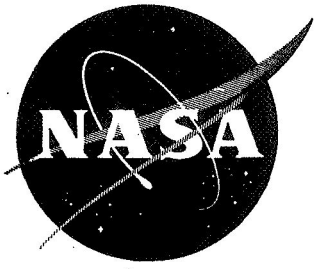
NASA TECHNICAL
MEMORANDUM

NASA TM X-58049
September 1970



GUIDE TO THE USE OF DATA COLLECTED BY THE NASA NP3A AIRCRAFT IN THE BOMEX BETWEEN JUNE 2 AND JUNE 10, 1969

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ABSTRACT

The NASA NP3A aircraft participated in the Barbados Oceanographic and Meteorological Experiment between June 2 and June 10, 1969. This report provides potential users of the data with the information required to select and use that data in a knowledgeable and effective manner. The systems aboard the aircraft and the format of their archived output are described. The ground tracks of the aircraft are depicted, and the logs manually taken aboard the aircraft are provided.

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By Victor S. Whitehead
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SUMMARY

Data collected by the NASA NP3A in the BOMEX* between June 2 and June 10, 1969, have been formatted and submitted to the BOMEX archives. Potential users of these data will be aided in their selection and use by referral to this report. The observational systems aboard the aircraft and the format of their archived output are described. The ground tracks of the six flights of the aircraft are depicted with time and aircraft altitude noted. Logs taken manually during the flights are provided.

INTRODUCTION

This report was prepared in order to aid potential users in selecting data appropriate to their needs and in using these data in an effective and knowledgeable manner. The data collected have been prepared for the archives in what the investigators believe is the most usable format for most applications. Users should request these data from the BOMEX archives at the National Weather Records Center, Asheville, N. C. It is possible that some investigators may find these formats inappropriate or may find the guide too general for their particular applications. Should this occur, the originator of this document should be contacted for advice.

This guide presents ground tracks, some flight parameters, a discussion of the instruments operated, a format of the archived data, and the peculiarities of these data. Logs compiled manually during the flights are also included.

DATA DESCRIPTION

A listing of the systems operated aboard the NASA NP3A aircraft between June 2 and June 10, 1969; the data quantity; and the data quality are given in table I. Individual systems are discussed in appendix A in more detail.

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*Barbados Oceanographic and Meteorological Experiment (BOMEX).

A brief description of each of the six flights is given in table II. A detailed plot of each ground track with time and altitude annotation is given in appendix B.

All data from the radiometer, the total air-temperature indicator, the dewpoint hygrometer, and the liquid-water content meter have been averaged over 5-second intervals in order to suppress some of the high-frequency noise; and the data have been submitted to BOMEX archives as (1) plots of numerical value as a function of time (G.m.t.), (2) print-outs of recorded output as a function of time (G.m.t.), and (3) recordings on magnetic tape (binary coded decimal format). (See appendix C for a description of the data format.) The annotation on the 35-millimeter film taken by the nadir-looking and oblique cameras is also given in appendix C.

At the time of the BOMEX mission, the auxiliary data annotation system (ADAS) timer, which sets the indicated time on the photographic record, was not synchronized exactly with the inter-range instrumentation group (IRIG) timer, which defines time on the taped data. While the difference between the two timers is always less than 1 minute, this time bias must be accounted for if a detailed attempt to relate the taped data to the photographs is to be made. This bias for each flight is given in table III.

When the communication channel was used for position reports or for other communication uses, high-frequency radio interference was recorded, resulting in a very noisy data record for short periods of time. Other short-duration noise from an unknown source was recorded with the data. A list of the periods of noise has been compiled and is given in appendix D. Users should not use the data taken during these periods or during the period 5 seconds before or after the period of interference.

Appendix E contains manual logs listing time (G.m.t.), latitude, longitude, pressure, altitude, aircraft heading, ground speed, total-air temperature, ambient air temperature, and ambient dewpoint temperature observed during each flight at intervals of approximately 5 or 10 minutes. Listed in appendix F are the photographic logs for the mission.

CONCLUSION

The data collected by the NASA NP3A in the Barbados Oceanographic and Meteorological Experiment are of variable quality because the data were taken under a variety of conditions and were subjected to random noise. This document provides information for selection of those parts of the data which are of the best quality and which are the most appropriate for the particular needs of the user.

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National Aeronautics and Space Administration
Houston, Texas, September 25, 1970
160-75-03-00-72

TABLE I. - QUANTITY AND QUALITY OF DATA COLLECTED FOR BOMEX BY THE NASA EARTH RESOURCES DIVISION NP3A AIRCRAFT

System	Data quantity	Data quality[a]
Block radiometer (10 to 12 microns)	22 hr of operation, PCM[b] to 63 points/sec, 4.99×10^6 data points	Requires smoothing over a 1/2-sec interval to filter noise.
Spectrometer (6.7 to 13.3 microns)	22 hr of operation, PCM to 90 points per scan at 7 scans/sec, 49.9×10^6 data points	Data noisy and will require filtering.
Rosemont probe (total air temperature)	22 hr of operation	Requires smoothing over a 5-sec interval.
Cambridge system (dewpoint temperature)	22 hr of operation	Requires smoothing over a 5-sec interval.
Liquid-water-content detector	22 hr of operation	Good except not zeroed exactly.
Pallet-boresighted 35-mm camera	20 hr of operation at 1 frame each 2 sec, 36 000 frames	Barely usable because of overexposure on part of each frame; time and date on each frame.
Side-looking radar boresighted 35-mm camera	190 min of operation at 1 frame each 10 sec, 1740 frames	Excellent; time and date on each frame.
Wide-angle 16-mm movie camera[c]	306 min of operation at 6 frames/sec, 110 160 frames	Excellent, but no time on frame; requires use of manual log and interpolation. Cloud top height below aircraft can be determined by parallax.

[a]All taped data have sporadic high-frequency radio interference.

[b]Pulse-code modulation.

[c]Hand-held camera and tape recorder operated by onboard observer. Data format not suitable for the BOMEX archives.

TABLE II. - THE BOMEX MISSION FLIGHT SUMMARY

Date, 1969	Flight path	Altitude, ft	Duration, hr
June 3	Southwest quadrant of the BOMEX array	2 000 10 000	6
June 4	Southwest quadrant of the BOMEX array with a diversion to the area of the shower activity	1 000 5 000 20 000	3-1/2
June 4	Southwest quadrant of the BOMEX array (night)	1 500 20 000	2-1/2
June 7	Line integral around the entire BOMEX array	16 000	6
June 8	Southern border of the BOMEX array with a diversion to the area of the shower activity	1 000 21 000	3
June 9	Line integral around the entire BOMEX array	16 000	5

Note: Line integral flights were flown at the request of the BOMEX project.

TABLE III. - MISSION 94 ADAS MINUS IRIG TIME BIAS[a]

Flight	Beginning bias, sec	Ending bias, sec
1	28.419	28.645
2	35.431	35.536
3	22.682	22.832
4	31.742	31.922
5	40.421	40.539
6	38.272	38.488

[a]These biases are the results of 5-second averages. The accuracy is ±0.025 second.

APPENDIX A

SYSTEMS DESCRIPTION

Airborne Rapid-Scan Spectrometer

The airborne rapid-scan spectrometer is used to measure radiation in the 6.7- to 13.3-micron range. The instrument consists of two units: (1) the control panel and signal conditioning unit located in the operator's console and (2) the scanning assembly located on the underside of the fuselage. The total estimated weight of the system is 75 pounds.

The spectrometer is part of a three-instrument package consisting of the spectrometer, an infrared radiometer, and a boresight camera. The instruments are carefully boresighted to each other so that their fields of view overlap. The spectrometer has an instantaneous field of view of 0.4°. The instrument uses no mechanical sweep or geometric scanning pattern as is used with imaging systems; however, a rotating-filter wheel produces a narrow-band spectral scan of the limited field of view over a wavelength range of 6.7 to 13.3 microns. The scanning rate is 3.5 rps, which produces seven spectra per second, with instantaneous bandwidth approximately 1 percent of the wavelength. (That is, the bandwidth is 0.1 micron at 10 microns, and 0.13 micron at 13 microns.)

The optics of the spectrometer are all reflective, except for the filter wheel and the cover over the detector aperture of the dewar. The detector is mercury-doped germanium, 0.1 inch per side, and is cooled to liquid-helium temperature.

The spectrometer output is an analog voltage which is representative of the irradiance entering the system aperture as compared to a reference black body inside the system. The reference black body maintains a constant temperature of 56° C. The system output is accompanied by reference pulse markers which provide a precise indication of the wheel position. A wavelength pulse every 2° of wheel rotation and an additional scan marker pulse at 0° and 180° are available. The temperature of the spectrometer case is also measured and provided as a calibrated electronic signal. The output data and the case temperature data are digitized by a pulse-code modulation (PCM) technique into a digital 11-bit-word format. The data are then multiplexed with those of the infrared radiometer onto one channel of a magnetic-tape recorder.

Because the detector operates at the temperature of liquid helium, a supply of liquid helium must be available at the air-terminal facility from which data flights are based. In addition, gaseous helium and liquid nitrogen must also be available. The primary mission constraint imposed by this instrument is the logistics involved in handling these materials.

The pallet which houses the spectrometer must be removed from the aircraft and transported to the area where the cryogenic facilities are available. All helium-transfer lines and dewars must then be attached to a vacuum pump and depressurized to 10^{-4} microns. The helium dewar is then purged with liquid nitrogen for precooling purposes;

following the precooling, the liquid helium is transferred to the dewar. Two people are required to support this operation. After this filling procedure is completed, the pallet is reinstalled in the bomb bay of the aircraft. An initial power-up of the system verifies that the detector is properly cooled and that a good "fill" has been accomplished. A proper fill may allow operation for 12 to 16 hours; however, the average duration of an operation is 6 to 8 hours. Therefore, aircraft departure as soon as possible after the filling is accomplished is desirable.

A second constraint to operations is optical fogging during aircraft descent. A slow rate of descent does not significantly decrease the problem, since the cold optics will invariably cause condensation.

The system is calibrated during ground tests by the use of a black-body reference cavity placed over the aperture. A spectral test is then executed by placing a known polystyrene filter over the optical path. A flight evaluation is performed by overflying a target of known characteristics, such as a large body of water. All of these tests serve to provide confidence that the system is performing satisfactorily prior to a mission. During data flights, the operator continuously monitors the radiance display on an oscilloscope.

Because of the large number of data collected by the spectrometer and because no decision has yet been made as to the best method of formatting these data for potential BOMEX users, only samples of data collected by this system have been submitted to BOMEX archives. Data will be made available to users by NASA.

Infrared Radiometer

The infrared radiometer is used to measure radiation in a fixed spectral band of 10.4 to 12.1 microns. The system consists of two units: (1) the control panel and signal conditioning unit located in the operator's console and (2) the radiometer detector assembly located in the bomb bay.

The infrared radiometer is part of a three-instrument package consisting of the radiometer, the airborne rapid-scan spectrometer, and a boresight camera. The instruments are carefully boresighted to each other, so that their fields of view overlap. The radiometer has a field of view of 0.4°. The instrument uses no mechanical sweep or geometric scanning pattern as is used with imaging systems. The instrument, which operates at 28 volts and uses direct current, provides radiometric data in a fixed spectral band of 10.4 to 12.1 microns. The detector is mercury-doped germanium, cooled to liquid-helium temperature, and is employed in conjunction with the reflective optics.

The output signal, which is proportional to the irradiance differential between a reference cavity and a target, is made available as an analog output voltage, which, with the spectrometer output, is digitized and recorded on magnetic tape as an 11-bit word. The system is calibrated by using a high-quality black-body cavity which covers the aperture of the system. The output of the infrared radiometer converted to equivalent black-body temperature and averaged over 5-second intervals has been submitted to the BOMEX archives.

As with the airborne rapid-scan spectrometer, the only modifications to the aircraft are the installation of the pallet-associated equipment and the modification of the hoist assembly. The logistics problems for the radiometer are also identical to the problems for the spectrometer. Because the infrared radiometer and the airborne rapid-scan spectrometer are operated simultaneously by the same operator, preflight and inflight procedures are similar. However, differential radiance is displayed on a meter rather than on an oscilloscope.

Total Air Temperature

The total air temperature probe allows accurate measurement of the outside air temperature. The probe housing is designed to prevent inaccurate temperature readings caused by expansion or compression of air in the high-velocity airflow.

The system consists of two units: (1) the control box, the power supply, and the indicator located at the operator's console and (2) the aerodynamic housing for the probe located in the airstream behind the nose radome on the port side of the aircraft. The total weight of the system is estimated to be less than 10 pounds.

