

ARESE Mission Summary

ARESE, the ARM Enhanced Shortwave Experiment, concluded a very successful deployment to Oklahoma on November 1, 1995. The purpose of this five week long campaign was to conduct a series of instrumented flights to measure the interaction of solar energy with clear and cloudy skies to provide additional insight into recent observations of enhanced absorption in cloudy atmospheres. As such, ARESE focused on two scientific objectives:

1. the direct measurement of the absorption of solar radiation by clear and cloudy atmospheres and the placement of bounds on these measurements; and
2. the investigation of the possible causes of absorption in excess of the model predictions.

To accomplish these objectives, ARESE used a combination of satellite, aircraft, and ground observations to make highly accurate solar flux measurements at different altitudes throughout the atmospheric column. At the heart of this was a carefully "stacked" Twin Otter and Egrett "cloud sandwich" with the Otter at 1500 - 5000 ft and the Egrett at 43,000 ft. This was overflown by an ER-2 flying at 65,000 ft, which because of its much higher speed did not stay in constant alignment with the Twin Otter/Egrett stack but did provide periodic coincidences with these other aircraft. All three aircraft carried identical up- and down-looking "Valero" radiometers and flew over identical up-looking radiometers at the CART central and extended facilities. Radiance measurements from the GOES satellites were used to retrieve top-of-the atmosphere fluxes. These flux measurements were supplemented by a variety of cloud property measurements from the ground, the Egrett and the ER-2, including radar, lidar and multispectral measurements.

These baseline ARESE flights were conducted at the CART site from September 25 through November 1. During that time twelve scientific data flights were flown and approximately 60 hours of in-flight data were accumulated under a variety of atmospheric conditions ranging from clear to solid overcast. These flights are detailed in Table 1 below and include: cloud forcing experiments under scattered, broken, and solid overcast conditions including low, mid-, and high-level cloud decks; clear sky column absorption and surface albedo measurements; clear sky flux profiling measurements; and in-flight, co-altitude intercomparisons of flux measurements made from the two aircraft. The data appear to be of excellent quality and comprise a unique data set for testing our understanding of the absorption of solar radiation in both clear and cloudy atmospheres.

In addition to these baseline solar absorption experiments, the ER-2 also performed some key calibration experiments. These used highly accurate spectral radiance measurements from the MODIS Airborne Simulator (MAS) to calibrate radiance measurements from the GOES satellite and to improve retrieval algorithms for converting spectral radiances to spectral fluxes.

The success of this deployment was the result of the tremendous efforts of a multi-laboratory multiagency team comprised of five DOE Laboratories, three NASA Centers, about a dozen universities and three aircraft companies. The ARM Program sponsored the ground-based measurements, ARM-UAV (Unmanned Aerospace Vehicle) the coordinated Egrett and Otter measurements, and ARM and NASA the ER-2 flights. Funding was provided through the DOE's

ARM Program and through DoD's Strategic Environmental Research and Development Program (SERDP).

Table 1. - ARESE Science Flight Summary		
Date	Platform (O=Otter E=Egrett)	Measurement conditions
09-25	O, E, ER-2	Solid to broken cloud field along NW track
09-29	O, E, ER-2	Scattered to broken clouds, lots of turbulence
10-03	O, ER-2	Clear sky profiling at 4, 7, 10, 13, 16, 19 kft; albedos at central facility
10-11	O, E, ER-2	Clear sky albedo, column absorption, and inter-comparison
10-13	O, E	Cloudy sky absorption on NW track (alto stratus and cirrus)
10-17	O, E, ER-2	Clear sky mission, data inter-comparison on SW and NW legs
10-19	O, E, ER-2	Clear sky albedo, column absorption NW leg
10-24	O, E	Thin cirrus cloud field
10-26	O, E	Sold cirrus deck to broken clouds to clear sky
10-28	O	Clear sky, Otter only experiment at 500 ft above Charlie Whitlock's radiometers to explore aerosol heating -- also excellent albedo data
10-30	O, E	Thick uniform low to mid-level deck
11-01	O, E	Solid to broken cloud field

The remaining portions of the document contain individual Mission Summaries, Mission Plans and Mission Notes. Unless noted otherwise, the summaries and plans were written by John Vitko.

ARESE / UAV Mission Summaries

Flight Date: 09/25/95
UAV Flight #: 1
ER-2 Flight #: 1

Meteorology During Flights (14 - 18 UTC 25 September 1995) [Gerald Mace]

The synoptic-scale features of interest that existed during this flight included a high amplitude ridge oriented along a north-south axis over the inter-mountain West and a longwave trough over the central U.S. The axis of the trough extended across central Oklahoma and northeastward. A shortwave trough was rotating around the trough axis as the flight commenced. The dynamics associated with this shortwave as well as low level moisture inflow and broad scale ascent in the right entrance region of a jet streak induced generally overcast skies with widespread rain and embedded convection. Satellite imagery and weather radar indicates that this area of rain and convection was centered on the state of Oklahoma. The northern boundary of the precipitation extended along the Kansas-Oklahoma border and moved eastward with time.

The cloud band propagated slowly southeastward during the flight. Imagery indicates that the Coldwater extended facility was clearing as the flight began. Lamont, Byron, Ringwater, and Vici were overcast. As the shortwave trough propagated through the longwave trough axis between 16 and 17 UTC, cloud tops warmed and precipitation subsided. This led to a thinning of the clouds along the Byron-Lamont portion of the flight track during the second half of the flight. Precipitation ended and the skies became broken in middle tropospheric clouds and cirrus at the CART site central facility after 18 UTC. There were scattered clouds at Coldwater, Byron, and Vici at 18:45 UTC, near the end of the Egrett flight and the third pass by the ER-2.

Mission Summary:

The Otter and Egrett flew the primary mission (flight plan 1) in stacked formation for one round trip. The Otter flew under cloud base at 1500 ft, and the Egrett flew above cloud top at approximately 43000 ft. Due to difficulties in aircraft-to-aircraft coordination, the Otter and Egrett flew a second round trip over a shorter track between Lamont and Byron. The approximate times of the overflights above the ground stations are given in table 1 below. After the second round trip, the Otter landed in order to refuel. The Egrett then began to fly a north-south track above the SGP CART site. It overflew the CART site 5 times between 17:50 and 18:20. The Egrett then ended its mission and returned to Ponca City.

The ER-2 flew five times around a clockwise triangular track over the ground stations at Coldwater, Byron, the Central Facility, Ringwater, and Vici. The estimated times of the overpasses for each ground station are given in table 2 below. The ER-2 overflew the stacked aircraft once during each round trip. The ER-2 and the Egrett were stacked above the instruments at the CART site at 18:20.

Site	Pass 1 (out)	Pass 2 (back)	Pass 3 (out)	Pass 4 (back)
CART	15:19	16:58	17:04	17:52
Byron	15:44	16:35	17:27	17:30
Coldwater	16:06	16:12	N/A	N/A

Site	Pass 1	Pass 2	Pass 3	Pass 4	Pass 5
Coldwater	16:20	17:14	18:08	19:02	19:56
Byron	16:28	17:22	18:16	19:10	20:04
CART	16:34	17:28	18:22	19:16	20:10
CART	16:43	17:37	18:31	19:25	20:19
Ringwater	16:49	17:43	18:37	19:31	20:25
Vici	16:56	17:50	18:44	19:38	20:32

Instrument / Platform Status:

- All ER-2 aircraft instruments were nominal.
- Most ARM UAV aircraft instruments were nominal. The CDL on the Egrett was not operational. About 60% of the CDL WFOV cloud images were good. The MPIR has not been installed on the Egrett. The dew point instrument on the Egrett was removed for servicing before the flight.
- Most CART instruments were nominal. The SIROS instruments at Coldwater and Byron were not operative during the flight day and did not collect data during the flights.

