NASA Reference Publication 1143

December 1985

Airborne Lidar Measurements of Aerosols, Mixed Layer Heights, and Ozone During the 1980 PEPE/NEROS Summer Field Experiment

Edward V. Browell,
Scott T. Shipley,
Carolyn F. Butler,
and Syed Ismail

NASA

NASA Reference Publication 1143

1985

Airborne Lidar Measurements of Aerosols, Mixed Layer Heights, and Ozone During the 1980 PEPE/NEROS Summer Field Experiment

Edward V. Browell
and Scott T. Shipley
Langley Research Center
Hampton, Virginia

Carolyn F. Butler
Old Dominion University Research Foundation
Norfolk, Virginia

Syed Ismail
SASC Technologies, Inc.
Hampton, Virginia

NASA
National Aeronautics
and Space Administration

Scientific and Technical
Information Branch

Contents

Symbols and Acronyms

B_{gas}	DIAL correction due to aerosol backscatter
$B_\lambda(R)$	total-volume backscatter coefficient
E_{gas}	DIAL correction due to aerosol extinction
$k_{\text{gas},\lambda}$	gas-absorption cross section
N_{gas}	gas concentration
R_{gas}	DIAL correction due to Rayleigh extinction
R_i	range
$S_\lambda(R)$	aerosol-to-molecular backscatter ratio
$\frac{P_{\text{aer},\pi}(R)}{4\pi}$	normalized backscatter phase function for aerosols
$P_\lambda(R)$	lidar return power
α	Angstrom coefficient
$\beta_{\text{aer},\lambda}$	aerosol extinction coefficient
$\beta_{\text{mol},\lambda}$	molecular extinction coefficient
γ_λ	lidar system constant
Δk_{gas}	differential gas-absorption cross section
δ	power law dependence on λ for volume backscatter coefficient
ϵ	power law dependence on λ for backscatter phase function
λ	wavelength
λ_{off}	off wavelength used in DIAL measurements
λ_{on}	on wavelength used in DIAL measurements
σ	standard deviation
$\sigma_{\text{aer}}(R)$	aerosol total scattering cross section
$\sigma_{\text{mol}}(R)$	molecular total scattering cross section

Acronyms:

AGL	above ground level
ASCII	American Standard Code for Information Interchange
DIAL	Differential Absorption Lidar
EDT	eastern daylight time
EPA	Environmental Protection Agency
GSFC	Goddard Space Flight Center
HSRL	High Spectral Resolution Lidar
INS	inertial navigation system
IR	infrared
JPL	Jet Propulsion Laboratory
KDP	KH_2PO_4 glass medium used for laser Q-switching
LaRC	Langley Research Center
LAS	Laser Absorption Spectrometer
MARS	Microwave Atmospheric Remote Sensor
MSL	mean sea level
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
Nd:YAG	Nd^{3+} doped $Y_3Al_5O_{12}$ glass medium for 1.06 μm radiation
OMA	Optical Multichannel Analyzer
PEPE/NEROS	Persistent Elevated Pollution Episode/Northeast Regional Oxidant Study
PMT	photomultiplier tube
ROM	regional oxidant model
UV	ultraviolet
VHF	very high frequency
VOR	VHF omnidirectional range (navigation aid)
WFC	Wallops Flight Center

Acknowledgments

The authors express their appreciation to Loyd W. Overbay, Norman L. McRae, William J. McCabe, Arlen F. Carter, and James H. Siviter, Jr., of the NASA Langley Research Center; Neale Mayo of PRC Kentron, Inc.; and Robert J. Allen of the Old Dominion University Research Foundation for their skilled technical support in the development of the airborne UV DIAL system. The UV DIAL archive was constructed with the additional help of Dana A. Brewer, Gladys R. Loar, John D. W. Barrick, and Brian L. Orndorff. Appreciation is also expressed to the NASA Wallops Flight Center for their cooperation in providing the Electra aircraft for our flight experiments.

Funds for this field experiment were provided by NASA and by the EPA under the 1980 NASA/EPA Memorandum of Understanding.

1 Introduction

This document describes the airborne NASA Ultraviolet Differential Absorption Lidar (UV DIAL) data archive for flights conducted during the Persistent Elevated Pollution Episode/Northeast Regional Oxidant Study (PEPE/NEROS) 1980 Summer Field Experiment (Vaughan et al. 1982). The NASA UV DIAL system was operated onboard the Wallops Flight Center (WFC) Lockheed 188A Electra aircraft for the simultaneous measurement of ozone (O_3) and aerosol profiles in the lower troposphere. This experiment was performed in cooperation with the U.S. Environmental Protection Agency (EPA) under a 1980 NASA/EPA Memorandum of Understanding. As part of this agreement, NASA was responsible for measuring the mixed layer heights on a regional scale with the airborne NASA UV DIAL system. Flight plans were provided by the EPA PEPE/NEROS field headquarters located in Columbus, Ohio. This report provides airborne-lidar information on mixed layer heights and detailed data on the distributions of atmospheric aerosols and O_3 measured during the PEPE/NEROS 1980 Summer Field Experiment.

The PEPE program was managed by the Regional Field Studies Office of the EPA Environmental Sciences Research Laboratory at Research Triangle Park, North Carolina. The 1980 PEPE experiment focused on the formation and transport of polluted air masses which extend over hundreds of kilometers. Several persistent elevated (i.e., in concentration) pollution episodes which show broad regions of haze characteristic of stagnant air masses have been identified in satellite imagery (Lyons et al. 1978). Reports of surface visibility and air quality patterns have been correlated with these air masses (Husar, Gillani, Husar, Paley, and Turcu 1976; Husar, Gillani, Husar, and Patterson 1976; Wolff, Kelly, and Ferman 1981), and field studies conducted by the EPA in 1978 recognized the need for regional-scale measurements. This document shows that regional-scale haze events may not only be "elevated" in the sense of high pollutant concentrations, but may also be elevated in height. Observed haze features were often detected at altitudes above the mixed layer, and in these cases satellite and surface sensor indications of pollutant concentrations were poorly correlated.

The NEROS program was managed by the Meteorology Division of the EPA Environmental Sciences Research Laboratory at Research Triangle Park, North Carolina. The NEROS experiment was composed of several separate studies to investigate characteristics of regional-scale air masses and urban plumes with emphasis on providing a data base for validation of the EPA regional oxidant model (ROM) (Lamb 1982). Both Eulerian and Lagrangian studies were performed near Columbus, Ohio, and Baltimore, Maryland, and in some cases involved the remnants of PEPE air masses as they migrated across the northeast corridor.

In addition to EPA and NASA, other major participants in the field experiment included the National Oceanic and Atmospheric Administration, the Federal Aviation Administration, the Tennessee Valley Authority, the National Science Foundation, the National Center for Atmospheric Research, the Argonne National Laboratory, and the Canadian Ministry of the Environment. The role of each organization is discussed elsewhere (Vaughan et al. 1982). In addition, several universities participated in the field experiment and have been involved in data interpretation and analysis. These include Ohio State University, University of Minnesota, Washington University at St. Louis, University of Washington, New York University Medical Center, University of Wisconsin, and Harvey Mudd College.

The NASA effort included airborne lidar measurements of atmospheric mixed layer heights on a regional scale. In addition, this intensive field program provided a vehicle for the further development, testing, and evaluation of several emerging remote sensor systems for future user-agency applications. These systems were the Langley Research Center (LaRC) UV DIAL for O_3 profiles, the University of Wisconsin High Spectral Resolution Lidar (HSRL) for aerosol extinction profiles, and the Jet Propulsion Laboratory (JPL) Laser Absorption Spectrometer (LAS) for O_3 column content measurements. The UV DIAL and HSRL were flown onboard the WFC Electra aircraft. The LAS was flown onboard the JPL Queen Air aircraft. Correlative measurements for these systems were obtained using a Cessna 402 airplane instrumented with in situ sensors. Other NASA sensors deployed during the field experiment included 12 photometer-transmissometer systems from the Goddard Space Flight Center (GSFC) and the University of Miami; the JPL ground-based Microwave Atmospheric Remote Sensor (MARS); and two LaRC instrumented tethered-balloon systems. A detailed technical description of the airborne UV DIAL system is given in Browell et al. (1983). Brief descriptions of the other NASA and NASA-sponsored instrumentation are given in Maddrea and Bendura (1981). A description and discussion of the data archive developed for all the above sensor systems during PEPE/NEROS is reported in Brewer et al. (1982).

Initial LaRC development of the DIAL technique was aimed at ground-based investigations of water vapor (Browell, Wilkerson, and McIlrath 1979) and sulfur dioxide (Browell 1982). These experiments were the first to demonstrate the DIAL technique in actual atmospheric measurements using the flexibility and energy efficiency of laser-pumped dye lasers. The knowledge gained from these ground-based DIAL experiments was used in the development of the airborne UV DIAL system (Browell et al. 1983). The airborne DIAL system has the flexibility to operate in the UV region for measurements of ozone or sulfur dioxide, in the visible region for measurements of nitrogen dioxide, and in the near-IR region for measurements of water vapor, atmospheric temperature (from water vapor or oxygen absorption lines), and pressure (from oxygen lines). Aerosol backscatter investigations in the UV, visible, and near-IR regions can be conducted simultaneously with the DIAL measurements. The capabilities of the airborne UV DIAL system are functionally the same as those proposed for an early phase of the NASA Shuttle Lidar Program (Harris and Browell 1979; NASA 1979; Greco 1980). The experience gained with this system has been useful for a preliminary evaluation of several potential Space Shuttle lidar investigations (Shipley and Browell 1984).

Recent emphasis for use of the airborne lidar has been for measurements of O_3, water vapor, and aerosol profiles. An understanding of the tropospheric ozone budget is essential for establishing a firm knowledge of tropospheric photochemistry and the potential impact of pollutants upon this photochemical system. High-spatial-resolution measurements of water vapor profiles are important for applications such as the initialization of numerical weather forecast models in data-sparse regions and studies of latent heat flux and troposphere-stratosphere exchange. Aerosols can be used directly as a tracer of atmospheric dynamics. Aerosol profiles can provide information on the boundary-layer mixing depth, condensation level, cloud-top altitude and statistics, and the altitude of stable layers above the boundary layer (Browell, Carter, and Shipley 1980; Browell and Shipley 1982; Shipley and Browell 1984).