The instrument operates in a temperature range of -107° to 60° C and can respond at a rate of 22° C per second with an accuracy of ±0.1 percent at full scale. A fast-response, platinum, temperature-sensitive resistance wire serves as one arm of a bridge-type circuit. The output of this circuit, which is linear over the temperature range of operation, is converted to a direct-current output of 0 to 5 volts. This output is frequency multiplexed with the outputs of the dewpoint hygrometer and of the liquid-water-content indicator onto one track of a magnetic-tape recorder.

Preflight checkout consists of examining the probe for foreign matter and checking all connectors and cables for irregularities. Since airflow over the probe is necessary for cooling purposes during operation, an interlock prevents operation on the ground. In flight, the operator monitors the indicator and records the values in the flight logs. A test position on the control panel allows the active element in the probe to be replaced by a known resistance.

Data collected by this system have been averaged over 5-second intervals and submitted to the BOMEX archives in units of degrees centigrade. To arrive at ambient air temperature, total air temperature must be corrected for dynamic heating, which is a function of true air speed. Figure A-1 illustrates this correction. Note that a comparison of ambient temperature, as determined by this correction, and dewpoint temperature indicates supersaturation ((temperature minus dewpoint temperature) $<0°$ C) often existed near the base of cumulus clouds. It has not yet been determined whether this indication is due to inaccuracy in the total-air-temperature reading, inaccuracy in the dynamic heating correction, inaccuracy in the hygrometer reading, or a lag in the hygrometer reading.

Dewpoint Hygrometer

The dewpoint hygrometer, which measures the prevailing dewpoint temperature, consists of two units: (1) the control box and power supply located in the operator's

console and (2) the probe located in the airstream on the forward port side of the aircraft. The total weight of this system is estimated to be less than 15 pounds.

The instrument covers a dewpoint range of -50° to 50° C. The manufacturers claim that the accuracy of the dewpoint measurement is ±0.5° C above 0° C, and ±1.0° C below 0° C. The dewpoint is measured by a thermistor imbedded in a temperature-controlled mirror. The mirror is cooled until a thin condensation layer forms. This condensation diffuses a beam of light directed at the mirror, and a photosensitive network is activated, thus providing a command signal to sense the thermistor. Below 0° C, the condensation layer is unstable and immediately changes to frost. Thus, at temperatures below 0° C, the frost point, rather than the dewpoint, is sensed. These frost-point data are easily converted to dewpoint data by the use of meteorological conversion tables (fig. A-2). The thermistor output is converted to a direct-current output of 0 to 50 millivolts for the -50° to 50° C range of operation. The voltage is amplified to a 0- to 5-volt direct-current signal and is frequency multiplexed with the total-air-temperature data and the liquid-water-content-indicator data onto one track of a magnetic-tape recorder. The output of the dewpoint hygrometer system has been averaged over 5-second intervals and submitted to the BOMEX archives in units of degrees centigrade.

Preflight checkout consists of examining the probe for foreign matter and checking all cables and connectors for irregularities. Since airflow over the probe is necessary for cooling during operations, an interlock prevents ground operation. In flight, the system is turned on and balanced and is allowed to operate continuously during the flight, with the operator monitoring and recording displayed values in the flight logs.

The manufacturers claim that the response of the system is 3° C per second; however, a value even approximating this has not been achieved in the installation aboard the NP3A. At an altitude of 1000 to 2000 feet, a response time of a few tenths of a degree per second may occur; but after climbing to an altitude of 10 000 feet, several minutes may be required to reach equilibrium. The user is encouraged to rely more on the direction of change in these data than on the specific value indicated.

Liquid-Water Content Indicator

The liquid-water-content indicator is used to measure the liquid-water content of outside air. The probe is housed in a container which is designed to compensate for temperature variations. The system consists of three units: (1) the control box and indicator unit mounted at the operator's console, (2) the power supply mounted inside the console, and (3) the probe mounted in the airstream along the top of the fuselage. The estimated weight of the total system is less than 15 pounds.

The instrument covers a range of 0 to 2 g/m^3 or 0 to 6 g/m^3, depending on the scale chosen by the operator. At 200 mph, the instrument can respond to changes as great as 2 g/m^3 sec, with an accuracy of approximately ±15 percent at full scale. Incoming air strikes a perpendicularly mounted resistive wire element with a temperature-dependent resistance. Water droplets which strike the wire are evaporated by its heat. Thus, the wire is cooled during this process, and its resistance

is changed. Another wire is mounted in the same housing, but it is parallel to the airflow. Thus, while the parallel wire is subjected to the same temperature changes as the perpendicular wire, it is not contacted and cooled by the water droplets. The bridge network is designed so that temperature changes compensated for, and the only measured condition is the water content of the air, which is displayed on a meter at the operator's console. The output is frequency multiplexed with the total-air-temperature data and hygrometer data onto one track of a magnetic-tape recorder.

Preflight procedures consist of checking the probe for foreign matter and inspecting all cables and connectors for irregularities. Since airflow over the probe is required for cooling purposes during operation, an interlock prevents ground operation. In flight, the instrument is balanced in clear-air conditions, and the appropriate airspeed is inserted. A visual display in grams per cubic meter is monitored, and the data are recorded in the operator's log.

A small, continuous bias appears in the output of this system, even when no liquid water is present. This bias is a very stable value which is easily accounted for in analysis of the data. The output of this system has been averaged over 5-second intervals and submitted to the BOMEX archives in units of grams per cubic meter.

Data System

The data system is composed of all equipment on the NP3-A that is used in the conditioning, monitoring, and retrieving of sensor data. The magnetic-tape recorder is a ruggedized 14-track recorder which uses the latest wide-band analog-recording techniques. The system intentionally has a minimum reproduction capability because of the lack of inflight requirements to reproduce the data. A switching device is built into the reproduction system to enable any of the 14 recorded signals to be reproduced through one of the four reproduction amplifiers. Any four signals may be reproduced simultaneously.

The patch panel provides a means of monitoring all signals being routed to the tape recorder. The four reproduced channels are also routed to the patch panel. A wide-band oscilloscope, a digital voltmeter, a frequency counter, and a bandswitching discriminator for proportional and constant-bandwidth demodulation are available to monitor the data. A strip-chart recorder may also be used for data monitoring from the patch panel.

The calibration and control panel provides on and off controls for the data conditioner and for the various modulation systems. The panel also facilitates simultaneous calibration of all tape-recorder tracks. A means of calibrating the various modulation packages used in the data system is also provided as part of the calibration and control panel. Calibration may be manual or automatic, depending on the particular requirements.

The ADAS is used for data correlation. The boresighted cameras have enclosed optical units that expose the various films and provide numeric displays of mission, date, and time. An ADAS tape-recorder output allows radar altitude, barometric

altitude, heading, drift, roll, pitch, ground speed, time, month, day, year, mission, flight, site, line, and run to be recorded on tape. This information is then reproduced on an ADAS reader during data verification and analysis.

Camera Systems

Photographs from the camera boresighted to the radiometer and spectrometer (nadir looking) and from the camera usually boresighted to the side-looking radar (oblique to the right side) have data and time shown on each frame, permitting a determination of the aircraft position relative to the clouds.

Both of these cameras are 35-millimeter systems. The nadir-looking camera took one frame each 2 or 3 seconds and operated the entire time the aircraft was over the BOMEX array, except for the night flight (flight 3). A large percentage of these frames were overexposed over a portion of their area of coverage because of the use of a thin-based film which permitted internal reflection off the pressure plate. As a result, it is difficult to use this film. The oblique photography was taken intermittently, and the film is of excellent quality. During periods of operation, film was exposed at the rate of one frame each 10 seconds.

The 16-millimeter, wide-angle, nadir-looking movie camera was also operated in an intermittent mode. This film does not have time annotation, which makes correlation of the film to other observations very difficult. This film has not been archived for this reason.

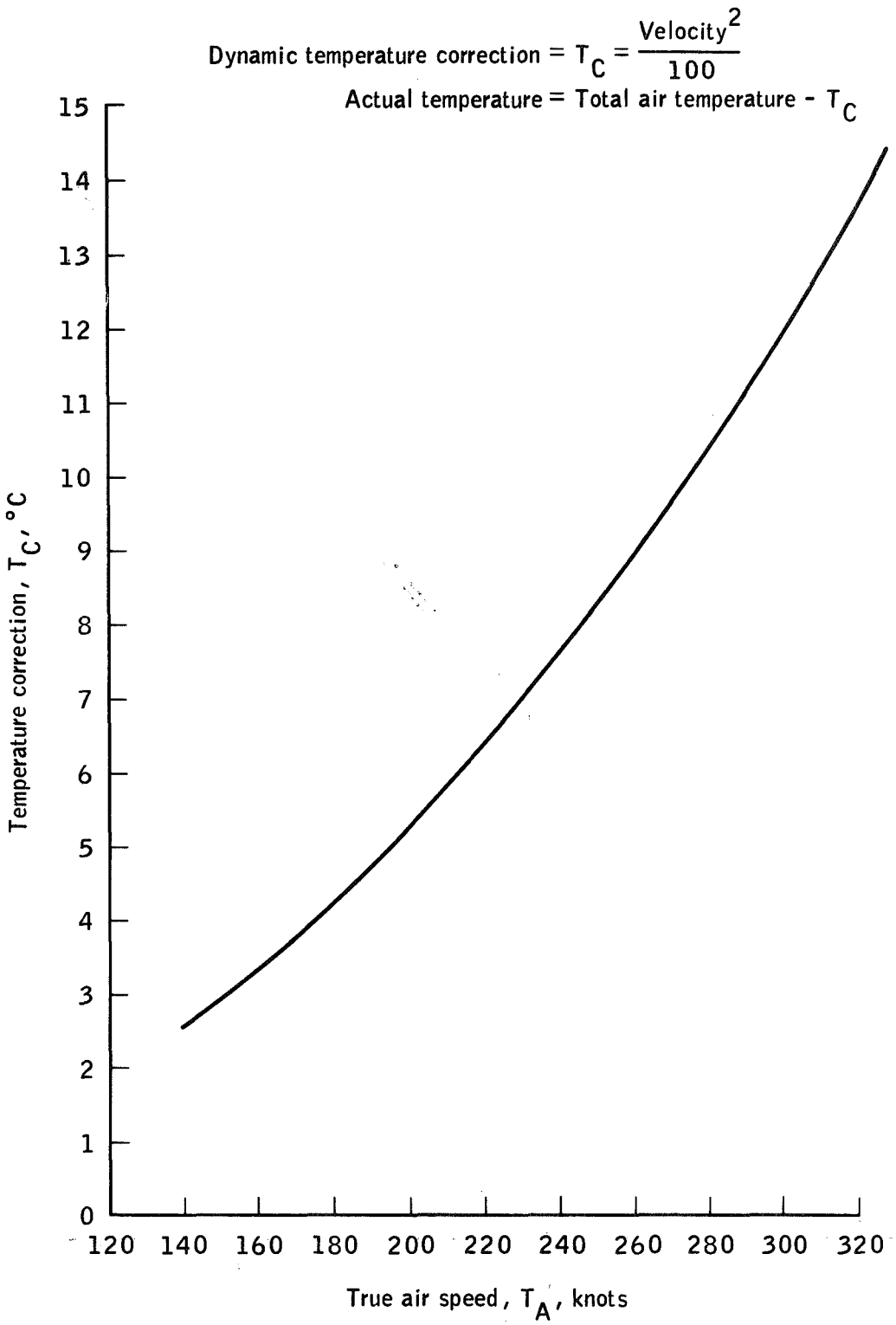


Figure A-1. - Dynamic temperature correction.

