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NASA GLOBAL ATMOSPHERIC SAMPLING PROGRAM (GASP) DATA REPORT FOR TAPE VL0003

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ABSTRACT

The NASA Global Atmospheric Sampling Program (GASP) is now obtaining measurements of atmospheric trace constituents in the upper troposphere and lower stratosphere using fully automated air sampling systems on board several commercial 747 aircraft in routine airline service. Atmospheric ozone, and related flight and meteorological data for May 1975, obtained during 49 flights of a Pan American World Airways 747, are now available as GASP tape VL0003 from the National Climatic Center, Asheville, North Carolina. In addition to the GASP data, tropopause pressure fields obtained from NMC archives for the dates of the GASP flights are included on the data tape. Flight routes and dates, instrumentation, data processing procedures, and data tape specifications are described in this report.

NASA GLOBAL ATMOSPHERIC SAMPLING PROGRAM (GASP) DATA REPORT FOR TAPE VL0003

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SUMMARY

Atmospheric trace constituents in the upper troposphere and lower stratosphere are now being measured as part of the NASA Global Atmospheric Sampling Program (GASP), using fully automated air sampling systems on board several commercial 747 aircraft in routine airline service. Measurements of atmospheric ozone and related meteorological and flight information obtained during 49 GASP flights in May 1975 are now available from the National Climatic Center, Asheville, North Carolina. In addition to the data from the aircraft, tropopause pressure data obtained from the National Meteorological Center (NMC) archives for the dates of the flights are included. This report is the third of a series of reports which describe the data currently available from GASP, including flight routes and dates, instrumentation, the data processing procedure used, and data tape specifications.

INTRODUCTION

This report announces the availability of ozone mixing ratio, static air temperature, and wind speed and direction data obtained at altitudes from 6 to 12 km during several flights of a Pan Am 747 airliner (N655PA) during May 1975.

The objectives of the NASA Global Atmospheric Sampling Program are to provide baseline data of selected atmospheric constituents in the upper troposphere and lower stratosphere for the next 5-to-10 year period, and to document and analyze these data to assess potential adverse effects between aircraft exhaust emissions and the natural atmosphere. At present there is much uncertainty in environmental impact studies on this subject due to the lack of comprehensive, long-term upper atmospheric data (refs. 1 and 2).

The GASP program began in 1972 with a feasibility study of the concept of using commercial airliners in routine service to obtain atmospheric data. This program has progressed from design and acquisition of hardware (ref. 3) to collecting global data on a daily basis. Fully automated GASP systems are now operating on a United Airlines 747, two

Pan American World Airways 747's, and a Qantas Airways of Australia 747. The United airliner is collecting data over the contiguous United States and between the west coast and Hawaii. Global coverage is provided by the Pan American and Qantas 747's. Pan Am routes from the United States include around-the-world in the Northern Hemisphere, trans-Atlantic to Europe, trans-Pacific to the Orient, inter-continental to Central and South America, and occasionally trans-Pacific to Australia. More frequent coverage in the Southern Hemisphere is provided by the Qantas 747 on transcontinental Australian flights and on flights from Australia to the South Pacific and Australia to Europe. The GASP system design, the measurement instruments, the on-board computer for automatic control and data management, and system maintenance procedures are described in reference 4.

This report is the third in a series of reports to announce the availability of GASP data from the National Climatic Center, Asheville, NC, 28801. Northern Hemisphere data for March 11-March 30, 1975 have been previously archived and reported (tape VL0001; refs. 5 and 6). Data over the contiguous United States and to Hawaii for March-October, 1975 are provided on GASP tape VL0002 (ref. 7). Data obtained during May 1975 on flights in North, Central, and South America, and from the United States to the Orient are now available on GASP tape VL0003. The data on this tape include ozone mixing ratios, related meteorological and flight information from the aircraft systems, and tropopause pressure fields obtained from the National Meteorological Center (NMC) for the dates of the GASP flights. In addition to announcing the availability of tape VL0003 data, this report describes the GASP instrumentation, data processing precedure, and data tape specifications.

ROUTE STRUCTURE AND DATA ACQUISITION

Flight routes for which data are given on GASP Tape VL0003 are shown on figure 1. All flights occurred between May 2 and May 30, 1975. The numbers in parentheses on the figure indicate the number of flights for each route. On the tape, GASP data are grouped and identified by flights with the airports of departure and arrival designated by the standard three-letter airport codes (ref. 8). A listing of flights included in tape VL0003 by airport-pair, date, and data acquisition time, is given in table I.

For each flight, data acquisition begins on ascent through the 6 km altitude flight level, and terminates on descent through 6 km. A complete GASP sampling cycle is 60 minutes, divided into 12 five minute segments. A 16 second recording is made at the end of each sampling segment.

During alternate segments (at 10 minute intervals), air sample data are recorded for all instruments. During the intervening segments the system is in one of six different calibration modes to allow for in-flight checks on instrument operation (if required). Whenever any calibration mode is not needed for a given instrument, that instrument acquires air sample data during the segment.

Cassette tapes, recorded in serial format, are removed from the aircraft at approximately two week intervals and transcribed to computer-compatible form for data reduction. At this stage, laboratory instrument calibration information required for data processing is included, redundant and non-usable data are removed, and the data are re-transcribed to final form and units. The detailed specifications and formats for the GASP data are given in appendix A. Data for each flight begins with an FLHT record (table A-I) to provide flight identification information. This record is followed by a series of DATA records (table A-II), one for each recording made during the flight.

MEASUREMENTS

Ozone

Ozone measurements are made using a DASIBI Model 1003-AH continuous ultraviolet ozone photometer. The concentration of atmospheric ozone is determined by measuring the difference in intensity of an ultraviolet light beam which alternately passes through the sample gas and an ozone-free zero gas (generated within the instrument). The range of this instrument is from 3 to 20,000 ppbv (parts per billion by volume), with a sensitivity of 3 ppbv. This instrument is described in reference 9, and data from flight tests of the instrument are given in reference 10. The ozone instrument is checked at NASA-Lewis (over the range 0 to 1000 ppbv) against an ozone generator which is calibrated by the one percent neutral buffered potassium iodide (KI) method (ref. 11). The estimated accuracy of the KI procedure is seven percent.

