FLIGHT SUMMARY REPORT

Flight Number: 93-057

Calendar/Julian Date: 29 January 1993 • 029

Sensor Package:
Aerosol Particulate Sampler (APS)
Advanced Microwave Precipitation Radiometer (AMPR)
Lightning Instrument Package (LIP)
Modis-N Airborne Simulator (MAS)
MIT Millimeter-wave Temperature Sounder (MTS)
Electro-Optic Camera System (EOC)
Radiation Measurement System (RAMS)
Cloud Lidar System (CLS)
Millimeter-Wave Imaging Radiometer (MIR)

Area Covered: Northeast Coast -- Queensland, Australia

Aircraft #: 709

Investigator: Spinhirne, NASA-GSFC

SENSOR DATA

Sensor Type	Sensor ID #	Quality	Remarks
APS	024	-----	
AMPR	105	-----	
LIP	106	-----	
MAS	108	Good	King 3 configuration (see write up)
MTS	110	-----	
EOC	111	-----	
RAMS	112	-----	
CLS	113	-----	
MIR	114	-----	

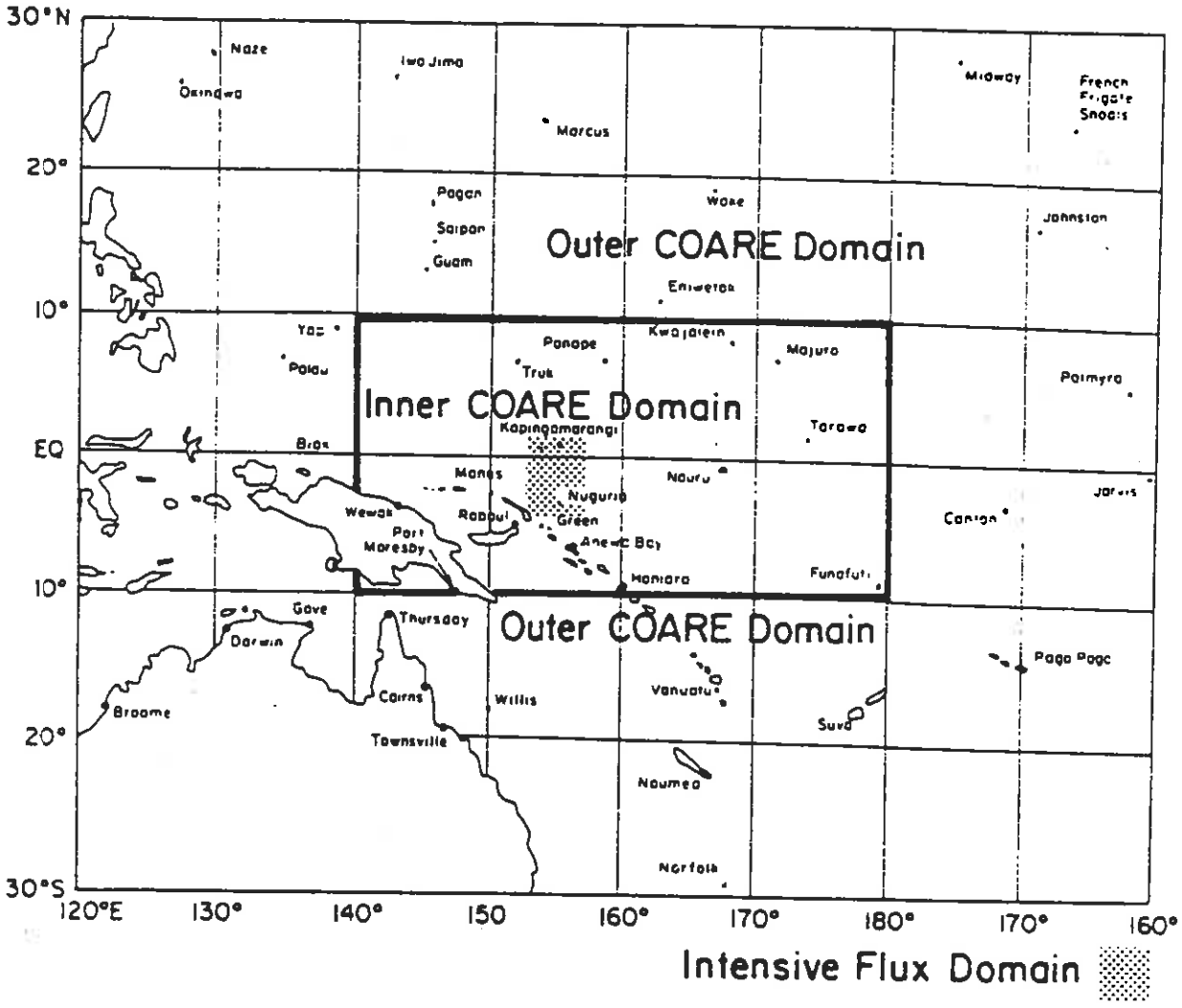
NASA AIRCRAFT TO STUDY OCEAN - CLOUD THERMAL EFFECTS IN SOUTH PACIFIC REGION