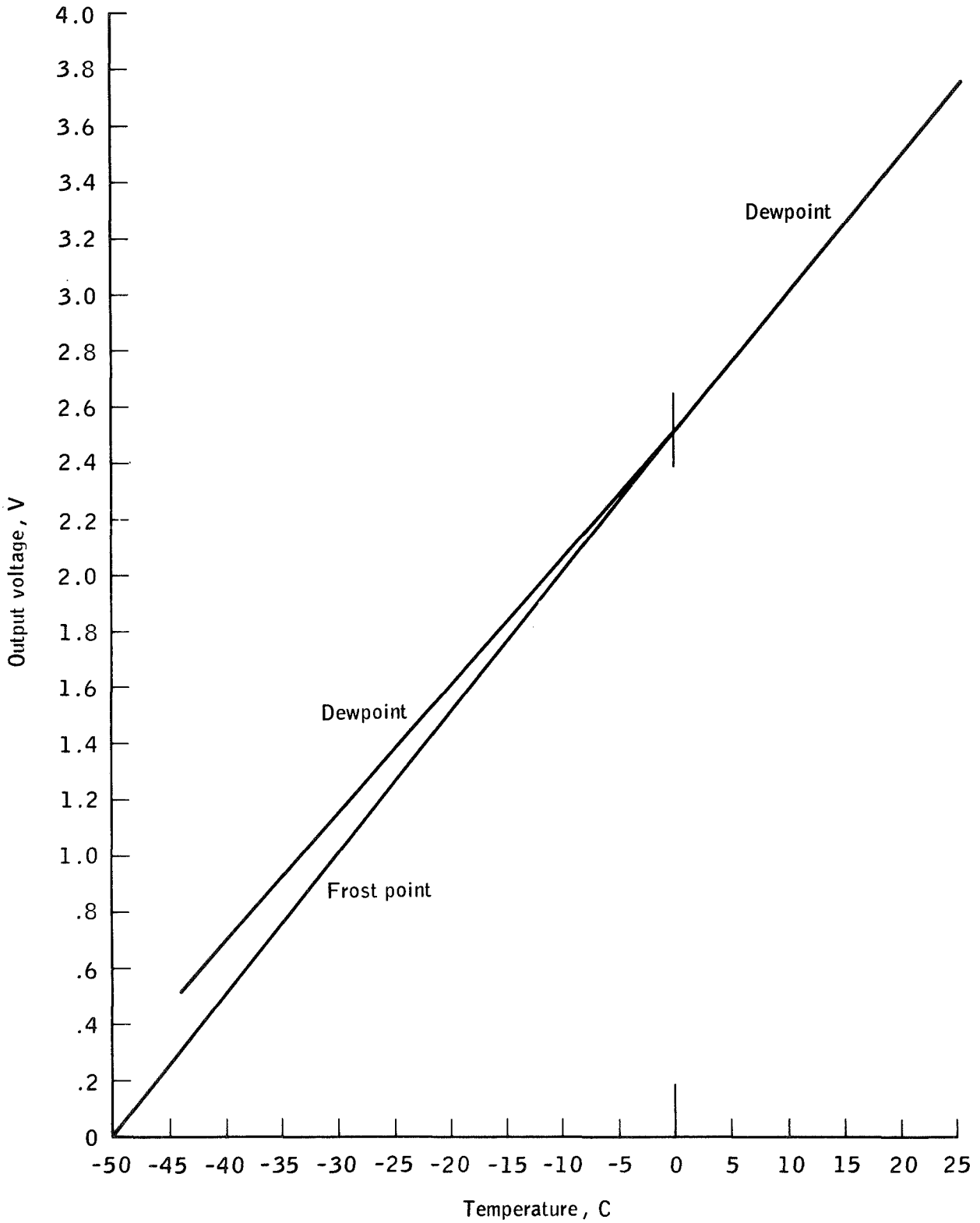
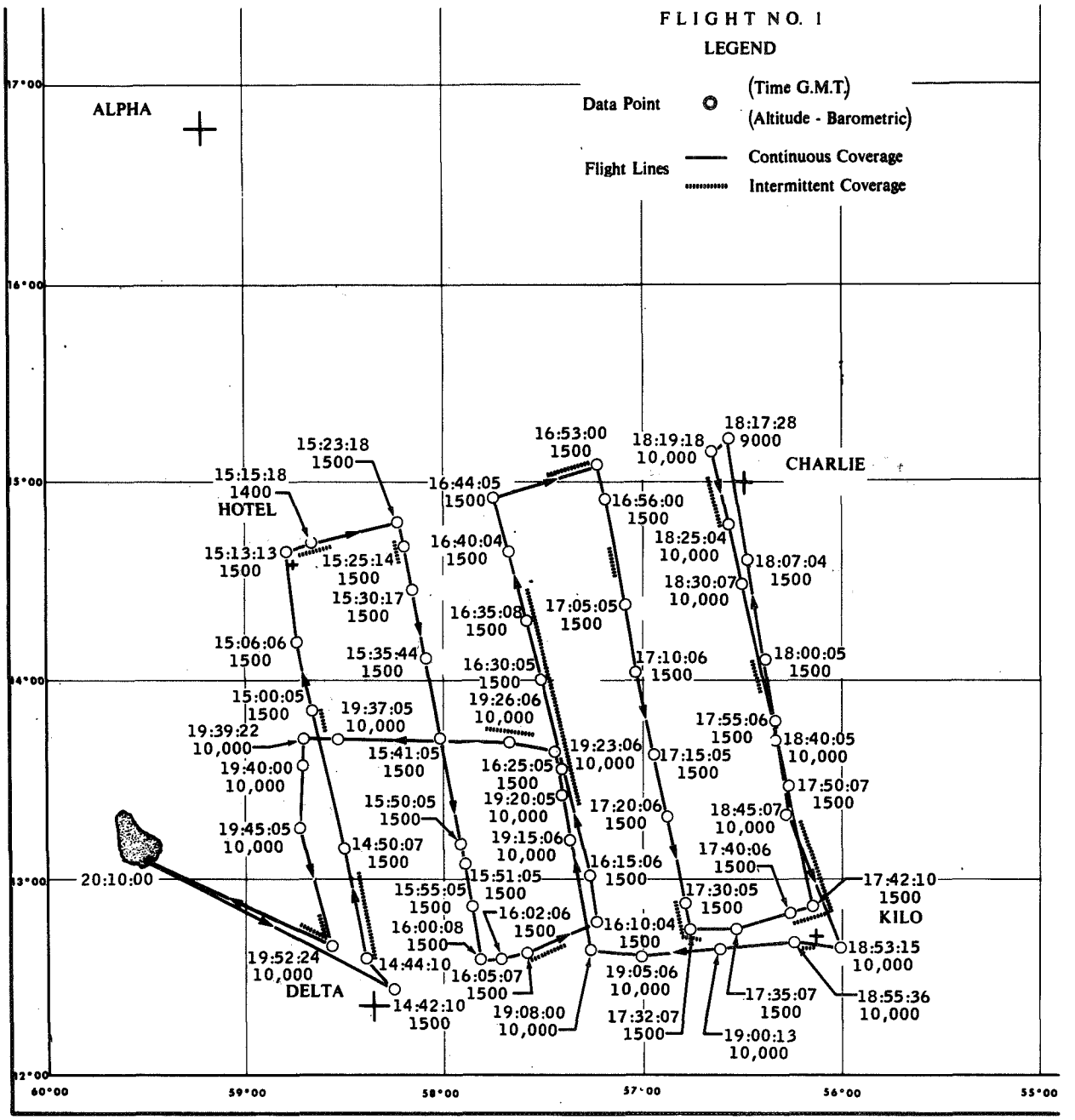


Figure A-2. - Dewpoint and frost point as a function of hygrometer output voltage.

APPENDIX B

GROUND TRACKS OF THE NASA NP3A



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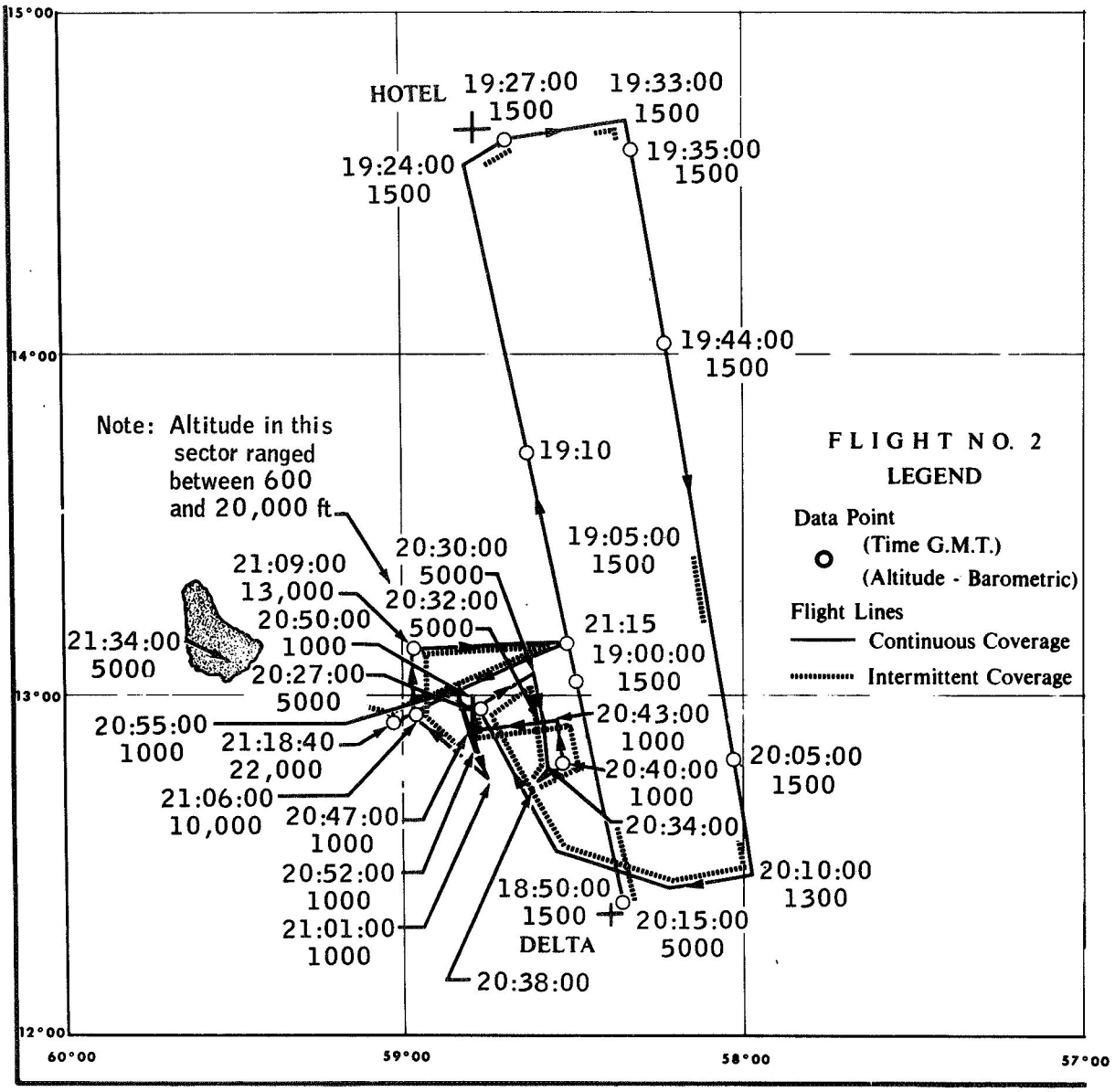