In-flight monitoring of the ozone instrument includes measurement of the instrument zero by flowing the sample through a charcoal filter external to the instrument, and measurement of the electronic span setting and control frequencies available from the instrument. For all GASP ozone instruments the span is set by the manufacturer at 58200 counts. The instrument is not calibrated in-flight with an ozone calibration gas due to the difficulty of generating a precisely known ozone concentration in the flight system. Periodic checks for calibration consistency are performed in the laboratory.

The destruction of ozone in the Teflon sample lines from the inlet probe to the instrument, and in the Teflon-coated diaphragm pump that raises the sample pressure to 10 N/cm2 (1 atm), has been measured under conditions simulating operation in flight. The ozone mixing ratio at the probe inlet (O3, in ppbv) is expressed in terms of the measured ozone mixing ratio (O3m, in ppbv) as

$$O3 = a(O3m)^{b} + \frac{O3m}{1 + c(O3m)} + d \qquad (1)$$

with the constants a, b, c and d determined by a regression analysis on the appropriate destruction test data. For all flights on tape VL0003, the ambient ozone mixing ratios were determined using equation (1) with a = 0.16, b = 1.0 and c = d = 0. The linear relationship between O3 and O3m thus defined, and the data from which it was determined are shown in figure 2. The uncertainty in this approximation is ± 8 percent. For comparison, the relations used for data on tapes VL0001 (ref. 5) and VL0002 (ref. 7) are shown. The destruction constants are given in the FLHT record for each flight (see Table A-I).

The form chosen for equation (1) is based on the ozone destruction mechanisms expected in the GASP system. If b = 0.5 in the first term, this term then approximates destruction of ozone in the sample lines (c.f. ref. 12). If c > 0 in the second term, this term is of the type which describes thermal decomposition of ozone (refs. 13 and 14). This mechanism could be important in the pump as the sample is heated by the (approximately) 3:1 compression. The percentage of the incoming ozone destroyed by the line mechanism decreases with increasing concentrations, whereas the percentage of the incoming ozone destroyed by the thermal mechanism increases with increasing concentration. Since both mechanisms are likely contributing to the system destruction, it is not surprising that the destruction data are approximated well with a linear relationship which gives a constant percentage destruction.

Flight Data

In addition to the air sample measurements, aircraft flight data are obtained with each data recording to precisely describe conditions when the data are acquired. Aircraft position, heading, and the computed wind speed and direction are obtained from the inertial navigation system. Altitude, air speed, and static air temperature are collected from the central air data computer in the aircraft. Vertical acceleration information (an indication of turbulence) is taken from the aircraft flight recording system. Date and time are provided by a separate GASP clock-calendar unit. The formats and units for these data are given in table A-II.

Tropopause Pressure Data

The National Meteorological Center (NMC) is presently maintaining a library of gridded meteorological data fields accessible on various disk and magnetic tape systems (ref. 15). Briefly, the data are interpolated to points on the NMC 65 X 65 grid, a square matrix map transformed from a polar stereographic map of the Northern Hemisphere. Among these gridded data are tropopause pressures, available on a twice daily basis (0000 and 1200 GMT).

Tropopause pressures are derived as a by product of the NMC objective analysis scheme which determines the height of constant pressure surfaces above each grid point. Vertical, mean layer temperature profiles, related directly to the vertical separation of the constant pressure levels, are calculated for each of the 4225 grid points, and fitted with a high order polynominal curve. By means of a slope testing routine, the tropopause is defined as the base of the lowest stable layer (pressures $\leq$ 500 mb) within which the average lapse rate is $\leq$ 2.5 degrees C/km.

The NMC tropopause pressure data arrays are included, when available, for the dates of the GASP flights to provide independent data for analysis of the constituent measurements in terms of their tropospheric-stratospheric behavior. The NMC reporting periods for which these data appear on tape VL0003 are given in Table II. The tropopause pressure arrays form a separate file (see Appendix A) following the GASP data. Each array (4225 points) is written as seven TRPR records (Table A-III). Coordinates for these data are the NMC 65 X 65 matrix. The relations for obtaining latitude and longitude from the NMC coordinates are given in appendix B. The aircraft location for each GASP DATA record is given both in NMC coordinates and latitude and longitude (see Table A-II).

SELECTED ANALYSIS

Because the majority of the flights on tape VL0003 were within $\pm$ 30 degrees of latitude from the equator (fig. 1), most of the data on this tape were obtained in the troposphere. One flight which did penetrate into the stratosphere was from New York to San Francisco on May 27, 1975 (fig. 3). The aircraft entered the lower stratosphere at approximately 82 degrees W longitude as shown by the simultaneous increase in ozone mixing ratio and static air temperature. From this point westward the increasing ozone levels suggest that the height of the tropopause was decreasing, since the flight altitude was constant. The high ozone levels and the cyclonic curvature of the winds from 108 to 118 degrees W longitude suggest the presence of a lower stratospheric trough over the Rocky Mountains.

Further insight into these data is provided by considering them with the National Weather Service tropopause pressure, temperature, and wind data for 0000 GMT on May 28th shown in figure 4. The tropopause pressure contours and the jet stream location shown on the figure were provided by P. D. Falconer, NOAA-Air Resources Laboratories, Silver Spring, Maryland. The heavy dotted line indicates the flight route. The southwesterly winds observed over Lake Erie (fig. 3) correspond to the curving of the jet stream to the north at the location where the flight entered the stratosphere. Across Michigan, Wisconsin, and Minnesota, the flight was generally parallel to, but above, the jet core. West from Minnesota to Utah the location of the jet stream was increasingly south of the flight route, and the aircraft measurements show a gradual shift in the wind direction from west to southwest accompanied by decreasing wind speed (fig. 3). The increasing ozone mixing ratios along this segment correspond to the increasing tropopause pressures shown in figure 4. This figure also shows the flight route crossing the trough-line over northwestern Utah. This is the location of the highest ozone mixing ratio measured during the flight. The high wind speeds measured near 120 W longitude (fig. 3) reflect the crossing of the polar jet over western Nevada just before the aircraft began its descent into San Francisco.

