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NASA GLOBAL ATMOSPHERIC SAMPLING PROGRAM (GASP) DATA REPORT FOR TAPES VL0007 & VL0008

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16 Abstract

The Global Atmospheric Sampling Program (GASP) is obtaining measurements of atmospheric trace constituents in the upper troposphere and lower stratosphere using fully automated air sampling systems on board the NASA CV-990 research aircraft and four commercial B-747 aircraft in routine airline service. In-situ measurements of atmospheric ozone and water vapor, data from laboratory analysis of filters exposed in flight, and related flight and meteorological data obtained from September 1976 through January 1977 are reported. These data are now available on GASP tapes VL0007 & VL0008 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.

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SUMMARY

Atmospheric trace constituents in the upper troposphere and lower stratosphere are being measured as part of the Global Atmospheric Sampling Program (GASP), using fully automated air sampling systems on board the NASA CV-990 research aircraft and four commercial B-747 aircraft in routine airline service. In-situ measurements of atmospheric ozone and water vapor, data from laboratory analysis of filters exposed in flight, and related meteorological and flight information obtained from September 26, 1976 through January 10, 1977 are reported herein. These data are now available from the National Climatic Center, Asheville, North Carolina. In addition to the GASP data, tropopause pressure data obtained from the National Meteorological Center (NMC) archives for the dates of the flights are included. This report is the seventh of a series of reports which describes the data currently available from GASP, including flight routes and dates, instrumentation, data processing procedures, and data tape specifications.

INTRODUCTION

This report announces the availability of atmospheric trace constituent data obtained at altitudes from 6 to 13.7 km during 686 flights of GASP-equipped aircraft from late-September 1976 through mid-January 1977.

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 from aircraft exhaust emissions on 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. 1-3).

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. 4) to collecting global data on a daily basis. Fully automated GASP systems are now operating on a United Airlines B-747, two Pan American World Airways B-747's, a Qantas Airways of Australia B-747, and the NASA CV-990 research aircraft. 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 B-747's. Pan Am routes from the United States include around-the-world flights in the Northern Hemisphere, transatlantic flights to Europe, transpacific flights to Australia and the Orient, and intercontinental flights to Central and South America. More frequent coverage in the Southern Hemisphere is provided by the Qantas B-747 on transcontinental Australian flights and on flights from Australia to the South Pacific, South Africa, and Europe. The NASA CV-990 is used for obtaining off-commercial route data, and for flight evaluation of candidate instruments for the B-747 systems (refs. 5-8). Data from the automated GASP system on the CV-990 are processed in the same manner as the data from the B-747 systems. 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 9.

This report is the seventh in a series of reports to announce the availability of GASP data from the National Climatic Center, Asheville, North Carolina, 28801. Data for March 1975 through September 1976 are archived on tapes VL0001-VL0006 (refs. 10-15). For each of these tapes, the time periods covered, and the GASP aircraft from which data are archived are identified in table I. Analyses of GASP data are reported in references 10-19. Global and domestic U.S. data for September 26, 1976 through January 10, 1977 are now available on GASP tapes VL0007 and VL0008; see table I. In addition to the atmospheric constituent measurements, the data on these tapes include 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.

DATA ACQUISITION

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 sampling segments. A 16 second recording is made at the end of each five minute 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 cycles to allow for in-flight checks on instrument operation (if required). Whenever any calibration cycle 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.

DISTRIBUTION OF MEASUREMENTS

On the GASP archive tapes, data are grouped by aircraft and identified by flights with the airports of departure and arrival designated by the standard three-letter airport codes (ref. 20). A listing of flights on each aircraft data file on tapes VL0007 and VL0008, by airport-pair, date, and data acquisition time, is given in tables II and III. Data from the Latitude Survey Mission (ref. 8) flown by the NASA CV-990 (N712NA) from October 26 to November 18, 1976 are included as file 1 of tape VL0007. Files 2 and 3 respectively of this tape contain data from the United B-747 (N4711U) and the Pan Am B-747SP (N533PA). Data from B-747's of Pan Am (N655PA) and Qantas (VH-EBE) are included in files 1 and 2 respectively of tape VL0008. The constituent data available for each flight are indicated in the tables. Note that water vapor data are only available from N533PA (tape VL0007, file 3) and that ozone data are not available for N655PA and VH-EBE (tape VL0008).

From September 26, 1976 through January 10, 1977, GASP-equipped aircraft obtained 46,657 data records which represent approximately 3100 flight hours above 6 km. About 80 percent of these measurements were normal recordings made at five minute intervals; the remainder were continuous recordings (at 15 records/min) of from one to five minute duration each. The distribution of the normal recordings by altitude, latitude, and local solar time is shown in figure 1. Two thirds of the total number of observations were at flight levels 330 through 390 (10-12 km). Data at flight levels above 390 were primarily obtained by the B-747SP which generally flies higher than the standard B-747's and the CV-990.

The latitude distribution reflects the route structure of the GASP-equipped aircraft. Approximately two-thirds of the observations were between 20 and 60 degrees North latitude since all GASP aircraft operated frequently within this latitude range. A major contribution here came from the United B-747 which operates exclusively between 20 and 45 degrees North latitude, and 75 and 160 degrees West longitude. Although some Southern Hemisphere data were obtained by both Pan Am aircraft and the CV-990, the major contribution there came from Qantas operations.

GASP aircraft acquire data on an around-the-clock basis as shown by the local solar time (LST) distribution in figure 1c). The data acquisition rate was largest (8 percent/hr) between 1300 and 1400 LST, and was smallest (2.6 percent/hr) from 1900 to 2000 LST. These rates may be compared to the value of 4.2 percent/hr which would be obtained if the distribution were uniform in time. Fifty-five percent of the GASP observations were obtained during daylight conditions as shown by the unshaded area.

MEASUREMENTS

For each in-situ constituent measurement, an instrument ID number is given in the FLHT record for each flight for which constituent data are available; otherwise, ID = "M". In addition, each measurement has an associated TAG in each DATA record. If TAG = "M", data are not available for that record, and the data field has been set equal to zero.

Ozone

Ozone measurements are made using a continuous ultraviolet absorption ozone photometer (ref. 21). 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 instrument output is digital, and the register is up-dated at the end of each 20 second measuring cycle. The range of this instrument is from 3 to 20,000 ppbv (parts per billion by volume), with a sensitivity of 3 ppbv. Data from flight tests of the instrument are given in reference 5.

At the time the data reported herein were obtained, GASP ozone instruments were checked (over the range 0 to 1000 ppbv) against an ozone generator which was calibrated at 1000 ppbv by the one percent neutral buffered potassium iodide (KI) method (ref. 22). Recent laboratory studies comparing ozone measurement techniques (ref. 23 and references therein) have reported that the KI method may actually give ozone levels which are from 10-30 percent high depending on the details of the procedure used. Because of this uncertainty of the KI procedure as a standard for ozone measurements, GASP ozone instruments are now checked against a commercial UV photometer, maintained at Lewis as a secondary transfer standard.

The span for all GASP ozone instruments from which data have been reported (tapes VL0001-VL0007) was set at 58200 counts. To date, this span setting has not been adjusted, pending results of calibration of the Lewis secondary transfer standard instrument against the Jet Propulsion Laboratory 5 meter path length UV photometer (ref. 29).

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. 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 air sample is pressurized to nominally 100 kPa (1 atm) prior to measurement of the ozone level. The ozone readings are corrected for drift of the instrument zero by subtracting the most current zero-level reading. To account for differences in regulated pressure between GASP systems, and to account for variations in the air sample temperature and pressure during flight, the zero-corrected ozone levels are normalized to standard atmospheric pressure and to a temperature of 25 degrees C. Data are not reported if the pressure of the sample entering the ozone instrument is less than 83 kPa.

The destruction of ozone in the Teflon sample lines from the inlet probe to the instrument, and in the Teflon-coated diaphragm pump is periodically measured on board the aircraft 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 most of the data reported here, the ambient ozone mixing ratios were determined using equation (1) with a = 0.13, b = 1.0 and c = d = 0. This is the same destruction correction used for tape VL0006 (ref. 15). The uncertainty in this approximation is ± 8 percent. Data from flights 4-14 of VL0007, file 1 (N712NA) and flights 70-75 of VL0007, file 2 (N4711U) were obtained using a different type of pump for pressurizing the sample. Destruction constants of a = 0.06, b = 1.0, c = d = 0.0 were determined from an ozone-loss test of the GASP system on the CV-990. The destruction constants used 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 (ref. 24). If c ≠ 0 in the second term, this term is of the type which describes thermal decomposition of ozone (refs. 25 and 26). 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.

Three ozone data values are reported in the DATA records (see table A-II). The reading at the time the recording is made is O3. The mean ozone level for the 128 seconds preceding the recording is O3A, and the standard deviation of the measured ozone levels for that period is O3S. Because for some DATA records O3 is available, but O3A and/or O3S are not, all three values are tagged separately.

Water Vapor

Atmospheric water vapor is measured with an aluminum oxide dew-frost point hygrometer (ref. 27). The sensing element consists of a small strip of aluminum which is anodized to provide a porous oxide layer. A very thin coating of gold is evaporated over this structure. The aluminum base and the gold layer form the two electrodes of a capacitor whose impedance varies with the amount of water adsorbed on the porous surface.

This instrument provides dew-frost point temperatures (DFPT) from -110 degrees C to +40 degrees C for air sample temperatures from -65 degrees C to +40 degrees C. The air temperature is measured with a thermistor mounted on the sensor probe. The sensors are calibrated by the manufacturer, with a specified DFPT accuracy of ± 3 degrees

C for -110 degrees C $\leq$ DFPT $\leq$ -60 degrees C and $\pm$ 2 degrees C for -60 degrees C < DFPT $\leq$ +40 degrees C.

The sensors are re-calibrated in an environmental chamber at NASA-Lewis prior to installation on the aircraft. Calibration gas is provided by blending room air (DFPT = 10 degrees C), laboratory service air (DFPT = -40 degrees C), and liquid nitrogen boil-off (DFPT = -70 degrees C). The calibration is performed by comparing the aluminum oxide sensor output with the dew-frost point temperature measured by a cooled-mirror hygrometer. Because the sensor output varies with air-sample temperature, calibration is performed at room temperature, -20 degrees C and -40 degrees C. Upon removal from the aircraft, sensors are re-calibrated again at room temperature. Data are used only if the recalibrations are within the limits specified above.

The water vapor sensor is mounted in a de-iced airscoop of the type used on B-747 aircraft for measurement of outside air temperature. The mounting of the sensor and the thermistor within the scoop is similar to that of the "B-57 Air Sampler" described in reference 28. GASP flight test data using this mounting are reported in reference 6. Because the scoop mount results in measurement at stagnation conditions, the water vapor-pressure calculated from the indicated DFPT is corrected by the ratio of static to total pressure, and then used to calculate the ambient water-vapor mixing ratio (in parts per million by weight, ppmw) and the ambient air dew-frost point.