BARBADOS OCEANOGRAPHIC AND
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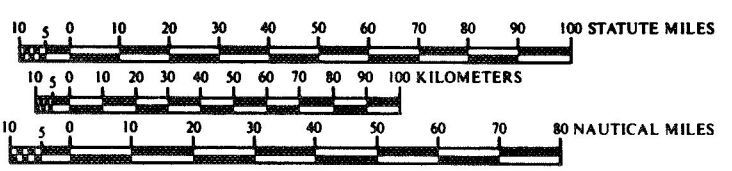
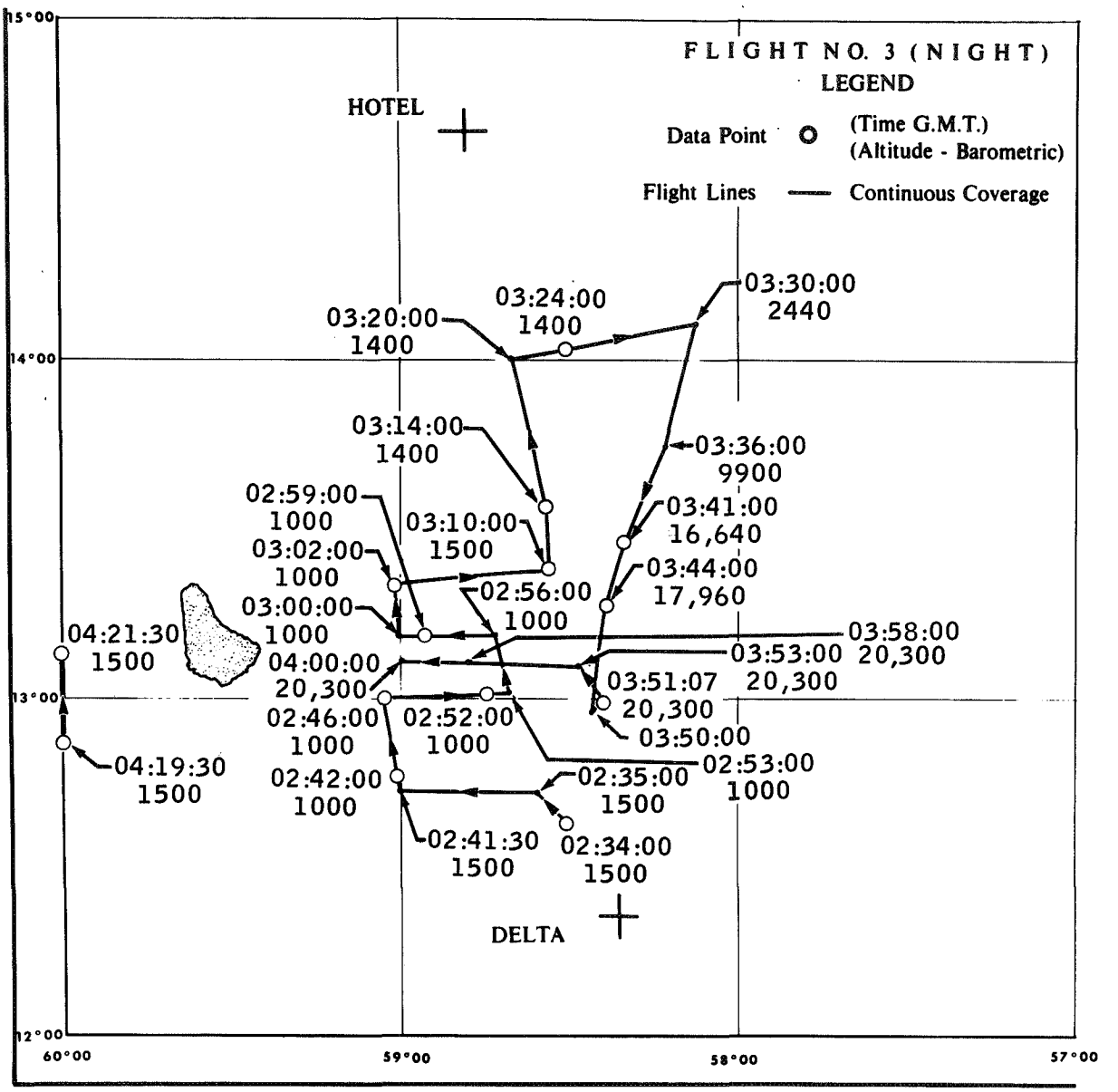
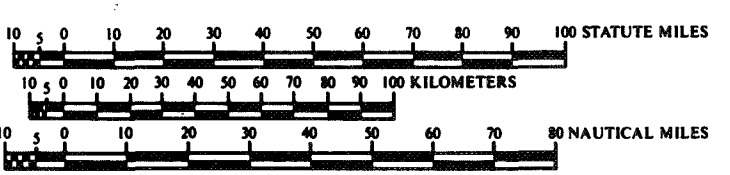
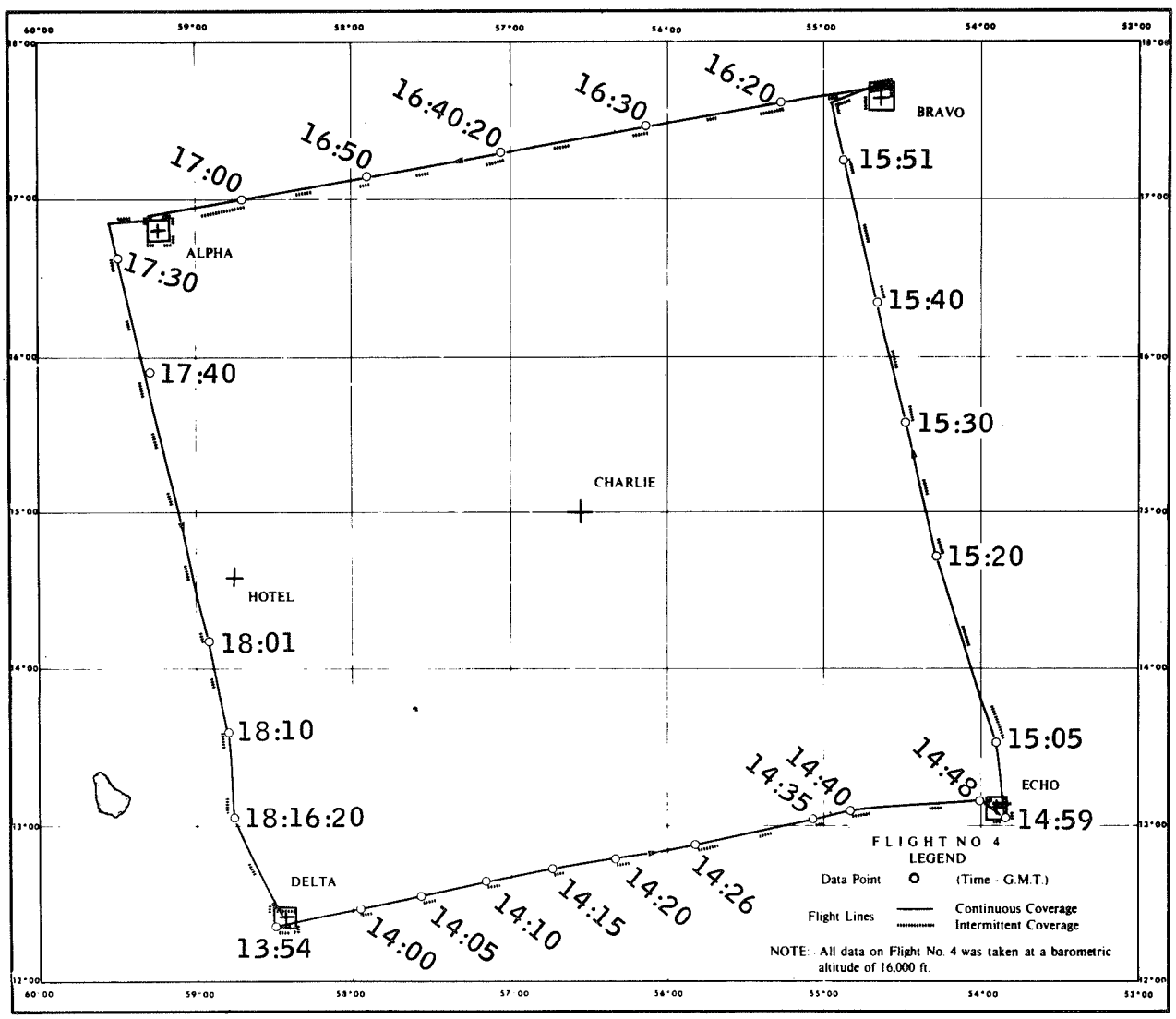
TEST SITE 710
MISSION 94





BARBADOS OCEANOGRAPHIC AND
METEOROLOGICAL EXPERIMENT
TEST SITE 710
MISSION 94





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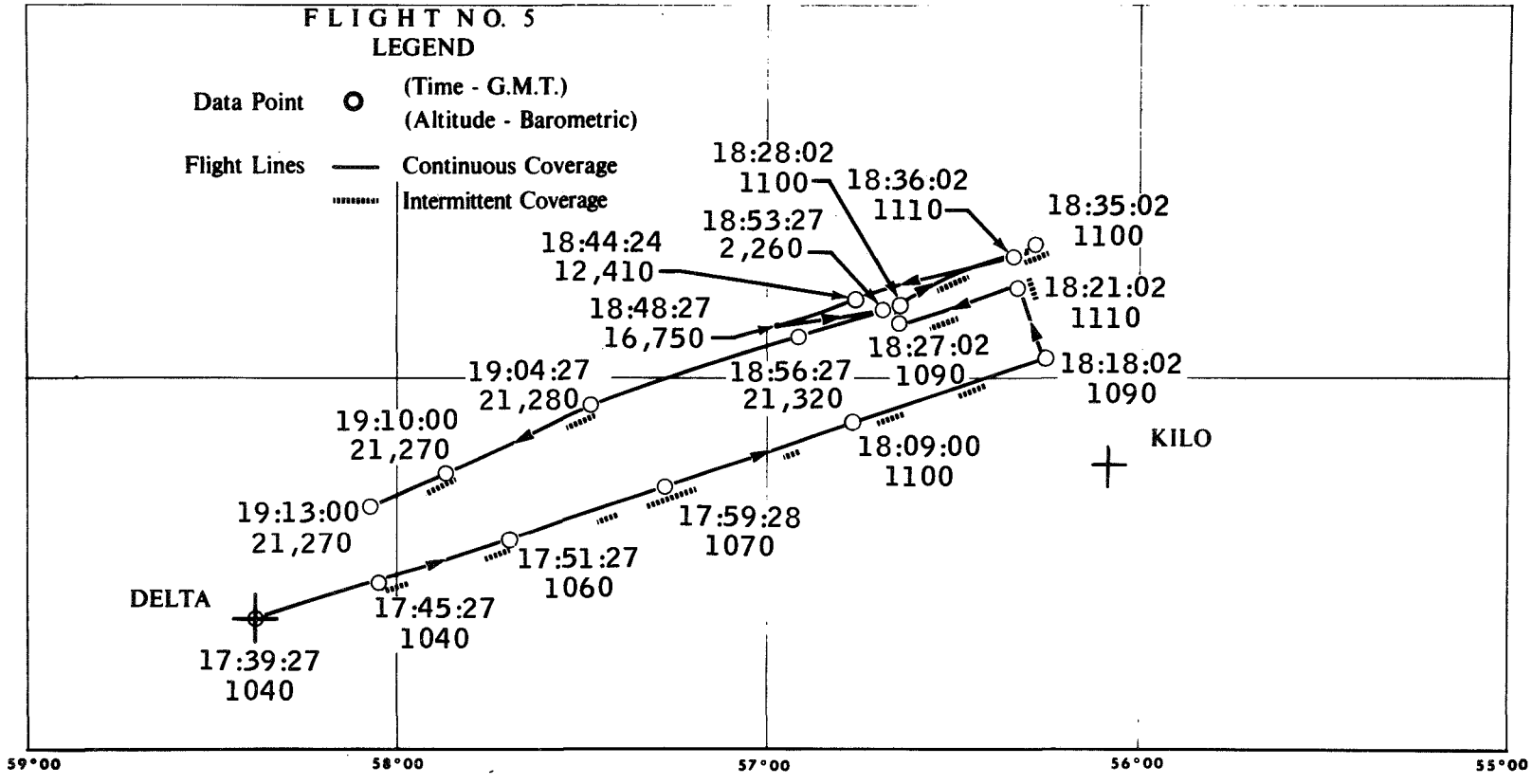

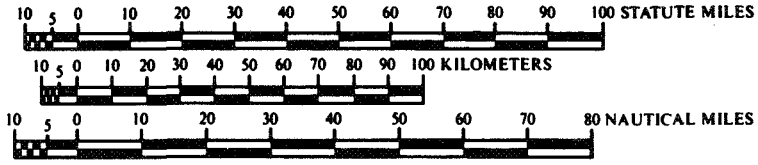

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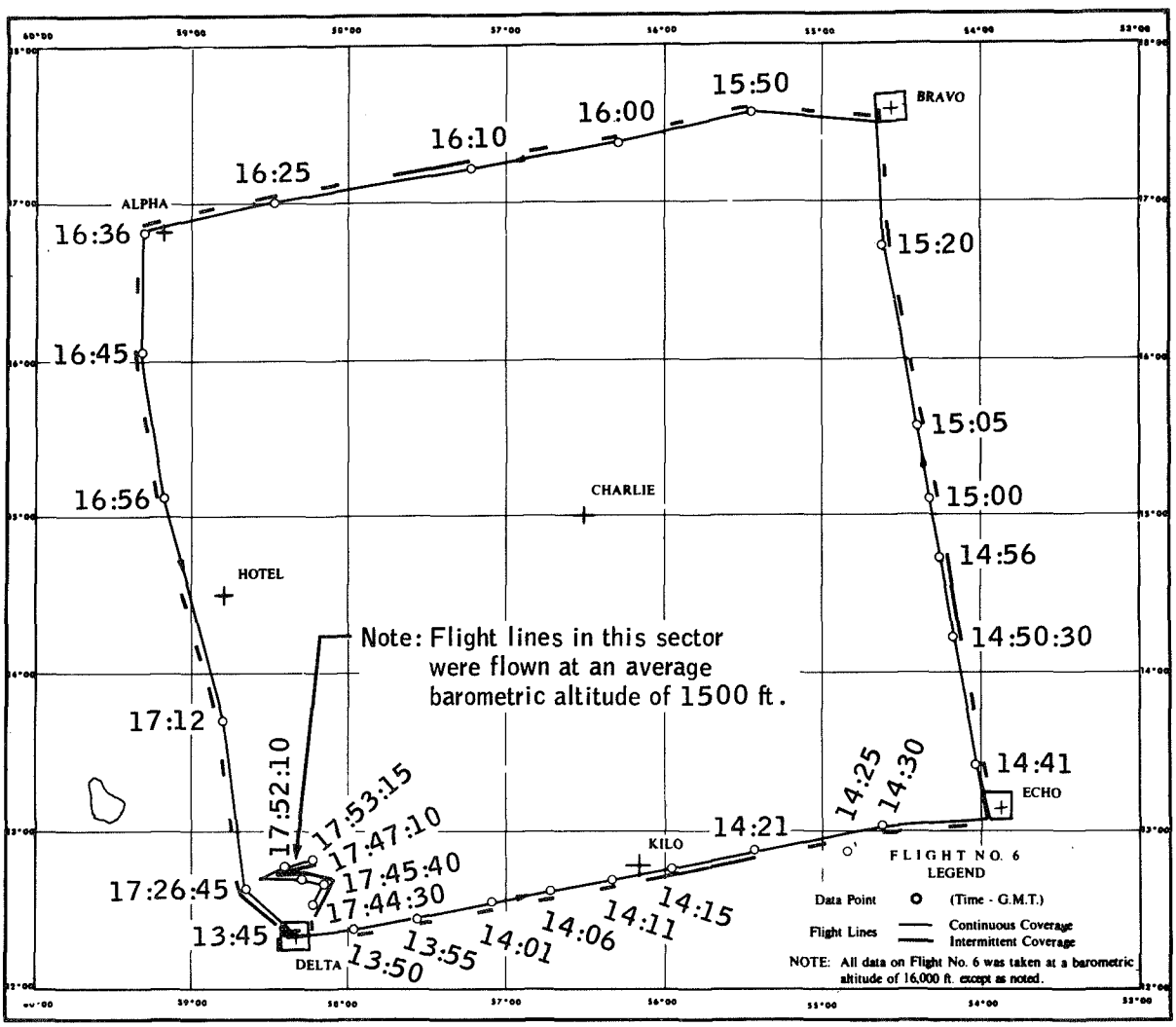

BARBADOS OCEANOGRAPHIC AND
METEOROLOGICAL EXPERIMENT
TEST SITE 710
MISSION 94

APPENDIX C

DATA FORMAT

The annotation on the frames of the 35-millimeter film used in the experiment is explained by the following example.