ARESE Mission Scientist: Bill Collins

Flight Date: 09/29/95
UAV Flight #: FY95-S1-4(EO)
ER-2 Flight #:

Meteorology During Flights (15 - 19 UTC 29 September 1995) [Gerald Mace]

The synoptic scale features of interest during this flight consisted of a deepening trough situated over the western U.S. and a series of shortwave troughs moving through the longer wave system. By 12 UTC, a vorticity maximum was moving into central Kansas and the CART domain was experiencing negative vorticity advection and general large scale downward vertical motions. Water vapor imagery indicates that the middle and upper troposphere was very dry although a moist southerly flow persisted in the low levels. During the flight, a trough of low pressure remained nearly stationary in a strong southerly flow that veered slowly with time. Convergence along the trough coupled with strong surface heating allowed boundary layer clouds to form along the trough axis while a capping inversion near 850 mb kept convective clouds confined to the low levels.

Mission Summary:

The Egrett and Otter flew the primary mission for one round-trip from Lamont to Vici (Track C) and one round trip from Lamont to Ringwood (half of Track C). The Egrett was at 43000 ft MSL, above the clouds, while the Otter flew at 1500 ft AGL, below the clouds. Due to excessive turbulence the Otter climbed to 6500 ft AGL (from 1900-1905 UTC), above the clouds, and both aircraft flew one more round trip from Lamont to Ringwood. The Otter refueled at Blackwell and recovered at Ponca City. The Egrett recovered at Ponca City. Approximate times for ground station overflight are given in Table 1.

Based on CDL data, pilot and ground observations, the cloud cover was generally considered to be scattered between 4000 and 5000 ft AGL over the entire track.

The ER-2 flew their standard clockwise racetrack, Lamont to Vici to Coldwater to Lamont, at 63000 ft MSL. Approximate ground station overflight times are given in Table 2. Approximate times for collocation of the ER-2 with the Otter and Egrett are: 1710, 1748, 1839, and 1931. All aircraft were stacked above Ringwood at 1748.

Table 1: Otter/Egrett Overpass Times UTC (Approximate)

Site	Lap 1 (out)	Lap 2 (back)	Lap 3 (out)	Lap 4 (back)	Lap 5 (out)	Lap 6 (back)
CART	1640	1803	1808	1851	1856	1938
Ringwood	1705	1747	1830	1835	1918	1923
Vici	1726	1730	--	--	--	--

Table 2: Planned ER-2 Overpass Times UTC

Site	Pass 1	Pass 2	Pass 3	Pass 4	Pass 5
Coldwater	1645	1739	1833	1927	2021
Byron	1653	1747	1841	1935	2029
CART	1659	1753	1847	1941	2035
CART	1708	1802	1856	1950	2044
Ringwood	1714	1808	1902	1956	2050
Vici	1721	1815	1909	2003	2057

Instrument / Platform Status:

- All ER-2 aircraft instruments were nominal.
- Egrett instrumentation operated nominally with the following exceptions: Rings on the zenith TDDR on the Egrett failed and were positioned out of the radiometer field-of-view for the duration of the flight. This radiometer was able to obtain valid flux measurements however. The MPIR and dew point instrument are not been installed on the Egrett. Signals from the SSP terminated at 1745 UTC for, as yet unknown, reasons.
- Otter instrumentation operated nominally .
- Most CART instruments were nominal. The upwelling IR SIROS instrument at Byron was not operative during the flight day. The PSU 94 GHz Doppler radar came on-line at 1730 UTC and continued to operate throughout the mission. Scripps" ground stations have not yet been deployed.

Operational Notes:

The new scheme of flying with a +/- 500 m corridor, either side of flight track, greatly reduced the amount of pitch and roll changes on both aircraft. This has the effect of increasing the quality of the radiometer data. Turbulence levels at 1500 ft AGL for these meteorological conditions may have compromised radiometer data. This will be determined during the next few days. Further improvement of coincident flight can be accomplished by better preflight briefings between the ER-2, Egrett, and Otter pilots and the Mission Scientist. Uplink problems to the Egrett continue to be a problem.

ARESE Mission Scientist: Bill Collins
Alternate: Anthony Strawa

Flight Date: 10/03/95
UAV Flight #: FY95-S1-5(EO)
ER-2 Flight #: 96-001

Meteorology During Flights (15 - 19 UTC 29 September 1995) [Gerald Mace]

With the exception of very widely scattered boundary layer cumulus, clear skies dominated the region during this flight. Surface high pressure was building over the area as a trough in the low levels moved east of the Mississippi river. Winds below 700 mb were northerly with speeds less than 10 m/s. Aloft, winds backed and increased in speed. 500 mb winds were westerly at 20 m/s. The 18 UTC sounding from the CART site central facility indicated very dry air through the depth of the troposphere. Two distinct layers with extremely low relative humidities existed at 850 and 530 mb. A weak temperature inversion is noted between 600 and 650 mb.

Mission Summary:

Because of weather and sky conditions, the alternate mission was flown. The Otter flew from the Pioneer VOR to Anthony VOR from 4000 ft to 19,000 ft, changing altitudes by 3000 ft on each leg to obtain a clear sky profile. Otter takeoff was at 1556 and landing at 1846; start of data legs are listed in Table 1. The ER-2 flew the primary flight track as scheduled, Anthony to Wichita to Pioneer. ER-2 overflew Anthony at times listed in Table 2 and terminated when the Otter terminated. The Otter made a low altitude pass at 1500 AGL over the CART site at the beginning of the mission. A final leg at 22,000 ft was aborted due to an instrument malfunction.

TABLE 1. Otter station crossings.

LOCATION	START POINT	TIME	ALTITUDE
CART	--	1606	4000 MSL
LEG 1	PER	1617	4000
LEG 2	ANY	1648	7000
LEG 3	PER	1707	10000
LEG 4	ANY	1735	13000
LEG 5	PER	1758	16000
LEG 6	ANY	1821	19000

TABLE 2. ER-2 ANY crossings	
LAP 1	1613
2	1701
3	1741
4	1835

Instrument / Platform Status:

- All ER-2 aircraft instruments were nominal.
- Otter instrumentation operated nominally the beginning of the leg at 22000 ft when an instrument problem causes a shutdown.
- Most CART instruments were nominal. The upwelling IR SIROS instrument at Byron was not operative during the flight day. The PSU 94 GHz Doppler radar came on-line at 1730 UTC and continued to operate throughout the mission. Scripps" ground stations have not yet been deployed.

Operational Notes:

None.

ARESE Mission Scientist: Anthony Strawa

Alternate: Gerald Mace

Flight Date: 10/11/95
UAV Flight #: FY95-SI-6
ER-2 Flight #: 96-002

Meteorology During Flights [Bill Syrett, PSU]

Clear skies dominated the region during this flight as a rather strong middle-and upper-tropospheric ridge built over and to the northwest of the area. In response to this feature a surface ridge of high pressure stretched from the mid-Atlantic coast to the four corners, with a primary high pressure center over West Virginia. This surface pressure pattern provided calm conditions early in the day with increasing southerly surface winds with time. By 2100 UTC southerly winds at about 5 m/s were common. The southerly flow brought low-level moisture, which, in combination with a fairly strong low-level inversion, resulted in a noticeable haze layer. Winds aloft were generally light, with northeasterly winds at the top of the troposphere near 20 m/s, shifting to northwest in the lower stratosphere at similar speeds. Humidity was low throughout the troposphere. The boundary layer became quite turbulent as strong solar heating caused thermals, however a general subsidence pattern helped limit boundary layer depth and allowed the Otter to climb above the rough air.

Mission Summary:

Objectives were to characterize clear sky surface albedo; obtain information on clear sky absorption with stacked aircraft; and obtain an intercalibration.

All science objectives were met. The Egrett and Otter flew three round trips to Vici. Otter altitude was increased from 1500 AGL to 5500 AGL due to turbulence. After the last leg, the aircraft joined for intercalibration at 9500 AGL.

The ER-2 flew standard triangles clockwise; take-off was 50 min. late.

Instrument / Platform Status:

- All instruments operated nominally; exceptions were nadir FSBR and TSBR on the Egrett. The data is expected to be valid for these instruments after the appropriate corrections are applied.
- Ground stations were operational at the central facility and Ringwood.