Laboratory tests on the aluminum oxide hygrometer have shown several serious deficiencies which must be considered in evaluating the flight data. In these tests the response of the aluminum oxide hygrometer was compared to two cooled-mirror hygrometers; an aircraft-type undergoing response testing with the aluminum oxide hygrometer, and the laboratory standard cooled-mirror hygrometer mentioned previously. The DFPT readings of the two cooled-mirror hygrometers generally agreed to within 1 degree C. Their response was faster than the response of the aluminum oxide hygrometer by about a factor of 10, thus the cooled-mirror hygrometer data were used as actual dew-frost point temperature.

Response to step change in sensor temperature at constant DFPT. As mentioned in a previous paragraph, the indicated DFPT is dependent on the equilibrium air-sample temperature. This effect is included in the data reduction through the use of temperature dependent calibration curves. In addition, however, the sensor has been found to have a transient response to changes in ambient temperature at constant DFPT (see ref. 6). This response is dependent on both the magnitude of the temperature change, and the rate of change. In response to a decrease in temperature of 20 degrees C at the rate of 2 degrees C/min, the indicated DFPT decreased during the temperature transient to less than the actual DFPT, and then slowly increased toward the true value with a time constant of approximately an hour. Thus a decreasing ambient temperature at constant dew-frost point will result in indicated DFPT values which are too low, and conversely increasing ambient temperature at constant dew-frost point will result in indicated DFPT values which are too high.

Response to step change in DFPT at constant sensor temperature. The time constant (to achieve 63 percent of a step change in DFPT) of the aluminum oxide hygrometer was found to vary from 8 to 30 minutes depending on the equilibrium air-sample temperature and the magnitude and direction of the step change in DFPT. In going from wet-to-dry conditions, the indicated DFPT was higher than the actual DFPT, and conversely, in going from dry-to-wet. the indicated DFPT was lower than the actual DFPT.

Sensor response during simulated climbout. The most severe gradients in ambient temperature and water vapor are encountered as the aircraft climbs to cruise altitude, with ambient temperature and DFPT both decreasing. The response characteristics described in the preceding paragraphs suggest that the aluminum oxide hygrometer would indicate too high a DFPT in response to the decreasing humidity, but would indicate too low a DFPT in response to the decreasing temperature. Thus the possibility exists for compensating effects.

Response following saturation. The recovery of the sensor from saturated conditions, as would be encountered with the passage of the aircraft through clouds, was found to be very slow. Laboratory test data showed that, after having been subjected to saturated conditions for 40 minutes, the aluminum oxide hygrometer continued to indicate saturation for an additional 30 minutes after the air was no longer saturated. The test was terminated at this time, and no data are available for the time required for the aluminum oxide hygrometer reading to return to the true DFPT. This slow response characteristic is apparent in the flight data also whenever prolonged saturation is indicated.

Because of the necessity of interpreting the water vapor measurements in terms of the response characteristics described above, and in relation to other measurements, water vapor data are reported only for flights for which ozone and meterological data are also available. On the tape, water vapor data are reported as both dew-frost point temperature (DFPTA) and water vapor mixing ratio (WVMRA) in the DATA records (see table A-II). Whenever the indicated dew-frost point temperature is equal to the static air temperature, DFTAGA = "S", as a flag to the fact that saturated conditions were encountered.

Cloud Detector

Flight test experience with the light-scattering particle counters included in the GASP systems (see ref. 6) has indicated that flight through clouds results in a significantly greater count of the largest size particles (D > 3 micrometers) than is obtained in clear air. A simple cloud detector is thus available by observing the counting rate of the largest size particles. This signal is monitored for 256 seconds prior to each data recording. The time (in seconds) during which the cloud rate, CLDRT, is greater than a preset level, CLDHI, is interpreted as time in clouds (CLSEC; see table A-II). The CLDHI level was programmed on board the United airliner based on visual observation of a light haze, and corresponds to a local particle density (for D > 3 micrometers) of 66,000 particles/cubic meter. If CLSEC > 0, CLTAG = "C". If cloud data are not available, CLTAG = "M".

The number of cloud encounters (CLAYR; see table A-II) is also available. Whenever clouds are detected (CLDRT > CLDHI), this is interpreted as a continuous encounter until cloud-free air is detected. This determination requires a second preset level, CLDLO. If n is the number of times that the cloud rate crosses CLDHI and CLDLO (or CLDLO and CLDHI) in succession, then CLAYR = (n+1)/2. For the data on tapes VL0007 and VL0008, CLDLO was set at CLDHI/8.

Flight and Meteorological 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. Date and time are provided by a separate GASP clock-calendar unit. The above parameters are obtained once per DATA record. The vertical acceleration of the aircraft is obtained from the aircraft flight recording system at the rate of 8/sec which provides 32 data points for each DATA record. The formats and units for these data are given in table A-II.

The programming for the GASP systems initiates a continuous recording whenever the vertical acceleration of the aircraft exceeds preset limits. This recording then continues until the acceleration has remained within limits for one minute. These limits are currently set at 0.8 and 1.2 G's to correspond to "light-to-moderate" turbulence. Continuous recordings triggered by an acceleration limit are identified by TYPE = "L", and the number of times (out of 32) that the acceleration has exceeded the limits is given by NE (see table A-II). For any flight during which one or more limit recordings occurred, LIMCHK = "T" in the FLHT record for that flight (see table A-I).

For each DATA record, the date, time, latitude, and longitude have been used to calculate the solar elevation angle (ref. 29). This is designated as ZEN in table A-II. Note that -90 deg < ZEN < +90 deg, where ZEN = +90 deg if the sun is directly overhead. The flight altitude is used to determine the solar elevation angle at sunrise and sunset, and day and night observations are identified by SUNTAG = " " and "N" respectively. If GMT is not available for a given record (GMTTAG = "M"), SUNTAG = "M", and ZEN = 0.

The primary purpose of the flight and meteorological data is to provide supporting information for the constituent measurements. However, these data, particularly the wind and temperature measurements, may be of interest even where constituent data are not available, and henceforth will be reported for all GASP flights.

Filter Samples

Atmospheric concentration data for sulfates, nitrates, chlorides, and fluorides are provided by exposure and subsequent laboratory analysis of filter samples. Filter exposures are programmed to occur at altitudes greater than 9.6 kilometers on the first flight of every third calendar day, provided that an unexposed filter is available. Filters are normally exposed for two hours, although shorter exposures may occur if the aircraft descends to an altitude less than 9.6 kilometers before two hours have elapsed. Filter data are included in the FLHT record (table A-I) for each flight. If an exposure occurs (FILEX = "T"), and if data from the laboratory analysis are available (FDATA = "T"), the date, time, altitude, and position for the beginning and end of the exposure period, the type of filter, and the constitutent data are reported. The data from the laboratory analysis (in micrograms/filter) are divided by the integrated filter flow rate (in ambient cubic meters), and data are reported as micrograms/cubic meter.

<u>Single filter apparatus</u>. The air inlet probe and the filter sampling system are described in reference 9. Briefly, the filter sampling apparatus contains a single

filter holder which is inserted into a 7.62 cm diameter duct for sampling, then retracted and stored; all on command from the GASP system control unit. The filter mechanism is stainless steel and is pressure tight. The filter holder can accommodate different types of filter material as appropriate to the atmospheric constituents of interest.

Filter preparation. All filter exposures for which data have been reported to date were made using IPC-1478 filter paper. This is a low resistance, cellulose type material made from second cut cotton linters with cotton scrim backing for added strength. This paper was specially designed for high altitude air sampling and thus features low pressure drop, high flow rate, and good retention for small airborne particles. This paper is impregnated with dibutoxyethylphthalate during manufacture to improve collection efficiency.

Prior to use, this paper must be washed to remove residual amounts of water soluble contaminants (ref. 30). Currently, additional filter purification is obtained by pre-soaking for at least 5 minutes with a strong carbonate buffer solution (0.24M sodium carbonate and 0.30M sodium bicarbonate) followed by at least a 3 minute soaking in 1.0M acetic acid. Using a coarse fritted disc funnel (to support the filter paper), each solution is poured onto the filter and momentarily vacuum-drawn through the filter to insure complete wetting. After the respective soaking periods, the remainder is then vacuum-drawn through the filter until air permeates it. Each filter is finally rinsed (vacuum-drawn) with six separate 30-35 ml portions of deionized water saturated with dibutoxyethylphthalate. After overnight vacuum drying, samples from each wash group are analyzed for background levels of contamination to verify the washing procedure.

Upon acceptance, the group of filters is transferred to a clean room for filter holder assembly and sealing. The filter holder assemblies are sealed in ultra-clean polyethylene bags to prevent contamination during shipping and handling. After filter exposure and removal from the aircraft, each assembly is re-bagged and carefully re-packaged for return shipment and analysis.

Filter analysis. Prior to analysis, each filter is cut into four equal segments for separate constituent analysis, if necessary, and for comparative repeat analyses. Sulfate, nitrate, chloride, and fluoride ion concentrations are determined by ion chromatography. The basics of this analysis technique are described in references 31, 32, and 33. This procedure requires wetting a filter segment with 10 ml of carbonate buffer (0.0024M sodium carbonate; and 0.003M sodium bicarbonate) as the extracting solution. A

0.5 ml sample is injected into the ion chromatograph flow system, which includes a carbonate eluant background, an anion separator column, a suppressor column for anion conversion to its acid form, and a conductivity detector.

The instrument is calibrated using solutions with known concentrations of the various anions in the extractant. Calculations of the anion concentration are made by comparing the constituent peak heights from the sample chromatograms to those obtained with the standard calibrating solution. The fluoride ion identification is still tentative. Further verification is necessary because the possibility of an interferring agent has not been completely eliminated.

The net amount of any constituent on a filter was deduced by subtracting an average background level determined from several reference filter blanks which were removed from unexposed filter holder assemblies. The background levels in micrograms per filter were approximately 1.6 for sulfate, 8.0 for nitrate, 3.3 for chloride, and 3.3 for fluoride. No other adjustment for any contamination due to handling and shipping was made. Summaries of the filter data included on tapes VL0007 and VL0008 are provided in tables IV and V.

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. 34). Briefly, the data are interpolated to points on the NMC 65X65 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).

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 behavior. These arrays from 1200 GMT on September 30, 1976 through 1200 GMT on January 10, 1977 are included as a separate file (see appendix A) following the GASP data files on both tapes VL0007 and VL0008. Each array (4225 points) is written as seven TRPR records (table A-III). Coordinates for these data are the NMC 65X65 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).