Example format:
690603
1442307
094

Interpretation: (year) 69 (month) 06 (day) 03
(hour) 14 (minutes) 42 (seconds) 30.7
(mission number) 094

The format of the archived taped data is explained in tables C-I to C-V.

TABLE C-I. - FORMAT OF MISCELLANEOUS SENSOR-TAPE DATA

Word (a)	Parameter	Units
1 2	Time (1st cycle)	sec
3 4	Liquid H_2O (1st cycle)	g/m^3
5 6	Dewpoint (1st cycle)	°C
7 8	Total air temperature (1st cycle)	°C
9 10	Time	sec
11 12	Liquid H_2O (2nd cycle)	g/m^3
13 14	Dewpoint (2nd cycle)	°C
15 16	Total air temperature (2nd cycle)	°C
17 18 19 20 21 22	Blank Blank Blank Blank Blank Blank	-- -- -- -- -- --

[a]Each (36 bit) word contains 6 binary coded decimal (BCD) characters of 6 bits each. Two words are allotted for each parameter.

Example: Decimal = 32 767. 123

BCD word 1 = 55 55 55 36 35 42
BCD word 2 = 41 42 57 34 35 36

Example: Decimal = -1. 356

BCD word 1 = 55 55 55 55 55 55
BCD word 2 = 46 34 57 36 40 41

TABLE C-II. - FORMAT OF DIFFERENTIAL RADIANCE TAPE DATA

Word (a)	Parameter	Units
1 2	Time (1st cycle)	sec
3 4	Differential radiance (1st cycle)	°C
5 6	Time (2nd cycle)	sec
7 8	Differential radiance (2nd cycle)	°C
9 10	Time (3rd cycle)	sec
11 12	Differential radiance (3rd cycle)	°C
13 14	Time (4th cycle)	sec
15 16	Differential radiance (4th cycle)	°C
17 18 19 20 21 22	Blank Blank Blank Blank Blank Blank	-- -- -- -- -- --

[a]Each (36 bit) word contains 6 binary coded decimal (BCD) characters of 6 bits each. Two words are allotted for each parameter.

Example: Decimal = 32 767.123
BCD word 1 = 55 55 55 36 35 42
word 2 = 41 42 57 34 35 36

Example: Decimal = -1.356
BCD word 1 = 55 55 55 55 55 55
word 2 = 46 34 57 36 40 41

TABLE C-III. - BINARY CODE DIGIT

CHARACTER CODE

Decimal	BCD
0	33
1	34
2	35
3	36
4	37
5	40
6	41
7	42
8	43
9	44
Decimal point	57
Minus sign	46
Blank	55

TABLE C-IV. - FILE ARRANGEMENT OF MISCELLANEOUS SENSOR TAPES

File	Flight
1	1
2	1
3	1
4	1
5	1
6	1
7	2
8	2
9	2
10	3
11	3
12	4
13	4
14	4
15	4
16	4
17	5
18	5
19	6
20	6
21	6
22	6

TABLE C-V. - FILE ARRANGEMENT OF DIFFERENTIAL RADIANCE TAPES

File	Flight
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	2
10	2
11	2
12	2
13	2
14	3
15	3
16	3
17	3
18	4
19	4
20	4
21	4
22	4
23	4
24	4
25	4
26	4
27	5
28	5
29	5
30	5
31	6
32	6
33	6
34	6
35	6
36	6
37	6
38	6

APPENDIX D

PERIODS OF INTERFERENCE

Flight number	Tape number	Start time, G. m. t.	Time of interference, G. m. t.	Duration of interference, sec	Systems affected			
					Total air temperature, T	Dewpoint temperature, T_d	Liquid-water content	Radiometer
1	1	14:42:30			X	X	X	
			14:56:01 to 14:56:01	1	X	X	X	
			14:59:50 to 14:59:50	1	X	X	X	
			15:19:02 to 15:19:02	1	X	X	X	
		15:22:25						X
			15:22:43 to 15:22:43	1				X
			15:24:10 to 15:24:10	1				X
			15:27:15 to 15:27:17	2				X
			15:29:21 to 15:29:21	1				X
			15:29:40 to 15:29:40	1				X
			15:31:06 to 15:31:06	1				X
			15:31:25 to 15:31:25	1				X
			15:32:58 to 15:32:58	1				X
			15:33:33 to 15:33:35	2				X
			15:34:01 to 15:34:01	1				X
			15:34:48 to 15:34:56	8	X	X	X	X
			15:36:25 to end tape	255	X	X	X	X
	2	15:40:40			X	X	X	X
			15:55:17 to 15:55:32	15				X
			16:08:52 to 16:08:52	1	X	X	X	
			16:09:39 to 16:09:39	1				X
			16:11:47 to 16:11:47	1				X
			16:19:48 to 16:19:48	1	X	X	X	
			16:20:47 to 16:20:47	1				X
			16:21:55 to 16:21:55	1				X
			16:22:16 to 16:27:26	310				X
			Rain shower					
			16:23:31 to 16:23:31	1	X	X	X	
			16:28:29 to 16:28:29	1				X
			16:31:48 to 16:31:48	1	X	X	X	
			16:34:32 to 16:34:32	1		X	X	
			16:41:14 to 16:42:54	100				X
			16:41:14 to 16:53:56	780	X	X	X	
			16:54:59 to 16:54:59	1	X	X	X	
			16:55:07 to 16:55:24	17	X	X	X	X
			16:55:46 to end tape	289	X	X	X	X
	3	17:00:35			X	X	X	X
			17:02:45 to 17:02:47	2	X	X	X	X
			17:04:00 to 17:04:18	18	X	X	X	X
			17:07:33 to 17:07:39	6	X	X	X	X
			17:13:58 to 17:13:58	1	X	X	X	
			17:16:13 to 17:16:13	1				X
			17:16:39 to 17:16:44	5	X	X	X	X
			17:17:50 to 17:17:50	1	X	X	X	
			17:33:56 to 17:34:21	25	X	X	X	
			17:48:27 to 17:48:29	2				X
			17:49:00 to 17:49:07	7				X
			17:49:32 to 17:50:27	55				X
			17:58:58 to 17:58:58	1				X
			17:59:09 to end tape	474	X	X	X	X
	4	18:07:03			X	X	X	X
			18:09:47 to 18:09:50	3				X
			18:10:57 to 18:10:57	1	X	X	X	
			18:11:37 to 18:11:37	1	X	X	X	
			18:21:58 to 18:22:05	7				X
			18:22:36 to 18:23:33	58				X

Flight number	Tape number	Start time, G. m. t.	Time of interference, G. m. t.	Duration of interference, sec	Systems affected			
					Total air temperature, T	Dewpoint temperature, T_d	Liquid-water content	Radiometer
			18:26:45 to 18:27:01	16	X			
			18:27:01 to 18:27:22	21	X	X	X	
			18:38:22 to 18:38:41	19	X	X	X	X
			18:42:03 to 18:42:18	15	X	X	X	X
			19:00:12 to 19:00:13	1				X
			19:00:19 to 19:00:32	13				X
			19:00:58 to 19:01:12	14				X
			19:01:24 to 19:02:20	56				X
			19:01:46 to 19:01:46	1	X	X	X	
			19:02:33 to 19:03:00	23				X
			19:03:00 to end run	640				X
			19:06:20 to 19:06:23	3	X	X	X	X
			19:07:02 to 19:07:02	1		X	X	
			19:07:25 to 19:07:25	1	X	X	X	
			19:08:17 to end tape	314				
	5	19:13:31			X	X	X	
			19:15:18 to 19:15:18	1	X	X	X	
			19:21:24 to 19:21:24	1		X	X	
			19:26:27 to 19:26:31	4				X
			19:26:34 to 19:26:38	4				X
			19:27:02 to 19:27:07	5				X
			19:35:53 to 19:35:54	1				X
			19:36:36 to 19:36:38	2				X
			19:37:32 to 19:37:39	7				X
			19:45:55 to 19:46:00	5	X			
			19:51:27 to 19:51:30	3				X
			19:51:54 to 19:51:58	4				X
			19:52:17 to end run	--				X
			19:57:25 to 19:59:05	100	X			
			20:00:12 to 20:00:12	1	X	X	X	
			20:00:15 to 20:00:45	30	X			
			20:09:17 to end tape	--				
2	1	18:49:00			X	X	X	X
			18:49:30 to 18:49:33	3				X
			18:49:53 to 18:49:56	3				X
			18:50:10 to 18:50:42	32				X
			19:02:25 to 19:03:24	59	X	X	X	X
			19:08:14 to 19:09:00	46	X	X	X	X
			19:09:23 to 19:09:59	36	X	X	X	X
			19:22:51 to 19:23:31	40	X	X	X	X
			19:25:22 to 19:25:22	1	X	X	X	
			19:25:58 to 19:26:02	4				X
			19:28:31 to 19:29:05	34				X
			19:37:12 to end tape	483	X	X	X	X
	2	19:43:35			X	X	X	X
			19:45:55 to 19:46:15	20	X	X	X	X
			19:48:51 to 19:48:51	1				X
			19:50:36 to 19:50:36	1	X	X	X	
			19:51:50 to 19:51:50	1	X	X	X	
			19:55:04 to 19:55:04	1			X	
			19:59:27 to 19:59:27	1				X
			19:59:35 to 19:59:35	1				X
			20:04:23 to 20:04:28	5				X
			20:06:42 to 20:07:13	31				X
			20:07:26 to 20:07:52	26				X
			20:07:45 to 20:15:00	435				X
			20:10:47 to 20:10:55	8				X
			20:19:28 to 20:19:28	1	X	X	X	
			20:19:39 to 20:19:41	2	X	X	X	
			20:19:55 to 20:19:55	1				X
			20:20:05 to 20:20:05	1			X	X
			20:20:30 to 20:20:38	8			X	