2 Airborne UV DIAL System

The airborne UV DIAL system uses the DIAL technique for the remote measurement of gas profiles. This technique has been discussed in detail by numerous authors (Schotland 1966; Measures and Pilon 1972; Byer and Garbuny 1973; Schotland 1974; Thompson 1976). In the DIAL technique, the average gas concentration over some selected range interval is determined by analyzing the difference in lidar backscatter signals for laser wavelengths tuned "on" and "off" a molecular absorption peak of the gas under investigation. The value of the average gas concentration $\bar{N}_{\text{gas}}(R_1, R_2)$ in the range interval from R_1 to R_2 can be determined from the ratio of the lidar signals at the on and off wavelengths. This relationship is given by

$$\bar{N}_{\text{gas}}(R_1, R_2) = \frac{1}{2(R_2 - R_1)(k_{\text{on}} - k_{\text{off}})} \times \ln\left[\frac{P_{\text{off}}(R_2)P_{\text{on}}(R_1)}{P_{\text{off}}(R_1)P_{\text{on}}(R_2)}\right] \quad (2.1)$$

where $k_{\text{on}} - k_{\text{off}}$ is the difference between the absorption cross sections at the on and off wavelengths and $P_{\text{on}}(R_i)$ and $P_{\text{off}}(R_i)$ are the signal powers received from range R_i at the on and off wavelengths, respectively. It is assumed in the analysis that the optical properties of atmospheric aerosols and molecules are equal at the on and off DIAL wavelengths. If there is an interfering gas which does not have the same absorption coefficient at these wavelengths, the concentration of this gas must be known or be determined by a separate measurement. In addition, a significant adjustment must be made to the calculated gas concentration when the wavelength dependence for total backscattering is a strong function of signal range. This correction is discussed in section 5.

A block diagram of the UV DIAL system is shown in figure 2.1. Two frequency-doubled Nd:YAG lasers are used to pump two high-conversion-efficiency tunable dye lasers. All four lasers are mounted on a rigid support structure which also contains the transmitting and receiving optics. The on and off wavelengths (λ_{on} and λ_{off}) that are used in the DIAL measurement are produced in sequential dye laser pulses with a time separation of 100 μs or less. This close temporal spacing ensures that the same atmospheric scattering volume is sampled at both wavelengths during the DIAL measurement. The output beams are separated and steered with dielectric-coated optics. They are then transmitted out of the aircraft coaxially with the receiver telescope through a 40-cm-diameter quartz window.

The wavelength of the two dye lasers is determined with a 1-m monochromator and a spectral reference lamp. The monochromator output is displayed in real time by an optical multichannel analyzer (OMA), and simultaneous operation with the spectral reference provides the laser wavelength to ± 10 pm. When more accurate wavelength control is needed, such as for DIAL measurements of H_2O, it is accomplished with a closed-loop wavelength control system. This system uses a stepping motor to control the dye laser grating angle, and it provides wavelength control to better than ± 0.3 pm. Parameters for the airborne UV DIAL transmitter subsystem are given in table 2.1.

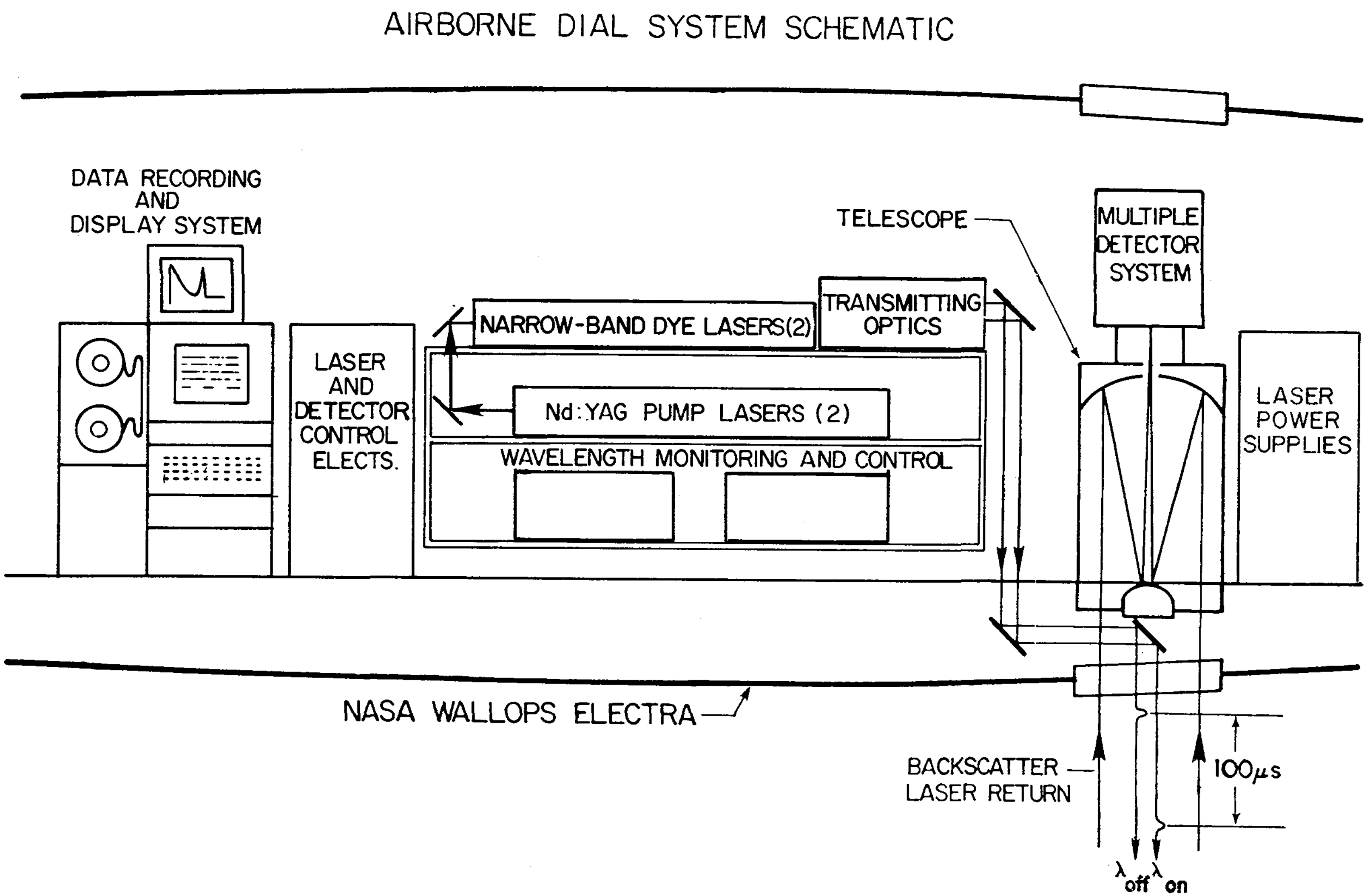


Figure 2.1 Airborne UV DIAL system.

The receiver system consists of a 35-cm-diameter Cassegrain telescope with optics to direct the received signals onto the detectors, which are gateable photomultiplier tubes. As many as three photomultiplier tubes can be accommodated. Normally only one or two are used. When the system is operating in the visible or the near-IR range, only one tube is needed for the on and off wavelengths, with the off-wavelength lidar return also providing an aerosol measurement.

Frequency-doubling crystals (KDP) are used to transform the visible radiation into the UV when making measurements in this spectral region. The residual off visible wavelength is also transmitted and is used to measure atmospheric aerosols. Two photomultiplier tubes are used, one optimized for the UV wavelength region and the other optimized for the visible wavelength. Three 10-bit Biomation Model 1010 transient digitizers, operating at a 10-MHz word conversion rate, sequentially digitize the on- and off-wavelength DIAL and aerosol return signals. The data are then stored on 1600-bpi digital magnetic tape by means of a Digital Equipment Corporation PDP-11/34 minicomputer. Gas-concentration profiles can be calculated in real time and displayed on a video system or printed out in a hard copy for real-time operator experiment control. Parameters for the airborne UV DIAL receiver subsystem are given in table 2.2.

Photographs of the UV DIAL system installed in the NASA WFC Electra aircraft are shown in figure 2.2. The receiver telescope and receiver optics housing are shown at the end of the laser support structure. The enclosed portion of the structure contains the Nd:YAG pump lasers, and the monochromator and OMA are mounted underneath. The dye lasers can be seen mounted on top of the structure along with the transmitter optics housing. The control electronics rack is at the far end of the structure. Figure 2.2(b) shows the dye lasers with the covers removed. The data system can be seen beyond the control electronics rack.

3 Airborne UV DIAL Operation During PEPE/NEROS

A summary of UV DIAL missions flown during the 1980 PEPE/NEROS Summer Field Experiment is given in table 3.1. A total of 42 1/2 hours of aerosol backscatter information was collected at a wavelength of 600 nm, and a total of 32 hours of dual-wavelength information for the retrieval of O_3 concentration profiles was collected at 300 and 286 nm. Out of 65 hours of actual flight time, 42 1/2 hours were available for data acquisition, the difference being due to instrument warm-up time, magnetic-tape rewind-mounting time, and system recalibration and alignment time.

4 Format of UV DIAL Data Archive

The complete archive of UV DIAL data obtained during the 1980 PEPE/NEROS Summer Field Experiment is presented in appendix A. This section discusses the organization of the archive, and it provides a brief description of each archive product type. The archive is organized into subsections by flight date, and each archive subsection presents information in the following order:

a. Flight map
b. UV DIAL instrument parameters
c. Navigation, cloud, and mixed layer height summary
d. Aerosol backscatter cross sections
e. Ozone profiles

4.1 Flight Maps

This archive product displays the WFC Electra aircraft flight path over the Eastern United States, with position information identified at 5-minute intervals (indicated by small plus marks). Positions on the hour (in EDT) are marked by a solid diamond. Positions on the half hour are marked by large plus marks, and radiosonde station locations are marked by solid dots. The map is a Mercator projection.

