FIRE CIRRUS
FLIGHT SUMMARY REPORT

Flight #:	92-033		
Date:	26 November 1991		
Sensor Package:	Modis-N Airborne Simulator (MAS) Cloud Lidar System (CLS) High Resolution Interferometer Sounder (HIS) Radiation Measurement System (RAMS) Electro-Optic Camera System (EOC)		
Area(s) Covered:	Kansas, Oklahoma, Missouri		
Investigator(s):	Jedlovec, NASA-MSFC; Smith, U. of Wisconsin; Spinhirne, NASA-GSFC	**Aircraft #:**	709
Flight Request:	2P22012, 2P22014, 2P22022	**Julian Date:**	330

SENSOR DATA

Accession #:	-----	-----	-----	-----	-----
Sensor ID #:	108	113	083	112	111
Sensor Type:	MAS	CLS	HIS	RAMS	EOC
Focal Length:	-----	-----	-----	-----	-----
Film Type:	-----	-----	-----	-----	-----
Filtration:	-----	-----	-----	-----	-----
Spectral Band:	-----	-----	-----	-----	-----
f Stop:	-----	-----	-----	-----	-----
Shutter Speed:	-----	-----	-----	-----	-----
# of Frames:	-----	-----	-----	-----	-----
% Overlap:	-----	-----	-----	-----	-----
Quality:	Good	-----	-----	-----	Good
Remarks:					

FIRE Cirrus IFO II

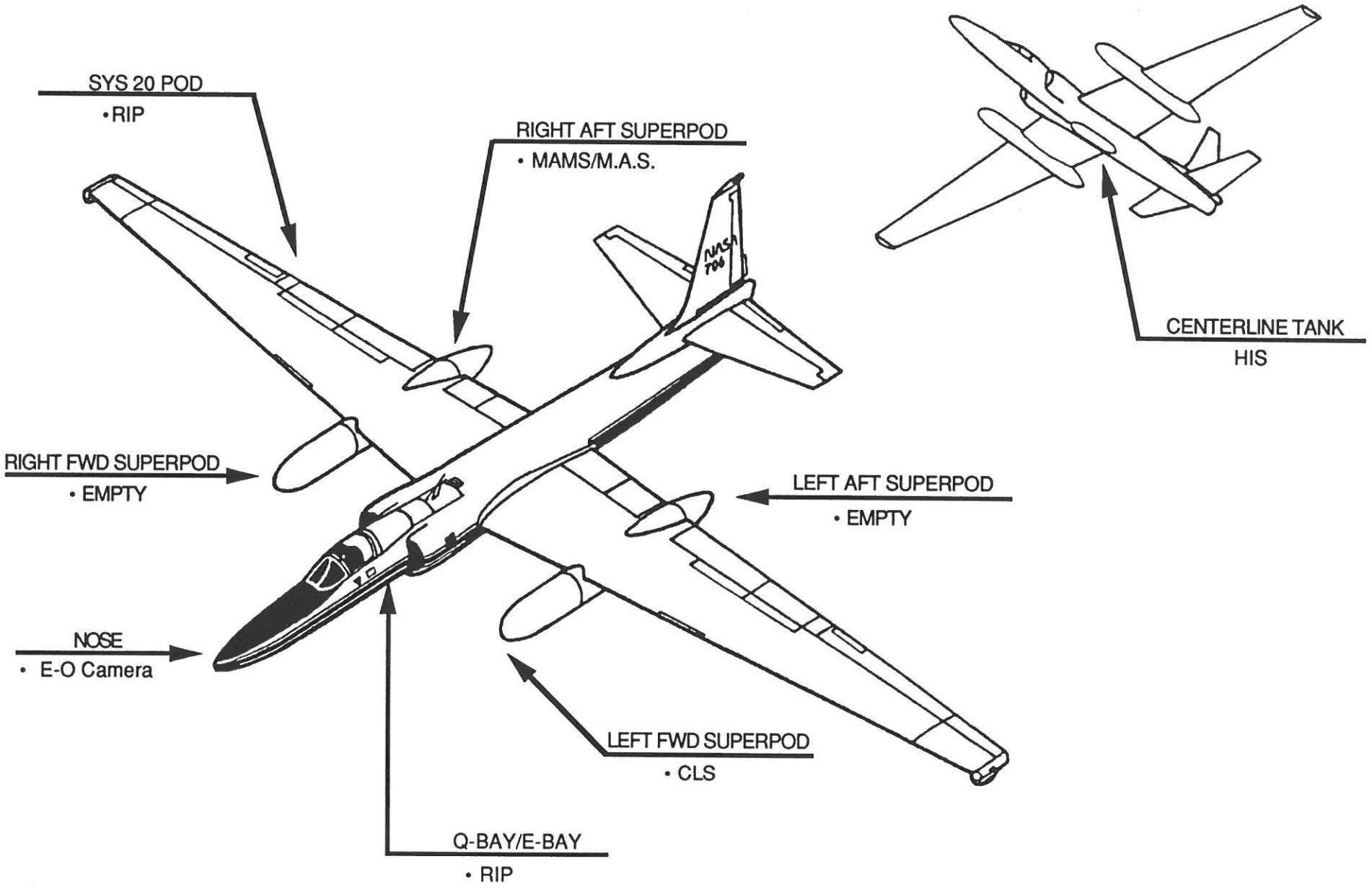
First ISCCP Regional Experiment (FIRE) is an ongoing multi-agency program designed to promote the development of improved cloud and radiation parameterizations for use in climate models, and to provide for assessment and improvement of International Satellite Cloud Climatology Program (ISCCP) products. The strategy of FIRE has been to combine modeling activities with satellite, airborne, and surface observations to study cirrus and marine stratocumulus cloud systems. These two types of climatically important cloud systems have important roles in the climate system by virtue of their extensive areal coverage, persistence, and radiative effects. The FIRE strategy consists of modeling and observation thrusts. Of primary importance are the intensive field observation studies. The initial cirrus observation experiment was conducted in 1986.

