDS software allows display of all the aircraft data in a variety of formats including horizontal tracks, time-series, altitude plots, Skew-T, and ASCII prints.

Both Zeb and WINDS require a Sun workstation running OS 4.1.2, either X11R4 or greater, or Open Windows 3.0, a minimum of 16 MBytes of RAM, 32 MBytes minimum swap space, and a CD-ROM player. However, data files can be accessed using most UNIX workstations. Further information on obtaining the CD-ROM set can be obtained from the Office of Field Project Support.

UCAR/OFPS is currently working on creating a CD-ROM containing selected operational and research STORM-FEST model output in gridded fields (GRIB format) and display software. This CD-ROM would be a "stand alone" package from the 3 CD-ROM set previously described. The STORM-FEST model output CD-ROM is expected to be completed in Autumn 1993.

Observing Networks and Data Collection

2.0 Observing Networks and Data Collection

New National Weather Service (NWS) operational observing systems supplemented with research facilities, provided the basis to obtain an unparalleled data set on fronts and mesoscale phenomena in a region where winter weather has received little detailed study. This data set provided documentation of the three dimensional structure, airflow, and evolution of the various types of fronts and associated precipitation that affect the central United States in winter with the ability to better understand the dynamics and physical process governing the structure and evolution of these features. New operational observing systems data will also be used to help assess the various components of the systems tests portion of the experiment. The following sections describe the various data sets that were archived for STORM-FEST, as well as information regarding their archive locations and accessibility.

2.1 Surface Data

Surface data were obtained from United States and Canadian national, regional, and research networks. Most of the larger scale national observations were hourly with some regional/special networks taking measurements as frequently as every minute. (A complete listing of the networks and site locations are given in Appendix A.)

2.1.1 National Networks

Automated Surface Observation System (ASOS) Data

The National Weather Service, Federal Aviation Administration (FAA), and the U.S. Navy are installing a national network of ASOS stations as part of the NWS modernization plan, FAA airport upgrades, and DoD installations. Forty-five stations were installed by the end of STORM-FEST, primarily in the Kansas-Oklahoma area (see Fig. 2.1). Data collected from each station consisted of hourly and 5-min averages of air temperature, dewpoint, wind speed and direction (incl. gust), barometric pressure, altimeter, density altitude, visibility, sky conditions (cloud cover and height) and precipitation (5-min totals). Visibility and sky condition data were computed using

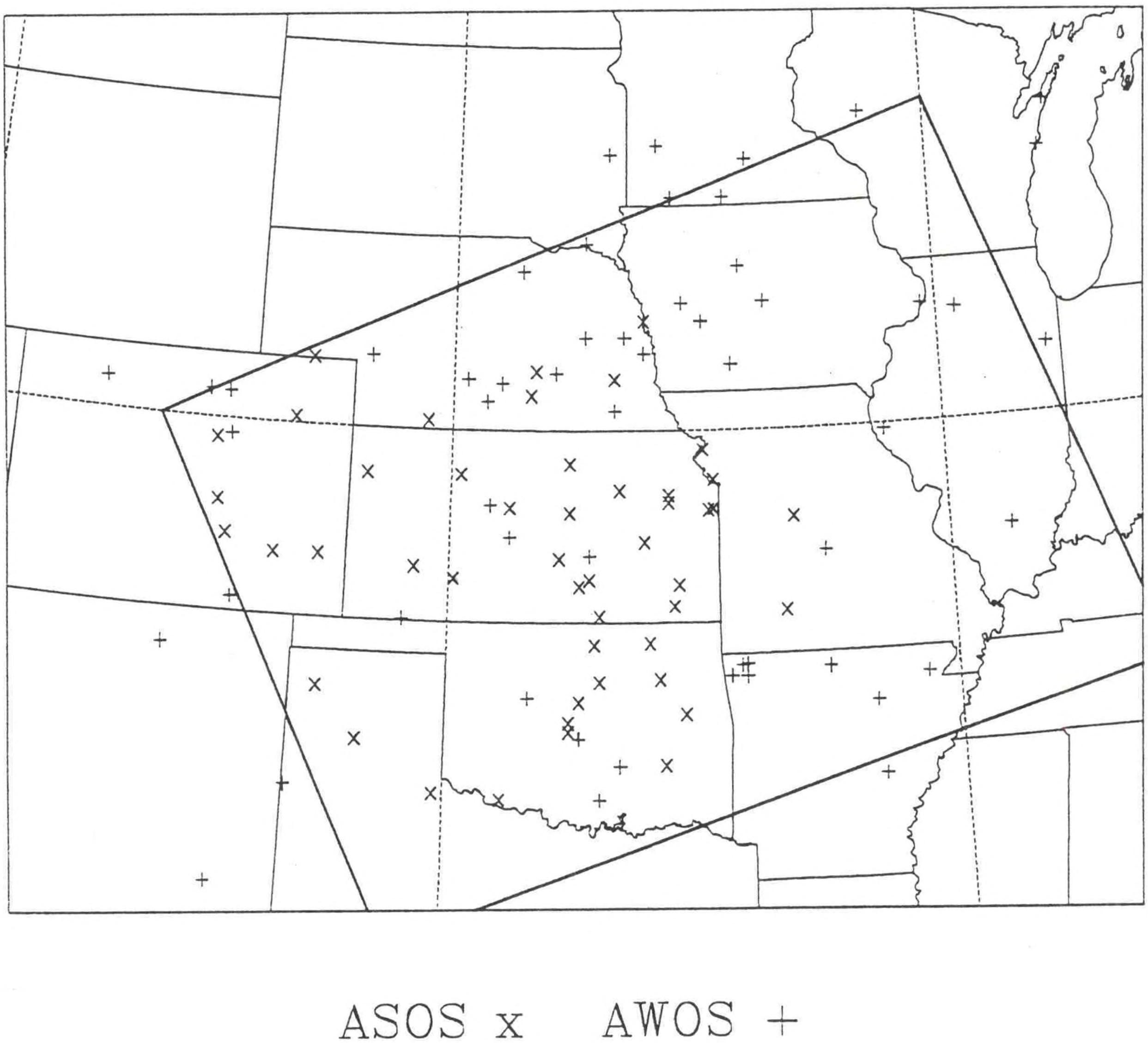


Figure 2.1 Location of the ASOS and AWOS surface observation stations that were available during STORM-FEST.

a 30-min running average. In addition, 1-minute resolution ASOS data were collected from Topeka, Kansas, collocated with an NCAR PAM II station. Only a few ASOS sites were officially commissioned during STORM-FEST, so collocated manual observations were also taken by the NWS as well. (Caution should be exercised by the researcher when using uncommissioned ASOS data.) ASOS data were collected in real-time by the STORM-FEST Data Management Center (SFDMC) and are available through the CODIAC system.

Aviation Weather Observation System (AWOS) Data

The AWOS data collected for STORM-FEST consisted of both Federal and Non-Federal networks of automated weather reporting stations located at 48 airports in the STORM-FEST domain (see Fig. 2.1). The FAA coordinated the operation, maintenance, and data dissemination of the Federal network, while individual airports/cities operated and maintained non-federal network stations. Most of the archived AWOS data consists of 20-minute averages of air temperature, dewpoint, altimeter, visibility, wind speed and direction, barometric pressure, sky conditions (cloud cover and height), density altitude, and precipitation averages. Winds were averaged using a 2-5 min running mean and cloud heights were averaged using a 30-min running mean. The 20-min data were collected in real-time by the SFDMC and are available through the CODIAC system. In addition, the Iowa Department of Transportation collected 1-min resolution data for Iowa AWOS stations, and are also available through the CODIAC system.

NWS/FAA Hourly Airways and Cooperative Observer Data

The existing national network of NWS first order stations, NWS Cooperative Observers, and FAA controlled airports collected routine temperature, precipitation, and other meteorological measurements. A map of the Surface Aviation Observation (SAO) network is shown in Fig. 2.2. All these data were collected, processed, quality controlled, and archived at the National Climatic Data Center (NCDC) as part of existing national data sets. Table 2.1 contains a description of these data sets with observation schedules and general observation parameters. The NWS first order and FAA controlled airport stations were usually fully instrumented and therefore recorded a complete range of meteorological parameters. The observations were generally recorded hourly or for a 24 hour period (midnight to midnight local time). Most of the private NWS Cooperative Observer Stations collected only daily maximum/minimum temperature data and/or 24-hour

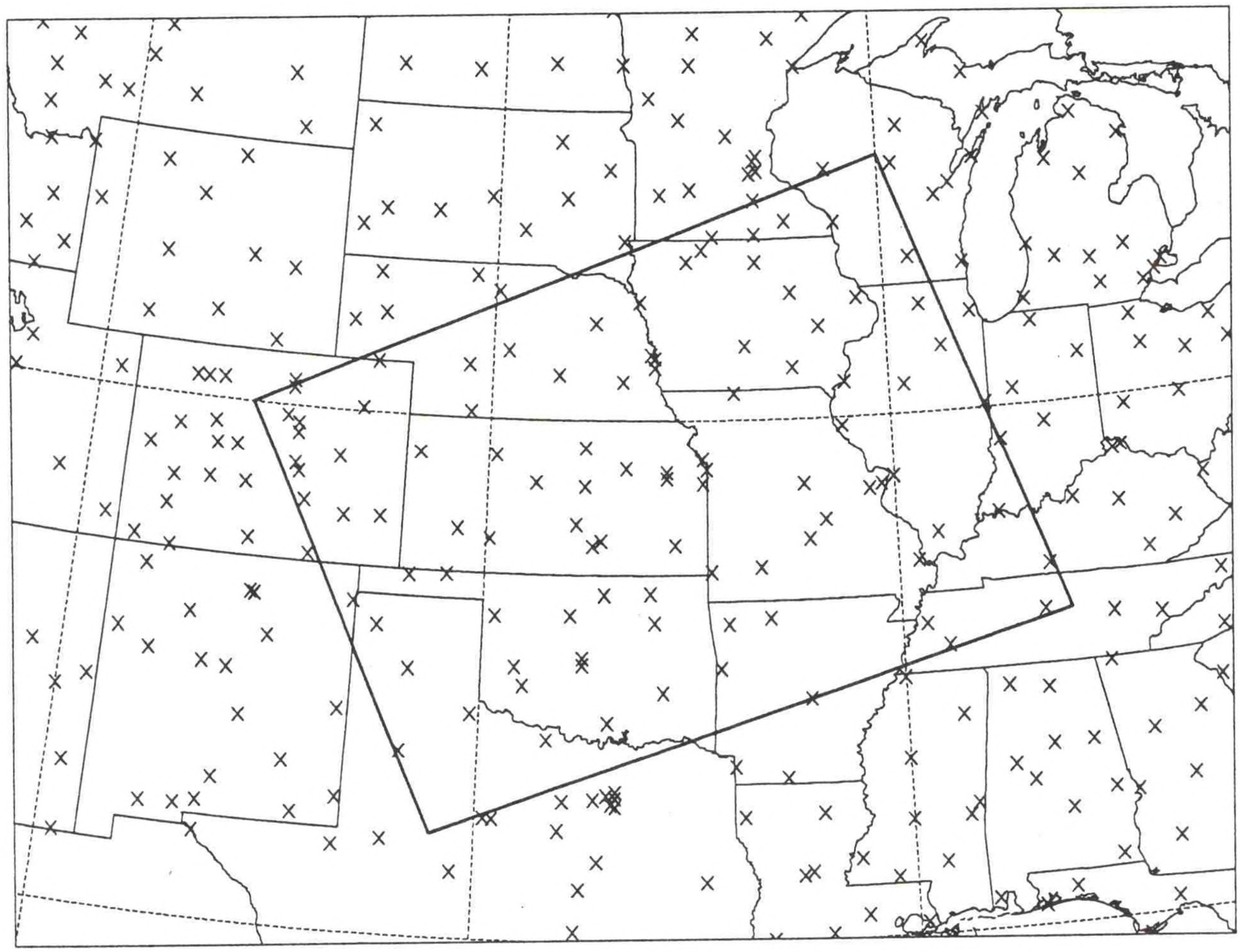


Figure 2.2 Location of the SAO (Surface Aviation Observation) network sites.

TABLE 2.1

NCDC SURFACE DATA SET DESCRIPTION

DATA SET NO.	DATA SET NAME	OBSERVATION SCHEDULE (Local Time)	DATA SET PARAMETERS
TD-3200	Summary of the Day (Cooperative)	Daily; Variable Times: (most 7A to 7A or 7P to 7P)	Temperature (min/max)*, Precip (24-h)*, Evap (amt), Soil Temperature, Wind (24-h) movement) **most stations only report*
TD-3210	Summary of the Day (First Order)	Daily; 2400 to 2400	Temperature (min/max/mean), Relative Humidity (avg), Dew Point Temperature (avg), Deg Day (heat/cool), Weather (type), Wind (avg/gust), Sun (%), Sky (cover), River (height), Ice (thick), Pressure (avg sta/avg sea)
TD-3240	Hourly Precipitation	Hourly Daily	Precip (1-hr, 24-h totals)
TD-3260	15 Minute Precipitation	15-min Daily	Precip (15-min, 24-h totals)
TD-3280	Surface Airways Hourly	Hourly	Cloud (Amount, ceiling, type), Visibility (horizontal), Wind (speed/dirc), Temp (dry/wet/Dew Point), Sky (cover), Relative Humidity (%), Pressure (sta/sea/alt), Present Weather (type)

precipitation data. Certain NWS Cooperative Observer Stations recorded higher frequency (i.e., 15-min and hourly) precipitation data. A complete map of all the Cooperative Observer sites measuring precipitation is shown in Fig. 2.3). Data set information and data collected from these networks during the STORM-FEST period are available through the CODIAC system.

U.S. Military Surface Observation Data

Routine DoD observations from US military facilities around the world were decoded, validated, resorted and archived at the U.S. Air Force Global Weather Center. These data were then further quality controlled and reformatted by the U.S. Air Force Air Weather Service before transfer to NCDC for archival and dissemination. A subset of these data were extracted for the STORM-FEST domain and period and are available through the CODIAC system.

Canadian AES Observations and Volunteer Observer Data

The Canadian Atmospheric Environment Service (AES) routinely collected data from an existing network of both hourly AES observer stations and daily summaries from over 3,000 volunteer observer stations across Canada. The data were transferred to the Canadian AES Climate Center in Downsview, Ontario for digitizing, quality assurance, and archiving. Data for the STORM-FEST period are available through the AES Climate Center upon request. Information regarding data access is available through the CODIAC system.

Observed Snow Cover Reports

Observed snow cover charts covering the conterminous United States and Southern Canada were prepared by NMC as part of their routine analysis and forecasting procedures. Data plotted on these charts used automatically processed data sets from the 1200 UTC Weather Service C circuit (3-h synoptic and hourly aviation observations). Total snow depth and previous 6-h snow increase are depicted on these charts. These daily charts are transferred to NCDC and processed on 35-mm microfilm for final archiving and distribution. These data for the STORM-FEST period are available through NCDC upon request. Information regarding data access is available through the CODIAC system.

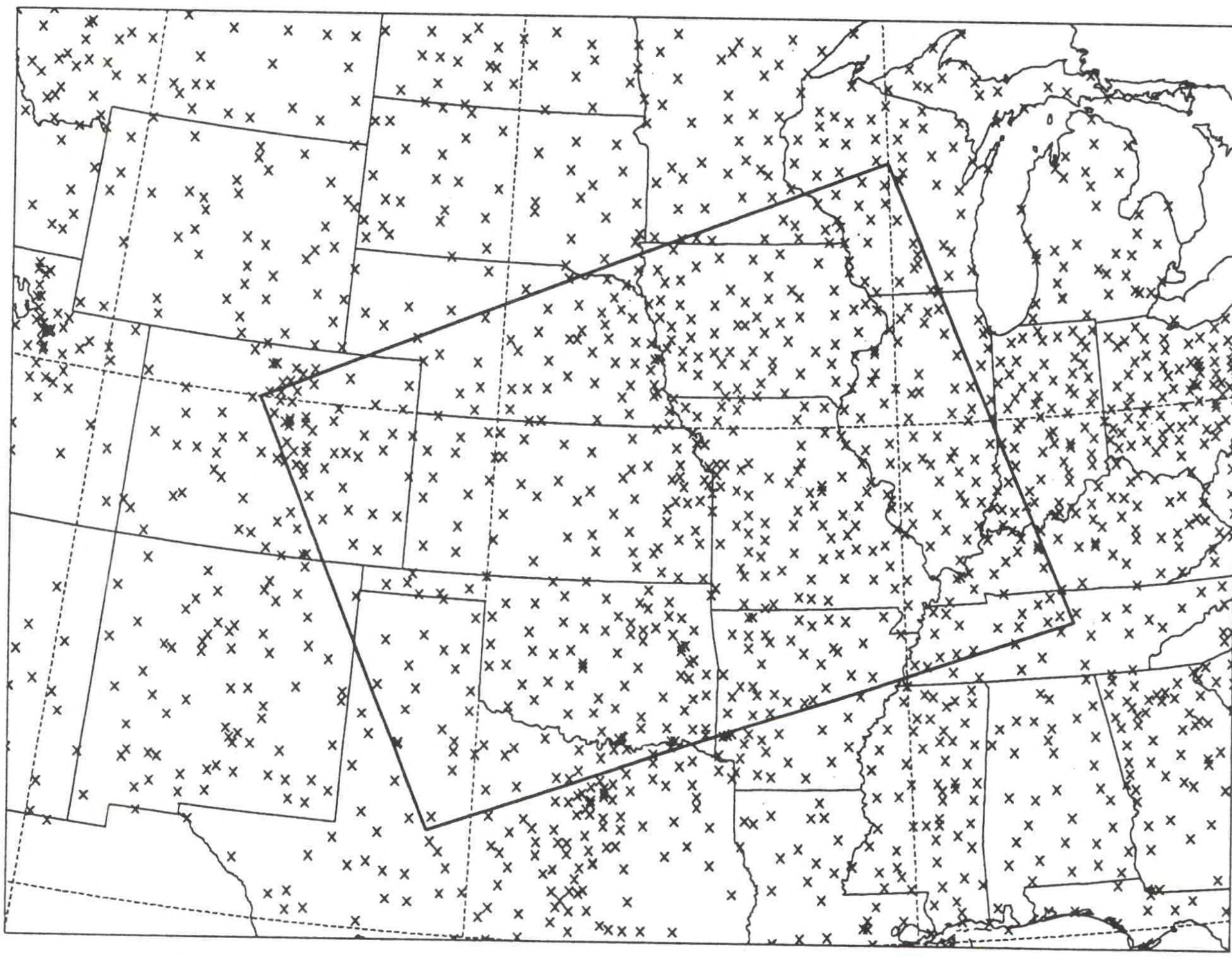


Figure 2.3 Location of the NWS Cooperative Observer Sites for precipitation.

2.1.2 State and Regional Networks

NOAA Forecast Systems Laboratory, Colorado Mesonet Data

The NOAA Forecast Systems Laboratory, FSL, operated and maintained a mesonet of automatic weather stations (22 total) in northeastern Colorado to provide current information on weather conditions that are used for modeling, forecasting, and research (ground truth) purposes (see Fig. 2.4). These stations measured 5-min averages of wind speed and direction, air temperature, dew point, barometric pressure, solar radiation, and 5-min precipitation totals. Each station was polled sequentially every 5-min via dedicated telephone lines from a central computer (VAX 11/780) at NOAA's Forecast System Laboratory (FSL). Data set information and data for the STORM-FEST period are available through the CODIAC system.

Illinois Climate Network (ICN) Data

The Midwest Climate Center operated and maintained an existing network of 19 Agricultural stations throughout Illinois (see Fig. 2.5). These stations collected 5-min averages of air temperature, relative humidity, pressure, wind speed and direction, and precipitation. Special high resolution pressure sensors provided by NASA were installed in the network for STORM-FEST. All data were stored on-site and transferred daily via telephone to a central computer located at the University of Illinois for quality assurance and final archiving. Data set information and data for the STORM-FEST period are available through the CODIAC system.

High Plains Climate Network (HPCN) Data

The High Plains Climate Center operated and maintained an existing network of 86 agricultural and drought monitoring automatic weather stations in Nebraska (35), Kansas (14), Iowa (7), North Dakota (14), South Dakota (10), Eastern Colorado (4), and Eastern Wyoming (2) (see Fig. 2.6). These stations measured hourly averages of air temperature, humidity, wind speed (simple average and vector magnitude), wind direction (vector and standard deviation), solar radiation, soil temperature, and precipitation (hourly totals). These data were stored locally on site and polled via telephone once per day to a central computer at the University of Nebraska at Lincoln for quality assurance and final archiving. Data set information and data for the STORM-FEST period are available through the CODIAC system.

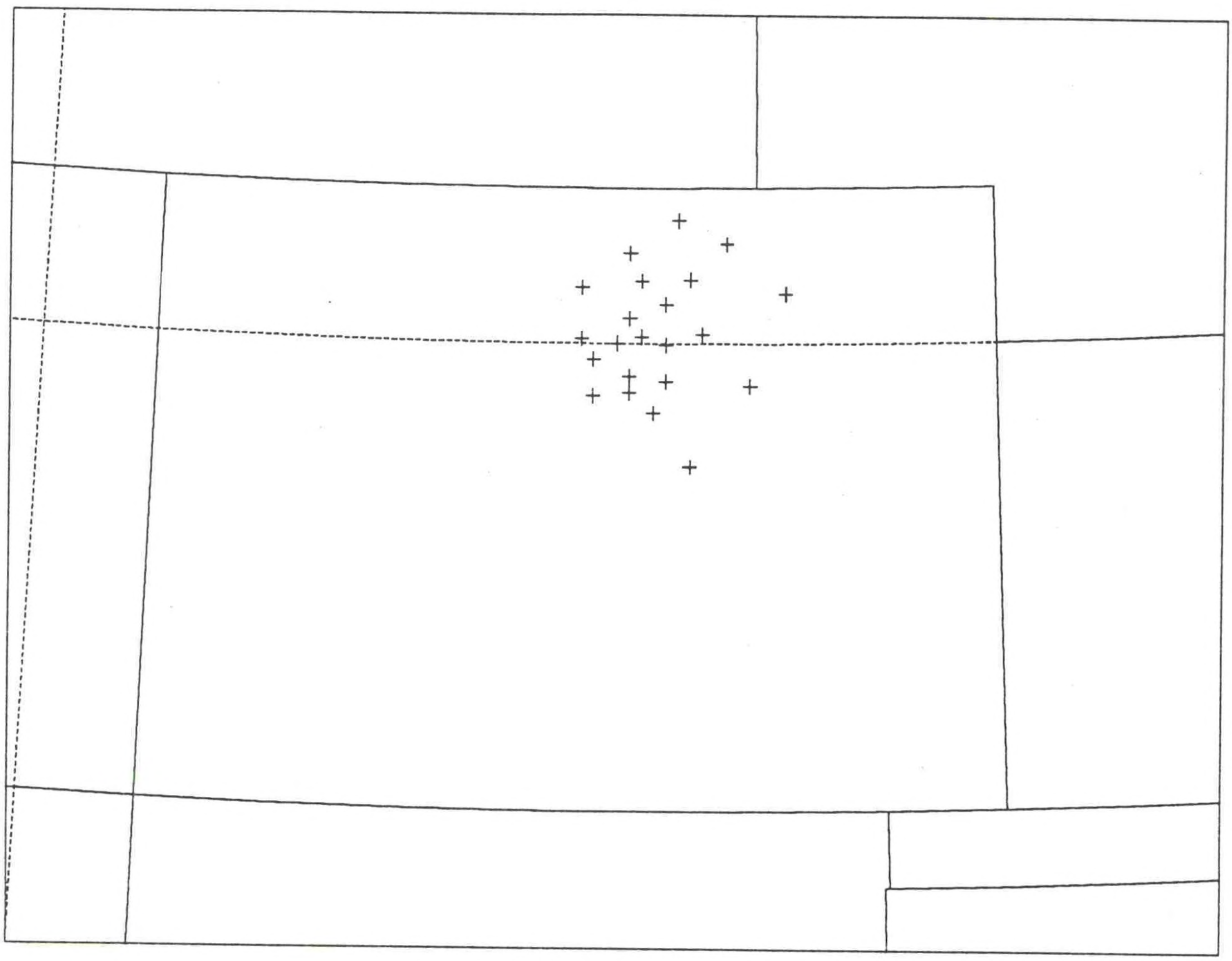


Figure 2.4 Location of the FSL surface mesonetwork stations in Colorado.

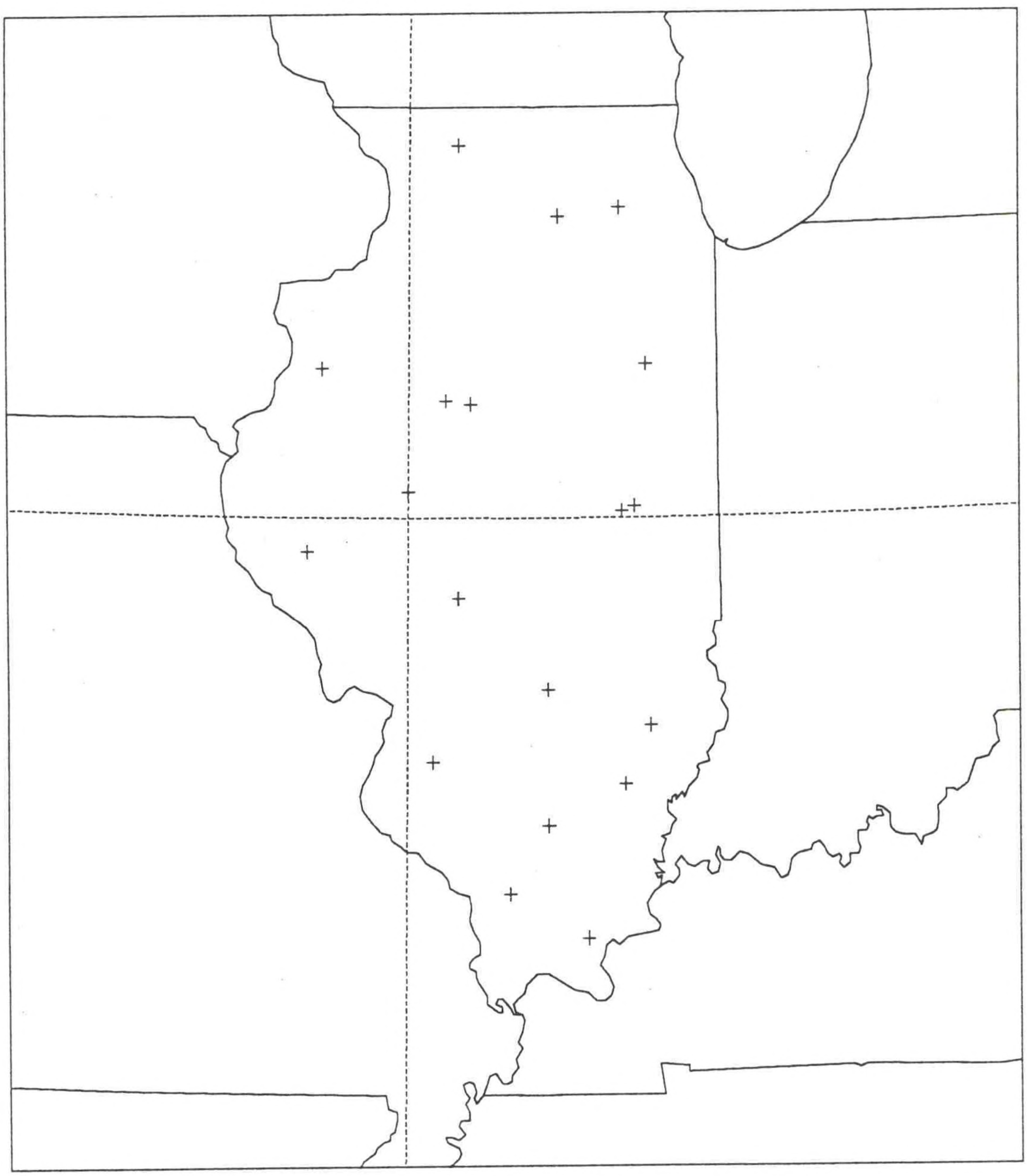


Figure 2.5 Location of the Illinois Climate Network Sites.

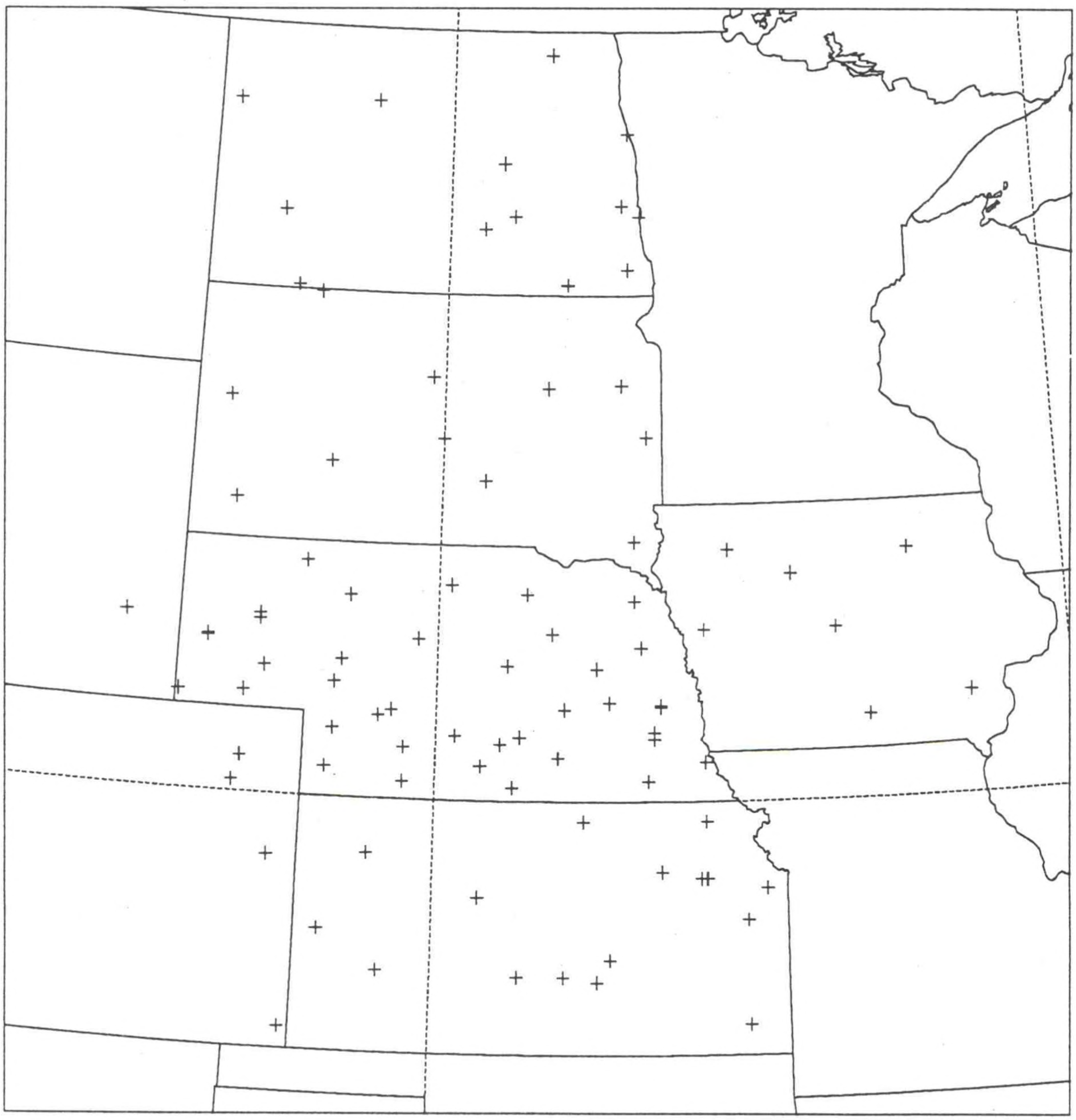


Figure 2.6 Location of the High Plains Climate Network Sites.

Flatlands Atmospheric Observatory (FAO) Data

The NOAA/ERL/Aeronomy Laboratory (AL), Illinois State Water Survey, and the National Science Foundation maintains the Flatlands Atmospheric Observatory, and a network of six digital barometer sites in east central Illinois. Measurements taken at the FAO included a surface meteorological station (wind speed, wind direction, air temperature, humidity, rainfall, and solar radiation at 30-second time intervals), a 49.8 MHz lower tropospheric radar profiler, and radiosonde system (thermodynamic variables only). The barometers were sampled once every 10 seconds and the results averaged over 2 minutes and stored on-site. These averages were downloaded each night over commercial phone lines to the AL in Boulder for quality assurance and final archival. Data set information and data for the STORM-FEST period are available through the CODIAC system.

USGS Precipitation and Hydrology Network (Oklahoma) Data

The USGS operated and maintain a network of 91 tipping bucket raingauges and flow streamgauges at their surface-water gauging stations throughout the State of Oklahoma. The locations of the precipitation sites are shown in Fig. 2.7. The data were telimetered automatically every 4 hours for processing and archival as part of the USGS National Water Information System (NWIS). The majority of the precipitation gauges reported 1-h precipitation totals, with a few sites reporting 15-min totals. No provisions for frozen precipitation were made during STORM-FEST. Data set information and data for the STORM-FEST period are available through the CODIAC system.

A streamflow gauging station was located at the outflow of the Little Washita Watershed and at the outflow of an upstream, smaller imbedded watershed, that was part of the Little Washita Basin. The data consisted of a continuous record of stage, individual measurements of discharge throughout a range of stages, and notations regarding factors that may affect the relationships between stage and discharge. Streamflow data are available through the USGS National Water Information System (NWIS). Information regarding data access is available through the CODIAC system.

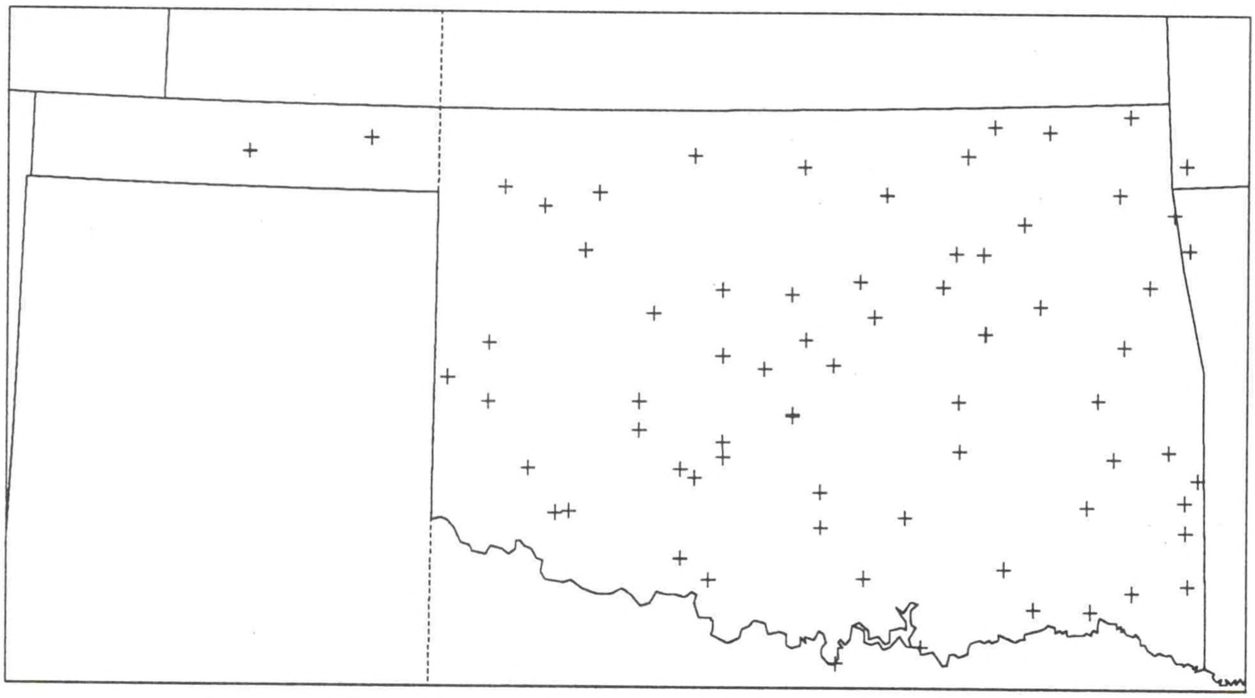


Figure 2.7 Location of the USGS precipitation gauges in Oklahoma.

USDA/ARS Precipitation Network (Little Washita Basin) Data

The USDA/Agricultural Research Station (ARS) precipitation network, located within the scanning range of two WSR-88D radars, consisted of 44 raingauges spaced over 230 square miles (i.e average spacing of 5 km) comprising the Little Washita watershed in Central Oklahoma (see Fig. 2.8). The network consisted of weighing type (chart recorder) gauges. The weekly charts were digitized into 5-min time and 0.01" resolution totals and quality controlled by ARS before being sent to the SFDMC for final archival. No provisions for frozen precipitation were made during STORM-FEST. Data set information and data for the STORM-FEST period are available through the CODIAC system.

Raindrop size distributions were also measured by a linear array of 3 disdrometers near Chickasha, Oklahoma, specifically installed and operated for STORM-FEST. The disdrometers were located at various spacing to relate scale discontinuities with radar; accessing space-time variability of stratiform precipitation. A drop size distribution was recorded after 1000 drops struck the disdrometer with a size resolution of 0.1 mm (minimum drop size 0.2 mm). The data consisted of 15-min records of these drop size distributions, rain rate, and calculated reflectivity factor and differential reflectivity. Data set information and data for the STORM-FEST period are available through the CODIAC system.

2.1.3 Research Networks

NCAR Portable Automated Mesonet (PAM II) Data

Forty-five NCAR second generation PAM II stations were deployed in the STORM-FEST domain (see Fig. 2.9). Nine of these stations were deployed in the STORM-FEST boundary layer network near Seneca Kansas (station spacing approx. 5 km) with the majority of the remaining 36 stations deployed throughout Missouri (station spacing approx. 100 km). In addition, a PAM II station was collocated with an ASOS station in Topeka, Kansas. The PAM stations measured 5-min averages of temperature, relative humidity, barometric pressure, 10-m wind speed and direction (u,v components), and rainfall totals. One-minute resolution data was collected at the Boundary Layer network and at Topeka. All data were stored locally on-site and transmitted via GOES satellite every 5-min to receiving stations at NCAR (Boulder, CO) and at the STORM-FEST Operations Center at Richards-Gebaur AFB for real-time display quality assurance, and archiving.

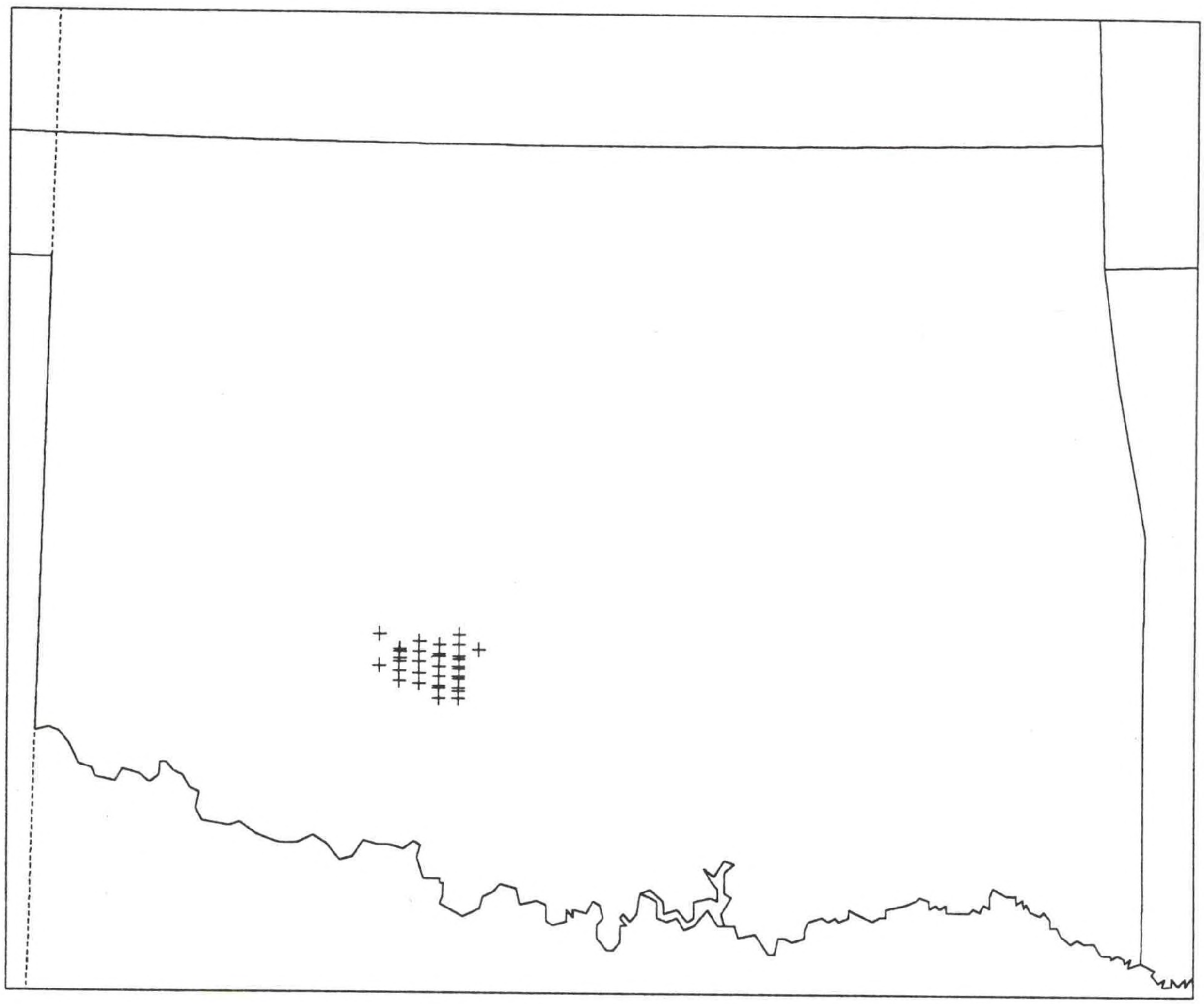


Figure 2.8 Location of the USDA/ARS Little Washita Basin Precipitation Network.

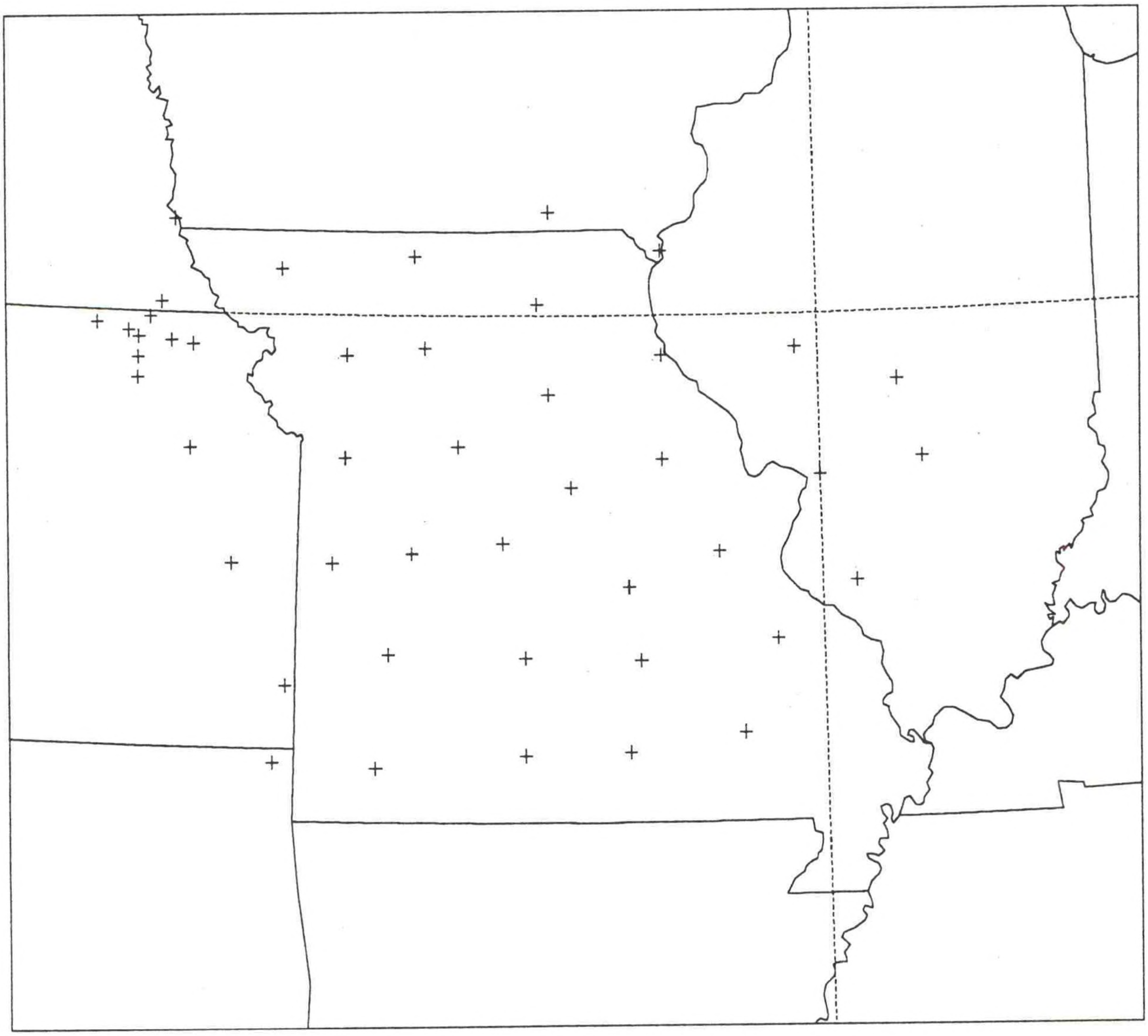


Figure 2.9 Location of the PAM Surface Mesonet Sites.

All data are available from NCAR/Research Data Program (RDP). Information regarding data access is available through the CODIAC system.

NCAR ASTER Facility Data

The NCAR Atmosphere-Surface Turbulent Exchange Research (ASTER) Facility collected measurements during STORM-FEST as part of the Boundary Layer Network near Seneca, Kansas. ASTER provided tower-based measurements of turbulent eddy correlation fluxes of momentum, sensible heat and water vapor as well as vertical profiles (10-m, 5 levels) of wind speed and direction, temperature, and water vapor. Additional ASTER measurements included barometric pressure, precipitation, net radiation and soil fluxes of temperature, moisture and heat (i.e., surface energy balance). ASTER collected 1-min time resolution data on-site which was processed, quality assured, and archived by NCAR. All data are available from NCAR/Research Data Program (RDP). Information regarding data access is available through the CODIAC system.

Misc. Observation Network Data

Numerous other small private and commercial meteorological networks existed in the STORM-FEST region. These include data collected by local agricultural extension stations, power and utility plants, and others. Arrangements are underway to obtain these data and other meteorological data routinely collected by other federal and state networks (i.e., Soil Conservation Services, the Army Corps of Engineers, US Geological Survey, DoD missile sites, etc.). Data set information and data for the STORM-FEST period will be available through the CODIAC system.

2.1.4 Composite Surface Data Sets

The STORM-FEST Data Management Center (SFDMC) created three contiguous U.S. composite surface data sets consisting of STORM-FEST data collected from the national, regional, and special research network data sets (i.e., ASOS, AWOS, NWS/FAA, FSL, ICN, HPCN, PAM, and USGS). The following composite data sets were created: (1) 5-min composite from data collected at 5-min or less resolution sites (Approx. 120 total sites); (2) 1-h composite from data collected at 1-h resolution sites (approx 720 sites); and (3) hourly and 15-min precipitation composites from all networks measuring precipitation (approx 2700 sites). All individual data sets were converted to a common internal format using standard parameters. Quality assurance was performed flagging data according to a MAPS comparison and station "buddy" checks. Final archival was performed using a conversion to E-BUFR format. Data set information and data for the STORM-FEST period are available through the CODIAC system.

2.2 Upper Air Data

Upper air soundings for STORM-FEST were provided by conventional systems (NWS, Military, AES) and research (CLASS, dropwindsonde and Profiler systems). Figures 2.10a and b shows the sounding and profiler sites for the inner and total STORM-FEST domains respectively. A complete listing of all upper air site locations are provided in Appendix A.

2.2.1 Surface-based Rawinsonde

National Weather Service (NWS) Rawinsonde Data

Standard and special soundings were taken for STORM-FEST from 33 NWS stations in the western and central United States using the NWS MicroART system. In addition to standard 12-h observations, special 3-h and 6-h soundings were taken in the STORM-FEST domain as requested by STORM-FEST Operations. The radiosondes were radio-directionally tracked from each sounding station and 1-sec thermodynamic data from the radiosonde were transmitted directly to the station for sounding computation. Special soundings taken for STORM-FEST were terminated at 100 mb. A total of approx. 5600 NWS soundings were taken during the STORM-FEST period. Archived data consists of 6-second vertical resolution (MicroART) data and mandatory/significant level data of pressure, temperature, relative humidity, wind speed and direction. Mandatory/Significant level data were archived into NCDC's TD-6201 national upper air data set. Following STORM-FEST, the 6-sec vertical resolution data were converted from MicroART format to NCAR CLASS format by the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

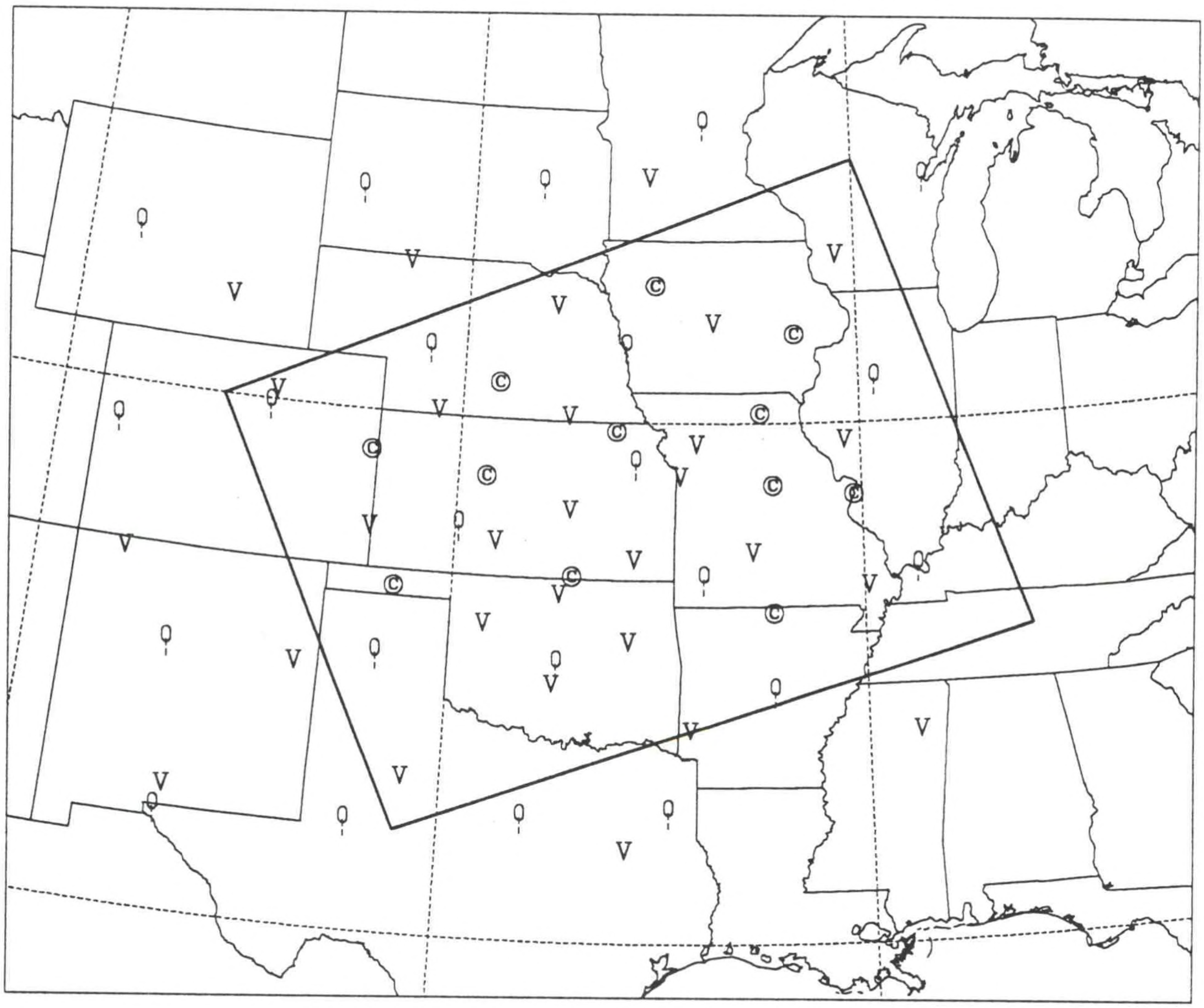


Figure 2.10a Location of the Inner Domain Sounding and Profiler Sites (ǫ-NWS sites, ©-Class sites, V-Profiler sites.

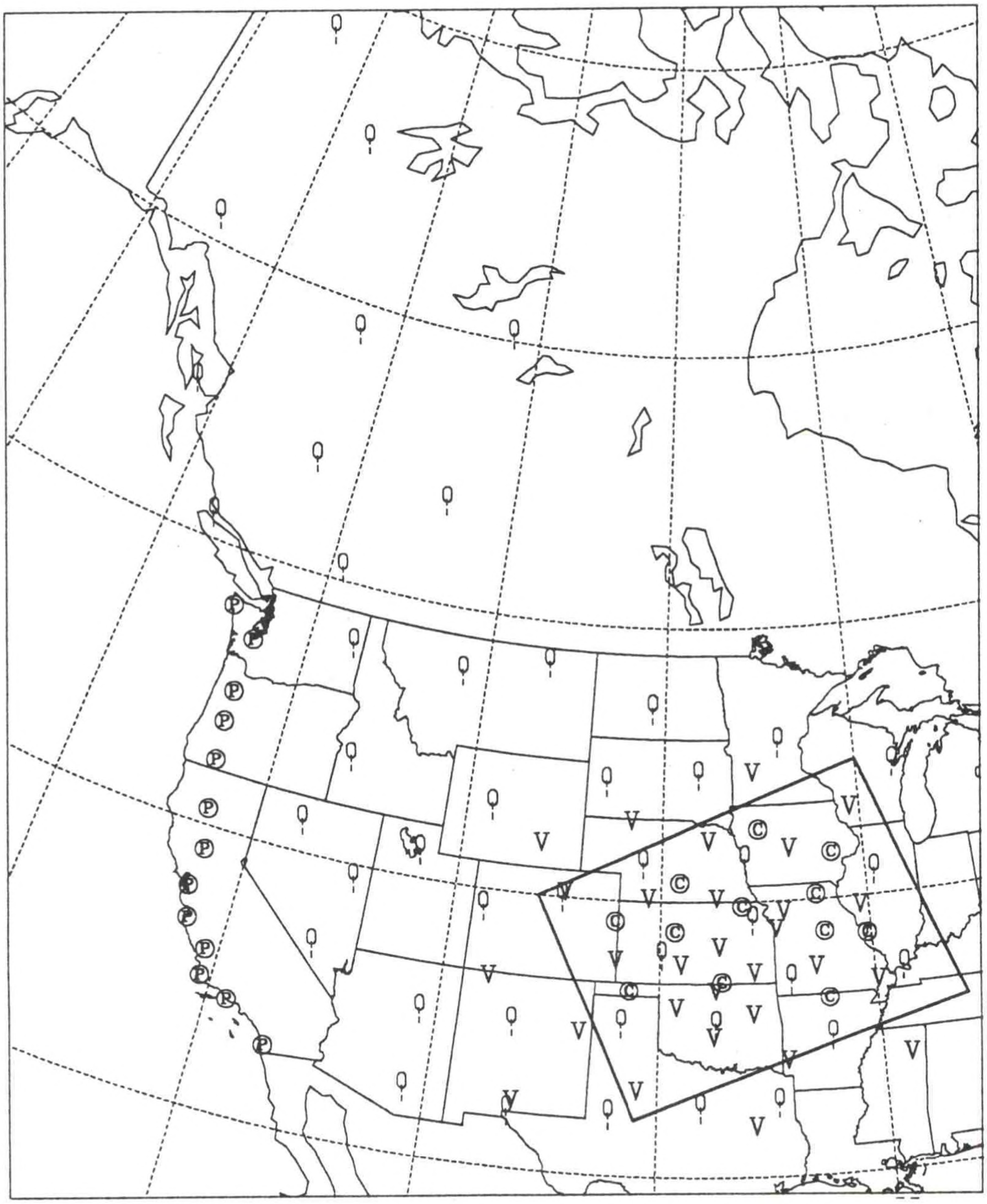


Figure 2.10b Location of the STORM-FEST Sounding and Profiler Sites (♀-NWS and AES sites, ©-Class sites, V-Profiler sites, ℗-Picket Fence).

Canadian AES Rawinsonde Data

Standard and special soundings were taken from 9 Canadian Atmospheric Environment Service (AES) stations in western Canada. In addition to standard 12-h routine operational soundings, selected stations provided 6-h special soundings as requested by the STORM-FEST Operations Center. The radiosondes were radio-directionally tracked and thermodynamic data from the radiosonde were transmitted directly to the station for sounding computation. These soundings consisted of 10-sec vertical resolution (where available) and mandatory/significant levels of pressure, temperature, relative humidity, wind speed and direction. Mandatory/significant level data were archived at the Canadian Climate Center in cycle format. Special soundings taken for STORM-FEST were terminated at 100 mb. A total of approx. 1500 AES soundings were taken during the STORM-FEST period. Following STORM-FEST, the 10-sec vertical resolution data (where available) and cycle format were converted to NCAR CLASS format by the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

NCAR and NOAA/NSSL CLASS Data

Twelve (12) special fixed site Cross-chain Loran Atmospheric Sounding System (CLASS) rawinsonde stations were operated by NCAR (8) and NSSL (4) and deployed to supplement the existing NWS rawinsonde and NOAA Profiler sites in the STORM-FEST inner domain. Soundings were taken as directed by STORM-FEST Operations (from a 12-h to 3-h interval schedule). CLASS used the LORAN navigational aid network to determine radiosonde position and calculate wind speed and direction. Thermodynamic parameters (pressure, temperature, and relative humidity) were transmitted directly from the radiosonde to the CLASS site. Complete soundings were terminated at 100 mb. A total of approx. 1200 CLASS soundings were taken during the STORM-FEST period. Data consists of 10-second vertical level resolution of pressure, temperature, relative humidity wind speed and direction. Following STORM-FEST, all CLASS sounding data were processed, quality checked, and archived by NCAR. All data are available from NCAR/Research Data Program (RDP). Information regarding data access are available through the CODIAC system.

U.S. Military Rawinsonde Data

Standard and special scheduled U.S. Military soundings were taken from selected Military installations to support STORM-FEST activities. These soundings were taken using a variety of rawinsonde systems on various schedules. Special soundings taken for STORM-FEST were terminated at 100 mb, except for soundings taken to support military activities. A total of approximately 250 soundings were taken during the STORM-FEST period. Data consists of 100-m vertical resolution (where available) and mandatory/significant levels of pressure, temperature, relative humidity, wind speed and direction. Following STORM-FEST, the highest vertical resolution data available was converted to NCAR CLASS format by the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

Naval Postgraduate School "Picket Fence" Rawinsonde Data

The Naval Postgraduate School (NPGS) at Monterey, California, coordinated a network of 7 special rawinsonde stations in addition west coast NWS, military, and AES stations. This higher density "Picket Fence" network consisted of a total of 15 stations along the west coast that extended from California to British Columbia with a station spacing of approx. 200 km. The purpose of the "Picket Fence" network was to provide observations of the environmental flow conditions upstream of the STORM-FEST domain. Soundings were taken as directed by NPGS personnel in coordination with STORM-FEST Operations (on a 3-h interval schedule for 4 IOPs of 24- to 48-h duration). The special Picket Fence sounding sites used the OMEGA navigational aid network to determine radiosonde position and calculate wind speed and direction. Thermodynamic parameters (pressure, temperature, and relative humidity) were transmitted directly from the radiosonde to individual sites. Complete soundings were terminated at 100 mb. A total of approximately 1000 Picket Fence soundings were taken during the STORM-FEST period. Data consists of 10-second vertical level resolution of pressure, temperature, relative humidity, wind speed and direction. Following STORM-FEST, all Picket Fence sounding data were converted from FGGE format to NCAR CLASS format by the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

2.2.2 Aircraft-Based Dropwindsonde

NCAR Lightweight Loran Digital Dropwindsonde (L2D2) Data

Approximately 96 NCAR L2D2 dropwindsondes were successfully deployed from research aircraft during STORM-FEST to increase data sampling along the aircraft flight tracks. The dropsondes were released primarily in the STORM-FEST inner domain from research aircraft (NOAA P-3 and NCAR King Air) equipped with telemetry receiving and data processing equipment. The L2D2 utilized the LORAN navigational aid network for tracking and computing winds, and transmitted the thermodynamic data (pressure, temperature, relative humidity) back to the aircraft. Data consisted of 10-second time vertical level resolution of pressure, temperature, relative humidity wind speed and direction. Following STORM-FEST, all L2D2 dropsonde data were processed, quality checked, and archived by NCAR. All data are available from NCAR/Research Data Program (RDP). Information regarding data access is available through the CODIAC system.

U.S. Military Dropwindsonde Data

The U.S. Air Force deployed approximately 200 dropsondes during STORM-FEST over the northeast Pacific Ocean in support of upstream upper air soundings for model initialization and air mass/frontal transition studies. The military dropwindsondes were released from C-130 aircraft at approximately 30,000 feet altitude, providing pressure, temperature, relative humidity, and wind speed and direction data. Mandatory/significant level data were relayed to NMC via weather circuit transmission for possible inclusion into numerical weather prediction models and real-time operational products. Following STORM-FEST, highest vertical resolution data (i.e., 10-sec) were converted into NCAR CLASS format by the SFDMC for conversion into NCAR CLASS format. Data set information and data for the STORM-FEST period are available through the CODIAC system.

2.2.3 Profilers

NOAA Demonstration Profiler Network Data

During STORM-FEST, the NOAA Demonstration Profiler network consisted of twenty six (26) 403 MHz profilers in and near the STORM-FEST domain. The remainder of the network was being installed. The data consists of 6-minute in 1-hr time resolution vertical profiles of winds and temperature from 0.5 to 14 km altitude. These data were collected, processed, quality checked by NOAA. A subset of hourly profiles were transmitted via UNIDATA to research scientists. Final archival of 6-min and hrly data was performed by NCDC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

NOAA/WPL Boundary Layer Network Research Profiler Data

NOAA/Wave Propagation Laboratory (WPL) operated and maintained five Boundary Layer Profilers (915 MHz) in the Boundary Layer Network during STORM-FEST. These lower tropospheric Profilers, equipped with RASS, provided vertical profiles of winds and temperatures at 0.5-h intervals. Winds were measured at 100 m resolution gates from 0.2 to 3.1 km, and at 400 m resolution from 0.4 to 5 km. Temperatures from the RASS were measured up to about 2 km. The data were processed, quality checked, and archived by NOAA/WPL. Data set information and data for the STORM-FEST period are available through the CODIAC system.

University of Wisconsin HIS Data

The University of Wisconsin operated and maintained a High-resolution Interferometer Sounder (HIS) as part of the STORM-FEST Boundary Layer Network near Seneca, Kansas. The HIS was a vertically viewing instrument providing vertical profiles of temperature and moisture every 12 minutes from calibrated infrared downwelling radiance spectra. The retrieval of temperature/moisture profiles worked well under cloud-free or high to mid-level cloud conditions, providing good spatial/temporal data of atmospheric structure. The HIS operated nearly continuously, except during periods of rain and snow, and for daily calibrations (centered near 0000 UTC). All data are available from The University of Wisconsin Space Science and Engineering Center. Information regarding data access is available through the CODIAC system.

2.2.4 Composite Upper Air Data Set

The STORM-FEST Data Management Center (SFDMC) created a composite upper air data set consisting of STORM-FEST data collected from all surface-based rawinsonde and aircraft-based dropwindsonde data sets (i.e., NWS, AES, CLASS, U.S. Military rawinsonde, Picket Fence, L2D2, and USAF dropwindsondes). All individual data sets were converted to NCAR CLASS format and interpolated to standard 10-mb pressure levels. A final quality assurance (and subsequent flagging of data) was performed by the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

2.3 Radar Data

Radar data were obtained from national, regional, and research networks (see Fig. 2.11) comprising the STORM-FEST domain. (A complete listing of the site locations is given in Appendix A.)

WSR-88D Radar Data

Operational ten-cm wavelength Doppler weather radar data (NEXRAD WSR-88D) were collected from four sites during STORM-FEST (Twin Lakes, OK; Frederick, OK; Norman, OK; and St. Louis, MO). The site at St. Louis began collecting data on 4 March and no Archive II data were recorded. Data recording was sparse from the Oklahoma area radars, restricted to selected periods when precipitation occurred in the area (see daily data collection grids). The Level II Archive data consist of radar reflectivity and velocity spectra for each full volume scan (i.e., every 5-10 minutes depending upon mode). These data were recorded on 8mm data tapes and archived at NOAA/OSF in Norman, OK. Copies of these tapes were provided to the STORM-FEST Data Management Center for distribution. Display software is being developed from NOAA/OSF and NOAA/NSSL in Norman, OK. Data set information and data for the STORM-FEST period are available through the CODIAC system.

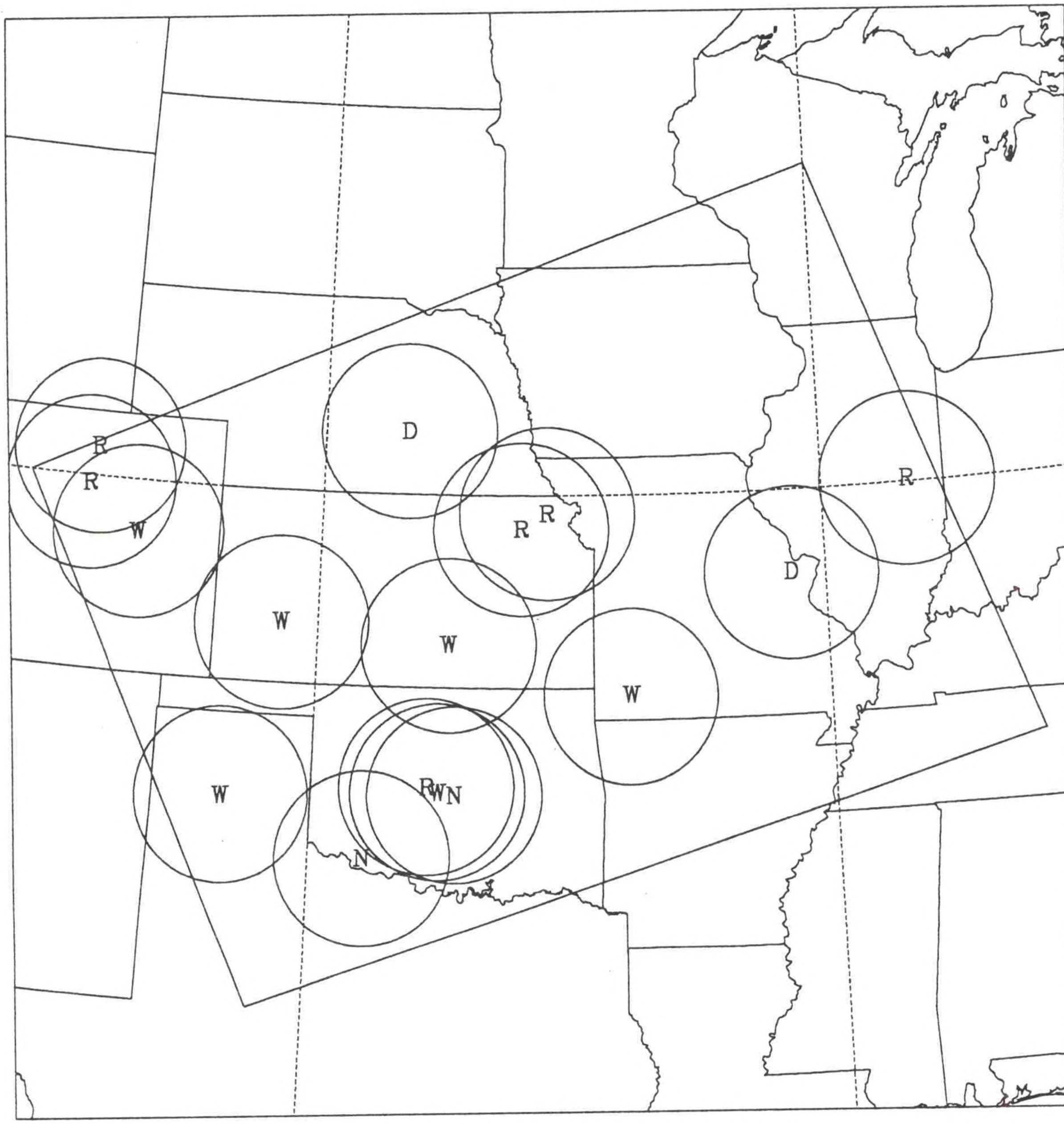


Figure 2.11 Location of the Research and Operational Radars (N-NEXRAD, W-Digitized Full Volume WSR-57 [RADAP-II], D-Digitized WSR-57, R-Research).

NWS WSR-57 Digitized Radar (St. Louis, Grand Island) Data

Two portable digitizers were interfaced to existing 10-cm non-coherent wavelength WSR-57 radars at St. Louis and Grand Island during STORM-FEST. The digitized PPI and volume scan reflectivity data were recorded on 9-track tapes and archived by SFDMC. The recorders were activated only during times requested by the STORM-FEST Operations Center (See the daily data collection grids). Software to read and display these data are available from NOAA/NSSL. Data set information and data for the STORM-FEST period are available through the CODIAC system.

NWS Manually Digitized Radar Data

National Weather Service WSR-57 radar data (reflectivity) for the United States were routinely manually digitized by the National Meteorological Center and distributed over the weather data communications networks in real-time. These data were routinely ingested, archived, and available from NCAR/SCD and NOAA/NCDC. Information regarding data access is available through the CODIAC system.

NWS Radar PPI Scan Films

The NWS routinely filmed Plan Position Indicator (PPI) displays from 59 NWS WSR-57 radar scopes during periods of significant weather (40-sec to 5-min image frequency). Photographic frames of the PPI scope provided the direction and distance of echoes, which included individual cells or areas of cells from the radar. From a series of frames, the intensity and direction of movement can be determined. A junction or coded lamp system displayed pertinent information about the radar function settings, range, clock, etc. The data are available from NCDC on 16- and 35-millimeter microfilm. Glossy prints from these microfilms are also available from NCDC. Information regarding data access is available through the CODIAC system.

NWS Radar Summary Charts (Microfiche)

Hourly WSR-57 radar summary (PPI composite) charts were prepared by the National Weather Service (NWS), National Meteorological Center (NMC) and archived on 35-mm microfilm by the National Climatic Data Center (NCDC). The charts contain analyzed areas, lines, and cells derived by radar reflectivity that include the base, tops, intensity, and movement of these cloud formations. Precipitation types and intensity change are also depicted. In addition, hourly and special radar weather observations were recorded on daily MF7-60 forms which provided information on character, type, and intensity of precipitation, echo heights and movement, and pertinent remarks. These forms are microfiched monthly and available from NCDC. Information regarding data access is available through the CODIAC system.

NCAR Research Doppler Radar Data

The NCAR CP-3 and CP-4 C band 5-cm wavelength research Doppler radars were operated in a dual Doppler coordinated made in northeast Kansas during STORM-FEST. Approximately 228 and 250 hours of data were recorded for CP-3 and CP-4, respectively. Measurements included radar reflectivity, velocity, spectral width (WS), normalized coherent power (NCP), signal noise ratio (SN), and received power (DM). The reflectivity and velocity data from CP-4 was displayed in real-time for operations on the NCAR/Research Data Program (RDP)'s ZEB workstations in the Field Operations Centers in Kansas City and Boulder. This lower resolution CP-4 data was also archived on ZEB and is available in ZEB Format. Following the field data collection, NCAR/RDP cataloged, processed, quality controlled, and archived the data. Data are available on the NCAR mass store in field format with software available to convert these data to Universal Format. High resolution scan catalogs produced during the processing are also available from NCAR/RDP. Information regarding data access is available through the CODIAC system.

NSSL Cimarron Radar Data

The 10-cm wavelength Cimarron Doppler radar located at NOAA/NSSL operated in dual-Doppler coordination with the Twin Lakes and Norman OSF WSR-88D radars when precipitation occurred in the Oklahoma area during STORM-FEST (see daily data collection grids). Approximately 26 hours of data were recorded during STORM-FEST. Reflectivity and velocity spectra data were recorded on 9-track tapes in real-time. The data were then quality controlled by NOAA/NSSL and copied to 8mm data tapes. Copies of these tapes were provided to the SFDMC for archival and distribution. Copies of the volume scan catalog are also available. Data set information and data for the STORM-FEST period are available through the CODIAC system.

Mile High (Denver) Radar Data

The Mile High (Denver) 10-cm wavelength Doppler radar operated almost every day during STORM-FEST in support of the FAA Terminal Doppler Weather Radar (TDWR) Program. Approximately 422 hours of data were recorded during STORM-FEST. The radar primarily operated from 1600 to 0000 UTC daily (see daily data collection grids), in TDWR scan mode (PPI), collecting a large fraction of data in periods of clear weather. The data (i.e., "raw" reflectivity and velocity) were archived on 8mm data tapes and sent to NCAR/Research Data Program (RDP). The data were then processed and archived on the NCAR Mass Store by RDP. Information regarding data access is available through the CODIAC system.

Illinois HOT Radar data

The University of Illinois HOT 5-cm wavelength Doppler Radar was located at the Urbana-Champaign Airport and operated by the Illinois State Water Survey during STORM-FEST. The radar was activated under the direction of the STORM-FEST Operations Director during designated IOPs. The data were recorded on 9-track tapes. All data are available from The University of Illinois. Information regarding data access is available through the CODIAC system.

NWS RADAP II Data

Five 10-cm non-coherent wavelength NWS WSR-57 radars (Garden City, KS; Monett, MO; Amarillo, TX; Limon, CO; Oklahoma City, OK) equipped with a second generation RAdar DAta Processor (RADAP II) and an interfaced Interactive Color Radar Display (ICRAD) system recorded radar reflectivity data during the STORM-FEST period. RADAP II automatically controlled radar operation and acquired approximate 15-minute tilt sequence volume scan data of low level PPI and volumetric reflectivity. These data (at a resolution of 2 deg by 1 nautical mile range from 10 to 125 nautical miles) consists of both low level PPI and volumetric reflectivity converted to 15 RADAP levels which corresponds to approximate rainfall rates. Raw data were collected on floppy disks and transferred to the NWS Techniques Development Laboratory (TDL) for processing and quality control. Final archival and availability of the RADAP II data was performed by NCDC. Information regarding data access is available through the CODIAC system.

WSI NOWRAD Radar Composites

WSI provided Planned Position Indicator (PPI) reflectivity data from individual NWS radars and produced regional NWS radar composites (NOWRAD) every 15-minutes during STORM-FEST. These high resolution regional radar composite images (8-bit) were ingested by the National Weather Service VDUC system (McIDAS) and archived by the National Severe Storms Forecast Center (NSSFC), Kansas City. A fixed regional sector (STORM-FEST Inner Domain) and a floater sector were downloaded to PC-McIDAS in real-time during STORM-FEST and archived by the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

NOAA/AOC WP-3D Airborne Radar Data

The NOAA/Aircraft Operations Center (AOC) WP-3D aircraft carried a 5-cm and a 3-cm wavelength radar during STORM-FEST: the horizontally scanning lower fuselage (LF) radar (5 cm), which measured reflectivity; and the vertically scanning tail (TA) radar (3 cm) which measured reflectivity and velocity. The LF radar was non-coherent and the TA radar was Doppler. Both radars were three axis stabilized, with the TA antenna nominally directed perpendicular to the aircraft ground track. Both antennas covered the full 360 deg of azimuth. Data were recorded on 9-track, 1600 bpi field tapes in raw "P-3" standard format. Software exists to read and display "raw" P-3 format and convert this format into Universal Format. All P-3 radar data were archived by the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

2.4 Satellite Data

NOAA GOES-7 VIS/IR/MSI Imagery

Most of the satellite data archived during STORM-FEST was obtained from the Geostationary Operational Environmental Satellite (GOES-7) positioned near 108 degrees longitude. The primary instrumentation on GOES-7 was the Visible and Infrared Spin-Scan Radiometer (VISSR) which produced both day and night Infrared (IR) [10.5 to 12.5 microns] and day visible (VIS) [0.5 to 0.7 microns] radiometric images of the full disk at 30-min intervals. In addition, the VISSR Atmospheric Sounder (VAS) sensor had four IR detectors and 12 narrow band filters that produced multi-spectral data [from 14.73 to 3.95 microns]. Multi-spectral imagery (MSI) was produced at 3-hour intervals (1-hr during 0030-0230 and 1230-1430 UTC). Although the scheduling of these bands varied, typically band 10 [6.7 microns] is widely used to depict water vapor distribution. The GOES-7 nominal VAS schedule is shown in Appendix C. This schedule during STORM-FEST provides a 30-min general listing of available image bands and Dwell Soundings (DS) associated with each Processor Data Load (PDL) and corresponding time length.

Image frequency was increased by placing the satellite into Rapid Interval Scan Operations Plan (RISOP) mode or "Rapid Scan". Under RISOP, up to 12 VIS/IR/MSI images per hour were obtained depending on location of interest. Appendix C describes the VAS schedule when the GOES satellite was in RISOP mode. Note that during RISOP, normal scheduled VAS operations were suspended or changed. Fourteen RISOP periods were called during STORM-FEST (see daily data inventories for specific times).

The primary source for GOES-7 imagery data was the IBM Mainframe McIDAS system located at the National Severe Storms Forecast Center (NSSFC) in Kansas City, MO. The imagery (Area files) were downloaded to PC-McIDAS in real-time and archived by the STORM-FEST Data Management Center. These data consist of 1-km resolution VIS imagery of the STORM-FEST inner domain; 8-km resolution MSI imagery of the northern hemisphere; and hourly VAS precipitable water imagery. All GOES-7 data were archived by NOAA/NESDIS at the University of Wisconsin Space Science and Engineering Center (SSEC) and are available in McIDAS and GARS format. Data set information and data for the STORM-FEST period are available through the CODIAC system.

NOAA GOES-7 Visible Image Loop Video Tapes

Florida State University (FSU) prepared a set of three Video Cassette Recorder (VCR) tapes containing loops of 8 km resolution GOES-7 imagery (visible, infrared, and MSI channel 10, respectively) over the central United States for the STORM-FEST period. The tapes were recorded at standard speed (2-hour length) and contain daily loops of 1-h interval imagery. The tapes were prepared using 8-bit imagery from FSU's GOES direct readout groundstation PC-based ingester. Since the FSU system relied on navigation transmitted from GOES-7, some navigational errors may be evident on these tapes. The video provides a browse capability in selection of post-research case studies, and should not be used in quantitative image studies. Copies of these tapes were archived and available from the SFDMC. Information regarding tapes for the STORM-FEST period are available through the CODIAC system.

NOAA GOES-7 VAS Data/Derived Products

The GOES-7 VISSR Atmospheric Sensor (VAS) capability provided IR radiance observations at 12 wavelengths between 3.9 and 14.7 micrometers as well as two imaging modes (6.9 to 13.8 km resolution) and a sounding mode (13.8 km resolution).

Meteorological parameters derived from VAS (for clear and partly cloudy areas) included: cloud cover, earth/cloud temperatures, cloud type, cloud motion derived winds, stereo derived cloud-top heights, water vapor fields, temperature fields, improved surface temperatures, and temperature and moisture profiles (Dwell Soundings). The interval and number of dwell soundings and derived products depended upon whether the satellite was in normal operation or RISOP mode. VAS data were routinely archived and available from NOAA/NESDIS and the University of Wisconsin's Space Science Engineering Center (SSEC). Information regarding data access is available through the CODIAC system.

NOAA AVHRR Imagery

Two NOAA series polar orbiting satellites (NOAA-11 and NOAA-12) carried the Advanced Very High Resolution Radiometer (AVHRR) sensor during STORM-FEST. AVHRR is a cross-track scanning system with five spectral channels in the visible, near-infrared, and infrared wavelength regions [0.58 to 12.50 microns]. The normal operating mode of the satellites was continuous High Resolution Picture Transmission (HRPT) to earth, where the data were recorded by a network of ground stations. For STORM-FEST, AVHRR data included 1-km resolution HRPT or LAC (Local Area Coverage) and 4-km resolution GAC (Global Area Coverage) resolution imagery (1600 km swath) during subsequent sunsynchronous morning/evening ascending and descending passes (up to 4 passes daily) over or near the STORM-FEST region. NOAA/NESDIS routinely archived AVHRR data during STORM-FEST. AVHRR data are available from NOAA/NESDIS and the University of Colorado (Western U.S. only). A listing of the HRPT scenes (satellite overpasses) during STORM-FEST is available through NOAA/NESDIS and CODIAC. Data set information and certain data for the STORM-FEST period are available through the CODIAC system.

NOAA TOVS System Data

Two NOAA series polar orbiting satellites (NOAA-11 and NOAA-12) carried the microwave TIROS Operational Vertical Sounder (TOVS) system during STORM-FEST. The TOVS system consisted of four separate sensors: (1) High Resolution Infrared Radiation Sounder (HIRS/2), which measured incident radiation primarily in the infrared region of the spectrum; (2) Microwave Sounding Unit (MSU), a passive scanning microwave spectrometer with 4 channels (5.5 micron region); (3) Stratospheric Sounding Unit (SSU), a step-scanned far-infrared spectrometer with three channels (15 micron region); and (4) Solar Backscattered Ultraviolet system (SBUV/2) which maps total ozone concentrations and vertical ozone distributions. Data were collected (1600 km swath) during subsequent sunsynchronous morning/evening ascending and descending passes (up to 4 passes daily) over or near the STORM-FEST region by NOAA/NESDIS. A listing of the satellite overpasses during STORM-FEST is available through NOAA/NESDIS and CODIAC. Information regarding data access is available through the CODIAC system.

DMSP SSM/I Data and Imagery

The USAF Defense Meteorological Satellite Program (DMSP) is a system of three near polar orbiting satellites (F8, F9, and F10) that provided global microwave data from the Special Sensor Microwave Imager (SSM/I). The SSM/I sensor provided water vapor measurements (1400 km swath) at three frequencies (19.35, 37.0, and 85.5 GHz). Two satellites (F8, F9) provided sun-synchronous SSM/I data primarily during dawn/dusk (F8) and noon/midnight (F9) ascending and descending passes (up to 4 passes total daily) over or near the STORM-FEST region. Note that no 85.5 GHz data were available from F8. Global SSM/I data and derived products were processed by NASA's WetNET Program. A subset of these global data (archived in PC-McIDAS format) for the STORM-FEST region was extracted and is available from NASA/MSFC following final WETnet processing. Information regarding data access is available through the CODIAC system.

2.5 Aircraft Data

NCAR King Air Aircraft Data

The NCAR/Research Aviation Facility operated a Beechcraft King Air Super 200 twin engine turboprop (maximum altitude 35 kft.), based at Richards-Gebaur AFB near Kansas City, MO. Thirty five research missions were flown during STORM-FEST from 03 February through 12 March, many in coordination with the University of Wyoming King Air. The King Air 1-second resolution data consisted of standard housekeeping parameters (time, position, performance); state parameters (fast response temperature and moisture, mean and turbulent components of air motion); and various microphysical measurements (cloud and precipitation particle spectra from four PMS probes, liquid water content from JW and King LWC probes). In addition for browse capability, the complete documentation and video tapes (forward & downward looking cameras) are available from the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

University of Wyoming King Air Aircraft Data

The University of Wyoming Department of Atmospheric Science operated a Beechcraft King Air Super 200 twin engine turboprop (maximum altitude 35 kft.), based at Richards-Gebaur AFB near Kansas City, MO. Seventeen research flights were flown during STORM-FEST from 03 February through 11 March, many in coordination with the NCAR King Air. The King Air 1-sec resolution data consisted of standard housekeeping parameters (time, position, performance); state parameters (fast response temperature and moisture, mean and turbulent components of air motion); and various microphysical measurements (cloud and precipitation particle spectra from four PMS probes, liquid water content from JW and King LWC probes). Data set information and data for the STORM-FEST period are available through the CODIAC system.

NASA ER-2 Aircraft Data

NASA/Ames Research Center operated a Lockheed ER-2 high altitude (stratospheric) reconnaissance jet (maximum altitude 65 kft.), flown by a single pilot, and based at Houston, Texas. Nine research flights were flown during STORM-FEST from 14 February through 14 March. The ER-2 flew the following instruments packages: Millimeter Imaging Radiometer

(MIR), Advanced Microwave Precipitation Radiometer (AMPR), Lightning Instrument Package (LIP), the High-resolution Interferometer Sounder (HIS), the Microwave Temperature Sounder (MTS), and the Wildfire Spectrometer (WILDFIRE). Additional details concerning ER-2 instrumentation are provided in Appendix B. All data are available from NASA/Marshall Space Flight Center. Information regarding data access is available through the CODIAC system.

NOAA/AOC WP-3D Aircraft Data

NOAA/Aircraft Operations Center (AOC) operated a Lockheed Orion WP-3D four engine turboprop (maximum altitude approximately 22 kft.), which was based at Richards-Gebaur AFB near Kansas City, MO. Nine research flights were flown during STORM-FEST from 05 February through 10 March, many in coordination with the University of Washington C-131. The P-3 1-sec resolution data consisted of standard aircraft housekeeping parameters (time, position, performance); state parameters (temperature, moisture, winds); and various microphysical measurements (cloud and precipitation particle spectra from four PMS probes, liquid water content from a JW probe, small ice particles, particle data [Formvar replicator]). The P-3 also collected data from two airborne radars (a tail Doppler 3 cm and lower fuselage 5 cm). Data set information and data for the STORM-FEST period are available through the CODIAC system.

University of Washington C-131 Aircraft Data

The University of Washington, Department of Atmospheric Science operated a C-131 twin engine turboprop (maximum altitude approximately 20 kft.), based at Richards-Gebaur AFB near Kansas City, MO. Sixteen research flights were flown during STORM-FEST from 05 February through 12 March, many in coordination with the NOAA/AOC P-3. The C-131 1-sec resolution data consisted of standard housekeeping parameters (time, position, performance); state parameters (fast response temperature and moisture, mean and turbulent components of air motion); and various microphysical measurements (cloud and precipitation particle spectra from four PMS probes, liquid water content from JW and King LWC probes). Data set information and data for the STORM-FEST period are available through the CODIAC system.

ACARS Data

Many commercial aircraft (over 2800) were equipped with the Aircraft Communication and Reporting System (ACARS) which reported temperature, wind speed and direction, and height derived from altimeter setting at approximately 7-minute time resolution. These data provided enhanced upper air reports to supplement soundings, and vertical profiles on aircraft descent and ascent in the vicinity of major airports. All reports were routinely archived by NOAA Forecast System Laboratory. Data set information and data for the STORM-FEST period are available through the CODIAC system.

2.6 Model Data

Model data were collected in real-time during STORM-FEST for all the operational models. Table 2.3 lists the Models and supporting information such as format, source, data collection times and estimated total size of the archive. Daily files of model data were stored on the NCAR Mass Store and later sub-divided for data management purposes. The following describes each of the models in greater detail.

NMC Nested Grid Model (NGM)

NMC ran the Regional Analysis and Forecast System (RAFS) NGM model every 12 hours (00 and 12 UTC) with up to 48 hour forecasts (6-h intervals) at a standard resolution of 80 km during STORM-FEST. Standard fields are available at 50-mb increments from the surface to 100 mb. The data cutoff for model runs was 2 hours, and the output format was ON84 (Office note 84). All NGM runs were recorded on the NMC History Tape during STORM-FEST and later archived on the NCAR Masstor. Information regarding data access is available through the CODIAC system.

NMC Limited Fine Mesh (LFM) Model

NMC ran the LFM model every 12 hours (00 and 12 UTC) with up to 48 hour forecasts (12-h intervals) at a standard resolution of 191 km during STORM-FEST. The data cutoff for model runs was 1.5 hours, and the output format was ON84 (Office note 84). All LFM runs were recorded on the NMC History Tape during STORM-FEST and archived on the NCAR Mass Store. Information regarding data access is available through the CODIAC system.

TABLE 2.3

Available Level IIIa Model Analyses Data Collected During STORM-FEST

Model:	Format:	Source:	Coverage:	Est. Total Size (MB):
NGM:	ON84	History Tape	Full	150
LFM	ON84	History Tape	Full	100
MRF sigma	ON85	History Tape	Full	1000
MRF flux, A	ON84/85, GRIB	History Tape	Full	100
MRF flux, C	ON84/85,GRIB	History Tape	Full	280
MRF flux, D	GRIB	History Tape	2/6-3/15	40
MRF forecast	ON85	History Tape	Full	400
FNOC	NEDN	Tape	Full	100
Early Eta	GRIB	FTP	Full	600
Aviation Run	GRIB (old)	FTP	Full	900
Aviation Run	GRIb (new)	FTP	2/13 - 3/15	330
MAPS	GRIB	FTP	Full	100
PC Grids	PC Grid	FTP	Full	180
Toss Lists	ASCII	FTP	Full	40

NMC Medium Range Forecast (MRF) Model

NMC ran the MRF model every 24 hours (00 UTC) with up to 240 hour forecasts (12-h intervals) at a standard resolution of 200 km during STORM-FEST. The output consisted of forecast, sigma, and three flux fields. The data cutoff for model runs was 6 hours, and the output format was ON84 and ON85 (Office note 84 and 85), as well as GRIB for the flux fields. All MRF runs were recorded on the NMC History Tape during STORM-FEST and archived on the NCAR Mass Store. Information regarding data access is available through the CODIAC system.

U.S. Navy Fleet Numerical Oceanographic Center (FNOC) Model

The U.S. Navy ran the FNOC model every 12 hours (00 and 12 UTC) with up to 48 hour forecasts (6-h intervals) at a standard resolution of 2.5 degrees lat/lon during STORM-FEST. The data consist of surface fields of pressure, temperature, vapor pressure, boundary layer u/v winds, and 9 upper level fields of heights, temperature, vapor pressure and u/v winds (1000, 925, 800, 700, 500, 400, 300, 250, and 200-mb) and total cloud cover. The FNOC output format was NEDN and all FNOC runs were recorded on a 9-track tape during STORM-FEST, with a copy archived by the SFDMC. Data set information and data for the STORM-FEST period are available through the CODIAC system.

NMC Early Eta Model

NMC ran the Early Eta model every 12 hours (00 and 12 UTC) with up to 48 hour forecasts (6-h intervals) at a standard resolution of 80 km during STORM-FEST. Standard fields are available at 38 levels to 100 mb. The data cutoff for model runs was approximately 1 hour, and the output format was GRIB. All Early Eta runs were electronically transferred to NCAR (via FTP) during STORM-FEST and archived on the NCAR Mass Store by the SFDMC. Information regarding data access is available through the CODIAC system.

Aviation Model

NMC ran the Aviation model (T126) every 12 hours (00 and 12 UTC) with up to 48 hour forecasts (12-h intervals) at a standard resolution of approximately 100 km during STORM-FEST. Standard fields are available at 18 level from the surface to 100 mb (6 layers below 850-mb to preserve the PBL). The data cutoff for model runs was 2.75 hours, and the output format was GRIB. [NOTE- The new GRIB format was used from 13 February through 15 March]. All Aviation runs were electronically transferred to NCAR (via FTP) during STORM-FEST and archived on the NCAR Mass Store. Information regarding data access is available through the CODIAC system.

Mesoscale Analysis and Prediction System (MAPS) Model

NMC ran the MAPS model every 6 hours (00, 06, 12 and 18 UTC) with up to 6 hour forecasts at standard resolution of approximately 60 km during STORM-FEST. Standard fields are available at 25 levels from the surface to 100 mb. The data cutoff for model runs was approximately 1 hour, and the output format was GRIB. A limited number of MAPS runs were electronically transferred to NCAR (via FTP) during STORM-FEST and archived on the NCAR Mass Store by the SFDMC. In addition, another version of MAPS was run by NOAA/Forecast Systems Laboratory (FSL). The SFDMC archived hourly interval MAPS surface analyses from FSL. Data set information and data for the STORM-FEST period are available through the CODIAC system.

NCAR Mesoscale Model (MM4)

The NCAR/Pennsylvania State University Mesoscale Model (MM4) was used to develop research model forecasts up to 36 hour (1-h intervals) of 20 km resolution over the STORM-FEST domain. NCAR/MMM ran the MM4 model every 24 hours (12 UTC) and at 00 UTC as directed by the STORM-FEST Operations Director to support IOP forecasting. The data cutoff for model runs was approximately 1.5 hours, and the output format was custom NCAR MM4. All MM4 data were archived on the NCAR Mass Store by the NCAR/Mesoscale Microscale Meteorology (MMM) Division. Information regarding data access is available through the CODIAC system.

Daily Weather and Opertations Summaries

3.0 Daily Weather and Operations Summaries

This chapter summarizes the daily operations of the STORM-FEST experiment. A detailed description of the meteorological conditions (including a 1200 UTC corresponding GOES-7 8 km satellite image and NOAA's "Daily Weather Map" series, operational summary, and data collection grid are provided for each day of the experiment.

The data collection grids include "blocked" times when data for that respective platform was collected. For the case of networks, (e.g., NWS Inner) the number of stations which collected data for that time are denoted. Hatched areas represent times when IOPs were in progress. For surface systems, the number of stations which collected hourly data out of a possible total is shown. "Intermittent" indicates stations which missed 20% or more hourly observations during the day. Triangles represent NOAA Polar orbiting Satellite overpass times for the STORM-FEST Inner Domain, and when data was archived by NOAA/NESDIS.

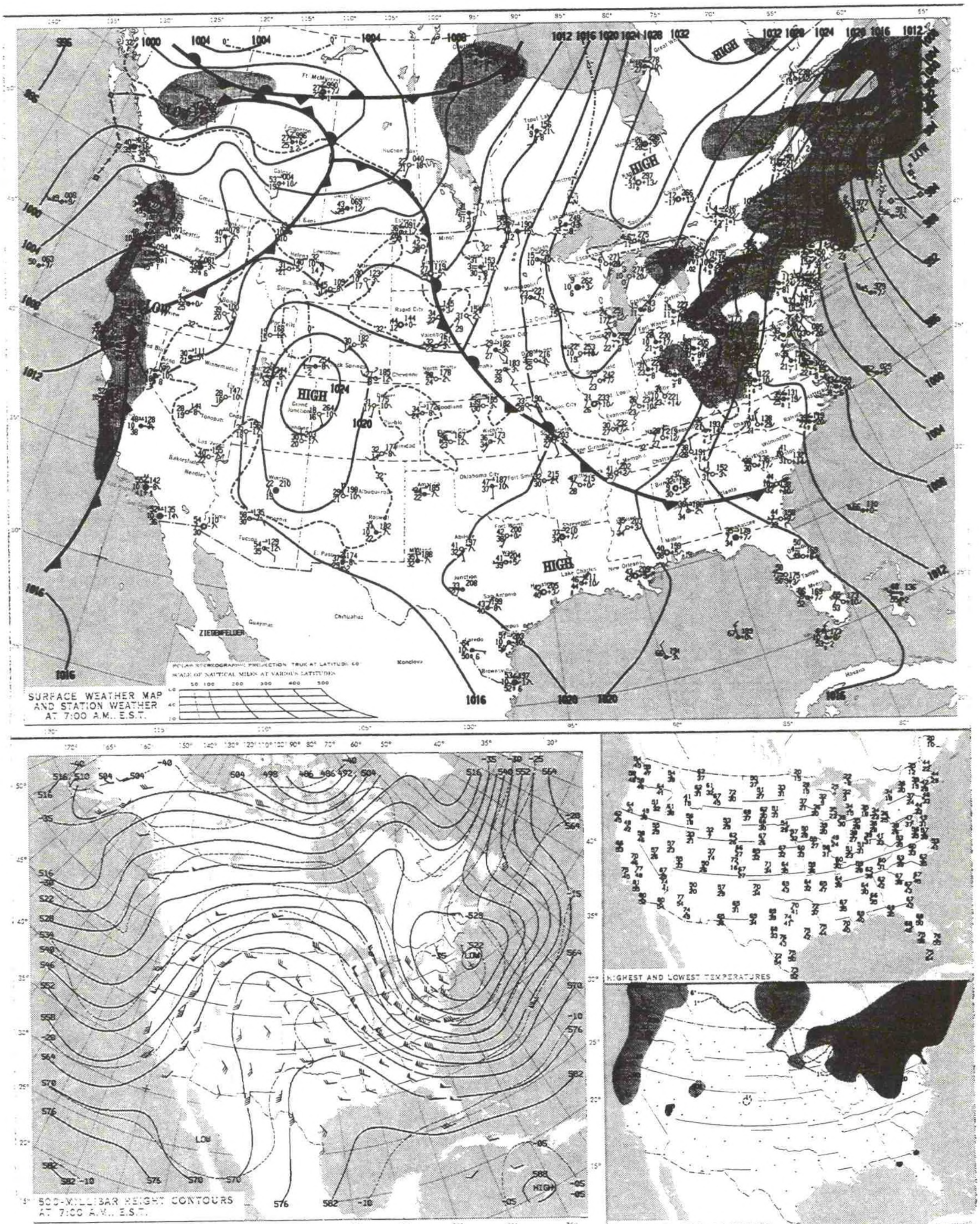
WEATHER SUMMARY

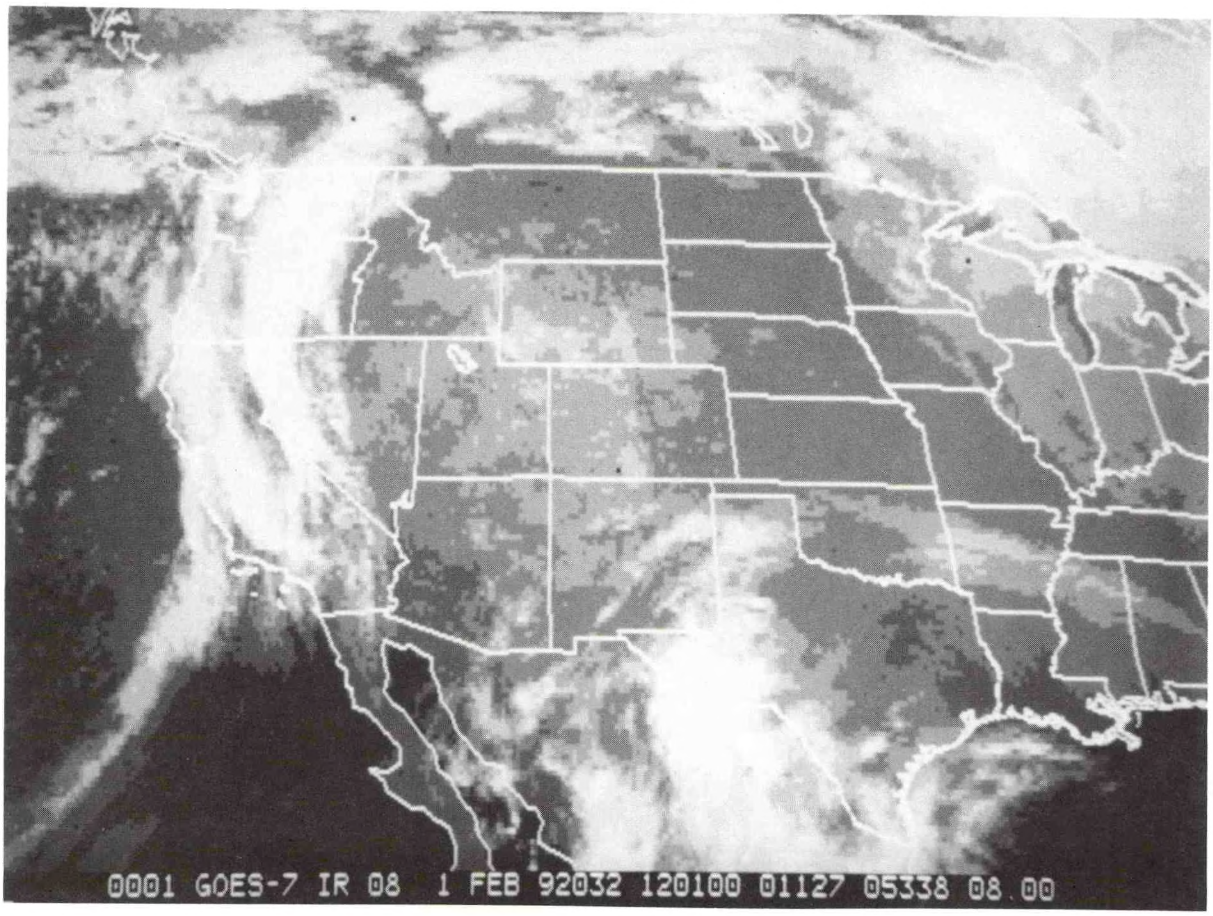
1 February 1992

On this first day of STORM-FEST, the long wave ridge to the west of the STORM-FEST experimental area and the trough to the east dominated the weather, as it had over the past month. There was a weak stationary front extending from eastern Kansas through central Nebraska extending into the Dakotas. No precipitation or active weather was expected along the front. A cold front was located in western Montana, and was expected to move into the STORM-FEST domain on 2 February. Again, little or no precipitation was expected with the front.

The forecast progs indicated that by 0000 UTC, 3 February, the 90% relative humidity contour should move into northeast Oklahoma. This, along with a weak cold front and a weak upper-level disturbance, could trigger some stable precipitation over Texas and Oklahoma with the possibility of a few embedded thunderstorms. The amount of precipitation that falls north and northeast of Oklahoma depended on the speed of the front and the availability of moisture.

SATURDAY, FEBRUARY 1, 1992




0001 GOES-7 IR 08 1 FEB 92032 120100 01127 05338 08.00

OPERATIONS SUMMARY

1 February 1992

Most observational systems were fully operational this first day of STORM-FEST. There were a few problems at some of the CLASS, PAM, and ASTER sites, but these were expected to be corrected in the next day or two.

The NCAR King Air was expected to arrive tomorrow, 2 February, after having some instrument problems. There were continuing major problems with the T-1 communications line from the National Severe Storms Laboratory to the Operations Center at Richards-Gebaur AFB.

