FIRE II Cirrus
Mission Summary

Date: November 25, 1991
Julian Day: 329
Experiment Day: 13

Summary | Active Sensors | Passive Sensors | Sonde and Sfcmet

Mission Scientist: David Starr
Deputy Mission Scientist: None

Mission Objective:

Development and dissipation of cirrus cloud systems with observation of cloud microphysical, radiative and dynamical properties and structure.

Mission Description:

Day #1 of Second Intensive Observing Period.

- **Large-scale**: Activation of the large scale rawinsonde network (6-hourly observations) will provide a very good test data base for regional models as a number of distinct cirrus systems were observed over the western United States with some notable dissipation regions.
- **Cirrus Missions**: Early morning flights worked over the Hub in coordination with ground-based remote sensing systems. Altocumulus clouds made surface-based observations difficult as a few very large dendritic crystals in the layer were apparently responsible for strong attenuation. Later, the middle level cloud moved off but so did the cirrus. Declining cirrus forced relocation of aircraft operations to Tulsa area where ER-2 and Citation and then ER-2 and Sabreliner worked extensively with the King Air profiling about 50 miles upwind. Overall, a very successful remote sensing (ER-2) and in situ mission. King Air also obtained good data in the altocumulus layer for calibration of the radars.
- **Water Vapor Mission:** A pre-dawn (on the 26th) sounding mission was conducted under clear skies by the NCAR King Air to provide a comparison of the in situ sensors, including the new cryogenic frost point hygrometer, with ground-based Raman lidar observations. The observations were closely coordinated and the mission was very successful.

Weather Synopsis:

Following the clear sky pre-dawn conditions, an thin altocumulus cloud developed between 2.8 and 3.2 km with cirrus between 10 and 11 km. Air temperatures during the morning were in the low 30's with little or no winds. The mid-level clouds moved eastward into Missouri by mid-morning. Bands of cirrus came over the Hub during the day. Denser cirrus were visible to the south and southwest during most of the day. Clouds cleared out during the evening.

Synoptic Situation:

The long wave trough was still to our east over the Tennessee and Ohio Valleys. The long wave ridge to our west had now moved eastward into Montana. The flow was northwesterly over the Great Plains States but the over-all pattern was deamplifying into a more zonal flow. Mountain wave cloud development marked the passage of a low amplitude short wave through the Rockies during the early morning. As the short wave moved southeastward, a well-defined cirrus cloud shield developed over the the state of Oklahoma by noon and persisted through the rest of the day. Wind profiles were able to define the areas of positive vertical motion over Oklahoma with the edge of the dynamic feature in southern Kansas. The cirrus cover over the Hub varied over the course of the day as the northern edge of this system vacillated north and south. The cirrus system was associated with a local turn to more westerly flow and ridging aloft. The cloud feature moved rapidly to the east after sunset.

Aircraft	Depart	Land	Notes
NASA ER-2	9:30 CST	13:35 CST	Flew N/S racetracks from the Hub to Tulsa. Coordinated with Sabreliner for 2 tracks
UND Citation	7:50 CST	12:25 CST	Flew profile legs over Hub, then moved to Tulsa for profiling in denser cirrus
NCAR King Air	9:56 CST	13:25 CST	Flew mid-level stratus legs over Hub, then moved to Ponca City for legs at 25 to 30K'
NCAR Sabreliner	10:36 CST	13:10 CST	Flew legs over the Tulsa area - 29 to 30 K'
NCAR King Air	4:53 CST	6:37 CST	Early a.m. on 26th. Clear sky sounding - spiraled up and down over Hub (28K')

Satellite	Hub Overpass Time	Zenith Angle	Azimuth Angle	RAOB
NOAA-11	21:23:06	42.59	260.33	yes
	09:47:36	1.70	111.62	no
NOAA-12	13:43:00	51.92	98.74	yes
	01:02:53	38.38	71.70	yes

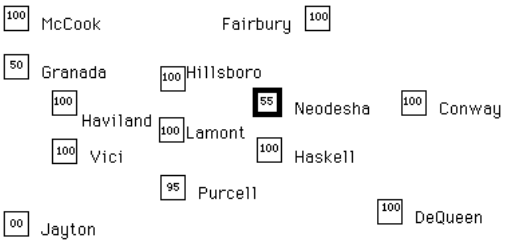
Rawinsonde Operations:

- Inner NWS stations (Type A): Intensive mode @ 12, 18, 00, 06 and 09 UTC
- Outer NWS stations (Type B): Intensive mode @ 12, 18, 00 and 09 UTC
- Hub CLASS station: Intensive mode @ 12, 18, 00 and 06 UTC,
  - plus satellite overpasses @ 14, 21 and 01 UTC
  - missed soundings at 09 and 10 UTC.
  - Ice replicator sonde attached to 12 UTC - good!!
- Remote CLASS stations: Intensive mode @ 12, 18, 00 and 06 UTC
- Hub GSFC/WFF station: Launches @ 19, 22, and 00 UTC
- CSU Parsons station: Launches @ 16 and 20 UTC