CONCLUDING REMARKS

Atmospheric trace constituents in the upper troposphere and lower stratosphere are now being measured as part of the NASA Global Atmospheric Sampling Program (GASP), using fully automated air sampling systems operating on 747 airliners in routine commercial service. Ozone mixing ratio, static air temperature, and wind speed and direction data obtained during several flights of a GASP-equipped Pan American 747 airliner from May 2 to May 30, 1975 are now available. The height of the tropopause obtained from NMC data archives for the dates of the GASP flights are included as a supplement to the GASP data. These data may be obtained as GASP tape VL0003 from the National Climatic Center, Federal Building, Asheville, NC, 28801. Flight routes and dates, instrumentation, data processing procedures, and tape specifications and formats are discussed in this report.

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TABLE I - GASP FLIGHTS ON TAPE VL0003

Tape Flight Number	Flight Route	Departure Date	Data Acquisition Time (GMT)
1	SFO-LAX	5/02/75	1437-1457
2	LAX-GUA		1713-2034
3	GUA-MIQ		2337-0212
4	MIQ-GIG	5/03/75	0411-0900
5	GIG-MIQ		1330-1821
6	MIQ-MIA		2007-2222
7	MIA-MIQ	5/04/75	0049-0244
8	MIQ-GIG		0453-0935
9	GIG-VCP		1135-1155
10	VCP-GIG	5/05/75	0221-0233
11	GIG-MIQ		0423-0923
12	MIQ-GUA		1119-1404
13	GUA-LAX		1719-2119
14	LAX-SFO		2311-2336
15	LAX-GUA	5/08/75	1713-2304
16	PTY-GUA	5/09/75	1305-1420
17	GUA-LAX		1643-2034
18	LAX-SFO		2237-2257
19	SFO-HNL	5/10/75	0237-0642
20	HNL-GUM		0953-1628
21	GUM-HKG		1855-2230
22	HKG-GUM	5/11/75	0742-1107
23	GUM-HNL		1348-1948
24	HNL-SFO		2303-0303
25	LAX-GUA	5/12/75	1711-2041
26	GUA-PTY		2309-0032
27	PTY-GIG	5/13/75	0244-0833
28	GIG-VCP		1025-1045
29	VCP-GIG	5/15/75	0212-0222
30	GIG-MIQ		0419-0914
31	MIQ-GUA		1126-1406
32	GUA-LAX		1629-2035
33	LAX-SFO		2321-2343
34	SFO-HNL	5/16/75	0245-0640
35	HNL-GUM		1857-0142
36	GUM-MNL	5/17/75	0404-0639
37	MNL-GUM		0945-1213
38	GUM-HNL		1440-2040

TABLE I - CONCLUDED

Tape Flight Number	Flight Route	Departure Date	Data Acquisition Time (GMT)
39	HNL-SFO	5/18/75	0036-0426
40	BDA-BOS	5/26/75	1635-1746
41	BOS-BDA		2036-2136
42	BDA-BOS		2355-0109
43	JFK-SFO	5/27/75	1338-1833
44	SFO-HNL	5/28/75	0248-0648
45	HNL-GUM		1059-1719
46	GUM-MNL		1923-2149
47	MNL-GUM	5/29/75	0844-1114
48	GUM-HNL		1403-2023
49	HNL-SFO	5/30/75	0053-0443

TABLE II - NMC TROPOPAUSE PRESSURE
DATA ON TAPE VL0003

	Date	GMT
1	5/02/75	1200
2	5/03/75	0000
3	5/03/75	1200
4	5/04/75	1200
5	5/05/75	0000
6	5/05/75	1200
7	5/06/75	0000
8	5/08/75	1200
9	5/09/75	0000
10	5/09/75	1200
11	5/10/75	0000
12	5/10/75	1200
13	5/11/75	0000
14	5/11/75	1200
15	5/12/75	0000
16	5/12/75	1200
17	5/13/75	0000
18	5/13/75	1200
19	5/14/75	0000
20	5/14/75	1200
21	5/15/75	0000
22	5/15/75	1200
23	5/26/75	1200
24	5/27/75	0000
25	5/28/75	0000
26	5/28/75	1200
27	5/29/75	0000
28	5/29/75	1200
29	5/30/75	0000
30	5/30/75	1200