NASA will send two aircraft bearing state-of-the-art scientific instruments to Australia in January 1993 to participate in a major international research program aimed at investigating meteorological phenomena in the equatorial region of the western Pacific Ocean near New Guinea and the Solomon Islands.

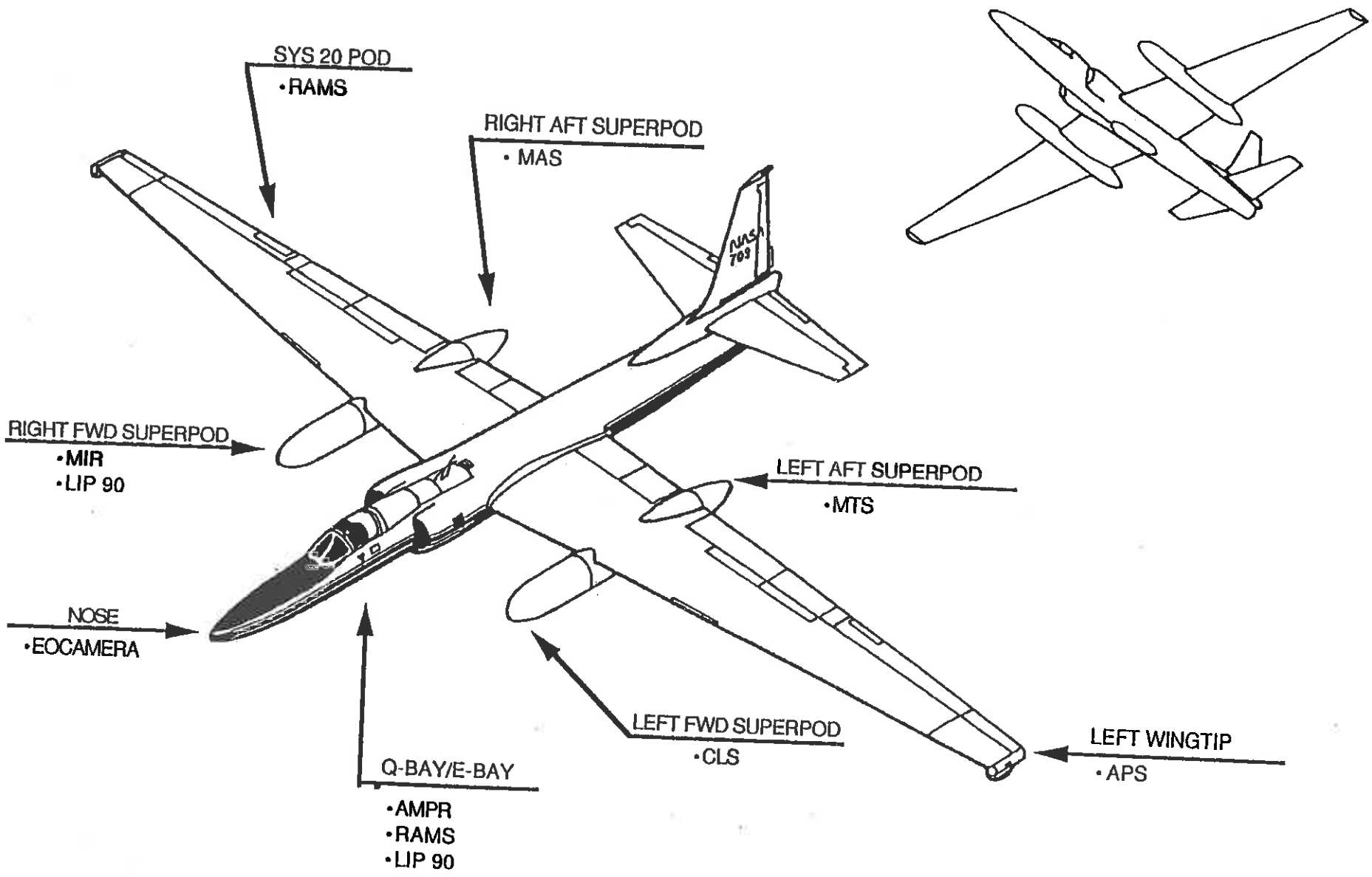
The program called TOGA COARE (Tropical Ocean Global Atmosphere-Coupled Ocean Atmospheric Response Experiment) will explore the scientific phenomena associated with the ocean, atmosphere and the interaction between the two in the warm pool region of the western Pacific Ocean. It is international in scope involving 15 nations, and several U.S. agencies in addition to NASA. In order to carry out the observations required during the experiment phase of the program, current plans call for the deployment of oceanographic ships and buoys, several ship and land based Doppler radars, multiple low and high level aircraft equipped with Doppler radar and other airborne sensors, as well as a variety of surface based instruments for *in situ* observations.