The second FIRE Cirrus Intensive Field Observations (IFO) of November, 1991 combines coordinated satellite, airborne, and surface observations to investigate the cloud properties and physical processes of mid-continent cirrus clouds associated with the sub-tropical jet stream. In recognition of the true multi-scale control of cirrus cloud systems, the Cirrus IFO II consists of a set of nested observations/platforms. The large scale will be defined by standard weather service and satellite products, and the regional environs monitored by special meteorological and wind profiler networks. The cloud and small scale will be passive sensing and by remote and *in situ* sensing from aircraft. The central field site location for the Cirrus IFO II is southeastern Kansas.

The role of the NASA ER-2 aircraft in the FIRE Cirrus IFO is to provide a platform for detailed measurement of outgoing cloud top radiation and for cloud top remote sensing. The measurements are applied to define cloud structural and microphysical parameters by remote methods and to provide supporting data for satellite observations. The instruments on the ER-2 are the Modis Airborne Simulator (MAS), Cloud Lidar System (CLS), High resolution Interferometer Spectrometer (HIS), Electro Optics Camera (EOC), and Radiation Measurement System (RAMS). As a continuation of work begun in 1986 the MAS, CLS, and HIS will define the vertical and horizontal structure for cirrus radiation parameters and particle characteristics, and RAMS defines radiation flux. The MAS, CLS, HIS, and RAMS are significantly improved in coverage and accuracy over instruments which were previously flown. A new experimental measurement by the 1991 FIRE ER-2 Cirrus Mission will be measurements by the EOC and RAMS instruments of the angular dependence of reflected solar radiation. The directional reflectance function is a critical factor for relating satellite data and models to the true characteristics and over all radiative influence of cirrus and will be observed extensively for the first time in this experiment.

FIRE CONFIGURATION

SHIP 709



Airborne Science and Applications Program

The Airborne Science and Applications Program (ASAP) is supported by three ER-2 high altitude Earth Resources Survey aircraft. These aircraft are operated by the High Altitude Missions Branch at NASA-Ames Research Center, Moffett Field, California. The ER-2s are used as readily deployable high altitude sensor platforms to collect remote sensing and *in situ* data on earth resources, celestial phenomena, atmospheric dynamics, and oceanic processes. Additionally, these aircraft are used for electronic sensor research and development and satellite investigative support.

The ER-2s are flown from various deployment sites in support of scientific research sponsored by NASA and other federal, state, university, and industry investigators. Data are collected from deployment sites in Kansas, Texas, Virginia, Florida, and Alaska. Cooperative international scientific projects have deployed the aircraft to sites in Great Britain, Australia, Chile, and Norway.

