FLIGHT SUMMARY REPORT

Flight Number:	97-047
Calendar/Julian Date:	09 February 1997 • 040
Sensor Package:	Dual Wild-Heerbrugg RC-10 Modis Airborne Simulator (MAS) Aerosol Particulate Sampler (APS)* High-Resolution Interferometer Sounder (HIS)* Cloud Lidar System (CLS)* Millimeter-Wave Imaging Radiometer (MIR)*
Area(s) Covered:	New England
Investigator(s):	Menzel, University of Wisconsin; Hall, NASA-GSFC
Aircraft #:	708

SENSOR DATA

Accession #:	05157	05158	-----
Sensor ID #:	076	035	108
Sensor Type:	RC-10	RC-10	MAS
Focal Length:	12” 304.89 mm	6” 153.46 mm	-----
Film Type:	Panatomic X Aerographic II 2412	Panatomic X Aerographic II 2412	-----
Filtration:	Wratten 12	Wratten 12 + 2.2 AV	-----
Spectral Band:	510-700 nm	510-700 nm	-----
f Stop:	8	5.6	-----
Shutter Speed:	1/200	1/275	-----
# of Frames:	46	46	-----
% Overlap:	10	60	-----
Quality:	Excellent	Excellent	-----

Remarks:

*** NOTE:** Other sensors aboard this flight: APS #024, HIS #083, CLS #113, MIR #114. See Sensor Description and Data Collection Summaries for more information.

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.

WINter Cloud Experiment

A NASA high altitude ER-2 was deployed to Madison, Wisconsin and based at Truax Field from January 23 to February 13, 1997. The aircraft supported the WINter Cloud Experiment (WINCE) conducted by NASA and the University of Wisconsin-Madison's Space Science and Engineering Center. The overall scientific goal of WINCE is to learn more about detecting clouds from space in winter conditions. WINCE will provide important data with which scientists can improve cloud detection from space for future satellite instruments such as the MODerate resolution Imaging Spectroradiometer (MODIS). This NASA research instrument, scheduled for launch in mid-1998, will assess earth climate trends of which clouds are an important component.

During WINCE, multispectral radiometric measurements of clouds and the earth were made by the Modis Airborne Simulator (MAS), the High-resolution Interferometer Sounder (HIS), and the Microwave Imaging Radiometer (MIR) remote sensing instruments onboard the ER-2. The radiometric measurements combine energy from clouds, atmosphere, and earth into a single measurement that can be divided into its components. Signature of clouds over snow-covered ground are revealed using reflectance and temperature data derived from these measurements. Direct measurements of clouds from the Cloud Lidar System (CLS) onboard the ER-2 can verify the position and thickness of clouds in the radiometric data. That data when combined with the radiometric measurements, allows University of Wisconsin scientists to examine the underlying signature of the cloud itself.

University of Wisconsin scientists Paul Menzel, Steve Ackerman, and William Smith will head the scientific analysis of the data set, along with NASA scientists Dorothy Hall, Jim Spinhirne, and Jim Wang of the Goddard Space Flight Center near Washington, DC. Their research findings will be applied to cloud detection algorithms for the MODIS and other future satellite instruments.

Modis Airborne Simulator

The Modis Airborne Simulator (MAS) is a modified Daedalus multispectral scanner configured to replicate the capabilities of the Moderate-Resolution Imaging Spectrometer (MODIS), an instrument to be orbited on an EOS platform. MODIS is designed for the measurement of biological and physical processes and atmospheric temperature sounding. The Modis Airborne Simulator records fifty 12-bit channels of multispectral data and is configured as follows:

Spectral Channel	Band center (µm)	Bandwidth (µm)	Spectral Range
1	0.4649	0.0397	0.4451-0.4848
2	0.5494	0.0417	0.5285-0.5703
3	0.6550	0.0511	0.6294-0.6805
4	0.7024	0.0415	0.6816-0.7231
5	0.7431	0.0420	0.7221-0.7641
6	0.8248	0.0427	0.8034-0.8461
7	0.8667	0.0414	0.8460-0.8874
8	0.9072	0.0409	0.8867-0.9276
9	0.9476	0.0397	0.9277-0.9674
10	1.6422	0.0519	1.6163-1.6682
11	1.6975	0.0505	1.6722-1.7228
12	1.7499	0.0506	1.7245-1.7752
13	1.8014	0.0491	1.7768-1.8259
14	1.8548	0.0489	1.8303-1.8792
15	1.9044	0.0487	1.8801-1.9288
16	1.9553	0.0483	1.9312-1.9794
17	2.0048	0.0487	1.9804-2.0291
18	2.0551	0.0484	2.0309-2.0793
19	2.1037	0.0486	2.0794-2.1280
20	2.1532	0.0483	2.1291-2.1774
21	2.2019	0.0481	2.1779-2.2259
22	2.2522	0.0486	2.2278-2.2675
23	2.3021	0.0487	2.2777-2.3265
24	2.3512	0.0476	2.3274-2.3750
25	2.4005	0.0483	2.3764-2.4246