FIRE Profiler Status:

- CSU 405 MHz @ Parsons: Continuous operation
- PSU 50 MHz @ Coffeyville: Continuous operation, noisy
- NOAA 405 MHz @ Coffeyville: Not operational

NWS Wind Profiler Status:



SPECTRE Operations:

> Good afternoon of clear sky and thin cirrus observations. SPECTRE went down in the evening in order to get up for the FIRE IOP next day. SPECTRE is now looking to run in a more selective mode since most of its clear sky initiative goals have been met.

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Significant Hardware Problems:

- Sabreliner NCAR data system problems but fixed in flight - best data is fine, i.e., Tulsa area.
- ER-2 HIS data system failure toward end of flight - the Tulsa area data may have been lost.
- Hub CLASS failure - sondes not launched for water vapor comparison (operator fired!!)
- NOAA 405 MHz profiler not operational.
- U.Wisc HSR lidar operating as dual-polarization lidar.
- U. Utah lidar having background and other problems, only one channel is working for limited observations.

Aircrew/Mission Scientist Debrief Notes:

> Aircraft/ATC coordination was great - five flights!

- UND CITATION: Flew along the wind (280deg. at 90 knots) step up/down patterns first over the Hub (32, 31, 30, 29, 28, 27, 26, 25, 25, 27, 28 and 29K') then moved to Tulsa area as cirrus thinned and then disappeared over the Hub. Cloud was described as not dense and very diffuse with only small ice crystals. Cloud base was initially at about 26K' and cloud top at about 32K'. Legs over Tulsa were flown at 33, 31, 29, 27, 25, 23 and 19K' (cloud base at 21.5K'). Crystals at cloud top were still small but particles up to 200-400 um were found at lower levels. Maximum concentrations were 20-30 per liter. There were scattered to broken clouds at lower levels like at the Hub. A halo was observed. Some problems with CN counter above 25K'. A very good microphysical mission.

- NCAR SABRELINER: Flew four racetrack patterns at cloud top (31K') and at 29, 28 and again at 31K' in the Tulsa area. Legs were oriented along a heading of about 300deg. which was roughly perpendicular to the ER-2 track and at an angle to the ambient wind (~260deg.). Excellent microphysical and radiometric data. The pattern was flown in almost the same location as the Citation pattern - they were just finishing as the Sabreliner began and were visually sited.

- ER-2: Flew coordinated flight with NCAR Sabreliner (and UND Citation). Eleven data legs were flown extending to the SSW from the Hub at one terminus to Tulsa at the other. Legs extended from over the thin edge (or clear) to over the dense portion of the cirrus cloud system. This was a very good mission. The HIS data system did fail toward the end of the flight. It is not known if any of the Tulsa area data were lost.

- NCAR KING AIR #1: Sampled altostratus over the Hub at 12.4K' for radar calibration. A few large dendritic crystal were observed which invalidates the calibration - an interesting cloud nonetheless. Then extensively profiled a cirrus layer near Ponca City, Oklahoma, which is roughly about 50 miles upwind of where the UND Citation and Sabreliner were working with the ER- 2. Flew racetracks at 25, 26, 27, 28 and 29K'. Very large crystals were observed at 28 and 29K' (operating ceiling due to airframe temperature limits). Finished with a spiral descent over Hub from 29K' through a stratus layer at 12.1K' that was breaking up and then to landing. Good mission!!

- NCAR KING AIR #2: A pre-dawn mission on the 26th. Thin cirrus present at take-off quickly moved off. Did spiral ascent to 28K' and then slow spiral descent to surface in coordination with Raman lidar water vapor observations. Unbelievable that CLASS soundings were not made as operator slept through alarm. Wallops Flight Facility did launch a sonde for SPECTRE not long after landing. Nonetheless, a really outstanding comparison where significant changes in water vapor profile were observed by cryogenic frost point and Raman systems between ascent and descent.

Highlights of FIRE Operations:

- An outstanding Day #1 of the second IOP. Formation of a very well-defined cirrus cloud system within the inner rawinsonde network and two other systems within the outer network.

- A tremendous amount of cirrus microphysical data were collected.

- Our first all-planes-in-the-air-at-once mission - very good coordination and ATC.

- An outstanding intercomparison of Raman lidar and in situ water vapor measurements including the NCAR cryogenic frost point hygrometer.