Photographic and digital imaging sensors are flown aboard the ER-2s in support of research objectives defined by the sponsoring investigators. High resolution mapping cameras and digital multispectral imaging sensors are utilized in a variety of configurations in the ER-2s' four pressurized experiment compartments. The following provides a description of the digital multispectral sensor used for data collection during this flight.

Airborne Visible and Infrared Imaging Spectrometer

The Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) is the second in the series of imaging spectrometer instruments developed at the Jet Propulsion Laboratory (JPL) for earth remote sensing. This instrument uses scanning optics and four spectrometers to image a 614 pixel swath simultaneously in 224 contiguous spectral bands (0.4-2.4 μm).

AVIRIS parameters are as follows:

IFOV:	1 mrad
Ground Resolution:	66 feet (20 meters) at 65,000 feet
Total Scan Angle:	30°
Swath Width:	5.7 nmi (10.6 km) at 65,000 feet
Spectral Coverage:	0.41-2.45 μm
Pixels/Scan Line:	614
Number of Spectral Bands:	224
Digitization:	10-bits
Data Rate:	17 MBPS

Spectrometer	Wavelength Range	Number of Bands	Sampling Interval
1	0.41 - 0.70 μm	31	9.4 nm
2	0.68 - 1.27 μm	63	9.4 nm
3	1.25 - 1.86 μm	63	9.7 nm
4	1.84 - 2.45 μm	63	9.7 nm

All AVIRIS data is decommutated and archived at JPL and not currently available for public distribution. For further information contact Rob Green at Jet Propulsion Laboratory, 4800 Oak Grove Drive, Mail Stop 183-501, Pasadena, California 91109-8099.

Modis-N Airborne Simulator

The Modis-N Airborne Simulator (MAS) is a modified Daedalus multispectral scanner. It records up to twelve 8-bit channels, which can be selected from an array of fifty available spectral bands. The band selection is made prior to flight and the instrument is hard-wired to that configuration. Channel 1 can be used to store additional bits which provide 10-bit resolution for channels 9 through 12. The band configuration for this FIRE Cirrus Deployment is as follows:

Channel	Band edges μm
1	-------
2	0.675 - 0.685
3	1.605 - 1.655
4	1.905 - 1.955
5	2.055 - 2.105
6	2.105 - 2.155
7	3.675 - 3.825
8	4.575 - 4.725
9*	4.325 - 4.575
10*	8.600 - 9.000
11*	10.700 - 11.200
12*	11.700 - 12.200

* 10-bit resolution

Sensor/Aircraft Parameters:

Spectral Channels:	50
Output Channels:	Seven 8-bit and four 10-bit
IFOV:	0.5 mrad
Ground Resolution:	163 feet (50 meters at 65,000 feet)
Total Scan Angle:	85.92°
Pixels/Scan Line:	716
Scan Rate:	6.25 scans/second
Ground Speed:	400 kts (206 m/second)
Roll Correction:	Plus or minus 3.5 degrees (approx.)

Cloud Lidar System

The Cloud Lidar System (CLS) is flown on the ER-2 to conduct cloud radiation and severe storm field experiments. Designed to operate at high altitudes in order to obtain measurements above the highest clouds, the instrument provides the true height of cloud boundaries and the density structure of less dense clouds. The height structure of cirrus, cloud top density and multiple cloud layers may also be profiled. System specifications are as follows:

Transmitter

Laser Type:	Nd:YAG I,II
Wavelength:	1064, 532 nm
Pulse Energy:	90, 30 mJ
PRF:	10 Hz
Beamwidth:	1 mrad
Data Acquisition:	Measurements at 20m intervals at 200 m/sec aircraft speed

Receiver

Diameter:	0.15 m
Beamwidth:	1.4 mrad
Polarization:	v & h

Data System

Range Resolution:	7.5 m
Number of Channels:	4
Samples per Channel:	3310
Record Capacity:	8 hours

For further information regarding this instrument contact Dr. James Spinhirne, NASA-Goddard Space Flight Center, Code 917, Greenbelt, MD 20771.

