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Compendium Of NASA Data Base For The Global Tropospheric Experiment's Pacific Exploratory Mission West-B (PEM West-B)

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COMPENDIUM OF NASA DATA BASE FOR THE GLOBAL TROPOSPHERIC EXPERIMENT'S PACIFIC EXPLORATORY MISSION WEST-B (PEM WEST-B)

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SUMMARY

The report provides a compendium of NASA aircraft data that are available from NASA's Global Tropospheric Experiment's (GTE) Pacific Exploratory Mission West-B (PEM West-B) conducted in February and March 1994. The NASA PEM West experiments (PEM West-A and -B) are a major component of the East Asia/North Pacific Regional Study (APARE), a project within the International Global Atmospheric Chemistry (IGAC) Program. PEM West flight experiments focused on the Pacific rim region and were primarily based at Guam, Hong Kong, and Japan. The broad objectives of the experiments were to study chemical processes and long-range transport associated with Asian continental outflow over the northwest Pacific Ocean and to document the magnitude of the human impact on the oceanic/marine atmosphere oven this region with an emphasis on ozone and sulfur chemistry (gas). PEM West-B, studied late-winter to early-spring meteorology during which Asian continental outflow was enhanced in comparison to outflow during the early-fall (September and October) time frame of the 1991 PEM West-A measurements. Results from PEM West-A and B are public domain (see Appendix B). PEM West-A data are summarized in NASA TM 109177 entitled "Compendium of NASA Data Base for the Global Tropospheric Experiment's Pacific Exploratory Mission West-A (published February 1995) and an in-press special issue of the Journal of Geophysical Research - Atmospheres.

The format of this compendium utilizes data plots--time series and altitude profiles--of selective data acquired aboard the NASA/Ames DC-8 aircraft during PEM West-B. The purpose of this document is to provide a representation of aircraft data that are available in archived format via NASA Langley's Distributed Active Archive Center (DAAC). The data format is intended only to assist the reader in identifying data that are of interest. This compendium is for only the NASA aircraft data. The DAAC archived data bases include numerous supporting data including meteorological observations/products, photochemical modeling products, results from surface studies, satellite observations, and sondes releases.

INTRODUCTION

The goal of the NASA Tropospheric Chemistry Program is to develop an understanding of the chemical cycles that control the composition of the troposphere and to assess the susceptibility of the global atmosphere to chemical change. A major component of the NASA program is the Global Tropospheric Experiment (GTE), which consists of a series of field experiments designed to (1) evaluate the capability of instrument techniques to measure, under field conditions, the minute concentrations of key chemical species in the troposphere; and (2) systematically address tropospheric chemistry issues relevant to global change, through airborne sampling expeditions, coupled with modeling and laboratory studies. GTE is primarily an aircraft-based program supplemented by ground-based measurements. Satellite data also play important roles. Space Shuttle observations of tropospheric carbon monoxide distributions have been used to plan and direct the course of expeditions, for example, over tropical rain forests and for continental outflow into the tropical Atlantic Ocean. Landsat land-surface images have facilitated the extrapolation of regional Arctic-tundra measurements into global-scale conclusions. Total Ozone Measurements from Satellites (TOMS) have helped place GTE observed ozone distributions/budgets into a global perspective (temporal and spatial) and to guide intensive aircraft studies over the tropical Atlantic Ocean. Weather data returned by environmental satellites have guided flight planning for research flights. The Distributed Active Archive Center (DAAC) data include many of the satellite, surface, and meteorological products used to support GTE missions or analyses.

The GTE airborne expeditions have focused on studies of the remote global atmosphere in order to provide well-documented baseline measurements of the unperturbed environment and to fully understand the chemical cycles underlying the natural environment. Table 1 and Figure 1 summarize GTE missions conducted through 1994 and the PEM Tropics mission scheduled for 1996. The GTE expeditions have been conducted in a diverse range of environments and with different scientific goals. The Chemical Instrument

Test and Evaluation (CITE) series was designed to study our ability to measure key tropospheric gaseous species by exposing selected instrumentation to a wide range of measurement conditions. The Atmospheric Boundary Layer Experiments (ABLE) were designed to study the emission, chemical processes, and dynamics of the boundary layer, and have been conducted over ecosystems known to have significant influence on the global troposphere. The importance of long-range transport of natural and anthropogenic emissions on the global troposphere has been investigated in the Pacific Exploratory Missions (PEM) and the Transport and Atmospheric Chemistry Experiment in the Atlantic (TRACE-A).

The GTE, managed through the Tropospheric Chemistry Program in the Mission to Planet Earth Office, NASA Headquarters, was initiated in the early 1980s. Implementation of the GTE Project is via a Project Office at the NASA Langley Research Center, Atmospheric Sciences Division.

SYMBOLS AND UNITS

ABLE	Atmospheric Boundary Layer Experiment
APARE	East Asia/North Pacific Regional Study
CITE	Chemical Instrument Test and Evaluation
CO	carbon monoxide
CO_2	carbon dioxide
C_2Cl_4	tetrachloroethylene
CH_3CCl_3	methyl chloroform
CH_3OOH	methyl peroxide
CH_3COOH	acetic acid
CH_4	methane
DAAC	Distributed Active Archive Center
deg.	degree
DMS	dimethyl sulfide
dp	dew point temperature, degree Centigrade

fine	aerosol in the size range of ~0.01 to 1 micron diameter
Ga.Inst. of Tech.	Georgia Institute of Technology, Atlanta, Georgia
GIT	Georgia Institute of Technology, Atlanta, Georgia
GTE	Global Tropospheric Experiment
H_2O_2	hydrogen peroxide
HCOOH	formic acid
HNO_3	nitric acid
IGAC	International Global Atmospheric Chemistry Program
ITCZ	Inter-Tropical Convergence Zone
LaRC	Langley Research Center
large	aerosol in the size range of 0.3 to 20 micron diameter
N_2O	nitrous oxide
NASA	National Aeronautics and Space Administration
NIES	National Institute for Environmental Studies, Japan
NO	nitric oxide
NO_y	total odd nitrogen
O_3	ozone
PAN	peroxyacetyl nitrate
PEM	Pacific Exploratory Mission
ppbv	parts-per-billion, by volume
ppmv	parts-per-million, by volume
PPN	peroxypropionly nitrate
pptv	parts-per-trillion, by volume
Rel. Humidity	relative humidity, percent
small	aerosol in the size range of 0.1 to 3 micron diameter
SO_2	sulfur dioxide
T	air temperature, degree Centigrade
Theta	potential temperature, degree Kelvin
TOMS	Total Ozone Measurements from Satellites
TRACE-A	Transport and Atmospheric Chemistry Experiment in the Atlantic

Univ.of CA, Irvine	University of California at Irvine, California
Univ.of NH	University of New Hampshire, Durham, New Hampshire
Univ. of RI	University of Rhode Island, Narragansett, Rhode Island
Univ.	University

PROGRAM AND DATA DESCRIPTIONS

The National Aeronautics and Space Administration's Pacific Exploratory Mission West (PEM West) is a major component of the East Asia/North Pacific Regional study (APARE), a project within the International Global Atmospheric Chemistry (IGAC) program. The broad objectives of the PEM West/APARE initiative is to study chemical processes and long-range transport over the northwest Pacific Ocean, and to estimate the magnitude of the human impact (specifically Asian continental outflow) on the marine/oceanic atmosphere of the region. Specific objectives of PEM West are (1) to investigate the atmospheric chemistry of ozone (O_3) and its precursors over the northwest Pacific including examination of their natural budgets as well as the impact of anthropogenic sources; and (2) to investigate the atmospheric gaseous sulfur cycle over the northwest Pacific with emphasis on the relative importance and influence of continental versus marine sulfur sources.

The Pacific Ocean is, perhaps, the only major region in the Northern Hemisphere that is "relatively" free from direct anthropogenic influences. In the remote regions of the northern Pacific and in most of the southern Pacific, it should be possible to study the biogeochemical cycles of carbon, nitrogen, ozone, sulfur, and aerosols in an environment which, from a global perspective, is least perturbed by anthropogenic activities. On the other hand, there is little doubt that long-range transport of air pollutants from Asia and, to a lesser extent, Europe and North America is beginning to have significant impact on the atmosphere over a large part of the Pacific. The results from the PEM West studies provide an extensive set of baseline data

from which the anthropogenic impact of this region can be reliably assessed for decades to come.

The overall experiment design for the PEM-West/APARE program encompassed two field studies positioned in time such that contrasting meteorological regimes in the northwestern Pacific could be studied. The first phase of the Pacific Exploratory Mission West, PEM West-A, was conducted over the Pacific Ocean off the coast of Asia during September and October, 1991. Significant characteristics of the lower troposphere airflow during this time of year includes periods during which the predominance of flow is from the mid-Pacific (marine) regions and periods in which the marine flow is modified/mixed with Asian continental outflow. Phase B of PEM West was conducted during February and March 1994, a period characterized by maximum outflow from the Asian continent with less predominance of flow from mid-Pacific marine regions.

The centerpiece of PEM West-B was a series of 16 research flights with the instrumented NASA Ames DC-8. The aircraft operated from three staging areas: Anderson Air Force Base, Guam; Kai Tak International Airport, Hong Kong; and Yokota Air Force Base, Japan. Table 2 summarizes the flights, and Figure 2 shows the flight regions. Flights 6-9, 11-12, and 14-17 were site-intensive flights based from Guam, Hong Kong, and Japan, respectively. Survey/ferry flights included (a) flights 4-5 from NASA Ames to Guam (via Hawaii), (b) flight 10 from Guam to Hong Kong and (c) flights 18-19 from Japan to Ames (via Anchorage, Alaska). While the prime objective of the survey/ferry flights was to move the aircraft to a new base of operation, the flight plans were designed to provide as much information on the atmospheric processes and vertical structure of the atmosphere as possible. The intensive flights were designed to take advantage of the geographical location of the site and prevailing meteorological conditions in addressing science objectives. As a result of the location of the three intensive sites (staging areas), flights covered a latitude range of about 45° N to the Equator and sampled air with continental lifetimes of <1 day (i.e., passed over the Asian continent within 1 day of sampling) to air which had been over the Pacific

Ocean for >5 days. The majority of flights focused on studying the impact of aged, 1 to 3 days, Asian outflow on Pacific marine regions. Unique PEM West-B sampling events included (1) two flights south to the ITCZ and Equator (flights 6 and 9), (2) a flight which encircled the island of Taiwan (flight 12), (3) an upwind/downwind study of the island of Japan (flight 15), and (4) sampling of stratospherically influenced upper-tropospheric air in which ozone was elevated to several hundred ppbv (portions of flights 17 and 18).

The core set of measurements aboard the aircraft focused on ozone and sulfur chemistry issues (gaseous). The aircraft data included a suite of chemical measurements which included ozone, nitric oxide (NO), total odd or "reactive" nitrogen gaseous species (NO_y), sulfur dioxide, dimethyl sulfide, peroxyacetyl nitrate or PAN, peroxypropionly nitrate, methane, carbon monoxide, carbon dioxide, nonmethane hydrocarbons, fluorocarbons, acetic acid, formic acid, nitric acid, hydrogen and methyl peroxides. Two sets (Nagoya University and Georgia Institute of Technology) of NO and NO_y data were measured aboard the aircraft. While the two NO data sets generally agreed, the NO_y data sets did not agree in many cases. Laboratory and flight tests conducted by GIT (the results to be reported in a planned special issue of the Journal of Geophysical Research - Atmospheres dealing with PEM West-B results) suggests that the NO_y measurements obtained by the GIT instrument may lack specificity. Thus, for some flight/sampling/environmental conditions, differences in sampling procedures (e.g., inlet design/material, NO_y converter parameters/conditions, sample flow rates, etc.) between the two instrumental approaches may account for much of the observed disagreement. Prior to publication of the planned special issue of the journal dealing with PEM West-B results, those interested in using PEM West-B NO_y data are recommended to contact the respective NO_y investigators.

Aerosol measurements included filter collections for "elemental-type" analyses and optical measurements of number density in the classifications of fine (~0.01 to 1 μ diameter), small (15 size bins covering the size range of ~0.1 - 3 μ), and large (30 size bins covering the size range of ~0.3 - 20 μ).

Table 3 identifies investigators responsible for the measurements, and Figure 3 shows a schematic of the aircraft instrument plan.

The aircraft platform as used in PEM West-B had a cruise speed at altitude of about 12 km/min and a maximum flight duration and ceiling of about 8-9 hours and 13 km, respectively. Survey flights were generally long-duration flights at high altitude (10 to 13 km) with (generally) at least one descent (spiral or ramp in addition to takeoff and landing) to about 150 to 300 m above sea level. Intensive flights combined numerous ramps, profiles, and level-flight legs to meet planned objectives. Generally, altitude profiles (spirals or ramps) were flown with ascent/descent rates of 150 to 300 m/min.

The PEM West-B DAAC data archive includes (1) data taken aboard the NASA Ames DC-8 aircraft; (2) data measured at surface sites throughout the Pacific rim basin; (3) sondes released from multiple locations in support of the aircraft flights; (4) photochemical modeling products used in analyses of results; and (5) numerous meteorological, land-use, and satellite data products used in flight (field) planning and post-mission analyses.

The data plots for the PEM West-B missions are given in Appendix A. For each flight, six pages of time series plots are provided: page 1 -- a pictorial diagram of the flight region and time series plots of altitude, temperature (T), dew point temperature (dp), relative humidity, and potential temperature (theta); page 2 -- ozone (O_3), carbon monoxide (CO), carbon dioxide (CO_2,) methane, nitrous oxide (N_2O), and benzene; page 3 -- nitric oxide (NO) as measured by Nagoya and GIT, total odd or "reactive" nitrogen gas species (NO_y) as measured by Nagoya and GIT, and nitric acid; page 4 -- acetylene, ethane, propane, tetrachloroethylene (C_2Cl_4), and methyl chloroform (CH_3CCl_3); and page 5 -- sulfur dioxide (SO_2), dimethyl sulfide (DMS), ethylene, peroxyacetly nitrate (PAN), and acetone; page 6 -- hydrogen peroxide (H_2O_2), methyl peroxide (CH_3OOH), and number density for fine, small, and large aerosol. The species were selected to provide the reader with information on both the source characteristics and photochemical history of

the air. Figure numbers correspond to flight numbers; e.g., Figure A4.2 represents page 2 of the plots for flight #4. Selected profile plots follow the time series plots as, e.g., Figure A4.7 is the first page of profile plots for flight 4. Profile plot sets include temperature, dew point temperature, ozone, carbon monoxide, and methane data plotted to the same altitude scale. One to three sets of profile plots are provided (format of two sets per page) for each flight. Table 4 summarizes the profiles selected. There are no figures with the prefix of A1, A2, or A3. Flights 1 to 3 were instrument checkout flights based at Ames and data were not archived. Data plots are in standardized format as discussed in Appendix A. The DAAC archive includes measurements aboard the DC-8 aircraft during PEM West-B which are not plotted in Appendix A.

CONCLUDING REMARKS

This compendium of data from NASA's Global Tropospheric Experiment's Pacific Exploratory Mission West-B provides only a representation of aircraft data that are available in archived format from NASA Langley's Distributed Active Archive Center (DAAC). The data presented here are intended only to serve as an overview of the PEM West-B data and provide some assistance to the reader in identifying data that are of interest and which may be obtained from Langley's DAAC archive. This compendium covers only selected NASA DC-8 aircraft data. The archived data bases include other data measured on board the aircraft as well as numerous supporting data including meteorological observations/products, photochemical modeling products, surface station observations, satellite observations, and sondes releases. GTE-sponsored analyses/results from the PEM West-B expeditions have been submitted (September 1995) for a Special Issue of the Journal of Geophysical Research - Atmospheres.

Questions or information regarding the Langley DAAC archive should be directed to Langley DAAC User and Data Services, Mail Stop 157B, NASA Langley Research Center, Hampton, Virginia 23681-0001. A brief description of the DAAC, log on procedures, and data bases is given as Appendix B.

TABLE 1. GTE Field Expeditions

Expedition	Date	General Geographic Region	Time of Year
Atmospheric Boundary Layer Experiments			
ABLE-1	1984	Barbados, French Guyana	June
ABLE-2A	1985	Amazon Basin	August
ABLE-2B	1987	Amazon Basin	May
ABLE-3A	1988	Alaska--Barrow, Bethel, Cold Bay	July/August
ABLE-3B	1990	Canada--Hudson Bay, Schefferville	July/August
Chemical Instrument Test and Evaluation Experiments			
CITE-1	1983	Hawaii	November
CITE-1	1984	Eastern North Pacific--off the California coast	April
CITE-2	1986	Western USA	August
CITE-3	1989	Western North Atlantic--Virginia coast	August
		and Western South Atlantic--Brazil coast	September
Global Scale Photochemistry/Transport Experiments			
PEM West-A	1991	Western Pacific Rim	October
TRACE-A	1992	Brazil, South Atlantic, southwest Africa	September
PEM West-B	1994	Western Pacific Rim	Feb./March
PEM-Tropics	1996	South tropical Pacific Ocean	September

TABLE 2. Summary of the Flights Conducted during the 1994 PEM West-B Expedition (All times are GMT)

Mission Number	Flight Date	Departure		Arrival		Purpose
		Time	Location	Time	Location	
4	Feb. 7	2012	NASA Ames	0111	Hawaii	survey & ferry
5	Feb. 8*	2012	Hawaii	0430	Guam	survey & ferry
6	Feb. 11	2100	Guam	0438	Guam	ITCZ, southern hemispheric air
7	Feb. 13	2313	Guam	0653	Guam	marine frontal system
8	Feb. 17	2258	Guam	0750	Guam	marine frontal system
9	Feb. 19	0253	Guam	0840	Guam	ITCZ, southern hemispheric air
10	Feb. 21	0058	Guam	0922	Hong Kong	survey & ferry, ITCZ
11	Feb. 25	0152	Hong Kong	0926	Hong Kong	Asian outflow
12	Feb. 27	0145	Hong Kong	0947	Hong Kong	Asian outflow & Taiwan flyby
13	March 1	0201	Hong Kong	0900	Yokota, Japan	survey & ferry
14	March 4	0335	Yokota, Japan	1005	Yokota, Japan	Asian outflow
15	March 5	2329	Yokota, Japan	0653	Yokota, Japan	upwind/downwind Island of Japan
16	March 7	0105	Yokota, Japan	0842	Yokota, Japan	Asian outflow
17	March 11	0010	Yokota, Japan	0710	Yokota, Japan	Asian outflow
18	March 13*	0012	Yokota, Japan	0738	Anchorage, Alaska	survey & ferry
19	March 14	1709	Anchorage, Alaska	2322	NASA Ames	survey & ferry

* Crossed International date line

TABLE 3. Principal Investigators and Institutions Participating in PEM West-B

Investigator	Institution	Investigation/Measurement
Bruce Anderson	NASA Langley Research Center	carbon dioxide, fine aerosol
Alan Bandy Donald Thornton	Drexel University	SO_2 & dimethyl sulfide
John Barrick	NASA Langley Research Center	meteorological/position data
John Bradshaw	Georgia Institute of Technology	nitric oxide, total oxides of nitrogen
Edward Browell	NASA Langley Research Center	ozone & aerosol profiles (remote sensor)
Gerald Gregory	NASA Langley Research Center	ozone (in situ)
Brian Heikes	University of Rhode Island	H_2O_2, CH_3OOH
Yutaka Kondo	Nagoya University, Japan	nitric oxide, total oxides of nitrogen
Rudolph Pueschel	NASA Ames Research Center	small and large aerosol
Sherry Rowland Donald Blake	University of California, Irvine	nonmethane hydrocarbons
Glen Sachse	NASA/Langley Research Center	carbon monoxide, methane, nitrous oxide
Hanwant Singh	NASA Ames Research Center	PAN, PPN, C_2Cl_4, acetone, acetyaldehyde
Robert Talbot	University of New Hampshire	HNO_3, HCOOH, CH_3COOH, aerosol composition (elemental)

TABLE 4. PEM West-B Profiles

Flight	Date	Time	Latitude, °N	Longitude, °E
4	February 7	2030	37.3	-122.9
4	February 8	0100	21.4	-157.7
5	February 8	2030	21.4	-158.8
5	February 9	0415	13.7	145.3
6	February 12	0030	- 9.6	152.2
6	February 12	0130	- 5.3	149.9
7	February 13	2330	14.8	145.3
7	February 14	0315	20.9	145.0
8	February 18	0115	29.2	145.2
8	February 18	0730	13.9	145.3
9	February 19	0500	0.9	146.3
9	February 19	0830	12.6	145.0
10	February 21	0500	5.8	119.4
10	February 21	0715	15.9	117.3
10	February 21	0900	21.9	114.2
11	February 25	0200	21.5	115.1
11	February 25	0430	8.8	117.2
12	February 27	0715	22.6	119.6
12	February 27	0930	22,2	114.9
13	March 1	0215	21.9	115.2
13	March 1	0845	34.6	139.6

Times are GMT

TABLE 4. Profiles continued.

Flight	Date	Time	Latitude, °N	Longitude, °E
14	March 4	0345	34.8	139.3
14	March 4	0800	25.9	138.9
15	March 6	0300	40.3	138.6
15	March 6	0600	36.2	144.7
16	March 7	0300	30.6	155.0
16	March 7	0425	27.9	163.9
17	March 11	0030	37.0	139.3
17	March 11	0700	36.1	139.7
18	March 13	0300	47.1	164.0
18	March 13	0515	53.8	-173.2
18	March 13	0730	60.9	-150.8
19	March 14	1730	60.4	-150.6
19	March 14	2045	44.2	-140.4
19	March 14	2145	39.7	-134.1

Times are GMT

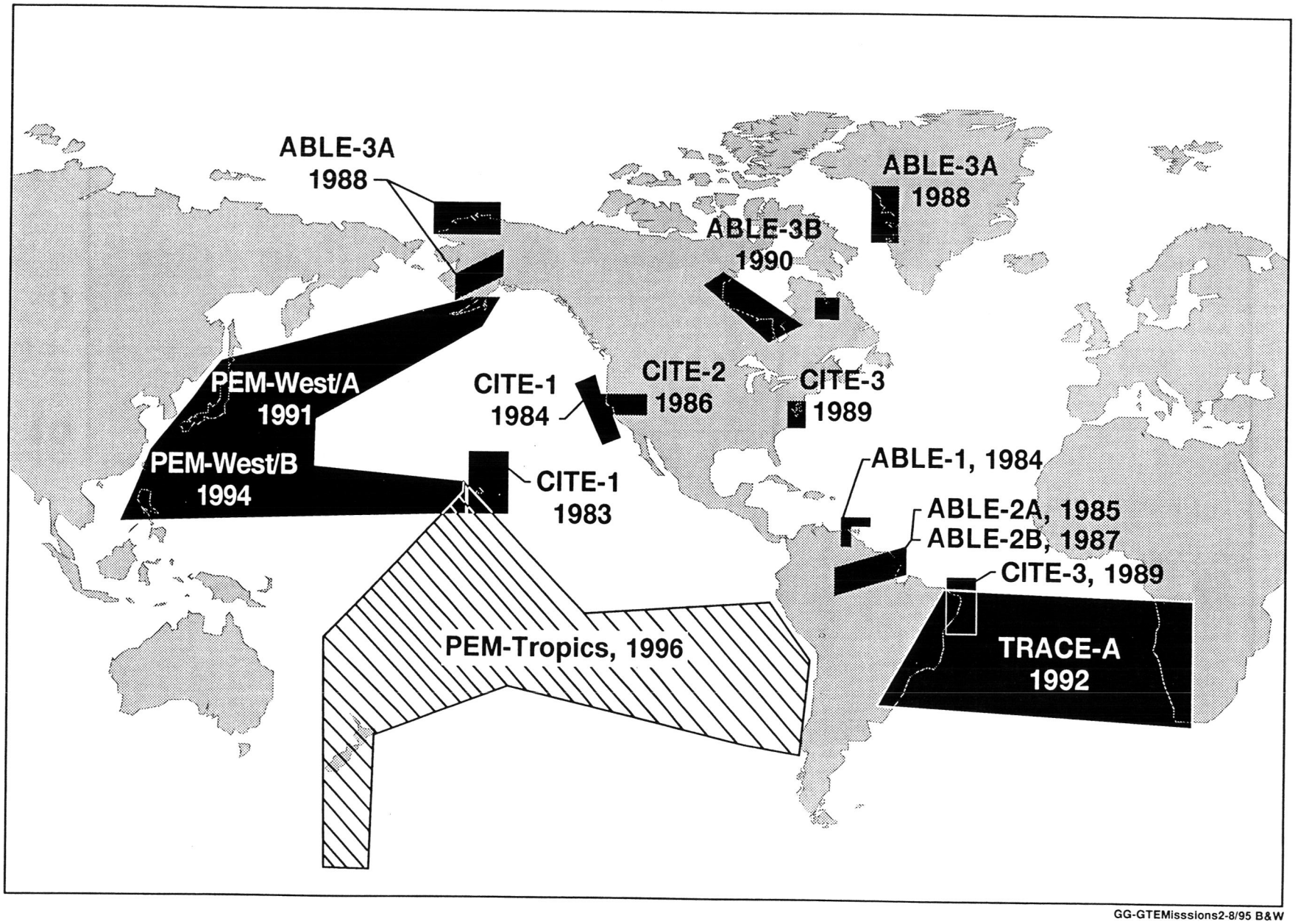


Figure 1. GTE mission sites

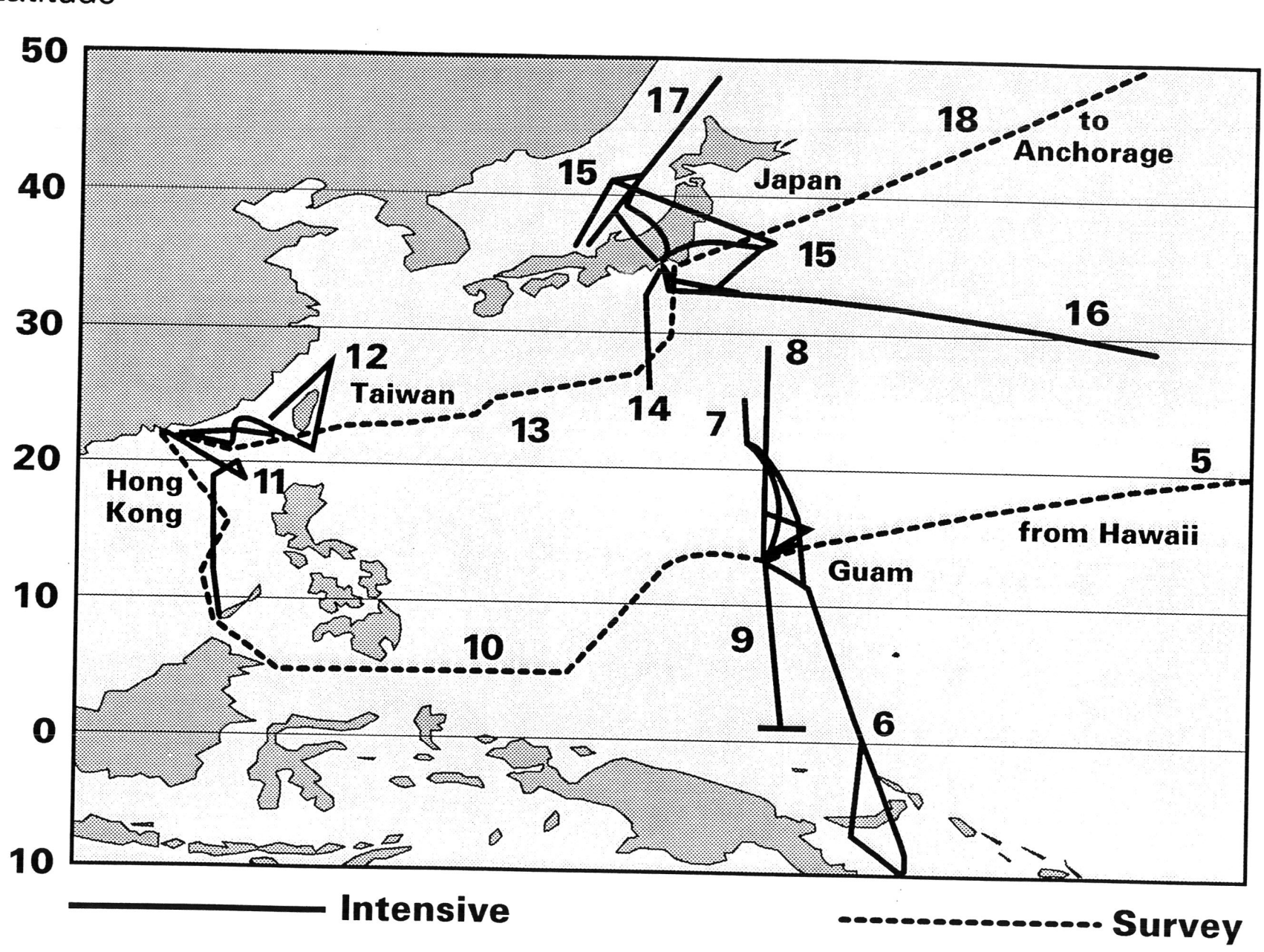


Figure 2. Flight tracks for the DC-8 aircraft during the PEM West-B mission

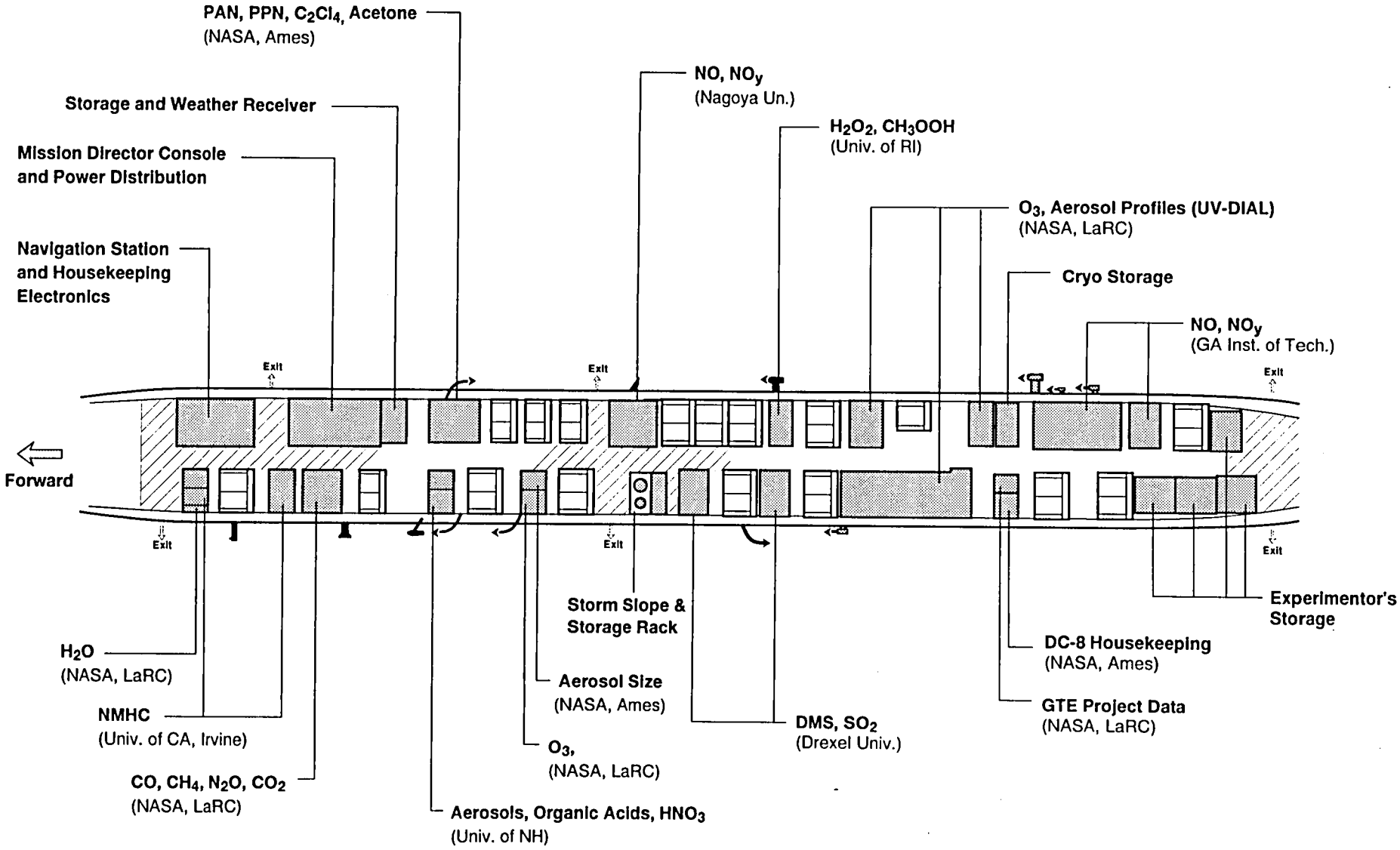


Figure 3. Instrument location on the NASA DC-8 aircraft during PEM-West B.

APPENDIX A: PEM WEST-B DATA PLOTS

Plots are presented in a standardized format, and the data (unedited) are from the Langley DAAC archive. Relative humidity and potential temperature are calculated from measurements made on the aircraft. In some cases (mostly for moist, boundary layer conditions) relative humidity may exceed 100% (not plotted) as dew point temperature exceeded air temperature by a few degrees (assumed to be the result of instrument measurement/calibration uncertainty). For time series plots, abscissa time scales for a given flight are identical. Ordinate scales (for a given parameter) may differ among flights and were selected to best represent all the data for the specie measured during the flight; thus, some data may be off-scale. As a result of the software used for the plots and the data archive use of codes (in place of valid data) for data taken (1) during instrument calibration, (2) when measurements were at "detection limit," and/or (3) when measurements were invalid, it is sometimes difficult to distinguish from the plots if data are off-scale or coded as invalid. For example, a symbol without an attached line may either mean that adjacent data are off-scale or have been coded as invalid. Inspection of the other plotted data often provides information which resolves the uncertainty. For profile plots, altitude scales are identical for all plots and the specie scales are those selected for the time series plots. In order to maintain the standardized format, plots for flights in which a specie data were not reported are plotted with the axes and a "NO DATA" entry.

Given below are the beginning page numbers for each flight's sequence of plots:

PEM (B) PACIFIC MISSION: FLIGHT 4

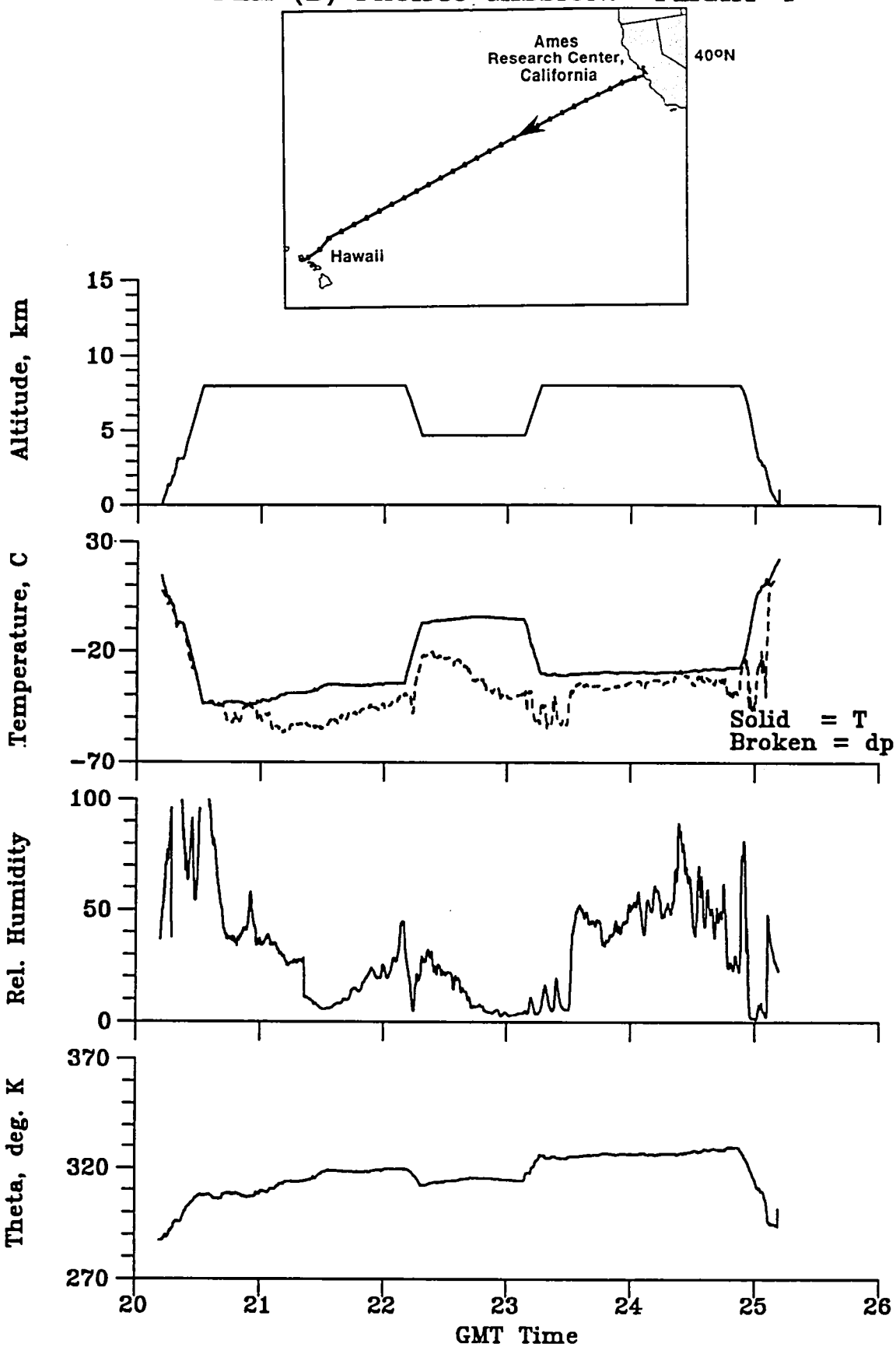


Figure A4.1

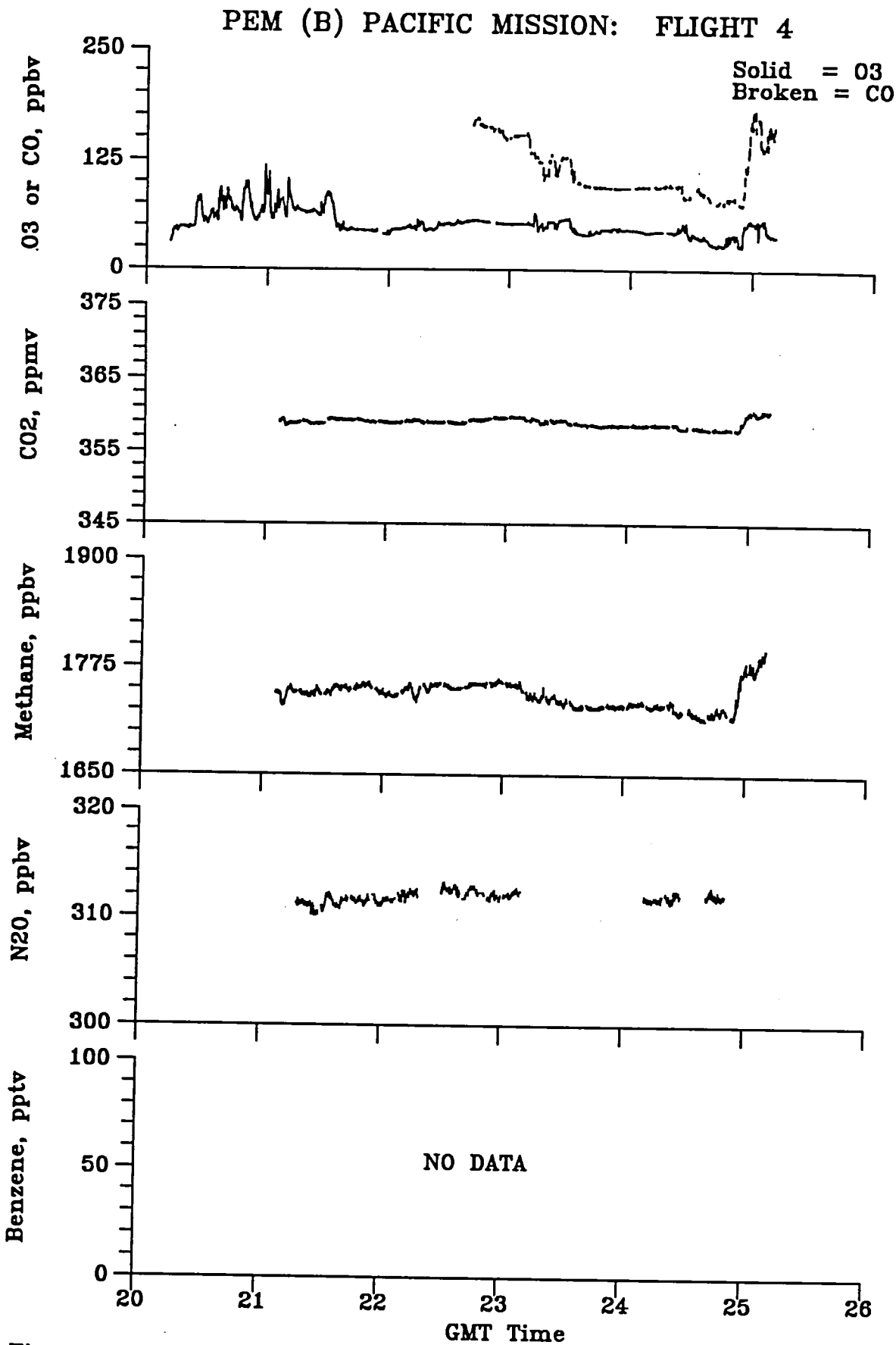

PEM (B) PACIFIC MISSION: FLIGHT 4
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
NO DATA
20
21
22
23
24
25
26
GMT Time

Figure A4.2

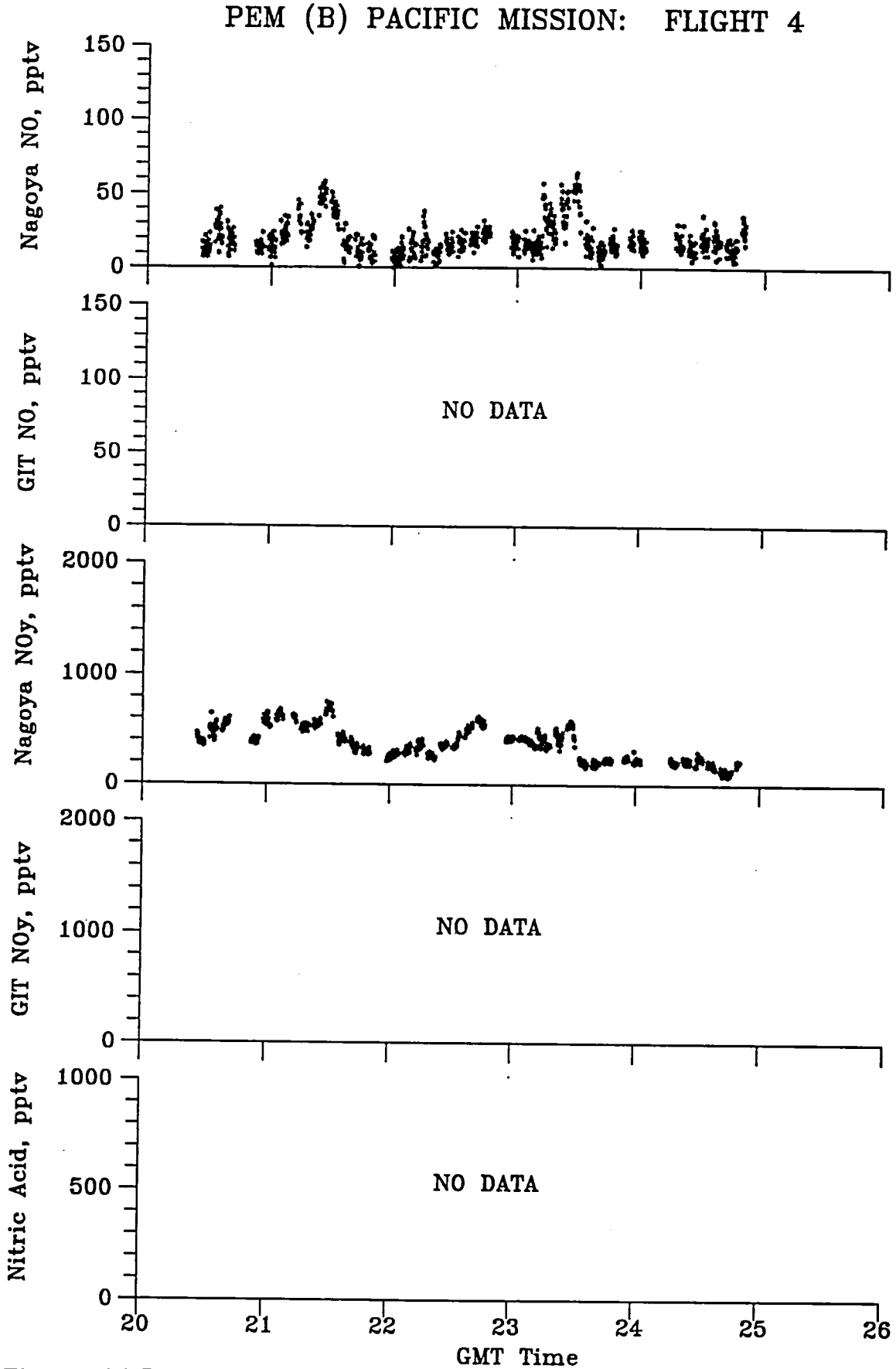

PEM (B) PACIFIC MISSION: FLIGHT 4
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
NO DATA
Nagoya NOy, pptv
2000
1000
GIT NOy, pptv
Nitric Acid, pptv
500
20
21
22
23
24
25
26
GMT Time

Figure A4.3

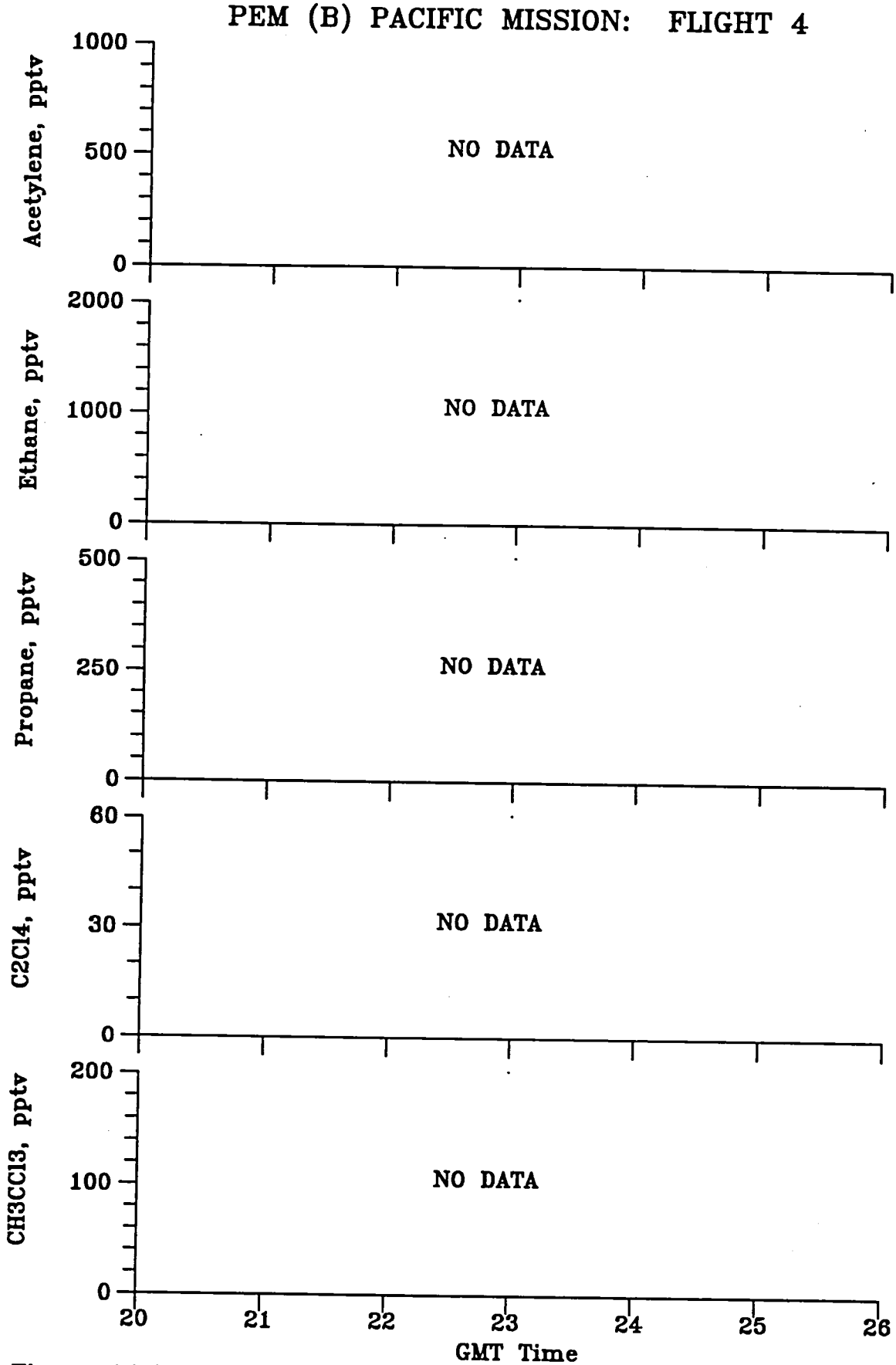

PEM (B) PACIFIC MISSION: FLIGHT 4
Acetylene, pptv
1000
500
0
NO DATA
Ethane, pptv
2000
1000
0
NO DATA
Propane, pptv
500
250
0
NO DATA
C2Cl4, pptv
60
30
0
NO DATA
CH3CCl3, pptv
200
100
0
NO DATA
20
21
22
23
24
25
26
GMT Time

Figure A4.4

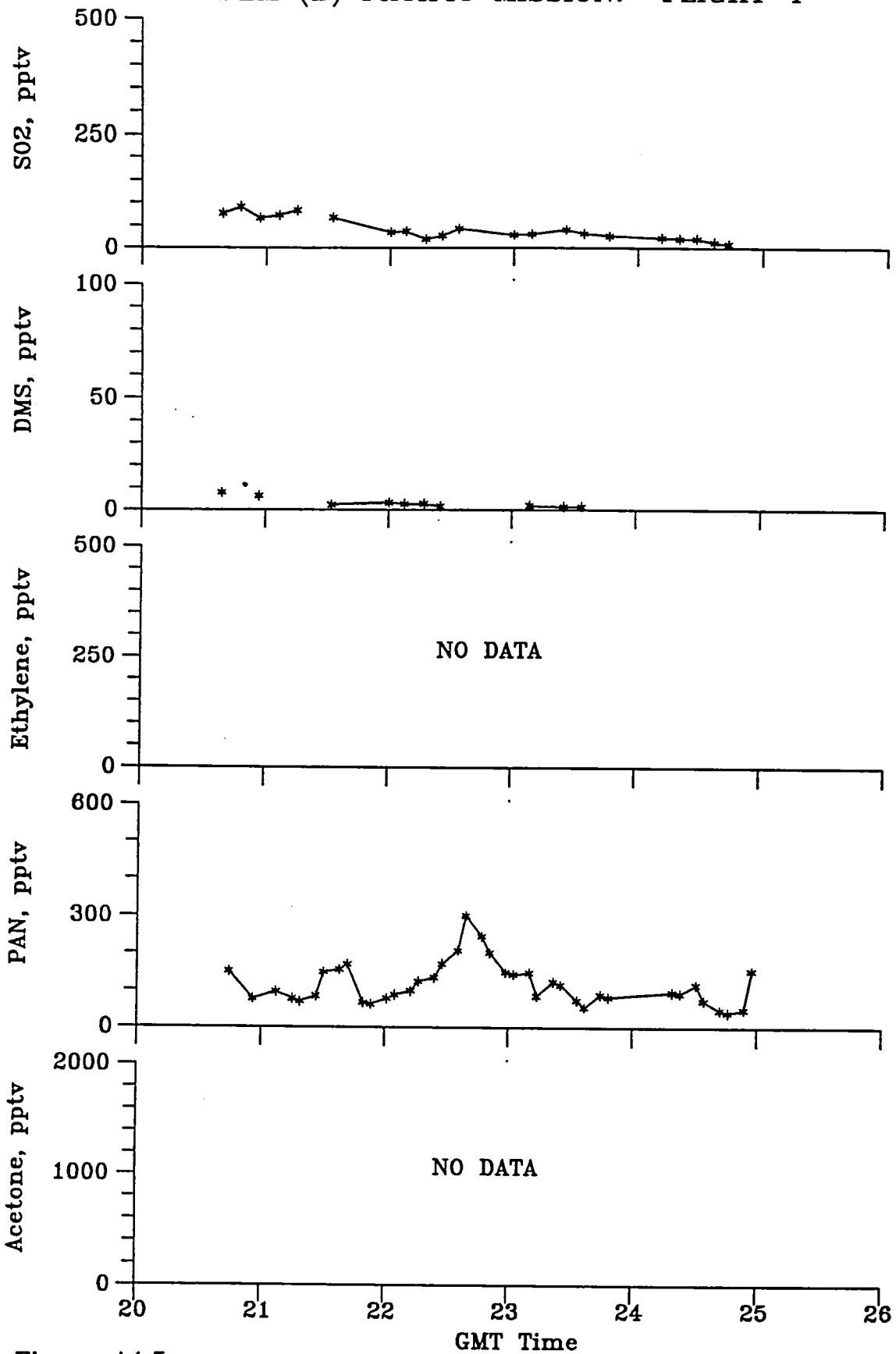

PEM (B) PACIFIC MISSION: FLIGHT 4
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
NO DATA
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
NO DATA
20
21
22
23
24
25
26
GMT Time

Figure A4.5

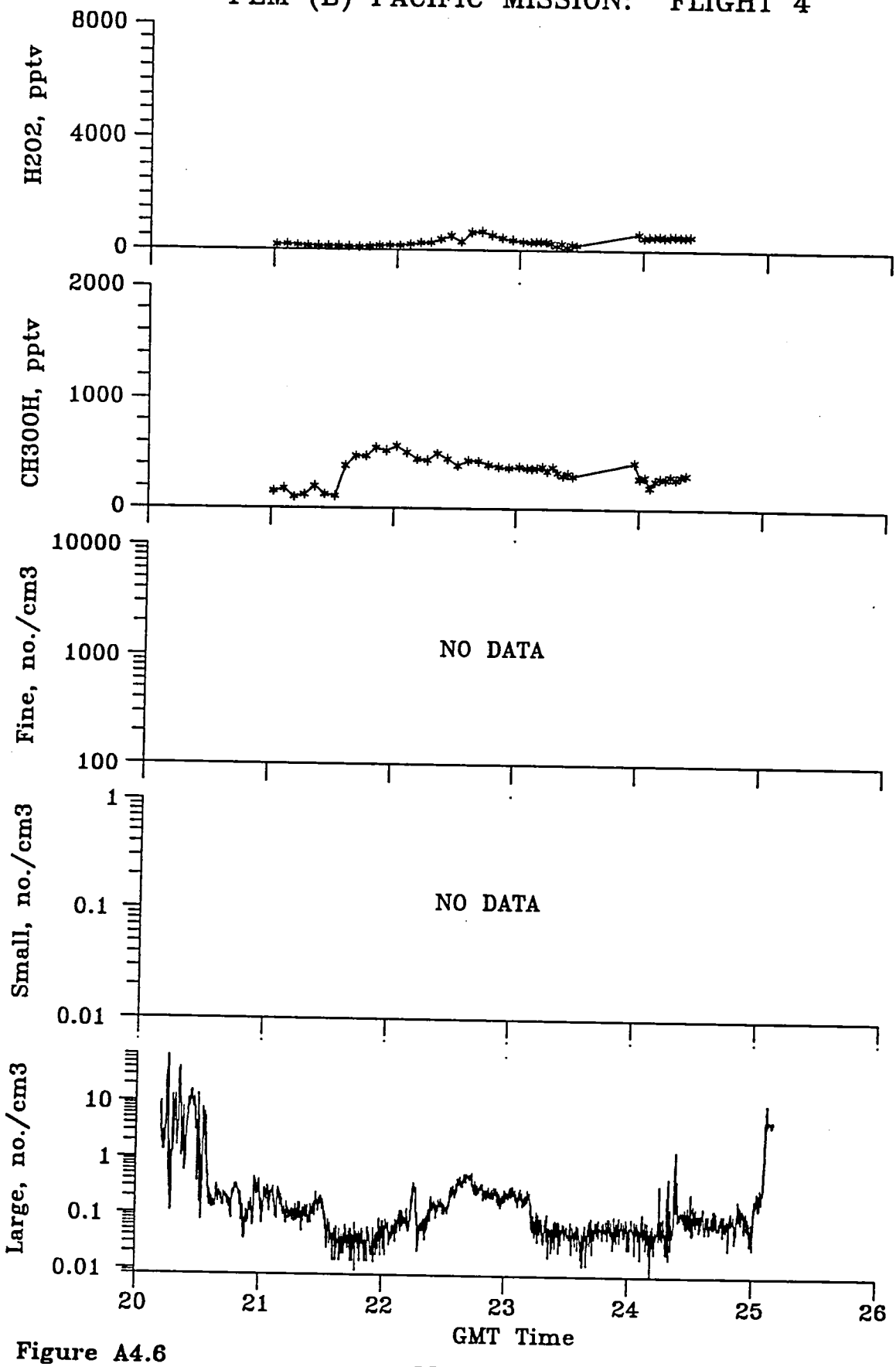
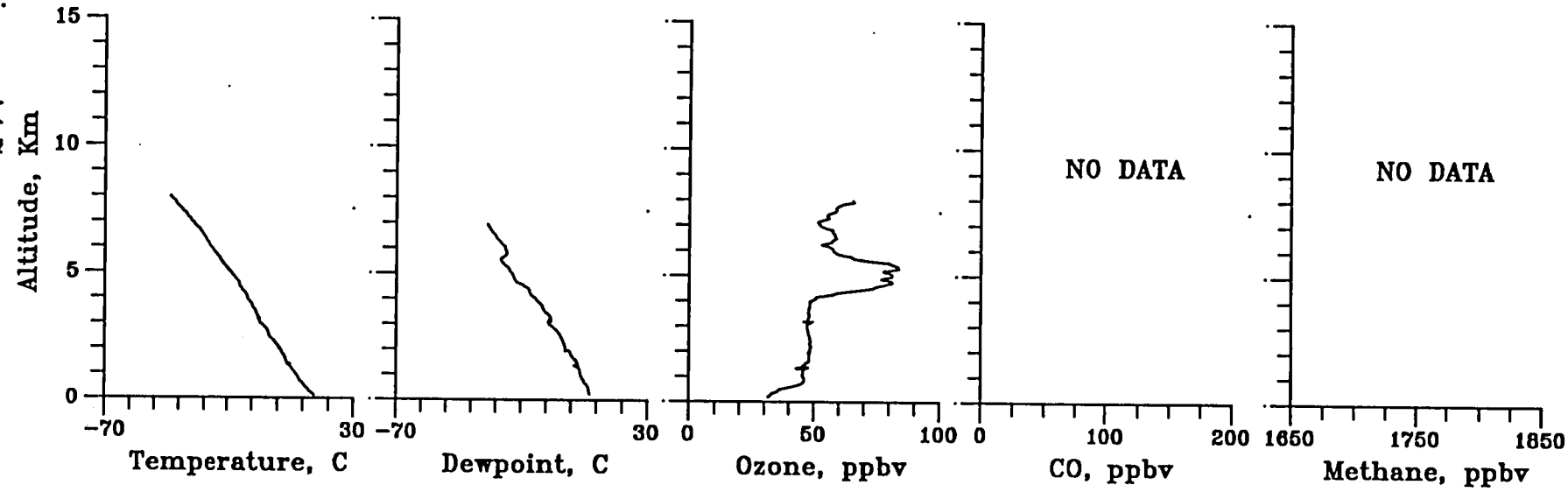

PEM (B) PACIFIC MISSION: FLIGHT 4
H2O2, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
10000
1000
100
NO DATA
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
10
1
0.1
0.01
20
21
22
23
24
25
26
GMT Time