4.2 UV DIAL Instrument Parameters

This archive product gives relevant UV DIAL instrument parameters which are required for processing data from the magnetic-tape archive. The entries are organized by data file number, and the data start with the file time interval (in EDT) and laser repetition rate (1 or 5 Hz). The UV photomultiplier tube (PMT) parameters include time delay (in microseconds after laser firing before the PMT is gated on), PMT base voltage, and Biomation Model 1010 transient digitizer input sensitivity (in volts full scale). One or two Biomation Model 1010 transient digitizers are used to record the UV DIAL return signals. The aerosol PMT parameters are interpreted similarly. The O_3 column indicates whether O_3 profiles were successfully retrieved (yes or no) from the UV data. The aircraft altitude gives the approximate height of the UV DIAL system in meters above mean sea level (MSL).

4.3 Navigation, Cloud, and Mixed Layer Height Summary

This archive product lists aircraft position (latitude and longitude) at 5-minute intervals. When

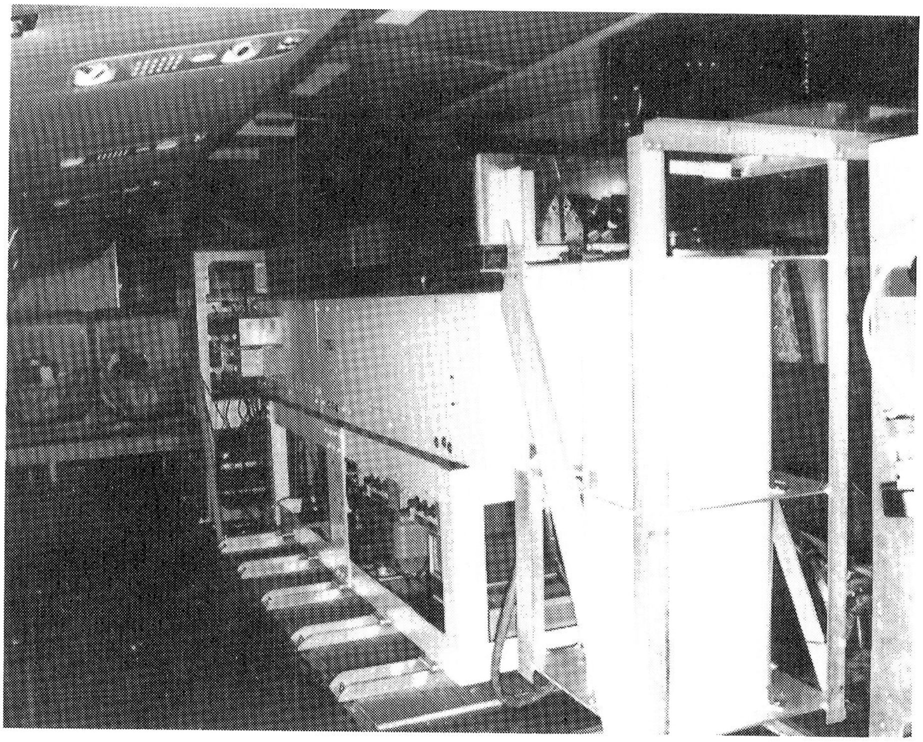
TABLE 2.1. AIRBORNE UV DIAL TRANSMITTER CHARACTERISTICS

Pump lasers (2)	Quantel Model YG 482
Pulse separation, μs	100
Pulse energy at $\lambda = 532$ nm, mJ	350
Pulse length, ns	15
Repetition rate, Hz	1, 5, or 10
Dye lasers (2)	Jobin-Yvon HP-HR
Dye output energy, fundamental,[1] mJ/pulse	120
Dye output energy, doubled fundamental,[2] mJ/pulse	30
Transmitted laser energy, fundamental,[1] mJ/pulse	80
Transmitted laser energy, doubled fundamental,[2] mJ/pulse	29
Laser line width, fundamental,[1] pm	<8
Laser line width, doubled fundamental,[2] pm	<4

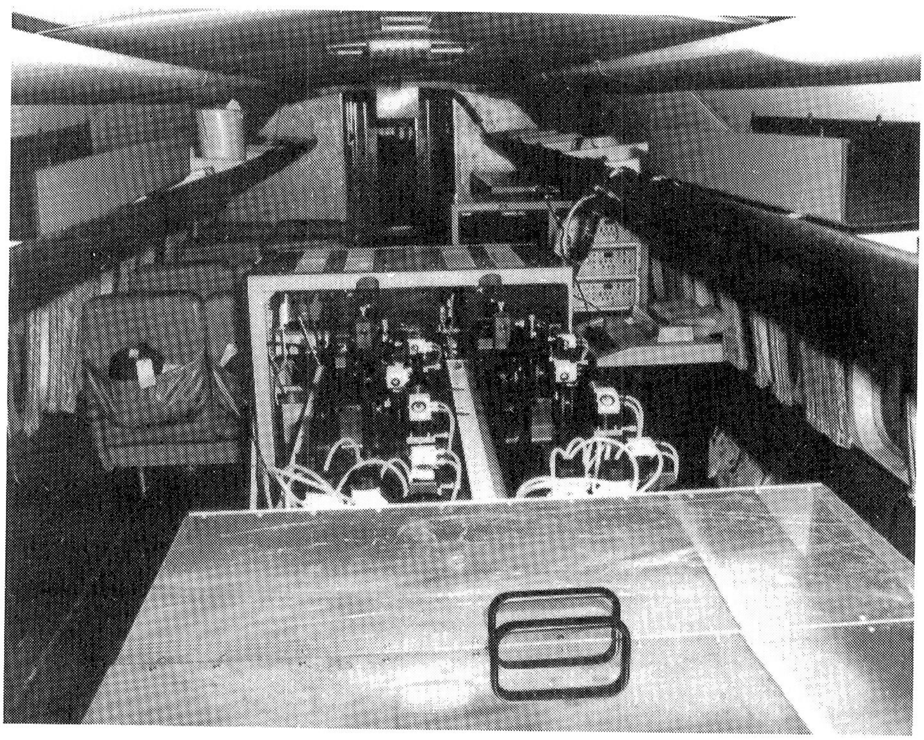
[1]Near 600 nm.
[2]Near 300 nm (UV).

TABLE 2.2. AIRBORNE UV DIAL RECEIVER CHARACTERISTICS

	Fundamental (near 600 nm)	Doubled fundamental (UV, near 300 nm)
Area of receiver, m^2	0.086	0.086
Receiver efficiency to PMT, percent	26	28
PMT quantum efficiency, percent	7.2	29
Total receiver efficiency, percent	1.9	8.1
Receiver field of view (selectable), mrad	<2	<2



(a) Side view of DIAL system oriented for nadir measurements.



(b) Top view of DIAL system looking forward in aircraft.

L-85-149

Figure 2.2 Airborne DIAL system installed in WFC Electra aircraft.

TABLE 3.1. SUMMARY OF UV DIAL PEPE/NEROS MISSIONS

Flight date	Flight time, EDT	General flight path, VOR station	Total time of UV DIAL operation, hr, for—	
			Aerosols	Ozone
7/18/80	1019–1433	SBY-DAY-LEX-SBY	3	3
7/24/80	1030–1523	SBY-MMJ-LOU-SBY	3 1/4	3 1/4
7/25/80	0933–1410	SBY-MGW-MFD-CVG-SBY	3 1/4	3 1/4
7/31/80	1159–1613	SBY-AML-ACY-PWL-HTO-SBY	3	3
7/31/80	2122–0115	SBY-HCM-MOL-BUF-ALB-SBY	2 3/4	2 3/4
8/02/80	0700–1211	SBY-ILM-OLDEY-CHS-JAX-CHS-GSO-ORF	4 1/4	2 1/2
8/05/80	0925–1403	SBY-ILM-GVE-HCM-HAR-RAV-COL-SBY	3 1/2	1/2
8/07/80	1716–2200	SBY-HCM-AML-MMJ-SBY	3 3/4	3 3/4
8/09/80	0510–1120	SBY-CHA-LEX-SBY	3 1/2	
8/10/80	0530–1050	SBY-MEM-BNA-SBY	3	3
8/12/80	0610–1205	SBY-ACY-ACUTE-CRI-HAR-FAK-PXT-ORF-SBY	2 1/2	2 1/2
8/13/80	1056–1429	SBY-CVG-DAY-ZZV-FDY-CTW-CMH	2 3/4	2 3/4
8/13/80	1513–1840	CMH-DAY-ZZV-FDY-CTW-CLE-CMH	2 1/4	1 1/2
8/13/80	2105–2455	CMH-ROD-PKB-BUD-MGW-SBY	1 3/4	1/4
Totals	65 hr/14 missions		42 1/2	32

aerosol backscatter data are available, information on aircraft altitude, mixed layer height, cloud height, and aerosol layering are also given. The top two lines present maximum and minimum values for each tabulated parameter. The tabulated data appear in the following order:

TIME	time of observation, EDT
LAT	latitude, in degrees (DEG) and minutes (MIN)
LONG	longitude, in degrees (DEG) and minutes (MIN)
ALT	surface altitude (elevation), in meters above MSL (MMSL)
K	"V" denotes variable terrain; aircraft altitude above ground level (AGL) cannot be determined
MIXHT	mixed layer height, in meters AGL (MAGL)
L	"S" denotes that MIXHT is given in meters MSL; "-" indicates MIXHT is lower than minimum detection altitude (MIXHT $\leq$ 100 m AGL)
H2SIG	2σ variation of mixed layer height, in meters (M)
LWCCL	lowest cloud condensation level, in meters AGL (MAGL)
M	"S" denotes that LWCCL is given in meters MSL
MXCL	maximum cloud height, in meters AGL (MAGL)
N+	"S" denotes that MXCL is given in meters MSL; "+" indicates that clouds are present between the aircraft and the maximum signal altitude
TPUSL	top of an aerosol layer above MIXHT, in meters AGL (MAGL)
N1+	"S" denotes that TPUSL is given in meters MSL; "M" indicates multiple aerosol layers above the mixed layer; "+" indicates that haze layers are present above the maximum signal altitude
MAXSG	maximum signal altitude or maximum detectable altitude of observation, in meters MSL (MMSL)
C	comments; numbered footnotes appear at end of table

These tables are identical copies of those stored in the PEPE/NEROS data archive on digital magnetic tape.