The tropopause pressure corresponding to each GASP data location is obtained by time and space interpolation from the NMC arrays. These pressures and the corresponding geopotential heights for the standard atmosphere are included in the GASP DATA records (TRPRMB and TRPRHM in table A-II). For normal interpolations (within a 12 hour interval) TPTAG = " ". If however, NMC data are missing for one reporting period such that the interpolation must be performed within a 24 hour interval, TPTAG = "L". If NMC data are missing for two or more consecutive reporting periods the time interpolation is not performed. In this case if the time of the GASP data point is within six hours of an NMC reporting period for which data are available, the space interpolated values at that reporting period are returned and TPTAG = "E", but if the time of the GASP data point is not within 6 hours of an NMC reporting period for which data are available, TRPRMB = TRPRHM = 0, and TPTAG = "M". For GASP records in which the observation time is not available, 1200 GMT has been assumed for tropopause interpolation, and TPTAG = "T". Whenever tropopause pressure values are available, DELP = TRPRMB - PAMB, and DELHGT = ALTMAV - TRPRHM are also reported.

From September 1974, through mid-December 1975, the location of the tropopause surface archived by NMC was determined by means of the Flattery global analysis method (ref. 35). This procedure made use of the vertical temperature profiles calculated for each NMC grid point, and tested the slope of the profile curve upwards from the first mandatory pressure level. However, as of December 17, 1975, (1200 GMT), the tropopause pressure surface, archived in the NMC 65X65 arrays, has been formulated using a different analysis scheme. This change adopts a procedure conceived by Gustafson (ref. 36) which models the tropopause in terms of the potential temperature, which is a meteorologically significant height indicator. The method is based on climatological observations that the tropopause surface is generally in phase with pressure variations along potential temperature surfaces in the lower stratosphere. The modeled tropopause is constrained to lie near various, pre-selected, potential temperature surfaces, depending on month and geographical location.

The Gustafson method first calculates a potential temperature, THETA, profile above each of the 4225 NMC grid points from the ambient temperature, T, at each of the reported pressure levels, p, from the following definition of the potential temperature:

$$\text{THETA} = (T)(1000/p)^{.2857} \qquad (2)$$

This profile is then scanned downward, and delta THETA/delta p is evaluated for each layer, until a distinct stability transition occurs near the expected THETA location of the mean tropopause. The temperature at the top of this layer is defined as the tropopause temperature. Next, temperatures are calculated upwards from the bottom of the layer assuming pre-selected tropospheric lapse rates (depending on temperature range). The pressure at which this profile attains a temperature equal to the previously determined tropopause temperature is defined as the tropopause pressure. Many details have been omitted from this brief description, and the reader would be best advised to refer to reference 36.

Monthly zonal-mean tropopause pressures at 5 degree latitude intervals, calculated from the NMC 65X65 arrays for January 1975 through August 1977, are listed in table VI. Values for January - November 1975 were obtained with the Flattery analysis, and values for January 1976 - August 1977 were obtained with the Gustafson method. Since the NMC changeover occurred in mid-December 1975, values for that month are a composite. It should be noted that tropopause pressures less than 130 hPa are reported as 130 hPa in the NMC 65X65 arrays. This has a significant effect on the 1975 zonal mean values, since tropopause pressures of 130 hPa (actual $\leq$ 130 hPa) were reported frequently when the Flattery analysis was used. Thus, the zonal means from these arrays are too high for latitudes and months where tropopause pressures less than 130 hPa would be expected. The data in table VI suggest that the current (Gustafson) analysis renders tropopause pressures consistently greater than those derived from the previous (Flattery) method, and that the differences increase toward the equator. We believe that the tropopause locations south of 30 degrees N, as reported after December 17, 1975, are suspect, and should be used with caution in analyzing GASP data. North of 30 degrees, the new tropopause pressures seem to fall within the statistical range of observed, mean pressures reported by Reiter (ref. 37) for the North American continent.

CONCLUDING REMARKS

Atmospheric constituent data and related flight and meteorological data obtained during 686 flights of GASP-equipped aircraft from September 26, 1976 through January 10, 1977 are now available. Tropopause pressure fields 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 on GASP tapes VL0007 and VL0008 from the National Climatic Center, Federal Building, Asheville, NC, 28801. Flight routes and dates, instrumentation, data processing procedures, and data tape specifications and formats are discussed in this report.

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Cloud detector and particle measurement	- T. W. Nyland
Filter preparation and analysis	- D. A. Otterson
Data acquisition system	- T. W. Nyland
Data tape specifications and format	- F. P. Michaelis

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TABLE I - GASP DATA ON TAPES VL0001-VL0008

Tape	File	Aircraft	Dates	FLHT*	DATA+	Data**	Ref
VL0001	1	N655PA	3/11/75- 3/30/75	43	1919	O	10
VL0002	1	N4711U	3/23/75-10/21/75	159	7274	O,W	11
VL0003	1	N655PA	5/02/75- 5/30/75	49	2173	O	12
VL0004	1	N4711U	12/26/75- 3/07/76	73	3572	O,W,F	13
	2	N655PA	1/22/76- 3/25/76	66	3757	O,F,B	13
VL0005	1	N4711U	3/29/76- 5/29/76	100	4892	O,W	14
	2	N655PA	3/25/76- 5/13/76	86	4716	O,B	14
	3	N533PA	4/13/76- 6/13/76	28	2640	O,B	14
VL0006	1	N655PA	7/11/76- 9/26/76	131	8724	O,F,B	15
	2	N533PA	7/08/76- 9/15/76	45	3594	O,B	15
	3	VH-EBE	7/13/76- 8/31/76	69	3977	O	15
VL0007	1	N712NA	10/28/76-11/18/76	14	3481	O	
	2	N4711U	11/24/76-12/30/76	75	3756	O,F	
	3	N533PA	9/30/76- 1/02/77	146	13773	O,W	
VL0008	1	N655PA	10/15/76- 1/10/77	165	10122	F	
	2	VH-EBE	9/26/76- 1/09/77	286	15525		

* Number of flights
\+ Number of DATA records
** Constituent measurements: O - Ozone
W - Water vapor
F - Filter data
B - Sample bottle data

TABLE II - GASP FLIGHTS ON TAPE VL0007

a) File 1 (NASA N712NA)

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
1	SFO-FAI	10/28/76	2139-0156	
2	FAI-FAI	10/29/76	1922-0039	
3	FAI-HNL	10/30/76	1644-2221	
4	HNL-HNL	11/ 1/76	1550-1759	O
5	HNL-HNL	11/ 3/76	2016-2252	O
6	HNL-PPG	11/ 7/76	2055-0141	O
7	PPG-MEL	11/ 8/76	2134-0258	O
8	MEL-MEL	11/10/76	1834-2329	O
9	MEL-MEL	11/11/76	1950-2229	O
10	MEL-CHC	11/12/76	2326-0347	O
11	CHC-CHC	11/14/76	0259-0751	O
12	CHC-PPG	11/16/76	0104-0541	O
13	PPG-HNL	11/17/76	2232-0355	O
14	HNL-SFO	11/18/76	1859-2254	O

* Meteorological and flight data are reported for all flights in tables II and III. The availability of GASP constituent data is identified by code as follows:

O - Ozone
W - Water vapor
F - Filter data

TABLE II - GASP FLIGHTS ON TAPE VL0007

b) File 2 (United N4711U)

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
1	SFO-HNL	11/24/76	0400-0816	O F
2	HNL-SFO	11/24/76	1143-1539	O
3	SFO-HNL	11/24/76	1832-2247	O
4	HNL-LAX	11/25/76	0047-0418	O
5	LAX-JFK	11/26/76	0014-0019	O
6	JFK-LAX	11/26/76	1728-2227	O
7	LAX-HNL	11/27/76	0045-0519	O
8	HNL-LAX	11/27/76	0942-1357	O
9	LAX-ORD	11/27/76	1611-1836	O
10	ORD-SFO	11/27/76	2202-0117	O
11	SFO-HNL	11/28/76	0351-0811	O
12	HNL-LAX	11/28/76	1924-2332	O
13	LAX-DEN	11/29/76	0149-0304	O
14	DEN-LAX	11/29/76	1756-1911	O
15	LAX-HNL	11/29/76	2146-0221	O
16	HNL-SFO	11/30/76	2009-0002	O
17	SFO-HNL	12/ 2/76	0347-0752	O
18	HNL-LAX	12/ 2/76	1924-2334	O
19	LAX-DEN	12/ 3/76	0145-0310	O
20	DEN-LAX	12/ 3/76	1836-1931	O
21	LAX-HNL	12/ 3/76	2137-0215	O
22	HNL-ORD	12/ 4/76	0451-1152	O
23	ORD-JFK	12/ 4/76	1344-1445	O
24	JFK-LAX	12/ 4/76	1724-2219	O
25	LAX-HNL	12/ 5/76	0046-0506	O
26	HNL-LAX	12/ 5/76	0942-1402	O
27	LAX-ORD	12/ 5/76	1629-1911	O
28	ORD-LAX	12/ 5/76	2211-0126	O
29	LAX-HNL	12/ 6/76	1809-2238	O
30	HNL-SFO	12/ 7/76	0057-0702	O
31	SFO-HNL	12/ 7/76	1730-2145	O
32	HNL-LAX	12/ 8/76	0008-0418	O
33	LAX-OMH	12/ 8/76	0625-0835	O
34	OMH-LAX	12/ 8/76	1008-1228	O
35	LAX-HNL	12/ 8/76	1757-2237	O
36	HNL-SFO	12/ 9/76	0055-0459	O
37	SFO-ORD	12/ 9/76	1948-2236	O
38	ORD-SEA	12/10/76	0250-0605	O
39	SEA-ORD	12/10/76	1655-1925	O
40	ORD-LAX	12/10/76	2213-0118	O
41	LAX-ITO	12/11/76	2002-0017	O
42	ITO-LAX	12/12/76	0245-0635	O
43	LAX-ORD	12/12/76	0853-1138	O
44	ORD-PIT	12/12/76	1358-1423	O
45	PIT-ORD	12/12/76	1639-1719	O

TABLE 11 - b) File 2 Concluded

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
46	ORD-LAX	12/12/76	1926-2231	O
47	LAX-JFK	12/13/76	2027-0024	
48	JFK-LAX	12/14/76	1727-2217	
49	LAX-HNL	12/15/76	0039-0514	
50	HNL-LAX	12/15/76	0954-1405	
51	LAX-ORD	12/15/76	1615-1900	
52	ORD-SFO	12/15/76	2208-0115	
53	SFO-HNL	12/16/76	0344-0819	
54	HNL-SFO	12/16/76	1028-1410	
55	SFO-HNL	12/16/76	1731-2203	
56	HNL-LAX	12/17/76	0019-0417	
57	LAX-JFK	12/17/76	2008-0013	
58	JFK-LAX	12/18/76	1703-2134	
59	LAX-HNL	12/19/76	0036-0521	
60	HNL-SEA	12/19/76	0922-1354	
61	SEA-ORD	12/19/76	1609-1844	
62	ORD-LAX	12/19/76	2147-0051	
63	LAX-HNL	12/20/76	1740-2214	
64	HNL-SFO	12/21/76	0032-0421	
65	SFO-JFK	12/21/76	2217-0222	
66	JFK-SFO	12/22/76	1546-2042	F
67	SFO-HNL	12/22/76	2240-0255	
68	HNL-LAX	12/23/76	0942-1357	
69	LAX-ORD	12/23/76	1617-1857	
70	SFO-JFK	12/28/76	2229-0228	O F
71	JFK-SFO	12/29/76	1531-2029	O
72	SFO-HNL	12/29/76	2311-0321	O
73	HNL-LAX	12/30/76	0932-1352	O
74	LAX-ORD	12/30/76	1623-1858	O
75	ORD-LAX	12/30/76	2234-0148	O