Spectral Channel	Band center (µm)	Bandwidth (µm)	Spectral Range
26	3.1192	0.1616	3.0384-3.2000
27	3.2809	0.1486	3.2066-3.3552
28	3.4330	0.1617	3.3521-3.5138
29	3.5940	0.1539	3.5170-3.6709
30	3.7449	0.1449	3.6724-3.8174
31	3.9069	0.1602	3.8267-3.9870
32	4.0707	0.1554	3.9929-4.1484
33	4.1699	0.0669	4.1365-4.2034
34	4.4029	0.1255	4.3401-4.4656
35	4.5404	0.1512	4.4648-4.6160
36	4.6979	0.1591	4.6184-4.7775
37	4.8536	0.1516	4.7778-4.9294
38	5.0033	0.1468	4.9298-5.0767
39	5.1588	0.1400	5.0888-5.2288
40	5.3075	0.1327	5.2412-5.3738
41	5.3977	0.0755	5.3590-5.4365
42	8.5366	0.3950	8.3391-8.7341
43	9.7224	0.5365	9.4541-9.9906
44	10.5071	0.4579	10.278-10.736
45	11.0119	0.4710	10.776-11.247
46	11.9863	0.4196	11.776-12.196
47	12.9013	0.3763	12.713-13.089
48	13.2702	0.4584	13.041-13.500
49	13.8075	0.5347	13.540-14.075
50	14.2395	0.3775	14.051-14.428

NOTE: Bandpass centers approximate

Sensor/Aircraft Parameters:

Spectral Bands:	50 (digitized to 16-bit resolution)
IFOV:	2.5 mrad
Ground Resolution:	163 feet (50 meter at 65,000 feet)
Swath Width:	22.9 mi/19.9 nmi (36 km)
Total Scan Angle:	85.92^{o}
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.)

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.

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.

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.

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^{o}
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.

Camera Systems

Various camera systems and films are used for photographic data collection. Film types include high definition color infrared, natural color, and black and white emulsions. Available photographic systems are as follows:

- Wild-Heerbrugg RC-10 metric mapping camera
  - 9 x 9 inch film format
  - 6 inch focal length lens provides area coverage of 16 x 16 nautical miles from 65,000 feet
  - 12 inch focal length lens provides area coverage of 8 x 8 nautical miles from 65,000 feet

- Hycon HR-732 large scale mapping camera
  - 9 x 18 inch film format
  - 24 inch focal length lens provides area coverage of 4 x 8 nautical miles from 65,000 feet

- IRIS II Panoramic camera
  - 4.5 x 34.7 inch film format
  - 24 inch focal length lens
  - 90 degree field of view provides area coverage of 2 x 21.4 nautical miles from 65,000 feet

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).

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).