4.4 Aerosol Backscatter Cross Sections

This archive product presents gray-scale depictions of the distribution of aerosol backscattering as monitored by the aerosol channel along the Electra aircraft flight path. The ordinate presents altitude in meters, and it is adjusted in height so that zero is approximately at sea level. The abscissa gives time (in EDT) and position (in degrees and minutes of latitude and longitude), with tick marks at 1-minute intervals. Time and position at 5-minute intervals are given above and below the aerosol cross sections, respectively. File numbers are shown at the upper left-hand corner of each file, with starting time shown to the earliest minute.

The gray-scale presentation format is described in detail by Browell et al. (1983). Darker shading indicates more aerosol backscattering and is considered an indication of higher aerosol concentration. The strong ground reflection appears as a dark line at the bottom of the cross section. Optically thick clouds also appear as thin, dark lines showing the cloud-top contour with no signal returns below the cloud because of high optical attenuation. These cloud "shadows" appear as vertically oriented white areas, usually with no ground reflection. Aircraft turns and banks appear as valleys in the ground reflection and aerosol layers because of a longer slant path for lidar signal propagation, and these valleys have not been calibrated out of this data product format.

4.5 O_3 Profiles

The UV DIAL derived O_3 profiles are shown displaced in time on a sliding scale from 0 to 200 ppbv. Each profile is the result of a 300-shot (1-minute) average. The O_3 profiles are individually identified by a letter and a symbol at both the top of the profile and the abscissa origin for that profile. The tabular information at the profile origin is abbreviated as follows:

A * NNN +
HHMMSS
XXxx
YYyy

where "A" is the profile letter, * is the profile symbol, NNN is the number of laser shots (out of 300) included in the average, + is an indication of profile truncation (explained below), HHMMSS is profile end time in hours (HH), minutes (MM), and seconds (SS), XXxx is latitude in degrees (XX) and minutes (xx), and YYyy is longitude in degreees (YY) and minutes (yy). The plus sign indicates that the vertical profile has been truncated to a shorter altitude interval because of poor signal quality.

4.6 Magnetic-Tape Archive

Four UV DIAL data subsets have been archived onto 9-track, 1600 bpi digital magnetic tape. The data subsets consist of raw or processed UV DIAL data taken during the 1980 PEPE/NEROS Summer Field Experiment. The data subsets are broken down as follows:

Navigation, Cloud, and Mixed Layer Height Summary	1 tape
UV DIAL O_3 Profiles	1 tape
1-Hz Aerosol Signal Summary	8 tapes
Original UV DIAL Data	66 tapes

The 10 tapes in the first 3 categories are available from the PEPE/NEROS data archive at Washington University (contact Noor Gillani, Center for Air Pollution Impact and Trend Analysis, Washington University, St. Louis, MO 63130). The original UV DIAL data tapes are archived at the NASA Langley Research Center.

4.6.1 Navigation, cloud, and mixed layer height summary. This data set is identical to that described in section 4.3. All 14 flight data sets are written as ASCII card images with the following format:

Number of cards:	1021
Data card format:	I4,4F5.1,F5.0,1X,A1,F6.0, 1X,A1,2F6.0,1X,A1,F6.0, 1X,2A1,F6.0,1X,3A1, F6.0,I2
Header card format:	I4,4F5.1,F5.0,2X,F6.0,2X, F5.0,1X,F6.0,2X,F6.0,3X, F6.0,4X,F6.0,2X

4.6.2 UV DIAL O_3 profiles. Profile information derived during the determination of O_3 concentrations from UV DIAL data has been condensed into 11 files, each file consisting of data derived from a single flight. These files are ordered chronologically. No files are present for August 5, 9, and 13 (flight no. 3) since no useful information on atmospheric ozone was obtained. An example of an O_3 profile entry is shown in table 4.1. Each profile tabulation begins with a header (lines (a) and (b)), followed by five profiles (data sets (c) through (g)). Line (a) gives the date, the tape number, the file number, the pressure altitude of aircraft (in meters), the on wavelength (in nanometers), the off wavelength (in nanometers), the starting shot number, and the ending shot number for the 300-shot average. Line (b) gives the time of the last shot (HHMMSS EDT), the number of profile data points (plus two), the number of shots (out of 300) used in the average, the latitude (in degrees and minutes), and the longitude (in degrees and minutes) of the measurement. The data sets are arranged as follows:

(c) point altitude (in meters MSL)
(d) ozone concentration (in ppbv), corrected for aerosol backscatter and Rayleigh extinction
(e) ozone correction for aerosol backscatter (in ppbv)
(f) one-standard-deviation variation in O_3 concentration (in ppbv)
(g) number of shots used in the average for each point

4.6.3 1-Hz aerosol signal summary. The raw aerosol signal profiles have been condensed to eight tapes for those applications not requiring UV DIAL ozone information. All these files have been truncated to one shot per second (1-Hz repetition rate) to reduce data volume and to improve data uniformity. This aerosol archive was used to create the aerosol cross sections shown in appendix A. A directory of files by date and tape number is given in table 4.2. Detailed specifications for data formatting are given in appendix B.

4.6.4 Original UV DIAL data. The 66 original data tapes are not available through the PEPE/NEROS archive and have been stored "as is" at the NASA Langley Research Center. A discussion of data formatting for these tapes is beyond the scope of this document. However, useful information on data storage philosophy and practice can be found in Butler, Shipley, and Allen (1981) and in Butler (1983, 1984).

5 Procedure for Derivation of O_3 Profile Information From UV DIAL Data

It is usually assumed that suitably accurate DIAL measurements can be made provided that interference due to aerosol backscattering and extinction can be neglected. In particular, most simulation studies make use of the fact that these interference errors approach zero as the difference in DIAL wavelengths becomes small (Wright et al. 1975; Remsberg and Gordley 1978). General analyses of such errors have been enumerated in the literature (e.g., Thompson 1976). As shown in the following subsections, analyses of UV DIAL measurements for concentrations of

TABLE 4.1 UV DIAL O_3 PROFILE ARCHIVE

07/18/80 1 1 3981.9 290.2 298.3 1.0 300.0 (a)

111559 104 143.0 37.0 56.5 79.0 18.0 (b)

2721.90	2706.90	2691.90	2676.90	2661.90	2646.90	2631.90	2616.90	2601.90	2586.90	(c)
2571.90	2556.90	2541.90	2526.90	2511.90	2496.90	2481.90	2466.90	2451.90	2436.90	
2421.90	2406.90	2391.90	2376.90	2361.90	2346.90	2331.90	2316.90	2301.90	2286.90	
2271.90	2256.90	2241.90	2226.90	2211.90	2196.90	2181.90	2166.90	2151.90	2136.90	
2121.90	2106.90	2091.90	2076.90	2061.90	2046.90	2031.90	2016.90	2001.90	1986.90	
1971.90	1956.90	1941.90	1926.90	1911.90	1896.90	1881.90	1866.90	1851.90	1836.90	
1821.90	1806.90	1791.90	1776.90	1761.90	1746.90	1731.90	1716.90	1701.90	1686.90	
1671.90	1656.90	1641.90	1626.90	1611.90	1596.90	1581.90	1566.90	1551.90	1536.90	
1521.90	1506.90	1491.90	1476.90	1461.90	1446.90	1431.90	1416.90	1401.90	1386.90	
1371.90	1356.90	1341.90	1326.90	1311.90	1296.90	1281.90	1266.90	1251.90	1236.90	
1221.90	1206.90									

93.91	94.35	95.81	95.87	96.27	94.71	94.32	91.87	90.01	87.99	(d)
85.66	84.11	81.87	79.64	81.95	81.68	81.87	83.38	81.90	81.91	
79.60	79.53	79.12	77.43	77.20	73.63	72.04	70.41	67.32	66.80	
62.99	57.74	56.35	54.42	54.46	54.40	51.30	49.64	46.93	48.06	
47.79	46.49	44.69	43.49	45.79	48.47	50.55	52.48	50.45	47.86	
53.41	57.67	61.59	63.95	67.93	73.08	78.10	81.33	80.36	81.78	
81.94	82.19	87.09	93.00	90.68	90.61	89.87	88.20	85.51	84.69	
82.12	81.14	84.51	82.71	79.97	79.72	79.65	75.28	77.60	74.22	
72.75	74.70	75.92	73.31	72.84	72.52	71.48	74.35	80.60	84.01	
81.71	85.87	81.49	79.19	83.07	82.33	82.94	90.97	92.08	90.64	
91.56	99.63									

.40	.23	.14	.10	.05	.09	.08	.05	.01	.00	(e)
.01	.01	.06	.05	-.08	-.18	-.30	-.45	-.49	-.56	
-.70	-.73	-.74	-.81	-.86	-.86	-.90	-1.05	-1.18	-1.23	
-1.29	-1.38	-1.60	-1.93	-2.20	-2.51	-2.90	-3.27	-3.72	-4.29	
-4.74	-5.23	-5.68	-6.14	-6.72	-7.25	-7.76	-8.10	-8.41	-8.64	
-8.86	-9.04	-9.04	-8.86	-8.81	-8.62	-8.36	-8.04	-7.56	-7.00	
-6.38	-5.72	-5.00	-4.39	-3.66	-3.00	-2.71	-2.79	-2.89	-2.91	
-3.36	-3.84	-4.26	-4.85	-5.49	-6.24	-7.09	-8.03	-9.04	-9.94	
-10.54	-10.79	-10.79	-10.59	-10.14	-9.42	-8.61	-7.80	-6.90	-5.75	
-4.51	-3.02	-1.46	.12	1.79	3.42	4.87	6.01	7.27	8.49	
9.47	10.54									