ARESE Mission Scientist: A. W. Strawa
Alt. Mission Scientist: S. K. Pope

Flight Date: 10/13/95
UAV Flight #: FS95-Si-7 (EO)
ER-2 Flight #:

Meteorology During Flights [Bill Syrett]

A strong cold front passed through the center of the region at about 1445 UTC. The sky was clear at the start of the mission. A fairly strong upper-level disturbance caused a rather extensive band of mixed cirrus and altostratus with convective elements imbedded within this band. The cloud band progressed from northwest to southeast with elements moving basically from west to east. The front end of the clouds reached Blackwell by 1800 UTC with mostly overcast conditions until the end of the mission. The back edge of the cloud reached the northwest corner of the study area as the mission ended. The front brought with it an abrupt shift in the wind from south-southwest to north-northwest. The surface wind speed increased from under 5 m/s to 10-15 m/s within two hours after frontal passage. By the end of the mission, however, winds had subsided to 5-8 m/s. Strong northerly winds in the lowest 3 km subsided to light westerlies in the 3-5 km layer. Increasing west-southwest winds were found above.

Mission Summary:

The science objective was met, with 2 stacked aircraft flying over and under a layer of clouds. The ER-2 was not able to fly due to a bay pressurization problem, but the Twin Otter and the Egrett flew in coordination along the Lamont-Byron-Coldwater track. The Twin Otter maintained an altitude of ~5000 ft. and the Egrett flew at ~43 kft. Data were collected by RAMS ground stations at the CART site (Lamont) and at the Byron Extended Facility.

Instrument / Platform Status:

- Most ARM UAV aircraft instruments were nominal.
- Most CART instruments were nominal.
- Both the Penn State and UMass 94 GHz radars performed well and captured the entire event.
- The data recorder on the Twin Otter experienced a problem and did lose some of the flight data, but this data was captured on telemetry.

ARESE Mission Scientist: Shelly Pope
Alternate Mission Scientist: Bill Syrett

Flight Date: 10/17/95
UAV Flight #: FS95-S1-9 (EO)
ER-2 Flight #: FY96-007

Print Date 2/20/96
Print Time 7:56 PM
Prepared by Schwartz

Meteorology During Flights [Bill Syrett]

A well-defined upper-level disturbance (that was poorly handled by the numerical models) continued eastward through the period and was centered near Coldwater KS at 1800 UTC. A thinning band of cirrus passed over the study region ahead of this system and moved out of the area to the east by 1515 UTC. An area of precipitating cirrus developed near the center of the disturbance and passed over the northwestern part of the triangle during the early afternoon. These clouds dissipated by the end of the mission. Surface winds were from the south-southwest and increased from a speed of about 7 m/s at takeoff to 10-15 m/s after 1700 UTC. Winds aloft were primarily southwesterly at moderate speeds, ranging from 15 m/s just above the surface to 10 m/s at 3 km to 35 m/s at 12 km.

Mission Summary:

The **alternate** operational and science objectives were met, with 2 stacked aircraft flying mainly under clear skies; light clouds were encountered during a portion of the flight. The ER-2 flew the high great circle as planned (5 laps). The Twin Otter and the Egrett flew in coordination as follows: one leg along the Lamont Ringwood Vici track; a second leg (with some cloud encounter) along the Lamont-Byron-Coldwater track. The Twin Otter maintained an altitude of ~5500 ft. and the Egrett flew at ~43 kft. The Egret flew the Lamont to Byron leg while the Otter refueled. The two aircraft rejoined and flew from Lamont to the northern corner. An intercomparison was conducted in a square pattern aligned along and perpendicular to the solar direction, at 12 kft south of the B-T airport. 214° heading and 90 deg about that.

Remarks:

Intercomparison was successful, at least qualitatively, based on real-time observation of data.

Considerable low level haze (wind blown dust?) was observed; not thought to affect absorption above 5500 ft.

Question raised about initialization of INS system and implications for data reduction of radiometers. To be resolved. Tooman to follow up.

Radars operating; some dust noted.

A four-way stack was achieved: Lamont, Otter, Egrett, ER-2.

Flying conditions smooth.

Data were collected by RAMS ground stations at the CART Central Facility (Lamont) and at the Byron and Ringwood Extended Facilities.

Instrument / Platform Status:

- Most ARM UAV aircraft instruments were nominal; problem developed with SSP; MPIR appears to have performed; brief loss to heater of broadband radiometer and 2 TDDRs.
- Most CART instruments were nominal.
- RAMS at Byron, Ringwood, and CART site nominal.
- Penn State and UMass 94 GHz radars nominal.
- Water vapor lidar at CART CF nominal.

Mission Scientists

UAV Scientist	Bob Ellingson
ARESE Chief Scientist	Francisco Valero
ARESE Mission Scientist:	Shelly Pope
Alternate Mission Scientist:	Steve Schwartz

Flight Date: 10/19/1995
UAV Flight #: FY95-S1-10 (EO)
ER-2 Flight #: FY96-8

Meteorology During Flights: (1500 - 2100 UTC 19 October 1995) [Bill Syrett]

A strong cold front passed southeast across the region during the morning, clearing Blackwell/Tonkawa by 1600 UTC. Variable surface winds shifted to generally northerlies and increased to 13 - 20 m/s within an hour after frontal passage. Strong winds continued through the end of the mission. Strong and shifting winds in the lowest 2 km created substantial turbulence, especially at the time of frontal passage. Above, the flow was generally westerly at moderate speed. Occasional turbulence was noted above 10 km. A narrow band of stratocumulus developed just behind the front and passed to the southeast and out of the study area by 1730 UTC. Bands of thick cirrus were being generated over northern Kansas during the morning, but unfortunately they moved east and stayed north of the region, leaving us with mostly clear skies with only scattered thin bands of stratus during the afternoon with visibility reduced by blowing dust.

Mission Summary:

Despite hope for fairly extensive cloudiness related to the passage of cold front (very well forecasted) only narrow band of scattered clouds was observed. Baseline ARESE configuration along the NW track was performed with ER-2 doing four circuits and Twin-Otter/Egrett flying coordinated mission. On takeoff Egrett reported strong turbulence but the radiometric measurements were stable. SSP diagnostics (temperature) performed. At the end of the mission Twin Otter climbed and Egrett descended to 12.5 Kft to perform end-of-the-mission INS pitch and roll offset test. L-shape pattern has been executed with the cross Sun flights followed by the from-towards Sun legs. Excellent coordination of aircraft was observed. Due to rapidly changing Sun at the end of the day slight adjustments to headings for reverse legs were requested and executed.

Instrument/Platform Status:

- The 50 MHz channel of the RASS is not operational.
- 915MHz system will be down 8:30-10:30 a.m. local today.
- Penn State and UMass Radars operational.
- AERI and SORTI spectrometer are operational.
- MPL1 operational, MPL2 lidar down.
- Microwave radiometer up.
- Aerosol trailer is not operational.
- The RAMS CF up (total and fractional tests in darkness till 13:51).
- Aircraft and surface RAMS instruments the same as of 10/17/95.
- RAMS operated nominally.
- SSP - drop out at the beginning of the flight. Recovered.
- The T1 line (network) and telephone lines were down for the most part of the mission.

ARESE Mission Scientist: Steve Schwartz
Alternate Mission Scientist: Piotr J. Flatau

Flight Date: 10/24/95
UAV Flight #: FY95-S1-11(EO)
ER-2 Flight #:

Meteorology During Flights: (1500-1900 UTC 24 October 1995) [Bill Syrett]

A weak upper-level disturbance over western New Mexico generated cirrus to the west and northwest of our area. The cirrus tended to dissipate as it moved eastward toward and over the region, but gradually became more extensive with time. A large patch of thick cirrus that generated over mountains to the northwest remained north of the region.

Winds were light and variable at the surface, gradually increasing with height to roughly 40 m/s at 11 km out of the west-southwest. The 1200 UTC central facility sounding indicated relatively moist layers centered at 6.5, 8.5, and 11.5 km.