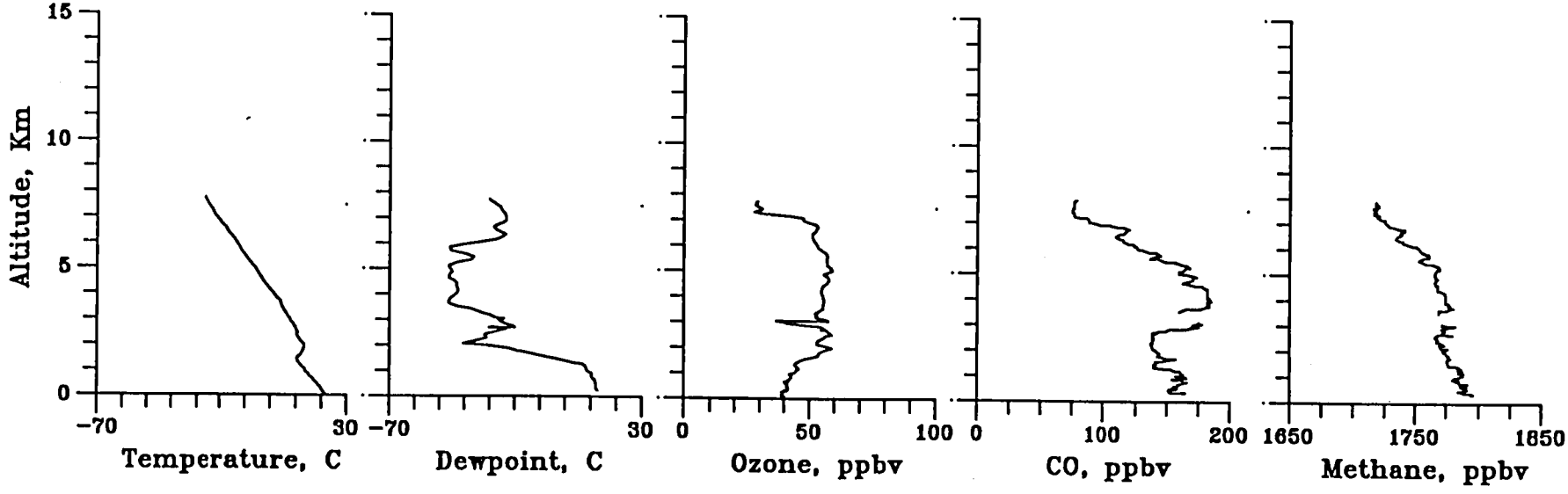
Figure A4.6

Figure A4.7

PEM (B) PACIFIC MISSION: FLIGHT 4 PROFILE AT 2030 GMT



PEM (B) PACIFIC MISSION: FLIGHT 4 PROFILE AT 0100 GMT



PEM (B) PACIFIC MISSION: FLIGHT 5

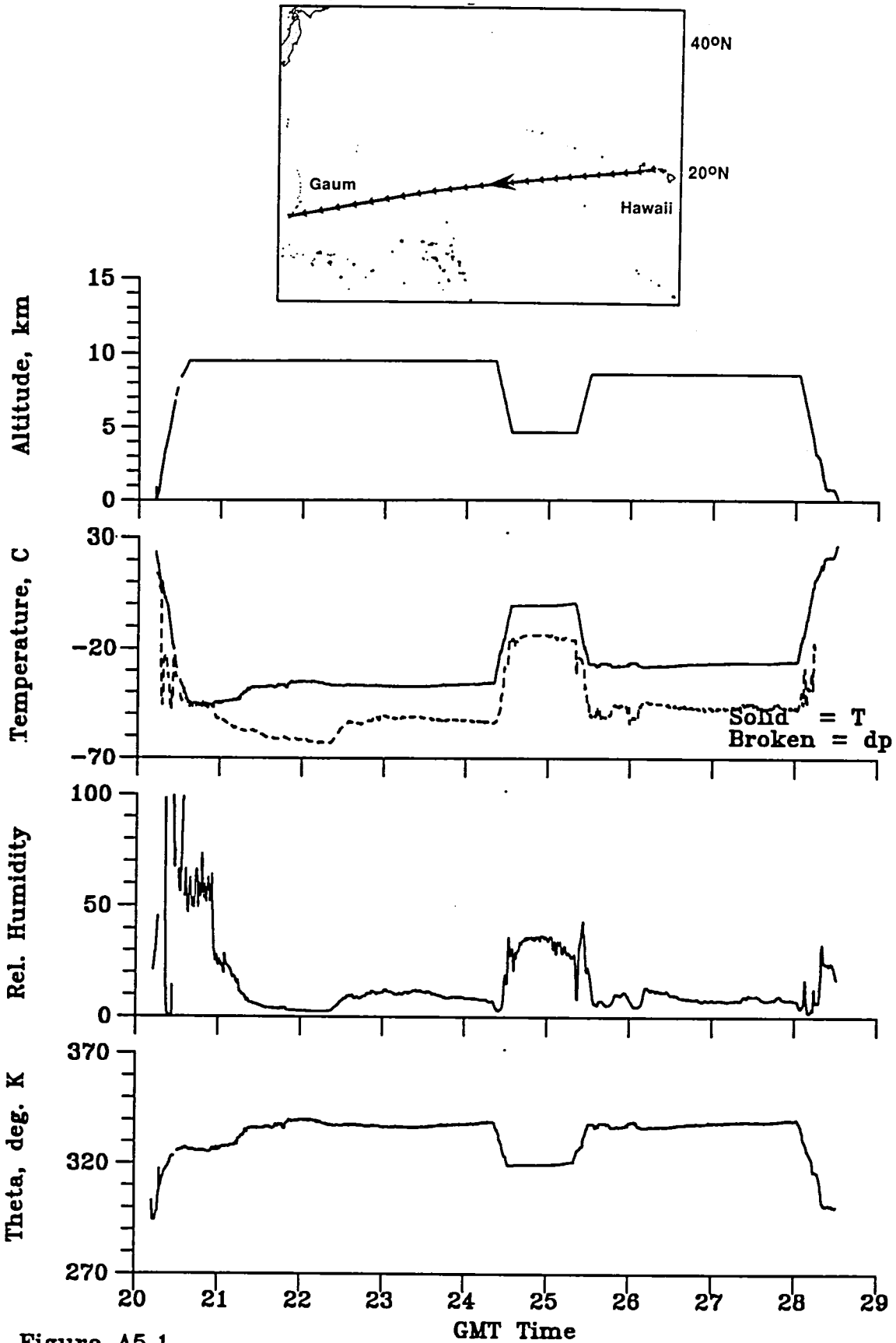


Figure A5.1

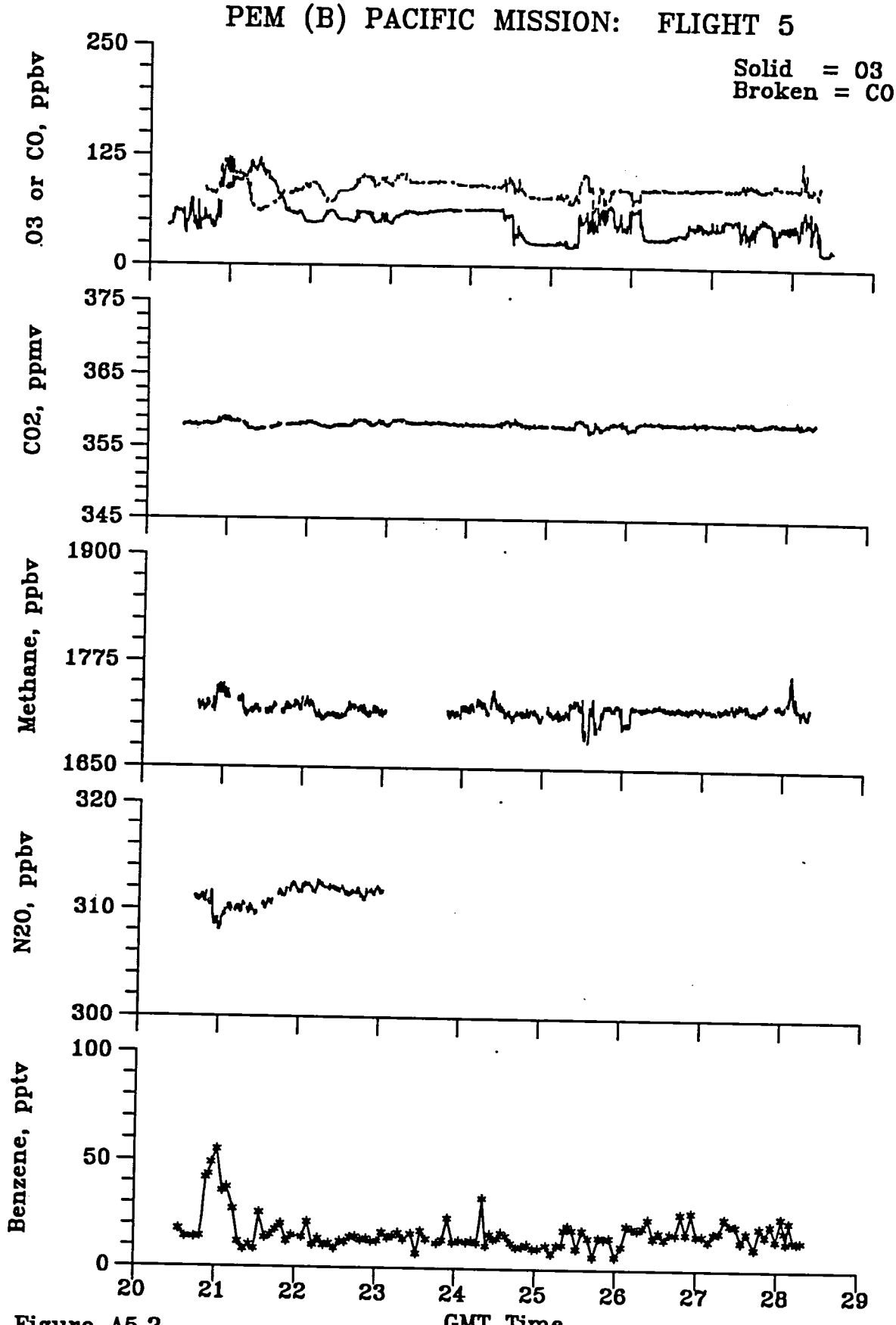

PEM (B) PACIFIC MISSION: FLIGHT 5
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
20
21
22
23
24
25
26
27
28
29
GMT Time

Figure A5.2

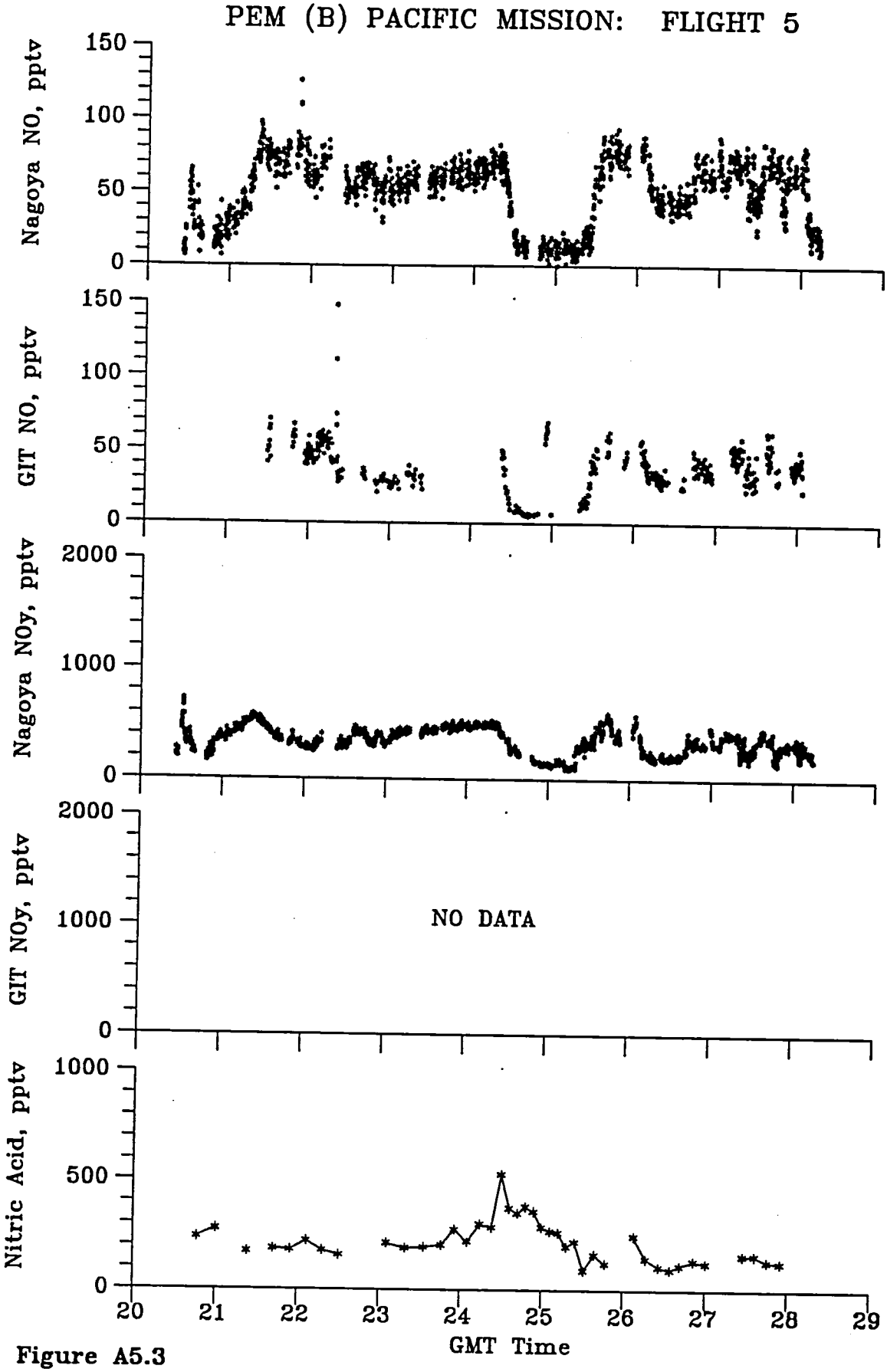

PEM (B) PACIFIC MISSION: FLIGHT 5
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
150
100
50
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
NO DATA
Nitric Acid, pptv
1000
500
0
20
21
22
23
24
25
26
27
28
29
GMT Time

Figure A5.3

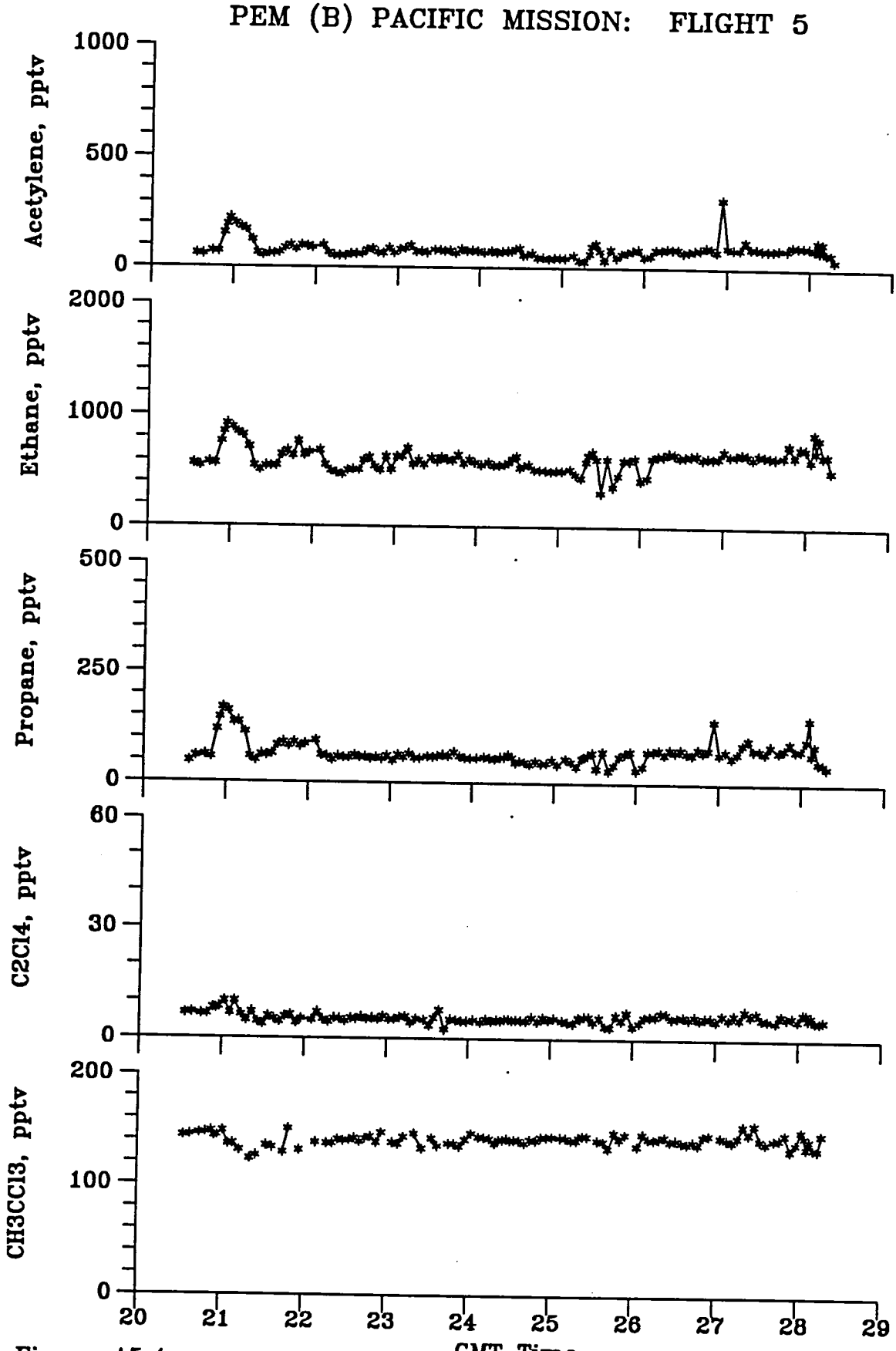

PEM (B) PACIFIC MISSION: FLIGHT 5
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
20
21
22
23
24
25
26
27
28
29
GMT Time

Figure A5.4

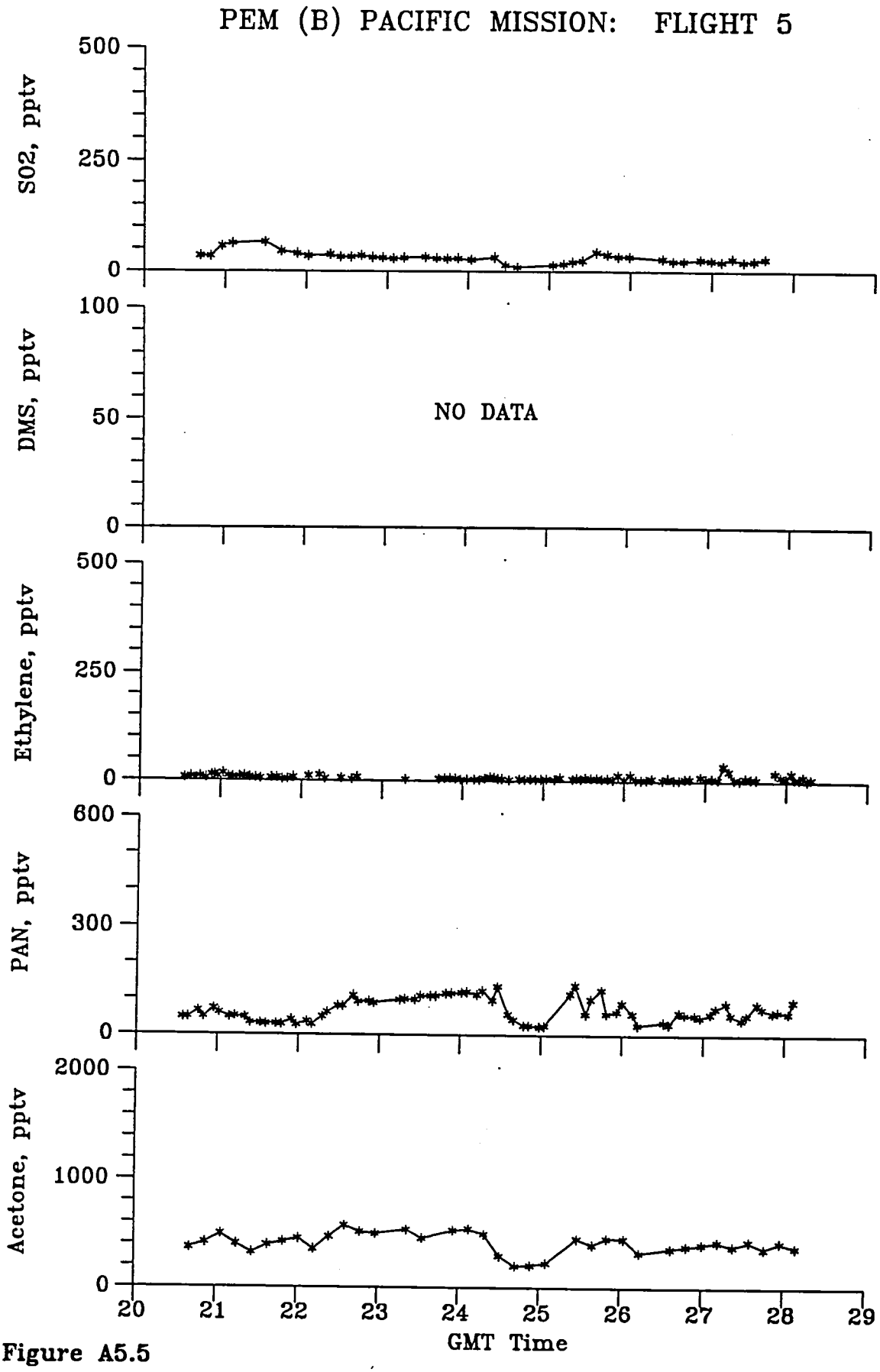

PEM (B) PACIFIC MISSION: FLIGHT 5
SO2, pptv
500
250
0
DMS, pptv
100
50
0
NO DATA
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
20
21
22
23
24
25
26
27
28
29
GMT Time

Figure A5.5

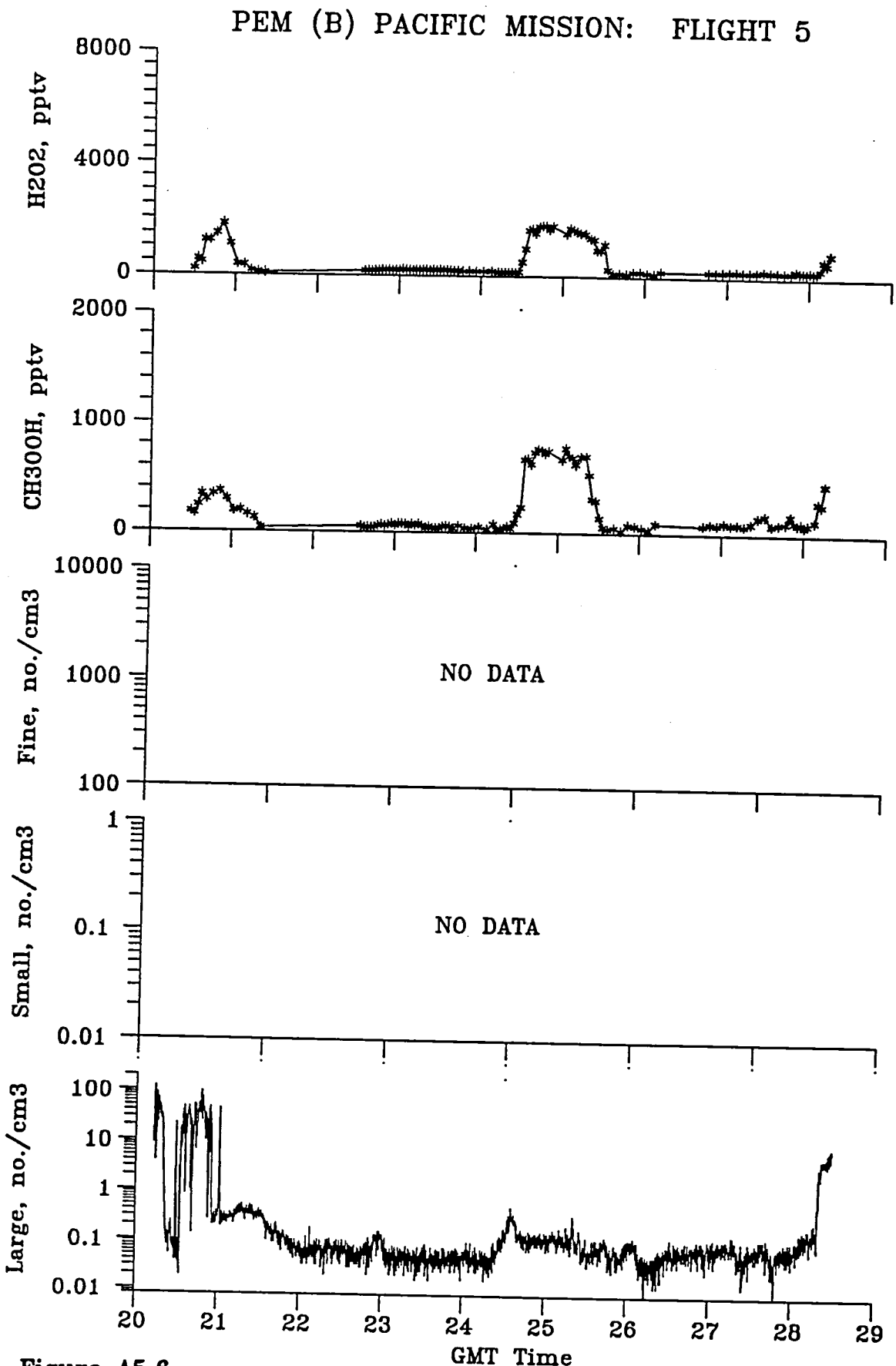
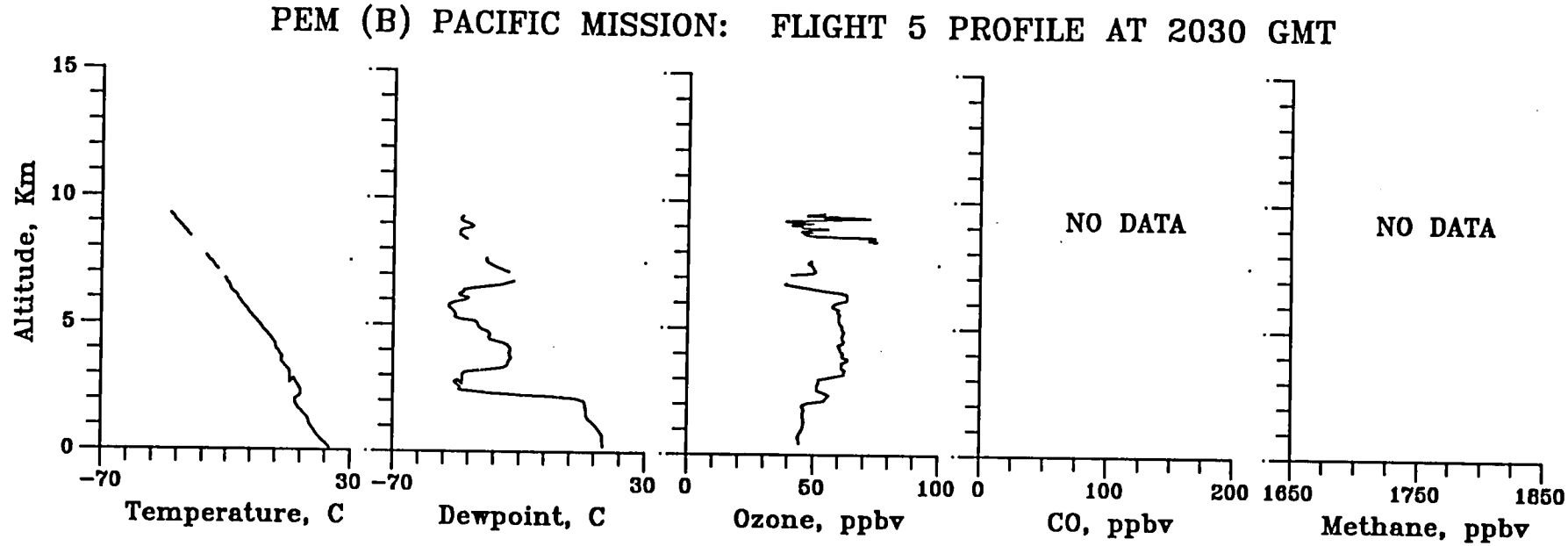
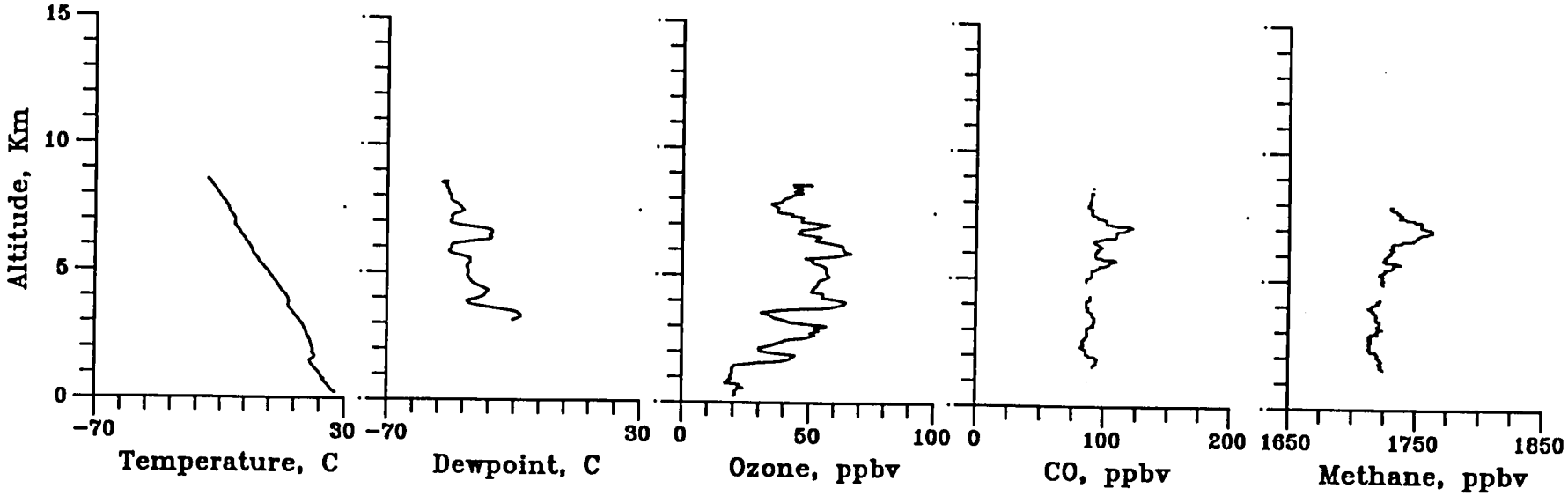

PEM (B) PACIFIC MISSION: FLIGHT 5
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
10000
1000
100
NO DATA
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
100
10
1
0.1
0.01
20
21
22
23
24
25
26
27
28
29
GMT Time

Figure A5.6

Figure A5.7


PEM (B) PACIFIC MISSION: FLIGHT 5 PROFILE AT 2030 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
NO DATA
0
100
200
CO, ppbv
NO DATA
1650
1750
1850
Methane, ppbv


PEM (B) PACIFIC MISSION: FLIGHT 5 PROFILE AT 0415 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
0
100
200
CO, ppbv
1650
1750
1850
Methane, ppbv

PEM (B) PACIFIC MISSION: FLIGHT 6

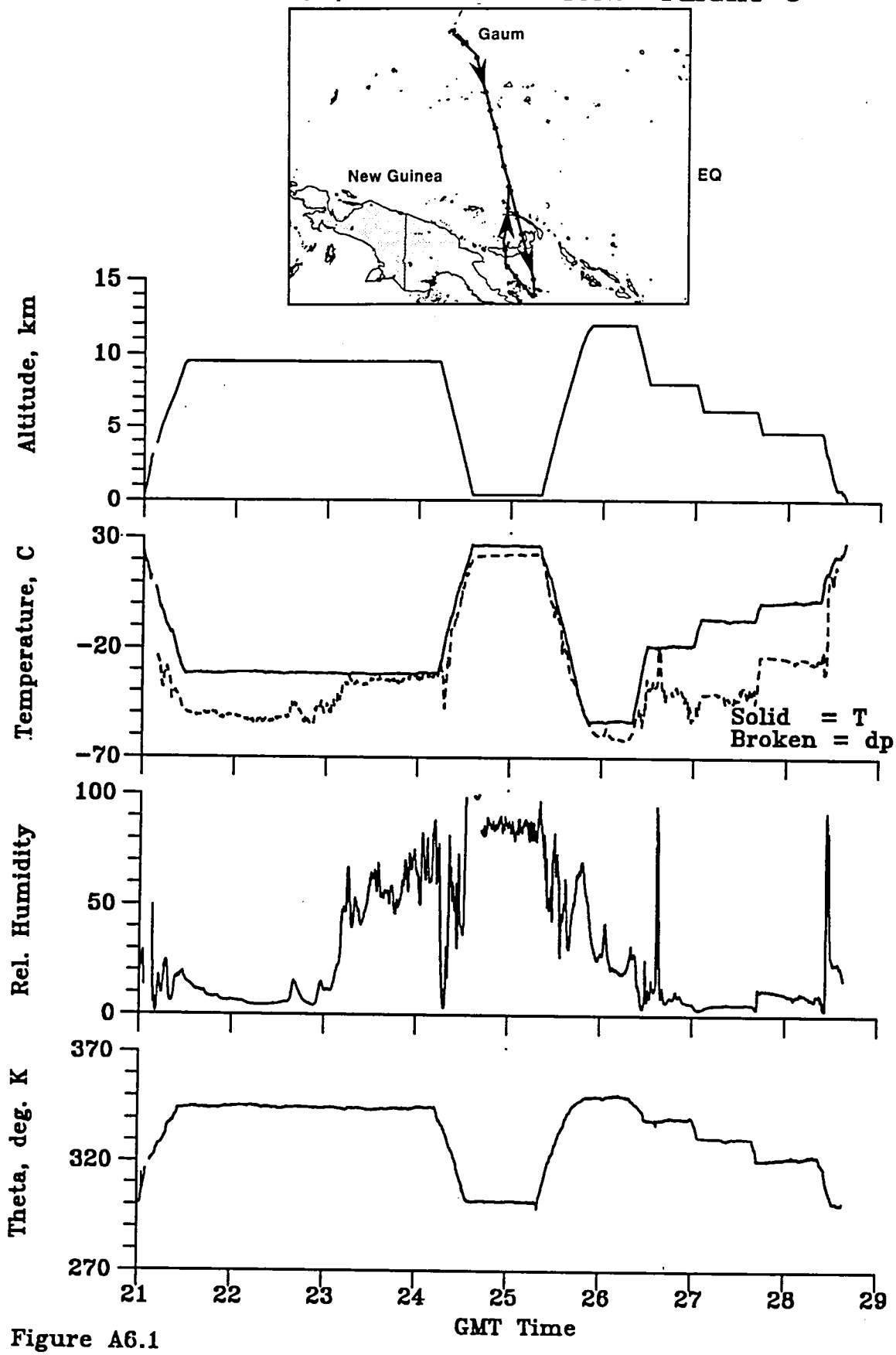


Figure A6.1

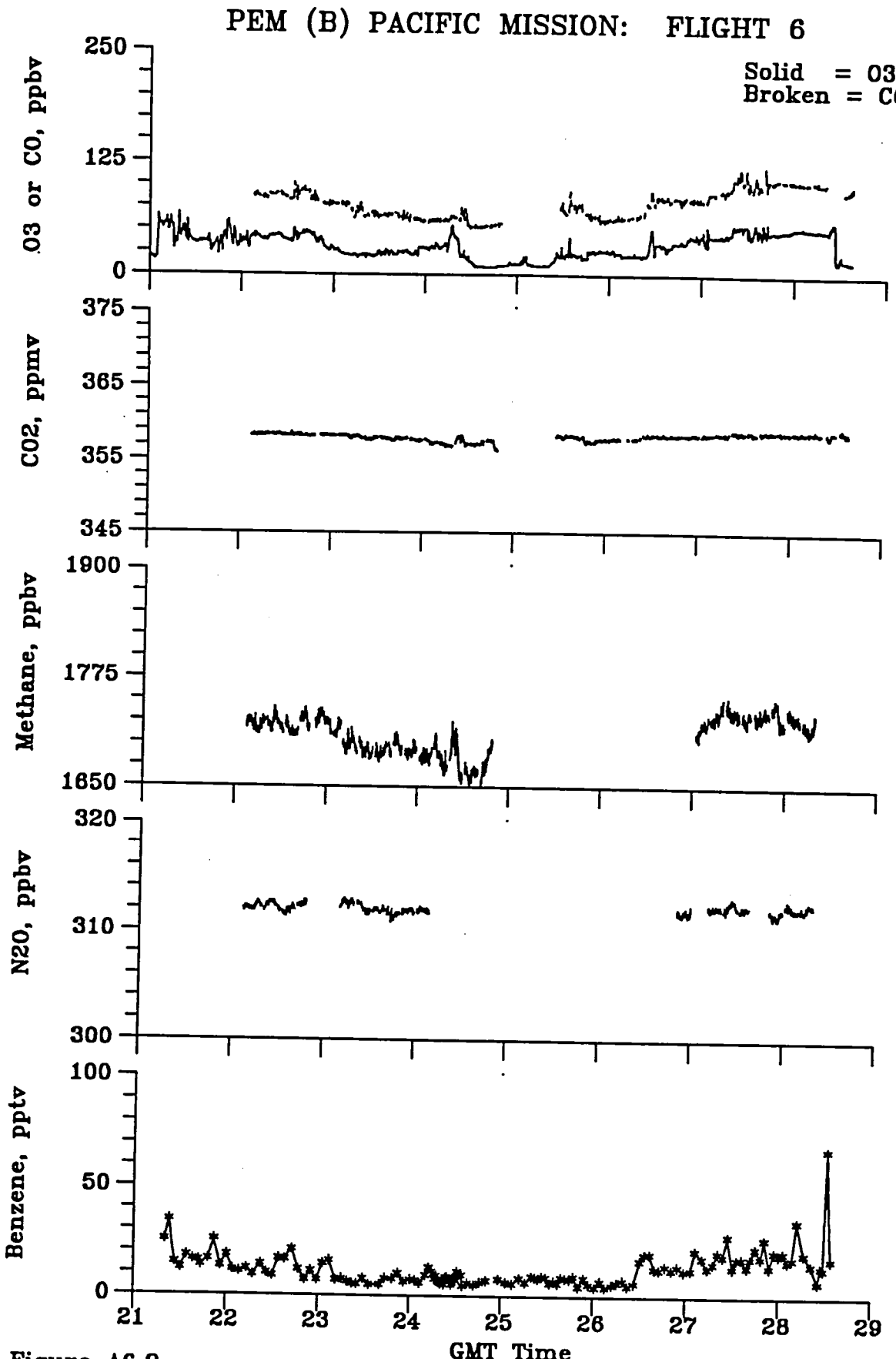

PEM (B) PACIFIC MISSION: FLIGHT 6
Solid = O3
Broken = CO
O3 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
21
22
23
24
25
26
27
28
29
GMT Time

Figure A6.2

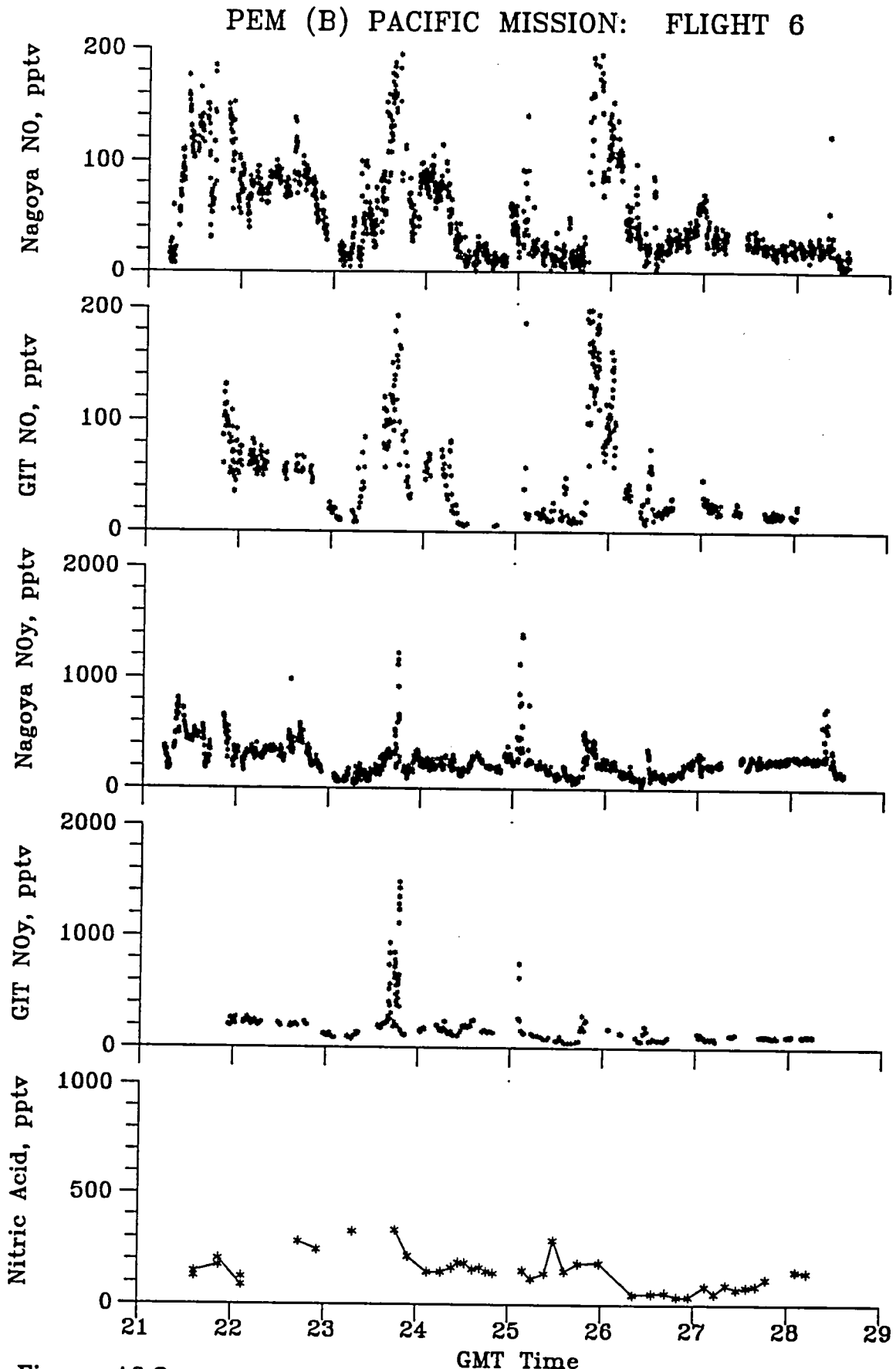

PEM (B) PACIFIC MISSION: FLIGHT 6
Nagoya NO, pptv
200
100
0
GIT NO, pptv
200
100
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
Nitric Acid, pptv
1000
500
0
21
22
23
24
25
26
27
28
29
GMT Time

Figure A6.3

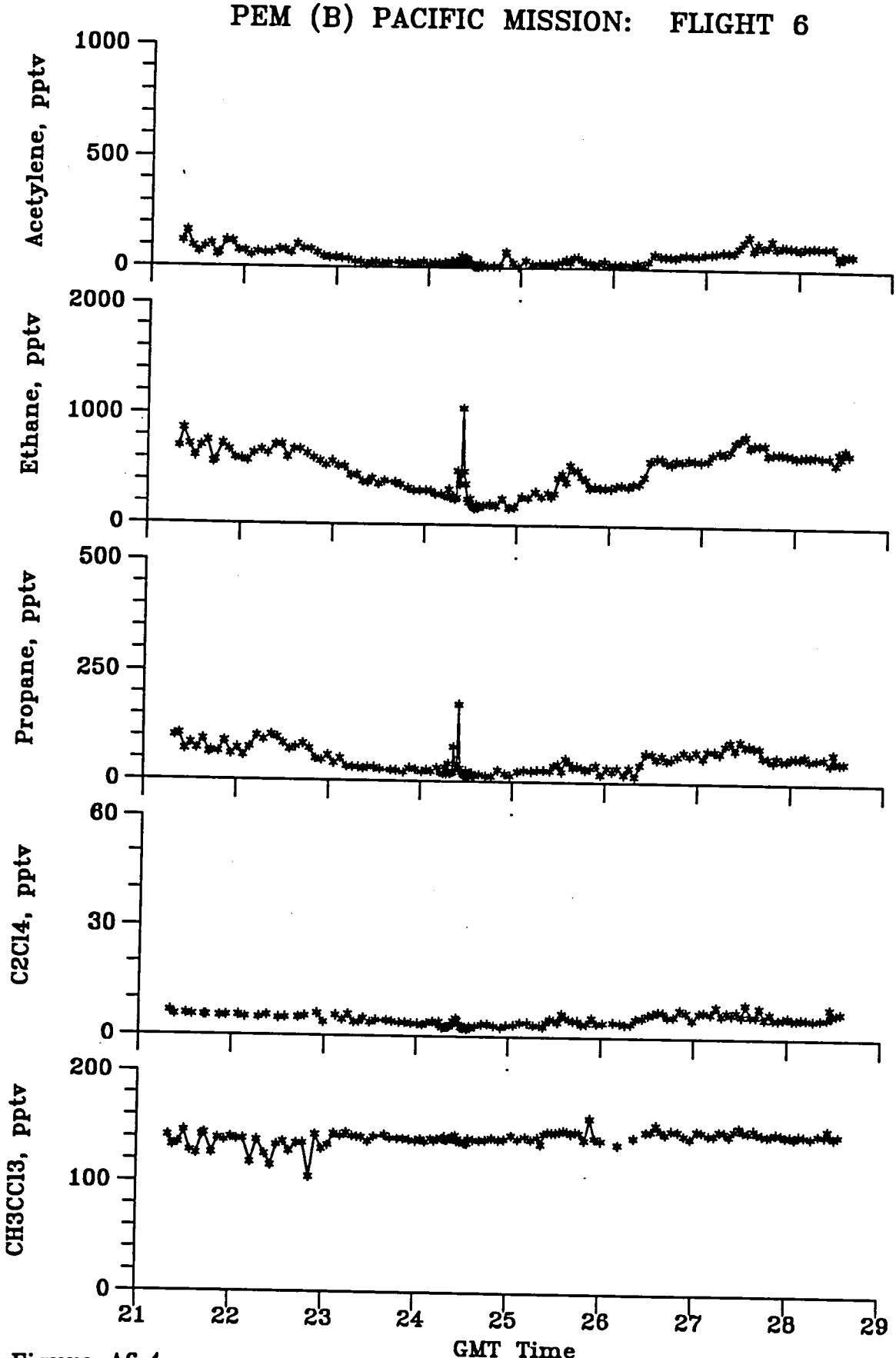

PEM (B) PACIFIC MISSION: FLIGHT 6
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
21
22
23
24
25
26
27
28
29
GMT Time

Figure A6.4

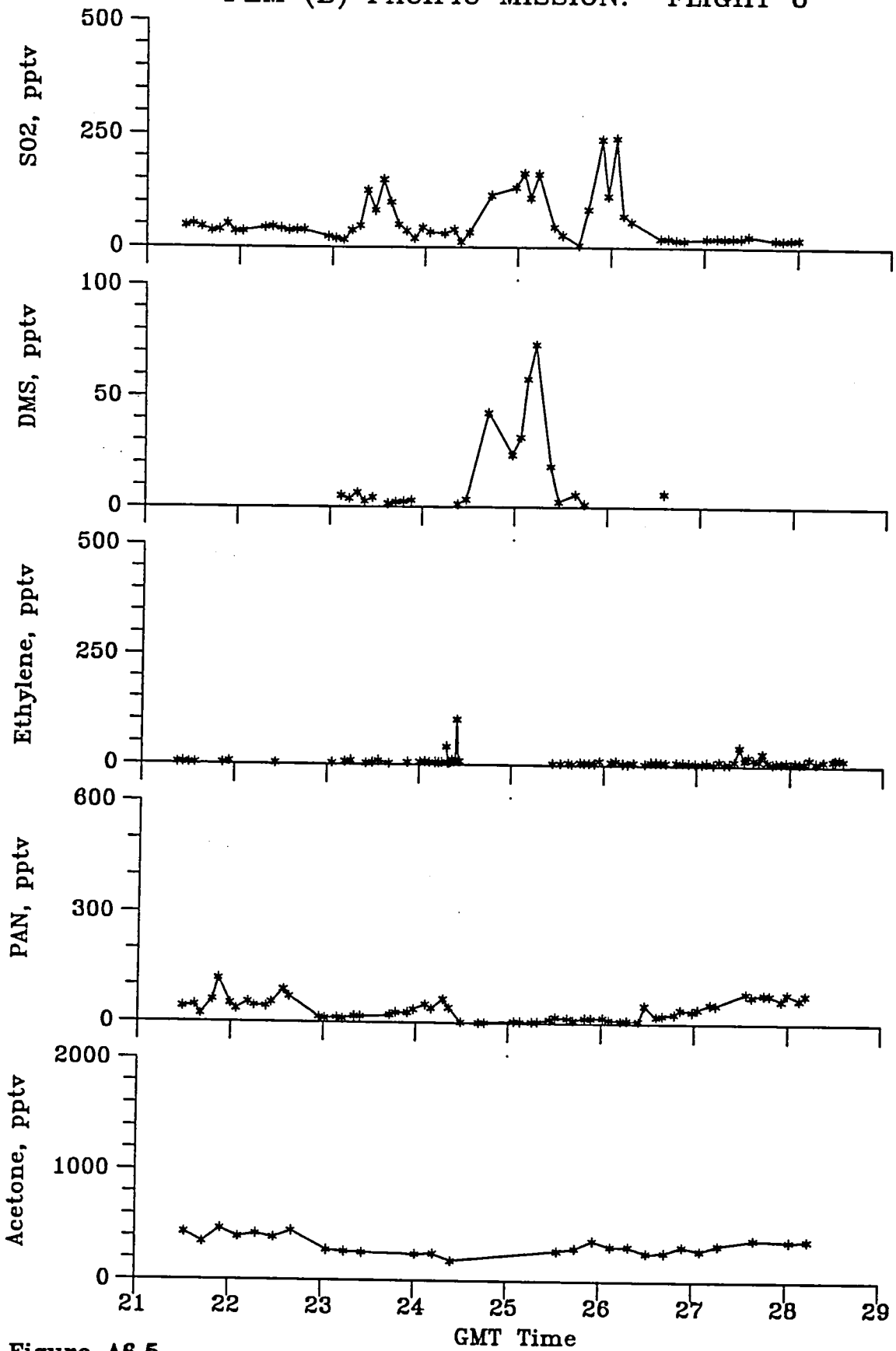

PEM (B) PACIFIC MISSION: FLIGHT 6
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
21
22
23
24
25
26
27
28
29
GMT Time

Figure A6.5

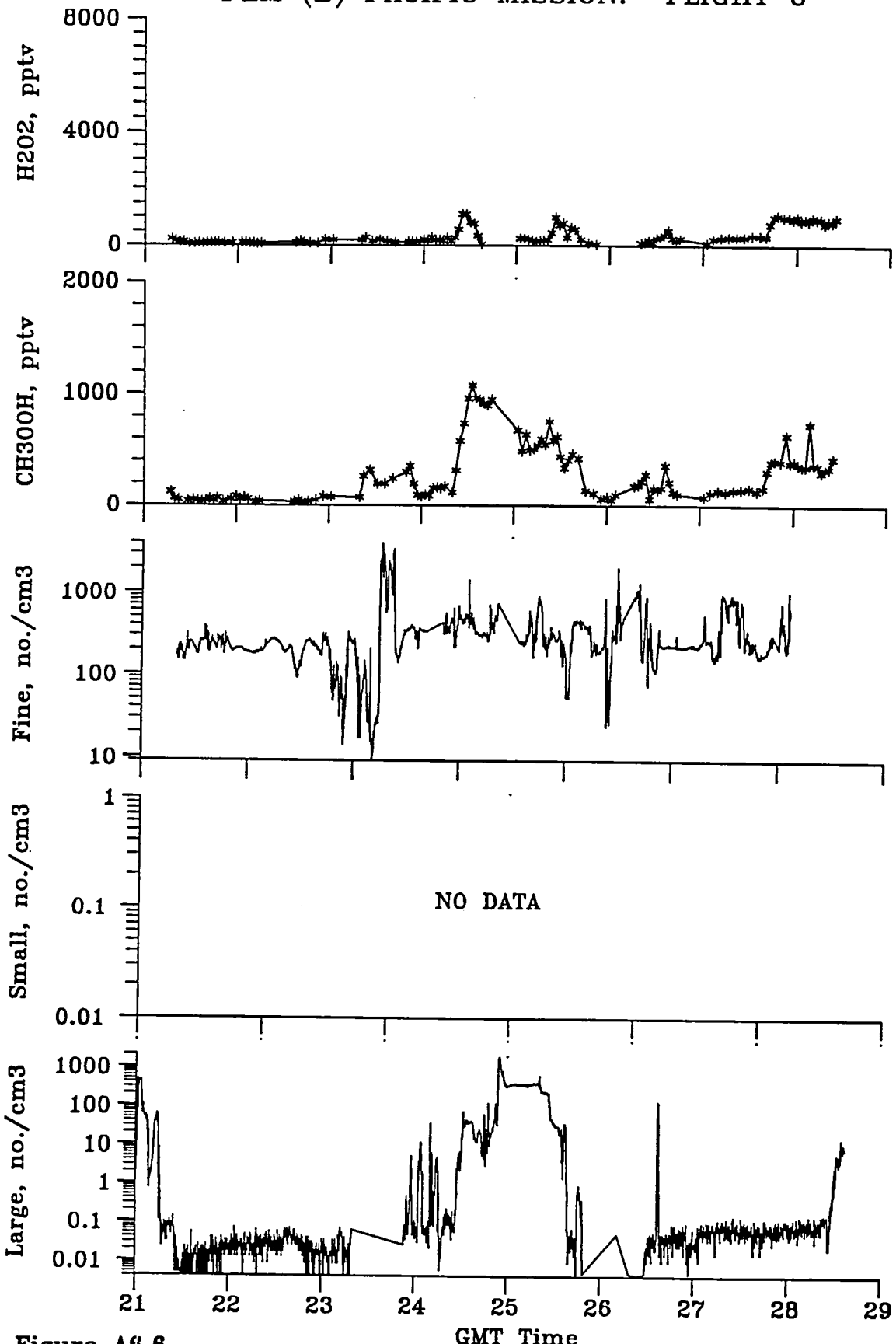
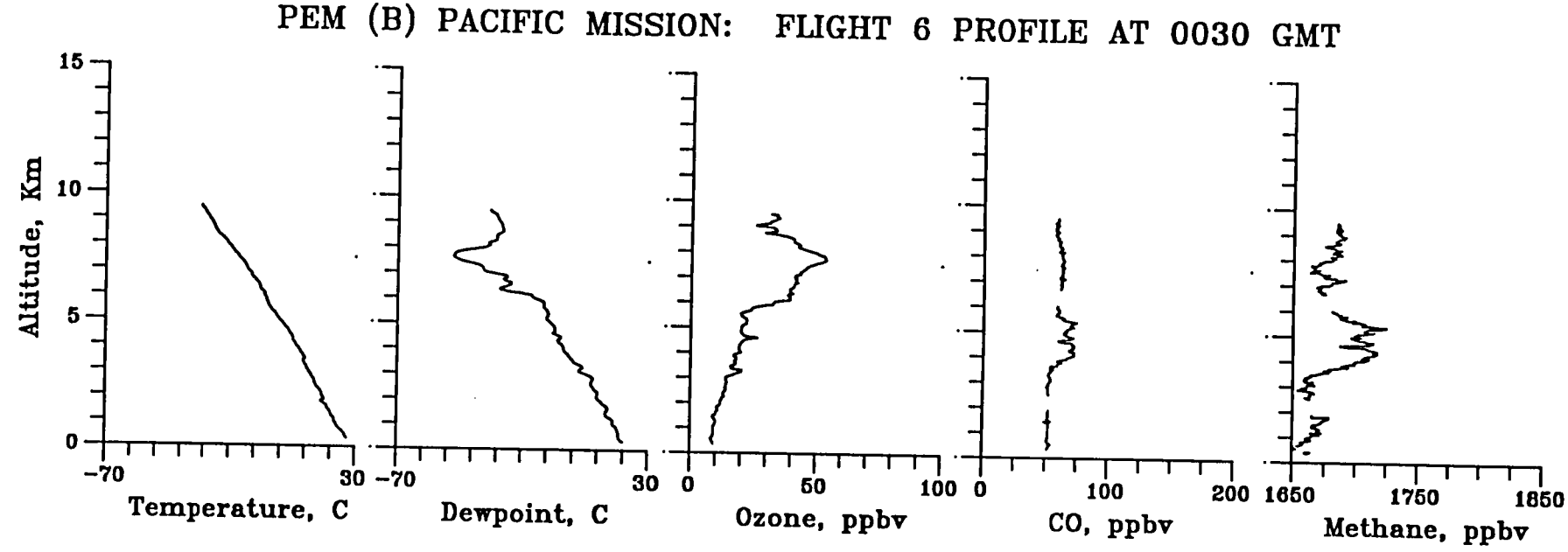
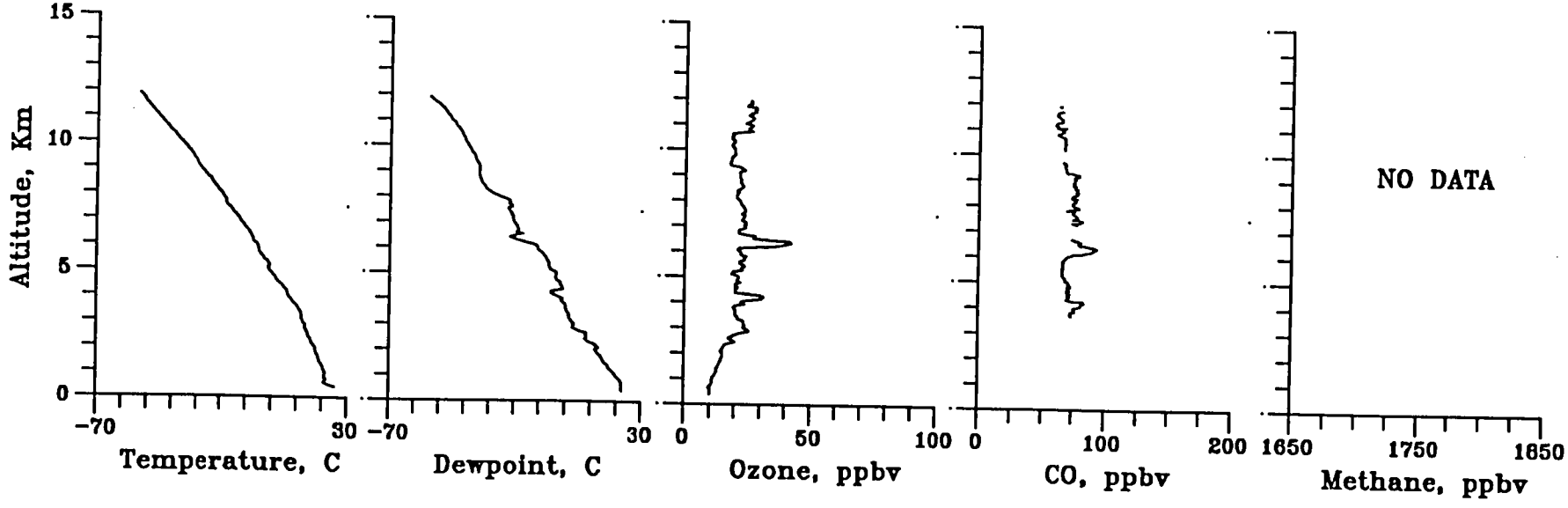

PEM (B) PACIFIC MISSION: FLIGHT 6
H2O2, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
1000
100
10
1
0.1
0.01
21
22
23
24
25
26
27
28
29
GMT Time

Figure A6.6

Figure A6.7


PEM (B) PACIFIC MISSION: FLIGHT 6 PROFILE AT 0030 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
200
CO, ppbv
1650
1750
1850
Methane, ppbv


PEM (B) PACIFIC MISSION: FLIGHT 6 PROFILE AT 0130 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
200
CO, ppbv
NO DATA
1650
1750
1850
Methane, ppbv

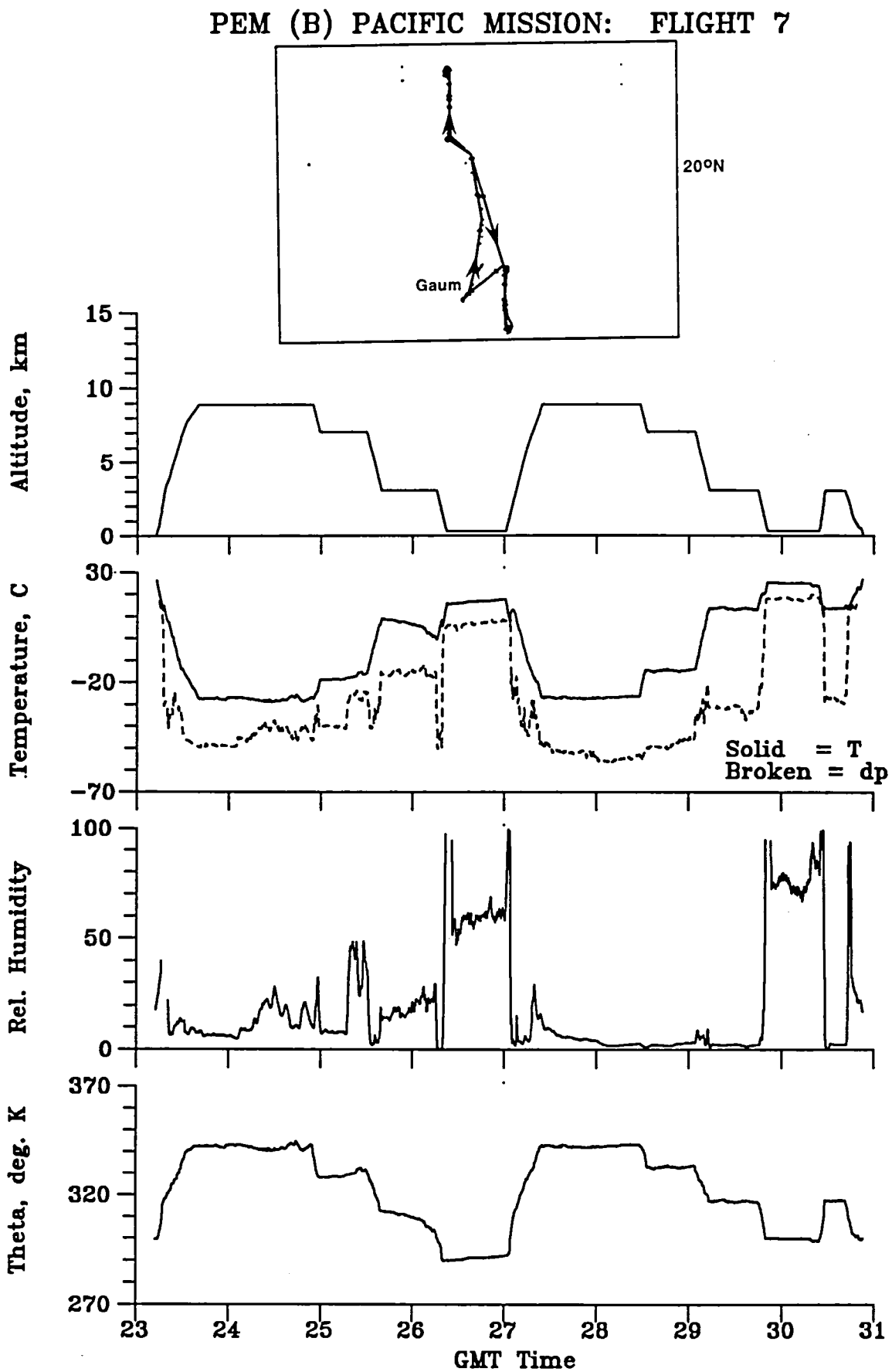

PEM (B) PACIFIC MISSION: FLIGHT 7
20°N
Gaum
Altitude, km
15
10
5
0
Temperature, C
30
-20
-70
Solid = T
Broken = dp
Rel. Humidity
100
50
0
Theta, deg. K
370
320
270
23
24
25
26
27
28
29
30
31
GMT Time