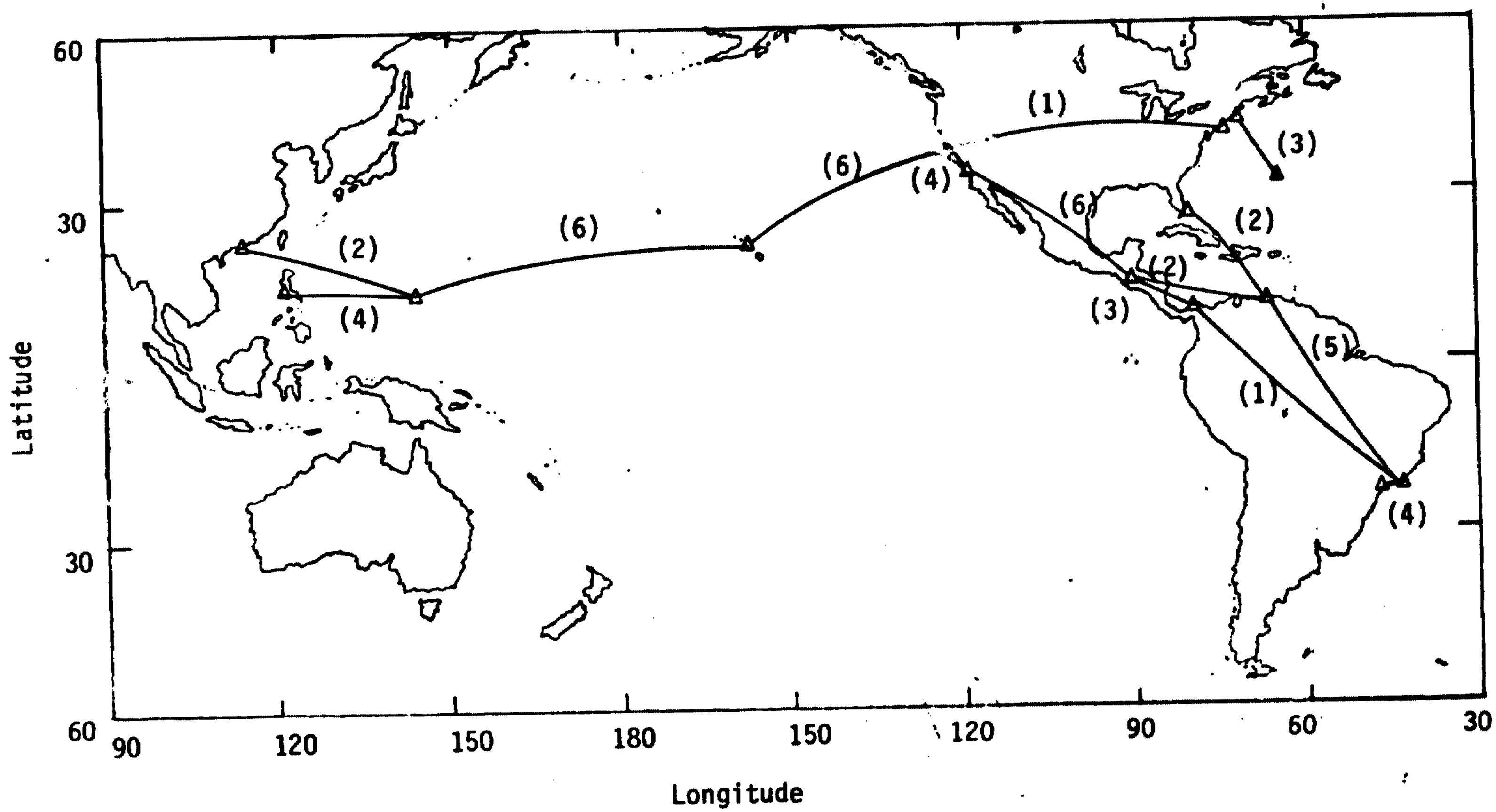

Figure 1 - GASP Flight Routes for Tape VL0003; Pan Am (N655PA), 2-30 May 1975. Numbers in Parentheses Indicate Number of Flights for Each Route.