3.12	3.14	3.24	3.36	3.39	3.51	3.52	3.55	3.43	3.34	(f)
3.45	3.36	3.36	3.50	3.75	3.97	4.03	4.14	4.17	4.49	
4.73	4.95	5.02	5.02	4.83	4.79	4.76	4.78	4.97	5.11	
5.25	5.16	5.18	5.36	5.61	5.56	5.55	5.69	5.77	5.99	
5.85	6.06	6.08	6.01	6.09	6.12	6.03	6.05	6.03	6.08	
6.01	6.02	5.94	5.91	5.80	6.02	6.23	6.28	6.22	6.56	
7.08	7.45	7.33	7.30	7.26	7.35	7.37	7.37	7.62	7.97	
8.21	7.91	7.62	8.19	8.59	8.91	8.84	9.02	8.98	8.83	
8.78	9.46	10.06	10.15	10.26	10.04	9.76	9.87	10.13	10.34	
11.16	12.18	12.37	13.15	13.82	14.56	15.26	15.86	16.94	17.02	
16.88	16.73									

143	143	143	143	143	143	143	143	143	143	(g)
143	143	143	143	143	143	143	143	143	143	
143	143	143	143	143	143	143	143	143	143	
143	143	143	143	143	143	143	143	143	143	
143	143	143	143	143	143	143	143	143	143	
143	143	143	143	143	143	143	143	143	143	
143	143	143	143	143	143	143	143	143	143	
143	143	143	143	143	143	143	143	143	143	
143	143	143	143	143	143	143	143	143	143	
143	143	143	143	143	143	143	143	143	143	
143	143									

TABLE 4.2. DIRECTORY FOR ORIGINAL AND 1-Hz AEROSOL TAPE ARCHIVES

Flight date	Original data archive		1-Hz aerosol archive	
	Tape number	File number	Tape number	File number
7/18/80	1186–1188	1–7	1253	1–7
7/24/80	1189–1194	1–6	1253	8–13
7/25/80	1195–1199	1–8	1254	1–8
7/31/80	1200–1202	1–4	1254	9–12
7/31/80	1203–1206	5–13	1255	1–9
8/02/80	1207–1208	1–4	1255	10–13
8/02/80	1209–1212	5–8	1256	1–4
8/05/80	1213–1215	1–5	1256	5–9
8/07/80	1216–1218	1–3	1256	10–12
8/07/80	1218–1223	4–13	1257	1–10
8/09/80	1224–1226	1–4	1257	11–14
8/09/80	1227	5	1258	1
8/10/80	1228–1234	1–8	1258	2–9
8/12/80	1235–1241	1–10	1259	1–10
8/13/80	1242–1244	1–4	1259	11–14
8/13/80	1245–1252	5–16	1260	1–10

trace gases such as ozone require independent knowledge of the magnitude and wavelength dependence of the aerosol-to-molecular "backscatter mixing" ratio and of the aerosol optical extinction coefficient. This additional information on atmospheric aerosols is derived from independent UV DIAL return signals at 300 and 600 nm.

The lidar equation can be defined in an abbreviated form as follows (Collis and Russell 1976):

$$P_\lambda(R)R^2 = \gamma_\lambda B_\lambda(R) \times \exp\left\{-2\int_0^R \left[\beta_\lambda(R) + N_{gas}(R)k_{gas,\lambda}\right] dR\right\} \tag{5.1}$$

where

$P_\lambda(R)$	lidar return signal power
λ	wavelength
R	range
γ_λ	lidar system constant
$B_\lambda(R)$	total-atmospheric-volume backscatter coefficient
$\beta_\lambda(R)$	total-atmospheric-volume optical extinction coefficient, neglecting absorption by the gas species of interest
$N_{gas}(R)$	concentration of gas species of interest
$k_{gas,\lambda}$	absorption cross section per molecule for gas species of interest

The DIAL measurement is made by comparing simultaneous return signals at two wavelengths tuned on and off an absorption feature of the gas species of interest, such that

$$\begin{aligned}\bar{N}_{gas}(R_1,R_2) &= \frac{1}{2(R_2-R_1)\Delta k_{gas}}\ln\left[\frac{P_{on}(R_1)P_{off}(R_2)}{P_{off}(R_1)P_{on}(R_2)}\right] && [M]\\ &- \frac{1}{2(R_2-R_1)\Delta k_{gas}}\ln\left[\frac{B_{on}(R_1)B_{off}(R_2)}{B_{off}(R_1)B_{on}(R_2)}\right] && [B]\\ &- \frac{1}{\Delta k_{gas}}(\beta_{on}-\beta_{off}) && [E]\end{aligned} \tag{5.2}$$

where

$\bar{N}_{gas}(R_1,R_2)$	average gas concentration in range interval R_1 to R_2
Δk_{gas}	differential absorption cross section for the gas species of interest between the on and off wavelengths

The $[B]$ and $[E]$ terms in equation (5.2) amount to interference in the DIAL measurement of $\bar{N}_{gas}(R_1,R_2)$ from wavelength variations in backscattering and extinction, respectively. The $[M]$ term in equation (5.2) gives the traditional DIAL measurement (eq. (2.1)) provided that the error terms $[B]$ and $[E]$ can be neglected. The error term $[B]$ can be neglected under conditions of spatially homogeneous backscatter. The error term $[E]$ is typically smaller than $[B]$, but it cannot be neglected under conditions of low atmospheric visibility.

5.1 The Extinction Error E

It is usually assumed that DIAL extinction errors resulting from molecular scattering and absorption by intefering gas species can be reduced through simple approximations of the atmospheric gas density profiles and appropriate choices of the DIAL on and off wavelengths. The remaining extinction error is then due to a finite wavelength dependence on optical attenuation by atmospheric aerosols. Given that the wavelength dependence of the aerosol extinction coefficient can be approximated by the power law

$$\beta_{aer,\lambda} \approx \lambda^{-\alpha} \tag{5.3}$$

where α is the so-called Angstrom coefficient, then the extinction error E_{gas} is

$$E_{gas} \approx \frac{\alpha\beta_{aer,\lambda_{on}}}{\Delta k_{gas}}\frac{\lambda_{on}-\lambda_{off}}{\lambda_{on}} \tag{5.4}$$

With λ_{on} = 286 nm, λ_{off} = 300 nm, and $\Delta k_{O_3} = 4.27 \times 10^{-3}$ ppbv^{-1}-km^{-1}, it follows that

$$E_{O_3} \approx \alpha\beta_{aer,\lambda_{on}}(11.5 \text{ ppbv-km}) \tag{5.5a}$$

The extinction error due to the wavelength dependence of molecular (Rayleigh) scattering is then

$$R_{O_3} \approx \beta_{mol,\lambda_{on}}(45.9 \text{ ppbv-km}) \tag{5.5b}$$

where $\beta_{mol,\lambda_{on}}$ is the molecular extinction coefficient for the on wavelength.

The Angstrom coefficient α for atmospheric aerosols at visible wavelengths under conditions of low relative humidity is on the order of unity (Shettle and Fenn 1979). At high relative humidities the Angstrom coefficient approaches zero for most aerosol models, and extinction errors in DIAL measurements of O_3 can be neglected. Clearly, the extinction error due to the wavelength dependence of aerosol attenuation will be reduced as the wavelength separation of the on and off wavelengths is reduced. For atmospheric conditions encountered during the summer of 1980 over the Eastern United States, extinction coefficients in the mixed layer typically ranged from 0.2 to 1 km^{-1} at 450 nm. If $\alpha \approx 1$, then these extinction coefficients correspond to systematic DIAL overestimates of the O_3 concentration in the range of 6 to 18 ppbv. Ozone concentration values in the lower troposphere averaged 20 to 150 ppbv during the 1980 field study. The Rayleigh extinction error is approximately 6.7 ppbv at standard atmospheric temperature and pressure.

5.2 The Backscatter Error B

The backscatter error for DIAL measurements can be rewritten in terms of the so-called backscatter mixing ratio (Collis and Russell 1976) as follows:

$$S_\lambda(R) = \frac{[P_{\mathrm{aer},\pi}(R)/4\pi]\sigma_{\mathrm{aer}}(R)}{(3/8\pi)\sigma_{\mathrm{mol}}(R)} \approx S_{\lambda_0}(R)\left(\frac{\lambda}{\lambda_0}\right)^{4-\delta} \tag{5.6}$$

such that

$$B_{\mathrm{gas}} = -\frac{1}{2(R_2 - R_1)\Delta k_{\mathrm{gas}}} \times \ln\left[\frac{1+S_{\mathrm{on}}(R_1)}{1+S_{\mathrm{off}}(R_1)}\,\frac{1+S_{\mathrm{off}}(R_2)}{1+S_{\mathrm{on}}(R_2)}\right] \tag{5.7}$$

where

$P_{\mathrm{aer},\pi}(R)/4\pi$	normalized aerosol backscatter phase function ($\propto \lambda^{-\epsilon}$)
$\sigma_{\mathrm{aer}}(R)$	aerosol scattering cross section per unit volume; nonabsorbing component of $\beta_{\mathrm{aer}}(R)$ ($\propto \lambda^{-\delta}$)
$\sigma_{\mathrm{mol}}(R)$	molecular scattering cross section per unit volume; nonabsorbing component of $\beta_{\mathrm{mol}}(R)$ ($\propto \lambda^{-4}$)

References to absolute magnitudes of the volume backscatter coefficient have vanished in equation (5.7). Given a homogeneous atmosphere such that $S_\lambda(R)$ is independent of range, then $S_\lambda(R_1) \approx S_\lambda(R_2)$ and the UV DIAL backscatter error reduces to zero. The range and wavelength dependence of the backscatter mixing ratio must be known when UV DIAL measurements are attempted in markedly inhomogeneous atmospheres.