* O - Ozone
F - Filter data

TABLE II.- GASP FLIGHTS ON TAPE VL0007

c) File 3 (Pan Am N533PA)

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
1	JFK-HND	9/30/76	1625-0513	
2	HND-LAX	10/ 1/76	0807-1632	
3	LAX-HND	10/ 1/76	2001-0632	
4	HND-JFK	10/ 2/76	1007-2131	
5	JFK-LHR	10/ 3/76	1431-1932	
6	LHR-BRU	10/ 3/76	2149-2204	
7	BRU-LHR	10/ 4/76	0809-0819	
8	LHR-BOS	10/ 4/76	1113-1703	
9	BOS-DTW	10/ 4/76	1841-1936	
10	DTW-BOS	10/ 4/76	2210-2300	
11	BOS-LHR	10/ 5/76	0107-0611	
12	LHR-AMS	10/ 5/76	0910-0920	
13	AMS-LHR	10/ 5/76	1500-1513	
14	LHR-JFK	10/ 5/76	1739-2359	
15	JFK-HND	10/ 6/76	1634-0532	
16	HND-LAX	10/ 7/76	0740-1630	
17	LAX-HND	10/ 7/76	2001-0607	
18	HND-JFK	10/ 8/76	1002-2122	
19	JFK-HND	10/ 9/76	1637-0529	
20	HND-LAX	10/10/76	0737-1557	
21	LAX-HND	10/10/76	1958-0644	
22	HND-JFK	10/11/76	1009-2118	
23	JFK-HND	10/12/76	1630-0534	
24	HND-LAX	10/13/76	0737-1616	
25	LAX-HND	10/13/76	1952-0607	
26	HND-JFK	10/14/76	0953-2101	
27	JFK-HND	10/15/76	1626-0535	
28	HND-LAX	10/16/76	0743-1614	
29	LAX-HND	10/16/76	2001-0618	
30	HND-JFK	10/17/76	0955-2117	
31	JFK-HND	10/18/76	1628-0548	
32	HND-LAX	10/19/76	0801-1700	
33	LAX-HND	10/19/76	1957-0602	
34	HND-JFK	10/20/76	1659-0439	
35	IAD-LHR	10/22/76	0004-0537	O
36	LHR-BOS	10/22/76	1020-1633	O
37	BOS-DTW	10/22/76	1800-1906	O
38	DTW-BOS	10/22/76	2121-2206	O
39	BOS-LHR	10/23/76	0005-0500	O
40	LHR-BOS	10/23/76	1011-1611	O
41	BOS-DTW	10/23/76	1753-1903	O
42	DTW-BOS	10/23/76	2116-2201	O
43	BOS-LHR	10/24/76	0117-0613	O
44	LHR-BOS	10/24/76	1007-1603	O
45	BOS-DTW	10/24/76	1804-1906	O

TABLE II - c) File 3 Continued....

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
46	DTW-BOS	10/24/76	2118-2203	O
47	BOS-LHR	10/25/76	0000-0501	O
48	LHR-BOS	10/25/76	1018-1613	O
49	BOS-DTW	10/25/76	1751-1856	O
50	DTW-BOS	10/25/76	2118-2208	O
51	BOS-LHR	10/26/76	0001-0506	O
52	LHR-JFK	10/26/76	1050-1725	O
53	JFK-HND	10/27/76	1526-0442	O
54	HND-LAX	10/28/76	0658-1518	O
55	LAX-HND	10/28/76	1850-0530	O
56	HND-JFK	10/29/76	0902-1954	O
57	JFK-HND	10/30/76	1527-0428	O
58	HND-LAX	10/31/76	0914-1724	O
59	LAX-HND	10/31/76	2119-0749	O
60	HND-JFK	11/ 1/76	1119-2226	O
61	JFK-LHR	11/ 2/76	1431-1937	O
62	JFK-GIG	11/ 5/76	2058-0527	O
63	GIG-JFK	11/ 6/76	1946-0411	O
64	JFK-HND	11/ 7/76	1143-0129	O
65	HND-JFK	11/ 8/76	0535-1622	O
66	JFK-HND	11/10/76	1727-0643	O
67	HND-JFK	11/11/76	1218-2335	O
68	GIG-JFK	11/13/76	0238-1114	O
69	JFK-HND	11/13/76	1729-0638	O
70	HND-JFK	11/14/76	1203-2323	O
71	JFK-HND	11/15/76	1724-0613	O
72	HND-JFK	11/16/76	1213-2308	O
73	JFK-HND	11/17/76	1729-0615	O W
74	HND-JFK	11/18/76	1208-2308	O W
75	JFK-HND	11/19/76	1723-0608	O W
76	HND-JFK	11/20/76	1237-2358	O W
77	JFK-GIG	11/21/76	0306-1118	O W
78	GIG-JFK	11/22/76	0216-1044	O W
79	JFK-HND	11/23/76	1725-0635	O W
80	HND-JFK	11/24/76	1140-2224	O W
81	JFK-HND	11/25/76	1729-0656	O W
82	HND-LAX	11/26/76	1111-1951	O W
83	LAX-HND	11/26/76	2241-0851	O W
84	HND-JFK	11/27/76	1210-2320	O W
85	JFK-GIG	11/28/76	0250-1106	O W
86	GIG-JFK	11/29/76	0153-1018	O W
87	JFK-HND	11/29/76	1726-0646	O W
88	HND-JFK	11/30/76	1155-2304	O W
89	JFK-HND	12/ 1/76	1739-0629	O W
90	HND-JFK	12/ 2/76	1159-2314	O W

TABLE II - c) File 3 Continued....

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
91	JFK-HND	12/ 3/76	1805-0705	O W
92	HND-LAX	12/ 4/76	1055-1935	
93	LAX-HND	12/ 4/76	2246-0903	
94	HND-JFK	12/ 5/76	1148-2253	
95	JFK-BAH	12/ 7/76	0008-1048	
96	BAH-JFK	12/ 8/76	0739-2125	O W
97	JFK-DFW	12/13/76	1620-1916	
98	DFW-HNL	12/13/76	2104-0359	O
99	HNL-PPG	12/14/76	0607-1032	O
100	PPG-PPT	12/14/76	1225-1433	O
101	PPT-PPG	12/14/76	1920-2150	O W
102	PPG-HNL	12/15/76	0007-0437	O
103	HNL-DFW	12/15/76	0721-1336	O
104	DFW-JFK	12/15/76	1536-1746	O
105	JFK-SFO	12/15/76	2305-0350	O
106	SFO-AKL	12/16/76	0712-1858	O
107	AKL-SYD	12/16/76	2128-2356	O
108	SYD-AKL	12/17/76	0609-0808	O
109	AKL-SFO	12/17/76	1232-2325	O
110	SFO-AKL	12/18/76	0642-1828	O
111	AKL-SYD	12/18/76	2100-2325	O
112	SYD-SFO	12/19/76	0558-1813	O
113	SFO-JFK	12/19/76	2033-0033	O
114	JFK-DFW	12/20/76	1612-1912	O
115	DFW-HNL	12/20/76	2040-0400	O W
116	HNL-PPG	12/21/76	0639-1119	O W
117	PPG-PPT	12/21/76	1309-1519	O W
118	PPT-PPG	12/21/76	1916-2145	O
119	PPG-HNL	12/21/76	2333-0346	O
120	HNL-DFW	12/22/76	0628-1233	O
121	DFW-JFK	12/22/76	1427-1626	
122	JFK-SFO	12/22/76	2302-0410	O
123	SFO-AKL	12/23/76	0702-1852	O
124	AKL-SYD	12/23/76	2057-2324	
125	SYD-AKL	12/24/76	0543-0752	O
126	AKL-SFO	12/24/76	1017-2144	O
127	SFO-AKL	12/25/76	0631-1850	O
128	AKL-SYD	12/25/76	2042-2302	O W
129	SYD-SFO	12/26/76	0647-1917	O
130	SFO-JFK	12/26/76	2145-0140	O W
131	JFK-DFW	12/27/76	1612-1902	O
132	DFW-HNL	12/27/76	2102-0520	O
133	HNL-PPG	12/28/76	0727-1212	O
134	PPG-PPT	12/28/76	1341-1551	O
135	PPT-PPG	12/28/76	1912-2146	O

TABLE II - c) File 3 Concluded

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
136	PPG-HNL	12/28/76	2340-0345	O W
137	HNL-DFW	12/29/76	0629-1224	O W
138	DFW-JFK	12/29/76	1426-1621	O W
139	JFK-SFO	12/29/76	2306-0402	
140	SFO-AKL	12/30/76	0639-1908	O W
141	AKL-SYD	12/30/76	2104-2334	O W
142	SYD-AKL	12/31/76	0542-0742	O W
143	AKL-SFO	12/31/76	0956-2111	O W
144	SFO-AKL	1/ 1/77	0624-1844	O W
145	AKL-SYD	1/ 1/77	2036-2309	O
146	SYD-SFO	1/ 2/77	0554-1811	O

* O - Ozone
W - Water vapor

TABLE III - GASP FLIGHTS ON TAPE VL0008

a) File 1 (Pan Am N655PA)

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
1	JFK-LHR	10/15/76	2350-0455	
2	LHR-FRA	10/16/76	0828-0853	
3	FRA-THR	10/16/76	1058-1500	
4	THR-DEL	10/16/76	1737-2009	
5	DEL-BKK	10/16/76	2213-0103	
6	BKK-HKG	10/17/76	0303-0603	F
7	HKG-HND	10/18/76	0110-0345	
8	HND-SFO	10/18/76	0622-1428	
9	SFO-SEA	10/18/76	1828-1928	
10	SEA-LHR	10/19/76	2100-0610 +	
11	LHR-SEA	10/19/76	1236-2041	
12	SEA-SFO	10/19/76	2330-0035	
13	SFO-SEA	10/20/76	1824-1920	F
14	SEA-LHR	10/20/76	2135-0605	
15	LHR-IAD	10/21/76	1030-1735	
16	JFK-FRA	10/22/76	0235-0822	
17	FRA-JFK	10/22/76	1102-1832	
18	JFK-FCO	10/24/76	0120-0800	
19	FCO-JFK	10/24/76	1215-2011	
20	IAD-LHR	10/26/76	0115-0701	
21	LHR-IAD	10/26/76	1015-1713	
22	JFK-FRA	10/27/76	0132-0855	
23	FRA-JFK	10/27/76	1155-1924	
24	JFK-FRA	10/27/76	2236-0436	
25	FRA-MUC	10/28/76	0635-0640	
26	MUC-FRA	10/28/76	0952-1002	
27	FRA-JFK	10/28/76	1229-1928	
28	JFK-FCO	10/29/76	0105-0814	
29	FCO-JFK	10/29/76	1348-2157	
30	JFK-MUC	10/30/76	0121-0802	
31	MUC-ATH	10/30/76	1349-1528	
32	ATH-BRU	10/30/76	1848-2103	
33	BRU-JFK	10/30/76	2314-0632	
34	JFK-LHR	11/ 1/76	1532-2027	
35	LHR-BRU	11/ 1/76	2302-2302	
36	BRU-LHR	11/ 2/76	0858-0908	
37	LHR-JFK	11/ 2/76	1134-1819	
38	JFK-FRA	11/ 3/76	0130-0710	
39	FRA-JFK	11/ 3/76	1104-1852	
40	JFK-CGN	11/ 4/76	0132-0806	
41	FRA-JFK	11/ 4/76	1326-2059	
42	IAD-LHR	11/ 5/76	0222-0748	
43	LHR-SEA	11/ 5/76	1335-2205	
44	SEA-SFO	11/ 6/76	0104-0214	
45	SFO-LAX	11/ 6/76	1548-1613	

TABLE III - a) File 1 Continued....