Figure A7.1

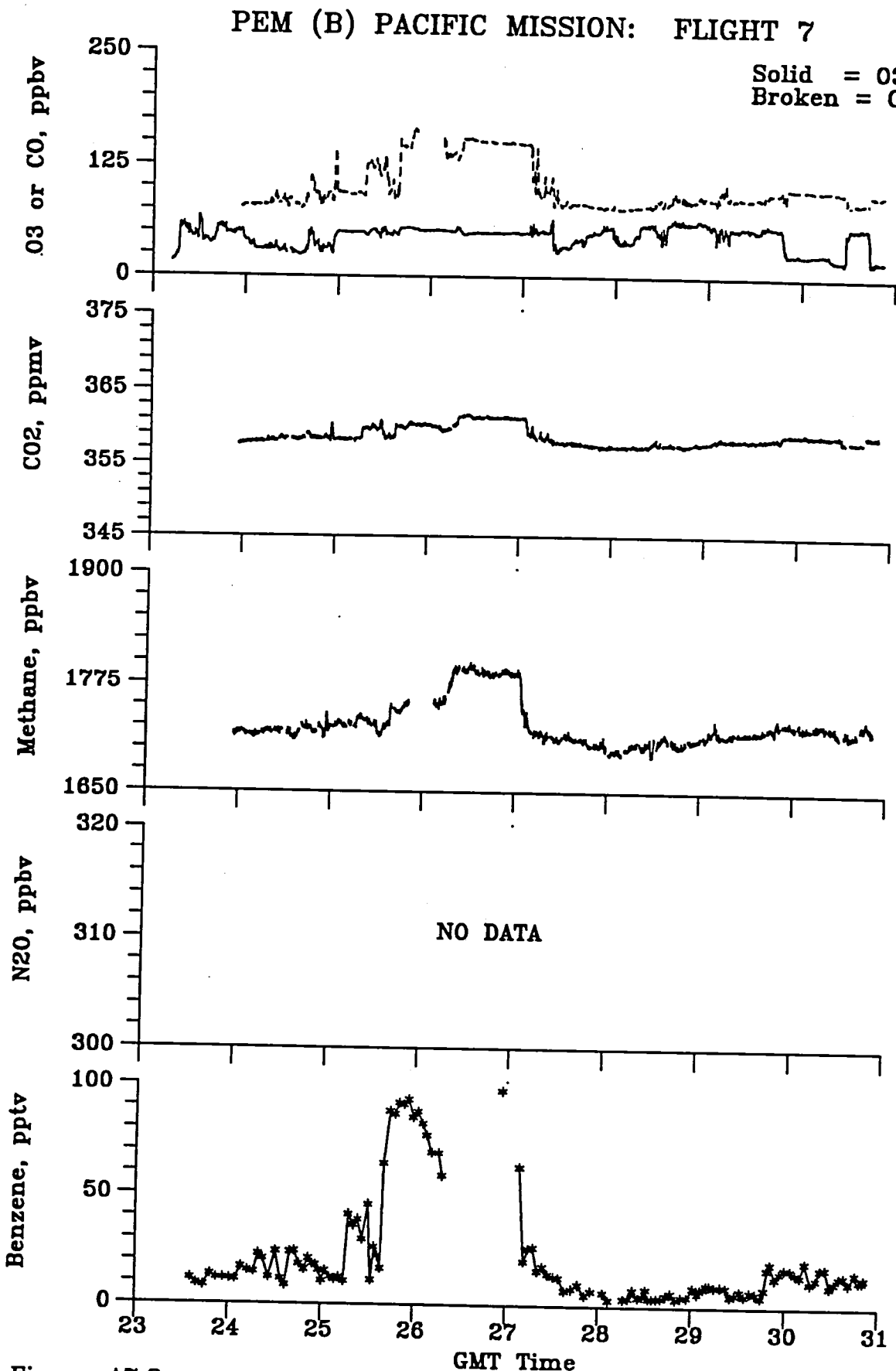

PEM (B) PACIFIC MISSION: FLIGHT 7
Solid = O3
Broken = CO
O3 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
NO DATA
Benzene, pptv
100
50
0
23
24
25
26
27
28
29
30
31
GMT Time

Figure A7.2

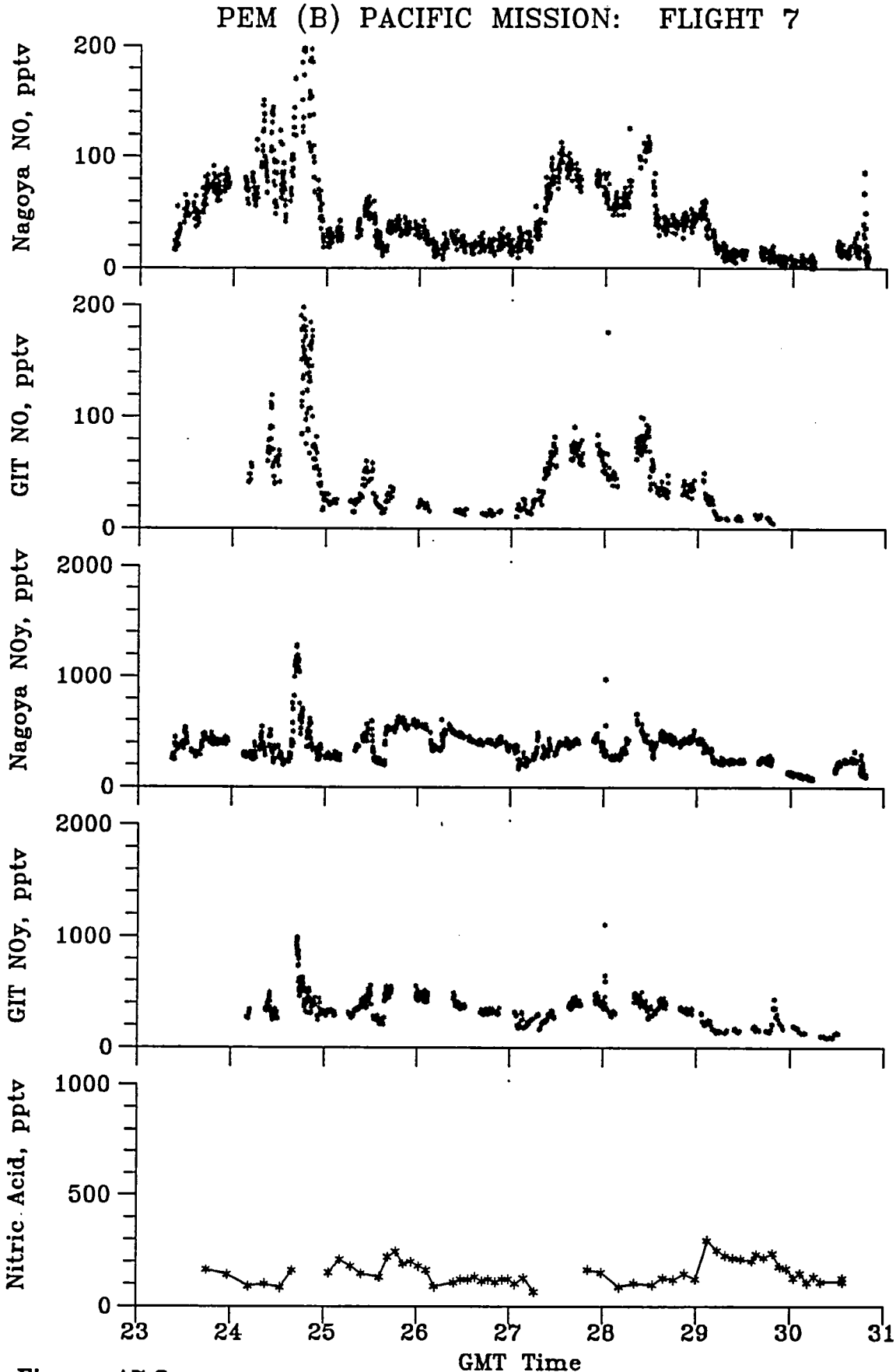

PEM (B) PACIFIC MISSION: FLIGHT 7
Nagoya NO, pptv
200
100
0
GIT NO, pptv
200
100
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
Nitric Acid, pptv
1000
500
0
23
24
25
26
27
28
29
30
31
GMT Time

Figure A7.3

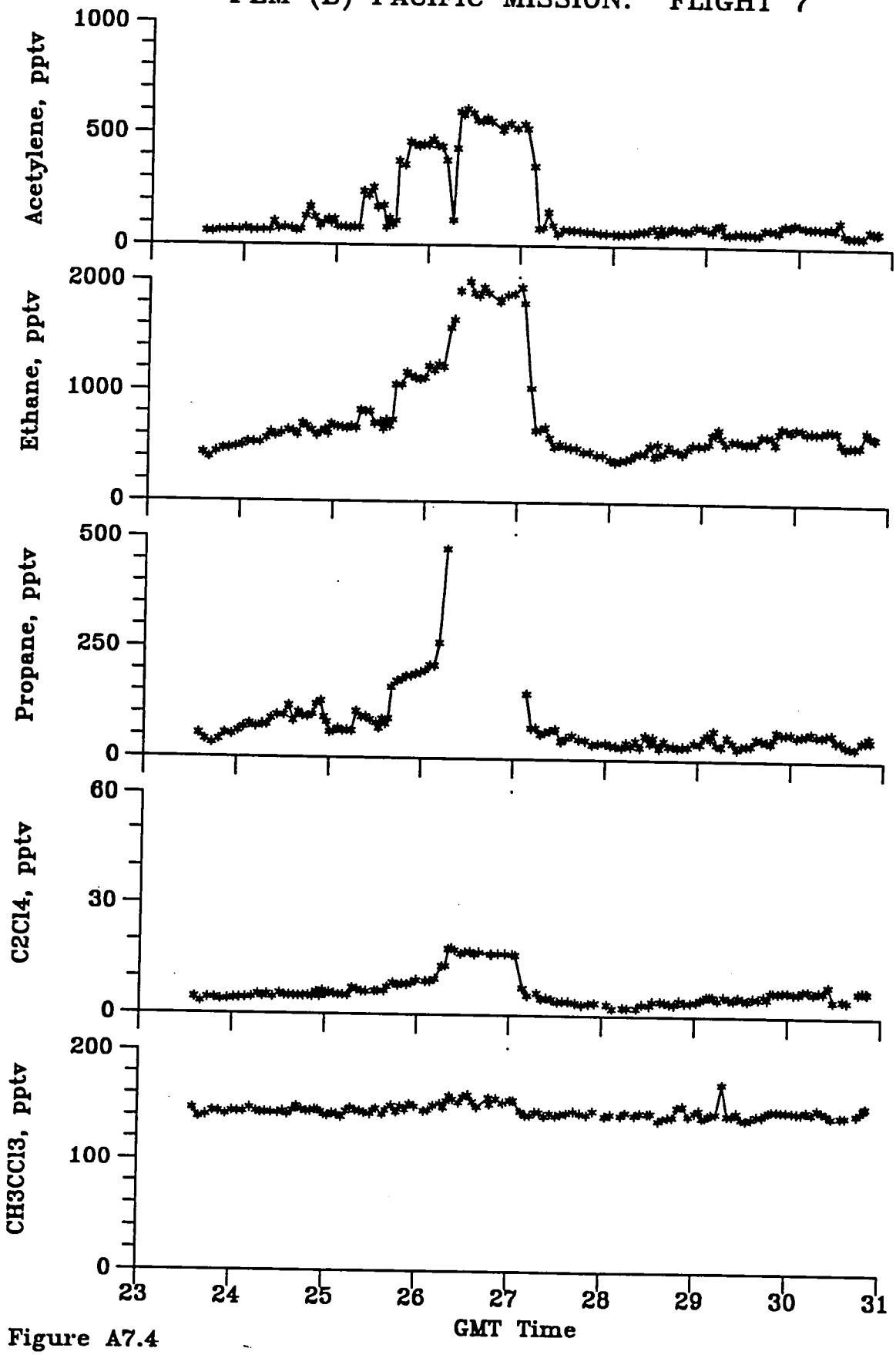

PEM (B) PACIFIC MISSION: FLIGHT 7
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
23
24
25
26
27
28
29
30
31
GMT Time

Figure A7.4

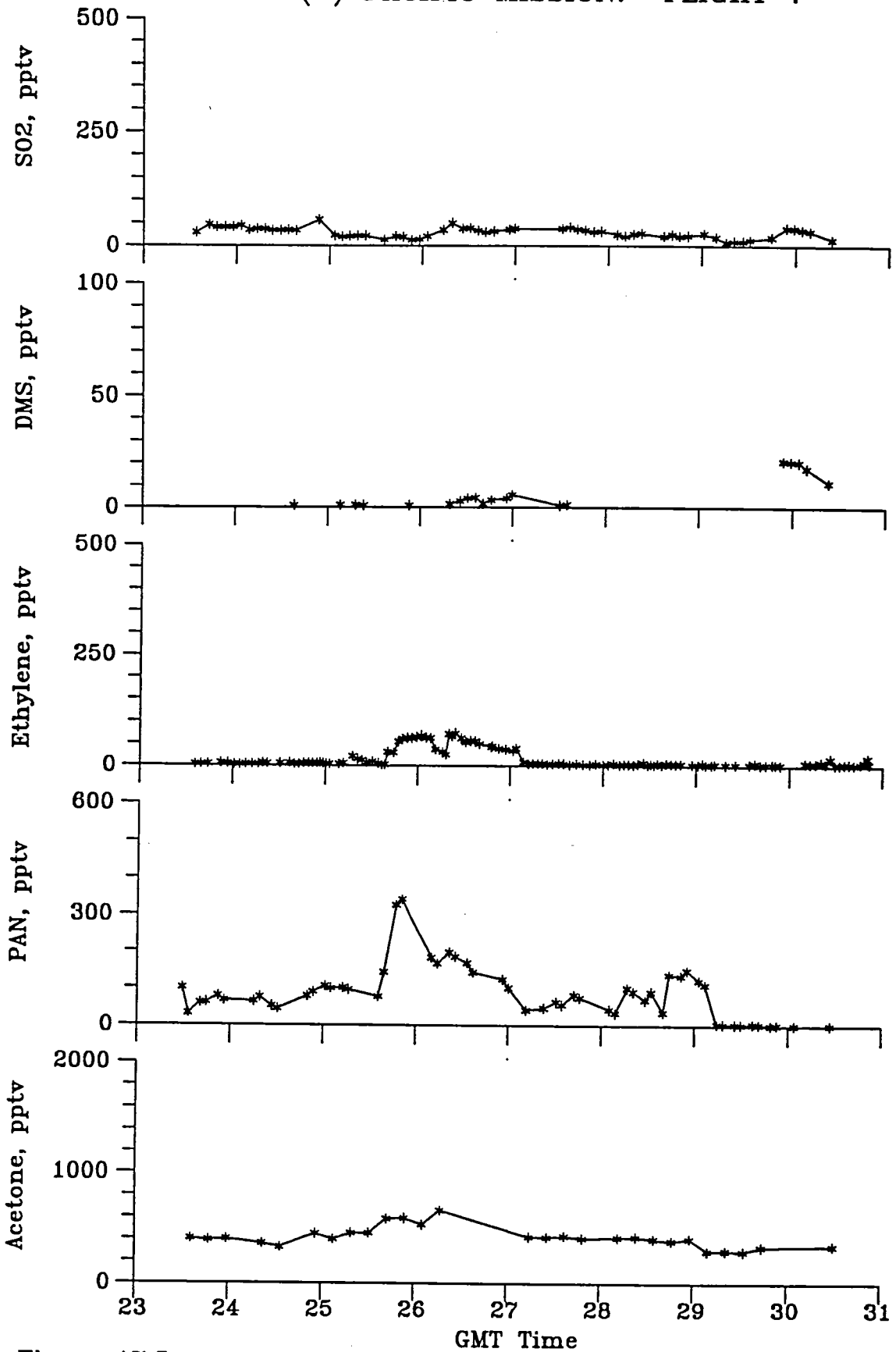

PEM (B) PACIFIC MISSION: FLIGHT 7
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
23
24
25
26
27
28
29
30
31
GMT Time

Figure A7.5

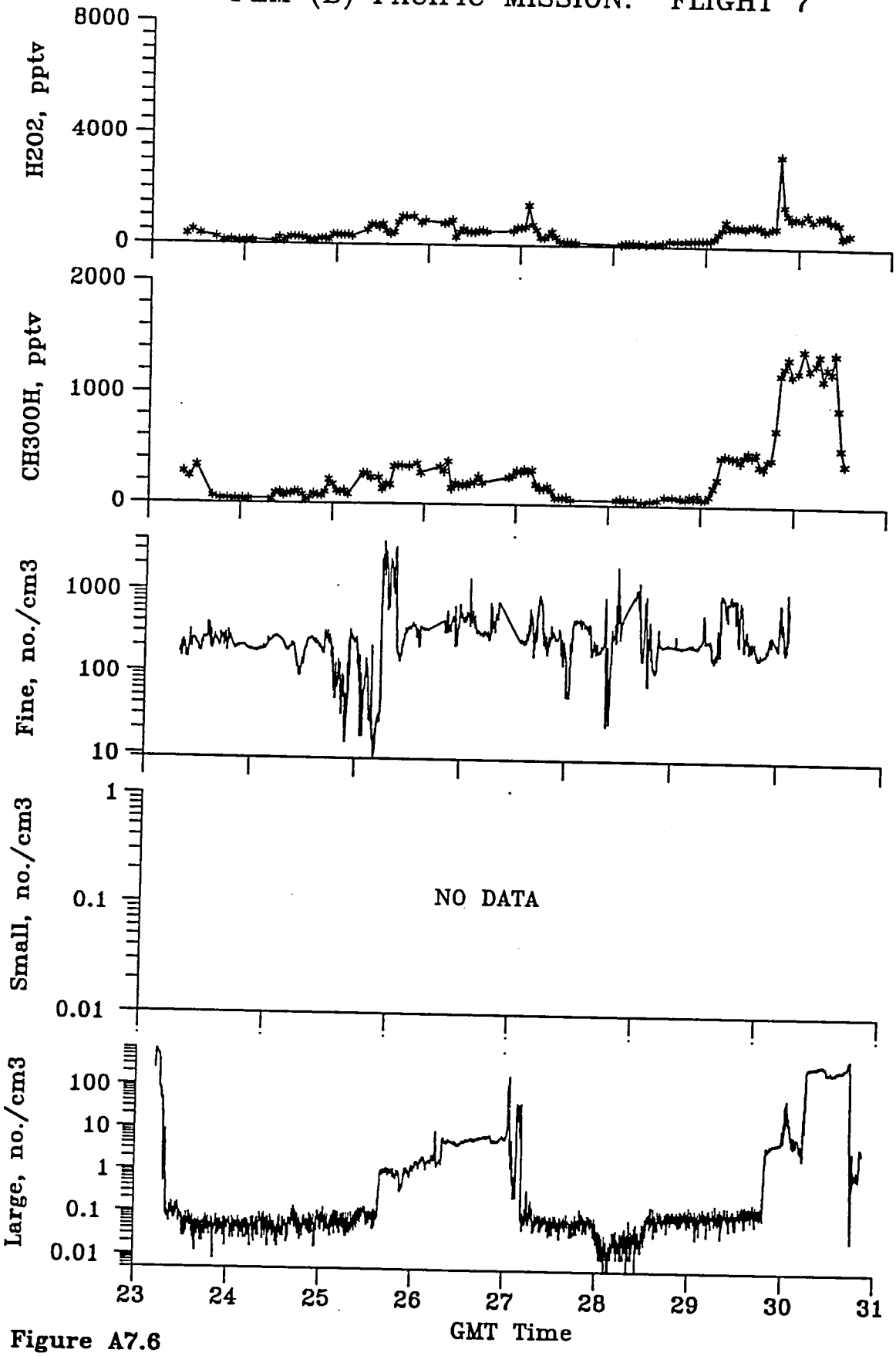
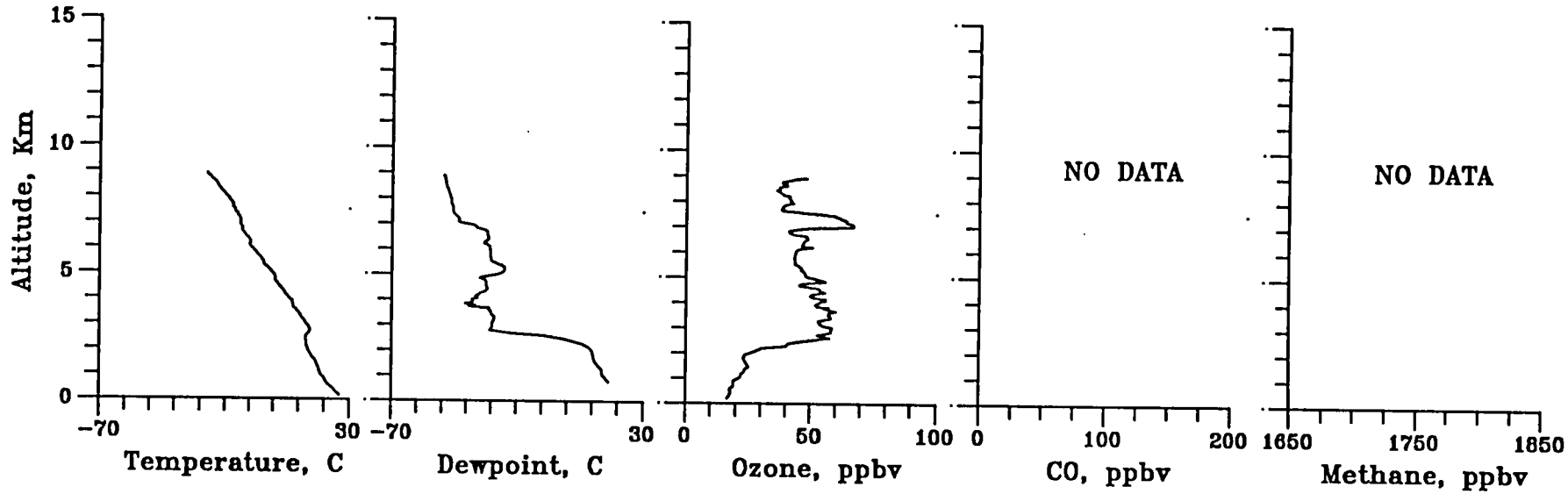

PEM (B) PACIFIC MISSION: FLIGHT 7
H2O2, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
100
10
1
0.1
0.01
23
24
25
26
27
28
29
30
31
GMT Time

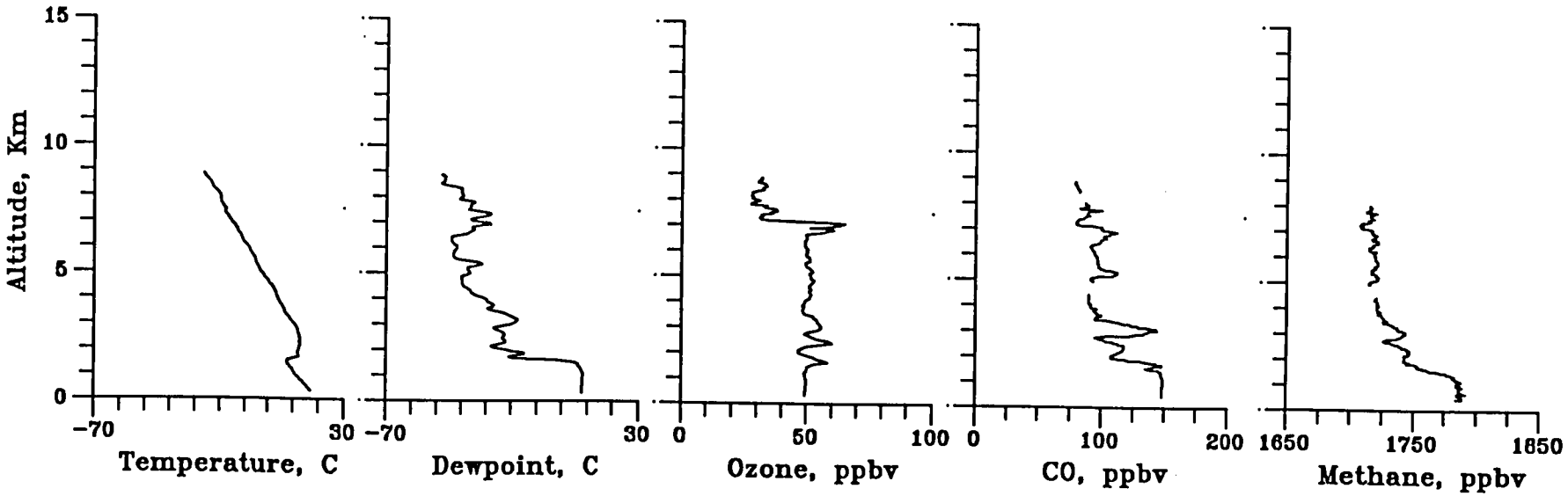
Figure A7.6

Figure A7.7

PEM (B) PACIFIC MISSION: FLIGHT 7 PROFILE AT 2330 GMT



PEM (B) PACIFIC MISSION: FLIGHT 7 PROFILE AT 0315 GMT



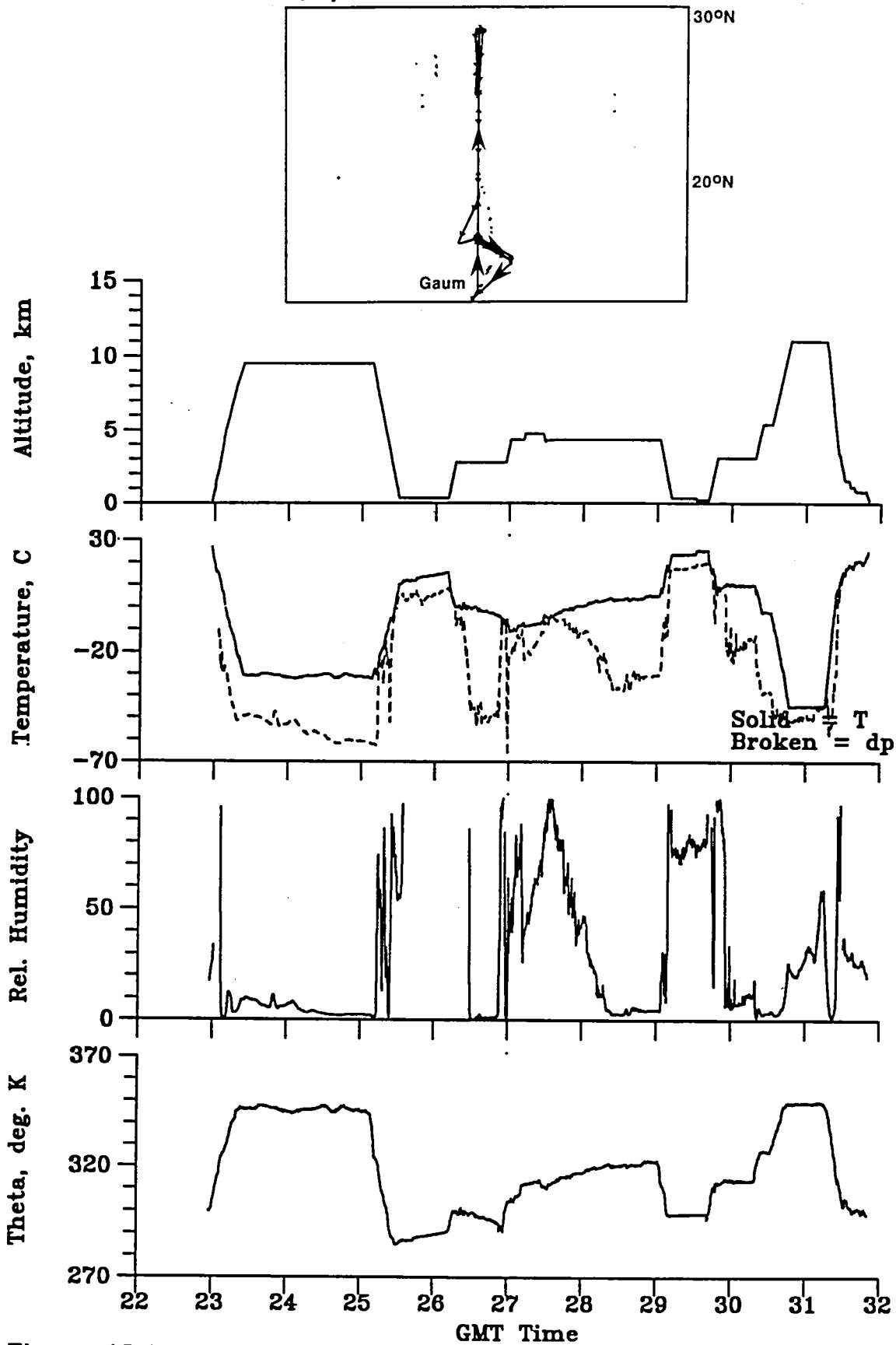

PEM (B) PACIFIC MISSION: FLIGHT 8
30°N
20°N
Gaum
Altitude, km
15
10
5
0
Temperature, C
30
-20
-70
Solid = T
Broken = dp
Rel. Humidity
100
50
0
Theta, deg. K
370
320
270
22
23
24
25
26
27
28
29
30
31
32
GMT Time

Figure A8.1

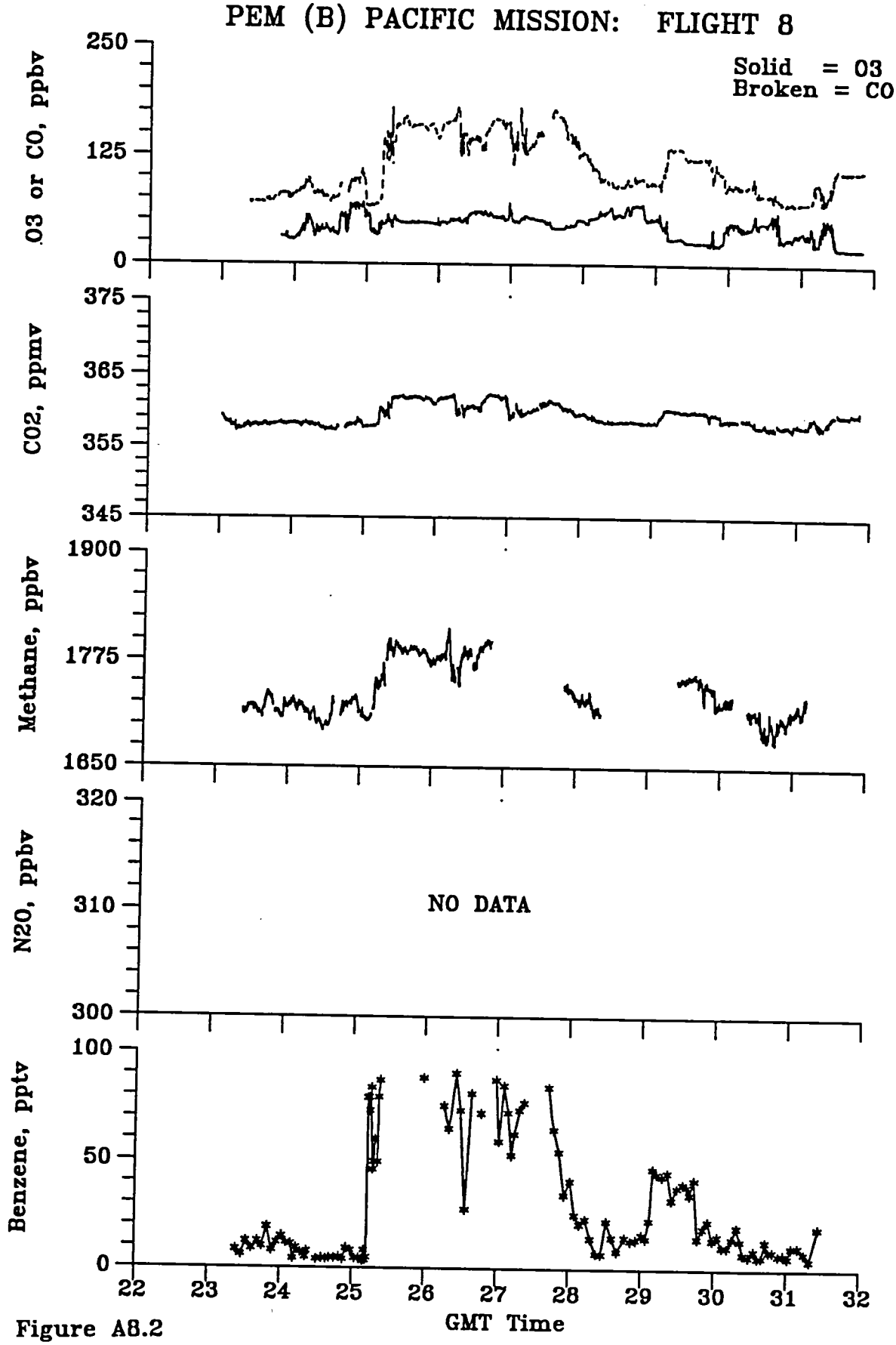

PEM (B) PACIFIC MISSION: FLIGHT 8
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
NO DATA
Benzene, pptv
100
50
0
22
23
24
25
26
27
28
29
30
31
32
GMT Time

Figure A8.2

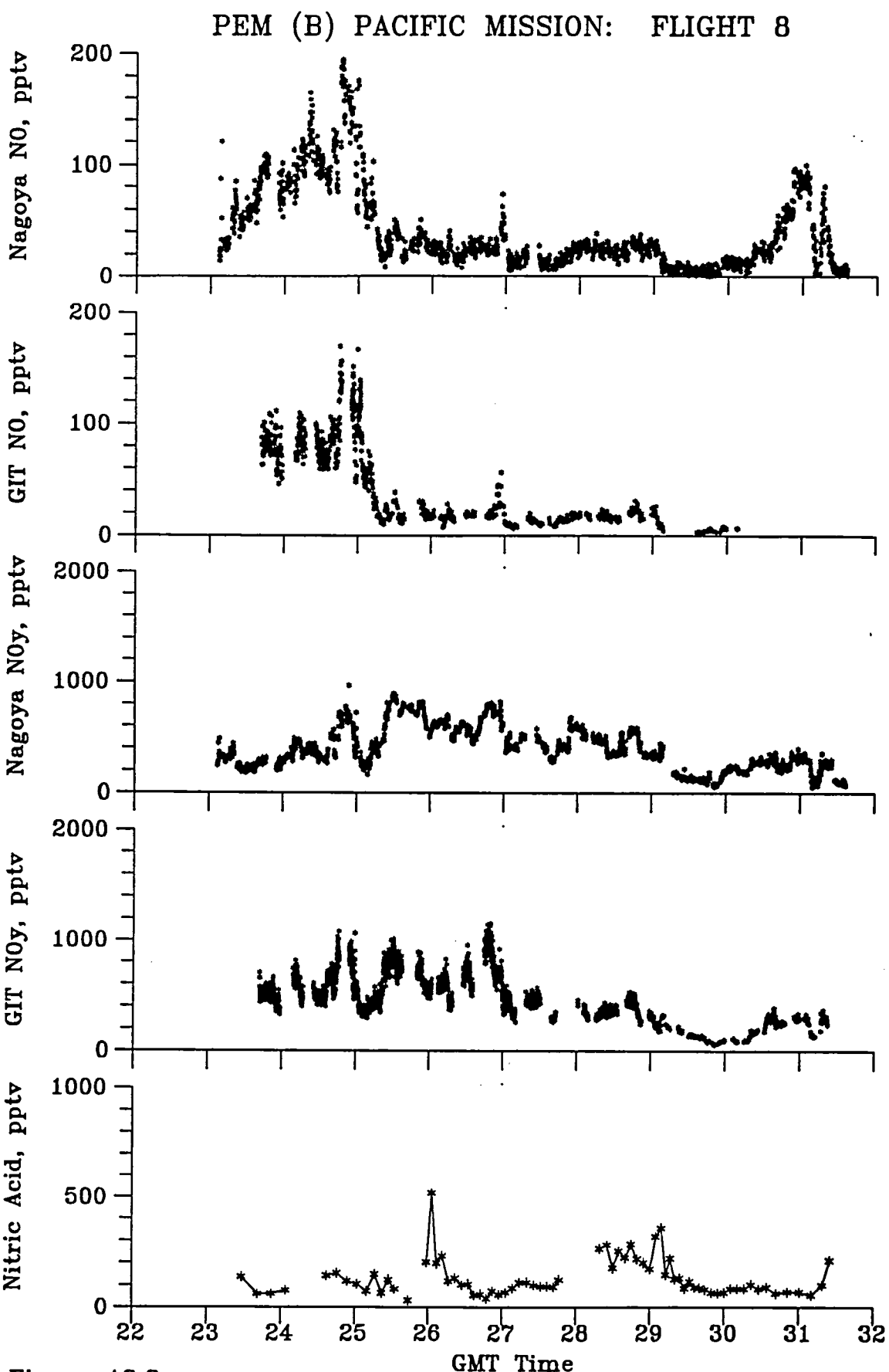

PEM (B) PACIFIC MISSION: FLIGHT 8
Nagoya NO, pptv
200
100
0
GIT NO, pptv
200
100
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
Nitric Acid, pptv
1000
500
0
22
23
24
25
26
27
28
29
30
31
32
GMT Time

Figure A8.3

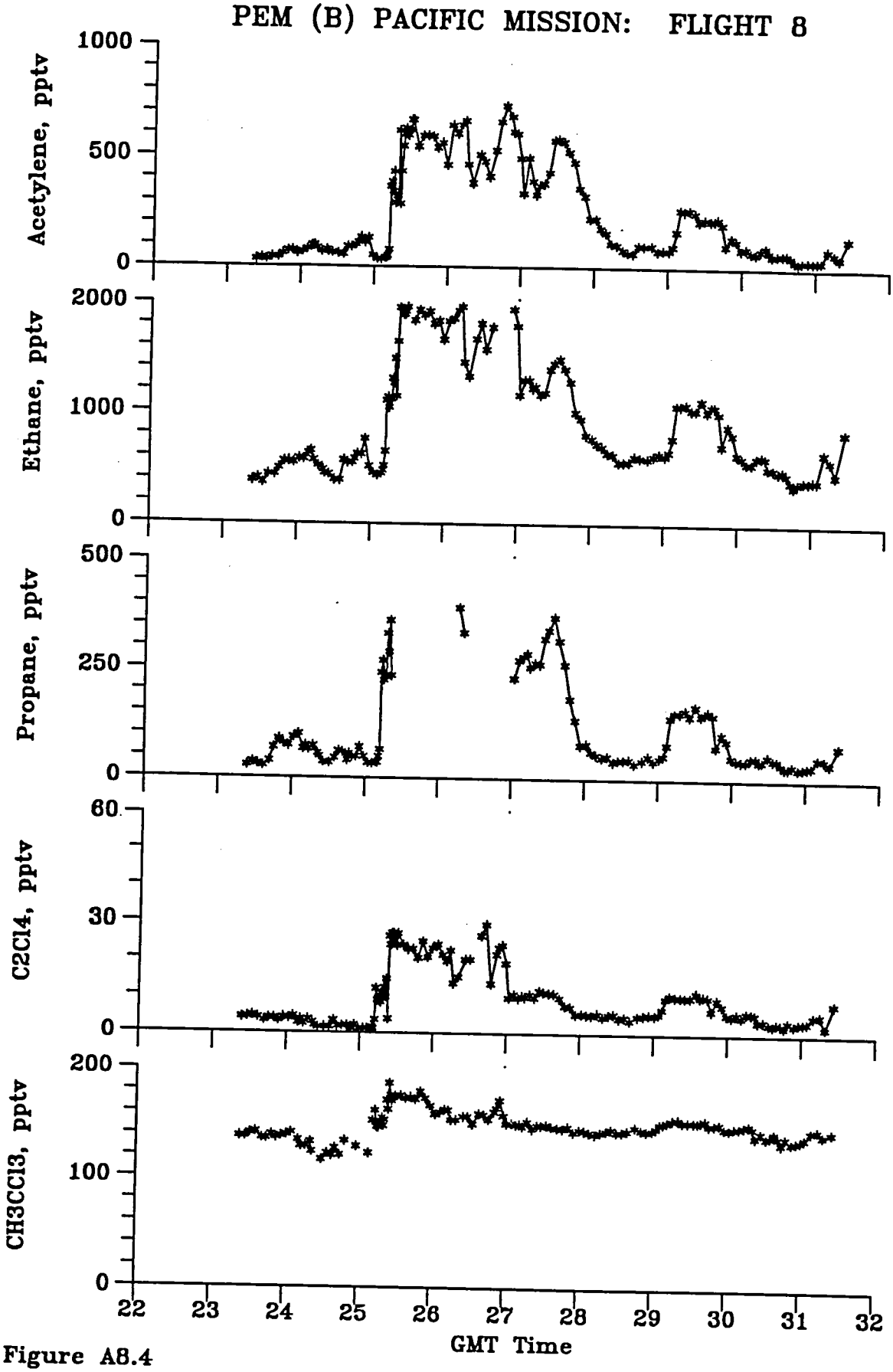

PEM (B) PACIFIC MISSION: FLIGHT 8
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
22
23
24
25
26
27
28
29
30
31
32
GMT Time

Figure A8.4

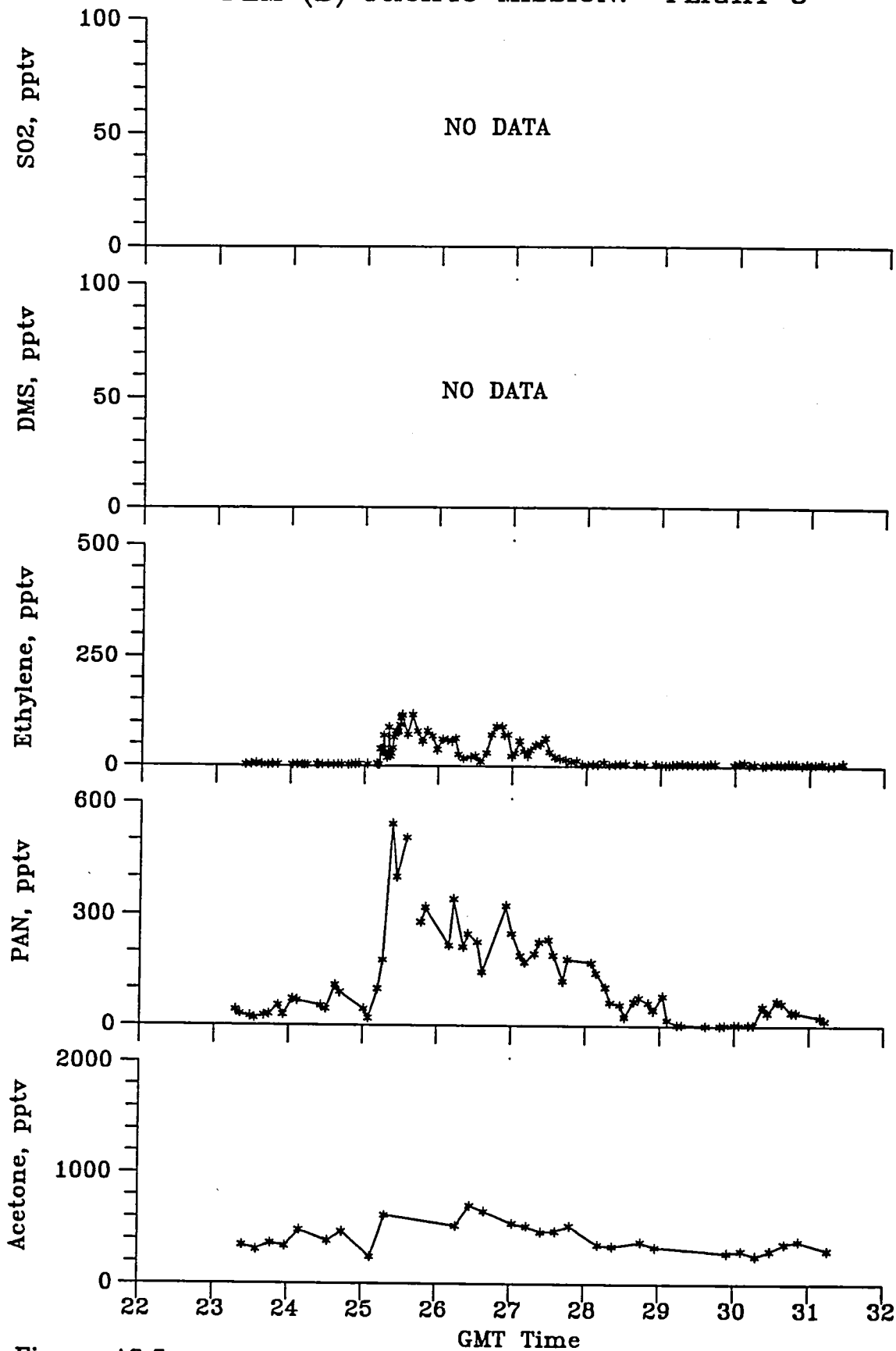

PEM (B) PACIFIC MISSION: FLIGHT 8
SO2, pptv
100
50
0
NO DATA
DMS, pptv
100
50
0
NO DATA
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
22
23
24
25
26
27
28
29
30
31
32
GMT Time

Figure A8.5

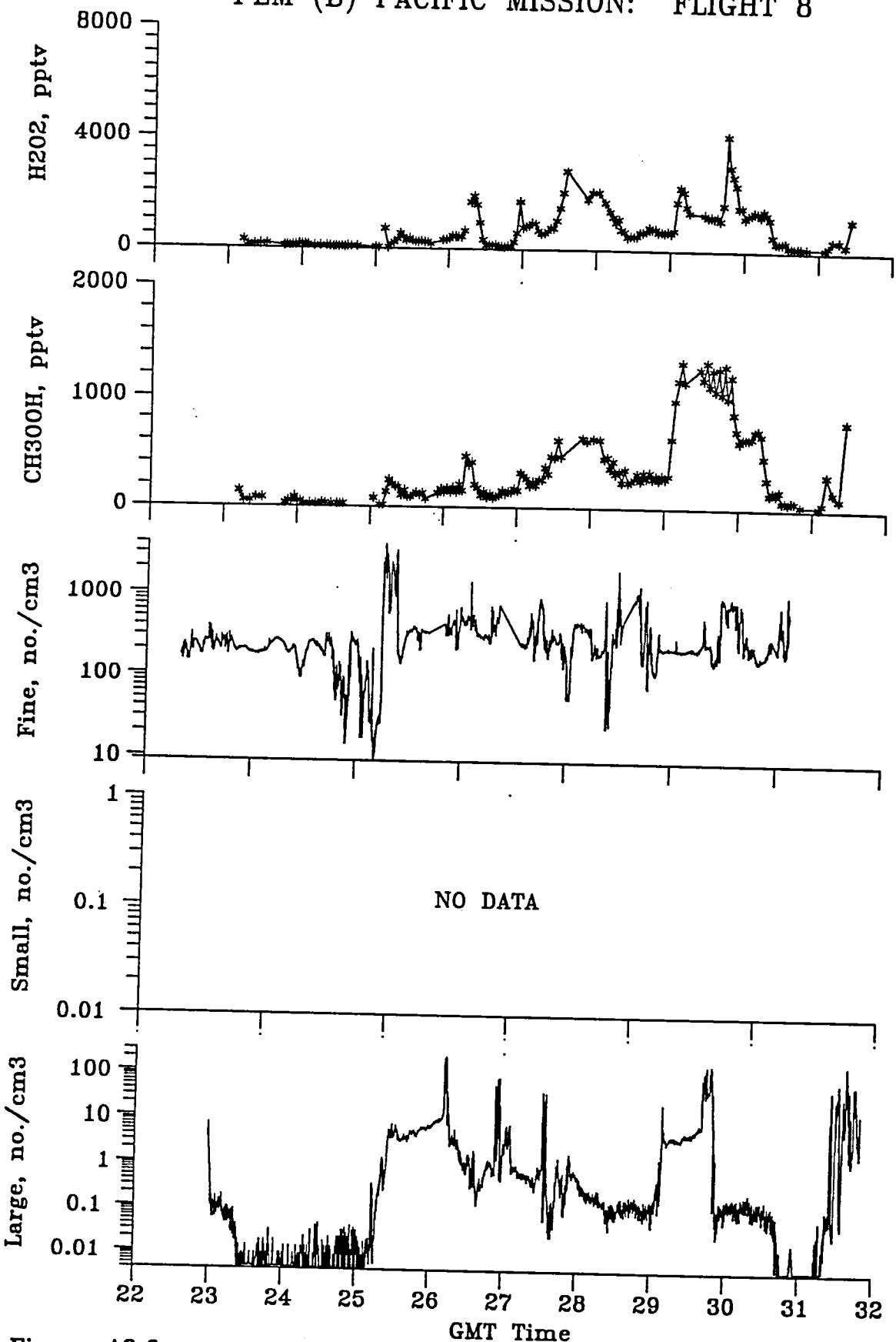
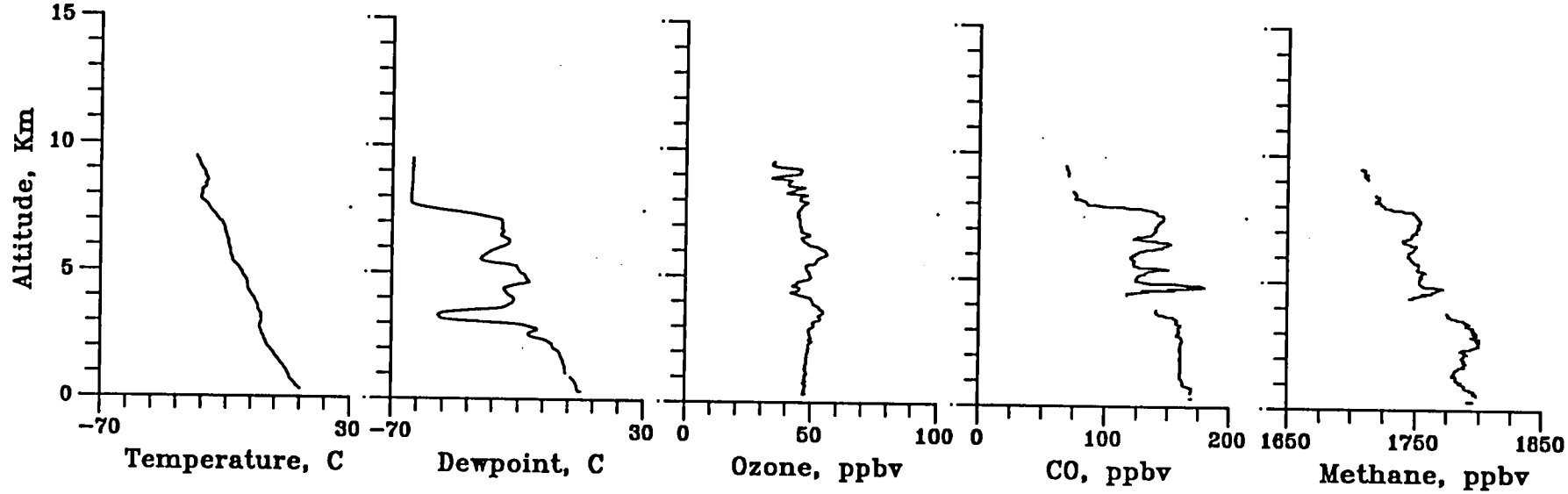

PEM (B) PACIFIC MISSION: FLIGHT 8
H2O2, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
100
10
1
0.1
0.01
22
23
24
25
26
27
28
29
30
31
32
GMT Time

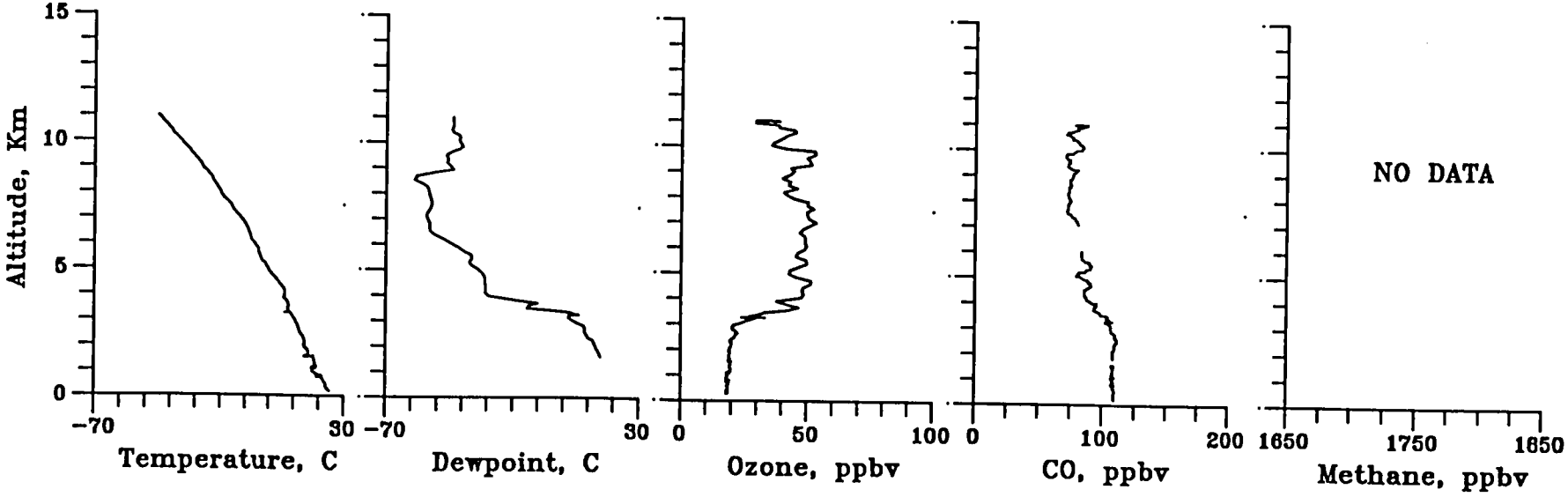
Figure A8.6

Figure A8.7

PEM (B) PACIFIC MISSION: FLIGHT 8 PROFILE AT 0115 GMT



PEM (B) PACIFIC MISSION: FLIGHT 8 PROFILE AT 0730 GMT



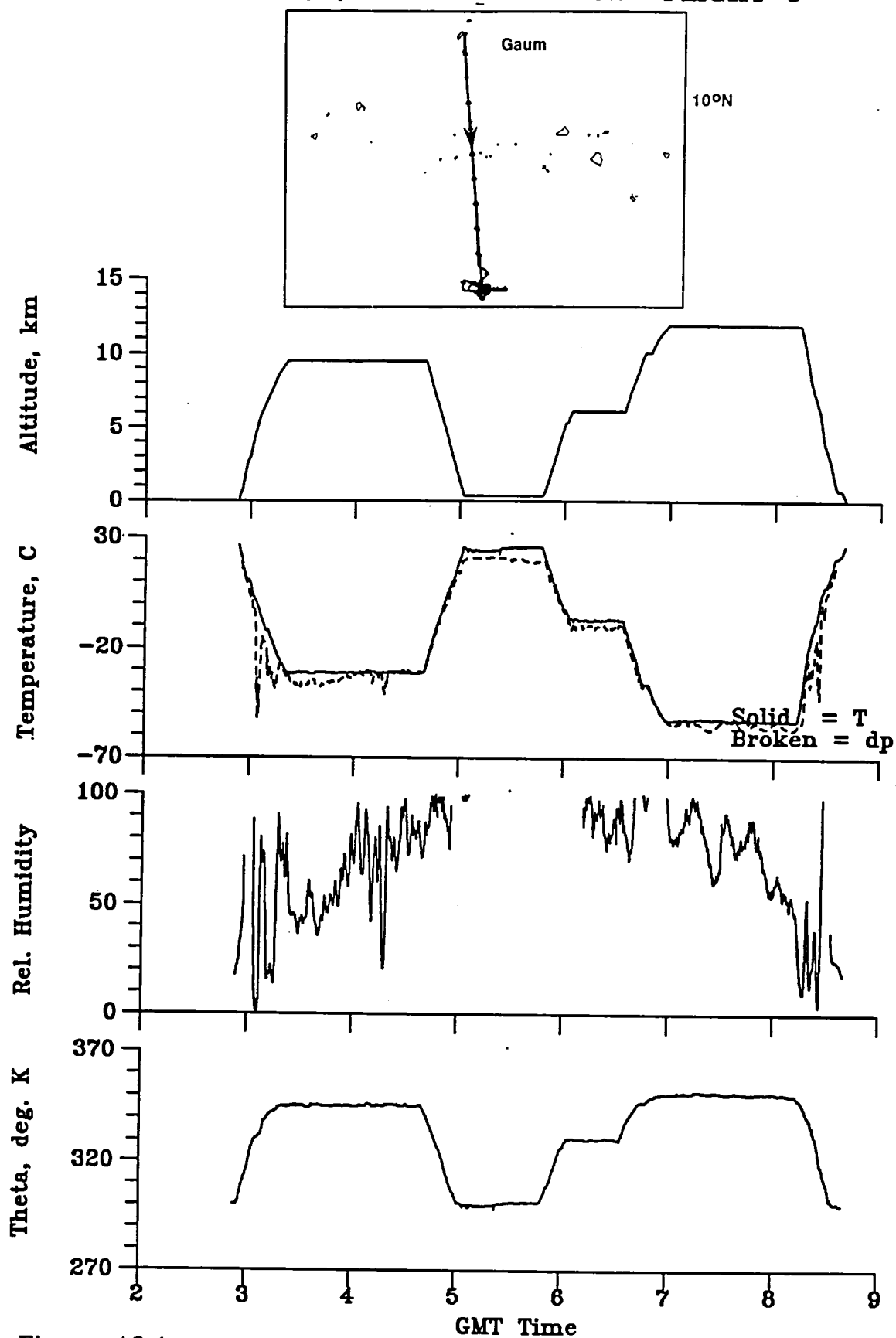

PEM (B) PACIFIC MISSION: FLIGHT 9
Gaum
10°N
Altitude, km
15
10
5
0
Temperature, C
30
-20
-70
Solid = T
Broken = dp
Rel. Humidity
100
50
0
Theta, deg. K
370
320
270
2
3
4
5
6
7
8
9
GMT Time

Figure A9.1

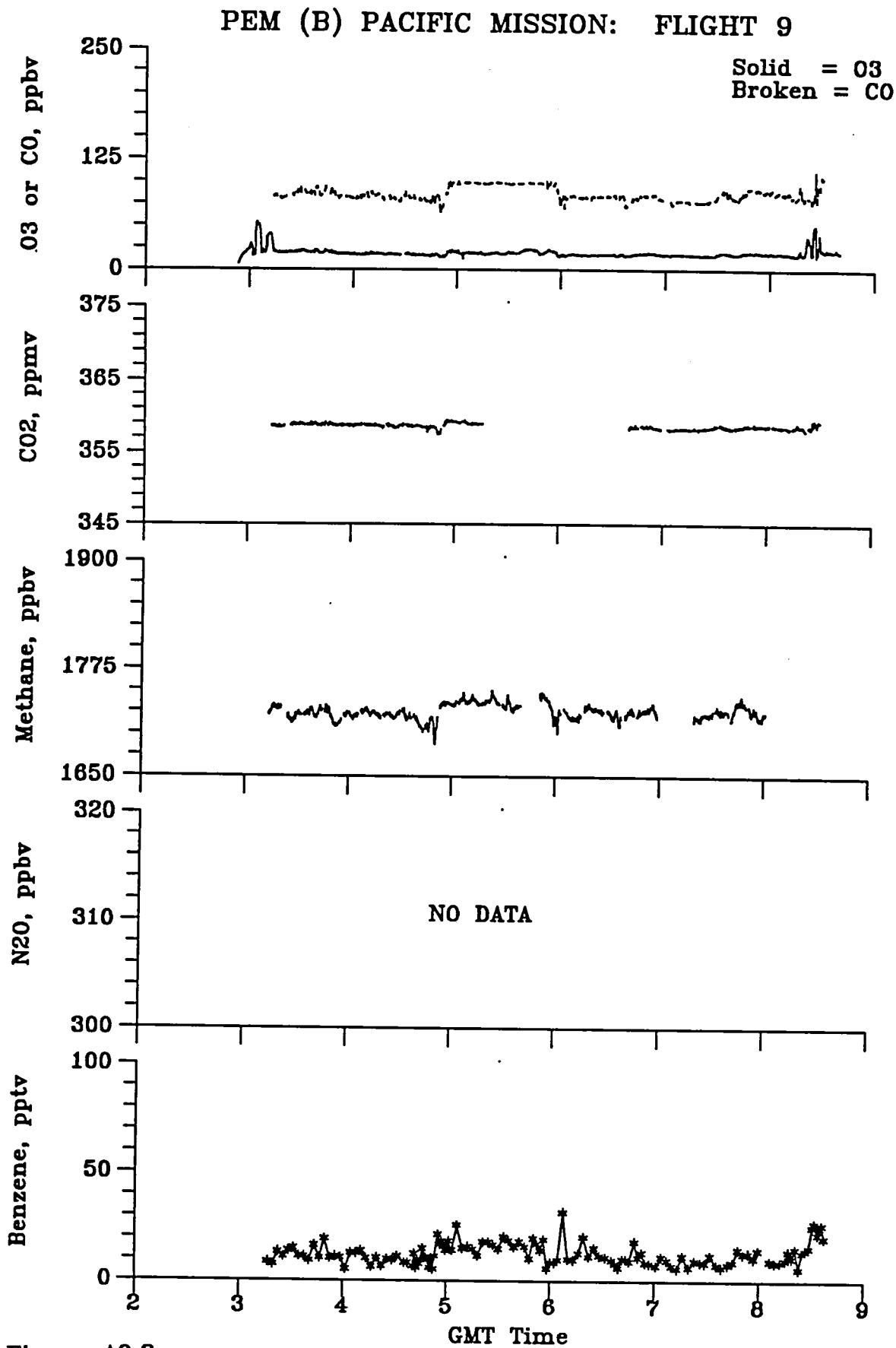

PEM (B) PACIFIC MISSION: FLIGHT 9
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
NO DATA
Benzene, pptv
100
50
0
2
3
4
5
6
7
8
9
GMT Time

Figure A9.2

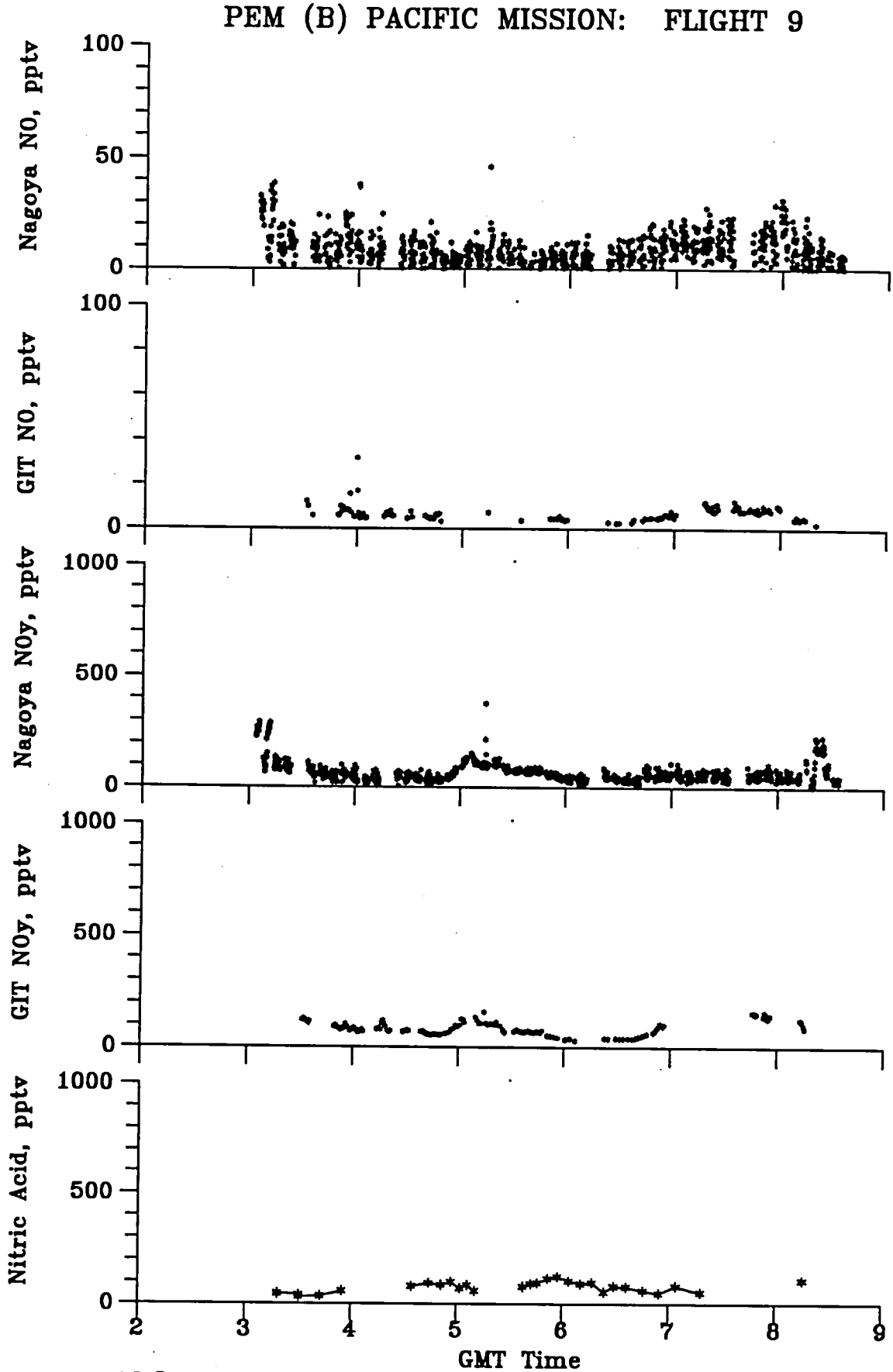

PEM (B) PACIFIC MISSION: FLIGHT 9
Nagoya NO, pptv
100
50
0
GIT NO, pptv
100
0
Nagoya NOy, pptv
1000
500
0
GIT NOy, pptv
1000
500
0
Nitric Acid, pptv
1000
500
0
2
3
4
5
6
7
8
9
GMT Time