As an example of the UV DIAL backscatter error magnitude, a calculation of a special case is presented for airborne UV DIAL measurement O_3 in the vicinity of the mixed layer top interface. Given the airborne UV DIAL return signals obtained above and within the mixed layer at ranges R_1 and R_2, respectively, it is assumed that the atmosphere above the mixed layer is characterized by pure Rayleigh scattering such that $S_\lambda(R_1)$ is vanishingly small. If the aerosol and molecular backscattering cross sections are inversely related to wavelength by power laws with exponents δ and 4, respectively, then the UV DIAL backscatter error in the vicinity of the mixed layer top interface is

$$B_{O_3} \approx \frac{-(4-\delta)}{2(R_2 - R_1)\Delta k_{O_3}}\,\frac{\Delta\lambda}{\lambda_{\mathrm{off}}}\,\frac{S_{\mathrm{off}}(R_2)}{1+S_{\mathrm{off}}(R_2)} \tag{5.8}$$

A depiction of this UV DIAL O_3 backscatter error for $R_2 - R_1 = 210$ m, $\lambda_{\mathrm{on}} = 286$ nm, and $\lambda_{\mathrm{off}} = 300$ nm is shown in figure 5.1 as a function of the mixed layer backscatter mixing ratio for several values of δ. Strong gradients in the backscatter mixing ratio were commonly encountered during UV DIAL operation during the 1980 field experiment. This analysis points out that the magnitude of the DIAL backscatter error may become large for high degrees of aerosol spatial inhomogeneity. As is the case for the extinction error, the magnitude of the backscatter error will be reduced as the wavelength separation between the on and off wavelengths is reduced toward zero.

5.3 Example of Error Magnitudes

The existence of an extensive set of simultaneous O_3 correlative measurements obtained with in situ sensors during the 1980 field experiment provides a unique opportunity for the study of UV DIAL errors due to aerosol interference. For example, coordinated correlative in situ and UV DIAL measurements were obtained over Ohio on July 25, 1980, during the period from 1124 to 1137 EDT (see section 6). A height depiction of the relative distribution of atmospheric aerosols under the Electra aircraft at the time of the correlative measurement is shown in file 4 of the aerosol cross sections for July 25, 1980, given in appendix A. This aerosol cross section shows a mixed layer height at 1300 m AGL capped by small cumuliform clouds (probably subvisible). Simultaneous signal returns obtained at 300 and 600 nm and averaged over 100 sequential firings of the UV DIAL system are shown in figure 5.2. These profiles correspond to a 2-km horizontal average.

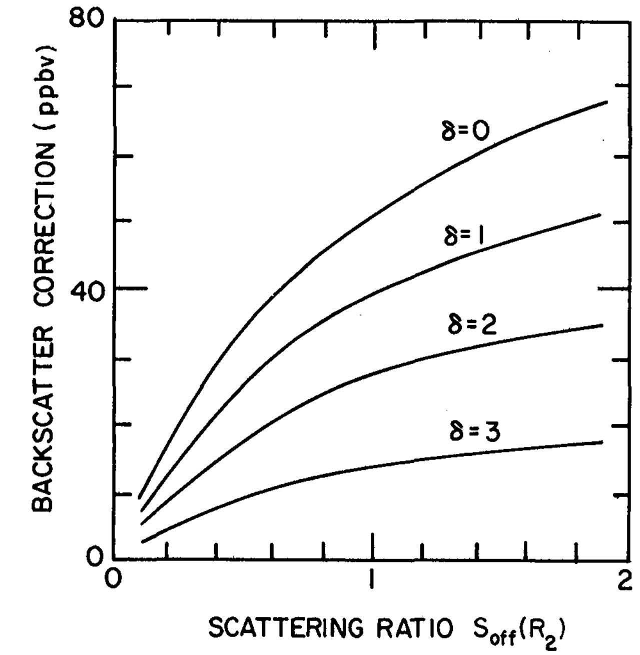


Figure 5.1. UV DIAL error in measurement of O_3 concentration at top of mixed layer due to aerosol backscatter interference. Atmosphere is assumed to be free of aerosols above mixed layer.

If we assume that aerosol optical extinction is uniformly distributed in height with a discontinuity at the mixed layer top interface, then the average slope solution can be used to derive the total optical extinction coefficient both above and within the mixed layer. The aerosol optical extinction coefficients are then obtained by subtracting independent estimates of the Rayleigh optical extinction, where $\beta_{mol,300} \approx 0.15\ km^{-1}$ and $\beta_{mol,600} \approx 0.09\ km^{-1}$. The jump in backscatter mixing ratio across the mixed layer top interface can be obtained from the change in the return signal, such that

$$\lim_{(R_2-R_1)\to 0} \frac{P_\lambda(R_2)R_2^2}{P_\lambda(R_1)R_1^2} = \frac{1+S_\lambda(R_2)}{1+S_\lambda(R_1)} \qquad (5.9a)$$

where R_2 is within and R_1 is above the mixed layer. The limit estimate in equation (5.9a) is achieved by linearly extrapolating ln $P_\lambda(R)R^2$ as a function of range both up and down to the mixed layer height. If negligible absorption by aerosols is assumed, then the aerosol backscatter phase function is obtained from the backscatter mixing ratio information in equation (5.9a) and the estimates of Rayleigh ($\sigma_{mol,\lambda}$) and aerosol ($\sigma_{aer,\lambda}(R)$) scattering cross section per unit volume, such that

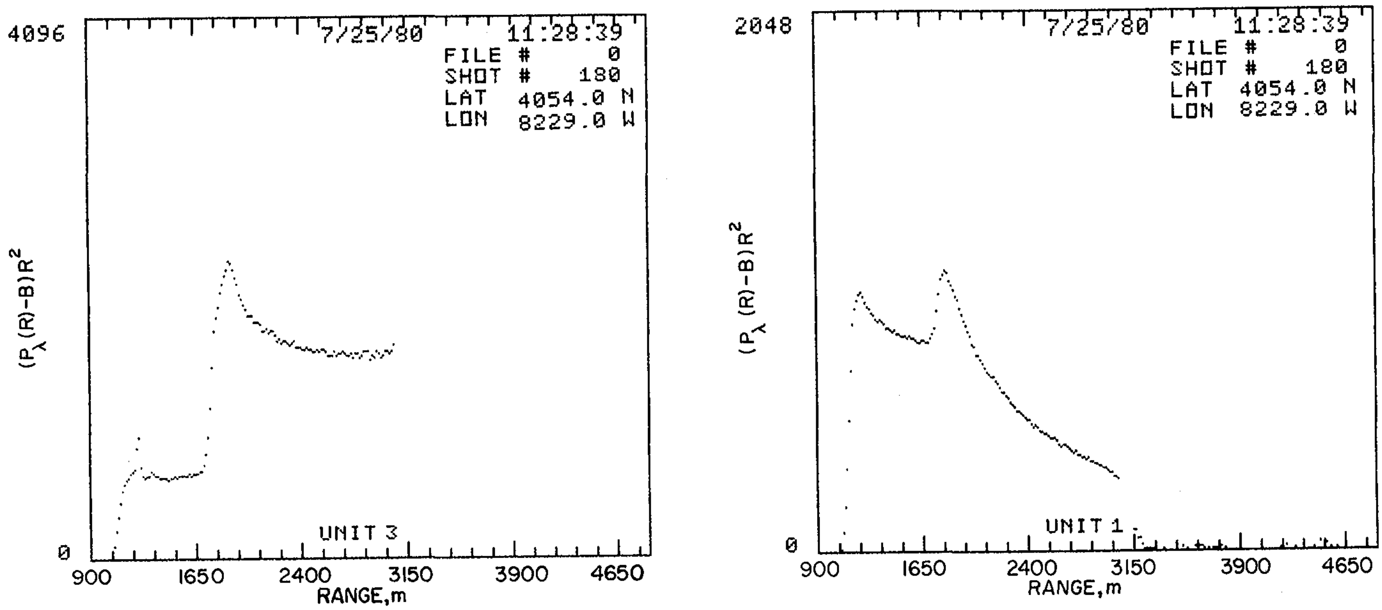
$$\frac{1+S_\lambda(R_2)}{1+S_\lambda(R_1)} = \frac{(3/8\pi)\sigma_{mol,\lambda} + (P_{aer,\pi}/4\pi)\sigma_{aer,\lambda}(R_2)}{(3/8\pi)\sigma_{mol,\lambda} + (P_{aer,\pi}/4\pi)\sigma_{aer,\lambda}(R_1)} \qquad (5.9b)$$

Results for aerosol optical properties at 300 nm and 600 nm from the data of figure 5.2 are summarized in table 5.1. Given the assumption of power law dependence in aerosol extinction and backscattering and the assumption of negligible absorption, these data imply an Angstrom coefficient $\alpha = 0.89 \pm 0.2$ (eq. (5.3)) and an exponent for wavelength dependence in the aerosol backscatter phase function $\epsilon = -0.21 \pm 0.3$ (eq. (5.7)). The wavelength dependence for the backscatter mixing ratio therefore follows an exponent of $\delta = 0.62 \pm 0.4$ (eq. (5.7)). From this information on the aerosol backscatter and extinction coefficients, the corresponding UV DIAL errors for the measurement of O_3 at the top of the mixed layer are $E_{O_3} \approx 5$ ppbv and $B_{O_3} \approx 36$ ppbv. It is expected that the UV DIAL backscatter error will be reduced to zero as the UV DIAL sample interval is advanced into the homogeneous mixed layer.

An example of a direct comparison between the UV DIAL derived O_3 profile that is not corrected for the aerosol backscatter and the aerosol extinction errors and a simultaneous in situ measurement of O_3 profile made onboard a Cessna aircraft is shown in figure 5.3. The profile of the difference between in situ and UV DIAL is also shown in figure 5.3. The largest difference between in situ and UV DIAL measurements (−20 ppbv) occurs at the top of the mixed layer near the altitude of 1550 m. The large difference at the top of the mixed layer can be attributed to the aerosol backscatter correction. In addition, the UV DIAL measurements are overestimated by about 4 ppbv in the mixed layer due to the aerosol extinction error in this example.