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
46	LAX-GUA	11/ 6/76	1854-2229	
47	GUA-CCS	11/ 7/76	0037-0315	
48	CCS-GUA	11/ 7/76	1407-1517	
49	GUA-LAX	11/ 7/76	1758-2145	
50	LAX-SFO	11/ 8/76	0026-0046	
51	SFO-HNL	11/ 8/76	0425-0834	
52	HNL-GUM	11/ 8/76	1126-1750	
53	GUM-MNL	11/ 8/76	2024-2255	
54	MNL-HKG	11/ 9/76	0028-0130	
55	HKG-MNL	11/ 9/76	0617-0707	
56	GUM-HNL	11/ 9/76	1523-2110	
57	HNL-LAX	11/10/76	0107-0522	
58	LAX-HNL	11/10/76	1926-2141	
59	HNL-SFO	11/11/76	0249-0423	
60	SFO-HNL	11/12/76	0425-0848	
61	HNL-GUM	11/12/76	1145-1756	
62	GUM-MNL	11/12/76	2019-2254	
63	MNL-HKG	11/13/76	0036-0141	
64	HKG-MNL	11/13/76	0625-0725	
65	MNL-GUM	11/13/76	0926-1151	
66	GUM-HNL	11/13/76	1431-2037	
67	HNL-HND	11/14/76	0152-0853	
68	HND-HNL	11/14/76	1243-1821	
69	HNL-SEA	11/14/76	2239-0245	
70	SEA-FAI	11/15/76	0602-0833	
71	FAI-SEA	11/15/76	1139-1409	
72	SEA-HNL	11/15/76	1754-2309	
73	HNL-LAX	11/16/76	0129-0530	
74	LAX-HNL	11/16/76	1659-2138	
75	HNL-SFO	11/17/76	0024-0412	
76	SFO-HNL	12/ 3/76	0458-0900	
77	HNL-GUM	12/ 3/76	1145-1817	
78	GUM-MNL	12/ 3/76	2039-2306	
79	MNL-HKG	12/ 4/76	0054-0159	
80	HKG-MNL	12/ 4/76	0621-0724	
81	MNL-GUM	12/ 4/76	0926-1211	
82	GUM-HNL	12/ 4/76	1431-2031	
83	HNL-HND	12/ 5/76	0016-0820	
84	HND-HNL	12/ 5/76	1256-1544	
85	HNL-SEA	12/ 5/76	2232-0312	
86	SEA-FAI	12/ 6/76	0608-0848	
87	FAI-SEA	12/ 6/76	1143-1401	
88	SEA-HNL	12/ 6/76	1749-2214	
89	HNL-SFO	12/ 9/76	0010-0410	
90	SFO-HNL	12/10/76	0458-0905	F

TABLE III - a) File 1 Continued....

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
91	HNL-GUM	12/10/76	1153-1818	
92	GUM-MNL	12/10/76	2028-2248	
93	MNL-HKG	12/11/76	0029-0129	
94	HKG-MNL	12/11/76	0607-0707	
95	MNL-GUM	12/11/76	0918-1153	
96	GUM-HNL	12/11/76	1426-2036	
97	HNL-HND	12/11/76	2329-0704	
98	HND-HNL	12/12/76	1219-1744	
99	HNL-LAX	12/13/76	0057-0507	
100	LAX-HNL	12/13/76	1636-2105	
101	HNL-SFO	12/15/76	0017-0402	
102	SFO-SEA	12/15/76	1920-2025	
103	SEA-LHR	12/15/76	2231-0656	
104	LHR-BOS	12/16/76	1117-1737	
105	BOS-DTW	12/16/76	1958-2058	
106	DTW-BOS	12/16/76	2305-0000	
107	BOS-LHR	12/17/76	0156-0656	
108	LHR-IAD	12/17/76	1310-2006	
109	JFK-LHR	12/18/76	1527-2057	
110	LHR-AMS	12/18/76	2240-2250	
111	AMS-LHR	12/19/76	0901-0911	
112	LHR-JFK	12/19/76	1154-1821	
113	JFK-LHR	12/20/76	0052-0612	
114	LHR-FRA	12/20/76	0957-1027	
115	FRA-THR	12/20/76	1257-1707	
116	THR-DEL	12/20/76	1929-2210	
117	DEL-BKK	12/21/76	0006-0251	
118	BKK-HKG	12/21/76	0432-0722	
119	HKG-HND	12/22/76	0215-0500	
120	HND-SFO	12/22/76	0739-1527	
121	SFO-LAX	12/23/76	0059-0124	
122	LAX-HNL	12/23/76	0427-0901	
123	HNL-NAN	12/23/76	1207-1719	
124	NAN-SYD	12/23/76	1910-2248	
125	SYD-MEL	12/24/76	0118-0153	
126	MEL-SYD	12/24/76	0341-0411	
127	SYD-NAN	12/24/76	0643-0938	
128	NAN-HNL	12/24/76	1259-1917	
129	HNL-LAX	12/24/76	2147-0227	
130	LAX-HNL	12/25/76	0521-1000	F
131	HNL-NAN	12/25/76	1416-1937	
132	NAN-SYD	12/25/76	2115-0040	
133	SYD-MEL	12/26/76	0242-0317	
134	MEL-SYD	12/26/76	0445-0510	
135	SYD-NAN	12/26/76	0721-1021	

TABLE III - a) File 1 Concluded

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
136	NAN-HNL	12/26/76	1212-1734	
137	HNL-LAX	12/26/76	2001-0009	
138	LAX-SFO	12/27/76	0200-0220	
139	SFO-SEA	12/27/76	1917-2017	
140	SEA-LHR	12/27/76	2224-0639	
141	LHR-SEA	12/28/76	1332-2218	
142	SEA-SFO	12/29/76	0355-0510	
143	SFO-HND	12/29/76	2057-0616	
144	HND-HKG	12/30/76	1003-1408	
145	HKG-BKK	12/30/76	1548-1843	
146	BKK-DEL	12/30/76	2024-2214	
147	DEL-THR	12/31/76	0141-0451	F
148	THR-FRA	12/31/76	0644-1117	
149	FRA-LHR	12/31/76	1344-1419	
150	LHR-JFK	12/31/76	1824-0033	
151	JFK-LHR	1/ 6/77	0057-0627	
152	LHR-FRA	1/ 6/77	0923-0948	
153	FRA-THR	1/ 6/77	1149-1603	
154	THR-DEL	1/ 6/77	1834-2103	
155	DEL-BKK	1/ 6/77	2345-0222	
156	BKK-HKG	1/ 7/77	0428-0712	
157	HKG-HND	1/ 8/77	0223-0454	
158	HND-SFO	1/ 8/77	0731-1520	
159	SFO-LAX	1/ 9/77	0100-0120	
160	LAX-HNL	1/ 9/77	0448-0934	F
161	HNL-PPG	1/ 9/77	1210-1625	
162	PPG-SYD	1/ 9/77	1844-2334	
163	SYD-MEL	1/10/77	0210-0245	
164	MEL-SYD	1/10/77	0426-0456	
165	SYD-PPG	1/10/77	0716-1006	

* F - Filter data

\+ Scheduled departure and arrival;
GASP GMT not available on tape

TABLE III - GASP FLIGHTS ON TAPE VL0008

b) File 2 (Qantas VH-EBE)

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
1	SYD-PER	9/26/76	0614-1026	+
2	PER-BOM	9/26/76	1140-2022	+
3	BOM-LHR	9/26/76	2144-0702	+
4	LHR-BOM	9/27/76	1158-2005	+
5	BOM-PER	9/27/76	2145-0552	+
6	PER-SYD	9/28/76	0710-1053	+
7	SYD-SIN	9/29/76	0550-1342	+
8	SIN-KUL	9/29/76	1542-1617	+
9	KUL-BAH	9/29/76	1714-2357	+
10	BAH-FRA	9/30/76	0110-0650	+
11	FRA-LHR	9/30/76	0808-0917	+
12	LHR-AMS	9/30/76	1743-1821	+
13	AMS-VIE	9/30/76	1954-2117	+
14	VIE-BAH	9/30/76	2240-0318	+
15	BAH-SIN	10/ 1/76	0500-1217	+
16	SIN-SYD	10/ 1/76	1344-2028	+
17	SYD-MEL	10/ 1/76	2233-2340	+
18	MEL-SYD	10/ 2/76	0309-0405	+
19	SYD-NAN	10/ 3/76	0336-0700	+
20	NAN-HNL	10/ 3/76	0814-1405	+
21	HNL-SFO	10/ 3/76	1541-2016	+
22	SFO-YVR	10/ 3/76	2124-2317	+
23	YVR-SFO	10/ 4/76	0103-0241	+
24	SFO-HNL	10/ 4/76	0359-0833	+
25	HNL-NAN	10/ 4/76	0950-1540	+
26	NAN-SYD	10/ 4/76	1703-2107	+
27	SYD-MNL	10/ 5/76	0103-0840	+
28	MNL-HKG	10/ 5/76	0948-1125	+
29	HKG-MNL	10/ 5/76	1256-1428	+
30	MNL-SYD	10/ 5/76	1547-2243	+
31	SYD-DRW	10/ 6/76	0555-1009	+
32	DRW-BKK	10/ 6/76	1115-1645	+
33	BKK-DAM	10/ 6/76	1810-0230	+
34	DAM-ATH	10/ 7/76	0404-0619	+
35	ATH-BEG	10/ 7/76	0757-0910	+
36	BEG-ORY	10/ 7/76	1016-1212	+
37	ORY-BEG	10/ 7/76	1535-1726	+
38	BEG-ATH	10/ 7/76	1839-1953	+
39	ATH-DAM	10/ 7/76	2112-2324	+
40	DAM-BKK	10/ 8/76	0026-0751	+
41	BKK-DRW	10/ 8/76	1028-1551	+
42	DRW-SYD	10/ 8/76	1708-2035	+
43	SYD-NAN	10/ 9/76	0052-0420	+
44	NAN-SYD	10/ 9/76	0540-0956	+
45	SYD-PER	10/10/76	0600-1026	+

TABLE III - b) File 2 Continued....