CAMERA FLIGHT LINE DATA
FLIGHT NO. 97-047

Accession # 05157

Sensor # 076

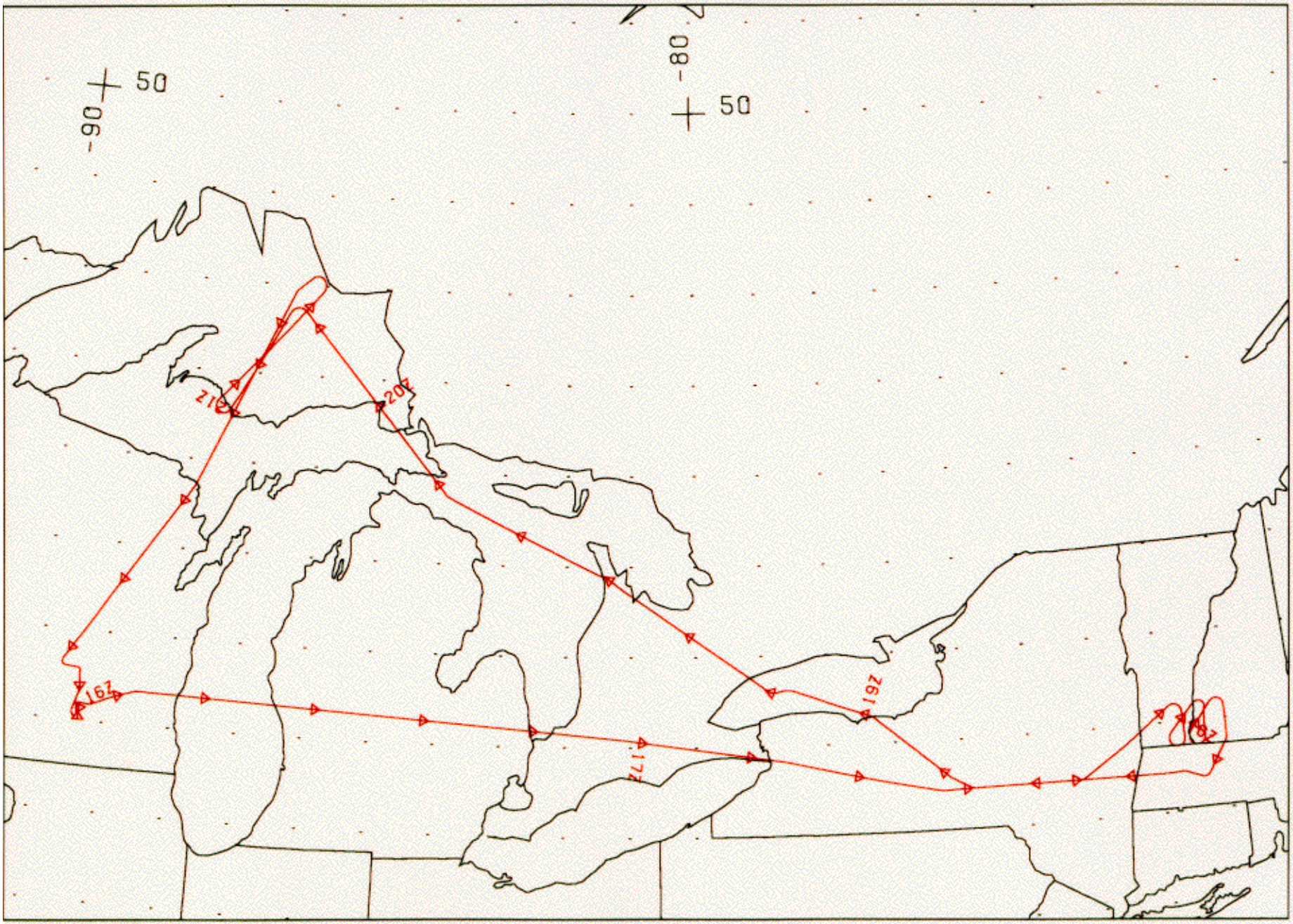
Check Points	Frame Numbers	Time (GMT-hr, min, sec)		Altitude, MSL feet/meters	Cloud Cover/Remarks
		START	END		
A - B	1770-1773	16:56:37	16:58:31	61600/18776	10-30% cirrus and cumulus (frames 1772-1773)
C - D	1774-1785	17:31:36	17:40:46	61842/18849	Clear
E - F	1786-1789	17:53:46	17:55:40	61550/18760	10-30% cumulus (frames 1786-1788)
G - H	1790-1793	18:04:34	18:06:27	61475/18738	20% cumulus (frame 1793)
I - J	1794-1797	18:15:36	18:17:30	61675/18799	10% cumulus (frames 1794-1796)
J - K	1798-1801	18:19:56	18:21:49	61750/18821	Clear
D - C	1802-1815	18:35:48	18:46:46	64043/19520	Clear