Since no active weather was expected to occur over the STORM-FEST domain for the next 24- to 36-h; no operations were planned.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 1 February

Julian Day: 32

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP																									
UPPER AIR	CLASS																								
	NWS (Inner)	22												22											
	NWS(Outer)	11												11											
	Picket Fence																								
	Canadian	9												9											
	Ft. Sill																								
	Flatlands																								
	Seneca																								
	HIS																								
	BL Profiler (RASS)													1											
	BL Profiler (Winds)													1											
RADAR	CP-3																								
	CP-4																								
	Mile High																								
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA	▲									▲														

Comments

SURFACE SYSTEMS	ASOS	32 of 42 stations reported.
	AWOS	45 of 47 stations reported; 6 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	15 of 19 stations reported; 15 stations intermittent.
	PAM5	35 of 35 stations reported; 5 stations intermittent.
	PROFS	21 of 22 stations reported; 3 stations intermittent.
	SAO	390 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

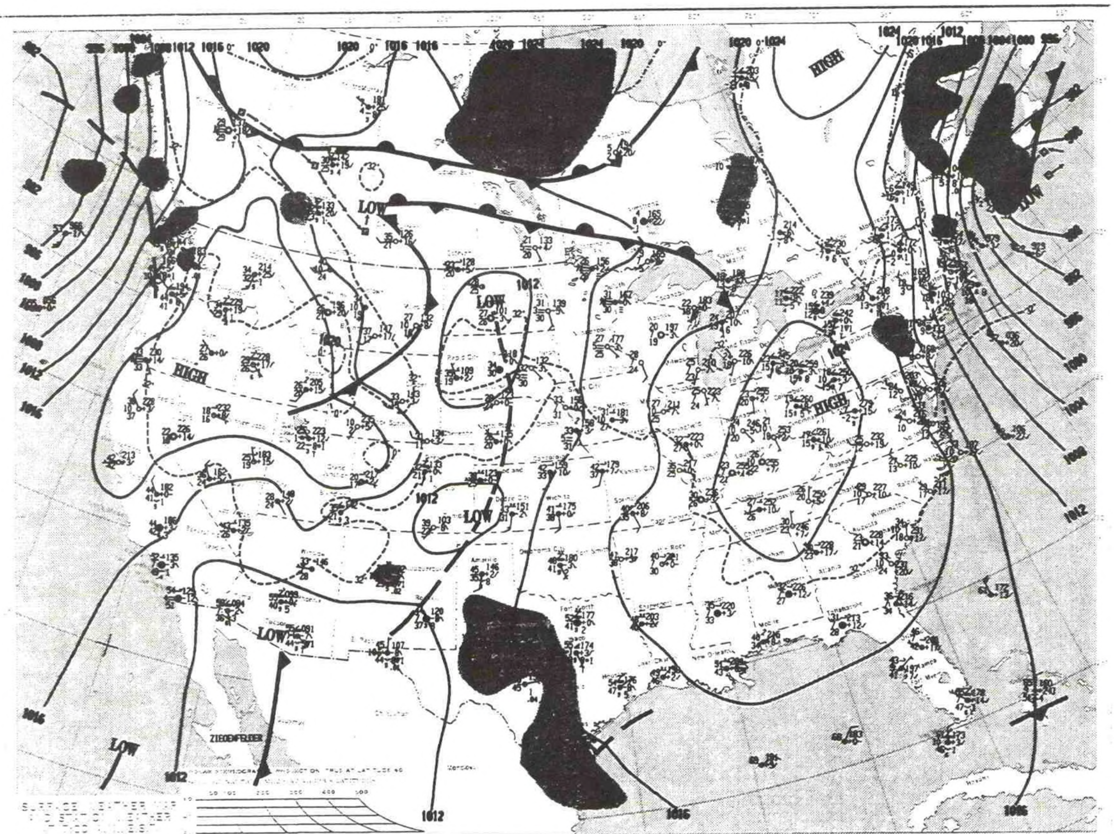
NOTES:

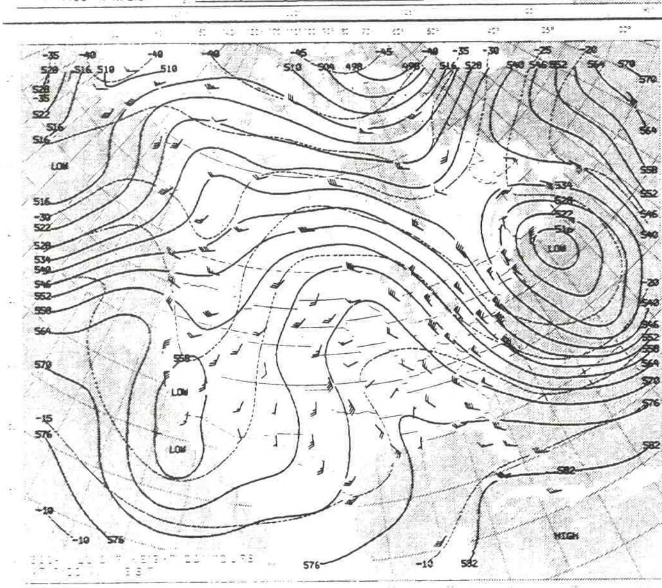
WEATHER SUMMARY

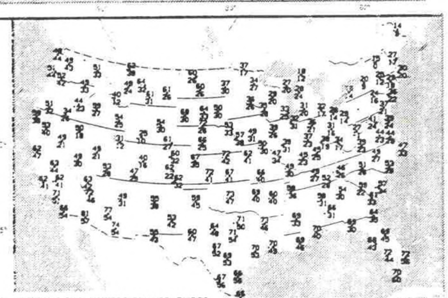
2 February 1992

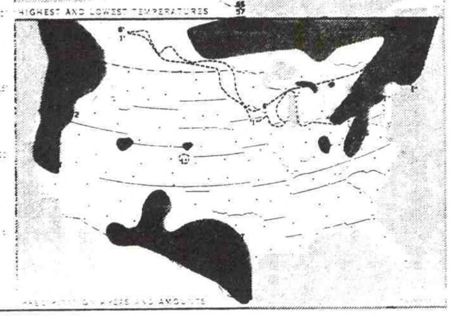
The general weather pattern from yesterday, 1 February, continued over the STORM-FEST domain. The stationary front located over the central United States had dissipated. There was a weak trough extending north-south from the central Dakotas down through central Nebraska and western Oklahoma. A weak low pressure center was located over southern Canada, with a cold front extending down through Montana and Wyoming. This weak front was expected to move to the southeast over the next 24-h and provide the first frontal passage and possible precipitation in the STORM-FEST domain.

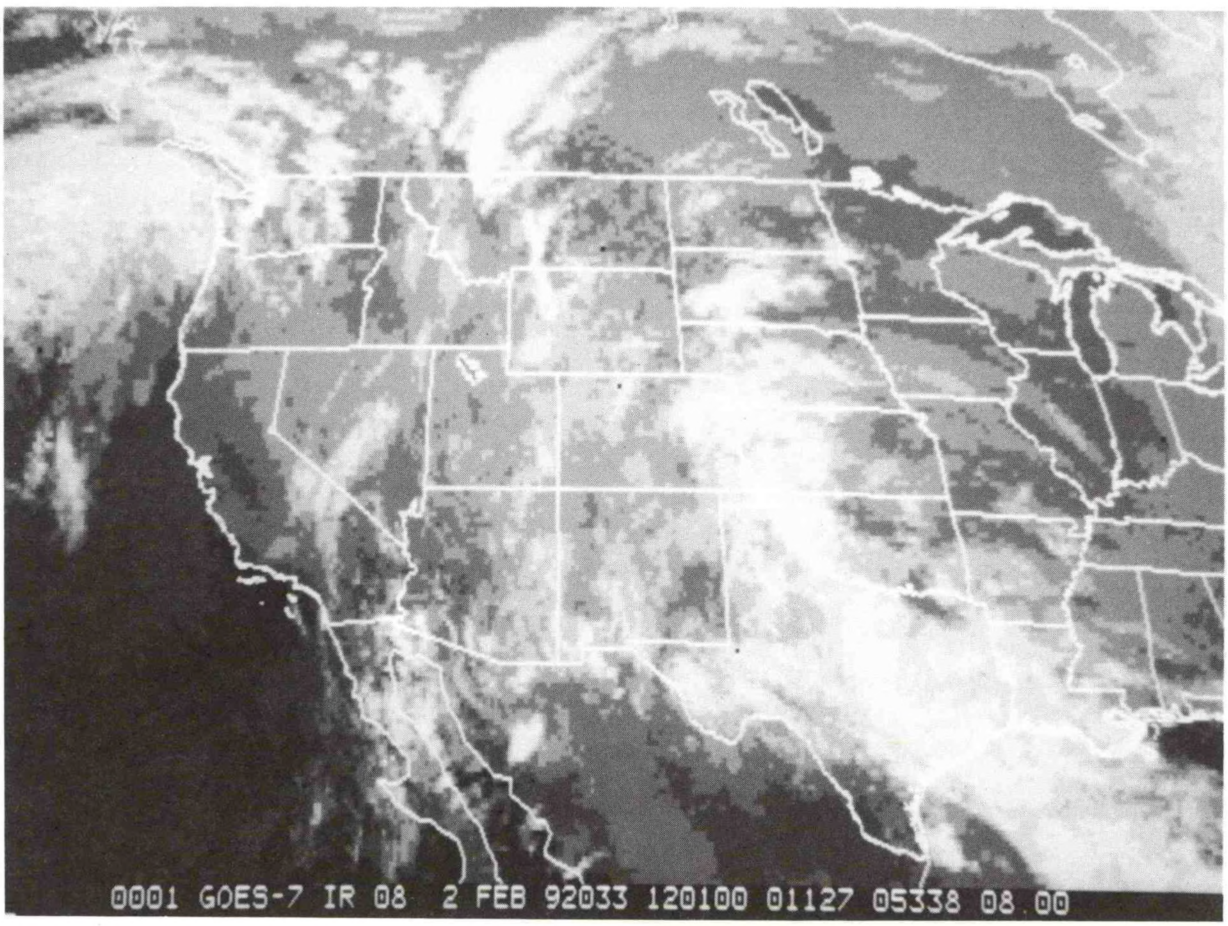
SUNDAY, FEBRUARY 2, 1992










0001 GOES-7 IR 08 2 FEB 92033 120100 01127 05338 08.00

OPERATIONS SUMMARY

2 February 1992

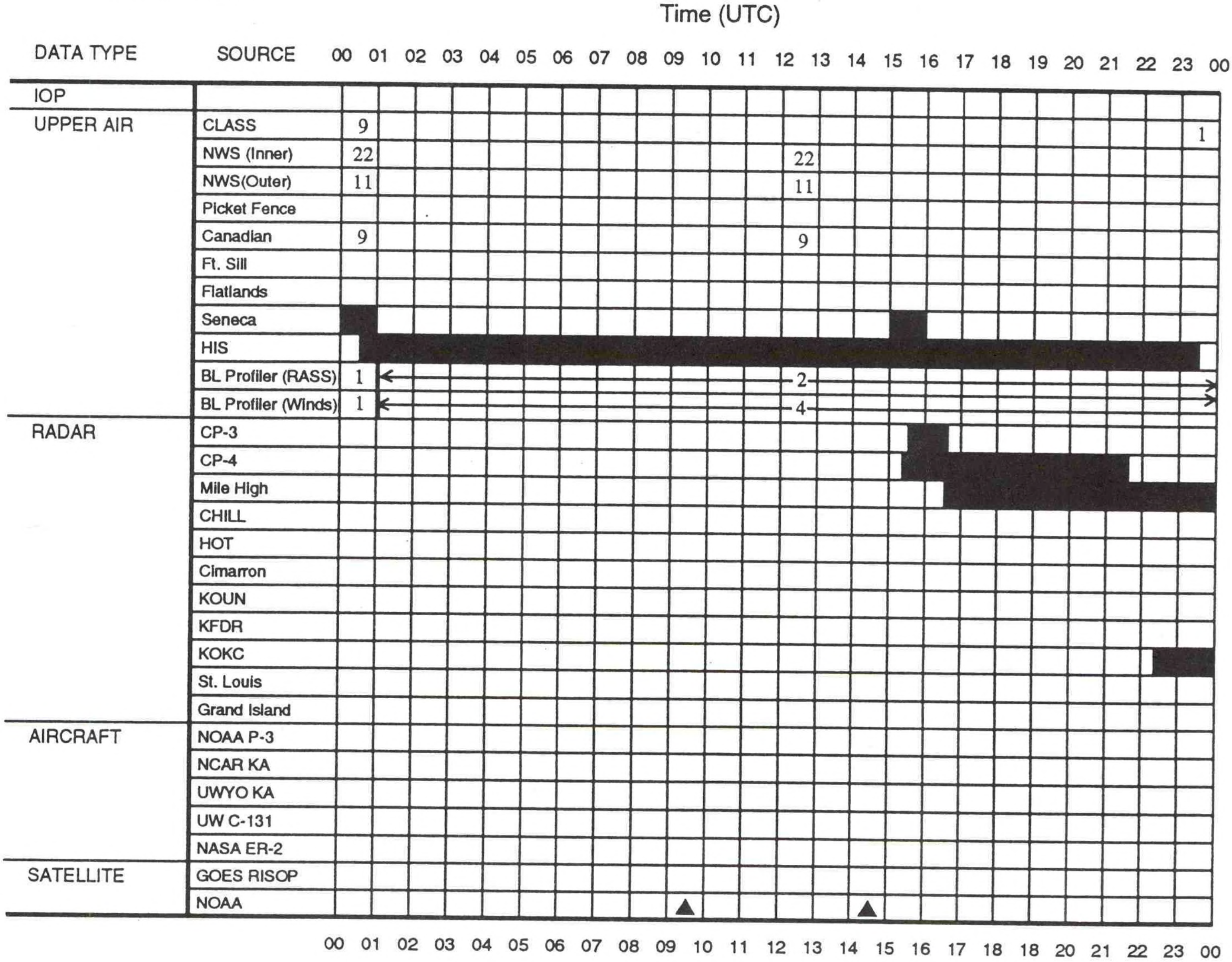
Again with no interesting weather over the STORM-FEST domain, no operations were planned for the next 24-h. CP-3 and CP-4 operated briefly during the afternoon for testing purposes. An operational test of the CLASS network was performed at 0000 UTC in conjunction with the normal NWS rawinsonde release.

Planning began for the first IOP (Intensive Observation Period) to start 3 February to investigate the structure of the weak cold front that was expected to move through the STORM-FEST domain, as well as investigate any precipitation associated with it. The NCAR King Air and the C-131 aircraft were placed on alert. Soundings were requested from the Seneca CLASS site and the Monett, Mo., NWS inner domain site. The NCAR CP-3 and CP-4, and the NSSL Cimarron radar were placed on alert for possible operations.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 2 February

Julian Day: 33



Comments

SURFACE SYSTEMS	ASOS	32 of 42 stations reported; 2 stations intermittent.
	AWOS	45 of 47 stations reported; 13 stations intermittent.
	HPCN	73 of 73 stations reported; 3 stations intermittent.
	ISWS	15 of 19 stations reported.
	PAM5	35 of 35 stations reported; 2 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	387 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

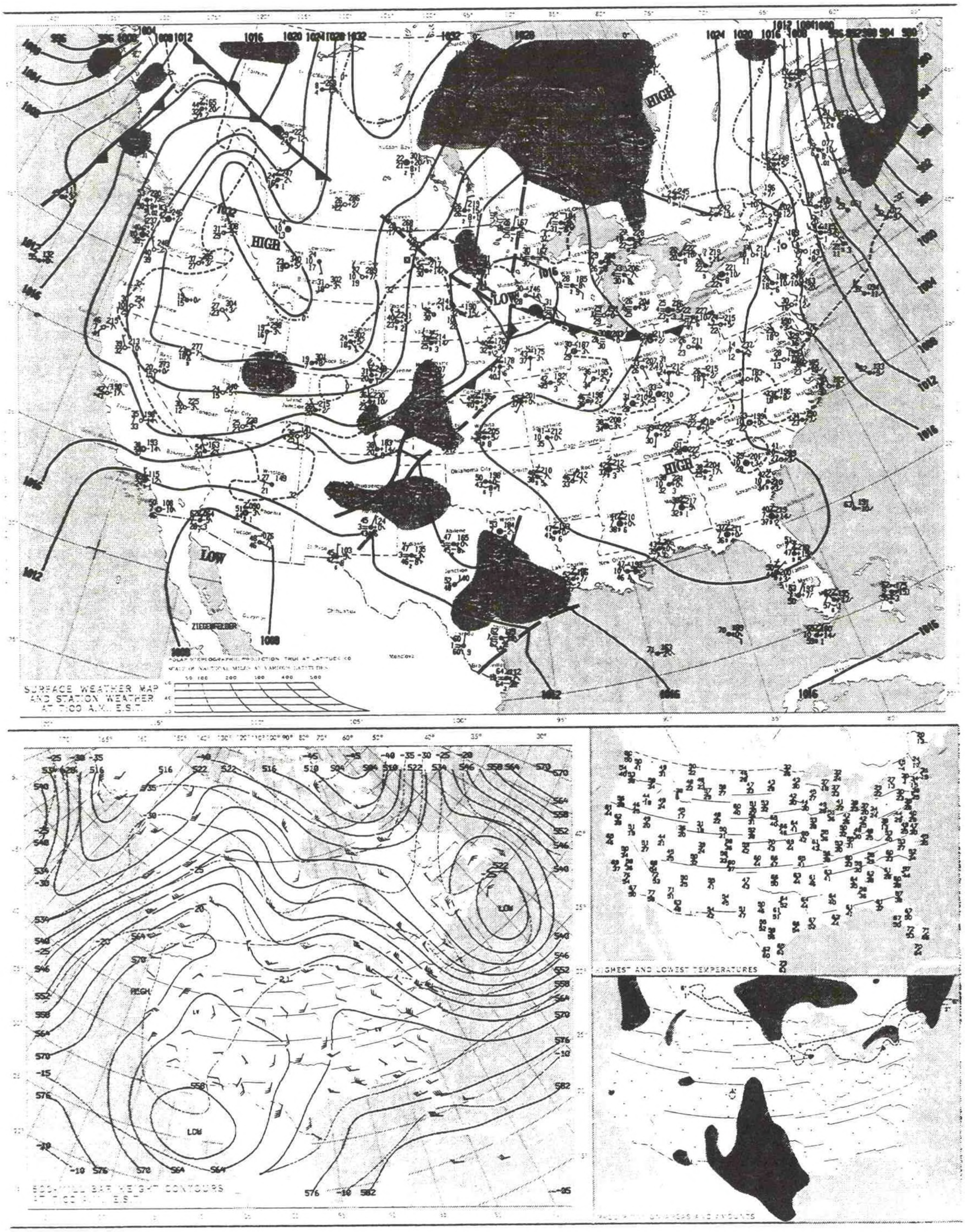
WEATHER SUMMARY

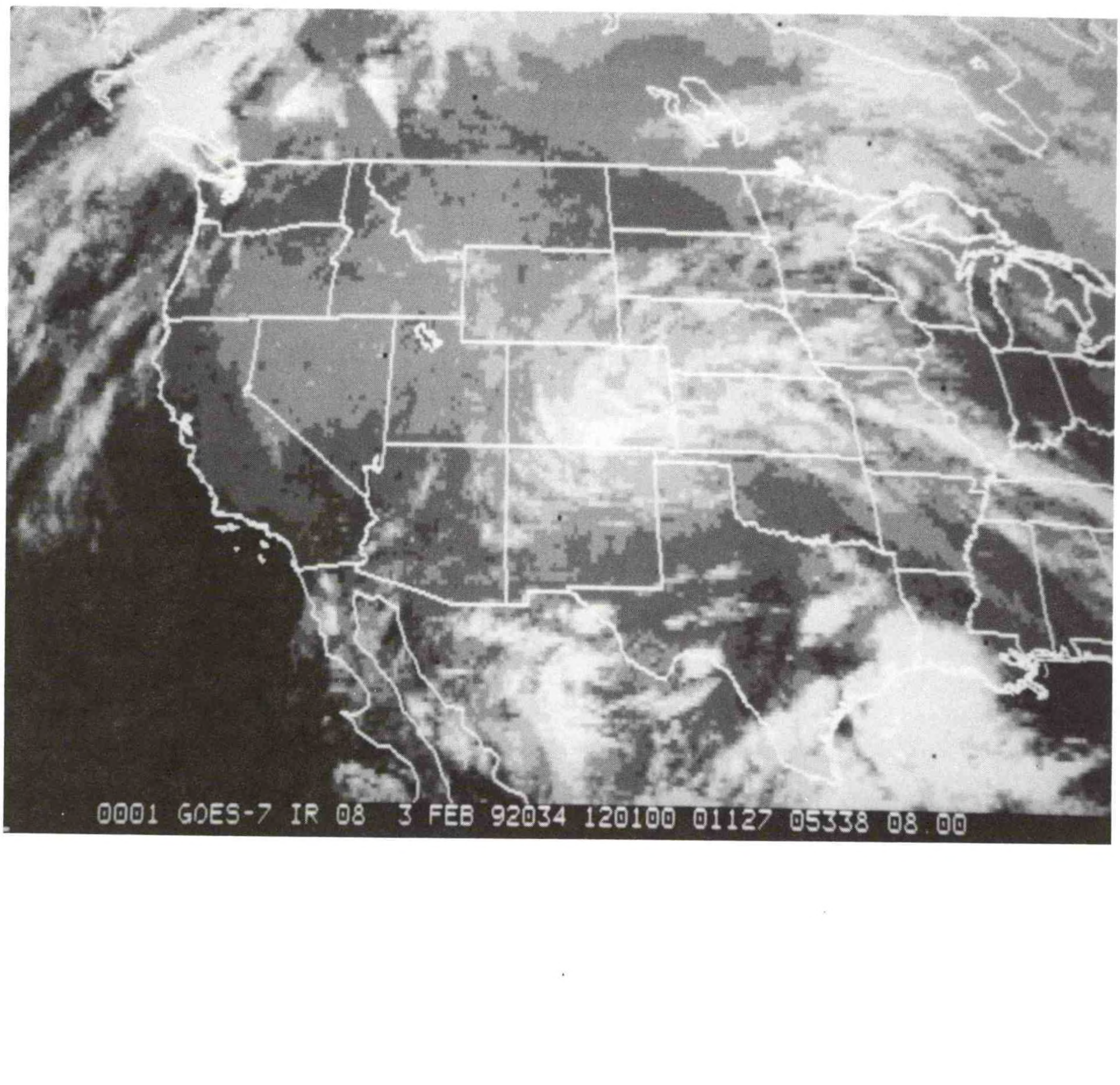
3 February 1992

The weak low pressure center that was located over southern Canada yesterday, 2 February, moved to the southeast and was located over southern Minnesota at 1200 UTC. A weak cold front extended southwestward from the low, and at 1200 UTC was located over eastern Nebraska, central Kansas and western Oklahoma. This cold front was expected to continue to move to the southeast and pass through the STORM-FEST boundary layer domain by early afternoon (2000 UTC). Little or no precipitation was expected along the front. The forecast progs indicated that this surface low and associated cold front would continue to move to the east over the next 24-h with possible precipitation in Texas and Oklahoma.

The NMC models agreed in keeping significant precipitation out of Oklahoma, instead focusing heavy precipitation over the west gulf coast. However, the MM4 model forecasted approximately 3 cm of precipitation near Wichita Falls, Texas, over the first 24-h forecast period from 1200 UTC. MM4 also forecasted a cm or so of precipitation in western Kansas, near where precipitation was occurring this morning, and maintained a stronger frontal structure than other models. It forecasted much colder air moving southward across Iowa, behind the shortwave trough, whereas the NGM model moved the cold air southeastward across the Great Lakes.

MONDAY, FEBRUARY 3, 1992




0001 GOES-7 IR 08 3 FEB 92034 120100 01127 05338 08.00

OPERATIONS SUMMARY

3 February 1992

Initial plans called for the NCAR King Air to fly a frontal mission on the weak cold front that was moving through Kansas and Missouri, as well as conduct a dropwindsonde test over the Seneca CLASS site. The dropwindsonde test was designed to investigate the potential interference problems with upsondes and dropsondes both transmitting near the same frequency. In addition, the University of Washington's C-131 was on alert for a possible cloud physics mission over the Little Washita basin in Oklahoma.

IOP 1 began at 1200 UTC with soundings from Seneca, KS, and Monett, MO. CP-4 began to collect clear air data at 1429 UTC and CP-3 began to collect data at 1510 UTC. The shallow cold front turned out to be so weak that it was decided at the 1500 UTC coordination meeting to switch emphasis to intercomparison flights between the University of Wyoming's King Air and the NCAR King Air. It was also decided to continue with the dropwindsonde test over the Seneca CLASS site.

The NCAR King Air took off at 2033 UTC and the University of Wyoming's King Air took off at 2122 UTC. An intercomparison showed general agreement between the two aircraft except for humidity. The CLASS and dropwindsonde interference test was completed and no interference problems were evident, although detailed evaluation of the data still needs to be completed. The possibility of HF radio and dropsonde interference was also tested and results were negative. The University of Wyoming King Air did conduct some frontal structure patterns to investigate what problems might be encountered in flying in the boundary layer domain. The NCAR King Air also flew in the boundary layer domain, but did not fly below 500 ft. The NCAR King Air landed at 2233 UTC and the University of Wyoming King Air landed at 2328 UTC.

The University of Washington's C-131 cloud physics flight was canceled when no precipitation developed over the Little Washita basin.

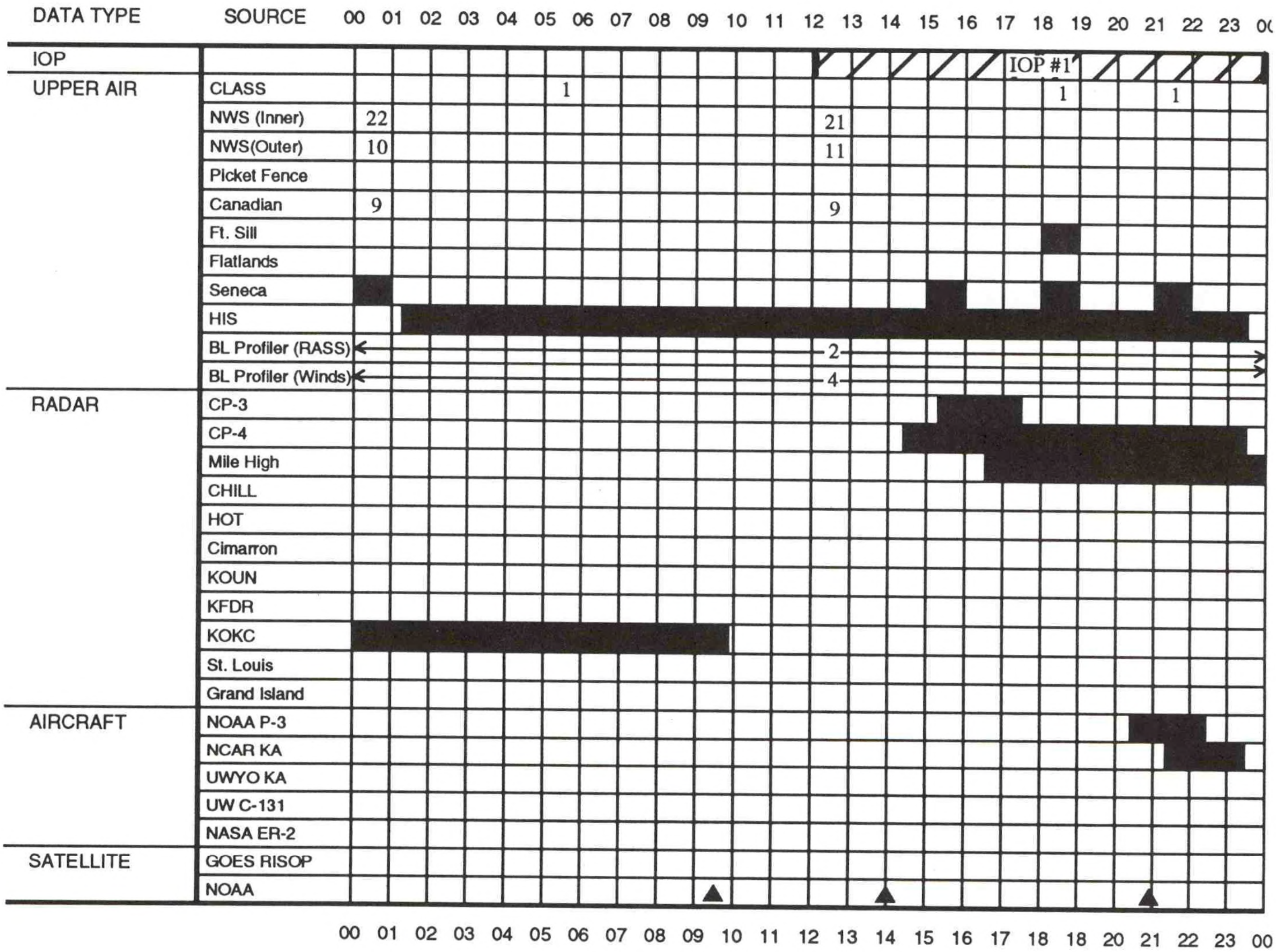
IOP 1 ended at 0000 UTC, 4 February.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 3 February

Julian Day: 34

Time (UTC)



Comments

SURFACE SYSTEMS	ASOS	32 of 42 stations reported; 1 stations intermittent.
	AWOS	45 of 47 stations reported; 9 stations intermittent.
	HPCN	73 of 73 stations reported; 2 stations intermittent.
	ISWS	15 of 19 stations reported.
	PAM5	35 of 35 stations reported; 3 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	398 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

WEATHER SUMMARY

4 February 1992

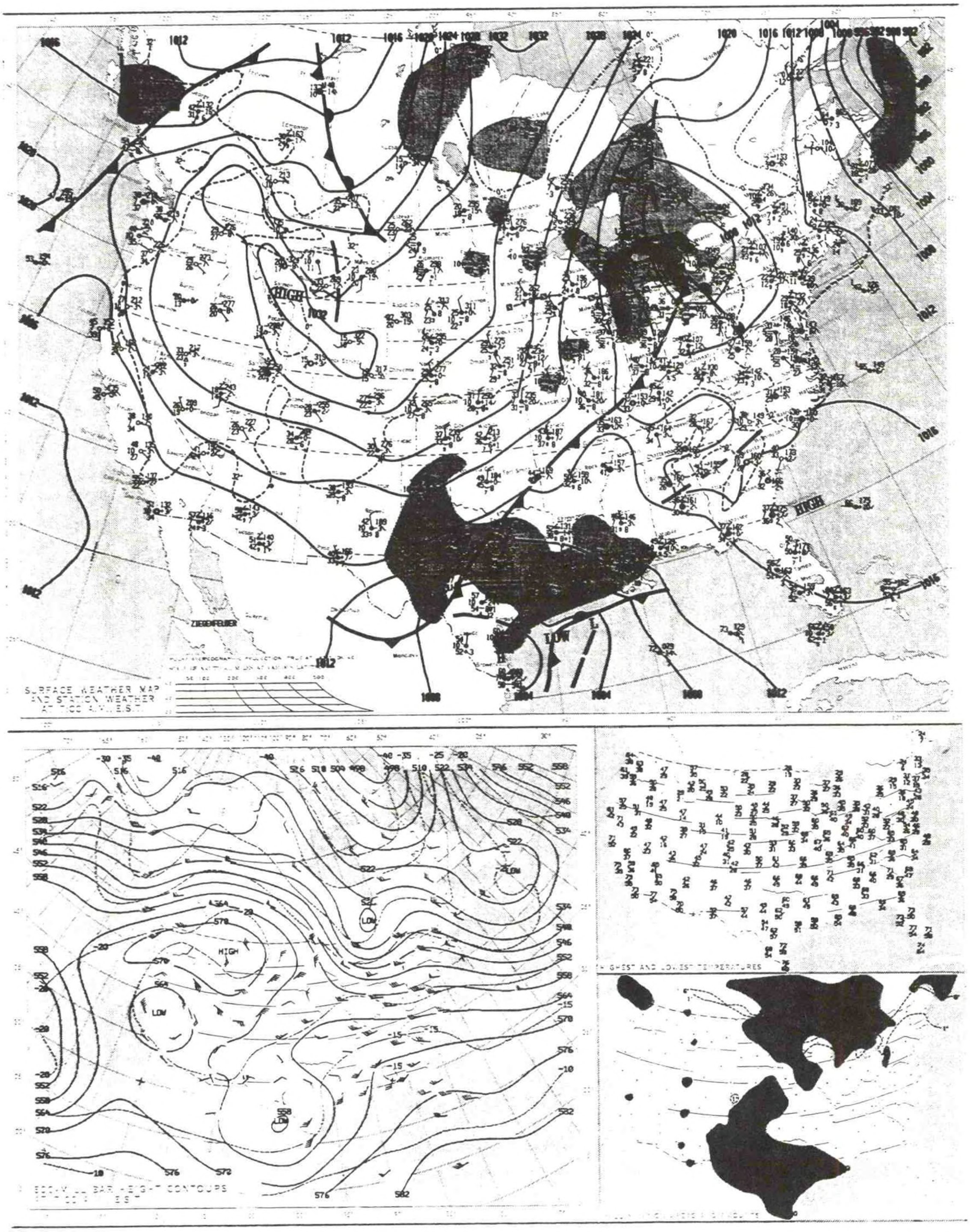
A strong surface high pressure area moved into the STORM-FEST domain, with a 1032 mb center located over Wyoming and Montana. The surface low pressure area and associated cold front that was the initial focus of IOP 1, continued to move eastward out of the STORM-FEST domain. Split flow in the upper-levels (with the northern branch in southern Canada and the southern branch in old Mexico) left the STORM-FEST domain with generally fair weather conditions.

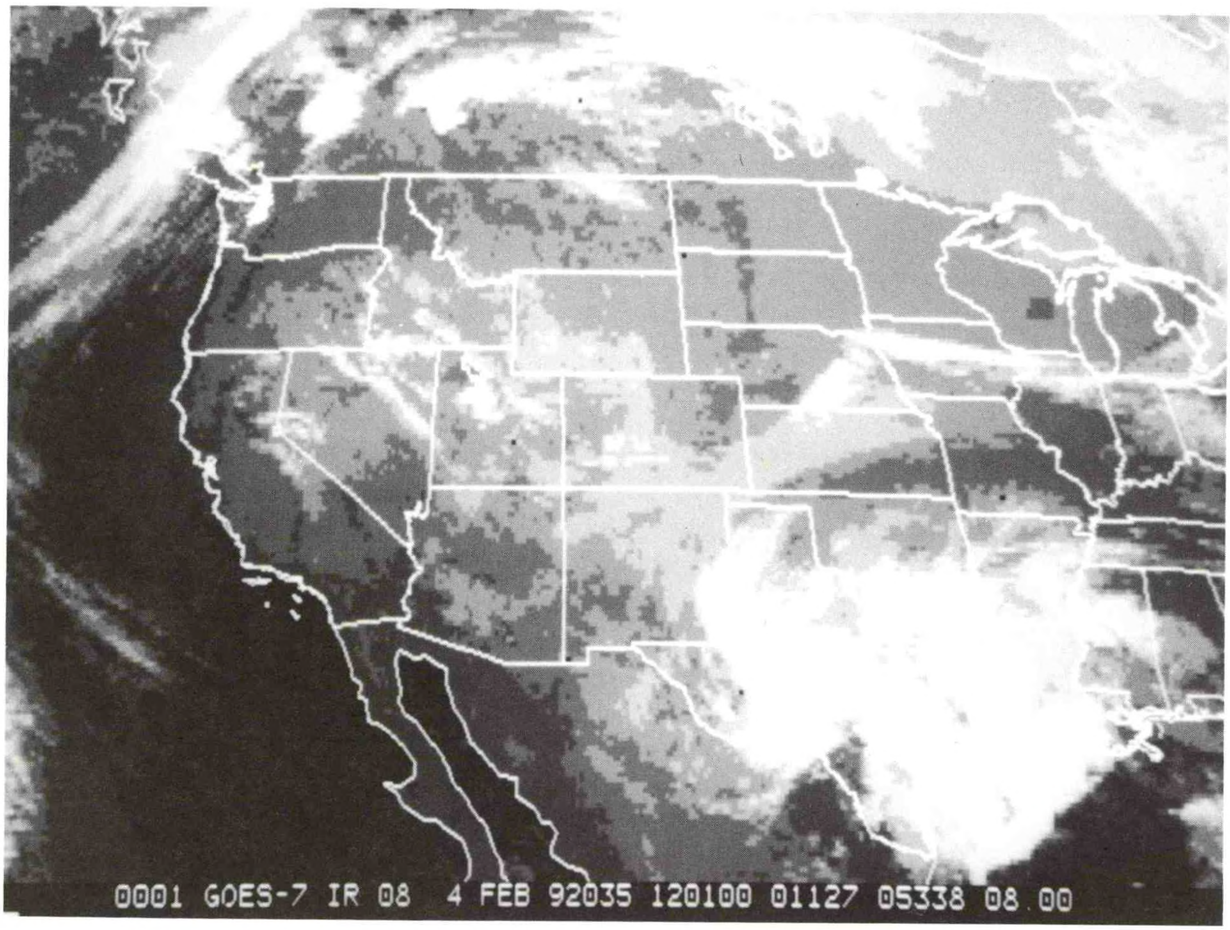
At the surface, a second cold surge had moved south through Kansas into Oklahoma, but did not produce any precipitation. Significant moisture was confined to south Texas, with an old polar continental front cutting off the return of Gulf moisture. Cool and generally clear conditions prevailed through the day over most of the STORM-FEST domain with some in the west southwest part of the STORM-FEST domain.

A small scale cyclonic vortex over Colorado could present a weak but interesting meteorological situation for Colorado during the next 24-h. Weak stability was allowing some amplification of this system, but this was not expected to last beyond 24-h as this system moved eastward into Oklahoma. Clear skies forecasted for northeast Kansas should allow for a radiation research aircraft flight planned for tomorrow, 5 February.

The forecast progs indicated that fair weather was expected to continue for the next several days over the STORM-FEST domain. Another trough should enter the STORM-FEST domain from the north during the next 24- to 48-h. Upper-level dynamics were expected to be strongest over the western Great Lakes, with frontal characteristics rather diffuse over Nebraska and Kansas. This continental polar airmass was relatively dry and precipitation was not expected.

TUESDAY, FEBRUARY 4, 1992




0001 GOES-7 IR 08 4 FEB 92035 120100 01127 05338 08.00

OPERATIONS SUMMARY

4 February 1992

With the strong surface high pressure area dominating the weather over the STORM-FEST domain, no operations were conducted this 24-h period.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 4 February

Julian Day: 35

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP																									
UPPER AIR	CLASS						1																1		
	NWS (Inner)	21												22											
	NWS(Outer)	11												11											
	Picket Fence																								
	Canadian	9												9											
	Ft. Sill													■					■				■		
	Flatlands																								
	Seneca	■																							
	HIS																								■
	BL Profiler (RASS)	←												2											→
	BL Profiler (Winds)	←												4											→
RADAR	CP-3																								
	CP-4																								
	Mile High																	■	■	■	■	■	■	■	■
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA		▲								▲				▲								▲		

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 18 20 21 22 23 00

Comments

SURFACE SYSTEMS	ASOS	32 of 42 stations reported; 1 stations intermittent.
	AWOS	45 of 47 stations reported; 8 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	15 of 19 stations reported.
	PAM5	35 of 35 stations reported; 5 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	393 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported; 1 station intermittent.

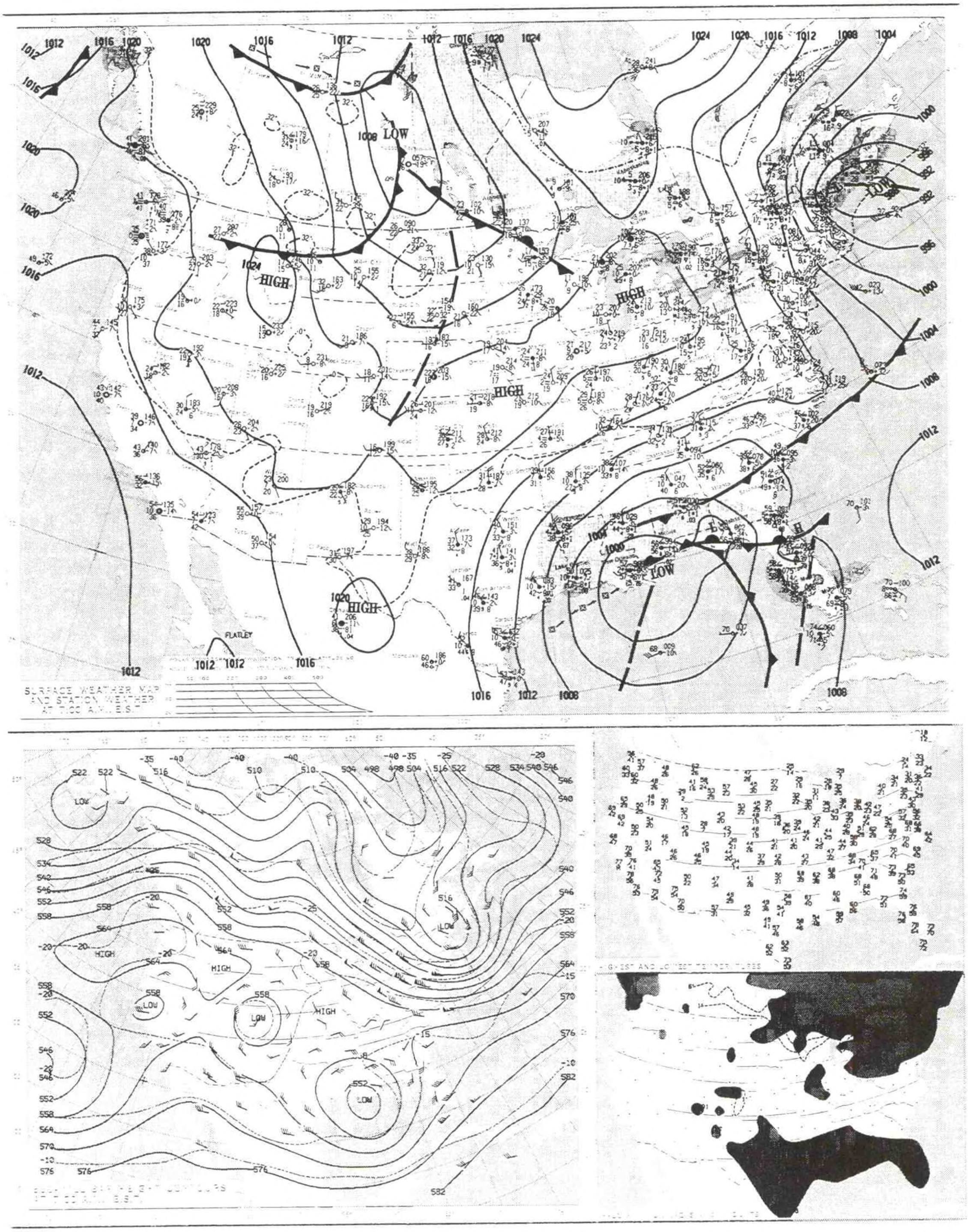
NOTES:

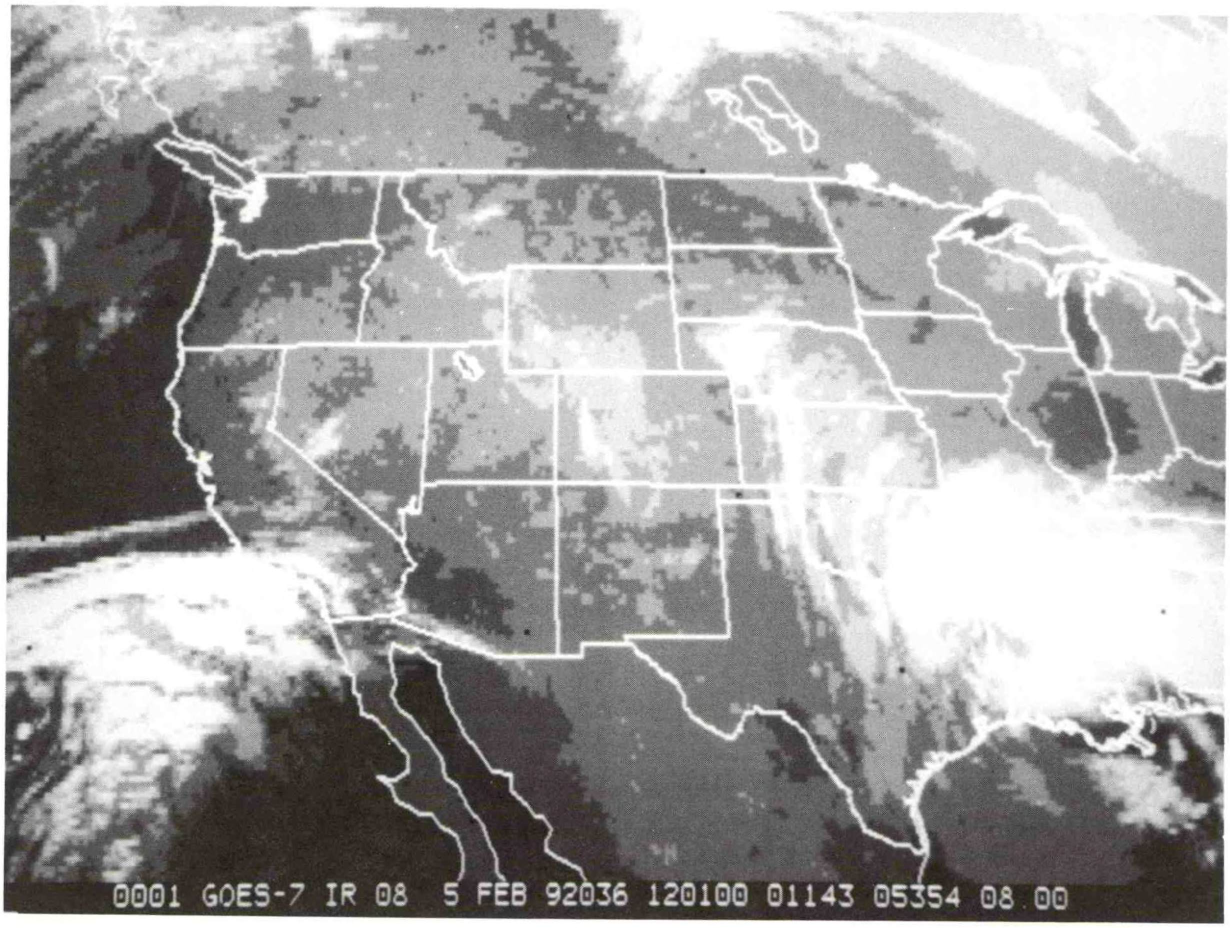
WEATHER SUMMARY

5 February 1992

The strong high pressure area that dominated the weather over the past several days continued to move to the east. Once again, as on 2 February, a weak surface low pressure area was located over southern Canada, with a cold front extending into Montana and Idaho. This surface low and associated cold front was expected to move to the southeast along the back side of the upper level trough, and be in the STORM-FEST domain tomorrow, 6 February.

WEDNESDAY, FEBRUARY 5, 1992




0001 GOES-7 IR 08 5 FEB 92036 120100 01143 05354 08.00

OPERATIONS SUMMARY

5 February 1992

Again with fair weather over the STORM-FEST domain, no operations were carried out during this 24-h period. The NCAR King Air flew a radiation mission during the night as part of a cooperative experiment run by Jim Telford of DRI, to investigate the evolution of the surface boundary layer through the night.

The scientific goal of this experiment was to relate the changes in air temperature at night to the radiative exchange and, in particular, to examine the upwelling radiation (both broad band and the narrow band IR) relative to the temperature and composition of the air below.

In conducting this experiment, a sequence of aircraft soundings showed that the air below the inversion warmed to about the dry adiabatic lapse rate. The moisture structure clearly showed the early inversion, but the temperature inversion smoothed out with time. The moisture then proceeded up against the stable temperature gradient, so a moisture increase occurred up to a level where the temperature lapse rate showed an increase to greater than the wet adiabatic rate.

This behavior agreed with a recent study showing that moisture commonly rises above the level of the heat flux. However, a strong west wind above the inversion could have been a factor in the moisture change, due to advection. The air was (probably) very hazy and this may also have enhanced the radiative heating of the air below the inversion (i.e., the haze particles are probably black in the atmospheric IR window).

We did not classify the radiation flights as STORM-FEST IOP's, although the data could be quite interesting with a number of vertical soundings being taken during the night by the King Air Aircraft (0600 UTC, 0730 UTC, 0900 UTC, 1030 UTC, 1200 UTC) in clear sky conditions. There were a total of three radiation missions flown during the STORM-FEST period.

Other Activities:

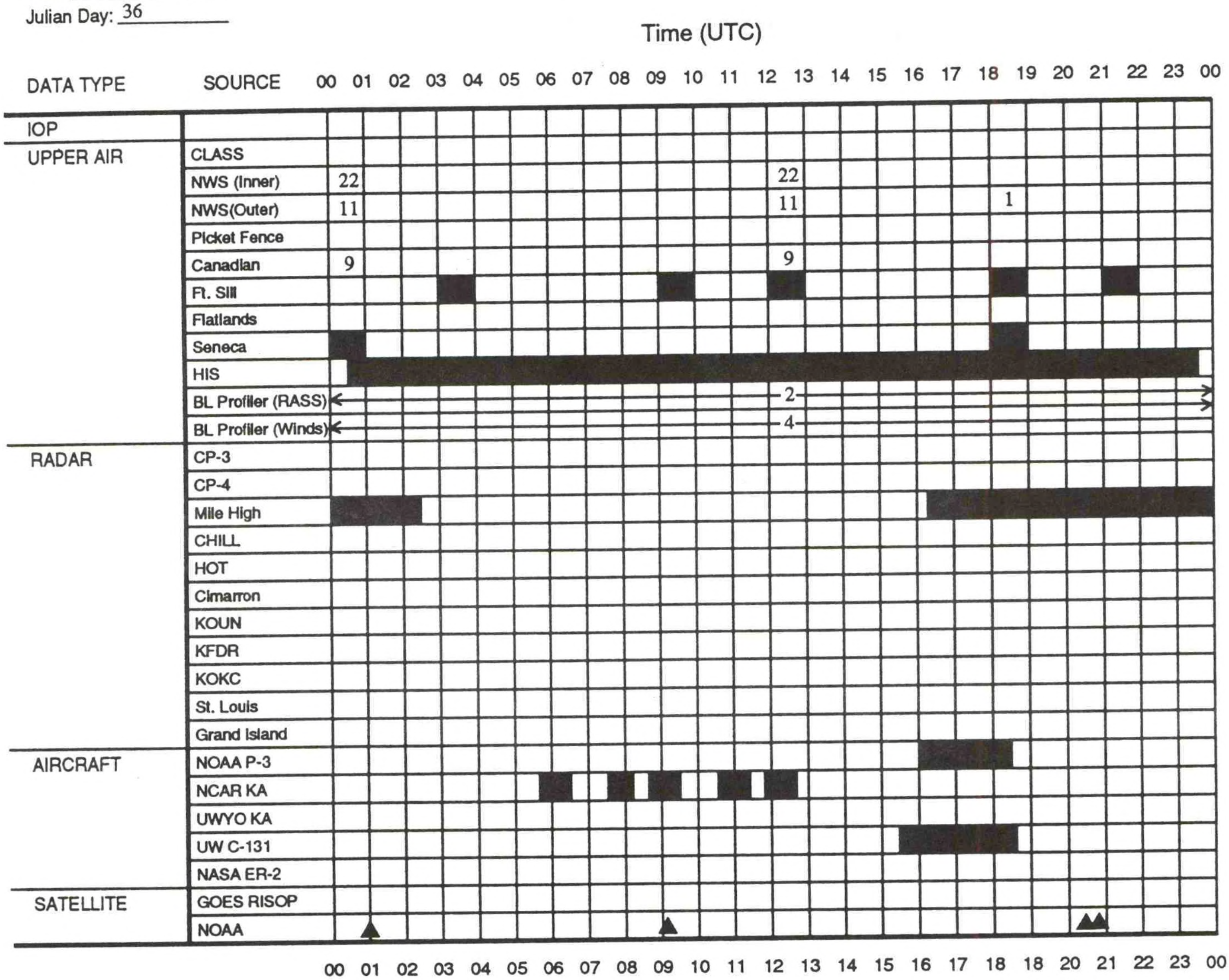
The NOAA P-3 and the University of Washington C-131 took advantage of the fair weather to conduct an intercomparison flight. The C-131 took off at 1537 UTC and the NOAA P-3 took off at 1556 UTC. Both aircraft were back on the ground by 1847 UTC. The intercomparison results looked quite good.

Planning for IOP 2 began to investigate the structure of the cold front and any associated precipitation that was forecasted to move through the STORM-FEST domain tomorrow (6 February). Six CLASS sites and 3 NWS sites were notified to take supplemental soundings starting on 6 February from 1200 UTC to 0000 UTC (7 Feb). The Wyoming King Air and the NCAR King Air aircraft were placed on alert. The radars were not put on alert at this time.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 5 February

Julian Day: 36



Comments

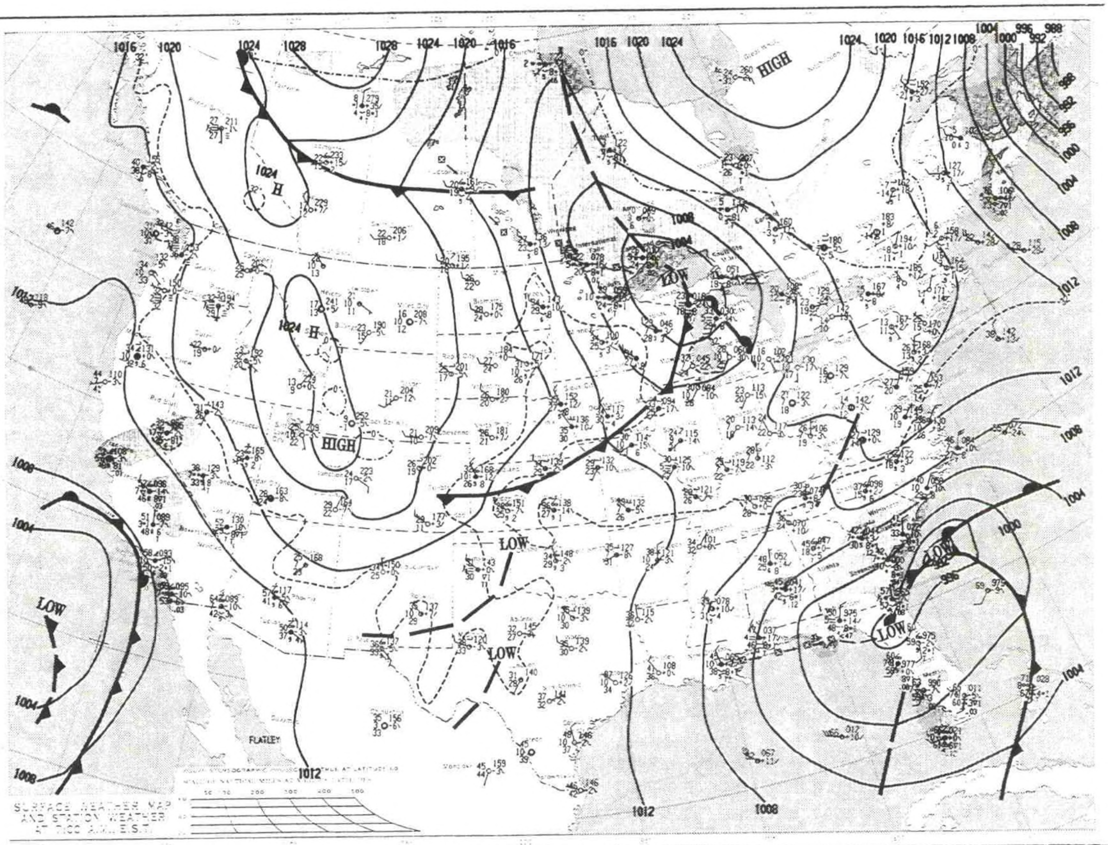
SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 2 stations intermittent.
	AWOS	45 of 47 stations reported; 9 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	16 of 19 stations reported; 1 station intermittent.
	PAM5	35 of 35 stations reported; 4 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	389 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported; 1 station intermittent.

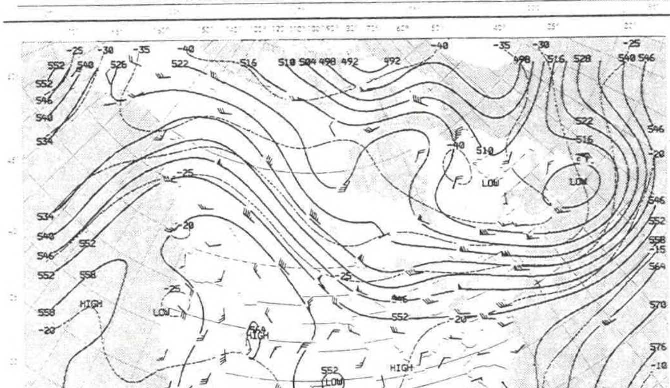
WEATHER SUMMARY **6 February 1992**

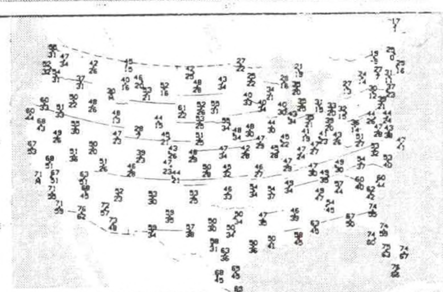
The surface low pressure center that was seen on 5 February over southern Canada, continued to move to the southeast and was located over Lake Superior at 1200 UTC. A cold front extended southwestward from the low, through Wisconsin, Iowa, Missouri and Kansas. This cold front was producing some very light rainfall over the central and eastern regions of the STORM-FEST domain.

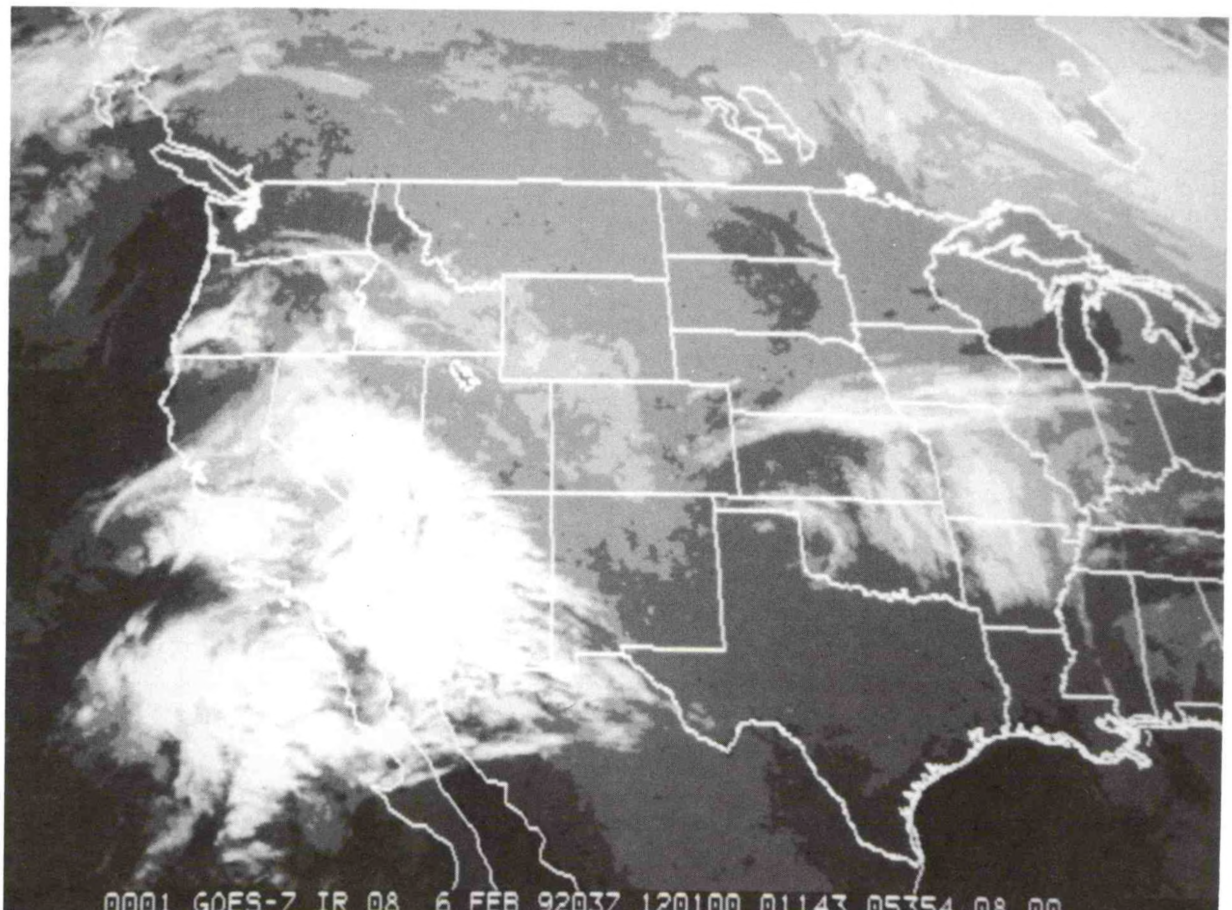
Arctic air was located much further to the north of the front over the Canadian prairies. A building surface ridge just east of the Canadian Rockies was expected to push this arctic air into the eastern and central portions of the STORM-FEST domain in the next 24- to 36-h period. This should be a strong baroclinic feature, but no significant precipitation was expected.

THURSDAY, FEBRUARY 6, 1992








0001 GOES-7 IR 08 6 FEB 92037 120100 01143 05354 08.00

OPERATIONS SUMMARY

6 February 1992

IOP 2 was conducted from 1200 UTC, 6 February to 0000 UTC, 7 February, to document the vertical structure of the weak, dry cold front that was moving through the STORM-FEST domain. Three hourly supplemental soundings from 6 CLASS sites and 3NWS inner domain sites were taken during this period.

The MM-4 model forecast guidance initialized 24-h earlier (1200 UTC, 5 February) suggested that the frontal system consisted of a prefrontal pressure through and windshift, corresponding to a thermal ridge, with the leading edge of the cold air behind (northwest of) the pressure trough. In the process of planning the mission, it was noted that the post frontal region might be cloudy and the prefrontal region relatively clear.

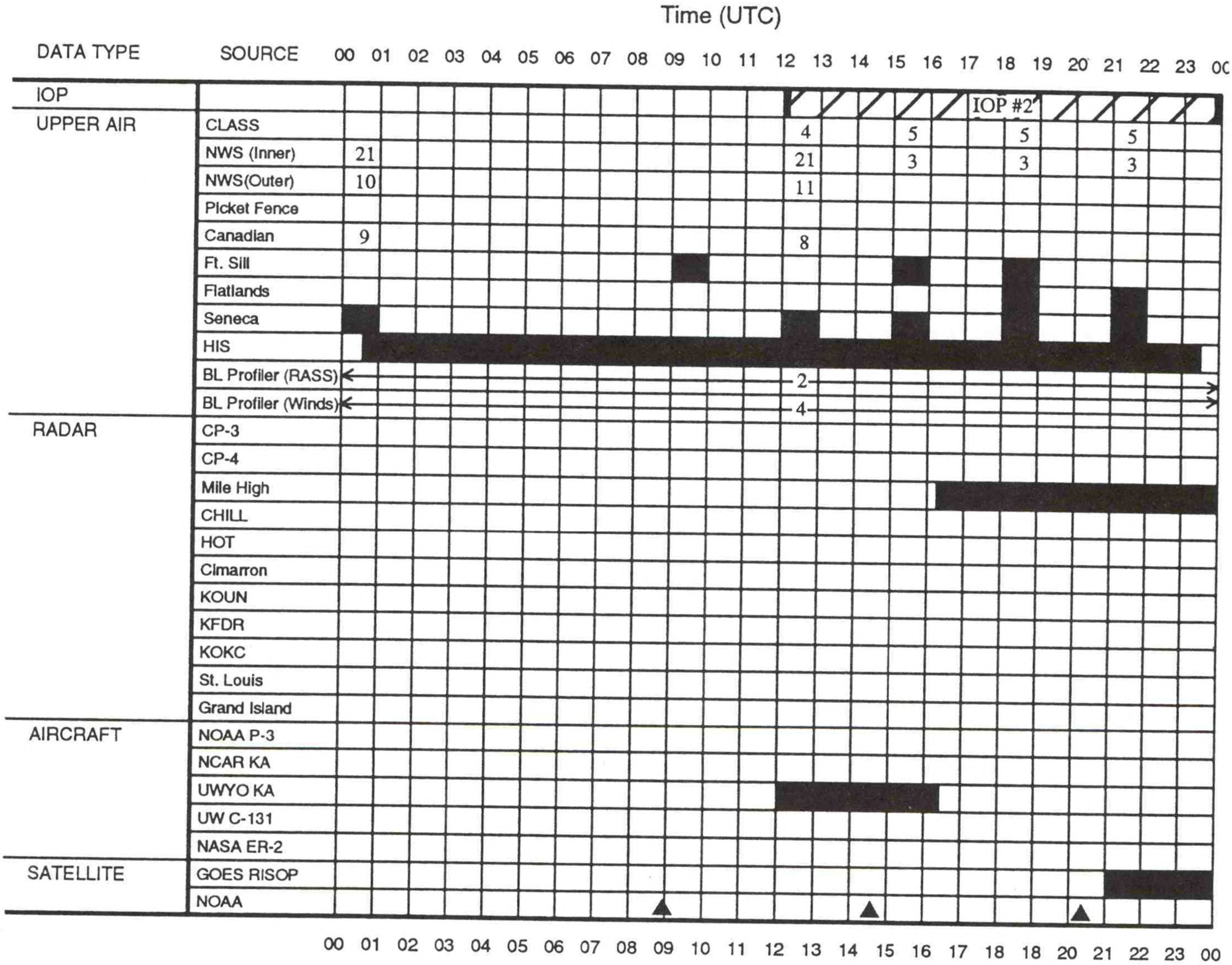
The University of Wyoming King Air took off at 1200 UTC to document the vertical structure of the cold front. The aircraft mission consisted of a stack of four 120 nm long legs (at 2k, 3k, 4k, 5 kft. pressure-altitude MSL; subtract ~ 1 kft. to obtain ft. AGL) centered at the Kirksville (IRK) VOR. The stack was oriented 335/155 degrees (magnetic). In addition, several ascent and decent soundings were taken to and from 8 kft. Aircraft observations showed that even though the front was relative weak and dry, it was characterized by multiple transition zones which was suggested in the MM-4 forecast guidance. The mission identified three distinct airmass regimes: 1) a very dry, warm region in the southeastern region of the flight, characterized by unlimited visibility; 2) a more moist, cooler region in the central portion of the flight (encountered about 1255 UTC at 2 kft.) which appeared somewhat hazy on approach from the southeast; and 3) a nearly saturated, cold, stratus-filled region on the northwestern end of the flight. The moisture boundaries appeared to be much narrower or more abrupt compared with the temperature and wind transitions. Each of these regimes was sampled on the 2 kft. flight leg. The aircraft landed at Richards-Gebaur at 1620 UTC.

The GOES-7 Satellite began RISOP mode at 2100 UTC. (Not in support of STORM-FEST objectives.)

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 6 February

Julian Day: 37



Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 1 stations intermittent.
	AWOS	44 of 47 stations reported; 5 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported; 3 stations intermittent.
	PAM5	35 of 35 stations reported; 2 stations intermittent.
	PROFS	21 of 22 stations reported; 2 stations intermittent.
	SAO	394 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 13 stations intermittent.

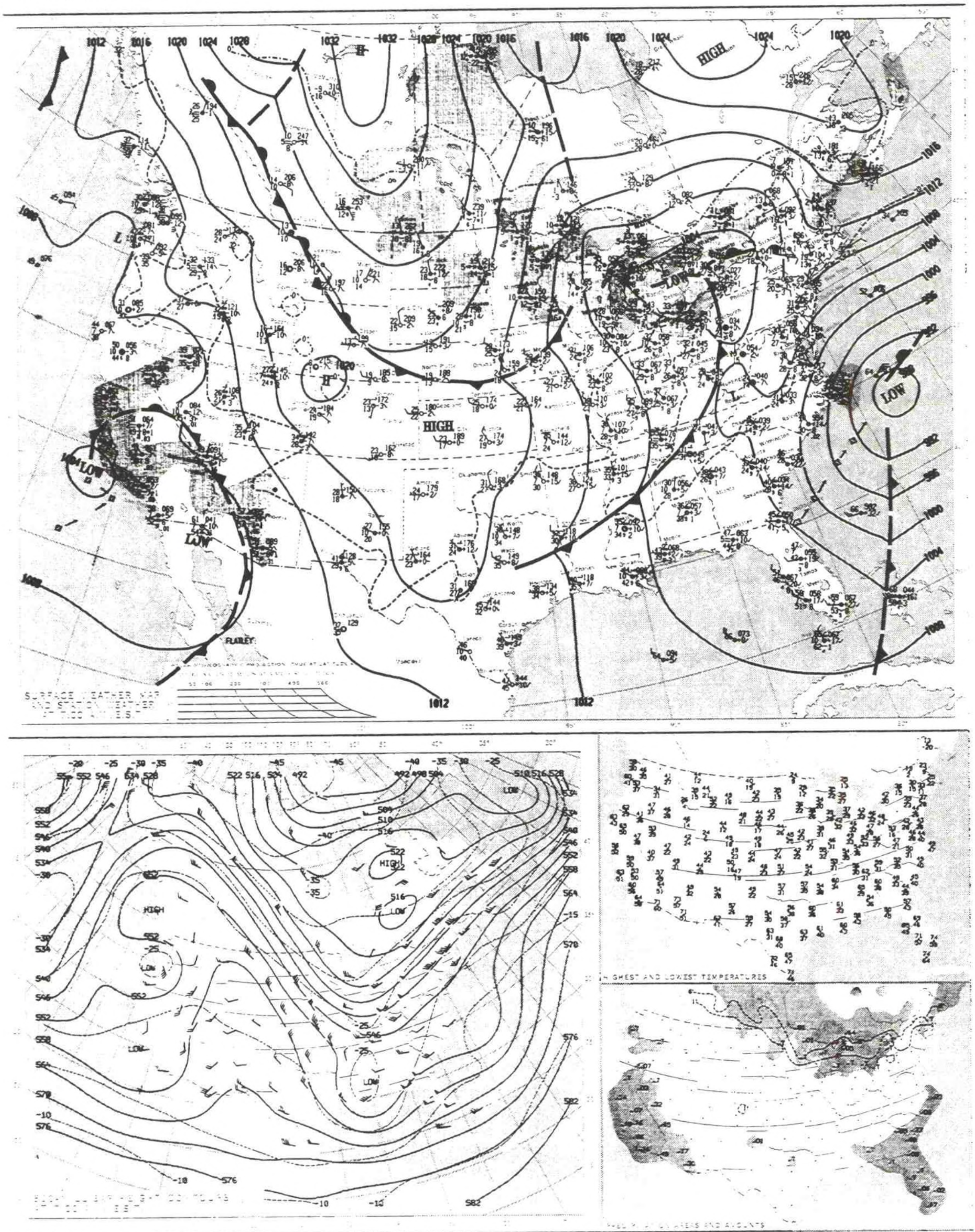
NOTES:

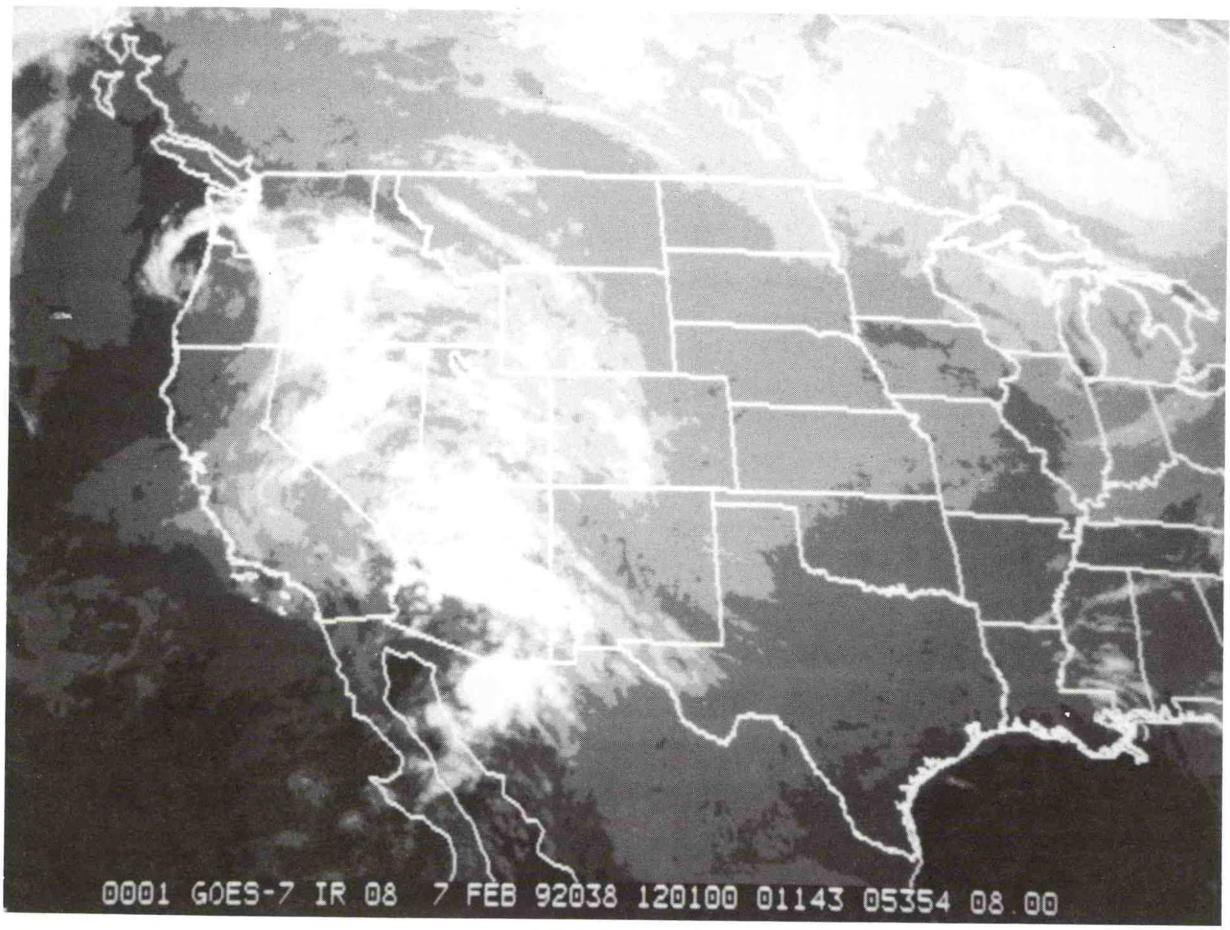
WEATHER SUMMARY 7 February 1992

A large surface high pressure area continued to dominate the STORM-FEST region. A secondary cold front was beginning to move through Nebraska and Iowa at 1200 UTC and was expected to move through the region early on 8 February. There was some possibility that there might be some very light snow over the front range of the Rockies, but no other precipitation was expected in the STORM-FEST domain.

The next 24- to 48-h was forecasted to be rather quiet as lee troughing began to push the frontal boundary into the plains. Late in the period, several short-waves in the upper-level flow could begin to interact with the boundary in the eastern half of STORM-FEST area. The 0000 UTC, 7 February, MRF run and the 1200 UTC, 7 February, NGM agreed fairly well with the timing of the shortwaves. The wave in the northern branch appeared to be the one for concern as it moves through the northern portion of the STORM-FEST area. Low-level moisture along, and east of the warm front was expected to increase as the northern wave approached and warm advection set up. At this time, a light snow event was forecasted in the next 48- to 72-h over the Iowa/Missouri border and into central southern Illinois with this system. Some snow might begin as early Sunday morning, 9 February.

FRIDAY, FEBRUARY 7, 1992




0001 GOES-7 IR 08 7 FEB 92038 120100 01143 05354 08.00

OPERATIONS SUMMARY

7 February 1992

With one more fair weather day over the STORM-FEST domain, no operations were carried out. Planning for IOP 3 began, with the IOP scheduled to begin at 0600 UTC, 9 February. This IOP will focus on the precipitation that was expected to develop along the cold front as it moved into the STORM-FEST domain.

The GOES-7 Satellite began RISOP mode at 2100 UTC. (Not in support of STORM-FEST objectives.)

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 7 February

Julian Day: 38

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP																									
UPPER AIR	CLASS	4																							
	NWS (Inner)	22												22											
	NWS(Outer)	11												11											
	Picket Fence																								
	Canadian	9												9											
	Ft. Sill																								
	Flatlands																								
	Seneca																								
	HIS																								
	BL Profiler (RASS)													2											
	BL Profiler (Winds)													4											
RADAR	CP-3																								
	CP-4																								
	Mile High																								
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA																								

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 18 20 21 22 23 00

Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported.
	AWOS	44 of 47 stations reported; 3 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 4 stations intermittent.
	PROFS	21 of 22 stations reported; 2 stations intermittent.
	SAO	395 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 7 stations intermittent.

NOTES:

WEATHER SUMMARY

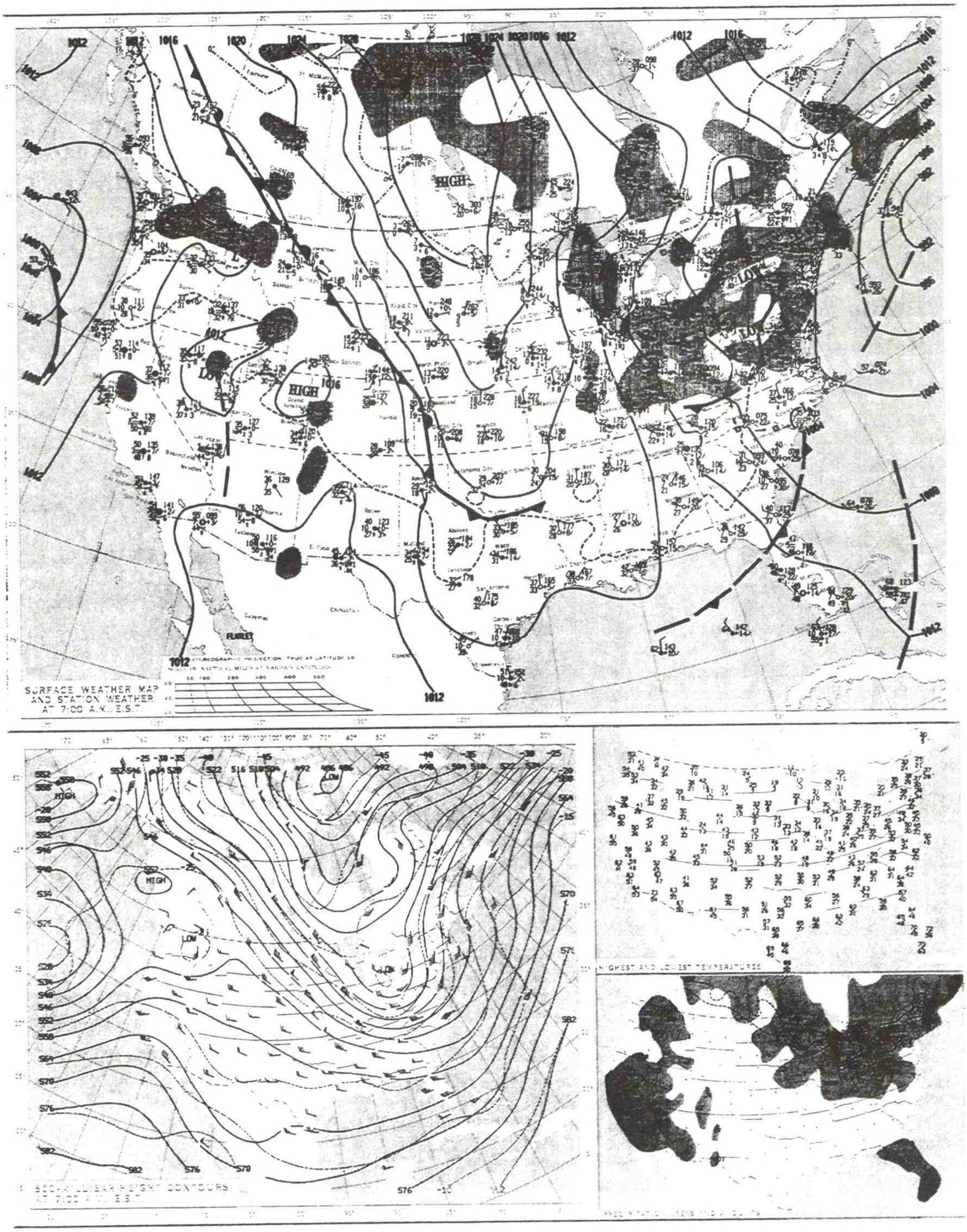
8 February 1992

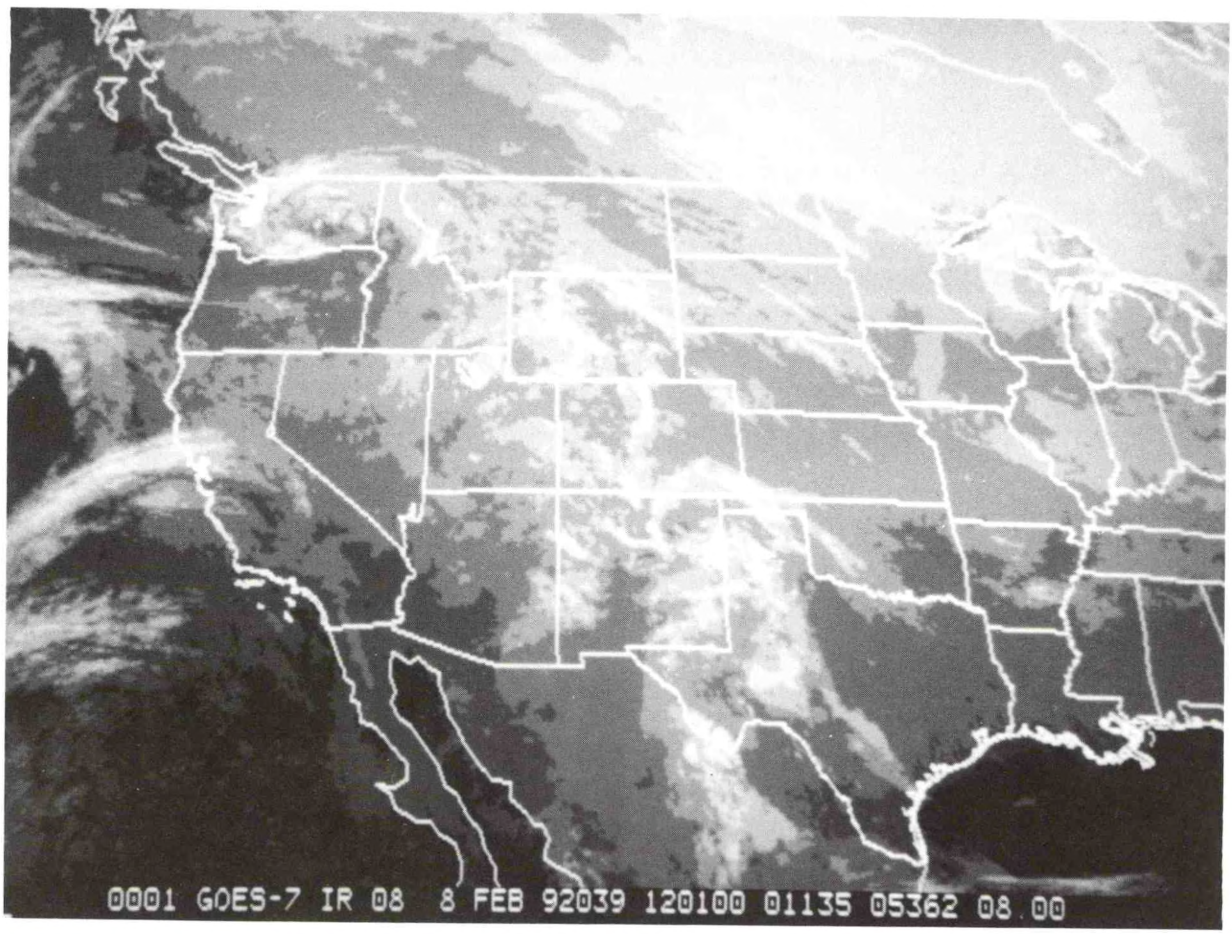
Another strong high pressure area centered over southern Canada was pushing cold air over most of the STORM-FEST area, with a stationary front backing up to the front range of the Rockies. Some very light precipitation occurred over eastern Nebraska and the Dakotas.

By 1200 UTC tomorrow, (9 February) precipitation was expected to break out along and ahead of the front in eastern Kansas, Nebraska, Iowa, and western Missouri; although precipitation amounts were not expected to be significant. The MM-4 model indicated increasing cloud moisture in the eastern STORM-FEST area, suggesting icing could be a problem over eastern Kansas, eastern Nebraska, northwestern Missouri and southwestern Iowa for the 1200 UTC-to-1800 UTC, 9 February period.

By 1800 UTC, 9 February, the front was forecast to be across eastern Kansas, Nebraska, and Oklahoma. Low-level warm advection should be increasing through the central plains with good isentrophic lift over the frontal boundary. Early precipitation along and east of the front would be mainly light, but could be enhanced by an approaching Pacific shortwave. It did not appear that there would be any jet streak influence with this event, since there appeared to be no indication of a speed max associated with the shortwave.

SATURDAY, FEBRUARY 8, 1992




0001 GOES-7 IR 08 8 FEB 92039 120100 01135 05362 08.00

OPERATIONS SUMMARY 8 February 1992

No operations were carried out during the day. IOP 3 was scheduled to begin 9 February at 1200 UTC extending until 0000 UTC, 10 February. The focus of this IOP was to study the precipitation bands associated with warm frontal overrunning. CLASS soundings were scheduled to begin at 1200 UTC, extending to 2100 UTC. NWS inner domain soundings were requested for 1500, 1800 and 2100 UTC. The CP-3 and CP-4 radars were placed on alert to begin at 1200 UTC. The University of Washington C-131 and University of Wyoming King Air aircraft were placed on alert for a possible 1200 UTC take-off.

In addition, scientists were beginning to look at a 4th IOP that could begin as early as 0000 UTC on the 11th. Details for this IOP were still being developed.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 8 February

Julian Day: 39

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP																									
UPPER AIR	CLASS	1																	1						
	NWS (Inner)	22												22			1			1			1		
	NWS(Outer)	11												11											
	Picket Fence																								
	Canadian	9												9											
	Ft. Sill																								
	Flatlands																								
	Seneca	■																	■						
	HIS		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	BL Profiler (RASS)	←												2											→
	BL Profiler (Winds)	←												4											→
RADAR	CP-3																								
	CP-4																								
	Mile High																	■	■	■	■	■	■	■	■
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																	■							
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP	■																							
	NOAA		▲																						

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 18 20 21 22 23 00

Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 6 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 5 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	386 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported.

NOTES:

WEATHER SUMMARY

9 February 1992

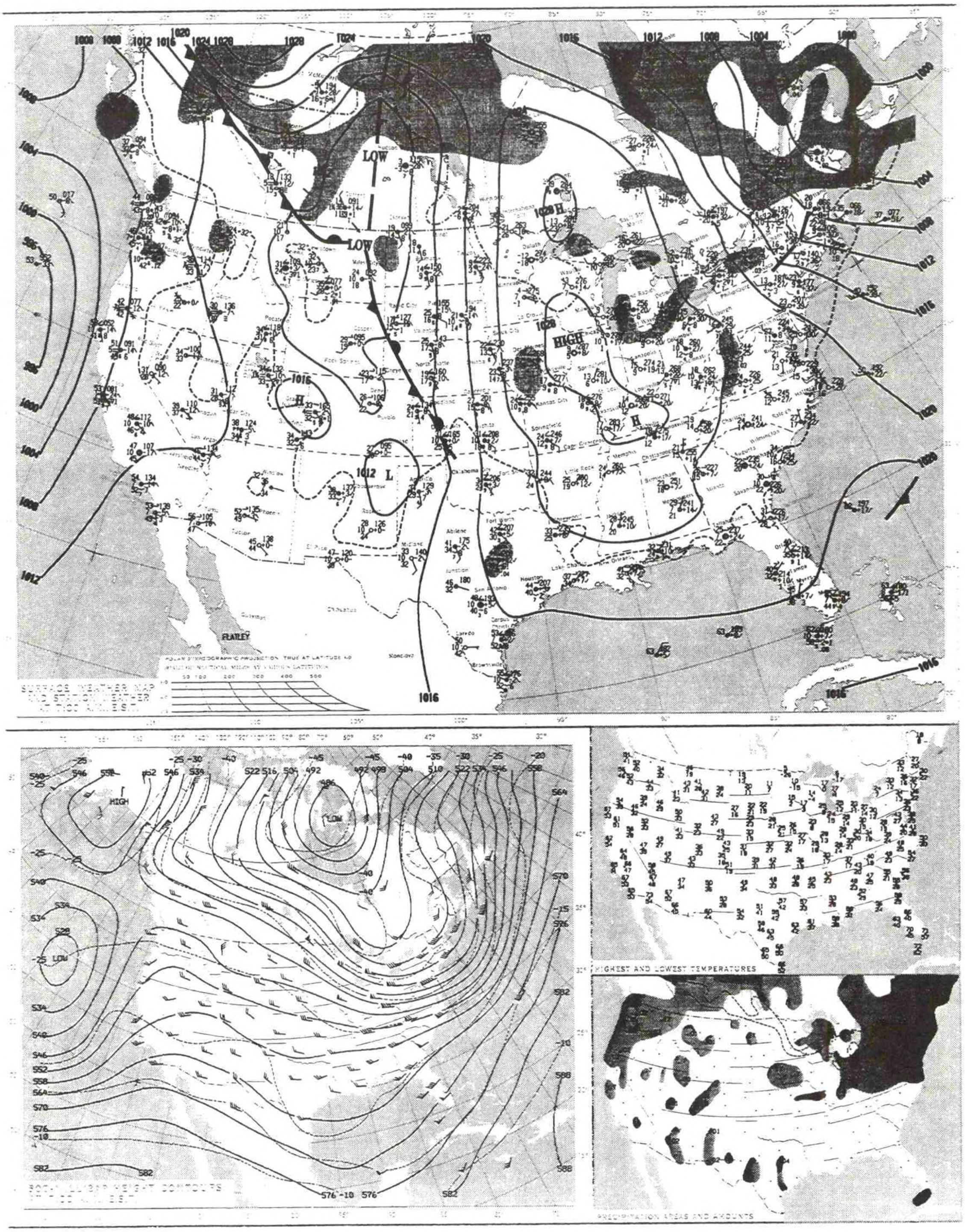
The strong surface high pressure area seen yesterday, 8 February, had moved to the southeast and was centered over Illinois. A weak stationary front was located over western Kansas, Nebraska and Wyoming and was expected to move slowly eastward to extend from northeast Iowa to eastern Arkansas by 0000 UTC tomorrow, 10 February. At 1200 UTC, light precipitation was occurring over eastern Nebraska and Iowa.

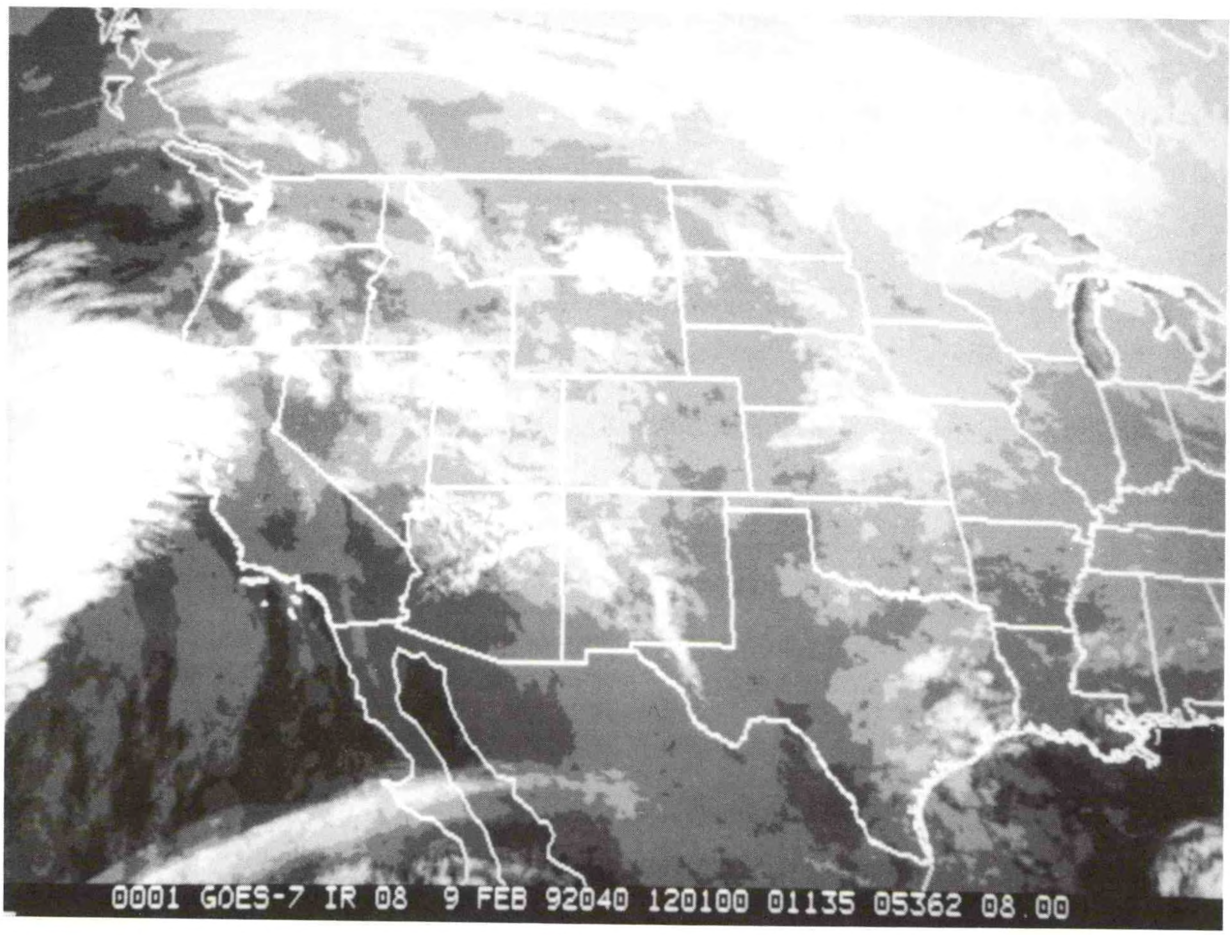
This front was forecast to move eastward and lie north-south through eastern Illinois by 1800 UTC, 10 February. Broken low-level cloud with some isolated showers were expected to occur near the front throughout the period.

A new surge of arctic air was currently poised over northern Montana and was expected to push into the extreme northern STORM-FEST area by 0000 UTC, 10 February. The front was forecast to move southeastward and be in the Oklahoma/Arkansas area in 48-h. The depth of the arctic air should be limited to below 700 mb, but deepen dramatically over the extreme northern STORM-FEST region. The airmass should be quite dry with only a few showers expected near the front, especially over the eastern STORM-FEST areas.

There was some concern that the long range models may not be initializing the systems off the west coast very well. Generally, the models were forecasting a push of more energy into the southern stream, south of the STORM-FEST area. This would keep the cold front from moving much further southwestward. The magnitude of this impulse was uncertain, thus leading to uncertainties in the frontal position in the next 24- to 48-h.

SUNDAY, FEBRUARY 9, 1992




0001 GOES-7 IR 08 9 FEB 92040 120100 01135 05362 08.00

OPERATIONS SUMMARY

9 February 1992

IOP 3 began at 1200 UTC (continuing to 2100 UTC, 9 February) with the objective to investigate the structure and precipitation associated with a very weak warm frontal overrunning situation. Weak radar echoes [0-20 dBZ] were present in two areas; one over the dual-Doppler (CP-3 and CP-4) area, and the other over southwest Iowa and northwest Missouri. The base of the warm frontal surface was located approximately 1 km above the surface. CLASS soundings were taken at 1200, 1500, 1800, and 2100 UTC and inner domain NWS supplemental soundings were taken at 1500, 1800, and 2100 UTC. The CP-3 and CP-4 Doppler radars operated from 1200 UTC to 1700 UTC monitoring the weak precipitation in the area.

Two aircraft flights were conducted. The University of Washington C-131 took off at [approximately] 1300 UTC and flew north of the CP-4 radar into the strongest echoes [~ 20 dBZ]. They did a vertical sounding to 12 kft where they encountered the top of the cloud. At that time they developed engine problems and had to return to Richards-Gebaur AFB.

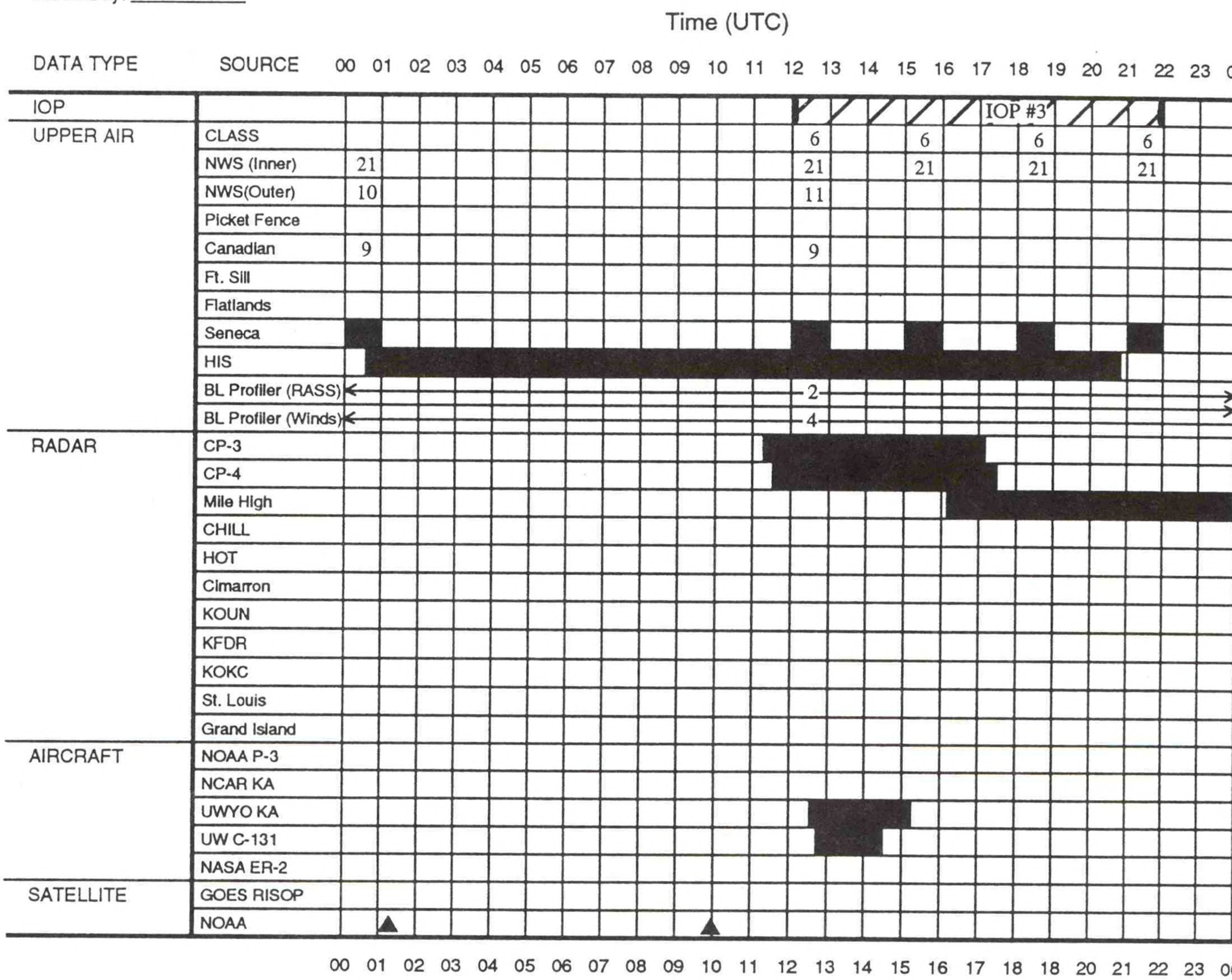
The University of Wyoming King Air took off at 1230 UTC, climbed to 10 kft. and flew southwest, descending along an "M surface" that extended to approximately Wichita. The aircraft came back on a similar leg to a position about 50 km southeast of CP-3, and then flew stacked 40 km legs to measure the geostrophic and ageostrophic wind components. The aircraft finished the flight with a descent sounding near Richards-Gebaur AFB and landed at 1510 UTC. The IOP ended at 2100 UTC, 9 February.

Planning continued for IOP 4, to study the vertical structure of the cold front and any precipitation associated with it. The IOP was scheduled to begin at 0600 UTC tomorrow, 10 February, with the start of upstream NWS and Canadian soundings. Supplemental NWS inner domain and CLASS soundings were scheduled to begin at 1500 UTC. The CP-3 and CP-4 dual-Doppler radars were placed on alert starting at 1700 UTC. All aircraft were placed on alert with no flights scheduled prior to 1800 UTC.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 9 February

Julian Day: 40



Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported.
	AWOS	46 of 47 stations reported; 2 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 5 stations intermittent.
	PROFS	21 of 22 stations reported; 2 stations intermittent.
	SAO	383 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported.

NOTES:

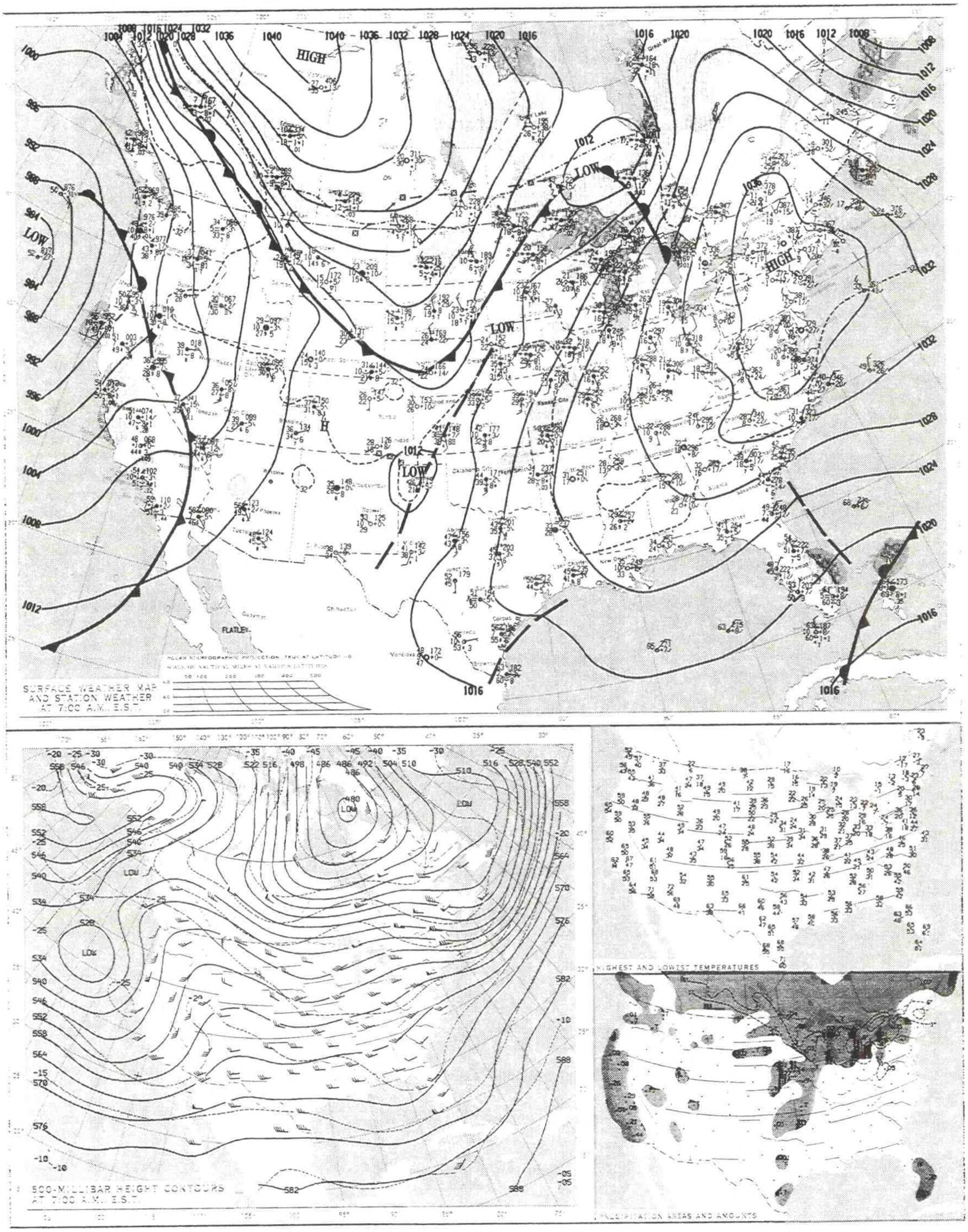
WEATHER SUMMARY **10 February 1992**

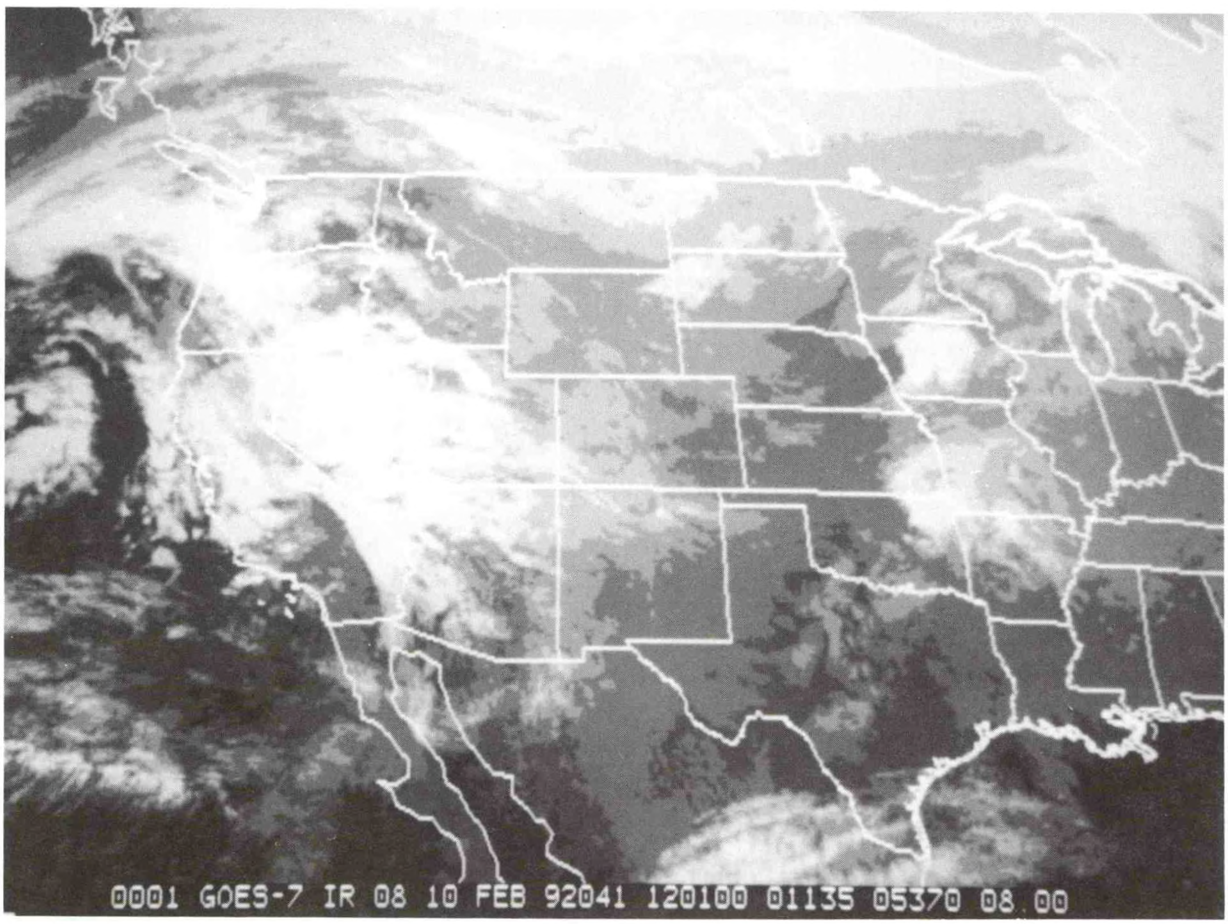
The weak arctic cold front that was discussed yesterday, had moved down through the northern portion of the STORM-FEST domain from a low pressure center located north of Lake Superior. The front was forecasted to weaken during the afternoon. Precipitation had developed and moved into Illinois and a small area of rain and freezing rain developed well southeast of the front in northeast Arkansas, in an area of isentropic uplift (seen on the 296K surface) and a nicely collocated PV anomaly at 320K. Both areas of precipitation were forecasted to weaken and propagate eastward through the period. No precipitation occurred in the CP-3 and CP-4 dual-Doppler area.