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
46	PER-BOM	10/10/76	1131-1958	+
47	BOM-LHR	10/10/76	2133-0646	+
48	LHR-BOM	10/11/76	1132-1953	+
49	BOM-PER	10/12/76	0025-0807	+
50	PER-SYD	10/12/76	0914-1251	+
51	SYD-NAN	10/13/76	0929-1249	+
52	NAN-HNL	10/13/76	1403-1939	+
53	HNL-SFO	10/13/76	2129-0139	+
54	SFO-HNL	10/14/76	0342-0853	+
55	HNL-NAN	10/14/76	1012-1614	+
56	NAN-SYD	10/14/76	1718-2120	+
57	SYD-PER	10/15/76	0617-1007	
58	PER-BOM	10/15/76	1158-2000	
59	BOM-LHR	10/15/76	2201-0637	
60	LHR-BOM	10/16/76	1138-1921	
61	BOM-PER	10/16/76	2114-0425	
62	PER-SYD	10/17/76	0653-1002	
63	SYD-SIN	10/18/76	0558-1254	
64	SIN-KUL	10/18/76	1448-1448	
65	KUL-BAH	10/18/76	1631-2248	
66	BAH-BEG	10/19/76	0058-0443	
67	BEG-LHR	10/19/76	0654-0844	
68	LHR-AMS	10/19/76	1809-1815	
69	AMS-BAH	10/19/76	2110-0217	
70	BAH-KUL	10/20/76	0359-1004	
71	KUL-SIN	10/20/76	1132-1142	
72	SIN-SYD	10/20/76	1409-2012	
73	SYD-MEL	10/20/76	2235-2305	
74	MEL-SYD	10/21/76	0322-0347	
75	SYD-NAN	10/21/76	0934-1214	
76	NAN-HNL	10/21/76	1406-1913	
77	HNL-SFO	10/21/76	2118-0119	
78	SFO-HNL	10/22/76	0407-0807	
79	HNL-NAN	10/22/76	1013-1541	
80	NAN-SYD	10/22/76	1737-2107	
81	SYD-MNL	10/23/76	0121-0801	
82	MNL-HKG	10/23/76	0939-1039	
83	HKG-MNL	10/23/76	1328-1428	
84	MNL-SYD	10/23/76	1627-2252	
85	SYD-MEL	10/25/76	0223-0258	
86	MEL-SIN	10/25/76	0444-1210	
87	SIN-BKK	10/25/76	1403-1525	
88	BKK-THR	10/25/76	1711-2338	
89	THR-ATH	10/26/76	0118-0433	
90	ATH-FCO	10/26/76	0608-0708	

TABLE III - b) File 2 Continued....

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
91	FCO-ATH	10/26/76	1850-1945	
92	ATH-THR	10/26/76	2144-0019	
93	THR-BKK	10/27/76	0213-0743	
94	BKK-SIN	10/27/76	0935-1050	
95	SIN-MEL	10/27/76	1250-1845	
96	MEL-SYD	10/27/76	2041-2111	
97	SYD-NAN	10/29/76	0925-1220	
98	NAN-HNL	10/29/76	1404-1914	
99	HNL-SFO	10/29/76	2122-0122	
100	SFO-HNL	10/30/76	0403-0808	
101	HNL-NAN	10/30/76	0955-1530	
102	NAN-SYD	10/30/76	1723-2113	
103	SYD-AKL	10/31/76	0117-0317	
104	AKL-SYD	10/31/76	0607-0822	
105	SYD-MEL	11/ 4/76	0356-0426	
106	MEL-SIN	11/ 4/76	0614-1259	
107	SIN-BKK	11/ 4/76	1513-1632	
108	BKK-THR	11/ 4/76	1808-0013	
109	THR-ATH	11/ 5/76	0151-0448	
110	ATH-FCO	11/ 5/76	0625-0730	
111	FCO-ATH	11/ 5/76	1933-2044	
112	ATH-THR	11/ 5/76	2233-0122	
113	THR-BKK	11/ 6/76	0306-0836	
114	BKK-SIN	11/ 6/76	1012-1132	
115	SIN-MEL	11/ 6/76	1348-2002	
116	MEL-SYD	11/ 6/76	2212-2237	
117	SYD-SIN	11/ 7/76	0604-1308	
118	SIN-BKK	11/ 7/76	1458-1613	
119	BKK-BAH	11/ 7/76	1755-2335	
120	BAH-FRA	11/ 8/76	0312-0817	
121	FRA-LHR	11/ 8/76	1011-1041	
122	LHR-FRA	11/ 8/76	1832-1902	
123	FRA-BAH	11/ 8/76	2102-0147	
124	BAH-BKK	11/ 9/76	0347-0901	
125	BKK-SIN	11/ 9/76	1057-1211	
126	SIN-MEL	11/ 9/76	1450-2040	
127	MEL-SYD	11/ 9/76	2246-2321	
128	SYD-DRW	11/10/76	0612-0939	
129	DRW-BKK	11/10/76	1155-1650	
130	BKK-DAM	11/10/76	1852-0242	
131	DAM-ATH	11/11/76	0422-0557	
132	ATH-BEG	11/11/76	0805-0840	
133	BEG-ATH	11/11/76	1934-2014	
134	ATH-DAM	11/12/76	0026-0156	
135	DAM-BKK	11/12/76	0350-1031	

TABLE III - b) File 2 Continued....

	Flight Route	Departure Date	Data Time Intvl (GMT)	Data *
136	BKK-DRW	11/12/76	1225-1724	
137	DRW-SYD	11/12/76	1915-2219	
138	SYD-AKL	11/13/76	0129-0328	
139	AKL-SYD	11/13/76	0539-0758	
140	SYD-PER	11/14/76	0616-1026	
141	PER-BOM	11/14/76	1159-2003	
142	BOM-FRA	11/14/76	2152-0535	
143	FRA-LHR	11/15/76	0739-1009	
144	LHR-BOM	11/15/76	1344-2120	
145	BOM-PER	11/15/76	2304-0615	
146	PER-SYD	11/16/76	0805-1055	
147	SYD-AKL	11/18/76	0115-0130	
148	SYD-NAN	11/18/76	1023-1311	
149	NAN-HNL	11/18/76	1457-2004	
150	HNL-SFO	11/18/76	2233-0225	
151	SFO-HNL	11/19/76	0519-0928	
152	HNL-NAN	11/19/76	1146-1711	
153	NAN-SYD	11/19/76	1904-2305	
154	SYD-SIN	11/21/76	0752-1452	
155	SIN-BKK	11/21/76	1639-1754	
156	BKK-BAH	11/21/76	1951-0128	
157	BAH-FRA	11/22/76	0347-0900	
158	FRA-LHR	11/22/76	1058-1131	
159	LHR-BOM	11/22/76	1506-2247	
160	BOM-PER	11/23/76	0048-0823	
161	PER-SYD	11/23/76	1533-1843	
162	SYD-AKL	11/24/76	0112-0304	
163	AKL-SYD	11/25/76	0459-0724	
164	SYD-NAN	11/26/76	1033-1318	
165	NAN-HNL	11/26/76	1507-2017	
166	HNL-SFO	11/26/76	2248-0241	
167	SFO-HNL	11/27/76	0528-0941	
168	HNL-NAN	11/27/76	1154-1709	
169	NAN-SYD	11/27/76	1904-2239	
170	SYD-SIN	11/28/76	0600-1302	
171	SIN-BKK	11/28/76	1509-1624	
172	BKK-BAH	11/28/76	1814-0003	
173	BAH-FRA	11/29/76	0244-0817	
174	FRA-LHR	11/29/76	1008-1042	
175	LHR-FRA	11/29/76	1834-1854	
176	FRA-BAH	11/29/76	2053-0141	+
177	BAH-BKK	11/30/76	0345-0901	
178	BKK-SIN	11/30/76	1042-1157	
179	SIN-SYD	11/30/76	1443-2058	
180	SYD-MEL	11/30/76	2309-2339	

TABLE III - b) File 2 Continued....

	Flight Route	Departure Date	Data time Intvl (GMT)	Data *
181	MEL-SYD	12/ 1/76	0611-0705	+
182	SYD-NAN	12/ 2/76	1029-1325	
183	NAN-HNL	12/ 2/76	1513-2030	
184	HNL-SFO	12/ 2/76	2243-0243	
185	SFO-HNL	12/ 3/76	0524-0929	
186	HNL-NAN	12/ 3/76	1137-1652	
187	NAN-SYD	12/ 3/76	1909-2229	
188	SYD-MEL	12/ 4/76	0225-0305	
189	MEL-SIN	12/ 4/76	0448-1133	
190	SIN-BKK	12/ 4/76	1341-1501	
191	BKK-DAM	12/ 4/76	1658-0103	
192	DAM-ATH	12/ 5/76	0239-0418	
193	ATH-FCO	12/ 5/76	0609-0719	
194	FCO-ATH	12/ 5/76	1826-1926	
195	ATH-THR	12/ 5/76	2129-0012	
196	THR-BKK	12/ 6/76	0158-0719	
197	BKK-SIN	12/ 6/76	0902-1022	
198	SIN-MEL	12/ 6/76	1249-1858	
199	MEL-SYD	12/ 6/76	2045-2118	
200	SYD-AKL	12/ 7/76	0121-0311	
201	AKL-SYD	12/ 7/76	0524-0744	
202	SYD-AKL	12/ 8/76	0123-0313	
203	AKL-SYD	12/ 8/76	0532-0752	
204	SYD-PER	12/ 9/76	0630-1035	
205	PER-BOM	12/ 9/76	1237-2017	
206	BOM-LHR	12/ 9/76	2207-0737	
207	LHR-BOM	12/10/76	1331-2044	
208	BOM-PER	12/10/76	2258-0630	
209	PER-SYD	12/11/76	0827-1117	
210	SYD-NAN	12/23/76	1034-1329	
211	NAN-HNL	12/23/76	1506-2016	
212	HNL-SFO	12/23/76	2246-0246	
213	SYD-NAN	12/13/76	1030-1330	
214	NAN-HNL	12/13/76	1518-2041	
215	HNL-SFO	12/13/76	2253-0253	
216	SFO-HNL	12/14/76	0528-0943	
217	HNL-NAN	12/14/76	1147-1656	
218	NAN-SYD	12/14/76	1859-2234	
219	SYD-AKL	12/15/76	0200-0355	
220	AKL-SYD	12/15/76	0619-0857	
221	SYD-NAN	12/15/76	1211-1506	
222	NAN-HNL	12/15/76	1647-2157	
223	HNL-SFO	12/16/76	0018-0353	
224	SFO-HNL	12/16/76	0641-1056	
225	HNL-NAN	12/16/76	1253-1825	

TABLE III - b) File 2 Continued....