High-Resolution Interferometer Sounder

The High-Resolution Interferometer Sounder (HIS) measures upwelling infrared spectral radiance at the aircraft altitude with high absolute accuracy using a passive Michelson interferometer and precision onboard blackbody calibration sources. The instrument has a single nadir staring field of view with observed spectra obtained every six seconds. The spectra cover the range 16.6 microns to 3.3 microns with a spectral resolution of 0.3 to 0.5 cm^{-1}. The primary use of the instrument is as an atmospheric sounder of temperature and water vapor. The spectra also contain important information on trace gases and surface properties. The HIS was developed by the University of Wisconsin at Madison and is a prototype instrument for advanced infrared satellite sounders.

Radiation Measurement System

The Radiation Measurement System (RAMS) is an integrated system of several radiometers. The system provides airborne measurements to support analysis and theoretical calculations of cloud properties and radiation fields and to provide validation of satellite radiance measurements. The airborne instruments consist of the following:

1. an electrically calibrated pyroelectric radiometer for hemispherical, broad spectral bandpass, radiative flux measurements in the solar spectral region (0.26 to 2.6 μm). This radiometer has two detectors;

2. an IR net flux radiometer (rotating) radiometer covering the spectral range from 5 to 40 μm;

3. a narrow field-of-view, narrow spectral bandpass IR radiometer (2 channels in the 5 to 40 μm region). This radiometer uses a liquid nitrogen cooled black body reference. This instrument provides upwelling infrared intensities above cloud; and

4. a total-direct-diffuse multichannel narrow spectral bandpass (about 5 to 10 nm) flux radiometer. This radiometer is used for optical depth determinations and direct/diffuse ratios.

Detailed information regarding this system may be obtained from Francisco P.J. Valero, Atmospheric Physics Research Branch, NASA-Ames Research Center, Mail Stop 245-4, Moffett Field, CA 94035-1000.

Electro-Optic Camera System

The NASA-Ames High Definition Electro-Optic Camera System (EOC) is an experimental sensor under development by the High Altitude Missions Branch at NASA-Ames Research Center. The system captures high resolution digitized images from a solid-state video camera and stores the imagery on magnetic tape. System characteristics are as follows:

CCD Video Camera

IFOV:	0.2 mrad
Ground Resolution:	15.8 feet (4.81 meters at 65,000 feet
Total Scan Angle:	13.96°
Swath Width:	3.3 nmi (6.2 km) x 2.7 nmi (4.9 km) at 65,000 feet
Spectral Coverage:	400-900 nm
Frame Size:	1280 pixels x 1025 pixels
Lens (Interchangeable):	28 mm
Shutter Speed:	Selectable
Aperture:	f/2.8
Filtration:	4 and 6 position filter wheels (4 and 6 spectral filters) Polarizing Filter
Tracking Capability:	Tilt 45° fore and aft

Data Collection

Frame Rate:	1 image every 3 seconds
Frame Overlap:	90% (to 40% w/6 filters)
Data Storage:	Tape Cassette
Capacity:	5.0 Gbytes