Mission Summary:

The science objective was to fly the northern track above and below the clouds. This was accomplished for one round trip to Coldwater and back. The Otter was instructed to refuel so that it would be airborne again at solar noon to take advantage of high sun angles and the thickening cloud deck. Shortly after takeoff, the Otter GPS failed. The Otter recovered at Blackwell while the Egrett flew a calibration box at altitude and then recovered.

Instrument/Platform Status:

- Otter instrumentation operated nominally. The GPS failed 2+30 into flight.
- All Egrett instrument operated nominally.
- CART instruments were nominal.
- Ground stations were deployed and operating.

Operational Notes:

None

ARESE Mission Scientist: Anthony Strawa
Alternate: Shelly Pope

Flight Date: 10/26/95
UAV Flight #: F95-S1-12(EO)
ER-2 Flight #:

Meteorology During Flights 1700-2215 UTC 26 October 1995 [Bill Syrett]

A strong jet streak, diving southeast from the northern Rockies spread a band of rather thick (2 km) cirrus over and through the region during the afternoon. The cirrus band thinned and weakened as it passed above the region, with the bulk of the clouds affecting areas well to the northeast. Preceding these clouds was a band of stratus that rapidly formed in the early morning hours and stretched from west of Vici to east of Ponca City. The stratus area shrank and moved north of the region by 1930 UTC. The cirrus band moved southeast of the region by 2100 UTC.

Surface winds shifted from south-southwest to west-northwest at speeds up to 7m/s, gradually increasing with height and time to roughly 40 m/s at 11 km out of the northwest. Wind direction was quite variable aloft from southwest to north-northwest and abrupt changes in direction with height were common.

The 1500 UTC central facility sounding indicated relatively moist layers below 1 km, from 5 to 7 km, and around 9 km.

Mission Summary:

The ARESE science objectives were met, with the Twin Otter and Egrett flying in coordination along the Lamont-Byron-Coldwater track for one round trip and along the Lamont-Byron track for another round trip. At one time or another there was both a low stratus layer and a high cirrus layer between the two aircraft. (Initially the Twin Otter flew lower than the standard 5 kft. to remain below the lower cloud. Otherwise the standard altitudes of 5 kft. and 43 kft. were used.) The transition between clear sky and cloudy sky was captured during the flight.

After the Twin Otter refueled the two aircraft rejoined at an altitude of about 8500 feet for the intercomparison, flying in formation while tracing out an L pattern.

Data were collected by RAMS ground stations at the CART site (Lamont), Byron, and Ringwood.

Instrument / Platform Status:

- Most ARM UAV aircraft instruments were nominal.
- The take-off of the Twin Otter was delayed while a problem with the GPS/C-MIGITS was solved.
- Most CART instruments were nominal.

ARESE Mission Scientist: Shelly Pope
Alternate Mission Scientist: Anthony Strawa

Flight Date: 10/28/95
UAV Flight #: FY95-S1-13(EO)
ER-2 Flight #:

Meteorology During Flights: (1800-2000 UTC 28 October 1995) [Bill Syrett]

High pressure passed just to the west of the region and provided clear and relatively calm conditions during the mission. A moist layer, shown nicely in the Oklahoma City and Central Facility soundings at 3 km, provided occasional very thin and small stratiform clouds to the east of the study area. Cirrus clouds approached from the west as the mission concluded, but clear sky held through the time of flight. Winds in the lowest 3 km were general light and variable.

Mission Summary:

Due to failure of the flight-critical instrument on-board the Egrett, the primary plan of flying the two aircraft in a clear-sky profiling and intercomparison mode was canceled and the alternate plan was put into effect. The Twin Otter was flown over Whitlock's ground-based radiometers. The fluxes were measured over these radiometer sites which are located in a cross-pattern near the CART site. The Twin Otter reduced speed as much as practicable and maintained an altitude of 500' above the ground

Data were collected by RAMS ground stations at the CART site (Lamont), Byron and Ringwood.

Instrument/Platform Status:

- Most ARM UAV aircraft instruments were nominal
- All CART instruments were nominal.

ARESE Mission Scientist: Shelly Pope
Alternate: Anthony Bucholtz

Flight Date: 10/30/95
UAV Flight #: FY95-S1-14(EO)
ER-2 Flight #:

Meteorology During Flights: (1700-2000 UTC 30 October 1995) [Bill Syrett]

Moist southerly flow caused an extensive stratus sheet to form over the region prior to the start of the mission. The stratus remained through the period. Broken cirrus became thin and scattered by the start of the mission and remained that way. A band of very uniform-looking stratus, as seen on visible satellite imagery, apparently was producing drizzle and light rain as it slowly moved eastward through the region. This cloud band was being produced by a weak shallow cold front creeping eastward from northwestern Oklahoma.

Ceilings outside this precipitation area were generally around 0.8 km and the cloud top was found by pilot observations and the Penn State cloud radar to be at about 2.4 km. The 1500 UTC central facility sounding detected a thin saturated layer at about 0.7 km and a deeper saturated layer from 1.2 to 2.3 km.

Winds in the lowest 3 km were generally southwest or south-southwest at 8 to 15 m/s. Winds at 13 km were west-southwest near 33 m/s.

Mission Summary:

The ARESE science objectives were met, with the Twin Otter and Egrett flying in excellent coordination along the Lamont-Ringwood-Vici tract for one round trip. At one time or another there was both a low stratus layer and a high cirrus layer between the two aircraft. (Initially the Twin Otter flew lower than the standard 5 kft. to remain below the lower cloud. Otherwise the standard altitudes of 5 kft. and 43 kft. were used.)

Instrument/Platform Status:

- Most ARM UAV aircraft instruments were nominal.
- The GPS/C-MIGITS on the Twin Otter failed approximately 35 minutes before the end of the flight
- The RAMS nadir TDDR on the Twin Otter was inoperable for the entire flight.
- Most CART instruments were nominal.

ARESE Mission Scientist: Anthony Bucholtz
Alternate: Shelly Pope

Flight Date: 11/01/95
UAV Flight #: FY95-S1-15(EO)
ER-2 Flight #:

Meteorology During Flights: (1620-1940 UTC 1 November 1995) [Bill Syrett]

A complicated weather pattern created interesting conditions for this mission. An area of showers, with thunderstorms well to the south, passed through the region before 1000 UTC. Increased low-level stability and subsiding air in the wake of this system caused clearing before sunrise. Radiational cooling created an area of fog and low status to the south and southwest of the region. After sunrise, southerly surface winds carried these clouds northward into the region. Surface heating caused a gradual rise in cloud base as the area moved north and by mission start the central facility reported a base of about 500 m, rising to 600 m by 1730 UTC. Heating also caused the cloud area to become more broken in character, with stratocumulus the predominant cloud type over the eastern part of the region. Scattered stratocumulus were found further south and west. An area of solid status was found north and west of a cold front that was located near Coldwater by 1730 UTC. Cloud base was low in this region, averaging below 100 m. the cold air moved eastward during the mission, keeping low stratus north of Byron through the period. Higher-based stratocumulus held from Blackwell-Tonkawa northward, with mostly clear skies to the south.

Surface winds remained southerly over most of the region at speeds between 5 and 9 m/s. Winds just above the surface, but in the lowest 3 km were generally southwest or south-southwest at 10 to 20 m/s. Winds at 13 km were southwest near 33 m/s.

Mission Summary:

The ARESE science objectives were met, with the Twin Otter and Egrett flying in coordination along the Lamont-Byron-Coldwater tract with a solid-to-broken layer of stratocumulus in between the two aircraft.

(There was no refueling and no intercomparison.)

Data were collected by RAMS ground stations at the CART site (Lamont), Byron, and Ringwood.

Instrument/Platform Status:

- Most ARM UAV aircraft instruments were nominal.
- The GPS/C-MIGITS on the Twin Otter failed about 1.5 hours into the flight.
- Most CART instruments were nominal.