Figure A9.3

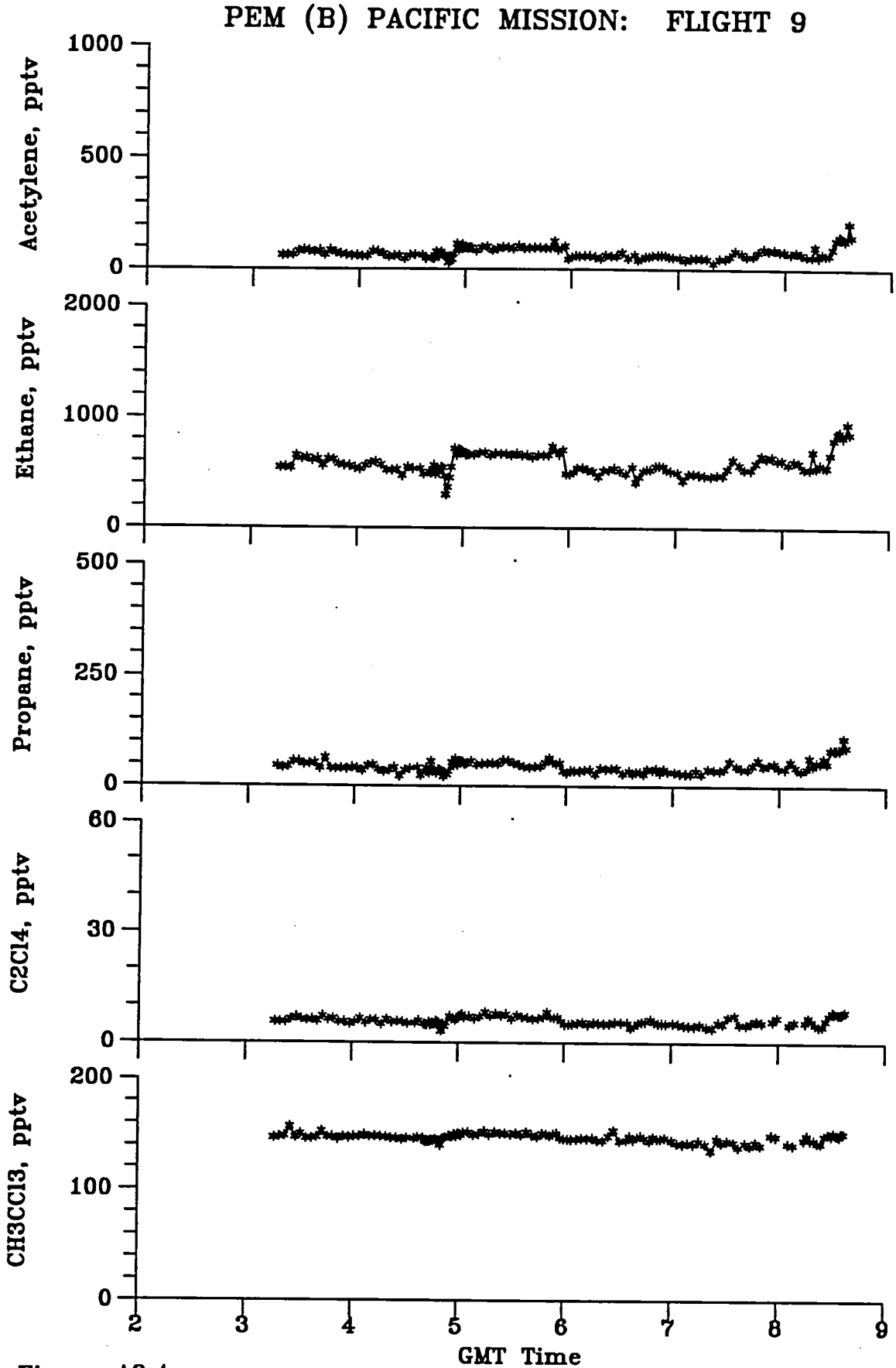

PEM (B) PACIFIC MISSION: FLIGHT 9
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
2
3
4
5
6
7
8
9
GMT Time

Figure A9.4

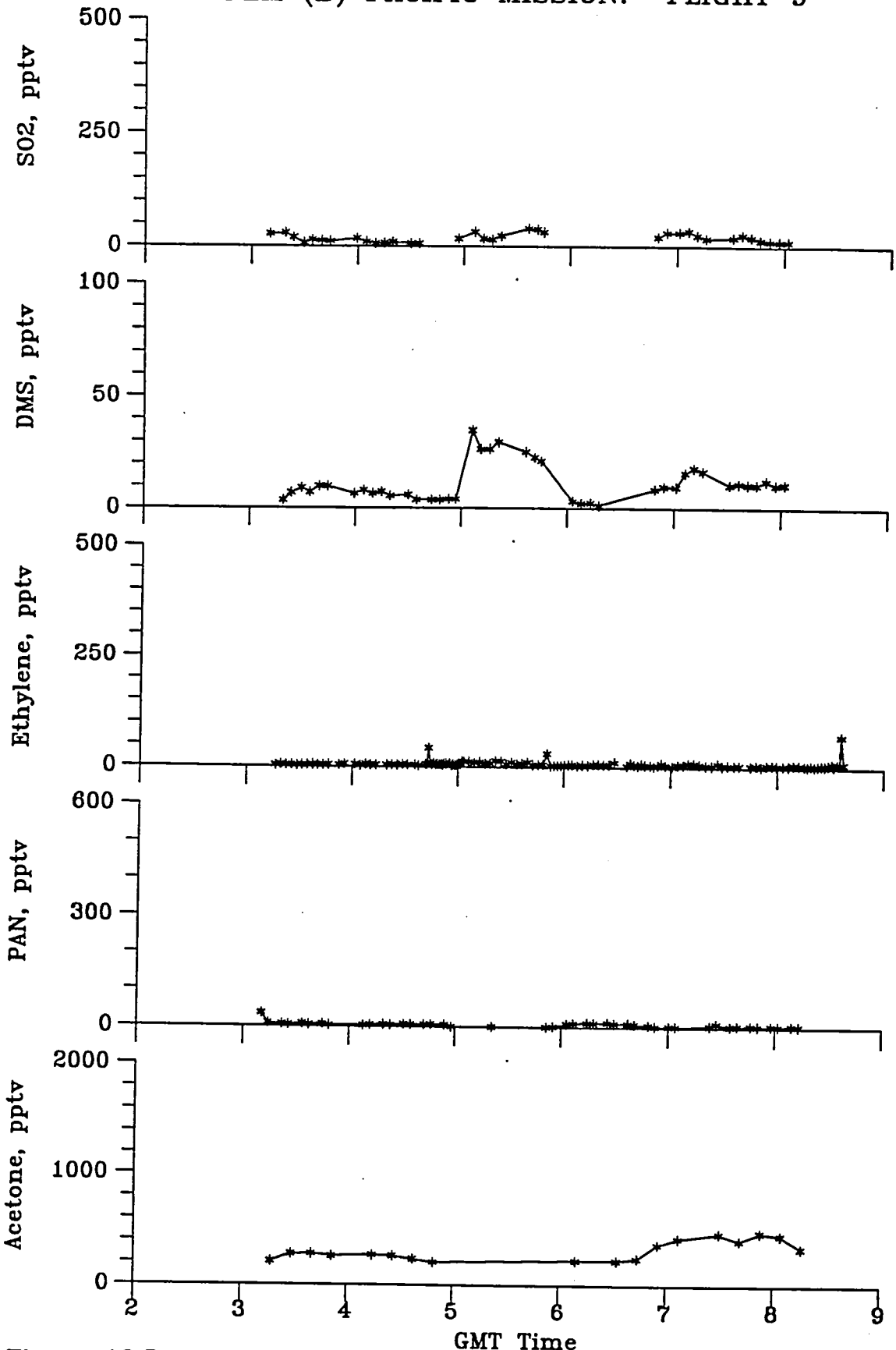

PEM (B) PACIFIC MISSION: FLIGHT 9
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
2
3
4
5
6
7
8
9
GMT Time

Figure A9.5

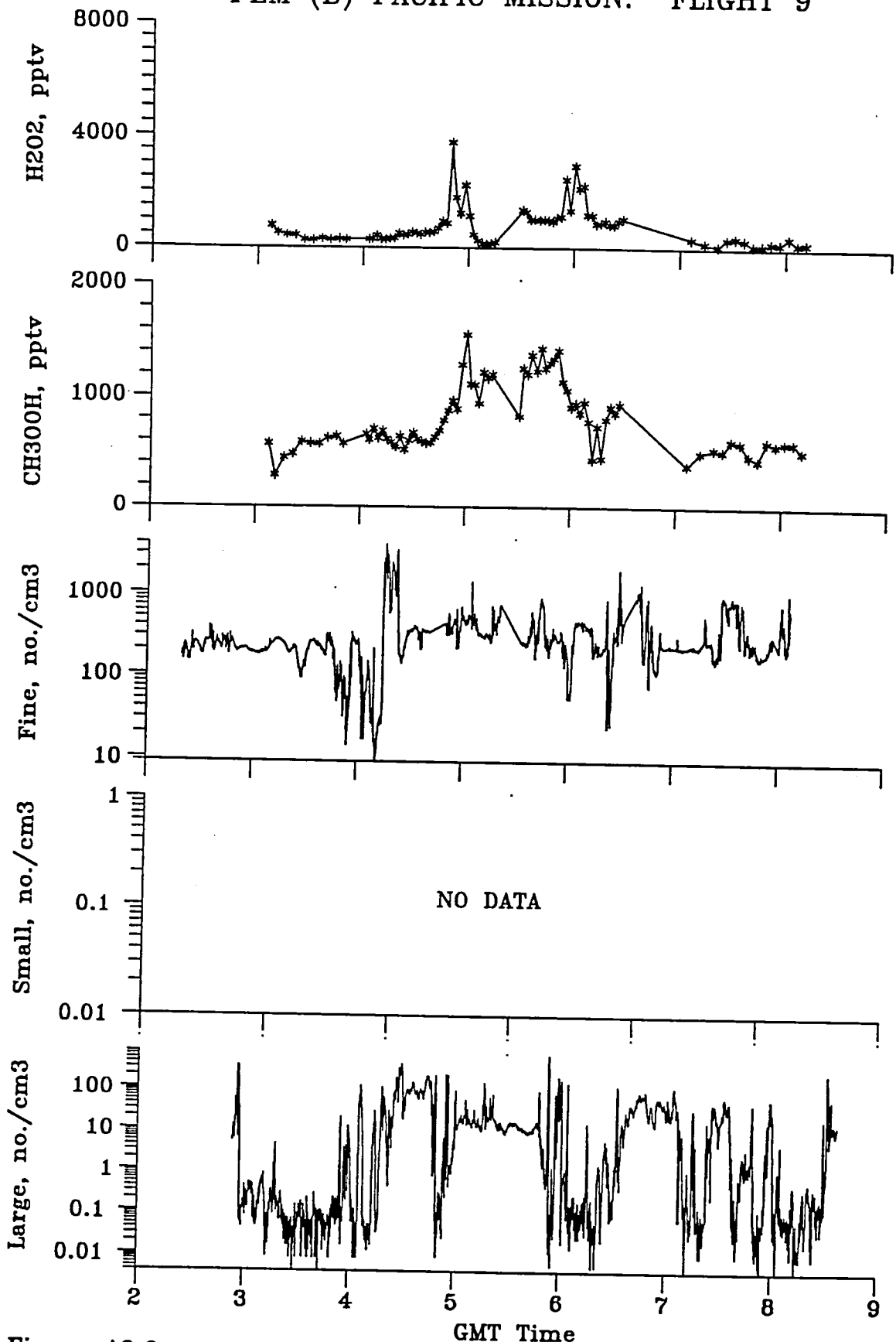
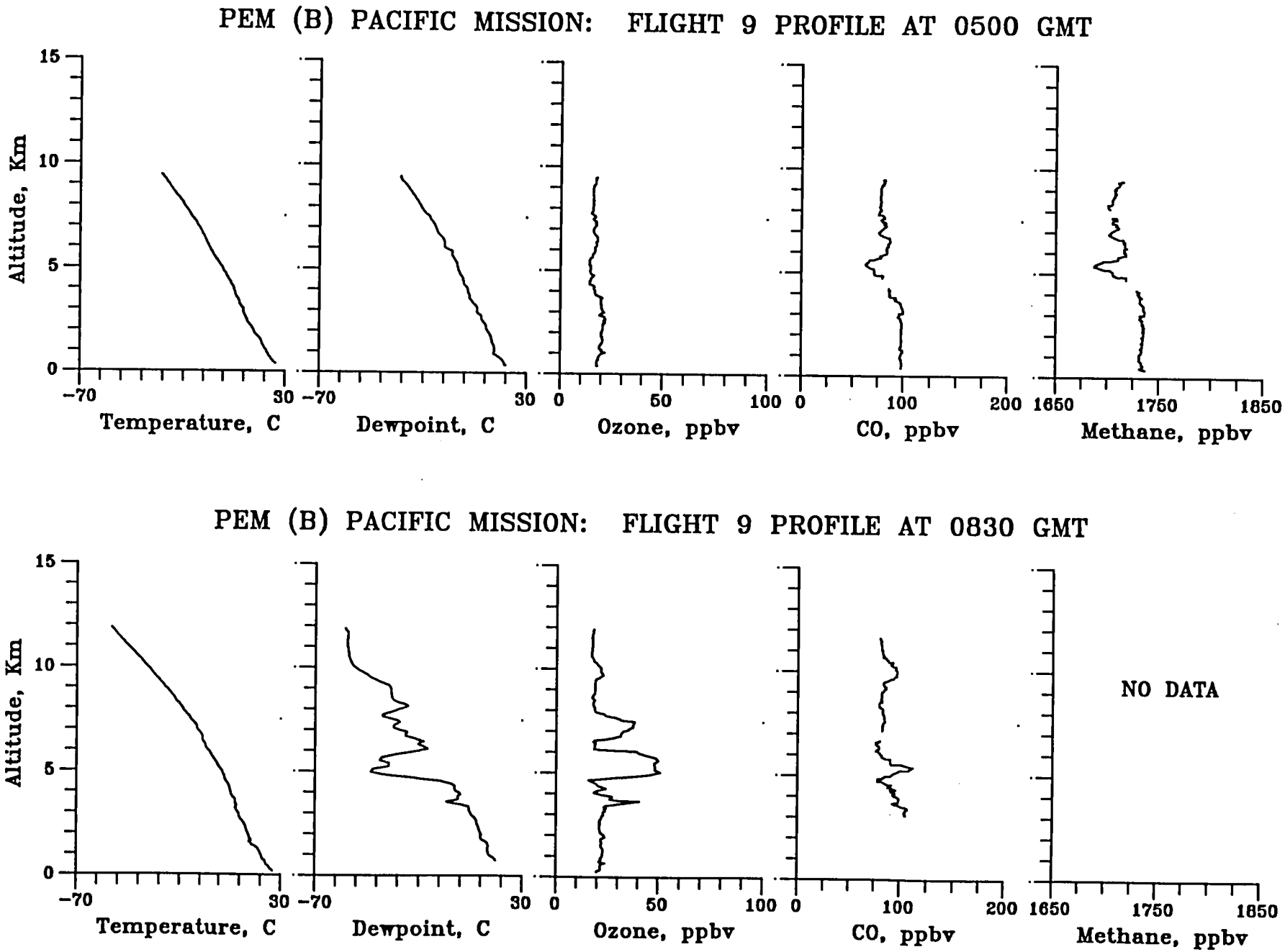

PEM (B) PACIFIC MISSION: FLIGHT 9
H2O2, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
100
10
1
0.1
0.01
2
3
4
5
6
7
8
9
GMT Time

Figure A9.6

Figure A9.7


PEM (B) PACIFIC MISSION: FLIGHT 9 PROFILE AT 0500 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
200
CO, ppbv
1650
1750
1850
Methane, ppbv
PEM (B) PACIFIC MISSION: FLIGHT 9 PROFILE AT 0830 GMT
NO DATA

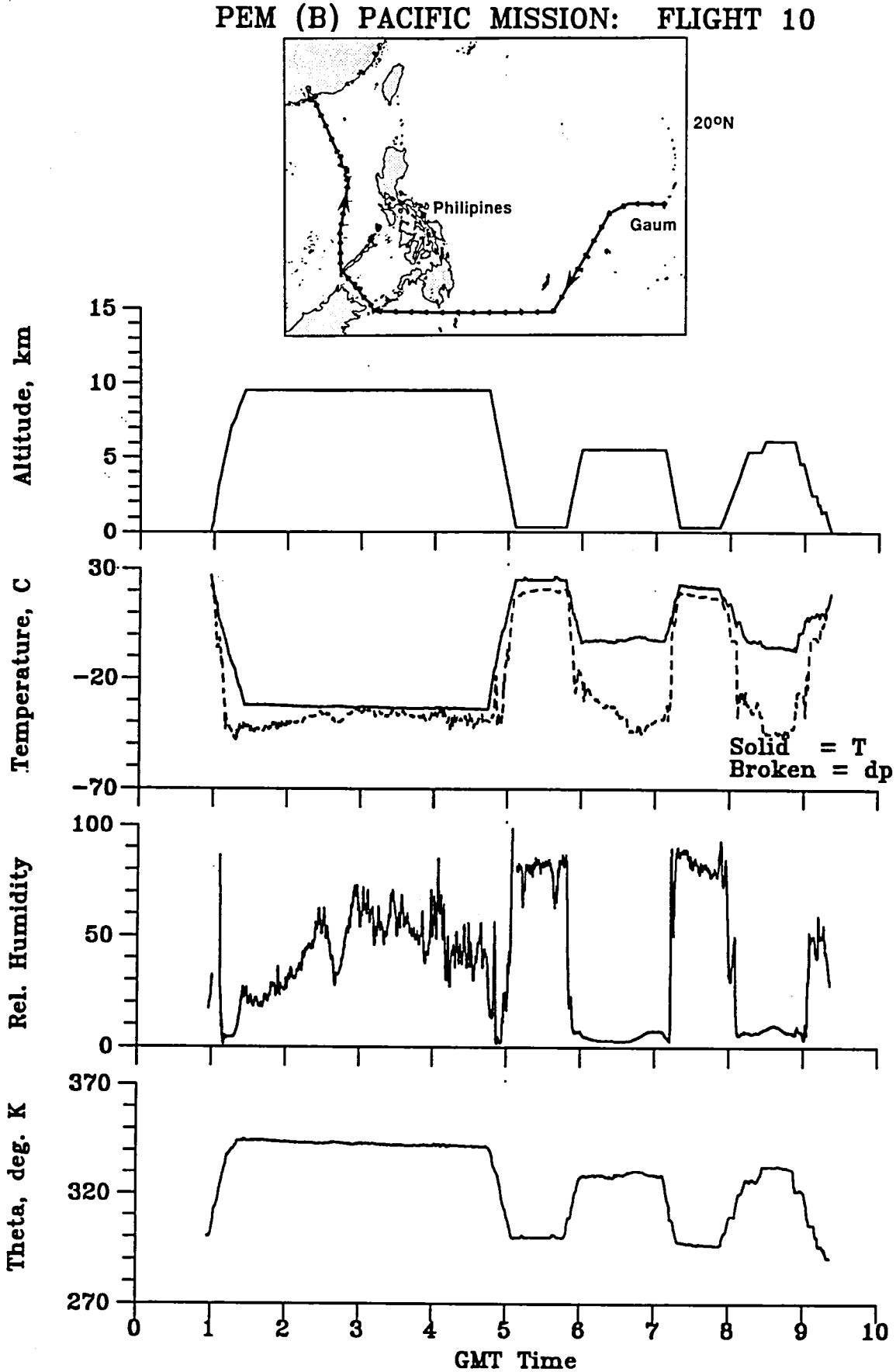

PEM (B) PACIFIC MISSION: FLIGHT 10
20°N
Philipines
Gaum
Altitude, km
15
10
5
0
Temperature, C
30
-20
-70
Solid = T
Broken = dp
Rel. Humidity
100
50
0
Theta, deg. K
370
320
270
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A10.1

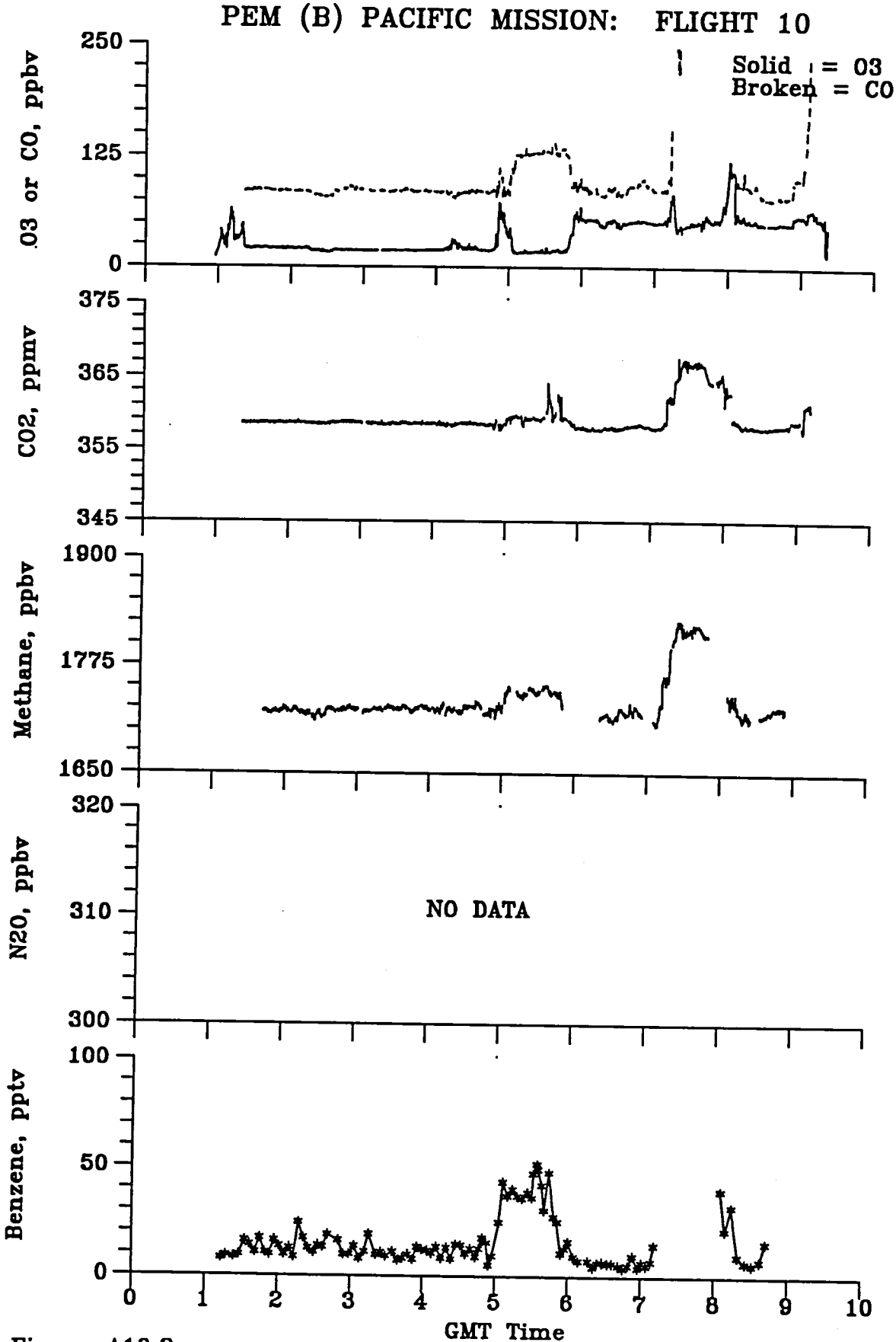

PEM (B) PACIFIC MISSION: FLIGHT 10
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
NO DATA
Benzene, pptv
100
50
0
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A10.2

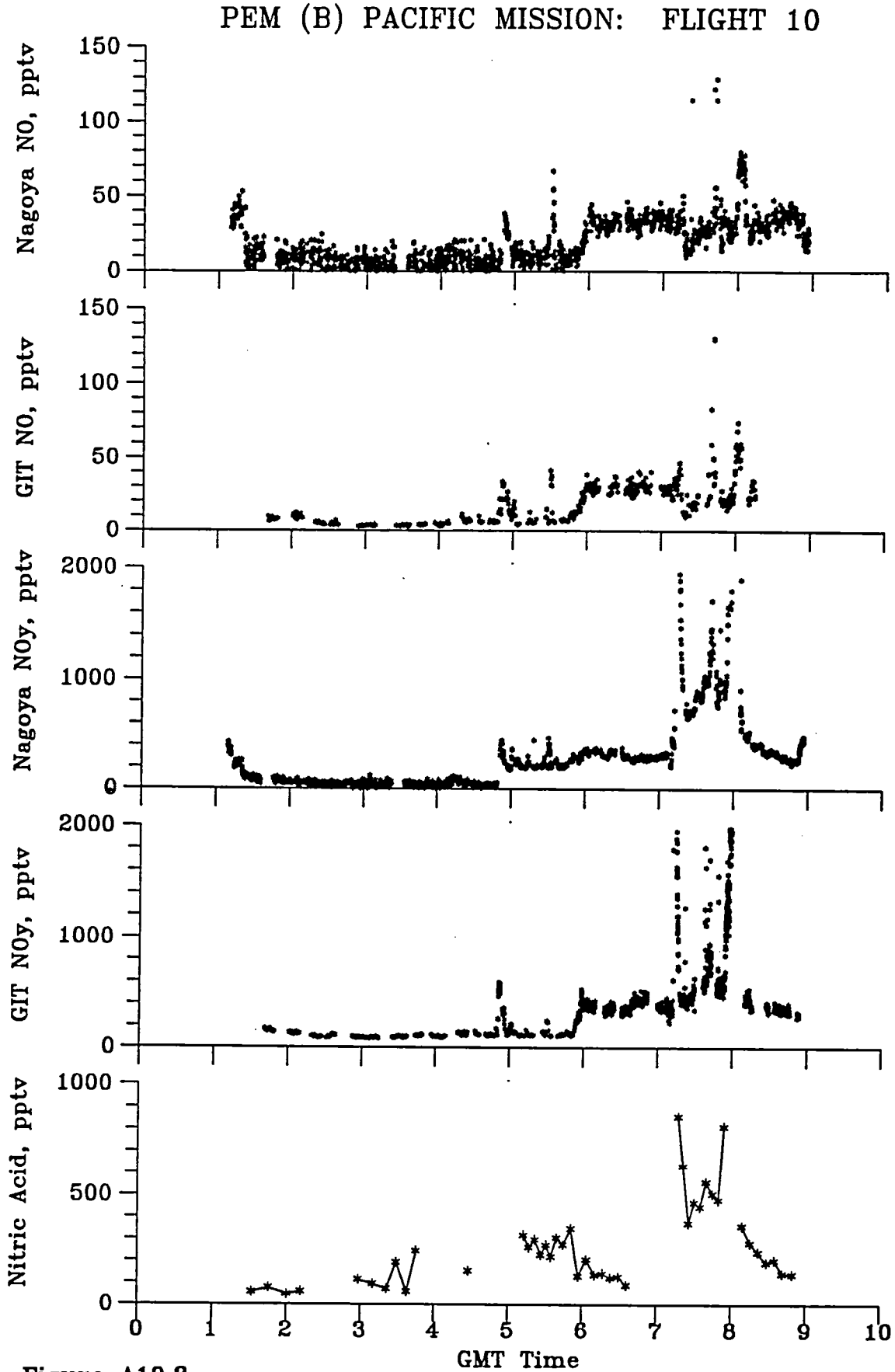

PEM (B) PACIFIC MISSION: FLIGHT 10
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
150
100
50
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
Nitric Acid, pptv
1000
500
0
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A10.3

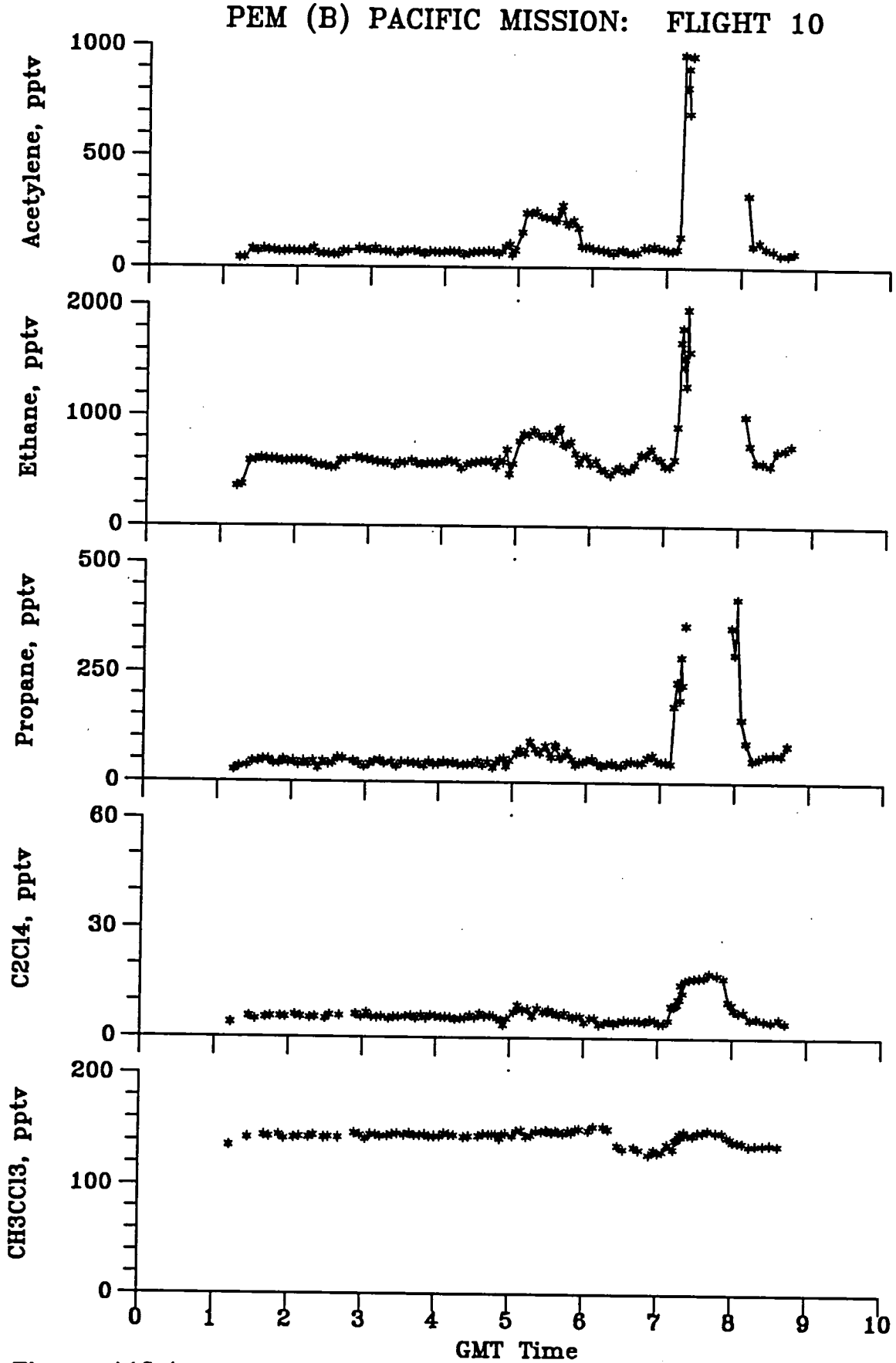

PEM (B) PACIFIC MISSION: FLIGHT 10
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A10.4

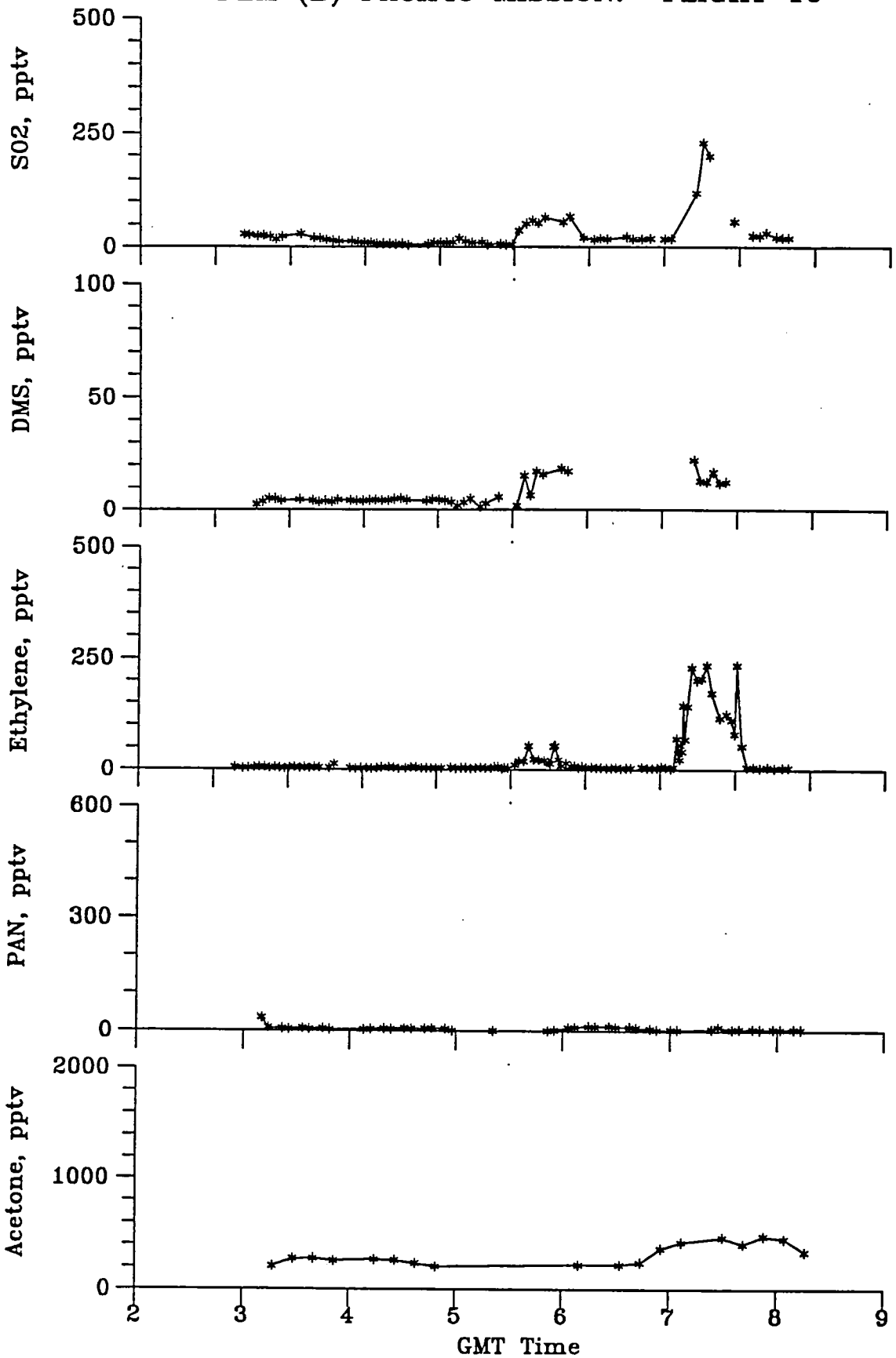

PEM (B) PACIFIC MISSION: FLIGHT 10
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
2
3
4
5
6
7
8
9
GMT Time

Figure A10.5

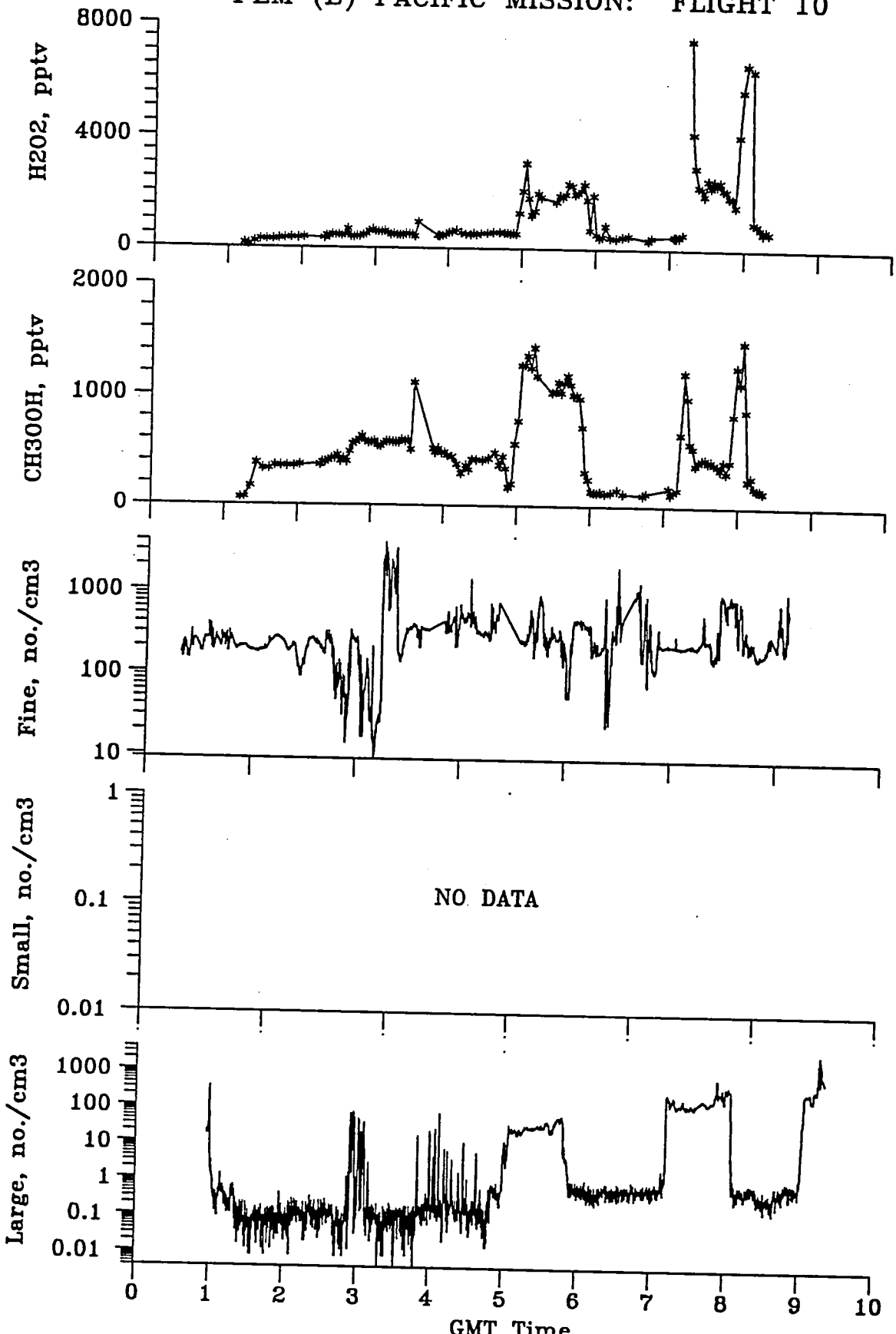
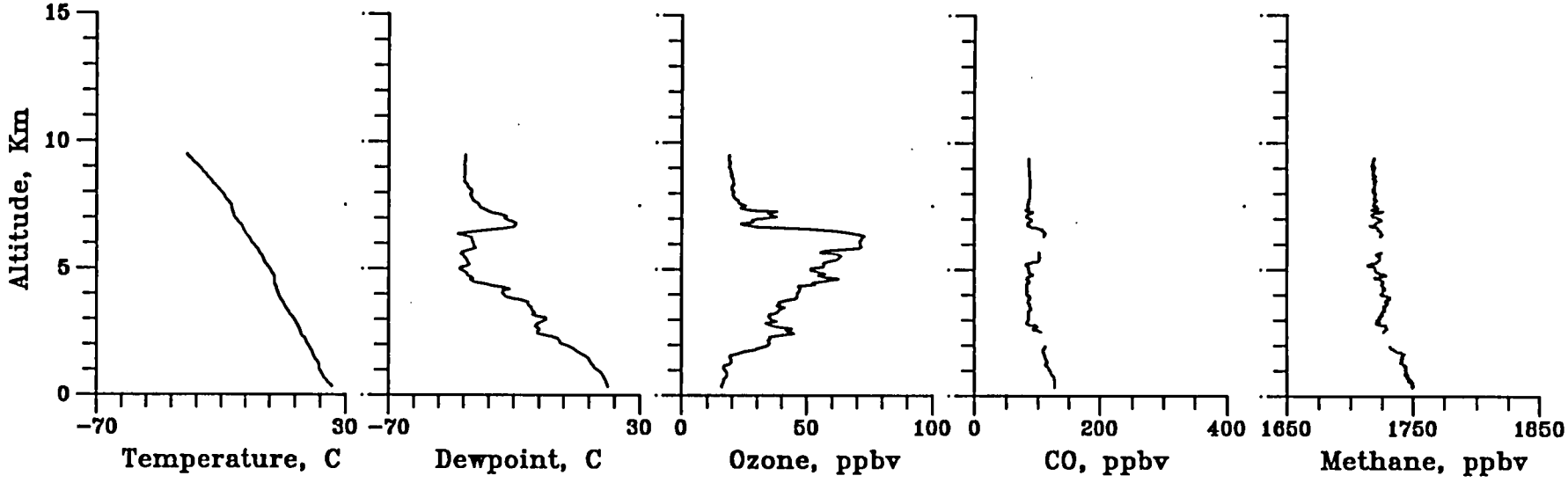

PEM (B) PACIFIC MISSION: FLIGHT 10
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
1000
100
10
1
0.1
0.01
0
1
2
3
4
5
6
7
8
9
10
GMT Time

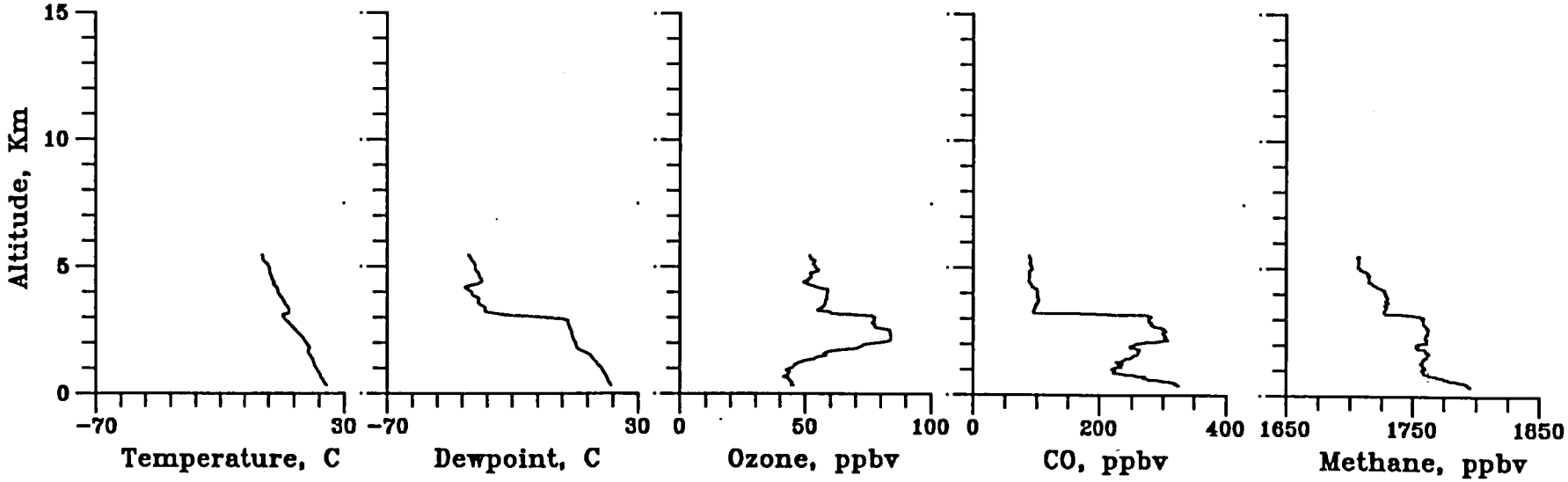
Figure A10.6

Figure A10.7

PEM (B) PACIFIC MISSION: FLIGHT 10 PROFILE AT 0500 GMT



PEM (B) PACIFIC MISSION: FLIGHT 10 PROFILE AT 0715 GMT



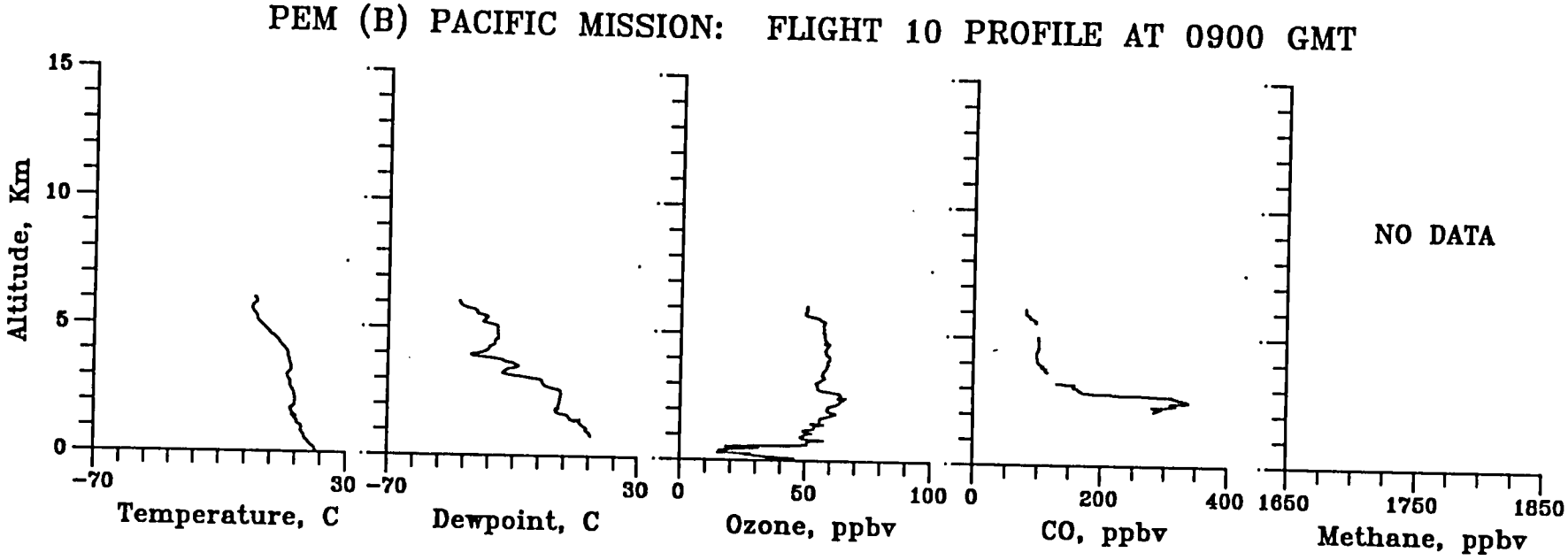

PEM (B) PACIFIC MISSION: FLIGHT 10 PROFILE AT 0900 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
-70
30
Dewpoint, C
0
50
100
Ozone, ppbv
0
200
400
CO, ppbv
1650
1750
1850
Methane, ppbv
NO DATA

Figure A10.8

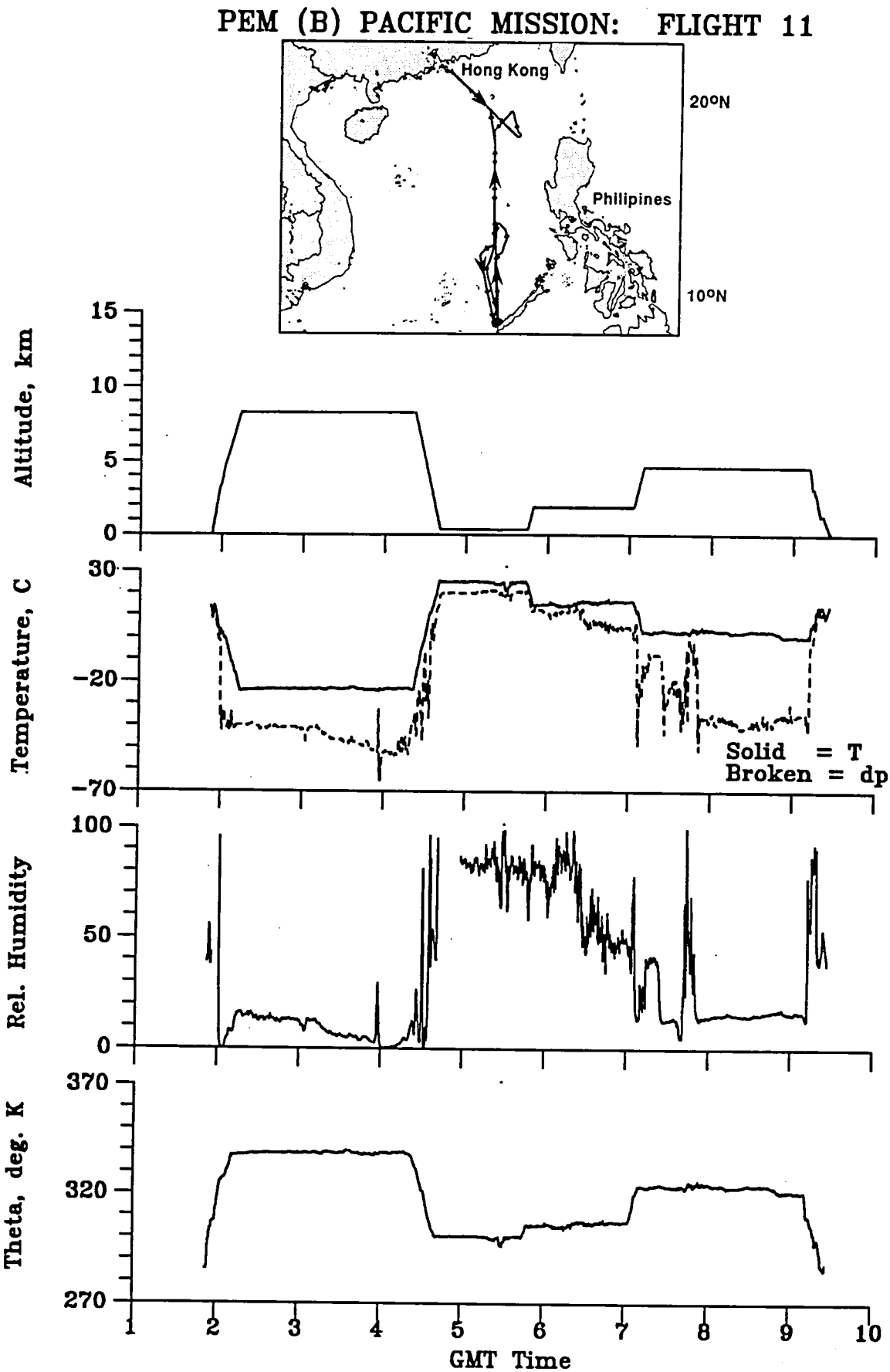

PEM (B) PACIFIC MISSION: FLIGHT 11
Hong Kong
Philippines
20°N
10°N
Altitude, km
15
10
5
0
Temperature, C
30
-20
-70
Solid = T
Broken = dp
Rel. Humidity
100
50
0
Theta, deg. K
370
320
270
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A11.1

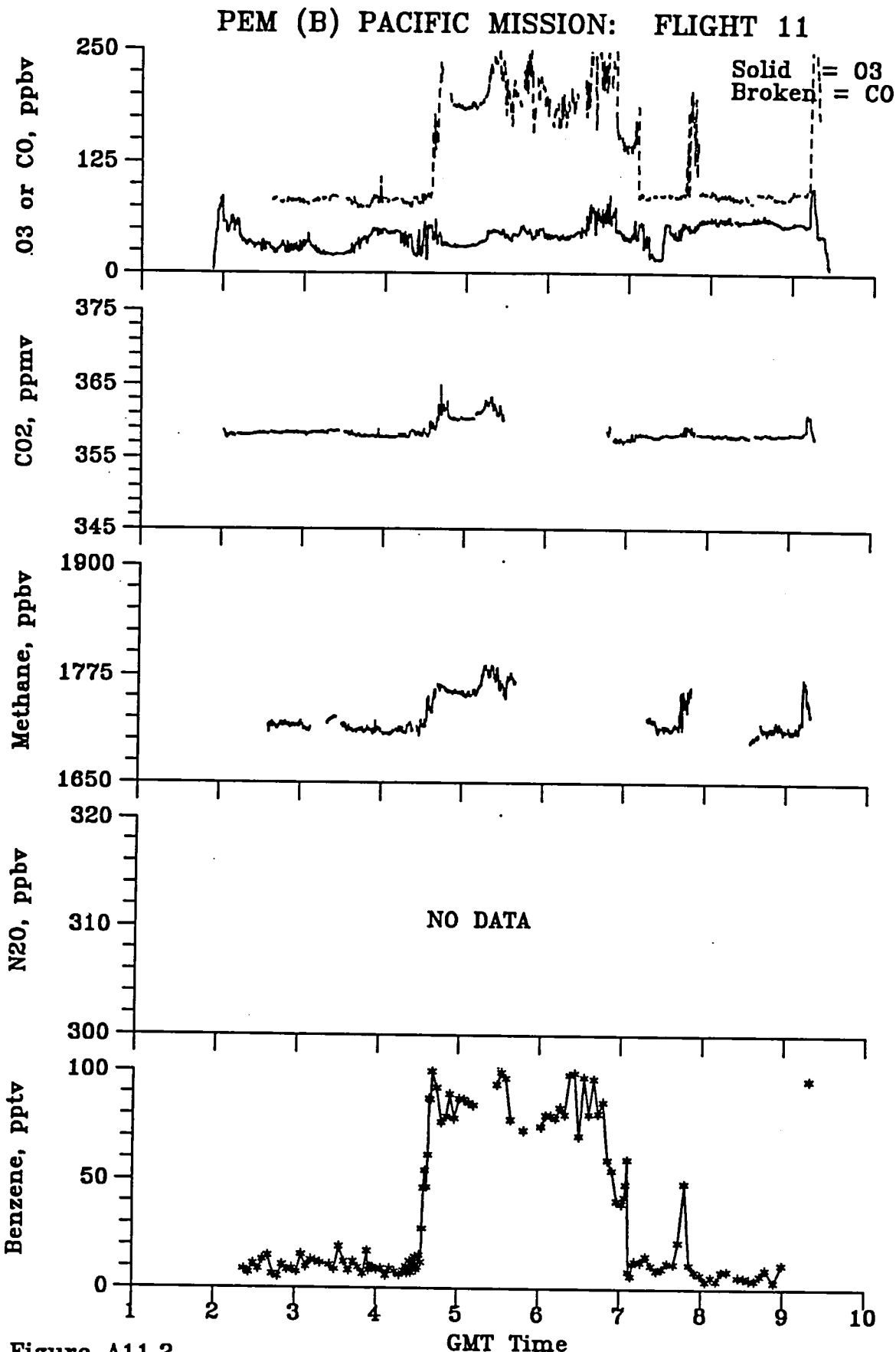

PEM (B) PACIFIC MISSION: FLIGHT 11
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
NO DATA
Benzene, pptv
100
50
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A11.2

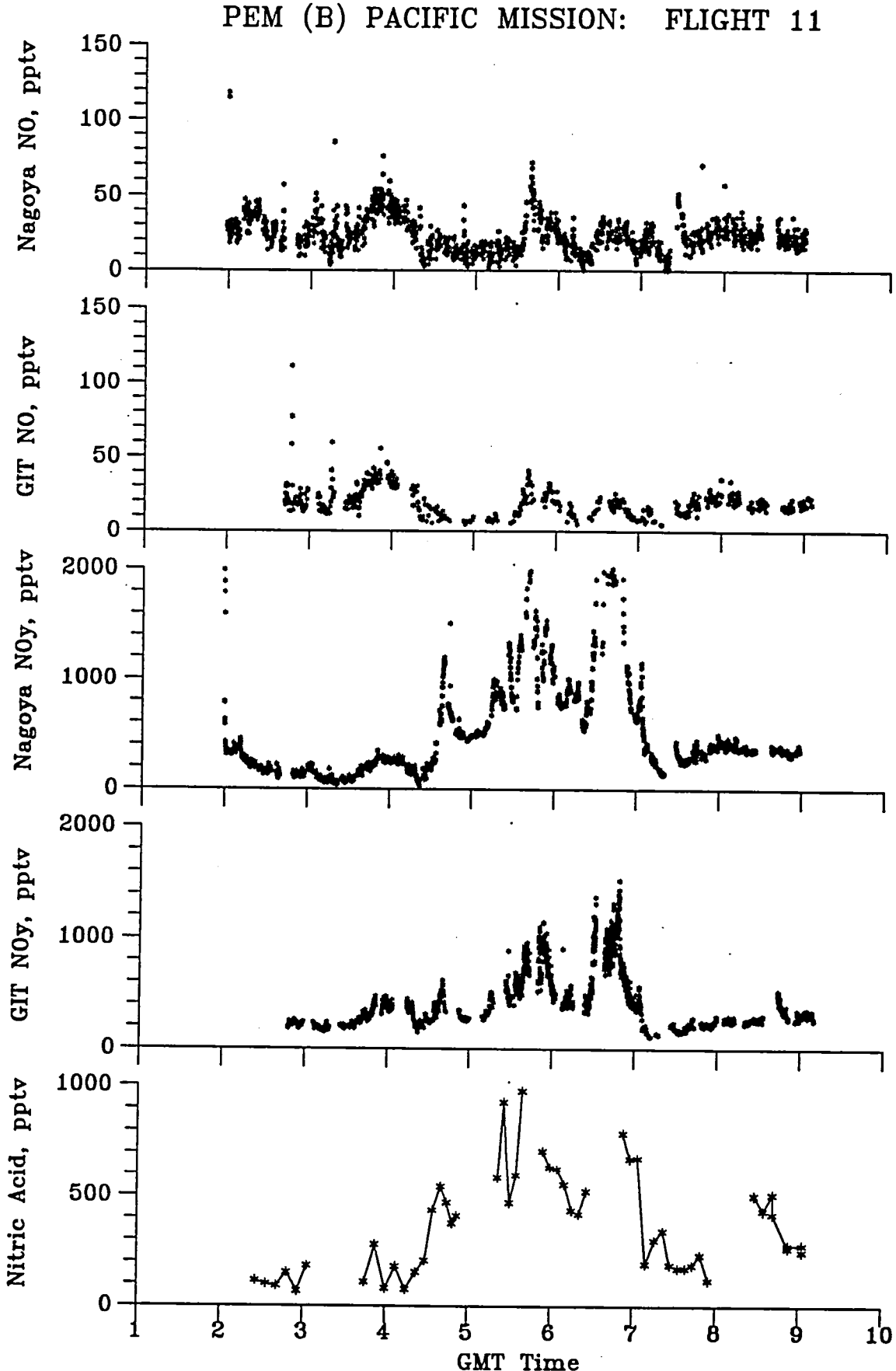

PEM (B) PACIFIC MISSION: FLIGHT 11
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
150
100
50
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
Nitric Acid, pptv
1000
500
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A11.3

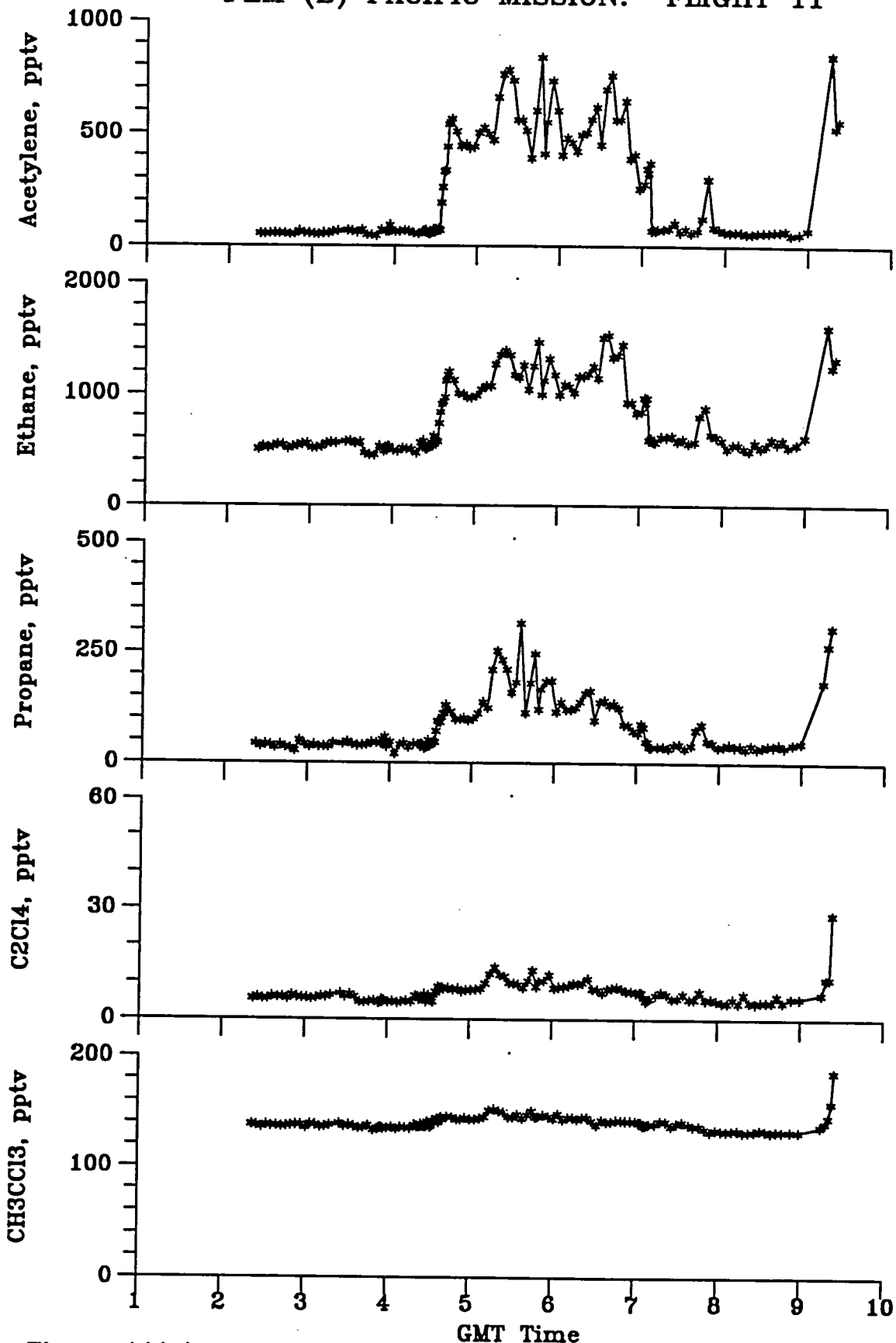

PEM (B) PACIFIC MISSION: FLIGHT 11
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A11.4