The NASA component of TOGA COARE, while contributing directly to overall COARE objectives, will emphasize scientific objectives associated with the Tropical Rainfall Measuring Mission (TRMM), an understanding of convection in general and NASA's cloud and radiation program. The highest priority will be given to the observations related to TRMM science, i.e., tropical ocean precipitation climatology (rainfall at the surface), vertical structure of precipitation processes, all aspects of the water cycle over the COARE domain. Cloud and radiation objectives are closely associated with the International Satellite Cloud Climatology Project (ISCCP) and first ISCCP Regional Experiment (FIRE) project objectives, and will emphasize the study of the tropical cirrus radiative properties. The two instrumented NASA aircraft are the ER-2 for heights required above tropical cloud formations at 65,000 feet, and the DC-8 which will be operating from 35,000 to 40,000 feet. Flights will be coordinated with other aircraft operating at lower levels and with surface observations made from ships and ground stations.

The array of instrumentation to be available in the intensive observation period (January 1, through February 28, 1993) of TOGA COARE offers NASA a unique opportunity to investigate in detail many of the scientific objectives noted. NASA's participation with a variety of radiometers, radar, lidar, and other instruments on-board the DC-8 and ER-2 aircraft will provide the high altitude remote sensing of atmospheric and surface parameters to correlate with measurements made from lower flying aircraft and surface stations. NASA's participation with surface precipitation radar observations and optical rain-rate gauges on all the participating TOGA COARE ships and surface moorings at or near the Intensive Flux Array (IFA) will meet the surface rainfall objectives for TRMM as well as fresh water input for ocean and related flux studies.


30°N
20°
10°
EQ
10°
20°
30°S
120°E
130°
140°
150
160°
170°
180°
170°
160°
Outer COARE Domain
Inner COARE Domain
Outer COARE Domain
Naze
Okinawa
Iwo Jima
Marcus
Midway
French Frigate Shoals
Pagan
Saipan
Guam
Wake
Johnston
Enewetak
Yap
Palau
Ponape
Truk
Kwajalein
Majuro
Palmyra
Tarawa
Kapingamarangi
Manus
Nauru
Nukuria
Wewak
Rabaul
Green
Port Moresby
Honiara
Funafuti
Jarvis
Canton
Gove
Darwin
Thursday
Broome
Cairns
Willis
Townsville
Vanuatu
Suva
Pago Pago
Noumea
Norfolk
Intensive Flux Domain

TOGA-COARE CONFIGURATION



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 sensors and camera system(s) used for data collection during this flight.

Aerosol Particulate Sampler

The Aerosol Particulate Sampler (APS) has been developed and is operated by Dr. Guy Ferry of the NASA-Ames Research Experiments Branch. The sampler is a non-imaging sensor designed to gather high altitude dust particles for laboratory research.

Advanced Microwave Precipitation Radiometer

The Advanced Microwave Precipitation Radiometer (AMPR) is a scanning passive microwave radiometer operating at frequencies of 10, 19, 37, and 85 GHz. The AMPR is configured to fit into the Q-bay of the ER-2 and scans cross-track +/- 45° to the left and right of nadir. The instrument's principle use is for gathering microwave image data of cloud water and precipitation primarily over the ocean. Some data collected also will be used for studies of vegetation, ground moisture, sea surface state, and snow cover. The AMPR is sponsored by Dr. Roy W. Spencer, NASA-MSFC, ES43, Huntsville, Alabama 35812.