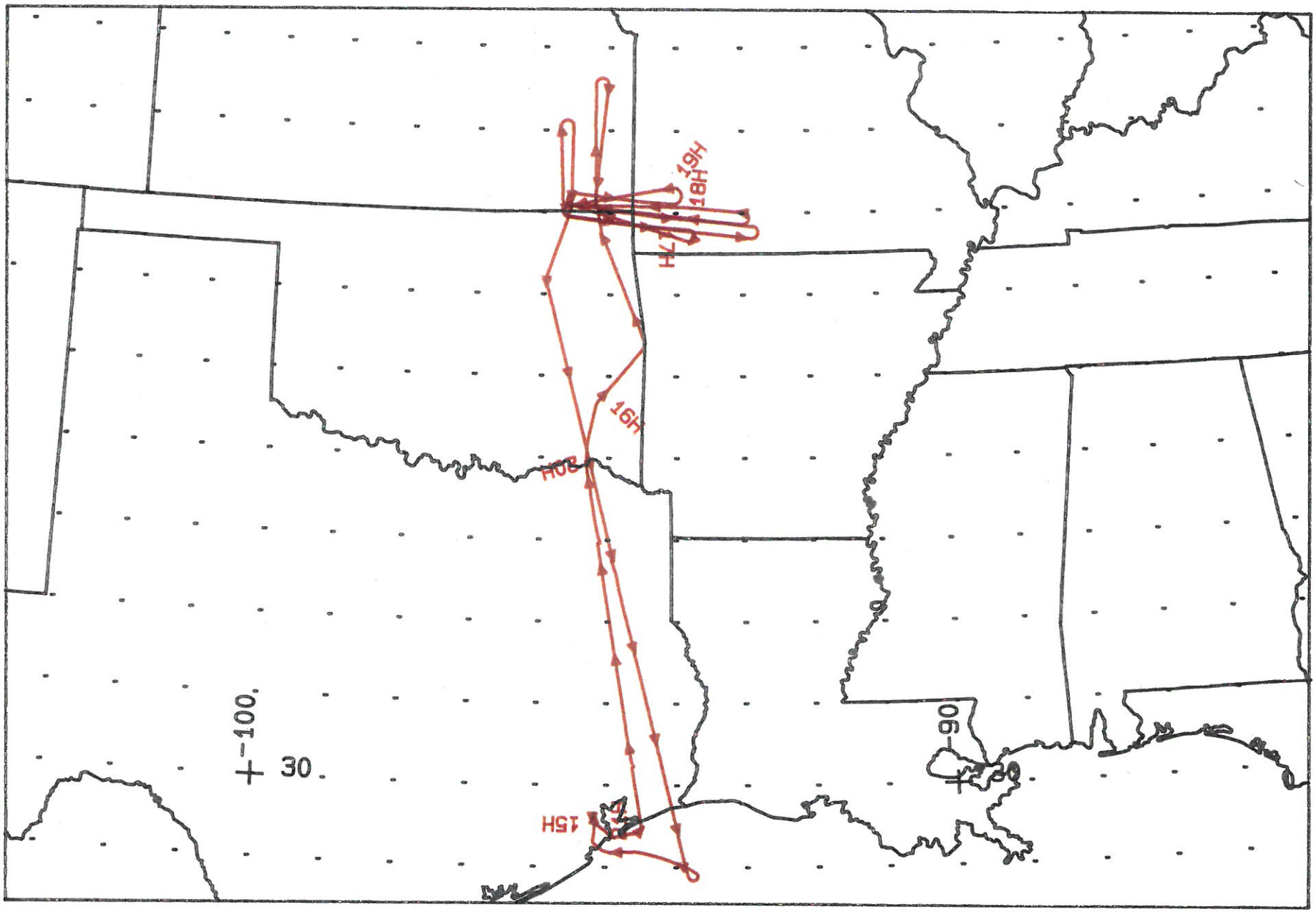
Further information may be obtained from Ted Hildum at NASA-Ames Research Center, Mail Stop 240-6, Moffett Field, California 94035-1000.

Additional information regarding ER-2 acquired photographic and digital data is available through the Aircraft Data Facility at Ames Research Center. For specific information regarding flight documentation, sensor parameters, and areas of coverage contact the Aircraft Data Facility, NASA-Ames Research Center, Mail Stop 240-6, Moffett Field, California 94035-1000 (Telephone: (415) 604-6252).