5.4 Inversion of Lidar Data for Information on Aerosol Backscatter and Extinction

Atmospheric lidar signals convey a large amount of information on the optical properties of atmospheric aerosols. Analytical solutions to the lidar equation (eq. (5.1)) which derive information on aerosol optical properties from independent lidar signals have been documented (Collis and Russell 1976; Klett 1981). However, the application of these solutions requires the use of approximations regarding aerosol absorption and backscattering, and they also require additional information on aerosol properties at some calibration range R_0 (Hitschfeld and Bordan 1954). For lidar studies of the stratospheric aerosol, this calibration information is typically provided through the identification of "clean" atmospheric regions where aerosol backscattering is sufficiently small (Russell, Swissler, and McCormick 1979). Additional information is



(a) 600 nm.

(b) 300 nm.

Figure 5.2. Average return signal profiles obtained during correlation period on July 25, 1980, at wavelengths of 600 and 300 nm. Profiles are corrected for range squared attenuation.

TABLE 5.1. ATMOSPHERIC AEROSOL OPTICAL PROPERTIES

[1128 EDT on July 25, 1980, near Mansfield, OH]

λ, nm	$\beta_\lambda(R_1)$, km^{-1}	$\beta_\lambda(R_2)$, km^{-1}	$\dfrac{1+S_\lambda(R_2)}{1+S_\lambda(R_1)}$	$\dfrac{P_{\text{aer},\pi}}{4\pi}$, sr^{-1}
300	0.240	0.644	1.52	0.026
600	.054	.276	3.86	.030

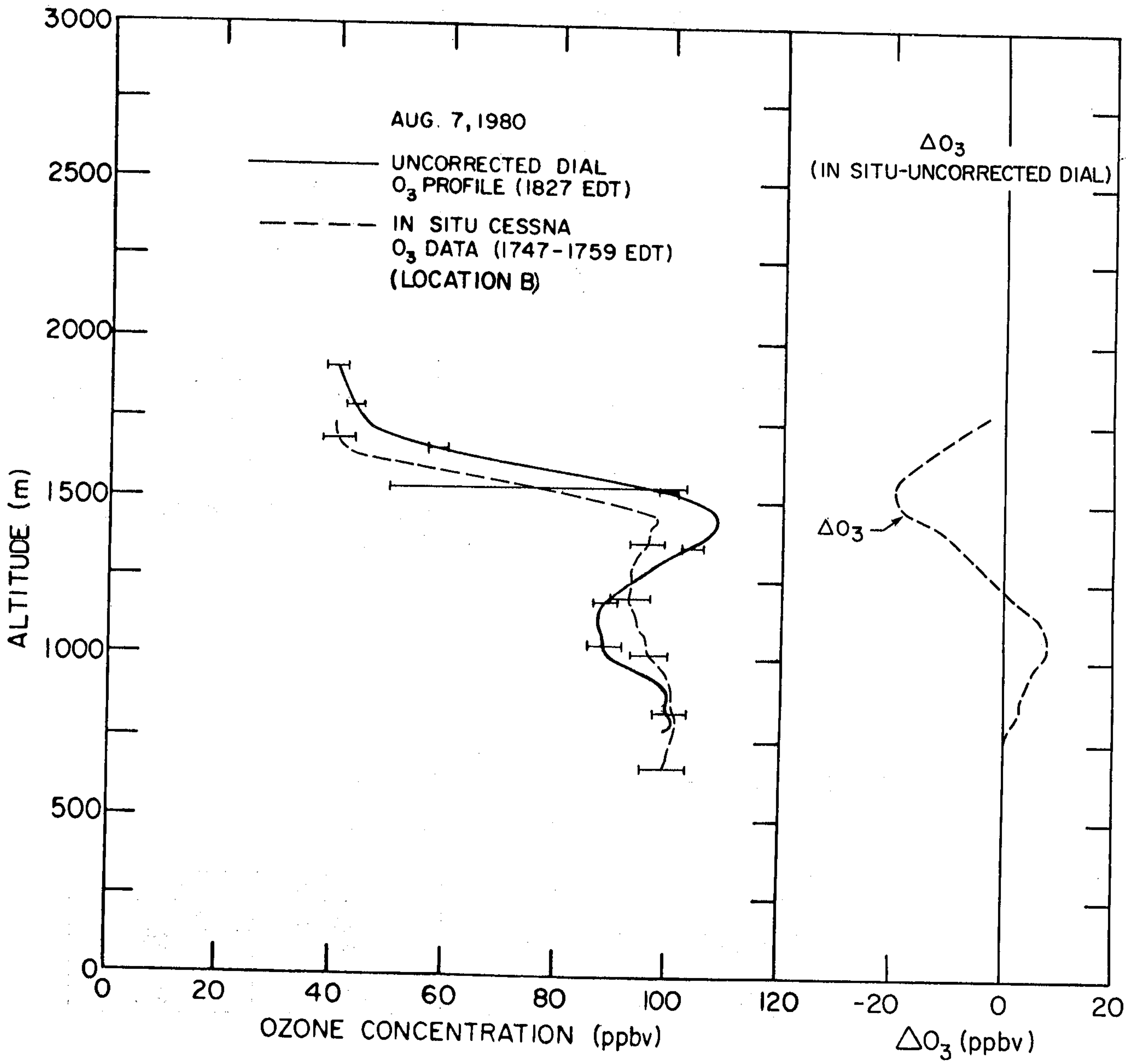


Figure 5.3. A comparison of uncorrected UV DIAL and in situ measurements with a profile of difference between two measurements as functions of altitude.

perhaps gained through the use of multiple wavelengths (DeLuisi, Schuster, and Sato 1975; Zakharov, Kostko, and Portasov 1974; Russell et al. 1981), but this additional wavelength information also requires additional assumptions on the wavelength dependence of aerosol optical properties. In the limit of spatial homogeneity, the so-called "slope" method can be applied to equation (5.1) to derive the total optical extinction coefficient as follows:

$$\beta_\lambda = -\frac{1}{2}\frac{d}{dR}\ln\left[P_\lambda(R)R^2\right] \tag{5.10}$$

Related methods can be applied with lidar signals obtained as a function of zenith angle with the assumption of horizontal homogeneity (Spinhirne, Reagan, and Herman 1980) or obtained beneath an aircraft flight path if statistical homogeneity is assumed (Shipley and Browell 1984).

The corrected UV DIAL O_3 profiles are combined with the Bernoulli solution to equation (5.1) to derive the vertical profile of aerosol optical properties needed to estimate terms [B] and [E] in equation (5.2). Such solutions and various calibration methods have been used extensively in both radar and lidar studies of attenuating media and have recently been popularly referred to as the "Klett" method (after Klett 1981). The Bernoulli solution is used with the assumption of a nonabsorbing scattering medium composed of aerosols and molecules; thus,

$$B_\lambda(R) = \frac{P_{\mathrm{aer},\pi}(R)}{4\pi}\sigma_{\mathrm{aer}}(R) + \frac{3}{8\pi}\sigma_{\mathrm{mol}}(R) \tag{5.11}$$

The scattering ratio can be obtained from a single-wavelength lidar signal by defining the following:

$$S_\lambda(R) = \frac{P_{\mathrm{aer},\pi}(R)}{4\pi}\xi_\lambda(R)\left[\frac{3}{8\pi}\sigma_{\mathrm{mol}}(R)\right]^{-1} - 1 \tag{5.12}$$

where

$$\xi_\lambda(R) = \frac{\exp\left[H(R) - H(R_0)\right]}{\frac{1}{\xi_\lambda(R_0)} - 2\int_{R_0}^{R}\exp\left[H(R') - H(R_0)\right]dR'} \tag{5.13a}$$

and

$$H(R) = \ln\frac{P(R)R^2}{P(R_0)R_0^2} - 2\int_{R_0}^{R}\frac{3}{8\pi}\sigma_{\mathrm{mol}}\left(\frac{P_{\mathrm{aer},\pi}}{4\pi}\right)^{-1}dR \tag{5.13b}$$

Following current practice, R_0 is set to the maximum range and $\xi_\lambda(R_0)$ is given a representative mixed layer value. Equations (5.13) are then solved with decreasing range. This method prevents grossly unphysical solutions due to numerical singularities, but there is no guarantee that the resulting scattering ratio profile is realistic in absolute value. Since the UV DIAL backscatter correction depends primarily on the range dependence of $S_\lambda(R)$, it is expected that equations (5.13) will provide estimates for that correction to within ±5 ppbv O_3. All UV DIAL O_3 corrections associated with the PEPE/NEROS archive have been computed with $P_{\mathrm{aer},\pi}/4\pi = 0.028\ \mathrm{sr}^{-1}$ and $\delta = 1$ (see Browell, Ismail, and Shipley 1985).

6 Comparison of UV DIAL and In Situ Measurements

6.1 Mixed Layer Height

The average height of the top of the mixed layer over a 1-minute interval near each 5-minute data point was determined from the 1-Hz gray-scale pictures. The boundary layer usually exhibits turbulent mixing processes up to a region of increased atmospheric stability, where there is usually a precipitous decrease in atmospheric scattering. This decrease is usually due to the enhanced aerosol loading and larger particles associated with the boundary layer compared with less aerosol loading and smaller particles in the free troposphere. The depth of the boundary layer can be determined from each laser firing to an accuracy on the order of ±30 m. (Recall that the lidar data are digitized in 15-m intervals.) However, the top of the boundary layer varies considerably in altitude along the Electra flight path because of normal convective and wave processes. The maximum excursion of the top of the mixed layer from the average value determined over the 1-minute interval was chosen as the 2σ value for the variance of the mixed layer top altitude.

A comparison of the lidar-derived mixed layer height measurements with those derived from in situ measurements onboard the Cessna aircraft is given in table 6.1. Cessna mixed layer heights were obtained by examining the temperature, dew point, and aerosol scattering profiles from an integrating nephelometer (Gregory, Beck, and Mathis 1981). It should be remembered that the Cessna was making a point measurement of a highly variable parameter; for example, the height of the mixed layer top changed by 600 m over the 1-minute interval at 1355 EDT on July 24, 1980. The mean absolute difference for the eight comparisons given in table 6.1 is 9 percent, including the highly variable case on July 24.