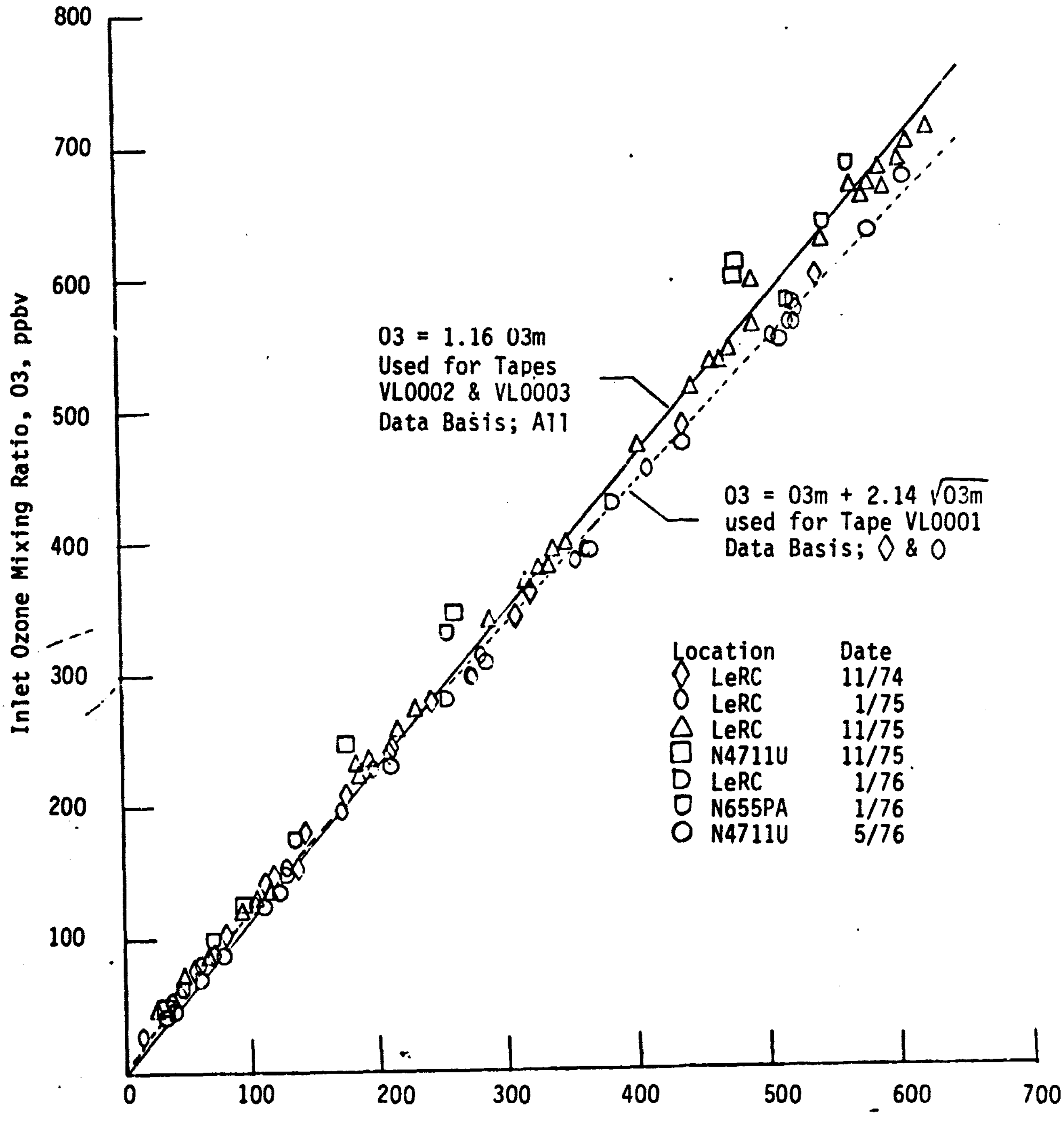

Figure 2 - GASP System Ozone Destruction Test Results

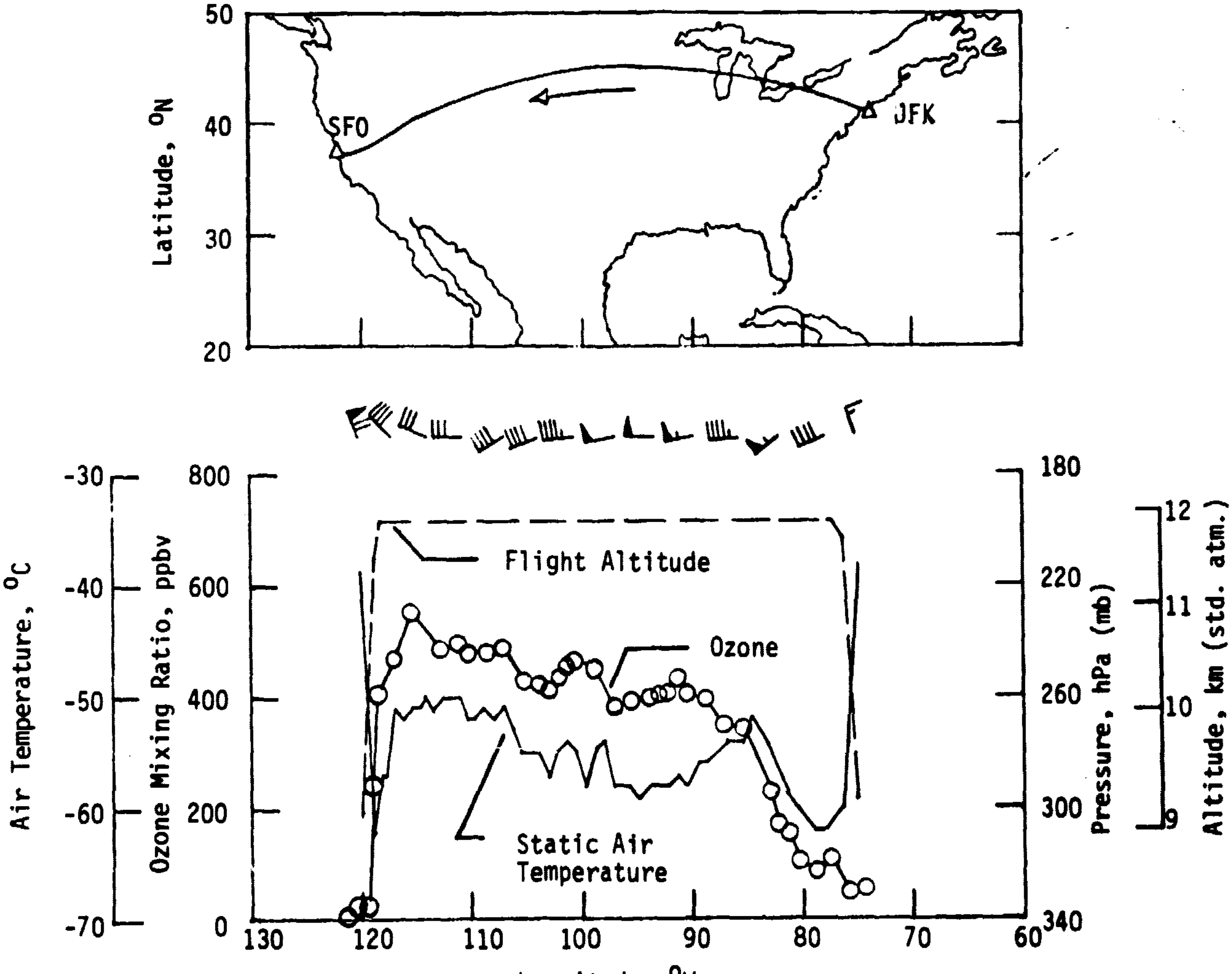

Figure 3. Flight Record for 5/27/75 (1338-1833 GMT) From New York to San Francisco, From Tape VL0003, Flight 43.