Lightning Instrument Package

The Lightning Instrument Package (LIP) comprises a set of optical and electrical sensors with a wide range of temporal, spatial, and spectral resolution to observe lightning and investigate electrical environments within and above thunderstorms. The instruments provide measurements of the air conductivity and vertical electric field above thunderstorms and provide estimates of the storm electric currents. In addition, LIP will detect total storm lightning and differentiate between intracloud and cloud-to-ground discharges. This data will be used in studies of lightning/storm structure and lightning precipitation relationships. The LIP is sponsored by Dr. Richard Blakeslee, NASA-MSFC, ES43, Huntsville, Alabama 35812.

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 50 available spectral bands. The band selection is made prior to flight and the instrument is hard-wired to that configuration. Channel one can be used to store additional bits which provide 10-bit resolution for channels 9 through 12. The two band configurations (Jed1 and King3) used for the TOGA COARE deployment are as follows:

Jedlovec Configuration (Jed 1)

Channel	Band edges µm
1	-----
2	0.675 - 0.685
3	1.605 - 1.655
4	1.955 - 2.005
5	3.675 - 3.825
6	4.325 - 4.575
7	4.575 - 4.725
8	9.000 - 9.400
9*	9.400 - 9.800
10*	9.800 - 10.200
11*	10.700 - 11.200
12*	12.200 - 12.700

King Configuration (King 3)

Channel	Band edges µm
1	-----
2	0.635 - 0.688
3	0.852 - 0.893
4	1.595 - 1.652
5	1.805 - 1.855
6	2.126 - 2.173
7	3.659 - 3.810
8	13.630 - 14.147
9*	8.342 - 8.738
10*	10.791 - 11.239
11*	13.023 - 13.375
12*	11.799 - 12.246

* 10-bit resolution

Sensor/Aircraft Parameters:

Spectral Channels:	50
Output Channels:	7 8-bit and 4 10-bit
IFOV:	5.0 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.)

MIT Millimeter-wave Temperature Sounder

The Millimeter-wave Temperature Sounder (MTS) is a dual-band microwave radiometer system for the measurement of atmospheric temperature and other phenomena affecting transmission in the microwave absorption bands of molecular oxygen. MTS data has been used to produce images of temperature and precipitation structure, to infer precipitation cell top altitudes and to detect atmospheric waves.

The instrument is capable of either downward- or upward-viewing operation on the ER-2 as well as ground-based operation. One radiometer is an eight channel scanning spectrometer with its radiometer centered on the 118,75 GHz oxygen line. The second radiometer is a single-channel (Channel 0) nadir (or zenith) viewing system with its local oscillator tunable under computer control from 52 to 54 GHz. Characteristics of the two radiometers are as follows:

Channel	Center freq. (MHz)	Width (MHz)
	Single Channel Radiometer	
0	115	170
Channel	**Center freq. (MHz)**	**Width (MHz)**
	Eight Channel Radiometer	
1	660	170
2	840	210
3	1040	240
4	1260	220
5	1470	240
6	1670	220
7	1900	270
8	500	125

For further information contact Michael Schwarz, Massachusetts Institute of Technology, MIT-RLE Mail Stop 26-357, 77 Massachusetts Ave., Cambridge, MA 02139.

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

For additional information contact Ted Hildum at NASA-Ames Research Center, Mail Stop 240-6, Moffett Field, California 94035-1000.

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.

For additional information regarding this system contact Francisco P.J. Valero, Atmospheric Physics Research Branch, NASA-Ames Research Center, Mail Stop 245-4, Moffett Field, CA 94035-1000.