Flight number	Tape number	Start time, G. m. t.	Time of interference, G. m. t.	Duration of interference, sec	Systems affected			
					Total air temperature, T	Dewpoint temperature, T_d	Liquid-water content	Radiometer
			20:20:34 to 20:22:50	136				X
			20:20:48 to 20:20:48	1			X	
			20:21:05 to 20:21:56	51	X	X		
			20:21:05 to 20:29:07	482			X	
			20:23:05 to 20:31:09	484				X
			20:30:20 to 20:30:20	1			X	
			20:32:05 to 20:32:07	2	X	X		
			20:33:16 to 20:33:20	4	X	X		
			20:33:40 to 20:33:40	1	X	X	X	
			20:34:06 to 20:34:06	1				
			20:34:14 to 20:34:18	4	X	X		
			20:34:40 to 20:34:40	1				X
			20:34:52 to 20:34:52	1				X
			20:35:25 to 20:35:29	4	X	X	X	
			20:36:01 to 20:36:05	4	X	X		
			20:43:18 to 20:43:21	3	X	X	X	
			20:44:24 to 20:44:24	1	X	X	X	
			20:44:24 to end tape	381	X	X	X	X
	3	20: 50: 45			X	X	X	X
			20:55:33 to 20:55:33	1	X	X	X	
			21:00:05 to 21:00:07	2				X
			21:00:15 to 21:00:17	2				X
			21:01:53 to 21:01:55	2				X
			21:08:40 to 21:08:40	1	X	X	X	
			21:17:15 to 21:17:17	2				X
			21:17:33 to 21:17:35	2				X
			21:17:55 to 21:18:05	10				X
			21:18:19 to 21:18:43	24				X
			21:20:15 to 21:21:03	48				X
			21:21:17 to 21:21:17	1	X	X		
			21:24:03 to 21:24:04	1				X
			21:38:07 to end tape	--				
3	1	01:12:16			X	X	X	
			01:14:32 to 02:27:30	6778	X	X	X	
			02:38:05 to 02:38:06	1				X
			02:38:27 to 02:38:55	28				X
			02:40:02 to 02:40:02	1				X
			02:49:30 to 02:49:30	1	X	X	X	
			02:55:25 to 02:55:25	1				X
			02:56:25 to 02:56:25	1	X	X	X	
			03:14:48 to 03:14:49	1				X
			03:24:46 to 03:25:53	67	X	X	X	
			03:26:18 to end tape	260	X	X	X	X
	2	03: 30: 38			X	X	X	X
			03:36:19 to 03:36:19	1				X
			03:40:00 to 03:40:00	1	X	X	X	
			03:43:04 to 03:43:04	1	X	X	X	
			03:54:07 to 03:54:07	1	X	X	X	
			04:01:38 to 04:01:40	2	X	X	X	
			04:01:51 to 04:02:04	13	X			
			04:04:09 to 04:10:28	379	X	X	X	X
			04:11:28 to 04:11:28	1	X	X	X	
			04:22:22 to end tape	--				
4	1	13: 48: 42			X	X	X	X
			13:56:24 to 14:00:01	215	X			
			13:56:45 to 13:57:16	31		X		X
			14:01:34 to 14:01:34	1	X			
			14:02:26 to 14:02:26	1	X			
			14:04:30 to 14:05:35	65	X			
			14:06:00 to 14:07:32	92	X			
			14:06:58 to 14:06:58	1				
			14:09:58 to 14:11:58	120	X		X	
			14:14:20 to 14:16:01	101	X			

Flight number	Tape number	Start time, G. m. t.	Time of interference, G. m. t.	Duration of interference, sec	Systems affected			
					Total air temperature, T	Dewpoint temperature, T_d	Liquid-water content	Radiometer
			14:16:33 to 14:17:03	30	X			
			14:19:15 to 14:19:47	32	X			
			14:23:49 to 19:23:49	1				X
			14:26:36 to 14:26:42	6	X			
			14:34:44 to 14:34:56	12	X			
			14:41:13 to 14:41:13	1	X	X	X	
			14:42:27 to end tape	268	X	X	X	X
	2	14: 46: 55			X	X	X	X
			14:55:47 to 14:55:47	1				X
			15:01:53 to 15:02:21	28				X
			15:08:42 to 15:08:42	1				X
			15:11:38 to 15:11:38	1				X
			15:30:24 to 15:31:05	41	X			
			15:45:26 to end tape	327	X	X	X	X
	3	15: 50: 52			X	X	X	X
			16:14:20 to 16:14:45	25				X
			16:15:05 to 16:15:05	1	X	X	X	
			16:32:49 to 16:32:59	10				X
			16:33:40 to 16:33:40	1	X	X	X	
			16:50:58 to 16:51:02	4	X	X	X	
			16:50:58 to 16:51:12	14				X
			16:52:39 to end tape	234	X	X	X	X
	4	16: 56: 33			X	X	X	X
			16:57:15 to 16:57:15	1	X	X	X	
			16:58:07 to 16:58:07	1	X	X	X	
			16:59:51 to 16:59:51	1	X	X	X	
			17:04:23 to 17:04:23	1			X	
			17:19:41 to 17:19:41	1	X	X	X	X
			17:20:05 to 17:20:05	1	X	X	X	X
			17:20:13 to 17:20:15	2				X
			17:20:18 to 17:20:18	1	X	X	X	X
			17:20:43 to 17:20:45	2	X	X	X	X
			17:21:09 to 17:21:10	1	X	X	X	X
			17:21:35 to 17:21:37	2	X	X	X	X
			17:22:20 to 17:22:20	1	X	X	X	X
			17:22:33 to 17:22:33	1	X	X	X	X
			17:23:10 to 17:23:12	2	X	X		X
			17:23:17 to 17:23:17	1	X	X	X	X
			17:24:04 to 17:24:04	1	X	X		
			17:24:08 to 17:24:08	1	X	X	X	X
			17:24:32 to 17:24:32	1	X	X		X
			17:25:13 to 17:25:13	1	X	X	X	X
			17:25:55 to 17:25:56	1	X	X	X	X
			17:26:10 to 17:26:12	2				X
			17:55:27 to end tape	299	X	X	X	X
	5	18: 00: 26			X	X	X	X
			18:05:07 to 18:05:28	21	X			
			18:07:50 to 18:08:20	30	X			
			18:09:23 to 18:09:36	13	X			
			18:19:24 to 18:19:24	1	X	X		
			18:22:17 to 18:22:31	14	X			
			18:29:33 to 18:29:33	1				X
			18:30:29 to end data	--				X
			18:33:09 to end flight	--	X	X	X	X
5	1	17: 39: 30			X	X	X	X
			18:35:35 to 18:36:20	45				X
			18:36:20 to end tape	--	X	X	X	X
	2	18: 43: 11			X	X	X	X
			18:59:55 to 19:00:07	12				X
			19:01:38 to 19:01:40	2				X
			19:01:45 to 19:01:46	1				X
			19:01:53 to 19:01:54	1				X
			19:02:09 to 19:02:12	3				X

Flight number	Tape number	Start time, G. m. t.	Time of interference, G. m. t.	Duration of interference, sec	Systems affected			
					Total air temperature, T	Dewpoint temperature, T_d	Liquid-water content	Radiometer
			19:02:29 to 19:02:30	1				X
			19:02:34 to 19:02:35	1				X
			19:09:18 to 19:09:18	1	X	X	X	
			19:12:22 to 19:12:37	15	X			
			19:12:58 to 19:13:03	5				X
			19:13:10 to 19:13:13	3				X
			19:13:20 to 19:13:27	7				X
			19:19:31 to 19:19:32	1				X
			19:19:37 to 19:19:43	6				X
			19:20:00 to 19:20:01	1				X
			19:20:07 to 19:20:11	4				X
			19:23:05 to 19:23:19	14				X
			19:23:59 to 19:24:00	1				X
			19:27:07 to end flight					
			19:27:07 to 19:48:55	1912	X	X	X	X
			19:52:02 to end flight		X	X	X	X
6	1	13: 33: 15			X	X	X	X
			13:46:24 to 13:46:25	1				X
			13:46:31 to 13:46:32	1				X
			14:31:08 to 14:31:10	2	X	X	X	X
			14:31:52 to end tape	254	X	X	X	X
	2	14: 36: 06			X	X	X	X
			14:39:30 to 14:39:57	27				X
			14:48:37 to 14:48:37	1	X	X	X	
			14:51:53 to 14:51:53	1	X	X	X	
			15:07:40 to 15:07:40	1	X	X	X	
			15:24:34 to 15:24:34	1				X
			15:29:27 to 15:30:53	86	X	X	X	X
			15:32:37 to 15:33:49	72	X	X	X	X
			15:35:02 to 15:36:31	89	X	X	X	X
			15:37:31 to 15:38:35	64	X	X	X	X
			15:41:47 to end tape	303	X	X	X	X
	3	15: 48: 00			X	X	X	X
			15:56:05 to 15:56:05	1	X	X	X	
			16:11:57 to 16:11:57	1				X
			16:36:20 to 16:41:00	280	X			
			16:42:13 to 16:42:21	8				X
			16:42:16 to 16:42:50	34	X			
			16:43:47 to 16:44:45	58	X			
			16:46:20 to end tape	490	X			
			16:47:15 to end tape	435		X	X	
	4	16: 54: 30						
			16:55:53 to 16:56:46	53	X			
			16:57:52 to 16:58:00	8	X			
			16:58:43 to 16:58:48	5	X			
			17:01:45 to 17:02:36	51	X			
			17:31:28 to 17:31:30	2				X
			17:33:53 to 17:33:55	2				X
			17:34:38 to 17:34:39	1				X
			17:38:17 to 17:43:00	283	X	X	X	X
			17:43:20 to 17:43:30	10				X
			17:43:37 to 17:44:14	37				X
			17:43:55 to 17:43:55	1	X	X	X	
			17:47:09 to 17:47:09	1	X	X	X	
			17:53:35 to end flight	--	X	X	X	X

APPENDIX E

DATA LOGS

Mission 94 (BOMEX), flight 1, June 3, 1969

Check-point	Time, G.m.t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
	14:42:00	12:26	58:19	1 500	351	298	35.6	23.6	25.0
	14:50:00	13:07	58:28	1 500	351	245	31.7	24.3	25.0
	15:00:00	13:47	58:38	1 500	351	232	31.2	24.1	24.0
	15:06:00	14:11	58:44	1 500	351	236	31.2	24.1	24.0
Hotel	15:13:00	14:39	58:49	1 500	000	236	30.9	24.0	24.0
	15:15:00	14:42	58:42	1 500	080	216	31.2	24.1	24.0
	15:23:00	14:49	58:14	1 500	080	216	31.1	24.0	24.0
	15:25:00	14:43	58:12	1 500	165	226	31.2	24.1	24.0
	15:30:00	14:25	58:08	1 500	164	218	31.2	24.0	24.0
	15:35:35	14:05	58:04	1 500	164	225	31.2	24.1	24.0
	15:41:00	13:43	58:00	1 500	164	226	31.4	24.4	24.0
	15:50:00	13:10	57:54	1 500	165	216	30.9	24.1	24.0
	15:55:00	12:52	57:51	1 500	165	220	30.9	23.9	24.5
	16:00:00	12:34	57:47	1 500	165	220	30.6	23.6	24.0
	16:02:00	12:34	57:41	1 500	079	212	--	--	--
	16:05:00	12:37	57:31	1 500	078	212	31.2	24.1	24.0
	16:10:00	12:41	57:14	1 500	Turn	--	30.6	--	25.0
	16:15:00	13:01	57:17	1 500	351	226	30.6	23.6	23.0
	16:25:00	13:41	57:27	1 500	351	230	30.9	23.8	23.0
	16:30:00	14:00	57:30	1 500	351	232	31.2	24.1	24.0
	16:35:00	14:21	57:36	1 500	351	227	31.2	24.1	24.5
	16:40:00	14:40	57:40	1 500	351	229	31.2	24.2	24.0
	16:44:00	14:56	51:44	1 500	351	229	31.4	24.4	24.0
	16:53:00	15:04	57:13	1 500	080	229	--	--	--
	16:51:00	14:55	57:10	1 500	080	229	30.9	23.9	24.0
	17:05:00	14:20	57:04	1 500	165	224	31.3	24.4	24.0
	17:10:00	14:01	57:01	1 500	165	218	30.7	24.2	24.5
	17:15:00	13:44	56:58	1 500	161	215	31.0	24.2	23.5
	17:20:00	13:27	56:54	1 500	161	219	30.7	24.1	24.0
	17:30:00	12:52	56:45	1 500	161	215	30.5	23.7	24.5
	17:32:00	12:45	56:42	1 500	--	--	--	--	--
	17:35:00	12:46	56:32	1 500	078	205	31.0	24.2	24.5
	17:40:00	12:51	56:15	1 500	078	207	30.7	23.7	24.8
	17:42:00	12:53	56:08	1 500	--	--	--	--	--
	17:50:00	13:25	56:15	1 500	351	217	30.7	23.7	20-25
	17:55:00	13:44	56:19	1 500	351	219	30.7	23.8	24.9
	18:00:00	14:04	56:23	1 500	355	224	30.7	23.8	24.0
	18:07:00	14:31	56:27	1 500	--	--	29.1	--	23.0
Charlie	18:17:00	15:11	56:33	1 500	--	--	--	--	--
	18:19:00	15:06	56:36	1 500	--	--	19.5	--	5.0
	18:25:00	14:44	56:31	10 000	165	247	19.5	9.9	3.0
	18:30:00	14:23	56:27	10 000	165	250	18.8	9.7	3.0
	18:40:00	13:41	56:19	10 000	165	250	19.6	10.2	3.0
	18:45:00	13:20	56:15	10 000	165	250	20.9	11.5	3.0
Kilo	18:53:00	12:49	56:00	10 000	--	--	--	--	--
	18:55:30	12:45	56:18	10 000	255	260	20.2	11.0	3.0
	19:00:00	12:42	56:35	10 000	256	266	19.6	10.5	4.0
	19:05:00	12:38	57:01	10 000	256	267	19.4	9.7	5.0
	19:08:00	12:37	57:14	10 000	--	--	--	--	--
	19:15:00	13:05	57:22	10 000	350	270	20.2	10.5	0
	19:20:00	13:31	57:25	10 000	351	269	19.9	10.4	1.0
	19:23:00	13:45	57:28	10 000	--	--	--	--	--
	19:26:00	13:46	57:41	10 000	258	267	20.5	10.8	-2.0
	19:37:00	13:38	58:32	10 000	259	268	19.6	10.9	1.0
	19:39:00	13:36	58:42	10 000	--	--	--	--	--