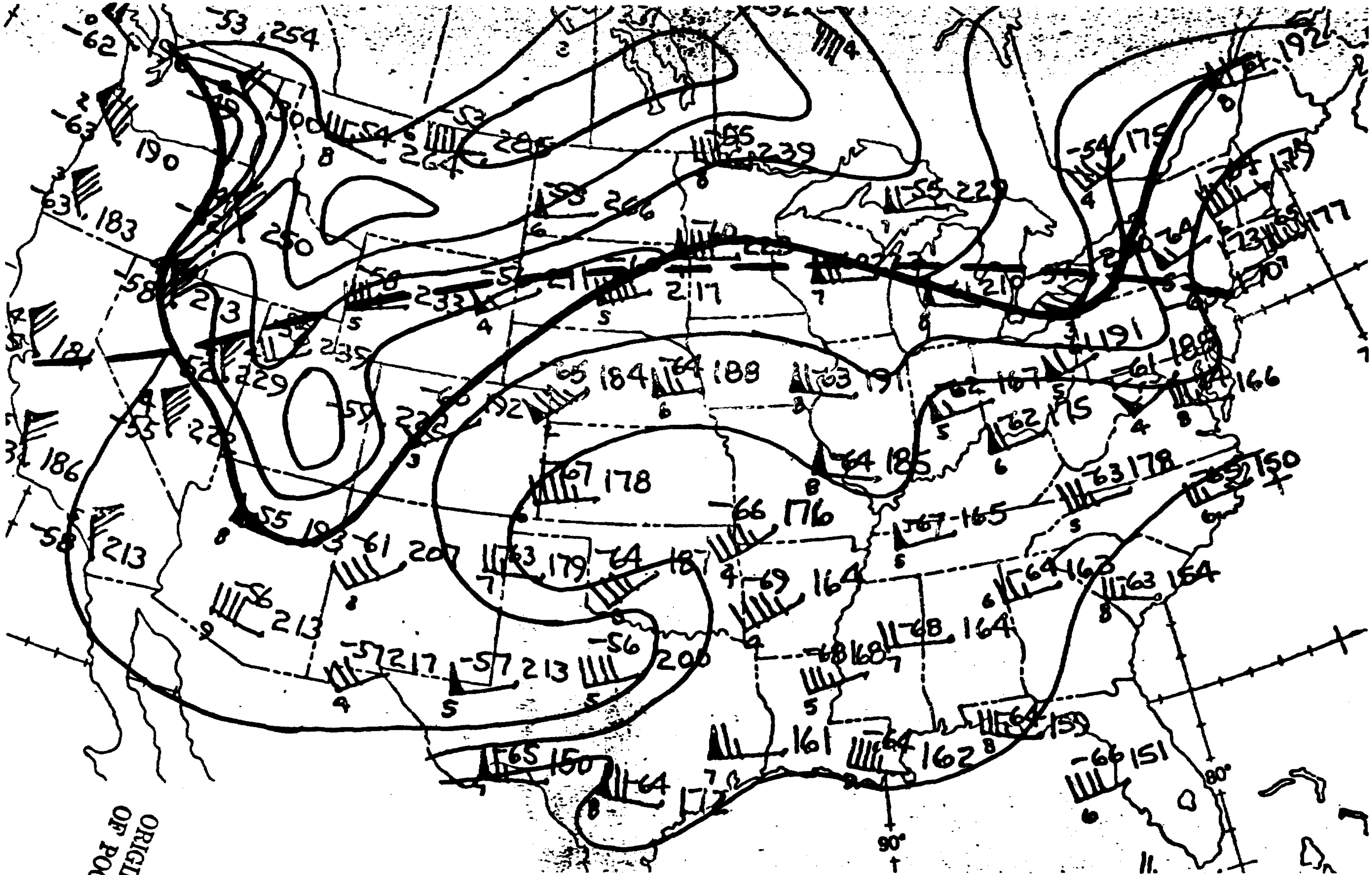

Figure 4 - NWS tropopause data for 0000 GMT on May 28, 1975. Data for each reporting station includes tropopause pressure (hPa (mb)), tropopause temperature (^{o}C), and wind direction and speed (knots). The light solid lines are contours of constant tropopause pressure, and the heavy solid line shows the location of the jet stream. The heavy dotted line is the route of GASP flight 43 on VL0003 from New York to San Francisco on May 27, 1975 (1338-1833 GMT).

APPENDIX A - Specifications for GASP Archive Tapes (VLXXXX)

GENERAL

1. Tapes are written in EBCDIC format using nine track tapes.

2. Tape density is 800 BPI.

3. Physical records (blocks) are 4096 bytes.

4. The tapes are unlabeled, with 2 files, a GASP data file and a tropopause pressure data file.

GASP DATA FILE

1. The GASP data on the tapes is grouped and identified by flights (takeoff to landing). Each flight begins with a logical FLHT record (flight identification data), which is followed by logical DATA records (one for each data recording made during the flight). FLHT and DATA records are 512 bytes, hence there are 8 logical records per physical record (block).

2. A FLHT record will always be the first logical record in a block. However, every block need not begin with a FLHT record (i.e., if there are more than seven DATA records in a flight). If the FLHT record plus the available DATA records for a flight do not fill an integer number of blocks, the unused logical records in the final block are padded with zeros creating PADD records. The diagram below shows how several short flights would be blocked.

Block	1	2	3
	F D D D D D P P	F D D D D D D D	D D P P P P P P
Logical Record	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8

Block	4	5	6
	F D D D D D D D	D D D D D D D D	F D D D D D D P
Logical Record	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8

where F is a FLHT record
D is a DATA record
P is a PADD record

3. The first four bytes in each logical record identify the record type as FLHT, DATA, or PADD. Detailed specification of the parameters and formats for FLHT and DATA records are given in Table A-I and A-II respectively.

   a) In each FLHT record, the number of DATA records to follow is given by NDATA (Bytes 78-81), and the number of blocks in the flight is given by NBLOCK (Bytes 82-84).
   b) In the last DATA record of each flight, LBFLG (Byte 5) = "L"; for the last DATA record on the tape, LBFLG = "T"; for all other DATA records, LBFLG =" ".

   Note: DATA records with LBFLG ≠ " " will be followed by PADD records if the physical record (block) is not complete.

TROPOPAUSE PRESSURE DATA FILE

1. Following the GASP data, in a separate file, tropopause pressure data for the dates of the GASP flights are included. Data are currently available from the National Meteorological Center (NMC) twice daily for 4225 locations in the Northern Hemisphere. Coordinates for these data are the NMC 65X65 square matrix grid, transformed from a polar stereographic map of the Northern Hemisphere.

2. Each 65X65 tropopause pressure array is written as seven TRPR records. Each TRPR record is a physical record (block), and is the same length as the GASP physical records (4096 bytes). All TRPR records contain identification information. Specifications and formats for the TRPR records are given in Table A-III.

Table A-I Format for FLHT Records

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
1-4	RECID	A4	RECID = "FLHT"
5-10	TAPID	A6	Original GASP tape number, GPXXX
11-25	ACID	A15	Aircraft ID; Airline and tail number
26-28	APTLV	A3	Airport of departure (3 letter code)
29-34	DATLV	I6	Date first DATA record this flight; Mo=29-30, Da=31-32, Yr=33-34
35-38	TIMLV	A4	Time (GMT) first DATA record this flight; Hr=35-36, Min=37-38
39-43	LATLV	F5.2	Latitude (deg) of APTLV
44	LALVT	A1	Hemisphere of LATLV; "N" or "S"
45-50	LONLV	F6.2	Longitude (deg) of APTLV
51	LOLVT	A1	Hemisphere of LONLV; "E" or "W"
52-54	APTAR	A3	Airport of arrival (3 letter code)
55-60	DATAR	I6	Date last DATA record this flight; Mo=55-56, Da=57-58, Yr=59-60
61-64	TIMAR	A4	Time (GMT) last DATA record this flight; Hr=61-62, Min=63-64
65-69	LATAR	F5.2	Latitude (deg) of APTAR
70	LAART	A1	Hemisphere of LATAR, "N" or "S"
71-76	LONAR	F6.2	Longitude (deg) of APTAR
77	LOART	A1	Hemisphere of LONAR, "E" or "W"
78-81	NDATA	I4	Number of DATA records for this flight
82-84	NBLCCK	I3	Total number of blocks for this flight
85-87	O3ID	A3	Ozone instrument ID number*
88-90	COID	A3	Carbon monoxide instrument ID number*
91-93	PCSID	A3	Particle counter sensor ID number*
94-96	PCEID	A3	Particle counter electronics ID number*
97-99	H2OID	A3	Water vapor sensor ID number*
100-102	HYGID	A3	Hygrometer ID number*
103-105		A3	Spare ID
106-108		A3	Spare ID
109-111		A3	Spare ID
112-114		A3	Spare ID