ARESE Mission Scientist: Anthony Bucholtz
Alternate: Shelly Pope

ARESE Mission Plans

Flight Date: 09/25/95

UAV Flight #: 1

ER-2 Flight #: 1

Meteorological Forecast: 12Z 09/24/95 (Gerald Mace)

Expected cloud conditions: Multilayer clouds are likely. Current cloud base altitude is approximately 6000 - 8000 ft over central Oklahoma, and current cloud top altitudes (based on satellite brightness temperatures) are approximately 30000 ft. Most clouds will be mid and upper level.

Synopsis: The high amplitude pattern with a blocking ridge in western North America and a trough in the central states is beginning to deamplify this morning. A weak shortwave trough is moving southward into the long-wave trough axis and is generating middle and upper tropospheric clouds with scattered showers.

Prog Discussion: Short range guidance suggests the weak trough and associated frontal boundary will keep clouds and scattered showers in the region today. As the trough fills and lifts eastward, the upper ridge and a developing surface high pressure system will diminish the threat of showers into tonight with clearing conditions expected by late in the forecast period.

48 hour Forecast:

12Z 09/24/95 - 00Z 09/25/95: Skies are expected to remain broken to overcast in cirrus and altostratus/altocumulus throughout the day. Occasional showers will develop in the area during the period. Surface winds will be light southerly and temperatures will climb into the mid 60's. Winds at 40 kft: 270/25 m/s.

00Z 09/25/95 - 12Z 09/25/95: While the threat of showers will diminish somewhat into the evening, skies will remain broken to overcast. Winds light and variable with lows in the 50's.

12Z 09/25/95 - 12Z 09/27/95: Clouds decreasing throughout the period with a chance of showers early.

Mission Objectives:

Fly ARESE baseline cloud absorption mission with stacked UAV above and below the clouds.

Instrument / Platform Status:

- Most aircraft instruments are nominal. Fractional SW radiometers on Egret have been temporarily replaced by broadband SW radiometers.
- Most CART instruments are nominal. The PSU radar and Raman Lidar are not currently operational. The surface RAMS instruments are in transit and will be installed later this week.

ARESE Mission Scientist: Bill Collins

Flight Plans:

1. Both aircraft will fly ARESE Flight Track C (NW flight plan between Lamont Byron, and Coldwater), weather permitting. The Otter will fly at 1500 ft, and the Egret at approximately 43000 ft.
2. If the Otter cannot fly at 1500 ft because of low cloud ceilings over a significant fraction of the track, then the aircraft will fly one of two alternative missions along track C (if operational considerations permit):
 - A. The Otter will fly at a constant altitude above the low level clouds. This will be a variation of the baseline ARESE cloud absorption mission. The Egret will stay at 43000 ft.
 - B. The Otter will fly at a constant altitude close to its ceiling above the low and mid-level clouds. This will be a stacked aircraft mission for measuring cloud radiative properties at two different distances. The Egret will stay at 43000 ft.

ARESE / UAV Mission Plan

Flight Date: 09/29/95
UAV Flight #: 2
ER-2 Flight #:

Meteorological Forecast: 12z 28 Sep (Gerald Mace)

Expected cloud conditions: Partly to mostly cloudy with convective activity a near certainty over some portion of the CART domain.

Synopsis: The upper level flow over the central and southern plains is becoming southwesterly as a trough deepens over the western states. A series of weak impulses are propagating northeastward in this southwesterly flow. In the lower levels, warm and moist air is advecting northward. Currently a strong capping inversion exists between 800 and 700 mb.

Prog Discussion: Although the strong capping inversion is expected to persist throughout the day, weakening gradually into tonight, scattered convection is still a reasonable concern as evidenced by the intense line of convection that formed east of Ponca City this morning. Warm and moist air is expected to continue streaming northward in a low level jet. Upper level ascent is forecast to continue throughout the period.

48 hour Forecast:

12z 28 Sep - 00Z 29 Sep: Mostly clear this morning over much of the area with scattered cumulus developing by late morning. The chance of convection will increase into this afternoon becoming likely tonight. Imagery indicates that cirrus is streaming northward from Arizona and New Mexico and is currently observed over Kansas. This cirrus should be observed in Northern Oklahoma this afternoon. Surface winds will be from the south at 15 knots and temperatures will climb into the middle 80's.

00Z 29 Sep - 12Z 29 Sep: Partly to mostly cloudy skies will continue with showers and thunderstorms likely before 06z - chances decreasing somewhat later in the period. Winds will maintain from the southwest at 5-10 knots and temperatures will fall into the upper 60's.

12z 28 Sep - 12Z 29 Sep: Partly to mostly cloudy with convective activity a near certainty over some portion of the CART domain. Numerical guidance suggests that dynamical support for convection maximizes near 18z.

Mission Objectives:

Fly ARESE baseline cloud absorption mission, SW to Vici, with stacked aircraft above and below the clouds.

Alternate 1: Fly ARESE baseline cloud absorption mission, NW to Coldwater, with stacked aircraft above and below the clouds.

Alternate 2: Fly ARM alternate mission with stacked aircraft above the clouds, with altitudes and flight track TBD.

Instrument / Platform Status:

- Aircraft platforms and instruments are nominal.
- Most CART instruments are nominal. The PSU radar and Raman Lidar are not currently operational. The surface RAMS instruments are in transit and will be installed later this week. Ozone sonde only will be launched at 1230L; this sonde includes a water vapor measurement.

ARESE Mission Scientist: Bill Collins; Alternate: Anthony Strawa

Flight Plans:

1. Both aircraft will fly ARESE Flight Track D (SW flight plan between Lamont Ringwood and Vici), weather permitting. The Otter will fly at 1500 ft, and the Egrett at approximately 43000 ft. The flight corridor is defined as being 500 m wither side of track. Aircraft are considered coincident within 2 km along the track.
2. In the event that convective clouds preclude flying Track d, both aircraft will fly ARESE Flight Track C (NW flight plan between Lamont Byron, and Coldwater), weather permitting. The Otter will fly at 1500 ft, and the Egrett at approximately 43000 ft.
3. If the Otter cannot fly at 1500 ft because of low cloud ceilings over a significant fraction of the track, then the aircraft will fly an alternative missions along either track C (if operational considerations permit):
The Otter will fly at a constant altitude, 3000 ft., above the low level clouds. This will be a variation of the baseline ARESE cloud absorption mission. The Egrett will stay at 16000 ft. above the cloud. This mission examines the effect of different fields-of-view on measurements.

ARESE / UAV Mission Plan

Flight Date: 10/03/95
UAV Flight #: FS95-Si-5(EO)
ER-2 Flight #: FY96-1

Meteorological Forecast: 12z 02 Oct (Gerald Mace)

Expected cloud conditions: Low altitude stratocumulus.

Synopsis: A deepening shortwave in the middle and upper troposphere is passing over the inter mountain West. Cold air advection in the middle and upper troposphere in the southwesterly flow ahead of the trough is causing lapse rates to destabilize. An area of showers and thunderstorms has formed in western Oklahoma and Kansas. The precipitation is moving slowly eastward.

Prog Discussion: The shortwave trough is expected to move slowly over the region during the next 18 hours. Given the intensity and current location of deep convection over Oklahoma, the models appear to be too slow and too weak. Precipitation will likely influence the CART region throughout the day as skies remain overcast. A cold front will pass after 00 UTC. The upstream ridge will likely influence the area tonight causing skies to clear. The next shortwave trough to influence the region will move into the Pacific Northwest this evening.

48 hour Forecast:

12z 02 Oct - 00Z 03 Oct: Cloudy skies with scattered thunderstorms and showers will persist during the period. Winds will remain light and temps will reach the lower 70's.

00Z 03 Oct - 12Z 3 Oct: Skies will clear overnight and temperatures will fall into the lower 50's. Areas of fog are possible after 06 UTC.

12z 03 Oct - 12Z 04 Oct: Skies will be mostly clear during the period although areas of stratocumulus may form in the cool northerly flow. Temperatures will reach the upper 60's.

Extended Range Discussion:

12z 04 Oct - 12Z 05 Oct: Medium range progs in general agreement. A trough is expected to deepen east of the Rockies during the period with development of a strong surface low pressure system in the central Plains. The movement of Tropical Storm Opal may influence the evolution of the pattern over the middle U.S.