By tomorrow (0000 UTC, 11 February) the front was forecast to extend from southeastern Wyoming to near the STORM-FEST boundary layer network. There might be some freezing drizzle generated in the low-level clouds behind the front. Precipitation accumulation was expected to be insignificant in the next 24-h.

A major shortwave had moved into central and south California, driven by a 120 kt jet, and should begin to affect the STORM-FEST domain by 0000 UTC, tomorrow (11 February). AVN grids indicate two areas of greater than .01 inch of precipitation: one in Texas along the Gulf coast and the other centered on Arkansas, Missouri and Oklahoma, with a .03 inch max 6-h accumulation ending at 1200 UTC.

MONDAY, FEBRUARY 10, 1992




0001 GOES-7 IR 08 10 FEB 92041 120100 01135 05370 08.00

OPERATIONS SUMMARY

10 February 1992

IOP 4 began at 0600 UTC with the start of Canadian and NWS outer domain soundings. CLASS and NWS inner domain soundings began at 1500 UTC. The objective of this IOP was to document the vertical structure of a shallow arctic cold front and any precipitation associated with it. The IOP ended at 0000 UTC, 11 February.

Since no precipitation occurred with the front, the NCAR King Air and University of Wyoming King Air flew a stacked pattern centered on Des Moines, Iowa. The mission was to define the vertical structure of this (relatively) dynamically simple front, as well as test aircraft coordination techniques. The NCAR King Air took off at 1820 UTC and the Wyoming King Air took off at 1830 UTC.

Initially, the NCAR King Air dropped dropwindsondes from 25 kft in a cross section directly over the low-level track flown by the Wyoming King Air. After completion of this part of the mission the aircraft did a descent sounding and joined-up with the Wyoming King Air northeast of Des Moines, Iowa. The aircraft then flew in stacked formation along a track between 2 kft and 3 kft with the Wyoming King Air 1 kft below the NCAR King Air. At the end of this track both aircraft flew back to Des Moines to refuel. The second flight of both aircraft was a stacked flight pattern on the return to Richards-Gebaur AFB via the boundary layer array. Both aircraft landed at approximately 2250 UTC. Airborne mission scientist reports indicated that there was substantial structure associated with the front; both in the vertical and the horizontal.

The NCAR CP-3 and CP-4 radars operated from about 1600 UTC, 10 February, through 0000 UTC, 11 February. Primary scanning mode was the surveillance mode since no precipitation developed in their area. The radars did observe some very interesting frontal structure at about 2300 UTC. Digitized radar data was collected at St. Louis beginning at 1530 UTC. GOES-7 RISOP mode began at 2100 UTC and extended through 0100 UTC (11 February).

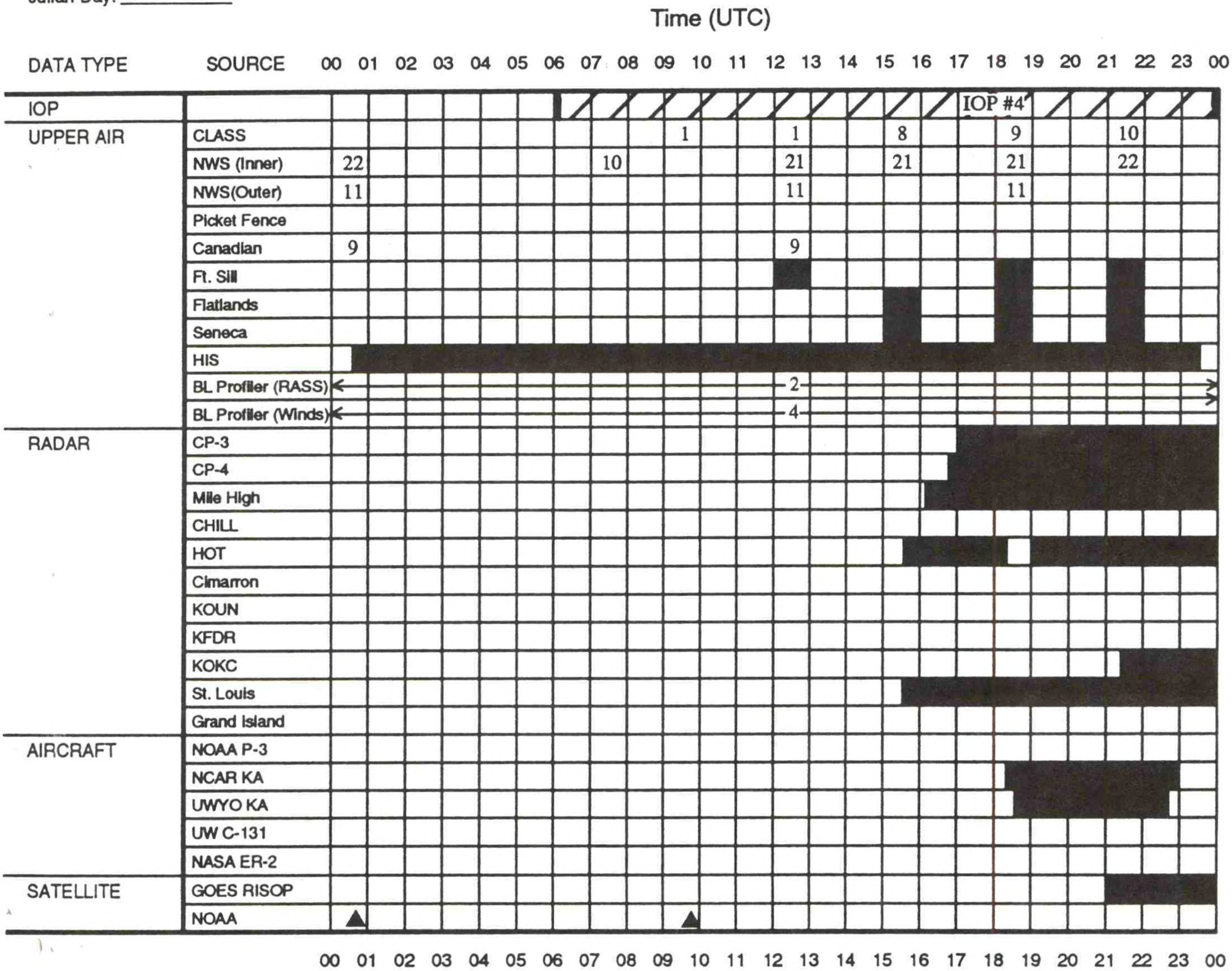
Subsequent to the end of this IOP, the arctic front began to interact with a storm system to the west of the STORM-FEST area. Since the objectives for investigating this new storm system were significantly different than for this IOP, it was decided to formally end this IOP and start a new one, IOP 5.

Plans for IOP 5, were to begin NWS outer domain soundings at 0000 UTC, tomorrow, 11 February, operating for 12-h until 1200 UTC 11 February. The NWS inner domain and CLASS soundings were also scheduled to begin at 0000 UTC (11 February) and operate until 1200 UTC (12 February). The CP-3, CP-4 and the Illinois State Water Survey HOT Radars were placed on alert beginning at 0900 UTC, 11 February. The NSSL Cimarron radars were placed on alert beginning at 0900 UTC, 11 February. RISOP was scheduled to begin at 1200 UTC, 11 February, and extend to 1200 UTC, 12 February. All aircraft were placed on alert, with the earliest take-off at 1300 UTC, 11 February.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 10 February

Julian Day: 41



Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported.
	AWOS	41 of 47 stations reported; 5 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 8 stations intermittent.
	PROFS	21 of 22 stations reported; 2 stations intermittent.
	SAO	392 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 1 station intermittent.

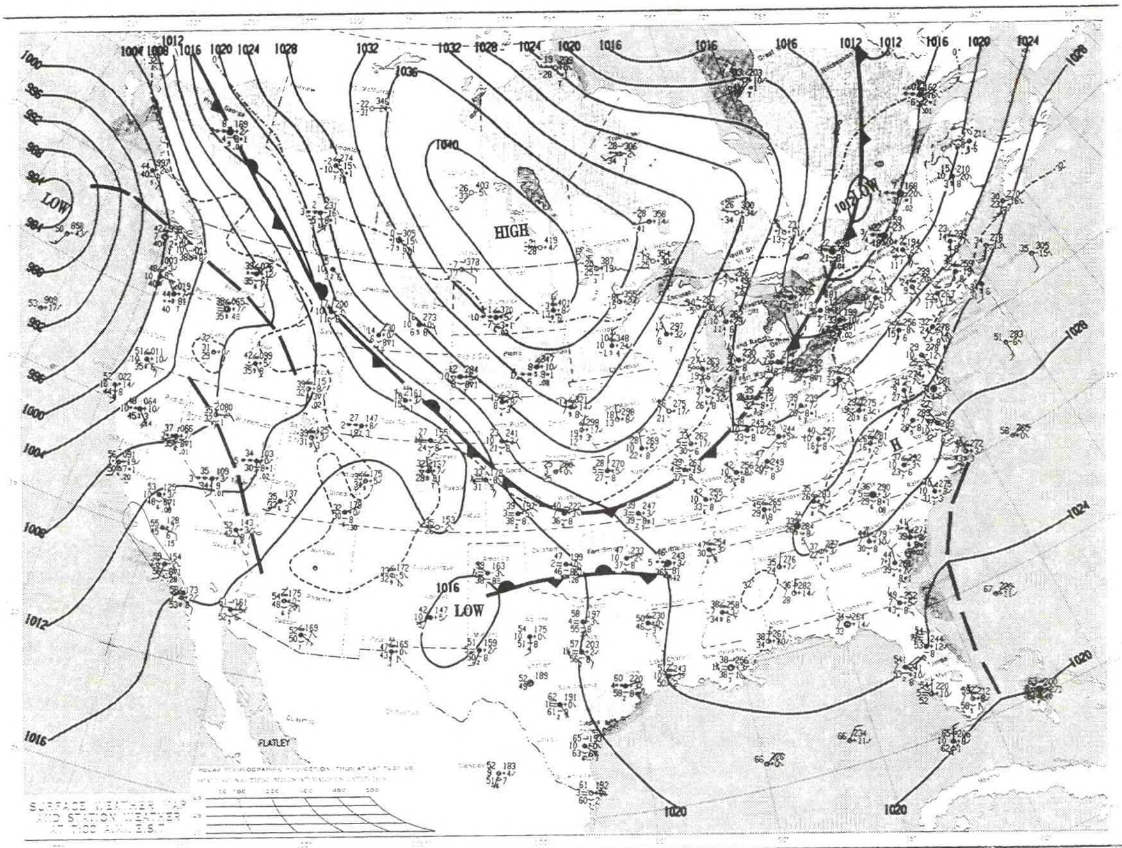
WEATHER SUMMARY

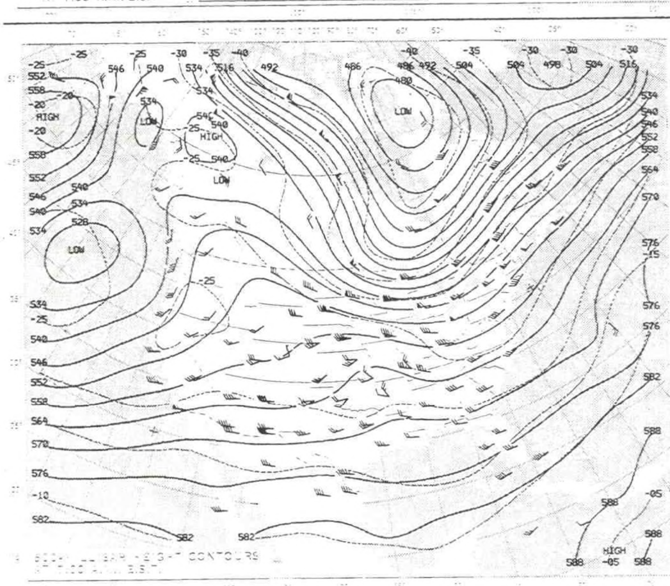
11 February 1992

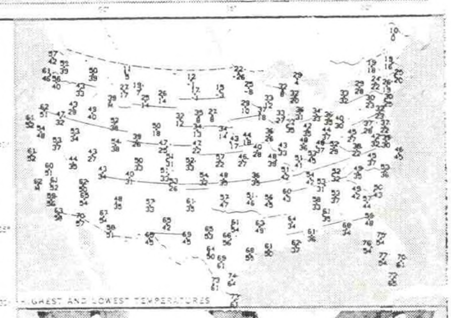
The shallow cold front that was seen yesterday, 10 February, moving into the northern part of the STORM-FEST domain continued to move southward, into the Kansas/Oklahoma area. The western boundary of the front extended back along the Rocky Mountains. A dryline was present over central Texas. A weak warm front was also analyzed on the surface charts extending through central Oklahoma eastward from the dryline. During the initial phase of IOP 5, weak radar echoes were observed over Oklahoma and Texas. Later in the day a band of weak echoes developed through central Kansas and southern Nebraska.

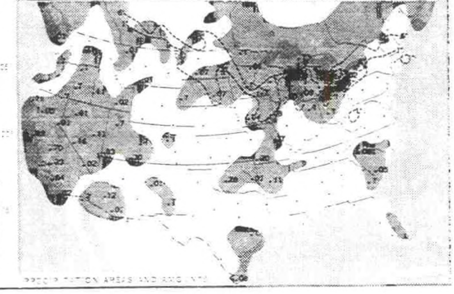
The Eta and NGM models both de-emphasized surface development along the front, supporting the argument that the evolution of system would be a warm frontal wave that would interact with surface cold air over the eastern part of the U.S. However, both these models forecast precipitation totals of > 1" over northwest Arkansas and adjacent areas. The MM-4 model was different in that although it forecasted that the surface front would refocus over northern Oklahoma this afternoon 11 February, with precipitation in southeast Oklahoma (as did the other models), it began to intensify a north-south surface trough through central Oklahoma later in the forecast period.

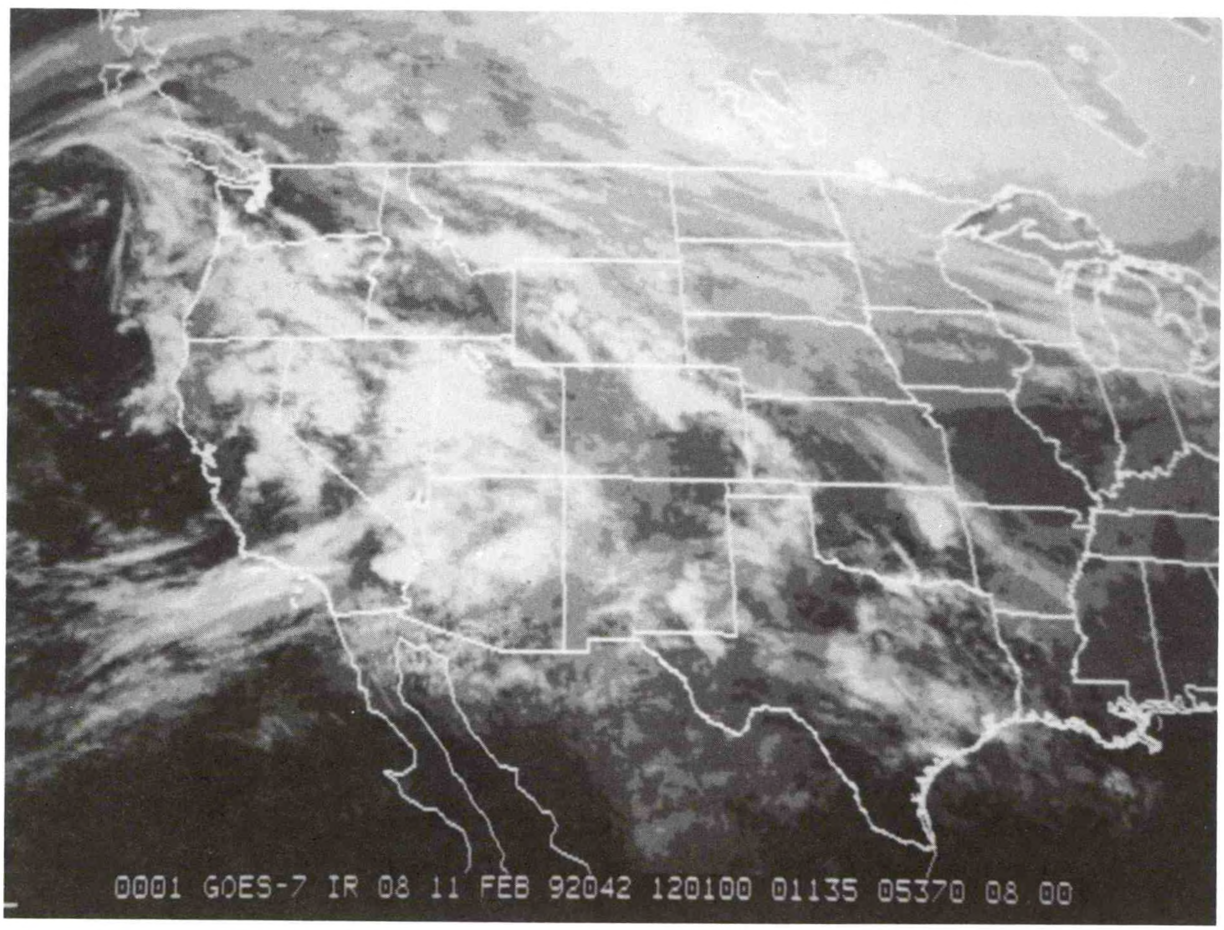
TUESDAY, FEBRUARY 11, 1992










0001 GOES-7 IR 08 11 FEB 92042 120100 01135 05370 08.00

OPERATIONS SUMMARY 11 February 1992

IOP 5 began at 0000 UTC and was scheduled to continue through 1200 UTC, tomorrow (12 February). The objectives of this IOP were to study the precipitation associated with the two fronts, the merging of the fronts, resulting frontogenesis, and the structure of the lee-side trough. The following events occurred as part of this IOP:

0000 UTC The NWS outer domain soundings began and were scheduled to continue for 12-hrs. The NWS Inner domain and CLASS soundings continued from IOP 4 with the official beginning for IOP 5 at 0000 UTC and were expected to continue until 1200 UTC tomorrow (12 February).

1200 UTC RISOP (Rapid Scan Satellite) began and was scheduled to continue to 1200 UTC (12 February).

1548 UTC The University of Washington C-131, took off and flew in the two rainbands just south of the Kansas/Oklahoma border. The aircraft made three passes between Richards-Gebaur AFB and Ardmore, Oklahoma. The first leg was flown at 10 kft., the second leg at 7 kft., the third (partial) leg was flown at 4 kft. before the aircraft had to return to Richards-Gebaur AFB. Most of the convection in the line, was below 15 kft., although there were a few towering cumulonimbus in the lines.

1830 UTC The NOAA P-3 took off and climbed to 20 kft. heading west along the Kansas/Oklahoma border, dropping dropwindsondes to explore the structure of the lee side trough. The aircraft then headed south and east passing over Oklahoma City. It flew along an east-west line of convection at 15 kft, from Oklahoma to western Arkansas. The tail Doppler radar documented the wind structure in the convective system. At 0230 UTC (12 February) the aircraft flew legs between Tulsa, Oklahoma and central Missouri, which was along the most intense convection in the band. During this period the aircraft was struck by lightning, damaging the on-board experimental HF communication system. On the northeast leg of the pattern, dropwindsondes were launched from 22 kft. The return leg to Richards-Gebaur AFB was flown at 15 kft. to continue documenting of the structure of the convection in the band using the Doppler radar. The aircraft landed at

Richards-Gebaur AFB at 0440 UTC, 12 February.

2240 UTC The University of Wyoming King Air took off and flew south to the warm front to sample the moist southerly inflow air into the system. The strongest inflow was thought to be in eastern Texas, where the aircraft conducted a limited LAD experiment. The aircraft landed at Tulsa for refueling where it encountered severe weather (lightning, freezing rain). The aircraft took off again at 0620 UTC (12 February) and flew back to Richards-Gebaur AFB. (Icing was reported at Richards-Gebaur AFB although no ice was observed on the runway.) On landing in Topeka and on return to Richards-Gebaur AFB, the aircraft obtained excellent measurements in strong freezing rain.

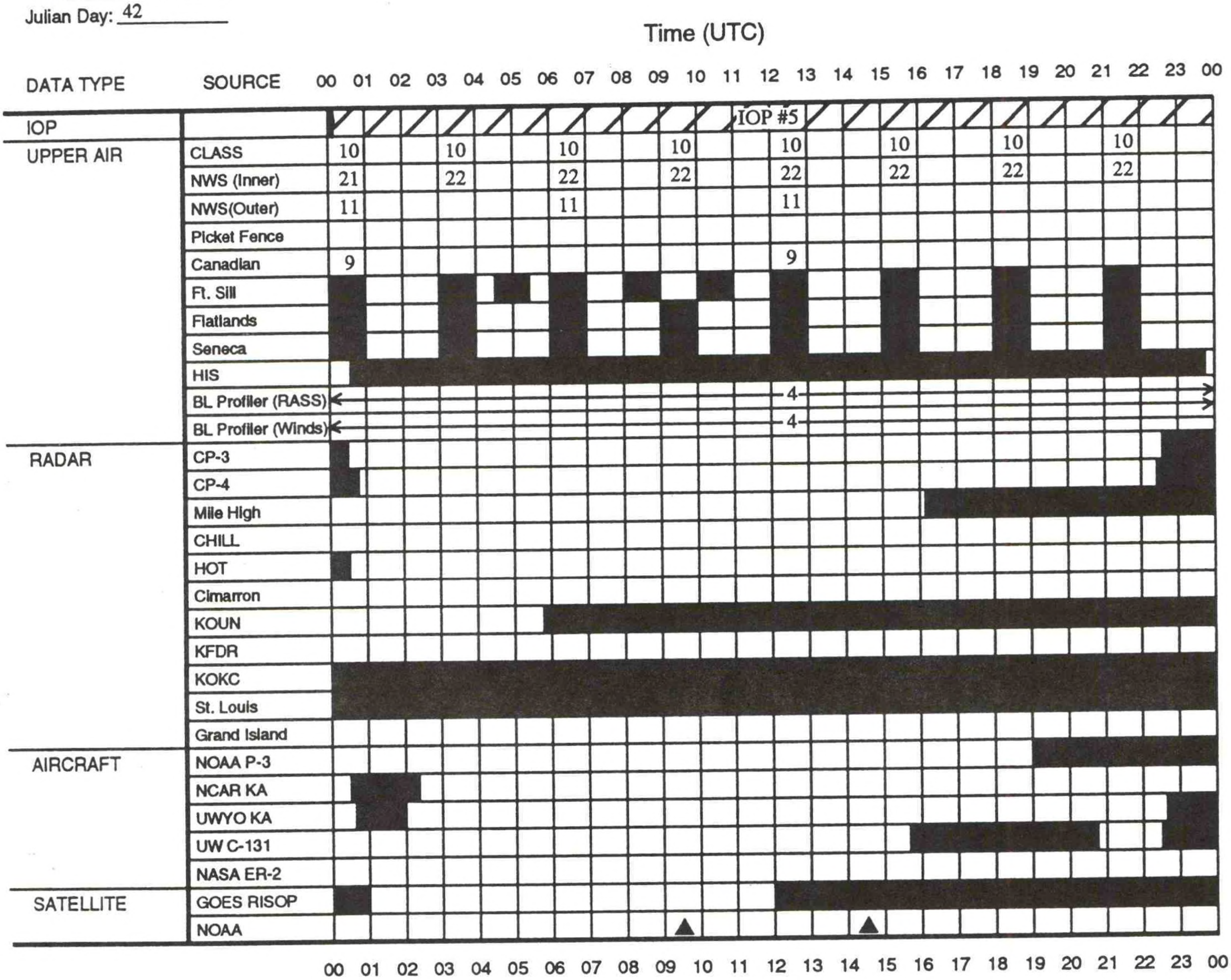
2240 UTC CP-3 and CP-4 radars began to collect data. Only second trip echoes were observed at this time. Precipitation over the radars occurred during the passage of a convective band between 0200 and 0800 UTC, 12 February. The CP-4 radar was inoperative during several penetrations of the NCAR aircraft on 12 February, although both radars were operating during the earliest and latest penetrations.

Radar data were also collected by the WSR-88D radars in Oklahoma. The WSR-88D radar at Oklahoma City began collecting Archive II level data at 0000 UTC and the WSR-88D radar at Norman began collecting Archive II data at 0600 UTC. The warm front moving north from the Red River area of Oklahoma interacted with the weak arctic front along the Kansas-Oklahoma border developing nocturnal convection in southcentral and southeastern Oklahoma on the 11th and 12th, which persisted throughout the day. However, all significant convection occurred in the eastern half of Oklahoma and only a few very light showers affected the Little Washita basin, which recorded only a trace of precipitation. Data were collected from two disdrometers and the ARS rainguage network in the Little Washita Watershed. KFDR and NSSL's Cimarron radars were inoperative. Digitized WSR-57 radar data were recorded at St. Louis beginning at 0000 UTC.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 11 February

Julian Day: 42



Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported.
	AWOS	46 of 47 stations reported; 5 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 13 stations intermittent.
	PROFS	21 of 22 stations reported; 2 stations intermittent.
	SAO	389 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 2 stations intermittent.

WEATHER SUMMARY

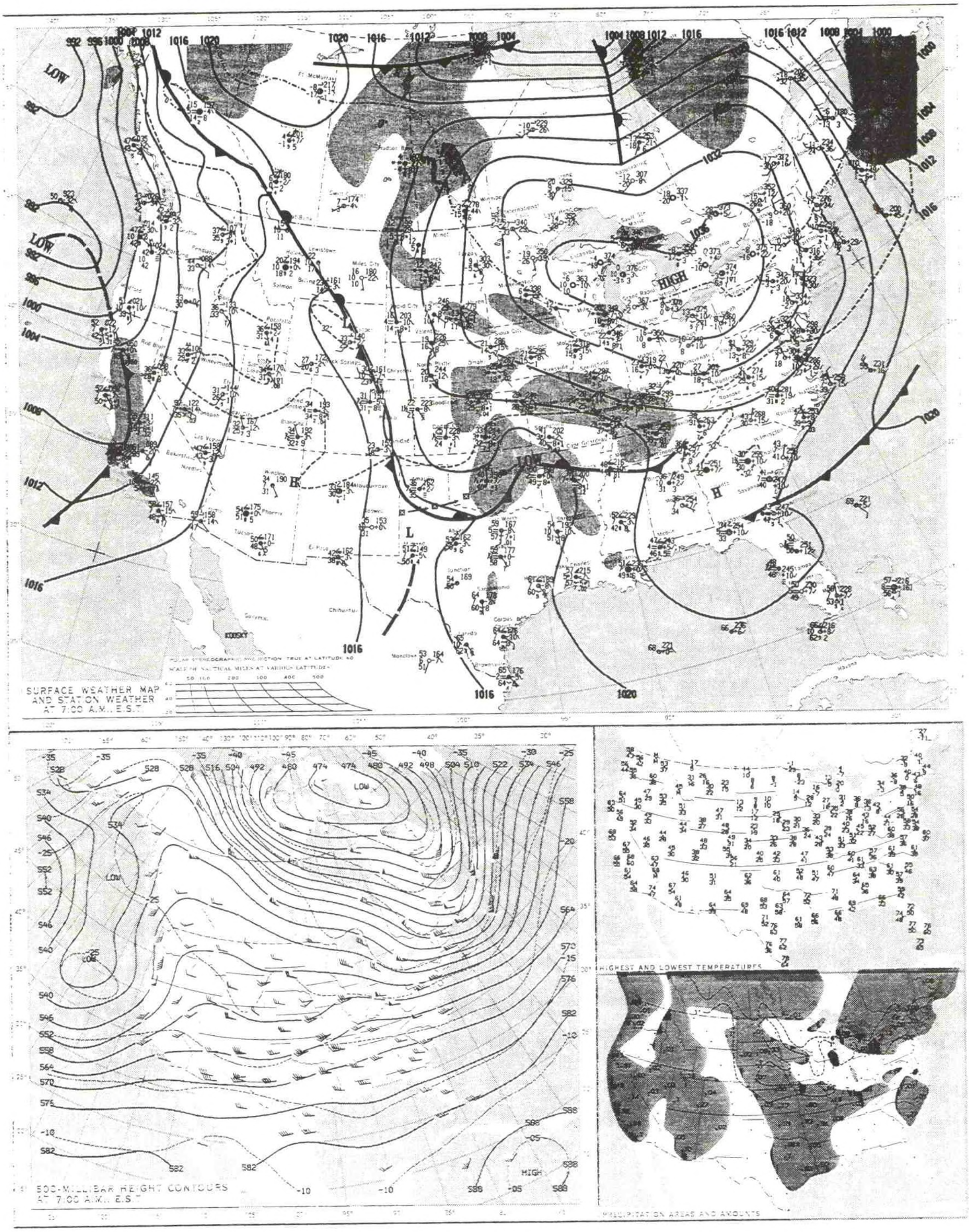
12 February 1992

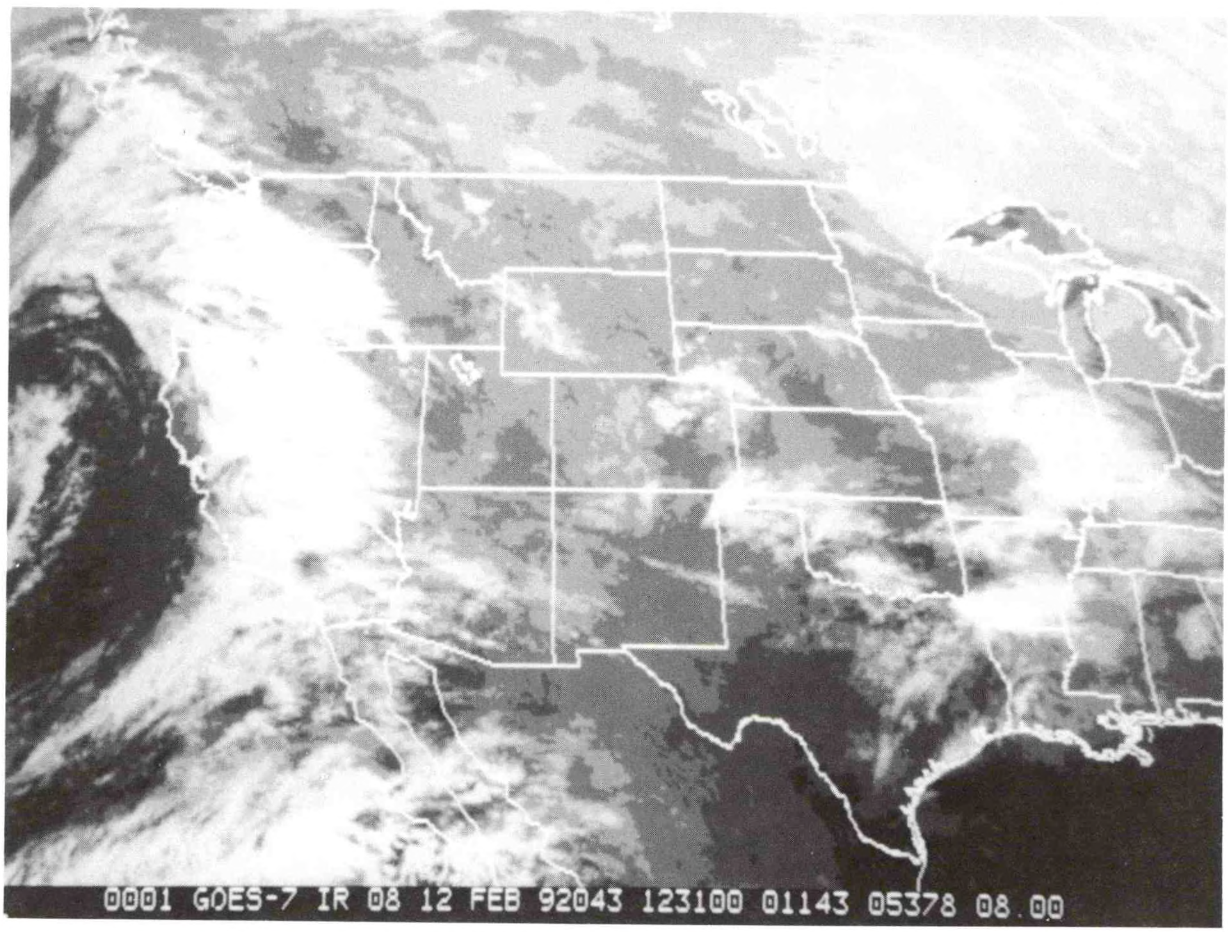
The convective system that has been the focus of IOP 5 continued to move to the east. The band of convection that had developed over central Kansas and southern Nebraska moved eastward passing over the dual Doppler radar array in Kansas between 0200 and 0600 UTC. Precipitation from this band fell initially as rain, but changed to freezing rain around 0600 UTC. By the time the band had passed over Kansas City, trees and cars were coated with several millimeters of ice, qualifying this storm as a light to moderate ice storm event.

By 1200 UTC, a weak surface low pressure area had developed along the front in eastern Oklahoma, with most of the precipitation located north of the front. This system continued to move to the east with only very light precipitation occurring in the eastern part of the STORM-FEST domain.

Last night's 72-h AVN model had forecast strong cyclogenesis for 0000 UTC (15 February). Based on this prog, an IOP might be called for Friday night. However, the 0000 UTC AVN forecast for 60-h showed this system to be much weaker, as well as there being a lot of disagreement between all models at 48-h. The results was that there was a chance of an excellent weather event friday night, but due to the amount disagreement in the models this was a difficult decision to make at this time.

WEDNESDAY, FEBRUARY 12, 1992




0001 GOES-7 IR 08 12 FEB 92043 123100 01143 05378 08.00

OPERATIONS SUMMARY

12 February 1992

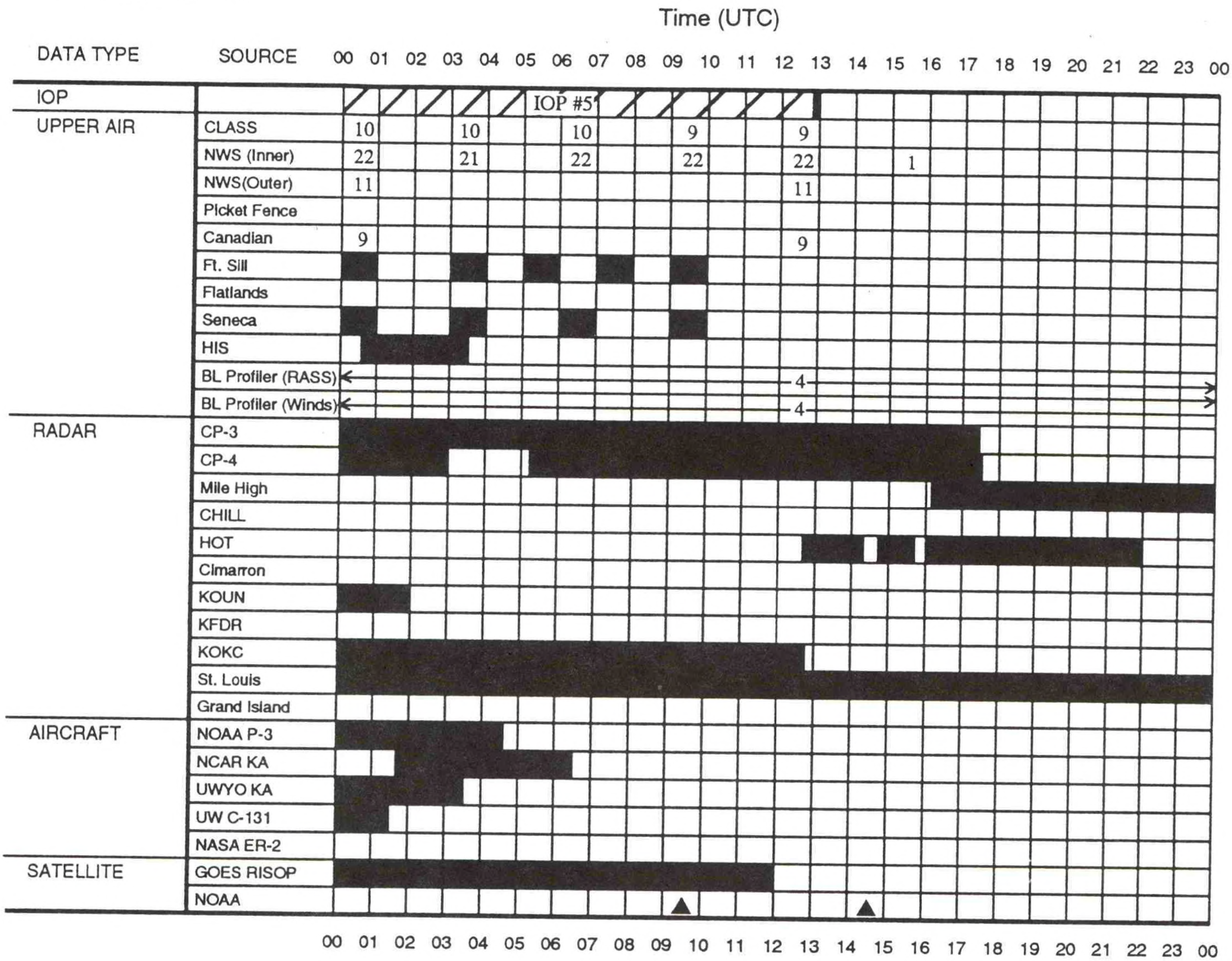
IOP 5 continued officially until 1200 UTC today, 12 February, after a very active day yesterday, 11 February. The CP-3 and CP-4 Doppler radars continued operations until 1722 UTC, collecting data on light precipitation that was still occurring in the area. The HOT radar also collected data on this system through 2200 UTC.

The only activities that occurred today; not discussed as part of the aircraft missions on 11 February, and the operations of the radars, was an NCAR King Air flight that took off at 0203 UTC to investigate the structure of a rainband that was moving over the CP-3 and CP-4 dual Doppler radar area. The NCAR King Air aircraft took off and flew stacked legs in the precipitation band that had moved into the Kansas dual Doppler radar area. Penetration legs were flown at 18k, 15k, 12k, 9k, 6k and 3 kft. Since there was extensive freezing rain in the area, the aircraft collected good data on freezing rain on its landing at Richards-Gebaur AFB at 0619 UTC.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 12 February

Julian Day: 43



Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 6 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 11 stations intermittent.
	PROFS	21 of 22 stations reported; 1 station intermittent.
	SAO	393 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

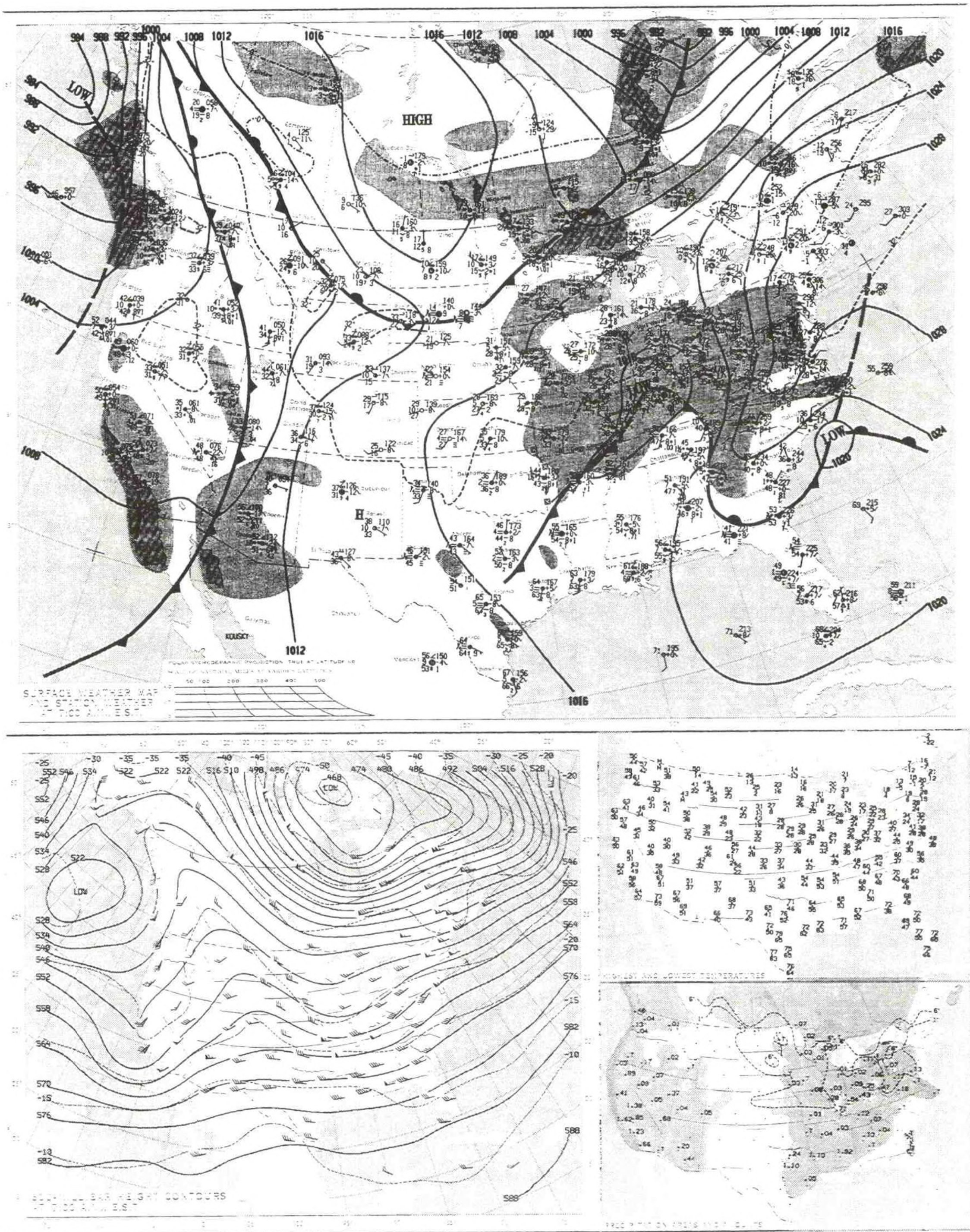
WEATHER SUMMARY **13 February 1992**

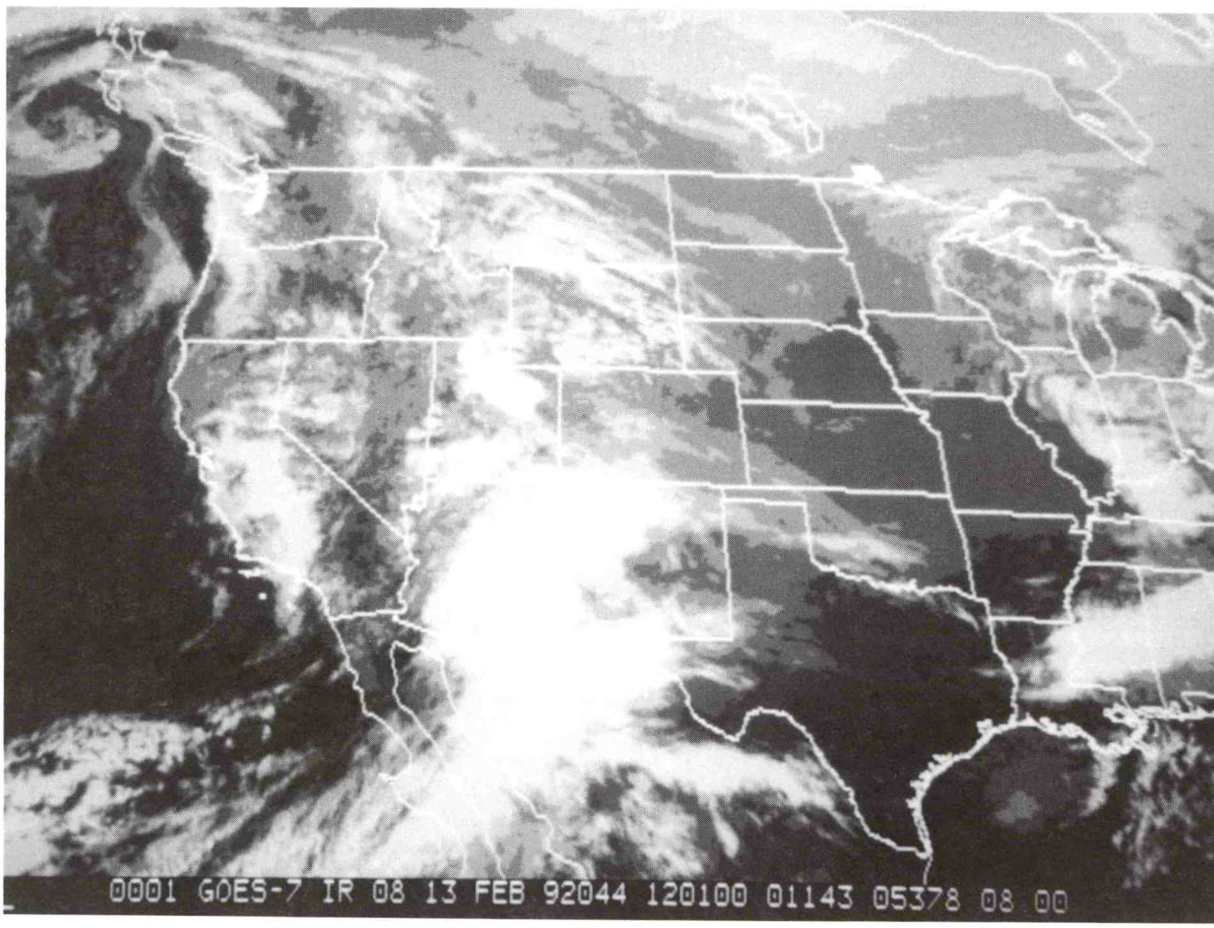
The storm system that was the focus of IOP 5 continued to move to the east and at 1200 UTC was located over Indiana with a cold front extending southwest over central Arkansas and eastern Texas. A second cold front was beginning to move into the northern portion of the STORM-FEST domain.

Cyclogenesis was expected to occur in the next 24-h in Colorado. This area was expected to move southeast into southeast Kansas by 1200 UTC, 13 February, and continued to move along the border until 1800 UTC. The cold front could trigger thunderstorms (possibly severe). Stable precipitation could also break out in western Kansas after 0600 UTC, 14 February, and spread across the state through the period. Amounts of precipitation should increase as this systems moves into eastern Kansas and Missouri. Thunderstorms should be enhanced by 60° dewpoint air ahead of system and a dry slot at mid-levels. A fairly strong jet streak could also phase in with the development of this system.

Over the Gulf of Alaska a southward moving 500 mb low pressure area supported by a strong northerly jet over the Aleutian Islands was forecast to dig southward to the west coast of the United States. By 60-h the AVN model showed a strong vortex maximum just west of Los Angeles with strong Positive Vorticity Advection (PVA) along the California coast. This feature was forecast to move inland during the day Saturday, 15 February, and could result in a IOP complete with "picket fence" soundings (IOP 7).

THURSDAY, FEBRUARY 13, 1992




0001 GOES-7 IR 08 13 FEB 92044 120100 01143 05378 08 00

OPERATIONS SUMMARY

13 February 1992

Today was declared a hard down day. West coast "picket fence" soundings began at 0600 UTC to monitor the strong trough and associated weather moving onto the west coast. These soundings were scheduled to continue until 1800 UTC today.

There was a misunderstanding between STORM-FEST Operations and the Naval Post Graduate School on timing of these soundings. This system, although quite strong and bringing a lot of precipitation and high winds to California, was not expected to affect the STORM-FEST domain. STORM-FEST scientists were more interested in the next major wave that was expected to move onto the west coast tomorrow, 14 February. Thus, the NWS outer domain soundings were scheduled to begin at 0000 UTC (14 February) and continue for 48- to 72-h. Thus, Picket Fence soundings were scheduled to begin again at 1800 UTC, tomorrow, 14 February, and continue for 48-h (A 24-h break was required between stop and start times of NWS special soundings).

IOP 6 was scheduled to begin at 0000 UTC tomorrow, 14 February, with the start up of outer domain NWS soundings, to study the short wave and associated precipitation that were forecast to begin moving into the western portion of the STORM-FEST domain.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 13 February

Julian Day: 44

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP																									
UPPER AIR	CLASS																			1					1
	NWS (Inner)	22												22											
	NWS(Outer)	10												10											
	Picket Fence							8			9			8			9			9					
	Canadian	9												9											
	Ft. Sill																								
	Flatlands																								
	Seneca																								
	HIS																								
	BL Profiler (RASS)	←												4											→
	BL Profiler (Winds)	←												4											→
RADAR	CP-3																								
	CP-4																								
	Mile High																								
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA		▲								▲				▲							▲			

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00

Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 8 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported; 1 station intermittent.
	PAM5	35 of 35 stations reported; 9 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	392 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

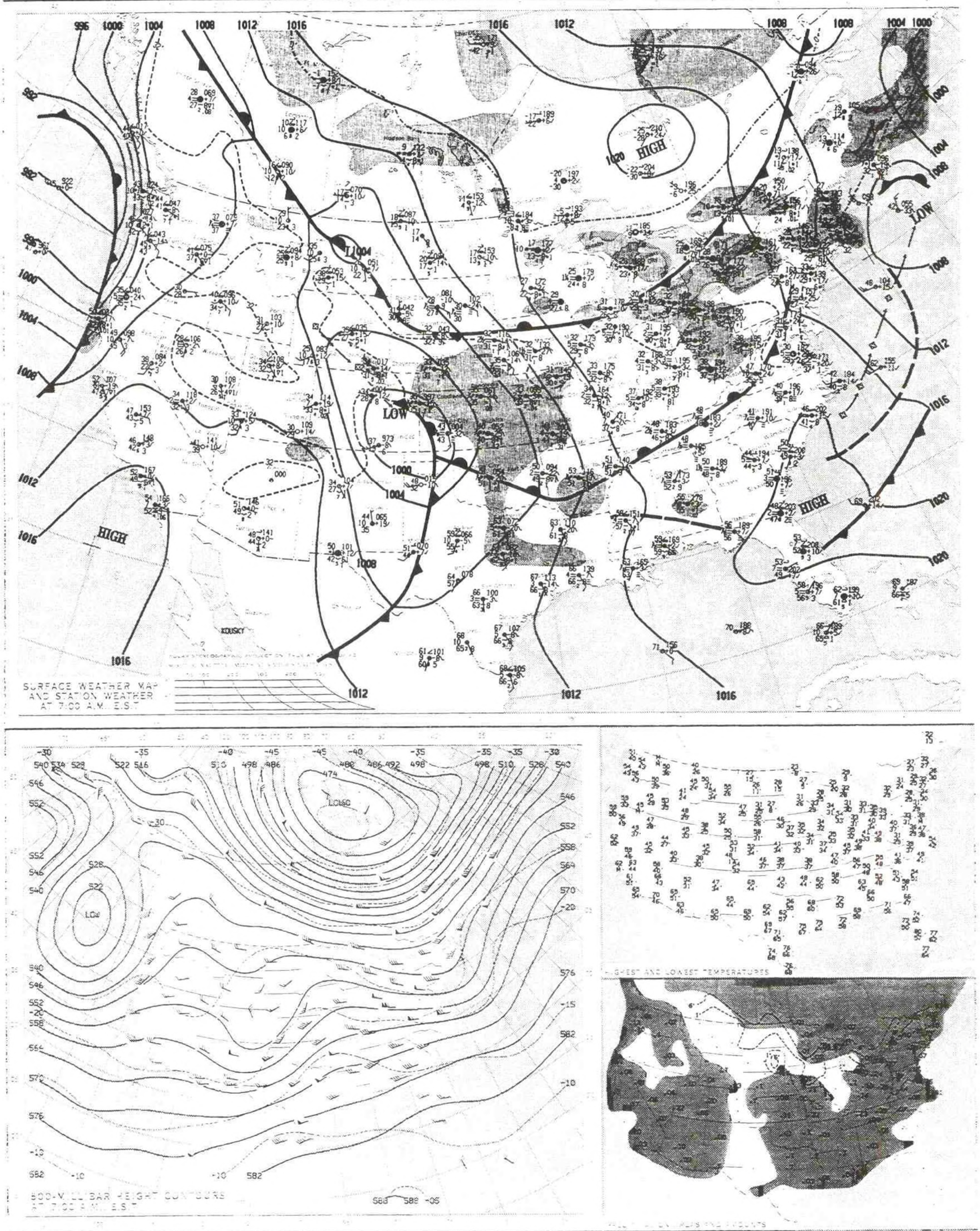
WEATHER SUMMARY **14 February 1992**

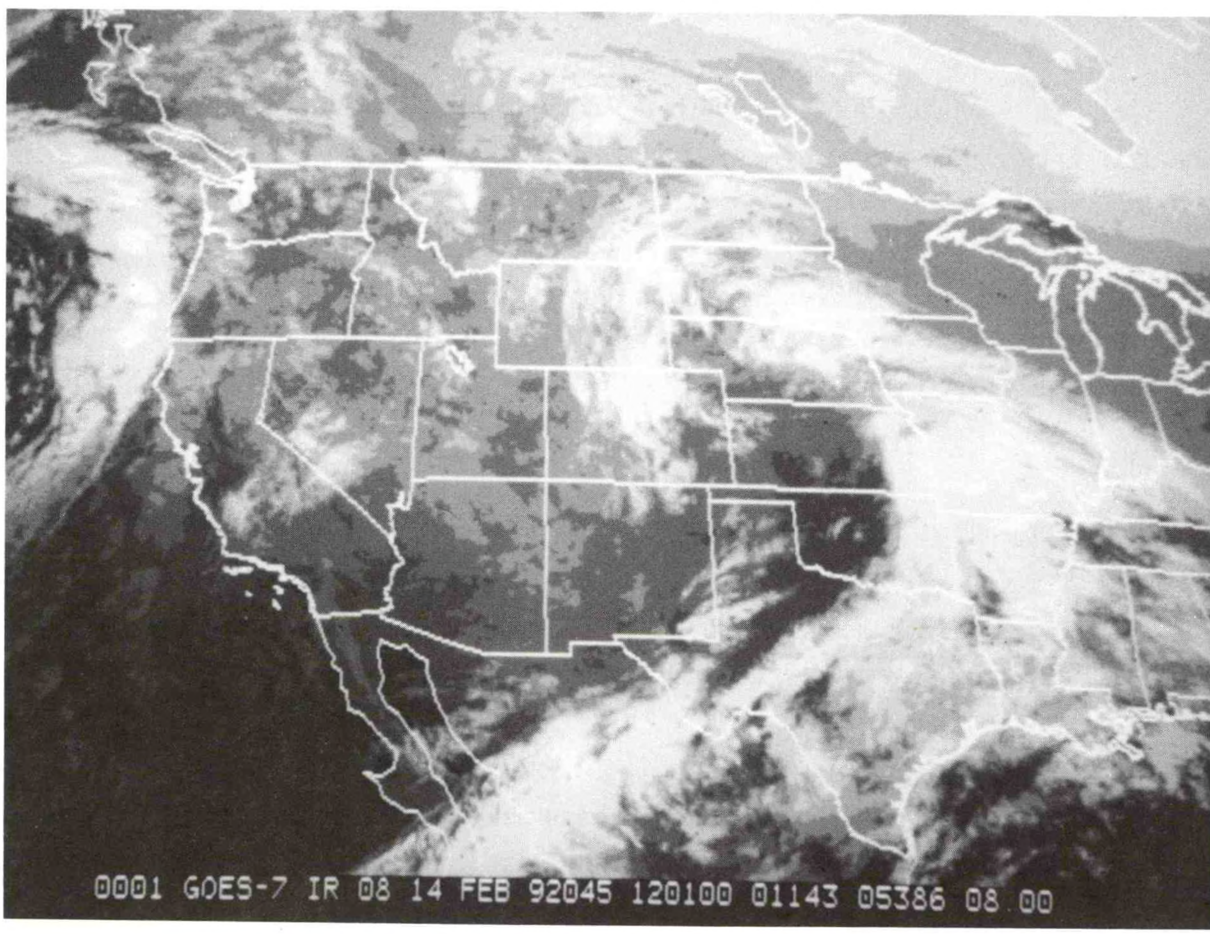
A large cyclonic storm has developed over the western portion of STORM-FEST domain. The initial precipitation band, that developed along a line from eastern Texas to Nebraska, and later from Arkansas to Iowa, was associated with the eastern progression of the trough. At the surface, the low pressure center was initially located over western Kansas and progressed eastward during the day. A dry line was located over central Texas and the cyclone had a well defined dry slot. A surface warm front was located along the Kansas/Oklahoma border with freezing rain and sleet in the overrunning air north of the Iowa/Missouri border. A sharp cold front developed along the leading edge of the wrap around part of the "comma" cloud pattern and heavy snow was observed at several locations behind the front.

Models supported the rapid movement of the low center into central Missouri by 0600 UTC and Illinois by 1200 UTC, 15 February. Strong warm and cold frontogenesis was expected across central Missouri (warm) and eastern Oklahoma and Kansas (cold). Thunderstorms were expected along the front (Red River area) later in the day. MM4 supported convective precipitation development between 1800 UTC and 0000 UTC in this area. By 1800 UTC (15 February) the low center and front was forecast to exit the STORM-FEST domain, with only wraparound precipitation continuing in Iowa, Illinois, Missouri, and Kentucky.

The outlook for 1800 UTC (15 February) to 1800 UTC (16 February) was for a new cyclonic system to develop over the Rocky Mountains beginning with cyclogenesis in Wyoming. Between 1200 UTC (16 February) and 0000 UTC (17 February) the MRF model forecasted the low to deepen to 999 mb. Toward the end of the 48-h period it was expected there would be a strengthening of the low-level flow out of the Gulf of Mexico and perhaps the initiation of some overrunning precipitation after 0000 UTC (17 February) in the central parts of Oklahoma, Kansas and Nebraska. This new system should be the focus of the next IOP (#7).

FRIDAY, FEBRUARY 14, 1992




0001 GOES-7 IR 08 14 FEB 92045 120100 01143 05386 08.00

OPERATIONS SUMMARY

14 February 1992

IOP 6 started at 0000 UTC with supplemental soundings taken from the NWS outer domain sounding sites, continuing until 1200 UTC (these soundings will continue, but will be classified as being for IOP 7). The CLASS sites began soundings at 0600 UTC and the NWS inner domain soundings began at 2100 UTC. The objectives of this IOP were to document the structure and evolution of the warm and cold fronts and the dry line, and to document the structure and dynamics of the mesoscale rainbands in this cyclone.

The NWS outer domain 6-h soundings and the West Coast Picket Fence soundings began at 1800 UTC to monitor the next major wave moving onto the West Coast, which officially started IOP 7. This system was expected to move into the STORM-FEST domain on 16 February.

The following activities were carried out to meet the objectives of IOP 6.

1200 UTC The GOES-7 Satellite began RISOP mode which was scheduled to continue until 1500 UTC (15 February).

1200 UTC The NCAR King Air conducted a dropwindsonde mission over the Kansas dual Doppler radar area. Four dropwindsondes were released (two successfully). The aircraft also made a pass through the convection at 17 kft. The aircraft landed at Richards-Gebaur AFB at 1540 UTC.

1300 UTC The University of Washington C-131 took off to fly flight patterns perpendicular to the warm front precipitation band located in Iowa/Kansas. The aircraft completed 4 tracks between 8k and 11 kft. The aircraft stayed at these high altitudes because of the threat of freezing rain. The aircraft landed at Richards-Gebaur AFB about 1800 UTC.

1530 UTC The NOAA P-3 took off to investigate the structure of the warm front located over central and eastern Missouri. The first part of the flight was a saw tooth pattern at 5 kft. along the front. The aircraft then climbed to 15 kft. and flew southward to north-central Arkansas releasing dropwindsondes across the front. After the dry line penetration, the P-3 turned northeast to return to the warm front, but the aircraft was caught between two lines of developing severe convection and turned back to Tulsa. The aircraft then flew at 5 kft. to sample the wrap around cold front that was located northwest of Tulsa. The aircraft performed a stacked penetration in the cold front, one at 5 kft. and the second at 8 kft. The aircraft then returned to Richards-Gebaur AFB because of deteriorating weather conditions at Kansas City, landing at 0010 UTC (15 February).

1905 UTC The NASA ER-2 flew from Houston (its Operation Base) on its first STORM-FEST mission. The aircraft made two transects at 60 kft. across the upper level trough and a "predicted" tropospheric fold. The scientific objective of this mission was to measure total ozone column below 60 kft. using the Wildfire Infrared Scanner. Also on board were the AMPR, LIP, and MTS instruments. The HIS instrument was not available. The two tracks ran from 36°N 93°W to 36°N 100°W and 38°N 100°W to 38°N 93°W. One significant event was the over-flight of probable gravity waves in eastern Kansas and eastern Oklahoma. The aircraft returned to Houston at 0025 UTC (15 February).

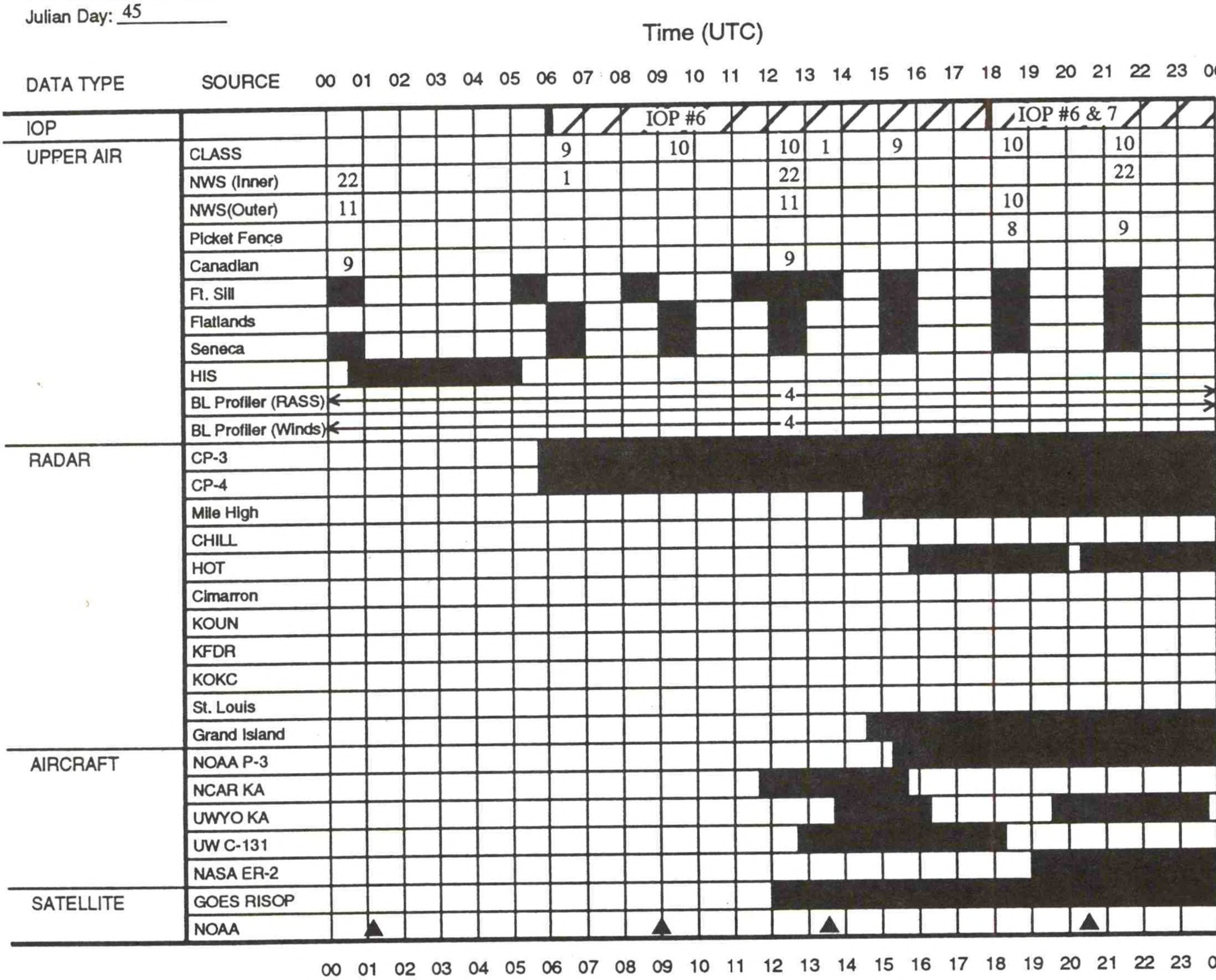
1921 UTC The University of Wyoming King Air took off to investigate the structure of the exit region of the upper level jet located over north central Oklahoma and Kansas. The aircraft climbed to 30 kft. and flew to a point over central Oklahoma where it began to carry out a parcel tracking mission; measuring the deceleration of the jet in the diffluent region downstream of the jet core. Because of restricted military airspace, the aircraft was not able to do a complete mission. The aircraft then attempted to fly an "M" surface, but had to abort the mission because of deteriorating weather conditions at Kansas City. The aircraft landed at Kansas City Metro Airport at 2350 UTC.

CP-3 and CP-4 began operations at 0600 UTC and continued to operate until 0400 UTC, 15 February. The HOT radar began recording data at 1430 UTC and continued intermittently until 1200 UTC, 15 February, as the system exited the STORM-FEST domain.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 14 February

Julian Day: 45



Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 7 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported; 1 station intermittent.
	PAM5	35 of 35 stations reported; 3 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	398 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

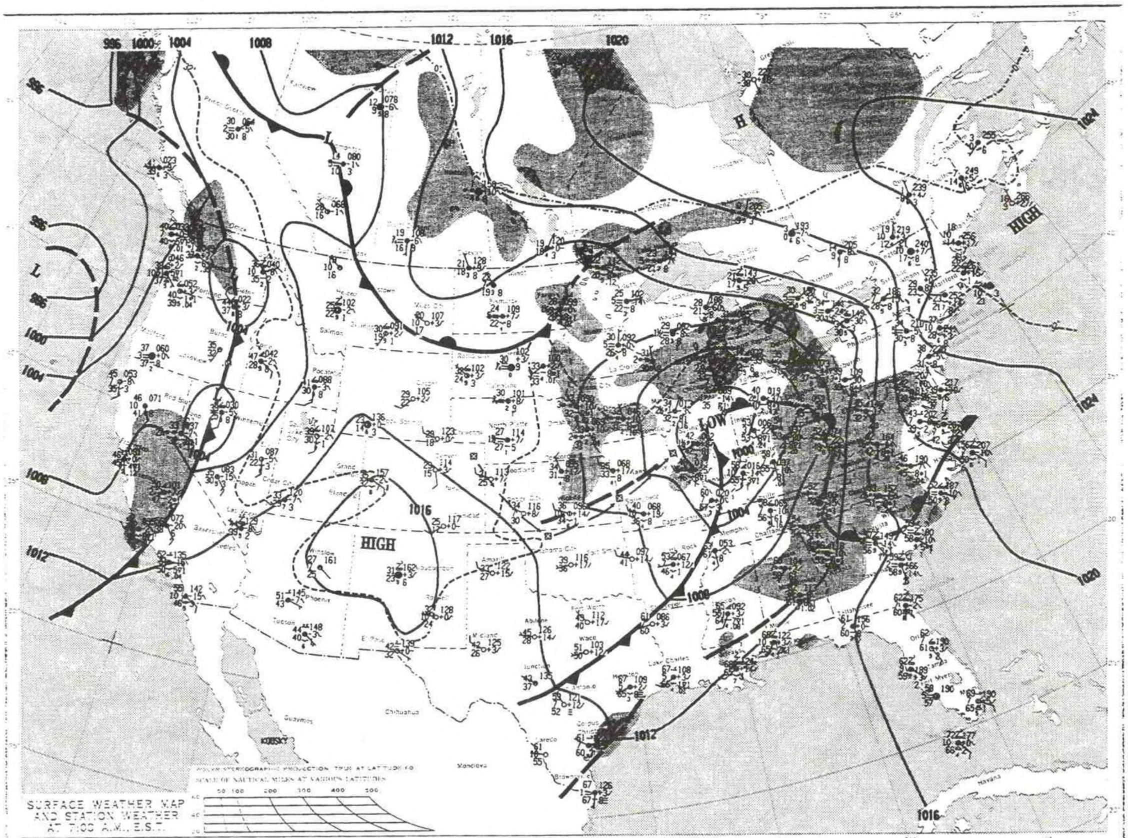
WEATHER SUMMARY

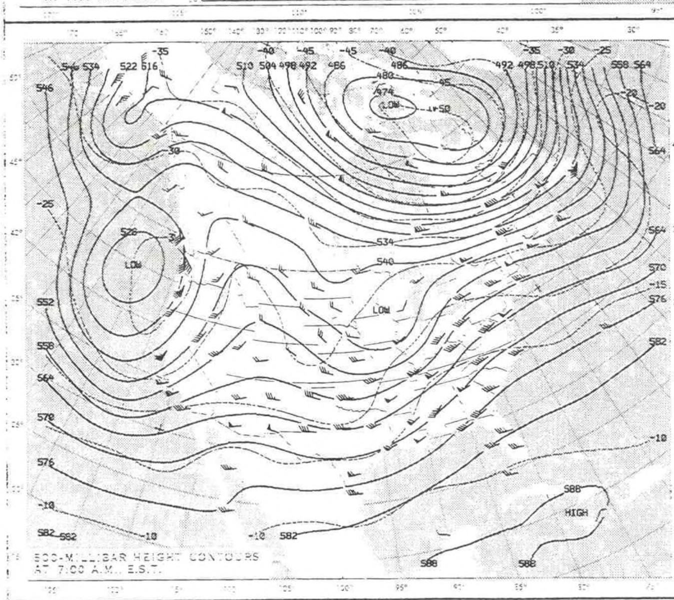
15 February 1992

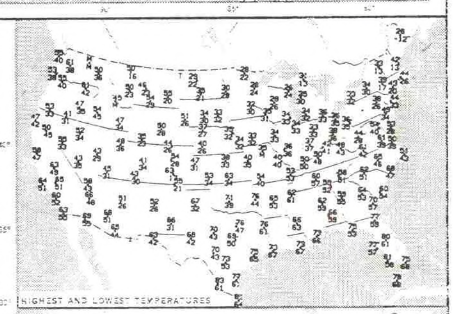
The surface low pressure area that moved over the STORM-FEST domain on 14 February and produced the various weather scenarios that were sampled by the aircraft and radars, continued to move to the east and at 1200 UTC was located over Illinois. Severe weather associated with this system included strong convection, lightning, tornado (on Arkansas/Missouri border), freezing rain in Iowa and about a 1/2 inch of rain in Kansas City.

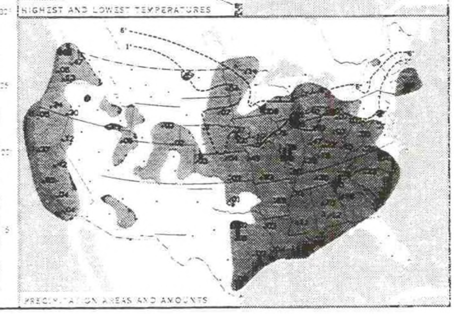
Along the west coast, a surface front was located over eastern Washington and Oregon, central Nevada, and southern California. It was expected that a low center would develop along the southern extent of the front and move into the western STORM-FEST domain on 16 February. This was one more in the series of cyclonic systems that had rotated around the bottom of the trough that has been located off the west coast for the past several weeks.

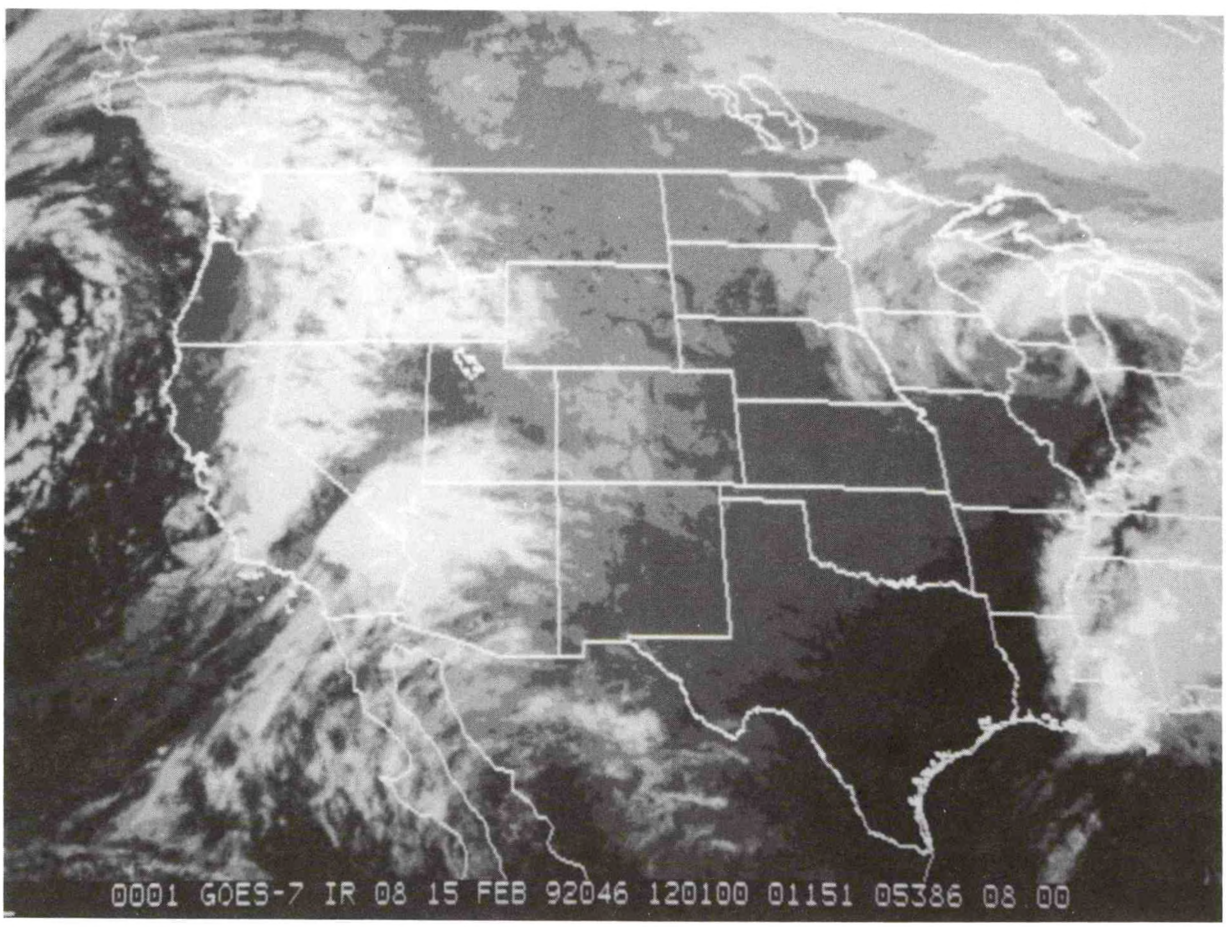
SATURDAY, FEBRUARY 15, 1992










0001 GOES-7 IR 08 15 FEB 92046 120100 01151 05386 08 00

OPERATIONS SUMMARY

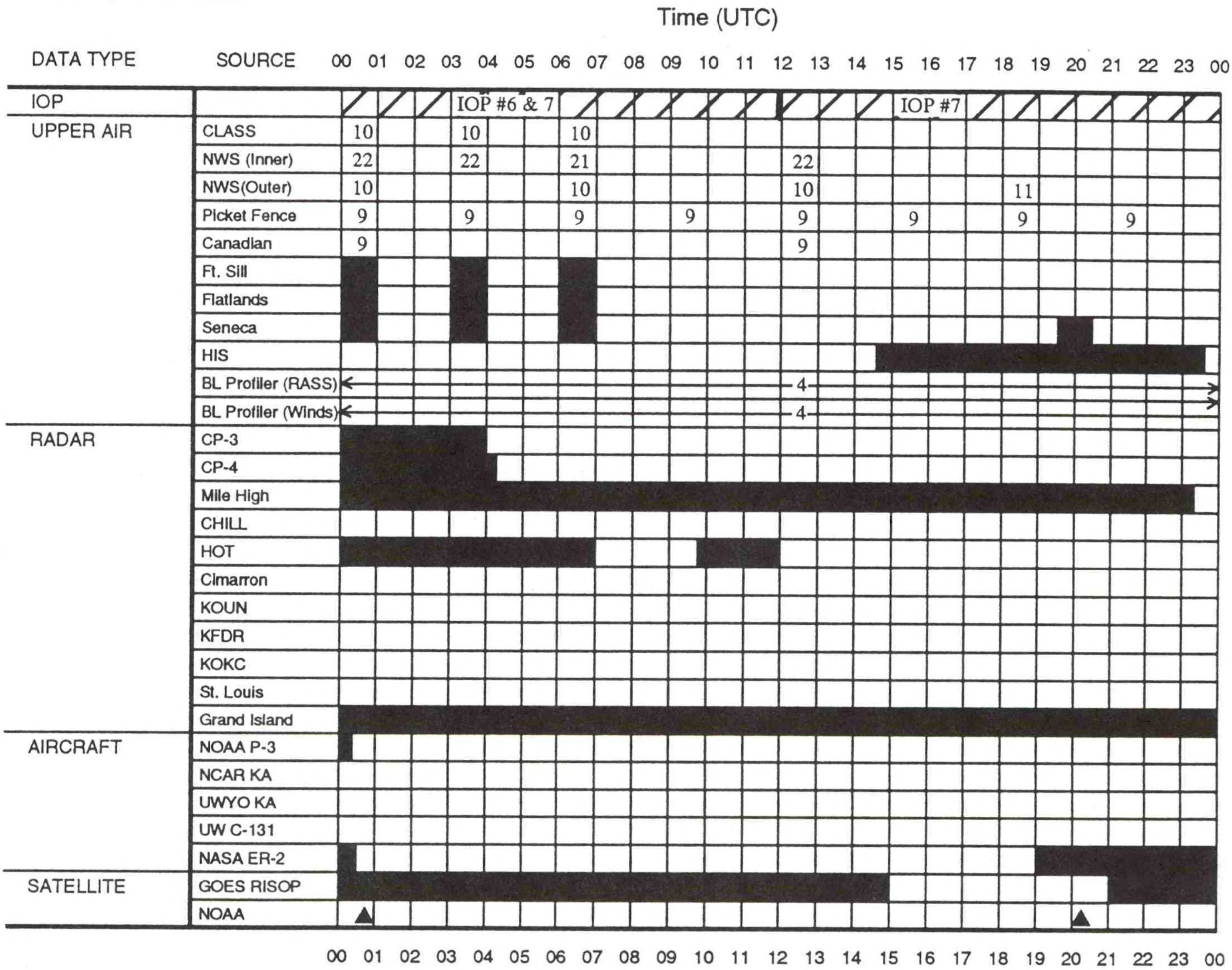
15 February 1992

IOP 6 ended at 0600 UTC with the end of CLASS and NWS inner domain soundings. IOP 7 continued with Picket Fence and NWS outer domain soundings being taken to monitor the wave moving into the west coast and the associated cold front moving into the inner mountain west. Activities were expected to begin within the STORM-FEST domain at 1200 UTC tomorrow, 16 February, to study the structure and dynamics of the front and the development of the low pressure area that was forecast to move into the western portion of the STORM-FEST domain. No other operations occurred today.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 15 February

Julian Day: 46



Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 6 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 5 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	391 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

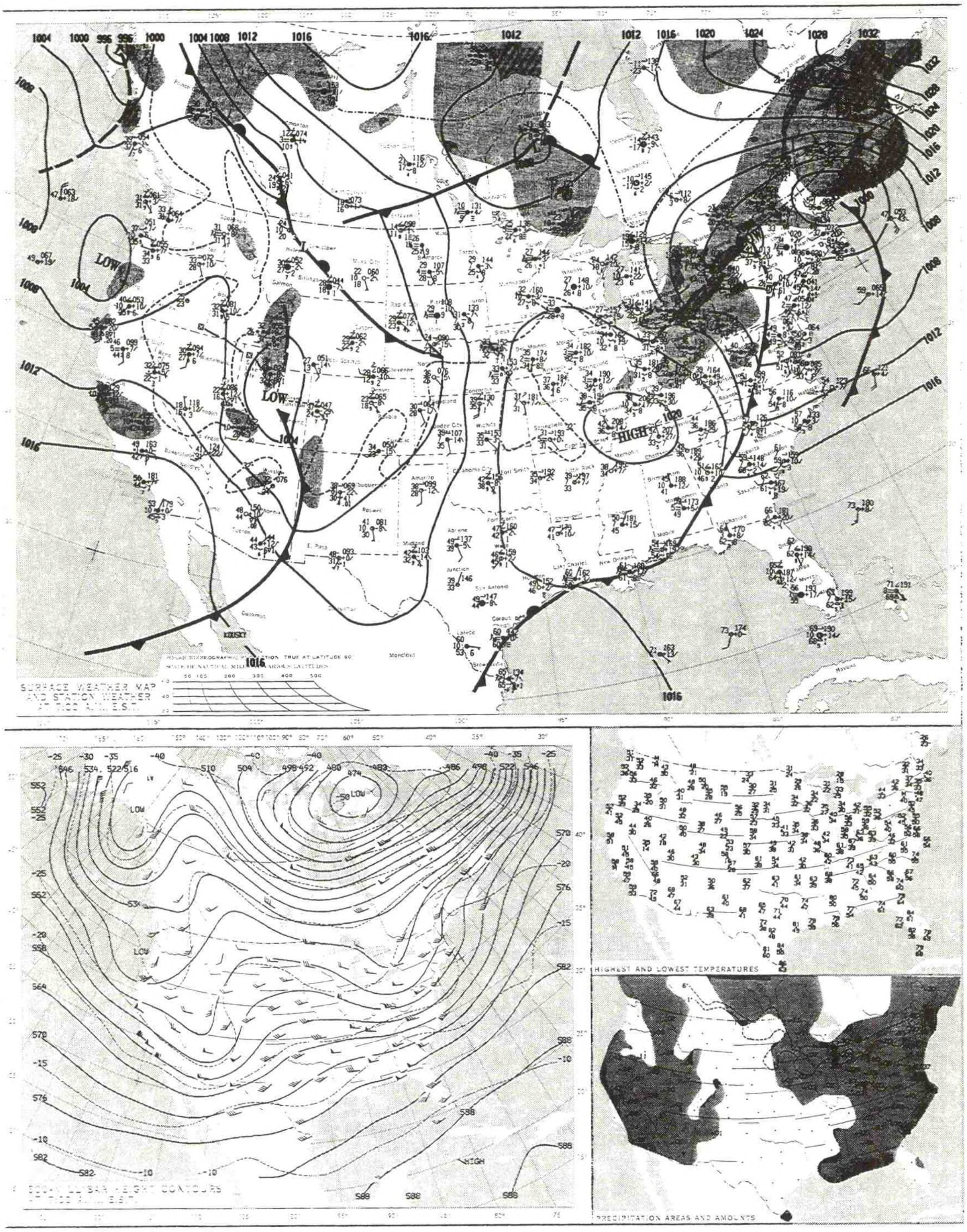
WEATHER SUMMARY **16 February 1992**

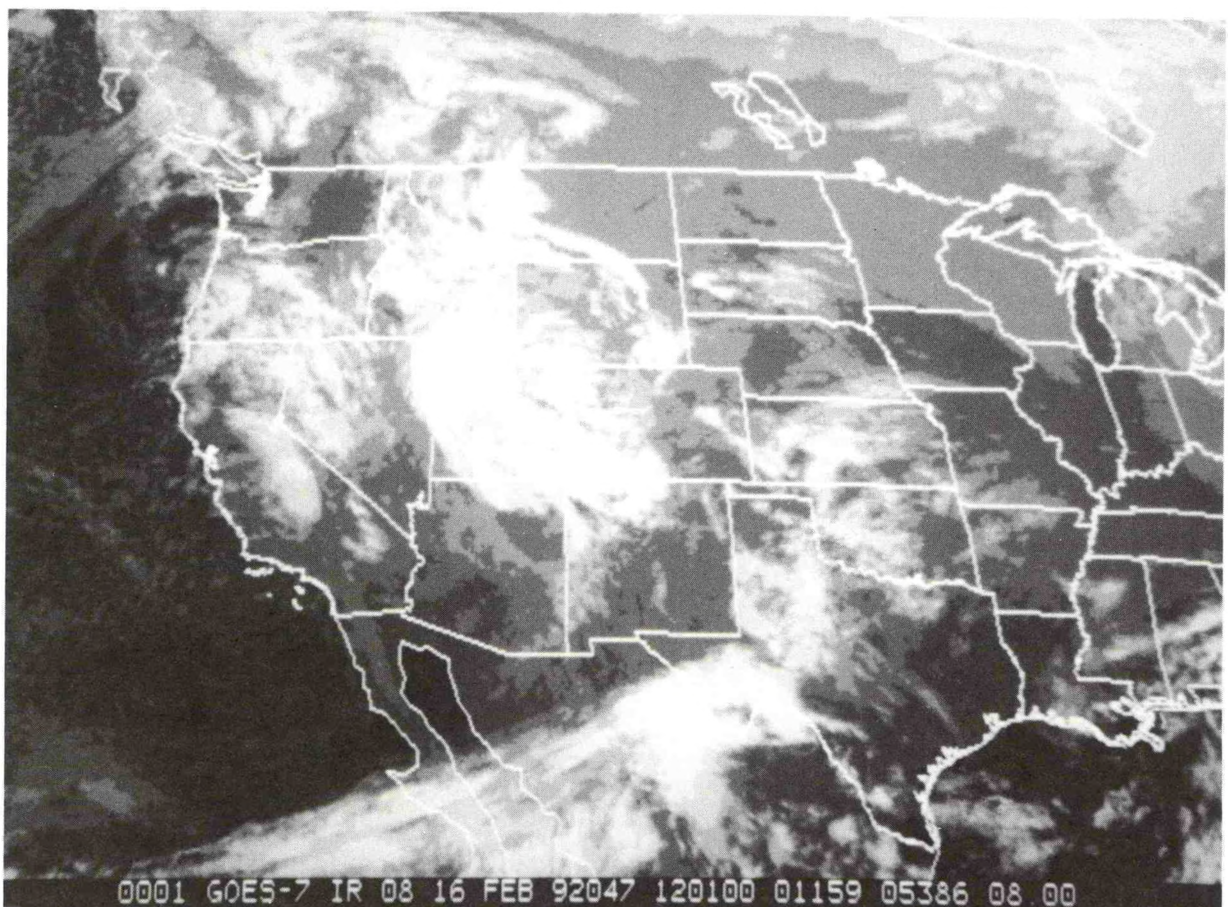
The surface low pressure area, that was predicted yesterday to develop along the front moving into the STORM-FEST domain, developed over the Utah/Colorado border and moved eastward throughout the day. It was expected that precipitation would develop as the system moved into more favorable environment.

The models (NGM, MM4, Eta) were in good agreement the regarding movement of the low pressure center that should be near Akron, CO, at 1800 UTC. Three boundaries were of interest: a pacific cold front in the western Texas Panhandle, a polar front in northeast Nebraska, and a dryline in the central Texas Panhandle. The low was forecast to track to the east across northern Kansas, with the cold front pushing across Oklahoma from about 0000 UTC to 1800 UTC, 17 February. The cold front should overtake the dryline about 1200 UTC. Consensus was that precipitation, (not breaking out until after around 1200 UTC) would develop ahead of and north of the low in Kansas and Nebraska, and in the warm advection ahead of the front in northeast Texas and Arkansas. Polar air, now in the northern plains, should move into northern Oklahoma by the end of the period. Strong frontogenesis should develop along the Pacific front in eastern Kansas and Missouri between 1200 and 1800 UTC tomorrow (17 February). Also cold frontogenesis should occur between 0600 and 1800 UTC in west Kansas.

The outlook for 1800 UTC, 17 February, to 1800 UTC, 18 February, was for the low to weaken and continue to move to the northeast into Illinois. Cold air should continue to sweep southeastward merging with the Pacific front by 1200 UTC, 18 February. Cold advection should be minimal through the remaining part of the period in the STORM-FEST domain. Wraparound precipitation could continue with snow likely in Nebraska, Iowa, and Wisconsin. Thunderstorms could break out during the beginning of the period and possibly become severe in southern Missouri and Arkansas through 0600 UTC, 18 February. There was very little vertical tilt with this system after 1200 UTC, 17 February, but strong winds and the arrival of gulf moisture could provide enough kick to have significant thunderstorm development.

SUNDAY, FEBRUARY 16, 1992




0001 GOES-7 IR 08 16 FEB 92047 120100 01159 05386 08.00

OPERATIONS SUMMARY

16 February 1992

Supplemental observations for IOP 7 within the STORM-FEST domain started at about 1200 UTC with the launch of soundings from the CLASS and NWS sites. The objectives of this IOP were to: 1) study the structure of the dryline and Pacific cold front during their merger early in the storm, 2) study the structure and evolution of frontal systems and associated rainbands and, 3) study the structure of the low pressure center vortex.

The following operations were conducted today in support of IOP 7

1800 UTC "Picket Fence" and NWS outer domain soundings end.

1852 UTC The University of Washington C-131 departed Richards-Gebaur AFB to investigate the structure of the cold front/dry line entering the western STORM-FEST region. After the aircraft took off it began to conduct porpoise soundings on the way out to the Initial Point, but shortly after takeoff, it developed engine problems and had to land in Wichita, Kansas.

2100 UTC NWS Inner domain soundings began.

The CP-3 and CP-4 radars became operational to monitor the various precipitation bands that moved over the dual-Doppler radar area. The radars operated until 1320 UTC, 17 February.

2143 UTC The NSSL Cimarron Doppler radar began collecting polarization data within rainbands over Oklahoma. The radar collected intermittent data until 0028 UTC, 17 February.

2204 UTC The University of Wyoming King Air took off from Richards-Gebaur AFB to fly "M-surfaces" and low-level jet dynamics near Gage, Oklahoma, for the storm system moving across the Rocky Mountains. After passing the low-level dry line and entering the dry slot ahead of the surface low in eastern Colorado, the aircraft flew south toward Gage, Oklahoma to work with the C-131 (see below). The aircraft did stair step "M-surface" profiles at 15k, 11k and 7 kft. On completion the aircraft returned to Richards-Gebaur AFB at 3 kft. with the C-131 at 5 kft. On encountering drier conditions the aircraft climbed to 23 kft. to pass over a line of weak convection south of Topeka, Kansas. The aircraft landed at 0307 UTC.

2230 UTC The University of Washington C-131 took off from Wichita, Kansas and carried out "porpoise" maneuvers along the Kansas/Oklahoma border to the cold front/dryline at approximately 100° W. The aircraft did traverses through the region at 1, 3, 5 and 7 kft. AGL. They performed more "porpoise" maneuvers on the return trip to Richards-Gebaur AFB after their tandem flight pattern (of about 20-30 min) with the University of Wyoming King Air. The aircraft landed at 0322 UTC.

The NOAA P-3 also took off at 2230 UTC to 1) document the structure of the Pacific cold front as it moved into the region of the dryline in the Texas panhandle, 2) document the structure of the dryline in northern Texas, and 3) document the structure of rainbands over Oklahoma and within the Kansas City dual-Doppler radar array. After takeoff the aircraft flew to eastern Colorado and headed southeast to the Texas panhandle. The upper-level front was not penetrated (it was later determined that it had not yet reached eastern Colorado). The aircraft then penetrated the dryline in northern Texas-southern Oklahoma and released 12 dropwindsondes to sample the low-level jet and dryline in the same region as the C-131 and Wyoming King Air aircraft. The aircraft flew northwest along a rainband in Oklahoma and then flew northeast to line-up with a rainband passing over the dual-Doppler radar area. Between 0334 UTC and 0530 UTC, the aircraft passed through the rainband at 20, 12 and 8 kft. within the dual-Doppler radar area. The aircraft landed at Richards-Gebaur AFB at 0601 UTC.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 16 February

Julian Day: 47

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP														IOP #7											
UPPER AIR	CLASS													3			2		1			1			1
	NWS (Inner)	21												22			1			1			22		
	NWS(Outer)	11						11						11						10					
	Picket Fence	9			9			9			9			9			4			4					
	Canadian	9												9											
	Ft. Sill																								
	Flatlands																								
	Seneca																								
	HIS																								
	BL Profiler (RASS)													4											
	BL Profiler (Winds)													4											
RADAR	CP-3																								
	CP-4																								
	Mile High																								
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA																								

Comments

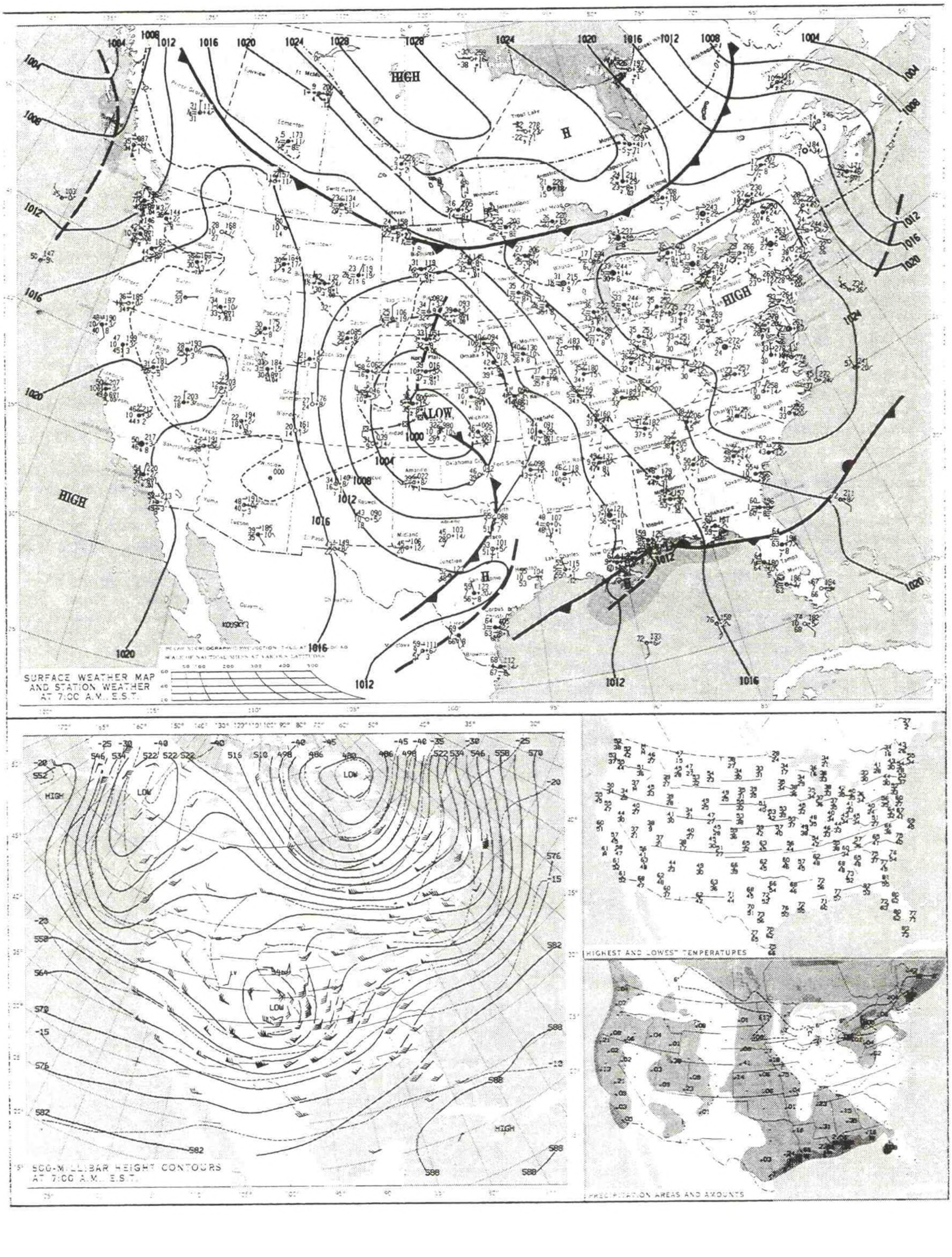
SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 7 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 9 stations intermittent.
	PROFS	21 of 22 stations reported; 13 stations intermittent.
	SAO	384 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported; 1 station intermittent.

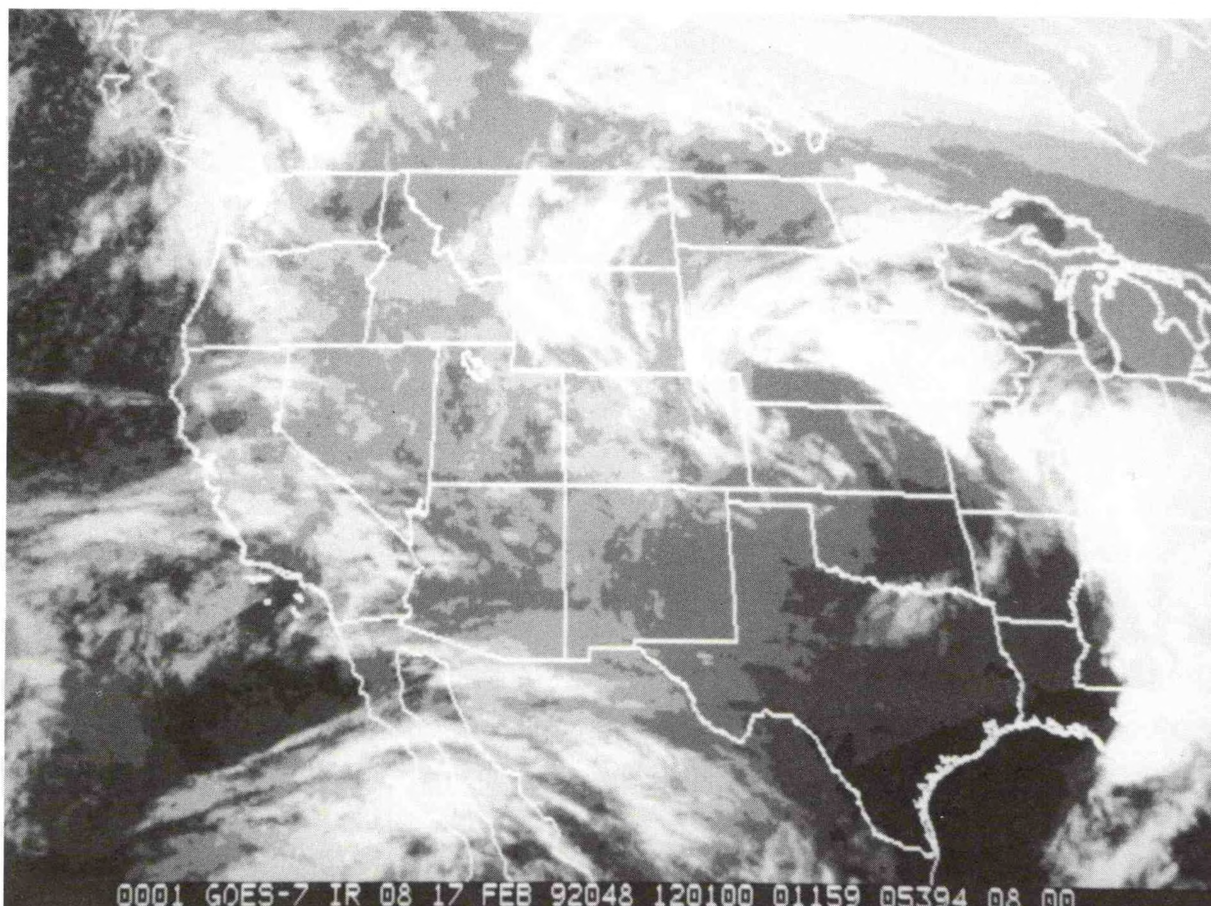
WEATHER SUMMARY 17 February 1992

The cyclone that had been the focus of IOP 7 was located over western Kansas at 1200 UTC, with a central pressure of about 998 mb. The system was vertically stacked with precipitation confined to the north and east quadrants of storm. A band of convection over central Missouri was producing some thunderstorm activity, but this was expected to remain in the eastern portion of the STORM-FEST domain. Wrap around precipitation in this system was the main weather maker with precipitation across Iowa, Nebraska, northwest Kansas and extreme northeast Colorado. There was little in the way of snow, although moderate to heavy rain was located north of the low. All the models were in agreement that the storm would keep its intensity and move slowly to the east. Frozen precipitation should be more common later in the day in the northeast sections of the STORM-FEST domain. Very dry air was pushing into the southern sections of the domain, so no precipitation was expected there.

In the next 36- to 48-h the cyclone should maintain its strength as it slowly moves to the east-northeast. Precipitation should continue in the extreme northeast sections of the STORM-FEST domain. High pressure will settle over the area as this system moves out.

MONDAY, FEBRUARY 17, 1992




0001 GOES-7 IR 08 17 FEB 92048 120100 01159 05394 08.00

OPERATIONS SUMMARY 17 February 1992

IOP 7 continued through 17 February. The following activities were carried out to support the IOP.

0000 UTC The NWS outer domain soundings end.

0808 UTC The NCAR King Air took off to fly a stacked pattern within a rainband over the dual-Doppler radar array. The aircraft flew across the southern lobe of the dual Doppler radar area at 20, 15 and 12 kft. The band was convective with occasional lightning. Dropsondes were released from the 20 kft. level, but these were poor in quality, particularly in winds. The low-levels of the band were sampled on approach to Richards-Gebaur AFB. The aircraft landed at 1103 UTC.

1320 UTC The CP-3 and CP-4 terminated operations with no precipitation observed in the area. The radars restarted operations at 1830 UTC when another convective band moved into the area. The radars continued operations until about 1030 UTC (18 February).

2103 UTC The ER-2 departed Houston and flew two horizontal legs at 60 kft. across the upper-level trough present over the STORM-FEST area. Data on the total ozone column below 60 kft. were obtained using the Wildfire Infrared Scanner. Data were also acquired by the AMPR, LIP, and MTS instruments. The HIS instrument was unavailable on this flight. The two flight legs were approximately 35°N 98°W to 35°N and 89°W to 37°N 98°W. The ER-2 also made a flight pass over the ocean off the Texas coast to provide calibration data for all instruments. The aircraft landed at 0328 UTC (18 February).

2235 UTC The University of Wyoming King Air took off to study the inverted trough in Nebraska, but on climb out the mission was changed to study the surface low that was passing directly over Kansas City, Missouri. [The C-131 was called up to conduct the inverted trough mission.]

The aircraft flew cyclonically around the cyclone at 10K, 5K, and 15 kft. The weather in the center of this mature extratropical cyclone was benign, but there was enough low-level precipitation for the dual-Doppler radars to be effective, so that multiple observing system comparison tests could be accomplished.