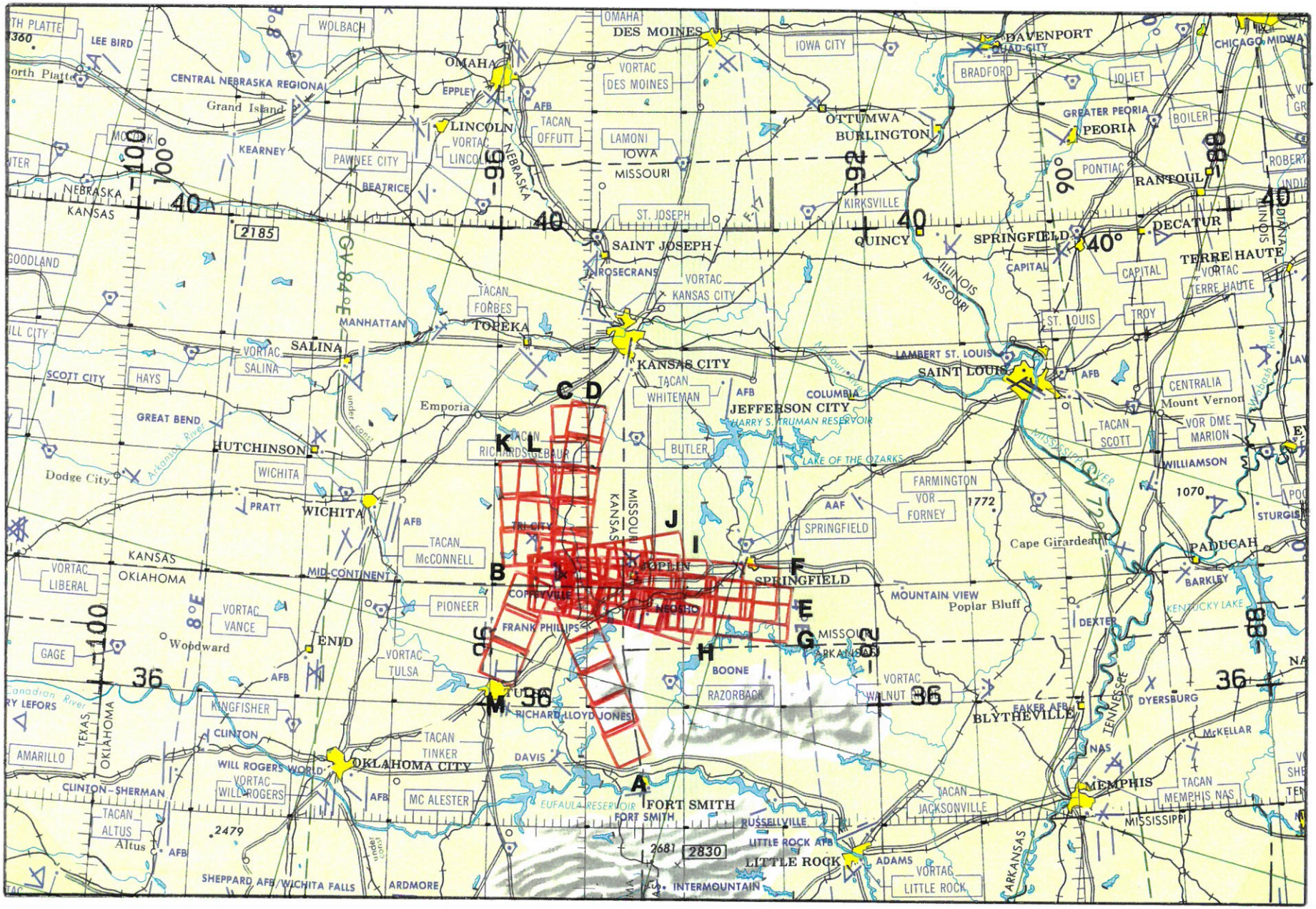
SCANNER FLIGHT LINE DATA
FLIGHT NO. 92-033

DAEDALUS FLIGHT DATA
FLIGHT NUMBER: 92-033

Check Points	Actual Time (GMT) Begin	Actual Time (GMT) End	Actual Scanline Begin	Actual Scanline End	Altitude feet/meter	Scan Speed (rps)	Total Good Scanlines	Total Interpolated Scanlines	Total Repeated Scanlines
A-B	16:08:03	16:23:36	28017	33826	65000/19812	6.25	5801	0	9
B-C	16:24:24	16:36:12	34126	38534	65000/19812	6.25	4401	0	8
D-B	16:39:25	16:51:11	39734	44134	65000/19812	6.25	4401	0	0
B-E	16:53:37	17:07:00	45038	50038	65000/19812	6.25	5001	0	0
F-B	17:09:56	17:29:14	51138	58347	65000/19812	6.25	7201	0	9
B-G	17:31:54	17:50:08	59346	66158	65000/19812	6.25	6802	0	11
F-B	17:53:22	18:13:43	67360	74965	65000/19812	6.25	7601	0	5
B-H	18:15:51	18:28:10	75765	80367	65000/19812	6.25	4601	0	2
H-B	18:31:08	18:44:00	81471	86277	65000/19812	6.25	4801	0	6
B-I	18:46:25	18:56:03	87181	90781	65000/19812	6.25	3601	0	0
J-B	18:59:32	19:11:02	92081	96381	65000/19812	6.25	4301	0	0
B-K	19:12:39	19:20:09	96981	99783	65000/19812	6.25	2801	0	2
L-B	19:23:06	19:30:05	100885	103493	65000/19812	6.25	2601	0	8
B-M	19:31:25	19:39:11	103993	106895	65000/19812	6.25	2901	0	2



FLIGHT 92-033 26 November 1991 A/C 709 FIRE Flight



FLIGHT 92-033 26 November 1991 Modis Airborne Simulator (MAS) GNC 2