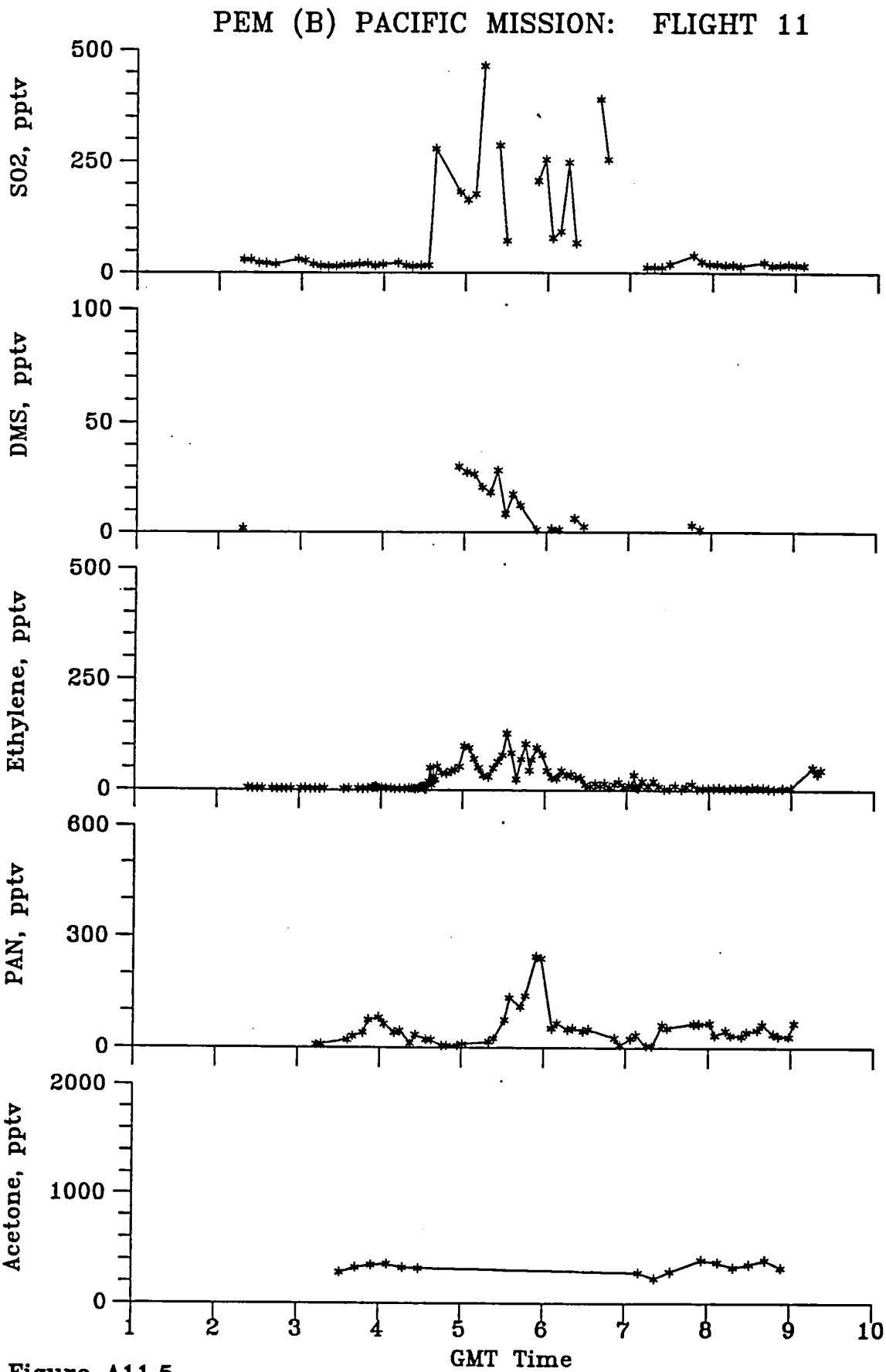

PEM (B) PACIFIC MISSION: FLIGHT 11
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A11.5

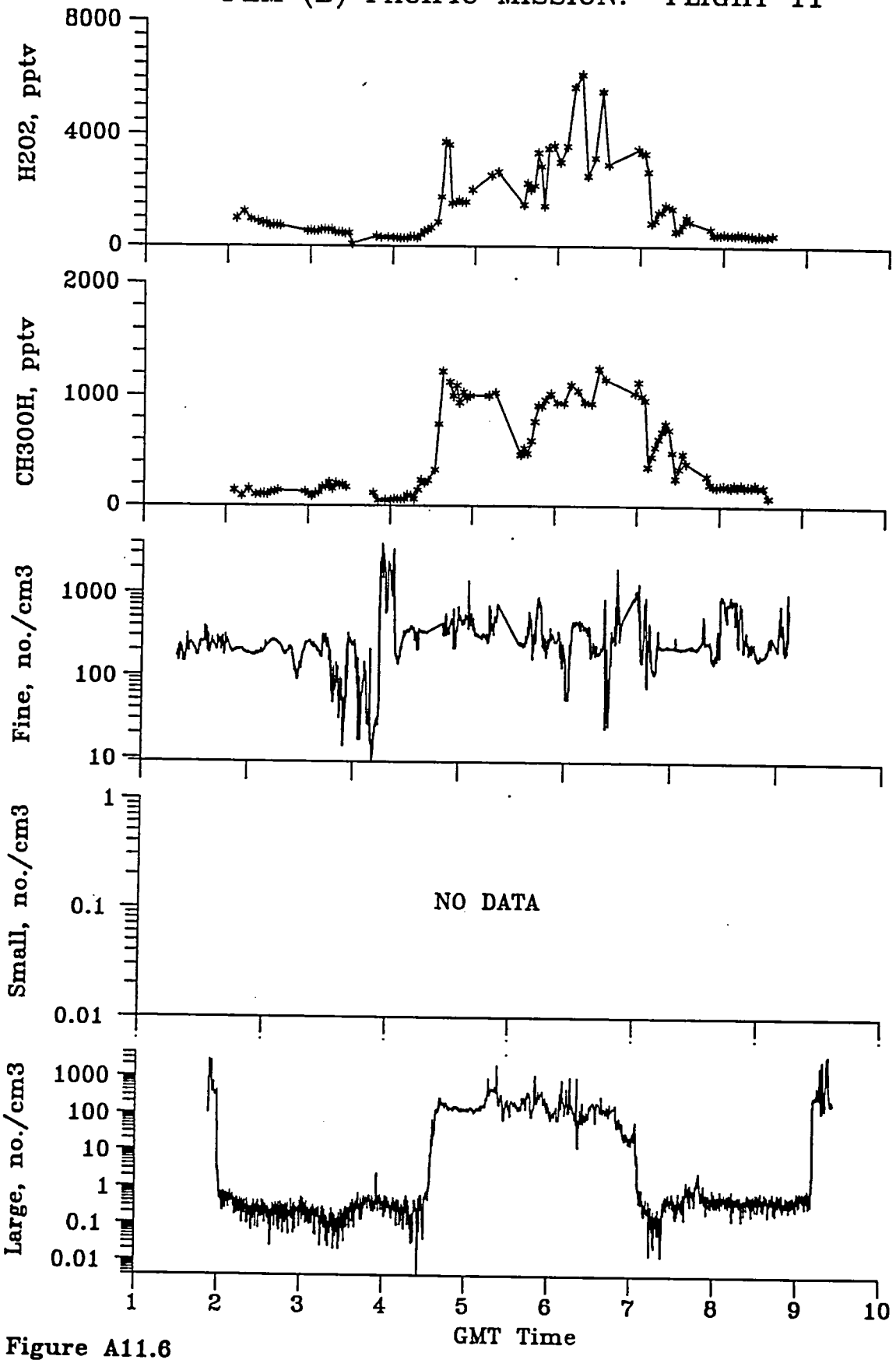

PEM (B) PACIFIC MISSION: FLIGHT 11
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
1000
100
10
1
0.1
0.01
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A11.6

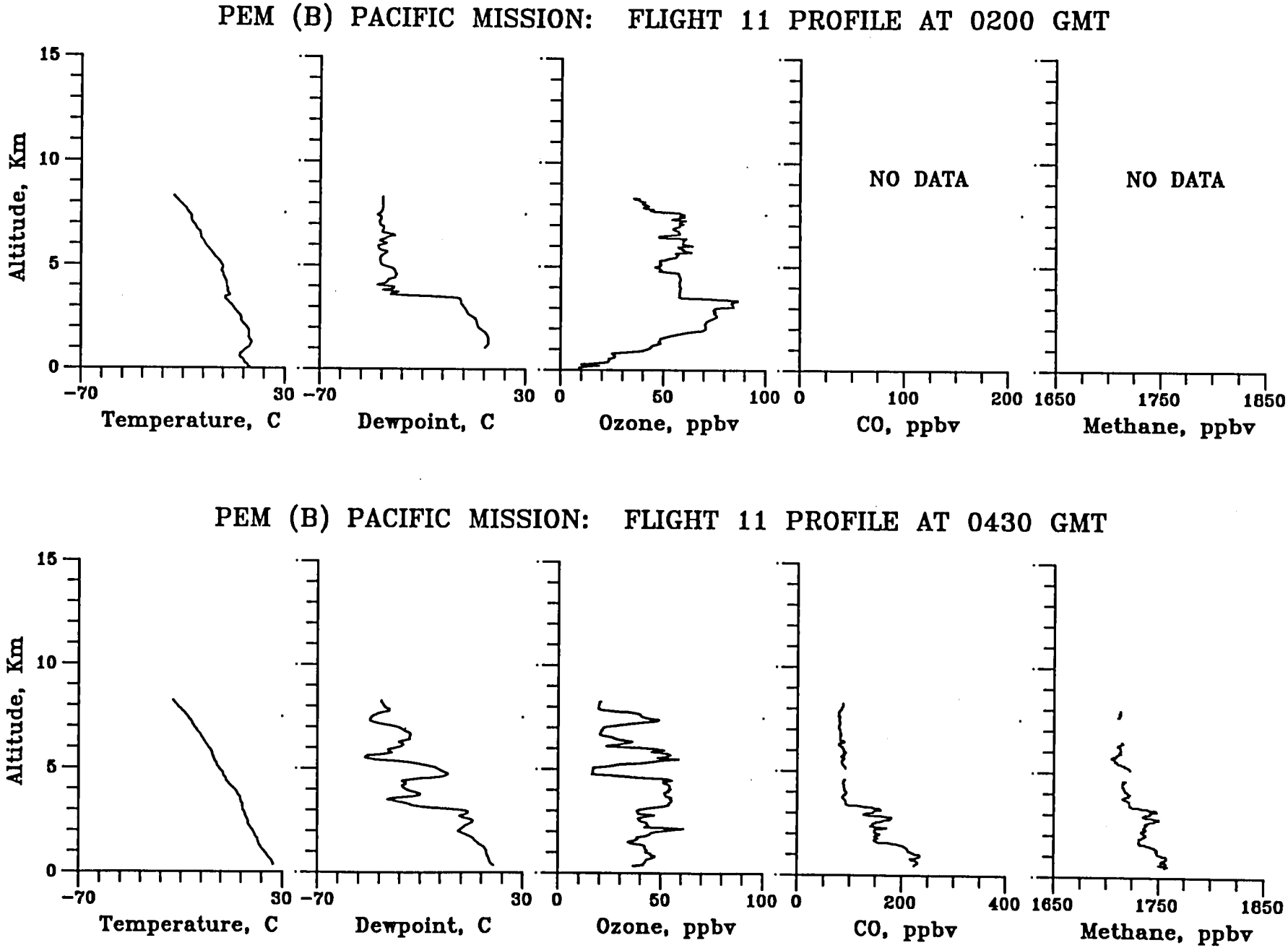

PEM (B) PACIFIC MISSION: FLIGHT 11 PROFILE AT 0200 GMT
Altitude, Km
15
10
5
0
−70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
NO DATA
0
100
200
CO, ppbv
NO DATA
1650
1750
1850
Methane, ppbv
PEM (B) PACIFIC MISSION: FLIGHT 11 PROFILE AT 0430 GMT
Altitude, Km
Temperature, C
Dewpoint, C
Ozone, ppbv
0
200
400
CO, ppbv
Methane, ppbv

Figure A11.7

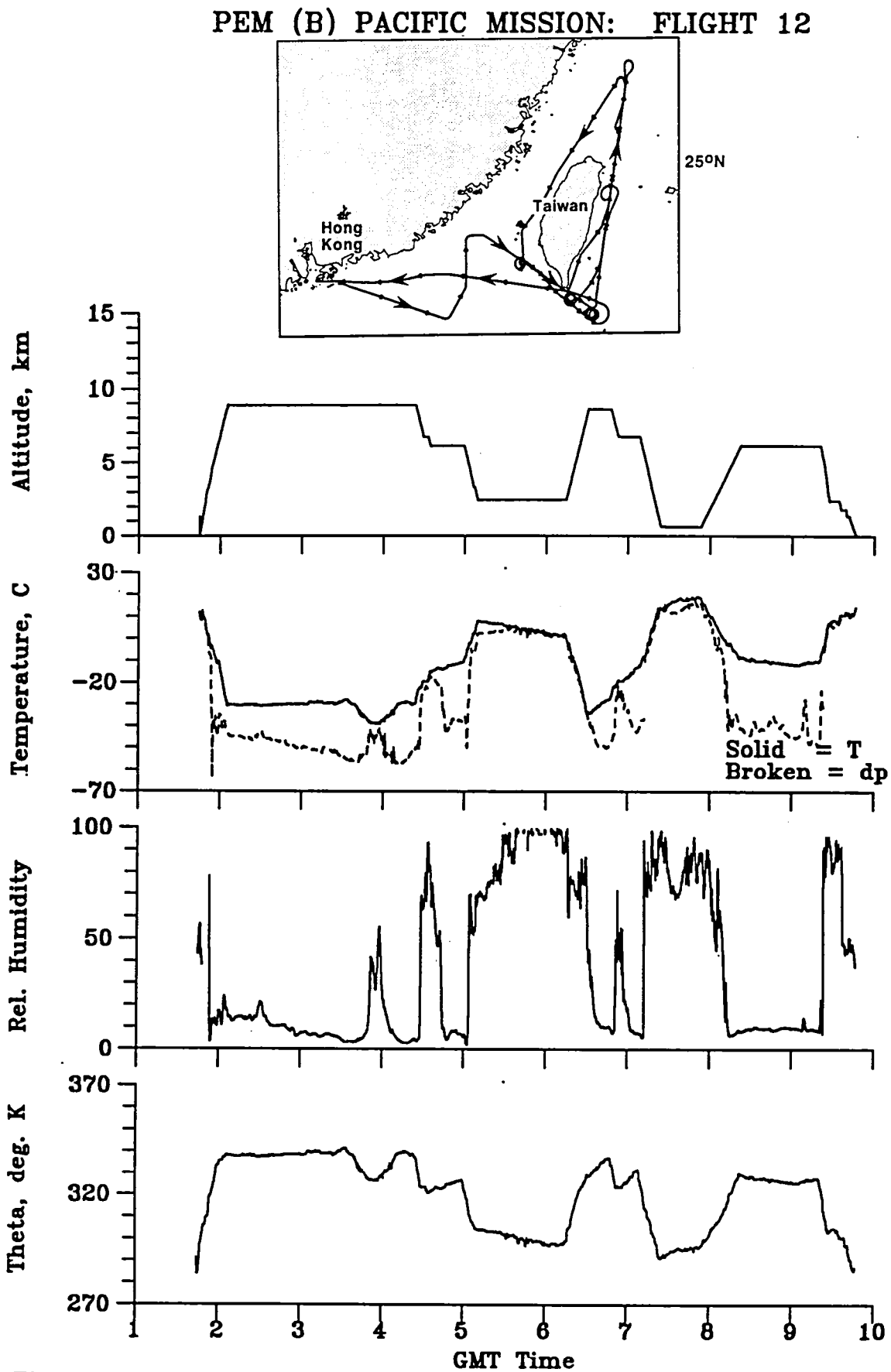

PEM (B) PACIFIC MISSION: FLIGHT 12
Hong Kong
Taiwan
25°N
Altitude, km
15
10
5
0
Temperature, C
30
-20
-70
Solid = T
Broken = dp
Rel. Humidity
100
50
0
Theta, deg. K
370
320
270
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A12.1

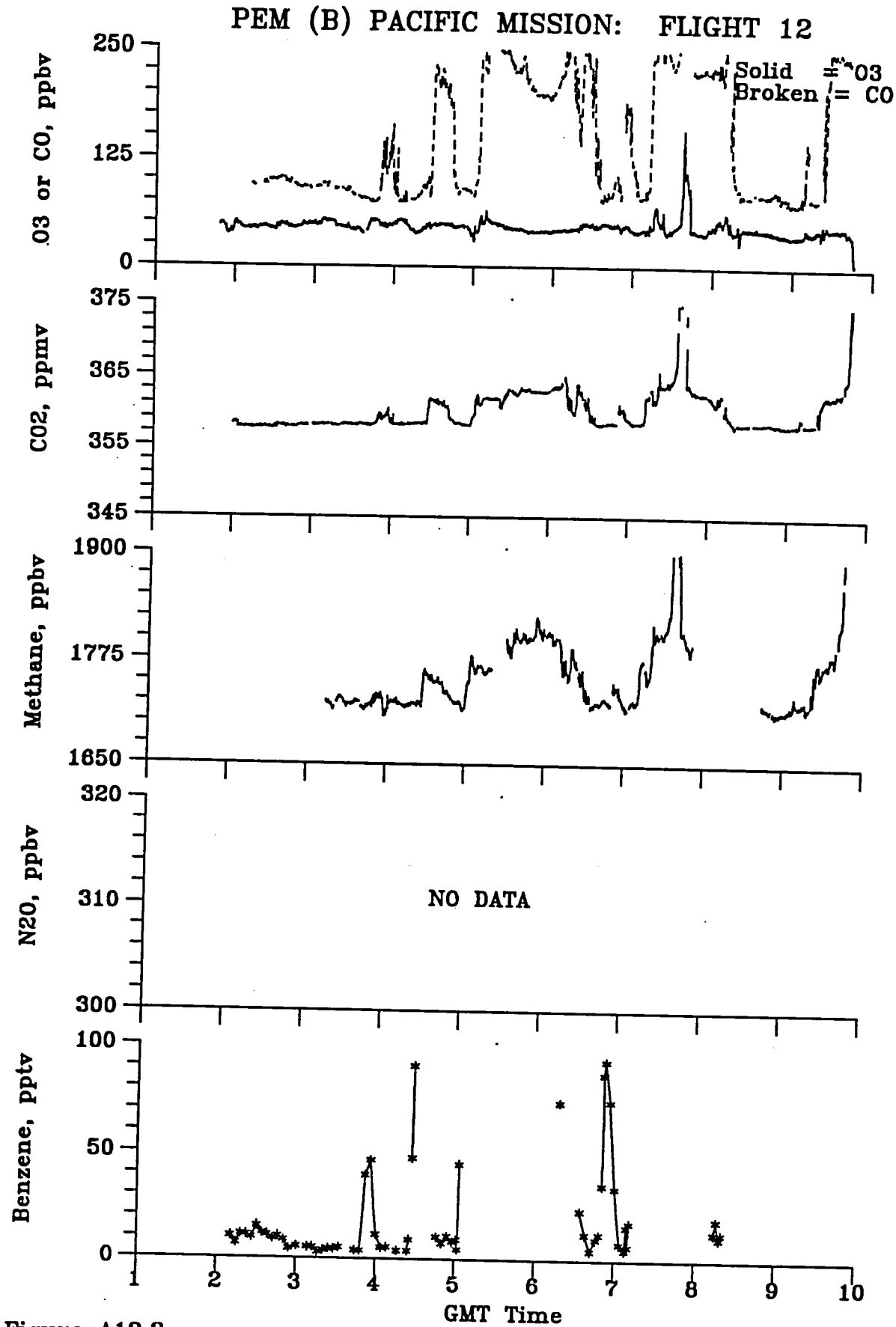

PEM (B) PACIFIC MISSION: FLIGHT 12
Solid = O3
Broken = CO
O3 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
NO DATA
Benzene, pptv
100
50
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A12.2

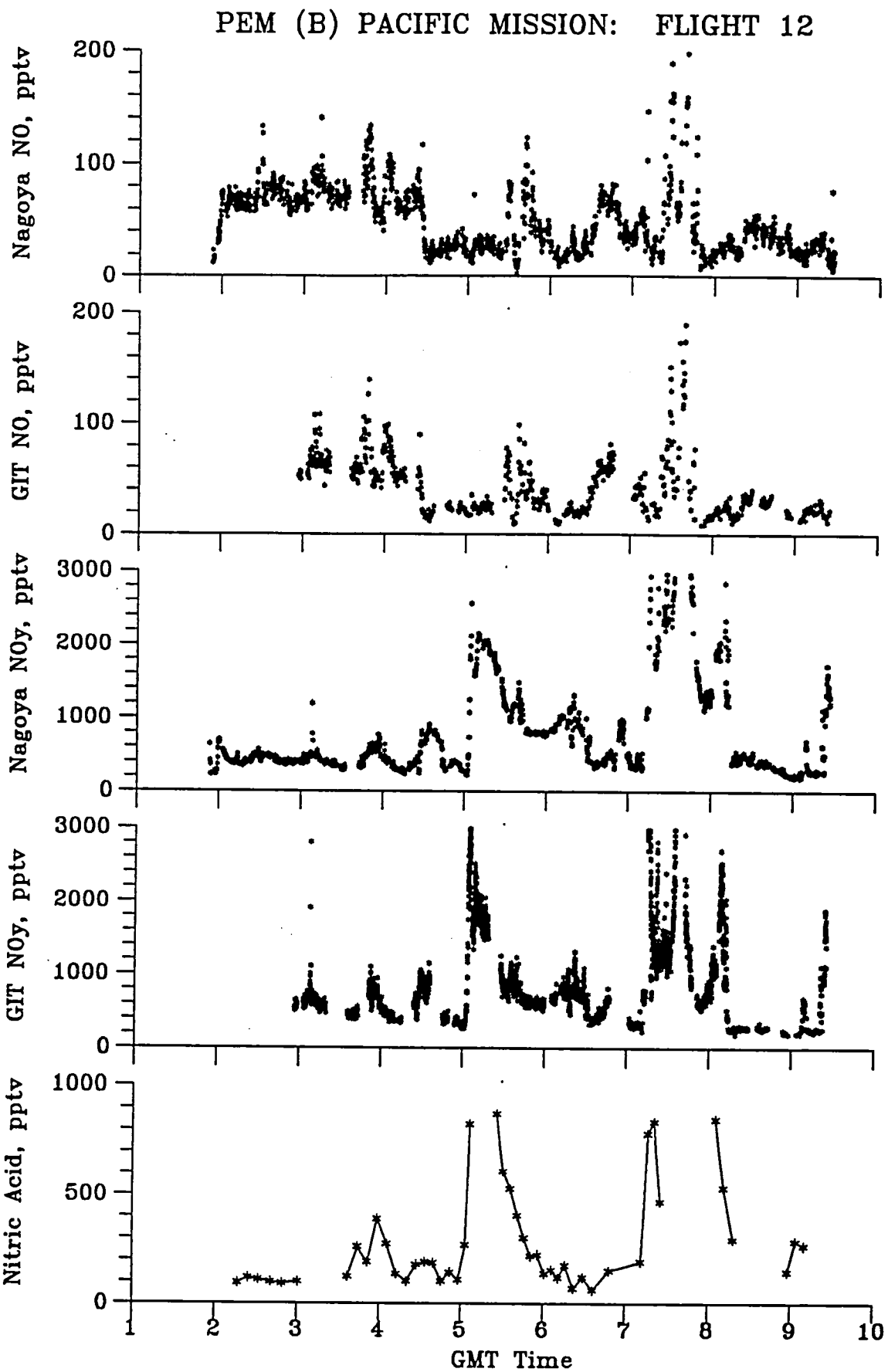

PEM (B) PACIFIC MISSION: FLIGHT 12
Nagoya NO, pptv
200
100
0
GIT NO, pptv
200
100
0
Nagoya NOy, pptv
3000
2000
1000
0
GIT NOy, pptv
3000
2000
1000
0
Nitric Acid, pptv
1000
500
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A12.3

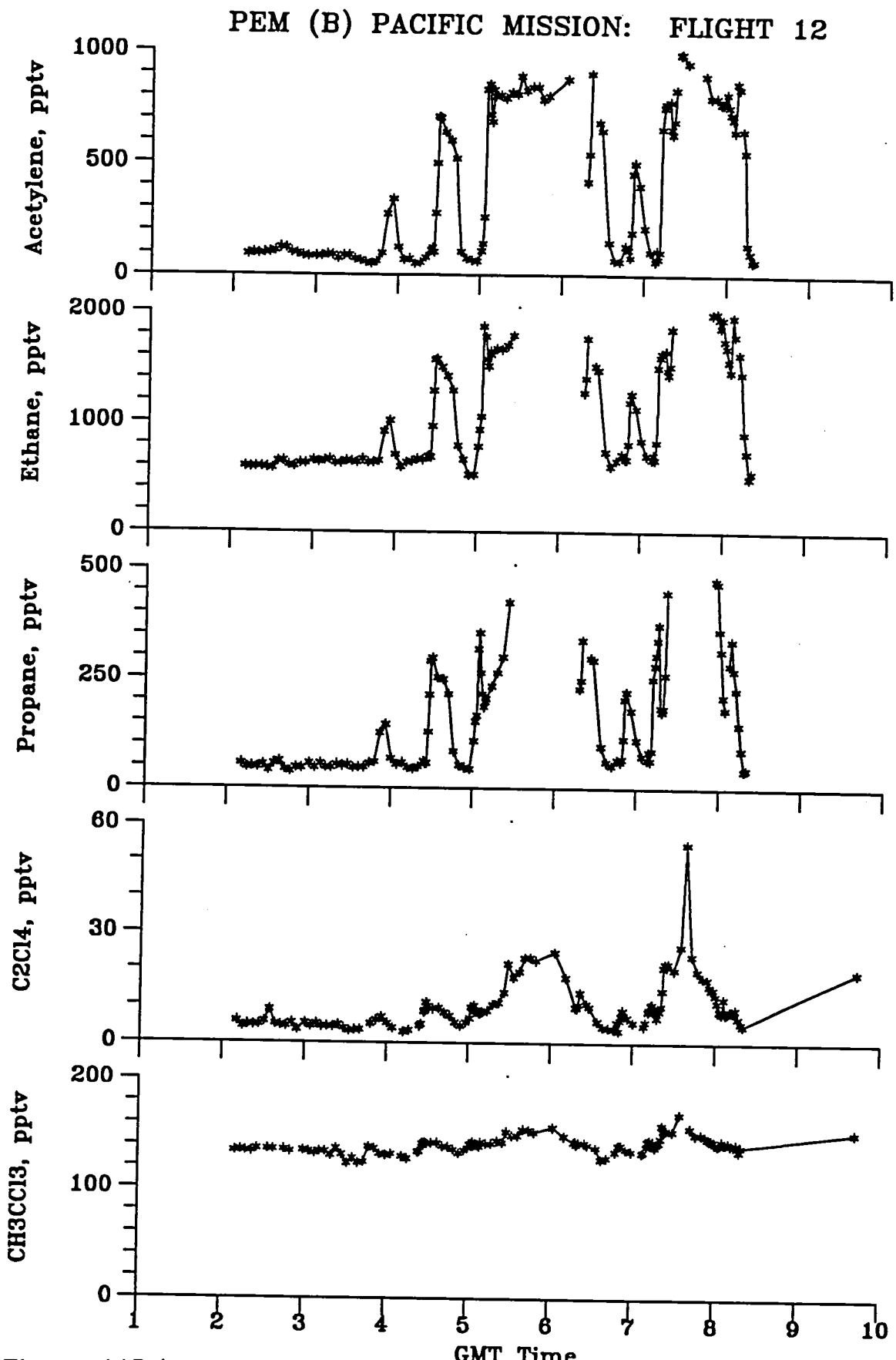

PEM (B) PACIFIC MISSION: FLIGHT 12
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A12.4

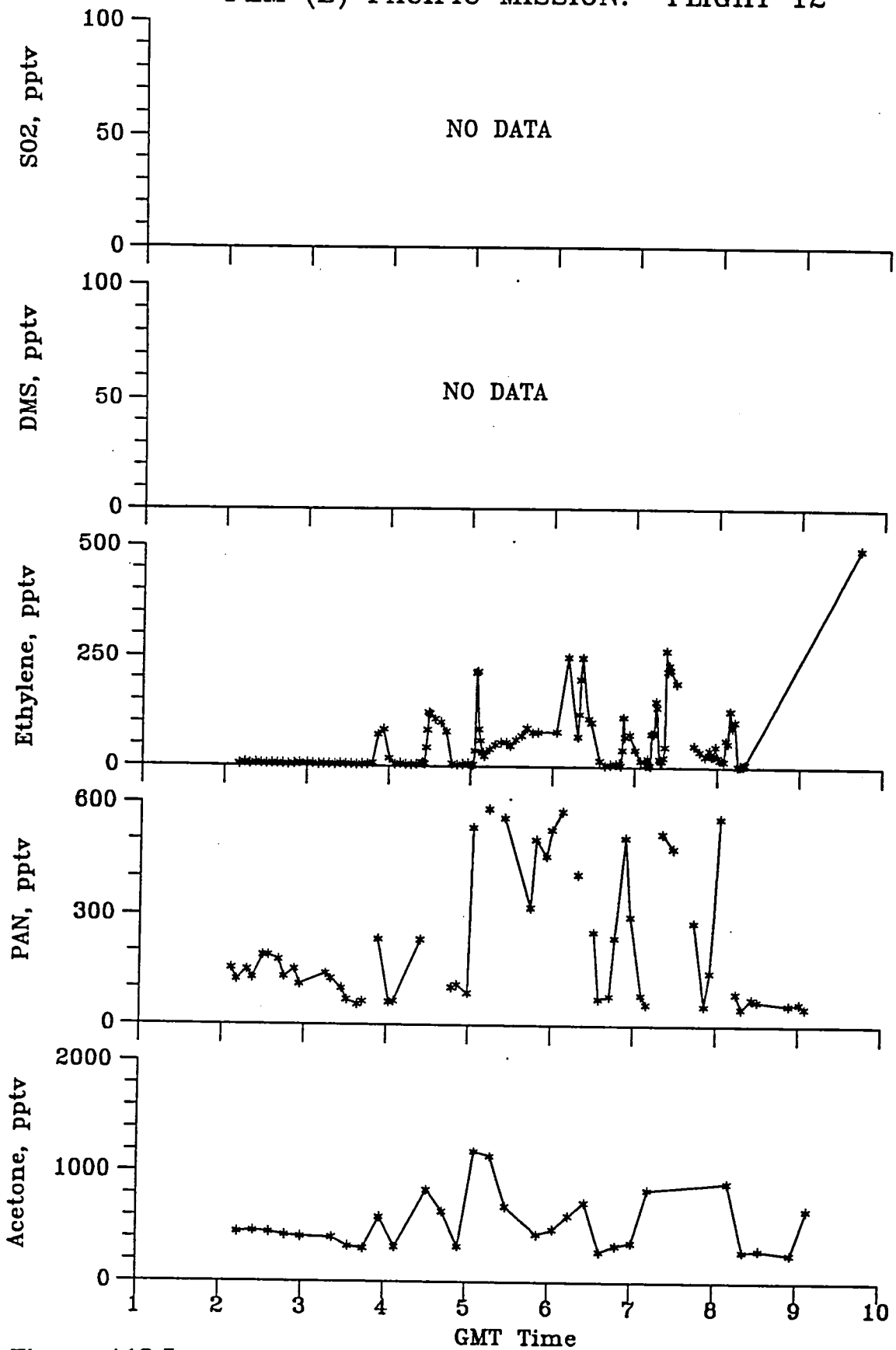

PEM (B) PACIFIC MISSION: FLIGHT 12
SO2, pptv
100
50
0
NO DATA
DMS, pptv
100
50
0
NO DATA
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A12.5

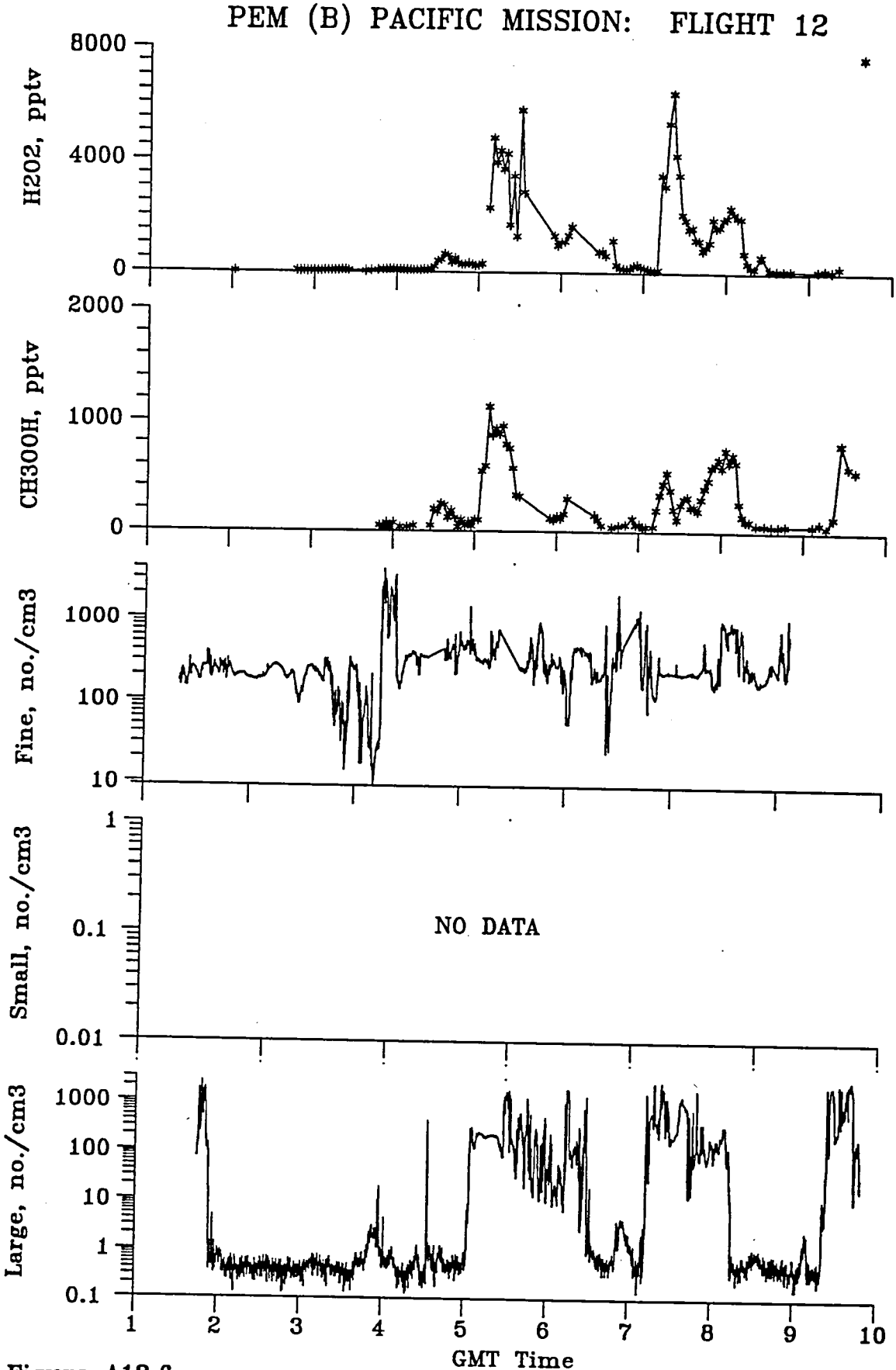

PEM (B) PACIFIC MISSION: FLIGHT 12
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
1000
100
10
1
0.1
1
2
3
4
5
6
7
8
9
10
GMT Time

Figure A12.6

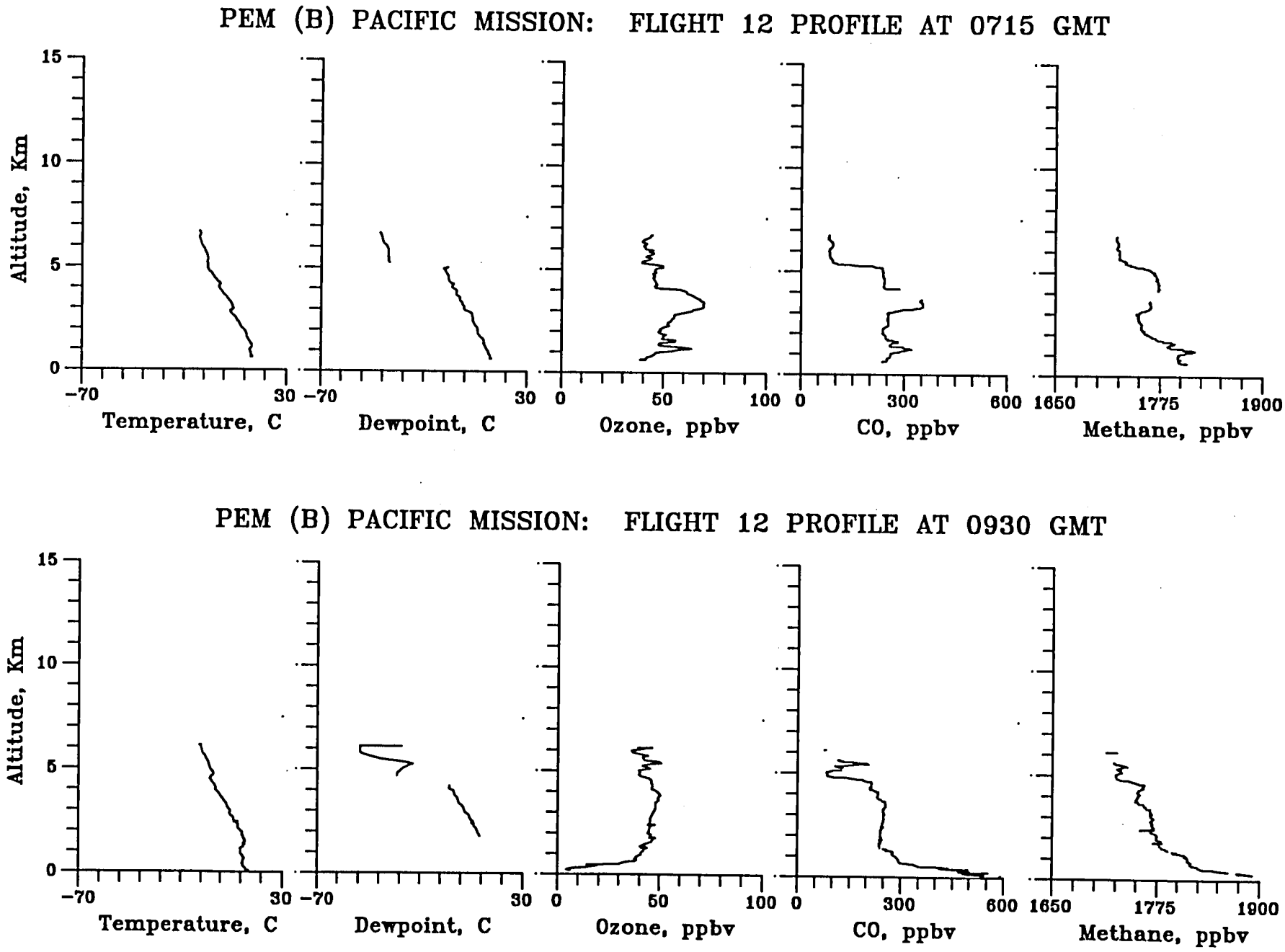

PEM (B) PACIFIC MISSION: FLIGHT 12 PROFILE AT 0715 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
300
600
CO, ppbv
1650
1775
1900
Methane, ppbv
PEM (B) PACIFIC MISSION: FLIGHT 12 PROFILE AT 0930 GMT

Figure A12.7

PEM (B) PACIFIC MISSION: FLIGHT 13

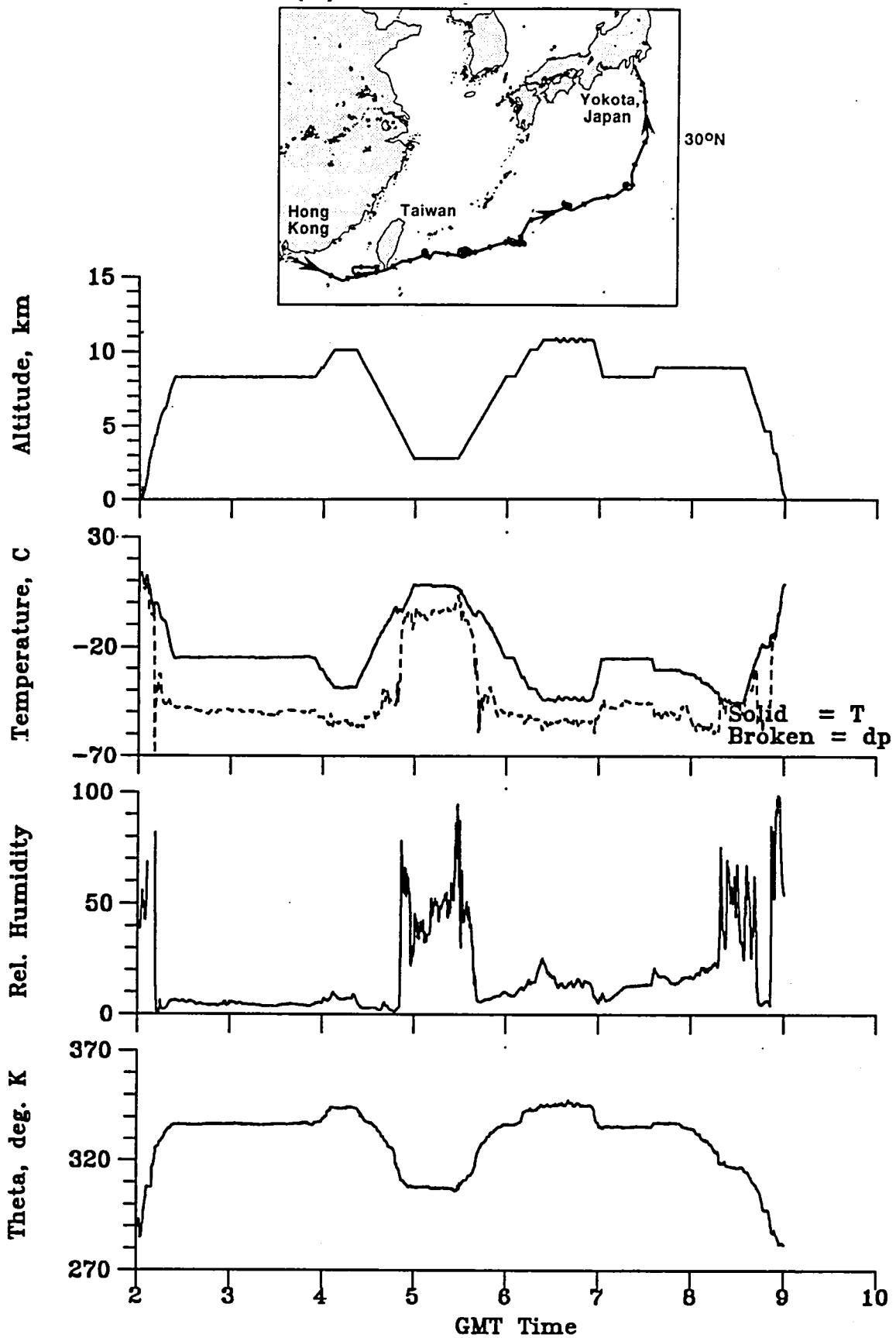


Figure A13.1

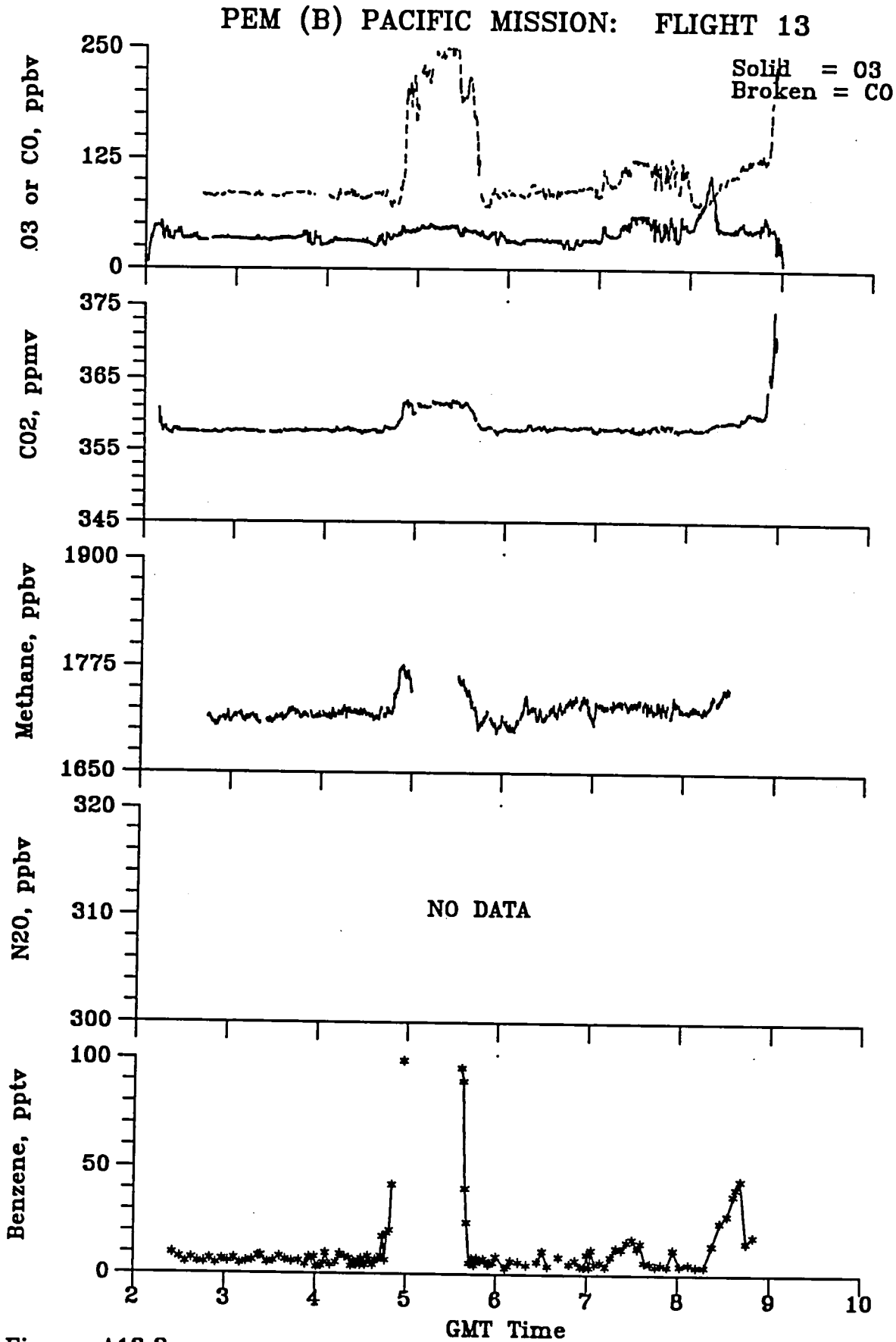

PEM (B) PACIFIC MISSION: FLIGHT 13
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
NO DATA
Benzene, pptv
100
50
0
2
3
4
5
6
7
8
9
10
GMT Time

Figure A13.2

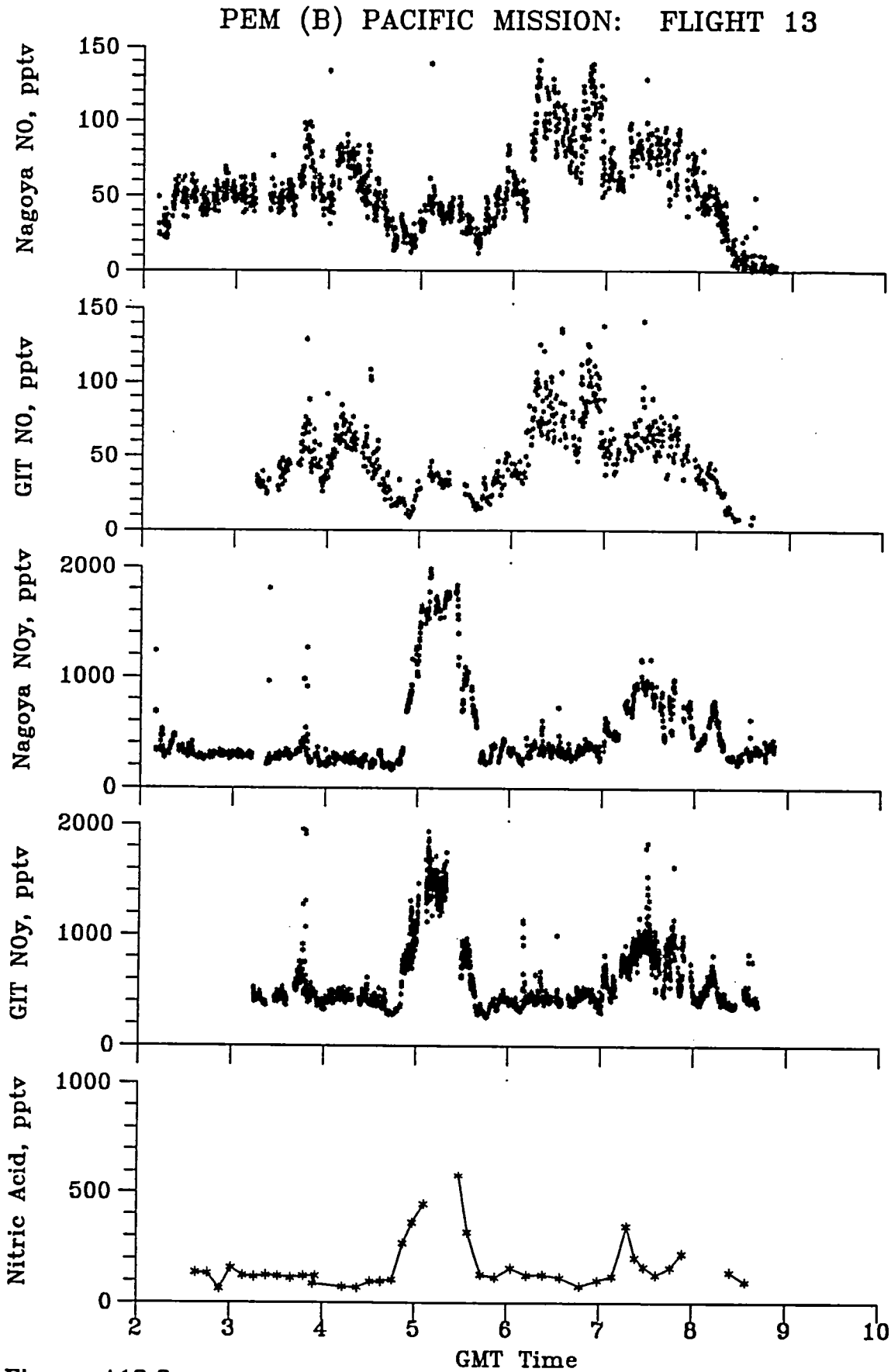

PEM (B) PACIFIC MISSION: FLIGHT 13
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
150
100
50
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
Nitric Acid, pptv
1000
500
0
2
3
4
5
6
7
8
9
10
GMT Time

Figure A13.3

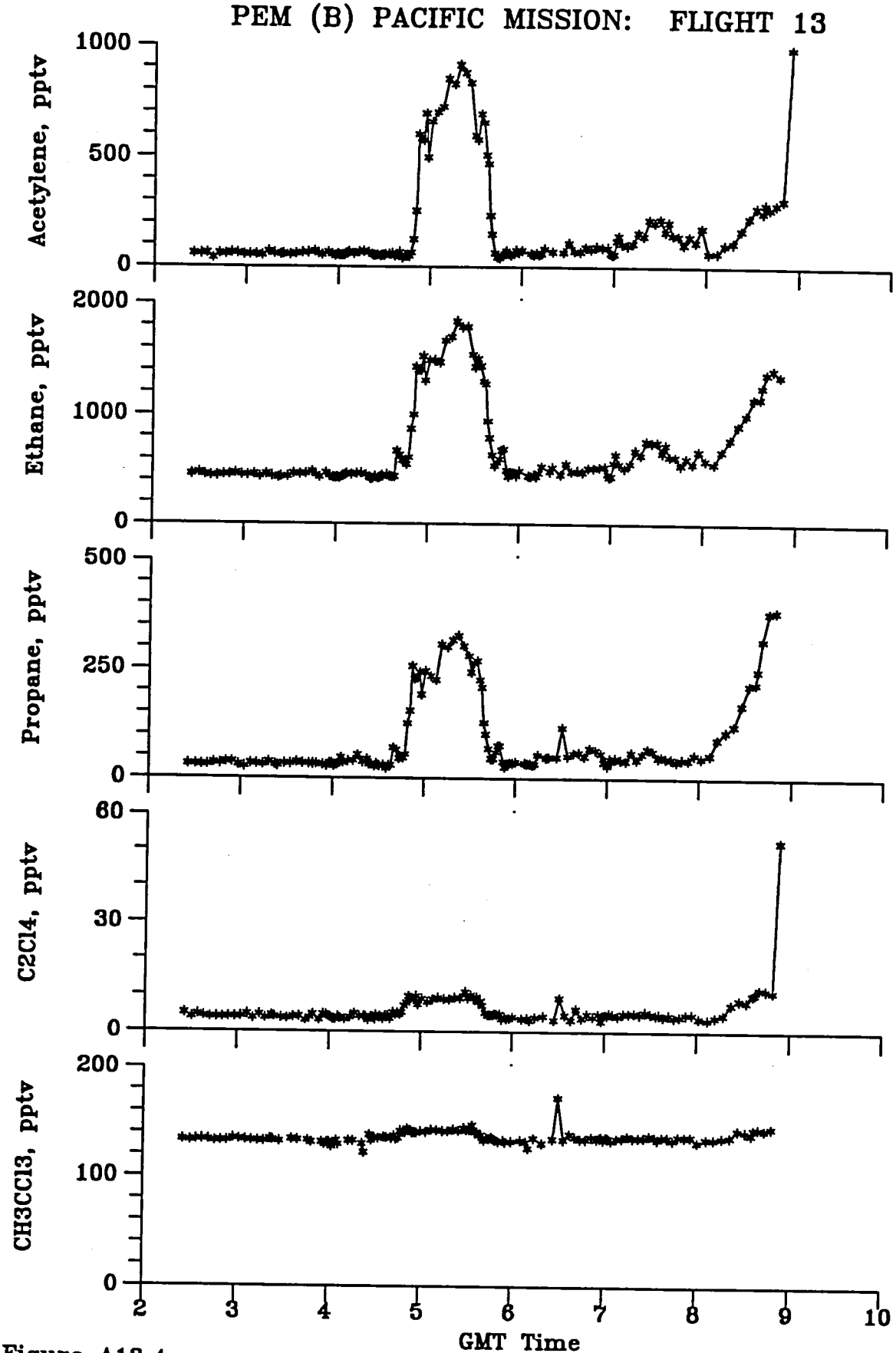

PEM (B) PACIFIC MISSION: FLIGHT 13
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
2
3
4
5
6
7
8
9
10
GMT Time

Figure A13.4

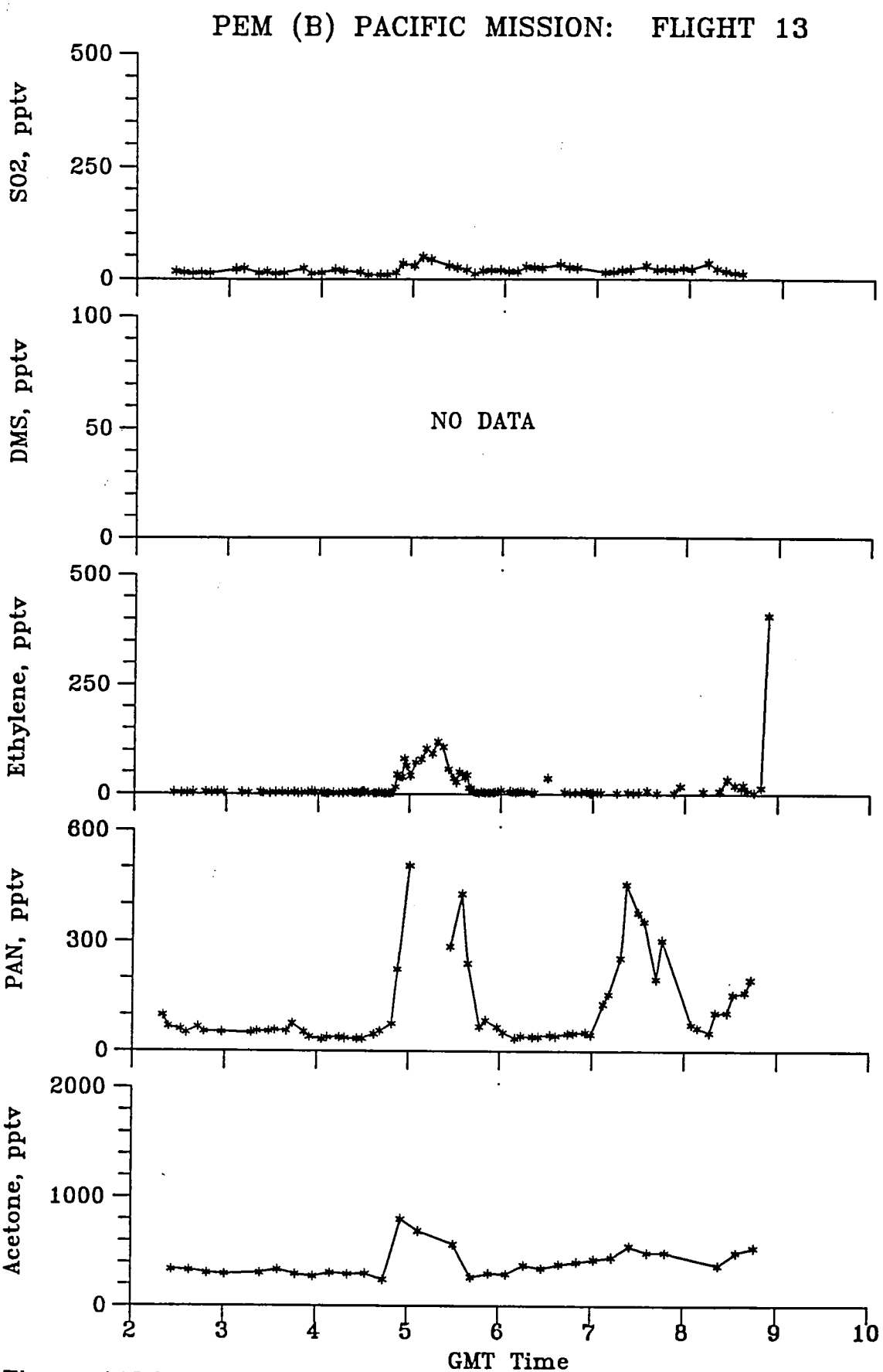

PEM (B) PACIFIC MISSION: FLIGHT 13
SO2, pptv
500
250
0
DMS, pptv
100
50
0
NO DATA
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
2
3
4
5
6
7
8
9
10
GMT Time