Mission Objectives:

Due to the unavailability of the Egrett aircraft, we cannot perform the primary ARESE mission. For this mission we expect to see an extended low-altitude stratocumulus deck of clouds. An alternative mission is to examine the effect of field of view on cloud albedo as measured from aircraft at different altitudes. This will be accomplished by having the Otter fly at about 20,000 ft with the ER-2 at about 60,000 ft over the same flight track.

Instrument / Platform Status:

- The Egrett is down for maintenance problems. Other aircraft platforms and instruments are nominal.
- Most CART instruments are nominal. The Raman Lidar are not currently operational. The surface RAMS instruments are in transit and will be installed later this week. Ozone sonde only will be launched at 1230L; this sonde includes a water vapor measurement.

ARESE Mission Scientist: Anthony Strawa
Alternate: Gerald Mace

Flight Plans:

1. The flight track is following victor airways from Pioneer VOR to Anthony VOR to Wichita VOR. The Otter will fly counter-clockwise, while the ER-2 will fly clockwise maximizing aircraft coincidences.
2. Alternate 1. The objective is to fly in clear air at different altitudes to measure clear sky absorption.
3. Alternate 2. Overfly the CART site in clear air at low altitude to measure surface albedo.

ARESE / UAV Mission Plan

Flight Date: 10/11/95
UAV Flight #: FS95-Si-6 (EO)
ER-2 Flight #: FY96-2

Meteorological Forecast: 12z 10 Oct (Bill Syrett)

Synopsis: The axis of a middle- and upper-tropospheric trough is passing over north central Oklahoma at this time, bringing with it only scattered cirrus and altostratus as it moves east and weakens. West of the trough axis the sky is predominantly clear as heights rise and the atmosphere becomes quite stable.

Prog discussion: The southern extent of the longwave trough will only very slowly move east during the next 36 to 48 hours, however as it weakens it becomes less likely that it will continue to produce much in the way of cloudiness. Heights are expected to rise fairly substantially over the CART region, especially over the northwestern part. Jet stream cirrus will ride over the top of this ridge, and may brush the region, especially up north late Tuesday and Tuesday night, however it should move away to the north and east by morning. This all translates to a high probability of clear sky during Wednesday. Although the upper air pattern predicted by both short-range models tends to be a stable (slow-changing) one, they both keep a progressive pattern and move a strong trough into the west coast by Wednesday night. If this verifies, increasing cloudiness may develop by late Thursday, although the models may be a bit quick to erode the ridge.

48-Hour Forecast:

12z 10 Oct - 12z 11 Oct: Scattered cirrus and altostratus will decrease in coverage during Tuesday afternoon and then may briefly increase overnight. Pleasant temperature and light winds.

12z 11 Oct - 12z 12 Oct: Looks like a clear day. Warm to almost hot with light winds. Bumpy ride 'in the boundary layer, which will become fairly deep.

00z 12 Oct - 12z 12 Oct: Skies should remain clear during the period. It will remain pleasantly warm and predominantly calm.

Extended Range Discussion:

12z 12 Oct - 12z 13 Oct: Medium range progs in general agreement through the first 4 days, although the final destination of hurricane Roxanne is not carved in stone by any means. A fair-to-good bet for increasing clouds Thursday night in advance of the approaching trough. Roxanne should have no effect on local weather through 12z 13 October.

Mission Objectives:

The primary objective is to characterize the clear-sky net flux with the three stacked aircraft flying the baseline ARESE mission. The second objective is to characterize the difference in column albedo between 30 and 40 kft. The third objective is to intercalibrate the instruments on the Egrett and Twin Otter.

Instrument/Platform Status:

- Aircraft platforms and instruments are nominal.
- Most CART instruments are nominal. The Raman lidar and the 50 MHz channel of the RASS are not operational for this mission. The 2 MPL systems may not be functioning correctly, and the status of these lidars is under investigation.
- The surface RAMS instruments will be installed in two locations: one at the CART site and the other underneath the flight track at Ringwood.

ARESE Mission Scientist: Anthony Strawa

Alternate Mission Scientist: Shelly Pope

Flight Plans:

1. The standard ARESE flight track between Lamont and Vici, with the Twin Otter at 1.5 kft AGL (with speed bump at 5 kft. MSL) and the Egrett at 43 kft. MSL. While the Twin Otter is refueling the Egrett will fly N-S legs over Lamont at 30 kft and then 40 kft. At the end of the mission the two aircraft will meet at 9500 MSL and fly in formation for 5 minutes to intercompare the radiometers. The ER-2 will fly CW on great triangle. The Twin Otter may climb to reach smooth air as needed.
2. The standard ARESE flight track between Lamont and Coldwater.

ARESE / UAV Mission Plan

Flight Date: 10/13/95
UAV Flight #: FS95-Si-7 (EO)
ER-2 Flight #: FY96-4

Meteorological Forecast 12z 12 October 1995 (Bill Syrett)

Forecast Based on Satellite, Current Surface Observations, 00z ETA, 00z NGM, 12z MAPS/RUC, 00z 11 Oct. MRF, 12z 10 Oct ECMWF

** Updated with 12z NGM data **

Synopsis: A strengthening pressure gradient between a developing lee trough to the west and northwest and high pressure to the east is causing an increase in southerly winds. A lack of humidity throughout the depth of the middle- and upper-troposphere is keeping the sky clear, however low-level moisture continues to cause hazy conditions. A cold front is causing rather extensive middle and high cloudiness with scattered precipitation over the central and northern Rockies. Circulation around hurricane Roxanne is causing cloudiness and scattered convective showers to back northwestward over the Gulf and into southeastern Texas.

Prog Discussion: A cold front is progged to pass southeast and through the region by 1400 UTC 13 October. The front should be drying out as it moves southeast and should not bring precipitation to the region. Additionally, frontal passage timing will inhibit convective development and will stop the northwestward progress of Gulf moisture before it can influence our weather. Model output relative humidity in the lowest 500 mb is sufficiently low to suggest that only scattered to potentially broken mid- or high-level clouds will precede and accompany the front. There may be a several-hour period of mid-to-upper cloud behind the front but before the longwave trough passes, and in fact the latest model output suggests this to be the case. The wind will strengthen ahead of this front today and be from a general southerly direction. An abrupt wind shift from southerly to northerly will herald the arrival of the front. Winds will become quite strong after the front passes and will shift from northerly to westerly with height. Mechanically-produced (wind-driven) turbulence is a good bet tomorrow.

*** 12z model update ***

Mid-level humidity is progged to be a bit higher than previously predicted and suggests that most of the cloudiness would be in the form of altostratus. In addition, the cold front is progged to pass through slightly later, which will increase the chance of cloudiness during tomorrow.

48-Hour Forecast:

12z 12 Oct - 12Z 13 Oct: Clear sky during the daylight hours with only a slight chance of isolated cumulus development. Some haze. Warm to hot temperature and brisk southerly winds near 20 kt with a few higher gusts during the afternoon. Winds will subside to 5-15 kt after sunset. Scattered to broken altostratus and/or cirrus should develop after midnight local time (0500 UTC). There is a slight chance of stratocumulus development, but any that form should be gone after the front passes.

12Z 13 Oct - 00Z 14 Oct: Clouds, predominantly at the mid levels, will decrease during the afternoon. Northerly winds to 25 kt with possible gusts to critical levels (30 kt), if the front

passes later than currently progged, winds will shift early from southwesterly to northerly. Cooler temperature.

00z 14 Oct - 12Z 14 Oct: Mostly clear with decreasing northerly wind. Cool.

Extended Range Discussion:

12z 14 Oct - 12Z 15 Oct: Models in fair agreement in building high pressure to our west. This is a dry and generally clear pattern that may hold for several days. The jet stream may remain close enough to allow occasional cirrus patches to pass over the region.

Mission Objectives:

The primary objective is to proceed, if there are clouds, with the three stacked aircraft flying the baseline ARESE mission.