Mission 94 (BOMEX), flight 1, June 3, 1969 - Concluded

Check-point	Time, G.m.t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
	19:40:00	13:31	58:42	10 000	--	--	--	--	--
	19:46:00	13:11	58:40	10 000	165	254	20.5	10.7	-1.0
	19:52:10	13:41	58:34	10 000	--	--	20.2	10.5	0
	20:10:00	13:05	59:29	10 000	--	--	--	--	--

Mission 94 (BOMEX), flight 2, June 4, 1969

Check-point	Time, G.m.t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
Delta	18:48:00	12:23	58:23	1 500	--	--	--	--	--
	18:50:00	12:24	58:22	1 500	352	226	31.5	24.4	20 to 25
	19:00:00	13:02	58:31	1 500	353	216	31.0	24.3	24.0
	19:05:00	13:20	58:35	1 500	--	--	31.6	--	24.0
	19:10:00	13:39	58:39	1 500	353	220	--	--	--
Hotel	19:24:00	14:32	58:50	1 500	--	--	31.3	--	23.5
	19:27:00	14:37	58:40	1 500	080	215	31.3	24.3	23.5 to 24.0
	19:33:00	14:42	58:18	1 500	--	--	31.3	--	23.5 to 24.0
	19:35:00	14:36	58:17	1 500	165	218	31.3	24.2	23.5
	19:44:00	14:02	58:12	1 500	165	230	31.6	24.5	24.0
	20:05:00	12:41	58:01	1 500	162	225	31.9	24.7	23.5
	20:10:00	--	--	--	--	--	--	--	--
	20:15:00	--	--	--	--	--	--	--	--
	20:27:00	12:58	58:43	5 000	--	220	25.7	19.3	18.0
	20:30:00	13:04	58:39	--	--	--	24.4	--	18.0
	20:32:00	12:57	58:37	--	--	--	--	--	--
	20:34:00	12:50	58:36	--	--	--	--	--	--
	20:38:00	12:46	58:38	--	--	--	--	--	--
	20:40:00	12:50	58:34	1 000	053	208	33.0	26.2	25.0
	20:43:00	12:57	58:35	1 000	--	--	--	--	--
	20:47:00	12:55	58:50	1 000	--	--	--	--	--
	20:50:00	13:00	58:49	1 000	--	--	31.9	--	25.0
	20:52:00	12:51	58:50	1 000	--	--	--	--	--
	20:55:00	13:01	58:53	1 000	--	210	32.7	26.1	25.0
	21:01:00	12:46	58:48	1 000	--	--	25.2	--	21.0
	21:06:00	12:56	58:58	10 000	--	--	--	--	--
	21:09:00	13:08	58:59	13 000	005	228	12.4	5.7	6.0
	21:15:00	13:09	58:33	18 000	--	--	--	--	--
	21:18:40	12:57	59:01	22 000	183	276	3.0	-7.0	-14.0
	21:28:00	--	--	--	--	--	--	--	--
	21:32:00	--	--	--	--	--	--	--	--
	21:34:00	13:05	59:31	5 000	334	245	25.7	18.5	15.0

Mission 94 (BOMEX), flight 3, June 4, 1969

Check-point	Time, G.m.t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
Delta	02:28:00	12:23	58:23	1 500	353	220	30.5	23.9	24.0
	02:34:00	12:40	58:30	1 500	353	226	30.8	23.7	24.0
	02:35:00	12:45	58:35	1 500	268	--	--	--	--
	02:41:30	12:43	59:00	1 500	268	--	--	--	--

Mission 94 (BOMEX), flight 3, June 4, 1969 - Concluded

Check-point	Time, G.m.t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
	02:42:00	12:45	59:00	1 000	355	217	31.6	25.0	25.0
	02:46:00	13:00	59:03	1 000	087	--	32.4	25.8	25.0
	02:52:00	13:01	58:44	1 000	090	200	32.4	25.5	25.0
	02:53:00	13:01	58:40	1 000	345	--	--	--	--
	02:56:00	13:12	58:43	1 000	270	--	--	--	--
	02:59:00	13:12	58:55	1 000	270	244	32.4	25.6	24.0
	03:00:00	13:12	59:00	1 000	355	--	--	--	--
	03:02:00	13:21	59:01	1 000	090	200	32.1	25.3	24.0
	03:10:00	13:23	58:33	1 500	358	--	32.1	--	24.0
	03:14:00	13:34	58:34	1 400	354	224	31.0	24.2	23.0
	03:20:00	14:00	58:40	1 400	346	233	31.3	24.0	24.0
	03:24:00	14:02	58:27	1 400	080	201	31.3	24.2	23.0
	03:30:00	14:06	58:07	2 400	199	--	--	--	--
	03:36:00	13:45	58:13	9 900	202	239	18.2	13.4	11.0
	03:41:00	13:28	58:20	16 640	199	211	10.7	4.9	0
	03:44:00	13:18	58:23	17 960	190	223	4.6	-2.2	-7.0
	03:50:00	12:57	58:26	17 960	034	--	--	--	--
	03:51:07	13:00	58:24	20 300	330	260	2.4	-6.8	-15.0
	03:53:00	13:07	58:28	20 300	270	--	--	--	--
	03:58:00	13:07	58:48	20 300	270	--	--	--	--
	04:00:00	15:07	59:00	20 300	270	--	3.0	-18.0	--
	04:19:30	12:57	60:00	1 500	001	185	29.6	24.7	23.0
	04:21:30	13:03	60:00	1 500	005	180	--	--	--

Mission 94 (BOMEX), flight 4, June 7, 1969

Check-point	Time, G.m.t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
Delta	13:43:10	12:23	58:23	16 000	091	282	10.7	-0.4	-16.0
Delta	13:45:10	12:23	58:23	16 000	360	277	10.7	-1.1	-16.0
Delta	13:48:15	12:23	58:23	16 000	270	269	10.9	-.3	-16.5
Delta	13:51:40	12:23	58:23	16 000	180	273	11.0	-.4	-17.0
Delta	13:54:00	12:23	58:25	16 000	180	275	10.7	-.8	-17.5
Delta	13:56:00	12:23	58:23	16 000	080	--	--	--	--
	14:00:00	12:25	57:57	16 000	080	299	11.2	-.7	-17.0
	14:05:00	12:30	57:33	16 000	080	297	11.3	-.4	-16.7
	14:10:00	12:34	57:09	16 000	080	299	11.6	0	-18.7
	14:15:00	12:39	56:44	16 000	079	297	11.0	-.7	-20.5
	14:20:00	12:45	56:20	16 000	079	297	11.0	-.7	-20.0
	14:26:00	12:51	55:50	16 000	079	297	10.7	-1.0	-17.5
	14:35:00	13:02	55:05	16 000	077	299	11.0	-.9	-16.0
	14:40:00	13:06	54:41	16 000	094	300	--	--	--
	14:48:00	13:10	54:00	16 000	090	300	--	--	--
Echo	14:51:00	13:08	53:51	16 000	355	295	11.0	-1.1	-12.5
Echo	14:53:50	13:08	53:51	16 000	266	288	11.0	-1.0	-12.5
Echo	14:56:30	13:08	53:51	16 000	156	288	11.0	-.9	-12.0
Echo	14:59:00	13:08	53:51	16 000	086	298	10.4	-1.3	-12.0
	15:05:00	13:31	53:52	16 000	340	292	10.5	-1.4	-11.0
	15:20:00	14:43	54:18	16 000	348	290	10.0	-2.1	-13.5
	15:30:00	15:33	54:29	16 000	348	290	11.3	-.8	-22.0
	15:40:00	16:21	54:40	16 000	349	289	11.3	-.8	-22.0
	15:51:00	17:15	54:53	16 000	349	280	11.3	0	-21.0
	16:01:50	17:40	54:40	16 000	270	278	8.5	-3.3	-20.6
Bravo	16:04:30	12:36	54:54	16 000	179	290	9.9	-1.3	-22.0
Bravo	16:07:35	17:36	54:54	16 000	089	280	9.9	-.9	-22.0

Mission 94 (BOMEX), flight 4, June 7, 1969 - Concluded

Check-point	Time, G. m. t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
Bravo	16:10:50	17:36	54:54	16 000	357	276	10.5	-0.5	-22.0
	16:13:00	17:36	54:54	16 000	--	--	--	--	--
	16:20:00	17:36	55:17	16 000	258	288	8.5	-2.1	-22.0
	16:30:00	17:26	56:08	16 000	259	290	10.7	-.8	-22.0
	16:40:20	17:17	57:03	16 000	259	291	11.9	.4	-23.0
	16:50:00	17:08	57:53	16 000	260	288	11.9	.3	-23.0
	17:00:00	17:00	58:45	16 000	260	290	11.9	.5	-22.5
Alpha	17:12:05	16:50	59:12	16 000	180	285	--	--	-22.5
Alpha	17:15:00	16:50	59:12	16 000	090	285	11.9	.8	-22.5
Alpha	17:17:50	16:50	59:12	16 000	359	280	--	--	--
Alpha	17:21:10	16:50	59:12	16 000	268	286	11.3	0	-23.2
	17:30:00	16:38	59:31	16 000	170	289	11.9	.5	-23.0
	17:40:00	15:51	59:22	16 000	165	290	11.9	.3	-23.0
	18:01:00	14:15	58:54	16 000	164	287	12.4	.7	-22.5
	18:10:00	13:33	58:44	16 000	170	290	12.4	.8	-21.0
	18:16:20	13:02	58:39	16 000	161	298	11.9	0	-21.0
Delta	18:21:40	12:23	58:23	16 000	180	297	12.7	.8	-21.0
Delta	18:24:30	12:23	58:23	16 000	090	299	12.4	.7	-21.5
Delta	18:27:10	12:23	58:23	16 000	360	287	12.4	.7	-21.5
Delta	18:30:10	12:25	58:23	16 000	268	291	12.4	.6	-21.5

Mission 94 (BOMEX), flight 5, June 8, 1969

Check-point	Time, G. m. t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
	17:40:30	12:23	58:25	1 040	081	224	30.5	23.7	22.0
	17:45:00	12:30	58:03	1 040	081	228	31.0	24.2	20.0
	17:51:00	12:35	57:40	1 060	081	228	29.6	22.8	23.0
	17:55:00	12:39	57:28	1 060	081	226	29.6	22.8	22.5
	18:00:00	12:45	57:15	1 070	081	220	29.6	22.8	23.0
	18:05:00	12:48	57:00	1 090	081	226	30.2	23.4	22.7
	18:10:00	12:53	56:43	1 100	081	228	29.6	22.8	23.0
	18:15:00	12:37	56:28	1 100	081	232	29.6	22.5	22.5
	18:17:00	13:02	56:20	1 090	351	--	--	--	--
	18:19:00	13:03	56:16	1 100	261	--	--	--	--
	18:20:00	13:13	56:18	1 100	254	222	28.2	21.6	22.8
	18:25:00	13:12	56:27	1 100	254	228	30.2	23.6	22.8
	18:30:00	13:15	56:29	1 100	071	216	28.5	21.9	23.5
	18:33:00	13:24	56:25	1 100	075	--	--	--	--
	18:35:00	13:21	56:12	1 100	075	222	28.5	21.9	23.0
	18:46:00	13:11	56:48	14 300	261	220	--	--	--
	18:50:00	13:09	56:46	18 270	080	254	--	--	--
	18:55:00	13:08	56:43	20 760	258	210	-.6	-5.2	-8.0
	19:01:00	13:03	57:10	21 300	256	263	3.5	-5.8	-12.5
	19:05:00	12:56	57:30	21 280	244	304	3.2	-9.0	-12.0
	19:10:30	12:45	57:49	21 270	244	304	3.2	-9.0	-12.0
	19:13:00	12:39	58:06	21 270	244	--	--	--	--