Table A-I Continued

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
115-117		A3	Spare ID
118-122	D1	F5.3	Smallest particle radius (microns) for PC range 1
123-127	D2	F5.3	Smallest particle radius (microns) for PC range 2
128-132	D3	F5.3	Smallest particle radius (microns) for PC range 3
133-137	D4	F5.3	Smallest particle radius (microns) for PC range 4
138-142	D5	F5.3	Smallest particle radius (microns) for PC range 5
143	LIMCHK	A1	LIMCHK="T" if ACC limit exceeded (NE .GT. 0) on any DATA record this flight; otherwise LIMCHK="F"
144	FILEX	A1	FILEX="T" if filter exposed this flight; otherwise FILEX="F"
145	FDATA	A1	FDATA="T" if filter data on tape; otherwise FDATA="F"
146-149	FPAKN	I4	Filter pack number
150-151	FILTN	I2	Filter number
152-161	FTYPE	A10	Filter type
162-167	FDATON	I6	Filter exposure start date; Mo=162-163, Da=164-165, Yr=166-167
168-171	FTIMON	A4	Filter exposure start time; (GMT); Hr=168-169, Min 170-171
172-176	FLATON	F5.2	Filter exposure start latitude (deg)
177	FLAONT	A1	Filter exposure start latitude tag; "N" or "S"
178-183	FLCNON	F6.2	Filter exposure start longitude (deg)
184	FLOONT	A1	Filter exposure start longitude tag; "E" or "W"
185-190	FHTMON	F6.0	Filter exposure start altitude (meters)
191-196	FDATOF	I6	Filter exposure stop date; Mo=191-192, Da=193-194, Yr=195-196
197-200	FTIMOF	A4	Filter exposure stop time (GMT); Hr=197-198, Min=199-200
201-205	FLATOF	F5.2	Filter exposure stop latitude (deg)
206	FLAOFT	A1	Filter exposure stop latitude tag; "N" or "S"
207-212	FLONOF	F6.2	Filter exposure stop longitude (deg)
213	FLOOFT	A1	Filter exposure stop longitude tag; "E" or "W"
214-219	FHTMOF	F6.0	Filter exposure stop altitude (meters)
220-229	FCOMP1	A10	Filter constituent 1 (name)
230-239	FCOMP2	A10	Filter constituent 2 "

Table A-I Continued

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
240-249	FCOMP3	A10	Filter constituent 3 "
250-259	FCCMP4	A10	Filter constituent 4 "
260-269	FCOMP5	A10	Filter constituent 5 "
270-279	FDC1	F10.3	Data for constituent 1 (micrograms/M**3)
280-289	FDC2	F10.3	Data for constituent 2 (micrograms/M**3)
290-299	FDC3	F10.3	Data for constituent 3 (micrograms/M**3)
300-309	FDC4	F10.3	Data for constituent 4 (micrograms/M**3)
310-319	FDC5	F10.3	Data for constituent 5 (micrograms/M**3)
320	SBUEX	A1	SBUEX="T" if bottle exposed this flight, otherwise SBUEX="F"
321	SDATA	A1	SDATA="T" if bottle data on tape; otherwise SDATA="F"
322-324	SBID	I3	Sample bottle unit number
325-326	STBN	I2	Bottle number
327-332	SDATON	I6	Bottle exposure start date; Mo=327-328, DA=329-330, Yr=331-332
333-336	STIMON	I4	Bottle exposure start time (GMT); Hr=333-334, Min=335-336
337-341	SLATON	F5.2	Bottle exposure start latitude (deg)
342	SLAONT	A1	Bottle exposure start latitude tag, "N" or "S"
343-348	SLONON	F6.2	Bottle exposure start longitude (deg)
349	SLCCNT	A1	Bottle exposure start longitude tag "E" or "W"
350-355	SHTMON	F6.0	Bottle exposure start altitude (meters)
356-361	SDATOF	I6	Bottle exposure stop date; Mo=356-357, DA=358-359, Yr=360-361
362-365	STIMOF	I4	Bottle exposure stop time (GMT); Hr=362-363, Min=364-365
366-370	SLATOF	F5.2	Bottle exposure stop latitude (deg)
371	SLAOFT	A1	Bottle exposure stop latitude tag; "N" or "S"
372-377	SLONOF	F6.2	Bottle exposure stop longitude (deg)
378	SLOOFT	A1	Bottle exposure stop longitude tag; "E" or "W"
379-384	SHTMOF	F6.0	Bottle exposure stop altitude (meters)
385-394	SCCMP1	A10	Bottle constituent 1 (name)
395-404	SCOMP2	A10	Bottle constituent 2 "
405-414	SCCMP3	A10	Bottle constituent 3 "

Table A-I Completed

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
415-424	SCOMP4	A10	Bottle constituent 4 *
425-434	SCOMP5	A10	Bottle constituent 5 *
435-444	SDC1	F10.1	Data for constituent 1 (PPTV)
445-454	SDC2	F10.1	Data for constituent 2 "
455-464	SDC3	F10.1	Data for constituent 3 "
465-474	SDC4	F10.1	Data for constituent 4 "
475-484	SDC5	F10.1	Data for constituent 5 "
485-489	a	F5.3	O3 destruction constant (see eq. 1)
490-494	b	F5.3	O3 destruction constant (see eq. 1)
495-499	c	F5.1	O3 destruction constant (see eq. 1)
500-507	d	E8.2	O3 destruction constant (see eq. 1)
508-512		5I1	Spares

*if ID="M", no data for this instrument this flight

Table A-II Format for DATA Records

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
1-4	RECID	A4	RECID= "DATA"
5	LBFLG	A1	LBFLG="L" if this is the last data record this flight; LBFLG="T" If this is the last GASP data record on the tape, otherwise LBFLG=" "
6-9	RECORD	I4	Record number on TAPID
10	FRAME	I1	Frame number on TAPID
11-12	MODE	I2	Program mode from DMCU
13	TYPE	A1	Record type from DMCU
14	CYCLE	A1	Cal set up from DMCU
15-20	DATE	I6	Mo=1[illegible]5, Da=17-18, Yr=19-20
21-24	TIME	A4	(GM[illegible]r=21-22, Min=23-24
25-30	ALTFAV	F6.0	Alt[illegible] (ft)
31-36	ALTMAV	F6.0	Alt[illegible] (meters)
37-43	PAMB	F7.2	Ambi[illegible] static pressure (millibars) - calc from ALTFAV
44	ALTAG	A1	ALTAG="C", "D", or "G" indicates climb, descent, or ground
45-49	LAT	F5.2	Latitude (deg)
50	LATAG	A1	Latitude hemisphere, "N" or "S"
51-56	LONG	F6.2	Longitude (deg)
57	LONGTAG	A1	Longitude hemisphere, "E" or "W"
58-62	XI	F5.2	Aircraft position in NMC grid coordinates
63-67	YI	F5.2	Aircraft position in NMC grid coordinates
68-71	HEADG	F4.0	Aircraft heading (deg)