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Instrument Logs

Active Sensors

	UTC Hour	Notes

Active Sensor	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	
Utah Lidar H		X	X		X	X	X	X		X	X													X	2 CHANNEL VISIBLE
LaRC Laser Ceilometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Wisc HSR Lidar H				X	X	X	X	X	X			X	X												POLARIZATION MODE ONLY
Wisc Vol Image Lidar				X	X	X	X	X	X																
GSFC RAMAN Lidar H													X	X	X	X	X	X	X	X	X	X	X	X	
NOAA CO2 Lidar H		X	X	X	X			X	X	X	X	X	X	X	X	X					X	X	X	X	
NOAA Radar H	X	X	X	X	X	X	X	X	X	X	X	X										X	X	X	
PSU Radar H	X	X	X	X	X	X	X	X	X	X	X	X													
PSU Laser Ceilometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	DATA DROPOUTS 02 TO 11 UTC
PSU 50 MHZ Wind Prof H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	DATA TO 6 KM, QUESTIONABLE HIGHER
PSU/NOAA 50 MHz RASS H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	POOR DATA QUALITY
NOAA 405 MHz RASS H																									NOT OPERATIONAL
LaRC Lidar P	X	X	X							X	X	X											X	X	
CSU Wind Prof/RASS P	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	RASS FROM 15 TO 00 UTC
CSU Laser Ceilometer P	X	X	X	X		X	X	X	X	X	X	X													

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Passive Sensors

Passive Sensor	UTC Hour																								Notes
	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	
NOAA μ-wave Radiometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NOAA Sun Photometer H																									NO OBSERVATIONS
NOAA H20 Photometer	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	3-HR COMPUTER LOCK UP
NOAA IR Flux Radiom. H	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	3-HR COMPUTER LOCK UP
NOAA Dobson Ozone H																									NO OBSERVATIONS
NOAA Surface Ozone H	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	3-HR COMPUTER LOCK UP
NOAA Trace Gas H							F				C														
PSU μ-wave Radiometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	SOME NOISE DUE TO REFLECTOR FLUTTER
PSU Sun Photometer H						X	X	X	X	X															
PSU Solar Flux Radiom. H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PSU IR Flux Radiometers H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PSU Sky Video H	X	X	X	X	X	X	X	X	X	X	X	X													
Utah IR-Window Radiom. H		X	X		X	X	X	X																X	
Utah Sky Video H		X	X	X	X	X	X	X	X	X	X	X													
LaRC Video H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
AFGL Sky Imager H	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Ames Radiometer H		X	X	X	X	X	X	X	X	X															
Denver Solar Radiom. H																									NOT OPERATIONAL
Denver IR-Spectrometers H							X	X	X	X	X	X	X												
GSFC IR-Spectrometer H							X	X	X	X	X	X		X											
Wisc. IR-Spectrometer H							X	X	X	X	X	X	X	X	X	X	X								
MRI Sun Photometer H					X	X	X	X	X	X	X														
MRI IR Radiometer H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
MRI Spectro-Radiom. H			X	X	X	X	X	X	X	X	X														
MRI Solar Flux Radiom. H	X	X	X	X	X	X	X	X	X	X	X	X	X												
GSFC Sun Photometer H					X	X	X	X	X	X	X														
CSU Sun Photometer P		X	X	X	X	X	X	X	X	X	X	X													
CSU IR-Window Radiom. P					X	X	X	X	X	X	X	X													
CSU Solar Flux Radiom. P		X	X	X	X	X	X	X	X	X	X	X													
CSU IR Flux Radiometers P	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CSU IR-Spectrometer P						X																			
CSU Sky Video P			X	X	X	X	X	X	X	X	X	X													
Ames Spectroradiometer H		X	X	X	X	X	X	X	X																
Ames 10 μm narrow fov H		X	X	X	X	X	X	X	X																

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Sonde and Surface Meterology

Sonde + Sfc Met Sensor	UTC Hour																								Notes
	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11	
NOAA Ozone Sonde H																									NO LAUNCHES
WFF Sonde H								X			X		X												19 UTC = OZONE SONDE

NCAR Cloud Ice Sonde H		X																						
NCAR/CLASS Sonde H	X		X				X			X			X	X										SOME MISSING WINDS, 09 UTC LAUNCH MISSING
NCAR PAMS H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
NCAR/CLASS (remote)	X						X						X								X			SOME MISSING WINDS IOLA 00 UTC LAUNCH DELAYED 12 UTC
NCAR PAMS (remote)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	IOLA THAWED @ 19 UTC, AND REFROZE @ 06 UTC
CSU Sonde P					X				X															
CSU Sfc Meteorp. P	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Type A NWS Sondes	X						X						X						X			X		
Type B NWS Sondes	X												X											
PSU Sfc Meteor H	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	