FLIGHT SUMMARY REPORT

Flight Number:	93-168
Calendar/Julian Date:	26 September 1993 • 269
Sensor Package:	Advanced Microwave Precipitation Radiometer (AMPR) High-Resolution Interferometer Sounder (HIS) Lightning Instrumentation Package (90) (LIP90) Multispectral Atmospheric Mapping Sensor (MAMS) Millimeter-wave Imaging Radiometer (MIR) Microwave Temperature Sounder (MTS)
Area Covered:	Atlantic Ocean off Virginia, North Carolina shore
Aircraft #:	709
Investigator:	Arnold, NASA-MSFC; Wang, NASA-GSFC

SENSOR DATA

Sensor Type	Sensor ID #	Remarks
AMPR	105	See data sheet
HIS	083	"
LIP90	106	"
MAMS	080	"
MIR	114	"
MTS	110	"

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

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.

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.

Lightning Instrumentation Package (90)

The Lightning Instrumentation Package (LIP90) 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.

Multispectral Atmospheric Mapping Sensor

The Multispectral Atmospheric Mapping Sensor (MAMS) is a modified Daedalus Scanner flown aboard the ER-2 aircraft. It is designed to study weather related phenomena including storm system structure, cloud-top temperatures, and upper atmosphere water vapor. The scanner retains the eight silicon-detector channels in the visible/near-infrared region found on the Daedalus Thematic Mapper Simulator, with the addition of four channels in the thermal infrared relating to specific water vapor features. The specific bands are as follows:

Daedalus Channel	Wavelength, μm
1	LSBs for Channels 9-12
2	0.45 - 0.52
3	0.52 - 0.60
4	0.57 - 0.67
5	0.60 - 0.73
6	0.65 - 0.83
7	0.72 - 0.99
8	0.83 - 1.05
9	6.20 - 6.90
10	10.3 - 12.1 offset for cold target
11	10.3 - 12.1 offset for warm target
12	12.5 - 12.8

Sensor specifications are as follows:

IFOV:	5.0 mrad
Ground Resolution:	325 feet (99 meters) at 65,000 feet
Total Scan Angle:	86°
Swath Width:	20 nmi (37 km) at 65,000 feet
Pixels/Scan Line:	716
Scan Rate:	6.25 scans/second
Ground Speed:	400 kts (206 m/second)
Digitization:	8-bit channels 2-8 10-bit channels 9-12

The data will not be archived at EROS Data Center because this is an experimental system with low spatial resolution and unique spectral characteristics. As all scenes will be primarily cloud-covered there would be little terrestrial application for the data. Further information concerning the data can be obtained from principal investigator, Gregory S. Wilson, Atmospheric Effects Branch, George C. Marshall Space Flight Center, National Aeronautics and Space Administration, Marshall Space Flight Center, Alabama 35812-5001.

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 (Ch. 0) nadir (or zenith) viewing system with its local oscillator tunable under computer control from 52 th 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.

ER-2 Doppler Radar

The ER-2 Doppler Radar (EDOP) is an X-band (9.6 GHz) Doppler radar located in the nose of the aircraft. EDOP has two 0.76 meter diameter antennas. One antenna is nadir pointing with pitch stabilization and the other is forward pointing. EDOP will map high resolution time-height sections of reflectivity, vertical hydrometeor velocity, and vertical air motion (when the hydrometer fallspeed and aircraft motions are removed). The forward beam will measure the linear depolarization ratio (LDR) which provides useful information on orientation of the hydrometeors, hydrometer phase and size. For additional information regarding EDOP contact Gerald Heymsfield, NASA Goddard Space Flight Center, Code 912, Goddard Space Flight Center, Greenbelt, MD 21077 (Telephone 301-286-4661). EDOP system specifications are as follows:

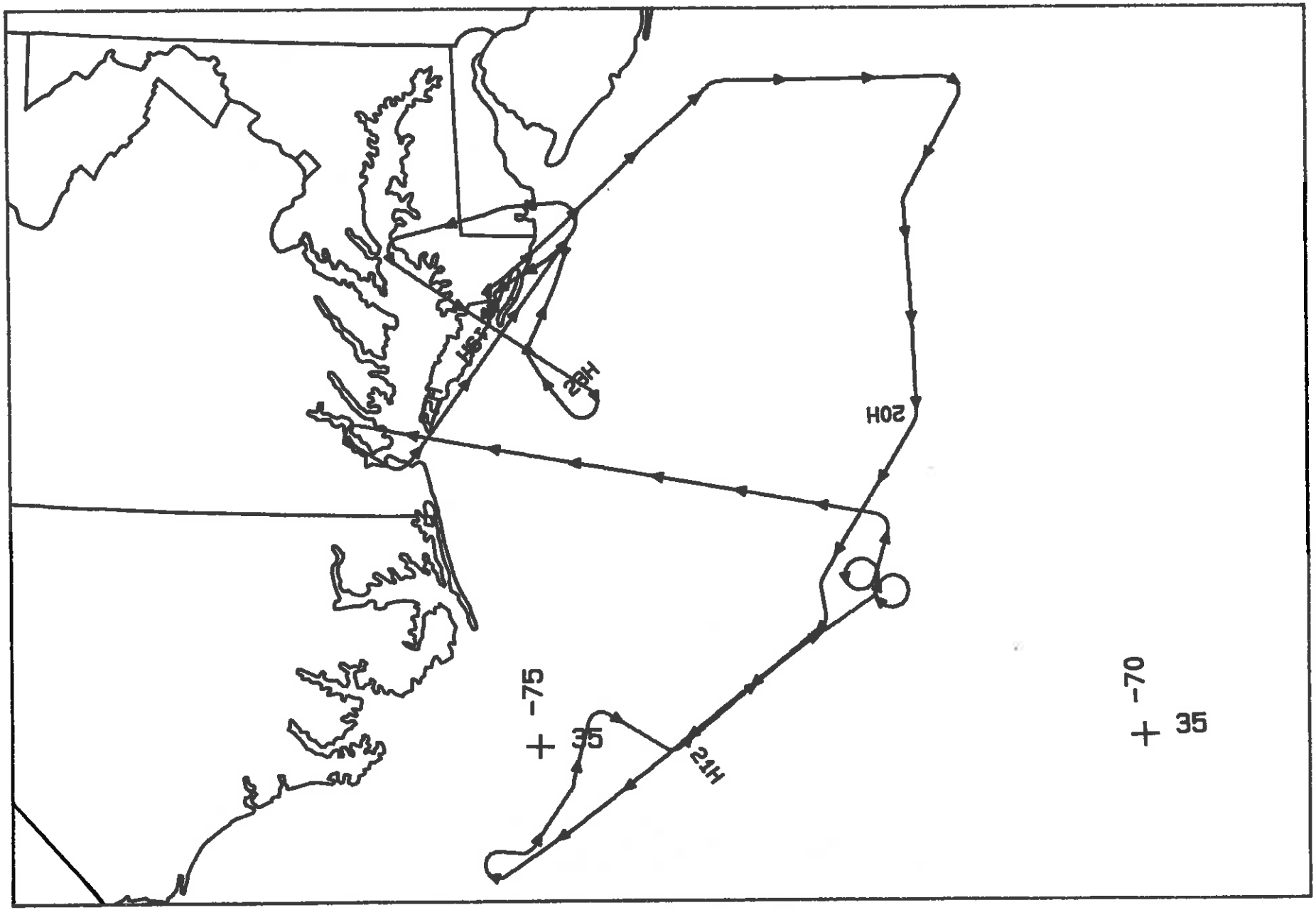
Center Frequency	9.6 GHz
Peak Power	20 kW
Duty Cycle	.01 max.
Pulse Length	.25, 1.0μs
Antenna Diameter	.76 m
Antenna Beamwidth	2.9o
First Side-lobe Level	<-30 dB
Cross polarization Level	<-38 dB
Receiver Dynamic Range	110 dB
Number of Doppler Channels	2
Number of Log Reflectivity Channels	3

Nadir Beam:	
Transmit Polarization	Horizontal
Received Polarization	Copolarized
Forward Beam:	
Transmit Polarization	Vertical
Received Polarization	Copolarized and Cross-polarized

Additional information on data tape format, logical record format, and scanner calibration data may be obtained from the Aircraft Data Facility, NASA-Ames Research Center, Mail Stop 240-6, Moffett Field, California 94035-1000 (Telephone: 415-604-6252).

FLIGHT NO. 93-168 CAMEX DEPLOYMENT 26 SEPTEMBER 1993

SENSOR	STATION	TIME ON	TIME OFF	REMARKS
AMPR	Q-bay	18:53	23:41	OK data flight. AMPR had good data during passes over storms. We encountered interference at 2141z (problems in 19 &37 during interference). We had minor noise in 85 GHz during flight.
HIS	Centerline pod	19:15	22:55	Good.
LIP90	FM'S Cond	18:52 18:52	23:42 23:42	Good (some lightning) OK. No noise on top mill (EDOP not on)
MAMS	Left aft superpod	19:26	22:55	At altitude. All data at altitude is good. Occasional very low amplitude noise associated with VHF/UHT communicaiton.
MIR	Rt. fwd. superpod	19:08	23:41	Good data. Some precip cells were observed. The two 360 turns were not made over precip.
MTS	Rt. aft superpod	18:51:46	19:51:53	80 second glitch after ascent. 53 GHz cycle 52.800, 52.952, 53.310, 53.480, 53.596, 5.5 secons each, in succession.



FLIGHT 93-168 28 SEPTEMBER 1993 A/C 709 MAMS