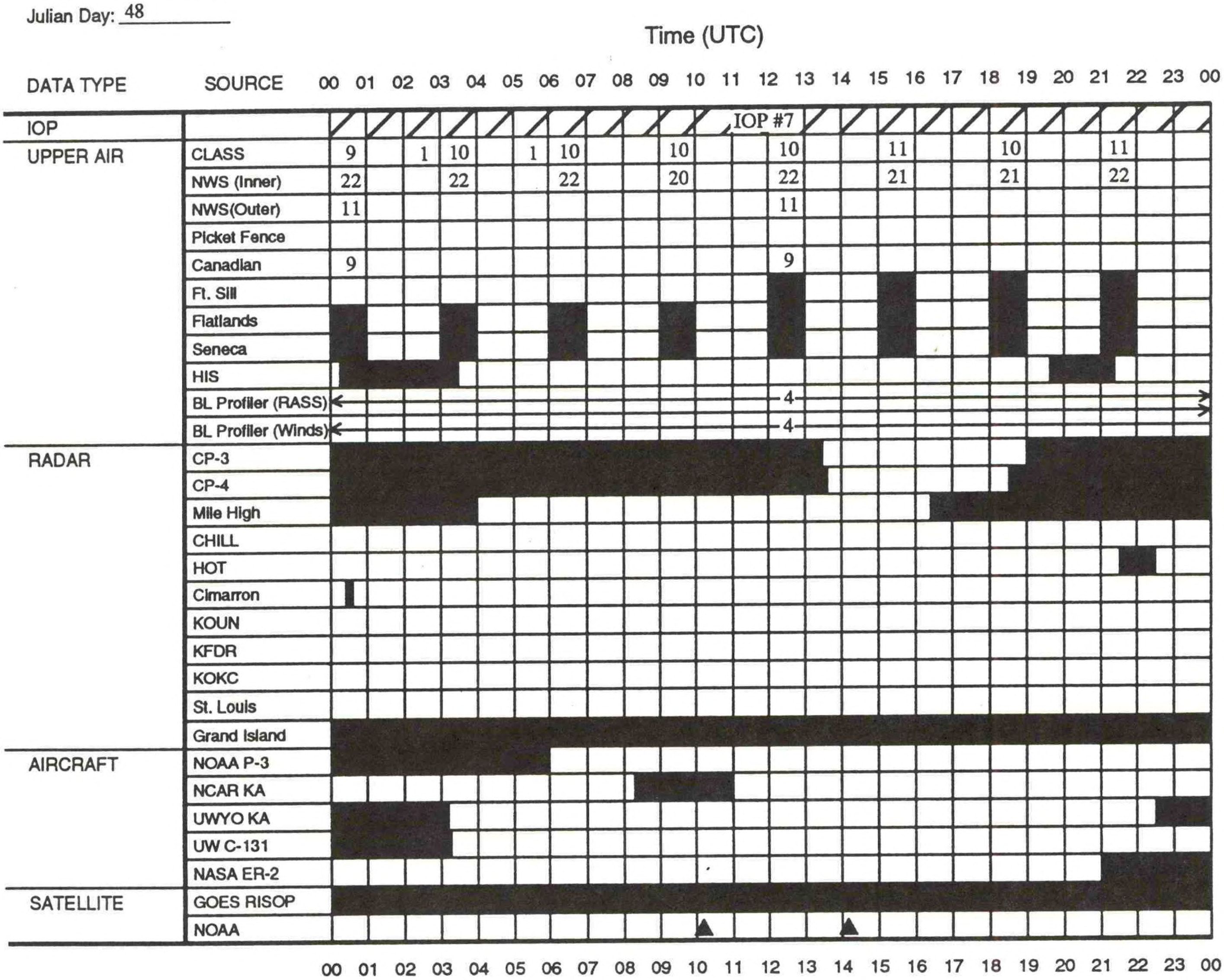
A unique aspect of this data set was that the cyclone center passed over the boundary layer wind profilers and RASS systems with dual Doppler radar and PAM coverage and in-situ aircraft observations. This should provide an unprecedented data set in this region of a continental cyclone.

2358 UTC The University of Washington C-131 took off for a third mission in the IOP to study the structure of the inverted trough in south central Nebraska. The aircraft flew stacked legs at 7k, 5k and 4 kft. The aircraft then flew to Beatrice, Nebraska and flew a full leg across the trough at 5 kft. and a half leg at 4 kft. On return to Richards-Gebaur AFB it passed through a rainband in the dual-Doppler radar array. The aircraft landed at 0600 UTC (18 February).

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 17 February

Julian Day: 48



Comments

SURFACE SYSTEMS	ASOS	33 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 3 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 7 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	390 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

WEATHER DISCUSSION

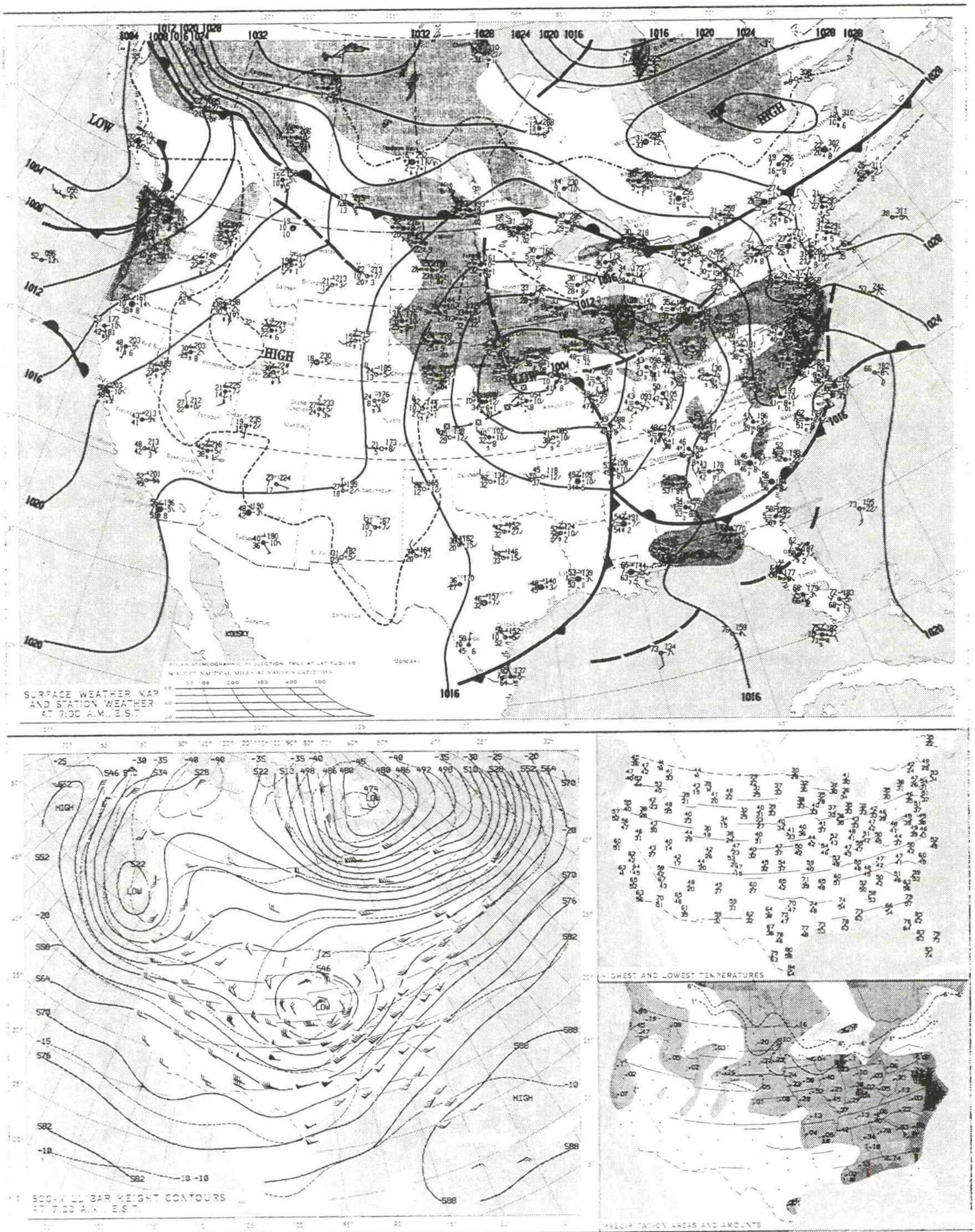
18 February 1992

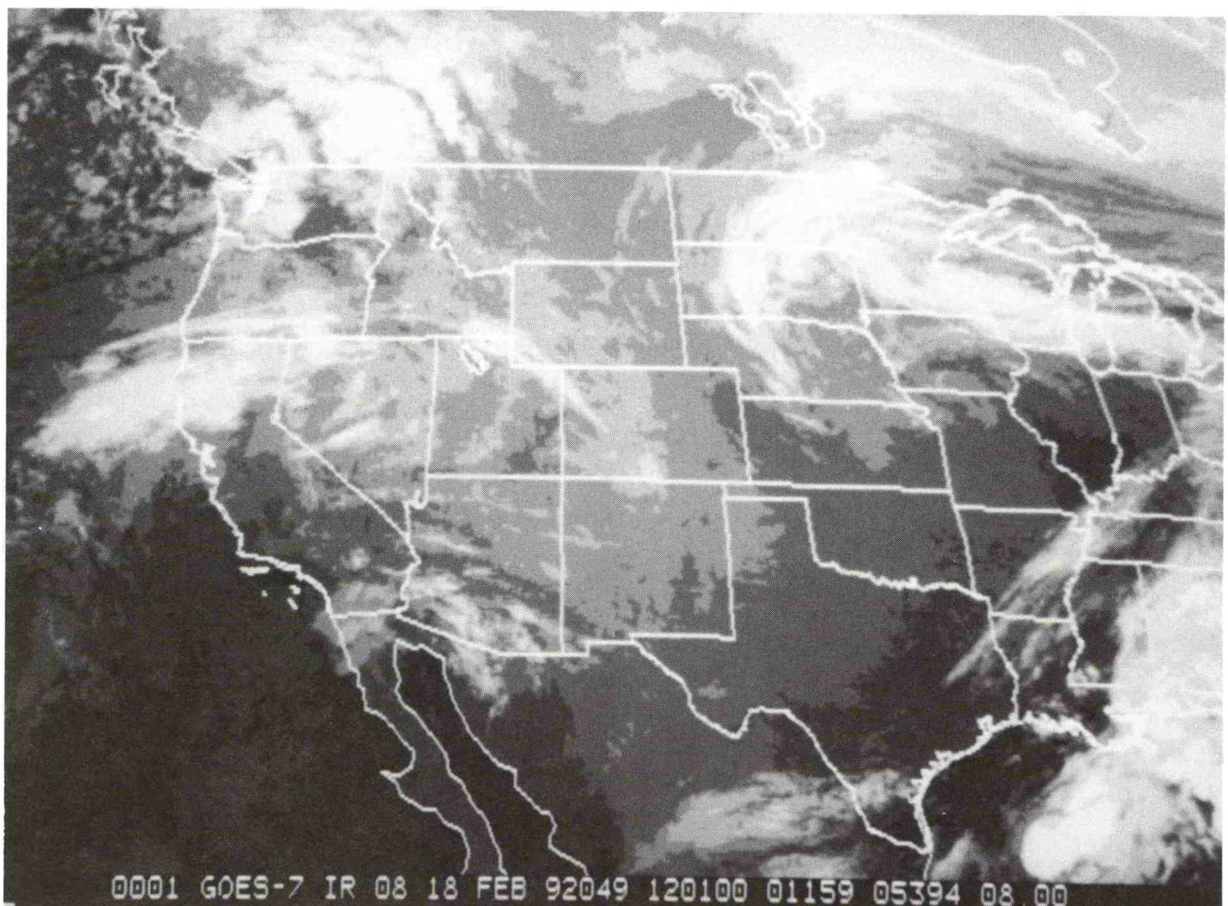
At 1200 UTC the surface low was located just east of Kansas City, and was expected to move to the northeast and be east of Chicago by 0600 UTC (19 February). Light snow to the north and west of the low pressure center (Iowa and eastern Nebraska) should move with the system. The extreme northeast corner of the STORM-FEST domain was expecting over an inch of snow between 1800 UTC and 0000 UTC (19 February).

By midday tomorrow, 19 February, a significant lee trough should be moving out of Montana and into the high plains. The pressure field over the STORM-FEST domain should be much flatter, as a large high pressure area moves into the region.

No fronts were forecasted for the next 24- to 48-h for the STORM-FEST domain, with the flow fairly zonal across the Dakotas. A cross section of potential temperature in northeast Kansas, using the MM4 model, indicated that the boundary layer array would be more stable tomorrow morning than it was this morning, with boundary layer RH decreasing slightly, which should provide reasonable conditions for a boundary layer study (focus of IOP 8). By 20 February, the next system that could affect the STORM-FEST domain should be moving into the southwest U.S. There was still some uncertainty in the timing of the onset of rain with this next system. Consensus indicated that first rain should not occur until late on 20 February in central Texas.

TUESDAY, FEBRUARY 18, 1992




0001 GOES-7 IR 08 18 FEB 92049 120100 01159 05394 08.00

OPERATIONS SUMMARY

18 February 1992

IOP 7 ended at 1200 UTC today. Although the low pressure center was still in the domain, the NWS had reached the maximum length of time supplemental soundings could be released (48-h).

The NOAA P-3, Wyoming King Air, and C-131 were scheduled for a hard down for 18 February. IOP 8 was scheduled to begin at 1200 UTC, 19 February, to investigate the boundary layer structure within the boundary layer domain, as well as determine the way points for future boundary layer missions. CLASS soundings at Seneca were scheduled to begin at 1200 UTC, extending to 0000 UTC (20 February).

Other:

A possible radiation flight was scheduled to begin at 0100 UTC, 20 February.

GOES-7 began RISOP mode at 2100 UTC for 3-h (not for STORM-FEST).

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 18 February

Julian Day: 49

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP		/	/	/	/	/	IOP #7	/	/	/	/	/	/												
UPPER AIR	CLASS	10			11			11			11			11											
	NWS (Inner)	21			22			22			22			21											
	NWS(Outer)	11												11											
	Picket Fence																								
	Canadian	9												9											
	Ft. Sill			■				■			■			■						■					
	Flatlands	■			■			■			■			■											
	Seneca	■			■			■						■			■								
	HIS																					■	■	■	■
	BL Profiler (RASS)	←												4											→
	BL Profiler (Winds)	←												4											→
RADAR	CP-3	■	■	■	■	■	■	■	■	■	■	■													
	CP-4	■	■	■	■	■	■	■	■	■	■	■													
	Mile High																								
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Grand Island	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA	■	■	■	■																				
	UW C-131	■	■	■	■	■	■																		
	NASA ER-2	■	■	■	■																				
SATELLITE	GOES RISOP																					■	■	■	■
	NOAA		▲								▲				▲										

Comments

SURFACE SYSTEMS	ASOS	36 of 42 stations reported; 3 station intermittent.
	AWOS	47 of 47 stations reported; 6 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 8 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	391 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported; 1 station intermittent.

NOTES:

WEATHER SUMMARY

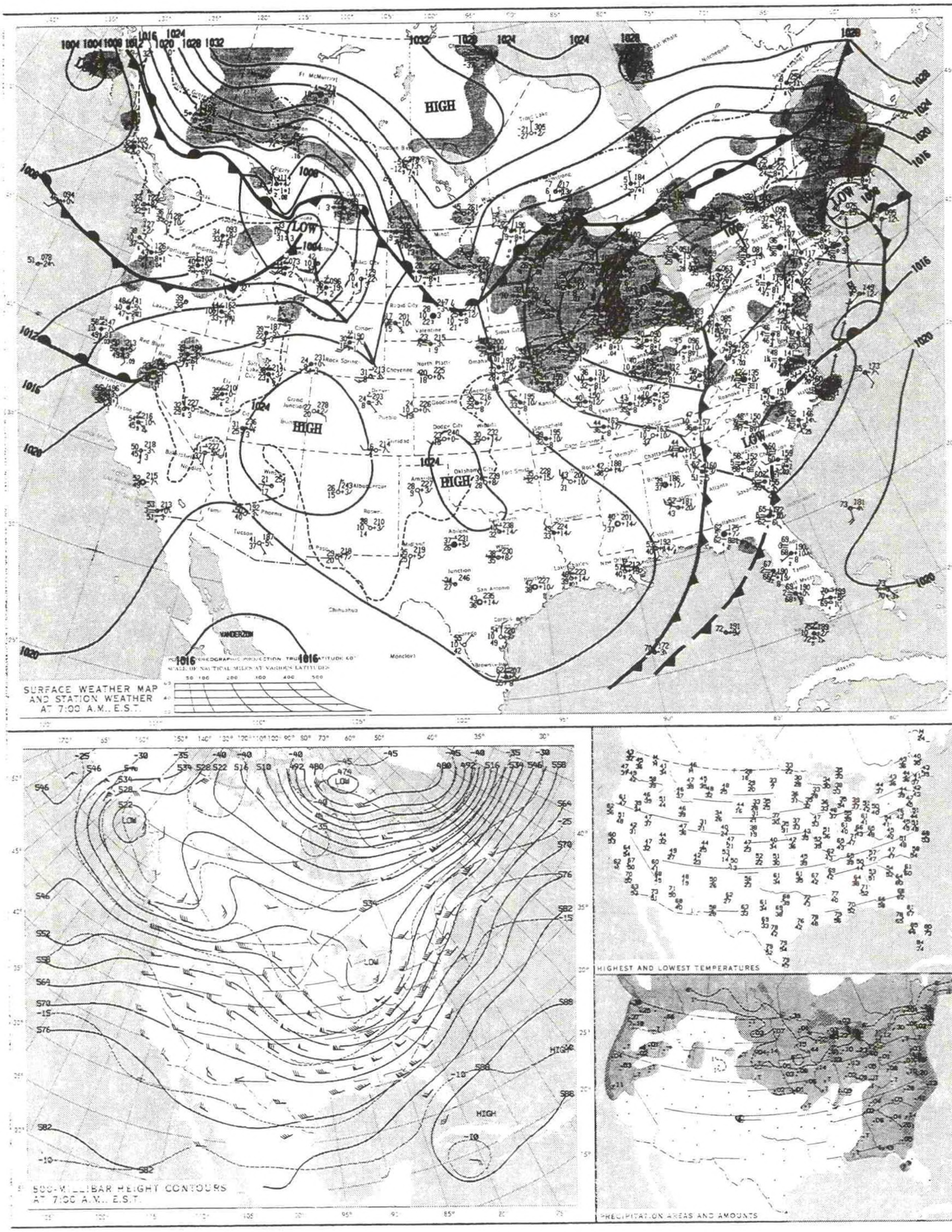
19 February 1992

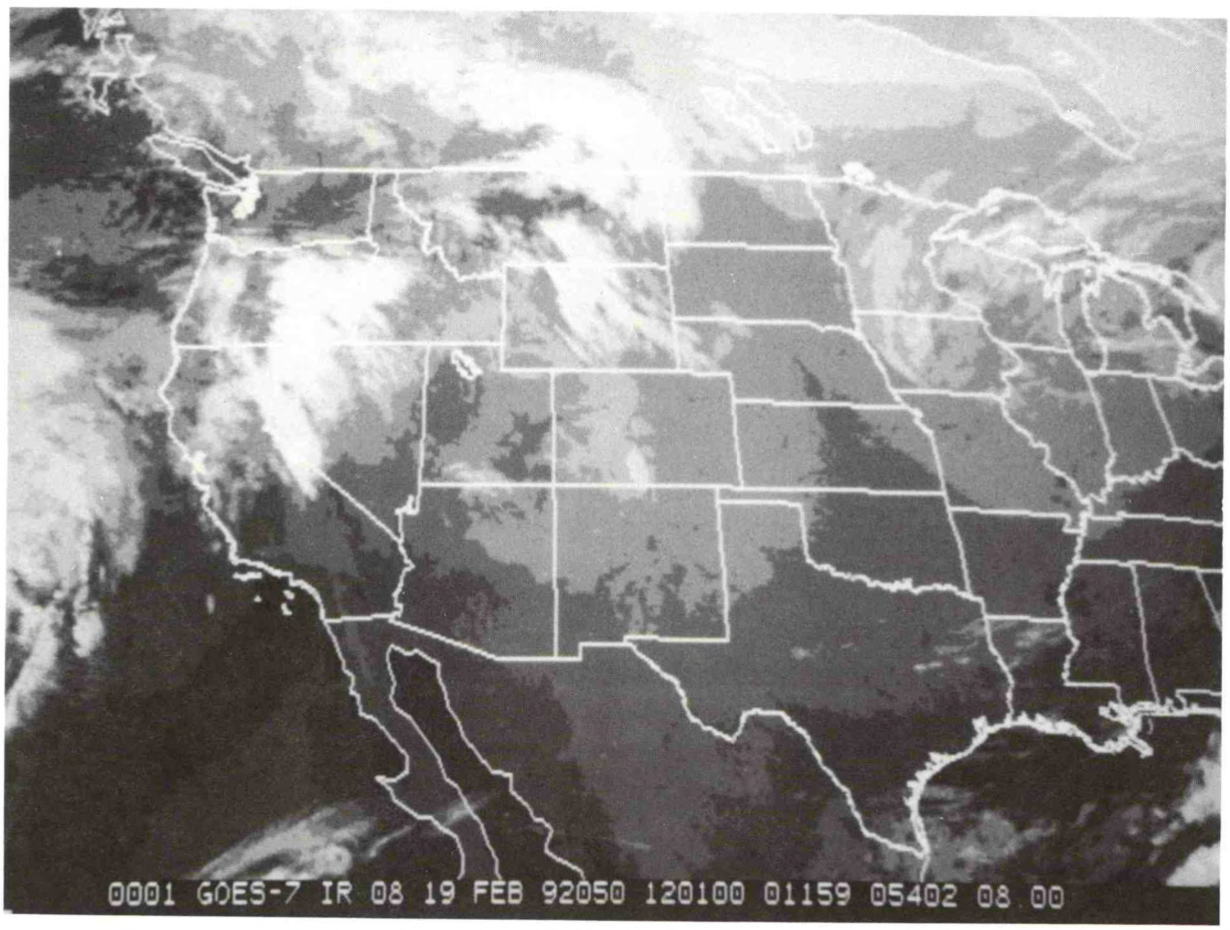
The surface low pressure center and upper level trough that had been the focus of IOP 7 had finally moved out of the STORM-FEST domain and was located over Michigan, with some wrap around precipitation extending back into the STORM-FEST domain and stratus clouds over the boundary layer array.

A second surface low and associated lee trough currently located in north-central Montana, should be in North Dakota by tomorrow morning (20 February). A cold front associated with the low was expected to move slowly to the south. Air ahead of the front was quite dry, so any precipitation was expected to light and post-frontal. The front was not expected to enter the STORM-FEST domain before 1800 UTC, tomorrow (20 February). High pressure at the surface would dominate the rest of the STORM-FEST area.

A deep trough entering the California coast was expected to weaken slightly as it moved into the southwestern Colorado area by 0000 UTC (21 February). This feature was forecast to strengthen slightly as it moved to the lee side of the Rocky Mountains. Return moisture on 21 February was limited to the southern STORM-FEST domain area, and the models indicated that the trough could supply enough lift over eastern Oklahoma to produce some precipitation. The Canadian front that should be located along the northern border of the STORM-FEST domain on 20 February was expected to continue moving to the south, and be located over the center of the STORM-FEST domain by 21 February. Any precipitation associated with this feature was expected to be quite light.

WEDNESDAY, FEBRUARY 19, 1992




0001 GOES-7 IR 08 19 FEB 92050 120100 01159 05402 08.00

OPERATIONS SUMMARY

19 February 1992

IOP 8 started at 1200 UTC with rawinsonde releases from the Seneca CLASS site to investigate the structure and evaluation of the boundary layer. The aircraft takeoff was delayed and then canceled at 1930 UTC, because of persistent stratus clouds over the boundary layer domain which made low-level flight legs impossible. The CP-3 and CP-4 radars terminated operations at 2000 UTC after collecting an hour of clear air data. The Seneca CLASS soundings was canceled before the 2100 UTC release.

The NCAR King Air radiation mission was carried out beginning at 2320 UTC to measure the radiational cooling at night in cloud free conditions. The final flight landed at 0444 UTC, 20 February. (See 5 February write-up for a description of the radiation mission objectives.)

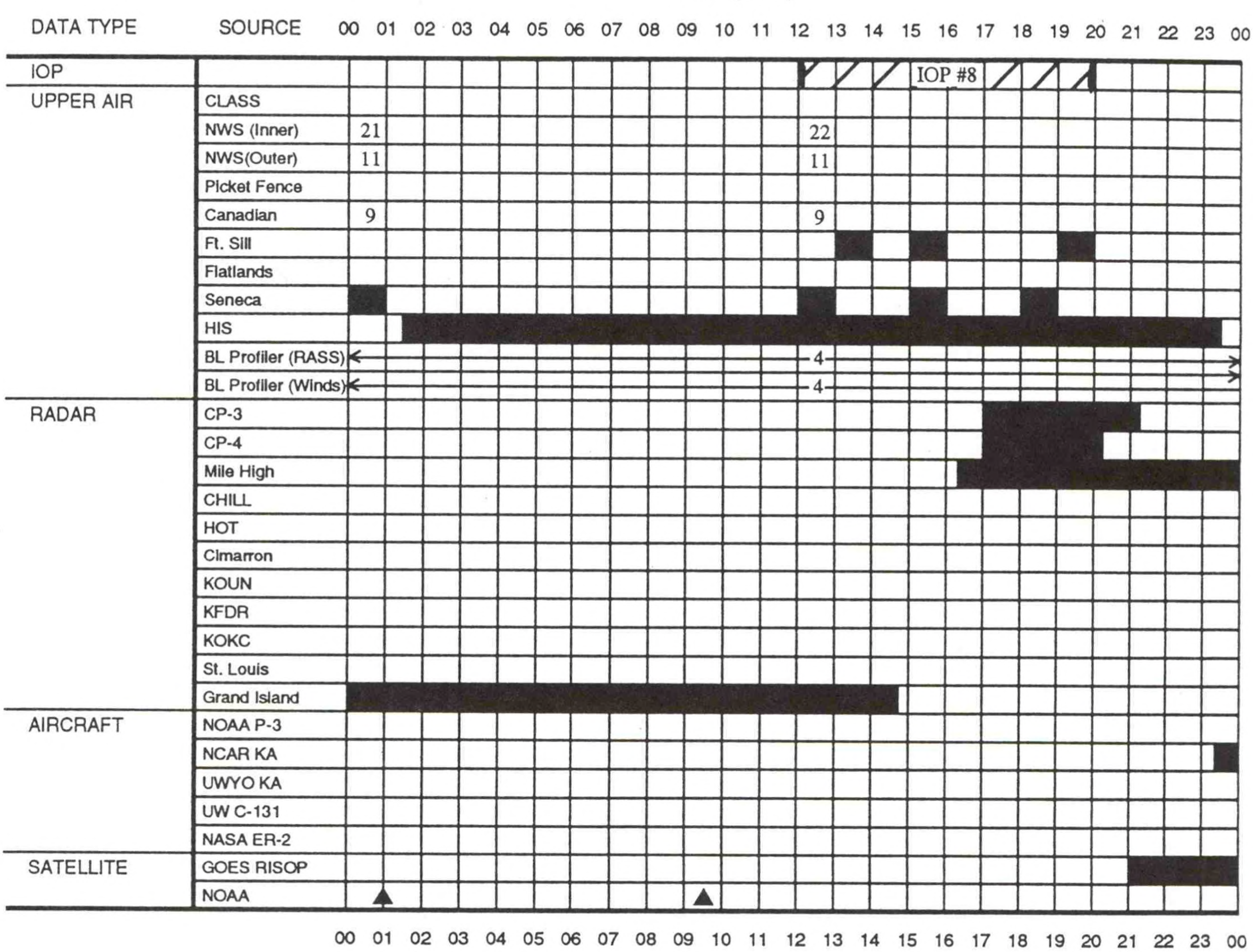
Picket Fence soundings have been scheduled to begin at 0000 UTC, 20 February and continue for 24-h to monitor the wave moving into the west coast. Since this system wasn't forecast to affect the STORM-FEST domain, no NWS upstream soundings were scheduled.

GOES-7 began RISOP mode at 2100 UTC and operated for four hours. (Not in support of STORM-FEST).

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 19 February

Julian Day: 50



Comments

SURFACE SYSTEMS	ASOS	36 of 42 stations reported; 5 station intermittent.
	AWOS	47 of 47 stations reported; 4 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 8 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	390 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

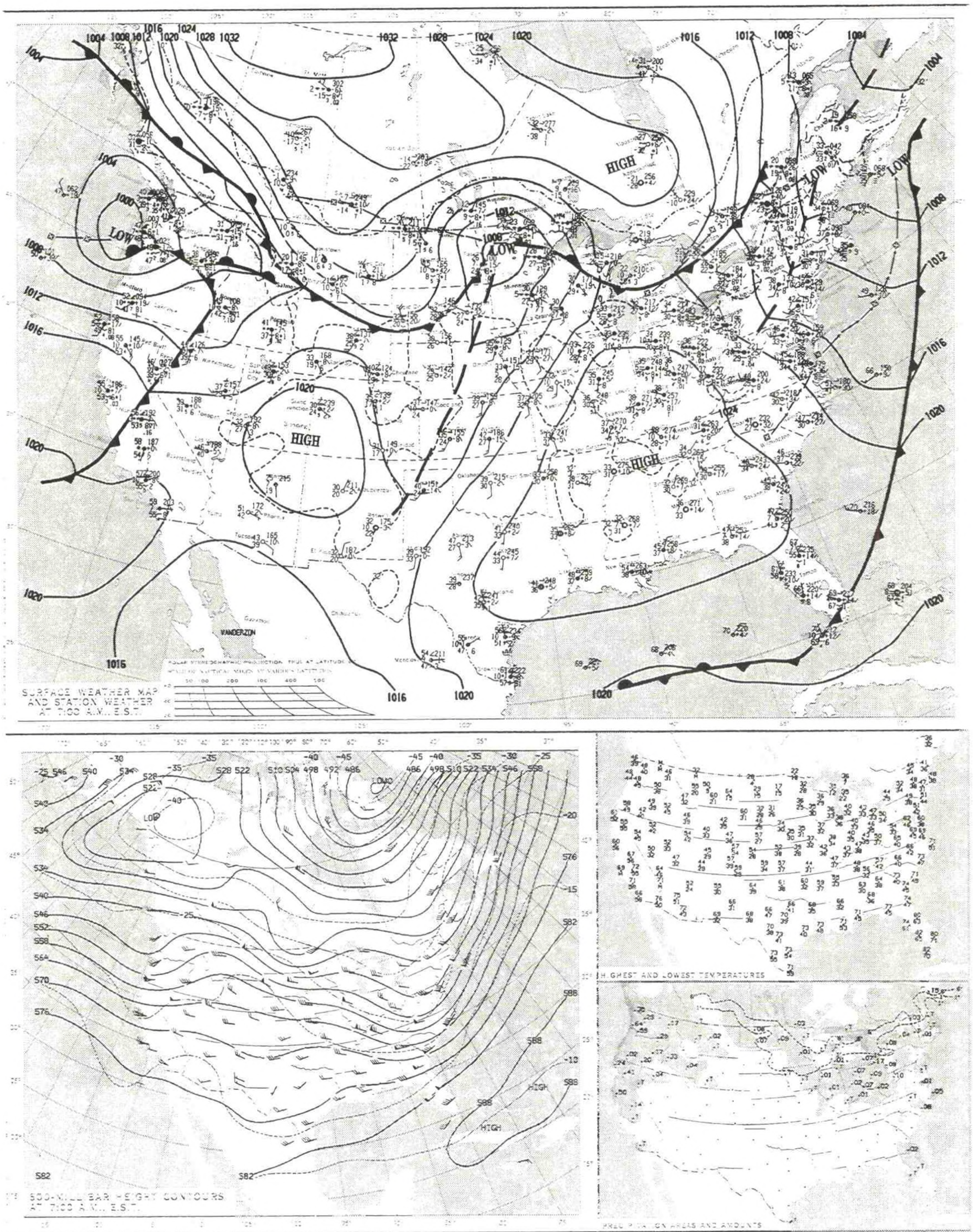
NOTES:

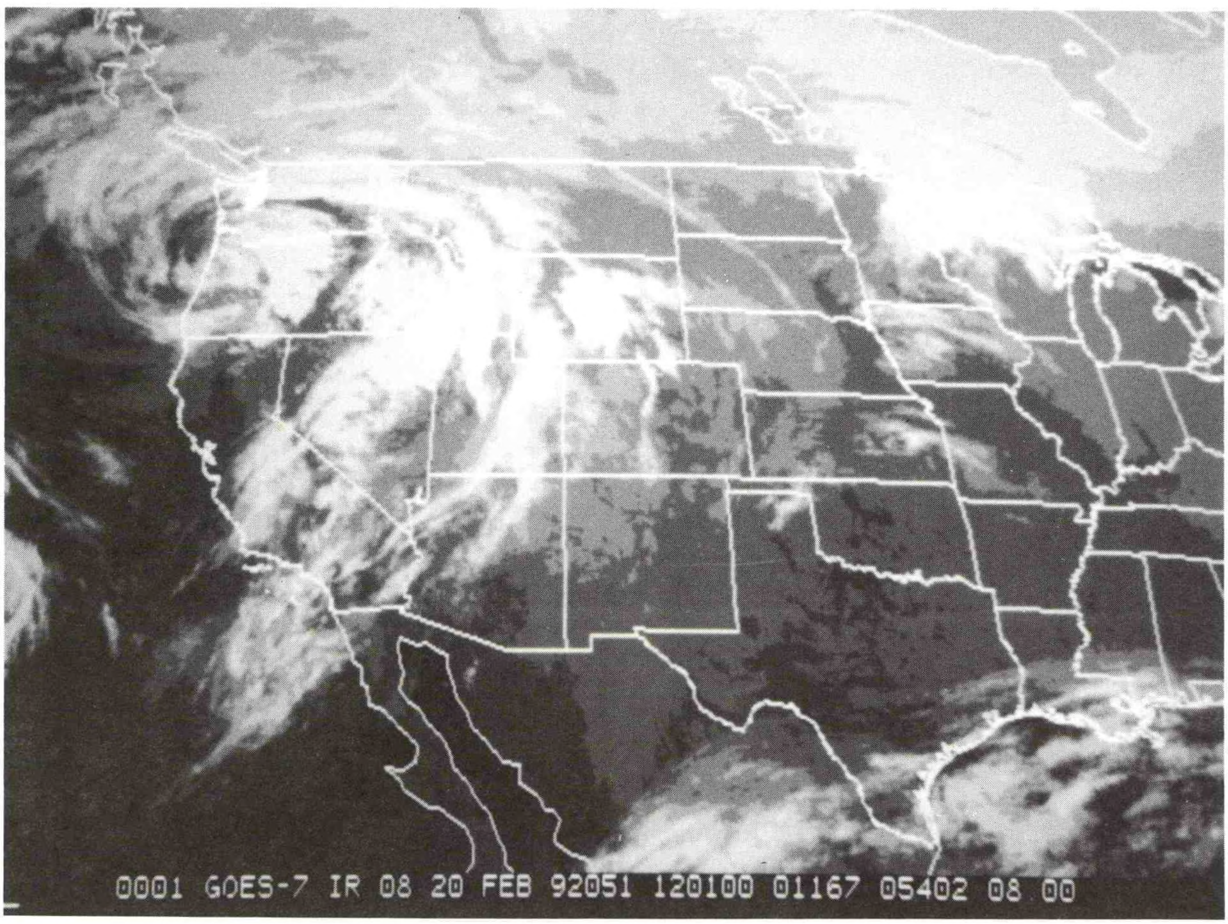
WEATHER SUMMARY

20 February 1992

At 1200 UTC, the surface low pressure center that was observed over Montana had moved over northern Minnesota with a trough extending from the low down to the Texas panhandle. A cold front extended back from the low into Wyoming and Montana. High pressure still dominated the STORM-FEST domain. Winds were fairly zonal, although the front was expected to continue moving south and be in the central part of the STORM-FEST domain by tomorrow, 21 February. As with many fronts this season, it will be very shallow with the cold air well to the north. There was some chance of light precipitation in Iowa later in the day. No major systems were expected to move into the STORM-FEST domain until at least 24-25 February.

THURSDAY, FEBRUARY 20, 1992




0001 GOES-7 IR 08 20 FEB 92051 120100 01167 05402 08 00

OPERATIONS SUMMARY

20 February 1992

No operations were carried out today, once the radiation mission was completed. IOP 9 was scheduled to begin tomorrow, 21 February, and will focus on boundary layer studies that were not conducted in IOP 8. The principle objectives of the IOP will be to intercompare the aircraft data with the boundary layer array data, including the Doppler radars. Soundings from the Seneca CLASS site were scheduled for 1800, 2100, 21 February and 0000 UTC, 22 February.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 20 February

Julian Day: 51

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP																									
UPPER AIR	CLASS																								
	NWS (Inner)	22												22											
	NWS(Outer)	11												11						1					
	Picket Fence	8			9			8			9			9			8			9			9	1	
	Canadian	9												9											
	Ft. Sill																								
	Flatlands																								
	Seneca																								
	HIS																								
	BL Profiler (RASS)													4											
	BL Profiler (Winds)													4											
RADAR	CP-3																								
	CP-4																								
	Mile High																								
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA																								

Comments

SURFACE SYSTEMS	ASOS	36 of 42 stations reported; 2 station intermittent.
	AWOS	47 of 47 stations reported; 4 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 8 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	393 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported; 1 station intermittent.

NOTES:

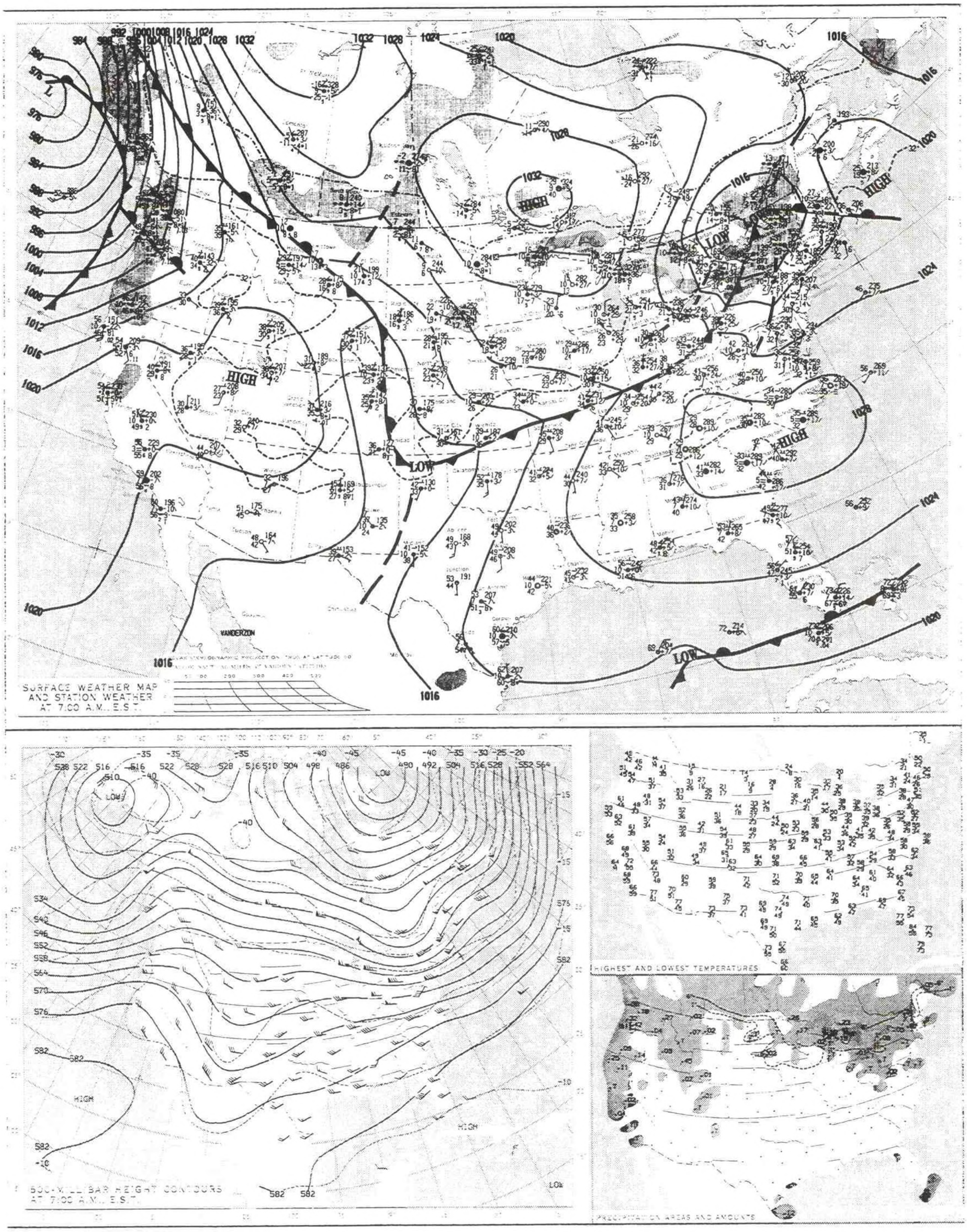
WEATHER SUMMARY

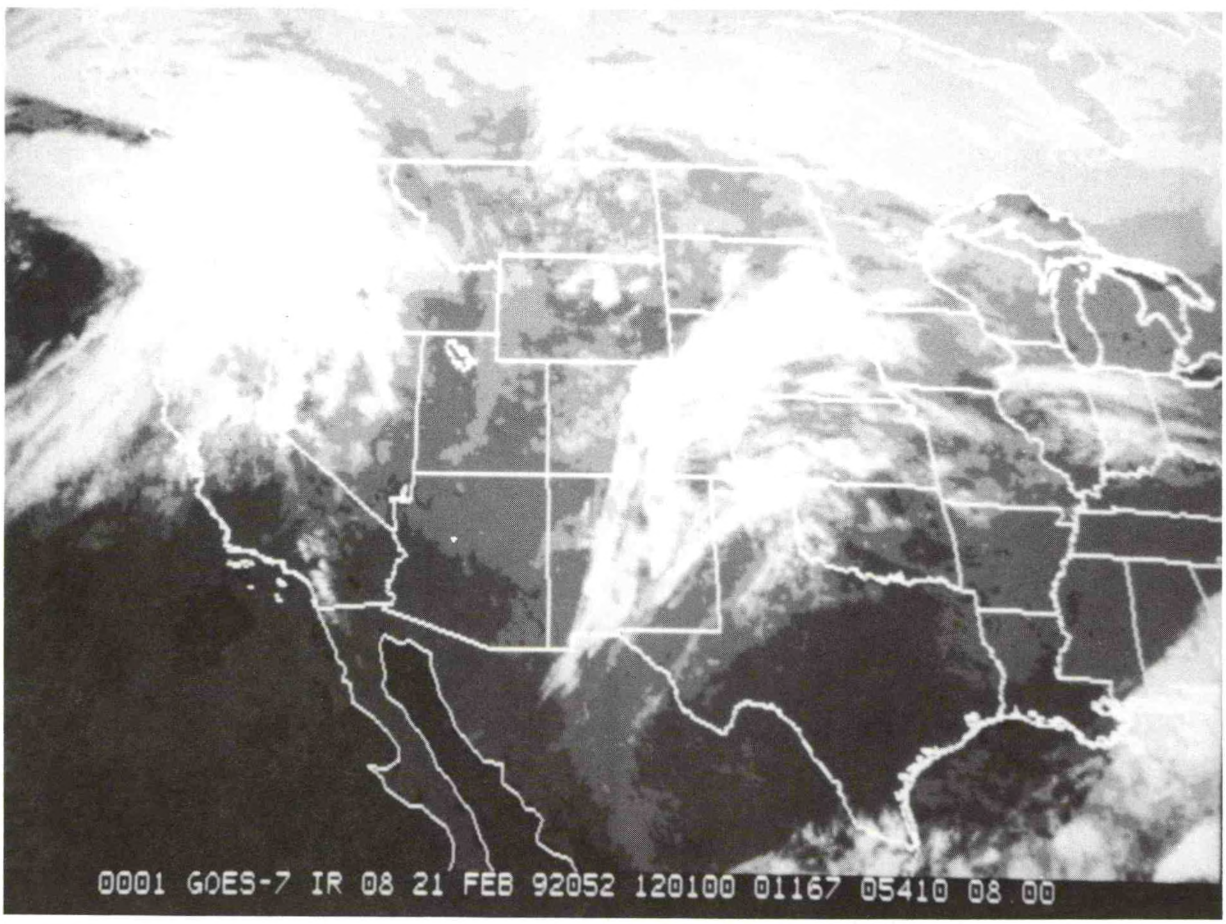
21 February 1992

The low pressure center that has skirted the STORM-FEST domain for the past several days continued to move to the east and at 1200 UTC was located over northern New York. A cold front extended westward from the low into the central part of the STORM-FEST domain. This front was expected to enter the boundary layer array by 2100 UTC and pass through Kansas City by 0000 UTC tomorrow, 22 February. As has been typical this year, the cold air was well behind the front such that there will be little temperature contrast directly related to the windshift along the front.

Over the next 36- to 48-h no significant weather was expected in the STORM-FEST domain. This weak front was expected to continue to move to the south and some light precipitation could develop in Texas and Oklahoma as an upper-level trough moves into that area.

FRIDAY, FEBRUARY 21, 1992




0001 GOES-7 IR 08 21 FEB 92052 120100 01167 05410 08.00

OPERATIONS SUMMARY 21 February 1992

IOP 9 began at 1600 UTC, focusing on the structure of the fair weather boundary layer as determined by aircraft and data from the boundary layer array. This mission was conducted in northeast flow after the passage of the weak short wave. The NCAR King Air aircraft took off at 1725 UTC and flew two box patterns; one at 600 m and one at 1200 m MSL; and two L-patterns at 450 m and 700 m MSL. Waves were observed above the inversion. Frequent vertical soundings were made with the aircraft to investigate the variation of the inversion height with time. The aircraft returned to Richards-Gebaur AFB at 2150 UTC.

Seneca CLASS soundings were taken at 1800, 2100, and 0000 UTC, 22 February, and the CP-3 and CP-4 radars operated in clear air flux scan mode throughout the aircraft mission.

This IOP was scheduled to end at 0000 UTC, 22 February, but an interesting tightening of the north-south thermal gradient along the front located across Missouri was of sufficient interest that a second King Air flight was scheduled to investigate the structure of the front. The NCAR King Air took off at 0011 UTC, 22 February, and flew a "butterfly" pattern at 650 m MSL over the PAM network in Missouri. Aircraft soundings were taken before and after the "butterfly" portion of the flight. Observations indicated that a low center may have formed just east of Richards-Gebaur AFB that initiated the thermal enhancement of the front. It appeared that this circulation weakened with time. The aircraft landed at 0254 UTC (22 February).

This event will be the focus of IOP 10 that is scheduled to start at 1200 UTC tomorrow, 22 February. Due to time constraints, only the CLASS sounding sites could be activated since the NWS sites required a 24-h notification.

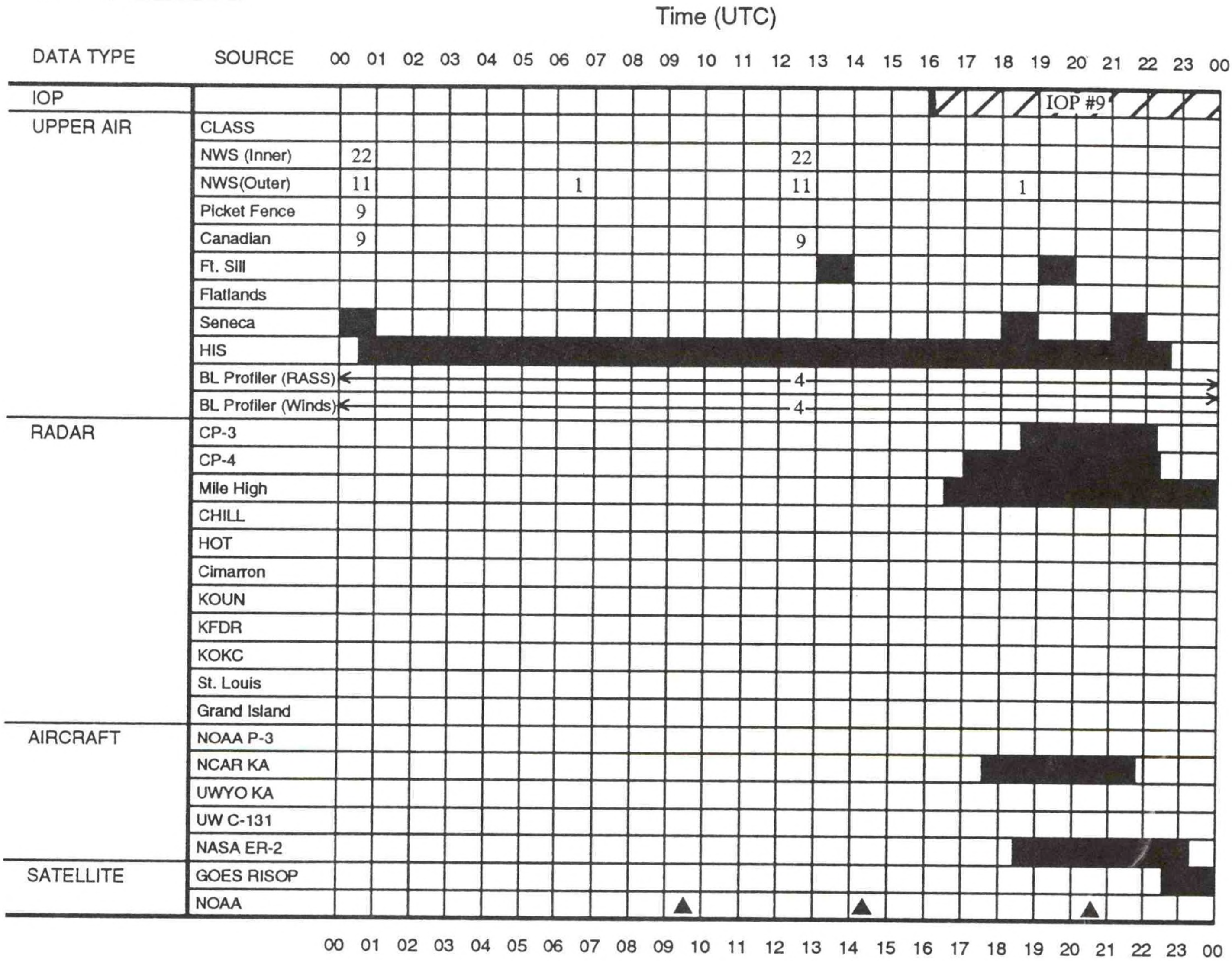
The ER-2 flew an oceanic convection mission (1830 UTC) off the Florida panhandle, which did not involve any STORM-FEST objectives.

GOES-7 RISOP mode began at 2230 UTC and continued to 0500 UTC (22 February). Again, not in support of STORM-FEST.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 21 February

Julian Day: 52



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 3 station intermittent.
	AWOS	47 of 47 stations reported; 3 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 14 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	397 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 2 stations intermittent.

NOTES:

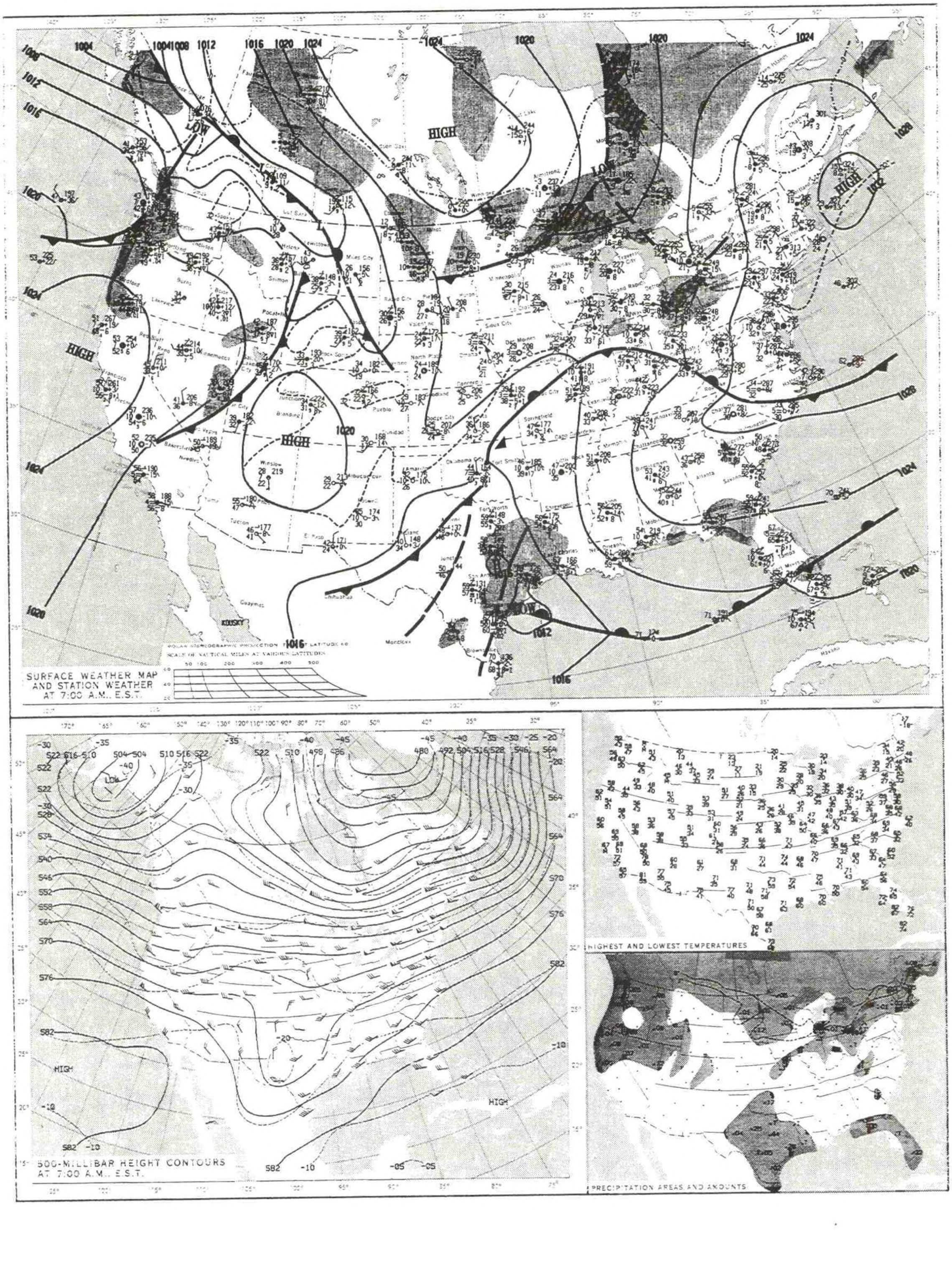
WEATHER SUMMARY

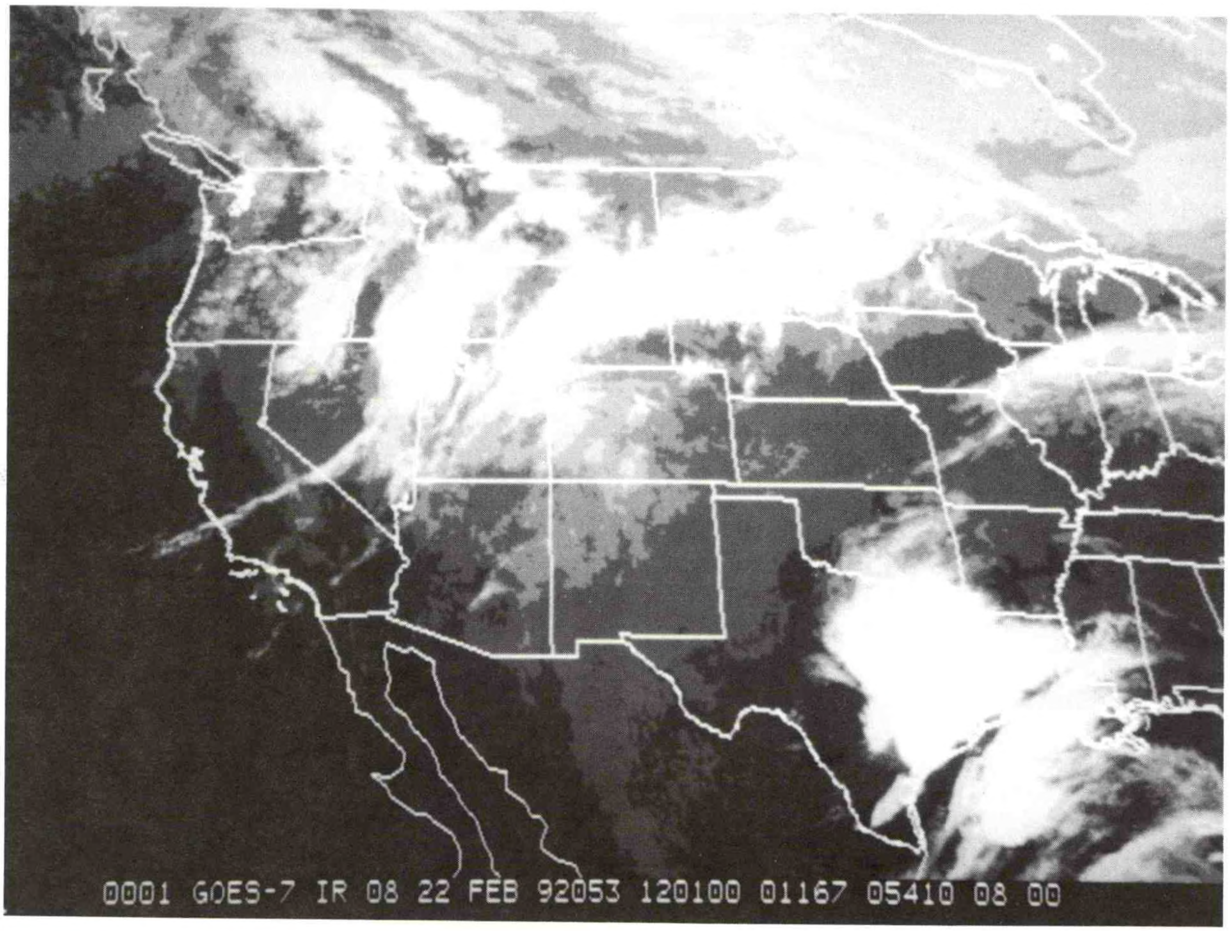
22 February 1992

At 1200, UTC the cold front that was seen yesterday, 21 February, continued to move slowly into central Oklahoma and Texas. A deep trough at 500 mb was still situated over Texas and there was light rain over southeastern Texas.

The models indicated that this front would slowly weaken and wash out over time. The main question was what would happen with the system that was forecast to develop over New Mexico in the next 24- to 36-h, and how would it affect the STORM-FEST domain? The model guidance was unclear as to the timing and phasing of the systems.

SATURDAY, FEBRUARY 22, 1992




0001 GOES-7 IR 08 22 FEB 92053 120100 01167 05410 08 00

OPERATIONS SUMMARY

22 February 1992

Based on the events of late yesterday, 21 February, IOP 10 was conducted to continue the investigations of the structure of the non-precipitating cold front that was examined in the second part of IOP 9. The original plans were to begin CLASS soundings at 1200 UTC, fly up to two aircraft and operate the CP-3 and CP-4 radars. With the front becoming weaker through time, the decision was made to schedule only four CLASS stations (located in Missouri and Kansas) for 1500 UTC soundings and only the Seneca CLASS site for the 1800 UTC sounding.

With diurnal warming, the frontal structure became more linear and weaker. Soundings indicated the front was sufficiently deep to sample, so it was decided to fly the frontal mission as planned in the region of tightest gradient (between Sedelia, KS and Columbia, MO).

Based upon this decision, the radar operation was canceled. The planned takeoff of the NCAR King Air was scheduled at 1730 UTC, but was delayed due to data-system problems. The takeoff occurred at 1818 UTC, and by this time satellite imagery showed that a rope cloud had developed along the front.

The aircraft flight pattern was flown roughly as planned although the rope cloud had dissipated. (Subsequent analysis of satellite imagery suggested that the cloud formed when a gravity wave caught up with the front and then dissipated as the gravity wave continued southward.)

The flight pattern consisted of a short zig-zag (almost a "butterfly" pattern) at 2200 ft MSL (~1200 ft. AGL) followed by transects normal to the front at 2200, 1200, and 3000 ft. MSL (1200, 200, and 2000 ft. AGL). The front was penetrated at all levels.

A summary of the mission was that it successfully continued the documentation of the weak stationary front that was investigated on the second flight of the NCAR King Air during IOP 9. Satellite data suggested that the front interacted with a gravity wave producing a rope-like cloud feature. This could possibly show up in PAM data.

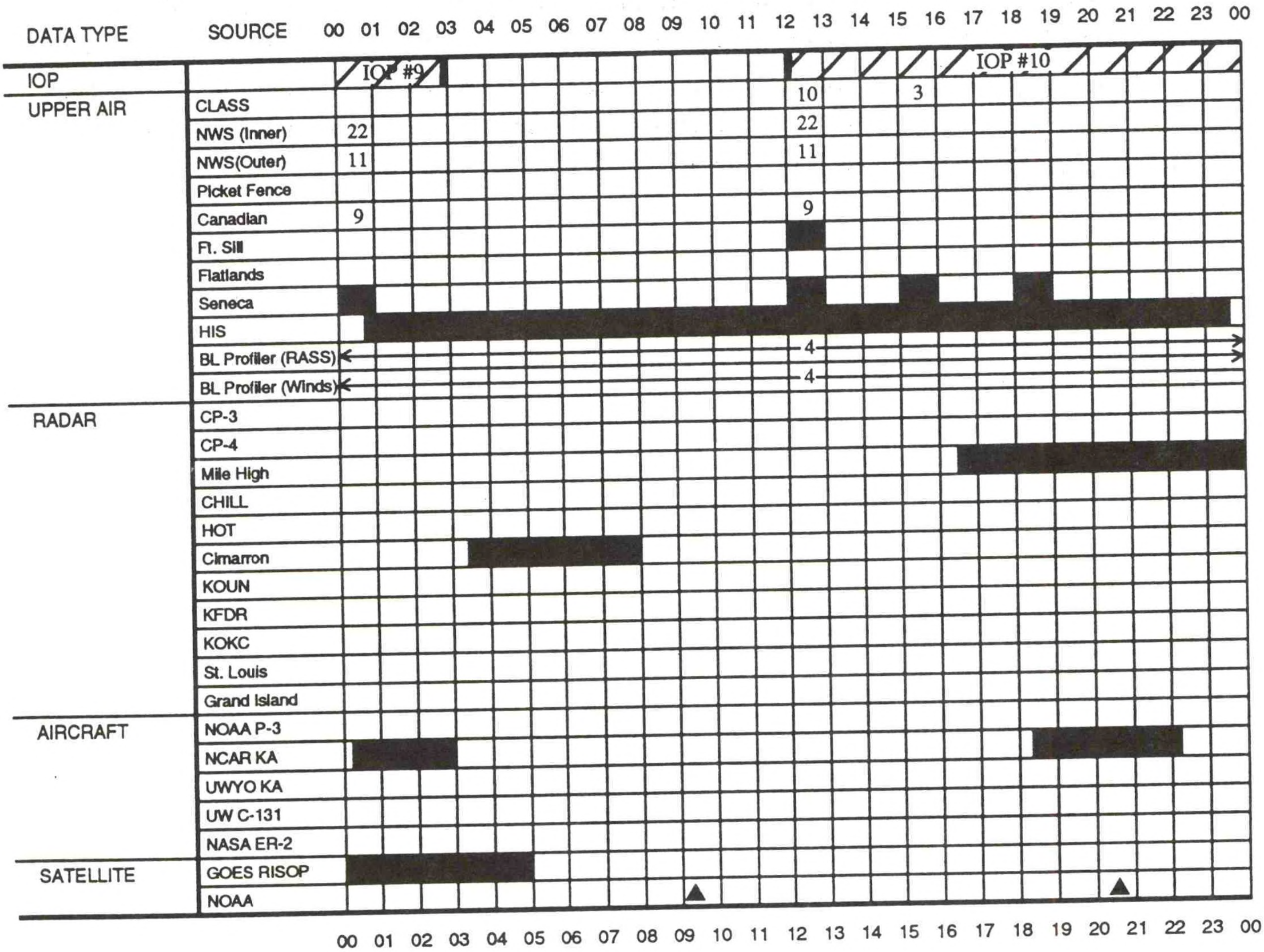
Other Activities:

Plans continued for IOP 11 to investigate the developing low and associated cold front that was expected to move out of New Mexico into the STORM-FEST domain tomorrow, 23 February. The NWS inner domain soundings were scheduled to begin at 2100 UTC (or earlier) and continue to 0900 UTC, 25 February. CLASS soundings were scheduled to begin at 1800 UTC and continue to 0900 UTC, 25 February. Satellite RISOP will begin at 1200 UTC and continue for 36-h. The CP-3 and CP-4 Doppler radars were scheduled to be operational by 1500 UTC. The earliest aircraft flights were not scheduled before 1600 UTC.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 22 February

Julian Day: 53



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 2 station intermittent.
	AWOS	47 of 47 stations reported; 4 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported; 1 station intermittent.
	PAM5	35 of 35 stations reported; 7 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	392 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported.

WEATHER SUMMARY

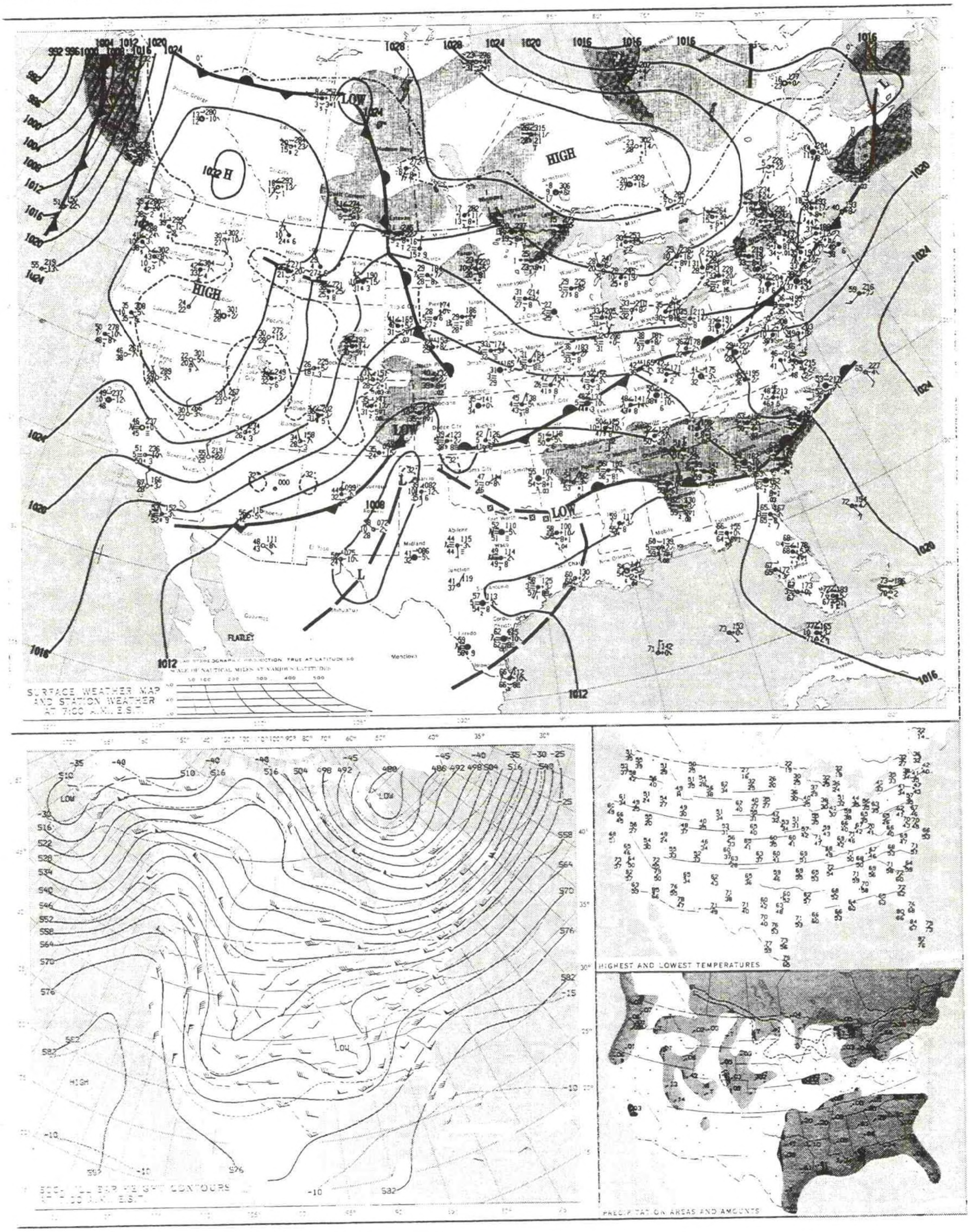
23 February 1992

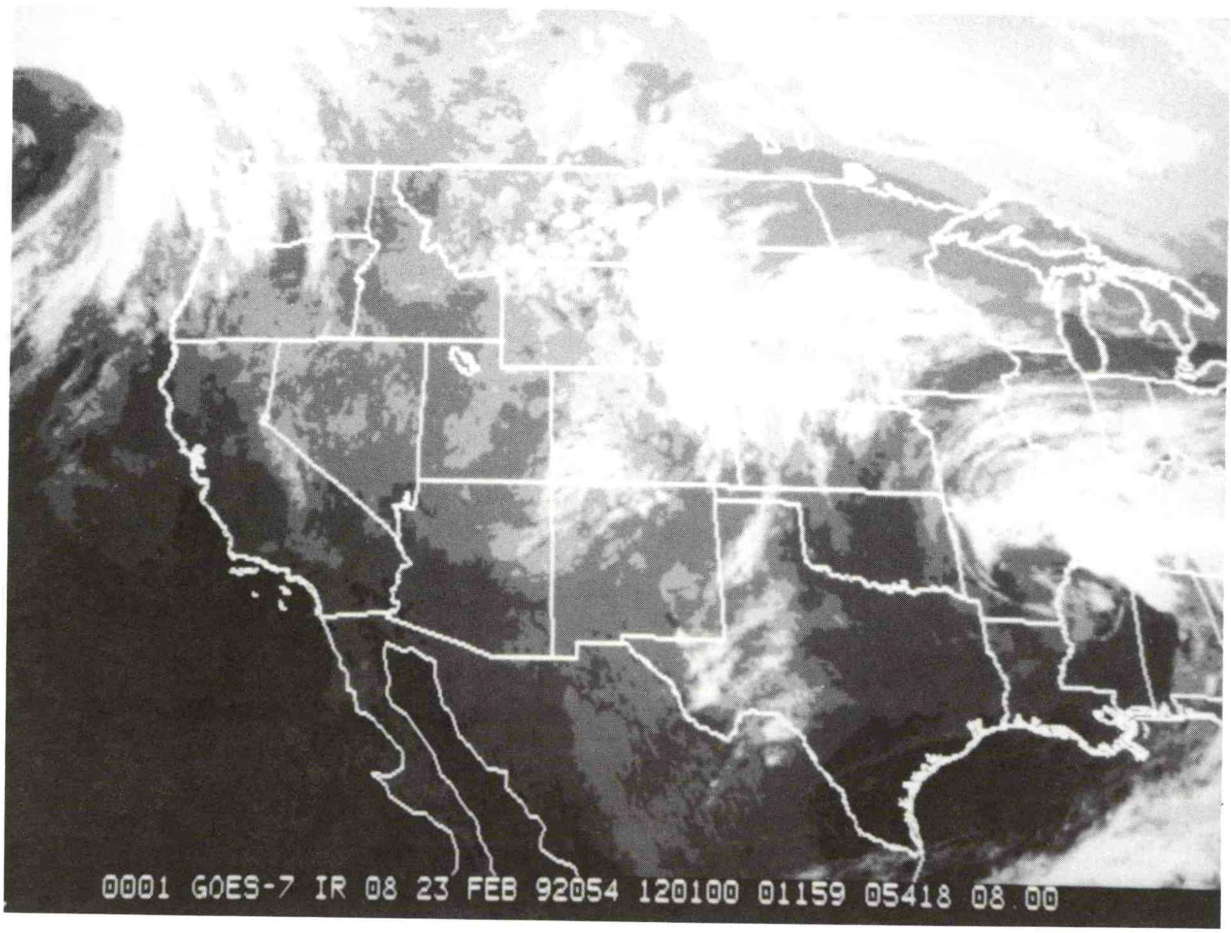
As predicted for the past several days, a very complex weather situation existed over the STORM-FEST domain. There was a well defined split trough, with one portion of the trough moving across Wyoming and the other diving south toward New Mexico. An interesting and complex cyclonic circulation was present north of Goodland, KS, with 30-40 kt winds behind this feature and some light snow and rain to the south and east. A weak (but well-shown on MAPS 30 m AGL winds) front had moved south across the boundary layer array behind the upper-level low centered in Arkansas. There was a narrow band of light showers associated with this feature that may be further enhanced over the next 12- to 24-h. The MM-4 model indicated that this precipitation area should expand in time as low-level convergence and low-level moisture increases. The main area of precipitation should be over the Texas panhandle, extending into Oklahoma. A main question was how much precipitation will be produced in the Little Washita Basin. NMC forecasters felt that the precipitation would mainly be over Texas, eventually shifting to the Gulf, and doubted the more northern precipitation location that the MM-4 model was predicting.

The models indicated that in the next 24- to 48-h, high pressure would build into the Rocky Mountain region pushing north and northeast winds through most of the STORM-FEST domain. In the earliest part of this period there could be precipitation in southern Oklahoma and northern Texas, although the greater likelihood will be that the heaviest precipitation would be located in southern Texas. This activity was expected to shift to the east and be out of the STORM-FEST domain by 06 UTC, 25 February.

All the models predicted a shortwave would move down from Alberta Canada into Montana by 0000 UTC, 25 February. There was very little moisture with this system, such that it would probably just bring down some colder air with increasing cloudiness.

SUNDAY, FEBRUARY 23, 1992




0001 GOES-7 IR 08 23 FEB 92054 120100 01159 05418 08.00

OPERATIONS SUMMARY

23 February 1992

IOP 11 began today at 1800 UTC to document a cold front and associated rainbands moving south from Nebraska into Missouri. At the beginning of this IOP there were three distinct features of interest. The first was a closed low circulation in Texas and Mexico. The second was a shallow cold surge/inverted trough which was moving eastward through Nebraska and Kansas. The third was an upper-level shortwave trough over eastern Kansas and Missouri. The following activities were carried out to support this IOP.

1800 UTC To study these events, particularly focusing on the cold front and associated precipitation, CLASS and NWS inner domain soundings began at 1800 UTC. Three hourly soundings were scheduled to continue until 0900 UTC, 25 February. Satellite RISOP began at 1200 UTC and was scheduled to continue for 36-h. The CP-3 and CP-4 radars became operational at 1947 UTC to monitor precipitation developing in the area.

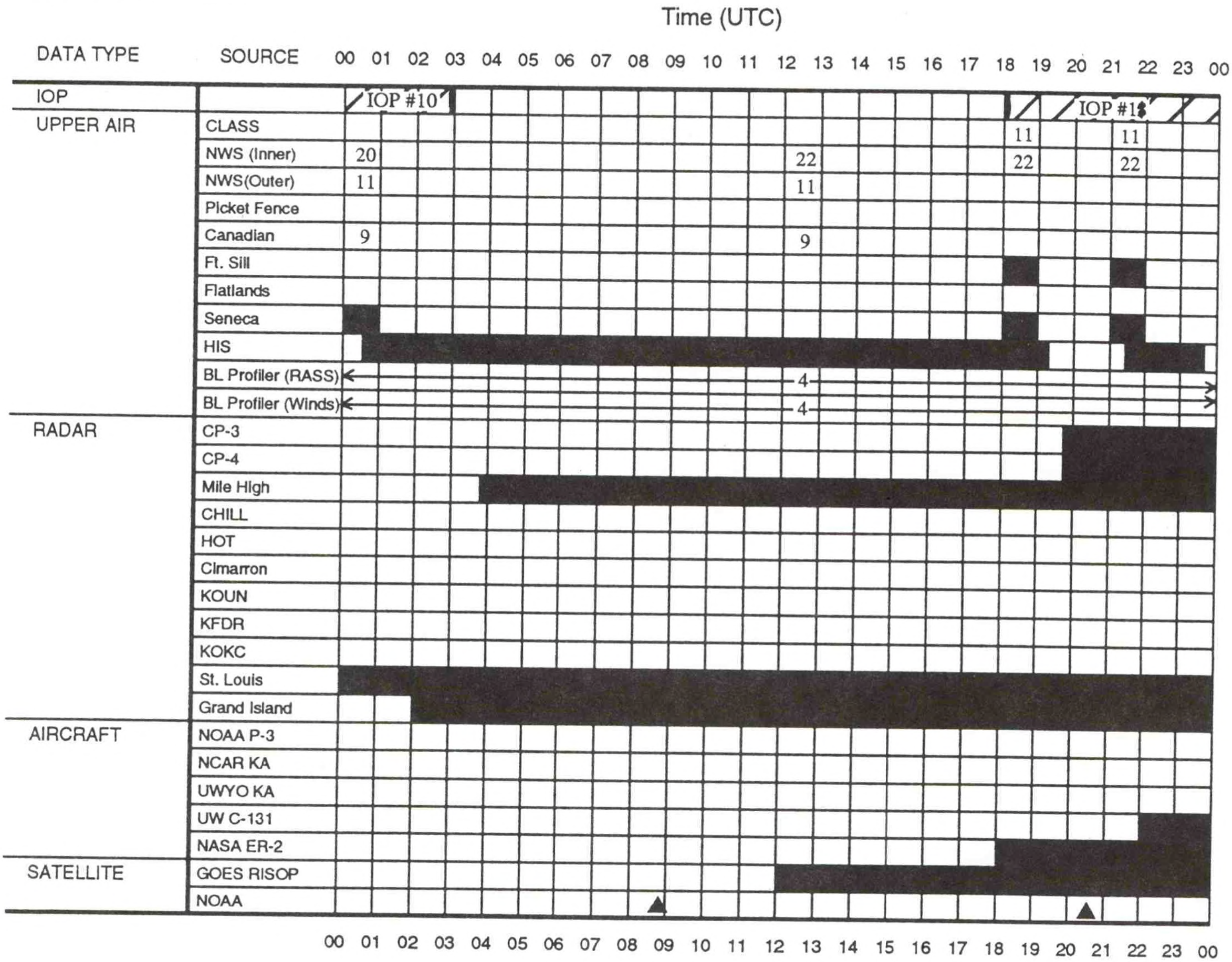
1800 UTC The NASA ER-2 took off to investigate the use of remote sensing to sample the rain/snow line in eastern Colorado, western Kansas, and western Nebraska. Rain or snow was reported across the front range of the Rocky Mountains and in the Nebraska panhandle. (Sydney, Nebraska, reported light snow throughout the flight. The ER-2 made several southwest to northeast passes along a well defined rainband.) The ER-2 also overflew an area of active convection in west Texas on both the outbound and inbound legs. All instruments were functioning, but the AMPR and LIP both had signal noise problems. The aircraft landed at 0030 (24 February).

2159 UTC The University of Washington C-131 aircraft took off to investigate the structure of a rainband that had moved over the dual Doppler area. The aircraft flew sawtooth patterns at 8k, 10k and 12 kft. from about 2230 UTC to 0100 UTC, 24 February. The aircraft then flew northwest at 10 kft. to intersect the front over Nebraska. The aircraft descended to 7 kft. at about 0200 UTC, and few to within 100 miles of North Platte, Nebraska, before turning back to Richards-Gebaur AFB. The aircraft flew back at Richards-Gebaur AFB at 5 kft. and landed at 0401 UTC, 24 February.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 23 February

Julian Day: 54



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported.
	AWOS	47 of 47 stations reported; 3 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 7 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	380 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported.

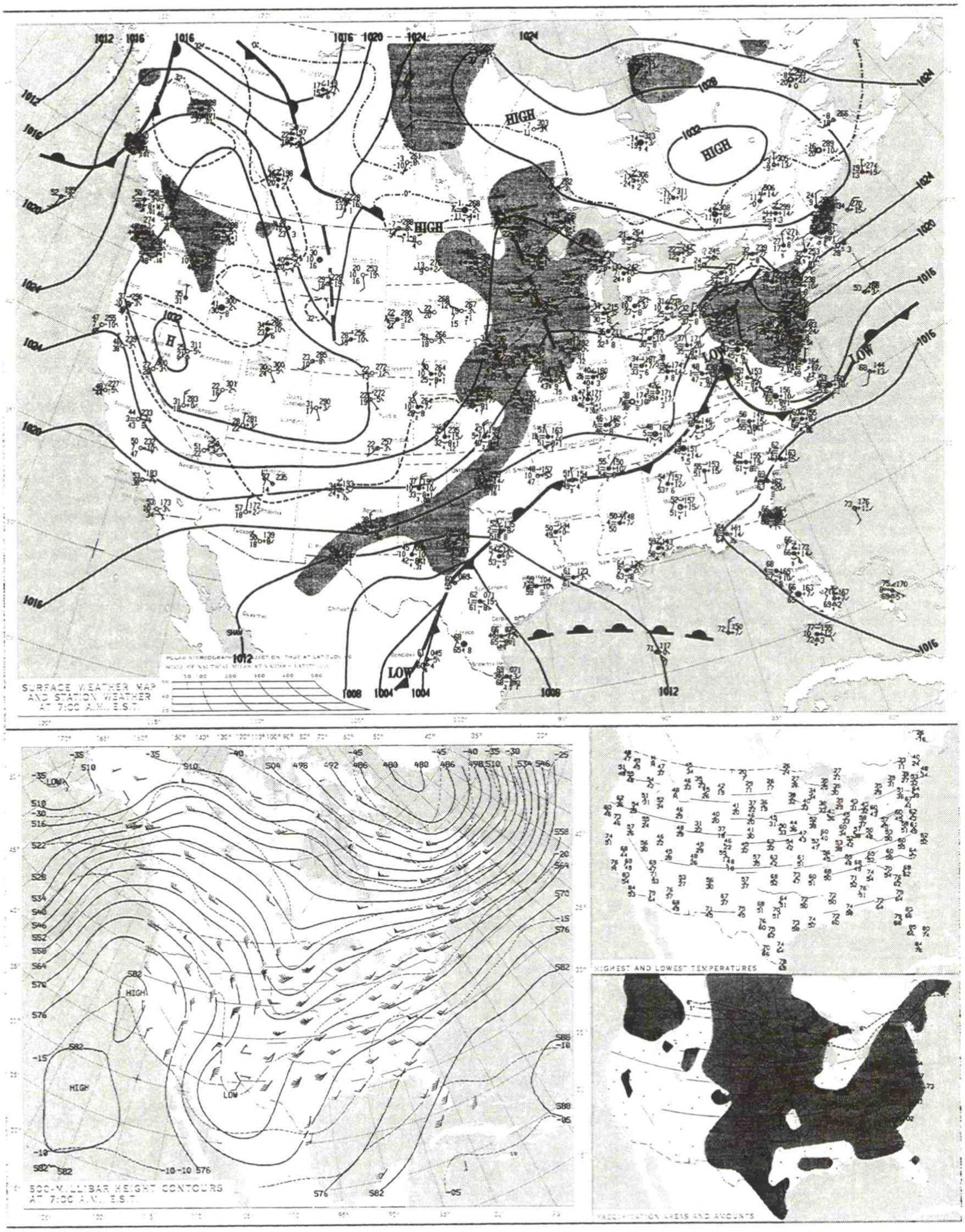
NOTES:

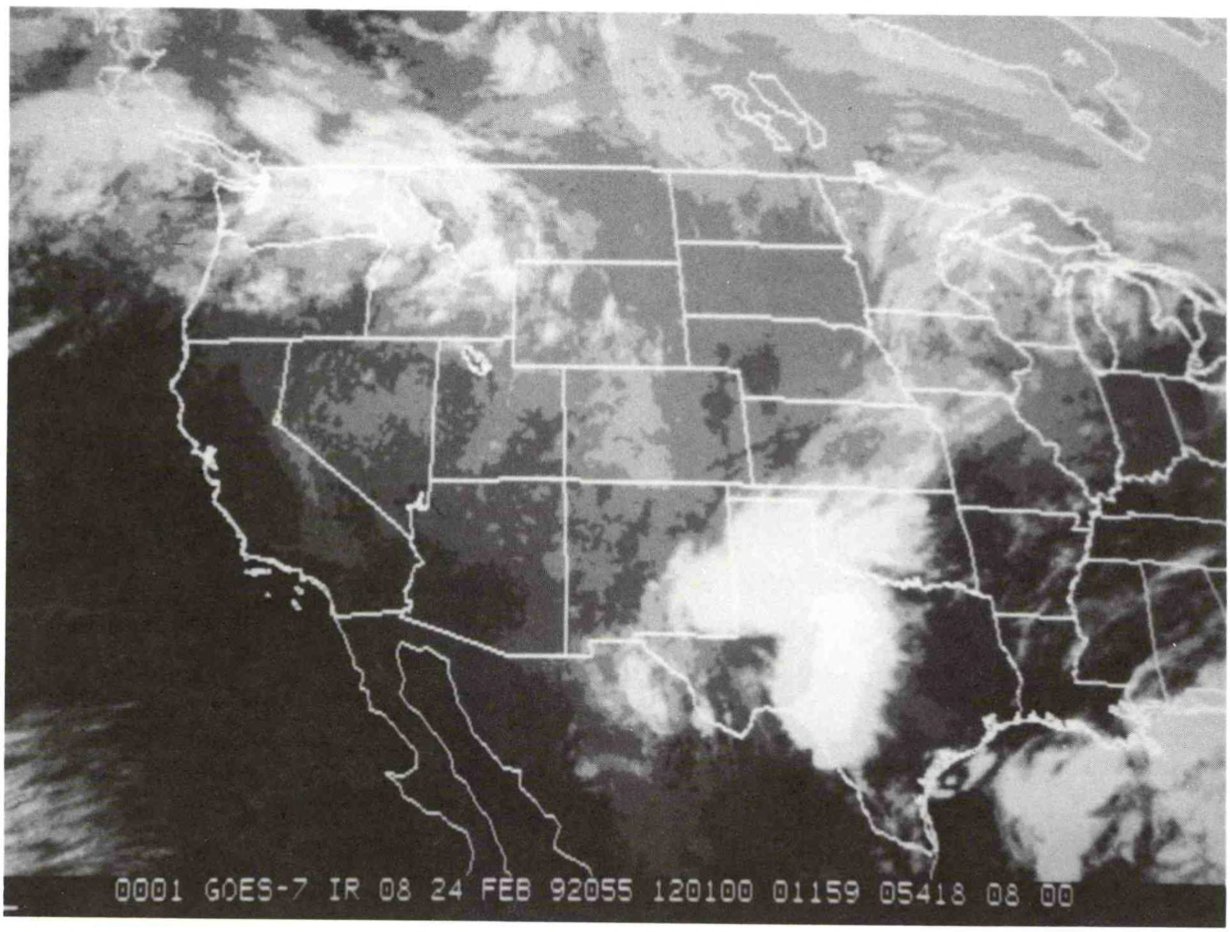
WEATHER SUMMARY **24 February 1992**

At 1200 UTC, there was an area of moderate precipitation in central Texas associated with the low pressure area in southern Texas and northern Mexico. A line of lighter precipitation extended from this area northeastward, up through Kansas City into Iowa and Minnesota. Behind this line there were strong northwest winds pushing much drier air into the STORM-FEST domain.

The deep 500 mb trough over southern Texas and New Mexico was forecast to move slowly to the east over the next 24-h. This was expected to push the current precipitation area eastward and be out of the STORM-FEST domain by tomorrow, 25 February. A weak shortwave was forecast to move through Colorado by 1200 UTC tomorrow, 25 February, that could develop a few rain or snow showers in eastern Colorado, western Nebraska and western Kansas. Other than that, high pressure at the surface should dominate the weather for the next 24- to 48-h period as it pushes cooler and drier air into the STORM-FEST domain.

MONDAY, FEBRUARY 24, 1992




0001 GOES-7 IR 08 24 FEB 92055 120100 01159 05418 08 00

OPERATIONS SUMMARY

24 February 1992

IOP 11 continued throughout the day. Soundings from the NWS inner domain and the CLASS sites continued all day. The C-band radars (CP-3 and CP-4) radars operated until 2140 UTC collecting data on the rainbands that moved through the area. The HOT radar collected data starting at 2200 UTC as the system moved through Illinois. GOES-7 remained in RISOP mode during the day.

Data were also collected from the NSSL Cimarron radar and the Oklahoma City WSR-88D. The Cimarron radar collected data from about 1220 UTC to 1755 UTC as a band of light to moderate precipitation moved through the Little Washita basin. The Oklahoma City WSR-88D collected Level II data from about 0400 UTC to 2200 UTC as this precipitation system moved through Oklahoma.

As the cold surge moved underneath the upper-level trough, the system appeared to organize into a distinct front and associated rainband over Missouri. This feature became the focus of the aircraft flights. This rainband was to far to the east to be observed by the CP-3 and CP-4 radars. The following summaries describe the aircraft missions in more detail.

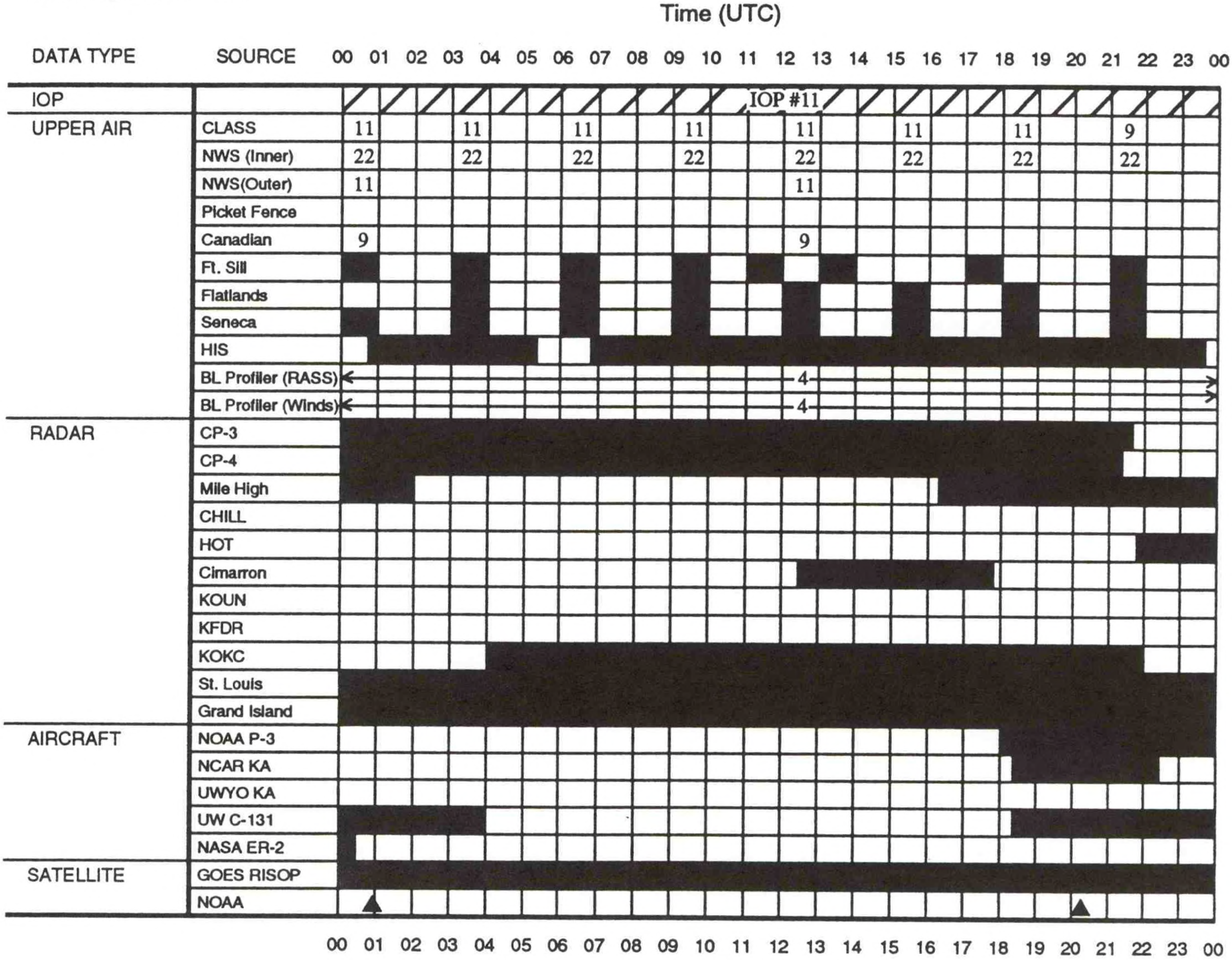
1756 UTC The NOAA P-3 took off to investigate the structure of the rainband that had formed in a southwest to northeast band across Missouri. The P-3 flew a sawtooth pattern along the length of the rainband at 14 kft. obtaining good radar coverage.

1800 UTC Both the NCAR King Air (takeoff at 1807 UTC) and the University of Washington C-131 (takeoff at 1802 UTC) took off to do complementary flights with the NOAA P-3. Both the King Air and the C-131 flew flight patterns across the width of the rainband. The King Air flew at 12k, 10k, 8k and 9 kft. The C-131 flew at 6k, 4k, 3k and 5 kft. The NCAR King Air aircraft landed at 2216 UTC. The University of Washington C-131 landed at 0101 UTC (25 February) and the NOAA P-3 landed at 0020 UTC (25 February).

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 24 February

Julian Day: 55



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 1 station intermittent.
	AWOS	47 of 47 stations reported; 2 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 6 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	395 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 2 stations intermittent.

NOTES:

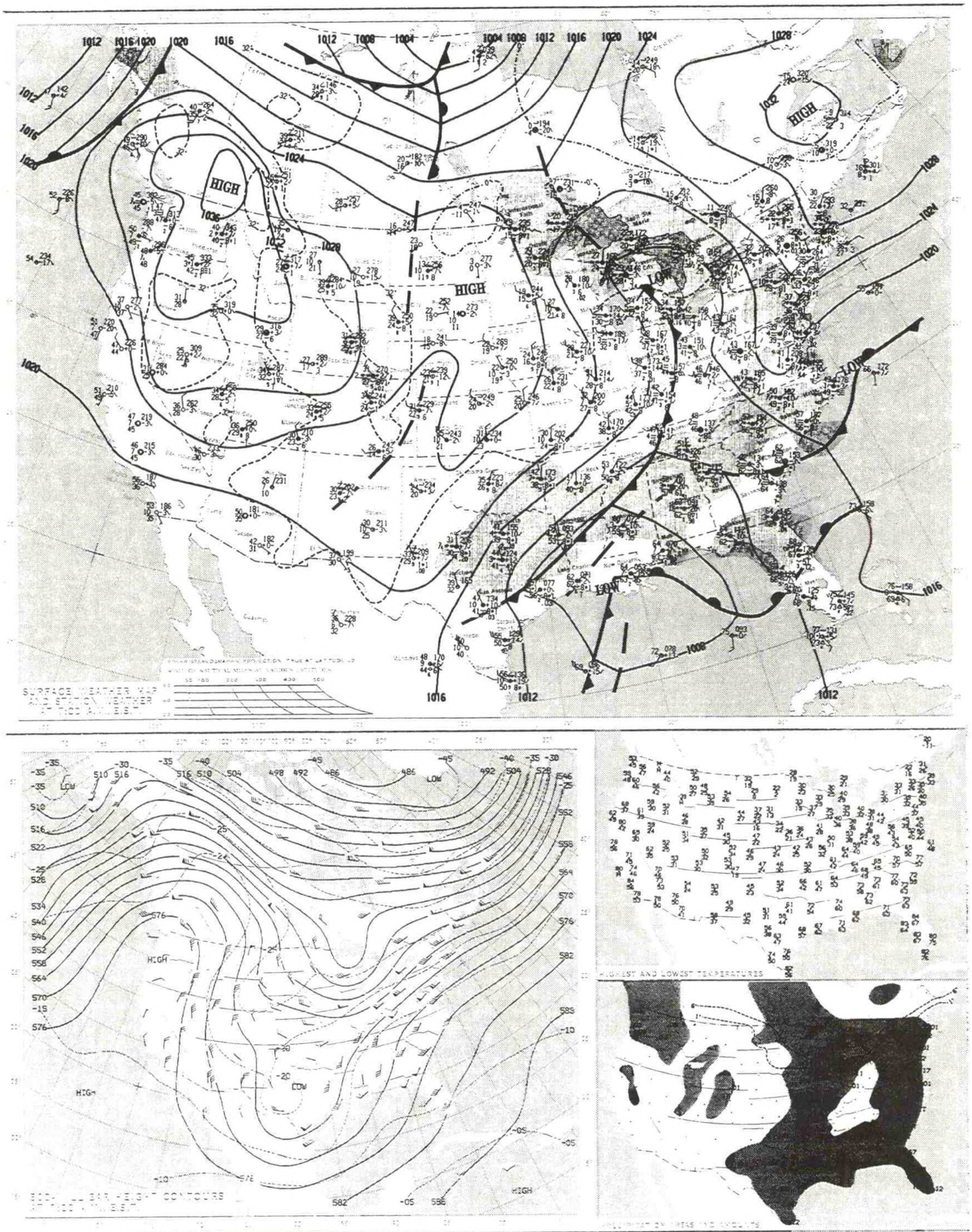
WEATHER SUMMARY 25 February 1992

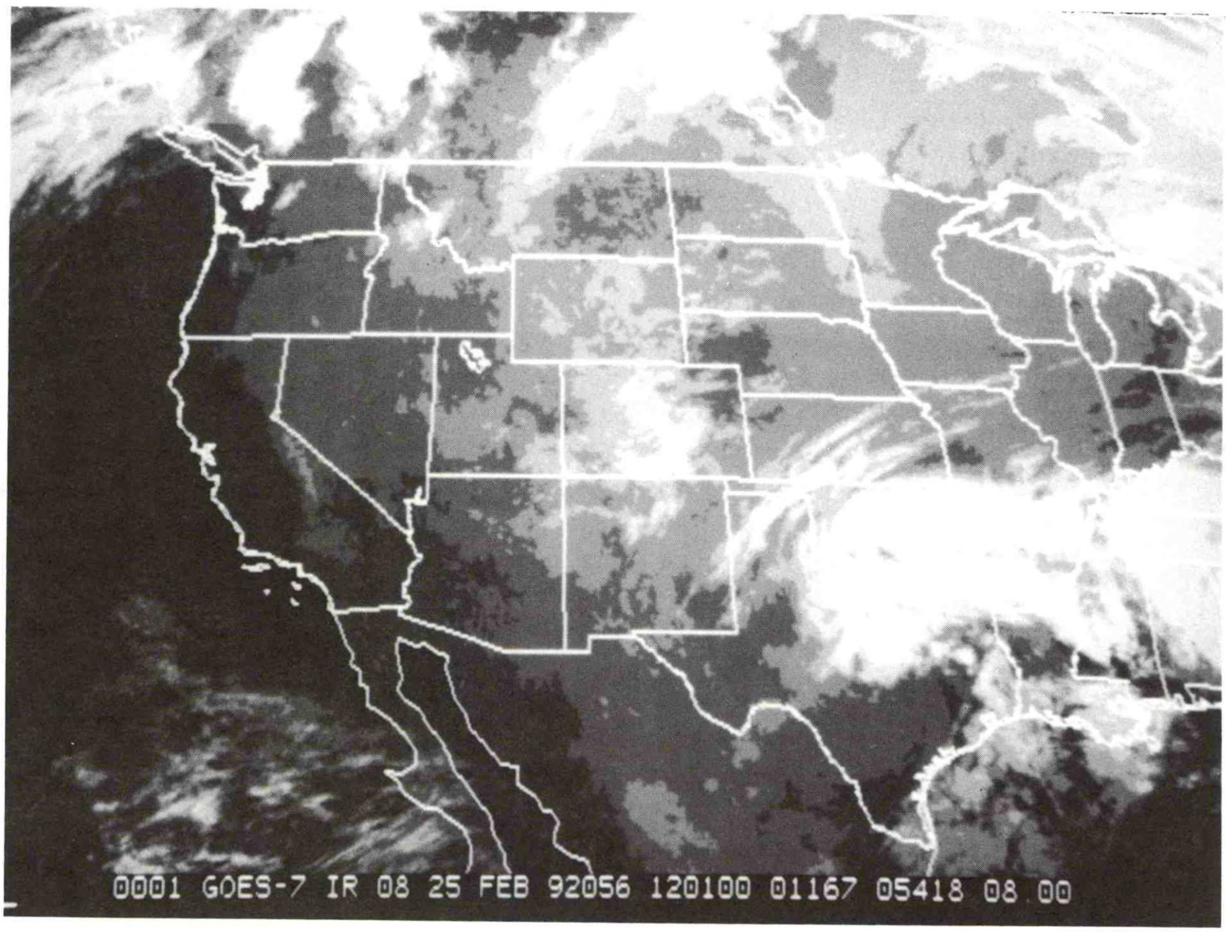
A large high pressure area has moved into the STORM-FEST domain, and dominated the weather. The low pressure-center and associated cold front that was the focus of IOP 11 was located over Michigan with a cold front extending down through Ohio, Kentucky, Tennessee, Louisiana and southern Texas. Intense overrunning over the shallow cold air caused moderately heavy stratiform rainfall in southern Arkansas and western Texas.

A deep trough at 500 mb located over Texas was expected to continue moving slowly eastward, although the shortwave over the four corners area was expected to push the trough further south.

Over the next 24- to 48-h a ridge will continue to build into the area. A new shortwave was expected to dive down from Canada into southern Iowa by 1200 UTC tomorrow, 26 February, that could bring snow, and additional cold air into the STORM-FEST domain. No significant weather was expected with this event.

TUESDAY, FEBRUARY 25, 1992




0001 GOES-7 IR 08 25 FEB 92056 120100 01167 05418 08.00

OPERATIONS SUMMARY

25 February 1992

IOP 11 terminated at 0100 UTC today, with the end of NWS inner domain and CLASS soundings and the aircraft landing at Richards-Gebaur AFB.

Just to keep things in a constant state of "flux", IOP 12 began at 1200 UTC today to investigate the clear air boundary layer structure in the boundary layer domain. This IOP was scheduled to continue until 0000 UTC, 26 February. Supplemental soundings were taken from Seneca at 1200, 1500, 1800, 1930, 2100, 2230 and 0000 UTC. Both the CP-3 and CP-4 radars collected clear air data during this period with CP-3 collecting data from 1703 to 2216 UTC and CP-4 collecting data from 1833 to 2200 UTC. The following aircraft flew missions during IOP 12:

1729 UTC The NCAR King Air took off at 1729 UTC to measure the budgets of sensible heat and momentum and compare them with those derived from the boundary layer Profilers. The aircraft flew an "L" pattern, one level box and one set of crosswind stacks; all flown within the mixed layer. Aircraft soundings were taken at different times during the flight to monitor the mixed layer depth. The aircraft landed at 2126 UTC.

1758 UTC The ER-2 took off at 1758 UTC, collecting radiance measurements in the STORM-FEST boundary layer array. The ER-2 made three passes over the array and the Seneca CLASS site. The times of the passes were approximately 2000, 2020, and 2130 UTC. The ER-2 also made two horizontal legs across clear skies in northern Kansas. At the end of the flight, (2200-2230 UTC), the ER-2 overflew CLASS sites in Kearney, Nebraska, and Hays, Kansas, followed by a flight leg south across clear sky in the Texas panhandle. All instruments were functioning for this mission. The aircraft landed at 0038 UTC, 26 February.

Other Activities:

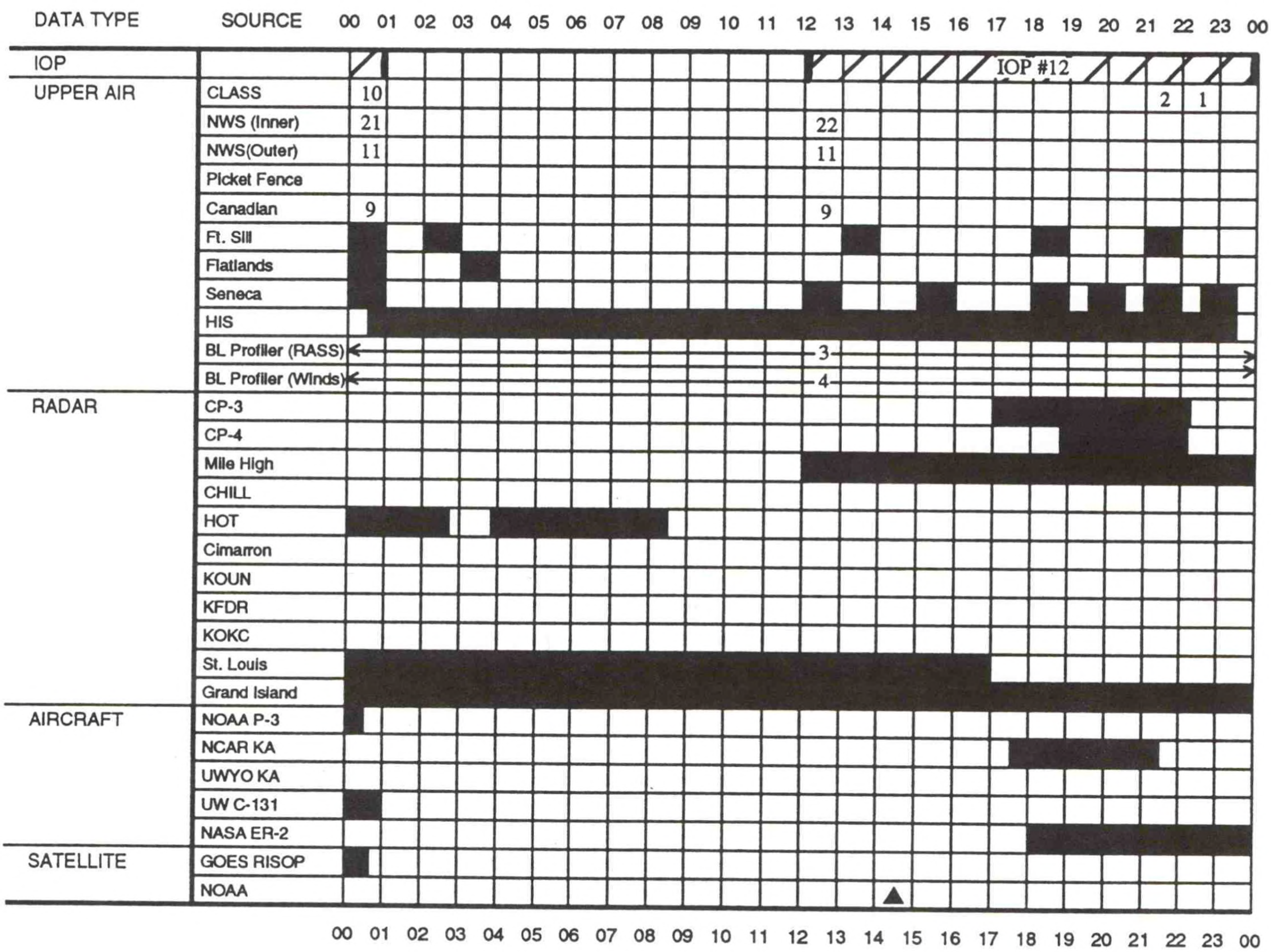
Tomorrow, 26 February has been scheduled as a hard down for the Project. As always though, a daily briefing was scheduled for 1830 UTC.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 25 February

Julian Day: 56

Time (UTC)



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 1 station intermittent.
	AWOS	47 of 47 stations reported; 3 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 8 stations intermittent.
	PROFS	21 of 22 stations reported.
	SAO	393 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 1 station intermittent.