	Flight Route	Departure Date	Data time Intvl (GMT)	Data *
226	NAN-SYD	12/16/76	2009-2344	
227	SYD-KUL	12/17/76	0533-1238	
228	KUL-MEL	12/17/76	1509-2144	
229	MEL-KUL	12/18/76	0159-0849	
230	KUL-SYD	12/18/76	1150-1845	
231	SYD-CHC	12/19/76	0343-0544	
232	CHC-SYD	12/19/76	0746-0956	
233	SYD-SIN	12/20/76	0607-1302	
234	SIN-KUL	12/20/76	1456-1456	
235	KUL-BAH	12/20/76	1647-2321	
236	BAH-BEG	12/21/76	0129-0522	
237	BEG-LHR	12/21/76	0754-0934	
238	LHR-AMS	12/21/76	1828-1833	
239	AMS-BAH	12/21/76	2040-0145	
240	BAH-KUL	12/22/76	0416-1021	
241	KUL-SIN	12/22/76	1159-1204	
242	SIN-SYD	12/22/76	1405-2020	
243	SFO-HNL	12/24/76	0520-0930	
244	HNL-NAN	12/24/76	1126-1646	
245	NAN-SYD	12/24/76	1842-2212	
246	SYD-NAN	12/25/76	1050-1348	
247	NAN-HNL	12/25/76	1529-2047	
248	HNL-SFO	12/25/76	2238-0233	
249	SFO-HNL	12/26/76	0527-0937	
250	HNL-NAN	12/26/76	1138-1655	
251	NAN-SYD	12/26/76	1854-2229	
252	SYD-AKL	12/27/76	0121-0316	
253	AKL-SYD	12/27/76	0614-0832	
254	SYD-MEL	12/28/76	0434-0509	
255	MEL-PER	12/28/76	0704-1009	
256	PER-BOM	12/28/76	1151-1932	
257	BOM-LHR	12/28/76	2127-0657	
258	LHR-FRA	12/29/76	1820-1845	
259	FRA-BAH	12/29/76	2055-0135	
260	BAH-BKK	12/30/76	0413-0920	
261	BKK-SIN	12/30/76	1104-1224	
262	SIN-SYD	12/30/76	1434-2104	
263	SYD-MEL	12/30/76	2311-2346	
264	MEL-SYD	12/31/76	0317-0347	
265	SYD-MNL	1/ 1/77	0114-0743	
266	MNL-HKG	1/ 1/77	0943-1043	
267	HKG-MNL	1/ 1/77	1307-1401	
268	MNL-SYD	1/ 1/77	1542-2212	
269	SYD-CHC	1/ 2/77	0308-0443	
270	CHC-SYD	1/ 2/77	0714-0947	

TABLE III -- b) File 2 Concluded

	Flight Route	Departure Date	Data time Intvl (GMT)	Data *
271	SYD-MNL	1/ 4/77	0116-0741	
272	MNL-HKG	1/ 4/77	0957-1059	
273	HKG-MNL	1/ 4/77	1257-1347	
274	MNL-SYD	1/ 4/77	1545-2221	
275	SYD-NAN	1/ 5/77	1030-1330	
276	NAN-HNL	1/ 5/77	1516-2023	
277	HNL-SFO	1/ 5/77	2243-0229	
278	SFO-HNL	1/ 6/77	0524-0937	
279	HNL-NAN	1/ 6/77	1133-1643	
280	NAN-SYD	1/ 6/77	1851-2211	
281	SYD-PER	1/ 7/77	0614-0939	
282	PER-BOM	1/ 7/77	1158-1933	
283	BOM-LHR	1/ 7/77	2152-0647	
284	LHR-BOM	1/ 8/77	1229-2001	
285	BOM-PER	1/ 8/77	2215-0535	
286	PER-SYD	1/ 9/77	0744-1049	

* Constituent data not available

\+ Take-off & landing times;
GASP GMT not available on tape

TABLE IV - FILTER DATA ON TAPE VL0007

Exposure Data

Filter no.	423	236	333
File,Flight	2,1	2,66	2,70
Date	11/24/76	12/22/76	12/28/76
Latitude, deg	37-31N	42-43N	40-44N
Longitude, deg	125-142W	76-94W	120-99W
Altitude, km	11.0	10.7,11.3	11.3,11.9,12.5
Time, min	119	115(92,23)	120(40,50,30)
Region **	T	U,S	T,T,S

Constituent Data

SO4=, $\mu g/m^3$	.033	.051	.041
NO3-, "	.028	.055	.091
Cl- , "	.000	.000	.000
F- , "	.000	.010	.002

** - T - Troposphere
S - Stratosphere
U - Uncertain

TABLE V - FILTER DATA ON TAPE VL0008

Exposure Data						
Filter no.	419	425	335	239	434	338
File,Flight	1,6	1,13	1,90	1,130	1,147	1,160
Date	10/17/76	10/20/76	12/10/76	12/25/76	12/31/76	1/9/77
Latitude, deg	12-15N	40-46N	37-30N	34-33N	29-30N	34-31N
Longitude, deg	102-111E	122-123W	125-144W	121-126W	75-60E	122-139W
Altitude, km	11.3	11.9	11.0	11.0	10.7	10.7
Time, min	122	55	120	30	121	120
Region **	T	U	U	T	T	U
Constituent Data						
$SO4=$, µg/m^3	.029	.020	.019	.026	.023	.030
NO3-, "	.051	.055	.015	.002	.007	.032
Cl- , "	.009	.001	.000	.005	.000	.002
F- , "	.000	.005	.004	.016	.005	.003

** - T - Troposphere
S - Stratosphere
U - Uncertain

TABLE VI - ZONAL MEAN TROPOPAUSE PRESSURES FROM NMC 65X65 ARRAYS (1200 GMT)

a) 1975 - (Flattery method)   Data expressed in hPa

	LATITUDE (Degrees North)													
Mo	20	25	30	35	40	45	50	55	60	65	70	75	80	85
J	131.5	138.3	165.5	210.6	234.6	243.9	253.5	262.1	267.4	268.1	264.6	260.8	256.9	251.8
F	134.3	153.5	189.5	223.6	241.3	254.1	262.6	265.1	264.4	262.0	261.8	264.8	265.9	264.3
M	132.6	149.0	183.2	212.8	228.7	242.9	255.3	262.9	268.1	274.3	281.5	286.7	287.5	285.1
A	134.0	145.2	169.3	195.4	212.9	226.0	239.3	251.3	262.7	275.0	287.9	299.4	306.5	308.7
M	130.2	135.1	154.9	184.9	207.1	221.7	234.9	247.0	258.6	269.3	278.0	286.6	297.2	304.9
J	130.2	130.7	135.4	152.3	180.3	205.7	220.8	232.2	244.9	256.7	267.4	277.1	281.9	280.8
J	130.3	130.5	130.6	133.9	150.7	182.7	213.0	229.1	235.9	242.8	252.8	261.4	265.7	267.2
A	130.4	130.8	131.1	133.9	148.7	179.8	211.1	227.9	235.4	240.5	247.0	256.0	265.2	270.8
S	130.3	131.0	132.1	137.7	158.2	191.6	218.4	232.7	242.2	251.5	262.5	272.4	276.6	275.1
O	132.0	132.8	136.4	151.8	182.3	215.4	237.5	247.0	251.4	257.7	267.7	277.9	286.3	292.1
N	131.1	134.4	145.1	172.2	201.9	223.0	239.0	252.2	263.0	270.3	273.6	275.7	279.9	285.5
D*	155.3	165.3	190.0	226.0	251.5	261.9	268.0	273.3	278.1	282.0	284.8	286.3	287.1	288.5

* - Gustafson method used from December 17 to December 31, 1975

TABLE VI - ZONAL MEAN TROPOPAUSE PRESSURES FROM NMC 65X65 ARRAYS (1200 GMT)

b) 1976 - (Gustafson method)   Data expressed in hPa

LATITUDE (Degrees North)

Mo	20	25	30	35	40	45	50	55	60	65	70	75	80	85
J	192.0	209.3	237.0	267.4	286.2	292.4	295.8	298.9	298.6	294.2	288.4	285.3	283.1	277.6
F	192.6	211.0	242.6	266.5	280.2	293.9	305.1	307.8	302.2	294.2	287.6	282.5	280.5	280.3
M	187.6	204.1	232.8	255.5	274.2	292.8	306.7	312.0	310.7	302.9	292.2	284.2	280.5	278.7
A	181.7	191.9	214.3	236.4	255.5	273.6	287.9	298.7	308.8	319.2	328.4	334.8	334.4	329.3
M	179.4	186.7	202.8	221.1	239.6	258.8	277.5	294.9	308.0	315.7	322.8	332.8	341.5	344.9
J	176.2	184.8	194.8	207.3	225.8	246.0	262.6	277.3	289.2	300.2	313.5	325.3	330.0	327.5
J	160.2	172.7	183.6	194.7	212.3	234.8	255.8	266.7	273.3	283.4	296.6	308.1	317.9	326.6
A	150.3	160.5	172.3	185.7	206.0	232.1	252.7	264.6	272.5	279.7	291.0	307.9	324.9	334.2
S	165.2	173.4	184.2	196.4	215.9	237.2	255.2	269.2	278.8	286.5	294.4	303.0	313.4	323.9
O	172.3	175.1	185.5	204.1	221.6	241.2	265.9	287.5	297.8	301.6	303.8	306.3	312.3	322.1
N	170.2	176.6	191.6	217.4	242.2	265.8	284.7	294.6	297.6	300.7	305.6	312.5	321.3	328.7
D	179.1	188.4	209.8	241.7	265.8	281.2	292.5	298.8	300.7	301.4	303.5	307.0	313.5	322.1

TABLE VI - ZONAL MEAN TROPOPAUSE PRESSURES FROM NMC 65X65 ARRAYS (1200 GMT)

c) 1977 - (Gustafson method) Data expressed in hPa

Mo	LATITUDE (Degrees North) 20	25	30	35	40	45	50	55	60	65	70	75	80	85
J	192.6	202.2	226.3	257.4	279.9	292.6	297.3	296.9	299.7	309.6	323.3	329.2	325.5	321.8
F	194.5	204.7	226.1	256.2	277.8	290.9	299.9	305.3	307.2	306.8	309.8	318.6	329.7	338.6
M	184.7	200.5	219.5	242.4	262.8	278.7	292.2	303.4	312.6	319.3	322.7	321.7	315.9	308.8
A	184.5	198.8	215.6	230.2	246.2	264.4	281.5	296.7	310.2	323.4	337.2	350.0	358.0	358.2
M	178.6	192.2	208.8	223.5	239.7	256.7	272.0	286.8	300.0	311.6	323.7	337.8	349.4	354.2
J	174.0	182.5	192.5	206.4	226.5	246.1	258.8	269.0	280.9	295.0	309.2	321.7	328.0	326.1
J	167.5	179.2	187.6	197.4	213.6	232.5	248.7	261.0	272.5	280.8	286.7	292.8	295.0	292.2
A	151.3	161.6	172.8	183.4	203.6	230.6	250.7	263.7	273.4	279.9	285.4	291.1	298.3	306.6