Instrument/Platform Status:

- Aircraft platforms and instruments are nominal.
- Most CART instruments are nominal. The 50 MHz channel of the RASS is not operational for this mission. One of the MPL systems is now operational as is the Raman lidar. The SIROS systems are working.
- The surface RAMS instruments will be installed in two locations: one at the CART site and the other underneath the flight track at Ringwood.

ARESE Mission Scientist: Shelly Pope

Alternate Mission Scientist: Bill Syrett

Flight Plans:

The standard ARESE flight track between Lamont and Vici, with the Twin Otter at 1.5 kft AGL (with speed bump at 5 kft. MSL) and the Egrett at 43 kft. MSL. While the Twin Otter is refueling the Egrett will fly N-S legs over Lamont at 43 kft. If there is opportunity at the end of the mission the two aircraft will meet at 9500 MSL and fly in formation for 5 minutes to intercompare the radiometers. The Twin Otter will likely climb to 5 kft. to reach smooth air.

The ER-2 will fly CW on great triangle.

ARESE / UAV Mission Plan

Flight Date: 10/17/95
UAV Flight #: FS95-S1-9 (EO)
ER-2 Flight #: FY96-007

Print Date 2/20/96
Print Time 7:56 PM
Prepared by Schwartz

Mission Objectives:

PRIMARY: Characterize cloudy-sky net flux at standard altitudes: Egrett at 43000 ft and the Otter at 5500 ft, with the ER-2 overhead.

Intercomparison measurements.

ALTERNATE: Clear sky at standard ARESE altitudes, with intercomparison.

Meteorological Forecast (Bill Syrett)

ARESE 48 hour Meteorological Forecast 12z 17 October 1995

Forecast Based on Satellite, Current Surface Observations, 12z ETA, 12z NGM,
03z Central Facility Sounding, 12z 16 Oct. ECMWF, 00z 17 Oct. MRF

Synopsis: An upper-level disturbance continues to move east and was located near the OK panhandle at 12z. It is producing scattered to broken cloudiness in a southwest-to-northeast swath about 150 km to its east. The clouds are primarily cirrus. Clouds have formed in the core of this disturbance during the past two hours and are moving east. These clouds are producing fallout are possibly convective in nature. Wind direction is primarily south-southwest in the lowest 4 km shifting gradually to southwest and then west-southwest above 10 km. Tropical storm Roxanne is still in the Bay of Campeche and still not affecting nor is it expected to affect our weather. It has begun a northwestward drift.

Prog Discussion: The thin band of cirrus overhead at 1300 UTC will move east of the region. The cloud area associated with the core of the upper-level disturbance will continue to move slightly north of due east. Latest data indicate that it should pass over the northwestern part of the region during the early afternoon. Models indicate a lower chance for significant cloud tomorrow, but small, fast moving features are typically poorly resolved by the models.

48-Hour Forecast:

12z 17 Oct - 00z 18 Oct: Cirrus moving east with a period of clear sky likely. Another period of cloud likely over the northwest part of the region, possibly extending as far south as Lamont by early afternoon. Warm with moderate to strong south-southwest winds to 15 m/s.

00z 18 Oct - 12z 18 Oct: Scattered cirrus with diminishing winds that will shift to northerly.

12z 18 Oct - 12z 19 Oct: Mostly clear with scattered patchy cirrus. Light winds.

Extended Range Discussion:

12z 19 Oct - 00z 20 Oct: Short range guidance indicates increasing humidity in both upper and lower levels, although models differ on amount of moisture. A fairly strong cold front will pass during Thursday and this will provide our last decent shot at clouds for the week. Increasing southwest winds ahead of the front, possibly shifting to moderate northerlies late.

Additional observations:

Cirrus developing along SW track. Shows on IR loop.

Reports from radar at CART site: base 9 km, top 10.5 km. Stars visible through cirrus.

Possible development of strong surface winds and gusts that may inhibit aircraft operations in mid day.

Winds aloft: SW 210 40 kts at 5 kft; 240 at 50 kts at 43 kft.

Radar echoes of precip observed in western Oklahoma at 0745 local.

Instrument/Platform Status:

- Aircraft platforms and instruments are nominal. MPIR is operational.
- Most CART instruments are nominal. The Raman lidar is operational. The 50 MHz channel of the RASS is not operational. The 2 MPL systems may not be functioning correctly, and the status of these lidars is under investigation. Penn State and UMass Radars operational.
- The surface RAMS instruments will be installed in three locations: at the CART site and the others underneath the flight track at Byron and Ringwood.

Mission Scientists

UAV Scientist Bob Ellingson
ARESE Chief Scientist Francisco Valero
ARESE Mission Scientist: Shelly Pope
Alternate Mission Scientist: Steve Schwartz

Flight Plans:

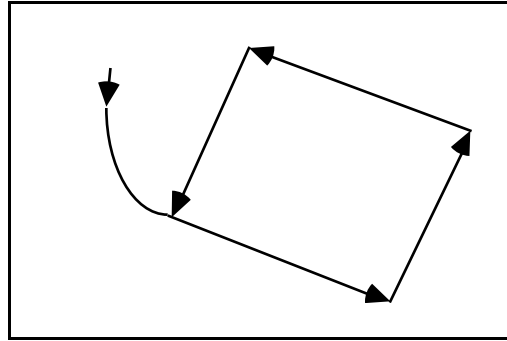
1. PRIMARY. The standard ARESE flight track, SW track Lamont to Ringwood to Vici, with the Twin Otter at 5500 ft MSL and the Egrett at 43 kft. MSL. Repeat all or part of track depending on Twin Otter fuel.

ER-2 is flying at 60 kft, great triangle course, clockwise.

While the Twin Otter is refueling the Egrett will fly round trip Lamont to Byron at 43 kft. if clouds at Byron; otherwise Egrett will fly round trip to Ringwood and back.

After refuel, rejoin and fly round trip Lamont to Ringwood to Vici.

At the end of the mission the two aircraft will meet south of the airport (near intersection of I-35 and US-60) at 9500 MSL and fly in echelon formation on a square pattern for nominal 3 minutes on a side to intercompare the radiometers. Track will be aligned along sun directions parallel and perpendicular. At time of intercomparison solar zenith angle SZA is expected to be about 70°.



Pattern of intercomparison flight. Nominal 3 minutes on a side. Echelon Formation Nominal 9500 ft.

2. ALTERNATE. The standard ARESE flight track between Lamont and Coldwater.
3. ALTERNATE. Symmetric distance above and below cloud is precluded by high cloud base.
4. ALTERNATE. If clouds break up, standard ARESE clear-sky mission.

ARESE / UAV Mission Plan

Flight Date: 10/19/95
UAV Flight #: FS95-S1-10 (EO)
ER-2 Flight #: FY96-8

Mission Objectives:

PRIMARY: Characterize cloudy-sky net flux at standard altitudes: Egrett at 43000 ft and the Otter at 5500 ft, with the ER-2 overhead.

ER-2 take-off at 16 UTC clockwise five triangles

Alternate: Clear sky at standard ARESE altitudes, with intercomparison.

Flight Plans:

1. PRIMARY. The standard ARESE flight track between Lamont and Coldwater. Depending on clouds switch to the standard ARESE flight track, SW track Lamont to Ringwood to Vici. INS initialization and radiometer pitch and roll offset L-shape legs at low Sun planned at the end of the mission. The pattern calls for two legs, 3-5 minutes in duration, from and towards the Sun and two additional legs of the same duration perpendicular to Sun's plane.
2. ALTERNATE. The standard ARESE flight track between Lamont and Ringwood to Vici

Alternate clear sky:

- (a) Intercomparison in steps to maximum Twin-Otter altitude
- (b) Step experiment of Stephens.

Meteorological Forecast (Bill Syrett)

1100z (0600 local) 19 October 1995

48 hour Meteorological Forecast [12z 19 October 1995]

Forecast Based on Satellite, Current Surface Observations, 00z ETA, 00z NGM, 06z C.F. Sonde, 06z RUC Output Animation, 12z 18 Oct. ECMWF, 00z 19 Oct. MRF

Synopsis: A strong cold front is moving toward the region from the northwest and should be southeast of the region by noon local time. Variable winds at light speeds are common ahead of the front. Strong north winds quickly develop after frontal passage and winds are currently gusting to 18 m/s over western Kansas. Strong upper-level support is generating cirrus to the north. This energy is moving southward. Tropical storm Roxanne remains weak over the western Gulf of Mexico.