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

Millimeter-Wave Imaging Radiometer

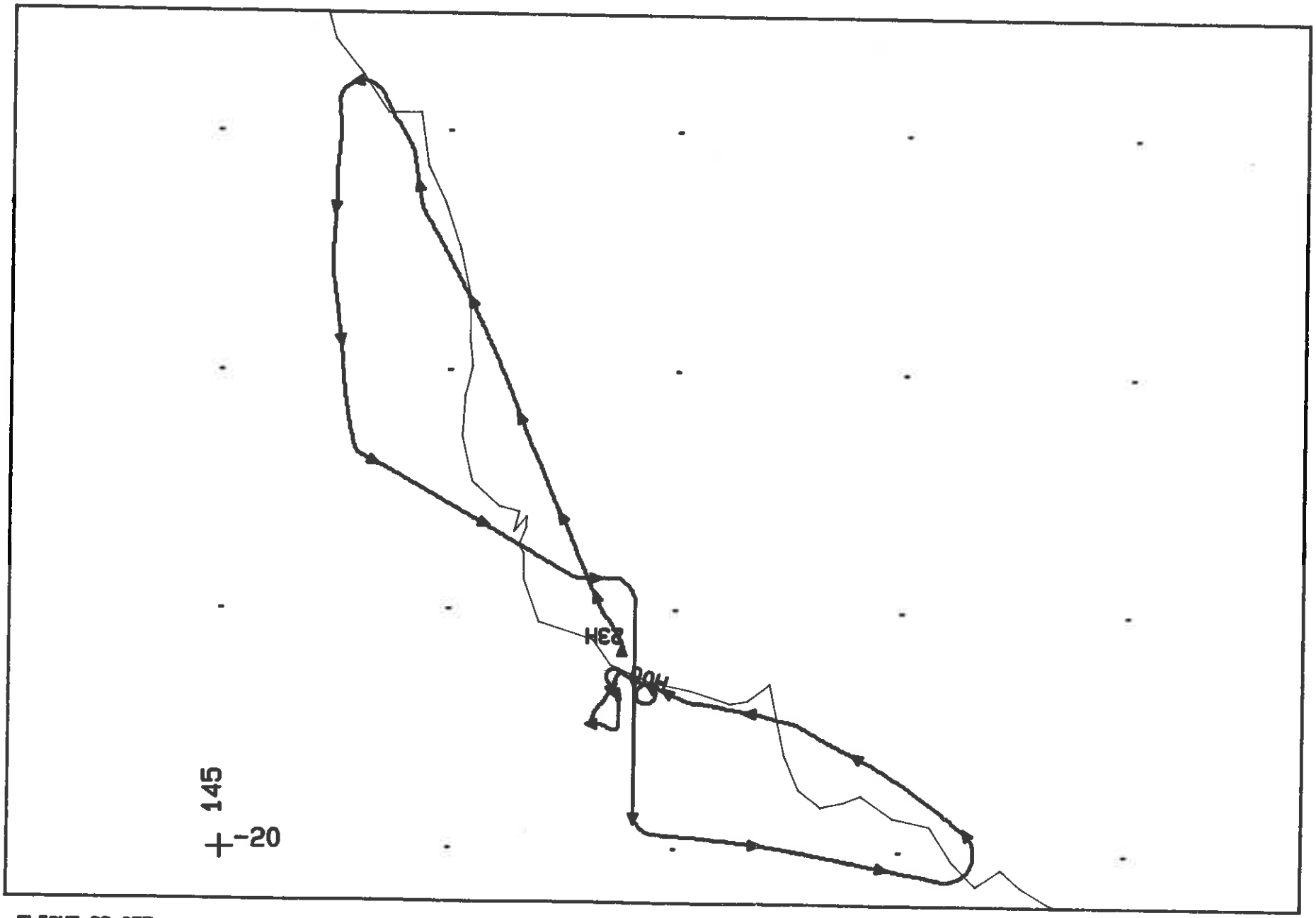
The Millimeter-Wave Imaging Radiometer (MIR) is a nine channel radiometer developed for atmospheric research. Three dual pass band channels are centered about the strongly opaque 183 GHz water absorption line and a fourth channel is located at 150 GHz. These four channels have varying degrees of opacity from which the water vapor profile can inferred. There are two additional channels located at 89 GHz and 220 GHz. The design includes three additional channels centered about 325 GHz which are supplied by the Georgia Institute of Technology.

Frequencies and polarization were chosen to match those of the Advanced Microwave Sounding Unit-B (AMSU-B) planned for NOAA operational polar weather satellites and the Earth Observing System (EOS). Frequencies also match closely with those of the Special Sensor Microwave Temperature Sounder-2 (SSMT-2) now aboard the DMSP satellite.

Information regarding this instrument may obtained from Paul Racette, NASA-Goddard Space Flight Center, Code 975, Greenbelt, MD 20771.

The U.S. Geological Survey's EROS Data Center at Sioux Falls, South Dakota serves as the archive and product distribution facility for NASA-Ames aircraft acquired photographic and digital imagery. For information regarding photography and digital data (including areas of coverage, products, and product costs) contact EROS Data Center, Customer Services, Sioux Falls, South Dakota 57198 (Telephone: (605) 594-6151).

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).



FLIGHT 93-057 29 JANUARY 1993 A/C 709 TOGA COARE NAS