Mission 94 (BOMEX), flight 6, June 9, 1969

Check-point	Time, G. m. t.	Latitude, deg: min	Longitude, deg: min	Altitude, ft	Heading, deg	Ground speed, knots	Total air temperature, °C	Ambient temperature, °C	Dewpoint temperature, °C
Delta	13:33:50	12:23	58:23	16 000	192	292	10.2	-1.9	-4.0
Delta	13:36:50	12:23	58:23	16 000	102	298	10.5	-1.6	-4.0
Delta	13:39:00	12:23	58:23	16 000	012	295	10.5	-1.4	-4.2
Delta	13:41:40	12:23	58:23	16 000	282	285	9.9	-1.6	-4.2
	13:50:00	12:23	57:58	16 000	088	295	10.7	-1.2	-4.2
	13:55:00	12:28	57:34	16 000	080	300	11.0	-1.0	-4.3
	14:01:00	12:34	57:03	16 000	080	300	11.9	-.3	-5.0
	14:06:00	12:38	56:39	16 000	080	300	12.4	0	-4.0
	14:11:00	12:43	56:14	16 000	079	295	11.9	-.4	-4.0
	14:15:00	12:47	55:55	16 000	079	295	11.3	-.8	-3.5
	14:21:00	12:53	55:24	16 000	079	300	11.3	-.9	-3.0
	14:25:00	12:57	55:04	16 000	079	304	11.3	-.8	-3.5
	14:30:00	13:02	54:38	16 000	079	306	11.3	-1.1	-3.5
	14:41:00	13:26	53:59	16 000	348	300	11.3	-1.1	-4.0
	14:50:00	14:13	54:07	16 000	348	300	11.9	-1.0	-4.0
	14:56:00	14:42	54:12	16 000	348	301	10.7	-1.9	-4.9
	15:00:00	15:02	54:16	16 000	348	301	10.7	-1.9	-5.0
	15:05:00	15:28	54:21	16 000	347	300	11.0	-2.0	-7.5
	15:20:00	16:44	54:35	16 000	349	296	11.6	-1.3	-19.0
Bravo	15:31:00	17:36	54:34	16 000	348	291	11.9	-.9	-17.0
Bravo	15:33:50	17:36	54:34	16 000	079	312	12.4	-.2	-16.0
Bravo	15:36:25	17:36	54:34	16 000	170	309	12.1	-.3	-16.5
Bravo	15:39:00	17:36	54:34	16 000	259	287	12.1	-.1	-17.5
	15:50:00	17:35	55:27	16 000	259	289	12.4	-.4	-18.5
	16:00:00	17:22	56:17	16 000	260	293	11.9	-.9	-11.2
	16:10:00	17:13	57:10	16 000	260	300	11.6	-1.3	-9.5
	16:25:00	17:01	58:29	16 000	260	300	12.7	-.6	-12.0
Alpha	16:36:00	16:50	59:12	16 000	170	308	12.7	-.2	-16.7
	16:45:00	16:04	59:19	16 000	170	318	12.4	-.8	-18.5
	16:56:00	15:07	59:11	16 000	160	319	13.0	.8	-20.0
	17:12:00	13:44	58:57	16 000	170	310	13.2	1.0	-15.0
	17:26:45	12:39	58:39	16 000	080	318	12.1	-1.3	-5.2
Delta	17:29:20	12:23	58:23	16 000	170	308	12.1	-1.3	-5.1
Delta	17:32:30	12:23	58:23	16 000	260	307	13.0	-.2	-5.2
Delta	17:35:20	12:23	58:23	16 000	350	310	12.4	-.6	-4.5
	17:44:30	12:38	58:12	1 500	--	--	--	--	--
	17:45:40	12:41	58:10	1 500	345	230	30.7	23.5	24.0
	17:47:10	12:42	58:15	1 500	255	238	30.7	23.5	24.2
	17:48:40	12:41	58:00	1 500	256	240	31.0	24.8	24.0
	17:52:10	12:47	58:21	1 500	079	225	31.3	24.1	24.5
	17:53:15	12:48	58:17	1 500	--	--	--	--	--

APPENDIX F

CAMERA LOGS

Flight	16-mm movie camera		Oblique camera	
	Time on, G. m. t.	Time off, G. m. t.	Time on, G. m. t.	Time off, G. m. t.
1	14:44:00	14:49:00	14:42:00	15:28:34
	14:58:15	15:00:00	16:05:00	16:07:00
	15:14:00	15:16:15	16:22:45	16:38:00
	15:25:00	15:27:15	16:50:38	16:53:00
	16:05:00	16:07:00	17:01:05	17:03:05
	16:22:45	16:38:00	17:30:00	17:32:30
	16:50:38	16:53:00	17:40:00	17:48:45
	17:01:05	17:03:05	18:21:00	18:25:00
	17:30:00	17:32:30	18:35:00	18:37:30
	17:40:00	17:48:45	18:53:00	18:55:00
	18:21:00	18:25:00	19:25:00	19:27:00
	18:35:00	18:37:30	19:50:30	19:53:00
	18:53:00	18:55:00	20:10:00	20:15:00
	19:25:00	19:27:00		
	19:50:30	19:53:00		
	20:10:00	20:15:00		
2	18:50:00	18:52:10	18:50:00	18:52:10
	19:25:00	19:27:00	19:25:00	19:27:00
	19:32:00	19:34:00	19:32:00	19:34:00
	19:54:00	19:56:00	19:54:00	19:56:00
	20:06:30	20:21:30	20:06:30	20:48:30
	20:29:30	20:48:30	21:04:00	21:24:00
	21:04:00	21:24:00	21:34:00	21:37:00
	21:34:00	21:37:00		
4	13:45:00	13:46:00	13:45:00	13:46:00
	13:50:00	13:51:00	13:50:00	13:51:00
	13:55:00	13:56:00	13:55:00	13:56:00
	14:00:00	14:01:00	14:00:00	14:01:00
	14:05:00	14:06:00	14:05:00	14:06:00
	14:10:00	14:11:00	14:10:00	14:11:00
	14:15:00	14:16:00	14:15:00	14:16:00
	14:20:00	14:21:00	14:20:00	14:21:00
	14:25:00	14:26:00	14:25:00	14:26:00
	14:30:00	14:31:00	14:30:00	14:31:00
	14:35:00	14:36:00	14:35:00	14:36:00
	14:40:00	14:41:00	14:40:00	14:41:00

Flight	16-mm movie camera		Oblique camera	
	Time on, G. m. t.	Time off, G. m. t.	Time on, G. m. t.	Time off, G. m. t.
	14:45:00	14:46:00	14:45:00	14:46:00
	14:50:00	14:51:00	14:50:00	14:51:00
	14:55:00	14:56:00	14:55:00	14:56:00
	15:00:00	15:01:00	15:00:00	15:01:00
	15:05:00	15:06:00	15:05:00	15:06:00
	15:10:00	15:11:00	15:10:00	15:11:00
	15:15:00	15:16:00	15:15:00	15:16:00
	15:20:00	15:21:00	15:20:00	15:21:00
	15:25:00	15:26:00	15:25:00	15:26:00
	15:30:00	15:31:00	15:30:00	15:31:00
	15:35:00	15:36:00	15:35:00	15:36:00
	15:40:00	15:41:00	15:40:00	15:41:00
	15:45:00	15:46:00	15:45:00	15:46:00
	15:50:00	15:51:00	15:50:00	15:51:00
	15:55:00	15:56:00	15:55:00	15:56:00
	16:00:00	16:01:00	16:00:00	16:01:00
	16:05:00	16:06:00	16:05:00	16:06:00
	16:10:00	16:12:00	16:10:00	16:12:00
	16:15:30	16:16:30	16:15:30	16:16:30
	16:20:00	16:22:00	16:20:00	16:22:00
	16:25:00	16:26:00	16:25:00	16:26:00
	16:30:00	16:31:00	16:30:00	16:31:00
	16:35:00	16:36:05	16:35:00	16:36:05
	16:40:00	16:41:00	16:40:00	16:41:00
	16:45:00	16:46:00	16:45:00	16:46:00
	16:50:00	16:51:00	16:50:00	16:51:00
	16:55:00	16:56:00	16:55:00	16:56:00
	17:00:00	17:02:30	17:00:00	17:01:00
	17:10:00	17:11:00	17:05:00	17:06:10
	17:15:00	17:16:00	17:10:00	17:11:00
	17:20:00	17:21:00	17:15:00	17:16:00
	17:25:00	17:26:00	17:20:00	17:21:00
	17:30:00	17:31:00	17:25:00	17:26:00
			17:30:00	17:31:00
	17:35:00	17:36:00	17:35:00	17:36:00
	17:40:00	17:41:00	17:40:00	17:41:00
	17:45:00	17:46:00	17:45:00	17:46:00
	17:50:00	17:51:00	17:50:00	17:51:00
	17:55:00	17:56:00	17:55:00	17:56:00
	18:00:00	18:01:00	18:00:00	18:01:00
	18:05:00	18:06:00	18:05:00	18:06:00
	18:10:00	18:11:00	18:10:00	18:11:00
	18:18:00	18:16:00	18:15:00	18:16:00
	18:20:00	18:21:00	18:20:00	18:21:00
	18:25:00	18:26:30	18:25:00	18:26:30
	18:30:00	18:32:00	18:30:00	18:32:00

Flight	16-mm movie camera		Oblique camera	
	Time on, G. m. t.	Time off, G. m. t.	Time on, G. m. t.	Time off, G. m. t.
5	17:45:00	17:46:00	17:45:00	17:46:00
	17:50:00	17:51:00	17:50:00	17:50:00
	17:55:00	17:56:00	17:55:00	17:56:00
	17:57:30	18:01:00	17:57:30	18:01:00
	18:05:00	18:06:00	18:05:00	18:06:00
	18:10:00	18:11:00	18:10:00	18:11:00
	18:15:00	18:16:00	18:15:00	18:16:00
	18:20:00	18:21:00	18:20:00	18:21:00
	18:25:00	18:26:00	18:25:00	18:26:00
	18:30:00	18:31:00	18:30:00	18:31:00
	18:35:00	18:36:00	18:35:00	18:36:00
	19:05:00	19:06:00	19:05:00	19:06:00
	19:10:00	19:11:00	19:10:00	19:11:00
	19:15:00	19:16:00	19:15:00	19:16:00
	19:20:00	19:21:00	19:20:00	19:21:00
	19:25:00	19:26:00	19:25:00	19:26:00
6	13:35:00	13:36:00	13:35:00	13:36:00
	13:40:00	13:41:00	13:40:00	13:41:00
	13:45:00	13:46:00	13:45:00	13:46:00
	13:50:00	13:51:00	13:50:00	13:51:00
	13:55:00	13:56:00	13:55:00	13:56:00
	14:00:00	14:01:00	14:00:00	14:01:00
	14:05:00	14:06:00	14:05:00	14:06:00
	14:10:00	14:11:00	14:10:00	14:11:00
	14:15:00	14:21:00	14:15:00	14:21:00
	14:25:00	14:26:00	14:25:00	14:26:00
	14:30:00	14:31:00	14:30:00	14:31:00
	14:35:00	14:36:00	14:35:00	14:36:00
	14:40:00	14:41:00	14:40:00	14:41:00
	14:45:00	14:46:00	14:45:00	14:46:00
	14:50:00	14:56:00	14:50:00	14:56:00
	15:00:00	15:01:00	15:00:00	15:01:00
	15:05:00	15:06:00	15:05:00	15:06:00
	15:10:00	15:11:00	15:10:00	15:11:00
	15:15:00	15:16:00	15:15:00	15:16:00
	15:20:00	15:22:00	15:20:00	15:22:00
	15:25:00	15:26:00	15:25:00	15:26:00
	15:30:00	15:31:00	15:30:00	15:31:00
	15:40:00	15:41:00	15:40:00	15:41:00
	15:45:00	15:46:00	15:45:00	15:46:00
	15:50:00	15:51:00	15:50:00	15:51:00
	15:55:00	15:56:00	15:55:00	15:56:00
	16:00:00	16:01:00	16:00:00	16:01:00
	16:05:00	16:06:00	16:05:00	16:06:00

Flight	16-mm movie camera		Oblique camera	
	Time on, G. m. t.	Time off, G. m. t.	Time on, G. m. t.	Time off, G. m. t.
	16:10:00	16:14:00	16:10:00	16:11:00
	16:15:00	16:16:00	16:15:00	16:16:00
	16:20:00	16:21:00	16:20:00	16:21:00
	16:25:00	16:26:00	16:25:00	16:26:00
	16:30:00	16:31:00	16:30:00	16:31:00
	16:35:00	16:36:00	16:35:00	16:36:00
	16:40:00	16:41:00	16:40:00	16:41:00
	16:45:00	16:46:00	16:45:00	16:46:00
	16:50:00	16:51:00	16:50:00	16:51:00
	16:55:00	16:56:00	16:55:00	16:56:00
	17:00:00	17:01:00	17:00:00	17:01:00
	17:05:00	17:06:00	17:05:00	17:06:00
	17:10:00	17:11:00	17:10:00	17:11:00
	17:15:00	17:16:00	17:15:00	17:16:00
	17:20:00	17:21:00	17:20:00	17:21:00
	17:25:00	17:30:00	17:25:00	17:30:00
	17:44:00	17:50:00	17:44:00	17:50:00