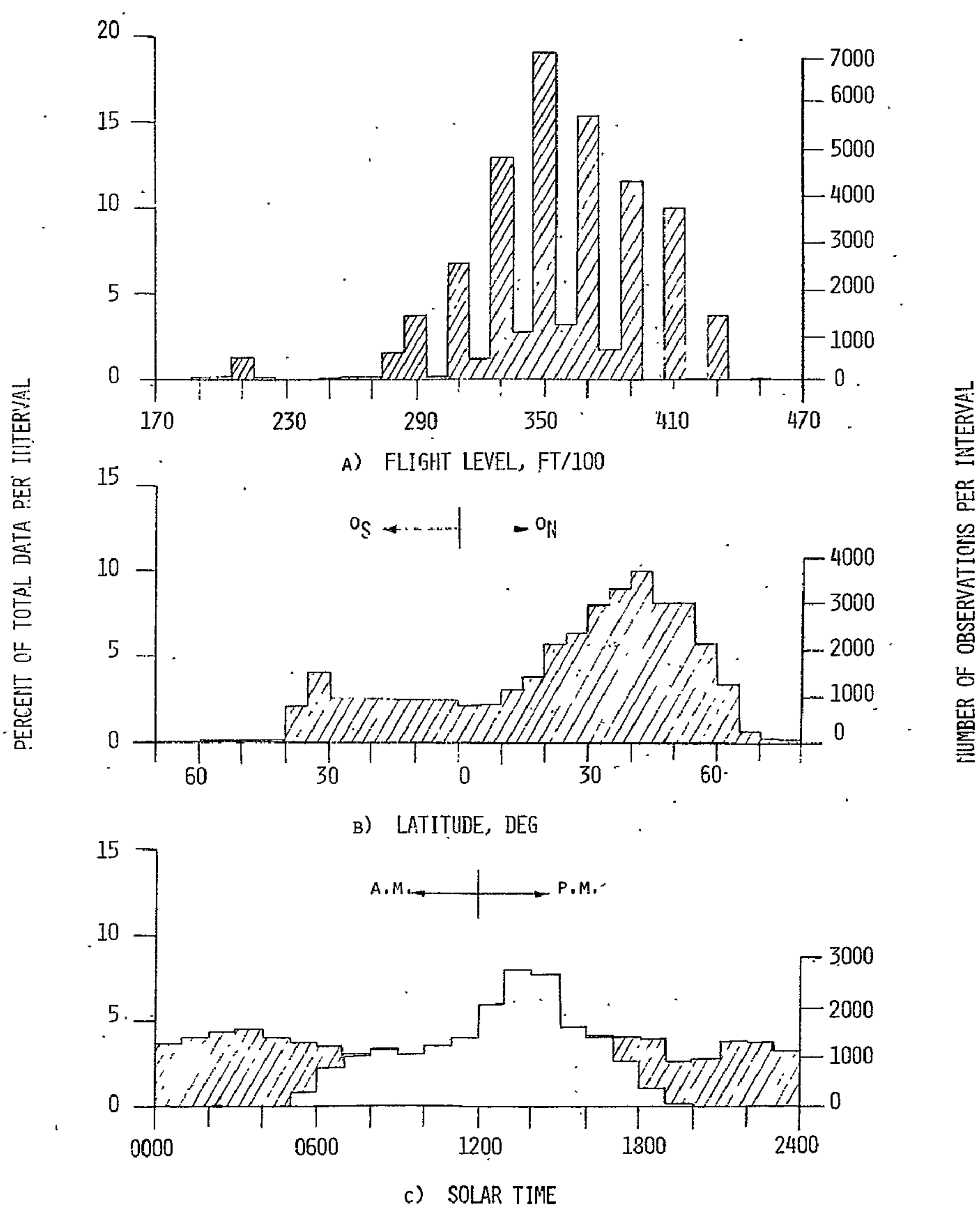

FIGURE 1. DISTRIBUTION OF GASP DATA ON TAPES VL0007 & VL0008

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, and contain one or more GASP data files followed by a tropopause pressure data file.

GASP DATA FILE

1. Each GASP data file contains data from a single GASP aircraft. Within each file, data are grouped and identified by flights (takeoff to landing) in chronological order.

2. The GASP data for 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). Both FLHT and DATA records contain 512 bytes, hence there are 8 logical records per physical record (block).

3. An FLHT record will always be the first logical record in a block. However, every block need not begin with an 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 an FLHT record
D is a DATA record
P is a PADD record

4. 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) For the last DATA record of each flight, LBFLG (Byte 5) = "L"; for the last DATA record in each file, LBFLG = "G" if the following file is a GASP data file, and LBFLG = "T" if the following file is the tropopause pressure file; 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	3I2	Date first DATA record this flight; Mo=29-30,Da=31-32,Yr=33-34
35-38	TIMLV	2A2	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	3I2	Date last DATA record this flight; Mo=55-56,Da=57-58,Yr=59-60
61-64	TIMAR	2A2	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	NBLOCK	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

Table A-I Continued

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
112-114		A3	Spare ID
115-117		A3	Spare ID
118-122	D1	F5.3	Smallest particle radius (micrometers) for PC range 1
123-127	D2	F5.3	Smallest particle radius (micrometers) for PC range 2
128-132	D3	F5.3	Smallest particle radius (micrometers) for PC range 3
133-137	D4	F5.3	Smallest particle radius (micrometers) for PC range 4
138-142	D5	F5.3	Smallest particle radius (micrometers) 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	3I2	Filter exposure start date; Mo=162-163,Da=164-165,Yr=166-167
168-171	FTIMON	2A2	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	FLONON	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	3I2	Filter exposure stop date; Mo=191-192,Da=193-194,Yr=195-196
197-200	FTIMOF	2A2	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)

Table A-I Continued

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
220-229	FCOMP1	A10	Filter constituent 1 (name)
230-239	FCOMP2	A10	Filter constituent 2 "
240-249	FCOMP3	A10	Filter constituent 3 "
250-259	FCOMP4	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	3I2	Bottle exposure start date; Mo=327-328,Da=329-330,Yr=331-332
333-336	STIMON	2A2	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	SLOONT	A1	Bottle exposure start longitude tag "E" or "W"
350-355	SHTMON	F6.0	Bottle exposure start altitude (meters)
356-361	SDATOF	3I2	Bottle exposure stop date; Mo=356-357,Da=358-359,Yr=360-361
362-365	STIMOF	2A2	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)

Table A-I Completed

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
385-394	SCOMP1	A10	Bottle constituent 1 (name)
395-404	SCOMP2	A10	Bottle constituent 2 "
405-414	SCOMP3	A10	Bottle constituent 3 "
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		5A1	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="G" If this is the last GASP data record in the file and the following file is a GASP data file; LBFLG="T" If this is the last GASP data record in the file and the following file is a tropopause pressure file; otherwise LBFLG=" "
6-9	RECORD	I4	Record number on TAPID
10	FRAME	I1	Frame number on TAPID
11-12	MODE	I2	Program mode: = 4 for normal recordings = 10 during sample bottle exposures
13	TYPE	A1	Record type: = "N" for normal recordings = "L" during limit recordings
14	CYCLE	A1	Cal cycle number, or CYCLE="D" for data
15-20	DATE	3I2	Mo=15-16, Da=17-18, Yr=19-20
21-24	TIME	2A2	(GMT), Hr=21-22, Min=23-24
25-30	ALTFAV	F6.0	Altitude (ft)
31-36	ALTMAV	F6.0	Altitude (meters)
37-43	PAMB	F7.2	Ambient static pressure in hPa - 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	YJ	F5.2	Aircraft position in NMC grid coordinates
68-71	HEADG	F4.0	Aircraft heading (deg)
72	HEADGT	A1	Tag for HEADG*

Table A-II Continued

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
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	Vertical acceleration (G's); 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 ave (PPBV); 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; if DFPTA=SAT, DFTAGA="S"*
281-286	COAVG	F6.3	Carbon monoxide data (PPMV)
287	COTAGA	A1	Tag for COAVG*

Table A-II Continued

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
288-293	COA	F6.3	Carbon monoxide ave (PPMV); 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; if CLSEC > 0, CLTAG="C"*
367-373	TRPRMB	F7.2	Tropopause pressure in hPa (mb)+
374	TPTAG	A1	Tag for tropopause data fields+ If TPTAG=" ", TRPRMB from 12 hour interpolation If TPTAG="L", TRPRMB from 24 hour interpolation If TPTAG="E", TRPRMB from nearest NMC reporting period If TPTAG="T", TRPRMB from 1200 GMT reporting period++ If TPTAG="M", data not available
375-381	DELP	F7.2	DELP = TRPRMB - PAMB, in hPa (mb)+
382-387	TRPRHM	F6.0	Tropopause height in meters (from TRPRMB assuming std. atm)+

Table A-II Completed

Bytes	Fortran Name	Fortran Format	Parameter Description, Units, and Comments
388-394	DELHGT	F7.0	DELHGT = ALTMAV - TRPRHM, in meters+
395	GMTTAG	A1	Tag for TIME* **
396-512		117A1	SPARES

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

+ Added beginning with VL0004 to provide time and space interpolated tropopause data

** Added beginning with VL0006 to identify records for which GMT is not available

++ Added beginning with VL0007 to identify tropopause data obtained from 1200 GMT arrays when GASP GMT is not available

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	3I2	Date of observation; Mo=6-7; Da=8-9; Yr=10-11
12-15	TIME	2A2	GMT of observation; Hr=12-13; Min=14-15
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) array
31-43	A	E13.6	Base for TROP(I,J) array
44-100		57I1	Spares
101-4000	ELE(I,J)	650I6	Tropopause pressures in hPa, 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 FOR NMC 65X65 GRID

The tropopause pressure data included on GASP tapes are given at each of the 4225 points on the NMC 65X65 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 $R^2 = ((XI-33)^2 + (YJ-33)^2)/RHO^2$

where RHO = 31.2043

The Latitude (deg) is given by

$$THETA = (180/PI)\ \arcsin((1-R^2)/(1+R^2))$$

If THETA > 0, LAT = THETA and LATAG = "N"

If THETA < 0, LAT = -THETA and LATAG = "S"

The Longitude (deg) is given by

$$PHI = -(10 + (180/PI)\ \arctan((YJ-33)/(XI-33))$$

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

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

If $0 < PHI < 170$, LONG = PHI and LONGTAG = "W"