Figure A13.5

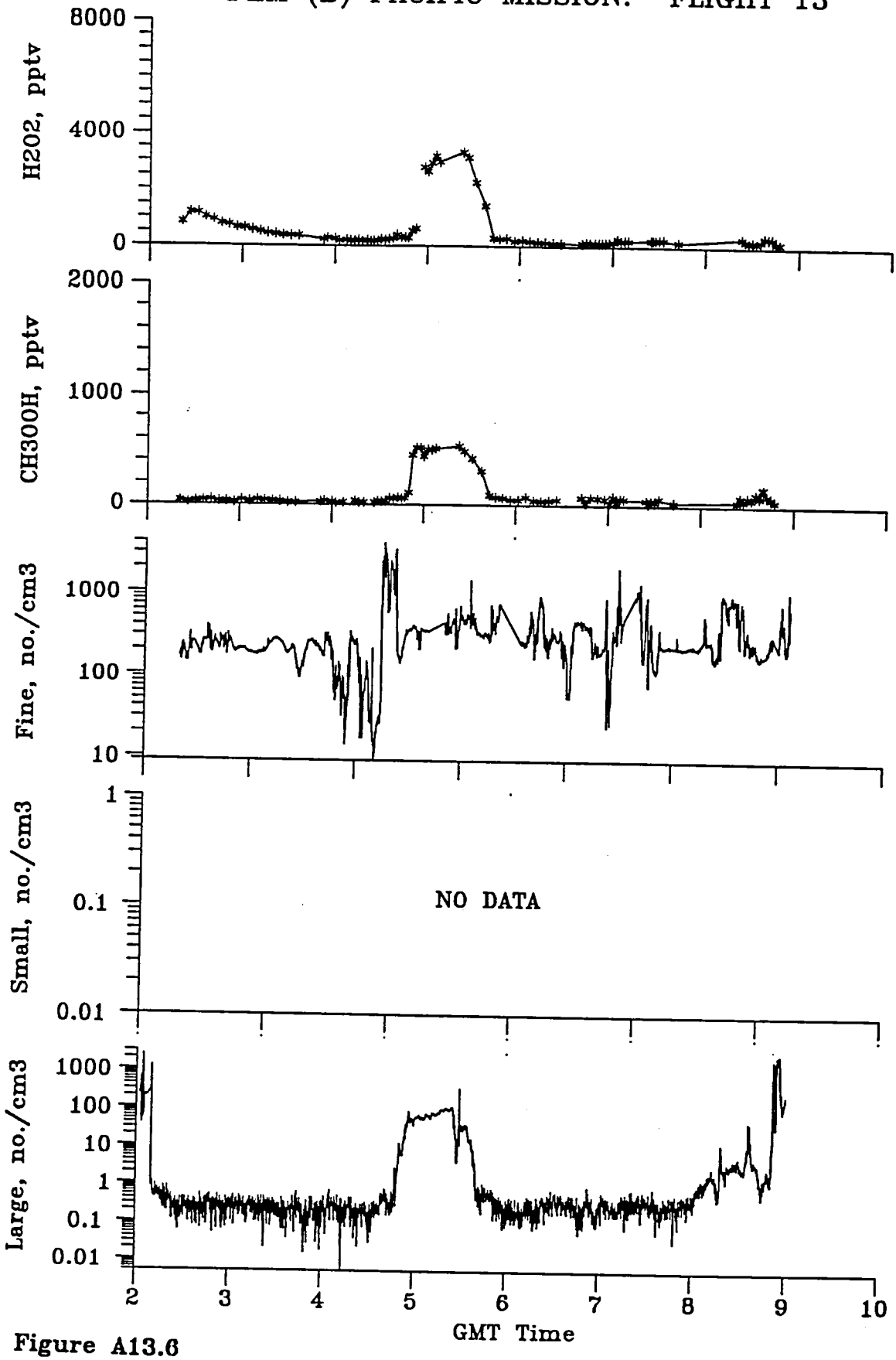
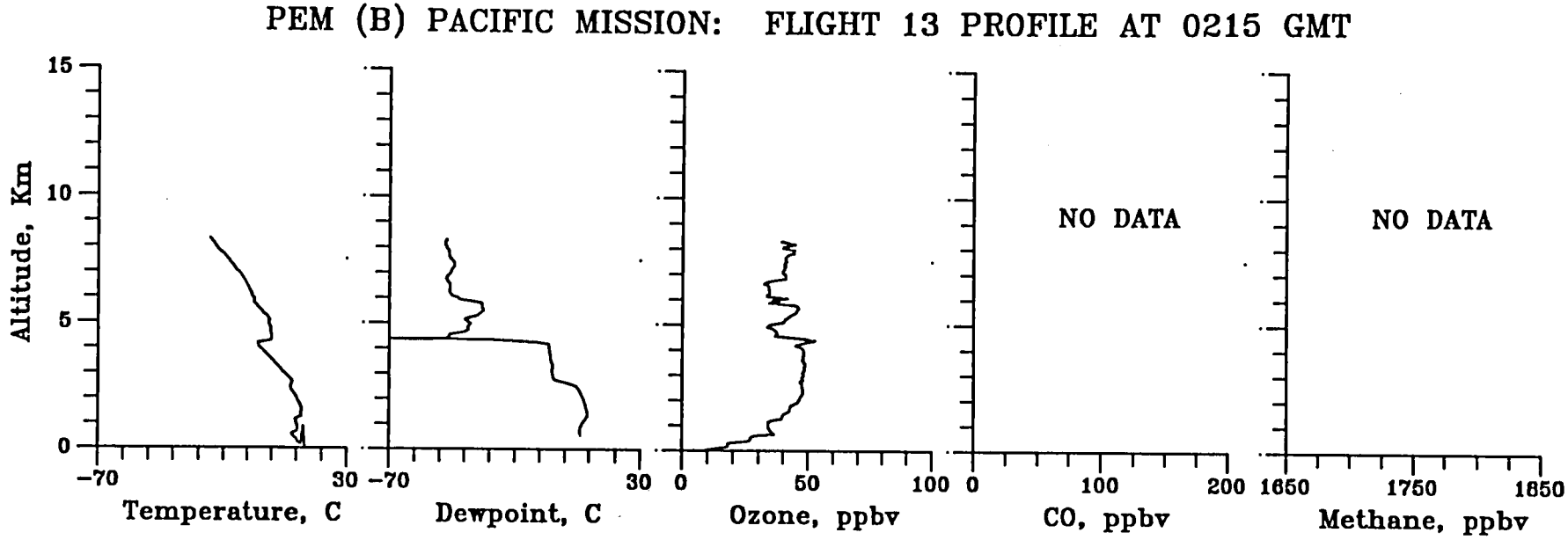
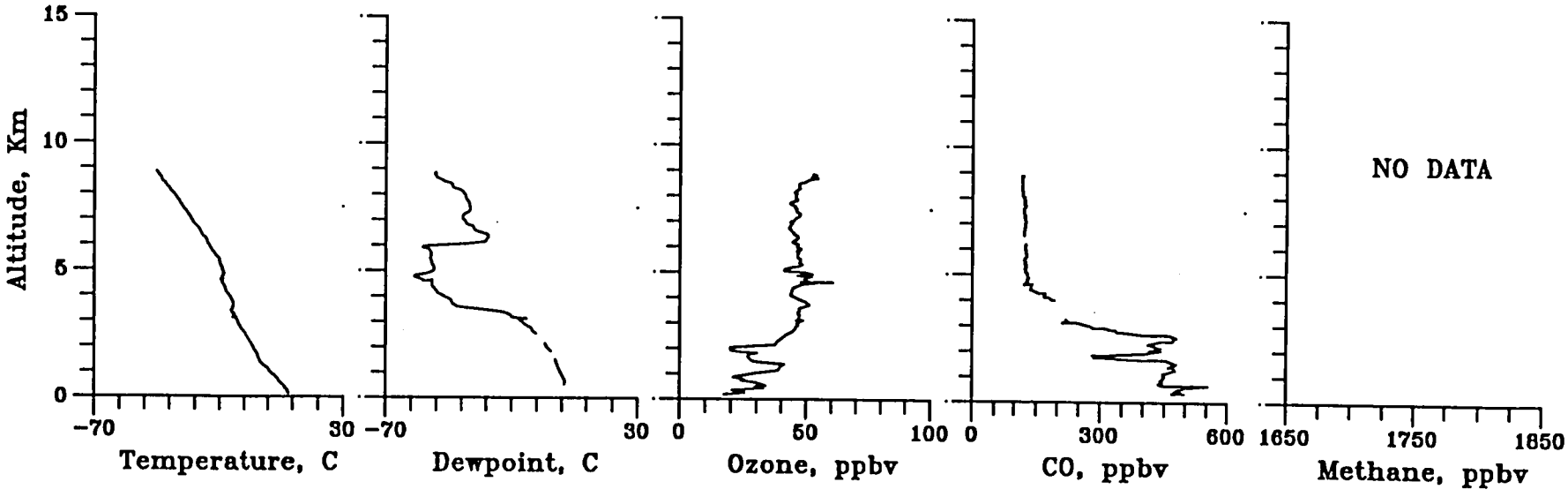

PEM (B) PACIFIC MISSION: FLIGHT 13
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1
0.1
0.01
NO DATA
Large, no./cm3
1000
100
10
1
0.1
0.01
2
3
4
5
6
7
8
9
10
GMT Time

Figure A13.6


PEM (B) PACIFIC MISSION: FLIGHT 13 PROFILE AT 0215 GMT
Altitude, Km
15
10
5
0
−70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
NO DATA
0
100
200
CO, ppbv
NO DATA
1650
1750
1850
Methane, ppbv


PEM (B) PACIFIC MISSION: FLIGHT 13 PROFILE AT 0845 GMT
Altitude, Km
15
10
5
0
−70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
0
300
600
CO, ppbv
NO DATA
1650
1750
1850
Methane, ppbv

PEM (B) PACIFIC MISSION: FLIGHT 14

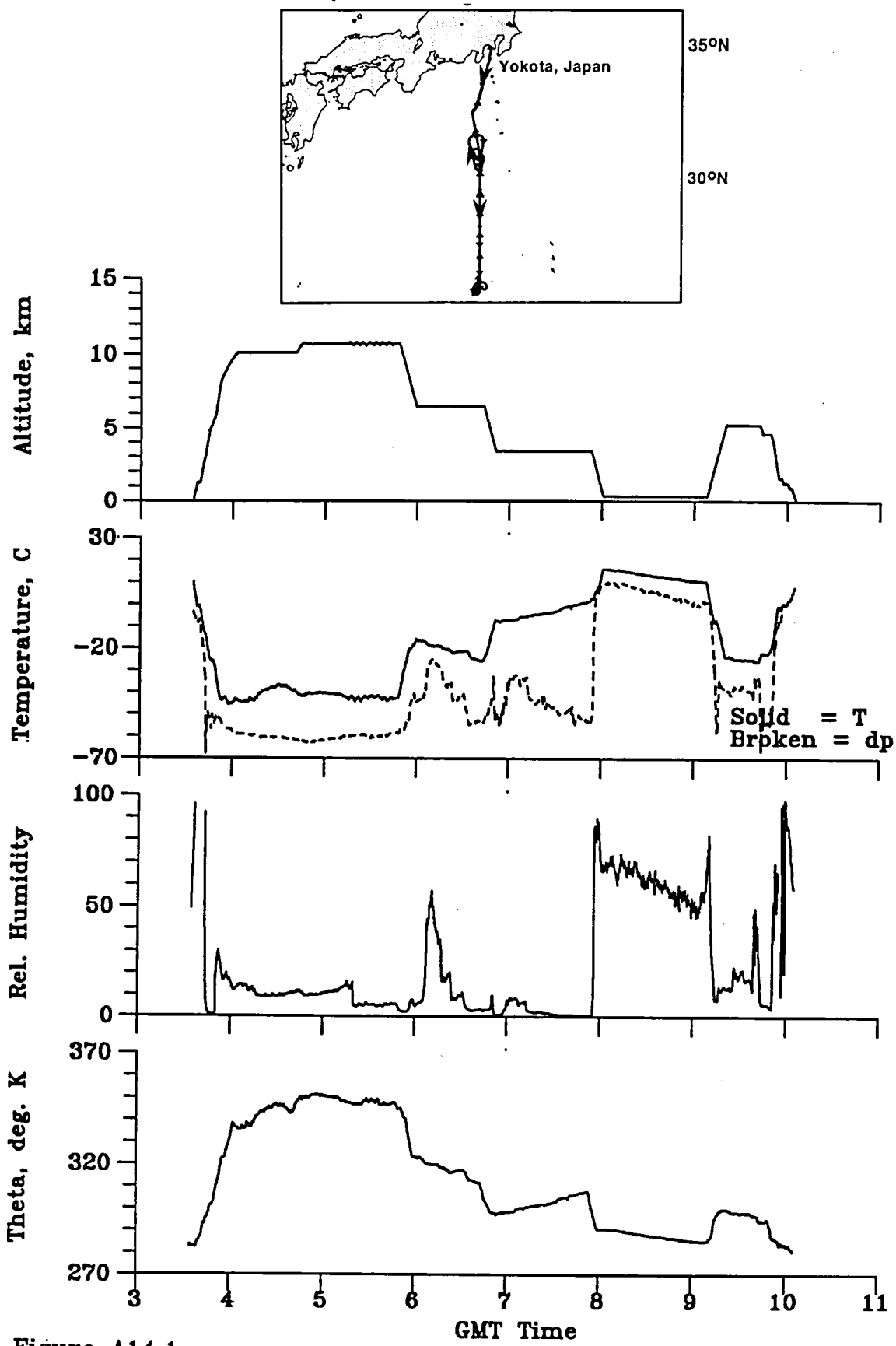


Figure A14.1

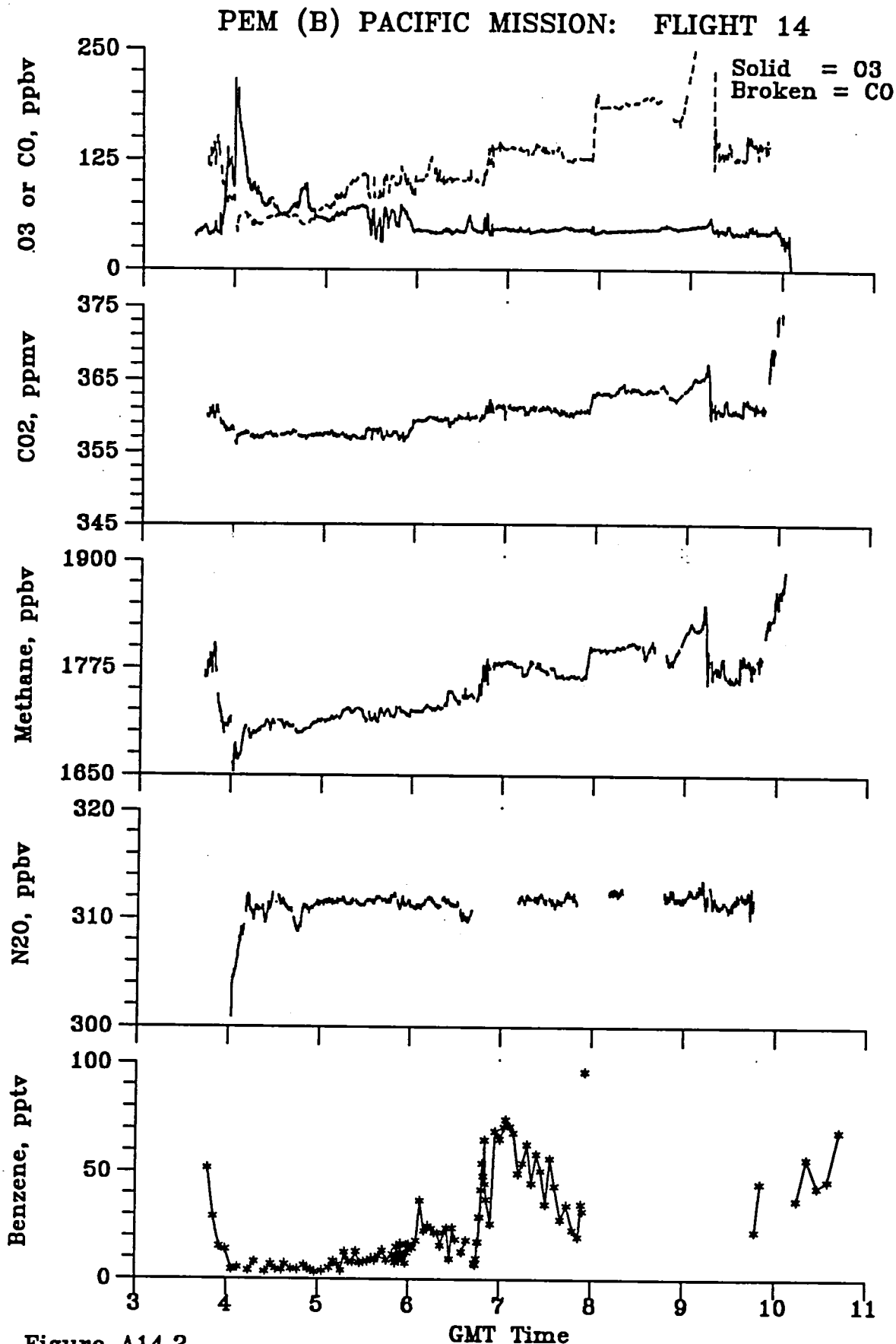

PEM (B) PACIFIC MISSION: FLIGHT 14
Solid = O3
Broken = CO
O3 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
3
4
5
6
7
8
9
10
11
GMT Time

Figure A14.2

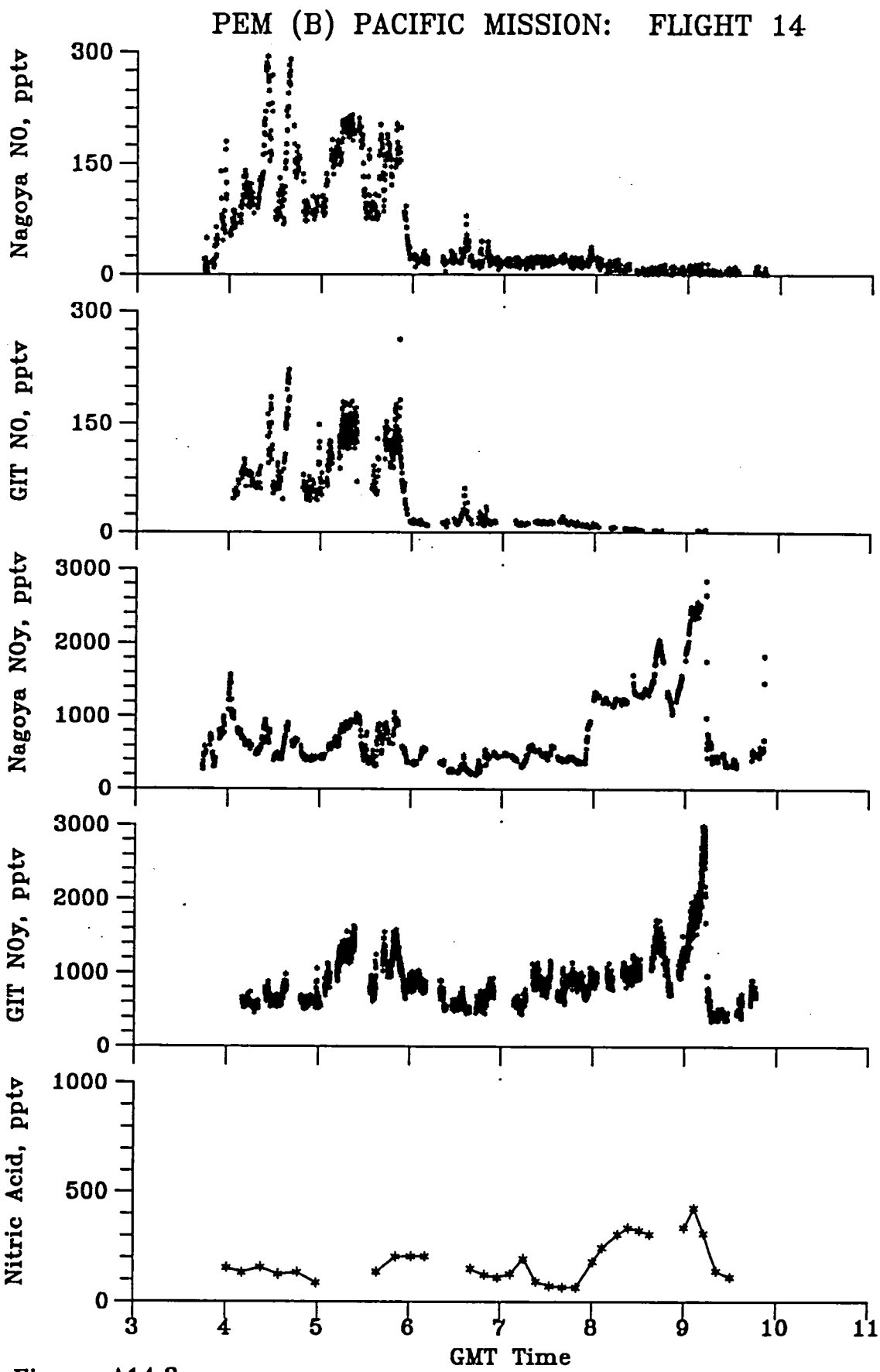

PEM (B) PACIFIC MISSION: FLIGHT 14
Nagoya NO, pptv
300
150
0
GIT NO, pptv
300
150
0
Nagoya NOy, pptv
3000
2000
1000
0
GIT NOy, pptv
3000
2000
1000
0
Nitric Acid, pptv
1000
500
0
3
4
5
6
7
8
9
10
11
GMT Time

Figure A14.3

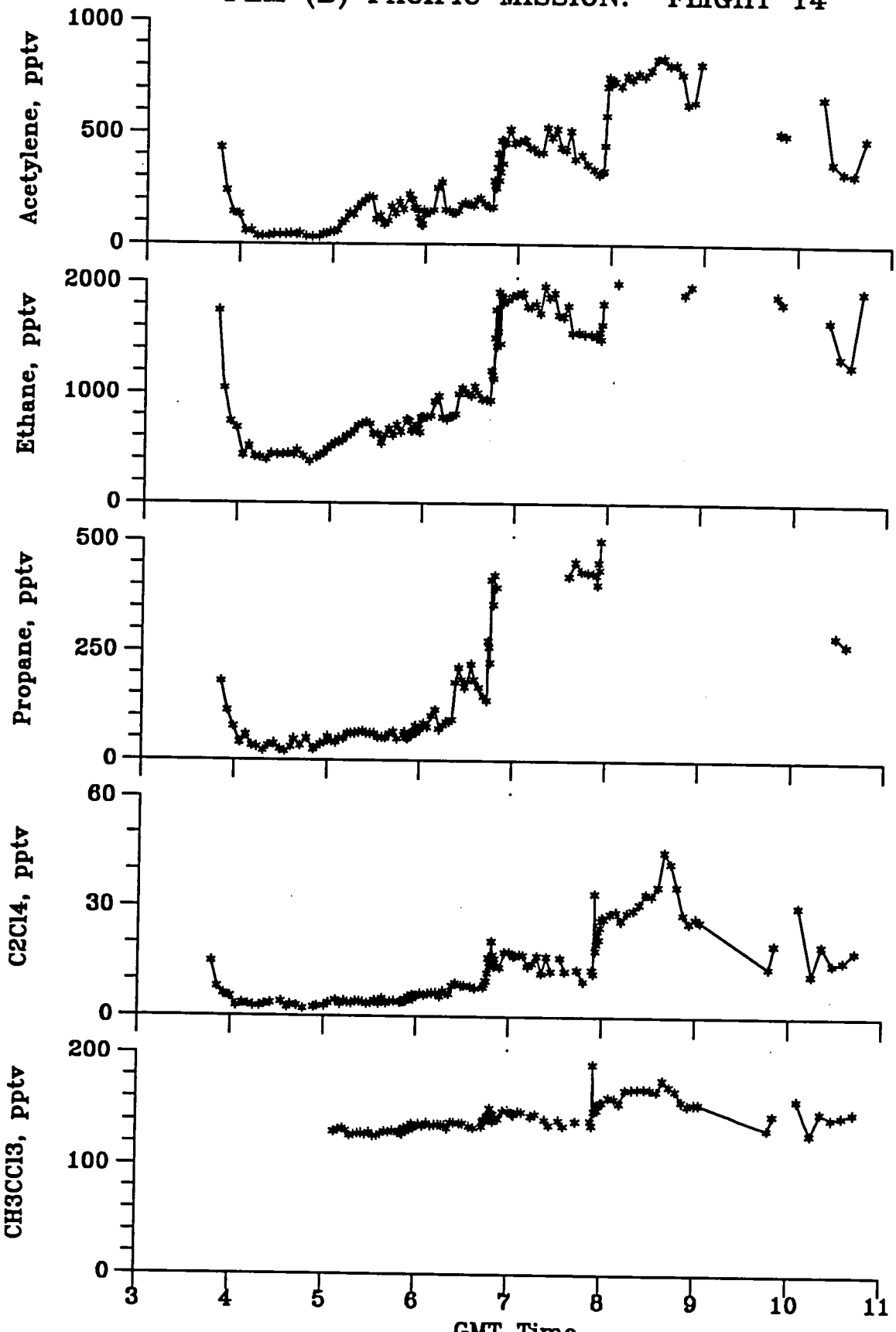

PEM (B) PACIFIC MISSION: FLIGHT 14
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
3
4
5
6
7
8
9
10
11
GMT Time

Figure A14.4

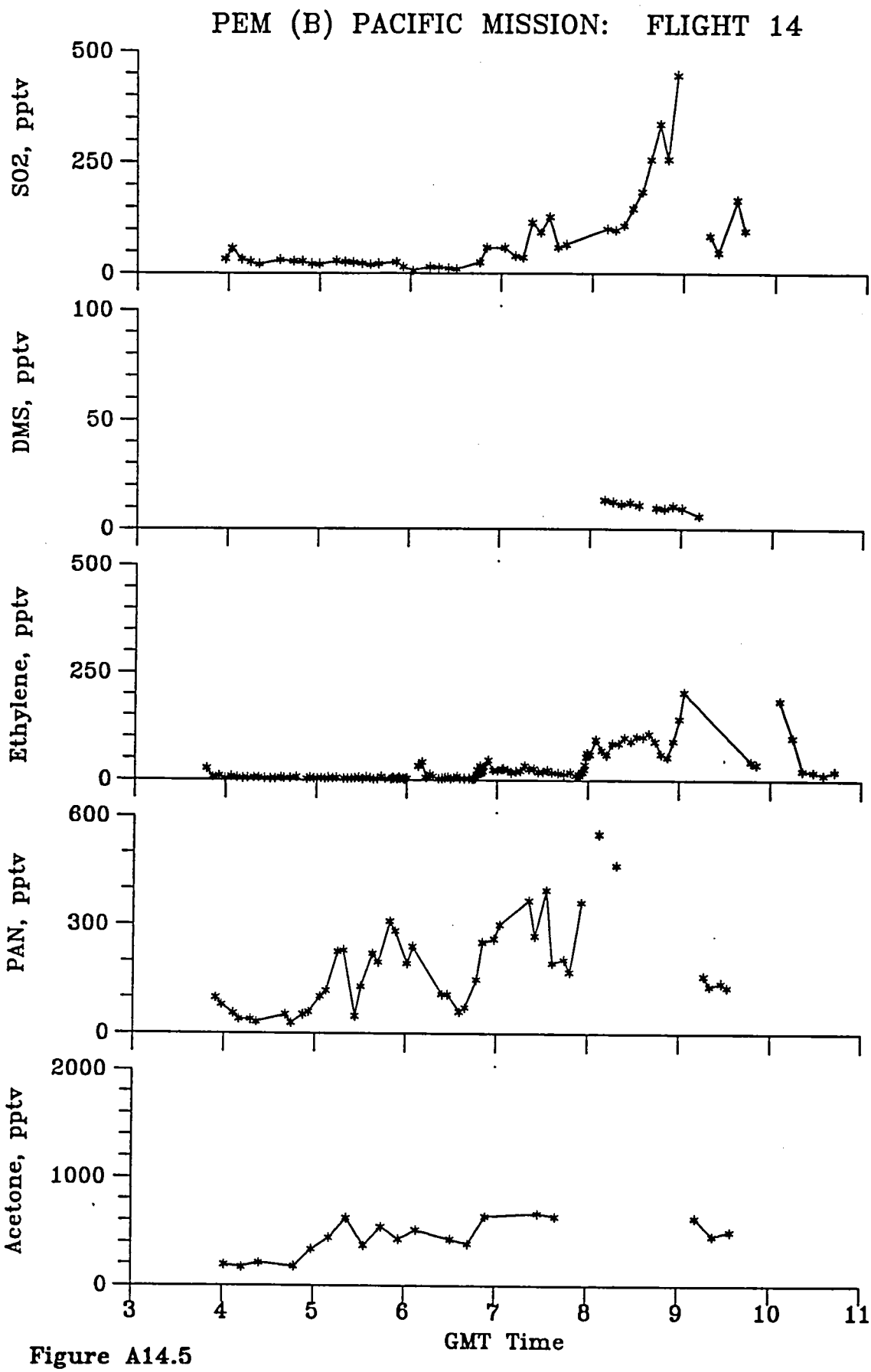

PEM (B) PACIFIC MISSION: FLIGHT 14
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
3
4
5
6
7
8
9
10
11
GMT Time

Figure A14.5

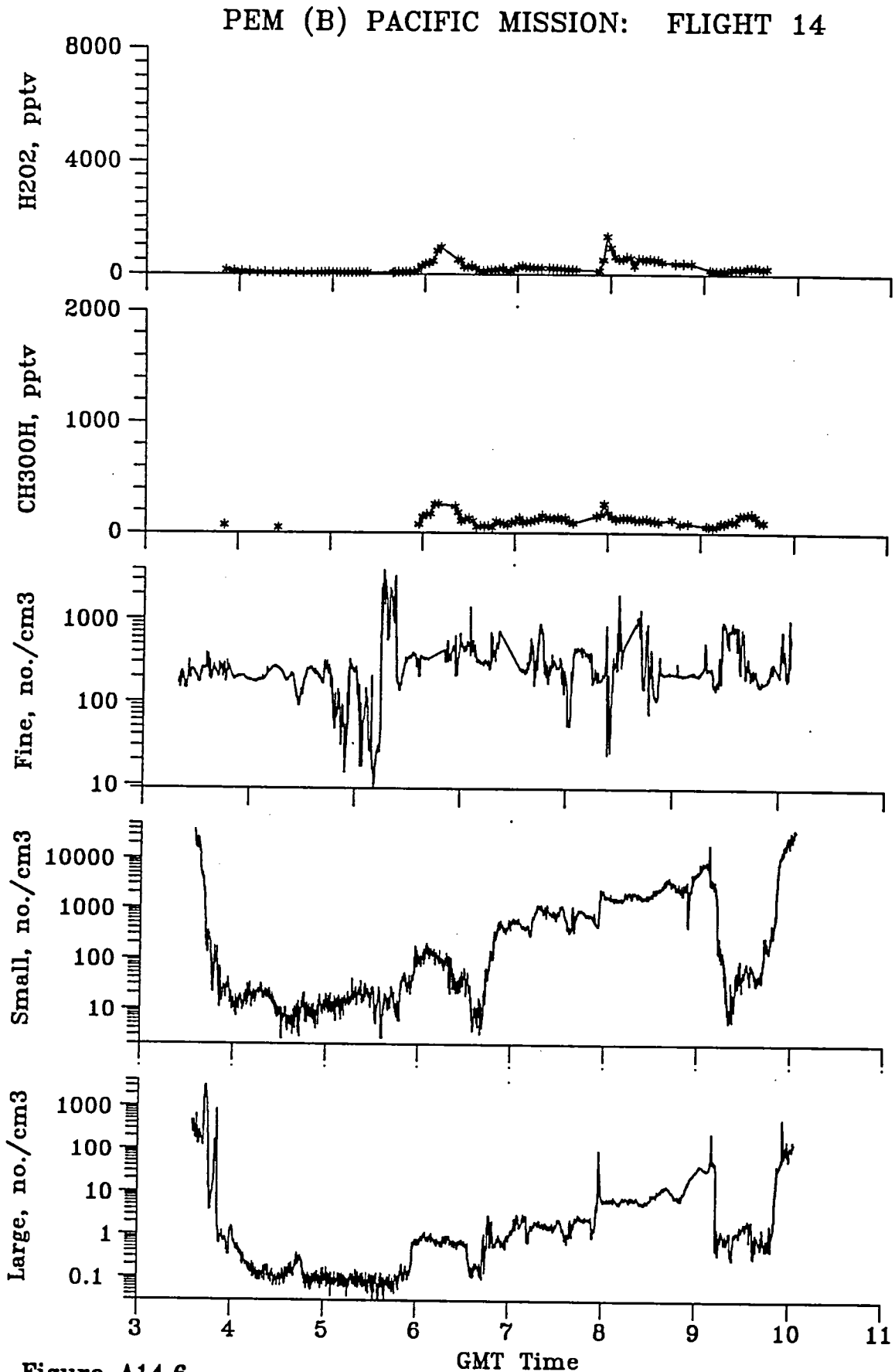
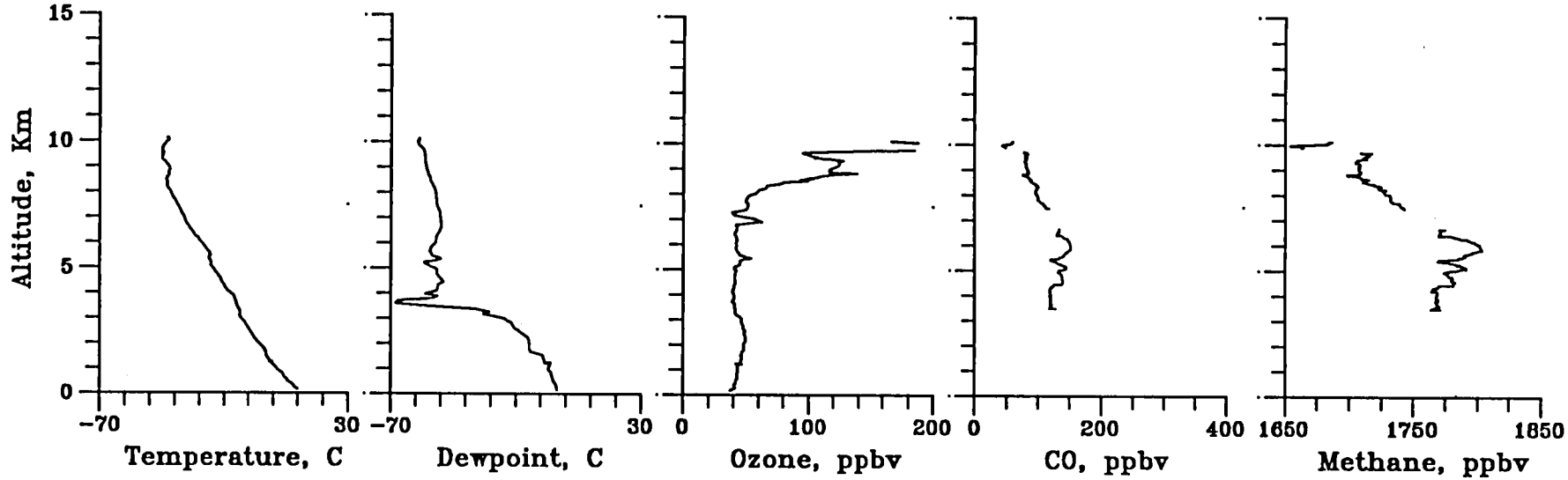
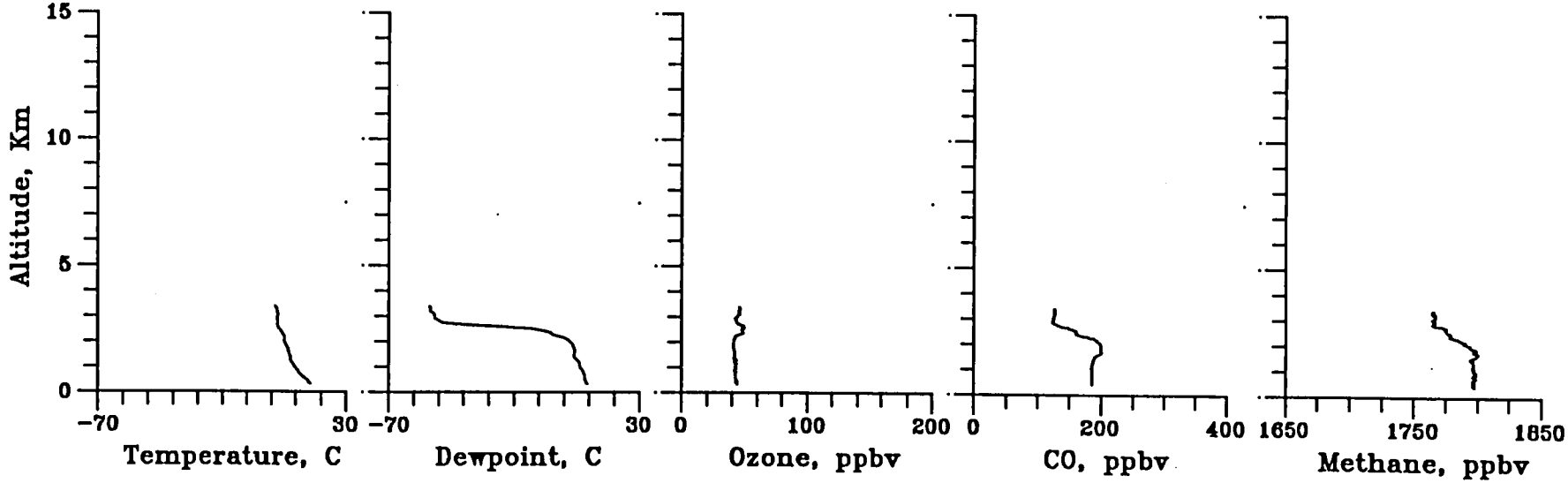

PEM (B) PACIFIC MISSION: FLIGHT 14
H2O2, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
10000
1000
100
10
Large, no./cm3
1000
100
10
1
0.1
3
4
5
6
7
8
9
10
11
GMT Time

Figure A14.6

PEM (B) PACIFIC MISSION: FLIGHT 14 PROFILE AT 0345 GMT



PEM (B) PACIFIC MISSION: FLIGHT 14 PROFILE AT 0800 GMT



PEM (B) PACIFIC MISSION: FLIGHT 15

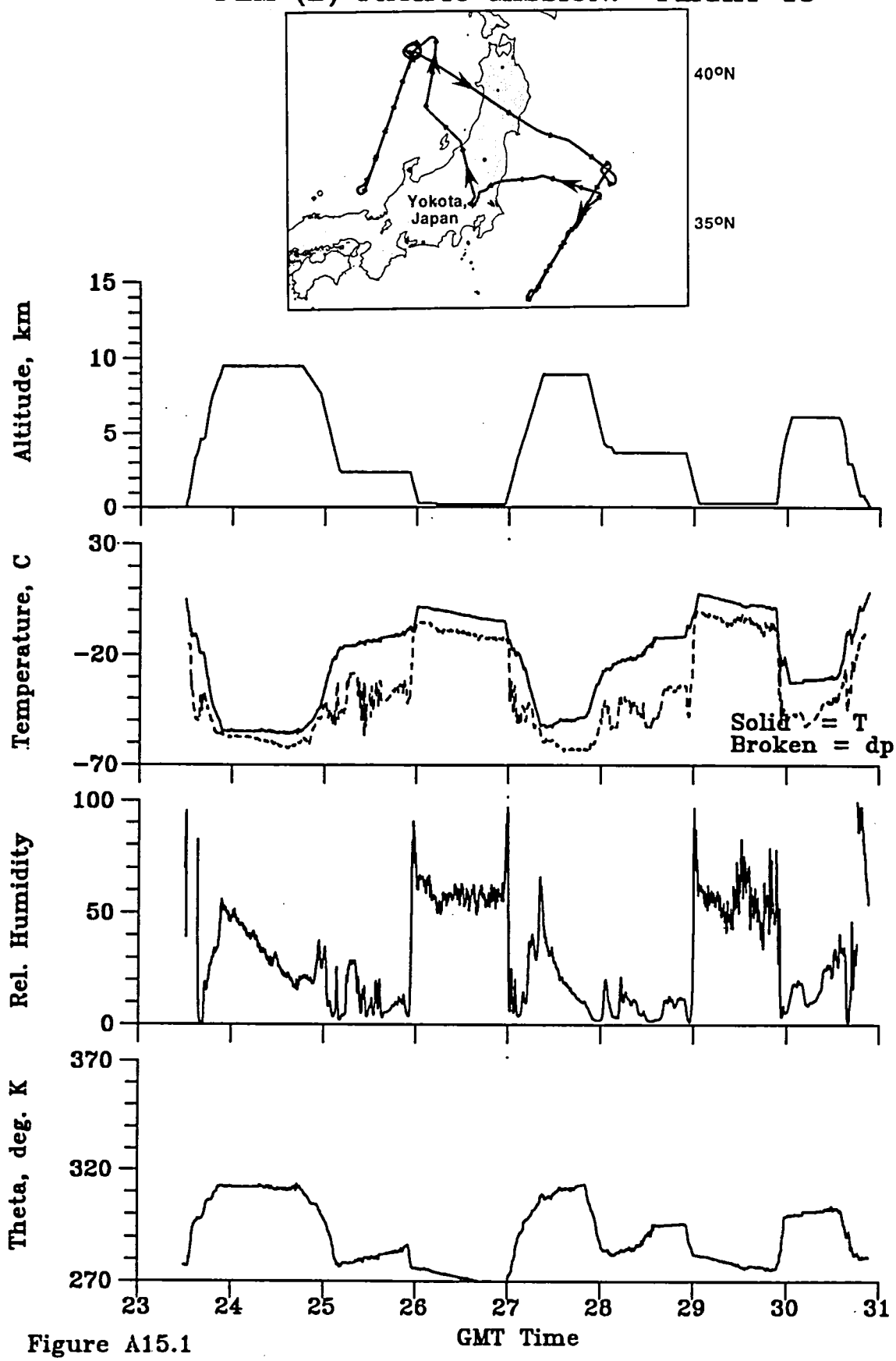


Figure A15.1

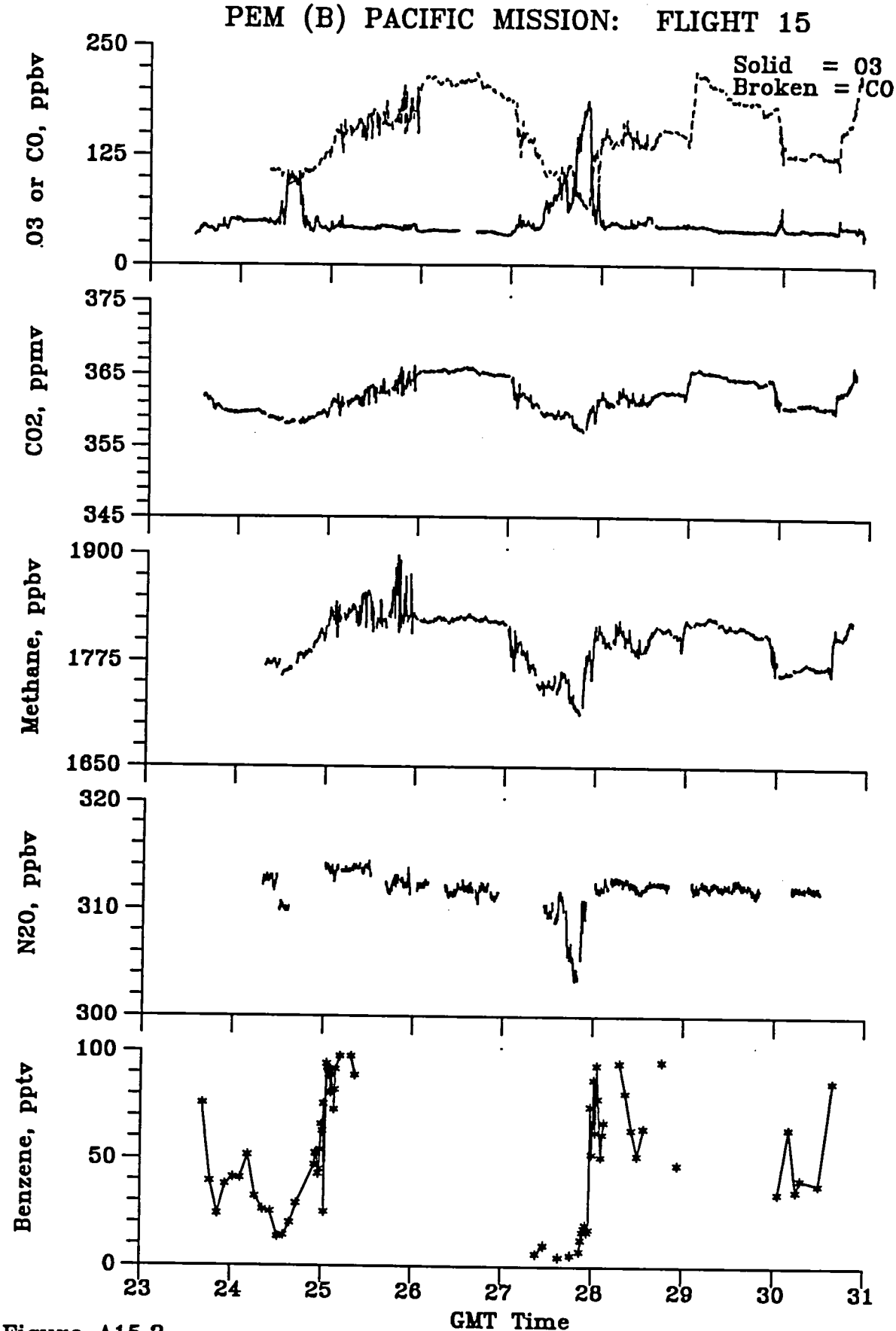

PEM (B) PACIFIC MISSION: FLIGHT 15
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
23
24
25
26
27
28
29
30
31
GMT Time

Figure A15.2

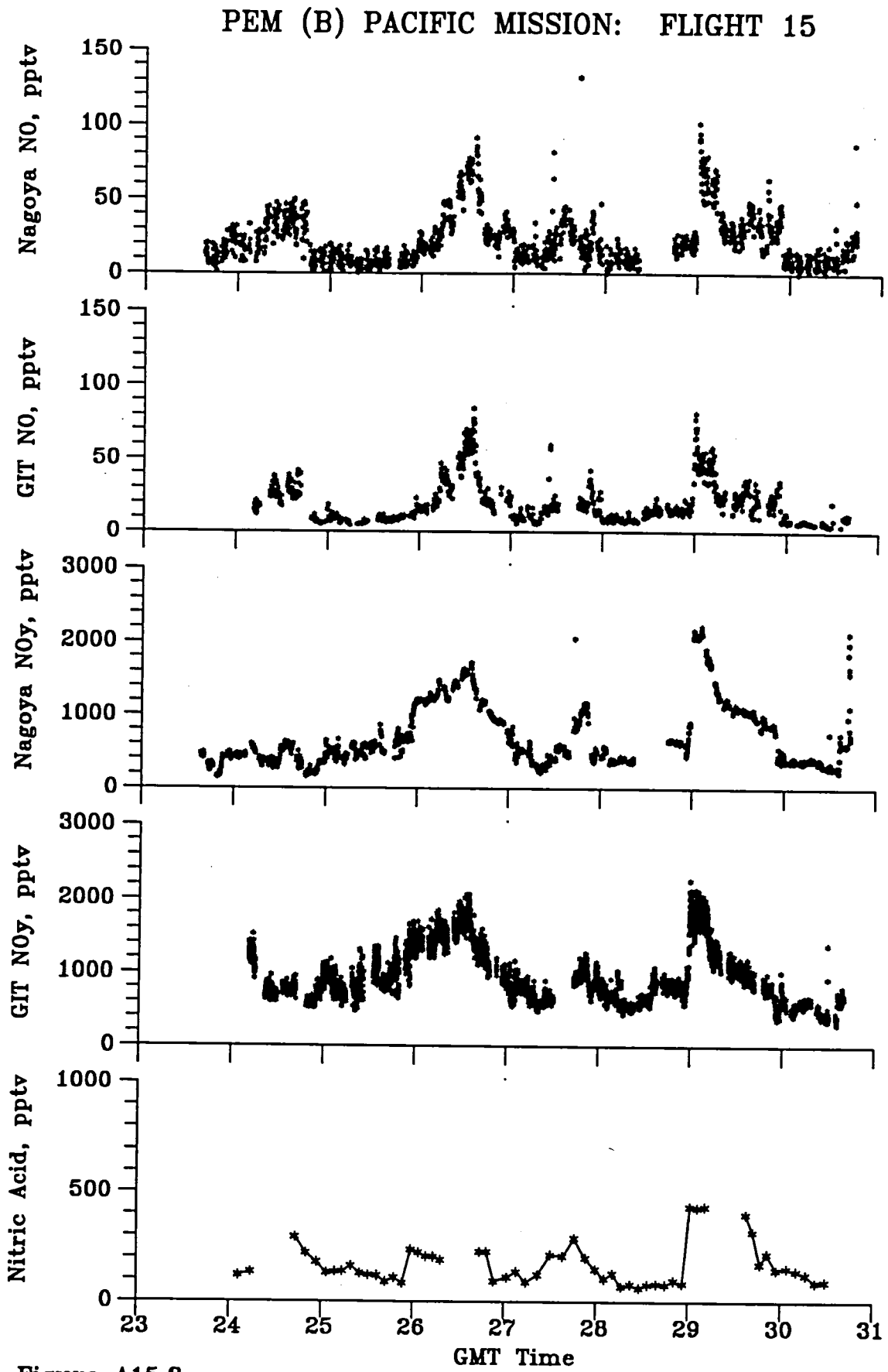

PEM (B) PACIFIC MISSION: FLIGHT 15
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
150
100
50
0
Nagoya NOy, pptv
3000
2000
1000
0
GIT NOy, pptv
3000
2000
1000
0
Nitric Acid, pptv
1000
500
0
23
24
25
26
27
28
29
30
31
GMT Time

Figure A15.3

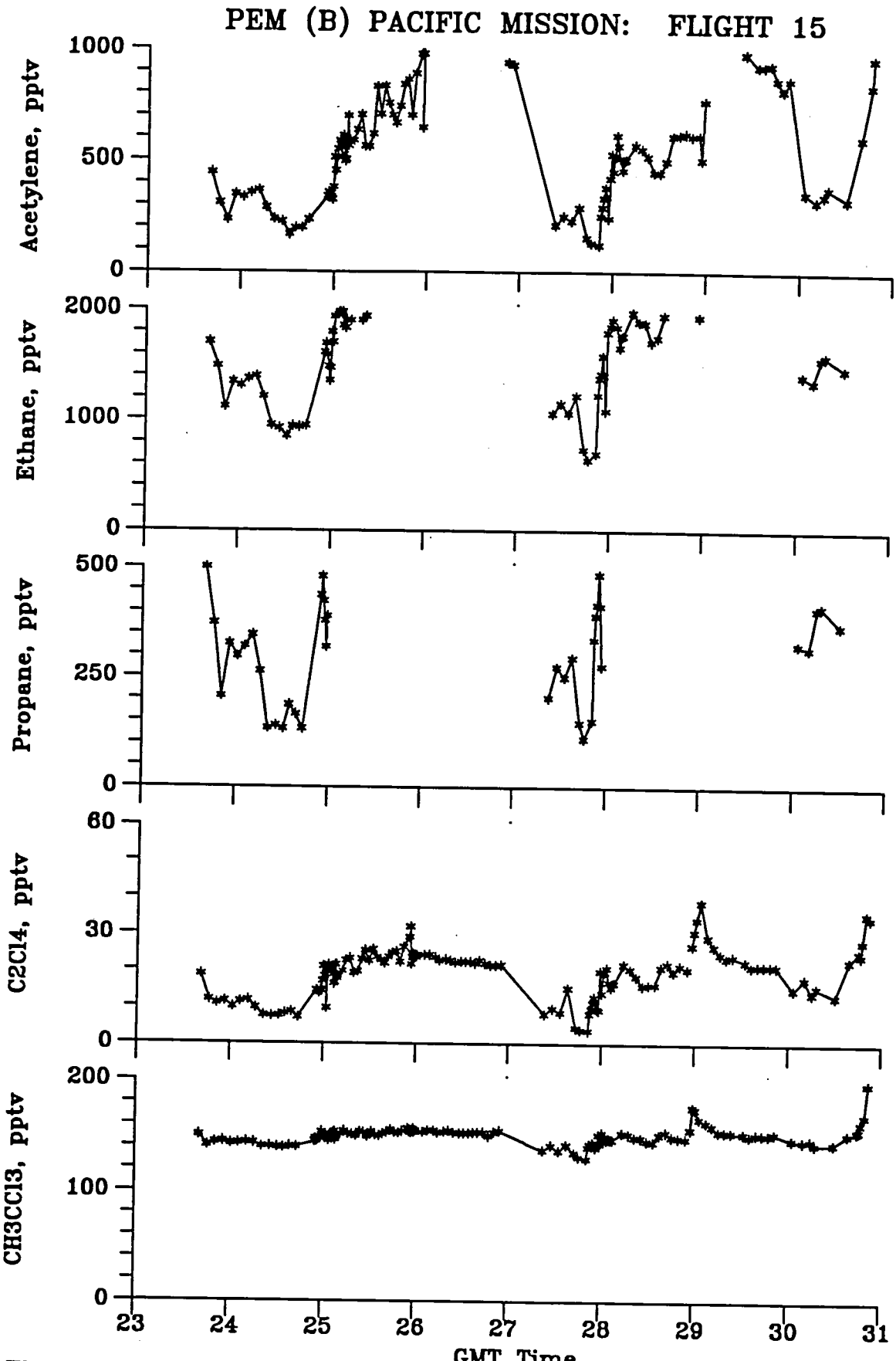

PEM (B) PACIFIC MISSION: FLIGHT 15
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
23
24
25
26
27
28
29
30
31
GMT Time

Figure A15.4

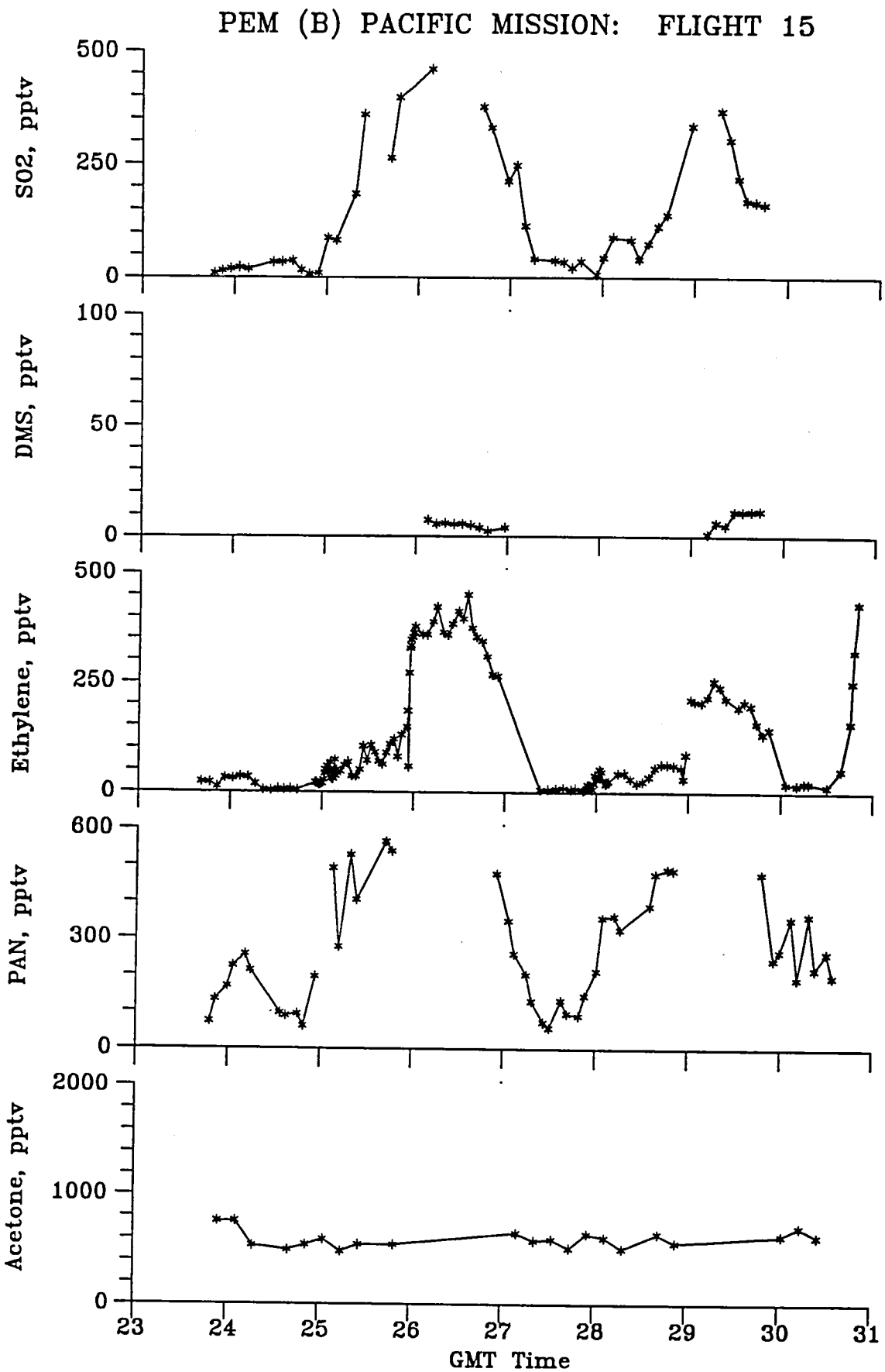

PEM (B) PACIFIC MISSION: FLIGHT 15
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
23
24
25
26
27
28
29
30
31
GMT Time

Figure A15.5

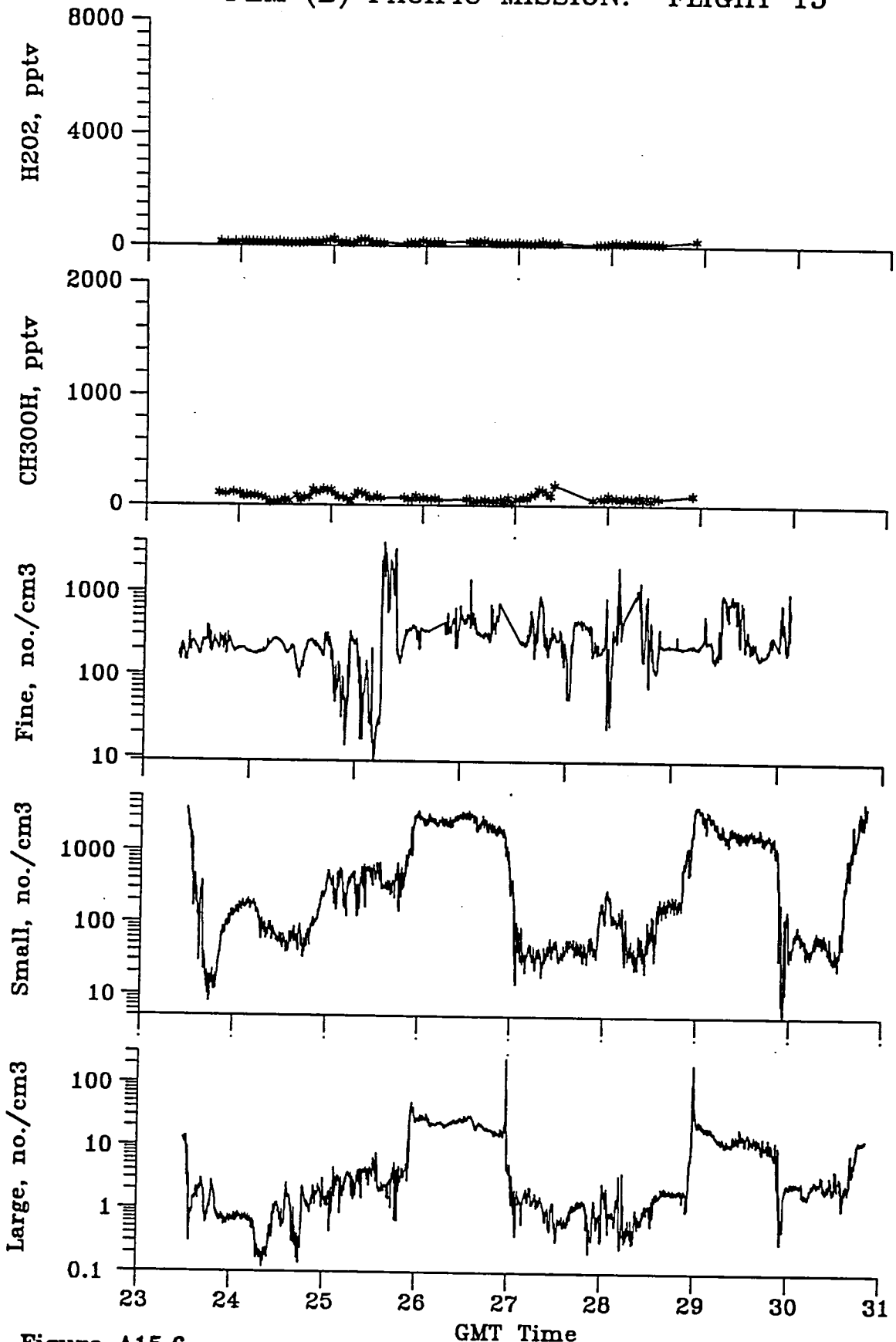
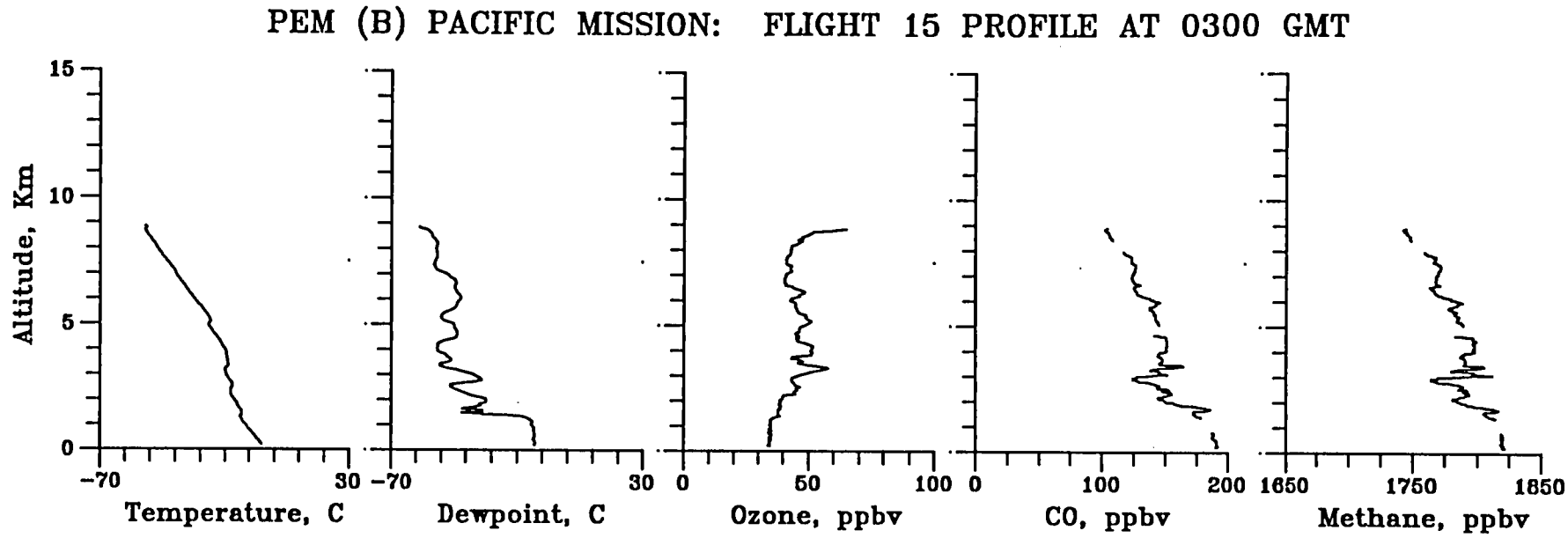

PEM (B) PACIFIC MISSION: FLIGHT 15
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1000
100
10
Large, no./cm3
100
10
1
0.1
23
24
25
26
27
28
29
30
31
GMT Time

Figure A15.6


PEM (B) PACIFIC MISSION: FLIGHT 15 PROFILE AT 0300 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
200
CO, ppbv
1650
1750
1850
Methane, ppbv

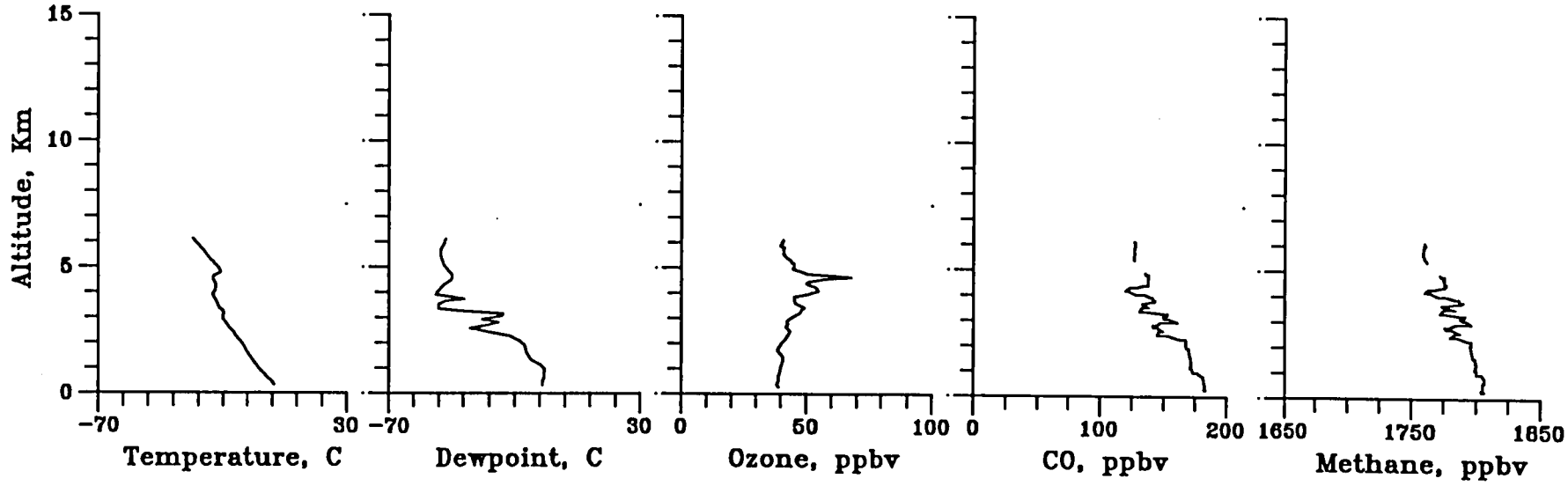

PEM (B) PACIFIC MISSION: FLIGHT 15 PROFILE AT 0600 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
200
CO, ppbv
1650
1750
1850
Methane, ppbv