NOTES:

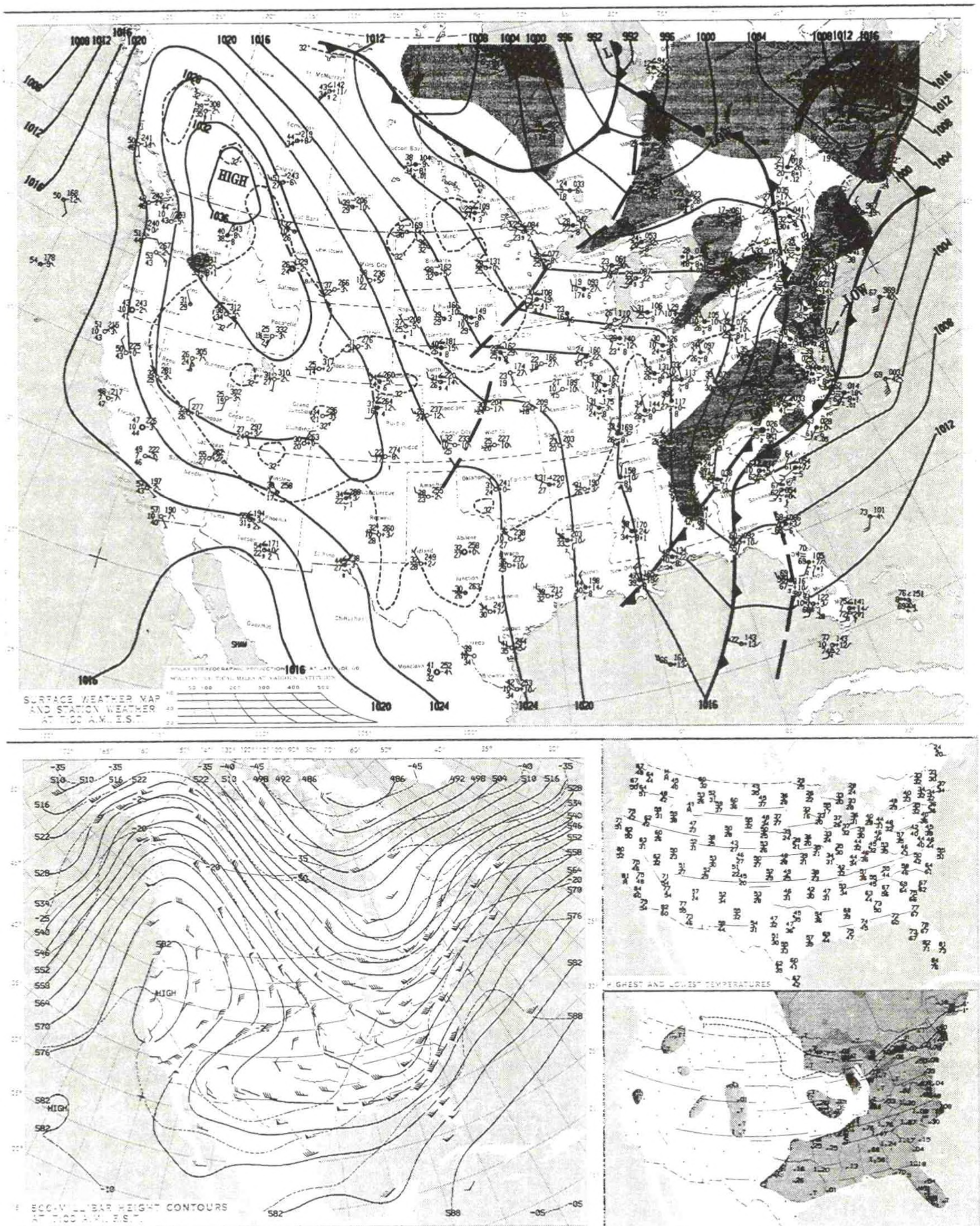
WEATHER SUMMARY

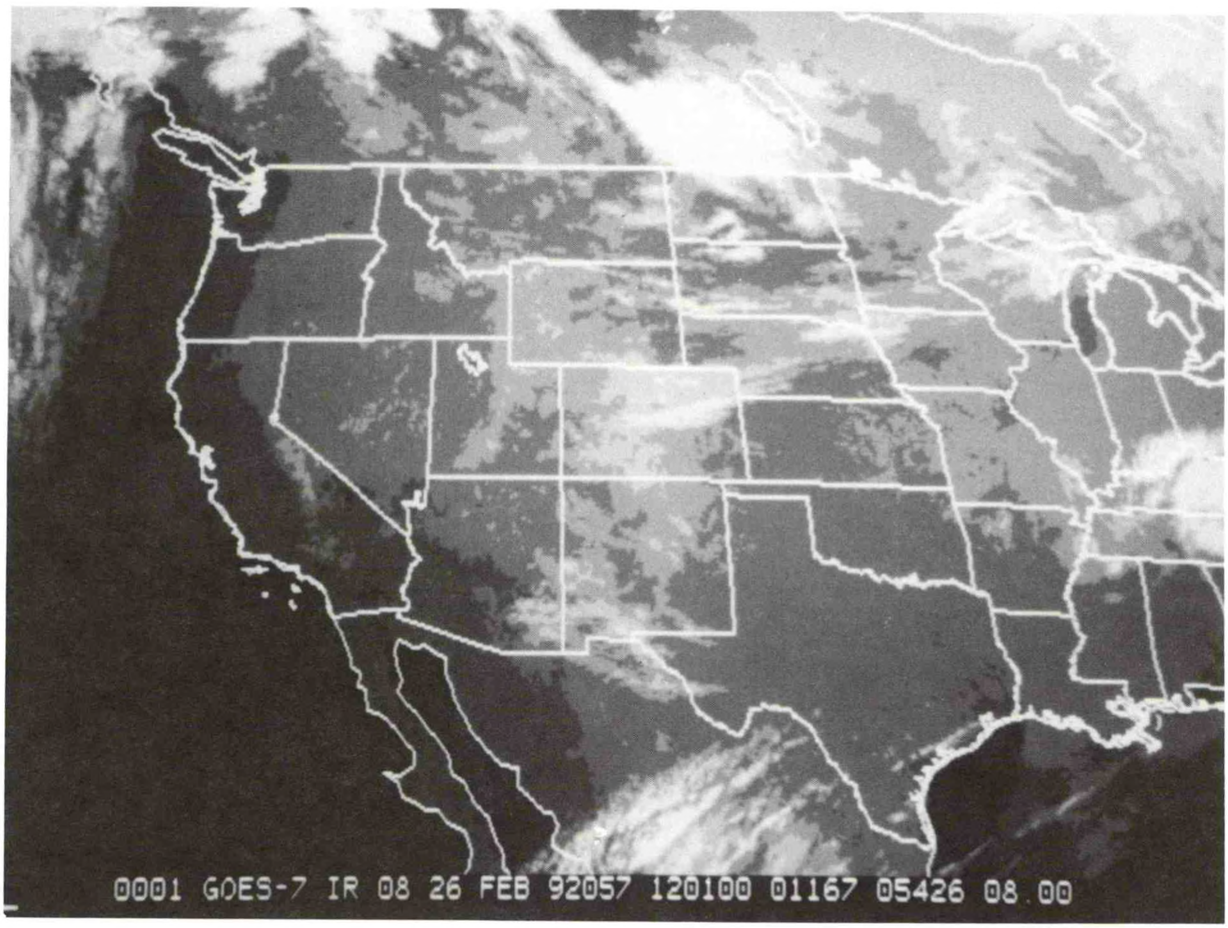
26 February 1992

A large high pressure area and northwest flow dominated the STORM-FEST domain. A weak trough existed through the center of the STORM-FEST domain, although there was no weather associated with it. A deep trough was still present over the southwest part of the U.S. and was expected to slowly dissipate over the next several days.

Over the next 24- to 36-h this pattern was not expected to change. There was a slight possibility that there could be some very light precipitation over the Kansas/Missouri area as this surface trough and upper-level shortwave moved through the area.

WEDNESDAY, FEBRUARY 26, 1992




0001 GOES-7 IR 08 26 FEB 92057 120100 01167 05426 08.00

OPERATIONS SUMMARY

26 February 1992

Today was a project down day, with no operations planned. Since this general atmospheric pattern was expected to continue for at least the next 24-h, a clear air boundary layer study was planned for tomorrow, 27 February. Operations will involve the NCAR King Air, the Seneca CLASS, and the CP-3 and CP-4 radars. Seneca, will begin CLASS releases at 1500 UTC, and all other operations including the King Air Aircraft were scheduled to begin at 1730 UTC.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 26 February

Julian Day: 57

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
IOP																										
UPPER AIR	CLASS																									
	NWS (Inner)	21												21												
	NWS(Outer)	10												11												
	Picket Fence																									
	Canadian	9												9												
	Ft. Sill																									
	Flatlands																									
	Seneca																									
	HIS																									
	BL Profiler (RASS)													3												
	BL Profiler (Winds)													4												
RADAR	CP-3																									
	CP-4																									
	Mile High																									
	CHILL																									
	HOT																									
	Cimarron																									
	KOUN																									
	KFDR																									
	KOKC																									
	St. Louis																									
	Grand Island																									
AIRCRAFT	NOAA P-3																									
	NCAR KA																									
	UWYO KA																									
	UW C-131																									
	NASA ER-2																									
SATELLITE	GOES RISOP																									
	NOAA																									

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00

Comments

DATA TYPE	SOURCE	Comments
SURFACE SYSTEMS	ASOS	38 of 42 stations reported.
	AWOS	47 of 47 stations reported; 4 stations intermittent.
	HPCN	73 of 73 stations reported; 2 stations intermittent.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 7 stations intermittent.
	PROFS	22 of 22 stations reported; 2 stations intermittent.
	SAO	390 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported.

NOTES:

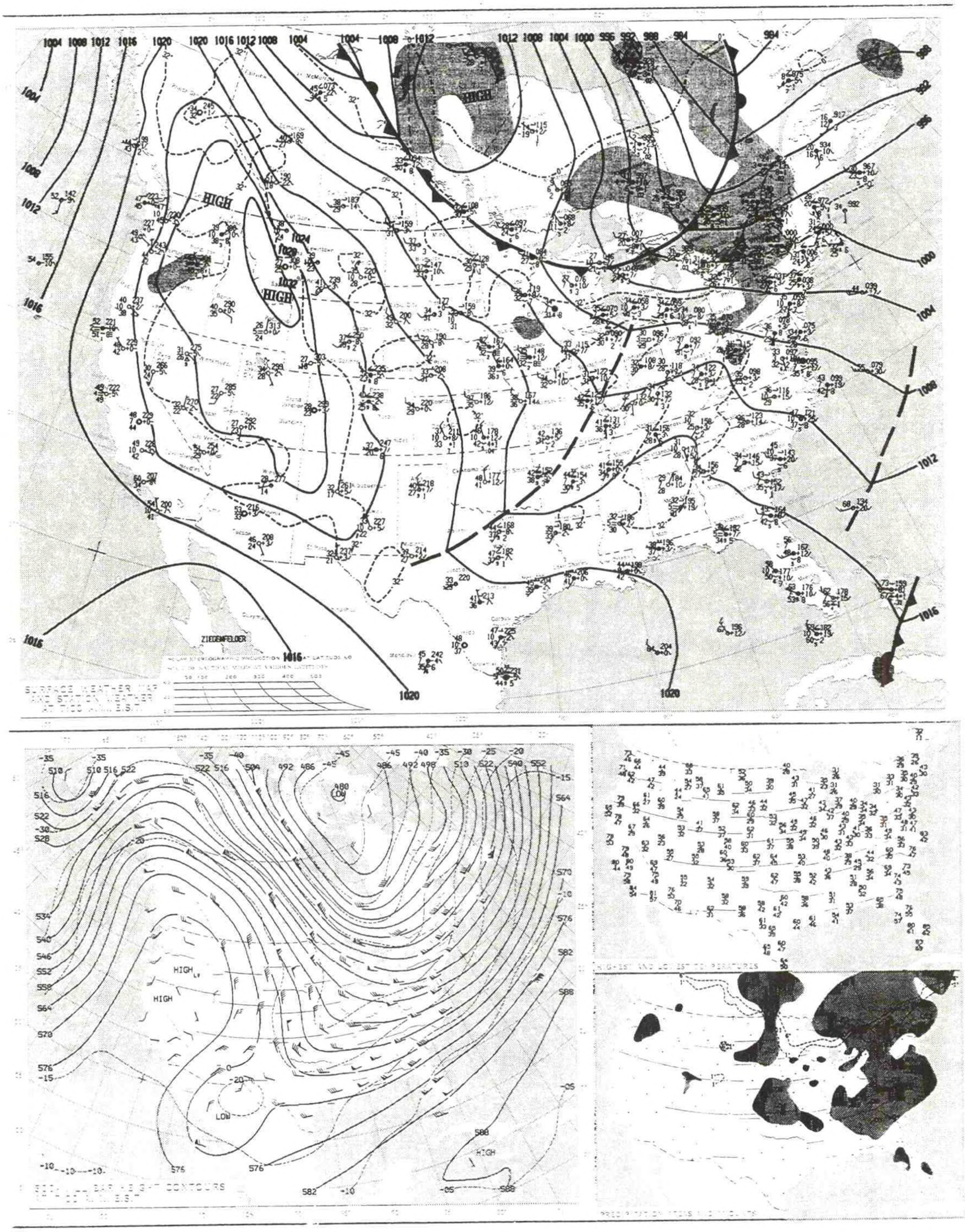
WEATHER SUMMARY

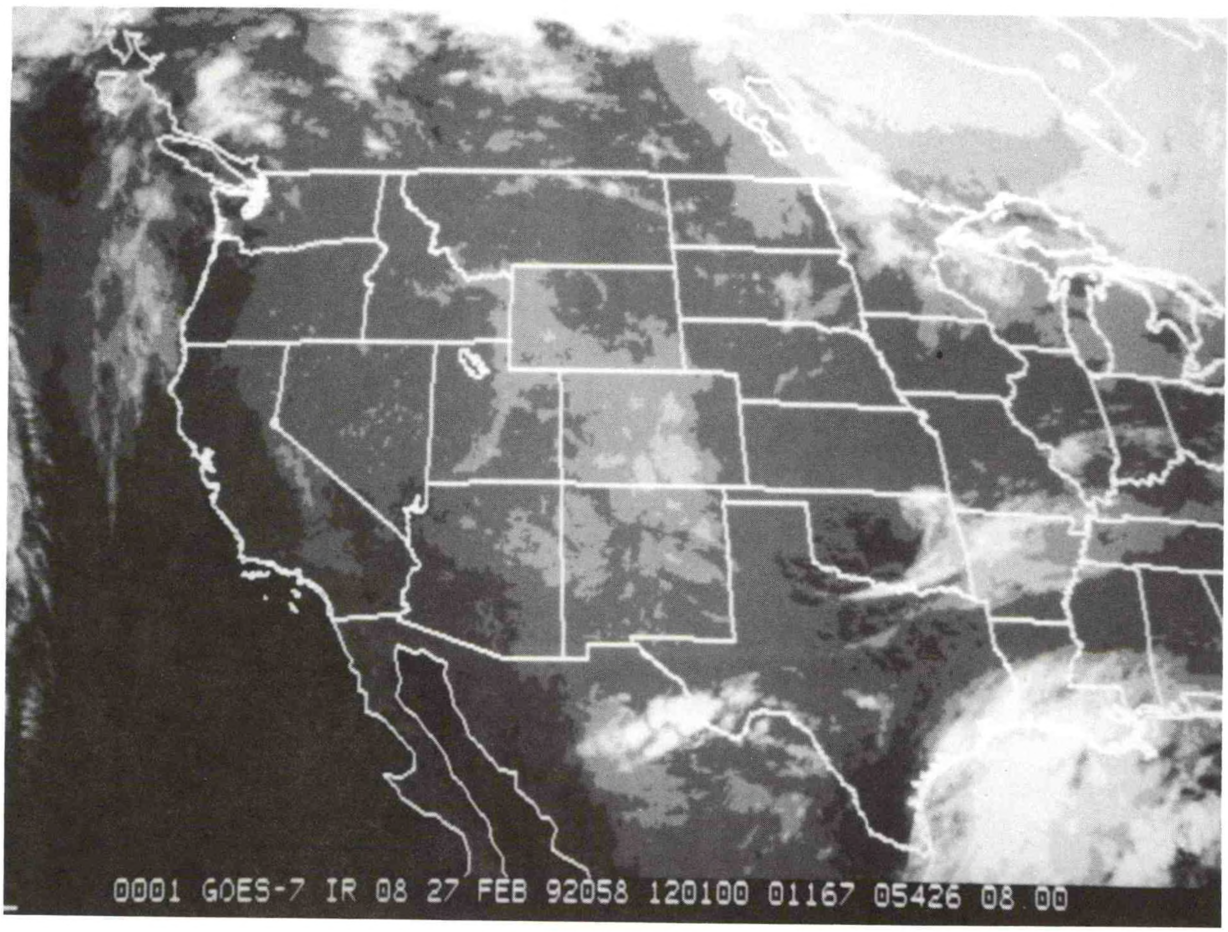
27 February 1992

As discussed yesterday, 26 February, the weather over the STORM-FEST domain was still dominated by the strong surface high pressure area over the northwest United States, with northwest flow over the STORM-FEST domain. Winds were expected to increase during the afternoon over the boundary layer array and the weather should be conducive for a nighttime radiation flight tomorrow night, 28 February.

Little change was expected over the next 24 -to 48-h. A weak shortwave was forecast to cross the Great Lakes which should push a weak front into the northeast part of the STORM-FEST domain, but there should be little weather associated with it. The MM-4 model places the front across Kansas in 48-h.

THURSDAY, FEBRUARY 27, 1992




0001 GOES-7 IR 08 27 FEB 92058 120100 01167 05426 08.00

OPERATIONS SUMMARY

27 February 1992

IOP 13 started today at 1500 UTC with supplemental soundings from the Seneca CLASS site. These were scheduled to continue until 0000 UTC (28 February). The primary objective of this IOP was to intercompare aircraft data with data from the boundary layer array and the Doppler radars to characterize the boundary layer structure and fluxes. The CP-4 radar began collecting clear air data at 1735 UTC, continuing until 2235 UTC. (CP-3 radar was down for repairs.)

At 1730 UTC the NCAR King Air took off from Richards-Gebaur AFB flying a set of 4 crosswind flux legs, a clockwise circumnavigation of the boundary layer array (crossing over the four outer Profilers), and a second set of crosswind flux legs. Aircraft soundings were interspersed with these patterns to check the inversion height. The aircraft landed at Richards-Gebaur AFB at 2138 UTC.

Other Activities:

There was some discussion about conducting a research flight tomorrow, to diagnose the jet exit region that was expected to be over the STORM-FEST domain.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 27 February

Julian Day: 58

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
IOP																					IOP #13					
UPPER AIR	CLASS																									
	NWS (Inner)	22												22												
	NWS(Outer)	11												11												
	Picket Fence																									
	Canadian	9												9												
	Ft. Sill																									
	Flatlands																									
	Seneca																									
	HIS																									
	BL Profiler (RASS)													5												
	BL Profiler (Winds)													5												
RADAR	CP-3																									
	CP-4																									
	Mile High																									
	CHILL																									
	HOT																									
	Cimarron																									
	KOUN																									
	KFDR																									
	KOKC																									
	St. Louis																									
	Grand Island																									
AIRCRAFT	NOAA P-3																									
	NCAR KA																									
	UWYO KA																									
	UW C-131																									
	NASA ER-2																									
SATELLITE	GOES RISOP																									
	NOAA																									

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00

Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported.
	AWOS	45 of 47 stations reported; 6 stations intermittent.
	HPCN	73 of 73 stations reported; 2 stations intermittent.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 10 stations intermittent.
	PROFS	22 of 22 stations reported.
	SAO	396 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 2 stations intermittent.

NOTES:

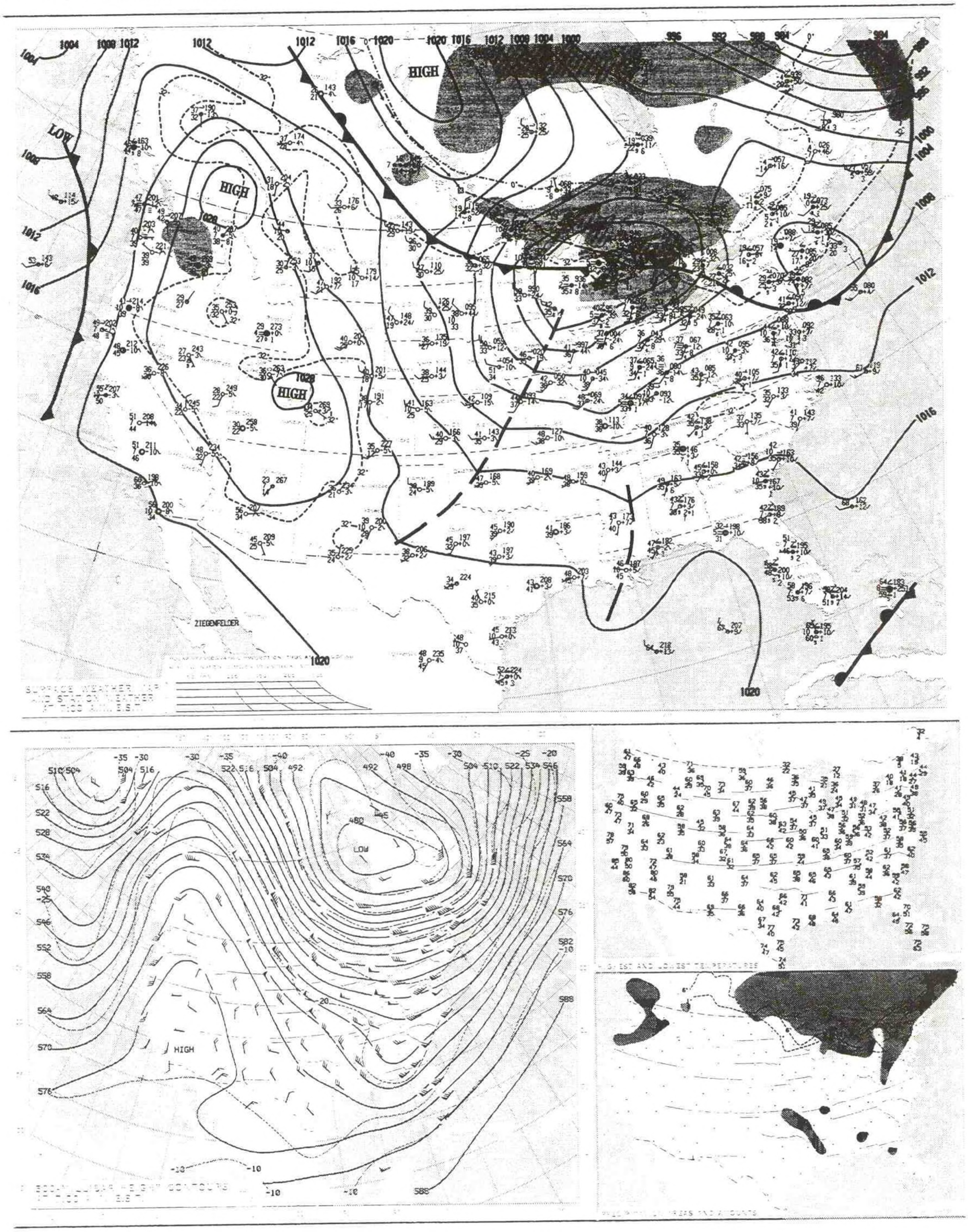
WEATHER SUMMARY

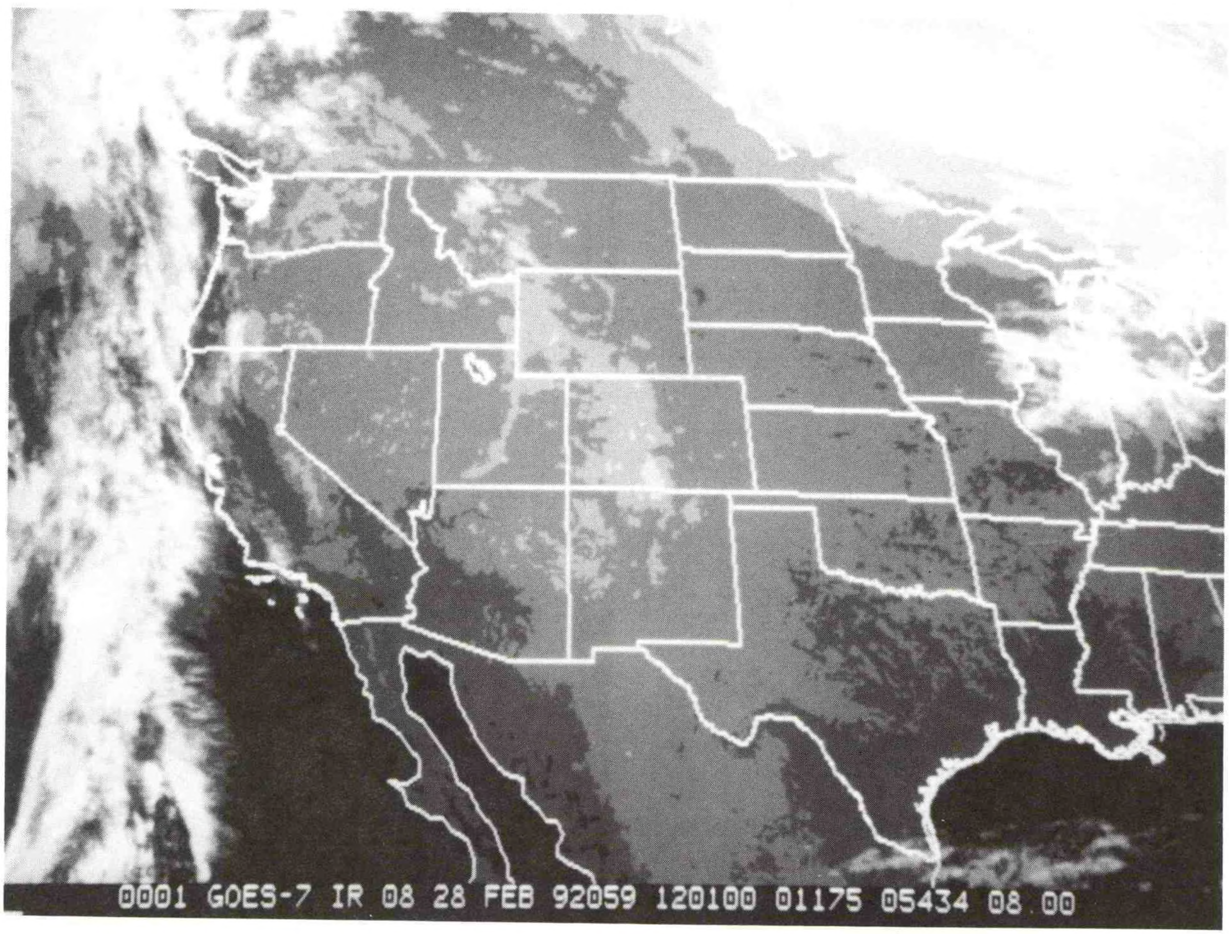
28 February 1992

Although not indicated on the 1200 UTC surface analysis, there was a weak cold front moving from northwest to southeast through the STORM-FEST domain, in response to an Alberta clipper moving down the back side of the trough. Cooler temperatures and gusty winds were associated with the frontal passage. The front was expected to be through the STORM-FEST domain by 0600 UTC, 29 February.

Over the next 24- to 48-h, the western half of the STORM-FEST domain should remain warm and dry; with a weak warm front through the middle of the domain. Little interesting weather was forecasted for STORM-FEST until the middle of next week (3-5 March).

FRIDAY, FEBRUARY 28, 1992




0001 GOES-7 IR 08 28 FEB 92059 120100 01175 05434 08.00

OPERATIONS SUMMARY

28 February 1992

IOP 14 began at 2300 UTC with the takeoff of the University of Wyoming King Air aircraft. The purpose of this mission was to test the procedures developed by John Marwitz to follow air parcels and diagnose accelerations (Lagrangian dynamics). The mission focused on the jet-exit region in moderate cyclonic streamline curvature that was over southern Iowa, western Illinois and northern Missouri.

The jet appeared well defined (57m s^{-1}), but cross-stream shears were weak. The most dramatic horizontal gradient was in the ozone concentration, which changed by a factor of four between the troposphere and stratosphere. The aircraft landed at 0356 UTC (29 February).

As noted by Dan Keyser (aircraft scientist) in addition to the Lagrangian dynamics experiment, this mission offered the opportunity to analyze the along-jet variability at the 29 kft. level, and to assess the ageostrophic wind at the 29k and 28 kft. levels. One could then compare the ageostrophic winds with their counterparts from the MAPS, NGM and MM-4 analyses.

CLASS soundings supporting this flight were taken at 0000 UTC and 0300 UTC, 29 February, from Storm Lake and Iowa City, IA.

Other Activities:

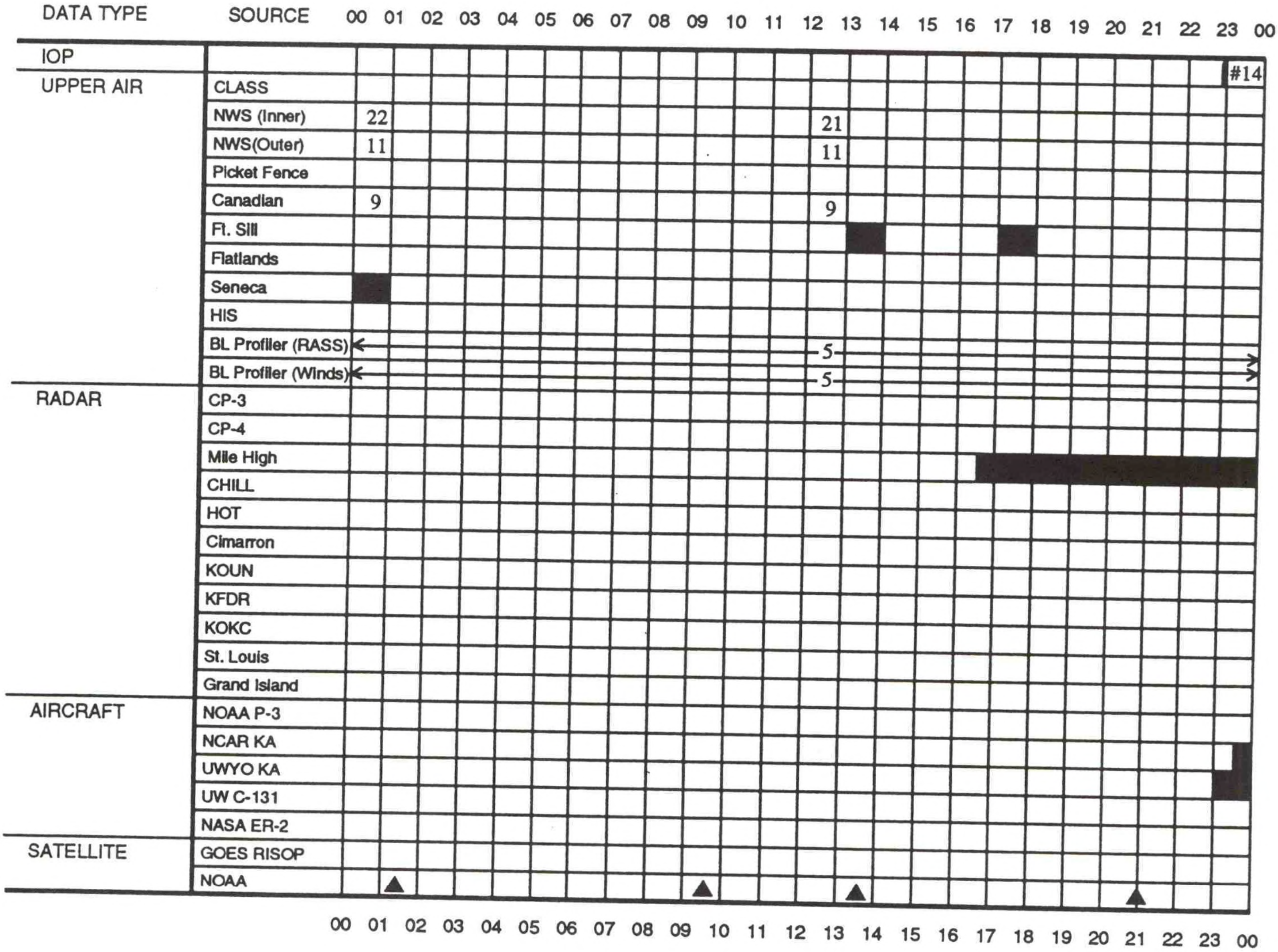
The NCAR King Air took off at 2350 UTC to fly the last of the radiation flights for Jim Telford. (See 5 February Operations Summary for review of radiation mission objectives.) The final flight landed at 0913 UTC (29 February).

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 28 February

Julian Day: 59

Time (UTC)



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported.
	AWOS	45 of 47 stations reported; 21 stations intermittent.
	HPCN	73 of 73 stations reported; 1 station intermittent.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 15 stations intermittent.
	PROFS	22 of 22 stations reported; 1 station intermittent.
	SAO	394 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

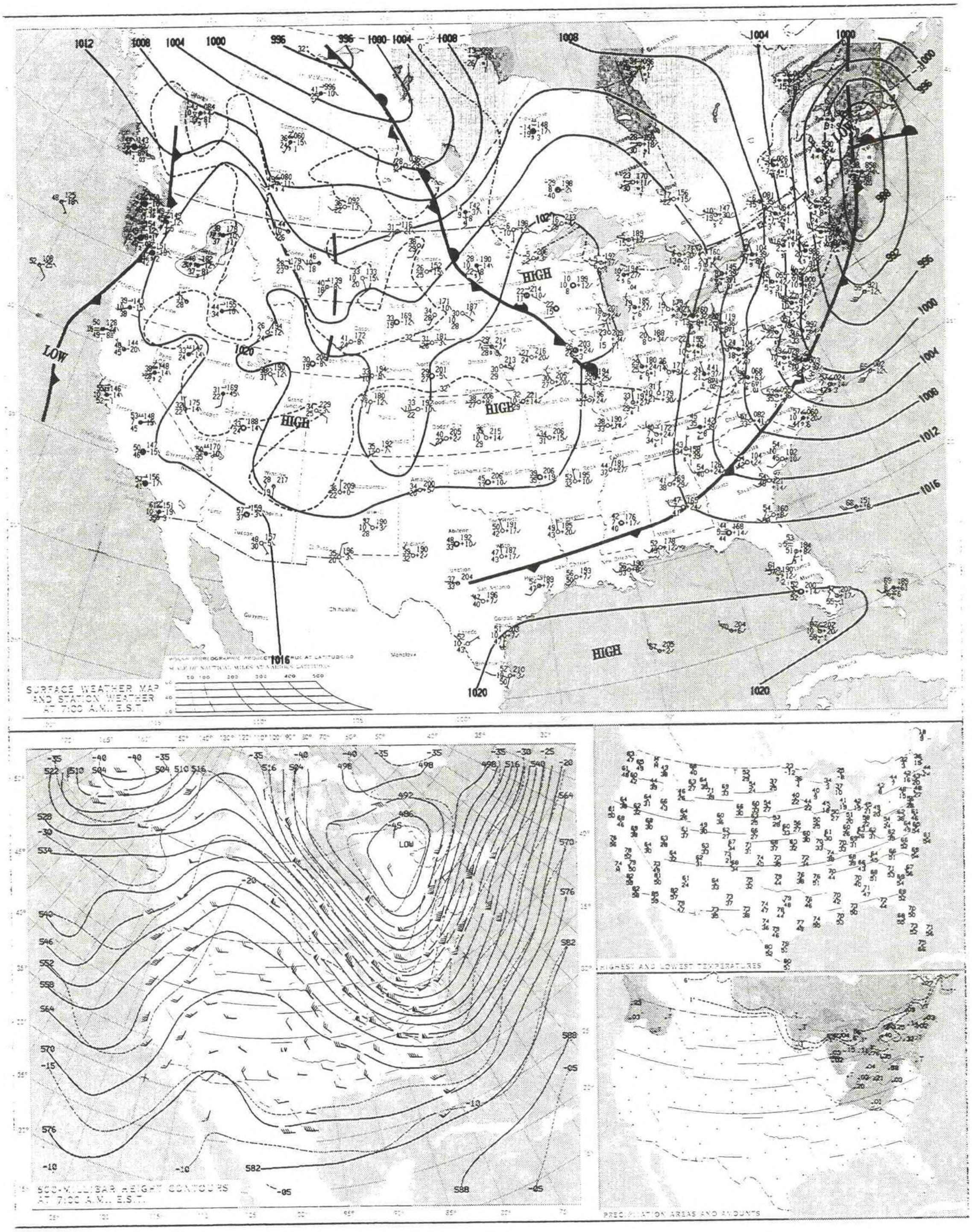
WEATHER SUMMARY

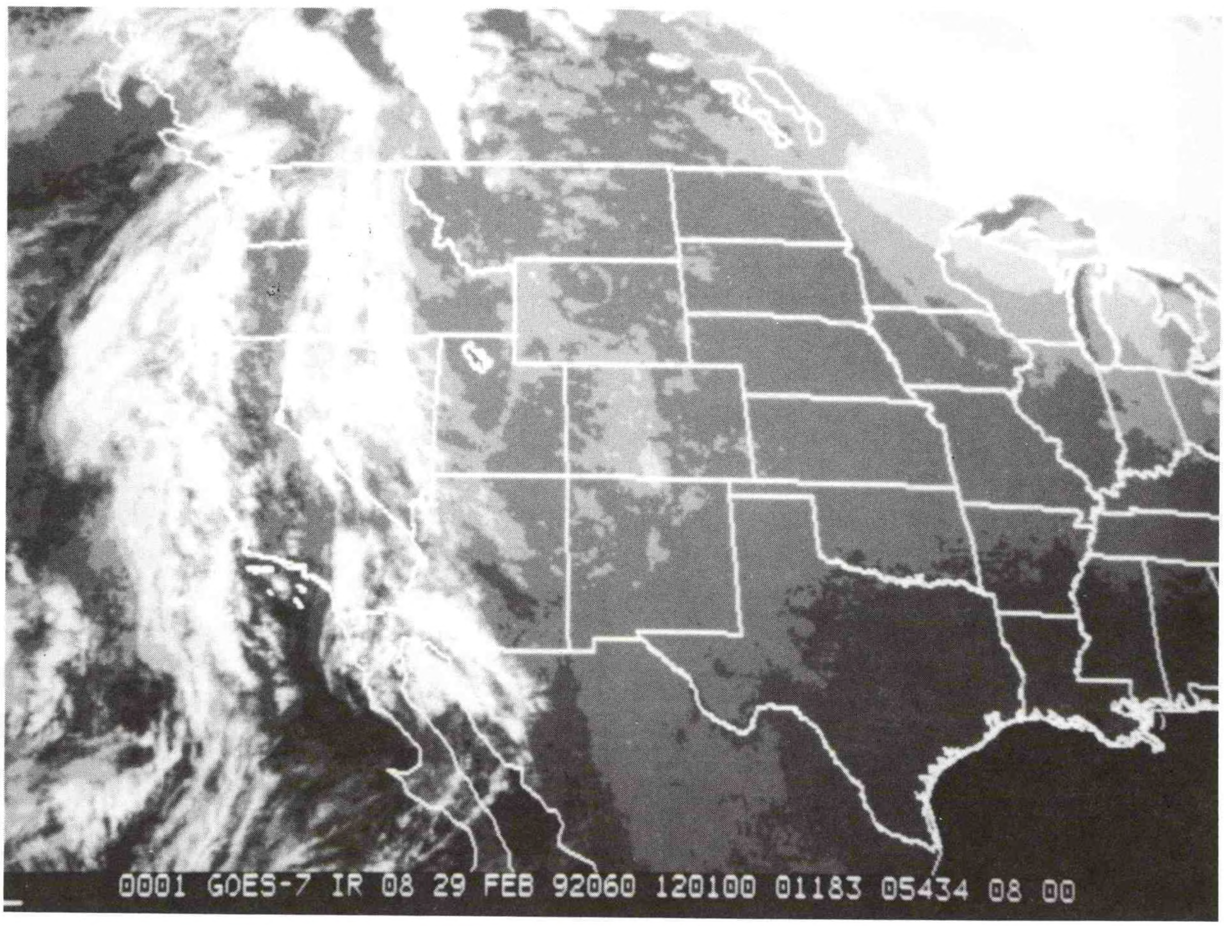
29 February 1992

A defuse high pressure area covered most of the STORM-FEST domain. Light winds and relatively warm temperatures dominated the area. Southwesterly winds were expected to increase over the area in the next 24- to 36-h and will be the dominant conditions for a (one more folks) boundary layer IOP scheduled for 1 March.

The next major weather issue was how the storm system now off the west coast was going to develop and would it move into the STORM-FEST domain or further south.

SATURDAY, FEBRUARY 29, 1992




0001 GOES-7 IR 08 29 FEB 92060 120100 01183 05434 08 00

OPERATIONS SUMMARY

29 February 1992

After both the University of Wyoming (0356 UTC) and NCAR King Air (0913 UTC) aircraft landed as part of IOP 14 and the radiation mission ended, no other operations were conducted. Planning still continued for the boundary layer IOP (15) for tomorrow, 1 March. In addition, scientists began to look at the timing for operations on the next weather system, that was expected to move into the STORM-FEST domain on or about 3 March.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 29 February

Julian Day: 60

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP				IOP #14																					
UPPER AIR	CLASS	2			2																				
	NWS (Inner)	22												20											
	NWS(Outer)	11												11											
	Picket Fence																								
	Canadian	9												9											
	Ft. Sill																								
	Flatlands																								
	Seneca																								
	HIS																								
	BL Profiler (RASS)													5											
	BL Profiler (Winds)													4											
RADAR	CP-3																								
	CP-4																								
	Mile High																								
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA																								

Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 23 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 9 stations intermittent.
	PROFS	22 of 22 stations reported; 10 stations intermittent.
	SAO	389 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

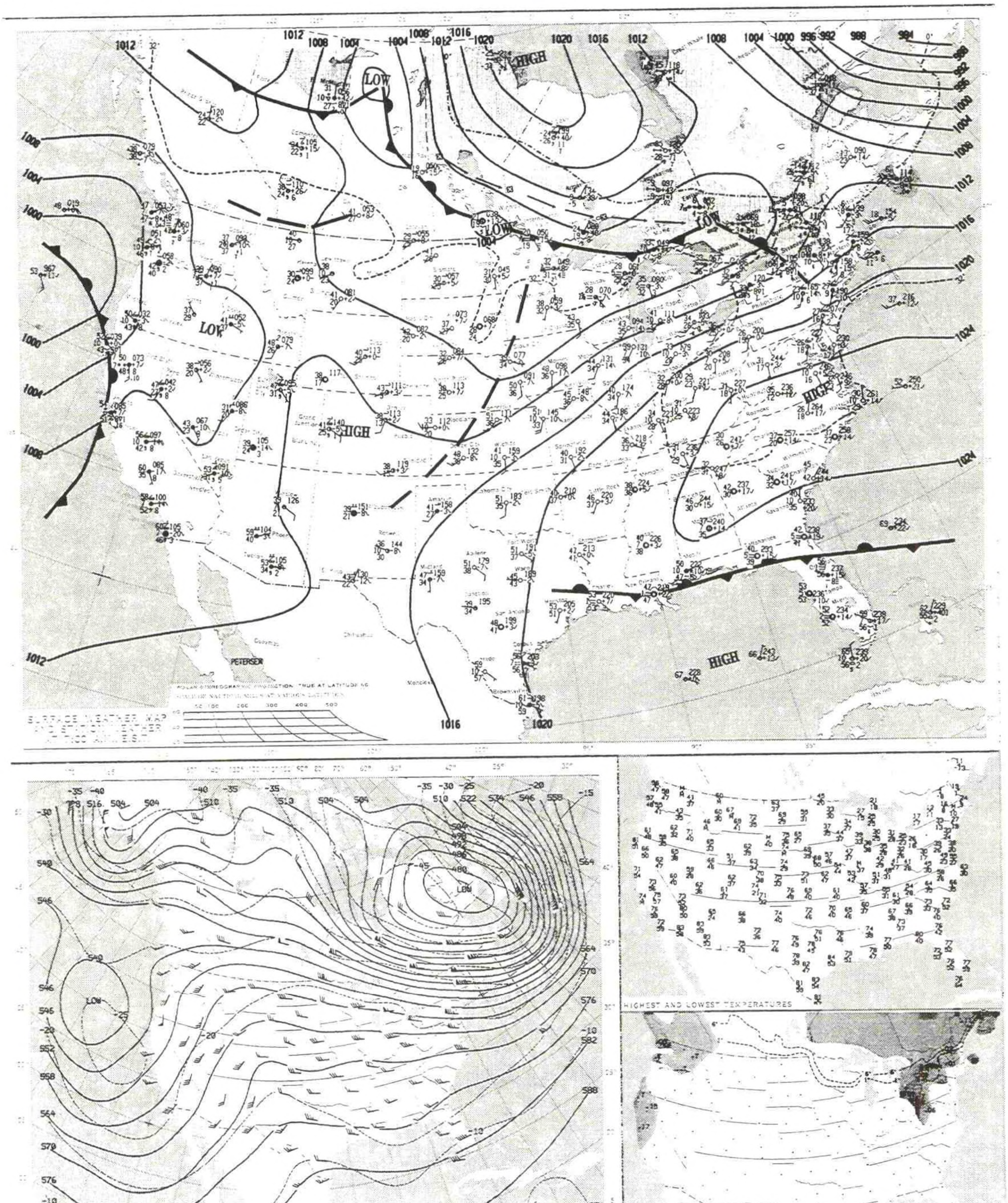
NOTES:

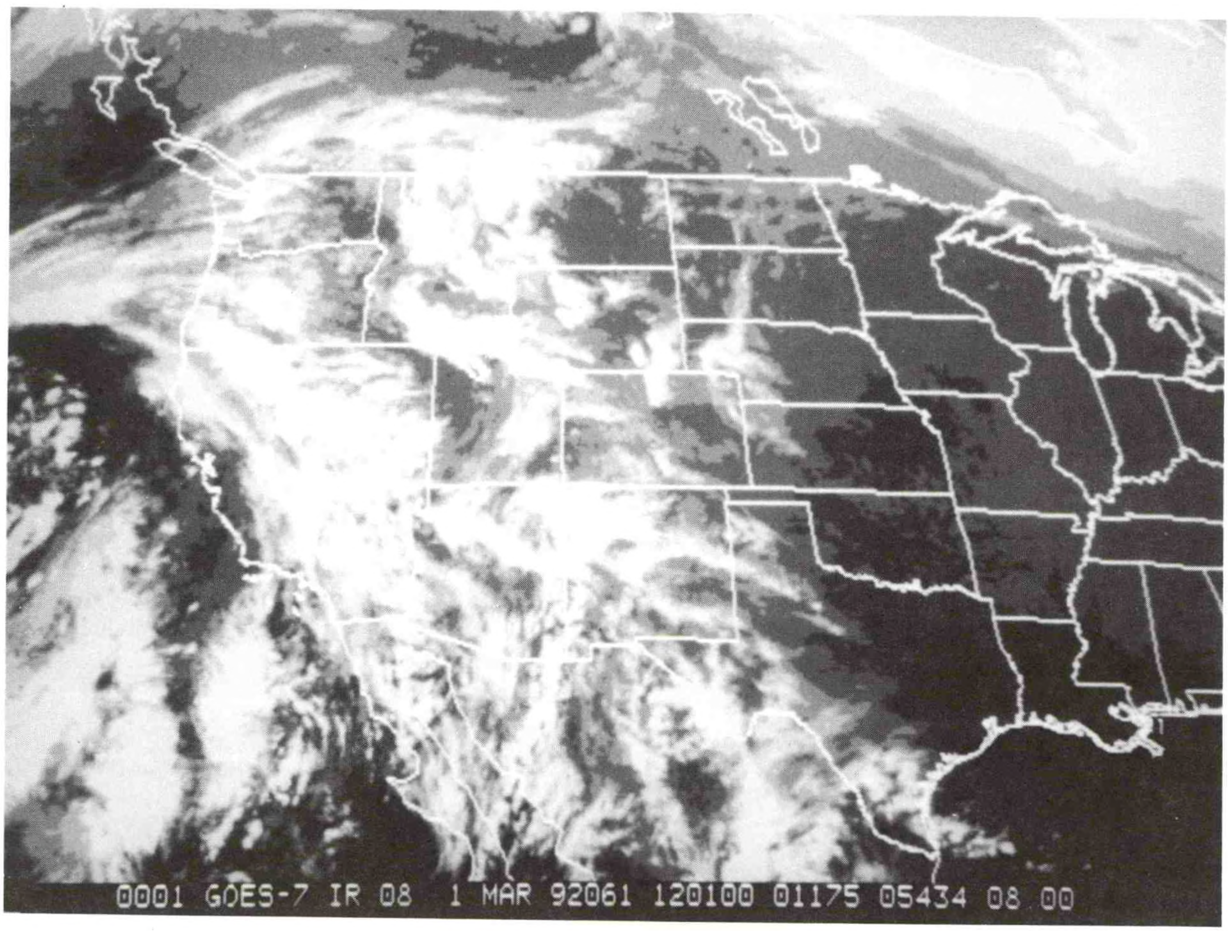
WEATHER SUMMARY **1 March 1992**

Fair skies existed over the entire STORM-FEST domain with relatively strong low-level winds from the south and southwest over the eastern portion of the STORM-FEST domain and weak westerly winds over the western portion of the domain.

The strong Pacific system seen at 1200 UTC should be closing off in the northern Baja region, with increasing diffluent southwest flow aloft. Low-level southerly flow in Texas/Oklahoma was expected to increase the low-level moisture from the Gulf of Mexico. The shortwave in the northern branch across southern Canada should develop a weak surface cold front in the northern part of the STORM-FEST domain by 2 March. All this should come together and focus the weather in the STORM-FEST region on or about 2-3 March. Precipitation was expected to begin in the extreme southern part of the domain after 1800 UTC (2 March). By this time, as the front stretches from west-central Kansas through northern Missouri into Illinois, low clouds would likely be increasing from north Texas through Oklahoma.

SUNDAY, MARCH 1, 1992




0001 GOES-7 IR 08 1 MAR 92061 120100 01175 05434 08 00

OPERATIONS SUMMARY

1 March 1992

The fair skies and strong southerly winds provided the setting for both a clear air ER-2 flight and a boundary layer study using the NCAR King Air with supplemental CLASS soundings from Seneca. The following operations were carried out today.

0900 UTC The ER-2 launched at 0900 UTC for a HIS mission over the boundary layer network centered at Seneca, Kansas. The scientific objective for this flight was to map the thermodynamic structure of the strong subsidence inversion which typically develops during the night in the Seneca region. The HIS ground-based profiler had shown the presence of a significant inversion the night before, and this feature was expected to develop again. It did and the special CLASS soundings released at Seneca, Kansas, at 1130 UTC and 1230 UTC substantiated it, as well as a strong low-level jet. The MAMS was in place for this flight which added its 3 water vapor channels to the ER-2 instrumentation. The total body of information sampled by airborne and ground-based HIS, MAMS, and the CLASS soundings during this flight was quite impressive and will be useful to the studies of inversion and jet features. This mission was also the first opportunity to fly the MTS in an "upward-looking" mode to calibrate against cold space and to profile above the aircraft.

The second aspect of today's operations was IOP 15 to investigate the boundary layer structure and fluxes in a south wind flow regime.

1500 UTC Five CLASS soundings (some 1.5-h frequency) were released from the Seneca site, from 1500-2230 UTC.

1707 UTC CP-4 became operational to support the NCAR boundary layer flight. The radar conducted alternating exploratory scans and 30° "flux" scans. The "exploratory" scans included low-level PPIs and RHIs. The radar operated until 2208 UTC.

1714 UTC The NCAR King Air Took off to study the boundary-layer structure and fluxes in a south wind regime. Two sets of flights around the boundary-layer region were made with aircraft soundings taken at Powhattan. Because the pattern flown took shorter than expected, the aircraft also flew optional legs at ($0.5Z_i$).

Radar flux scans were fairly well synchronized with the first set of flux legs, but were a bit late for the second set of flux legs. Low-level radar scans indicated that the flight pattern was flown in the presence of roll-vortices orientated 240° to 060°, roughly along the mean boundary layer wind. Their presence was consistent with fairly strong winds, which exceeded 20 m/s at flight level at the top of the boundary layer. (The 1800 UTC Seneca CLASS sounding showed a low-level jet of 62 kt.) Airborne observers noted the presence of "wave cloud," which was probably associated with smoke from agricultural burning, since the air was very dry. The inversion was strong and well-defined in the Seneca soundings. Z_i varied between 3500 ft and 3900 ft msl (2200-2600 agl), at least during the first two-thirds of the flight.

The orientation of the cross-wind flight legs were NW-SE, meaning they were not optimum for crossing the maximum number of rolls, but the pattern was constrained to fly over ASTER and to keep the leg within the Boundary Layer array. In fact, there was some concern that the cross wind legs might not have been long enough. In response to this, the low-level legs in the second set of flights around the boundary-layer domain were flown at full length. The aircraft landed at 2130 UTC.

Clear air radar reflectivity was good out to 70-80 km. The air crew noticed a small number of insects at their altitude.

IOP 15 ended at 0000 UTC (2 March).

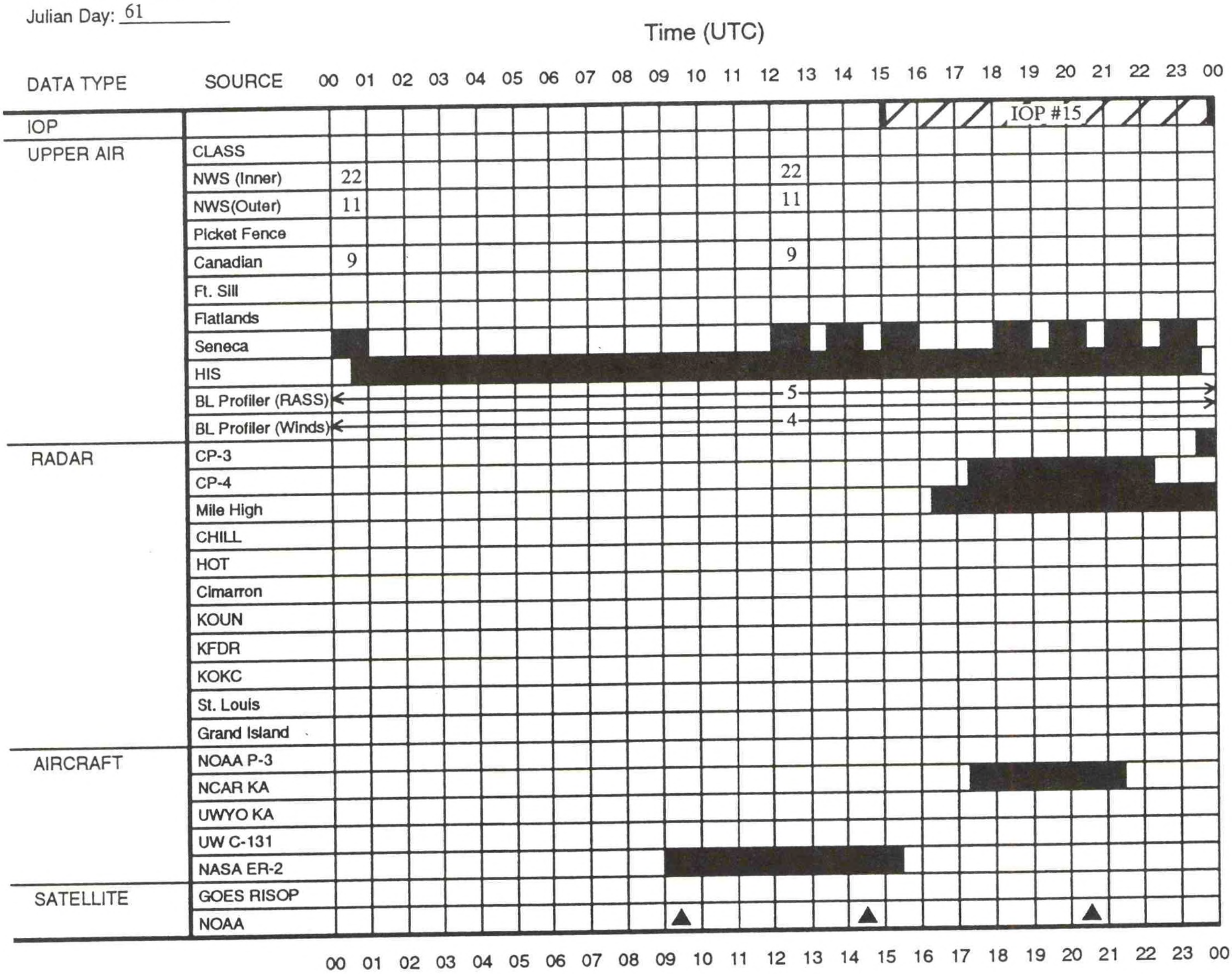
Other Activities:

Plans continued to be developed for the next IOP for the storm system that was expected to affect the STORM-FEST domain on 3-5 March.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 1 March

Julian Day: 61



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 8 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 13 stations intermittent.
	PROFS	22 of 22 stations reported; 3 stations intermittent.
	SAO	384 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

WEATHER SUMMARY

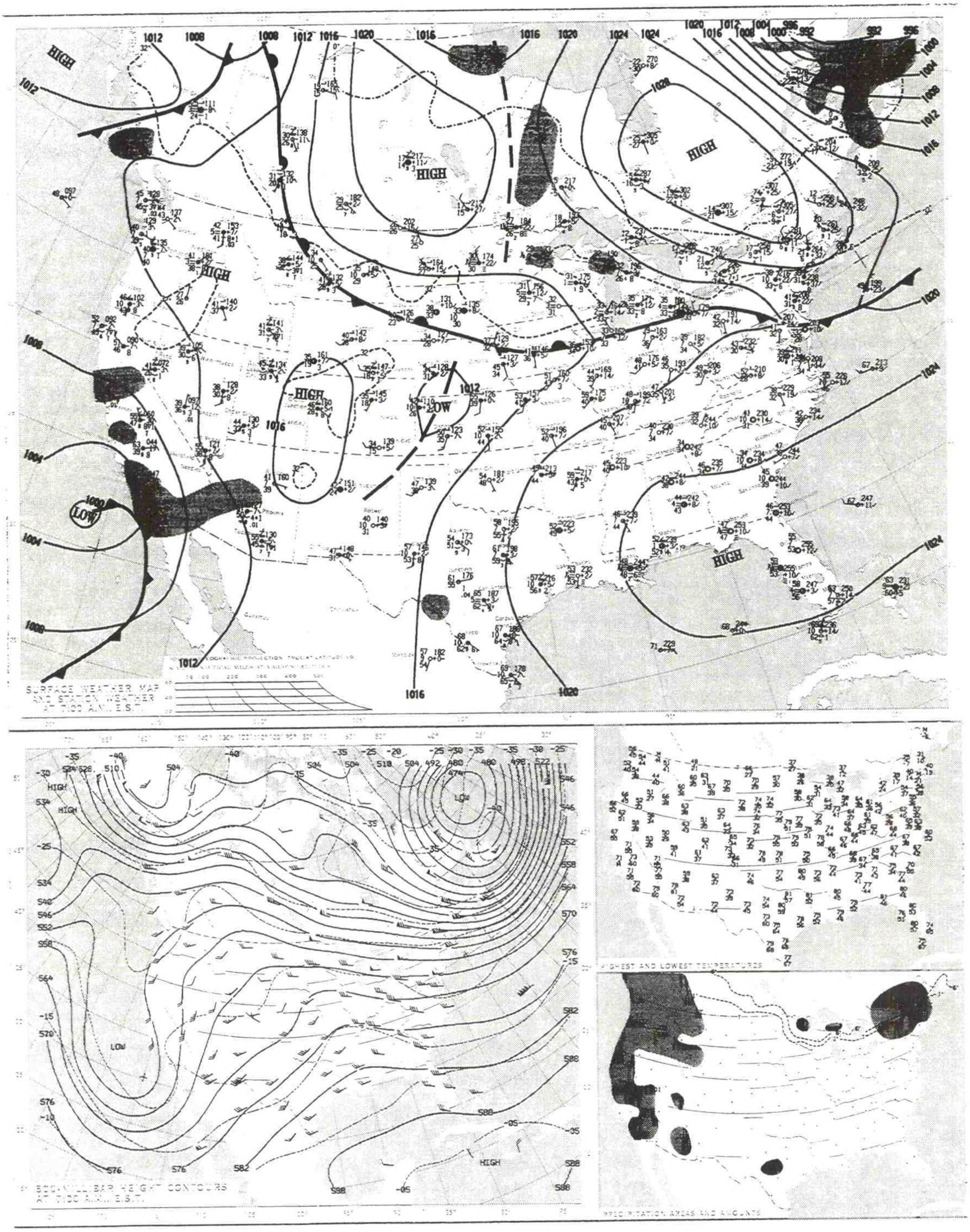
2 March 1992

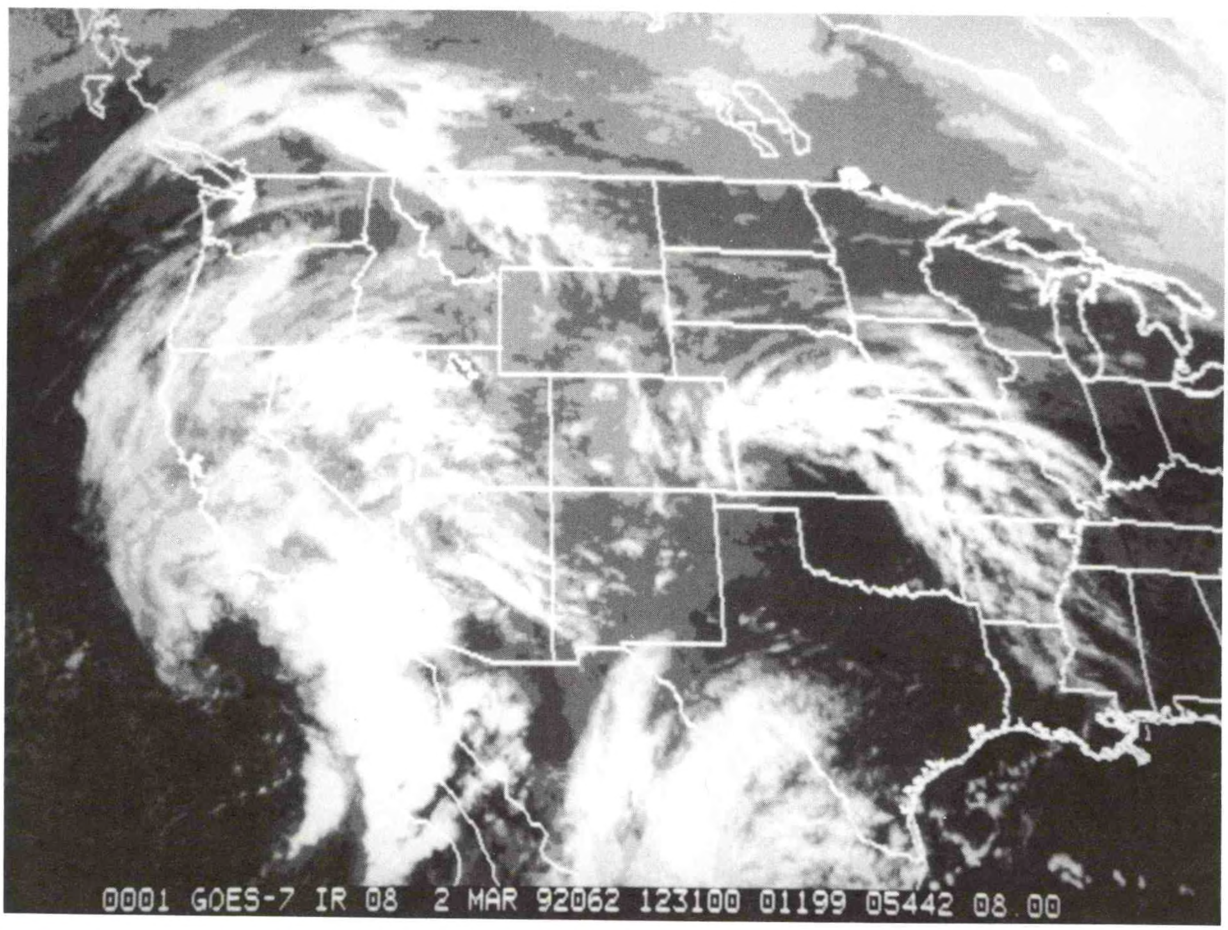
There was still no active weather in the STORM-FEST domain (although conditions were changing). At the surface, a weak stationary front was located across the northern portion of the STORM-FEST domain, 1016 mb high was present over the Rocky Mountains and a surface low was located just off the southern California coast. The upper-level 500 mb trough had dug further south off the California coast and was expected to move into southern California and Arizona by tomorrow, 3 March.

Low-level moisture was moving rapidly northward from the Gulf of Mexico into the southeastern part of Oklahoma. It was expected that shower activity would develop there by morning, 3 March, as a 500 mb shortwave moves across north Texas. It was expected that as this storm moves eastward, the low-level flow in Texas and Oklahoma would become more southeasterly and low-level moisture would be advected toward a developing surface low in extreme northeast New Mexico/southwest Kansas. As the low-level moisture increases in southwest Oklahoma (by 3 March), showers and thunderstorms would be likely to produce as much as 0.25 inches of precipitation.

The model progs indicated that as the upper-level storm system moves eastward and the surface low develops in the Texas panhandle early Tuesday afternoon (3 March), showers and thunderstorms would develop along the dry line in the Texas panhandle. This activity should move into western Oklahoma by 2000 UTC, 3 March. At this time it appears that the cold advection at 500 mb and warm/moist low-level advection would destabilize the atmosphere enough to produce some severe thunderstorms and heavy precipitation. The best six hour time block for precipitation in the Little Washita basin appeared to be from 2000 UTC (3 March) to 0200 UTC (4 March).

MONDAY, MARCH 2, 1992




0001 GOES-7 IR 08 2 MAR 92062 123100 01199 05442 08.00

OPERATIONS SUMMARY

2 March 1992

No operations occurred during the day. Planning continued for IOP 16 with NWS inner domain soundings and CLASS soundings scheduled to begin at 1800 UTC, 3 March, and running to 0000 UTC, 5 March. The CP-3 and CP-4 radars were placed on alert to begin operations as early as 1500 UTC, 3 March. First aircraft flights could begin as early as 1200 UTC, 3 March. A briefing at 0400 UTC (3 March) was scheduled.

In preparation for the expected precipitation in Oklahoma, Oklahoma City (KOKE) WSR-88D radar began collecting Archive II data at 2330 UTC.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 2 March

Julian Day: 62

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP																									
UPPER AIR	CLASS																								
	NWS (Inner)	22												21											
	NWS(Outer)	11												11											
	Picket Fence																								
	Canadian	9												9											
	Ft. Sill																								
	Flatlands																								
	Seneca																								
	HIS																								
	BL Profiler (RASS)													5											
	BL Profiler (Winds)													4											
RADAR	CP-3																								
	CP-4																								
	Mile High																								
	CHILL																								
	HOT																								
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis																								
	Grand Island																								
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA																								

Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 2 stations intermittent.
	AWOS	46 of 47 stations reported; 6 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 7 stations intermittent.
	PROFS	22 of 22 stations reported; 22 stations intermittent.
	SAO	391 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

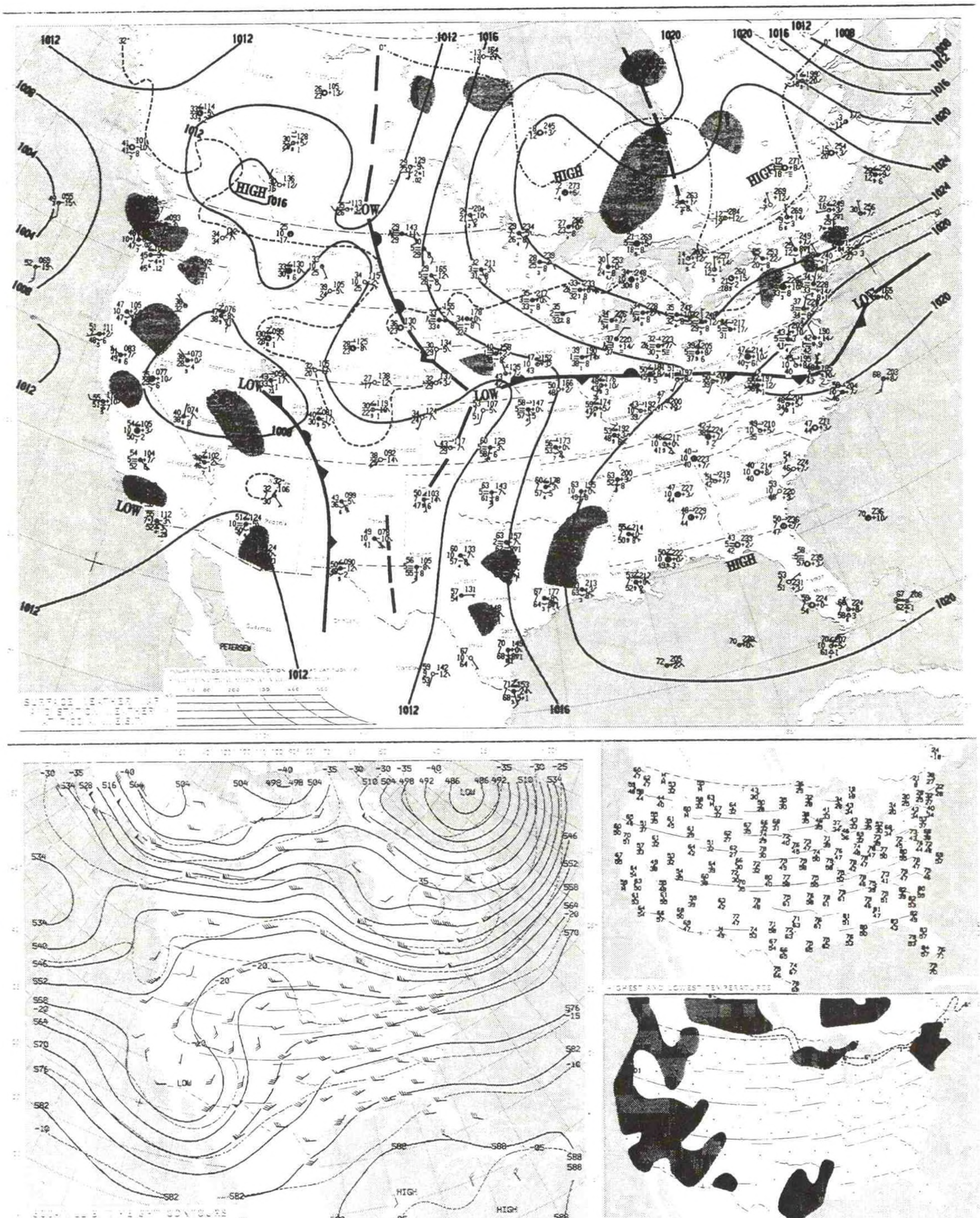
WEATHER SUMMARY

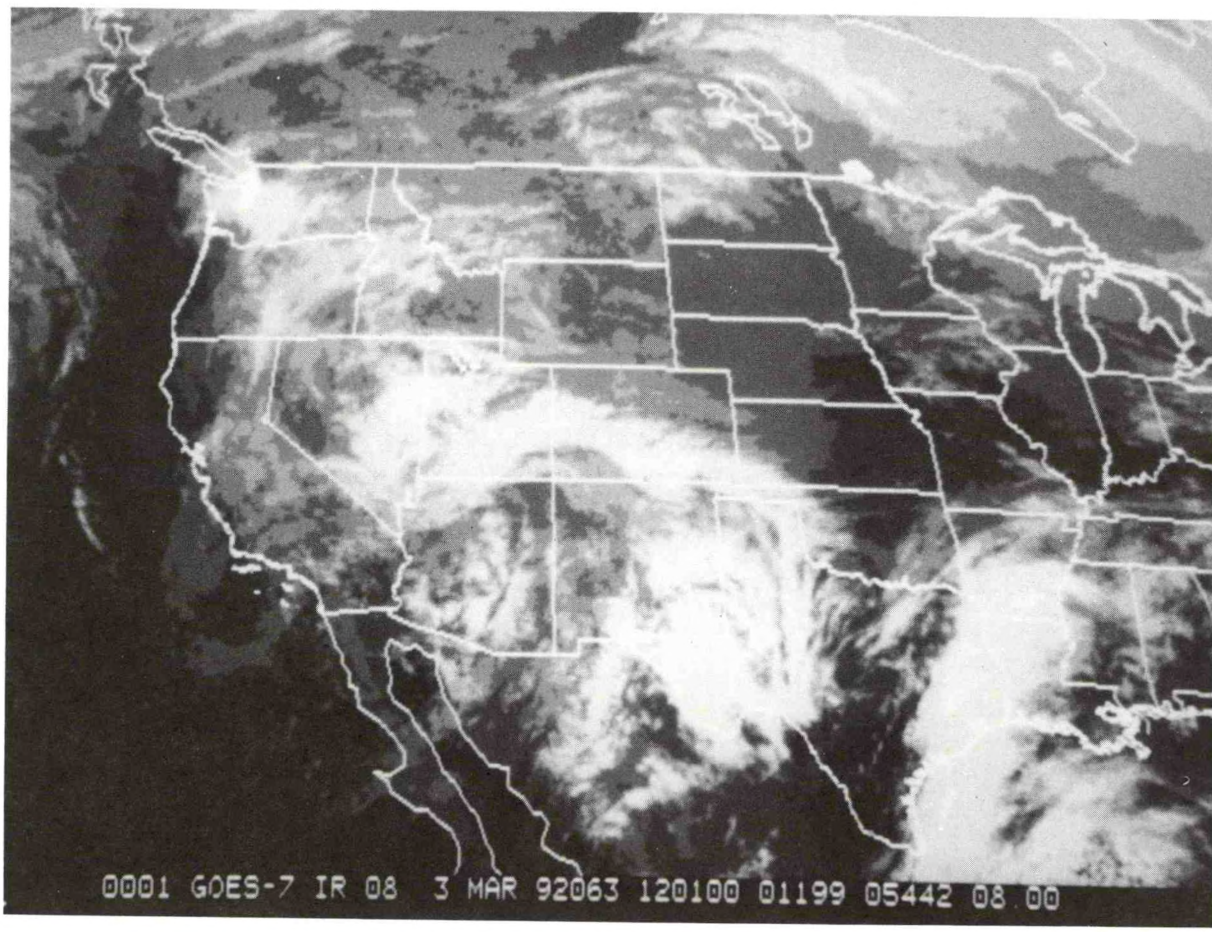
3 March 1992

The surface low pressure center associated with the West Coast trough was slowly deepening over central Nevada/Utah. The upper-level low now entering Arizona was forecast to move due east over New Mexico in the next 24-h. This placed Oklahoma in diffluent flow with imbedded short waves. One of these short waves was initiating convection ahead of the surface boundary near the New Mexico/Texas border. There was weak upper-level warm advection along with high level cloudiness over Oklahoma and eastern Texas which inhibited convection in that area. The aforementioned short wave trough should begin to change this situation by at least 0000 UTC, 4 March, with thunderstorms expected in southwest Oklahoma. These should spread east during the day tomorrow, 4 March.

Although the NGM seemed to have trouble phasing the PVA and vertical velocities with the trough moving into the west Coast in the next 24- to 36-h, it initialized well with satellite imagery. The NGM forecasted the movement of the surface and upper lows more slowly east than the LFM, and more on a southerly track than the AVN model, which lifted them to the northeast at 36-h. There was a strong jet (>130 kt @ 300 mb) located at the base of the upper low, in northern Mexico. This argued in favor of the more southerly track forecasted by the NGM. There is very little low-level cold air with this system. However, the cold air should move east with the system into Oklahoma on the afternoon of 4 March, ending most of the precipitation in the western part of the state.

TUESDAY, MARCH 3, 1992




0001 GOES-7 IR 08 3 MAR 92063 120100 01199 05442 08 00

OPERATIONS SUMMARY

3 March 1992

The following operations were conducted to support IOP 16.

1515 UTC The P-3 conducted a brief dropwindsonde test flight over Richards-Gebaur AFB prior to the start of IOP 16.

1800 UTC IOP 16 began with NWS inner domain soundings and CLASS soundings. The objective of this IOP was to study the formation and evolution of the cyclone in southeast Colorado/southwest Kansas and the fronts and rainbands associated with it.

1800 UTC Along with NWS inner domain and CLASS soundings, GOES-7 RISOP mode began and was scheduled to continue until 0000 UTC, 5 March.

1845 UTC The NCAR King Air took off to sample the environment in southern Kansas and northern Oklahoma in anticipation of thunderstorms developing in that region. Only a few weak showers developed and the mission was terminated at 2119 UTC.

1915 UTC CP-3 Radar became operational.

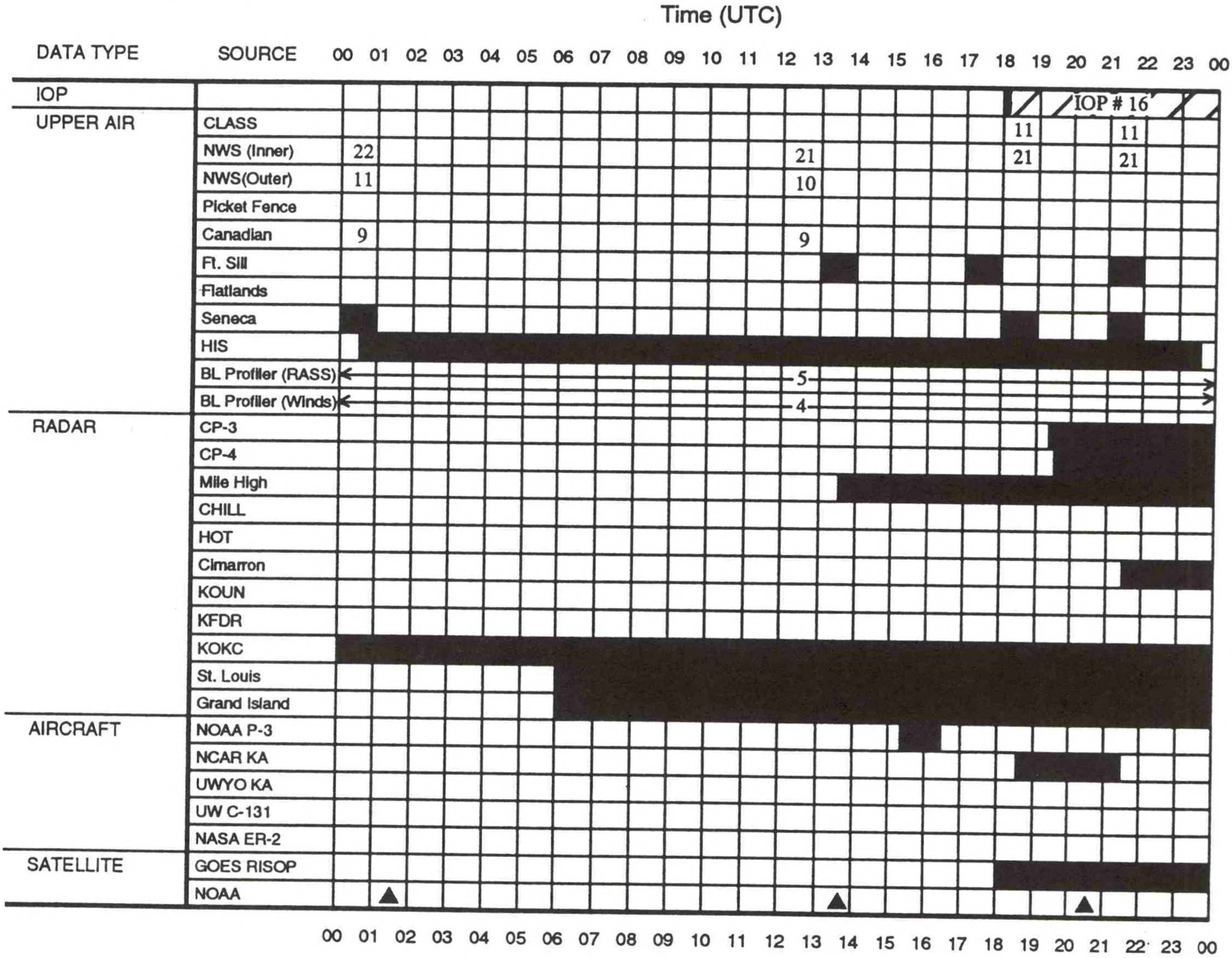
1930 UTC CP-4 Radar became operational.

2217 UTC NSSL Cimarron radar became operational.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 3 March

Julian Day: 63



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 3 stations intermittent.
	AWOS	47 of 47 stations reported; 4 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 9 stations intermittent.
	PROFS	22 of 22 stations reported.
	SAO	394 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported; 12 stations intermittent.

NOTES:

WEATHER SUMMARY

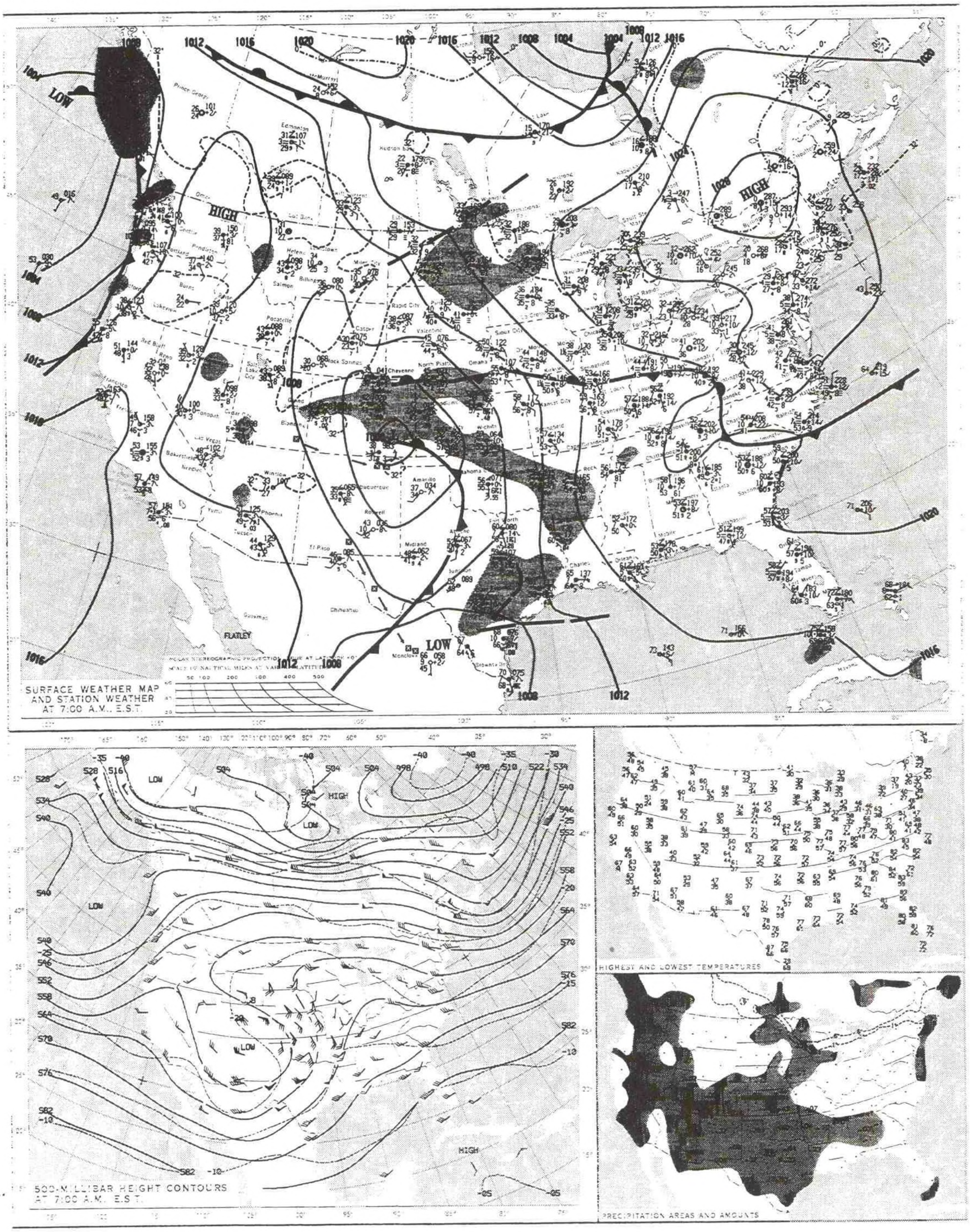
4 March 1992

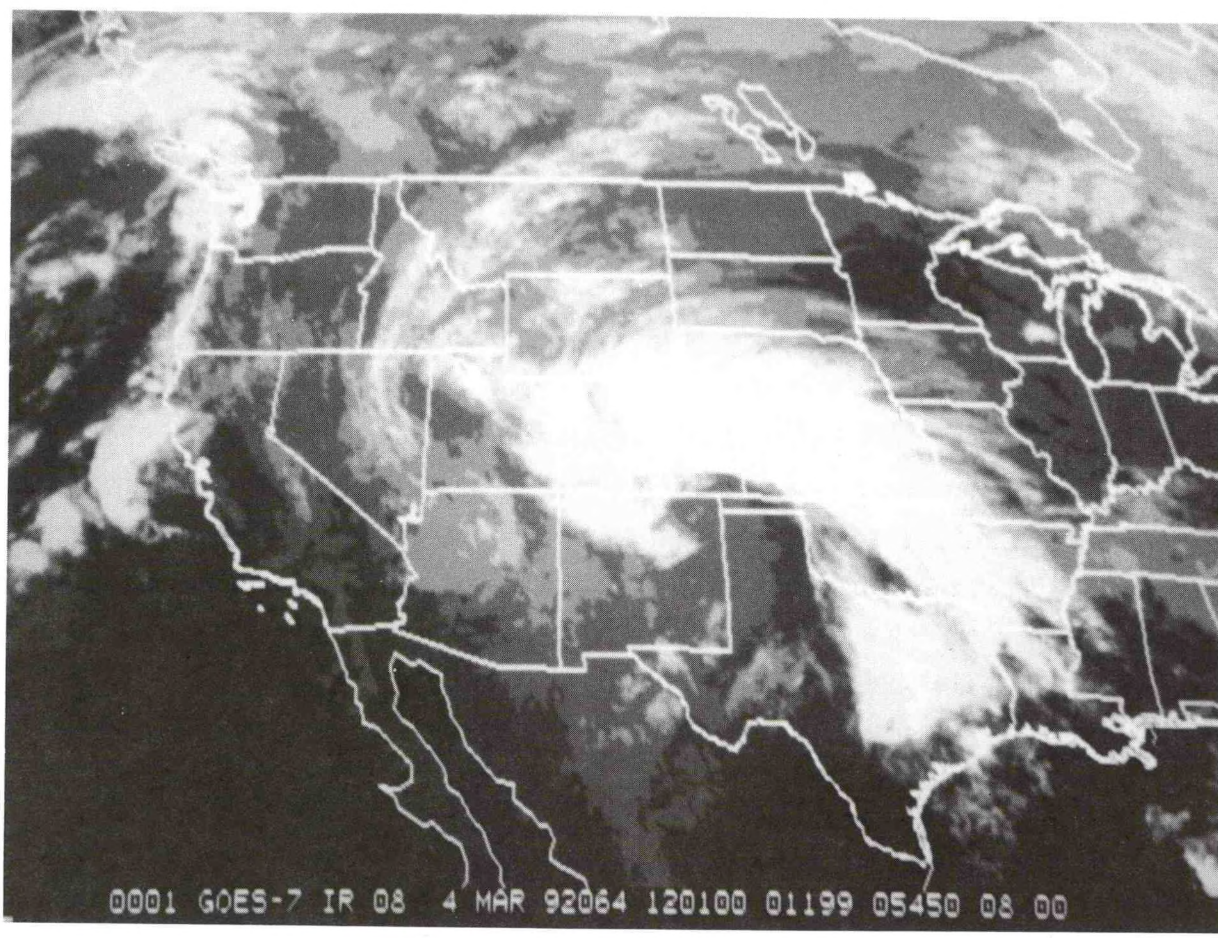
At 1200 UTC, the surface low had moved over the southern Colorado/Kansas area with a weak cold front extending down over western Oklahoma and central Texas. A major precipitation band extended from the surface low southeastward down through northern Oklahoma and central Arkansas. A weak stationary front was still evident in the surface analyses extending east-west from southern Nebraska to southern Indiana.

An upper-level cold low was centered over northwest New Mexico and was slowly drifting east, giving potential for destabilizing the atmosphere over Oklahoma during the afternoon. There were indications of a short wave trough (SWT) located at the base of the upper low (now over El Paso), which could trigger convection over Oklahoma. The difficult question was the timing of a dryline/cold front now entering the extreme southwest corner of Oklahoma.

Surface heating (skies were partly cloudy over southwest Oklahoma) ahead of the dryline, combined with the SWT, should fire convection first over central Oklahoma, and then over the eastern half of Oklahoma, from this evening through 1200 UTC, 5 March. The NGM forecasted strong upward motion and rain amounts over 1.5 inches over eastern Oklahoma from 0000-1200 UTC, 5 March. Since this model depicted the SWT mentioned above, and produced the precipitation on 3 March (now over southern Kansas), this seemed a likely scenario.

WEDNESDAY, MARCH 4, 1992




0001 GOES-7 IR 08 4 MAR 92064 120100 01199 05450 08 00

OPERATIONS SUMMARY

4 March 1992

IOP 16 continued with soundings, radar operations, GOES-7 RISOP, and flights of the C-131, NOAA P-3, Wyoming King Air and NCAR King Air to sample the environment around the low pressure center and developing precipitation band associated with the low. The following operations were conducted today to support this IOP.

0012 UTC The University of Washington C-131 took off to sample the deepening surface low pressure area centered over eastern Colorado/western Kansas. The C-131 flew at 12 kft. from Kansas City to the low centered over western Kansas. It then flew at approximately 8 kft. to the Oklahoma panhandle and then flew eastward to sample the larger scale environment. On return to Kansas City, thunderstorms developed in central and eastern Kansas. The aircraft landed at 0554 UTC. This flight should provide information on the developing low and conditions in Kansas prior to and during initial stages of precipitation.

1505 UTC The NOAA P-3 took off to document the precipitation band in what some scientists called a "barotropic" cyclone, anticipating that there would be dry southerly flow south of the band, moist easterly flow in the band, and a warm moist tongue and a steep cloud edge along the south edge of the band. Neither the thermal signature nor the steep cloud edge was seen. There was a very distinctive wind signature with a sharp wind shift and a strong easterly jet just north of the dry southerly flow. There was also a displacement of about 100 km north of the precipitation band from the cloud edge.

After takeoff, the P-3 did a dropwindsonde run from Richards-Gebaur AFB to the southeast, followed by a short vertical stack near Wichita. The P-3 then flew northward into Nebraska and did a "sawtooth" pattern into the more active area of the cloud band near the Nebraska corner of Colorado. The return leg, also flown in the cloud band, was a "sawtooth" pattern back to Richards-Gebaur AFB. Much of this flight was conducted at 11 kft. MSL at a temperature of about -3°C. The result was excellent documentation of along band variability of cross band structure. As stated above, the south edge of the wrap around moisture was clearly identified in the wind field, but absent in the thermal field. Clearly a boundary existed between southerly dry and easterly moist flow, but it was not a front in the thermal field. (Had this been a baroclinic cyclone, the thermal front would have been there.) The aircraft landed at 2306 UTC.

1625 UTC The University of Wyoming King Air took off to conduct an "M" surface flight pattern in the rainband near Emporia, Kansas. After a moderately successful flight, the aircraft did an along band stack in a rainband that had moved into the dual-Doppler area. Stacks were flown at 12k, 11k, 9k and 10 kft. The aircraft encountered some turbulence and updrafts of 4-5 ms^{-1}. The aircraft landed at 2114 UTC.

1734 UTC The NCAR King Air took off to sample the main rainband located in south central Nebraska. The aircraft flew across the rainband at 12k, 9k and 6 kft. Two dropwindsonde soundings were taken near the center of the band prior to the aircraft heading back to Richards-Gebaur AFB. The aircraft landed at 2155 UTC.

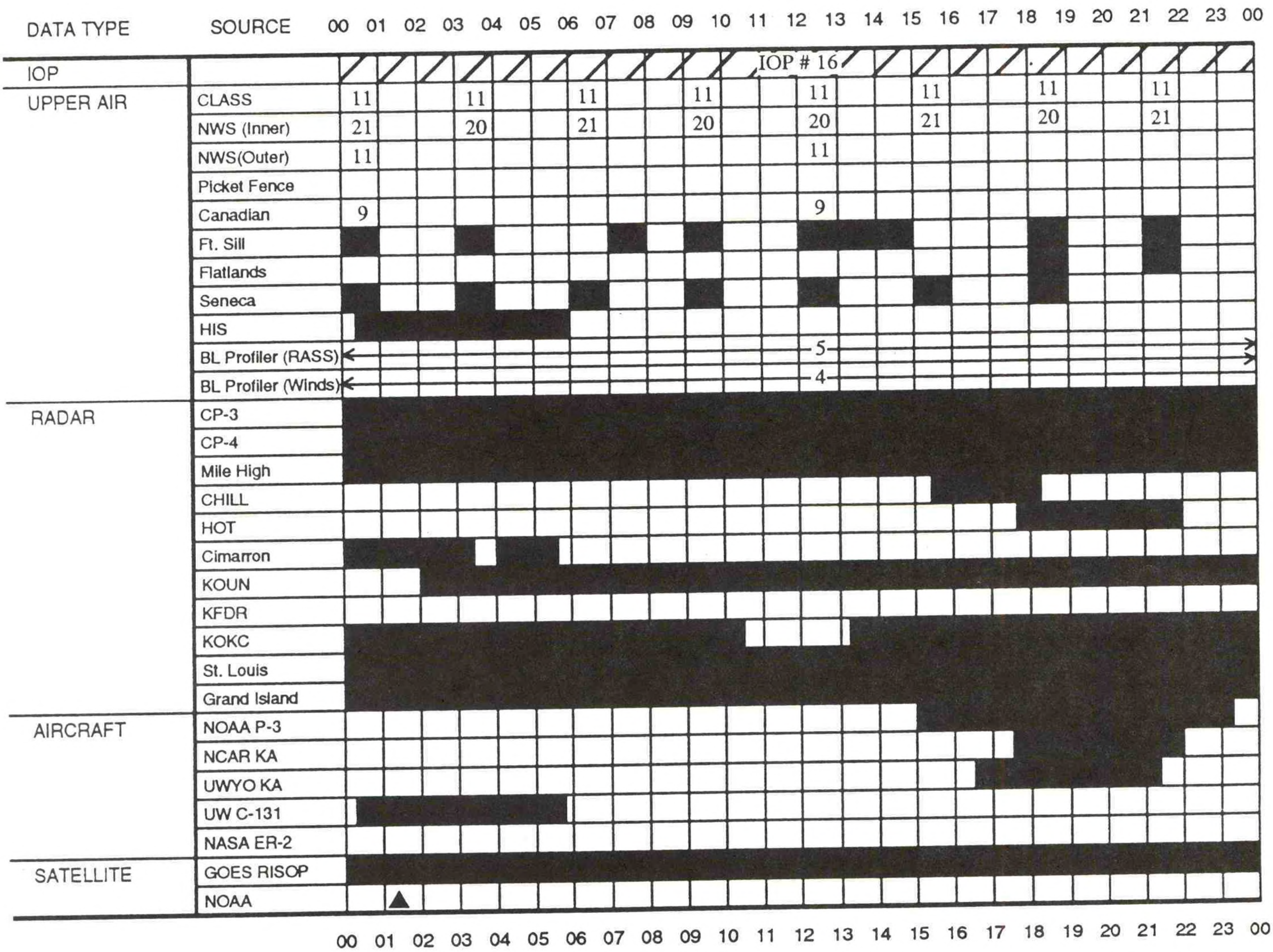
CP-3 and CP-4 Radar operated all day sampling the various precipitation bands that moved through the dual-Doppler array.

The Oklahoma radars (KOUN, Cimarron, and KOKC) sampled convective activity which formed ahead of the front that moved across the Little Washita Basin during the evening. This was followed by a narrow squall line associated with the front. Precipitation ended over the Little Washita Basin by 0800 UTC, 04 March, with total precipitation accumulations ranging from 0.5 to 1.6 inches.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 4 March

Julian Day: 64



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 3 stations intermittent.
	AWOS	47 of 47 stations reported; 5 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 10 stations intermittent.
	PROFS	22 of 22 stations reported; 1 station intermittent.
	SAO	394 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 13 stations intermittent.

WEATHER SUMMARY

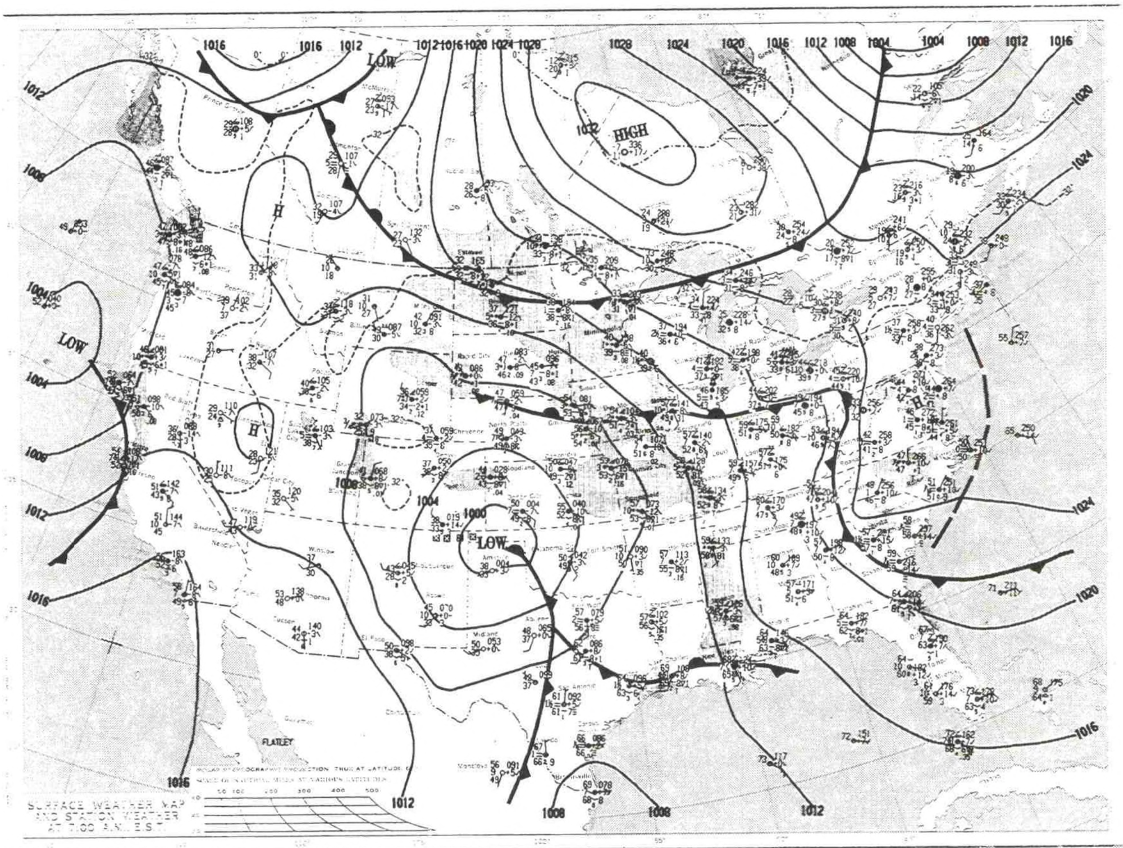
5 March 1992

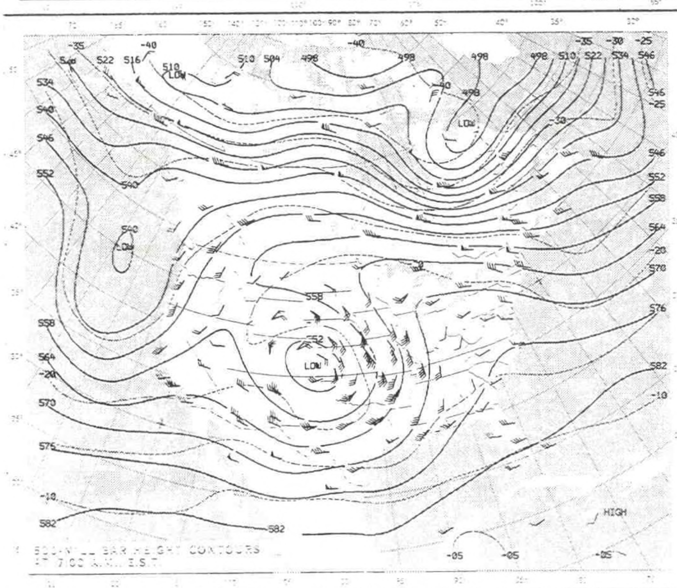
At 1200 UTC, the surface low pressure area was located over the Texas panhandle/Kansas border, with a weak stationary front located over Nebraska, Iowa and Illinois. The 500 mb closed low had continued to move very slowly eastward and at this time was located over the surface low. The model progs indicated that the upper low would open up and begin to swing out to the east-northeast. The forecast called for gradual clearing to occur from west to east across the high plains, with lingering showers in Nebraska and possible development of thunderstorms in western Kansas.

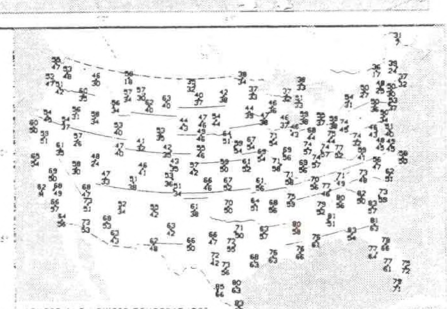
The longer range model progs indicated that over the next 24- to 48-h conditions should be drying out under the influence of a weak shortwave ridge ahead of the next major trough. The surface pressure gradient should weaken considerably, with a very broad weak trough extending across most of the central U.S.

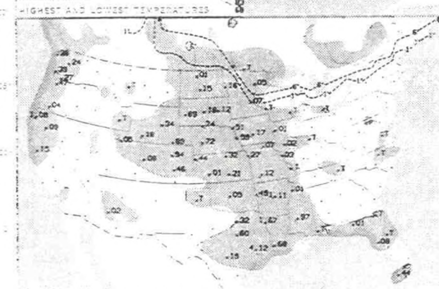
Forecasters were beginning to discuss the likelihood of a major cyclonic system moving into the STORM-FEST domain on 8-9 March in relation to the next major wave moving into the west coast. This could be the focus of the next IOP.