Table A-II Continued

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
72	HEADGT	A1	Tag for HEADG*
73-76	TASK	F4.0	True airspeed (knots)
77-81	XMATAS	F5.3	Flight mach number
82	TATAG	A1	Tag for TASK and XMATAS*
83-86	WS	F4.0	Wind speed (knots)
87-90	WSM	F4.0	Wind speed (meters/sec)
91	WSTAG	A1	Tag for WS and WSM*
92-95	WDEG	F4.0	Wind direction (deg)
96	WDEGTG	A1	Tag for WDEG*
97-100	SAT	F4.0	Static (ambient) air temperature (deg C)
101	SATAG	A1	Tag for SAT*
102-229	ACC(I)	32F4.2	Aircraft acceleration (gs); 32 values each record at 8/sec
230-233	ACCMAX	F4.2	Max of ACC(I)
234-237	ACCMIN	F4.2	Min of ACC(I)
238-239	NE	I2	Number of times ACC(I) > 1.2 or ACC(I) < 0.8
240	ACCTAG	A1	Tag for ACC(I), ACCMAX, ACCMIN, NE*
241-245	ZEN	F5.1	Solar elevation angle (deg); 0 deg = horizontal
246	SUNTAG	A1	SUNTAG="N" if sun below horizon
247-252	O3	F6.0	Ozone data (PPBV)
253	O3TAG	A1	Tag for O3*
254-259	O3A	F6.0	Ozone data (PPBV); ave for 128 sec preceding recording
260	O3ATAG	A1	Tag for O3A*
261-266	O3S	F6.0	Ozone std deviation (PPBV); for 128 sec preceding recording
267	O3STAG	A1	Tag for O3S*
268-273	DFPTA	F6.1	Dew/frost point temperature (deg C)
274-279	WVMRA	F6.1	Water vapor mixing ratio (PPMW)
280	DFTAGA	A1	Tag for DFPTA and WVMRA*
281-286	COAVG	F6.3	Carbon monoxide data (PPMV)
287	COTAGA	A1	Tag for COAVG*

Table A-II Completed

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
288-293	COA	F6.3	Carbon monoxide data (PPMV); ave for 128 sec preceding recording
294	COATAG	A1	Tag for COA*
295-300	COSD	F6.3	Carbon monoxide std deviation (PPMV); for 128 sec preceding recording
301	COSTAG	A1	Tag for COSD*
302-311	PD1	1PE10.3	Particle density for particles > D1 (particles/M**3)
312	PDTAG1	A1	Tag for PD1*
313-322	PD2	1PE10.3	Particle density for particles > D2 (particles/M**3)
323	PDTAG2	A1	Tag for PD2*
324-333	PD3	1PE10.3	Particle density for particles > D3 (particles/M**3)
334	PDTAG3	A1	Tag for PD3*
335-344	PD4	1PE10.3	Particle density for particles > D4 (particles/M**3)
345	PDTAG4	A1	Tag for PD4*
346-355	PD5	1PE10.3	Particle density for particles > D5 (particles/M**3)
356	PDTAG5	A1	Tag for PD5*
357-361	CLSEC	F5.0	Time in clouds (sec) during 255 sec preceding recording
362-365	CLAYR	F4.0	Number of cycles in and out of clouds (layers) during 255 sec preceding recording
366	CLTAG	A1	Tag for CLSEC and CLAYR*
367-512		146I1	Spares

*If TAG="M", corresponding data field will be zero; the "M" tag is used whenever data is not available or an instrument is in a calibration mode.

Table A-III Format for TRPR Records

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
1-4	RECID	A4	RECID = "TRPR"
5	HEMIS	A1	HEMIS= "N" for Northern Hemisphere
6-11	DATE	I6	Date of Observation; Mo=8-9; Da=8-9; Yr=10-11
12-15	TIME	A4	GMT of Observation; Hr=12-13; Min=13-14
16	NBLOCK	I1	NBLOCK = Block Counter this data array
17-18	ISTART	I2	ISTART = 1+(NBLOCK-1)*10
19-20	ISTOP	I2	ISTOP = NBLOCK*10 for NBLOCK = 1-6;ISTOP = 65 for NBLOCK=7
21-22	JSTART	I2	JSTART = 1
23-24	JSTOP	I2	JSTOP = 65
25-30	SCALE	E6.1	Scale factor for TROP(I,J)
31-43	A	E13.6	Base for TROP(I,J)
44-100		57I1	Spares
101-4000	ELE(I,J)	650I6	Tropopause Pressures in mb. ,TROP(I,J) = ELE(I,J)*SCALE+A where: ((ELE(I,J),I = ISTART,ISTOP),J = JSTART,JSTOP) Note that in the seventh block of each array only bytes 101-2050 are needed.
4001-4096		96I1	Spares

APPENDIX B - LATITUDE AND LONGITUDE FROM NMC COORDINATES

The tropopause pressure data included on GASP tapes are given at each of the 4225 points on the NMC 65 X 65 grid, a square matrix transformed from a polar stereographic map of the Northern Hemisphere. In the NMC coordinates the North Pole is the point (33, 33), with the 10 deg E - 170 deg W meridian given by the line YJ = 33, and the 100 deg E - 80 deg W meridian given by the line XI = 33. The transformation from this coordinate system to latitude (deg N or S) and longitude (deg E or W) is as follows:

Let $R^2 = ((XI-33)^2 + (YJ-33)^2)/R_\varepsilon^2$ (A1)

where $R_\varepsilon = 31.2043$

The Latitude ϕ (deg) is given by

$$\phi = (180/\pi)\ \arcsin((1-R^2)/(1+R^2)) \qquad \text{(A2)}$$

If $\phi > 0$, LAT = ϕ and LATAG = "N"

If $\phi < 0$, LAT = $-\phi$ and LATAG = "S"

The Longitude θ (deg) is given by

$$\theta = -(10 + (180/\pi)\ \arctan((YJ-33)/(XI-33))) \qquad \text{(A3)}$$

If $-190 < \theta < -180$, LONG = $\theta + 360$ and LONGTAG = "W"

If $-180 < \theta < 0$, LONG = $-\theta$ and LONGTAG = "E"

If $0 < \theta < 170$, LONG = θ and LONGTAG = "W"