CAMERA FLIGHT LINE DATA
FLIGHT NO. 97-047

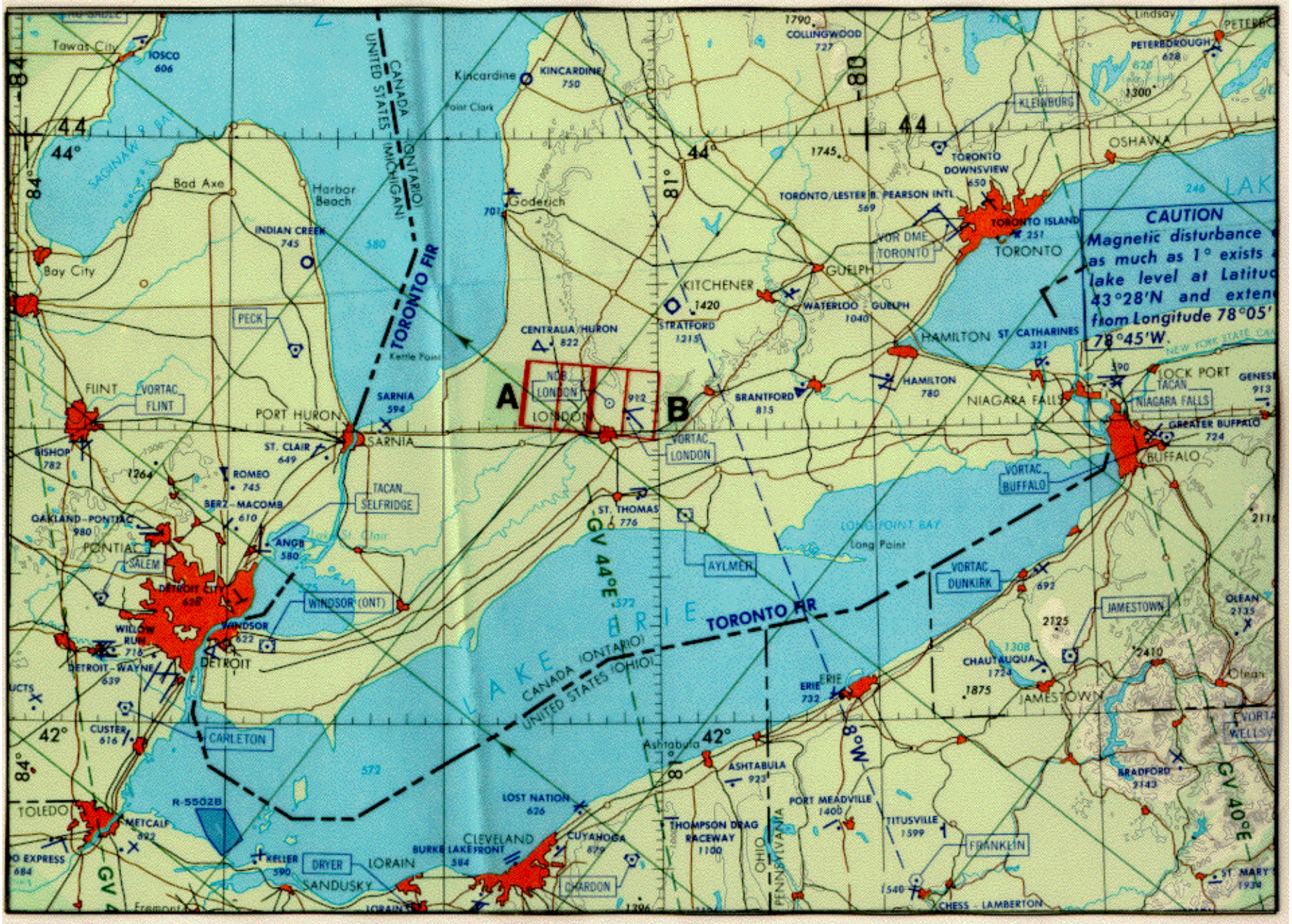
Accession # 05158

Sensor # 035

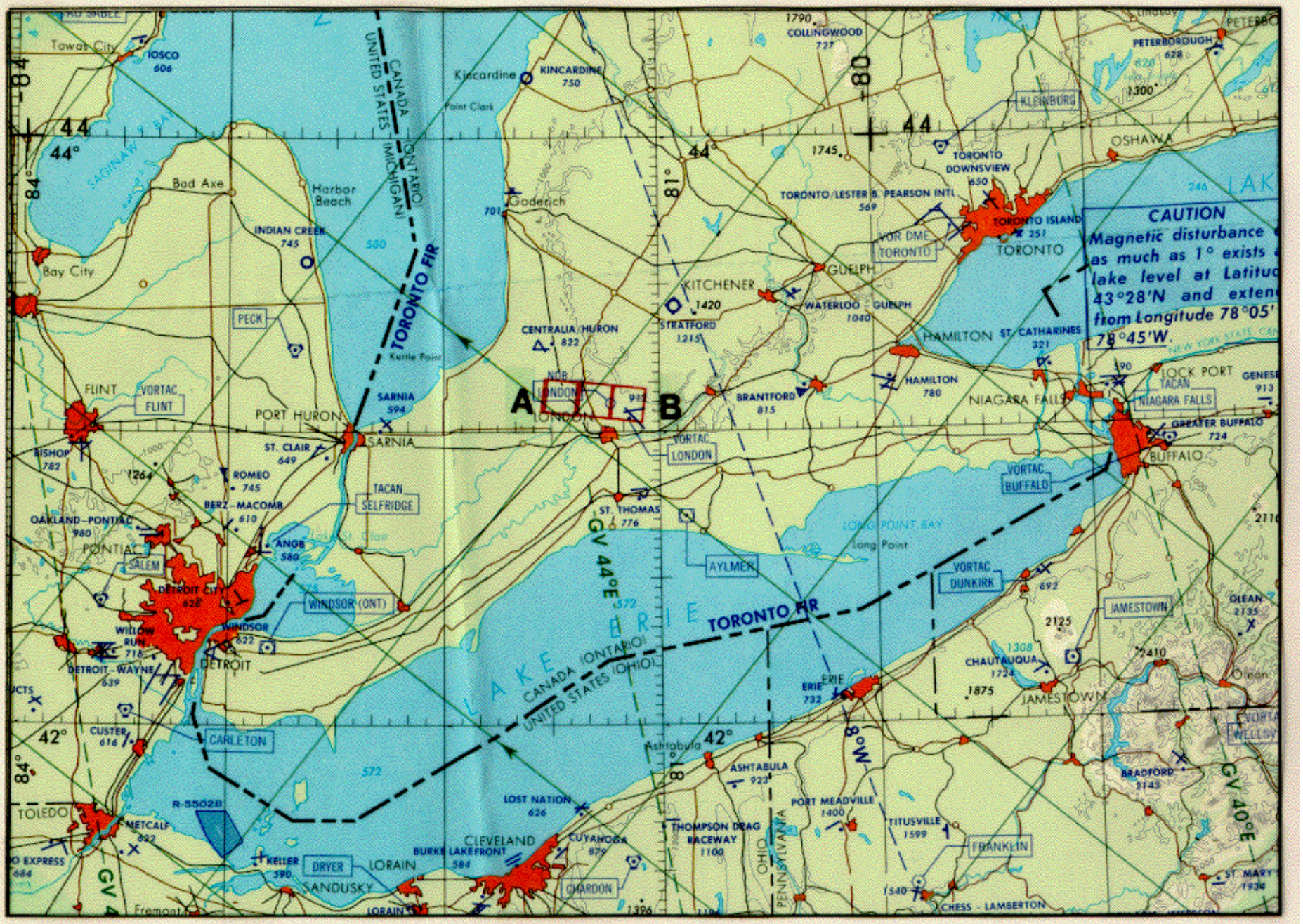
Check Points	Frame Numbers	Time (GMT-hr, min, sec) START	Time (GMT-hr, min, sec) END	Altitude, MSL feet/meters	Cloud Cover/Remarks
A - B	3651-3654	16:56:38	16:58:32	61600/18776	10-40% cumulus and cirrus
C - D	3655-3666	17:31:37	17:40:47	61850/18852	Clear
E - F	3667-3670	17:53:47	17:55:41	61550/18760	10-30% cumulus
G - H	3671-3674	18:04:35	18:06:28	61475/18738	10-30% cumulus (frames 3673-3674)
I - J	3675-3678	18:15:37	18:17:31	61675/18799	10-20% cumulus (frames 3675-3677)
J - K	3679-3682	18:19:57	18:21:50	61750/18821	20% cumulus (frame 3682)
D - C	3683-3696	18:35:49	18:46:47	64043/19520	Thin cirrus (frames 3683-3684)