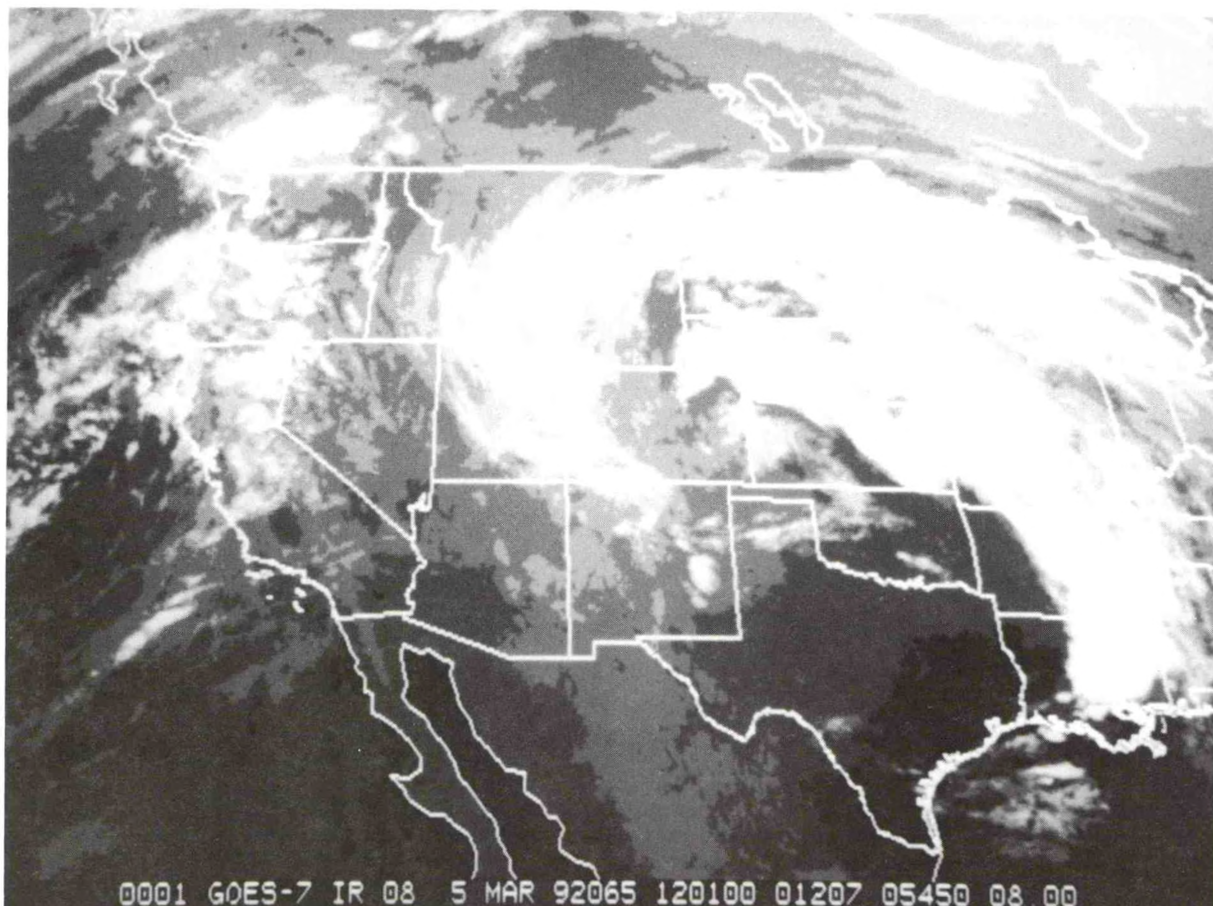
THURSDAY, MARCH 5, 1992










0001 GOES-7 IR 08 5 MAR 92065 120100 01207 05450 08.00

OPERATIONS SUMMARY

5 March 1992

IOP 16 ended today with the last of the NWS and CLASS soundings being taken in the inner domain at 1200 UTC. There was one aircraft flight earlier in the day in support of IOP 16.

0151 UTC During the late evening another precipitation band appeared in southeast Kansas. The University of Washington C-131 took off to obtain detailed measurements in the well organized cloud band as it moved into the dual-Doppler area. [The main "spiral" precipitation band that was studied in earlier flights had moved north into Nebraska.] The aircraft flew a sawtooth flight pattern from 15k to 3 kft. The precipitation encountered was virtually all light and stratiform in nature with little liquid water or rimmed crystals. This appeared to be another case of low stratocumulus topped by miniature convective cells driven by the disturbance aloft. The aircraft scientists reported that crystal types varied from "warm" habits (columnar) to "cold" (stellars and dendritic forms).

The principal feature of interest in this IOP was a cloud band (tops generally below 600-500 mb) that extended in an arc from Kansas to Colorado and then southward in conjunction with weak surface cyclogenesis (~1000 mb) over southeastern Colorado. This cyclogenesis occurred in conjunction with a slow-moving diffluent trough in the southern branch of the westerlies over northern Mexico and southern Texas. A noteworthy feature was the absence of deep baroclincity in the large-scale flow.

The principal cloud band was sampled by the P-3 on 4-5 March. Noteworthy features included a broad area of isothermal conditions (~ 0° C) at 700 mb and a confluent asymptote (20-40°) along the band. At mid-levels (~500 mb) the cloud band environment was characterized by a ~ +2° C temperature anomaly on the north side of the band in an otherwise weak baroclinic environment.

This case is a good example of the evolution of an expanding comma-shaped cloud pattern associated with a very slow moving and developing cutoff cyclone. Cyclogenesis was very modest. Unstable air on the south and east side of the vortex was associated with precipitation bands with embedded convective activity. There was a major convective outbreak in southeastern Texas that led to major flooding, severe storms, tornadoes in Texas and Oklahoma.

Other Activities:

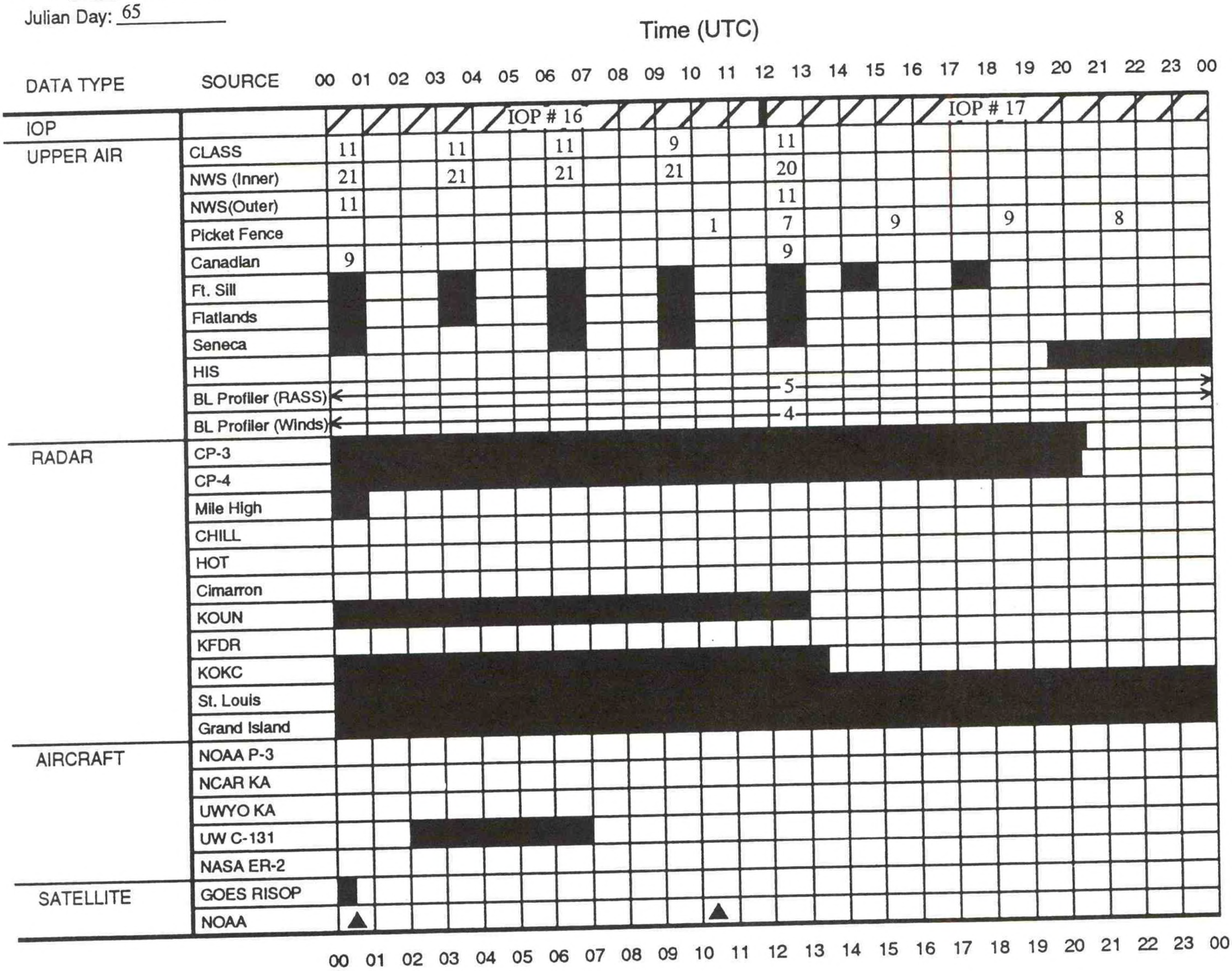
With the likelihood of a major winter storm developing in the STORM-FEST area on 8-9 March IOP 17 started today with the start-up of West Coast "Picket Fence" soundings at 1200 UTC. These were expected to continue for the next 48-h. Outer domain NWS soundings were scheduled to start at 0000 UTC (6 March). The focus of this IOP was to study the frontal structure, evolution of precipitation, and boundary-layer processes in a major mid-latitude cyclonic event that was expected to enter the STORM-FEST domain on or about 9 March.

With the ending of IOP 16 and the expected activity in the STORM-FEST domain in 3-4 days, tomorrow, 6 March, was declared a hard down-day to rest the air crews, radar crews and CLASS crews. (No rest for the Operation Crews.)

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 5 March

Julian Day: 65



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 1 station intermittent.
	AWOS	46 of 47 stations reported; 5 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 7 stations intermittent.
	PROFS	22 of 22 stations reported; 3 stations intermittent.
	SAO	391 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 13 stations intermittent.

WEATHER SUMMARY

6 March 1992

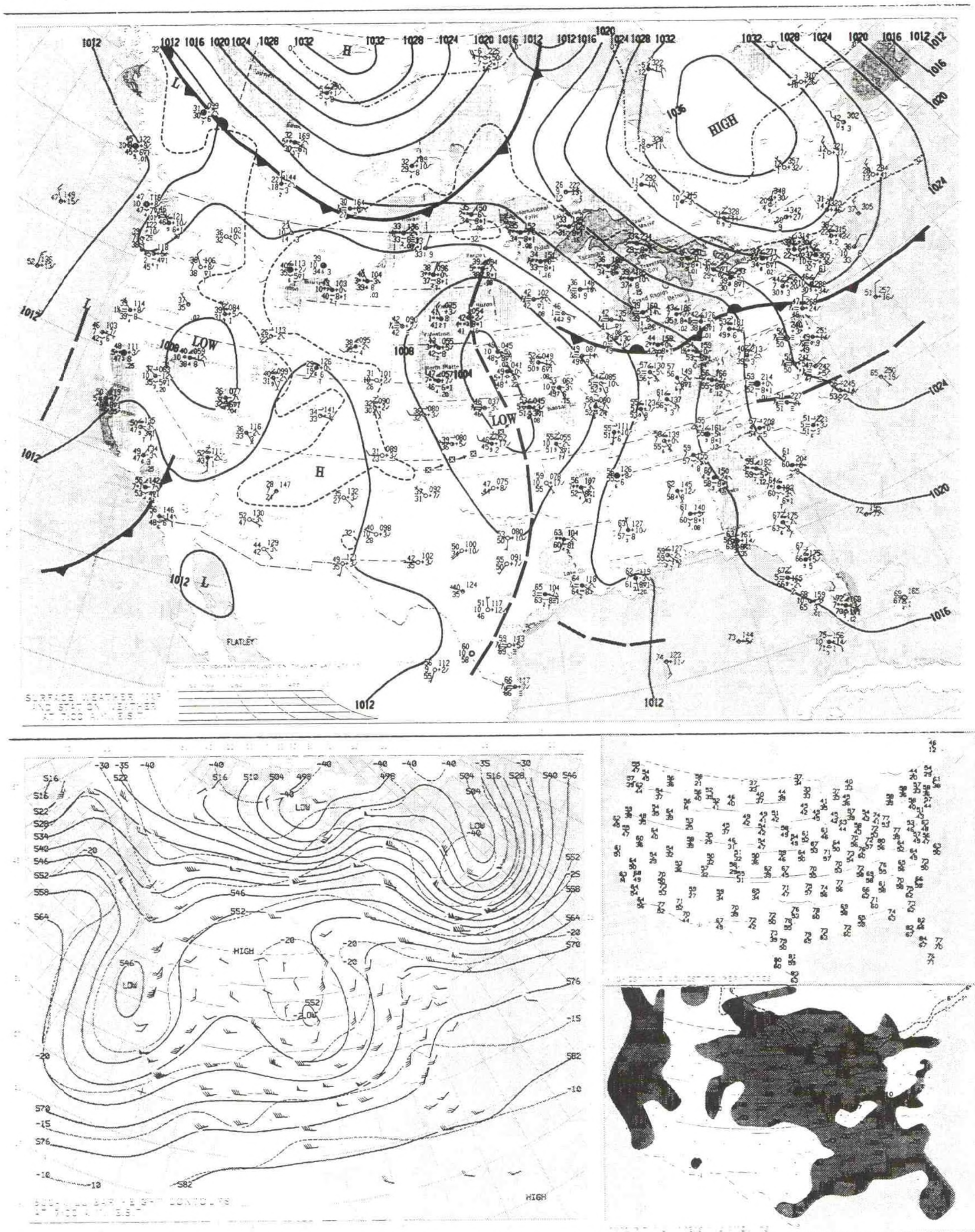
The upper-level low pressure area that had affected the STORM-FEST domain for the past several days continued to drift slowly northeast, with light rain over eastern Nebraska, Iowa and Missouri. Precipitation should end in Nebraska before 0000 UTC tomorrow, 7 March. The MM4 model indicated the possibility of moderate to heavy precipitation moving from northern Missouri into Illinois, extending south into Kentucky by 0600 UTC, 7 March. The possibility of convection existed in southern Illinois and western Kentucky.

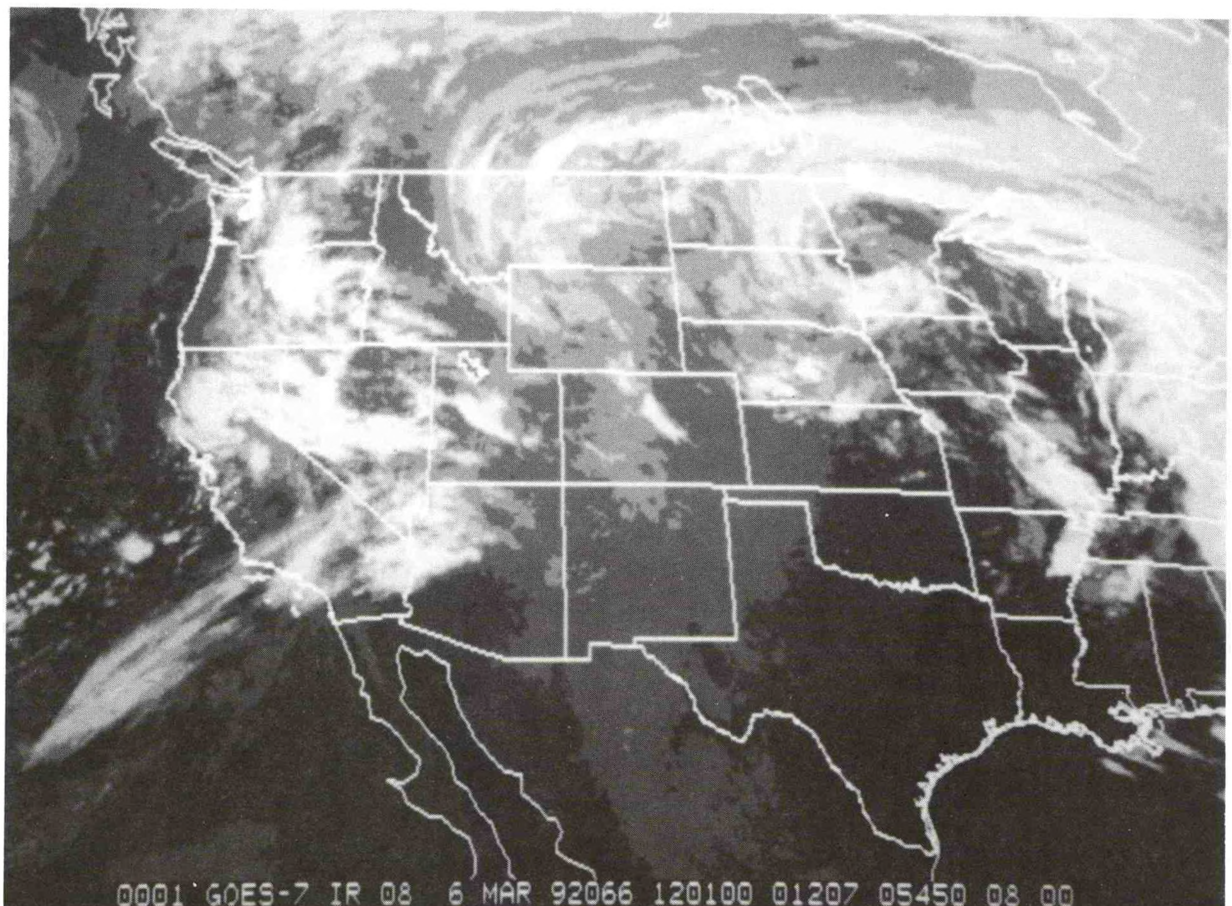
As one of the Norman, OK forecasters said, "the forecast emphasis is on the next several days when a powerhouse system is expected to wind up over the central U.S. This system will likely provide the whole spectrum of weather events for the STORM-FEST domain, as Gulf moisture rapidly returns and arctic air enters the fray by early next week [9-10 March]."

Models hinted that a shortwave swinging northeast ahead of main system across Texas and Oklahoma Saturday night (~0000 UTC, 8 March) would add lift and possible shower development, but timing was highly uncertain this far out. An upper-level jet axis was also forecast to develop from New Mexico, northeast to Nebraska, resulting in an increasingly diffluent pattern over Oklahoma and Texas. A surface low pressure area should begin to spin up over southeast Colorado during this time, in response to increasing flow aloft and approach of the main upper level system. The NGM suggested that a warm front would develop eastward across Kansas on Saturday night (7 March), with warm advection north of this boundary. More widespread precipitation was expected further west over the Rocky Mountains, with the upper-level system, at least through Sunday morning (1200 UTC, 8 March).

On Sunday, 8 March, everything should begin coming together as the cold front/dry-line moves east across Oklahoma and Texas, and arctic air moves south into the northern Plains/Rocky Mountains. Western Oklahoma may again be shut off from precipitation by midday Sunday, with strong thunderstorms developing further east over eastern Oklahoma Sunday afternoon, 8 March. A deep surface low was expected to move east-northeast through the STORM-FEST domain Monday, 9 March, with arctic air surging south through the Plains behind it. The potential was very high for a major winter storm over central/northern Plains and upper midwest with this system.

FRIDAY, MARCH 6, 1992




0001 GOES-7 IR 08 6 MAR 92066 120100 01207 05450 08 00

OPERATIONS SUMMARY

6 March 1992

IOP 17 continued throughout the day.

The "Picket Fence" sounding network continued 3-h soundings and the NWS outer domain sounding sites began taking 6-hourly soundings starting at 0000 UTC, as the deep upper level trough off California continued to move eastward.

Other Activities:

As this system moved eastward, soundings from the Canadian sounding sites were placed on alert to begin taking supplemental soundings at 0000 UTC, 7 March, to monitor the northern jet and associated push of cold arctic air southward out of Canada into the U.S.

Otherwise, today was a hard down day for all operations in the STORM-FEST program. (Getting ready for the big one).

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 6 March

Julian Day: 66

Time (UTC)

DATA TYPE	SOURCE	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
IOP													IOP # 17												
UPPER AIR	CLASS																								
	NWS (Inner)	21									1			22											
	NWS(Outer)	11						11						11						11					
	Picket Fence	8			9			9			9			9			9			9			9		
	Canadian	9												9											
	Ft. Sill														■				■						
	Flatlands																								
	Seneca	■			■																				
	HIS	■	■														■	■	■	■	■	■	■	■	■
	BL Profiler (RASS)	←												5											→
	BL Profiler (Winds)	4	←											5											→
RADAR	CP-3																								
	CP-4																								
	Mile High																		■	■	■	■	■	■	■
	CHILL																								
	HOT																			■	■	■	■	■	■
	Cimarron																								
	KOUN																								
	KFDR																								
	KOKC																								
	St. Louis	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Grand Island	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
AIRCRAFT	NOAA P-3																								
	NCAR KA																								
	UWYO KA																								
	UW C-131																								
	NASA ER-2																								
SATELLITE	GOES RISOP																								
	NOAA											▲				▲									

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00

Comments

SURFACE SYSTEMS	ASOS	39 of 42 stations reported; 1 station intermittent.
	AWOS	47 of 47 stations reported; 5 stations intermittent.
	HPCN	72 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	34 of 35 stations reported; 15 stations intermittent.
	PROFS	22 of 22 stations reported; 22 stations intermittent.
	SAO	396 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

WEATHER SUMMARY **7 March 1992**

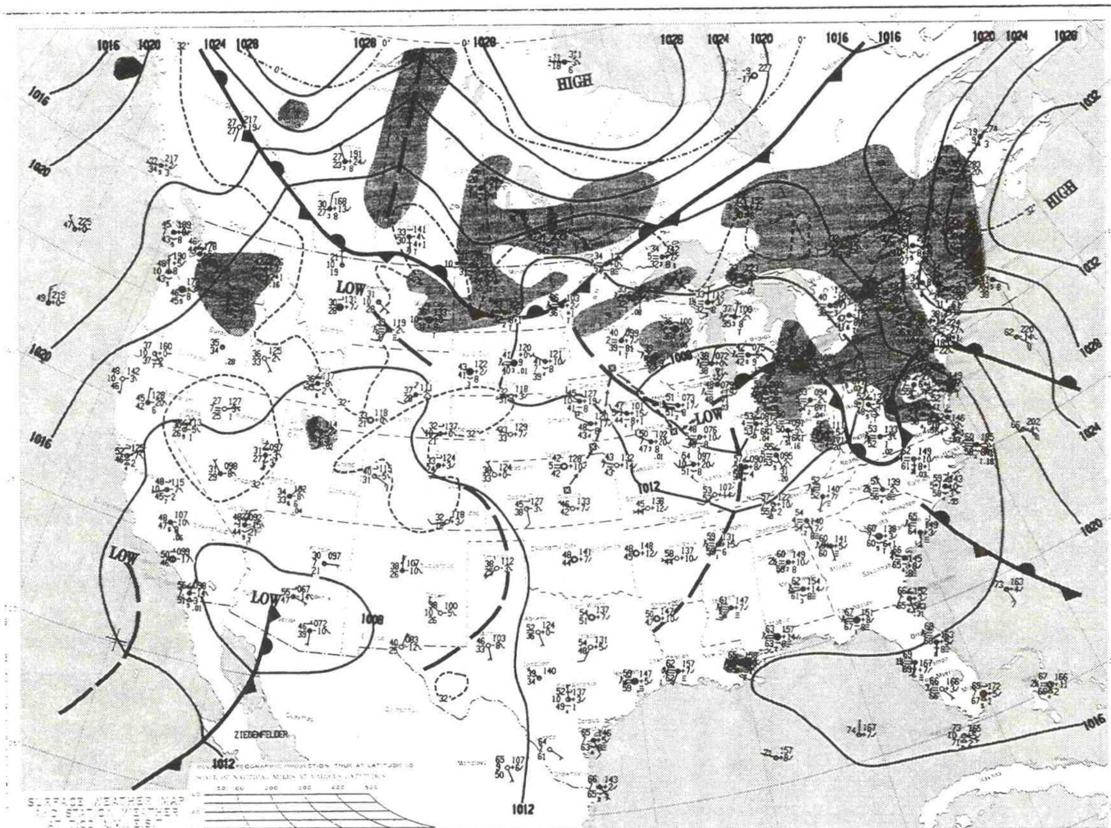
At 1200 UTC the upper-level trough had moved onto the west coast, with a weak surface low analyzed over southern Arizona. Mostly fair skies were forecasted over the STORM-FEST domain as the weak surface low and associated precipitation that was the focus of IOP 16 continued to move to the east.

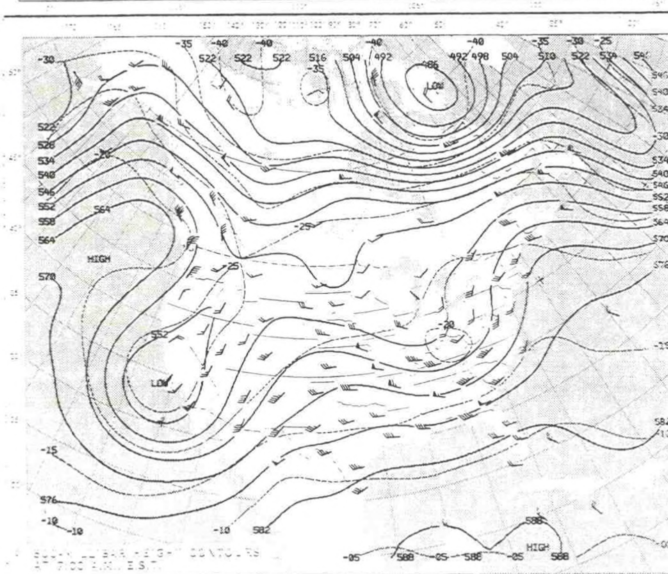
The models indicated that an arctic front should be pushing through Wyoming and Nebraska by 1200 UTC, 8 March, with precipitation breaking out behind it; upslope snows in Wyoming could be intense. Some prefrontal showers were indicated by the MM-4 model in Kansas and Missouri area, but only light amounts of precipitation were expected.

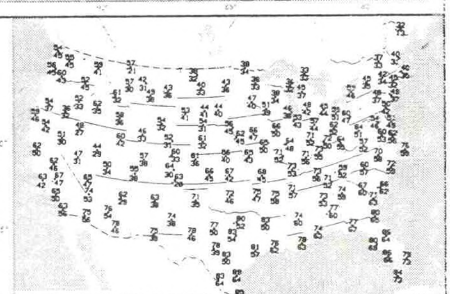
By 1800 UTC, 8 March, thunderstorms were likely to redevelop along the cold front/dry line over western Oklahoma and perhaps as far west as the east Texas panhandle, developing eastward across Oklahoma during Sunday evening, 0000 UTC, 9 March. Return of Gulf moisture should be more rapid than indicated by the models, resulting in greater destabilization. SELS indicated that the Eta model forecasted a -10 lifted index over southern Oklahoma and northern Texas by Sunday evening, 8 March, where as the NGM has a -4 lifted index. Increasing difluence between upper jet axes, increase of the low-level jet to over 40 knots, and increasingly favorable directional shear all pointed to a high potential for tornadoes across Oklahoma and Texas, if moisture can return fast enough. Western Oklahoma would likely dry out Sunday afternoon, 8 March, before the cold front drives south into Oklahoma on 9 March. With the upper level system lifting east northeast, forecasters expected only minimal chances of wraparound precipitation being pulled south into Oklahoma on 9 March.

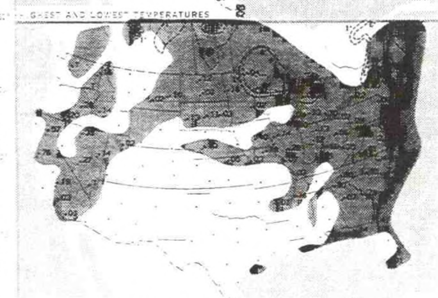
The model progs indicated that by 0000 UTC, 9 March, the front should be pushing well into the STORM-FEST domain. At that time, it was expected that upslope conditions would exist through Wyoming, and just beginning along the foothills of Colorado. The postfrontal precipitation in the high plains should begin as rain, turning to sleet and snow as the colder air moves in behind the front. By 48-h, 1200 UTC, 9 March, the Eta model indicated a major snowstorm in the Nebraska panhandle, near the Colorado/Kansas border. Snow should be covering a major portion of the northern STORM-FEST domain; from Wyoming, Nebraska, Colorado and northwest Kansas. Another area of precipitation would be in Missouri/Iowa in response to warm frontal overrunning, with an area of possibly severe weather in eastern Oklahoma and northeast Texas as discussed above. This was a potent system, with surface and upper level forcing coming together over the high plains to create a major winter storm.

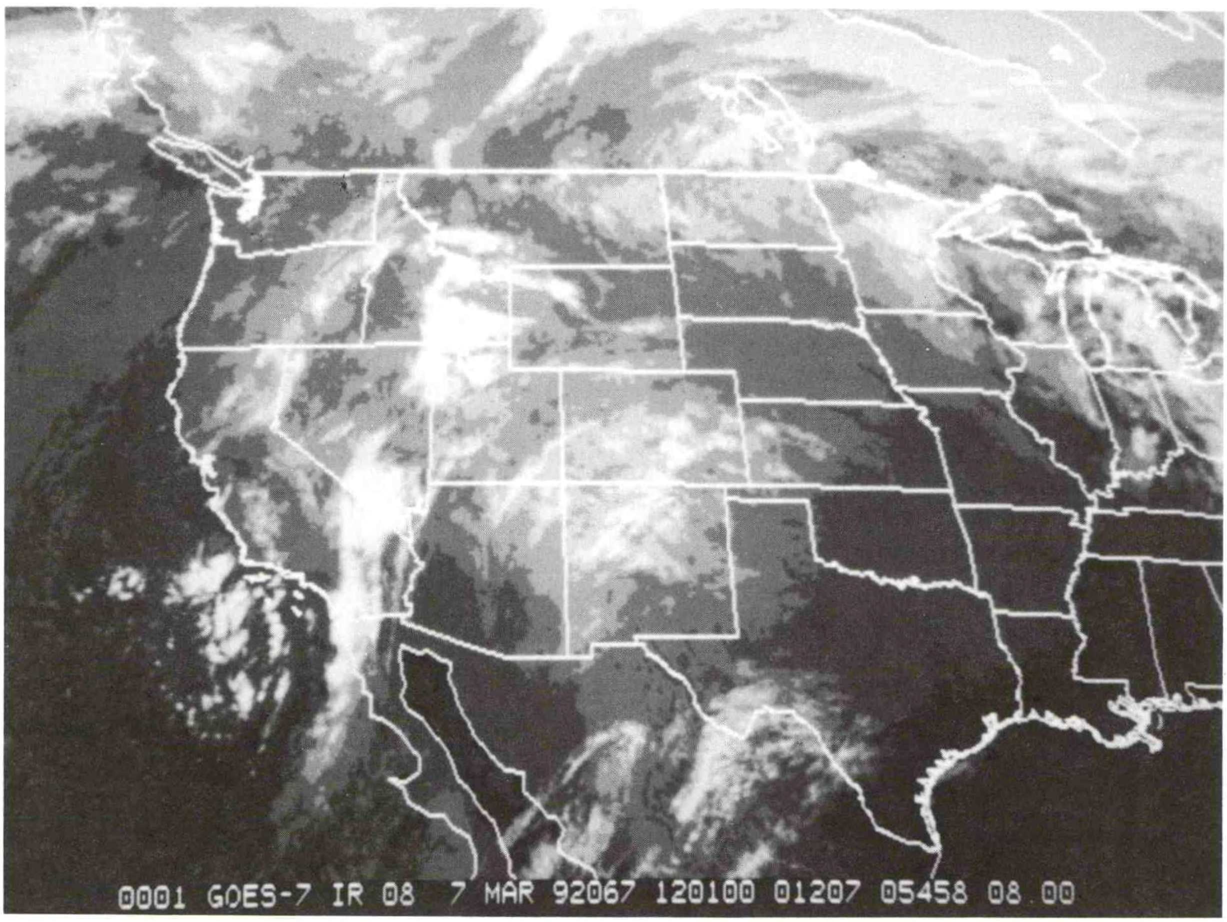
SATURDAY, MARCH 7, 1992










0001 GOES-7 IR 08 7 MAR 92067 120100 01207 05458 08 00

OPERATIONS SUMMARY

7 March 1992

IOP 17 continued throughout the day.

0000 UTC Canadian soundings array began to take 6-hourly soundings. These were scheduled to continue for the next 48-h.

Other Activities:

The principle objectives of this IOP were to study frontal structures, evolution of precipitation and boundary layer processes in this major cyclonic event. Primary mission planning team activities today focused on the timing of the inner domain soundings and the proposed aircraft flights and radar operations.

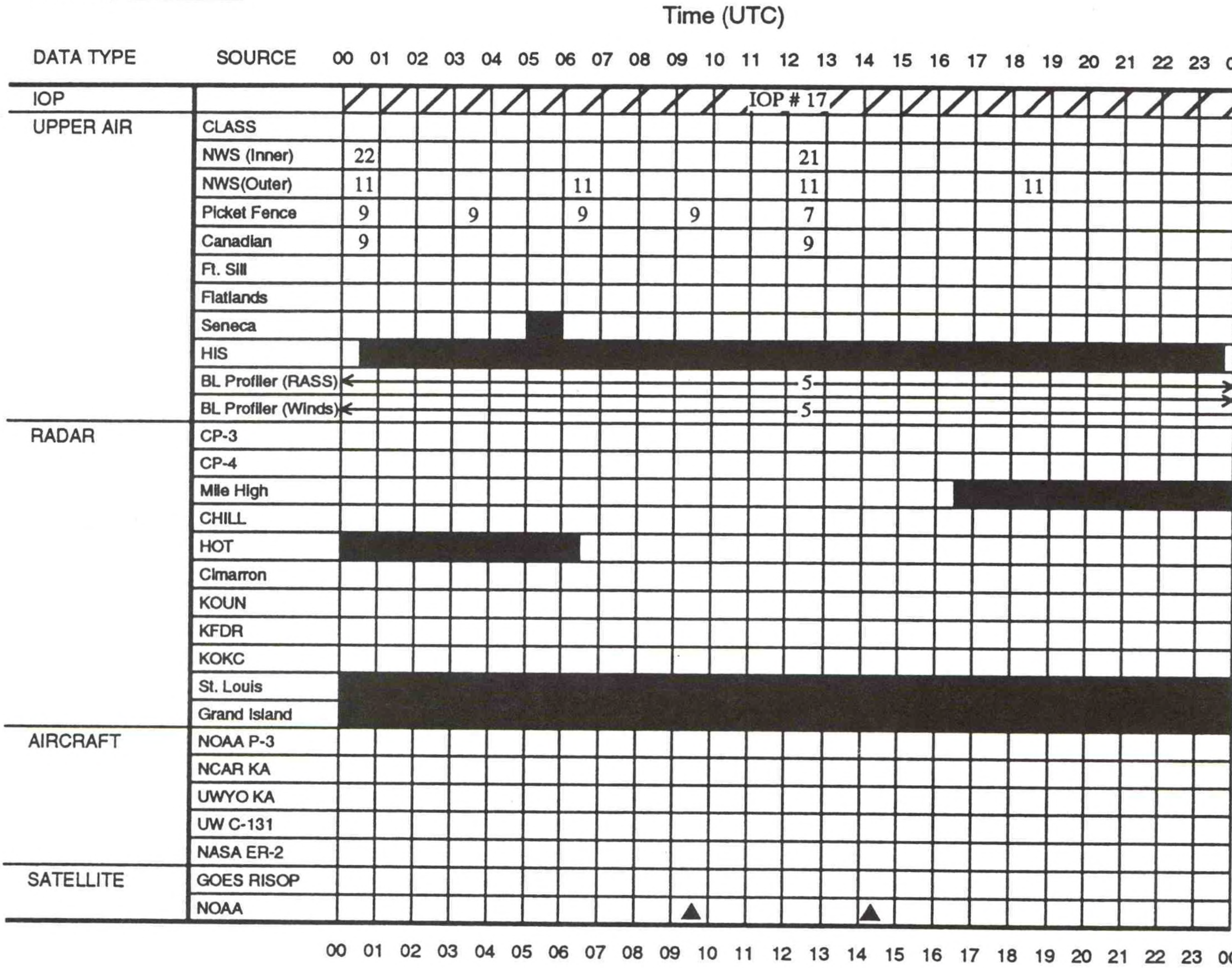
The Wyoming King Air was scheduled to depart for Oklahoma City at 0000 UTC tomorrow, 8 March, in order to study both the upper level and lower level jet maxima in the warm air ahead of the eastward moving polar front and the southward moving arctic front. Timing of this flight was proposed to be between 1600 UTC and 1800 UTC, 8 March.

The HOT radar concluded measurements at 0730 UTC of precipitation from the low pressure system which tracked across Illinois (part of IOP 16).

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 7 March

Julian Day: 67



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 1 station intermittent.
	AWOS	45 of 47 stations reported; 1 station intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 11 stations intermittent.
	PROFS	22 of 22 stations reported; 3 stations intermittent.
	SAO	389 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

WEATHER SUMMARY

8 March 1992

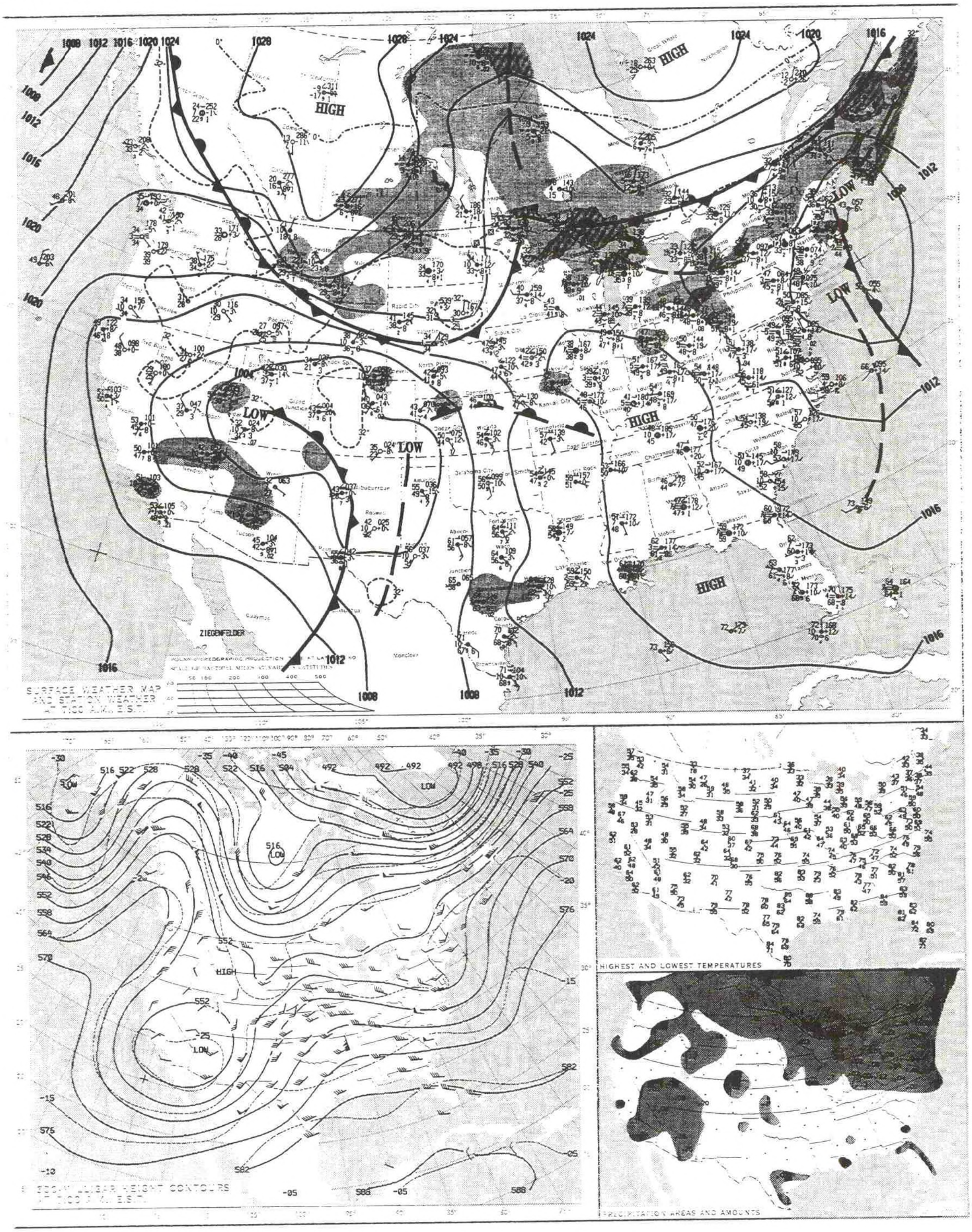
An upper level trough and cutoff low moved into the STORM-FEST domain coincident with the low level intrusion of arctic air. A convective outbreak was expected this afternoon in the Texas/Oklahoma area as a front/dryline associated with a surface low in southeastern Colorado pushed eastward into Texas and Oklahoma. Good moist southerly flow continued in Texas, Oklahoma, and Kansas. A 100 kt jet moving around the cutoff low was expected to move over southeast Texas, putting the Texas/Oklahoma panhandle region under the left exit region of the jet. Low-level flow was strong ahead of this boundary, and with good turning in the low-level winds, severe thunderstorms and tornadoes were possible.

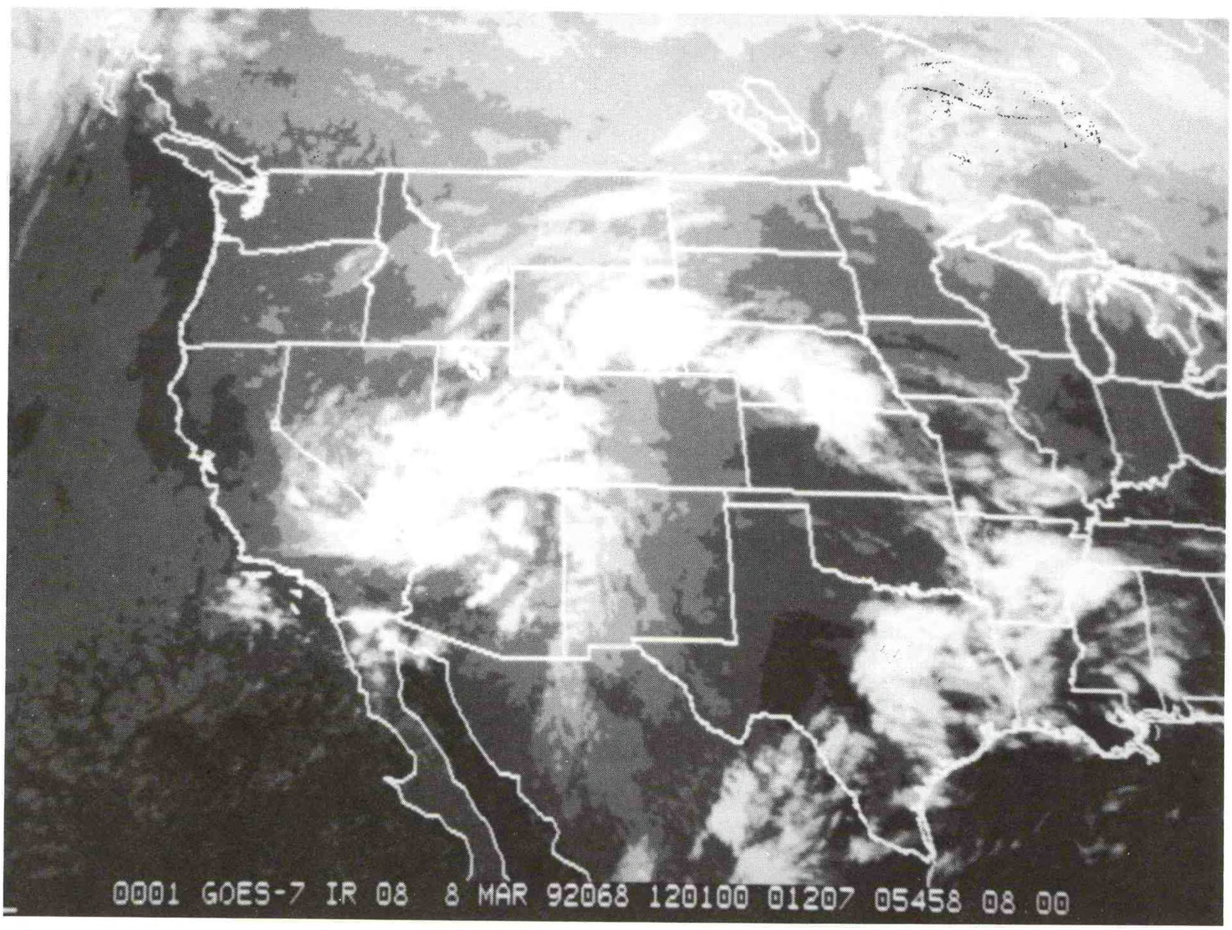
Best estimates were that initial development of convection should occur along the dryline. A solid line of convection was expected to form by dark and sweep eastward into central Oklahoma during the evening and into eastern Oklahoma after midnight. Lack of strong surface deepening indicated minimal chance of wraparound precipitation in Oklahoma behind the arctic front, which should enter the panhandle Monday morning, 10 March, and reach southeastern Oklahoma by Monday evening.

By tomorrow, 9 March, the second major weather event should occur in the Colorado, Nebraska and Wyoming area extending into the northern part of the STORM-FEST domain. An intense snowstorm should be developing by about 0600 UTC, 9 March, with the low pressure center in southeastern Colorado providing good upslope.

The model progs indicated that the front should continue to push through the STORM-FEST domain during the next 24-h. Snows in the western STORM-FEST domain should be tapering off by 1800 UTC, 9 March, and should become more widely scattered over Colorado, Nebraska, and Kansas. The eastern part of the STORM-FEST domain should see an increase of precipitation as the low rides up the front to the northeast. Most of the precipitation should occur to the south of the domain, in Louisiana and Mississippi.

SUNDAY, MARCH 8, 1992




0001 GOES-7 IR 08 8 MAR 92068 120100 01207 05458 08 00

OPERATIONS SUMMARY **8 March 1992**

IOP 17 continued throughout the day. The following activities were conducted today in support of the IOP.

1200 UTC Inner domain NWS and CLASS soundings began to take 3 hourly soundings as the major cyclonic system moved out of the inner-mountain west into the STORM-FEST domain.

1200 UTC GOES-7 RISOP mode began.

1500 UTC The CP-3 and CP-4 radars began surveillance mode operations.

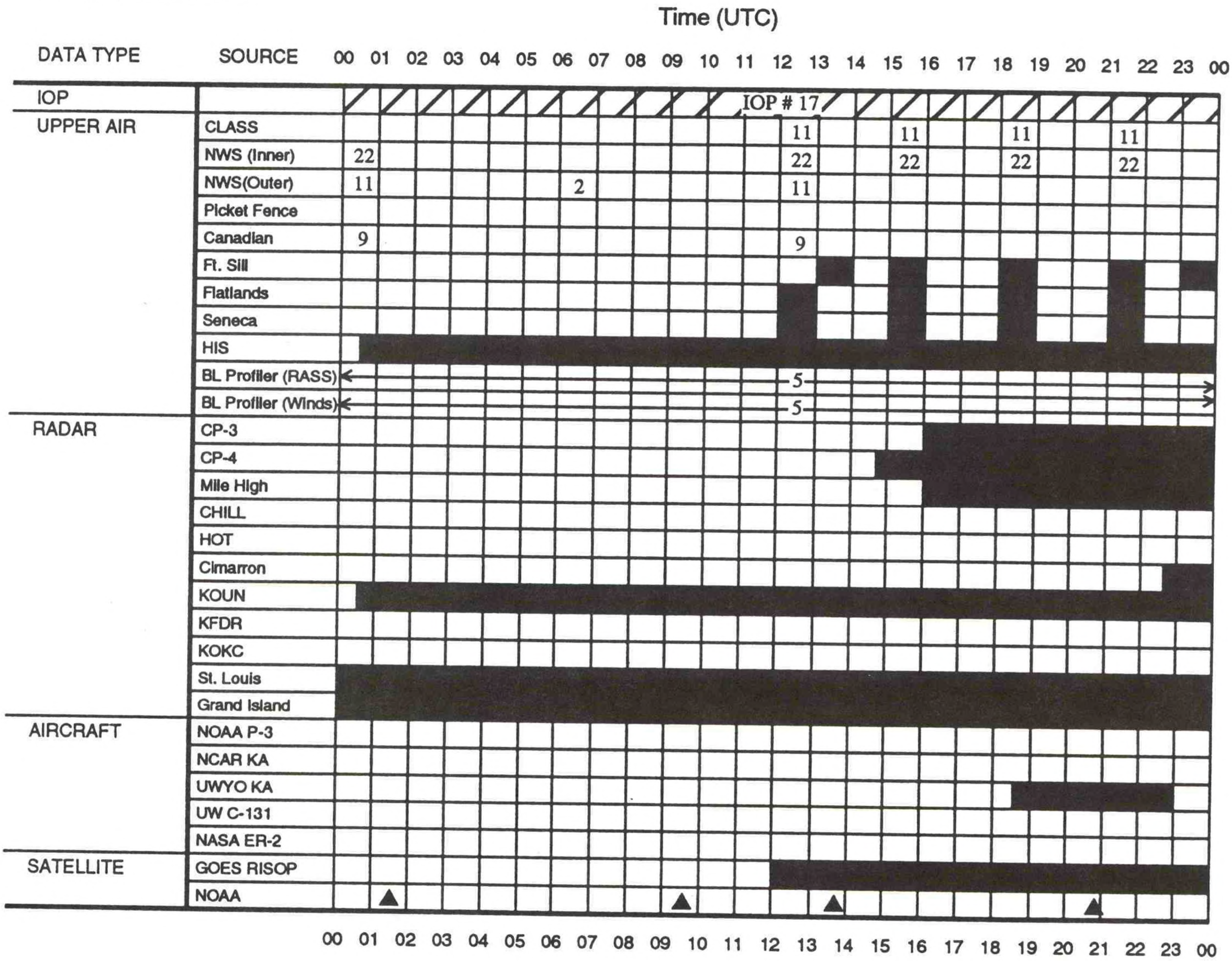
1842 UTC The University of Wyoming King Air took off from Oklahoma City to study both the upper and lower jet maxima ahead of the eastward moving polar front and southward moving arctic front. The aircraft ascended to 28,500 ft. flying to Amarillo, Texas, which corresponded to the center of the jet core at that altitude and within the exit region of the jet. The jet core maximum winds were at 200 mb (40 kft.). The aircraft did a parcel tracking study following a parcel downstream into Oklahoma. When the lower-level flow did not develop a well-defined jet core, the decision was made to continue the upper-level jet investigation. When fuel ran short, the aircraft terminated the parcel tracking mission and flew directly back to Richards-Gebaur AFB. The aircraft landed at 2252 UTC.

2300 UTC The NSSL Cimarron radar became operational as convection began to develop in southwest Oklahoma and continued until 0520 UTC, 9 March. Convection occurred within the vicinity of the Little Washita Basin, but only 0.1 inch of precipitation was recorded within the rainguage network. In addition, data for this event were also collected from the ARS rainguage network, and the two USGS streamguage sites. Archive II data were collected for the WSR-88D radar at Norman until 0700 UTC, 9 March.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 8 March

Julian Day: 68



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 2 station intermittent.
	AWOS	45 of 47 stations reported; 37 stations intermittent.
	HPCN	73 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 7 stations intermittent.
	PROFS	22 of 22 stations reported; 4 stations intermittent.
	SAO	380 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

WEATHER SUMMARY

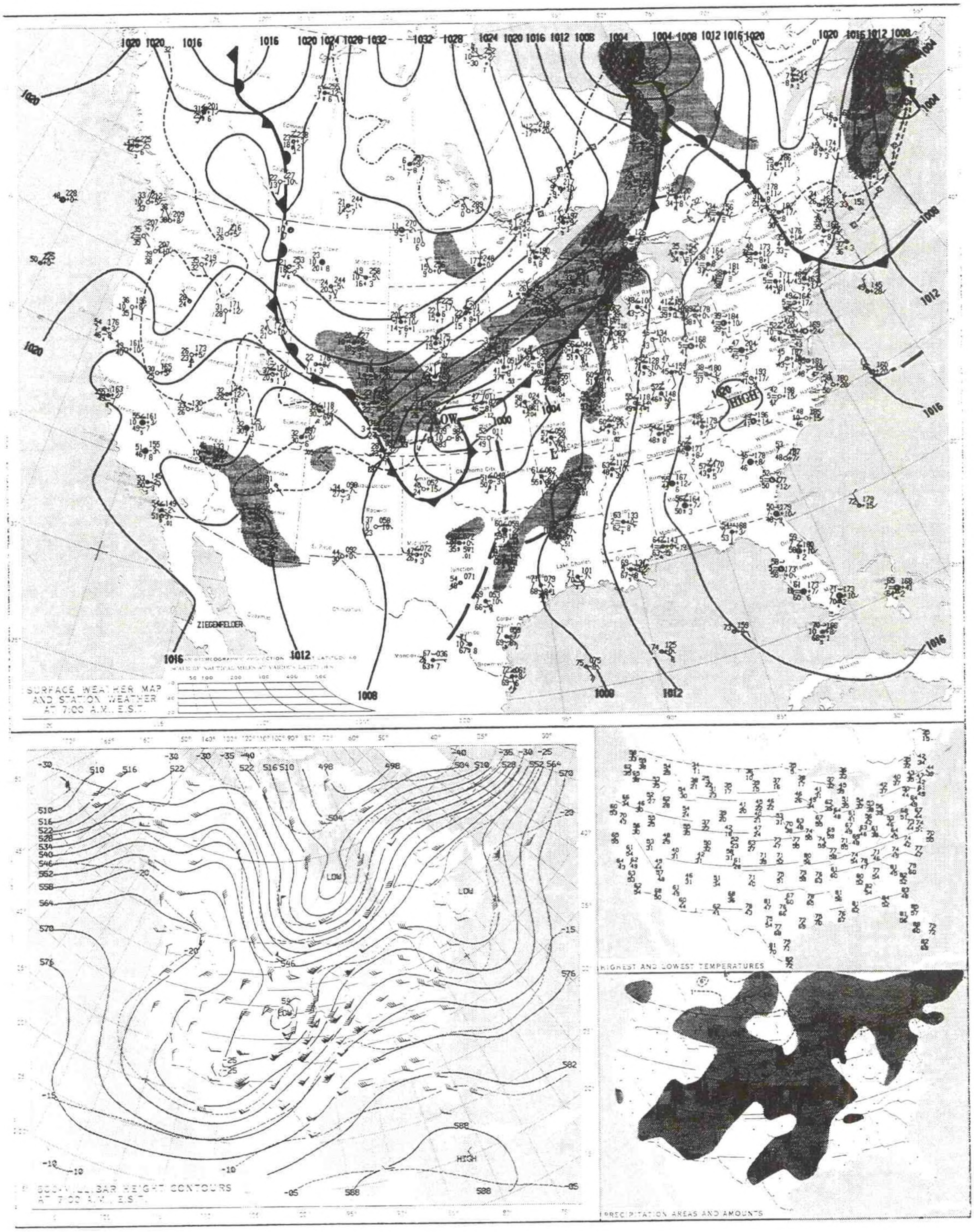
9 March 1992

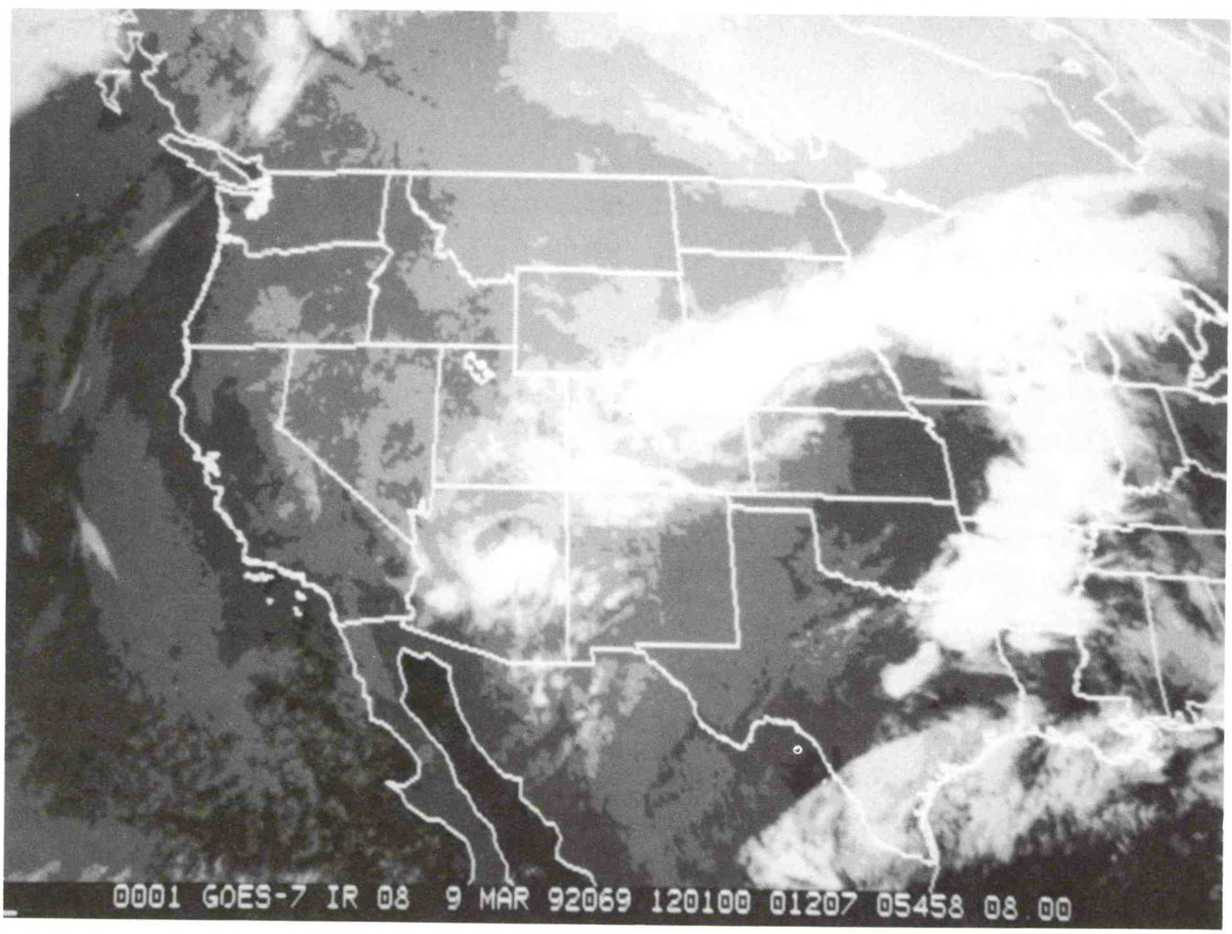
As forecasted, a deep surface low developed over southeast Colorado, which produced thunderstorms in eastern Colorado and Wyoming. As the arctic front moved into Colorado, it enhanced the deep upslope conditions over the front range causing very heavy snow. By 1200 UTC, almost two feet of snow had fallen from Boulder to Ft. Collins, Colorado. During this period, thunderstorms developed along the dryline/Pacific front that moved into Texas and Oklahoma. Moderate convection developed over Oklahoma, but only light precipitation occurred over the Little Washita Basin. The arctic front began to move into the boundary layer domain at about 1200 UTC, with a broad band of cloud and precipitation north of the front. During the next 12- to 24-h, the front was expected to continue moving south and east through the STORM-FEST domain.

Precipitation was expected to continue behind the arctic front as it passed through the STORM-FEST domain. There was a possibility of some light precipitation over Little Washita Basin between 0200 UTC and 0800 UTC, 10 March, but liquid amounts were forecasted to be less than 0.2 inches. Precipitation ahead and along the front was likely to occur in thunderstorms embedded in stratiform precipitation.

Over the next 24- to 48-h after this major winter storm had moved to the east, a weak shortwave was expected to move into the STORM-FEST domain. This would develop a warming trend ahead of the shortwave/cold front, but trajectories would be from the southwest so warming was not expected not be dramatic ahead of the front.

MONDAY, MARCH 9, 1992




0001 GOES-7 IR 08 9 MAR 92069 120100 01207 05458 08.00

OPERATIONS SUMMARY

9 March 1992

IOP 17 continued throughout the day. The following activities were conducted today to support IOP 17.

0000 UTC CP-3 and CP-4 went into a dual Doppler mode as a line of echoes moved into the south dual Doppler lobe of the radars.

0200 UTC CP-3 and CP-4 went back into surveillance mode after the band of echoes dissipated.

0522 UTC The NSSL Cimarron stopped collecting data, when all precipitation moved out of radar range.

0554 UTC The NOAA P-3 took off to study the frontal structure in Nebraska and cyclone development in western Kansas. The aircraft flew northward at 2 kft. AGL into the cold air, and then ascended briefly into the warm air. The aircraft then returned southward from Sioux Falls, SD, on a constant altitude radar survey through the front. It then ascended to dropwindsonde altitude near St. Joe, MO, (encountering hail) and released sondes along a "saw-tooth" pattern toward Grand Island, NE. "Porpoise" patterns were then flown through the front north of North Platte, NE. The aircraft then flew southward into Kansas where it located the low (calm winds) at 744 mb (1102 UTC) and again at 833 mb (1139 UTC). The aircraft flew eastward studying the low-level front, along an airway that allowed it to "porpoise" from minimal altitude northwestward through the front into central Nebraska. The P-3 then climbed to high altitude where dropsondes were released at a high rate to investigate the fine-scale spatial resolution along the track of the storm. The aircraft landed at 1519 UTC.

1156 UTC The University of Washington C-131's mission was designed to compliment the first P-3 mission, but concentrated observations in the precipitation region behind the arctic cold front that was moving southward into the STORM-FEST domain. The C-131 took off at 1156 UTC and flew northwest where it intercepted the front. The aircraft flew a "porpoise" pattern up the frontal surface, crossing the front, and flew into Nebraska before turning back southeast on a track west of the original flight track. The C-131 then flew "porpoise" pattern back down the front toward central Kansas, turned northwest and intercepted the front at 5 kft. The aircraft "zig-zagged" back through the front toward Richards-Gebaur AFB and landed at 1804 UTC.

1200 UTC NWS outer domain soundings and Canadian soundings ended.

1240 UTC The first NCAR King Air flight took off to examine the cold front just as it entered and moved through the boundary layer array. The front arrived in the early morning with clear conditions south of the front and overcast conditions behind the front. "Flux" legs were flown in the boundary layer domain southeast to northwest ahead of the front at 2k, 1.9k, 2.5k and 3 kft. (AGL). After completing the last "flux" leg at 1314 UTC, the aircraft descended to 2.3 kft and proceeded from Powhattan, KS, toward Home City, KS, intercepting the front at 1310 UTC. Passes were made through the front at 2.3k, 2.4k and 3.7 kft. At 1435 UTC, the aircraft descended to 2.1 kft. and flew toward the ASTER facility overflying ASTER at 1447 UTC. At 1451 UTC the aircraft headed for Richards-Gebaur AFB landing at 1527 UTC.

1530 UTC The University of Wyoming King Air took off to investigate the structure of the front and conduct an "M-surface" investigation. Shortly after takeoff the aircraft reported problems with the transponder and had to land at the Kansas City downtown airport for repairs. Following repairs, the aircraft took off to undertake an aircraft mission with the University of Washington C-131 [see second flight of the C-131 below (2000 UTC)].

1700 UTC The front had passed the boundary layer array by 1700 UTC when the NCAR King Air took off for a second mission to continue to monitor the diurnal modification of the arctic front. At this time, diurnal heating was occurring in the clear air ahead of the front with overcast conditions behind the front. This flight was designed to: 1) investigate turbulence characteristics, mean structure and kinetic energy dissipation in the evolving front, and 2) measure the sensible heat flux in the clear air in the subcloud layer behind the front.

After takeoff the aircraft did a missed approach sounding at Topeka, Kansas, and continued north through the front below cloud based until IFR conditions required the aircraft to ascend. The aircraft climbed and turned south toward Topeka, KS, into the clear air. Thereafter, aircraft penetrations were made normal to the front from the south. Sensible heat flux was measured by means of stacks at levels between 0.5 and 1.8 km MSL in the clear air and at 0.8 and 1.3 km MSL in the subcloud layer. Frontal penetrations, however, were only made at 0.5 km MSL, near cloud base. Frontal penetrations found a sharp transition in both horizontal and vertical velocity, as well as temperature and humidity across the front. The mission was completed with an along front (in the clear air) flight of approximately 100 km toward the east. The aircraft landed at Richards-Gebaur AFB at 2033 UTC.

1700 UTC The CP-3 and CP-4 radars had to terminate operations due to wind loading on the antennas.

2000 UTC The well-defined arctic front, studied earlier in the day in Nebraska and northeast Kansas, had moved southward through Kansas City and Richards-Gebaur AFB. A well defined, narrow band of non-precipitating cumulus clouds had formed along the leading edge of the front. At this time the University of Washington C-131 and University of Wyoming King Air aircraft took off to investigate the along-front structure of the cold front's leading edge. This mission was carried out between 2000 UTC and 0000 UTC, 10 March.

An initial attempt was made to stack the two aircraft to work along the same line (extending approximately from Richards-Gebaur AFB to the northeast into Missouri). However, due to the shallow nature of the front (< 4 kft.) and the problems associated with IFR vs. VFR, this pattern could not be carried out. Thus, the Wyoming King Air flew the leading edge of the front along a line from Richards-Gebaur AFB down to the southwest, also taking some short across-front measurements at the end of the flight legs. During this same time, the C-131 was flying in northern Missouri parallel to the front. The initial track was some distance back from the leading edge of the front. During the latter portion of the flight, the C-131 moved up to the leading edge of the front where it encountered graupel (with one lightning strike to aircraft) and icing (at -3°C) on the approach to Richards-Gebaur AFB. The University of Wyoming King Air landed at 2316 UTC and the C-131 aircraft landed at 2344 UTC.

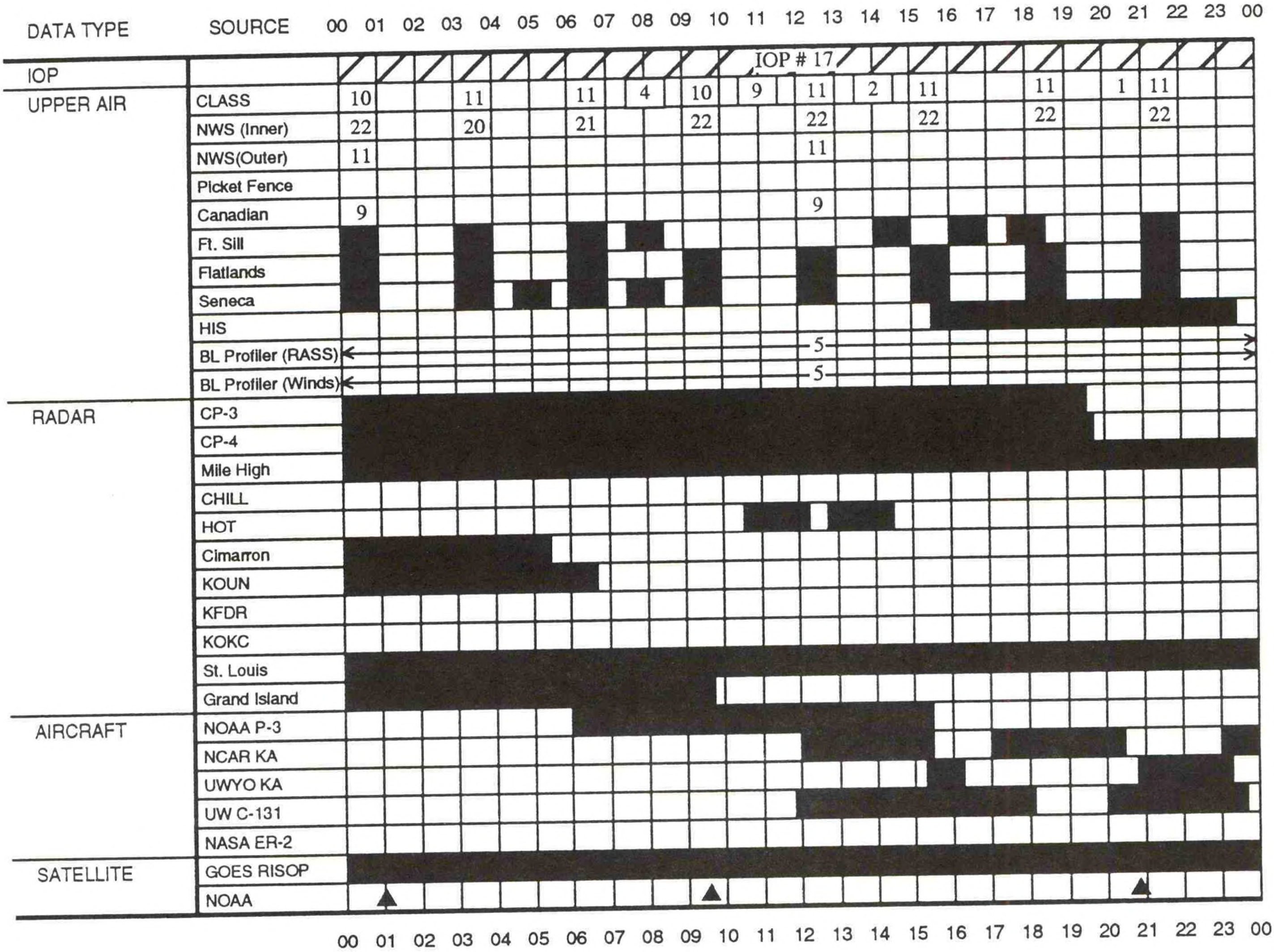
2306 UTC The NCAR King Air took off for a third mission to continue to examine the diurnal modification of the front following the flight procedures carried out in the two earlier missions. The front had pivoted to a southwest-northeast orientation through central Missouri directly over the PAM network. The aircraft flew from Richards-Gebaur AFB to Columbia, MO, to reach the warm sector of the front. Flight stacks were flown between 0.65 kft and 1.3 kft MSL to measure the sensible heat flux. Frontal penetrations were made at 0.6 kft MSL near cloud base. As in the previous mid-afternoon mission, a sharp transition zone was encountered, particularly in vertical velocity. This latter feature was also associated with a line of cumulus congestus at the front that evolved between the second and this third mission. The aircraft returned to Richards-Gebaur AFB early, at 0142 UTC, 10 March, in order to avoid icing problems which were beginning to be reported in the Kansas City area.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 9 March

Julian Day: 69

Time (UTC)



Comments

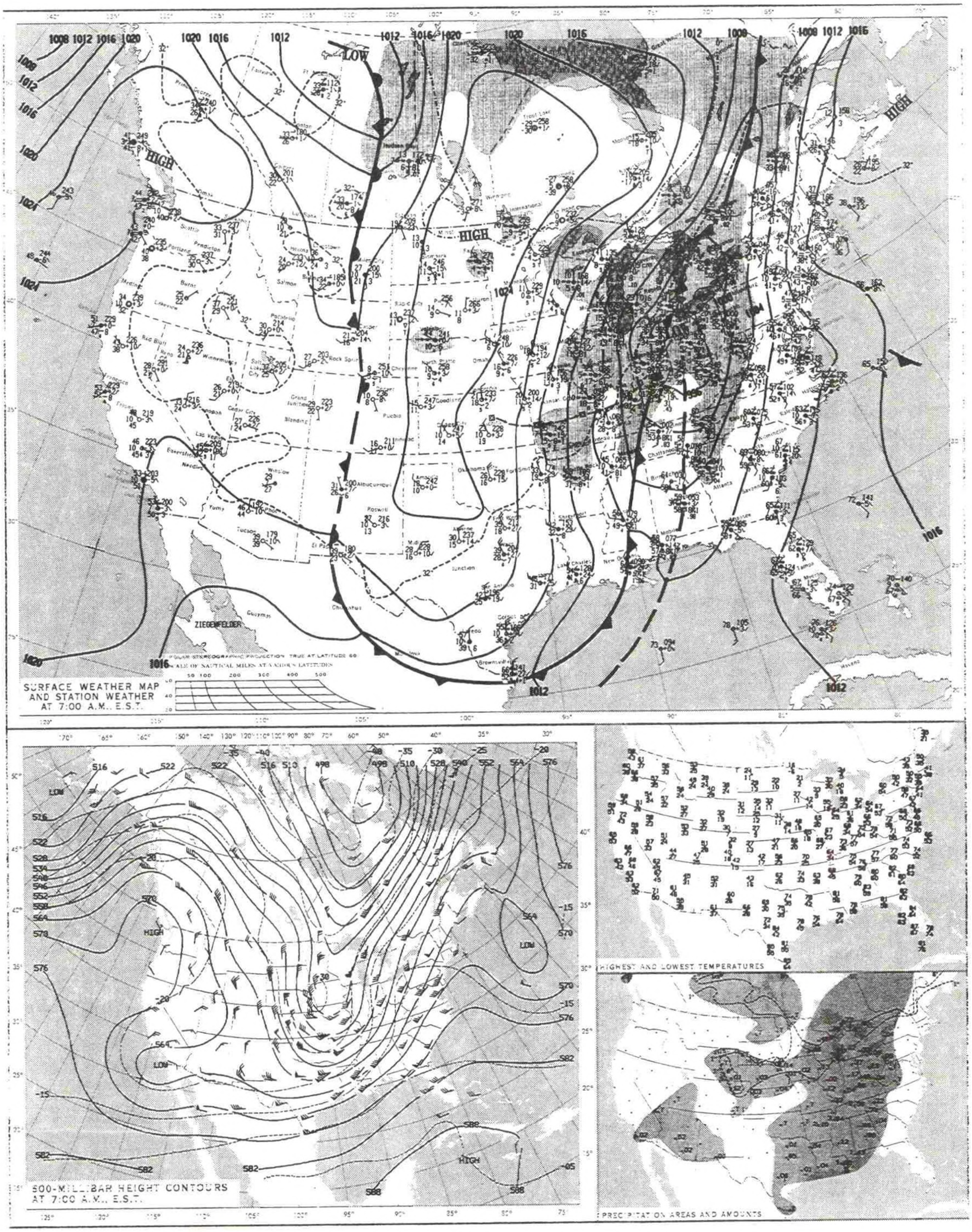
SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 5 station intermittent.
	AWOS	47 of 47 stations reported; 9 stations intermittent.
	HPCN	73 of 73 stations reported; 1 station intermittent.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 5 stations intermittent.
	PROFS	22 of 22 stations reported; 11 stations intermittent.
	SAO	394 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 1 station intermittent.

WEATHER SUMMARY

10 March 1992

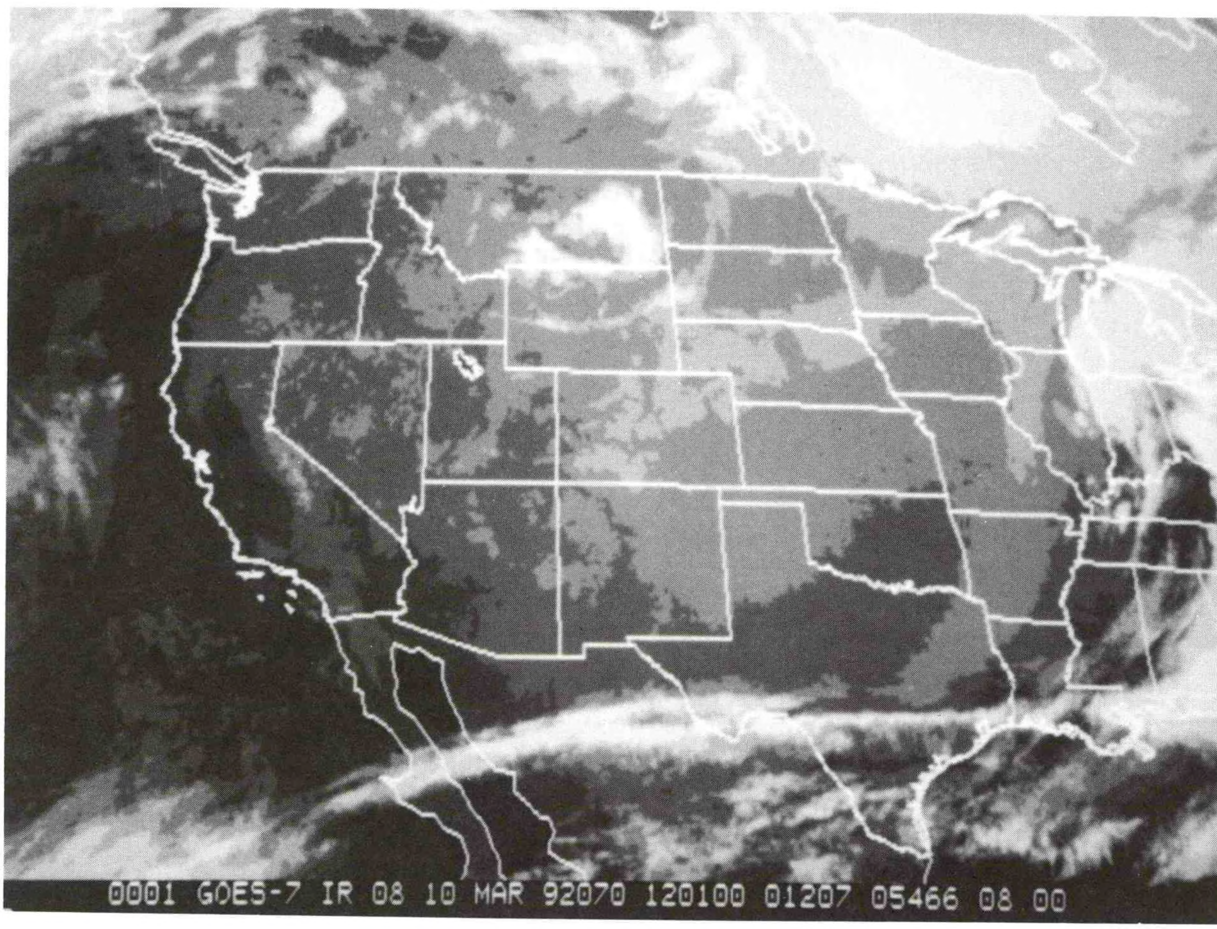
The major winter storm that had affected the STORM-FEST area over the past two days continued to move eastward and at 1200 UTC was located over the Ohio valley with a broad area of precipitation both ahead of and behind the front. Strong northerly winds dominated most of the STORM-FEST domain as a 1024 mb high pressure area moved into the region. The model progs indicated that the storm system should continue to move eastward with a short wave moving down the back side of the trough in the next 24- to 36-h. This could develop some light precipitation along the front, which should be characterized by more of a windshift line rather than much of a temperature change.

TUESDAY, MARCH 10, 1992



SURFACE WEATHER MAP AND STATION WEATHER AT 7:00 A.M., E.S.T.

500-MILLIBAR HEIGHT CONTOURS AT 7:00 A.M., E.S.T.


0001 GOES-7 IR 08 10 MAR 92070 120100 01207 05466 08 00

OPERATIONS SUMMARY

10 March 1992

IOP 17 continued through 1400 UTC. The following activities were conducted today to support IOP 17.

0100 UTC The HOT radar began collecting data and operated until 2130 UTC to document the passing of the storm system.

0600 UTC The NOAA P-3 took off to continue examining the characteristics of the frontal system that had been documented earlier within the STORM-FEST domain. At the time of the flight (0600 UTC-1400 UTC 10 March), the frontal system contained several features: a shallow "arctic" front and a deeper "polar" front behind the arctic front, with both situated over the southeastern U.S. (Arkansas, Mississippi, Alabama). A severe squall line was located in the warm boundary of the polar front. Objectives of the flight were to document the vertical structure of both frontal zones and to survey the squall line using multiple-view Doppler radar. The flight track selected was from northwestern Arkansas to Birmingham, AL. The mission succeeded in documenting the structure of the arctic front, including internal waves in a capping frontal inversion; the polar front, which appeared to extend from the tropopause to the surface, which included a well-defined upper-level jet; and a squall line. The squall line contained dramatic reflectivity features, including a possible mesocyclone hook-echo signature. On the return leg to Richards-Gebaur AFB, 13 dropwindsondes (approximately one every ten minutes) were deployed from 22 kft. to obtain additional documentation of the frontal features sampled on the earlier outbound portion of the mission.

1200 UTC NWS Inner domain and CLASS supplemental soundings terminated.

1400 UTC The NOAA P-3 landed at Richards-Gebaur AFB and IOP 17 officially ended at this time.

IOP 17 Summary (Bill Blumen/Mel Shapiro)

This mid-latitude cyclonic event was monitored from the time that the maritime polar front entered the Pacific Coast between 1200 UTC and 1500 UTC on 5 March until the system moved out of the STORM-FEST area on the morning of 10 March.

Data were collected from the West Coast "Picket Fence" and NWS outer domain sounding networks. Soundings were also obtained from the participating Canadian network as the Arctic front started moving to the south. The inner NWS and CLASS sounding network were put into operation as the Arctic front approached the STORM-FEST area from the north, and as the low associated with the Pacific front reached Colorado, where an intense winter storm developed along the Colorado Rocky Mountains. All STORM-FEST inner network observing systems were in operation as the low pressure area moved into Kansas and as the Arctic front moved southward across the boundary layer array. Aircraft missions, listed above, monitored both synoptic, meso- and microscale turbulent aspects of this major mid-latitude event. All surface based and aircraft systems appeared to be up and operating satisfactorily. The principal investigators were uniformly satisfied with the planning and implementation of IOP 17.

IOP 18:

1600 UTC IOP 18 began when the CP-3 and CP-4 radars became operational and collected data in both flux scan and surveillance mode. The focus of this IOP was to investigate the sensible heat and momentum budgets during a cold air outbreak in a baroclinic boundary layer within the boundary layer array. Two approaches were used — an aircraft method and a profiler method. As part of a systems test, these methods will be compared.

1730 UTC 90 minute soundings began at the Seneca CLASS site ending at 2230 UTC.

1753 UTC The NCAR King Air took off to fly the boundary layer mission in the boundary layer array. The proposed mission had to be cut short because high winds slowed operations. Wave like signatures were observed in the vertical velocity, temperature and humidity data within the mixed layer. Convection waves were observed from just above the inversion to 10 kft. MSL.

2204 UTC The NCAR King Air landed and IOP 18 ended.

2215 UTC CP-3 and CP-4 ended operations.

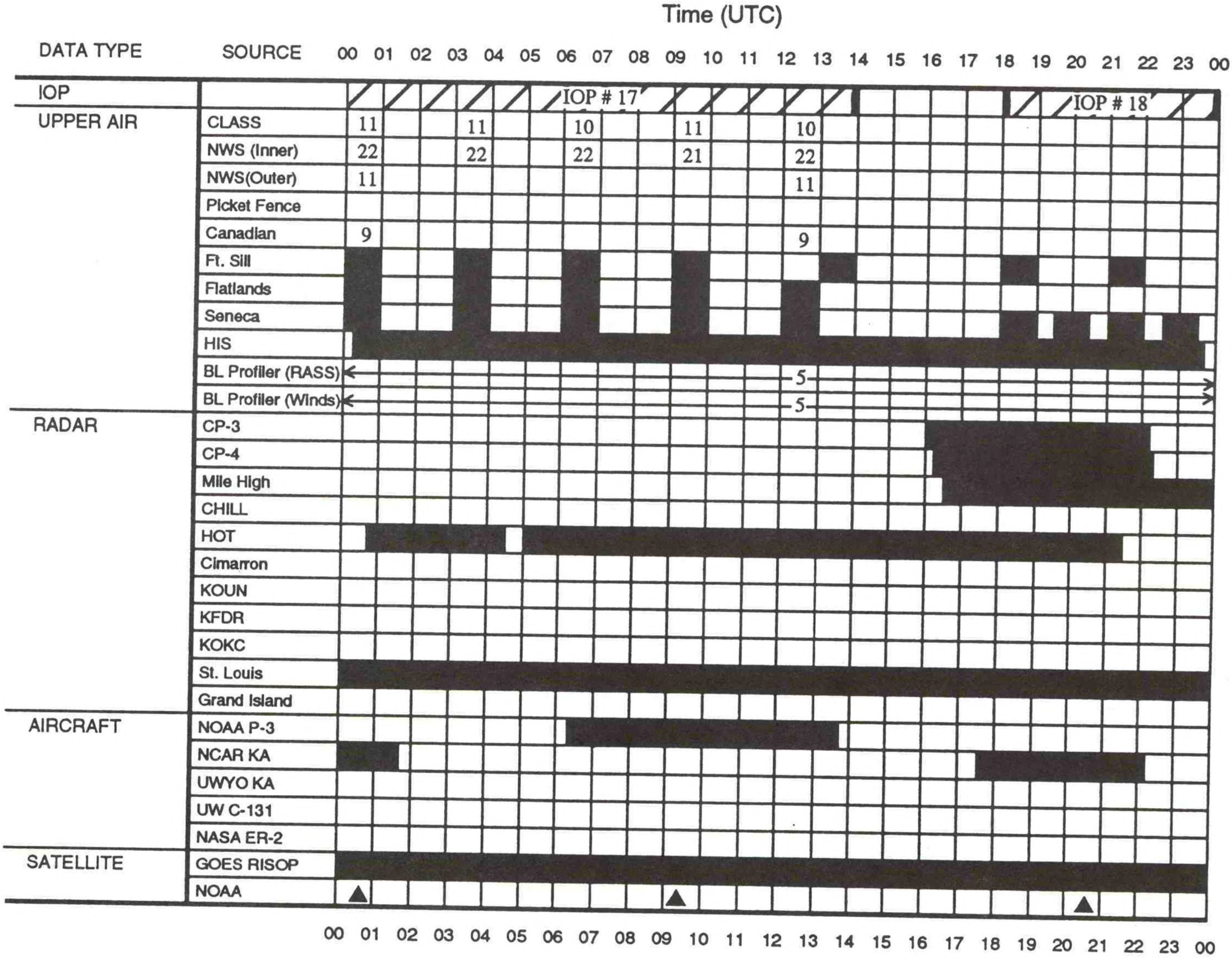
Other Activities:

Planning began for IOP 19 to study the structure of the Alberta Clipper that was forecasted to move into the STORM-FEST domain tomorrow, 11 March.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 10 March

Julian Day: 70



Comments

SURFACE SYSTEMS	ASOS	38 of 42 stations reported; 2 station intermittent.
	AWOS	47 of 47 stations reported; 2 stations intermittent.
	HPCN	72 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 19 stations intermittent.
	PROFS	22 of 22 stations reported; 22 stations intermittent.
	SAO	391 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

WEATHER SUMMARY

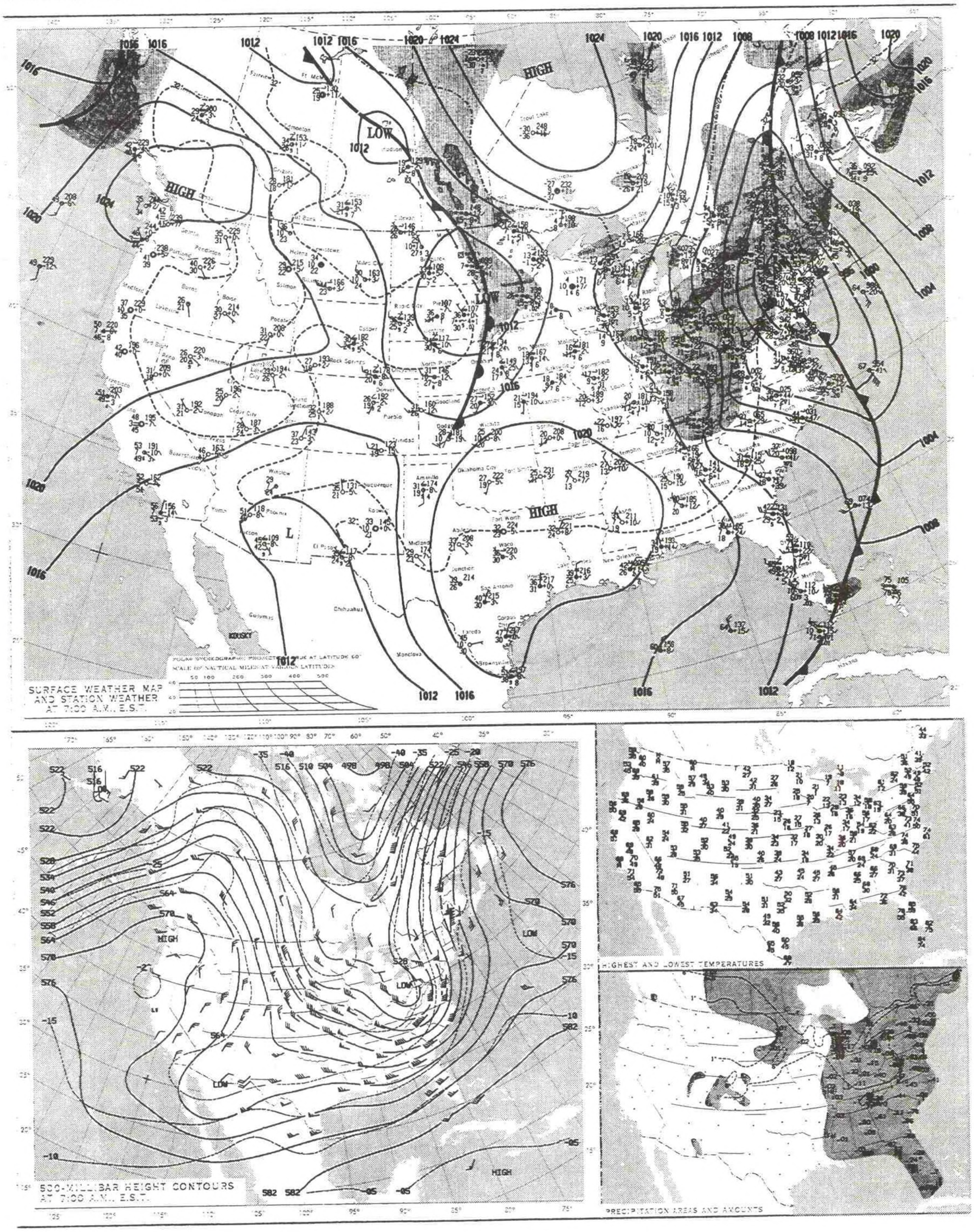
11 March 1992

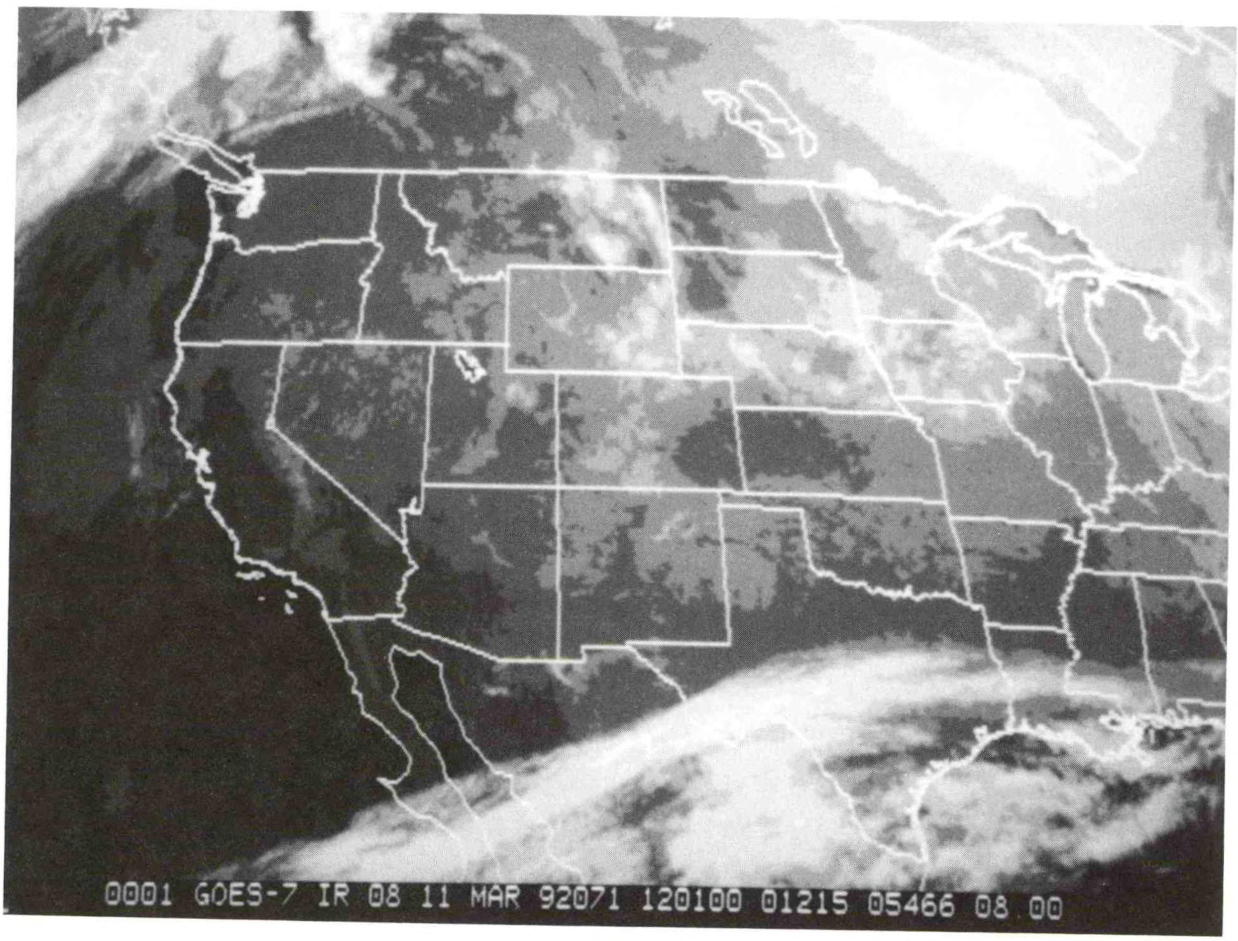
After passage of the major winter storm system out of the STORM-FEST domain, a series of short wave disturbances moved down from the northern Plains into the center of the STORM-FEST domain. An "Alberta Clipper" formed at the surface in association with this upper air scenario, and was responsible for the formation of 1-5 inches of snow across southern Minnesota, northern Iowa, and western Illinois, as well as light rain showers across Missouri and eastern Kansas. On the backside of the upper level tough, a strong upper-level jet, (analyzed in the NMC analyses at 300 mb as only 70-80 kt, but in cloud-tracking was estimated to be 110 kt over North Dakota at 1200 UTC) propagated rapidly southward, with a strong diffluent exit region over southern Nebraska at 1800 UTC and over eastern Kansas at 0000 UTC (12 March) though less diffluent by that time. The surface low remained at 1009 mb throughout the day as it travelled from southwestern Minnesota to eastern Kansas.

A weak warm front extended from the surface low pressure and was oriented along a northwest to southeast line that could develop rain/snow bands. This front was forecast to move into the dual-Doppler array.

After this event the MRF model indicated that not much interesting weather was expected in the STORM-FEST domain until 16-17 March.

WEDNESDAY, MARCH 11, 1992




0001 GOES-7 IR 08 11 MAR 92071 120100 01215 05466 08.00

OPERATIONS SUMMARY

11 March 1992

As discussed yesterday IOP 19 was carried out to study the warm frontal structure, upper-level jet dynamics and associated precipitation bands of the "Alberta Clipper" that formed in response to a series of short wave disturbances that moved down the back side of the trough. The following activities were conducted to support the IOP.

1200 UTC — CLASS soundings were the only remaining soundings resources available. These began at 1200 UTC and were to continue until 0600 UTC (12 March) although the number of sites that could release soundings after 0000 UTC decreased due to diminishing resources at various sites. Radiosondes were also released from Ft. Sill and at the Flatlands radar sites.

1200 UTC — GOES-7 RISOP mode began and was scheduled to continue until 0000 UTC, 12 March.

1500 UTC — CP-3 and CP-4 radar became operational collecting dual-Doppler radar data in light rain. These radar echoes propagated into the array from southeastern Nebraska and took on the appearance of bands oriented along the low-level isotherms. As these echoes moved into the southern dual Doppler lobe their strength decreased.

1806 UTC — The Wyoming King Air took off from Richards-Gebaur AFB on a mission designed to map out ageostrophic winds in the exit region of the upper-level jet over southern Nebraska. Though the original guidance was to position the aircraft in central Nebraska, McIDAS tracked cloud motions suggested a better position for the axis of the jet core to be 171°/44 n mi from the Kearney, Nebraska, VORTAC. The aircraft recorded rapidly increasing wind speeds as it approached this position from southern Nebraska with peak values of 45 m/s at 30 kft. altitude. The King Air then flew the "LAD" pattern (designed by John Marwitz for mapping parcel accelerations and ageostrophic winds in the jet exit region) from this position to a location about 80 n mi downstream (southeast).

The King Air terminated the LAD mission after making only 2 intersects of the jet core, in an attempt to conduct an "M surface" (symmetric instability/absolute momentum) mission over the dual-Doppler radar array. At 2057 UTC, the aircraft was vectored to a position of 321°/70 n mi from the Topeka VORTAC to start the "M surface" pattern at 8500 ft altitude (near the -5°C level). The objective was to determine whether there was evidence of conditional symmetric instability in a region where the precipitation bands were decidedly oriented along the thermal wind (NW-SE). However, by the time the King Air arrived at its destination, the precipitation pattern had changed to a less conspicuous banded appearance and the echoes were too far away for the aircraft to perform the "M surface" mission successfully. The King Air returned to Richards-Gebaur AFB at 2227 UTC.

1846 UTC The University of Washington C-131, took off from Richards-Gebaur AFB on a mission to observe precipitation bands near and over the dual-Doppler radar array. The aircraft ascended to 15 kft. as it proceeded to 245°/25 n mi from the Topeka VORTAC, which was the starting point for the precipitation band transects. Northeast-southwest oriented transects were conducted starting at 1956 UTC at the 15 and 11 kft. levels on a precipitation band west of Omaha. The aircraft was then advised to move to a position in the northern dual-Doppler radar lobe (184°/48 n mi from the Topeka VORTAC) to begin transects there at 2024 UTC, with the first endpoint being 197°/97 n mi. Transects were made at 11, 6, and 3 kft. levels across highly elongated precipitation bands before returning to Richards-Gebaur AFB at 2220 UTC.

1957 UTC The NASA ER-2 took off from Houston, TX, at 1957 UTC on a mission to investigate mesoscale gravity wave structure using remote sensing instruments. This flight was coordinated with that of the Wyoming King Air, to attempt to relate jet exit region dynamics with gravity wave generation. The ER-2 flew at 20 km along a northeastward track from Houston to Urbana, IL (2200 UTC), westward to Lincoln, Nebraska (2300 UTC), southeastward to Jonesboro, Arkansas (0000 UTC, 12 March), and back to Houston, landing at 0140 UTC, 12 March. Observations were made by the MTS, HIS, and MAMS sensors.

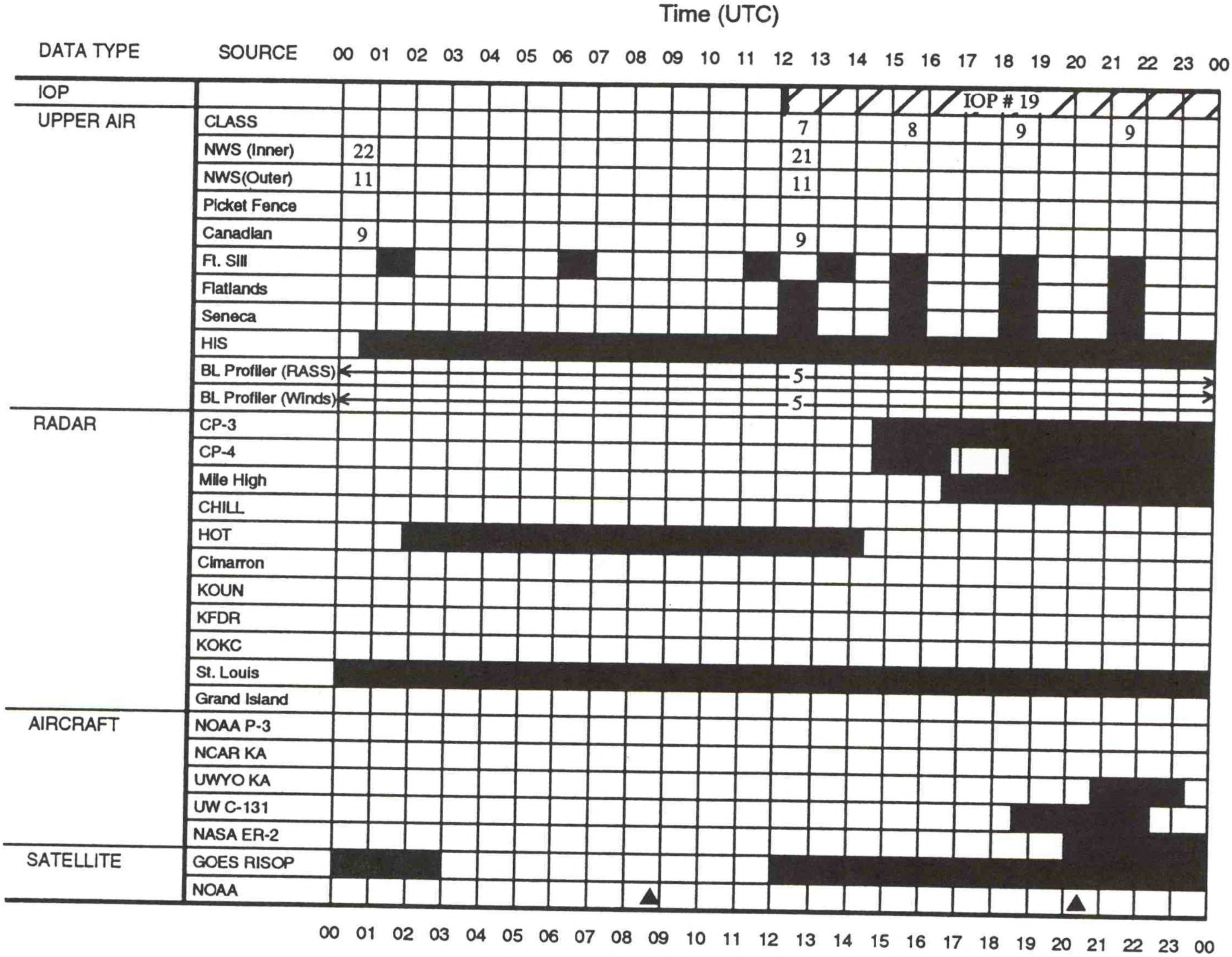
2346 UTC The NCAR King Air took off to sample the structure of the warm front that was positioned in eastern Kansas at 0000 UTC (to its mid-tropospheric location in western Illinois), in search of any relationship between patterns in the precipitation field and this frontal feature. The aircraft proceeded southwestward from Richards-Gebaur AFB to find the position of the low-level front. The aircraft reported rising temperatures to +3°C at the 3 kft. level as it proceeded to (38.12 N, 95.12 W) lat/lon. This point marked the beginning of the cross-frontal "porpoise" traverse, which started at 0053 UTC. Winds veering from 270° to 310° was experienced as the King Air passed upward through the 7 kft. level, consistent with the rawinsonde observations from Columbia, MO, of a low-level inversion whose base (top) was at 5k (7500) ft. Because of the possibility of a deeper frontal layer, the aircraft was advised to increase the top of the porpoise from 7 to 13 kft. Another inversion was found at 3300 m MSL (10 kft.), consistent with NWS sounding cross sections through the region. The King Air reported an inversion base at 13 kft. at 0136 UTC, and the top of the inversion at 13.9 kft with a potential temperature of 290K. This height seemed to be higher than that expected from the rawinsonde analyses.

Because of the complexity of the situation, the aircraft was told to continue the "porpoise" pattern between the 13 kft. and 4.5 kft levels all the way to Quincy, Illinois. On its last descent prior to attempting a dropwindsonde release, the aircraft scientist reported a low-level inversion with a base at 882 mb at (39.2N, 92.8W) lat/lon. Dropsonde releases were attempted at the 20 kft. altitude following this last "porpoise" pattern. The first dropsonde release at 0232 UTC (12 March) was successful, but subsequent attempts failed due to LORAN locking, and this part of the mission was discontinued 10 min. later. Shallow "porpoise" patterns were conducted near the 850 mb level on the aircraft return leg to Richards-Gebaur AFB. The aircraft landed at 0328 UTC (12 March).