Figure A15.7

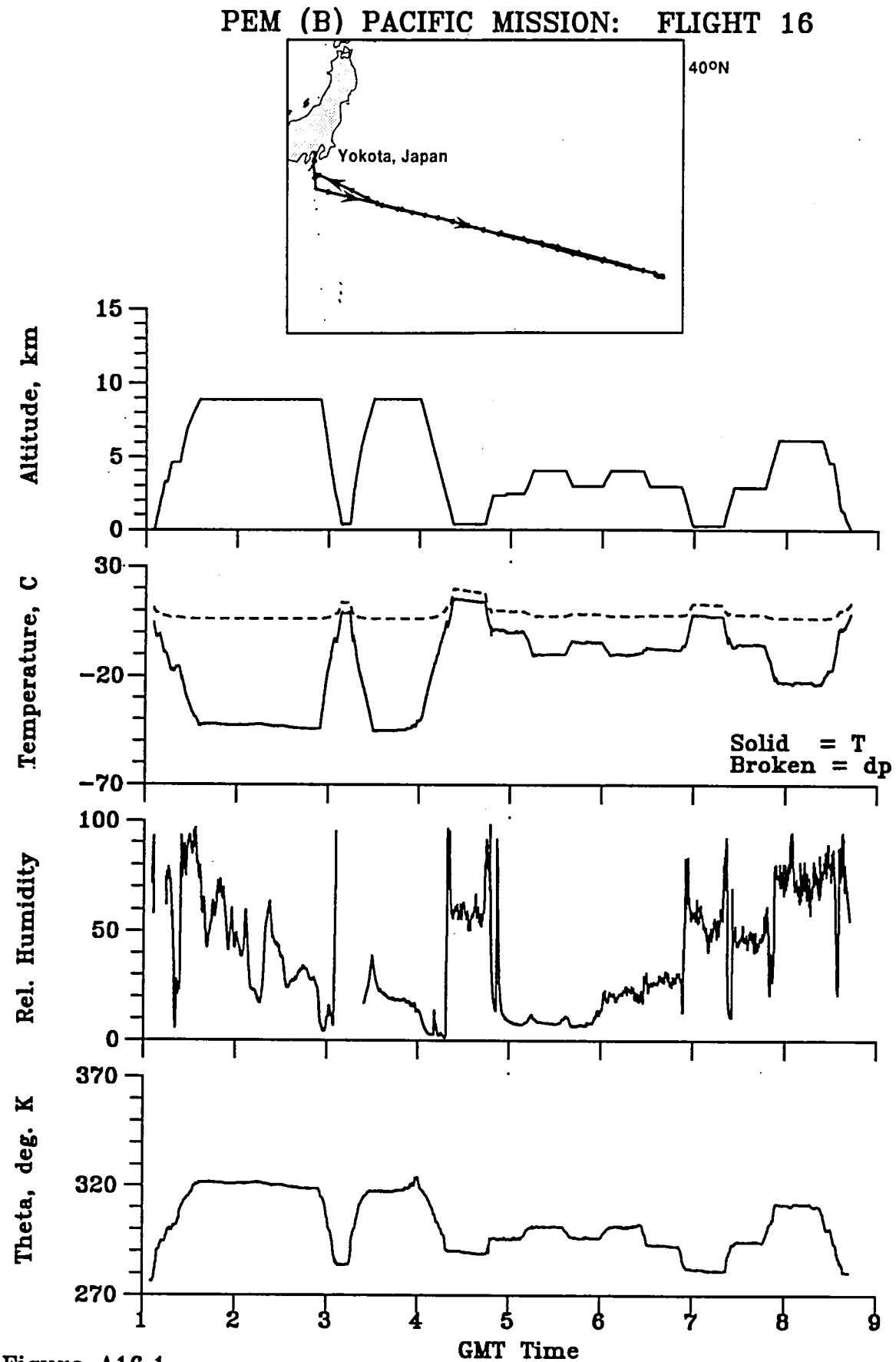

PEM (B) PACIFIC MISSION: FLIGHT 16
40°N
Yokota, Japan
Altitude, km
15
10
5
0
Temperature, C
30
-20
-70
Solid = T
Broken = dp
Rel. Humidity
100
50
0
Theta, deg. K
370
320
270
1
2
3
4
5
6
7
8
9
GMT Time

Figure A16.1

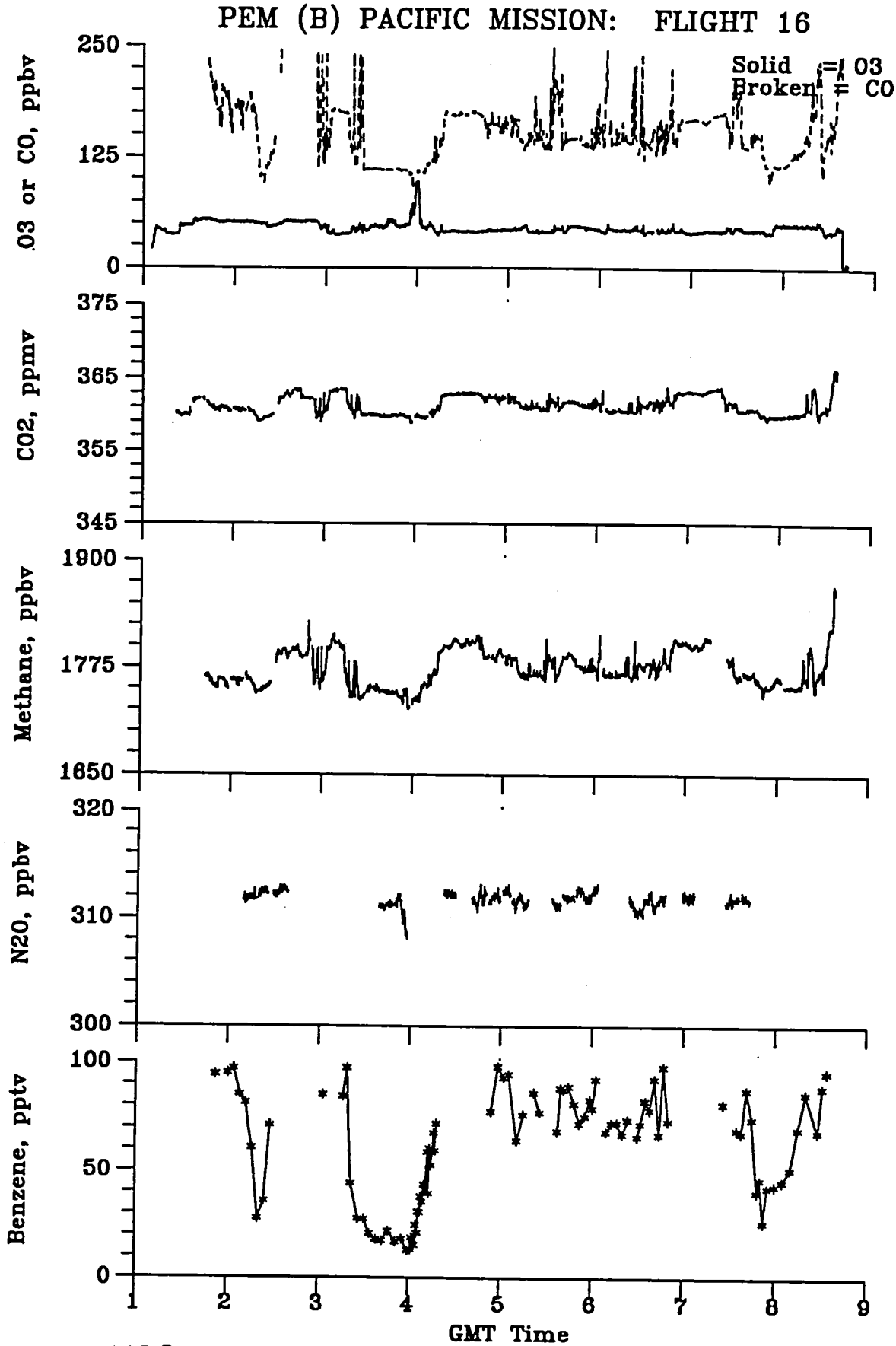

PEM (B) PACIFIC MISSION: FLIGHT 16
Solid = O3
Broken = CO
O3 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
1
2
3
4
5
6
7
8
9
GMT Time

Figure A16.2

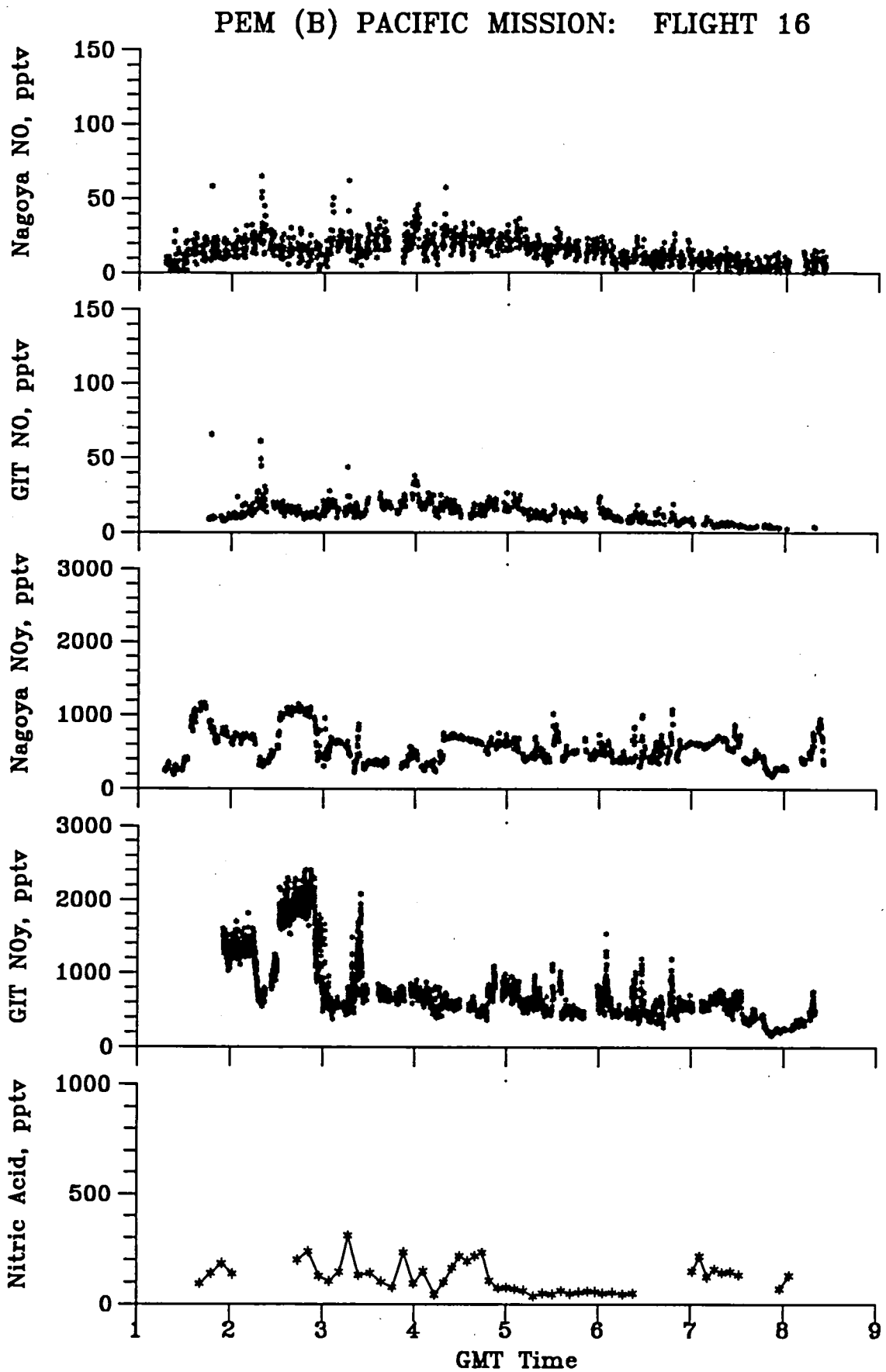

PEM (B) PACIFIC MISSION: FLIGHT 16
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
150
100
50
0
Nagoya NOy, pptv
3000
2000
1000
0
GIT NOy, pptv
3000
2000
1000
0
Nitric Acid, pptv
1000
500
0
1
2
3
4
5
6
7
8
9
GMT Time

Figure A16.3

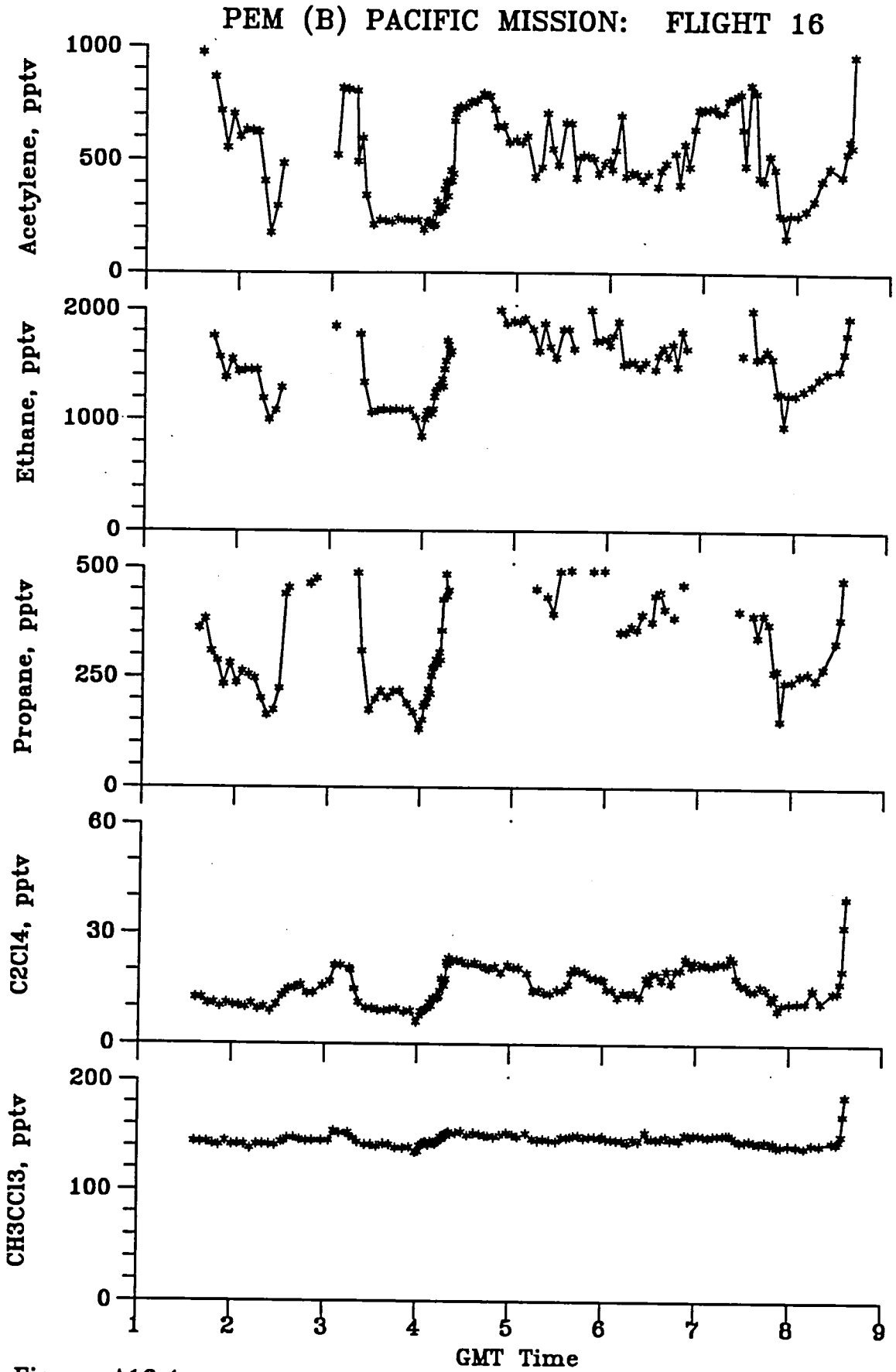

PEM (B) PACIFIC MISSION: FLIGHT 16
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
1
2
3
4
5
6
7
8
9
GMT Time

Figure A16.4

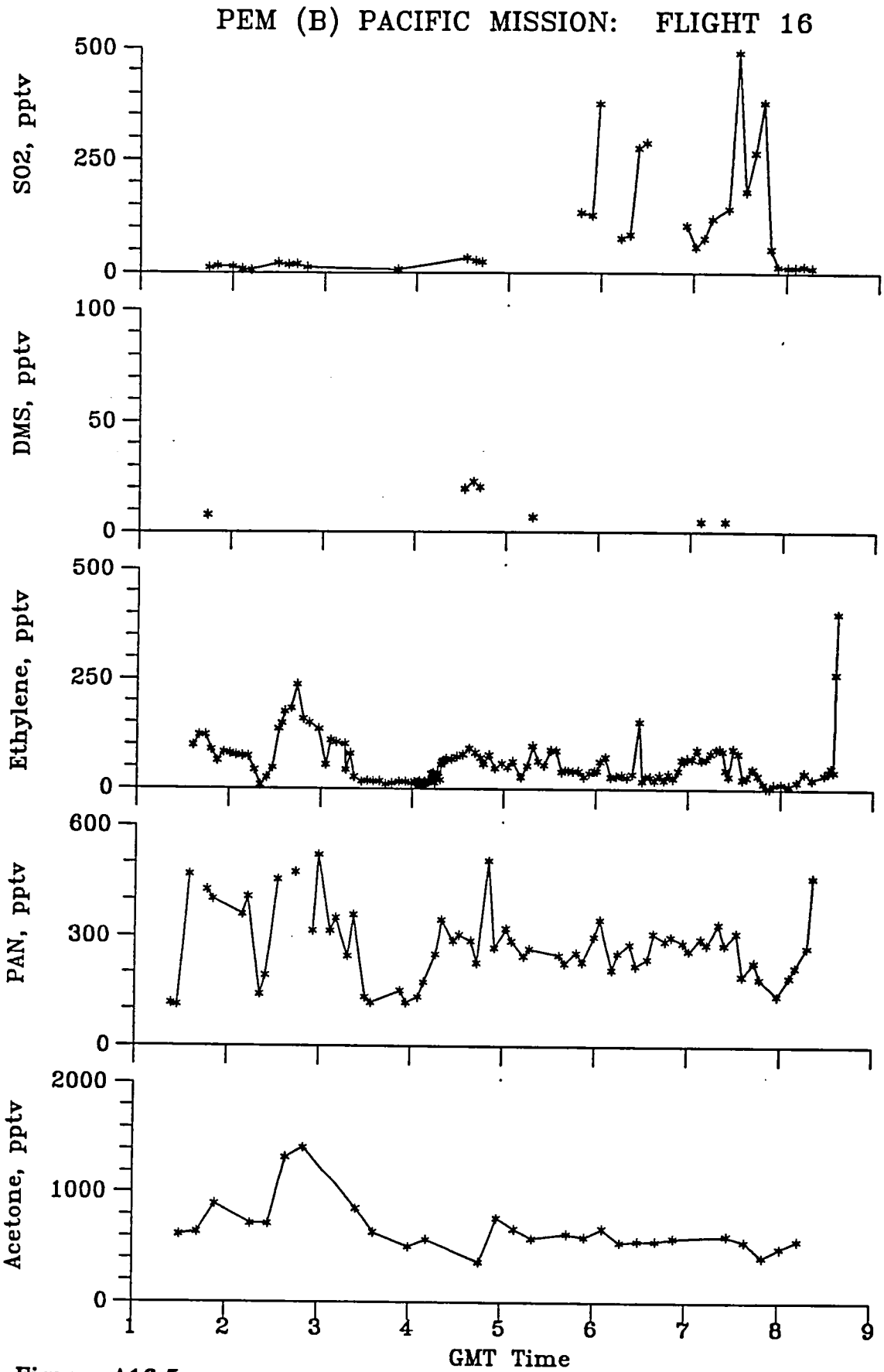

PEM (B) PACIFIC MISSION: FLIGHT 16
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
1
2
3
4
5
6
7
8
9
GMT Time

Figure A16.5

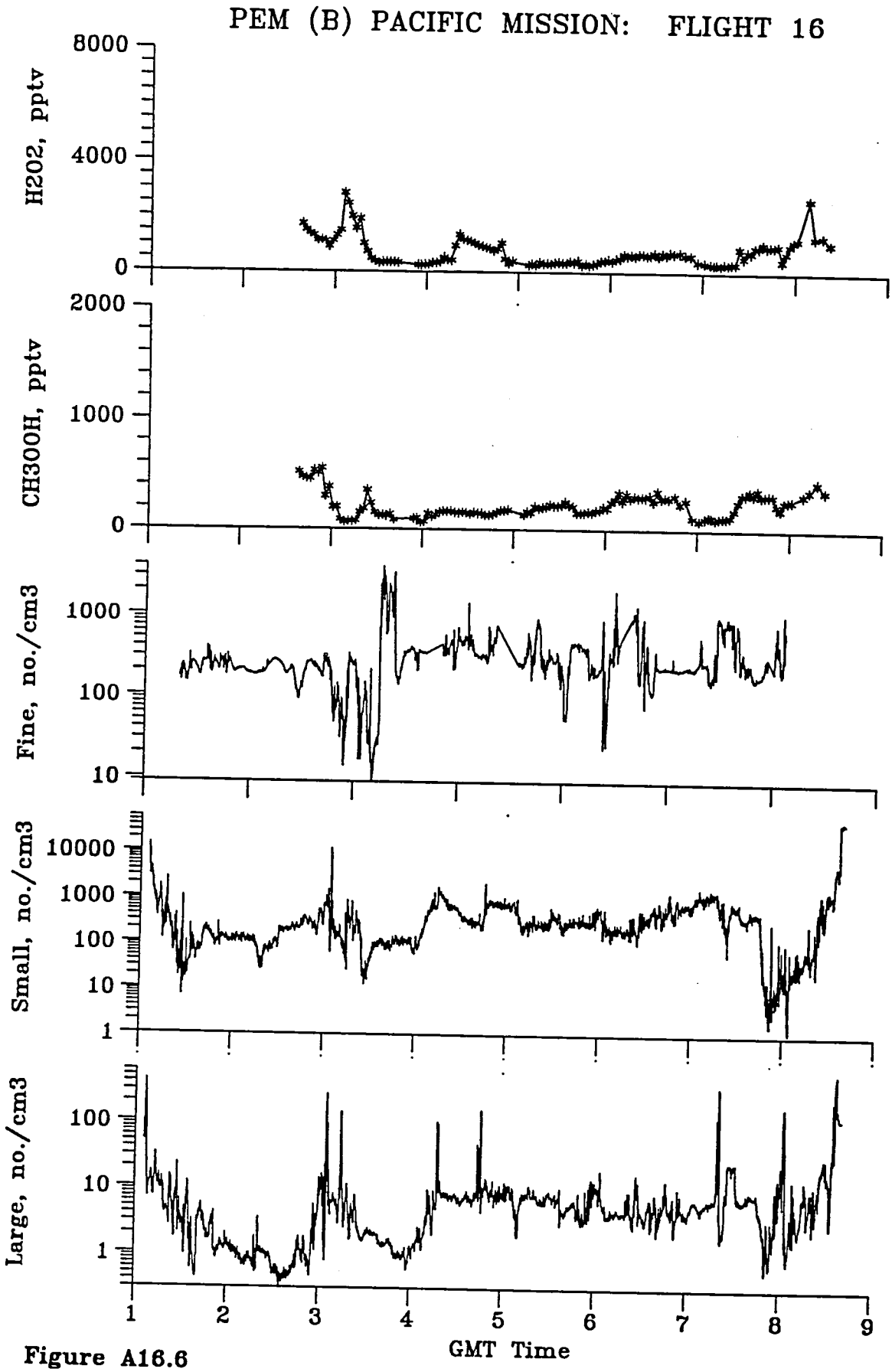

PEM (B) PACIFIC MISSION: FLIGHT 16
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
10000
1000
100
10
1
Large, no./cm3
100
10
1
1
2
3
4
5
6
7
8
9
GMT Time

Figure A16.6

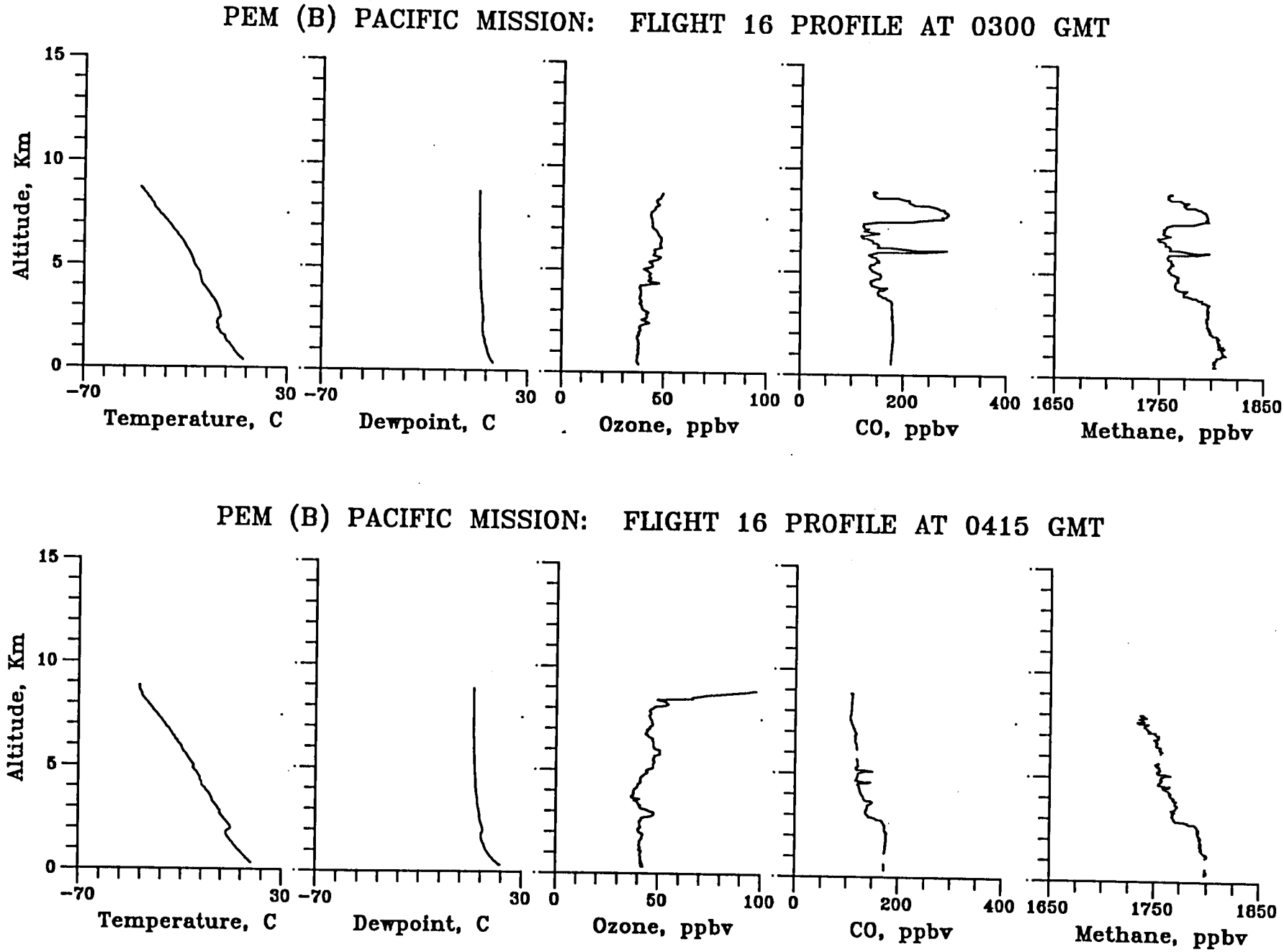

PEM (B) PACIFIC MISSION: FLIGHT 16 PROFILE AT 0300 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
50
100
Ozone, ppbv
200
400
CO, ppbv
1650
1750
1850
Methane, ppbv
PEM (B) PACIFIC MISSION: FLIGHT 16 PROFILE AT 0415 GMT

Figure A16.7

PEM (B) PACIFIC MISSION: FLIGHT 17

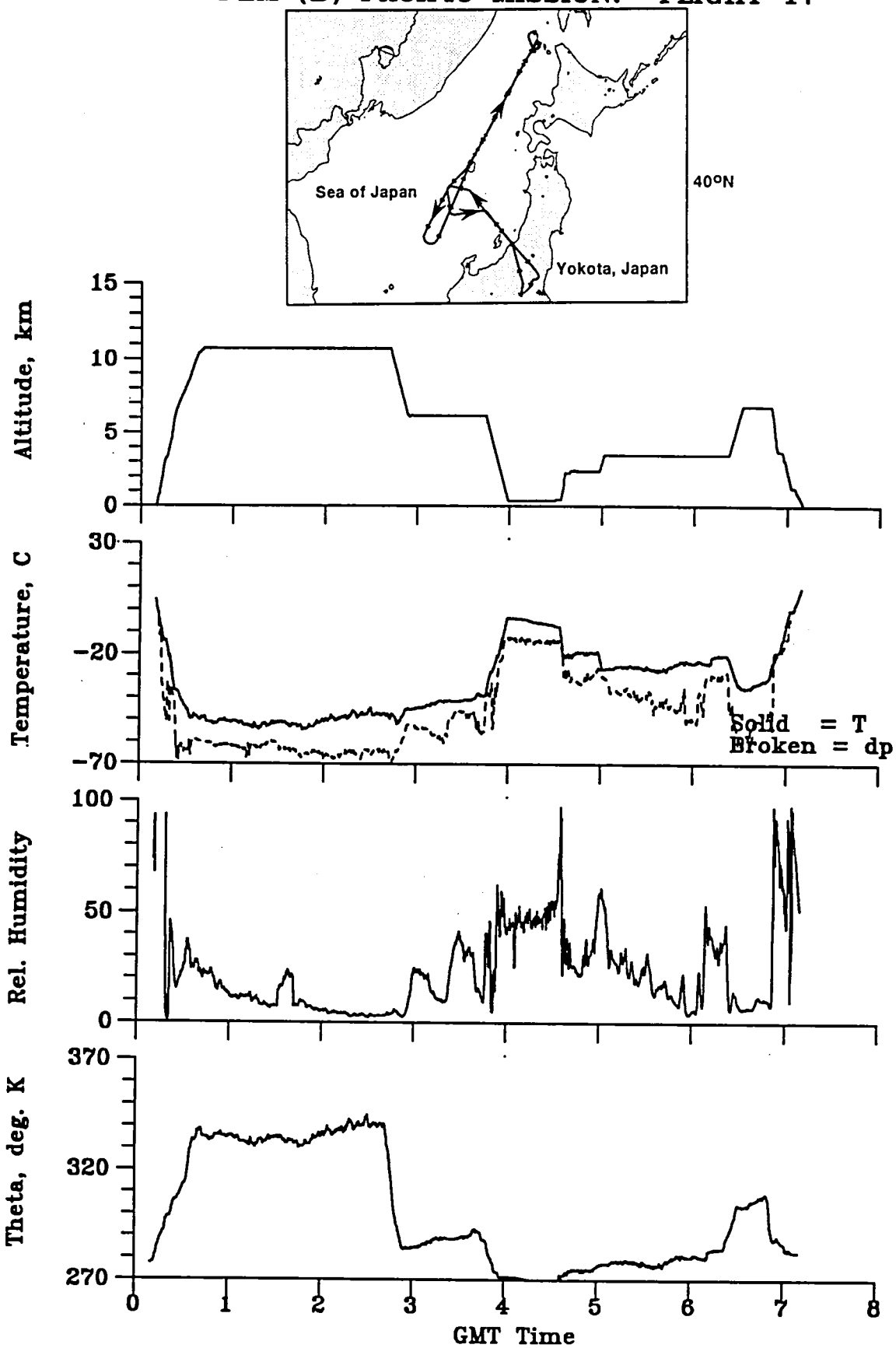


Figure A17.1

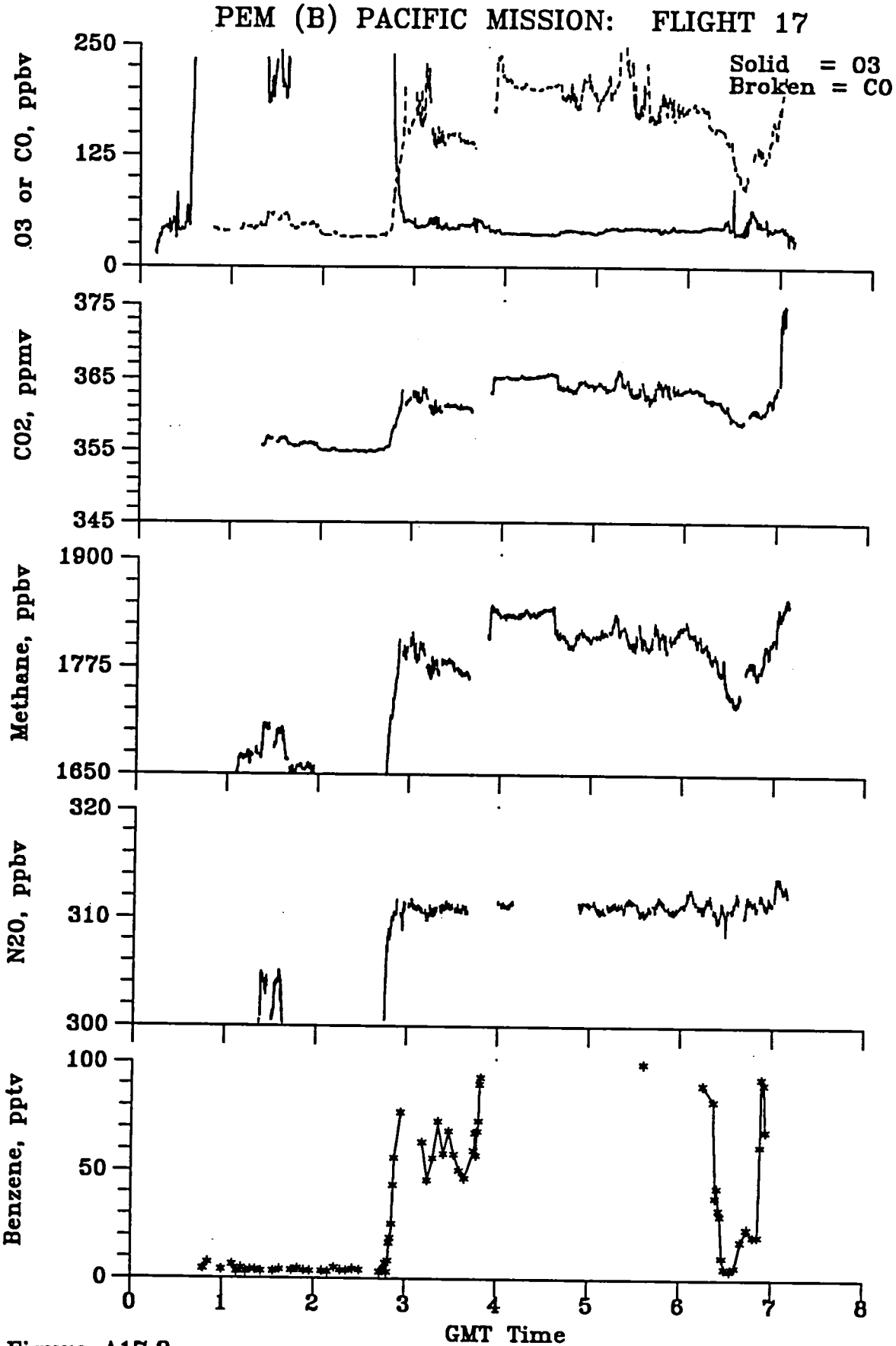

PEM (B) PACIFIC MISSION: FLIGHT 17
Solid = 03
Broken = CO
03 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
0
1
2
3
4
5
6
7
8
GMT Time

Figure A17.2

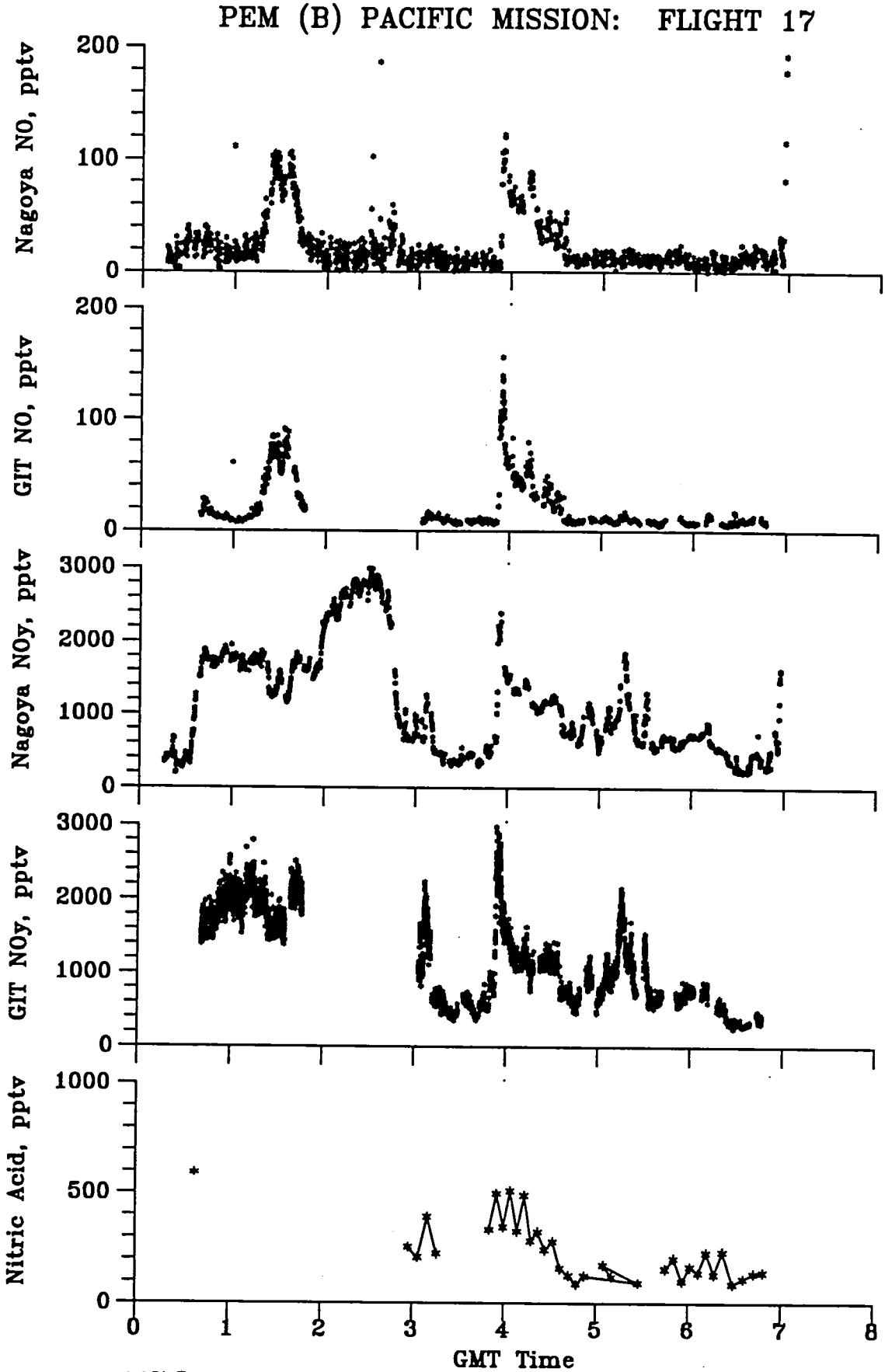

PEM (B) PACIFIC MISSION: FLIGHT 17
Nagoya NO, pptv
200
100
0
GIT NO, pptv
200
100
0
Nagoya NOy, pptv
3000
2000
1000
0
GIT NOy, pptv
3000
2000
1000
0
Nitric Acid, pptv
1000
500
0
0
1
2
3
4
5
6
7
8
GMT Time

Figure A17.3

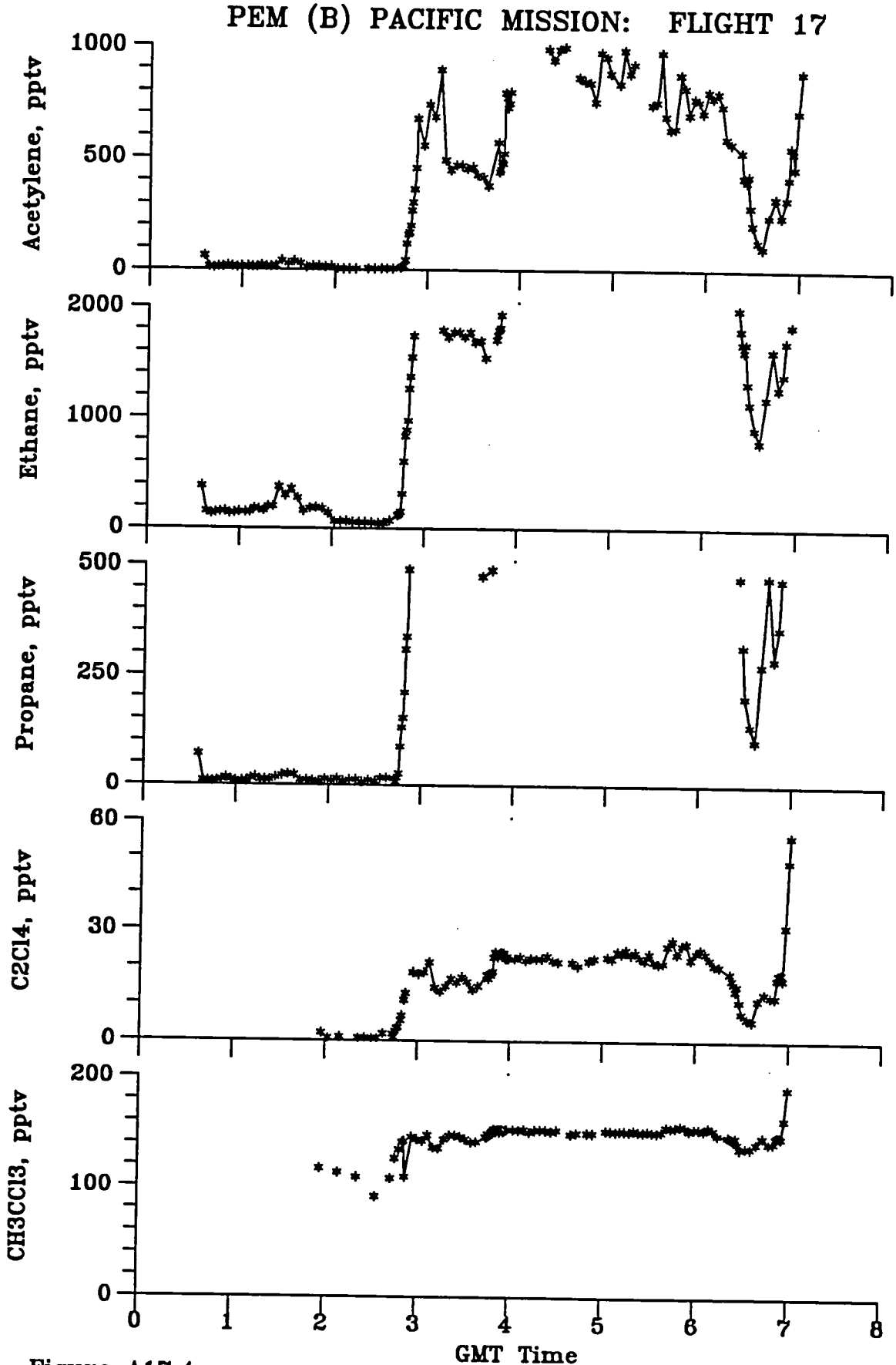

PEM (B) PACIFIC MISSION: FLIGHT 17
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
0
1
2
3
4
5
6
7
8
GMT Time

Figure A17.4

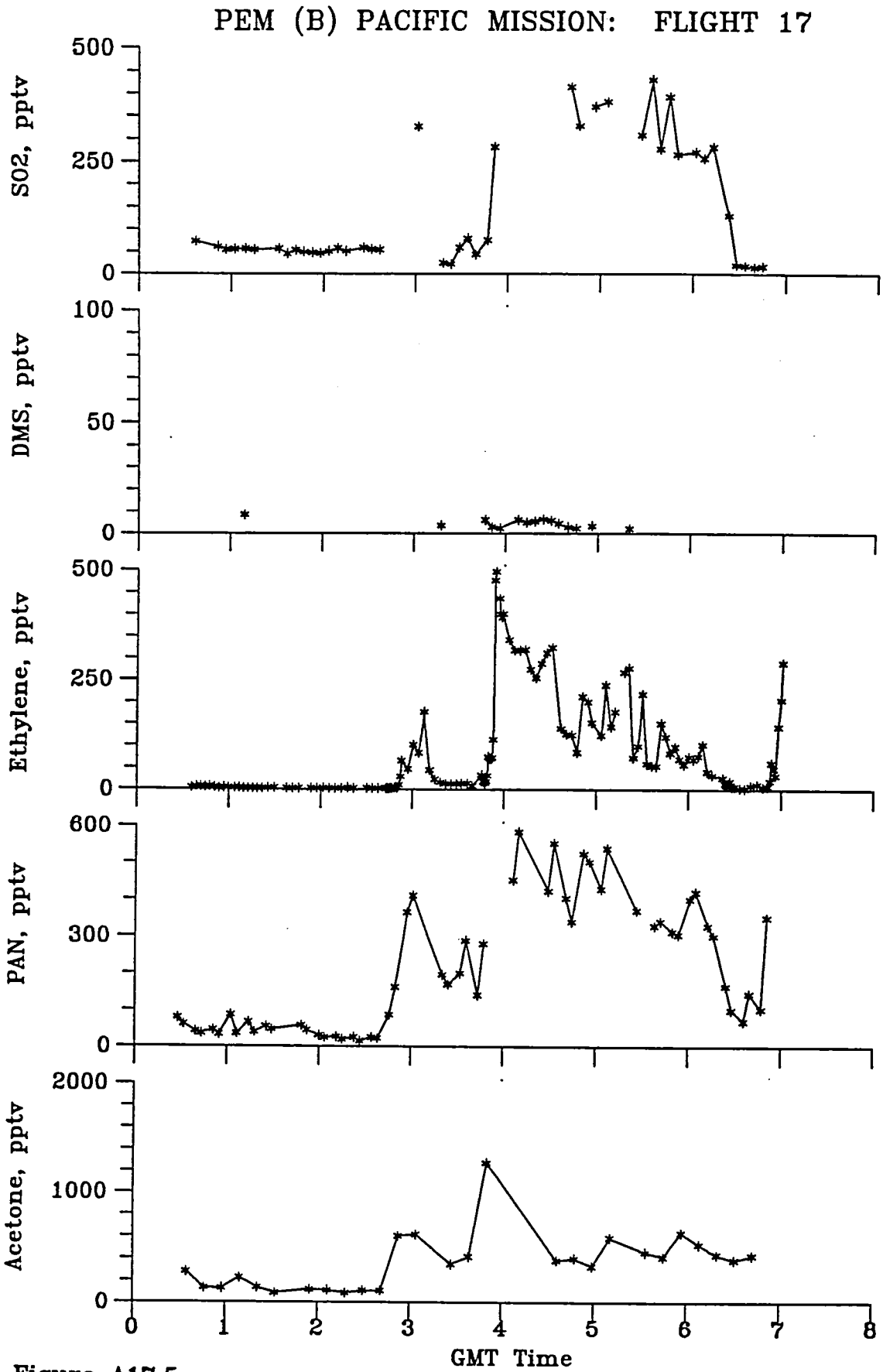

PEM (B) PACIFIC MISSION: FLIGHT 17
SO2, pptv
500
250
0
DMS, pptv
100
50
0
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
0
1
2
3
4
5
6
7
8
GMT Time

Figure A17.5

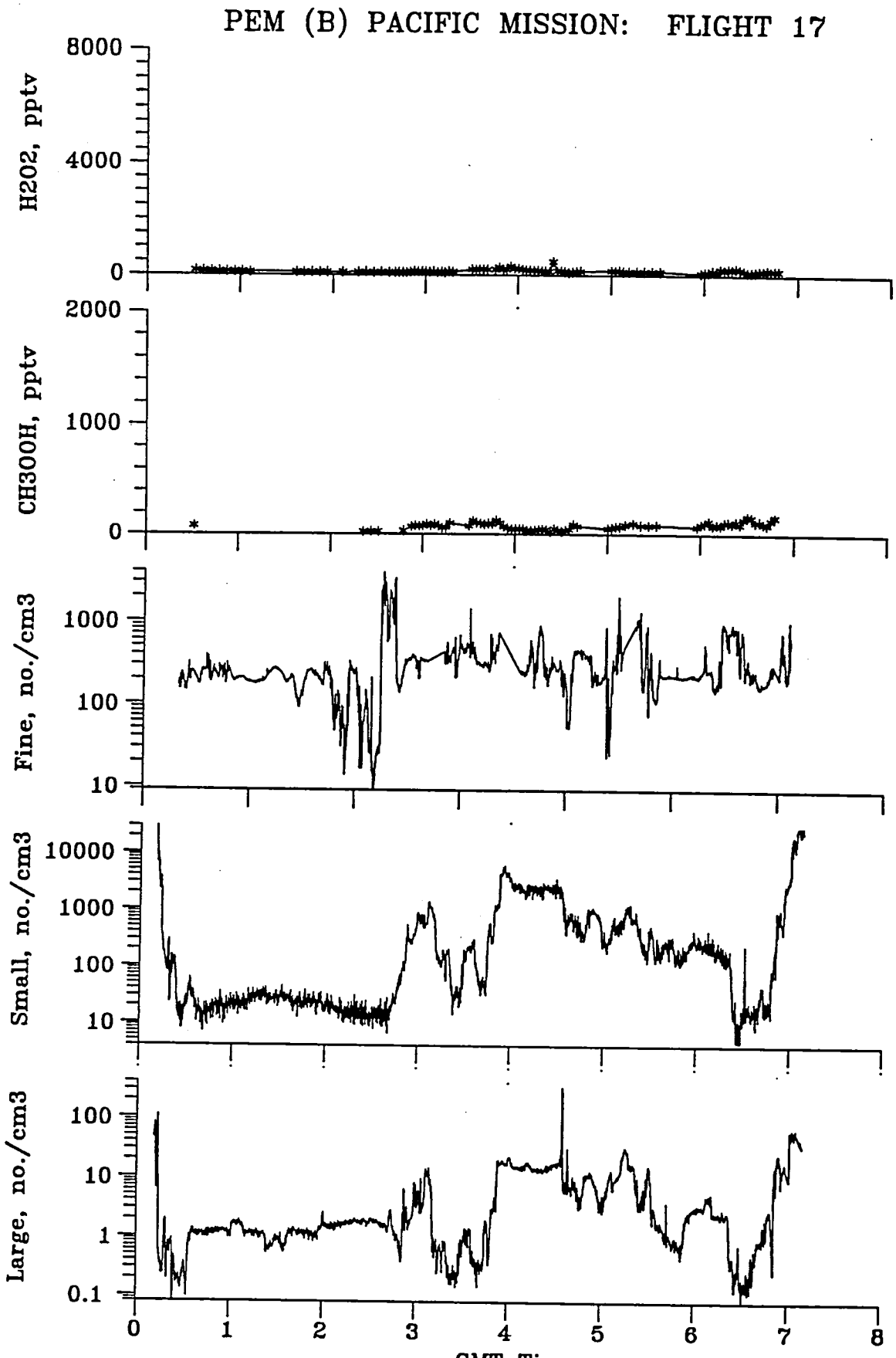

PEM (B) PACIFIC MISSION: FLIGHT 17
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
10000
1000
100
10
Large, no./cm3
100
10
1
0.1
0
1
2
3
4
5
6
7
8
GMT Time

Figure A17.6

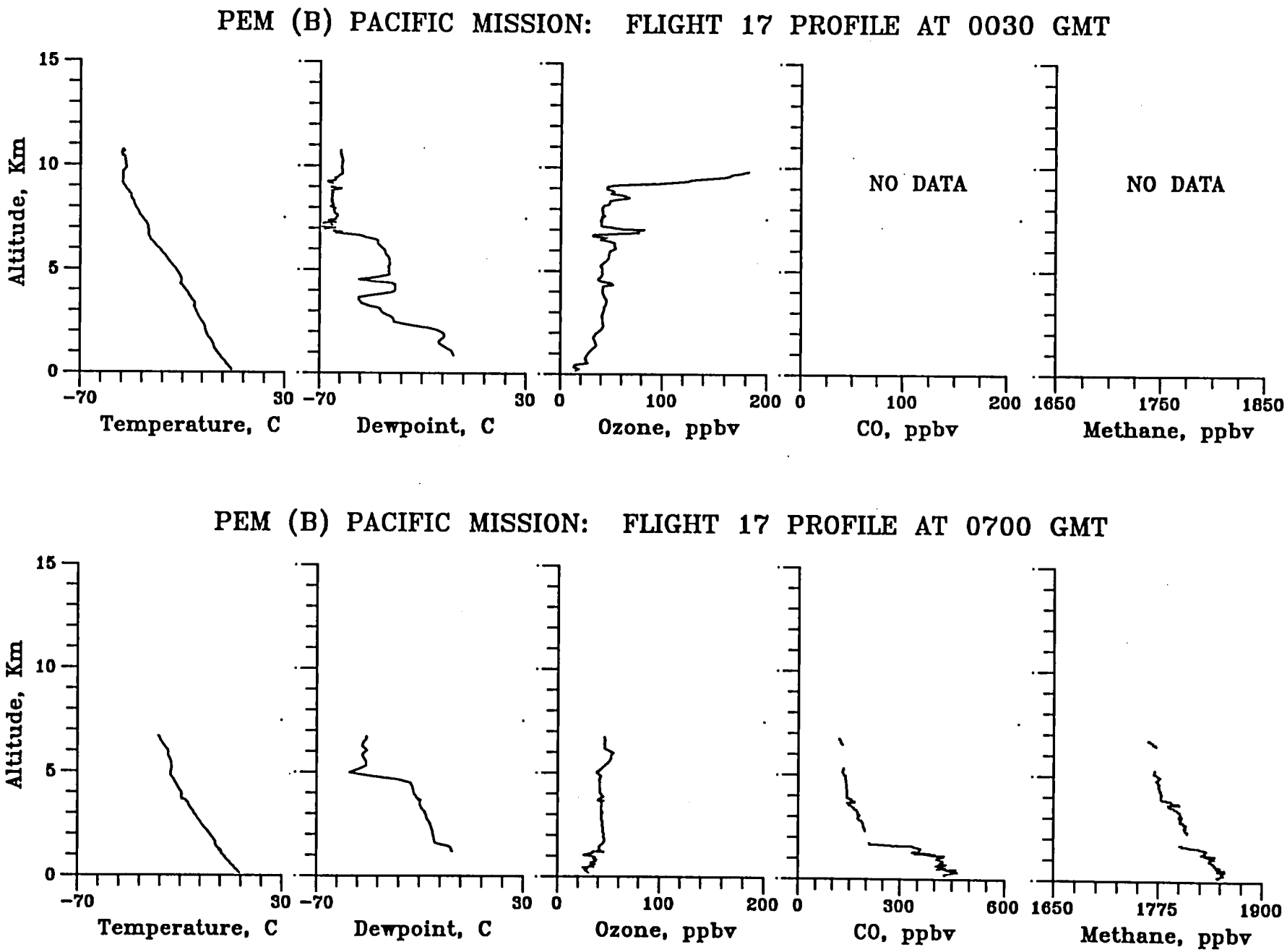

PEM (B) PACIFIC MISSION: FLIGHT 17 PROFILE AT 0030 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
100
200
Ozone, ppbv
NO DATA
CO, ppbv
1650
1750
1850
Methane, ppbv
PEM (B) PACIFIC MISSION: FLIGHT 17 PROFILE AT 0700 GMT
300
600
1775
1900

Figure A17.7

PEM (B) PACIFIC MISSION: FLIGHT 18

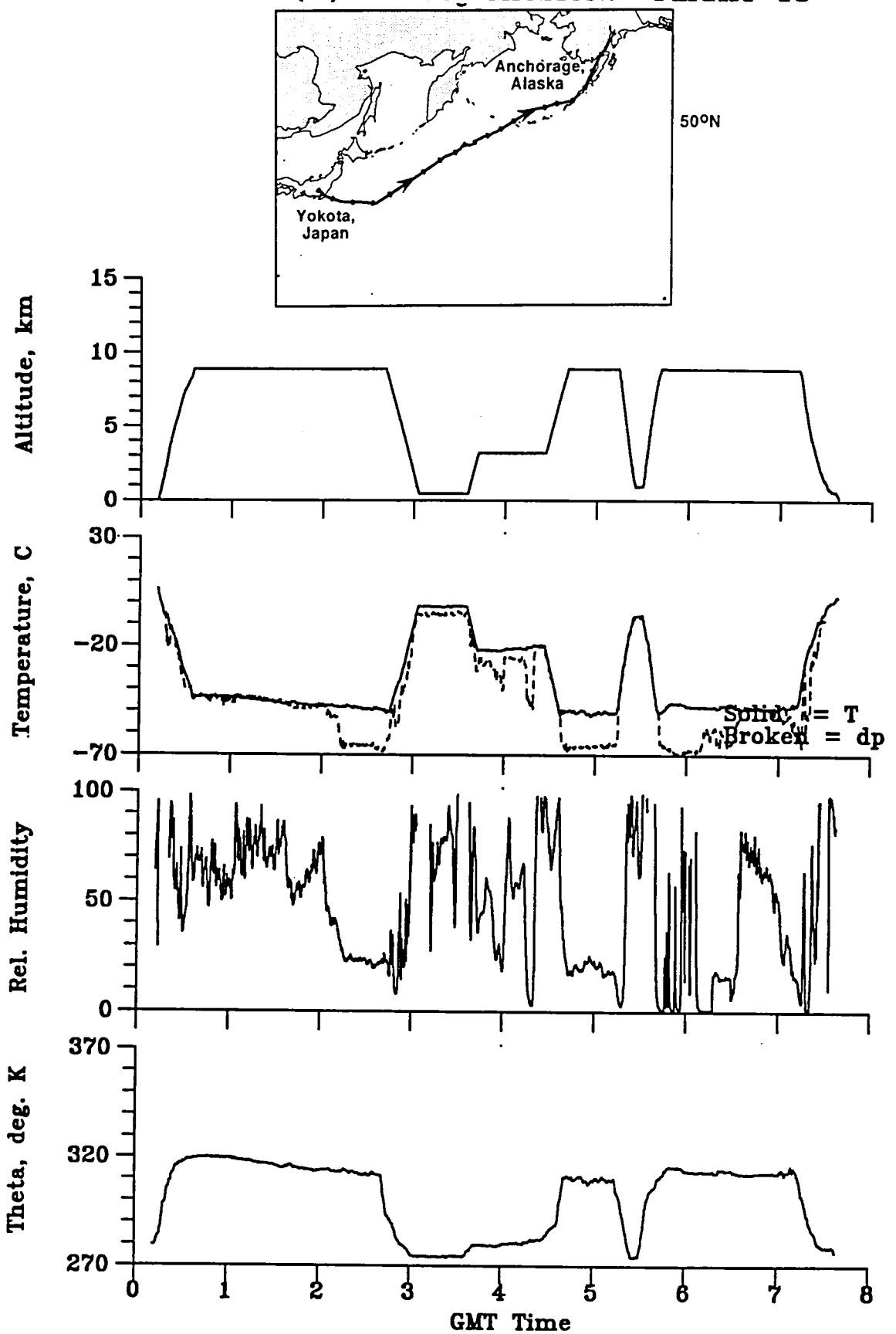


Figure A18.1

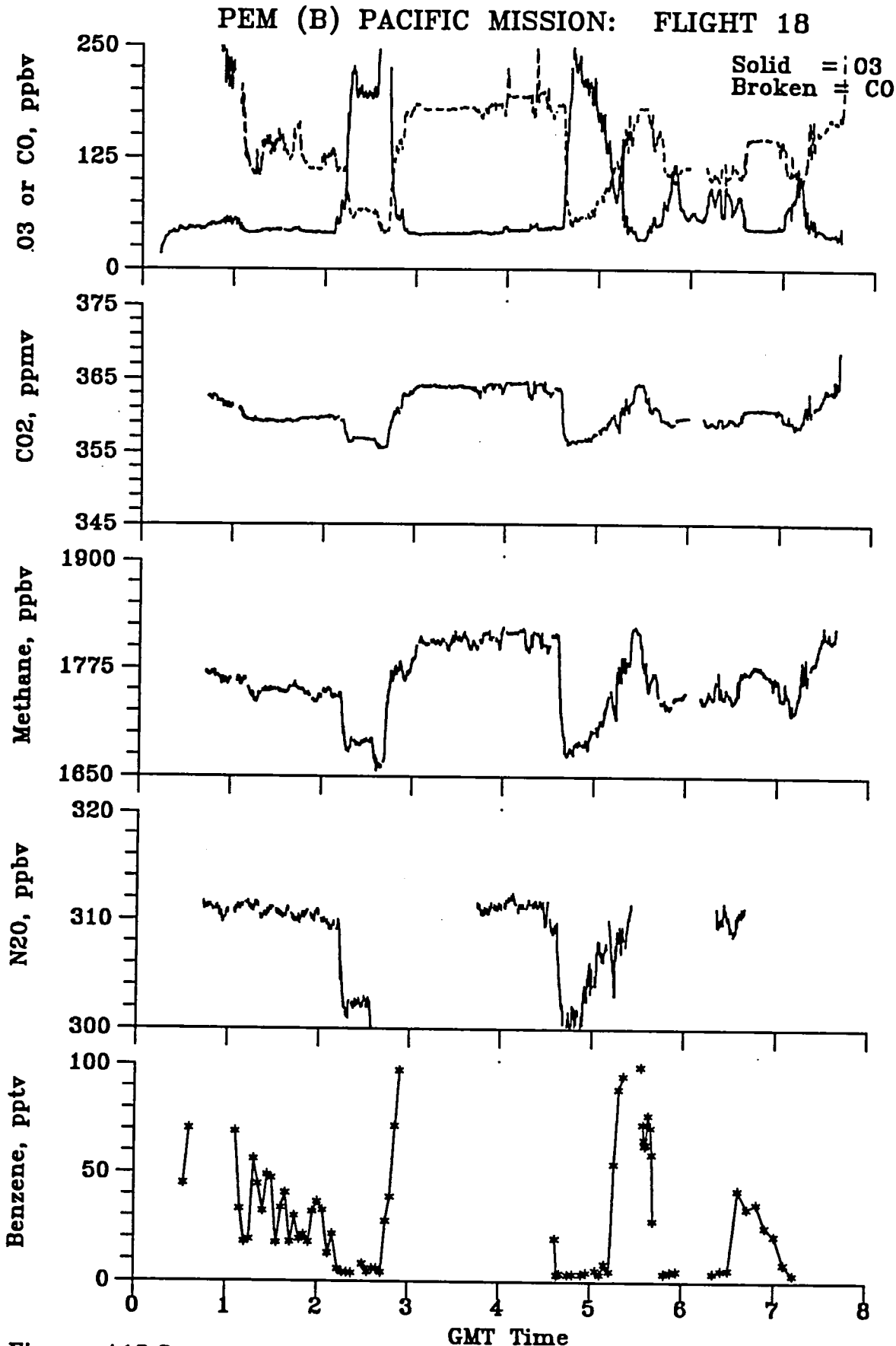

PEM (B) PACIFIC MISSION: FLIGHT 18
Solid = O3
Broken = CO
O3 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
0
1
2
3
4
5
6
7
8
GMT Time