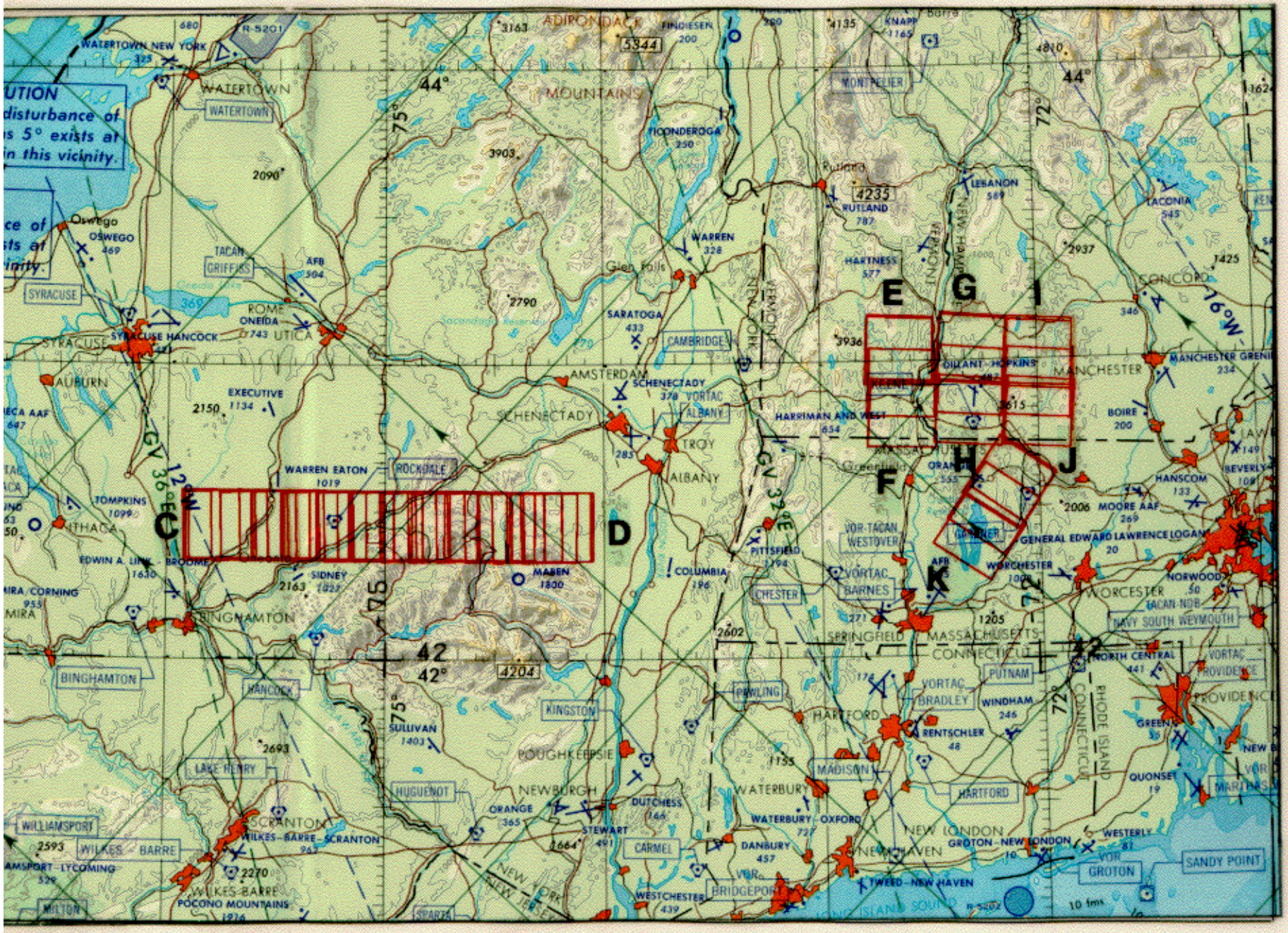
FLIGHT 97-047 9 FEBRUARY 1997 A/C 708 DUAL RC-10 / MAS



FLIGHT 97-047 9 FEBRUARY 1997 A/C 708 RC-10 (6") JNC 45



FLIGHT 97-047 9 FEBRUARY 1997 A/C 708 RC-10 (12") JNC 45



LIGHT 97-047 9 FEBRUARY 1997 A/C 708 RC-10 (6") JNC 45

FLIGHT 97-047 9 FEBRUARY 1997 A/C 708 RC-10 (12") JNC 45