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 11 March

Julian Day: 71



Comments

SURFACE SYSTEMS	ASOS	39 of 42 stations reported; 6 station intermittent.
	AWOS	47 of 47 stations reported; 2 stations intermittent.
	HPCN	72 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	34 of 35 stations reported; 15 stations intermittent.
	PROFS	22 of 22 stations reported; 22 stations intermittent.
	SAO	396 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

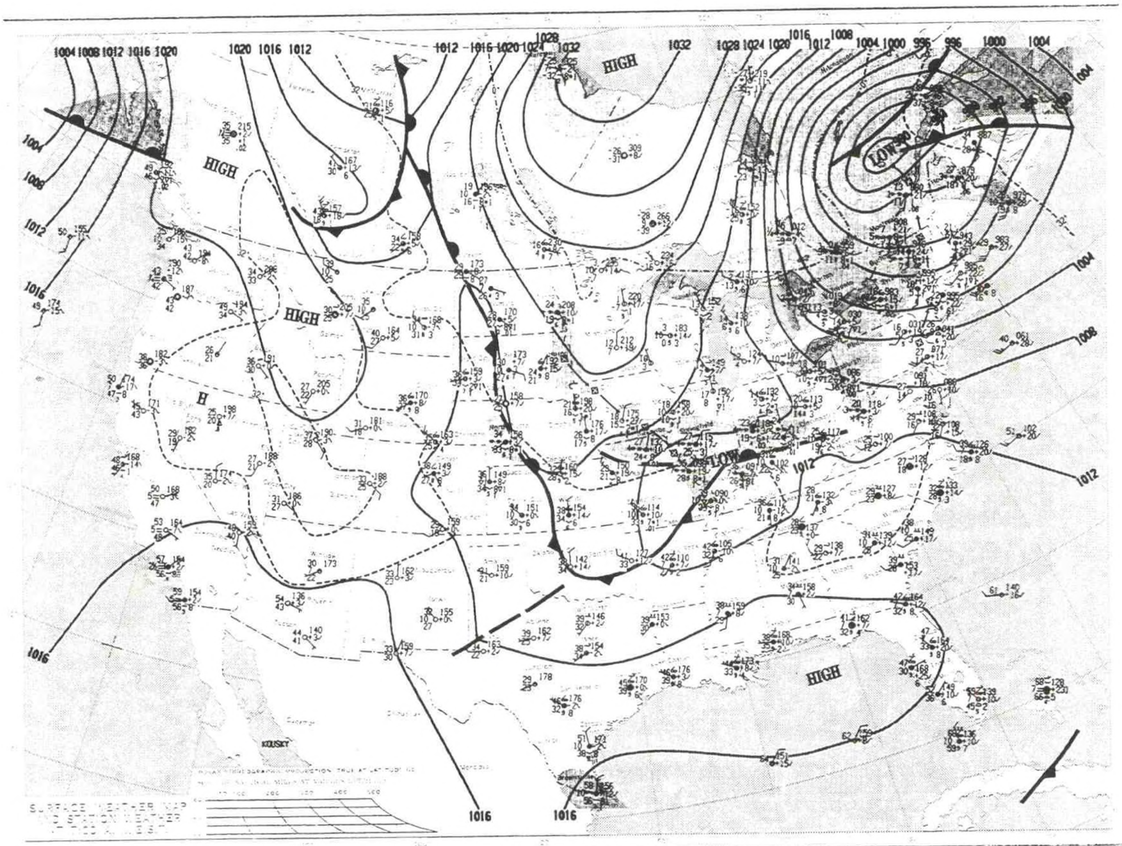
NOTES:

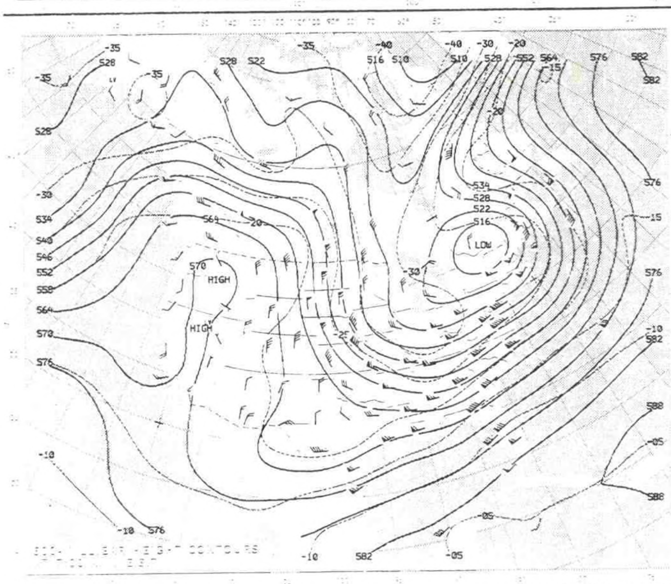
WEATHER SUMMARY

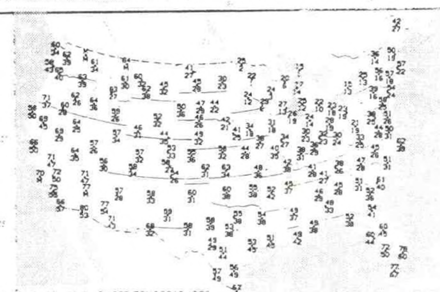
12 March 1992

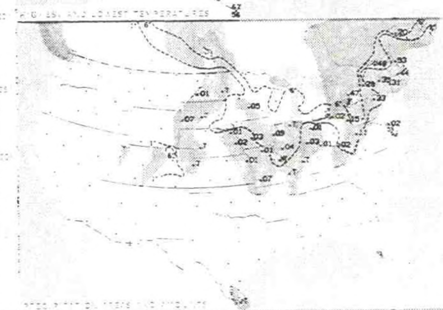
The surface cold front that was in northern Arkansas, stretching across the Red River, was expected to move out of the STORM-FEST domain by evening. Very light snow was expected to taper off over Missouri and northern Arkansas by 0000 UTC (13 March). The next "Alberta Clipper" was expected to move into northeast North Dakota, by 1800 UTC, 13 March. This system was expected to develop mid and low clouds over Minnesota, the eastern Dakotas, and eastern Iowa by evening. Only very light snow was expected with this system in the northeast area of the STORM-FEST domain beginning on 14 March. This system was similar to the one that moved through the area yesterday (11 March) except that it would be warmer and probably drier.

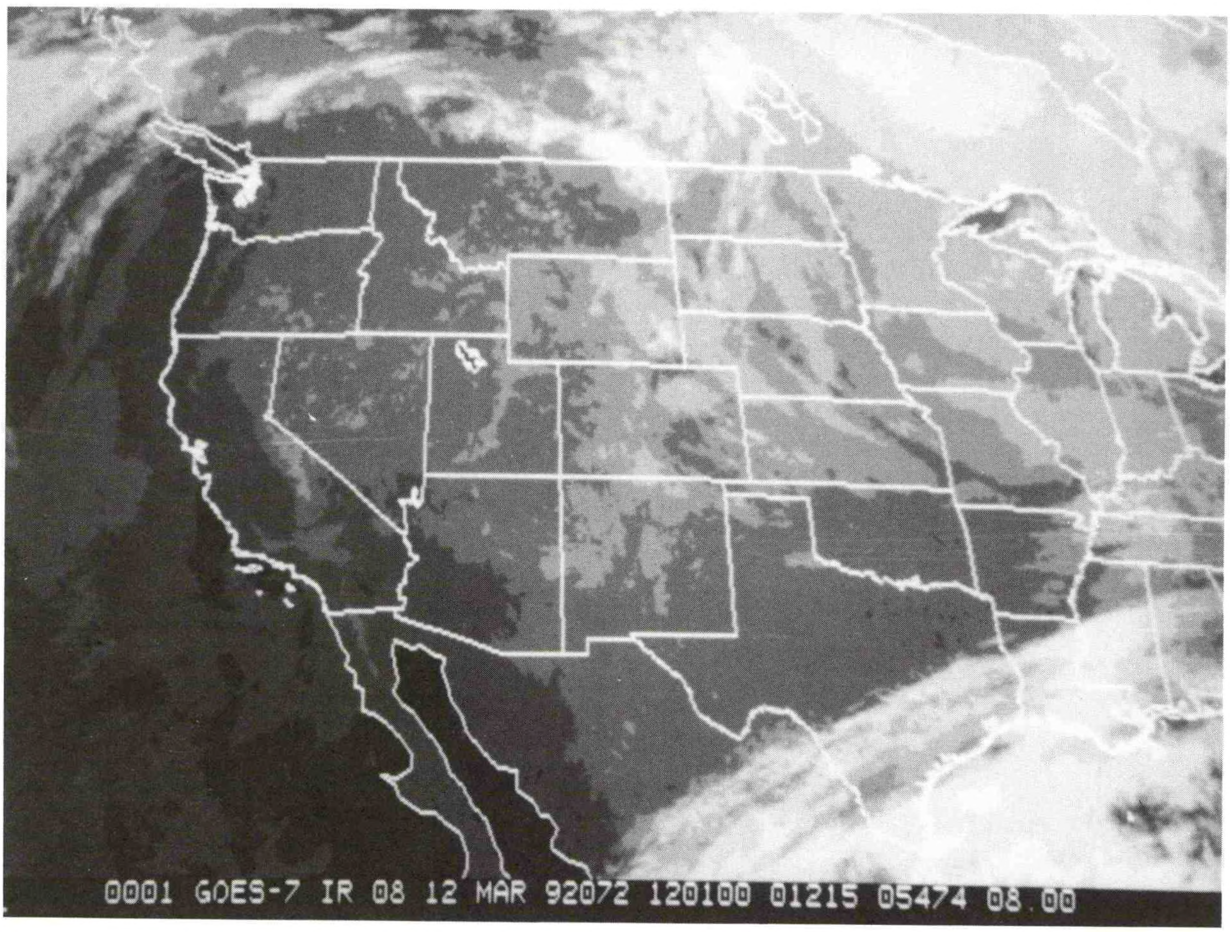
THURSDAY, MARCH 12, 1992










0001 GOES-7 IR 08 12 MAR 92072 120100 01215 05474 08.00

OPERATIONS SUMMARY

12 March 1992

0600 UTC IOP 19 ends with the last of supplemental CLASS soundings.

This IOP was highly successful. The aircraft and Doppler radars were well-coordinated for investigating the relationship between upper-tropospheric jet dynamics, gravity wave generation and structure, precipitation band structure, and warm frontal/low-level inversion structures. Only the "M-surface" part of the mission was of dubious success.

Other Activities:

With generally fair weather and light winds IOP 20 was conducted to document the non-linear flow fields between the boundary layer profilers and examine the refractive index structure of the atmosphere above the profilers as part of "system test" activities. The following activities were conducted in support of this IOP.

1800 UTC The NCAR King Air took off and flew to the boundary layer area to conduct its mission. The University of Washington C-131 also flew calibration legs with the King Air followed by a counterclockwise triangle flight pattern over three boundary layer profiler stations.

1800 UTC Hourly soundings to 500 mb began at Seneca, KS.

1815 UTC The CP-3 and CP-4 radars began taking clear-air dual-Doppler data in the northern lobe of the radar array.

2200 UTC The University of Washington C-131 aircraft landed.

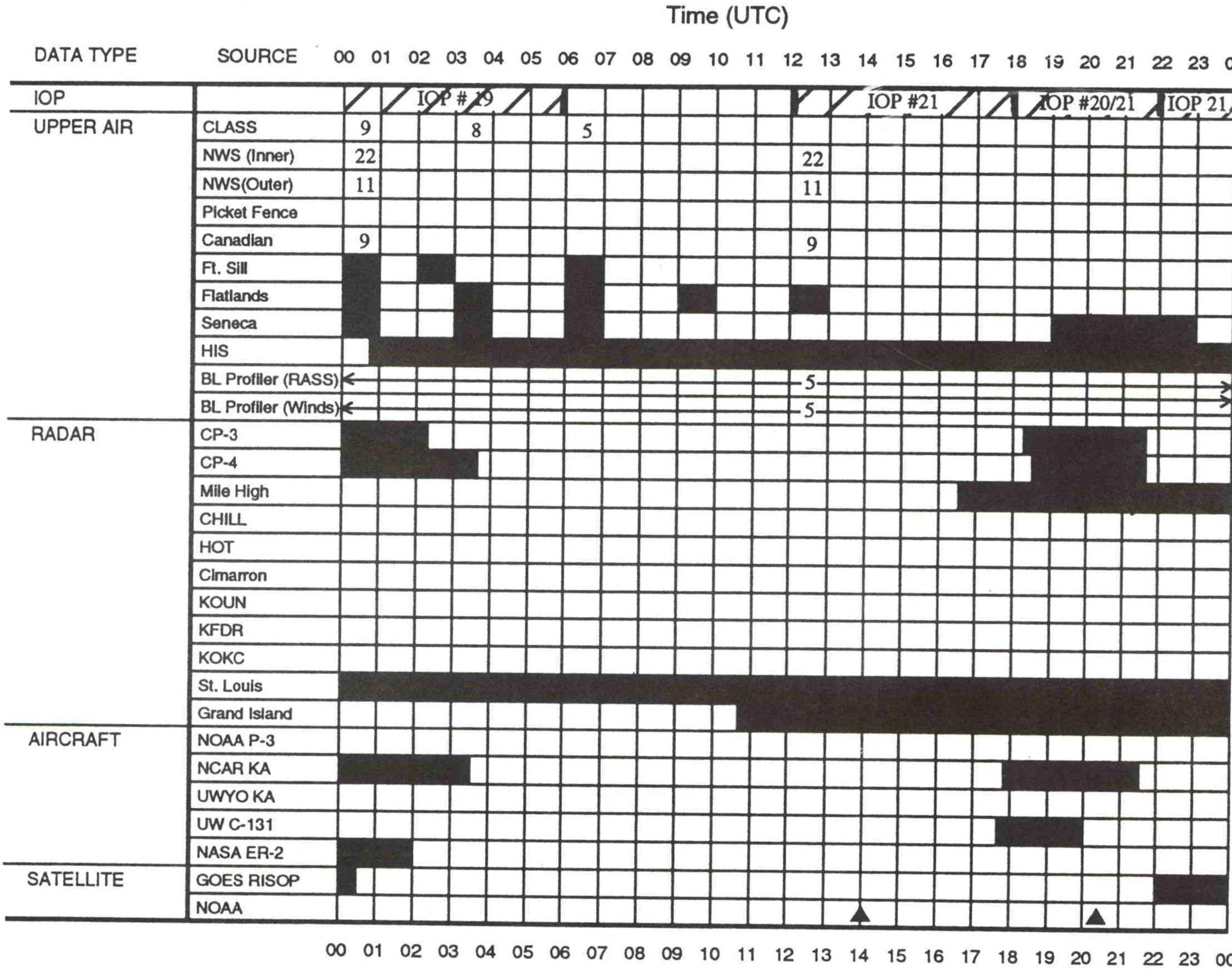
2100 UTC Seneca, KS, soundings end.

2130 UTC The NCAR King Air landed.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 12 March

Julian Day: 72



Comments

SURFACE SYSTEMS	ASOS	41 of 42 stations reported; 10 station intermittent.
	AWOS	47 of 47 stations reported; 4 stations intermittent.
	HPCN	72 of 73 stations reported.
	ISWS	19 of 19 stations reported.
	PAM5	34 of 35 stations reported; 12 stations intermittent.
	PROFS	22 of 22 stations reported.
	SAO	391 of 410 stations reported; 65 stations intermittent.
	WDPN	12 of 13 stations reported.

NOTES:

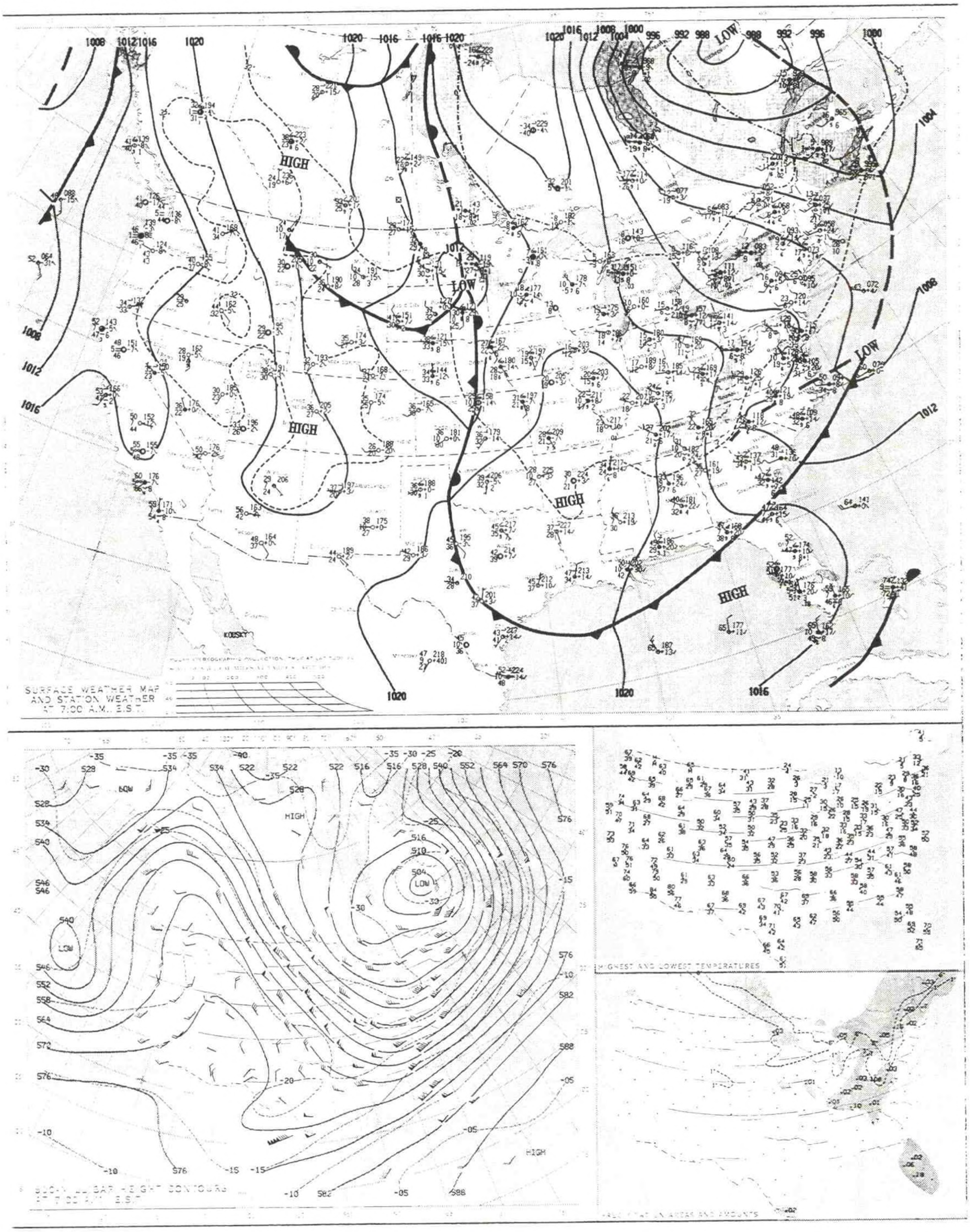
WEATHER SUMMARY

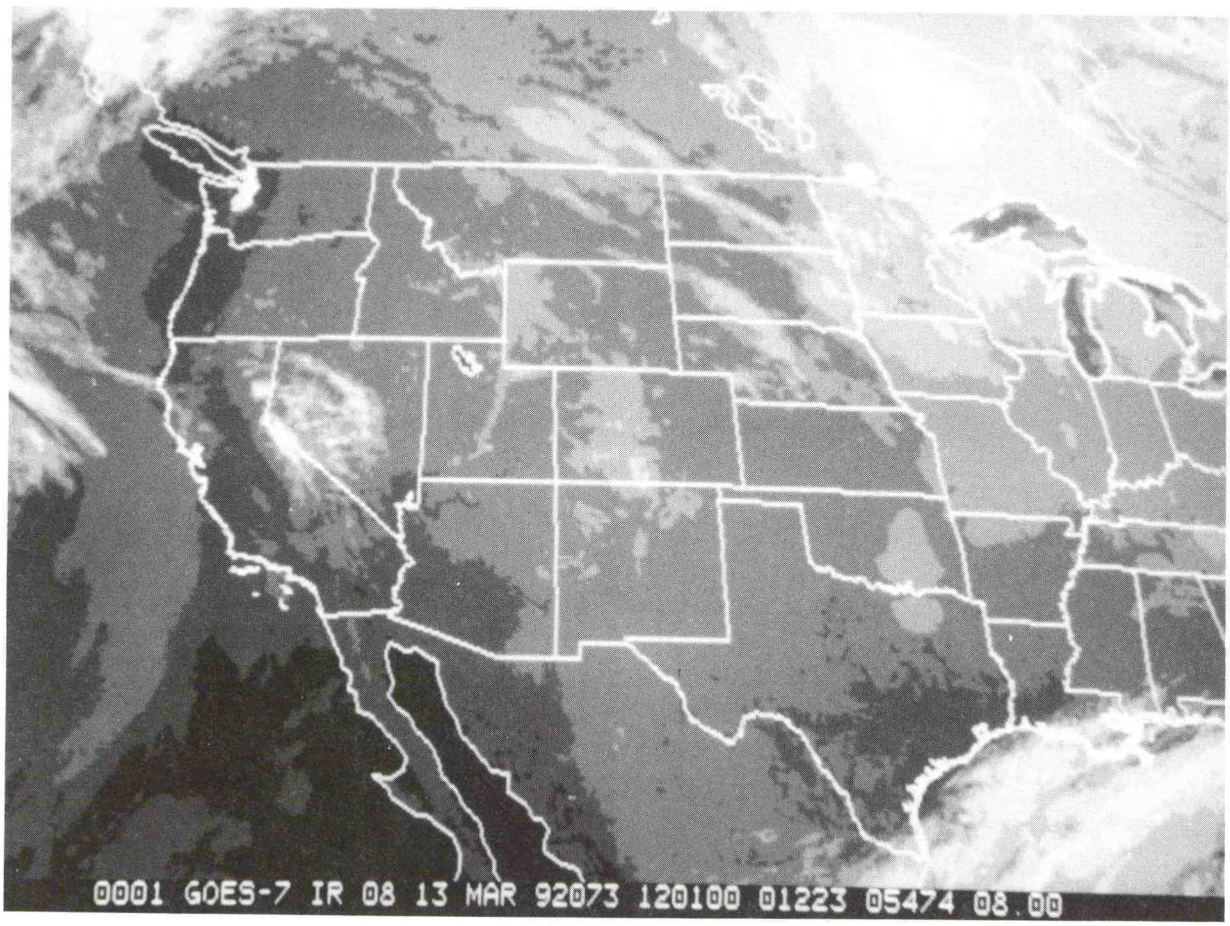
13 March 1992

Another Alberta "clipper" (almost exactly like the one on 11 March), will be the weather maker for the next 24-h, as it moves to north of Kansas City and then east southeast rather quickly. It was expected that this would develop a narrow band of precipitation of perhaps an inch or so of snow to the north and east, with lighter snow around the band. A strong jet oriented north northwest—south southeast in the vicinity of Kansas City is expected to continue through Saturday (14 March). Over the next 24-h only slightly cooler air was expected to move south in response to the surface low pressure circulation.

Over the next 24- to 48-h another rather strong shortwave was expected to rotate around the eastern Canada upper level low and be near Kansas City by 1200 UTC Sunday, 15 March. A fairly strong surface high should move south behind this shortwave with sub-540 thickness contours south of Kansas City on Sunday. This front should continue to move south toward northern Texas on 16 March.

FRIDAY, MARCH 13, 1992




0001 GOES-7 IR 08 13 MAR 92073 120100 01223 05474 08.00

OPERATIONS SUMMARY

13 March 1992

With the strong jet moving out of Canada, it was decided to operate the Canadian 6-h supplemental sounding sites beginning at 0000 UTC (13 March), for 48 hrs through 0000 UTC, 15 March, to document the evolution of the upper-level jet.

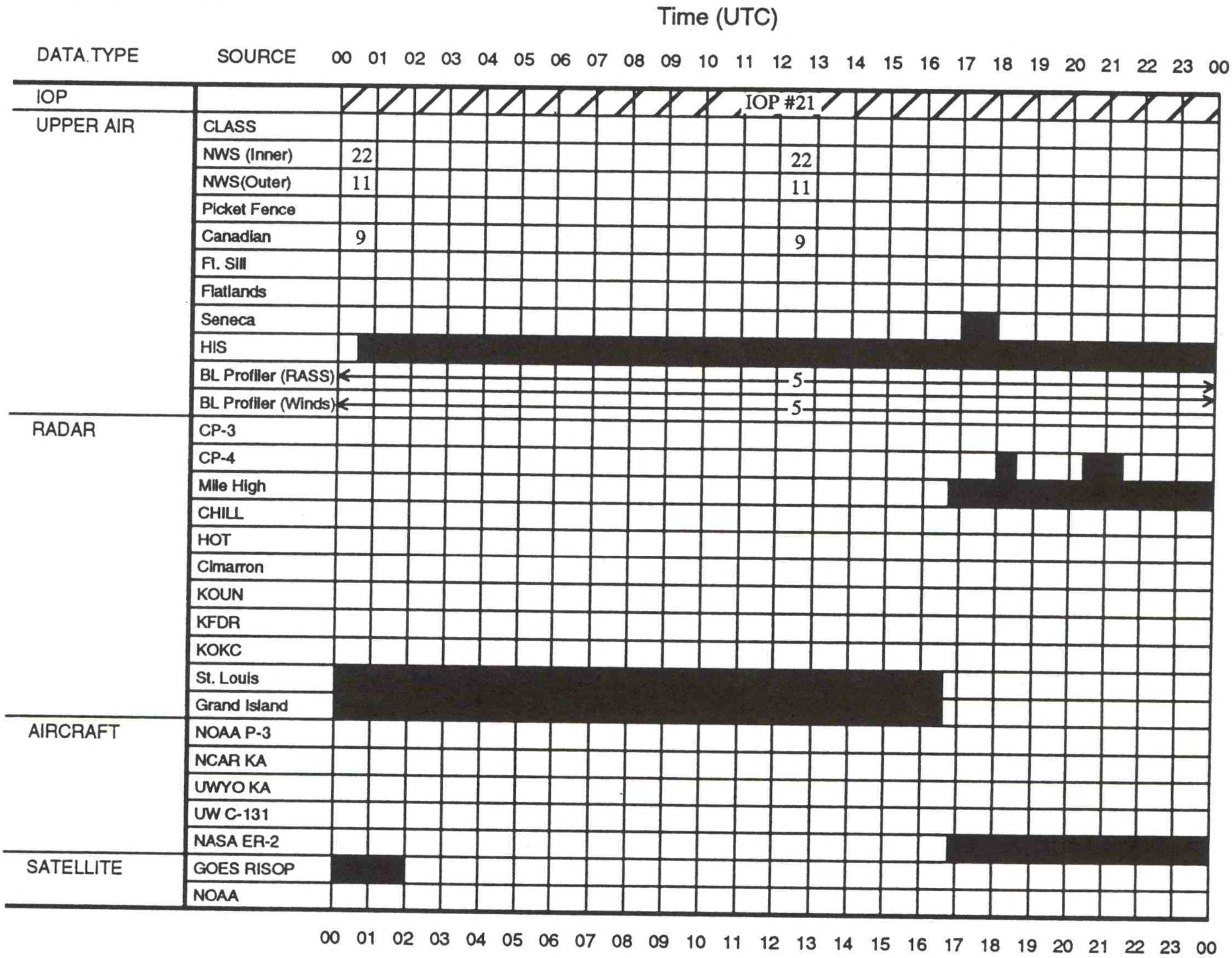
Locally, with the very strong likelihood of no storms or significant precipitation in the STORM-FEST area for at least the next 2- to 3-days, it was decided to end special observations for STORM-FEST, effective at 2140 UTC. Thus, the end of the field phase of STORM-FEST.

The ER-2 performed one more flight to coordinate with the HIS and Seneca CLASS measurements during 14 March.

STORM-FEST
HOURLY COLLECTION OF DATA

Date: 13 March

Julian Day: 73



Comments

SURFACE SYSTEMS	ASOS	39 of 42 stations reported; 6 station intermittent.
	AWOS	47 of 47 stations reported; 2 stations intermittent.
	HPCN	72 of 73 stations reported; 1 station intermittent.
	ISWS	19 of 19 stations reported.
	PAM5	35 of 35 stations reported; 10 stations intermittent.
	PROFS	22 of 22 stations reported.
	SAO	389 of 410 stations reported; 65 stations intermittent.
	WDPN	13 of 13 stations reported; 1 station intermittent.

NOTES:

Appendix A

Appendix A: Station Locations

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
Wind Profiler, NOAA Demo Net					
33.01667/-100.98000	JTN	Jayton	TX	6 minute	707.00
34.08972/- 88.86444	OKO	Okolona	MS	6 minute	125.00
34.11111/- 94.29056	DQU	DeQueen	AR	6 minute	195.00
34.97972/- 97.51862	PRC	Purcell	OK	6 minute	331.00
35.08000/-103.61000	TCU	Tucumcari	NM	6 minute	1241.00
35.80778/- 95.78167	HKL	Haskell	OK	6 minute	212.00
36.07195/- 99.21750	VCI	Vici	OK	6 minute	648.00
36.69111/- 97.48250	LMN	Lamont	OK	6 minute	306.00
36.88389/- 89.97195	BLM	Bloomfield	MO	6 minute	130.00
37.38000/- 95.63472	NDS	Neodesha	KS	6 minute	255.00
37.52334/- 92.70250	CNW	Conway	MO	6 minute	390.00
37.65223/- 99.09111	HVL	Haviland	KS	6 minute	648.00
37.77167/-102.17833	GDA	Granada	CO	6 minute	1155.00
38.30917/- 97.29556	HBR	Hillsboro	KS	6 minute	447.00
38.96000/- 94.57000	NRC	Kansas City	MO	6 minute	244.00
39.58000/- 94.18667	LTH	Lathrop	MI	6 minute	297.00
39.66000/- 90.48000	WNC	Winchester	IL	6 minute	170.00
40.08583/-100.65361	RWD	McCook	NE	6 minute	800.00
40.10000/- 97.34000	FBY	Fairbury	NE	6 minute	433.00
40.18000/-104.71944	PLT	Platteville	CO	6 minute	1524.00
41.90083/- 93.69917	SLA	Slater	IA	6 minute	315.00
42.20722/- 97.79361	NLG	Neligh	NE	6 minute	524.00
42.90556/-101.69473	MRR	Merriman	NE	6 minute	991.00
43.22000/- 90.53000	BLR	BlueRiver	WI	6 minute	226.00
44.67167/- 95.44833	WDL	WoodLake	MN	6 minute	319.00
NWS Cooperative Observer					
32.05000/- 89.55000		RALEIGH	MS	15 minute	164.60
32.10000/- 91.71667		WINNSBORO, 5 SSE	LA	15 minute	24.40
32.10000/- 89.05000		ROSEHILL, 4 SW	MS	15 minute	153.90
32.13333/- 99.16667		CROSSPLAINS, 2	TX	15 minute	545.60
32.13333/- 97.48333		KOPPERL, 5 NNE	TX	15 minute	195.10
32.21667/- 98.18333	SEP	STEPHENVILLE, WSMO	TX	15 minute	401.70
32.23333/- 98.66667		GORMAN, 2 NNE	TX	15 minute	420.60
32.23333/- 87.41667		ALBERTA	AL	15 minute	53.30

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
32.26667/-101.48333		BIGSPRING, FIELDSTN	TX	15 minute	755.90
32.26667/- 96.63333		BARDWELL, DAM	TX	15 minute	140.50
32.30000/- 90.86667		VICKSBURG, WATERWAYS EXPST	MS	15 minute	54.90
32.30000/- 86.40000	MGM	MONTGOMERY, DANNELLY FIELD	AL	15 minute	67.10
32.31667/-102.53333		ANDREWS	TX	15 minute	966.80
32.31667/- 97.01667		MAYPEARL	TX	15 minute	161.50
32.31667/- 90.08333	JAN	JACKSON, THOMPSON FIELD	MS	15 minute	104.90
32.31667/- 89.75000		PELAHATCHIE, 3E	MS	15 minute	118.90
32.31667/- 89.48333		FOREST, 3 S	MS	15 minute	146.30
32.33333/-100.91667		LAKE COLORADO CITY	TX	15 minute	640.10
32.33333/- 88.75000	MEI	MERIDIAN, KEYFIELD	MS	15 minute	90.80
32.35000/- 96.11667		MABANK, 4 SW	TX	15 minute	109.70
32.35000/- 94.65000		LONGVIEW, WSMO	TX	15 minute	124.10
32.38333/-103.80000		WASTE ISOLTN PILOT PLT	NM	15 minute	1041.80
32.40000/- 98.85000		EASTLAND	TX	15 minute	445.00
32.41667/-104.23333		CARLSBAD	NM	15 minute	951.00
32.41667/- 99.68333	ABI	ABILENE, MUNICIPAL ARPT	TX	15 minute	541.90
32.41667/- 93.63333		REDRIVER, RESEARCH STN	LA	15 minute	47.20
32.45000/- 95.41667		SWAN, 4 NW	TX	15 minute	137.20
32.45000/- 89.40000		CONAHATTA, 1 NE	MS	15 minute	158.50
32.46667/- 93.81667	SHV	SHREVEPORT, WSO AP	LA	15 minute	78.00
32.48333/- 97.00000		MIDLOTHIAN, 2	TX	15 minute	219.50
32.51667/- 96.66667		FERRIS	TX	15 minute	143.30
32.51667/- 92.33333		CALHOUN, RESEARCH STN	LA	15 minute	54.90
32.53333/- 97.61667		CRESSON	TX	15 minute	320.00
32.53333/- 92.06667		MONROE, NLU	LA	15 minute	21.30
32.55000/- 97.31667		BURLESON	TX	15 minute	222.50
32.58333/- 93.28333		MINDEN	LA	15 minute	56.40
32.65000/-103.38333		PEARL	NM	15 minute	1158.20
32.65000/- 97.45000		BENBROOK, DAM	TX	15 minute	240.80
32.70000/- 87.26667		MARION, 7 NE	AL	15 minute	52.40
32.73333/- 94.98333		GILMER, 2 W	TX	15 minute	118.90
32.75000/- 97.33333		FORT WORTH, FEDERAL BUILDING	TX	15 minute	187.80
32.76667/-104.38333		ARTESIA, 6 S	NM	15 minute	1011.90
32.76667/- 97.81667		WEATHERFORD	TX	15 minute	324.60
32.78333/- 98.11667		MINERAL WELLS, 1 SSW	TX	15 minute	257.60
32.78333/- 88.66667		DE KALB	MS	15 minute	141.70
32.78333/- 87.83333		WARRIOR, LOCKAND DAM	AL	15 minute	33.50
32.80000/-105.56667		SACRAMENTO, # 2	NM	15 minute	2301.20
32.80000/- 89.33333		EDINBURG	MS	15 minute	114.90
32.81667/-104.73333		HOPE	NM	15 minute	1249.70
32.81667/-103.70000		MALJAMAR, 4 SE	NM	15 minute	1219.20
32.81667/- 97.35000	FTW	FORT WORTH, MEACHAM FIELD	TX	15 minute	204.20
32.81667/- 92.16667		MARION, 7 SE	LA	15 minute	46.00
32.85000/- 96.85000	DAL	DALLAS, LOVE FIELD	TX	15 minute	147.80
32.88333/-105.95000		ALAMOGORDO	NM	15 minute	1325.90
32.88333/- 86.70000		THORSBY, EXP STATION	AL	15 minute	207.30
32.90000/- 97.68333		SPRINGTOWN, 4 S	TX	15 minute	321.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
32.90000/- 97.03333	DFW	DALLAS/FT WORTH, Regional Airport	TX	15 minute	181.70
32.90000/- 90.88333		ROLLING FORK	MS	15 minute	32.00
32.90000/- 90.38333		YAZOO CITY, 5 NNE	MS	15 minute	32.60
32.93333/- 99.78333		STAMFORD, 1	TX	15 minute	499.90
32.93333/- 94.96667		PITTSBURG, 5 S	TX	15 minute	106.70
32.95000/- 97.56667		RENO	TX	15 minute	234.70
32.96667/-101.81667		O DONNELL	TX	15 minute	928.40
32.96667/- 97.05000		GRAPEVINE, DAM	TX	15 minute	178.30
32.98333/- 89.38333		KOSCIUSKO, 13 SE	MS	15 minute	128.00
33.01667/- 99.05000		WOODSON	TX	15 minute	385.00
33.01667/- 89.05000		NOXAPATER, 1N	MS	15 minute	134.10
33.03333/- 96.48333		LAVON, DAM	TX	15 minute	155.50
33.06667/- 97.01667		LEWISVILLE, DAM	TX	15 minute	169.50
33.08333/- 97.30000		JUSTIN	TX	15 minute	195.10
33.10000/- 88.53333		MACON, 2 E	MS	15 minute	51.80
33.11667/- 89.46667		ETHEL	MS	15 minute	128.00
33.13333/- 90.06667		LEXINGTON, 2 NNW	MS	15 minute	96.00
33.13333/- 89.06667		LOUISVILLE	MS	15 minute	177.10
33.15000/- 96.83333		FRISCO	TX	15 minute	205.70
33.15000/- 95.63333		SULPHUR SPRINGS	TX	15 minute	150.90
33.17000/- 95.00000		MOUNT PLEASANT	TX	15 minute	129.50
33.18333/-102.83333		PLAINS	TX	15 minute	1121.70
33.20000/- 97.10000		DENTON, 2 SE	TX	15 minute	192.00
33.21667/- 97.83333		LAKE BRIDGEPORT, DAM	TX	15 minute	265.20
33.23333/- 98.15000		JACKSBORO, 1 NNE	TX	15 minute	310.90
33.25000/-100.56667		JAYTON	TX	15 minute	612.70
33.26667/- 95.90000		COMMERCE	TX	15 minute	169.20
33.30000/-104.53333	ROW	ROSWELL,INDUSTRIAL AIR PARK	NM	15 minute	1117.70
33.30000/- 94.16667		WRIGHT PATMAN, DAM & LAKE	TX	15 minute	86.00
33.30000/- 92.48333		CALION, LOCK & DAM	AR	15 minute	30.50
33.32000/- 93.23000		MAGNOLIA, 3 N	AR	15 minute	97.50
33.35000/-105.66667		RUIDOSO, 2	NM	15 minute	2114.40
33.35000/- 96.53333		ANNA	TX	15 minute	207.30
33.36667/- 93.56667		LEWISVILLE	AR	15 minute	103.60
33.38000/- 97.65000		ALVORD, 4 NE	TX	15 minute	315.50
33.38333/-105.26667		HONDO, 1 SE	NM	15 minute	1606.30
33.41667/- 94.08333		TEXARKANA	TX	15 minute	118.90
33.43333/- 90.91667		STONEVILLE, EXP STN	MS	15 minute	38.70
33.45000/-105.73333		BONITO, DAM	NM	15 minute	2218.90
33.45000/- 94.41667		NEW BOSTON	TX	15 minute	105.20
33.46667/- 88.78333		STATE UNIVERSITY	MS	15 minute	56.40
33.51667/-103.33333		CROSSROADS	NM	15 minute	1264.90
33.51667/- 95.31667		DEPORT	TX	15 minute	129.50
33.51667/- 90.18333		GREENWOOD, 2	MS	15 minute	40.80
33.55000/-105.56667		CAPITAN	NM	15 minute	1970.50
33.55000/- 89.23333		EUPORA, 2 E	MS	15 minute	134.10
33.56667/- 86.75000	BHM	BIRMINGHAM, MUNICIPAL ARPT	AL	15 minute	196.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
33.58333/-100.03333		BENJAMIN, 15 W	TX	15 minute	502.90
33.58333/- 95.90000		HONEY GROVE	TX	15 minute	207.30
33.60000/-100.53333		PITCHFORK RANCH	TX	15 minute	592.80
33.60000/- 99.38333		RED SPRINGS, 2 ESE	TX	15 minute	416.70
33.60000/- 92.81667		CAMDEN, 1	AR	15 minute	35.40
33.60000/- 91.80000		MONTICELLO, 3 SW	AR	15 minute	88.40
33.61667/- 95.06667		CLARKSVILLE, 1 W	TX	15 minute	129.80
33.61667/- 87.61667		BERRY, 3 S	AL	15 minute	129.50
33.63333/-105.88333	Q37	CARRIZOZO, 1 SW	NM	15 minute	1647.40
33.63333/- 97.13333		GAINESVILLE	TX	15 minute	237.70
33.65000/-101.81667	LBB	LUBBOCK, REGIONAL ARPT	TX	15 minute	996.10
33.68333/- 93.96667		MILLWOOD, DAM	AR	15 minute	96.30
33.70000/-101.83333		LUBBOCK, 9 N	TX	15 minute	989.10
33.73333/- 95.91667		LAKE CROCKETT	TX	15 minute	161.50
33.73333/- 94.40000		FOREMAN	AR	15 minute	121.90
33.75000/- 99.15000		LAKE KEMP	TX	15 minute	355.70
33.76667/- 99.83333		TRUSCOTT, 2 NW	TX	15 minute	460.30
33.76667/- 97.60000		BONITA	TX	15 minute	298.10
33.80000/-100.51667		DUMONT	TX	15 minute	612.70
33.80000/- 96.85000		GORDONVILLE	TX	15 minute	228.60
33.80000/- 93.38333		PRESCOTT	AR	15 minute	93.90
33.80000/- 90.71667		CLEVELAND, 3 N	MS	15 minute	42.70
33.80000/- 89.76667		GRENADA, DAM	MS	15 minute	85.30
33.80000/- 88.11667		VERNON, 2 N	AL	15 minute	80.80
33.81667/-102.56667		PEP	TX	15 minute	1115.60
33.81667/- 96.56667		DENISON, DAM	TX	15 minute	186.80
33.81667/- 86.80000		WARRIOR, 2	AL	15 minute	198.10
33.83333/- 88.51667		ABERDEEN	MS	15 minute	64.60
33.86667/- 95.51667		PAT MAYSE, DAM	TX	15 minute	150.90
33.88333/- 91.48333		DUMAS	AR	15 minute	48.80
33.90000/-105.00000		CIRCLE F, RANCH	NM	15 minute	1645.90
33.91667/- 89.33333		CALHOUN CITY, 2 NW	MS	15 minute	86.60
33.92000/- 89.00000		HOUSTON	MS	15 minute	82.30
33.95000/- 93.86667		NASHVILLE	AR	15 minute	125.00
33.96667/- 98.48333	SPS	WICHITA FALLS, MUNICIPAL ARPT	TX	15 minute	309.10
34.00000/- 95.51667		HUGO	OK	15 minute	173.70
34.00000/- 95.40000		HUGO, DAM	OK	15 minute	142.00
34.01667/-100.83333		MATADOR	TX	15 minute	698.00
34.01667/- 96.71667		KINGSTON	OK	15 minute	251.50
34.03333/- 93.41667		ANTOINE	AR	15 minute	86.90
34.05000/- 86.76667		HANCEVILLE	AL	15 minute	161.50
34.10000/- 94.38333		DE QUEEN, DAM	AR	15 minute	169.80
34.10000/- 87.98333		HAMILTON, 3 S	AL	15 minute	132.60
34.11667/- 94.23333		GILLHAM, DAM	AR	15 minute	158.50
34.13333/- 94.70000		BROKEN BOW, DAM	OK	15 minute	135.00
34.13333/- 89.28333		SAREPTA, 1 NNE	MS	15 minute	115.20
34.15000/-105.00000		RAMON, 8 SW	NM	15 minute	1623.70
34.15000/- 97.15000		ARDMORE, # 2	OK	15 minute	259.10

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
34.15000/- 94.10000		DIERKS, DAM	AR	15 minute	209.10
34.15000/- 93.71667		NARROWS, DAM	AR	15 minute	132.60
34.15000/- 93.05000		ARKADELPHIA, 2 N	AR	15 minute	59.70
34.15000/- 89.91667		ENID, DAM	MS	15 minute	91.40
34.20000/- 90.56667		CLARKSDALE	MS	15 minute	52.70
34.21667/-102.73333		MULESHOE, 2	TX	15 minute	1158.20
34.21667/- 92.01667		PINE BLUFF	AR	15 minute	65.50
34.21667/- 87.16667		ADDISON	AL	15 minute	240.50
34.21667/- 86.16667		BOAZ	AL	15 minute	326.10
34.23333/- 96.21667		CANEY	OK	15 minute	176.80
34.23333/- 95.08333		PINE CREEK, DAM	OK	15 minute	149.40
34.25000/- 95.63333		ANTLERS	OK	15 minute	158.50
34.25000/- 94.78333		CARTER, TOWER	OK	15 minute	396.20
34.25000/- 87.58333		HALEYVILLE, 2 ENE	AL	15 minute	297.20
34.26667/- 88.76667	TUP	TUPELO, C D LEMONS ARPT	MS	15 minute	110.00
34.36667/-101.75000		KRESS	TX	15 minute	1060.70
34.38333/- 89.53333		UNIVERSITY	MS	15 minute	115.80
34.40000/- 89.80000		SARDIS, DAM	MS	15 minute	70.10
34.41667/-105.88333		PROGRESSO	NM	15 minute	1919.30
34.41667/-103.20000		CLOVIS	NM	15 minute	1307.60
34.43333/-100.28333	CDS	CHILDRESS, FCWOS AP	TX	15 minute	594.70
34.46667/-105.40000		DURAN	NM	15 minute	1914.10
34.46667/- 96.21667		LEHIGH	OK	15 minute	195.10
34.46667/- 91.41667		STUTTGART, 9 ESE	AR	15 minute	60.40
34.48333/- 97.96667		DUNCAN, AIRPORT	OK	15 minute	342.90
34.51667/- 97.36667		HENNEPIN, 1 WNW	OK	15 minute	284.40
34.53333/- 93.60000		MOUNT IDA, 3 SE	AR	15 minute	212.50
34.56667/- 94.26667		MENA	AR	15 minute	344.40
34.56667/- 93.20000		BLAKELY MOUNTAIN, DAM	AR	15 minute	129.80
34.58333/- 99.33333		ALTUS, IRIG RES STATION	OK	15 minute	420.60
34.60000/-104.38333		SUMNER, LAKE	NM	15 minute	1312.50
34.60000/-103.21667		CLOVIS, 13 N	NM	15 minute	1351.80
34.61667/- 95.28333		TUSKAHOMA	OK	15 minute	182.90
34.61667/- 89.18333		HICKORY FLAT	MS	15 minute	121.90
34.63333/- 96.88333		ROFF, 2 WNW	OK	15 minute	382.50
34.65000/- 86.76667	HSV	HUNTSVILLE, Madison County JETPLEX	AL	15 minute	190.80
34.66667/- 88.56667		BOONEVILLE	MS	15 minute	149.40
34.73333/- 98.71667		WICHITA, MTN WL REF	OK	15 minute	507.50
34.73333/- 88.95000		RIPLEY	MS	15 minute	158.50
34.75000/- 90.13333		ARKABUTLA, DAM	MS	15 minute	73.20
34.76667/- 92.45000		FERNDALE, 6 E	AR	15 minute	150.00
34.76667/- 86.95000		ATHENS	AL	15 minute	207.30
34.80000/-101.55000		WAYSIDE	TX	15 minute	1036.30
34.80000/- 92.86667		ALUM FORK	AR	15 minute	237.70
34.81667/-102.40000		HEREFORD	TX	15 minute	1164.30
34.81667/- 97.26667		PAOLI, 2 W	OK	15 minute	283.80
34.81667/- 89.43333		HOLLYSPRINGS, 4 N	MS	15 minute	147.20

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
34.83333/-100.21667		WELLINGTON	TX	15 minute	621.80
34.83333/- 92.26667	1M1	NORTHLITTLEROCK,ARPT	AR	15 minute	171.60
34.85000/- 95.08333		BENGAL, 2 NNW	OK	15 minute	202.70
34.86667/- 89.68333		BYHALIA	MS	15 minute	97.50
34.88333/- 95.78333	MLC	MCALESTER, MUNICIPAL AP	OK	15 minute	231.70
34.88333/- 91.18333		BRINKLEY	AR	15 minute	61.00
34.90000/- 94.10000		WALDRON	AR	15 minute	205.70
34.91667/- 88.51667		CORINTH, CITY	MS	15 minute	117.40
34.93333/- 94.71667		WISTER, DAM	OK	15 minute	151.80
34.93333/- 93.50000		BRIGGSVILLE	AR	15 minute	140.20
34.95000/- 93.16667		NIMROD, DAM	AR	15 minute	146.30
35.01667/- 99.08333		HOBART	OK	15 minute	489.20
35.05000/- 97.91667		CHICKASHA, EXPERIMENT STN	OK	15 minute	330.70
35.05000/- 90.00000	MEM	MEMPHIS, WSCMO AP	TN	15 minute	100.90
35.06667/- 91.90000		BEEBE	AR	15 minute	76.20
35.08333/- 96.68333		WOLF	OK	15 minute	210.30
35.10000/- 98.43333		FORT COBB	OK	15 minute	382.50
35.10000/- 93.91667		BOONEVILLE, 3 SSE	AR	15 minute	213.40
35.10000/- 93.65000		BLUE MOUNTAIN, DAM	AR	15 minute	129.80
35.15000/- 88.31667		SAVANNAH, 6 SW	TN	15 minute	128.00
35.16667/-105.96667		STANLEY, 1 NNE	NM	15 minute	1944.60
35.18333/-105.06667		DILIA	NM	15 minute	1585.00
35.20000/-103.68333		TUCUMCARI, 4 NE	NM	15 minute	1245.40
35.23333/-101.70000	AMA	AMARILLO, INT'L ARPT	TX	15 minute	1098.80
35.23333/-100.60000		MC LEAN	TX	15 minute	871.70
35.25000/- 95.12000		STIGLER, 1 SE	OK	15 minute	173.70
35.25000/- 90.80000		WYNNE	AR	15 minute	79.30
35.25000/- 87.35000		LAWRENCEBURG, FILTER PLANT	TN	15 minute	265.20
35.26667/- 88.98333		BOLIVAR, WATERWORKS	TN	15 minute	138.70
35.30000/- 95.36667		LAKE EUFAULA	OK	15 minute	221.30
35.30000/- 91.38333		AUGUSTA, 2 NW	AR	15 minute	59.40
35.33333/- 99.86667		MAYFIELD	OK	15 minute	611.10
35.33333/- 94.78333		ROBERT S KERR, DAM	OK	15 minute	150.30
35.33333/- 94.36667	FSM	FORT SMITH, MUNICIPAL ARPT	AR	15 minute	143.00
35.38333/- 99.40000		ELK CITY	OK	15 minute	600.50
35.40000/-104.18333		CONCHAS, DAM	NM	15 minute	1293.60
35.40000/- 97.60000	OKC	OKLAHOMA CITY, WSFO AP	OK	15 minute	390.80
35.40000/- 89.53333		MASON	TN	15 minute	97.20
35.43333/- 96.30000		OKEMAH	OK	15 minute	285.00
35.45000/- 89.80000		MUNFORD	TN	15 minute	136.60
35.45000/- 86.80000		LEWISBURG, EXP STN	TN	15 minute	239.90
35.48333/- 97.66667		LAKE OVERHOLSER	OK	15 minute	387.10
35.51667/- 92.00000		GREERS FERRY, DAM	AR	15 minute	160.60
35.53333/-105.20000		LAS VEGAS, SEWAGE PLANT	NM	15 minute	1935.20
35.53333/- 93.40000		CLARKSVILLE, 6 NE	AR	15 minute	259.10
35.55000/- 95.16667		WEBBERS FALLS, DAM	OK	15 minute	158.50
35.56667/-100.96667		PAMPA, 2	TX	15 minute	960.10
35.58333/- 89.26667		BROWNSVILLE, SEWAGE PLANT	TN	15 minute	108.20

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
35.60000/- 95.05000		TENKILLER FERRY, DAM	OK	15 minute	234.70
35.61667/-105.98333		SANTA FE, 2	NM	15 minute	2047.70
35.61667/- 88.83333		JACKSON, EXP STN	TN	15 minute	121.90
35.63333/-100.40000		GAGEBY, 3 WNW	TX	15 minute	853.40
35.63333/- 98.31667		GEARY	OK	15 minute	486.20
35.66667/- 98.88333		CUSTER CITY	OK	15 minute	542.50
35.66667/- 88.41667		LEXINGTON	TN	15 minute	164.60
35.68333/-102.33333		CHANNING	TX	15 minute	1158.20
35.70000/- 96.88333		CHANDLER, 1	OK	15 minute	290.50
35.71667/- 97.98333		OKARCHE	OK	15 minute	379.50
35.71667/- 92.46667		BOTKINBURG, 3 NE	AR	15 minute	394.70
35.75000/- 99.83333		MACKIE, 4 NNW	OK	15 minute	655.30
35.75000/- 91.63000		BATESVILLE, L&D 1	AR	15 minute	84.40
35.75000/- 87.45000		CENTERVILLE, WATER PLANT	TN	15 minute	201.20
35.76667/- 95.33333		MUSKOGEE	OK	15 minute	177.70
35.81667/- 91.78333		BATESVILLE, LIVESTOCK	AR	15 minute	174.00
35.83333/-101.45000		STINNETT	TX	15 minute	954.00
35.83333/- 93.75000		ST PAUL, 1 E	AR	15 minute	481.60
35.85000/- 95.36667		OKAY 3 W, LOCK 17	OK	15 minute	158.50
35.86667/- 95.23333		FORT GIBSON, DAM	OK	15 minute	161.90
35.90000/- 91.08333		ALICIA	AR	15 minute	78.00
35.91667/- 86.36667		MURFREESBORO, 5 N	TN	15 minute	167.60
35.95000/-104.20000		ROY	NM	15 minute	1791.60
35.95000/- 96.28333		HEYBURN, DAM	OK	15 minute	253.30
35.95000/- 93.25000		PARTHENON	AR	15 minute	274.30
35.98333/- 92.71667		GILBERT	AR	15 minute	189.00
36.03333/- 98.96667		TALOGA	OK	15 minute	519.70
36.03333/- 89.38333		DYERSBURG, 2	TN	15 minute	85.00
36.05000/- 90.11667		HORNERSVILLE	MO	15 minute	76.20
36.06667/- 96.56667		OILTON, 2 SE	OK	15 minute	268.20
36.06667/- 95.55000		INOLA, 6 SSW	OK	15 minute	166.10
36.06667/- 93.75000		HUNTSVILLE, 1 SSW	AR	15 minute	543.50
36.06667/- 87.38333		DICKSON	TN	15 minute	237.70
36.08333/- 93.30000		COMPTON	AR	15 minute	660.20
36.08333/- 87.86667		WAVERLY, 4 W	TN	15 minute	134.10
36.10000/- 94.16667		FAYETTEVILLE, EXP STN	AR	15 minute	387.10
36.11667/- 97.10000		STILLWATER, 2 W	OK	15 minute	272.80
36.11667/- 86.68333	BNA	NASHVILLE, METRO ARPT	TN	15 minute	182.00
36.15000/- 97.61667		MARSHALL	OK	15 minute	318.50
36.15000/- 96.25000	HRL	KEYSTONE, DAM	OK	15 minute	214.90
36.16667/- 95.01667		ROSE, TOWER	OK	15 minute	381.00
36.16667/- 88.78333		GREENFIELD	TN	15 minute	121.90
36.18333/-105.05000		OCATE, 1 N	NM	15 minute	2336.30
36.20000/- 95.90000	TUL	TULSA, WSO AP	OK	15 minute	206.00
36.21667/- 86.33333		LEBANON, 3 W	TN	15 minute	163.10
36.23333/-100.26667		LIPSCOMB	TX	15 minute	746.80
36.25000/- 98.18333		AMES	OK	15 minute	369.70

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
36.25000/- 92.25000		NORFORK, DAM	AR	15 minute	129.50
36.28333/- 99.86667		SHATTUCK, 1 N	OK	15 minute	672.10
36.28333/- 96.55000		CLEVELAND, 5 WSW	OK	15 minute	271.30
36.31667/- 91.48333		HARDY, 2 SW	AR	15 minute	115.80
36.31667/- 87.21667		CHEATHAM, LOCK AND DAM	TN	15 minute	119.50
36.36667/-105.30000		ANGEL FIRE, 2 S	NM	15 minute	2631.00
36.36667/-104.58333		SPRINGER	NM	15 minute	1805.00
36.36667/- 92.56667		BULL SHOALS, DAM	AR	15 minute	146.30
36.36667/- 91.83333		SALEM	AR	15 minute	213.40
36.40000/- 96.81667		PAWNEE, 5 N	OK	15 minute	304.80
36.40000/- 95.30000		PRYOR, 6 N	OK	15 minute	195.10
36.40000/- 90.58333		CORNING	AR	15 minute	91.40
36.40000/- 89.05000		UNION CITY	TN	15 minute	106.70
36.41667/- 93.78333		EUREKA SPRINGS, 3 WNW	AR	15 minute	432.80
36.43333/- 95.68333		OOLOGAH, DAM	OK	15 minute	208.20
36.43333/- 93.61667		BERRYVILLE, 5 NW	AR	15 minute	359.70
36.45000/-103.15000	CAO	CLAYTON, MUNICIPAL AIR PARK	NM	15 minute	1514.60
36.45000/- 89.31667		SAMBURG, WILD LIFE REFUGE	TN	15 minute	94.50
36.46667/- 86.83333		SPRINGFIELD, EXP STN	TN	15 minute	227.10
36.55000/-105.26667		EAGLE NEST	NM	15 minute	2517.70
36.55000/-101.08333		RANGE	OK	15 minute	826.00
36.55000/- 99.58333		FORT SUPPLY, DAM	OK	15 minute	632.50
36.56667/- 96.16667		BARNSDALL	OK	15 minute	234.70
36.58333/- 98.86667		WAYNOKA	OK	15 minute	457.20
36.58333/- 86.53333		PORTLAND, SEWAGE PLANT	TN	15 minute	242.00
36.60000/-101.61667		GOODWELL, RESEARCH STN	OK	15 minute	1008.90
36.60000/- 93.31667		TABLE ROCK, DAM	MO	15 minute	249.90
36.60000/- 89.98333		MALDEN, MUNICIPAL AP	MO	15 minute	88.40
36.61667/- 88.96667		CLINTON, 4 S	KY	15 minute	106.70
36.65000/-101.13333		OPTIMA, LAKE	OK	15 minute	863.80
36.66667/- 96.35000		PAWHUSKA	OK	15 minute	254.50
36.66667/- 93.11667		OZARK, BEACH	MO	15 minute	213.40
36.68333/- 93.86667		CASSVILLE, RANGER STN	MO	15 minute	408.40
36.70000/- 95.63333		NOWATA	OK	15 minute	221.00
36.72000/- 87.62000		HERNDON, 3 SW	KY	15 minute	167.60
36.73333/-102.48333		BOISE CITY, 2 E	OK	15 minute	1263.40
36.73333/- 97.10000	PNC	PONCA CITY, FAA AIRPORT	OK	15 minute	304.50
36.73333/- 91.83333		WEST PLAINS	MO	15 minute	307.90
36.73333/- 86.21667		SCOTTSVILLE, 3 SSW	KY	15 minute	259.10
36.75000/- 98.13333		GREAT SALT PLAINS, DAM	OK	15 minute	365.80
36.76667/- 92.25000		DORA	MO	15 minute	301.80
36.78333/-100.41667		RIVERSIDE, 4 W	OK	15 minute	746.80
36.80000/-101.90000		EVA	OK	15 minute	1089.40
36.80000/- 92.57000		WASOLA	MO	15 minute	393.20
36.85000/- 94.61667		SENECA	MO	15 minute	256.00
36.85000/- 88.33000		BENTON	KY	15 minute	111.30
36.91667/-104.43333		RATON, FILTER PLANT	NM	15 minute	2112.90
36.91667/- 96.10000		HULAH, DAM	OK	15 minute	226.80

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
36.93333/- 90.28333		WAPPAPELLO, DAM	MO	15 minute	125.00
36.98333/- 94.53333		SPRING CITY	MO	15 minute	338.30
37.00000/-101.88333	1K5	ELKHART, AMOS	KS	15 minute	1105.80
37.01667/- 98.48333		KIOWA	KS	15 minute	408.40
37.05000/-100.00000		ENGLEWOOD, 1 NW	KS	15 minute	600.50
37.05000/- 97.61667		CALDWELL	KS	15 minute	344.40
37.06667/- 88.76667	PUK	PADUCAH, BARKLEY FIELD	KY	15 minute	125.00
37.08333/-105.05000		TERCIO, 4 NW	CO	15 minute	2520.70
37.08333/- 89.90000		ADVANCE, 1 S	MO	15 minute	109.70
37.10000/- 88.60000		PADUCAH, SEWAGE PLANT	KY	15 minute	99.10
37.11667/- 90.78333		CLEARWATER, DAM	MO	15 minute	201.20
37.12000/- 87.87000		PRINCETON, 1 SE	KY	15 minute	151.50
37.15000/-104.55000		TRINIDAD, LAKE	CO	15 minute	1865.40
37.15000/- 92.26667		MOUNTAIN GROVE, 2 N	MO	15 minute	442.00
37.15000/- 91.45000		ALLEY SPRING, RGR STN	MO	15 minute	213.40
37.16667/-104.48333		TRINIDAD	CO	15 minute	1837.90
37.16667/- 94.85000		COLUMBUS, 1 SW	KS	15 minute	274.30
37.16667/- 88.43333		SMITHLAND, LOCK & DAM	IL	15 minute	108.80
37.18333/- 95.45000		MOUND VALLEY, 3 WSW	KS	15 minute	243.80
37.18333/- 86.63333		WOODBURY	KY	15 minute	141.70
37.20000/-105.41667		SAN LUIS	CO	15 minute	2435.70
37.21667/- 93.81667		MILLER, 1 E	MO	15 minute	399.30
37.23333/- 93.38333	SGF	SPRINGFIELD, REGIONAL AP	MO	15 minute	385.90
37.28333/- 95.80000		ELK CITY,LAKE	KS	15 minute	242.30
37.33333/- 92.90000		MARSHFIELD	MO	15 minute	454.20
37.35000/- 87.51667		MADISONVILLE	KY	15 minute	134.10
37.36667/- 96.45000		GRENOLA, 1 N	KS	15 minute	352.00
37.36667/- 90.35000		JEWETT, 7 E	MO	15 minute	189.00
37.38333/-102.73333		SPRINGFIELD, 7 WSW	CO	15 minute	1396.00
37.38333/- 93.95000		LOCKWOOD	MO	15 minute	329.20
37.40000/- 98.96667		SUN CITY, 2 NW	KS	15 minute	512.10
37.43333/- 88.66667		DIXON SPRINGS, AGR CENTER	IL	15 minute	164.60
37.45000/-105.87000	ALS	ALAMOSA, BERGMAN FIELD	CO	15 minute	2295.10
37.45000/-103.31667		KIM, 15 NNE	CO	15 minute	1569.70
37.48333/-100.85000		SUBLETTE	KS	15 minute	890.00
37.53333/- 87.26667		CALHOUN, LOCK 2	KY	15 minute	122.50
37.55000/-101.63333		BIG BOW, 4 WSW	KS	15 minute	984.50
37.55000/- 91.90000		LICKING, 4 N	MO	15 minute	359.70
37.55000/- 86.76667		DUNDEE	KY	15 minute	128.00
37.60000/- 93.41667		BOLIVAR, 1 NE	MO	15 minute	329.20
37.61667/- 86.76667		FORDSVILLE	KY	15 minute	146.30
37.63333/-104.78333		WALSENBURG	CO	15 minute	1874.50
37.63333/- 91.53333		SALEM	MO	15 minute	365.80
37.65000/- 97.43333	ICT	WICHITA, MID-CONTINENT ARPT	KS	15 minute	402.60
37.65000/- 96.53333		BEAUMONT	KS	15 minute	481.60
37.65000/- 96.08333		FALL RIVER, LAKE	KS	15 minute	310.90
37.67000/- 92.65000		LEBANON, 2 W	MO	15 minute	389.80

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
37.68000/- 90.73000		BELLEVIEW	MO	15 minute	317.00
37.70000/- 93.78000		STOCKTON, DAM	MO	15 minute	281.60
37.71667/-105.23333		SHEEP MOUNTAIN	CO	15 minute	2363.40
37.71667/- 91.13333		VIBURNUM	MO	15 minute	388.90
37.71667/- 86.21667		CUSTER, 4 SE	KY	15 minute	237.70
37.73333/- 89.36667		MURPHYSBORO, 2 SW	IL	15 minute	167.60
37.75000/- 95.93333		TORONTO, LAKE	KS	15 minute	292.90
37.76667/- 99.96667	DDC	DODGE CITY, MUNICIPAL AP	KS	15 minute	787.00
37.76667/- 87.15000		OWENSBORO, 3 W	KY	15 minute	123.40
37.78333/- 90.40000		FARMINGTON	MO	15 minute	285.00
37.80000/- 87.98333		UNIONTOWN, LOCK & DAM	IN	15 minute	103.60
37.81667/- 88.45000		ELDORADO	IL	15 minute	115.80
37.85000/- 94.96667		UNIONTOWN	KS	15 minute	289.60
37.85000/- 94.40000		NEVADA, SEWAGE PLANT	MO	15 minute	225.60
37.86667/-104.11667		WHITE ROCK	CO	15 minute	1441.70
37.90000/- 98.18333		ARLINGTON	KS	15 minute	493.80
37.90000/- 86.63333		CANNELTON	IN	15 minute	122.50
37.91667/- 95.43333		IOLA, 1 W	KS	15 minute	290.80
37.92000/- 93.32000		POMME DE TERRE, DAM	MO	15 minute	274.30
37.93333/-104.93333		RYE, SCHOOL	CO	15 minute	2055.90
37.93333/- 87.36667		NEWBURGH, LOCK & DAM	IN	15 minute	115.80
37.95000/- 91.76667		ROLLA, UNI OF MISSOURI	MO	15 minute	359.70
37.96667/- 97.55000		HALSTEAD, 3 SW	KS	15 minute	431.00
37.98333/-100.81667		GARDEN CITY, EXPERIMENT STN	KS	15 minute	874.20
37.98333/- 89.95000		KASKASKIA, R NAV LOCK	IL	15 minute	115.80
38.00000/- 91.36667		STEELVILLE, 2 N	MO	15 minute	213.40
38.03333/- 88.98333		REN DLAKE, DAM	IL	15 minute	138.70
38.05000/- 96.63333		CASSODAY	KS	15 minute	445.00
38.05000/- 93.70000		OSCEOLA	MO	15 minute	233.50
38.05000/- 87.53333	EVV	EVANSVILLE, DRESS Regional Arpt	IN	15 minute	127.10
38.06667/-102.91667		JOHN MARTIN, DAM	CO	15 minute	1162.50
38.06667/-102.31667		GRANADA	CO	15 minute	1061.60
38.06667/- 88.18333		CARMI, 3	IL	15 minute	102.10
38.08333/- 90.11667		PRAIRIE DUROCHER, 1 WSW	IL	15 minute	117.40
38.10000/-103.50000		CHERAW, 1 N	CO	15 minute	1262.20
38.10000/- 95.01667		BLUE MOUND	KS	15 minute	336.80
38.16667/- 89.70000		SPARTA, 3 N	IL	15 minute	158.50
38.18333/- 91.13333		SULLIVAN, 3 SE	MO	15 minute	231.70
38.18333/- 86.26667		HARRISON, CRAWFORD State Forest	IN	15 minute	259.10
38.20000/- 94.03333		APPLETON CITY	MO	15 minute	243.80
38.20000/- 92.61667		LAKESIDE	MO	15 minute	180.40
38.20000/- 91.98333		VIENNA, 2 WNW	MO	15 minute	234.70
38.21667/- 86.11667		CORYDON	IN	15 minute	179.80
38.25000/- 95.75000		JOHN REDMOND, LAKE	KS	15 minute	332.50
38.25000/- 93.36667		TRUMAN, DAM & RESERVIOR	MO	15 minute	192.60
38.26667/- 99.75000		BAZINE, 13 SSW	KS	15 minute	665.70
38.28333/-104.51667	PUB	PUEBLO, MEMORIAL AP	CO	15 minute	1439.30
38.28333/- 87.25000		SPURGEON, 2 N	IN	15 minute	134.10

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
38.33333/- 89.18333		ASHLEY	IL	15 minute	169.20
38.35000/- 87.58333		PRINCETON, 1 W	IN	15 minute	146.30
38.38333/- 97.08333		MARION, LAKE	KS	15 minute	417.30
38.38333/- 91.40000		ROSEBUD	MO	15 minute	274.30
38.38333/- 86.93333		JASPER	IN	15 minute	140.20
38.40000/- 93.77000		CLINTON	MO	15 minute	234.70
38.40000/- 87.75000		MOUNT CARMEL	IL	15 minute	131.10
38.40000/- 86.11667		PALMYRA	IN	15 minute	234.70
38.45000/- 86.70000		DUBOIS, S IND FORAGE FRM	IN	15 minute	210.30
38.46667/-101.76667		TRIBUNE, 1 W	KS	15 minute	1108.30
38.48333/- 94.60000		DREXEL	MO	15 minute	301.80
38.48333/- 92.58333		HIGH POINT	MO	15 minute	277.40
38.50000/- 95.70000		MELVERN, LAKE	KS	15 minute	333.20
38.50000/- 90.28333		JEFFERSON BARRACKS	MO	15 minute	149.40
38.50000/- 89.85000		BELLEVILLE, SIU RESEARCH	IL	15 minute	137.20
38.51667/-103.70000		ORDWAY, 2 1N	CO	15 minute	1452.70
38.51667/- 88.40000		CISNE, 2 ESE	IL	15 minute	138.40
38.51667/- 88.00000		WEST SALEM	IL	15 minute	135.60
38.55000/- 91.00000		WASHINGTON	MO	15 minute	152.40
38.58333/- 92.18333		JEFFERSON CITY	MO	15 minute	158.50
38.60000/-100.61667		HEALY	KS	15 minute	868.70
38.60000/- 97.95000		KANOPOLIS, LAKE	KS	15 minute	454.80
38.61667/- 95.28333		OTTAWA	KS	15 minute	274.30
38.63333/- 90.20000		ST LOUIS, SCIENCE CENTER	MO	15 minute	164.60
38.65000/- 98.95000		GALATIA, 1 NW	KS	15 minute	609.60
38.65000/- 95.56667		POMONA, LAKE	KS	15 minute	324.00
38.66667/- 94.90000		HILLSDALE, LAKE	KS	15 minute	307.90
38.66667/- 86.80000		SHOALS, HIWAY 50 BRIDGE	IN	15 minute	167.60
38.68333/-104.70000		FOUNTAIN	CO	15 minute	1696.20
38.68333/- 96.51667		COUNCIL GROVE, LAKE	KS	15 minute	402.30
38.68333/- 88.56667		FLORA, 5 NW	IL	15 minute	152.40
38.73333/- 87.68333		LAWRENCEVILLE	IL	15 minute	134.70
38.75000/- 90.36667	STL	ST LOUIS, LAMBERT INT'L ARPT	MO	15 minute	174.00
38.78333/- 93.75000		WARRENSBURG, 2 NW	MO	15 minute	217.60
38.80000/- 97.65000	SLN	SALINA, FAA AIRPORT	KS	15 minute	384.40
38.81667/-104.71667	COS	COLORADO SPRINGS, MUNICIPAL AP	CO	15 minute	1881.20
38.81667/- 94.66667		STANLEY, 3 S	KS	15 minute	320.00
38.81667/- 92.21667	COU	COLUMBIA, REGIONAL ARPT	MO	15 minute	271.00
38.81667/- 90.86667		WENTZVILLE	MO	15 minute	176.80
38.85000/-104.93333		MANITOU SPRINGS	CO	15 minute	2020.80
38.85000/-104.26667		YODER, 2 WNW	CO	15 minute	1883.70
38.85000/-102.16667		ARAPAHOE	CO	15 minute	1225.30
38.85000/- 91.95000		FULTON	MO	15 minute	265.20
38.86667/- 99.33333		HAYS, 1 S	KS	15 minute	612.70
38.86667/- 94.03333		ELM	MO	15 minute	259.10
38.86667/- 87.30000		FREELANDVILLE	IN	15 minute	167.60
38.88333/-105.28333		FLORISSANT FOSSIL BED	CO	15 minute	2572.50

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
38.88333/-101.58333		WALLACE, 2 S	KS	15 minute	993.70
38.88333/- 86.55000		OOLITIC, PURDUE EXP FARM	IN	15 minute	198.10
38.90000/-100.11667		COLLYER, 10 S	KS	15 minute	733.70
38.91667/-105.48333		LAKE GEORGE, 8 SW	CO	15 minute	2596.90
38.91667/- 88.11667		NEWTON, 6 SSE	IL	15 minute	155.50
38.93333/- 95.33333		CLINTON, LAKE	KS	15 minute	298.40
38.95000/- 94.40000		UNITY VILLAGE	MO	15 minute	286.50
38.95000/- 91.90000		MC CREDIE, EXPERIMENT STN	MO	15 minute	259.10
38.96667/- 98.48333		WILSON, LAKE	KS	15 minute	460.90
38.96667/- 89.06667		VANDALIA	IL	15 minute	164.60
38.98333/- 94.71667		SHAWNEE, 2 S	KS	15 minute	323.10
39.00000/-105.88333		ANTERO, RESERVOIR	CO	15 minute	2718.80
39.00000/- 90.70000		CAP AU GRIS, LOCK AND DAM 25	MO	15 minute	137.20
39.01667/- 92.76667		NEW FRANKLIN, 1 W	MO	15 minute	195.40
39.06667/- 95.63333	TOP	TOPEKA, MUNICIPAL ARPT	KS	15 minute	267.90
39.06667/- 94.88333		BONNER SPRINGS	KS	15 minute	253.00
39.08333/- 96.88333		MILFORD, LAKE	KS	15 minute	368.80
39.10000/-105.08333		WOODLAND PARK, 8 NNW	CO	15 minute	2365.30
39.10000/-104.73333		GREENLAND, 9 SE	CO	15 minute	2279.90
39.11667/- 95.41667		PERRY, LAKE	KS	15 minute	292.60
39.11667/- 91.40000		MIDDLETOWN	MO	15 minute	207.30
39.12000/- 93.22000		MARSHALL	MO	15 minute	240.80
39.13333/-103.46667		HUGO	CO	15 minute	1532.80
39.13333/- 88.53333		EFFINGHAM	IL	15 minute	181.40
39.13333/- 87.66667		HUTSONVILLE, POWER PLANT	IL	15 minute	138.70
39.15000/-104.08333		SIMLA	CO	15 minute	1822.70
39.16667/- 87.18333		JASONVILLE, 1 E	IN	15 minute	187.50
39.18333/-103.70000	LIC	LIMON	CO	15 minute	1694.10
39.18333/- 94.58333		GLADSTONE	MO	15 minute	283.50
39.21667/-104.73333		GREENLAND, 6 NE	CO	15 minute	2103.10
39.25000/-105.23000		DECKERS	CO	15 minute	1980.90
39.25000/- 96.60000		TUTTLE CREEK, LAKE	KS	15 minute	322.20
39.25000/- 92.50000		HIGBEE, 4 S	MO	15 minute	257.60
39.28333/- 93.96667		RICHMOND	MO	15 minute	246.90
39.28333/- 89.88333		CARLINVILLE, 2	IL	15 minute	189.30
39.30000/-102.86667		SEIBERT	CO	15 minute	1433.50
39.30000/- 89.26667		NOKOMIS	IL	15 minute	207.30
39.31667/- 96.21667		ONAGA, 12 SSW	KS	15 minute	320.00
39.31667/- 94.71667	MCI	KANSAS CITY, INTL ARPT	MO	15 minute	311.80
39.35000/-100.03333		MORLAND, 1 E	KS	15 minute	710.20
39.35000/- 95.45000		VALLEY FALLS	KS	15 minute	283.50
39.35000/- 90.21667		GREENFIELD	IL	15 minute	170.70
39.35000/- 88.16667		DIONA, 3 SW	IL	15 minute	185.90
39.36667/-101.70000	GLD	GOODLAND, RENNER FIELD	KS	15 minute	1114.70
39.36667/- 99.83333		HILL CITY, 1 E	KS	15 minute	654.40
39.36667/- 94.33333		KEARNEY, 2 E	MO	15 minute	246.90
39.36667/- 90.90000		CLARKSVILLE, LOCK AND DAM 24	MO	15 minute	140.20
39.38333/-101.06667		COLBY, 1 SW	KS	15 minute	966.20

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
39.38333/- 94.55000		SMITHVILLE, LAKE	MO	15 minute	275.50
39.40000/- 93.73000		STET, 1 S	MO	15 minute	234.70
39.40000/- 92.43333		MOBERLY	MO	15 minute	256.00
39.40000/- 88.78333		SHELBYVILLE, DAM	IL	15 minute	199.60
39.40000/- 86.45000		MARTINSVILLE, 2 SW	IN	15 minute	185.90
39.41667/- 89.46667		MORRISONVILLE	IL	15 minute	192.00
39.51667/- 88.63333		SULLIVAN, 5 SSW	IL	15 minute	195.10
39.51667/- 87.11667		BRAZIL	IN	15 minute	207.30
39.53333/-104.65000		PARKER, 6 E	CO	15 minute	1923.30
39.55000/-103.35000		SHAW, 2 E	CO	15 minute	1578.60
39.55000/- 97.65000	CNK	CONCORDIA, BLOSSER MUNI AP	KS	15 minute	453.90
39.55000/- 86.10000		NEW WHITELAND	IN	15 minute	239.30
39.56667/-105.21667		INTER CANYON	CO	15 minute	2145.80
39.61667/- 90.80000		PITTSFIELD, NO 2	IL	15 minute	204.20
39.63333/-105.31667		EVERGREEN	CO	15 minute	2133.60
39.63333/-102.65000		JOES, 2 SE	CO	15 minute	1295.70
39.63333/-102.18333		BONNY, LAKE	CO	15 minute	1142.40
39.63333/- 87.70000		PARIS, WATERWORKS	IL	15 minute	207.30
39.63333/- 87.40000		CLINTON, 1 S	IN	15 minute	146.30
39.65000/-105.20000		MORRISON	CO	15 minute	1761.70
39.65000/-104.85000		CHERRY CREEK, DAM	CO	15 minute	1721.20
39.66667/- 98.35000		IONIA	KS	15 minute	481.60
39.66667/- 95.51667		HORTON	KS	15 minute	313.90
39.68333/-100.96667		ATWOOD, 10 SSE	KS	15 minute	938.80
39.70000/-105.21667		GOLDEN, 3 S	CO	15 minute	2170.20
39.71667/- 91.36667		HANNIBAL, WATER WORKS	MO	15 minute	217.00
39.73000/- 92.48000		LONG BRANCH, RESERVOIR	MO	15 minute	256.30
39.73333/- 99.31667		PHILLIPSBURG, 1 SSE	KS	15 minute	581.30
39.73333/- 90.20000		JACKSONVILLE, 2 E	IL	15 minute	185.90
39.73333/- 86.26667	IND	INDIANAPOLIS, INT'L ARPT	IN	15 minute	241.40
39.75000/-104.13333		BYERS, 5 ENE	CO	15 minute	1554.50
39.75000/- 94.85000		ST JOSEPH, CORPS OF ENGR	MO	15 minute	237.70
39.76667/-105.63333		LAWSON	CO	15 minute	2468.90
39.76667/-104.86667	DEN	DENVER, STAPLETON INT'L AP	CO	15 minute	1625.50
39.76667/- 86.18333		INDIANAPOLIS ZOO	IN	15 minute	216.40
39.78333/- 95.05000		TROY, 2 E	KS	15 minute	323.10
39.81667/-100.23333		NORCATUR, 3 WSW	KS	15 minute	774.20
39.81667/- 99.93333		NORTON, DAM	KS	15 minute	713.20
39.83333/- 96.63333		MARYSVILLE	KS	15 minute	359.70
39.83333/- 89.01667		DECATUR	IL	15 minute	189.00
39.85000/- 89.68333		SPRINGFIELD, CAPITAL ARPT	IL	15 minute	182.00
39.88333/- 87.03333		WAVELAND, 2 NE	IN	15 minute	239.30
39.90000/- 91.43333		QUINCY, DAM 21	IL	15 minute	147.20
39.96667/- 91.88333		STEFFENVILLE	MO	15 minute	210.30
39.96667/- 86.93333		CRAWFORDSVILLE, 5 S	IN	15 minute	227.10
39.97000/- 95.13000		OREGON	MO	15 minute	318.50
40.00000/-104.08333		HOYT	CO	15 minute	1524.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
40.03000/-105.58000		SILVER LAKE	CO	15 minute	3157.70
40.03333/-105.26667		BOULDER, #2	CO	15 minute	1650.50
40.03333/- 96.05000		DUBOIS	NE	15 minute	327.70
40.03333/- 94.13333		PATTONSBURG, 2 S	MO	15 minute	251.50
40.05000/-101.53333		BENKELMAN	NE	15 minute	922.00
40.06667/- 86.46667		LEBANON, WATERWORKS	IN	15 minute	289.60
40.08333/- 99.20000		HARLAN COUNTY, LAKE	NE	15 minute	609.60
40.10000/- 98.96667		FRANKLIN, 2	NE	15 minute	612.70
40.10000/- 88.23333		URBANA	IL	15 minute	226.50
40.11667/-102.48333		ECKLEY	CO	15 minute	1188.70
40.11667/- 95.75000		DAWSON, 5 ESE	NE	15 minute	339.90
40.13333/- 87.65000		DANVILLE	IL	15 minute	170.10
40.15000/-103.15000		AKRON, 4 E	CO	15 minute	1383.80
40.16667/- 97.58333		HEBRON	NE	15 minute	451.10
40.18333/-105.86667		GRAND LAKE, 6 SSW	CO	15 minute	2526.20
40.20000/-105.53333		ALLENSPARK, LODGE	CO	15 minute	2575.90
40.20000/- 94.55000		STANBERRY	MO	15 minute	271.30
40.20000/- 89.73333		MASON CITY, 1 W	IL	15 minute	178.30
40.21667/-100.63333		MC COOK, 2	NE	15 minute	786.40
40.21667/- 92.58333		KIRKSVILLE	MO	15 minute	295.70
40.21667/- 86.11667		TIPTON, 5 SW	IN	15 minute	272.80
40.23333/- 90.93333		AUGUSTA	IL	15 minute	207.30
40.25000/-105.15000		LONGMONT, 6 NW	CO	15 minute	1569.70
40.25000/- 88.65000		FARMER CITY	IL	15 minute	222.50
40.28333/- 99.78333		EDISON	NE	15 minute	646.20
40.28333/- 95.08333		SKIDMORE	MO	15 minute	286.50
40.28333/- 87.25000		ATTICA	IN	15 minute	158.50
40.30000/- 96.75000		BEATRICE, 1 N	NE	15 minute	395.30
40.31667/- 88.16667		RANTOUL	IL	15 minute	225.60
40.31667/- 86.50000		FRANKFORT, DISPOSAL PLANT	IN	15 minute	254.50
40.38333/-105.51667		ESTES PARK	CO	15 minute	2293.00
40.38333/- 95.75000		AUBURN, 5 ESE	NE	15 minute	283.50
40.40000/- 91.36667		KEOKUK, LOCK DAM 19	IA	15 minute	160.60
40.41667/-104.70000		GREELEY, UNC	CO	15 minute	1437.10
40.42000/- 94.05000		RIDGEWAY, 8 NW	MO	15 minute	292.60
40.43333/-105.33333		DRAKE	CO	15 minute	1880.60
40.45000/- 95.38333		TARKIO	MO	15 minute	289.60
40.45000/- 91.88333		LURAY	MO	15 minute	225.60
40.46667/- 87.66667		HOOPESTON, 1 NE	IL	15 minute	216.40
40.46667/- 87.00000		WEST LAFAYETTE, 6 NW	IN	15 minute	214.90
40.48000/- 92.37000		DOWNING	MO	15 minute	265.20
40.48333/- 94.41667		GRANT CITY	MO	15 minute	344.40
40.48333/- 86.40000		BURLINGTON	IN	15 minute	242.60
40.50000/- 90.38333		MARIETTA	IL	15 minute	195.10
40.51667/-101.01667		HAYES CENTER	NE	15 minute	929.90
40.58333/-105.08333	FCL	FORT COLLINS	CO	15 minute	1525.20
40.58333/-102.30000		HOLYOKE	CO	15 minute	1136.90
40.60000/-103.85000		NEW RAYMER	CO	15 minute	1457.90

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
40.61667/- 96.95000		CRETE	NE	15 minute	437.40
40.61667/- 95.65000		HAMBURG, 2	IA	15 minute	274.30
40.62000/- 93.95000	3OI	LAMONI	IA	15 minute	343.80
40.66667/-105.21667		FORT COLLINS, 9 NW	CO	15 minute	1591.10
40.66667/-100.50000		CURTIS, 3 NNE	NE	15 minute	829.40
40.66667/- 96.18333		SYRACUSE	NE	15 minute	335.30
40.66667/- 89.68333	PIA	PEORIA, GREATER PEORIA ARPT	IL	15 minute	200.90
40.66667/- 86.88333		CHALMERS	IN	15 minute	213.40
40.68333/- 99.70000		CANADAY, STEAM PLANT	NE	15 minute	719.90
40.68333/- 94.30000		MOUNT AYR, 4 SW	IA	15 minute	378.00
40.68333/- 93.50000		CLIO, 4 NW	IA	15 minute	329.20
40.70000/-105.80000		RUSTIC, 12 WSW	CO	15 minute	2462.80
40.70000/-104.78333		NUNN	CO	15 minute	1583.70
40.70000/- 99.38333		ELM CREEK, 1 SSW	NE	15 minute	685.80
40.70000/- 89.41667		WASHINGTON, 1 WSW	IL	15 minute	222.50
40.71667/-105.71667		RUSTIC, 9 WSW	CO	15 minute	2347.30
40.71667/- 96.03333		DUNBAR, 4 N	NE	15 minute	374.90
40.73333/- 98.85000		GIBBON	NE	15 minute	627.90
40.73333/- 92.86667		CENTERVILLE	IA	15 minute	298.70
40.73333/- 88.51667		FAIRBURY, WATERWORKS	IL	15 minute	210.30
40.75000/- 88.18333		PIPER CITY	IL	15 minute	204.20
40.75000/- 86.05000		PERU, WATERWORKS	IN	15 minute	195.10
40.76667/- 87.45000		KENTLAND	IN	15 minute	208.80
40.78333/- 90.01667		YATES CITY	IL	15 minute	205.70
40.81667/- 91.16667		BURLINGTON, RADIO KBUR	IA	15 minute	214.30
40.83333/- 94.05000		BEACONSFIELD, 2 N	IA	15 minute	347.50
40.85000/- 96.75000	LNK	LINCOLN, MUNICIPAL ARPT	NE	15 minute	364.90
40.85000/- 86.50000		ROYAL CENTER	IN	15 minute	219.50
40.86667/- 97.60000	K17	YORK	NE	15 minute	490.70
40.86667/- 96.15000		WEEPING WATER	NE	15 minute	335.30
40.88333/- 94.56667		LENOX	IA	15 minute	394.70
40.91667/- 90.63333		MONMOUTH	IL	15 minute	234.70
40.93333/- 93.45000		DERBY	IA	15 minute	362.70
40.93333/- 87.15000		RENSSELAER	IN	15 minute	198.10
40.95000/- 91.55000		MOUNT PLEASANT, 1 SSW	IA	15 minute	222.50
40.96667/- 98.31667	GRI	GRAND ISLAND, WSO AP	NE	15 minute	563.00
41.03333/- 89.40000		LACON, 1 N	IL	15 minute	140.20
41.06667/-102.08333		BIG SPRINGS	NE	15 minute	1027.20
41.06667/- 90.56667		ALEXIS, 1 SW	IL	15 minute	207.30
41.06667/- 86.21667		ROCHESTER	IN	15 minute	234.70
41.08333/-106.00000		JELM, 2 S	WY	15 minute	2310.40
41.08333/- 95.06667		WALLIN, 1 NW	IA	15 minute	381.00
41.10000/- 92.45000	OTM	OTTUMWA, INDUSTRIAL AP	IA	15 minute	256.60
41.13333/-100.68333	LBF	NORTH PLATTE, LEE BIRD FLD	NE	15 minute	846.70
41.13333/- 87.88333		KANKAKEE, WATER POLL CTL	IL	15 minute	195.10
41.15000/-104.81667	YS	CHEYENNE, WSFO AP	WY	15 minute	1873.60
41.15000/- 96.20000		GRETNA, 4 NE	NE	15 minute	365.80

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
41.16667/-104.15000		PINEBLUFFS, 5 W	WY	15 minute	1578.90
41.16667/- 93.15000		COLUMBIA	IA	15 minute	289.60
41.16667/- 86.90000		MEDARYVILLE, STATE NURSERY	IN	15 minute	211.80
41.18333/- 87.33333		SHELBY	IN	15 minute	195.10
41.22000/-101.65000		KINGSLEY, DAM	NE	15 minute	1011.30
41.23333/- 95.41667		CARSON	IA	15 minute	353.90
41.25000/- 98.80000		ASHTON	NE	15 minute	623.30
41.26667/- 97.11667		DAVID CITY	NE	15 minute	490.70
41.26667/- 96.65000		MALMO, 3 E	NE	15 minute	399.30
41.28333/- 93.80000		ST CHARLES	IA	15 minute	323.10
41.28333/- 91.68333		WASHINGTON	IA	15 minute	230.40
41.30000/-105.63333		LARAMIE, 2 WSW	WY	15 minute	2186.90
41.30000/- 94.46667		GREENFIELD	IA	15 minute	408.40
41.33333/- 93.11667		KNOXVILLE	IA	15 minute	280.40
41.35000/- 96.10000		BENNINGTON, 3 E	NE	15 minute	370.30
41.35000/- 88.43333		GEBHARD WOODS, STATE PARK	IL	15 minute	153.90
41.36667/- 96.01667	OVN	OMAHA, WSFO	NE	15 minute	399.00
41.40000/- 99.63333		BROKEN BOW, 2	NE	15 minute	752.90
41.41667/- 95.00000		ATLANTIC, 1 NE	IA	15 minute	365.80
41.41667/- 91.01667		ILLINOIS CITY, DAM 16	IL	15 minute	167.60
41.45000/- 97.76667		GENOA, 2 W	NE	15 minute	484.60
41.45000/- 90.50000		MOLINE, QUAD CITY ARPT	IL	15 minute	179.80
41.45000/- 87.63333		CRETE	IL	15 minute	202.40
41.50000/-102.25000		OSHKOSH, 10 NE	NE	15 minute	1074.40
41.50000/- 94.63333		ADAIR	IA	15 minute	414.50
41.51667/- 95.45000		SHELBY	IA	15 minute	414.50
41.51667/- 94.23333		DEXTER	IA	15 minute	346.00
41.51667/- 92.06667		NORTH ENGLISH	IA	15 minute	242.90
41.51667/- 90.56667		ROCK ISLAND, LOCK & DAM 15	IL	15 minute	173.10
41.51667/- 87.03333		VALPARAISO, WATERWORKS	IN	15 minute	243.80
41.51667/- 86.26667		LAKEVILLE	IN	15 minute	256.30
41.53333/- 93.65000	DSM	DES MOINES, INTL AP	IA	15 minute	292.00
41.56667/- 95.88333		MISSOURI VALLEY, 1 NNE	IA	15 minute	374.90
41.60000/- 99.83333		ANSELMO, 2 SE	NE	15 minute	789.40
41.60000/- 86.71667		LA PORTE	IN	15 minute	246.90
41.63333/-104.48333		PHILLIPS	WY	15 minute	1518.50
41.65000/- 96.21667		HERMAN	NE	15 minute	320.00
41.65000/- 91.53333		IOWA CITY	IA	15 minute	195.10
41.66667/-103.10000		BRIDGEPORT	NE	15 minute	1117.40
41.66667/- 96.66667		SCRIBNER	NE	15 minute	381.00
41.66667/- 89.95000		PROPHETSTOWN	IL	15 minute	185.90
41.68333/- 98.36667		SPALDING	NE	15 minute	577.60
41.68333/- 98.13333		ALBION, 7 W	NE	15 minute	586.70
41.70000/- 86.31667	SBN	SOUTHBEND, WSO AP	IN	15 minute	239.00
41.71667/- 97.36667		CRESTON	NE	15 minute	492.30
41.71667/- 92.73333		GRINNELL, 3 SW	IA	15 minute	275.80
41.73333/- 95.71667		WOODBINE	IA	15 minute	332.20
41.73333/- 87.76667		CHICAGO, MIDWAY AP 3 SW	IL	15 minute	189.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
41.76667/- 88.75000		WATERMAN, 1 ESE	IL	15 minute	240.80
41.78333/- 99.13333		BURWELL	NE	15 minute	664.50
41.78333/- 95.20000		IRWIN	IA	15 minute	399.30
41.78333/- 87.60000		CHICAGO, UNIVERSITY	IL	15 minute	181.10
41.85000/- 98.08333		PETERSBURG	NE	15 minute	579.10
41.86667/-103.60000	BFF	SCOTTSBLUFF, COUNTY ARPT	NE	15 minute	1208.50
41.86667/- 94.66667		COON RAPIDS	IA	15 minute	361.20
41.86667/- 90.93333		LOWDEN	IA	15 minute	217.90
41.88333/- 93.38333		MAXWELL	IA	15 minute	266.70
41.90000/- 90.15000		FULTON, LOCK & DAM #13	IL	15 minute	180.40
41.95000/- 86.41667		BERRIEN SPRINGS, 5 W	MI	15 minute	229.20
41.98333/-100.58333		THEDFORD	NE	15 minute	896.10
41.98333/- 97.43333	OFK	NORFOLK, WSO AP	NE	15 minute	478.80
41.98333/- 95.76667		SOLDIER	IA	15 minute	342.90
42.00000/- 89.28333		OREGON, 2E	IL	15 minute	228.60
42.00000/- 87.88333	ORD	CHICAGO, O'HARE INTL AP	IL	15 minute	204.20
42.01667/- 93.80000		AMES, 8 WSW	IA	15 minute	335.00
42.03333/- 94.03333		OGDEN	IA	15 minute	335.30
42.06667/-102.58333		ANTIOCH	NE	15 minute	1184.20
42.06667/-101.46667		WHITMAN, 4 E	NE	15 minute	1075.90
42.06667/- 92.93333		MARSHALLTOWN	IA	15 minute	265.20
42.08333/-104.21667		TORRINGTON, EXP FARM	WY	15 minute	1249.10
42.10000/- 89.83333		LANARK	IL	15 minute	265.20
42.11667/-104.95000		WHEATLAND, 4 N	WY	15 minute	1413.70
42.11667/- 96.70000		PENDER	NE	15 minute	408.40
42.13333/- 95.20000		BOYER, 4 SE	IA	15 minute	442.00
42.15000/- 96.08333		HORNICK, 5 S	IA	15 minute	326.10
42.18333/- 93.58333		STORY CITY	IA	15 minute	297.20
42.18333/- 92.46667		TRAER	IA	15 minute	289.60
42.20000/- 97.53333		PIERCE	NE	15 minute	484.90
42.20000/- 91.53000		CENTRAL CITY	IA	15 minute	262.10
42.20000/- 89.10000	RFD	ROCKFORD, WSO AP	IL	15 minute	224.00
42.23333/- 98.91667		AMELIA, 2 W	NE	15 minute	667.50
42.23333/- 86.31667		COLOMA, 3 NNW	MI	15 minute	213.40
42.25000/- 88.83333		BELVIDERE	IL	15 minute	248.40
42.26667/- 90.41667		BELLEVUE, LOCK & DAM 12	IA	15 minute	183.80
42.28333/- 97.06667		WAYNE, 4 NW	NE	15 minute	457.20
42.30000/- 91.01667		CASCADE	IA	15 minute	259.10
42.30000/- 89.60000		FREEPORT, WASTE WATERPLANT	IL	15 minute	228.60
42.33333/- 98.11667		ROYAL	NE	15 minute	570.00
42.40000/- 96.38333	SUX	SIOUX CITY, WSO AP	IA	15 minute	334.10
42.40000/- 95.51667		IDA GROVE, 5 NW	IA	15 minute	402.30
42.40000/- 94.60000		ROCKWELL CITY, 2	IA	15 minute	362.70
42.40000/- 90.70000	DBQ	DUBUQUE, MUNICIPAL AP	IA	15 minute	321.90
42.46667/- 93.80000		WEBSTER CITY	IA	15 minute	356.60
42.48333/- 96.06667		MOVILLE	IA	15 minute	364.20
42.50000/- 97.20000		COLERIDGE	NE	15 minute	490.70

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
42.53333/- 93.26667		IOWA FALLS	IA	15 minute	344.40
42.55000/- 92.40000	ALO	WATERLOO, MUNICIPAL AP	IA	15 minute	265.80
42.56667/- 88.83333		CLINTON, 2 NNW	WI	15 minute	292.60
42.58333/- 99.53333		BASSETT	NE	15 minute	707.10
42.61667/- 90.43333		CUBA CITY	WI	15 minute	289.60
42.61667/- 89.06667		AFTON	WI	15 minute	226.20
42.66667/-104.03333		HARRISON, 9 W	NE	15 minute	1435.60
42.68333/- 91.53333		STRAWBERRY POINT	IA	15 minute	365.80
42.70000/- 94.26667		HUMBOLDT, 3 W	IA	15 minute	338.30
42.70000/- 92.60000		SHELLROCK, 2 W	IA	15 minute	298.70
42.75000/-105.38333	4DG	DOUGLAS	WY	15 minute	1464.60
42.75000/- 96.91667		VERMILLION, 2 SE	SD	15 minute	362.70
42.80000/- 89.86667		BLANCHARDVILLE	WI	15 minute	253.00
42.81667/- 95.96667		REMSEN	IA	15 minute	405.40
42.83333/- 98.46667		LYNCH	NE	15 minute	426.70
42.83333/- 90.78333		LANCASTER, 4 WSW	WI	15 minute	317.00
42.85000/- 97.48333		GAVINS POINT, DAM	NE	15 minute	382.50
42.86667/-100.55000	VTN	VALENTINE, WSO AP	NE	15 minute	787.60
42.86667/- 95.55000		LARRABEE	IA	15 minute	410.00
42.86667/- 88.51667		EAGLE, 2W	WI	15 minute	274.30
42.95000/-105.15000		DOUGLAS, 17 NE	WY	15 minute	1502.70
42.95000/- 93.28333		SHEFFIELD, 4 NW	IA	15 minute	320.00
42.95000/- 87.90000	MKE	MILWAUKEE, MITCHELL FLD	WI	15 minute	220.10
43.01667/- 91.18333		MCGREGOR	IA	15 minute	191.10
43.03333/- 96.63333		ALCESTER	SD	15 minute	431.30
43.05000/-104.65000		LANCE CREEK, 1 W	WY	15 minute	1344.80
43.05000/- 96.15000		SIOUX CENTER, 2 SE	IA	15 minute	414.50
43.05000/- 89.46667		CHARMANY, FARM	WI	15 minute	277.40
43.06667/- 98.53333		PICKSTOWN	SD	15 minute	454.20
43.06667/- 86.20000		GRAND HAVEN, WASTE WTR PLANT	MI	15 minute	184.40
43.10000/-101.56667		LA CREEK, NATL WILDLIFE	SD	15 minute	999.70
43.13333/- 95.13333		SPENCER	IA	15 minute	314.90
43.13333/- 89.33333	MSN	MADISON, DANE CO REGNL ARPT	WI	15 minute	261.80
43.16667/- 86.23333	MKG	MUSKEGON, COUNTY ARPT	MI	15 minute	191.10
43.20000/- 91.95000		SPILLVILLE	IA	15 minute	329.80
43.21667/- 91.10000		LYNXVILLE, DAM 9	WI	15 minute	192.90
43.23333/- 97.58333		MENNO	SD	15 minute	403.60
43.28333/- 93.63333		FOREST CITY, 2 NNE	IA	15 minute	396.20
43.30000/-103.81667		EDGEMONT	SD	15 minute	1054.60
43.30000/-100.66667		MISSION	SD	15 minute	788.50
43.30000/- 94.51667		RINGSTED	IA	15 minute	371.90
43.30000/- 89.35000		ARLINGTON, UNIV FARM	WI	15 minute	329.20
43.31667/- 88.40000		HARTFORD, 2 W	WI	15 minute	298.70
43.38333/- 92.91667		STANSGAR	IA	15 minute	356.60
43.40000/-103.26667		ORAL	SD	15 minute	902.20
43.41667/-104.95000		DULL CENTER, 1 SE	WY	15 minute	1345.70
43.45000/- 95.71667		SIBLEY, 5 NNE	IA	15 minute	509.00
43.45000/- 88.63333		HORICON	WI	15 minute	268.20

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
43.46667/- 86.41667		MONTAGUE, 4 NW	MI	15 minute	198.10
43.51667/- 89.43333		PORTAGE	WI	15 minute	243.80
43.55000/-103.48333		WIND CAVE	SD	15 minute	1261.90
43.56667/- 96.73333	FSD	SIOUX FALLS, FOSS FIELD	SD	15 minute	435.00
43.56667/- 91.23333		GENOA, DAM 8	WI	15 minute	194.80
43.56667/- 90.63333		LA FARGE	WI	15 minute	246.90
43.58333/- 98.43333		STICKNEY	SD	15 minute	490.70
43.58333/- 91.66667		SPRING GROVE, 1 W	MN	15 minute	411.50
43.63333/-103.91667		EDGEMONT, 23 NNW	SD	15 minute	1341.70
43.63333/- 94.78333		SHERBURN, 3 WSW	MN	15 minute	402.30
43.65000/- 95.58333		WORTHINGTON, 2 NNE	MN	15 minute	478.50
43.66667/- 96.20000		LUVERNE	MN	15 minute	457.20
43.66667/- 93.30000		ALBERT LEA, 3 E	MN	15 minute	374.90
43.68333/- 95.18333		LAKEFIELD	MN	15 minute	459.60
43.68333/- 92.41667		SPRING VALLEY	MN	15 minute	388.60
43.73333/- 96.61667		SIOUX FALLS, EROS CENTER	SD	15 minute	484.60
43.75000/-101.95000		INTERIOR, 3 NE	SD	15 minute	743.70
43.83333/- 91.76667		RUSHFORD	MN	15 minute	234.70
43.85000/-104.21667		NEWCASTLE	WY	15 minute	1344.20
43.86667/- 91.30000		LA CRESCENT, DAM 7	MN	15 minute	197.20
43.88333/-100.70000		MURDO	SD	15 minute	707.10
43.91667/- 92.50000	RST	ROCHESTER, WSO AP	MN	15 minute	400.80
43.96667/-101.86667		COTTONWOOD, 2 E	SD	15 minute	735.80
43.96667/- 89.81667		FRIENDSHIP, RANGER STATION	WI	15 minute	292.60
43.98333/-104.41667		OSAGE	WY	15 minute	1316.70
44.00000/- 91.43333		TREMPEALEAU, DAM 6	WI	15 minute	201.20
44.00000/- 90.50000		TOMAH, RANGER STATION	WI	15 minute	292.60
44.01667/- 97.51667		HOWARD	SD	15 minute	475.50
44.03333/- 92.83333		DODGE CENTER	MN	15 minute	387.10
44.03333/- 88.15000		CHILTON	WI	15 minute	256.00
44.03333/- 86.51667		LUDINGTON, STATE PARK	MI	15 minute	181.40
44.05000/-103.06667	RAP	RAPID CITY, REGIONAL ARPT	SD	15 minute	970.20
44.06667/-103.48333		PACTOLA, DAM	SD	15 minute	1438.70
44.06667/- 99.46667		LAKE SHARPE, PROJECT	SD	15 minute	445.00
44.23333/- 95.61667		TRACY	MN	15 minute	427.60
44.25000/- 99.45000		STEPHAN, 1 ENE	SD	15 minute	568.50
44.25000/- 94.98333		SPRINGFIELD, 1 NW	MN	15 minute	324.90
44.26667/-104.95000		MOORCROFT	WY	15 minute	1281.70
44.28333/- 90.85000		BLACK RIVER FALLS, SEWAGE	WI	15 minute	246.90
44.30000/- 90.11667		BABCOCK, 1 WNW	WI	15 minute	298.70
44.31667/- 96.76667		BROOKINGS, 2 NE	SD	15 minute	499.90
44.33333/- 91.93333		ALMA, DAM 4	WI	15 minute	204.20
44.38333/- 98.21667	HON	HURON, REGIONAL ARPT	SD	15 minute	392.00
44.45000/-100.41667		OAHE, DAM	SD	15 minute	506.00
44.46667/- 93.91667		LE SUEUR	MN	15 minute	257.60
44.46667/- 93.15000		NORTHFIELD, 2 NNE	MN	15 minute	271.30
44.48333/- 88.13333	GRB	GREENBAY, AUSTIN STRAUBEL FLD	WI	15 minute	211.80

