

FIRE II Cirrus

Mission Summary



Date: November 30, 1991
Julian Day: 334
Experiment Day: 18

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Mission Scientist: David Starr
 Deputy Mission Scientist: None

Mission Objective:

Radiative and microphysical properties of Subtropical Jet Stream Cirrus

Mission Description:

Surface-based, and airborne radiometric observations and in situ microphysical observations were made of high level cirrus clouds associated with the flow of upper level moisture from the tropics overrunning of the subtropical upper troposphere over the midlatitude tropopause, i.e., cirrus above the tropopause in a double tropopause situation. The in situ observations were made to our south in northern Oklahoma.

Weather Synopsis:

This was a breezy cold morning with temperatures in the mid-30's and northwest winds at 10-15 knots. Cirrus were visible to the south and at times over the Hub. A middle level cloud was also present and increased during the morning. Strong directional shear was apparent in the differential motion of the different cloud layers.

Synoptic Situation:

A large trough along the California coast dominated weather in the southwest. A polar air mass, extensive low clouds and northerly flow dominated the Rockies and Plains States. An upper level disturbance over Arizona was evident in the satellite imagery. Southeast Kansas was on the northern fringe of a large swath of subtropical cirrus streaming northeastward from Mexico into central and eastern Texas, Oklahoma and southern Missouri. Much of the cirrus was orographically initiated in Mexico. Winds aloft reached 170 knots.

Morning soundings (12 UTC) at Amarillo and Oklahoma City showed a distinct double tropopause structure with the first just below 12 km and a second near 14 km. A nearly 2-km deep layer with a tropospheric lapse rate was found below the higher tropopause and above the strong inversion layer associated with the lower pause where wind speeds approached 150 knots. Cirrus were found in this between-the-pauses layer and are presumed to be associated with the subtropical jet stream causing an overrunning of the subtropical upper troposphere over the middle latitude troposphere.

Aircraft	Depart	Land	Notes
NASA ER-2			No flight
UND Citation	09:00 CST	11:15 CST	Good profiling mission over OK
NCAR Sabreliner	09:27 CST	11:03 CST	A couple of good radiation legs over OK
NCAR King Air	10:04 CST	~12:00 CST	Good flight in middle level clouds

Satellite	Hub Overpass Time	Zenith Angle	Azimuth Angle	RAOB
NOAA-11	20:25:23	41.31	70.77	yes
	10:30:23	51.44	290.26	no
NOAA-12	13:39:42	54.63	98.03	yes
	00:59:42	42.06	71.20	no

Rawinsonde Operations:

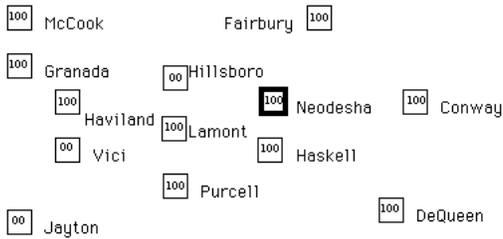
- Inner NWS stations (Type A): Routine @ 12 and 00 UTC
- Outer NWS stations (Type B): Routine @ 12 and 00 UTC
- Hub CLASS station: Enhanced @ 12, 18, and 00 UTC
 - (12 and 00 sounding terminated at 250 and 589 mb)
 - and 14 and 20 UTC satellite overpasses
- Remote CLASS stations: Enhanced @ 12, 18, and 00 UTC
 - (12 and 18 failed at Arkansas City)
- Hub GSFC/WFF station: No launches
- CSU Parsons station: No launches

FIRE Profiler Status:

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

NWS Wind Profiler Status:





SPECTRE Operations:

No significant operations due to low cloud cover.

Aircrew/Mission Scientist Debrief Notes:

- **GENERAL:** Very limited observations from surface-based systems as low clouds closed in on us before aircraft missions got very far. Citation and Sabreliner measurements should be very complimentary. King Air observations of middle cloud layer were impressive.
- **UND CITATION:** Flew southeast to northeast Oklahoma to work cirrus band (downwind of Sabreliner legs). Flew along-the-wind legs at 35 (cloud base), 36, 37 and 38K'(cloud tops). Legs were then flown at 37, 36, 35 and 34K' (cloud base was at 34.3K') followed by a ramp ascent at 500' per minute to 37K' (cloud top) and then to 38K'. Particle concentrations up to 52 per liter were found at 36K' with sizes peaking mostly around 100 um and none larger than 250um. There was some light turbulence at 33K' (100-140 knot wind shear seen over 28-31K' layer). No optical effects were observed. Made good contrails -"look for us on the NOAA overpass imagery!" - and penetrated own contrail a few times. Lower tropopause was at 265 mb and the base of the overlying cirrus layer with tropospheric lapse rate was at about 240 mb.
- **NCAR SABRELINER:** Flew N-S (Hub-Tulsa) legs at 33K' under very thin, homogeneous cirrus (bluish white). Southern end of first orbit was not far upwind of where Citation was working. Cirrus dissipated/moved off before second orbit was flown at 35K' - never got into the cloud. Very good SPEARAD and TDDR data. Cryogenic hygrometer failed.
- **NCAR KING AIR:** Worked the middle cloud deck composed of castellatus breaking out of an altocumulus layer. Beautiful dendrites up to 1 cm in size were observed - no wonder surface-based systems are not getting through this layer. No slides were taken due to icing but 2-D probe data looks great. Concentrations up to 200 per liter were observed near cloud top. Castellatus tops reached 17K' over Hub at -14deg.C and cloud base was at 12.3K' and -6deg.C. Mission was flown as a series of penetrations of individual castellatus elements at altitudes of 16, 15, 14 and 13K'. Drops were found at middle levels but ice above -11deg.C with homogeneous crystals near cloud top. Observed lots of aggregates from "anvil" at 16.5K'. A step down was flown followed by an ascent to 29K' and descent to landing to test cryogenic hygrometer - good comparison. A tremendous inversion(10deg.C) was observed at 850 mb - the cold front!

Significant Hardware Problems:

- Sabreliner cryogenic hygrometer failed.
- NOAA 405 MHz profiler not operational.
- U.Wisc HSR lidar operating as dual-polarization lidar.

Highlights of FIRE Operations:

- Excellent microphysical observations and some good extinction measurements in high subtropical jet stream cirrus - a **high priority case!!**
- Very good microphysical and other in situ measurements in a layer of altocumulus developing into castellatus - very large dendrites and other stuff.

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Instrument Logs

Active Sensors

Active 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	
Utah Lidar H																										NO OBSERVATIONS
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	X	
Wisc HSR Lidar H				X	X	X	X																			POLARIZATION MODE ONLY
Wisc Vol Image Lidar			X	X	X																					VARIABLE DATA DUE TO LOW CLOUDS
GSFC RAMAN Lidar H																										NO OBSERVATIONS
NOAA CO2 Lidar H	X	X	X	X	X					X	X															HOURS 21 AND 22 CALIBRATION
NOAA Radar H																										NOT OPERATIONAL
PSU Radar H	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	X	
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	X	
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	X	POOR DATA QUALITY(HIGH WINDS)
NOAA 405 MHz RASS H																										NOT OPERATIONAL
LaRC Lidar P																										NO OBSERVATIONS
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	X	RASS FROM 14 TO 16 UTC
CSU Laser Ceilometer P																										NO OBSERVATIONS

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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 H2O Photometer	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 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	X	X	X	
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	X	X	X	
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																									NOT OPERATIONAL
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																		
Utah IR-Window Radiom. H																									NO OBSERVATIONS
Utah Sky Video H																									NO OBSERVATIONS
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													
Ames Radiometer H																									NO OBSERVATIONS
Denver Solar Radiom. H																									NO OBSERVATIONS
Denver IR-Spectrometers H																									NO OBSERVATIONS
GSFC IR-Spectrometer H																									NO OBSERVATIONS
Wisc. IR-Spectrometer H																									NO OBSERVATIONS
MRI Sun Photometer H																									NO OBSERVATIONS
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																									NO OBSERVATIONS
MRI Solar Flux Radiom. H	X	X	X	X	X	X	X	X	X	X	X														
GSFC Sun Photometer H																									NO OBSERVATIONS
CSU Sun Photometer P																									NO OBSERVATIONS
CSU IR-Window Radiom. P			X	X	X																				
CSU Solar Flux Radiom. P		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																									NO OBSERVATIONS
CSU Sky Video P																									NO OBSERVATIONS
Ames Spectroradiometer H																									NO OBSERVATIONS
Ames 10 μ m narrow fov H																									NO OBSERVATIONS
CISRO/WPL/PSU IR W. Rad	X	X	X	X	X	X	X																		

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Sonde and Surface Meteorology

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																									NO LAUNCHES
NCAR Cloud Ice Sonde H																									NO LAUNCHES
NCAR/CLASS Sonde H	X		X				X		X				X												SOME WIND LOSS
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	X	
NCAR/CLASS (remote)	X						X						X												ARKANSAS CITY MISSED 12 AND 18 UTC, SOME WIND LOSS AT OTHERS
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	X	LACK OF SUN KILLED STATIONS, IOLA DOWN ALL DAY, OTHERS PARTIAL DAY
CSU Sonde P																									NO LAUNCHES
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	X	
Type A NWS Sondes	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	X	