Figure A18.2

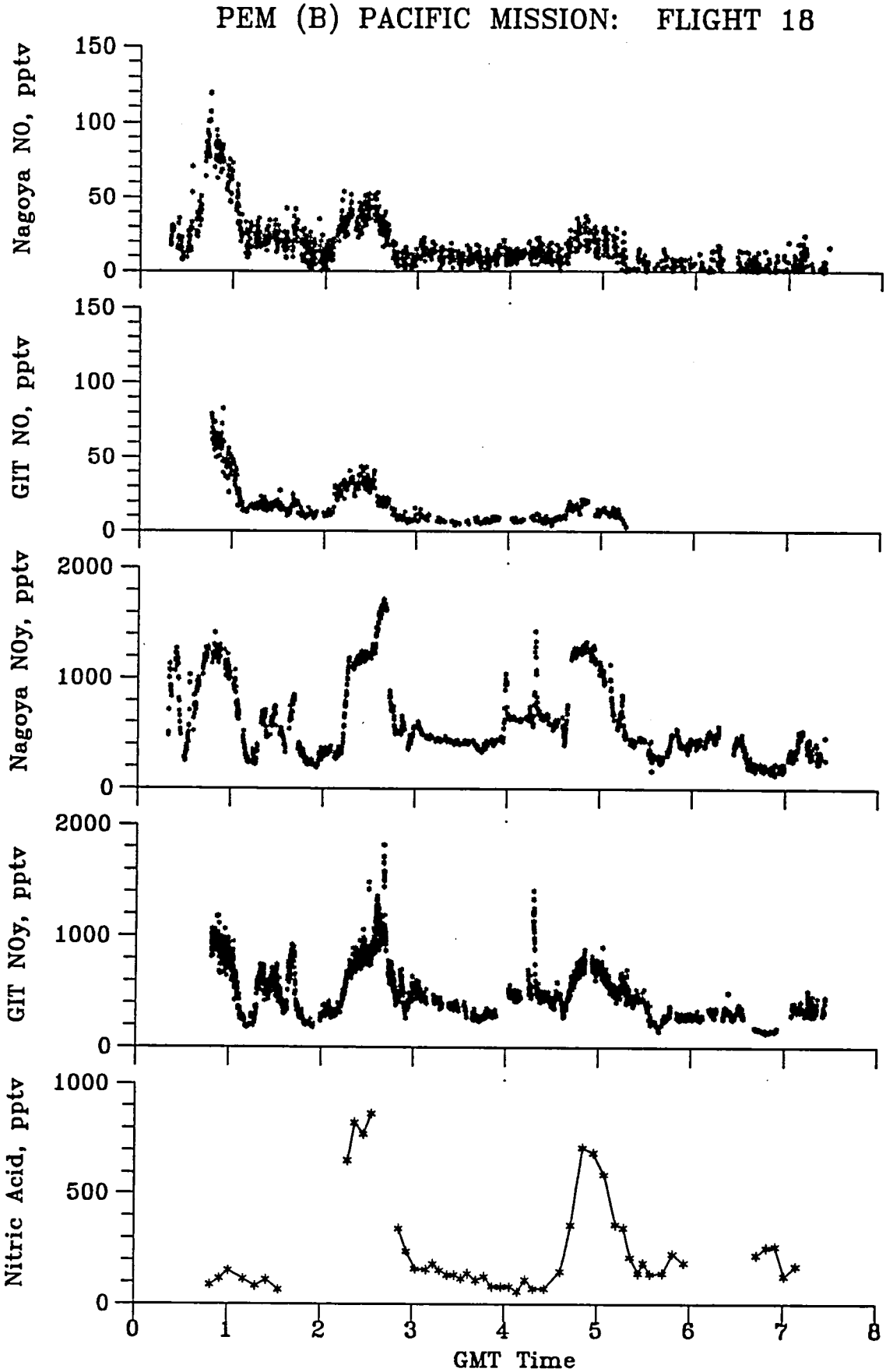

PEM (B) PACIFIC MISSION: FLIGHT 18
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
150
100
50
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
Nitric Acid, pptv
1000
500
0
0
1
2
3
4
5
6
7
8
GMT Time

Figure A18.3

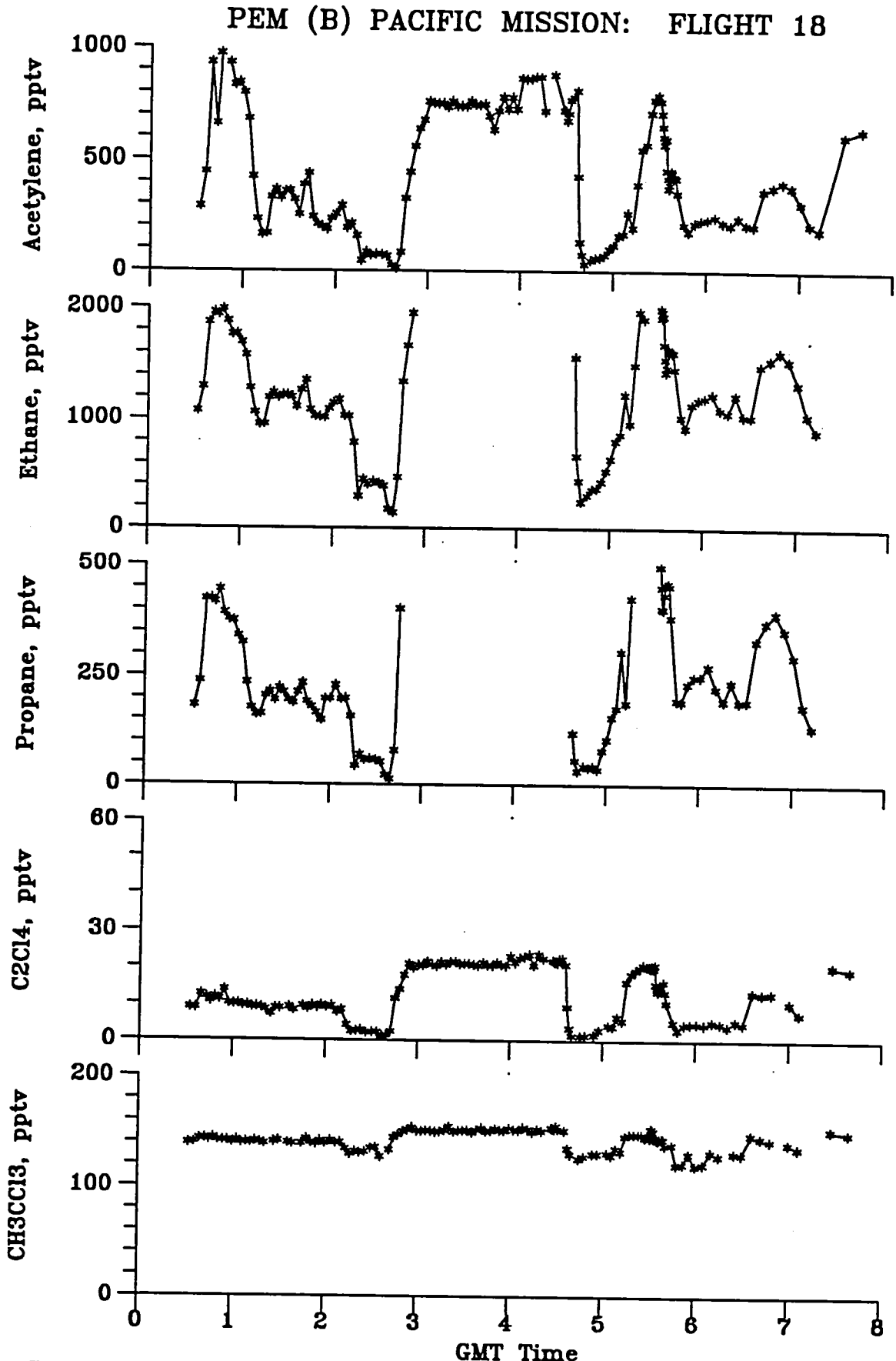

PEM (B) PACIFIC MISSION: FLIGHT 18
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
0
1
2
3
4
5
6
7
8
GMT Time

Figure A18.4

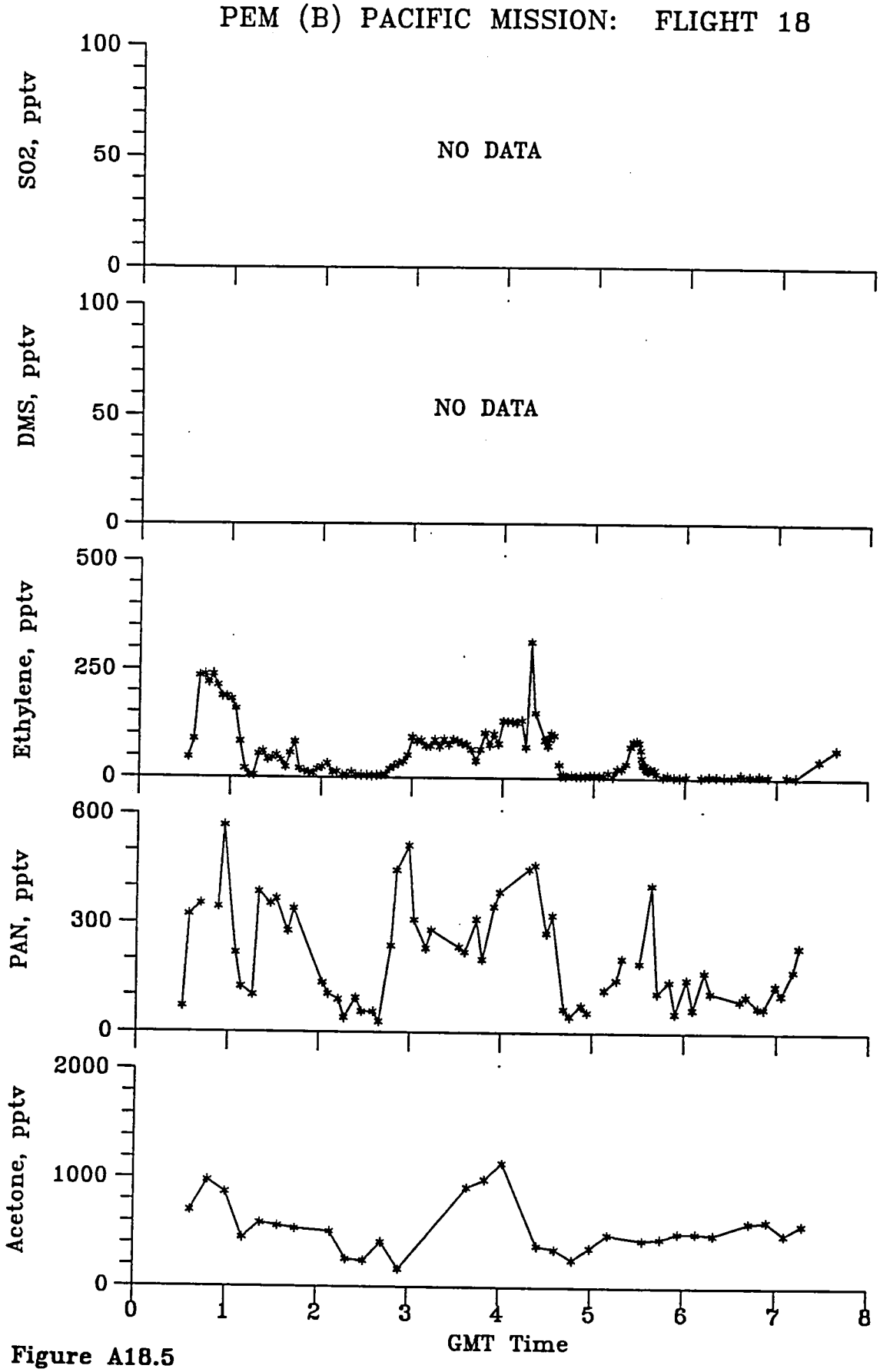

PEM (B) PACIFIC MISSION: FLIGHT 18
SO2, pptv
100
50
0
NO DATA
DMS, pptv
100
50
0
NO DATA
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
0
1
2
3
4
5
6
7
8
GMT Time

Figure A18.5

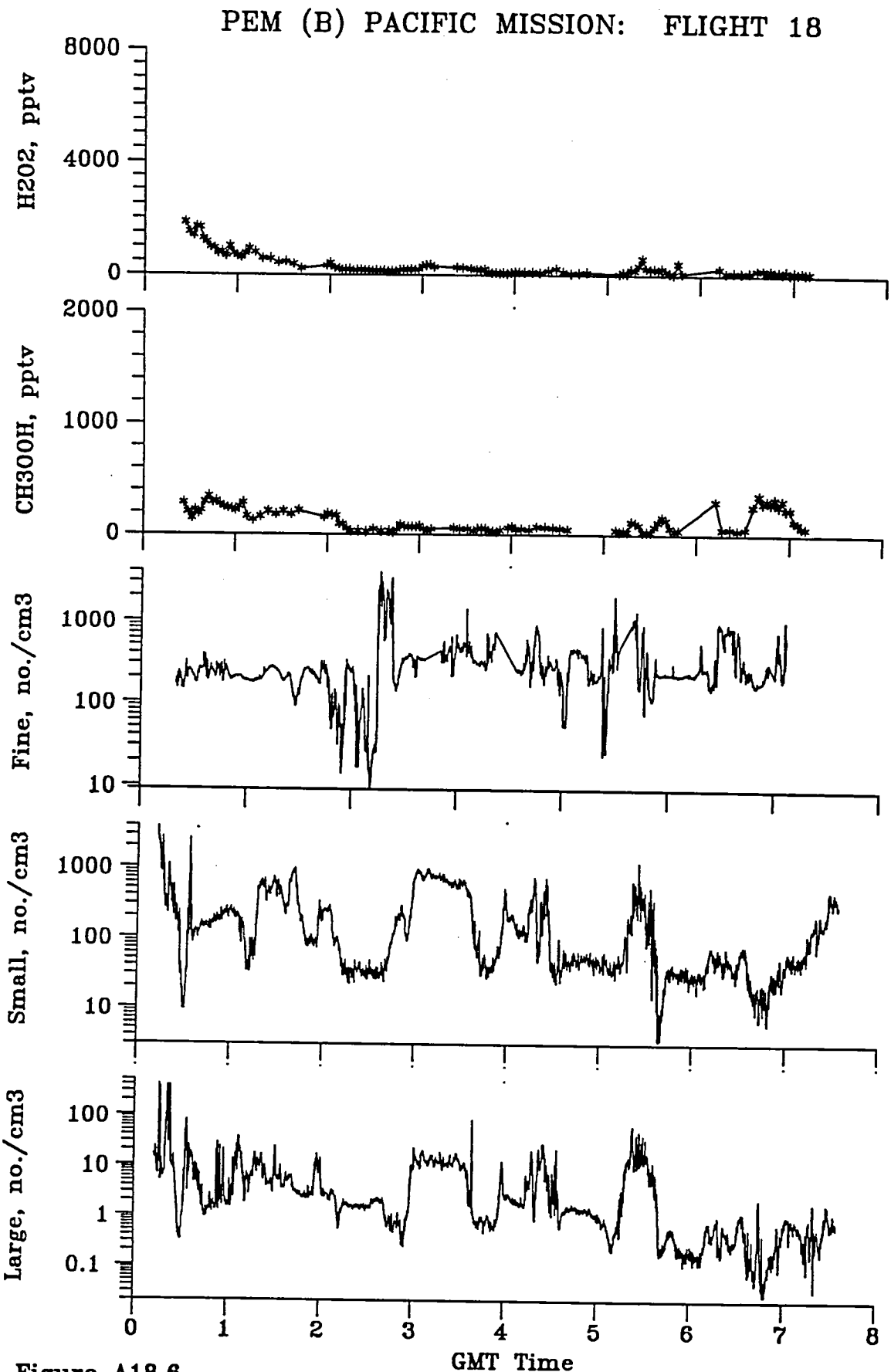
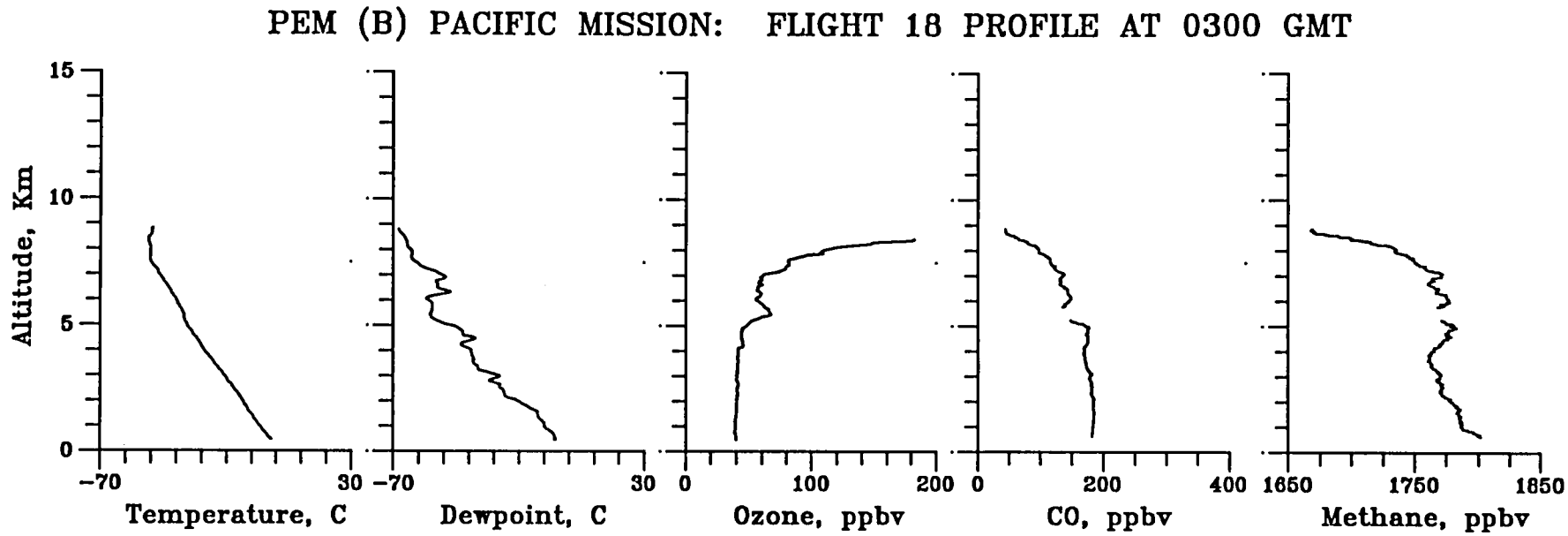

PEM (B) PACIFIC MISSION: FLIGHT 18
H202, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
1000
100
10
Large, no./cm3
100
10
1
0.1
0
1
2
3
4
5
6
7
8
GMT Time

Figure A18.6


PEM (B) PACIFIC MISSION: FLIGHT 18 PROFILE AT 0300 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
100
200
Ozone, ppbv
400
CO, ppbv
1650
1750
1850
Methane, ppbv

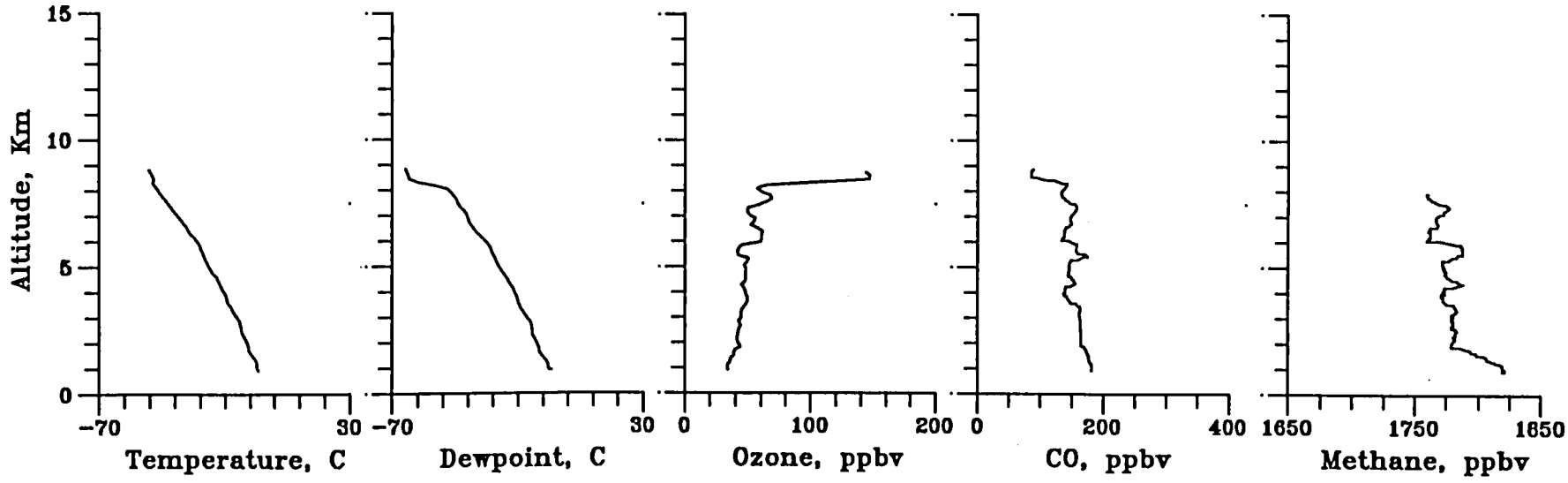

PEM (B) PACIFIC MISSION: FLIGHT 18 PROFILE AT 0515 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
100
200
Ozone, ppbv
400
CO, ppbv
1650
1750
1850
Methane, ppbv

Figure A18.7

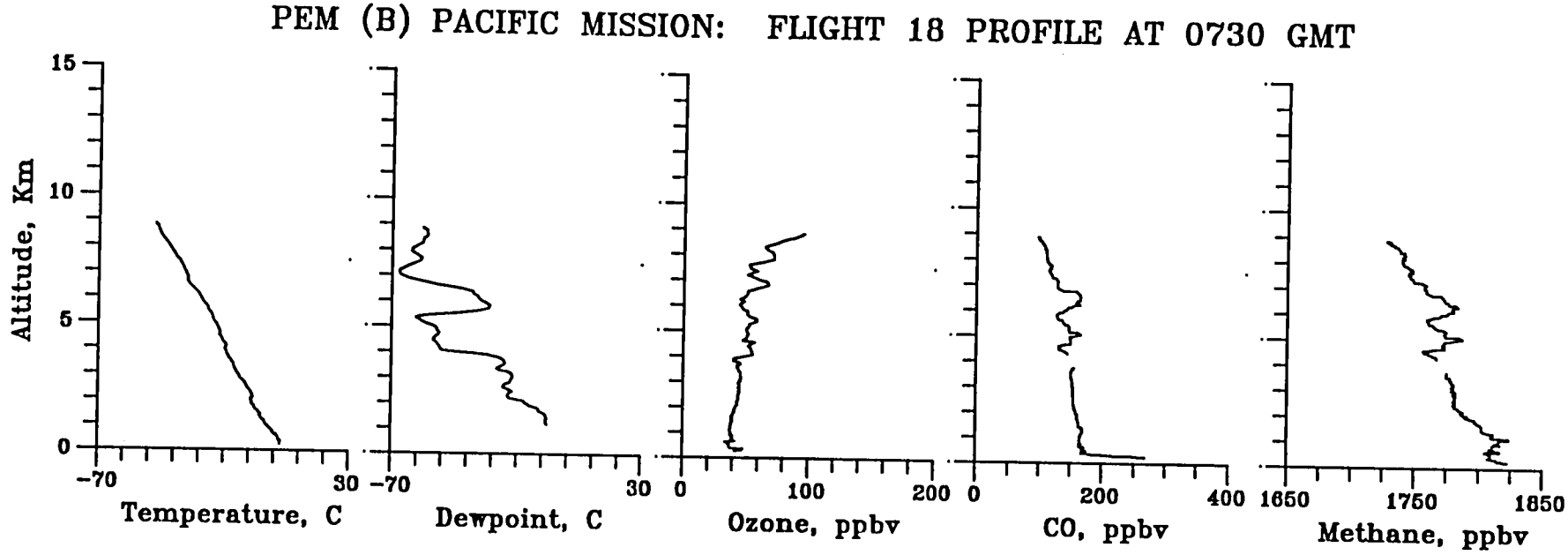

PEM (B) PACIFIC MISSION: FLIGHT 18 PROFILE AT 0730 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
-70
30
Dewpoint, C
0
100
200
Ozone, ppbv
0
200
400
CO, ppbv
1650
1750
1850
Methane, ppbv

Figure A18.8

PEM (B) PACIFIC MISSION: FLIGHT 19

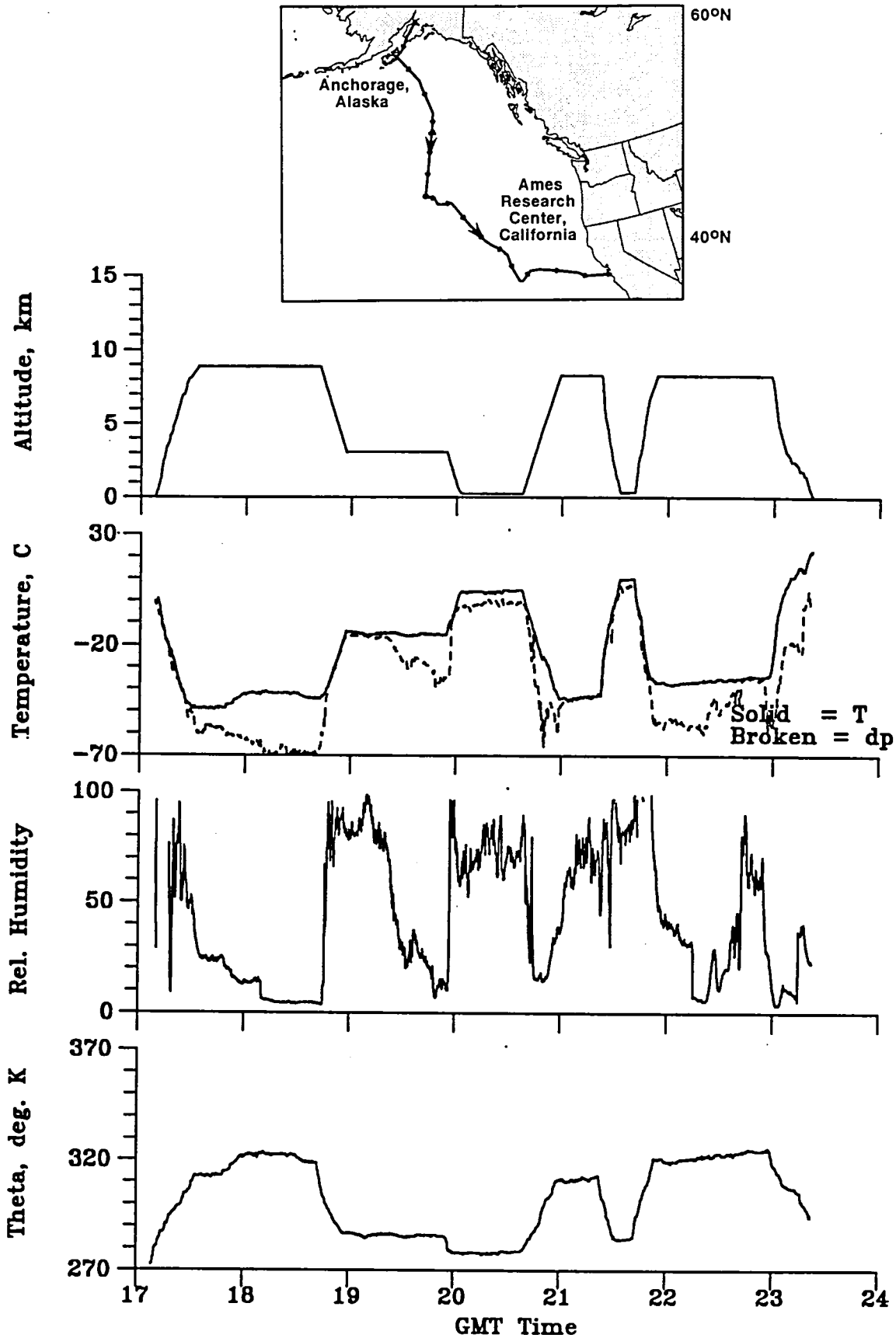


Figure A19.1

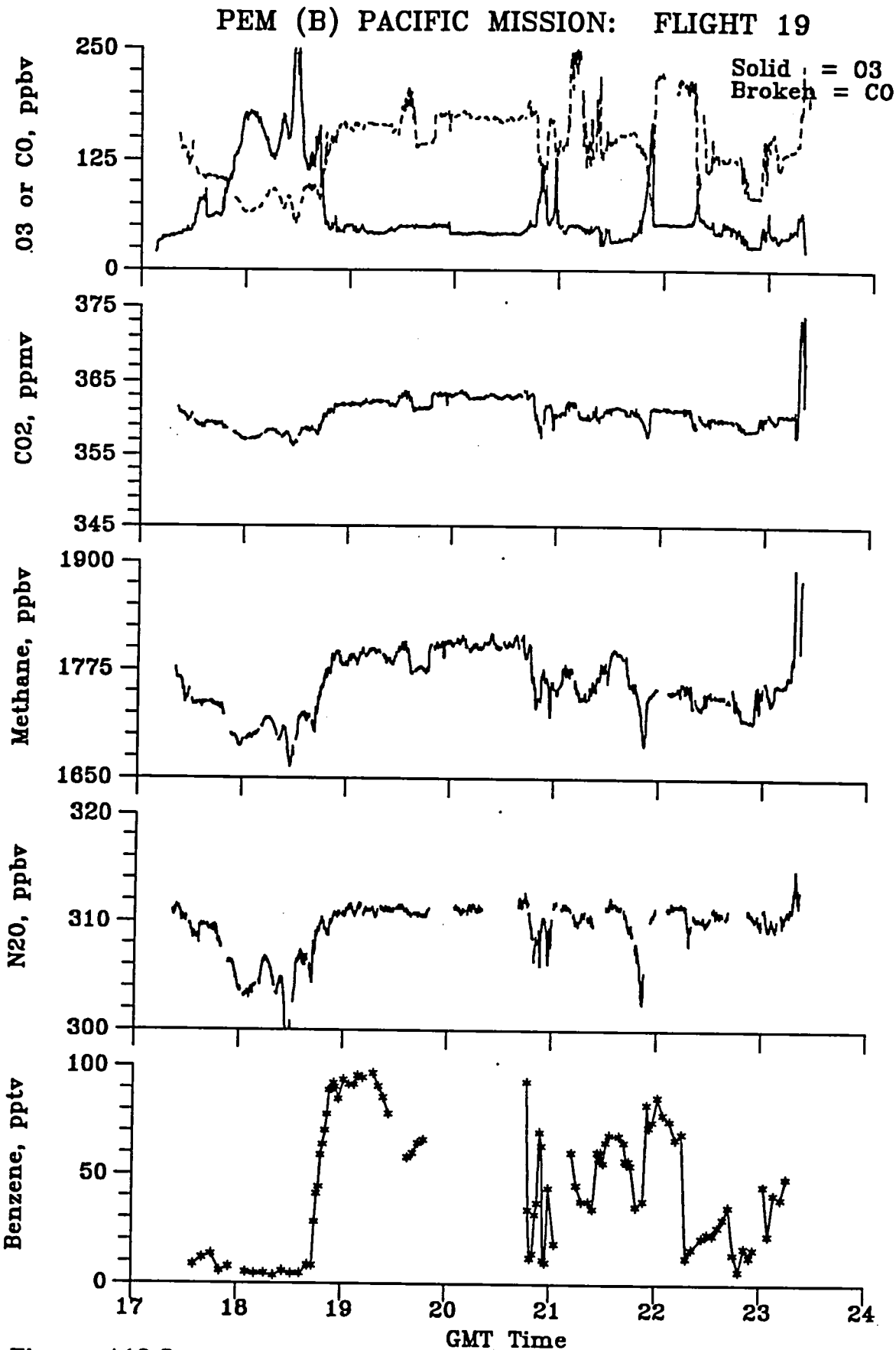

PEM (B) PACIFIC MISSION: FLIGHT 19
Solid = O3
Broken = CO
O3 or CO, ppbv
250
125
0
CO2, ppmv
375
365
355
345
Methane, ppbv
1900
1775
1650
N2O, ppbv
320
310
300
Benzene, pptv
100
50
0
17
18
19
20
21
22
23
24
GMT Time

Figure A19.2

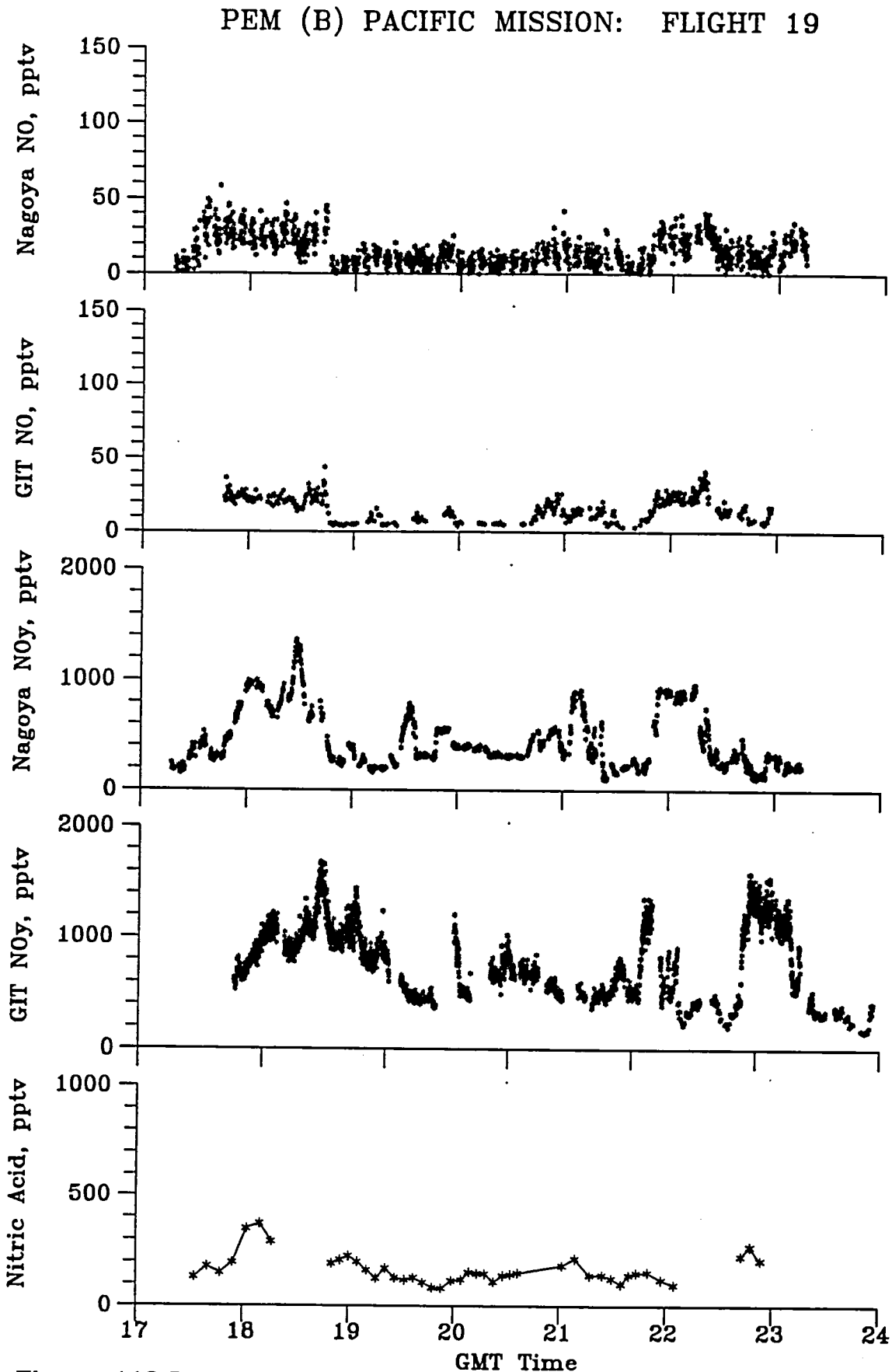

PEM (B) PACIFIC MISSION: FLIGHT 19
Nagoya NO, pptv
150
100
50
0
GIT NO, pptv
150
100
50
0
Nagoya NOy, pptv
2000
1000
0
GIT NOy, pptv
2000
1000
0
Nitric Acid, pptv
1000
500
0
17
18
19
20
21
22
23
24
GMT Time

Figure A19.3

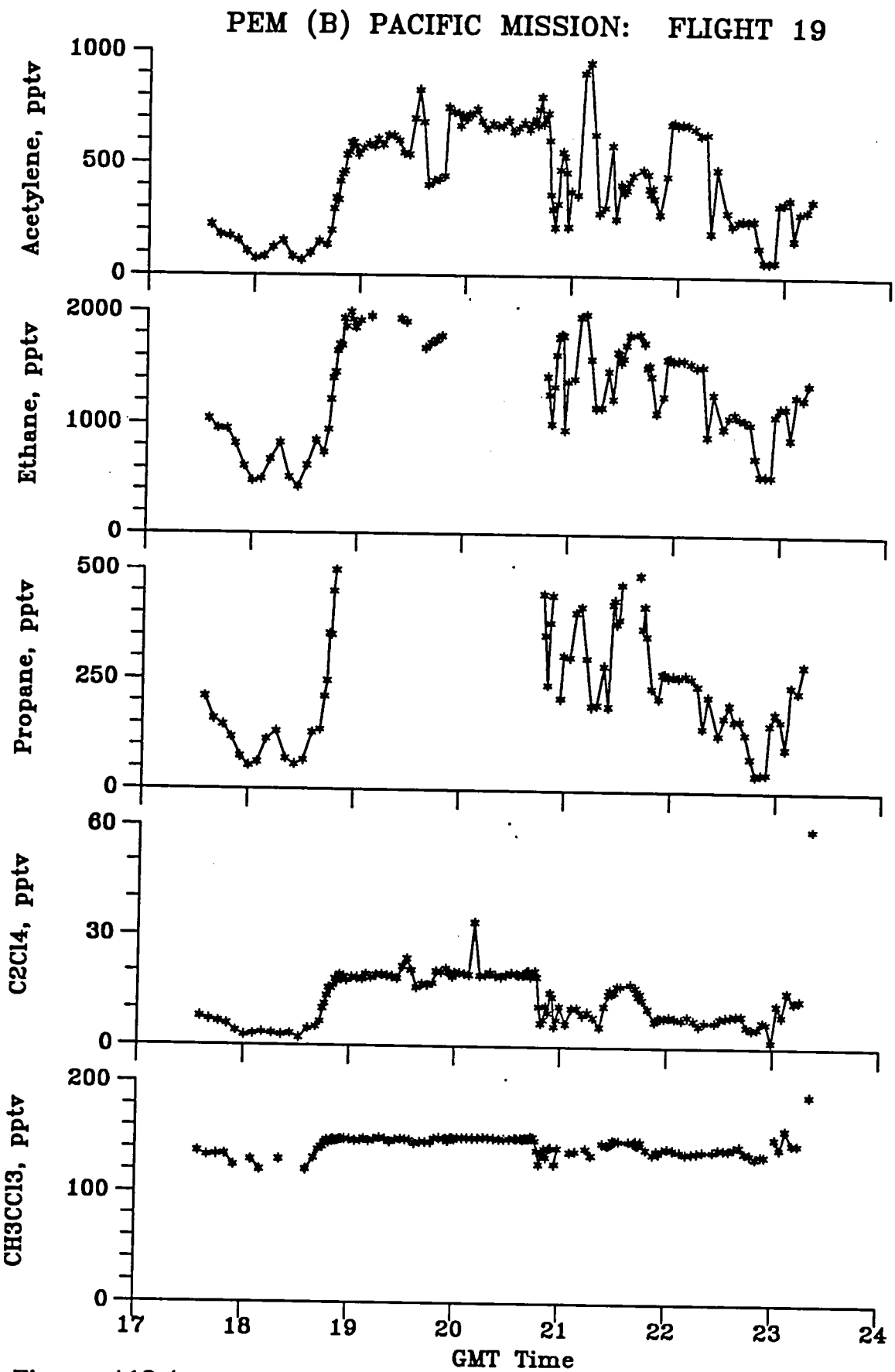

PEM (B) PACIFIC MISSION: FLIGHT 19
Acetylene, pptv
1000
500
0
Ethane, pptv
2000
1000
0
Propane, pptv
500
250
0
C2Cl4, pptv
60
30
0
CH3CCl3, pptv
200
100
0
17
18
19
20
21
22
23
24
GMT Time

Figure A19.4

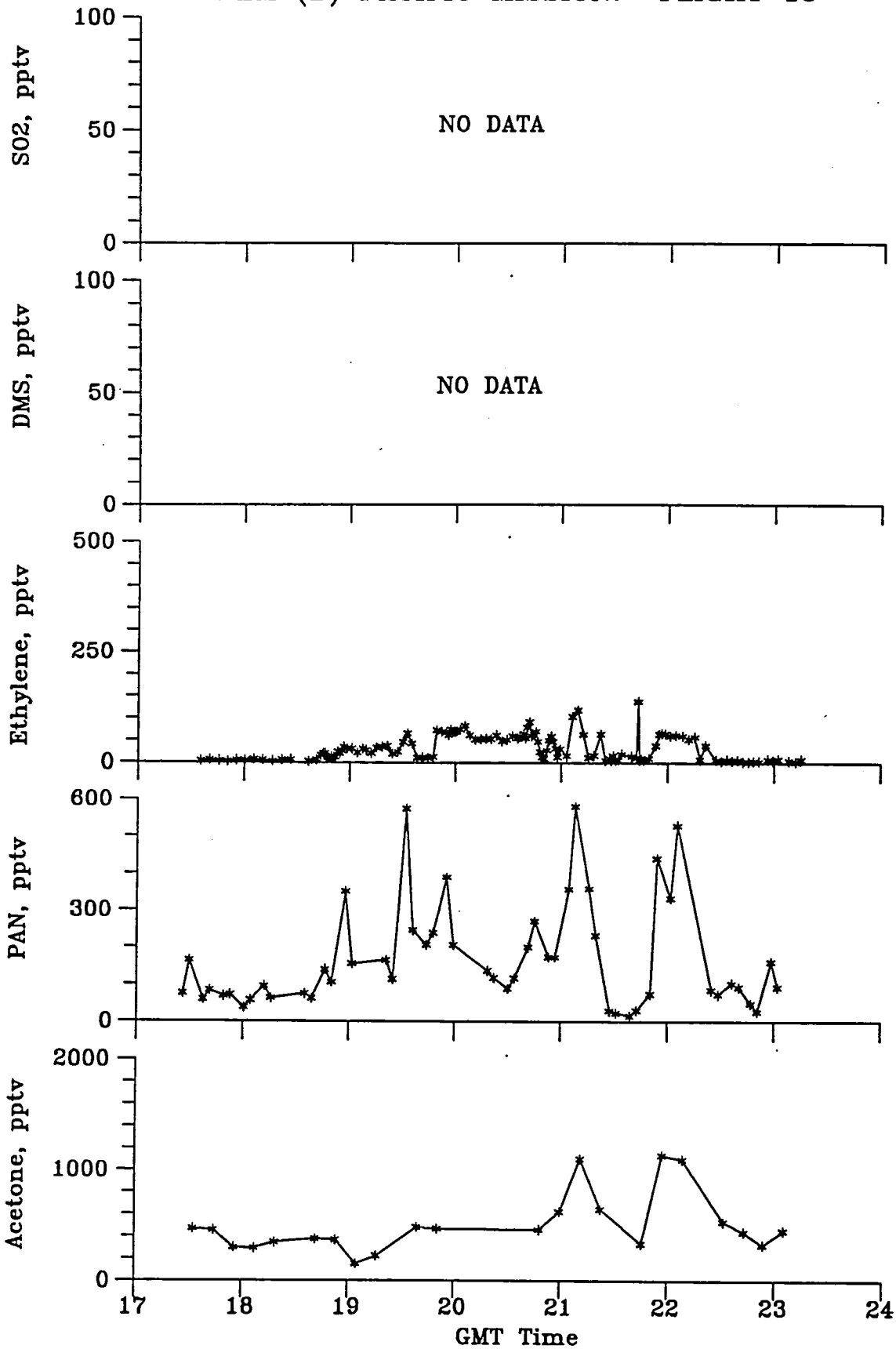

PEM (B) PACIFIC MISSION: FLIGHT 19
SO2, pptv
100
50
0
NO DATA
DMS, pptv
100
50
0
NO DATA
Ethylene, pptv
500
250
0
PAN, pptv
600
300
0
Acetone, pptv
2000
1000
0
17
18
19
20
21
22
23
24
GMT Time

Figure A19.5

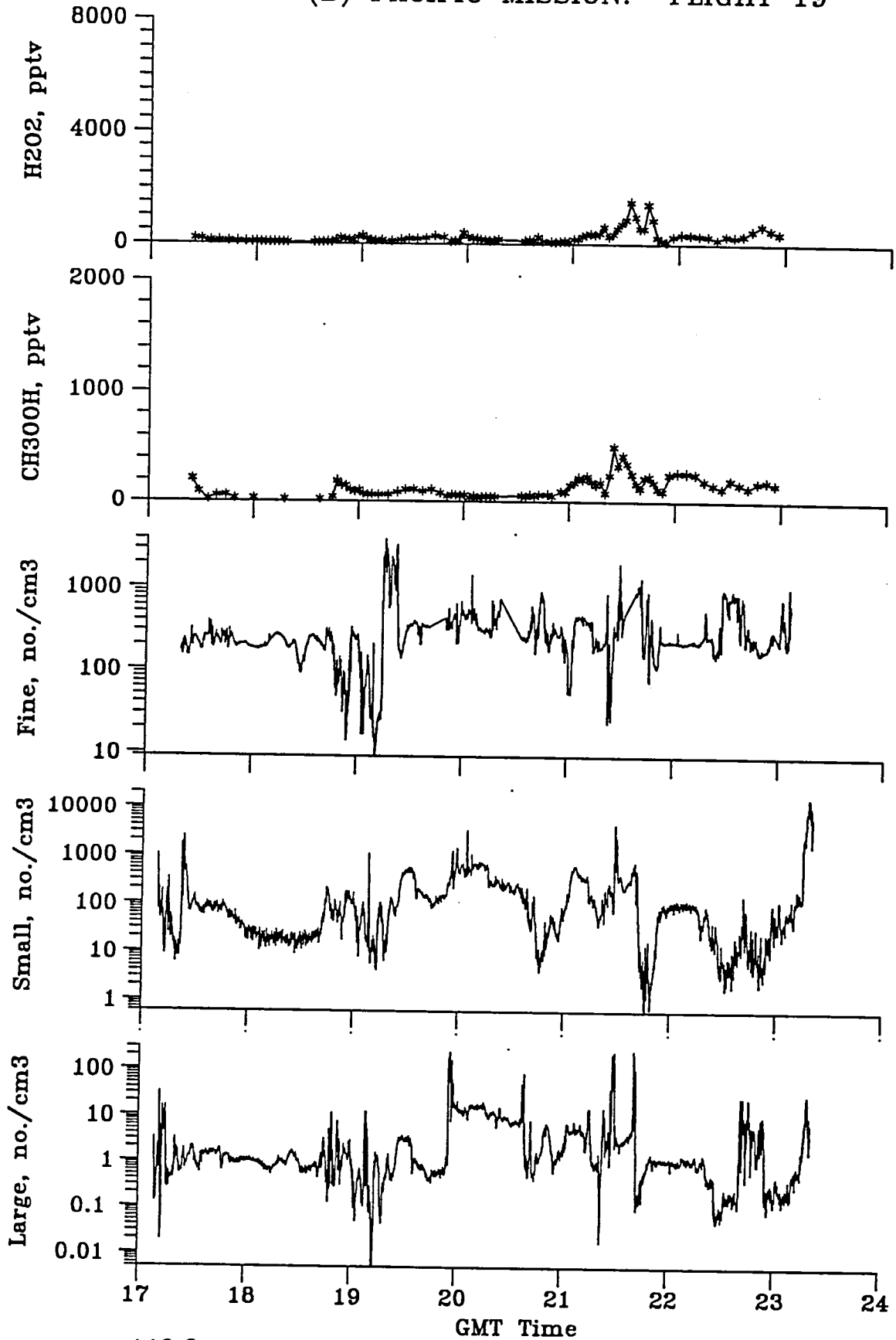
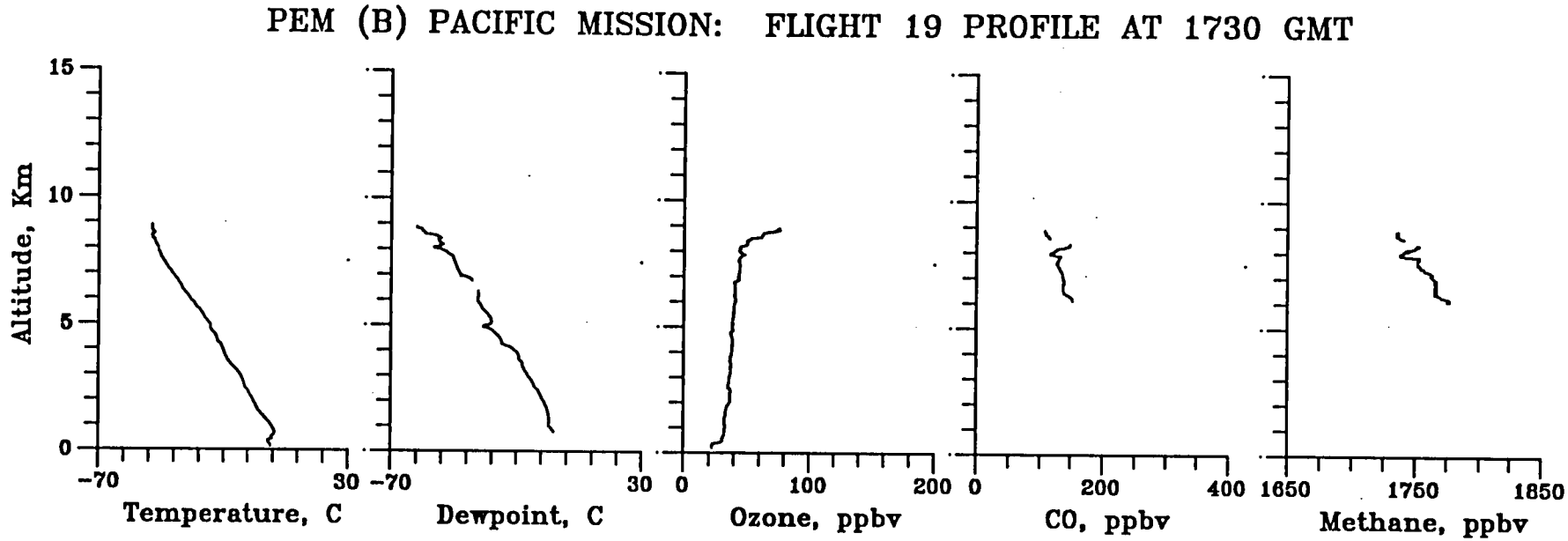
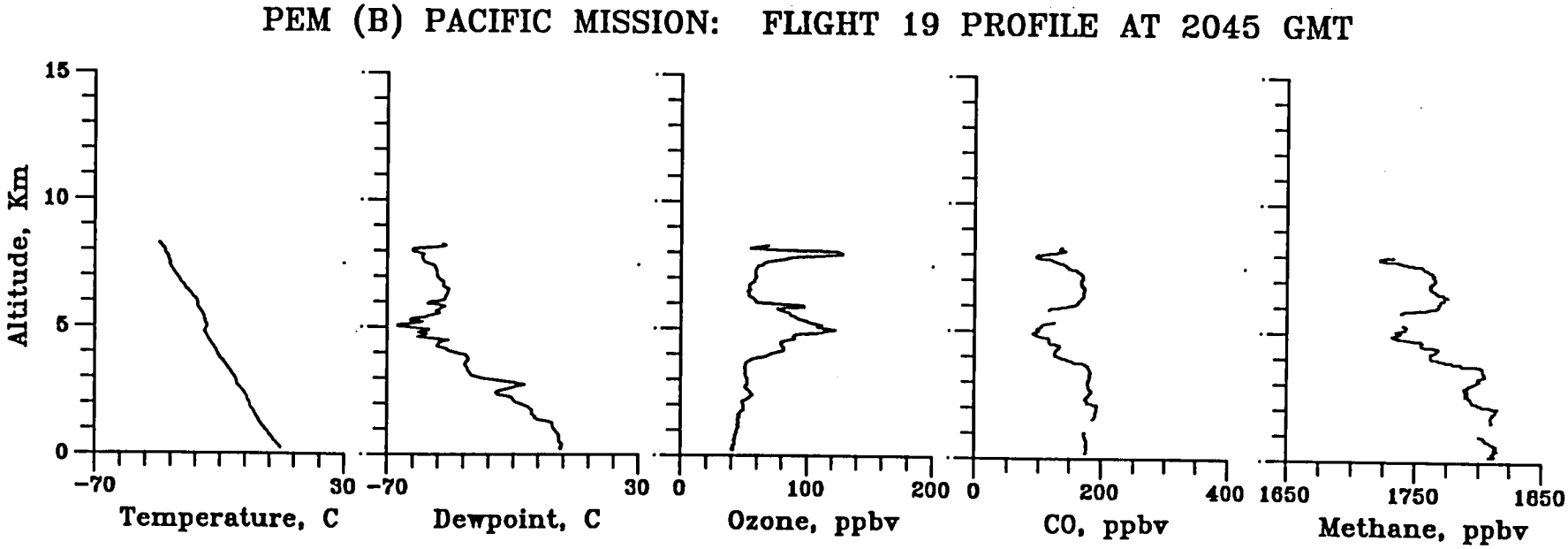

PEM (B) PACIFIC MISSION: FLIGHT 19
H2O2, pptv
8000
4000
0
CH3OOH, pptv
2000
1000
0
Fine, no./cm3
1000
100
10
Small, no./cm3
10000
1000
100
10
1
Large, no./cm3
100
10
1
0.1
0.01
17
18
19
20
21
22
23
24
GMT Time

Figure A19.6

Figure A19.7


PEM (B) PACIFIC MISSION: FLIGHT 19 PROFILE AT 1730 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
100
200
Ozone, ppbv
400
CO, ppbv
1650
1750
1850
Methane, ppbv


PEM (B) PACIFIC MISSION: FLIGHT 19 PROFILE AT 2045 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
Dewpoint, C
0
100
200
Ozone, ppbv
400
CO, ppbv
1650
1750
1850
Methane, ppbv

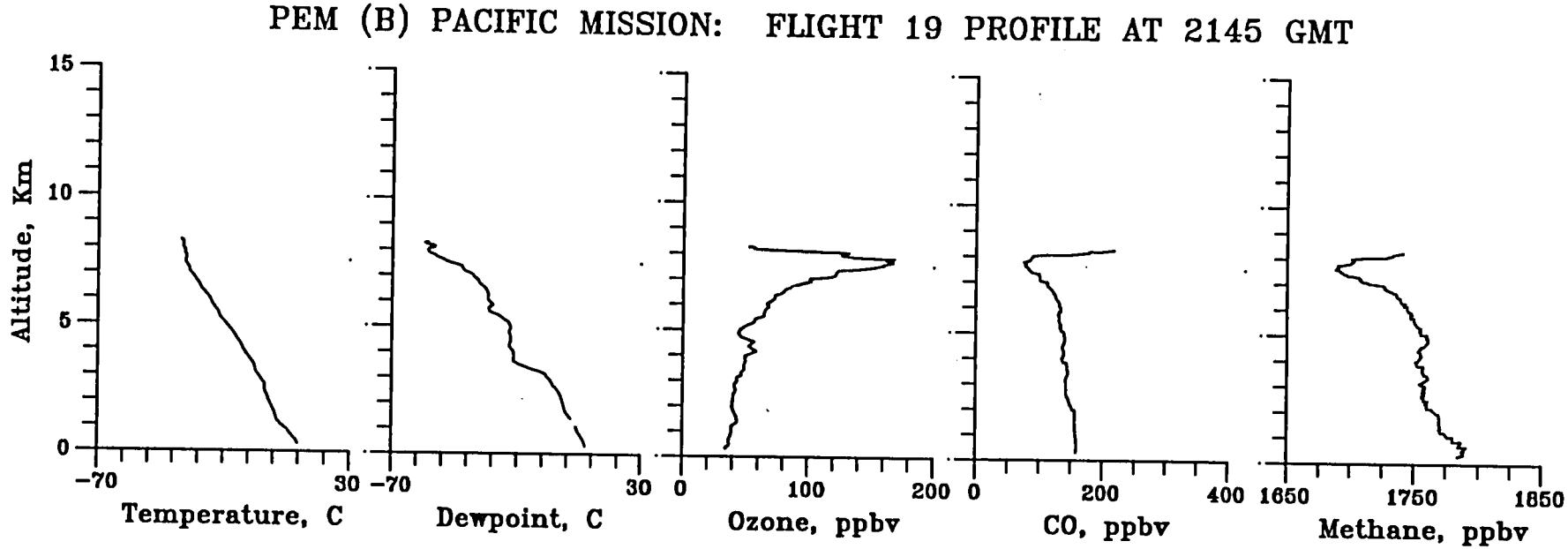

PEM (B) PACIFIC MISSION: FLIGHT 19 PROFILE AT 2145 GMT
Altitude, Km
15
10
5
0
-70
30
Temperature, C
-70
30
Dewpoint, C
0
100
200
Ozone, ppbv
0
200
400
CO, ppbv
1650
1750
1850
Methane, ppbv

Figure A19.8

APPENDIX B: LANGLEY DAAC DATA ARCHIVE

System Description

The Langley Distributed Active Archive Center (DAAC), located at the NASA Langley Research Center in Hampton, Virginia, is responsible for archiving and distributing NASA science data in the areas of radiation budget, clouds, aerosols, and tropospheric chemistry. This DAAC will also archive some of the data sets which result from the EOS program and other elements of Mission to Planet Earth. The DAAC has developed an on-line computer system which allows the user to log on, search through the DAAC's data inventory, choose the desired data sets, and place an order. Data may be received either electronically (via FTP) or on media such as 4mm tape, 8mm tape, or CD-ROM (prepackaged data sets only).

Log On Procedures

1. Users with an X-Windows terminal (e.g., Motif) or a Sun Open Windows display system with access to Internet, may log onto the system by entering:

```
xhost +  eosdis.larc.nasa.gov
(or:  xhost + 192.107.191.17)
telnet eosdis.larc.nasa.gov
login name:  ims
password:  larcims
```

At the prompts, enter x for the X-Windows interface and then your display name (name of your workstation followed by ":0" or Internet address followed by ":0").

2. Users with access to NCSA Mosaic can use the following URL address:

http://eosdis.larc.nasa.gov/

3. Users without access to a terminal with an X-Windows display system but who have access to Internet may log onto the system by entering:

telnet eosdis.larc.nasa.gov

login name: ims

password: larcims

At the prompt, enter c for the character interface and then press return.

4. Users who cannot access the system or who have any questions concerning the Langley DAAC may contact:

Langley DAAC User and Data Services
Mail Stop 157B
NASA Langley Research Center
Hampton, VA 23681-0001
Phone: (804) 864-8656
FAX: (804) 864-8807
email: larc@eos.nasa.gov

DAAC Data Bases

1. ERBE (Earth Radiation Budget Experiment)--Data were collected from three satellites (ERBS, NOAA-9, NOAA-10) carrying two ERBE instruments (scanner, nonscanner). The objective is to measure global albedo, fluxes, and solar incidence.

2. ISCCP (International Satellite Cloud Climatology Project)--ISCCP focuses on the study of the distribution and variation of cloud radiative properties. The objective is to improve the understanding and modeling of the effects of clouds on climate and also to elucidate the role of clouds in the radiation balance and improve our knowledge of the long-term global hydrologic cycle.

3. SAGE (Stratospheric Aerosol and Gas Experiment)--SAGE I gathered data concerning the spatial distribution of stratospheric aerosols, ozone, and nitrogen dioxide on a global scale. The goals of SAGE II are to determine the spatial distributions of stratospheric aerosols, ozone, nitrogen dioxide, water vapor, and cloud occurrence by mapping vertical profiles and calculating monthly averages of each.

4. SRB (Surface Radiation Budget)--The SRB data sets were calculated using inputs from ISCCP and ERBE data. They are designed to give global daily and monthly averages of the albedo, irradiance, cloud properties, and meteorology.

5. FIRE (First ISCCP Regional Experiment)--This series of experiments includes aircraft, satellite, and surface-based measurements of cirrus and marine stratocumulus cloud parameters. The purpose of this program is to validate and improve ISCCP data products and cloud/radiation parameterizations used in general circulation models (GCMs).

6. GTE (Global Tropospheric Experiment)--Data were collected primarily from aircraft and ground-based instruments from a variety of areas such as the Amazon Rain Forest and the northern tundra and boreal forest. Many parameters were measured including O_3, CH_4, PAN, CO, NO, NO_2, CO_2, and aerosols.

7. MAPS (Measurement of Air Pollution from Satellites)--Data were collected during Space Shuttle flights in 1981, 1984, and 1994. The main pollutant measured was carbon monoxide (CO).

8. SAM II (Stratospheric Aerosol Measurement)--This instrument was flown on board the Nimbus-7 satellite and consisted of a one-spectral channel Sun photometer, centered at 1.0 um, which viewed a small portion of the Sun through the Earth's atmosphere during spacecraft sunrise and sunset. The data obtained from this instrument were used to determine the vertical distribution of stratospheric aerosols in the polar regions of both hemispheres.

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12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

This compendium describes aircraft data that are available from NASA's Pacific Exploratory Mission West-B (PEM West-B). PEM West is a component of the International Global Atmospheric Chemistry's (IGAC) East Asia/North Pacific Regional Study (APARE) project. Objectives of PEM West are to investigate the atmospheric chemistry of ozone over the northwest Pacific--natural budgets and the impact of anthropogenic/continental sources; and to investigate sulfur chemistry--continental and marine sulfur sources. The PEM West program encompassed two expeditions. PEM West-A was conducted in September 1991 during which the predominance of tropospheric air was from mid-Pacific (marine) regions, but (at times) was modified by Asian outflow. PEM West-B was conducted during February 1994, a period characterized by maximum Asian outflow. Results from PEM West-A and B are public domain. PEM West-A data are summarized in NASA TM 109177 (published February 1995). Flight experiments were based at Guam, Hong Kong, and Japan. This document provides a representation of NASA DC-8 aircraft data that are available from NASA Langley's Distributed Active Archive Center (DAAC). The DAAC includes numerous other data such as meteorological and modeling products, results from surface studies, satellite observations, and sonde releases.

14. SUBJECT TERMS
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