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
44.50000/-103.86667		SPEARFISH	SD	15 minute	1109.50
44.50000/- 91.45000		STRUM, 4 S	WI	15 minute	268.20
44.53333/-101.56667		MILESVILLE, 8 NE	SD	15 minute	676.70
44.55000/-102.18333		PLAINVIEW, 4 SSW	SD	15 minute	742.20
44.61667/- 92.61667		REDWING, DAM 3	MN	15 minute	206.40
44.61667/- 88.75000		CLINTONVILLE	WI	15 minute	243.80
44.63333/- 97.91667		CARPENTER	SD	15 minute	445.00
44.65000/- 90.13333		MARSHFIELD, EXP FARM	WI	15 minute	381.00
44.71667/- 96.28333		CANBY	MN	15 minute	378.90
44.73333/- 90.71667		WILLARD	WI	15 minute	454.20
44.73333/- 89.75000		EAU PLEINE, RESERVOIR	WI	15 minute	346.90
44.75000/-105.70000		RECLUSE	WY	15 minute	1264.90
44.81667/- 95.55000		GRANITE FALLS, POWER PLANT	MN	15 minute	271.90
44.86667/- 89.65000		WAUSAU, 7 SSW	WI	15 minute	359.70
44.86667/- 87.33333		STURGEON BAY, EXP FARM	WI	15 minute	200.00
44.88000/- 91.93000		MENOMONIE	WI	15 minute	237.70
44.88333/- 93.21667	MSP	MINNEAPOLIS, INT'L ARPT	MN	15 minute	256.00
44.90000/- 98.50000	3DE	REDFIELD, 2 NE	SD	15 minute	393.20
44.91667/- 97.15000	ATY	WATERTOWN, MUNICIPAL AP	SD	15 minute	532.20
44.91667/- 94.36667		HUTCHINSON, 1 N	MN	15 minute	333.80
44.93333/- 91.38333		CHIPPEWA FALLS	WI	15 minute	259.10
45.00000/- 93.40000		GOLDEN VALLEY	MN	15 minute	277.40
HIS					
39.83000/- 96.11000	62K	Seneca, HIS	KS	no set schedule	384.00
High Plains Climate Network					
37.27000/-102.20000	059	Walsh	CO	hourly	210.00
37.37000/- 95.27000	034	Parsons	KS	hourly	277.00
37.87000/- 97.50000	093	Wichita	KS	hourly	379.00
37.93000/- 98.75000	036	Sandyland	KS	hourly	564.00
37.93000/- 98.02000	079	Hutchinson	KS	hourly	477.00
37.98000/-100.80000	037	GardenCity	KS	hourly	866.00
38.13000/- 97.38000	035	Hesston	KS	hourly	412.00
38.45000/-101.75000	038	Tribune	KS	hourly	1101.00
38.60000/- 95.27000	033	Ottawa	KS	hourly	277.00
38.87000/- 99.32000	040	Hays	KS	hourly	610.00
38.98000/- 94.93000	094	DeSoto	KS	hourly	286.00
39.10000/- 95.92000	078	Rossville	KS	hourly	281.00
39.10000/- 95.83000	032	Silver Lake	KS	hourly	271.00
39.18000/- 96.57000	031	Manhattan #1	KS	hourly	320.00
39.30000/-102.50000	057	Stratton	CO	hourly	390.00
39.37000/-101.07000	039	Colby	KS	hourly	966.00
39.78000/- 97.78000	041	Scandia	KS	hourly	451.00
39.78000/- 95.80000	080	Powhattan	KS	hourly	365.00
40.15000/-103.13000	018	Akron	CO	hourly	1384.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
40.17000/- 98.87000	096	Red Cloud	NE	hourly	524.00
40.22000/-100.57000	MCK	McCook	NE	hourly	792.00
40.25000/- 96.73000	087	Beatrice	NE	hourly	376.00
40.37000/-101.72000	003	Champion	NE	hourly	1029.00
40.42000/- 99.37000	061	Holdrege	NE	hourly	707.00
40.45000/-103.02000	058	Sterling	CO	hourly	200.00
40.47000/- 95.87000	095	Rockport	MO	hourly	268.00
40.52000/- 98.13000	009	South Central	NE	hourly	552.00
40.63000/-100.50000	052	UNSTA Curtis	NE	hourly	784.00
40.68000/- 99.00000	024	Gibbon	NE	hourly	625.00
40.75000/- 96.68000	055	Lincoln IANR	NE	hourly	383.00
40.77000/- 98.75000	098	Shelton	NE	hourly	614.00
40.78000/- 99.73000	053	Lexington	NE	hourly	731.00
40.83000/-101.67000	022	Grant	NE	hourly	975.00
40.83000/- 96.67000	015	Havelock	NE	hourly	351.00
41.00000/-100.92000	005	Dickens	NE	hourly	945.00
41.00000/- 93.27000	067	Chariton	IA	hourly	396.00
41.07000/-100.73000	012	North Platte	NE	hourly	922.00
41.10000/- 98.00000	054	Central City	NE	hourly	517.00
41.13000/- 96.50000	001	Mead	NE	hourly	366.00
41.15000/- 96.50000	051	Mead Turf Farm	NE	hourly	366.00
41.18000/-104.08000	042	Pine Bluffs	WY	hourly	1554.00
41.18000/- 97.32000	046	Rising City	NE	hourly	375.00
41.22000/-103.00000	014	Sidney	NE	hourly	1317.00
41.22000/- 91.68000	090	Crawfordsville	IA	hourly	216.00
41.37000/-101.67000	056	Arapahoe Prarie	NE	hourly	97.00
41.52000/-102.78000	026	Silverthorn	NE	hourly	1302.00
41.57000/- 97.55000	048	Tarnov	NE	hourly	472.00
41.60000/- 98.93000	017	Ord	NE	hourly	625.00
41.63000/-101.50000	006	Arthur	NE	hourly	1097.00
41.82000/- 96.80000	007	West Point	NE	hourly	442.00
41.83000/-103.68000	011	Panhandle	NE	hourly	1244.00
41.85000/-103.68000	097	Scottsbluff	NE	hourly	1208.00
41.90000/-100.32000	082	Halsey	NE	hourly	824.00
41.98000/- 98.27000	065	Elgin	NE	hourly	619.00
42.03000/- 95.80000	060	Castana Exp. Sta N	IA	hourly	432.00
42.03000/- 93.73000	050	Gilbert	IA	hourly	305.00
42.03000/- 93.73000	050	Ames Southwest	IA	hourly	305.00
42.07000/-104.93000	043	Wheatland	WY	hourly	417.00
42.07000/-102.85000	063	Alliance North	NE	hourly	213.00
42.13000/-102.85000	062	Alliance West	NE	hourly	213.00
42.37000/- 96.97000	010	North East	NE	hourly	445.00
42.40000/-101.43000	013	Gudmundsen's	NE	hourly	1049.00
42.45000/- 98.63000	030	O'Neill	NE	hourly	670.00
42.55000/- 99.85000	023	Ainsworth	NE	hourly	765.00
42.68000/- 94.42000	091	Gilmore	IA	hourly	360.00
42.78000/-102.15000	025	Gordon	NE	hourly	1109.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
42.93000/- 92.55000	068	Nashua	IA	hourly	360.00
42.97000/- 95.48000	066	Sutherland	IA	hourly	396.00
43.07000/- 96.92000	064	Beresford	SD	hourly	381.00
43.48000/-103.32000	029	Buffalo Gap	SD	hourly	981.00
43.78000/- 99.32000	028	Oacoma	SD	hourly	427.00
43.97000/-101.85000	069	Cottonwood	SD	hourly	722.00
44.27000/-100.00000	092	Pierre	SD	hourly	451.00
44.30000/- 96.75000	019	Brookings	SD	hourly	500.00
44.67000/-103.55000	070	Nisland	SD	hourly	722.00
44.87000/- 98.38000	021	Redfield	SD	hourly	395.00
44.90000/- 97.13000	081	Watertown	SD	hourly	532.00
44.98000/-100.27000	020	Gettysburg	SD	hourly	568.00
Illinois Water Survey Network					
37.45000/- 88.67000	dxs	Dixon Springs	IL	5 minute	165.00
37.72000/- 89.23000	siu	Carbondale	IL	5 minute	137.00
38.13000/- 88.92000	rdl	Rend Lake	IL	5 minute	130.00
38.38000/- 88.38000	frf	Fairfield	IL	5 minute	136.00
38.52000/- 89.88000	bel	Belleville	IL	5 minute	133.00
38.73000/- 88.10000	one	Olney	IL	5 minute	134.00
38.95000/- 88.95000	brs	Brownstown	IL	5 minute	177.00
39.52000/- 89.62000	llc	Springfield	IL	5 minute	177.00
39.80000/- 90.83000	orr	Orr	IL	5 minute	206.00
40.05000/- 88.37000	bnd	Bondville	IL	5 minute	213.00
40.08000/- 88.23000	cmi	Champaign	IL	5 minute	219.00
40.17000/- 90.08000	snd	Sand Farm	IL	5 minute	152.00
40.70000/- 89.52000	icc	Peoria	IL	5 minute	207.00
40.72000/- 89.75000	wfp	Wildlife Park	IL	5 minute	186.00
40.92000/- 90.73000	mnh	Monmouth	IL	5 minute	229.00
40.95000/- 88.17000	sll	Stelle	IL	5 minute	213.00
41.85000/- 88.85000	dek	DeKalb	IL	5 minute	265.00
41.90000/- 88.37000	scs	St. Charles	IL	5 minute	226.00
42.28000/- 89.67000	fre	Freeport	IL	5 minute	265.00
NCAR ASTER					
39.91000/- 95.84000	BLN	Sabetha	KS	1 minute	410.00
NCAR PAM Mesonet					
36.88000/- 93.89810	032	Monett	MO	5 minute	436.00
36.90970/- 94.88940	031	Miami	OK	5 minute	245.00
36.97250/- 92.68580	033	Ava	MO	5 minute	385.00
36.99220/- 91.71750	034	Mountain View	MO	5 minute	354.00
37.12440/- 90.71280	035	Piedmont	MO	5 minute	142.00
37.44360/- 94.73310	026	Pittsburg	KS	5 minute	287.00
37.61860/- 91.60750	029	Salem	MO	5 minute	369.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
37.64360/- 92.65420	028	Lebanon	MO	5 minute	402.00
37.66190/- 93.81470	027	Stockton	MO	5 minute	317.00
37.76190/- 90.42940	030	Farmington	MO	5 minute	280.00
38.13060/- 91.76420	023	Rolla	MO	5 minute	340.00
38.14580/- 89.70190	025	Sparta	IL	5 minute	162.00
38.28030/- 95.21670	014	Garnett	KS	5 minute	302.00
38.28940/- 94.34250	015	Butler	MO	5 minute	264.00
38.36000/- 93.68110	016	Clinton	MO	5 minute	248.00
38.37420/- 90.97560	024	St. Clair	MO	5 minute	203.00
38.42720/- 92.87440	017	Versailles	MO	5 minute	310.00
38.81780/- 92.21470	018	Columbia	MO	5 minute	271.00
38.89080/- 90.05330	020	East Alton	IL	5 minute	165.00
38.98830/- 89.16420	022	Vandalia	IL	5 minute	163.00
39.01190/- 91.41750	019	Montgomery City	MO	5 minute	234.00
39.01670/- 94.21310	009	Grain Valley	MO	5 minute	257.00
39.07250/- 95.62560	037	Topeka	KS	1 minute	268.00
39.09890/- 93.19890	010	Marshall	MO	5 minute	234.00
39.46470/- 92.43110	011	Moberly	MO	5 minute	263.00
39.53310/- 89.32360	021	Taylorville	IL	5 minute	188.00
39.55030/- 96.12720	043	Havensville (BLN-9)	KS	1 minute	386.00
39.69610/- 96.11530	045	Centralia (BLN-h)	KS	1 minute	412.00
39.72720/- 91.44670	012	Hannibal	MO	5 minute	232.00
39.72750/- 94.27220	005	Cameron	MO	5 minute	309.00
39.77110/- 90.23940	013	Jacksonville	IL	5 minute	188.00
39.78310/- 93.49750	006	Chillicothe	MO	5 minute	237.00
39.79610/- 95.64560	040	Powhattan (BLN-3)	KS	1 minute	365.00
39.81360/- 95.86220	047	Woodlawn (BLN-d)	KS	1 minute	401.00
39.83000/- 96.10780	041	Seneca (BLN-5)	KS	1 minute	386.00
39.87830/- 96.29560	046	Axtell (BLN-a)	KS	1 minute	427.00
39.92830/- 96.51390	042	Home (BLN-7)	KS	1 minute	420.00
39.97280/- 96.07640	044	Seneca North (BLN-e)	KS	1 minute	370.00
40.08170/- 95.99030	039	Humboldt (BLN-1)	NE	1 minute	326.00
40.09390/- 92.54060	007	Kirksville	MO	5 minute	293.00
40.33470/- 94.81920	002	Maryville	MO	5 minute	296.00
40.41830/- 93.59810	003	Princeton	MO	5 minute	256.00
40.46280/- 91.43140	008	Keokuk	IA	5 minute	202.00
40.65690/- 95.86000	001	Nebraska City	NE	5 minute	325.00
40.72720/- 92.43000	004	Bloomfield	IA	5 minute	269.00

ASOS

34.35000/- 98.98000	FDR	Frederick	OK	5 minute	383.00
34.43000/-100.29000	CDS	Childress	TX	5 minute	595.00
34.88000/- 95.78000	MLC	McAlester	OK	5 minute	235.00
35.22000/-101.71000	AMA	Amarillo	TX	5 minute	1099.00
35.39000/- 97.60000	OKC	Oklahoma City, WSFO Airport	OK	5 minute	398.00
35.53000/- 97.65000	PWA	Oklahoma City, Wiley Post Airport	OK	5 minute	396.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
35.66000/- 95.36000	MKO	Muskogee	OK	5 minute	186.00
35.85000/- 97.42000	GOK	Guthrie	OK	5 minute	327.00
36.02000/-102.55000	DHT	Dalhart	TX	5 minute	1219.00
36.16000/- 97.09000	SWO	Stillwater	OK	5 minute	300.00
36.20000/- 95.89000	TUL	Tulsa	OK	5 minute	206.00
36.73000/- 97.10000	PNC	Ponca City	OK	5 minute	304.00
36.76000/- 96.01000	BVO	Bartlesville	OK	5 minute	220.00
37.17000/- 97.04000	WLD	Winfield/Ark City	KS	5 minute	353.00
37.24000/- 93.39000	SGF	Springfield	MO	5 minute	387.00
37.33000/- 95.51000	PPF	Parsons	KS	5 minute	274.00
37.45000/-105.87000	ALS	Alamosa	CO	5 minute	2299.00
37.65000/- 97.43000	ICT	Wichita, Mid-Continent Airport	KS	5 minute	409.00
37.67000/- 95.49000	CNU	Chanute	KS	5 minute	308.00
37.75000/- 97.22000	3KM	Wichita, Jabara Airport	KS	5 minute	433.00
37.76000/- 99.96000	DDC	Dodge City	KS	5 minute	790.00
37.93000/-100.72000	GCK	Garden City	KS	5 minute	879.00
38.05000/-103.51000	LHX	LaJunta	CO	5 minute	1285.00
38.07000/-102.69000	LAA	Lamar	CO	5 minute	1129.00
38.07000/- 97.86000	HUT	Hutchinson	KS	5 minute	465.00
38.29000/-104.50000	PUB	Pueblo	CO	5 minute	1439.00
38.33000/- 96.19000	EMP	Emporia	KS	5 minute	370.00
38.70000/- 93.18000	DMO	Sedalia	MO	5 minute	277.00
38.79000/- 97.65000	SLN	Salina	KS	5 minute	391.00
38.81000/-104.71000	COS	Colorado Springs	CO	5 minute	1881.00
38.83000/- 94.89000	IXD	Olathe	KS	5 minute	331.00
38.85000/- 94.74000	OJC	Olathe	KS	5 minute	343.00
38.87000/- 98.81000	RSL	Russell	KS	5 minute	570.00
38.95000/- 95.66000	FOE	Topeka, Forbes Field	KS	5 minute	329.00
39.07000/- 95.62000	TOP	Topeka, Municipal Airport	KS	1 minute	270.00
39.14000/- 96.67000	MHK	Manhattan	KS	5 minute	326.00
39.30000/- 94.72000	MCI	Kansas City	MO	5 minute	313.00
39.37000/-101.70000	GLD	Goodland	KS	5 minute	1124.00
39.38000/- 99.83000	HLC	Hill City	KS	5 minute	677.00
39.55000/- 97.65000	CNK	Concordia	KS	5 minute	452.00
39.77000/-104.88000	DEN	Denver	CO	5 minute	1629.00
39.77000/- 94.91000	STJ	St Joseph	MO	5 minute	249.00
40.17000/-103.22000	AKO	Akron	CO	5 minute	1409.00
40.21000/-100.59000	MCK	McCook	NE	5 minute	786.00
40.60000/- 98.43000	HSI	Hastings	NE	5 minute	592.00
40.85000/- 96.76000	LNK	Lincoln	NE	5 minute	363.00
40.97000/- 98.31000	GRI	Grand Island	NE	5 minute	566.00
41.10000/-102.98000	SNY	Sidney	NE	5 minute	1313.00
41.76000/- 96.18000	TQE	Tekamah	NE	5 minute	313.00

AWOS

32.85000/-104.47000	ATS	Artesia	NM	20 minute	1081.00
34.30000/- 97.02000	IFO	Ardmore	OK	20 minute	232.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
34.42000/-103.08000	CVN	Clovis	NM	20 minute	1284.00
34.60000/- 91.57000	SGT	Stuttgart	AR	20 minute	68.00
34.81000/- 96.67000	ADH	Ada	OK	20 minute	307.00
35.23000/- 97.47000	OUN	Norman (Univ. of Oklahoma)	OK	20 minute	359.00
35.73000/- 91.65000	BVX	Batesville	AR	20 minute	141.00
35.86000/- 98.42000	OK7	Watonga	OK	20 minute	468.00
36.13000/- 90.62000	ARG	Walnut Ridge	AR	20 minute	84.00
36.18000/- 94.13000	ASG	Springdale	AR	20 minute	412.00
36.19000/- 94.49000	SLG	Siloam Spring	AR	20 minute	364.00
36.29000/- 92.59000	FLP	Flippin	AR	20 minute	219.00
36.35000/- 94.22000	HOO	Bentonville	AR	20 minute	609.00
36.37000/- 94.20000	H00	Bentonville Municipal Airport	AR	20 minute	401.00
36.37000/- 94.11000	ROG	Rogers	AR	20 minute	415.00
36.46000/-105.67000	SKX	Taos	NM	20 minute	2161.00
37.05000/-100.97000	LBL	Liberal	KS	20 minute	880.00
37.25000/-104.33000	TAD	Trinidad	CO	20 minute	1756.00
38.06000/- 97.28000	EWK	Newton	KS	20 minute	467.00
38.10000/- 92.55000	AIZ	Kaiser/Lake Ozark	MO	20 minute	265.00
38.32000/- 88.87000	MVN	Mount Vernon	IL	20 minute	146.00
38.35000/- 98.86000	GBD	Great Bend	KS	20 minute	576.00
38.85000/- 99.27000	HYS	Hays	KS	20 minute	609.00
39.79000/-104.55000	FTG	Denver (Front Range)	CO	20 minute	1672.00
39.93000/- 91.20000	UIN	Quincy	IL	20 minute	234.00
40.32000/- 96.75000	BIE	Beatrice	NE	20 minute	402.00
40.43000/-104.63000	GXY	Greeley	CO	20 minute	1420.00
40.45000/-105.02000	FNL	Fort Collins	CO	20 minute	1529.00
40.45000/- 99.33000	HDE	Holdrege	NE	20 minute	705.00
40.73000/- 99.00000	EAR	Kearney	NE	20 minute	649.00
40.79000/- 99.78000	LXN	Lexington	NE	20 minute	734.00
40.89000/- 97.99000	AUH	Aurora	NE	20 minute	549.00
41.02000/- 94.36000	CSQ	Creston	IA	1 minute	395.00
41.07000/- 87.85000	IKK	Greater Kankakee	IL	20 minute	191.00
41.12000/-101.77000	OGA	Ogallala	NE	20 minute	999.00
41.20000/- 96.11000	MLE	Omaha (Millard)	NE	20 minute	320.00
41.45000/- 97.35000	OLU	Columbus	NE	20 minute	440.00
41.45000/- 96.51000	FET	Fremont	NE	20 minute	367.00
41.70000/- 94.92000	ADU	Audubon	IA	20 minute	396.00
41.74000/- 89.67000	SQI	Sterling/Rock Falls	IL	20 minute	197.00
41.83000/- 90.33000	CWI	Clinton	IA	1 minute	216.00
41.98000/- 95.38000	DNS	Denison	IA	1 minute	389.00
41.99000/- 93.62000	AMW	Ames	IA	20 minute	283.00
42.47000/- 98.68000	ONL	O'Neill	NE	20 minute	619.00
42.55000/- 94.18000	FOD	Fort Dodge	IA	20 minute	353.00
42.92000/- 97.38000	YKN	Yankton	SD	20 minute	397.00
43.65000/- 95.58000	OTG	Worthington	MN	20 minute	480.00
43.65000/- 94.42000	FRM	Fairmont	MN	20 minute	354.00
44.13000/- 87.67000	MTW	Manitowoc	WI	20 minute	198.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
44.22000/- 93.92000	MKT	Mankato	MN	20 minute	311.00
44.31000/- 96.81000	BKX	Brookings	SD	20 minute	499.00
44.45000/- 95.82000	MML	Marshall	MN	20 minute	359.00
44.84000/- 87.42000	SUE	Sturgeon Bay	WI	20 minute	221.00
44.87000/- 91.48000	EAU	Eau Claire	WI	20 minute	276.00
Radar, NWS RADAP					
35.23000/-101.70000	AMA	Amarillo	TX	no set schedule	1098.80
35.40000/- 97.60000	OKC	Oklahoma City, WSFO Airport	OK	no set schedule	390.80
36.88000/- 93.90000	UMN	Monett	MO	no set schedule	438.90
37.65000/- 97.43000	ICT	Wichita, Mid-Continent Airport	KS	no set schedule	402.60
37.93000/-100.72000	GCK	Garden City	KS	no set schedule	878.40
39.18000/-103.70000	LIC	Limon	CO	no set schedule	1694.10
Radar, NWS WSR-57					
38.70000/- 90.68000	STL	St. Louis	MO	no set schedule	185.00
40.97000/- 98.32000	GRI	Grand Island	NE	no set schedule	566.00
PROFS mesonet					
39.23000/-104.63000	ELB	Elbert	CO	5 minute	2135.00
39.57000/-104.96000	LTN	Littleton	CO	5 minute	1740.00
39.68000/-105.49000	SQM	Idaho Springs	CO	5 minute	3456.00
39.70000/-105.16000	LAK	Lakewood	CO	5 minute	1826.00
39.74000/-104.13000	BYE	Byers	CO	5 minute	1555.00
39.77000/-104.87000	AUR	Aurora	CO	5 minute	1608.00
39.80000/-105.10000	ARV	Arvada	CO	5 minute	1635.00
39.91000/-105.49000	ROL	Rollinsville	CO	5 minute	2749.00
39.99000/-104.80000	BRI	Brighton	CO	5 minute	1519.00
40.01000/-105.25000	BOU	Boulder	CO	5 minute	1612.00
40.04000/-105.54000	WRD	Ward	CO	5 minute	3005.00
40.05000/-105.01000	ERI	Erie	CO	5 minute	1584.00
40.07000/-104.51000	KNB	Keenesburg	CO	5 minute	1519.00
40.17000/-105.16000	LGM	Longmont	CO	5 minute	1536.00
40.26000/-104.87000	PLT	Platteville	CO	5 minute	1449.00
40.33000/-103.80000	FTM	Fort Morgan	CO	5 minute	1370.00
40.37000/-105.56000	EPK	Estes Park	CO	5 minute	2396.00
40.41000/-105.04000	LVE	Loveland	CO	5 minute	1513.00
40.42000/-104.63000	GLY	Greeley	CO	5 minute	1415.00
40.59000/-105.15000	FOR	Fort Collins	CO	5 minute	1603.00
40.65000/-104.34000	BGD	Briggsdale	CO	5 minute	1480.00
40.80000/-104.76000	NUN	Nunn	CO	5 minute	1638.00
Wind Profiler, Research					
39.50920/- 96.13500		Havensville (BLN-9)	KS	1 minute	387.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
39.79780/- 95.64750		Powhattan (BLN-3)	KS	1 minute	360.00
39.82920/- 96.10720		Seneca (BLN-5)	KS	1 minute	384.00
39.88690/- 96.51920		Home (BLN-7)	KS	1 minute	409.00
40.05000/- 88.38000	FAO	Bondville, Flatlands Observatory	IL	1 minute	212.00
40.07390/- 95.98890		Humboldt (BLN-1)	NE	1 minute	320.00

Rawinsonde, CLASS

36.38000/- 92.23000	HEN	Henderson	AR	no set schedule	175.00
36.70000/-101.48000	GUY	Guymon	OK	no set schedule	939.00
37.05000/- 97.10000	AKZ	Arkansas City	KS	no set schedule	377.00
38.64000/- 90.24000	STL	St. Louis	MO	no set schedule	161.00
38.82000/- 92.22000	COU	Columbia	MO	no set schedule	271.00
38.90000/- 99.32000	HYS	Hays	KS	no set schedule	626.00
39.24000/-102.29000	3V1	Burlington	CO	no set schedule	1286.00
39.83000/- 96.11000	62K	Seneca	KS	no set schedule	384.00
40.19000/- 92.59000	IRK	Kirksville	MO	no set schedule	291.00
40.70000/- 99.10000	EAR	Kearney	NE	no set schedule	662.00
41.71000/- 91.61000	IOW	Iowa City	IA	no set schedule	241.00
42.64000/- 95.21000	SLB	Storm Lake	IA	no set schedule	430.00

Rawinsonde, NWS

32.22000/- 98.18000	SEP	Stephenville	TX	12 hourly	401.70
32.38000/- 94.72000	GGG	Longview	TX	12 hourly	111.00
34.73000/- 92.23000	LIT	Little Rock	AR	12 hourly	78.00
35.23000/-101.70000	AMA	Amarillo	TX	12 hourly	1098.80
35.23000/- 97.47000	OUN	Norman	OK	12 hourly	362.00
36.88000/- 93.90000	UMN	Monett	MO	12 hourly	438.90
37.07000/- 88.77000	PAH	Paducah	KY	12 hourly	120.10
37.77000/- 99.97000	DDC	Dodge City	KS	12 hourly	787.00
39.07000/- 95.62000	TOP	Topeka, Municipal Airport	KS	12 hourly	267.90
39.75000/-104.87000	DEN	Denver	CO	12 hourly	1625.00
40.67000/- 89.68000	PIA	Peoria	IL	12 hourly	200.90
41.13000/-100.97000	LBF	North Platte	NE	12 hourly	849.00
41.30000/- 95.90000	OMA	Omaha	NE	12 hourly	299.90
44.05000/-103.07000	RAP	Rapid City	SD	12 hourly	970.20
44.38000/- 98.22000	HON	Huron	SD	12 hourly	392.00
44.48000/- 88.13000	GRB	Green Bay	WI	12 hourly	211.80

Radar, Research Doppler

35.48000/- 97.81000	CIM	Cimarron	OK	no set schedule	399.00
39.46000/- 96.05000	CP4	Havensville, NCAR CP-4 radar	KS	no set schedule	425.00
39.71000/- 95.53000	CP3	Horton, NCAR CP-3 radar	KS	no set schedule	353.00
39.88000/-104.76000	MHR	Denver, Mile High Radar	CO	no set schedule	1604.00
40.04000/- 88.28000	HOT	Champaign	IL	no set schedule	237.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
40.45000/-104.64000	CHILL	Fort Collins (CHILL)	CO	no set schedule	1423.00

USGS Raingauge Data

33.43400/- 97.09350	07316000	Gainesville, Red River	OK	hourly	-999.90
33.49050/- 96.34200	07331500	Denison, Lake Texoma	OK	hourly	-999.90
34.00420/- 95.22490	07336600	Hugo, Hugo Lake	OK	hourly	-999.90
34.01360/- 95.45000	07335300	Unger, Muddy Boggy Creek	OK	hourly	-999.90
34.06430/- 95.04460	07337300	Wright City, Pine Creek	OK	hourly	-999.90
34.08350/- 94.41000	07338900	Broken Bow, Broken Bow Lake	OK	hourly	-999.90
34.13570/- 98.02510	07313400	Waurika, Waurika Lake	OK	hourly	-999.90
34.14000/- 96.58320	07331000	Dickson, Washita River	OK	hourly	-999.90
34.16170/- 95.54430	07334000	Farris, Muddy Boggy Creek	OK	hourly	-999.90
34.21440/- 98.16560	07311000	Walters, East Cache Creek	OK	hourly	-999.90
34.27440/- 94.38060	07338750	Smithville, Mountain Fork	OK	hourly	-999.90
34.32290/- 97.14490	07329700	Hoover, Wildhorse Creek	OK	hourly	-999.90
34.35400/- 96.39550	07334200	Fittstown, Byrds Mill Spring	OK	hourly	-999.90
34.37450/- 95.21030	07335775	Clayton, Sardis Lake	OK	hourly	-999.90
34.38040/- 99.05470	07305000	Headrick, North Fork Red River	OK	hourly	-999.90
34.38160/- 98.59540	07307010	Snyder, Otter Creek	OK	hourly	-999.90
34.38180/- 94.36450	07335700	Big Cedar, Kiamichi River	OK	hourly	-999.90
34.45170/- 97.15040	07328500	Pauls Valley, Washita River	OK	hourly	-999.90
34.46250/- 94.30430	07247250	Page, Black Fork below Big Creek	OK	hourly	-999.90
34.50160/- 98.07270	07327447	Cement, Little Washita River	OK	hourly	-999.90
34.53080/- 99.17430	07302500	Lugert, Lake Altus	OK	hourly	-999.90
34.53330/- 98.13580	07327442	Cyril, Little Washita River	OK	hourly	-999.90
34.54450/- 95.09200	07247500	Red Oak, Fourche Maline	OK	hourly	-999.90
34.56100/- 94.43100	07248000	Wister, Wister Lake	OK	hourly	-999.90
34.57480/- 97.53570	07327550	East Ninnekah, Little Washita River	OK	hourly	-999.90
34.58400/- 96.14360	07231500	Calvin, Canadian River	OK	hourly	-999.90
35.07020/- 98.33490	07325500	Carnegie, Washita River	OK	hourly	-999.90
35.12130/- 97.25520	07229055	Norman, Bishop Creek	OK	hourly	-999.90
35.12240/- 97.28510	07229030	Norman, Merkle Creek	OK	hourly	-999.90
35.15500/- 95.14210	07245000	Whitefield, Canadian River	OK	hourly	-999.90
35.15560/- 96.12210	07242000	Wetumka, North Canadian River	OK	hourly	-999.90
35.17050/- 99.37180	07301481	Sayre, North Fork Red River	OK	hourly	-999.90
35.17260/- 98.35380	07325800	Eakly, Cobb Creek	OK	hourly	-999.90
35.25200/- 99.58080	07301420	Sweetwater, Sweetwater Creek	OK	hourly	-999.90
35.28430/- 97.39470	07241000	Oklahoma City, N. Canadian R.Blw Lake Overholser	OK	hourly	-999.90
35.30010/- 97.11370	07241550	Harrah, North Canadian River	OK	hourly	-999.90
35.33470/- 97.57260	07239500	El Reno, North Canadian River	OK	hourly	-999.90
35.34230/- 95.04070	07198000	Gore, Illinois River	OK	hourly	-999.90
35.37350/- 99.40050	07316500	Cheyenne, Washita River	OK	hourly	-999.90
35.38540/- 97.21470	07242340	Arcadia, Arcadia Lake	OK	hourly	-999.90
35.40260/- 96.04060	07243500	Beggs, Deep Fork	OK	hourly	-999.90
35.46550/- 96.51140	07243000	Kendrick, Dry Creek	OK	hourly	-999.90
40.45000/-104.64000	CHILL	Fort Collins (CHILL)	CO	no set schedule	1423.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
35.48430/- 98.25140	07239300	Watonga, North Canadian River Below Weavers Creek	OK	hourly	-999.90
35.49230/- 95.38390	07165570	Haskell, Arkansas River	OK	hourly	-999.90
35.55140/- 97.25320	07160000	Guthrie, Cimarron River	OK	hourly	-999.90
35.55160/- 94.50140	07197000	Eldon, Baron Fork	OK	hourly	-999.90
35.56520/- 96.17550	07165000	Heyburn, Heyburn Lake	OK	hourly	-999.90
35.57060/- 97.54510	07159100	Dover, Cimarron River	OK	hourly	-999.90
35.59090/- 96.54430	07161450	Ripley, Cimarron River	OK	hourly	-999.90
36.07480/- 94.34190	07195500	Watts, Illinois River	OK	hourly	-999.90
36.08260/- 96.00220	07164500	Tulsa, Arkansas River	OK	hourly	-999.90
36.09020/- 96.15080	07164200	Sand Springs, Keystone Lake	OK	hourly	-999.90
36.11000/- 98.55150	07238000	Seiling, North Canadian River	OK	hourly	-999.90
36.18260/- 95.41520	07176000	Claremore, Verdigris River	OK	hourly	-999.90
36.20070/- 94.38240	07191220	Sycamore, Spavinaw Creek	OK	hourly	-999.90
36.26120/- 99.16410	07237500	Woodward, North Canadian River	OK	hourly	-999.90
36.28080/- 95.02290	07190000	Langley, Lake O'the Cherokees	OK	hourly	-999.90
36.30150/- 96.43410	07152500	Ralston, Arkansas River	OK	hourly	-999.90
36.31000/- 98.52450	07158000	Waynoka, Cimarron River	OK	hourly	-999.90
36.33140/- 99.34160	07236500	Fort Supply, Fort Supply Lake	OK	hourly	-999.90
36.37530/- 94.35120	07189000	Tiff City, Elk River	OK	hourly	-999.90
36.40190/- 97.18330	07151000	Tonkawa, Salt Fork Arkansas River	OK	hourly	-999.90
36.43100/- 96.07560	07174600	Okesa, Sand Creek	OK	hourly	-999.90
36.43170/-101.29210	07232500	Guymon, Beaver River	OK	hourly	-999.90
36.44400/- 98.08080	07150000	Jet, Great Salt Plains Lake	OK	hourly	-999.90
36.49200/-100.31080	07234000	Beaver, Beaver River	OK	hourly	-999.90
36.51050/- 95.35100	07171000	Lenapah, Verdigris River	OK	hourly	-999.90
36.53130/- 95.57100	07174300	Copan, Copan Lake	OK	hourly	-999.90
36.55430/- 94.57260	07185000	Commerce, Neosho River	OK	hourly	-999.90

USGS Stream Flow Gauges

34.84000/- 98.12000		Chickasha, STORM-FEST Stream Gage 1	OK	hourly	-999.90
34.96000/- 97.90000		Chickasha, STORM-FEST Stream Gage 2	OK	hourly	-999.90

Radar, WSR-88D

34.36000/- 98.98000	KFDR	Frederick	OK	no set schedule	396.00
35.24000/- 97.46000	KOUN	Norman	OK	no set schedule	362.00
35.33000/- 97.28000	KOKC	Twin Lakes	OK	no set schedule	383.00

Oklahoma ARS

34.75390/- 98.08920	G166	Little Washita Basin (166)	OK	5 minute	390.00
34.75390/- 97.99390	G168	Little Washita Basin (168)	OK	5 minute	399.00
34.75440/- 98.03610	G167	Little Washita Basin (167)	OK	5 minute	396.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
34.78330/- 97.93190	G158	Little Washita Basin (158)	OK	5 minute	408.00
34.79310/- 97.98420	G159	Little Washita Basin (159)	OK	5 minute	433.00
34.79750/- 98.08310	G161	Little Washita Basin (161)	OK	5 minute	427.00
34.80140/- 98.03670	G160	Little Washita Basin (160)	OK	5 minute	411.00
34.81330/- 98.14170	G162	Little Washita Basin (162)	OK	5 minute	399.00
34.81750/- 98.19500	G163	Little Washita Basin (163)	OK	5 minute	408.00
34.82610/- 98.26360	G165	Little Washita Basin (164)	OK	5 minute	399.00
34.83640/- 97.91330	G157	Little Washita Basin (157)	OK	5 minute	381.00
34.84060/- 98.03610	G155	Little Washita Basin (155)	OK	5 minute	393.00
34.84250/- 97.95780	G156	Little Washita Basin (156)	OK	5 minute	399.00
34.84500/- 98.07330	G182	Little Washita Basin (182)	OK	5 minute	369.00
34.85530/- 98.13360	G154	Little Washita Basin (154)	OK	5 minute	402.00
34.85640/- 98.19830	G153	Little Washita Basin (153)	OK	5 minute	408.00
34.86080/- 98.25060	G152	Little Washita Basin (152)	OK	5 minute	415.00
34.87970/- 97.91640	G144	Little Washita Basin (144)	OK	5 minute	384.00
34.88360/- 98.07500	G147	Little Washita Basin (147)	OK	5 minute	430.00
34.88420/- 97.97440	G145	Little Washita Basin (145)	OK	5 minute	372.00
34.88580/- 98.02280	G146	Little Washita Basin (146)	OK	5 minute	360.00
34.88920/- 98.30330	G181	Little Washita Basin (181)	OK	5 minute	430.00
34.90080/- 98.12780	G148	Little Washita Basin (148)	OK	5 minute	427.00
34.90140/- 98.18890	G149	Little Washita Basin (149)	OK	5 minute	415.00
34.90580/- 98.25060	G150	Little Washita Basin (150)	OK	5 minute	427.00
34.91330/- 98.29440	G151	Little Washita Basin (151)	OK	5 minute	442.00
34.91580/- 97.91720	G137	Little Washita Basin (137)	OK	5 minute	347.00
34.92690/- 97.96690	G136	Little Washita Basin (136)	OK	5 minute	366.00
34.92750/- 98.01940	G135	Little Washita Basin (135)	OK	5 minute	360.00
34.93500/- 98.07530	G134	Little Washita Basin (134)	OK	5 minute	384.00
34.94170/- 98.17830	G132	Little Washita Basin (132)	OK	5 minute	427.00
34.94190/- 98.12500	G133	Little Washita Basin (133)	OK	5 minute	427.00
34.94940/- 98.23310	G131	Little Washita Basin (131)	OK	5 minute	454.00
34.95640/- 98.28470	G130	Little Washita Basin (130)	OK	5 minute	430.00
34.95860/- 97.89280	G121	Little Washita Basin (121)	OK	5 minute	341.00
34.97110/- 98.01330	G123	Little Washita Basin (123)	OK	5 minute	372.00
34.97390/- 98.05780	G124	Little Washita Basin (124)	OK	5 minute	390.00
34.97750/- 97.95220	G122	Little Washita Basin (122)	OK	5 minute	357.00
34.98560/- 98.12750	G125	Little Washita Basin (125)	OK	5 minute	421.00
35.01250/- 97.95250	G111	Little Washita Basin (111)	OK	5 minute	369.00
35.01390/- 98.37640	G110	Little Washita Basin (110)	OK	5 minute	378.00
35.03611/- 97.90611	G230	Chickasha	OK	5 minute	331.00
35.03694/- 97.91667	G401	Chickasha	OK	5 minute	331.00
35.03694/- 97.91583	G402	Chickasha	OK	5 minute	331.00

Surface Airways Observations

32.21667/- 98.18333	SEP	STEPHENVILLE, WSMO	TX	hourly	398.00
32.30000/- 86.40000	MGM	MONTGOMERY, DANNELLY FIELD	AL	hourly	64.00
32.31667/- 90.08333	JAN	JACKSON, THOMPSON FIELD	MS	hourly	90.00
32.33333/-104.26667	CNM	CARLSBAD, CAVERN CITY AIR TERM	NM	hourly	986.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
32.33333/- 88.75000	MEI	MERIDIAN, KEY FIELD	MS	hourly	89.00
32.41667/- 99.68333	ABI	ABILENE, MUNICIPAL ARPT	TX	hourly	545.00
32.43333/- 99.85000	DYS	ABILENE, DYESS AFB	TX	hourly	544.00
32.46667/- 93.81667	SHV	SHREVEPORT, WSO AP	LA	hourly	77.00
32.51667/- 92.05000	MLU	MONROE, MUNICIPAL ARPT	LA	hourly	23.00
32.55000/- 88.56667	NMM	MERIDIAN, NAAS	MS	hourly	84.00
32.68333/-103.20000	HOB	HOBBS, FAA AIRPORT	NM	hourly	1114.00
32.68333/- 96.86667	RBD	DALLAS, REDBIRD ARPT	TX	hourly	209.00
32.73333/- 96.96667	NBE	DALLAS, HENSLEY FLD NAS	TX	hourly	149.00
32.78333/- 98.06667	MWL	MINERAL WELLS, MUNICIPAL AP	TX	hourly	283.00
32.81667/- 97.35000	FTW	FORT WORTH, MEACHAM FIELD	TX	hourly	204.00
32.85000/- 96.85000	DAL	DALLAS, LOVE FIELD	TX	hourly	159.00
32.90000/- 97.03333	DFW	DALLAS/FORT WORTH, Regional Arpt	TX	hourly	167.00
32.90000/- 87.25000	CKL	CENTREVILLE, WSMO	AL	hourly	138.00
32.96667/- 96.83333	ADS	DALLAS, ADDISON ARPT	TX	hourly	209.00
33.21667/- 92.80000	ELD	ELDORADO, GOODWIN FIELD	AR	hourly	76.00
33.23333/- 87.61667	TCL	TUSCALOOSA, MUNICIPAL AP	AL	hourly	51.00
33.30000/-104.53333	ROW	INDUSTRIAL AIR PARK	NM	hourly	1113.00
33.45000/- 94.00000	TXK	TEXARKANA, FAA AIRPORT	AR	hourly	110.00
33.50000/- 90.08333	GWO	GREENWOOD, FAA AIRPORT	MS	hourly	47.00
33.56667/- 86.75000	BHM	BIRMINGHAM, MUNICIPAL ARPT	AL	hourly	192.00
33.65000/-101.81667	LBB	LUBBOCK, REGIONAL ARPT	TX	hourly	993.00
33.96667/- 98.48333	SPS	WICHITA FALLS, MUNICIPAL ARPT	TX	hourly	306.00
34.10000/-105.68333	4CR	CORONA, 11 SSW	NM	hourly	1981.00
34.26667/- 88.76667	TUP	TUPELO, C D LEMONS ARPT	MS	hourly	107.00
34.30000/- 97.01667	ADM	ARDMORE, MUNICIPAL AP	OK	hourly	240.00
34.38333/-103.31667	CVS	CLOVIS, CANNON AFB	NM	hourly	1309.00
34.43333/-100.28333	CDS	CHILDRESS, FCWOS AP	TX	hourly	594.00
34.65000/- 86.76667	HSV	HUNTSVILLE, Madison County JETPLEX	AL	hourly	192.00
34.73333/- 92.23333	LIT	LITTLEROCK, ADAMS FIELD	AR	hourly	84.00
34.75000/- 87.61667	MSL	MUSCLE SHOALS, FAA AIRPORT	AL	hourly	164.00
34.88333/- 95.78333	MLC	MCALESTER, MUNICIPAL AP	OK	hourly	231.00
35.00000/- 99.05000	HBR	HOBART, MUNICIPAL AP	OK	hourly	473.00
35.05000/- 90.00000	MEM	MEMPHIS, WSCMO AP	TN	hourly	82.00
35.23333/-101.70000	AMA	AMARILLO, INT'L ARPT	TX	hourly	1094.00
35.33333/- 94.36667	FSM	FORT SMITH, MUNICIPAL ARPT	AR	hourly	141.00
35.35000/- 99.20000	CSM	CLINTON, SHERMAN AP	OK	hourly	595.00
35.40000/- 97.60000	OKC	OKLAHOMA CITY, WSFO AP	OK	hourly	391.00
35.53333/- 97.63333	PWA	OKLAHOMA CITY, Wiley Post Arpt	OK	hourly	396.00
35.60000/- 88.91667	MKL	JACKSON, FCWOS AP	TN	hourly	131.00
35.65000/-105.15000	LVS	LAS VEGAS, FAA AIRPORT	NM	hourly	2092.00
36.01667/-102.55000	DHT	DALHART, MUNICIPAL AP	TX	hourly	1216.00
36.01667/- 89.40000	DYR	DYERSBURG, MUNICIPAL AP	TN	hourly	103.00
36.11667/- 86.68333	BNA	NASHVILLE, METRO ARPT	TN	hourly	181.00
36.16667/- 94.11667	ASG	SPRINGDALE, MUNICIPAL ARPT	AR	hourly	413.00
36.20000/- 95.90000	TUL	TULSA, WSO AP	OK	hourly	203.00
36.26667/- 93.15000	HRO	HARRISON, FAA AIRPORT	AR	hourly	418.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
36.30000/- 99.76667	GAG	GAGE, FAA AIRPORT	OK	hourly	667.00
36.33333/- 97.91667	END	ENID, VANCE AFB	OK	hourly	121.00
36.41667/-105.56667	E23	TAOS	NM	hourly	2122.00
36.45000/-105.66667	SKX	TAOS, MUNI AP	NM	hourly	2161.00
36.45000/-103.15000	CAO	CLAYTON, MUNICIPAL AIR PARK	NM	hourly	1515.00
36.73333/- 97.10000	PNC	PONCA CITY, FAA AIRPORT	OK	hourly	304.00
36.75000/- 96.00000	BVO	BARTLESVILLE, Frank Phillips Field	OK	hourly	2156.00
36.96667/- 86.43333	BWG	BOWLING GREEN, FAA AP	KY	hourly	162.00
37.00000/-101.88333	1K5	ELKHART, AMOS	KS	hourly	1105.00
37.05000/-100.96667	LBL	LIBERAL, MUNICIPAL AIRPORT	KS	hourly	878.00
37.15000/- 94.50000	JLN	JOPLIN, FAA AIRPORT	MO	hourly	298.00
37.23333/- 93.38333	SGF	SPRINGFIELD, REGIONAL AP	MO	hourly	387.00
37.23333/- 89.56667	CGI	CAPE GIRARDEAU, MUNICIPAL AP	MO	hourly	103.00
37.25000/-104.33333	TAD	TRINIDAD, LAS ANIMAS COUNTY AP	CO	hourly	1751.00
37.45000/-105.86667	ALS	ALAMOSA, BERGMAN FIELD	CO	hourly	2298.00
37.65000/- 97.43333	ICT	WICHITA, MID-CONTINENT ARPT	KS	hourly	402.00
37.66667/- 95.48333	CNU	CHANUTE, FAA AIRPORT	KS	hourly	298.00
37.75000/- 97.23333	3KM	WICHITA, JABARA ARPT	KS	hourly	433.00
37.75000/- 92.10000	TBN	FORT LEONARD WOOD	MO	hourly	335.00
37.75000/- 89.00000	MWA	MARION, WILLIAMSON CO AP	IL	hourly	143.00
37.76667/- 99.96667	DDC	DODGE CITY, MUNICIPAL AP	KS	hourly	786.00
37.93333/-100.71667	GCK	GARDEN CITY, 9 ESE	KS	hourly	878.00
38.05000/-103.51667	LHX	LA JUNTA, 4 NNE	CO	hourly	1277.00
38.05000/- 87.53333	EVV	EVANSVILLE, DRESS Regional Arpt	IN	hourly	121.00
38.06667/- 97.86667	HUT	HUTCHINSON, MUNICIPAL AP	KS	hourly	464.00
38.08333/-102.61667	4LJ	LAMAR	CO	hourly	1105.00
38.11667/- 91.76667	VIH	VICHY, ROLLA NAT'L ARPT	MO	hourly	350.00
38.28333/-104.51667	PUB	PUEBLO, MEMORIAL AP	CO	hourly	1420.00
38.66667/- 90.65000	SUS	ST LOUIS, SPIRIT OF ST LOUIS AP	MO	hourly	142.00
38.75000/- 90.36667	STL	ST LOUIS, LAMBERT INT'L ARPT	MO	hourly	172.00
38.80000/- 97.65000	SLN	SALINA, FAA AIRPORT	KS	hourly	384.00
38.81667/-104.71667	COS	COLORADO SPRINGS, MUNICIPAL AP	CO	hourly	1857.00
38.81667/- 92.21667	COU	COLUMBIA, REGIONAL ARPT	MO	hourly	272.00
38.85000/- 94.73333	OJC	OLATHE, Johnson County Exec AP	KS	hourly	339.00
38.86667/- 98.81667	RSL	RUSSELL, MUNICIPAL ARPT	KS	hourly	568.00
38.88333/- 90.05000	ALN	ALTON, ST LOUIS REGIONAL AP	IL	hourly	179.00
38.95000/- 95.66667	FOE	TOPEKA, FORBES FIELD	KS	hourly	100.00
38.96667/-104.81667	AFF	USAF ACADEMY, AF	CO	hourly	2003.00
39.06667/- 95.63333	TOP	TOPEKA, MUNICIPAL ARPT	KS	hourly	269.00
39.11667/- 94.60000	MKC	KANSAS CITY, MUNICIPAL ARPT	MO	hourly	227.00
39.15000/- 96.66667	MHK	MANHATTAN, MUNICIPAL AP	KS	hourly	318.00
39.18333/-103.70000	LIC	LIMON	CO	hourly	1694.00
39.31667/- 94.71667	MCI	KANSAS CITY, INTL ARPT	MO	hourly	297.00
39.36667/-101.70000	GLD	GOODLAND, RENNER FIELD	KS	hourly	1111.00
39.38333/- 99.83333	HLC	HILL CITY, 1NE	KS	hourly	670.00
39.45000/- 87.30000	HUF	TERRE HAUTE, Hulman Regional AP	IN	hourly	181.00
39.55000/- 97.65000	CNK	CONCORDIA, BLOSSER MUNI AP	KS	hourly	448.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
39.56667/-104.85000	APA	ENGLEWOOD, CENTENNIAL AP	CO	hourly	1776.00
39.73333/- 86.26667	IND	INDIANAPOLIS, INT'L ARPT	IN	hourly	241.00
39.76667/-104.86667	DEN	DENVER, STAPLETON INT'L AP	CO	hourly	1611.00
39.90000/-105.11667	BJC	BROOMFIELD, Jefferson County AP	CO	hourly	1719.00
39.93333/- 91.20000	UIN	QUINCY, FAA AIRPORT	IL	hourly	232.00
40.16667/-103.21667	AKO	AKRON, WASHINGTON CO AP	CO	hourly	1421.00
40.20000/- 87.60000	DNV	DANVILLE, VERMILION CO AP	IL	hourly	211.00
40.21667/-100.58333	MCK	MCCOOK	NE	hourly	785.00
40.41667/- 86.93333	LAF	WEST LAFAYETTE, Purdue Univ AP	IN	hourly	182.00
40.45000/-105.01667	FNL	LOVELAND, Ft Collins-Loveland AP	CO	hourly	1528.00
40.58333/-105.08333	FCL	FORT COLLINS	CO	hourly	1525.00
40.61667/- 93.95000	3OI	LAMONI	IA	hourly	344.00
40.66667/- 89.68333	PIA	PEORIA, GREATER PEORIA ARPT	IL	hourly	205.00
40.78333/- 91.11667	BRL	BURLINGTON, MUNICIPAL AP	IA	hourly	212.00
40.85000/- 96.75000	LNK	LINCOLN, MUNICIPAL ARPT	NE	hourly	364.00
40.96667/- 98.31667	GRI	GRAND ISLAND, WSO AP	NE	hourly	562.00
41.10000/-102.98333	SNY	SIDNEY, 3 S	NE	hourly	1313.00
41.10000/- 92.45000	OTM	OTTUMWA, INDUSTRIAL AP	IA	hourly	256.00
41.11667/- 95.91667	OFF	BELLEVUE, OFFUTT AFB	NE	hourly	97.00
41.13333/-100.68333	LBF	NORTH PLATTE, LEE BIRD FLD	NE	hourly	847.00
41.30000/- 95.90000	OMA	OMAHA, EPPLEY AIR FIELD	NE	hourly	298.00
41.31667/-105.68333	LAR	LARAMIE, GENERAL BREES FIELD	WY	hourly	2214.00
41.36667/- 96.01667	OVN	OMAHA, WSFO	NE	hourly	398.00
41.36667/- 88.61667	MMO	MARSEILLES, WSMO	IL	hourly	198.00
41.43333/- 99.65000	BBW	BROKEN BOW, MUNICIPAL AP	NE	hourly	773.00
41.53333/- 93.65000	DSM	DES MOINES, INTL AP	IA	hourly	294.00
41.70000/- 86.31667	SBN	SOUTH BEND, WSO AP	IN	hourly	238.00
41.86667/-103.60000	BFF	SCOTTSBLUFF, COUNTYARPT	NE	hourly	1203.00
41.88333/- 91.70000	CID	CEDARRAPIDS, MUNICIPALAP	IA	hourly	269.00
41.98333/- 97.43333	OFK	NORFOLK, WSOAP	NE	hourly	471.00
42.00000/- 87.88333	ORD	CHICAGO, O'HAREINTLAP	IL	hourly	204.00
42.05000/-102.80000	AIA	ALLIANCE, MUNICIPALAP	NE	hourly	1235.00
42.13333/- 86.43333	BEH	BENTONHARBOR, ROSSFIELD	MI	hourly	191.00
42.20000/- 89.10000	RFD	ROCKFORD, WSOAP	IL	hourly	223.00
42.40000/- 96.38333	SUX	SIOUX CITY, WSOAP	IA	hourly	339.00
42.40000/- 90.70000	DBQ	DUBUQUE, MUNICIPAL AP	IA	hourly	321.00
42.55000/- 92.40000	ALO	WATERLOO, MUNICIPAL AP	IA	hourly	265.00
42.58333/- 99.98333	ANW	AINSWORTH, MUNICIPAL AP	NE	hourly	788.00
42.75000/-105.38333	4DG	DOUGLAS	WY	hourly	1464.00
42.83333/-103.08333	CDR	CHADRON, MUNICIPAL AP	NE	hourly	1010.00
42.86667/-100.55000	VTN	VALENTINE, WSO AP	NE	hourly	788.00
42.95000/- 87.90000	MKE	MILWAUKEE, General Mitchell Field	WI	hourly	210.00
43.13333/- 89.33333	MSN	MADISON, DANE CO Regional Arpt	WI	hourly	262.00
43.15000/- 93.33333	MCW	MASON CITY, AP	IA	hourly	363.00
43.16667/- 95.15000	3SE	SPENCER	IA	hourly	405.00
43.16667/- 86.23333	MKG	MUSKEGON, COUNTY ARPT	MI	hourly	192.00
43.40000/- 94.75000	EST	ESTHERVILLE, MUNICIPAL ARPT	IA	hourly	417.00

Lat/Lon (dec. deg.)	Id	Station Name	St	Frequency	Elev (m)
43.56667/- 96.73333	FSD	SIOUX FALLS, FOSS FIELD	SD	hourly	435.00
43.65000/- 94.41667	FRM	FAIRMONT, MUNICIPAL AP	MN	hourly	353.00
43.68333/- 93.36667	AEL	ALBERT LEA, MUNICIPAL ARPT	MN	hourly	385.00
43.73333/-103.61667	0V1	CUSTER, COUNTY AP	SD	hourly	516.00
43.76667/- 99.31667	9V9	CHAMBERLAIN, MUNICIPAL AP	SD	hourly	515.00
43.86667/- 91.25000	LSE	LA CROSSE, MUNICIPAL ARPT	WI	hourly	200.00
43.91667/- 92.50000	RST	ROCHESTER, WSO AP	MN	hourly	392.00
44.05000/-103.06667	RAP	RAPID CITY, REGIONAL ARPT	SD	hourly	965.00
44.06667/-101.65000	P05	PHILIP, 2 N	SD	hourly	683.00
44.26667/- 88.51667	ATW	APPLETON, Outagamie County Arpt	WI	hourly	263.00
44.33333/- 93.31667	FBL	FARIBAULT, MUNICIPAL ARPT	MN	hourly	323.00
44.38333/-100.28333	PIR	PIERRE, FAA AIRPORT	SD	hourly	526.00
44.38333/- 98.21667	HON	HURON, REGIONAL ARPT	SD	hourly	391.00
44.45000/- 95.81667	MML	MARSHALL, RYAN FIELD	MN	hourly	360.00
44.48333/- 88.13333	GRB	GREENBAY, Austin Straubel Field	WI	hourly	211.00
44.55000/- 95.08333	RWF	REDWOOD FALLS, MUNI ARPT	MN	hourly	312.00
44.83333/- 93.45000	FCM	MINNEAPOLIS, FLYING CLOUD AP	MN	hourly	276.00
44.86667/- 91.48333	EAU	EAU CLAIRE, FAA AIRPORT	WI	hourly	271.00
44.88333/- 93.21667	MSP	MINNEAPOLIS, INT'L ARPT	MN	hourly	262.00
44.91667/- 97.15000	ATY	WATERTOWN, MUNICIPAL AP	SD	hourly	532.00
44.91667/- 89.61667	AUW	WAUSAU, FAA AIRPORT	WI	hourly	365.00
44.91667/- 87.41667	SUE	STURGEON Bay, Door Cty Cherry Land Ap	WI	hourly	220.00

Flatlands Observatory Surfobs

39.79000/- 88.29000	TUS	Tuscola	IL	1 minute	203.00
40.01000/- 88.65000	ALP	Allerpark	IL	1 minute	208.00
40.02000/- 88.07000	SID	Sidney	IL	1 minute	201.00
40.05000/- 88.38000	FAO	Bondville, Flatlands Observatory	IL	1 minute	212.00
40.17000/- 88.16000	URB	Urbana	IL	1 minute	219.00
40.19000/- 88.56000	MAN	Mansfield	IL	1 minute	221.00

Rawinsonde, Other

40.04000/- 88.27000	WIL	Bondville, Flatlands Observatory	IL	no schedule	218.00

Rawinsonde, Military

34.39000/- 98.24000	FSI	Fort Sill, OK	OK	12 hourly	360.00

USGS Distrometers

35.05000/- 97.92000	003	Chickasha, STORM-FEST distrometers	OK	15 minute	-999.90

Appendix B

Appendix B: The MAMS and Wildfire ER-2 Aircraft Data for STORM-FEST

"The MAMS and Wildfire ER-2 Aircraft Data for STORM-FEST"
Gary J. Jedlovec, NASA/Marshall

NASA's role in STORM-FEST was one of collecting aircraft remote sensing measurements during the field phase of the program and to participate in research supporting the use of these measurements to address specific STORM-FEST objectives. The ER-2 high altitude platform was used with a suite of advanced visible, infrared, and microwave instruments to measure temperature, humidity, ozone, precipitation, and atmospheric electric fields. These measurements were to demonstrate prototype observing capabilities and to study the structure and dynamics of winter storms and mesoscale events. The following information highlights data from two of the six instruments flown on the ER-2, namely, the Wildfire spectrometer and the Multispectral Atmospheric Mapping Sensor (MAMS).

DATA COLLECTION OBJECTIVES

The Wildfire and MAMS spectrometers were used during the STORM-FEST field program to support two general research topics which are funded by NASA Headquarters: 1) investigate the variability of upper tropospheric/lower stratospheric ozone and 2) study the structure and dynamics of jet streaks and associated gravity waves.

Wildfire

The newly developed Wildfire spectrometer was flown aboard the NASA ER-2 to collect a variety of unique high resolution measurements in support of STORM-FEST. This work focuses on the feasibility of using passive infrared techniques to detect small scale variations in the ozone distribution important to the study of jet streaks and mid-latitude storm systems. The specific goals are to:

1) collect high quality Wildfire data in conjunction with other *in situ* and remote measurements available during the STORM-FEST field phase (1 February-15 March 1992),

2) develop algorithms for retrieval of the ozone variability below the flight altitude, com are and integrate the results with total column ozone from TOMS and HIRS, and

3) use the ozone information, along with water vapor imagery, to better understand the 3-dimensional structure and dynamics of jet streaks and frontal systems in a case study investigation.

The first objective was successfully completed during the field phase of this study. A high quality data set now exists and will be used to address the latter two objectives.

The NASA ER-2 aircraft flew at an altitude of 20 km during STORM-FEST, slightly below the climatological ozone maximum, yet far above the tropopause. The opportunity to fly the Wildfire instrument at that altitude over active frontal disturbances to observe ozone and water vapor at high resolutions will prove to be very instructive. By comparing the Wildfire products to TOMS- and/or HIRS-derived total ozone estimates, two layers of ozone information can be defined (above and below 20 km), which will help to resolve the questions raised by previous case studies. Obtaining these measurements within the data-rich context of STORM-FEST is especially valuable in refining our understanding of frontal zone and jet streak dynamics, and how they contribute to the total ozone signatures being observed from satellite orbit. Although the usual derivation of total ozone content uses measurements in the ultraviolet portion of the spectrum, the use of infrared measurements to estimate total column ozone is not new. The Wildfire spectrometer presents an opportunity to apply several new techniques to the infrared retrieval problem.

Multispectral Atmospheric Mapping Sensor (MAMS)

The main science objective with MAMS for STORM-FEST is the detection and diagnostic analysis of water vapor and cloud signatures related to gravity waves. Gravity waves are often generated by intense convective activity or by the propagation of an unbalanced jet streak through an upper-level trough. The analysis of the observable parameters of these wave features is important to understanding their initiation and role in the dynamics of mid-latitude weather systems. To achieve this objective, the ER-2 made several flights over intense storm systems. An additional flight was made over the exit region of a rapidly propagating jet streak. Data collected from MAMS will be used to identify any discernible gravity wave features present in cloud tops or water vapor imagery ahead of significant storm features. The MAMS data will be used to characterize the structure of these features, determine propagation rates, and to derive relative and absolute moisture parameters associated with these features. These parameters will allow for a quantitative analysis of the moisture variability associated with these features.

AIRCRAFT INSTRUMENTATION

Wildfire (a.k.a., the MODIS-N Airborne Simulator, MAS)

The Wildfire spectrometer is a 50 channel airborne scanner that senses reflected and upwelling radiation from the earth and atmosphere in fairly narrow, uniformly spaced regions the near-infrared and thermal infrared spectrum (from 0.70 to 12.7 micrometers). The Wildfire was flown on a NASA ER-2 high altitude aircraft at a nominal altitude of 20 km during STORM-FEST, providing a horizontal ground resolution of each field-of-view of about 50m at nadir. From this altitude, the width of the entire cross path field-of-view scanned by the sensor is roughly 37 km, thereby providing detailed resolution of atmospheric and surface features across the swath width and along the aircraft flight track. The Wildfire design is based on that of other instruments developed by Daedalus Enterprises, Inc. for visible and infrared mapping. It shares the same scan head, digitizer, tape system and supporting electronics as other airborne scanners for the ER-2, including the MAMS. The difference in airborne scanners lies in the different spectrometers and therefore provide different spectral capabilities. The Wildfire channels used during STORM-FEST are presented below. The primary channels of interest are the thermal infrared channels (8-12). These channels have varying sensitivity to water vapor and ozone absorption and will be used to retrieve total ozone content in a column of the atmosphere below the aircraft. The horizontal distribution of this parameter will provide the basis for the case study analysis. The visible channels will serve to identify surface and cloud features of interest. The mid-infrared channels became unusable because of a leak which developed in the dewar. Channel 1 is used as a bit bucket for the least significant bits (9 and 10) of the 10 bit digitized data of channels 9-12.

Selected Wildfire Channels for STORM-FEST

Channel	Wavelength μm	Absorbing Constituents/Use
1	-	Bit bucket for ch 9-12 least significant bits
2	0.68	Broad band visible-near infrared
3	1.64	Reflective infrared
4	1.98	Reflective infrared
5	3.75	Bad dewar, no data
6	4.54	Bad dewar, no data
7	4.70	Bad dewar, no data
8	9.20	Ozone absorption (weak)
9	10.00	Ozone absorption (weak)
10	9.60	Ozone absorption (strong)
11	10.95	Clean window
12	12.45	Water vapor (weak)

Multispectral Atmospheric Mapping Sensor (MAMS)

The MAMS is a multispectral scanner which measures reflected radiation from the Earth's surface and clouds in eight visible/ near-infrared bands, and thermal emission from the earth's surface, clouds, and atmospheric constituents (primarily water vapor) in four infrared bands. The MAMS was flown on the same NASA ER-2 high altitude aircraft as the Wildfire but not at the same time. The larger aperture of MAMS produced a single field of view resolution of 100m at nadir. The width of the entire cross path field-of-view scanned by the sensor is still 37 km, thereby providing detailed resolution of atmospheric and surface features across the swath width and along the aircraft flight track.

The infrared channels from MAMS are similar to those from the AVHRR and VAS sensors on existing weather satellites. The 11 micrometer channel of MAMS and VAS are very similar while that of the AVHRR is narrower and shifted towards shorter wavelengths. The 12 micrometer channel of AVHRR is positioned near 11.8 micrometers with a band width about twice that of MAMS and VAS (which are centered at longer wavelengths). The 12 micrometer channels measure upwelling radiation where water vapor and other constituent absorption (particularly, by the Q-branch of CO_2 at 792 cm^{-1}) is more significant. The spectral differences of the 12 micrometer channels produce small differences in brightness temperatures for VAS and MAMS, but a somewhat larger differences between AVHRR and MAMS (or VAS).

For STORM-FEST, the 6.5 micrometer channel was used in place of the 3.7 micrometer channel to support the water vapor mapping and gravity wave activity. The MAMS re-router card was used to provide channels 9-12 at 10 bit resolution, with the least significant bits going in place of channel 1. When the 10 bit data is reconstructed, the two last significant bits will provide additional sensitivity to small amplitude variations in the scene data.

MAMS Channels for STORM-FEST

Visible

Channel	Wavelength µm
1	0.42 - 0.45
2	0.45 - 0.52[1]
3	0.52 - 0.60[1]
4	0.60 - 0.67
5	0.63 - 0.73[1]
6	0.69 - 0.83
7	0.76 - 0.99[1]
8	0.83 - 1.05

Infrared

Channel	Central Wavelength µm	Bandwidth @50% response µm
9	6.54	6.28 - 6.98[2]
10	6.54	6.28 - 6.98[2]
11	11.12	10.55 - 12.24
12	12.56	12.32 - 12.71

[1]Similar to Landsat TM channel.
[2]Different channel gain and offsets.

DATA FOR STORM-FEST

ER-2 Flights

The NASA ER-2 aircraft flew in support of the STORM-FEST field program from 13 February through 15 March 1992. The plane was deployed out of Ellington Field, just south of Houston, Texas. A total of 11 flights were made during the deployment, 8 of which directly supported the STORM-FEST objectives. The table below lists all the ER-2 STORM-FEST flights, including the Wildfire/MAMS flights. The attached figures show the precise location of the aircraft flight tracks during the specific missions. The flight numbers and times are included in t@e legend of each map. Two of the flights with the Wildfire spectrometer (14/17 February) were in direct support of the ozone variability objectives. The Wildfire spectrometer was also flown on three other supporting missions. Six missions were flown with the MAMS, one (11 March) was in direct support of the gravity wave objectives.

Data Quality

The utility of a data set to meet a specific science objective is heavily dependent on data quality and whether the data set captured the phenomenon of interest. Instrument data quality is a function of a number of factors including instrument noise (both random and systematic), quality of the calibration data (directly affects relative and absolute calibration accuracy), appropriateness of channel gain/offset settings (affects channel sensitivity dynamic range), the amount of missing data, and other data peculiarities. In general, data is of good quality and the MAMS data is very good.

Wildfire and MAMS Flights for STORM-FEST

Flight Date	Number	Region	Instrument	Objective
1. 14 Feb	92045 92061	OK, KS, M0, AR, TX	Wildfire	Ozone variability tropopause fold
2. 17 Feb	92048 92062	OK, M0, AR, TX, TN	Wildfire	Ozone variability tropopause fold
3. 21 Feb	92052 92063	Gulf coast, FL	Wildfire	Support thunderstorm flight
4. 23 Feb	92054 92064	CO, KS, TX	Wildfire	Support precipitation study
5. 25 Feb	92056 92065	NE, KS, OK, TX	Wildfire	Support HIS moisture mission
6. 1 Mar	92061 92066	NE, KS, OK, TX	MAMS	Support HIS boundary layer study
7. 7 Mar	92067 92067	TX, Gulf coast	MAMS	ER-2 test flight
8. 8 Mar	92068 92068	TX,	MAMS	Flight abort, AC problems
9. 11 Mar	92071 92069	TX, AR, M0, NE, KS	MAMS	Gravity waves, with MTS
10. 13 Mar	92073 92070	TX,LA Gulf coast	MAMS	MTS system test
11. 14 Mar	92074 92071	TX, OK, NE, KS	MAMS	HIS 4-D assimilation study

Analysis Plans

Current analysis plans consist of three days when the Wildfire was flown on the ER-2 aircraft. No analysis plans exist for the M"S data flights. The case study days are listed below.

14 February 1992: Wildfire case study
17 February 1992: Wildfire case study
25 February 1992: HIS/Wildfire data comparisons

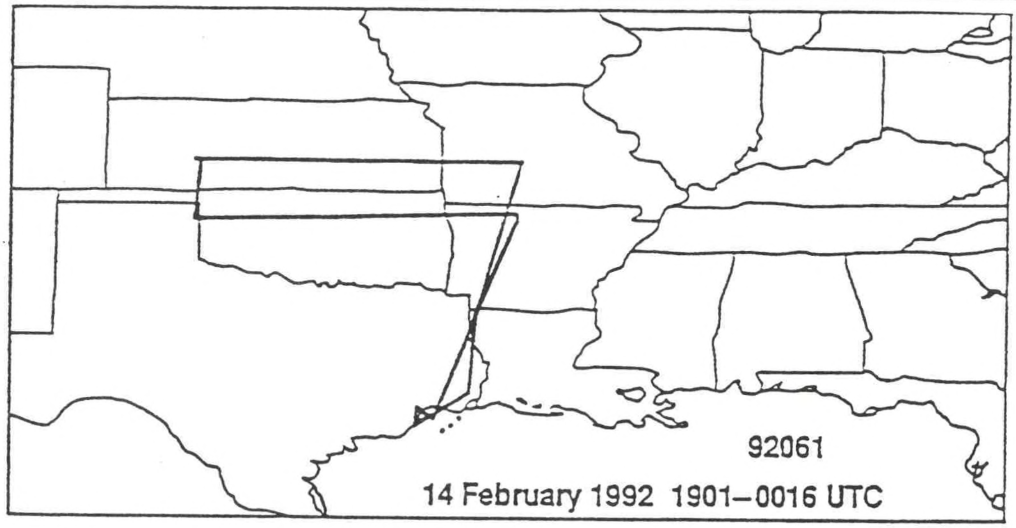
Data Availability

Both the MAMS and Wildfire (MAS) instruments have very high data rates which exceed 200 megabytes of data per hour. This data is currently recorded on high density 14 track magnetic tapes during the flight. These 14 track tapes are permanently archived at NASA's Ames Research Center at Moffett Field, California. Limited amounts of MAMS and Wildfire data were processed in the field after each flight using the MSFC Quick View System. The QVS allowed for the rapid display and evaluation of Daedalus scanner data immediately after a flight. This evaluation served as the basis for gain changes from one flight to the next. All MAMS and Wildfire data collected during STORM-FEST can be obtained from Ames in raw form (uncalibrated - level 0 data) on 9 track tape. The focal point for requesting this data is:

Mr. Jeff Myers (415-694-6252)
High Altitude Missions Branch
NASA Ames Research Center
Mail Stop 240-6
Moffett Field, CA 94035

MSFC has obtained all of the MAMS and Wildfire data for STORM-FEST from Ames. Because of the volume of data and the number of data flights, this data will not be mass distributed or put in an active archive. Data for specific flights will be processed and made available on an individual request basis. Data can be requested in either raw or calibrated form on magnetic tape in either a McIDAS area data format or in a generic flat file format. Complete documentation of these formats will be provided upon request. For special case studies, higher level data may be available, including navigated and earth located scenes and flight tracks. This scene data may be composed of either radiances or temperature data, and may include derived products such as integrated water and ozone content, upper level humidity, and cloud top temperatures. Scanner data and products produced at MSFC can be requested through:

Dr. Gary J. Jedlovec (205-544-5695)
Remote Sensing Branch
NASA Marshall Space Flight Center
Mail Code ES 43
Huntsville, AL 35812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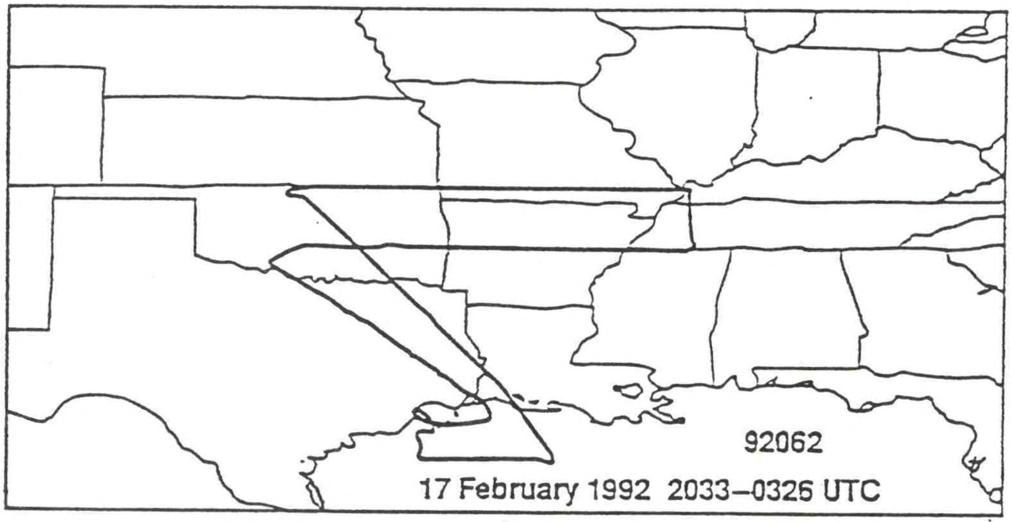
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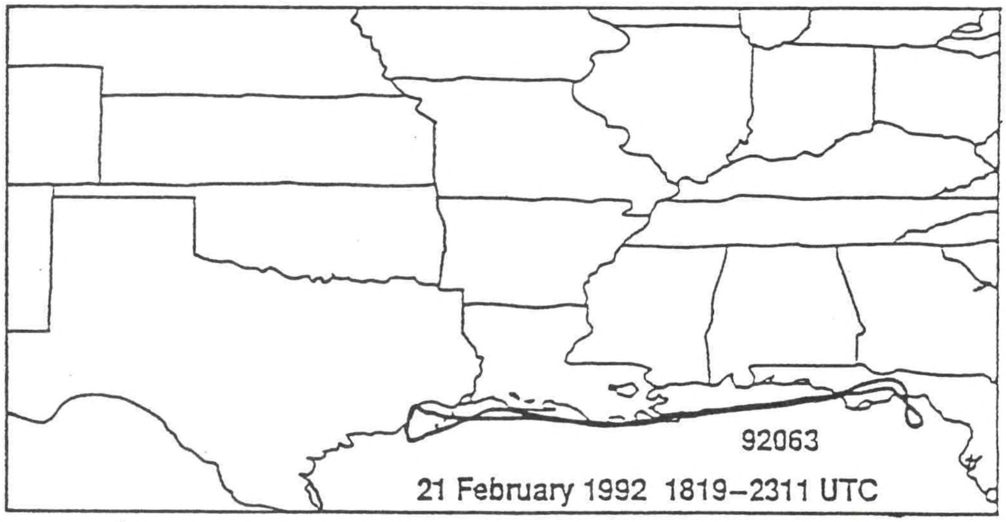
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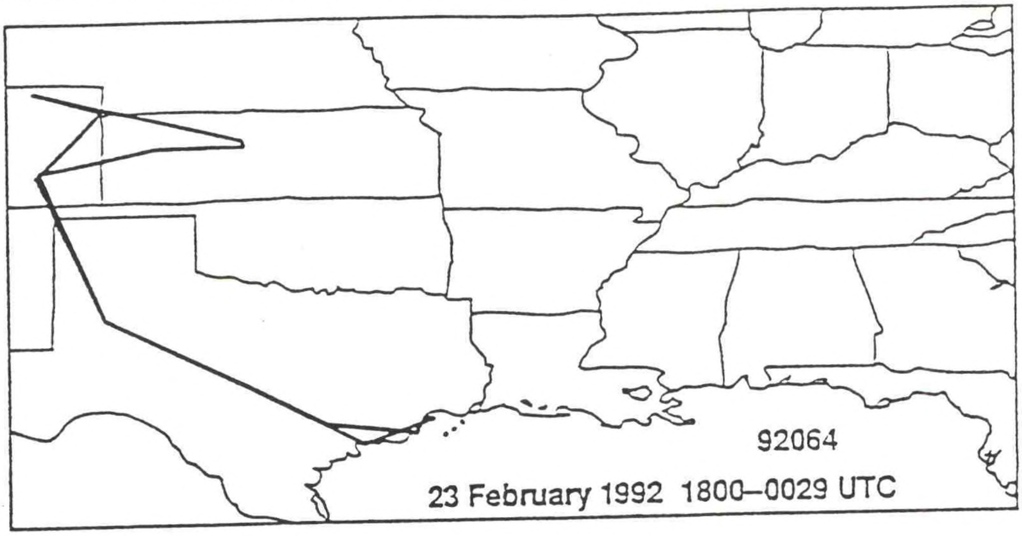
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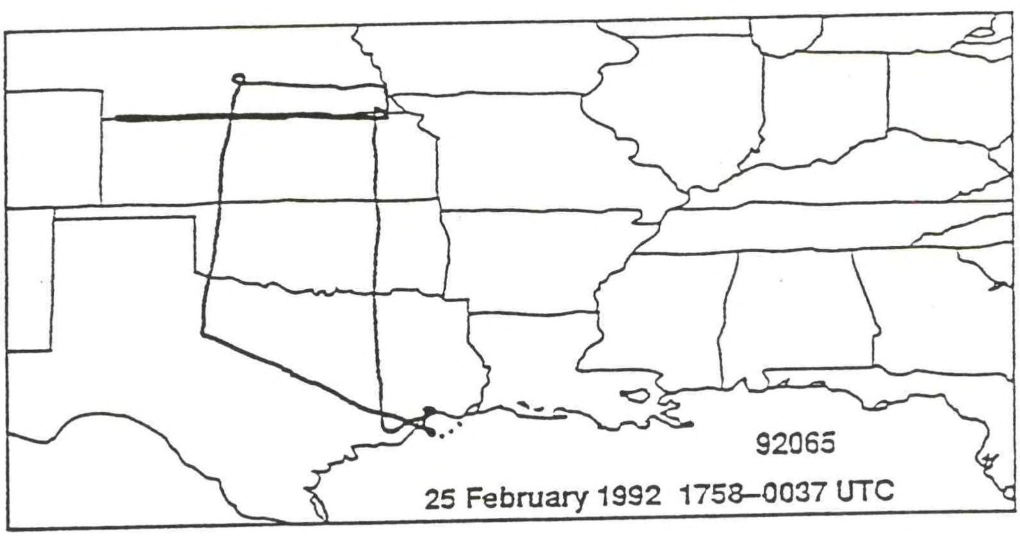
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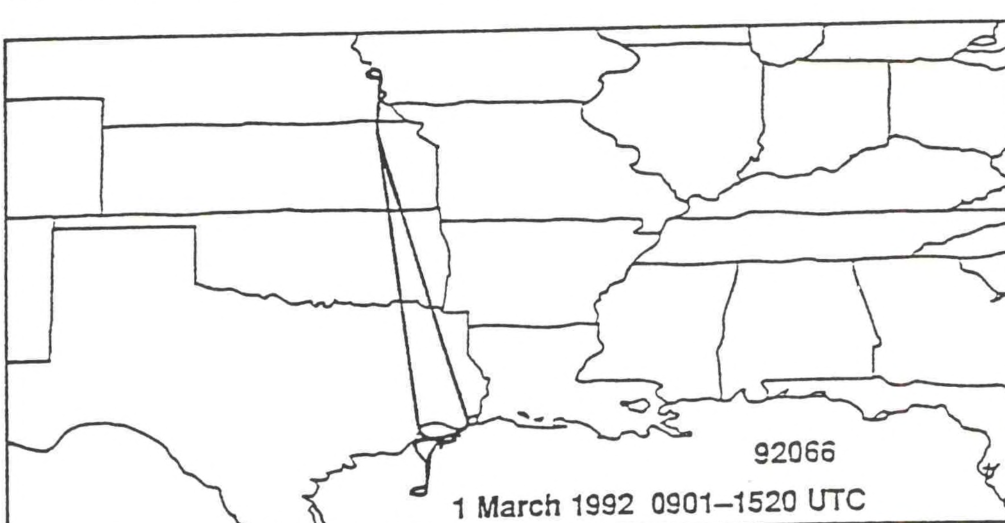
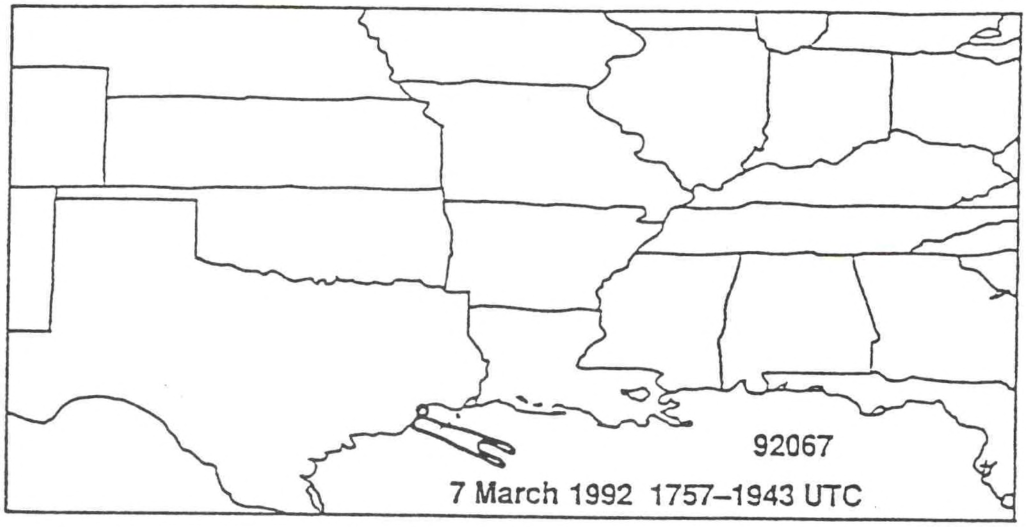
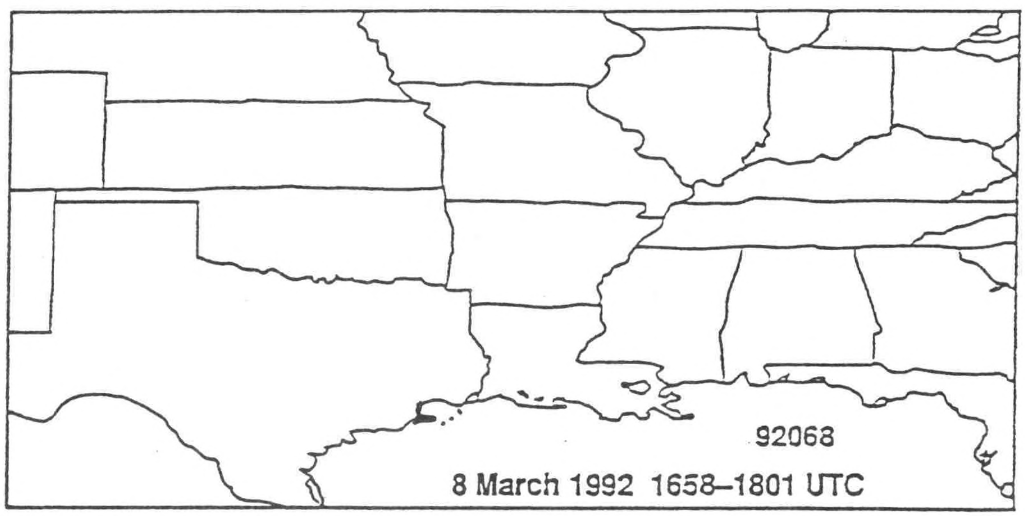
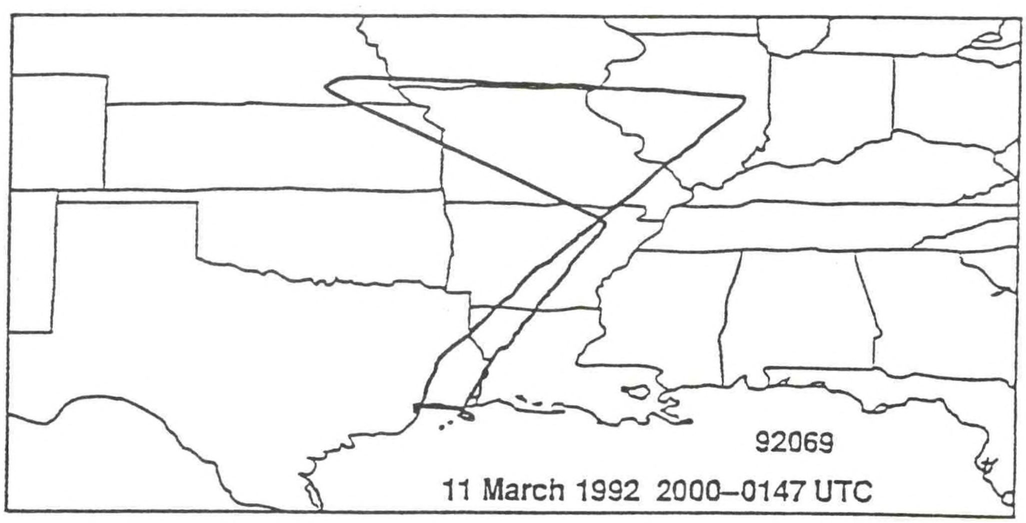
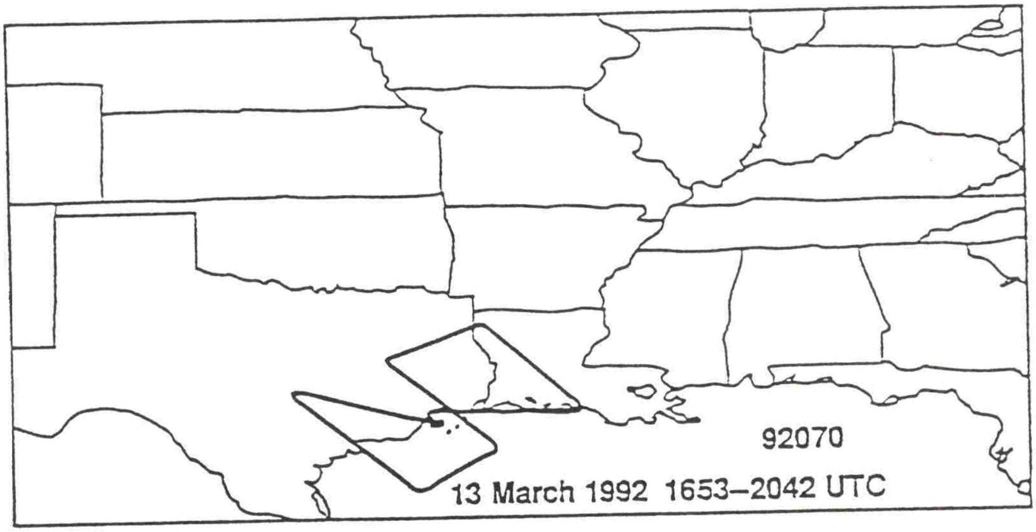
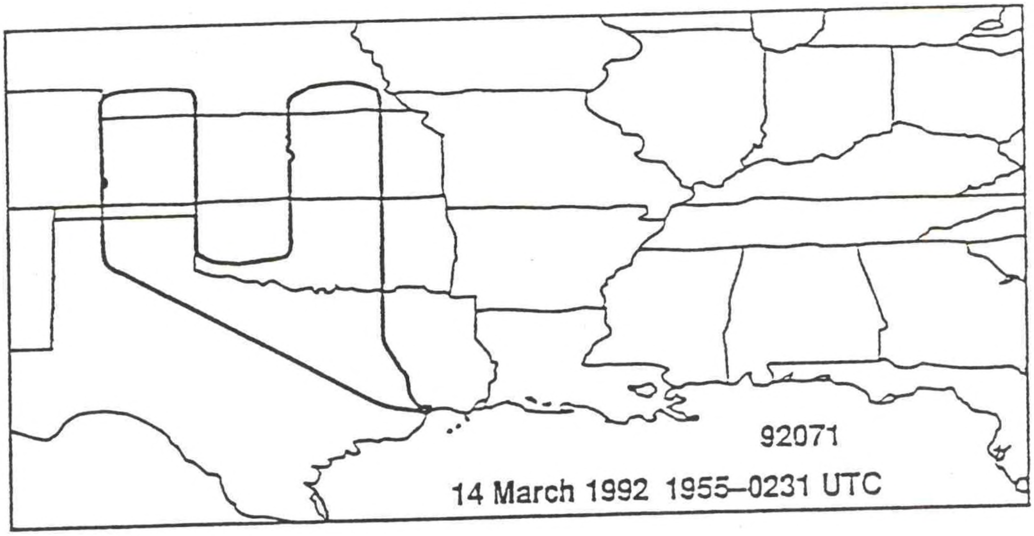

92066
1 March 1992 0901–1520 UTC


92067
7 March 1992 1757–1943 UTC


92068
8 March 1992 1658–1801 UTC


92069
11 March 1992 2000–0147 UTC


92070
13 March 1992 1653–2042 UTC


92071
14 March 1992 1955–0231 UTC

Appendix C

Appendix C: STORM-FEST VAS Schedule

Although the VAS instrument has been active for 10 years, very little has been done since the initial VAS demonstration to in vestigate the potential of the instrument for high-resolution soundings, given good signal-to-noise from adequate sampling in the dwell sounding mode of operations. Under normal satellite operations, soundings are routinely taken quasi-operationally with geographic coverage over much of the United States. This is accomplished by compromising the sounding spin budget (hence signal-to-noise) in order to achieve the latitudinal coverage in the time available (10 minutes each half-hour). During STORM-FEST, there were two special types of coverage obtained. The first, MESOB, covered the STORM-FEST Boundary layer network (39.75-41.0 deg latitude), and second, MESOA, covered the STORM-FEST mesoscale Inner Domain. Because of operational constraints, the MESOA coverage was divided into two sections: (1) MESOAN (north) from 44 to 37 deg latitude; and (2) MESOAS (south) from 37 to 31 deg latitude.

The following table represents the GOES-7 VAS and RISOP Schedules for STORM-FEST where, each line represents both nominal and RISOP Activities for each daily half hour. The activity is sequential with the processor data load (minutes) in parentheses. The following is a brief description of each activity:

XX-XX: Imagery band range [e.g., 7-12(16) represents bands 7-12 imagery for 16 minutes].

DI: Dwell Image [e.g., DI(8) represents Dwell image for 8 minutes].

DS: Dwell Soundings in two sections: North and South [e.g., DSN(8) represents Dwell Soundings (north) for 8 minutes).

MESOA: Dwell Sounding MESOA coverage was divided into two sections: (1) MESOAN (north) from 44 to 37 deg latitude; and (2) MESOAS (south) from 37 to 31 deg latitude.

MESOB: Dwell Sounding MESOB coverage was approximately 39.75-41.0 deg latitude.

Secondary information on the spin budgets and PDLs used in the VAS and RISOP schedule are provided on the following pages. This information includes specific coverage and location, sensor spins, and any pertinent comments.

Goes-7 and RISOP Schedules for STORM-FEST

TIME UTC	ACTIVITY NOMINAL		RISOP
0000	7-12(16),	5-12(4)17-12(4)	7-10(16), DI(8)
0030	10-12(14),	MESOB(10)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
0100	7-10(6),	MESOAN(19)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
0130	10-12(14),	MESOB(10)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
0200	7-10(6),	MESOAS(19)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
0230	10-12(14),	MESOB(10)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
0300	7-10(16),	5-12(4),7-12(4)	7-10(16), DI(8)
0330	5-12(16),	MESOB(8)	5-10(8), 9-12(4),9-10(4),1-2(4),6-11(4)
0400	7-10(16),	DSN(8)	7-10(8), 6-11(4),9-10(4),3-4(4),7-12(4)
0430	5-12(16),	MESOB(8)	5-10(8), 6-9(4),9-10,(4),3-4(4),7-2(4)
0500	7-10(16),	DSS(8)	7-10(8), 6-11(4),9-10(4),3-4(4),7-12(4)
0530	5-12(16),	MESOB(8)	5-10(8), 9-12(4),9-10(4),1-2(4),6-11(4)
0600	7-10(16),	5-12(4),7-12(4)	7-10(16), DI(8)
0630	7-12(14),	MESOB(10)	7-10(8), 7(4)15-10(4)117-12(4),7(4)
0700	7-10(6),	MESOAN(19)	1-10(8), 7(4)15-10(4),7-12(4),7(4)
0730	7-12(14),	MESOB(10)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
0800	7-10(6),	MESOAS(19)	7-10(8), 7(4),3-10(4),7-12(4),7(4)
0830	9-12(14),	MESOB(10)	9-10(8), 7(4),5-10(4),7-12(4),7(4)
0900	7-10(16),	5-12(4),7-12(4)	7-10(16), DI(8)
0930	9-12(16),	MESOB(8)	5-9(8), 9-12(4),9-10(4),1-2(4),6-11(4)
1000	7-10(16),	DSN(8)	7-10(8), 6-11(4),9-10(4),3-4(4),7-12(4)
1030	5-9(16),	MESOB(8)	5-9(8), 6-9(4),9-10(4),3-4(4),1-2(4)
1100	7-10(16),	DSS(8)	7-10(8), 6-11(4),9-10(4),3-4(4),7-12(4)
1130	5-12(16),	MESOB(8)	5-10(8), 9-12(4),9-10(4),1-2(4),6-11(4)
1200	7-10(19),	7-12(4)	7-10(19)
1230	10-12(14),	MESOB(10)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
1300	7-10(6),	MESAN(19)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
1330	10-12(14),	MESOB(10)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
1400	7-10(6),	MESOAS(19)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
1430	10-12(14),	MESOB(10)	7-10(8), 7(4),5-10(4),7-12(4),7(4)
1500	7-10(16),	5-12(4), 7-12(4)	7-10(16), DI(8)
1530	5-12(16),	MESOB(8)	5-10(8), 9-12(4),9-10(4),1-2(4),6-11(4)
1600	7-10(16),	DSN(8)	7-10(8), 6-11(4),9-10(4),3-4(4),7-12(4)
1630	5-12(16),	MESOB(8)	5-10(8), 6-9(4),9-10,(4),3-4(4),1-2(4)
1700	7-10(16),	DSS(8)	7-10(8), 6-11(4),9-10(4),3-4(4),7-12(4)
1730	5-12(16),	MESOB(8)	5-10(8), 9-12(4)19-10(4),1-2(4),6-11(4)
1800	7-10(16),	5-12(4), 7-12(4)	7-10(16), DI(8)
1830	7-12(14),	MESOB(10)	7-10(8), 7(4),5-10(4),7-12(4),7(4)

TIME UTC	ACTIVITY NOMINAL		RISOP	
1900	7-10(6),	MESOAN(19)	7-10(8),	7(4),5-10(4),7-12(4),7(4)
1930	7-12(14),	MESOB(10)	7-10(8),	7(4),5-10(4),7-12(4),7(4)
2000	7-10(6),	MESOAS(19)	7-10(8),	7(4),5-10(4),7-12(4),7(4)
2030	9-12(14),	MESOB(10)	9-10(8),	7(4),5-10(4),7-12(4),7(4)
2100	7-10(16),	5-12(4),7-12(4)	7-10(16), DI(8)	
2130	9-12(16),	MESOB(8)	5-9(8),	9-12(4),9-10(4),1-2(4),6-11(4)
2200	7-10(16),	DSN(8)	7-10(8),	6-11(4),9-10(4),3-4(4),7-12(4)
2230	5-9(16),	MESOB(8)	5-9(8),	6-9(4),9-10,(4),3-4(4),1-2(4)
2300	7-10(16),	DSS(8)	7-10(8),	6-11(4),9-10(4),3-4(4),7-12(4)
2330	5-12(16,	MESOB (8)	5-10(8),	9-12(4),9-10(4),1-2(4),6-11(4)

MSI	A B C D E F G H	
7	08-13-07-13-08-13-07-13	S
5-2	08-01-08-01-08-02-08-02	S
5-4	08-03-08-03-08-04-08-04	S
5-9	08-05-08-05-08-09-08-09	S
5-10	08-05-08-05-09-10-08-10	S
5-12	08-05-08-05-06-12-08-12	S
6-9	08-06-08-06-08-09-08-09	S
6-11	08-06-08-06-08-11-08-11	S
7-10	08-07-08-07-08-10-08-10	S
7-12	08-07-08-07-08-12-08-12	S
9-10	06-09-08-09-08-10-08-10	S
9-12	08-09-08-09-08-12-08-12	S
10-12	08-10-08-10-08-12-08-12	S

PDL	HSZ	CEN	TIM	COV	COMMENT
7(4)	170	411	3.4	5IN-22N	RISOP 5 min loop
1-2(4)	170	411	3.4	5IN-22N	RISOP MSI sounding
3-4(4)	170	411	3.4	5IN-22N	RISOP MSI sounding
5-9(8)	400	501	8.0	90N-EQ	RISOP H20 winds
5-9(16)	800	901	16.0	full	water vapor winds loop
5-10(4)	170	411	3.4	51N-22N	RISOP 5 min loop
5-10(8)	400	501	8.0	9ON-EQ	RISOP H20 winds
5-12(16)	800	901	16.0	full	
5-12(4)	170	411	3.4	5ON-23N	Nominal schedule rapid imaging
6-9(4)	170	411	3.4	9ON-15N	RISOP MSI sounding
6-11(4)	170	411	3.4	5IN-22N	RISOP MSI sounding
7(4)	170	411	3.5	5IN-22N	RISOP 5 min loop
8(4)	170	411	3.5	5IN-22N	RISOP 5 min loop
10(6)	300	401	6.0	9ON-13N	short MSI to allow MESOA DS
7-10(8)	400	501	8.0	9ON-EQ	
7-10(14)	700	801	14.0	9ON-42S	
7-10(16)	800	901	16.0	full	
7-10(19)	910	911	18.2	full	
7-12(4)	170	411	3.5	5IN-22H	RISOP 5 min loop and Non Sch rapid imaging
7-12(14)	700	801	14.0	9ON-42S	
7-12(16)	800	901	16.0	full	
9-10(4)	170	411	3.4	5IN-22N	RISOP MSI sounding
9-10(8)	400	501	8.0	9ON-27S	RISOP only
9-12(4)	170	411	3.4	51N-22N	RISOP MSI sounding
9-12(14)	700	801	14.0	9ON-42S	
9-12(16)	800	901	16.0	full	
10-12(14)	700	801	14.0	9ON-42S	

DS	SPINS	IGFOV	S1,S3	HSZ	CEN	COV
	1- 2- 3- 4- 5- 6- 7- 8- 9- A- B- C	3456789A				
N(8)	0- 1- 2- 2- 2- 2- 2- 1- 2- 1- 1- 1	SSSLSLLL	4,4	77	291	50N-35N
S(8)	0- 1- 2- 2- 2- 2- 2- 1- 2- 1- 1- 1	SSSLSLLL	4,4	77	441	36N-23N
MESOB1(8)	15-8- 15-8- 13-8- 15-1- 25-11-11-1	SSSLSLSS	2,2	6	*297	41N-39N
MESOB2(8)	15-8- 15-8- 13-8- 15-1- 25-11-11-1	SSSLSLSS	2,2	6	*300	41N-39N
MESOB3(8)	15-6- 15-8- 13-8- 15-1- 25-11-11-1	SSSLSLSS	2,2	6	*303	41N-39N
MESOB4(8)	15-8- 15-8- 13-8- 15-1- 25-11-11-1	SSSLSLSS	2,2	6	*306	41N-39N
MES0B5(8)	15-8- 15-8- 13-8- 15-1- 25-11-11-1	SSSLSLSS	2,2	6	*309	41N-39N
MESOB6(8)	15-8- 15-9- 13-8- 15-1- 25-11-11-1	SSSLSLSS	2,2	6	*312	41N-39N
MESOB1(10)	20-9- 21-10-16-9- 20-1- 31-14-13-1	SSSLSLSS	2,2	6	*297	41N-39N
MESOB2(10)	20-9- 21-10-16-9- 20-1- 31-14-13-1	SSSLSLSS	2,2	6	*300	41N-39N
MESOB3(10)	20-9- 21-10-16-9- 20-1- 31-14-13-1	SSSLSLSS	2,2	6	*303	41N-39N
MESOB4(10)	20-9- 21-10-16-9- 20-1- 31-14-13-1	SSSLSLSS	2,2	6	*306	41N-39N
MESOB5(10)	20-9- 21-10-16-9- 20-1- 31-14-13-1	SSSLSLSS	2,2	6	*309	41N-39N
MESOB6(10)	20-9- 21-10-16-9- 20-1- 31-14-13-1	SSSLSLSS	2,2	6	*312	41N-39N
MESOAN(10)	5- 3- 5- 4- 5- 4- 5- 1- 8- 4- 4- 1	SSSLSLSS	2,2	39	329	45N-38N
MESOAS(19)	5- 3- 5- 4- 6- 4- 5- 1- 4- 4- 4- 1	SSSLSLSS	2,2	39	405	38N-31N
DI(8)	0- 1- 2- 2- 1- 2- 1- 1- 2- 1- 1- 1	SSSLSLLL	4,4	85	319	46N-31N

*Center of meso-ß coverage must shift as a function of time of day to accommodate apparent earth notion. Motion will specified in late January 1992.

Appendix D

Appendix D: Acronym List

4DDA	Four Dimensional Data Assimilation
ACARS	Aircraft Communication and Reporting System
AES	Atmospheric Environment Service (Canada)
AFB	Air Force Base (U.S.)
AGL	Above Ground Level
AL	Aeronomy Laboratory (NOAA)
AMPR	Advanced Microwave Precipitation Radiometer
AOC	Aircraft Operations Center (NOAA)
ARS	Agricultural Research Station (USDA)
ASCII	American National Standard Code for Information Interchange
ASOS	Automated Surface Observation System
ASTER	Atmosphere-Surface Turbulent Exchange Research (NCAR)
AVHRR	Advanced Very High Resolution Radiometer
AWOS	Aviation Weather Observation System
CD-ROM	Compact Disk - Read Only Memory
CLASS	Cross Chain LORAN Atmospheric Sounding System
COD	Consultant on Duty
CODIAC	Cooperative Distributed Interactive Atmospheric Catalog System
DMSP	Defense Meteorological Satellite Program
DoD	Department of Defense (U.S.)
DS	Dwell Soundings

EFF	Experimental Forecasting Facilities (NWS)
ERL	Environmental Research Laboratory (NOAA)
FAA	Federal Aviation Administration (U.S.)
FAO	Flatlands Atmospheric Observatory
FGGE	First GARP Global Experiment
FNOC	Fleet Numerical Oceanographic Center (U.S. Navy)
FSL	Forecast Systems Laboratory (NOAA)
FSU	Florida State University
FTP	File Transfer Protocol
GAC	Global Area Coverage
GARP	Global Atmospheric Research Program
GOES	Geostationary Operational Environmental Satellite
HIRS/2	High Resolution Infrared Radiation Sounder
HIS	High-resolution Interferometer Sounder (U of Wisconsin)
HPCN	High Plains Climate Network
HRPT	High Resolution Picture Transmission
ICN	Illinois Climate Network
ICRAD	Interactive Color Radar Display
IFR	Instrument Flight Range
IOP	Intensive Operation Period
L2D2	Lightweight LORAN Digital Dropsonde
LAC	Local Area Coverage
LAPS	Local Analysis and Prediction System
LFM	Limited Fine Mesh Model
LIP	Lightning Instrument Package
LWC	Liquid Water Content

MAMS	Multispectral Atmospheric Mapping Sensor
MAPS	Mesoscale Analysis and Prediction System Model
McIDAS	Man-computer Interactive Data Access System
MIR	Millimeter Imaging Radiometer
MM4	NCAR Mesoscale Model (Version 4)
MMM	Mesoscale Microscale Meteorology Division (NCAR)
MRF	Medium Range Forecast Model
MSFC	Marshall Space Flight Center (NASA)
MSI	Multi-Spectral Imagery
MSL	Mean Sea Level
MSU	Microwave Sounding Unit
MTS	Microwave Temperature Sounder
NASA	National Aeronautics and Space Administration (U.S.)
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NESDIS	National Environmental Satellite Data Information Service
NGM	Nested Grid Model
NMC	National Meteorological Center (NWS)
NOAA	National Oceanic and Atmospheric Administration
NPGS	Naval Post Graduate School
NSSFC	National Severe Storms Forecast Center (NOAA)
NSSL	National Severe Storms Laboratory (NOAA)
NWIS	National Water Information System (USGS)
NWS	National Weather Service
OFPS	Office of Field Project Support (UCAR)
OSF	Operational Support Facility (NOAA)

PAM II	Portable Automated Mesonet (second generation)
PBL	Planetary Boundary Layer
PDL	Processor Data Load
PMS	Particle Measurement System
PPI	Plan Position Indicator
PVA	Positive Vorticity Advection
RADAP II	RAdar DAta Processor (second generation)
RAF	Research Aviation Facility (NCAR)
RAFS	Regional Analysis and Forecast System
RAM	Random Access Memory
RASS	Radio Acoustic Sounding System
RDP	Research Data Program (NCAR)
RHI	Range Height Indicator
RISOP	Rapid Interval Scan Operations Plan
SAO	Surface Aviation Observation
SBUV/2	Solar Backscattered Ultraviolet System
SCD	Scientific Computing Division (NCAR)
SFDMC	STORM-FEST Data Management Center
SSEC	Space Science Engineering Center (U of Wisconsin)
SSM/I	Special Sensor Microwave Imager
SSU	Stratospheric Sounding Unit
STORM	STormscale Operational and Research Meteorology
STORM-FEST	STORM Fronts Experiment Systems Test
TDL	Techniques Development Laboratory (NWS)
TDWR	Terminal Doppler Weather Radar
TIROS	Television and InfraRed Operational Satellite
TOVS	TIROS Operational Vertical Sounder

UCAR	University Corporation for Atmospheric Research
USAF	United States Air Force
USDA	United States Department of Agriculture
USGS	United States Geological Survey (U.S.)
USWRP	United States Weather Research Program
UTC	Universal Time Coordinated
VAS	VISSR Atmospheric Sounder
VCR	Video Cassette Recorder
VFR	Visual Flight Range
VISSR	Visible and Infrared Spin-Scan Radiometer
WPL	Wave Propagation Laboratory (NOAA)
WSFO	Weather Service Forecast Office (NWS)
WSR	Weather Service Radar

Appendix E

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