Prog Discussion: Frontal passage in the mid-to-late morning. Variable wind becoming strong north-northwest to 20 m/s and gusty. A band of cirrus or cirrostratus will pass through during the afternoon.

12-Hour Forecast: 12z 19 Oct - 00z 20 Oct: Variable, generally southerly, winds to 7 m/s shifting to north-northwest to 20 m/s after frontal passage which is expected by 1630 UTC. One or more cloud bands composed primarily of cirrus will pass through the region, especially northeast sections, during the afternoon.

Extended Range Discussion:

Medium-range models agree with short-range trend of a general amplification of the longwave pattern. Latest runs indicate that the stubborn longwave ridge may return early next week and limit the probability for substantial cloud.

Instrument/Platform Status:

Aircraft platforms and instruments are nominal.

Mission Scientists

UAV Scientist Bob Ellingson
ARESE Chief Scientist Francisco Valero
ARESE Mission Scientist: Steve Schwartz
Alternate Mission Scientist: Piotr J. Flatau

ARESE / UAV Mission Plan

Flight Date: 10/26/95
UAV Flight #: F95-S1-12(EO)
ER-2 Flight #: none

Meteorological Forecast 12z 26 October 1995 (Bill Syrett)

Forecast Based on Satellite, Current Surface Observations, 00z ETA, 00z NGM, 12z MAPS/RUC, 00z 11 Oct. MRF, 12z 10 Oct ECMWF

** Updated with 12z NGM data **

Synopsis: A strengthening pressure gradient between a developing lee trough to the west and northwest and high pressure to the east is causing an increase in southerly winds. A lack of humidity throughout the depth of the middle- and upper-troposphere is keeping the sky clear, however low-level moisture continues to cause hazy conditions. A cold front is causing rather extensive middle and high cloudiness with scattered precipitation over the central and northern Rockies. Circulation around hurricane Roxanne is causing cloudiness and scattered convective showers to back northwestward over the Gulf and into southeastern Texas.

Prog Discussion: A cold front is progged to pass southeast and through the region by 1400 UTC 13 October. The front should be drying out as it moves southeast and should not bring precipitation to the region. Additionally, frontal passage timing will inhibit convective development and will stop the northwestward progress of Gulf moisture before it can influence our weather. Model output relative humidity in the lowest 500 mb is sufficiently low to suggest that only scattered to potentially broken mid- or high-level clouds will precede and accompany the front. There may be a several-hour period of mid-to-upper cloud behind the front but before the longwave trough passes, and in fact the latest model output suggests this to be the case. The wind will strengthen ahead of this front today and be from a general southerly direction. An abrupt wind shift from southerly to northerly will herald the arrival of the front. Winds will become quite strong after the front passes and will shift from northerly to westerly with height. Mechanically-produced (wind-driven) turbulence is a good bet tomorrow.

*** 12z model update ***

Mid-level humidity is progged to be a bit higher than previously predicted and suggests that most of the cloudiness would be in the form of altostratus. In addition, the cold front is progged to pass through slightly later, which will increase the chance of cloudiness during tomorrow.

48-Hour Forecast:

12z 12 Oct - 12Z 13 Oct: Clear sky during the daylight hours with only a slight chance of isolated cumulus development. Some haze. Warm to hot temperature and brisk southerly winds near 20 kt with a few higher gusts during the afternoon. Winds will subside to 5-15 kt after sunset. Scattered to broken altostratus and/or cirrus should develop after midnight local time (0500 UTC). There is a slight chance of stratocumulus development, but any that form should be gone after the front passes.

12Z 13 Oct - 00Z 14 Oct: Clouds, predominantly at the mid levels, will decrease during the afternoon. Northerly winds to 25 kt with possible gusts to critical levels (30 kt), if the front

passes later than currently progged, winds will shift early from southwesterly to northerly. Cooler temperature.

00z 14 Oct - 12Z 14 Oct: Mostly clear with decreasing northerly wind. Cool.

Extended Range Discussion:

12z 14 Oct - 12Z 15 Oct: Models in fair agreement in building high pressure to our west. This is a dry and generally clear pattern that may hold for several days. The jet stream may remain close enough to allow occasional cirrus patches to pass over the region.

Mission Objectives:

The primary objective is to fly the baseline ARESE mission with the two stacked aircraft.

Instrument/Platform Status:

- Aircraft platforms and instruments are nominal.
- Most CART instruments are nominal. The 50 MHz channel of the RASS is not operational for this mission. One of the MPL systems is now operational as is the Raman lidar. The SIROS systems are working.
- The surface RAMS instruments will be installed at the CART site and at the Extended Facilities at Byron and Ringwood.

ARESE Mission Scientist: Shelly Pope

Alternate Mission Scientist: Bill Syrett

Flight Plans:

1. The standard ARESE flight track between Lamont and Coldwater, with the Twin Otter at 5 kft. MSL and the Egrett at 43 kft. MSL. While the Twin Otter is refueling the Egrett will fly N-S legs over Lamont at 43 kft. If there is opportunity at the end of the mission the two aircraft will meet at 9500 MSL and fly in formation in an L-shaped track to intercompare the radiometers.

Mission Notes from John Henderson (John.Henderson@quickmail.llnl.gov)

Cloud Detection Lidar (CDL) Wide Field of View (WFOV) supplement to science logs
(Note: "~ " indicates very approximate time, otherwise time should be good to a couple of minutes.)

11 OCT 95

CDL shows clear skies (ground returns) throughout flight

24 OCT 95

- ~15:12 cloud radar gives weak indication of very thin cirrus cloud at 6 km.
- 15:56 thin cirrus at 11.0 km alt 15:59 two cirrus layers, 11.15 km and 10.75 km alt
- 16:07 clear to faint cirrus
- 16:18 cirrus at 11.1, 10.8, and 10.6 km alt
- 17:37 intermittent cirrus, two layers
- 18:10 shift in cloud level
- 18:18 clear
- 18:29 thick cirrus and then clear
- 18:41 thin cirrus at 2.5 km below Egrett, low density but of increasing thickness
- 18:45 thick clouds fade to clear
- ~18:50 thin clouds fade in and out

26 OCT 95

- 16:55 Egrett pilot reports cloud deck at ~3000 MSL, high cirrus to NW 17:00 good WFOV showing clouds
- 17:06 WFOV showing clouds , cloud shadows (on ground), and ground 17:18 CDL showing strong ground return as well as return from ground aerosol detected during ascent
- 17:26 ground aerosol signature fading
- 17:33 CDL showing intermittent cloud layer at ~800m AGL 18:18 big cirrus 8.3 to 9.3 km
- 18:20 cloud thick enough that CDL does not see ground

18:28 CDL see 3 cirrus layers and layer at 650 m, agrees with Otter report of clouds at that elevation.

18:33 WFOV indicates clouds are uniform

18:38 Egrett reports a hole in the upper cloud deck is approaching ??? CDL punches through top and sees internal cloud structure and ground(?)

18:54 CDL shows clear to ground

~19:00 GPS shows 13.4 km alt, CDL shows ~12.9 AGL. Pilot maps show NW leg to be ~2300 ft higher than at BT (3000 ft vs. 1700 ft). 500 m difference consistent with expected difference up to 700 m.

19:14 WFOV shows broken clouds

20:00 WFOV shows uniform clouds

20:19 WFOV shows clear to ground

21:12 Egrett starts descent to 9500 ft

21:17 CDL shows some cirrus at 8.5 km

21:23 CDL rotates up-looking

21:25 Egrett in descent, CDL sees cirrus above Egrett. to 21:47 intermittent clouds and clear
21:38 Egrett stable at 2.91 km

21:47 begin tandem flight, CDL shows clear skies above Egrett 22:08 CDL to debug mode

22:09 CDL off