TABLE 6.1. COMPARISON OF AVERAGE MIXED LAYER HEIGHTS DETERMINED FROM DIAL AND IN SITU MEASUREMENTS

Date	Time, EDT	UV DIAL mixed layer height, m MSL $\pm 2\sigma$	In situ mixed layer height, m MSL
7/24/80	1355	1690 ± 300[a]	1400[b]
			2500[c]
7/25/80	1112	1514 ± 100	1750
	1245	1429 ± 150	1350[c]
		1969 ± 150[d]	1915
7/31/80	1355	1538 ± 120	1500
8/07/80	1830	1574 ± 30	1500
8/13/80[e]	1250	2074 ± 150	2000
	1620	2527 ± 80	2150

[a]Maximum altitude of observation below strong inversion.
[b]Weak inversion.
[c]Strong inversion.
[d]Higher (elevated) layer.
[e]No data recorded below 1500 m MSL.

TABLE 6.2. UV DIAL AND CESSNA O_3 CORRELATIVE MEASUREMENT LOCATIONS

Date	UV DIAL data (*a*)				Nearest Cessna location (*b*)	Cessna measurement time, EDT
	Tape	File	Shots	Time, EDT		
7/24/80	5	5	151–451	1353	B	1327–1402
7/25/80	2	3	1–300	1112	A	1120–1144
7/25/80	3	6	200–500	1242	B	1240–1248
7/31/80 (no. 1)	2	2	150–450	1355	A	1325–1430
7/31/80 (no. 2)	5	6	1–300	2154	Leg AB	2056–2212
8/07/80	1	1	700–1000	1827	B	1747–1759
8/13/80 (no. 1)	3	4	700–1000	1302	Leg AB	1237–1329
8/13/80 (no. 2)	7	8	1500–1800	1617	A	1619–1646
8/13/80 (no. 2)	7	8	2250–2550	1620	B	1652–1717

[a]Closest UV DIAL data to Cessna location.
[b]From table II in Gregory, Beck, and Mathis (1981) and figures 6.1 through 6.7 herein.

6.2 O_3 Profiles

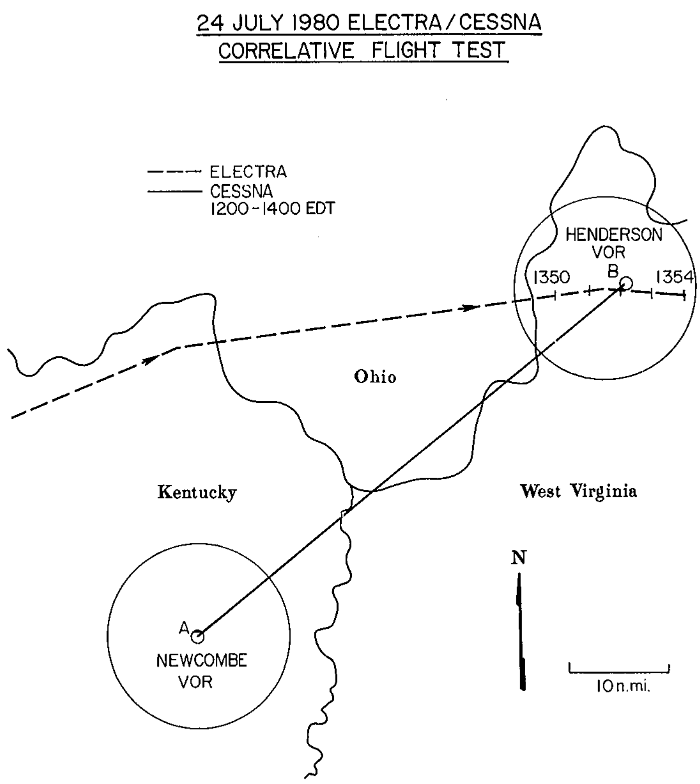
NASA participation in the PEPE/NEROS field experiment included an evaluation of the UV DIAL instrument for the measurement of O_3 profiles under various atmospheric conditions. As outlined by Gregory, Beck, and Mathis (1981), there were 11 intercomparison opportunities during the PEPE/NEROS program. Although the Cessna data were provided to the PEPE/NEROS data archive as independent experimental measurements, the primary role of the Cessna was to provide correlative data for the remote sensors on the Electra. Flight plans were therefore designed to provide correlative measurement opportunities on each Electra mission. Eight of the eleven flights resulted in successful comparisons of UV DIAL and in situ data. Table 6.2 lists the date, time, and location of each intercomparison opportunity.

The primary measurements made with the Cessna were O_3 concentrations (chemiluminescent technique), total scattering cross section (integrating nephelometer), temperature (resistance probe), dewpoint temperature (cooled mirror), and flight parameters of altitude, heading, air speed, and time (Gregory, Beck, and Mathis 1981). The O_3 concentrations were determined with a Monitor Labs Model 8410A ozone analyzer which measured the chemiluminescence reaction between O_3 and C_2H_4. A gas-phase titration (O_3 to NO) traceable to a National Bureau of Standards (NBS) NO source was used for calibration. The accuracy of the in situ O_3 measurement is given as 10 percent or 5 ppbv, whichever is larger, and the precision is given as 2 percent or 3 ppbv, whichever is larger. The air sample for the nephelometer was heated in the inlet to vaporize liquid droplets. All instruments were calibrated using accepted EPA or NBS procedures. The O_3 instrument and the nephelometer were reviewed by the PEPE/NEROS audit team and were within acceptable limits.

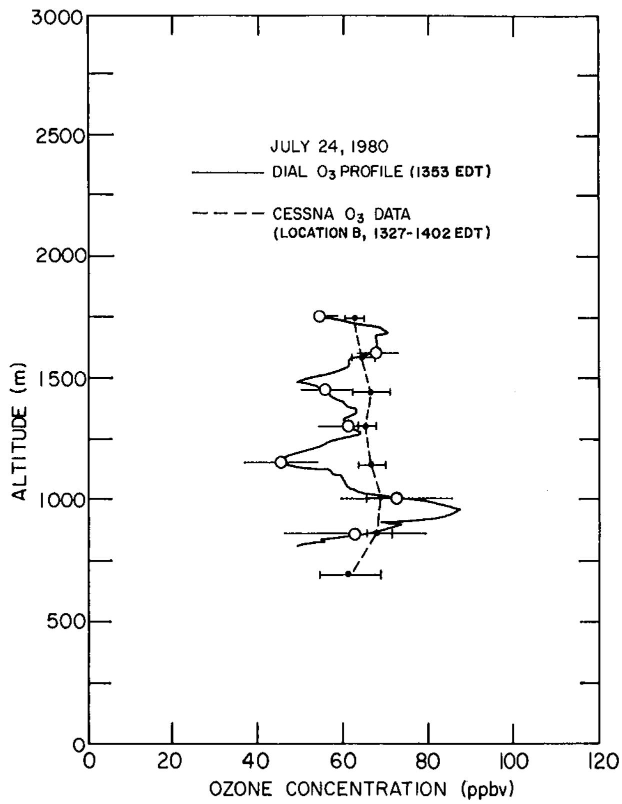
All O_3 profile intercomparisons are shown in figures 6.1 through 6.7. The flight paths of the Electra and the measurement locations for the Cessna are provided for each intercomparison case. The Cessna data are presented as average values for 150-m-altitude increments. The horizontal bars on these in situ data represent the 1σ variation of the measurements taken over that interval. The data included may be from one or more spirals at a given location or from an entire leg and may include data from ascents, descents, and constant-altitude patterns. The nominal Cessna spiral diameter was 13 km (4 n.mi.). The airborne UV DIAL measurements of O_3 are each presented as a concentration profile over a measurement altitude range which varies with Electra altitude. The vertical resolution used in the UV DIAL data reduction was 210 m, and 300 individual O_3 profiles were averaged together to obtain the average UV DIAL O_3 profile used for these comparisons. These lidar-derived O_3 profiles are corrected for aerosol backscatter and extinction effects as set forth in section 5. The nominal horizontal resolution corresponding to a 300-profile average is 6 km for UV DIAL operation at 5 Hz if a nominal aircraft speed of 100 m-s^{-1} is assumed. The horizontal bars on the UV DIAL O_3 profiles represent the 1σ variation in the O_3 concentration observed over the 300-profile average. This variation is associated with both measurement uncertainty and the natural variability of O_3 over the 6-km measurement interval. In several instances the UV DIAL and in situ data are not coincident in space and time because of any or all of the following: DIAL system considerations (tape changing, laser optimization, etc.), difficulty in the coordination of the Cessna flight path to accommodate last minute changes in Electra flight path, limited flight duration of the Cessna, and cloud cover. However, every effort was made to achieve coincidence in space and time where possible. Other systematic DIAL errors may be present, the most common being range-dependent detector gain variations and transmitter-receiver misalignment.

6.2.1 July 24, 1980, profiles. The first O_3-measurement comparison opportunity occurred on July 24, 1980, near the Henderson VOR (VHF omnidirectional range). Figure 6.1(a) shows the path of the Electra relative to the Cessna spiral at location B. The center point for the UV DIAL 1-minute (300-shot) profile average was at 1353 EDT, which put the Electra about 6.6 km from the center of the Cessna spiral. Figure 6.1(b) shows the comparison of the UV DIAL and Cessna O_3 profiles and indicates agreement of mean $O_3 \pm 1\sigma$ to within 10 ppbv. The UV DIAL profile displays additional vertical structure at 1150 m altitude which appears to be statistically significant. The UV DIAL measurements of O_3 from 1100 to 800 m altitude show a 1σ variability of 12 to 18 ppbv.

6.2.2 July 25, 1980, profiles. The flight paths for two correlative tests conducted on July 25, 1980, are indicated in figure 6.2(a). The nearest UV DIAL and Cessna data were obtained during the Cessna spiral at location A at 1112 EDT. The results of these correlative flights are shown in figure 6.2(b). The measurements differ by 12 ppbv at the upper altitudes, with the UV DIAL data being systematically lower. At lower altitudes the UV DIAL data are again low by 25 ppbv. However, there is a large increase in

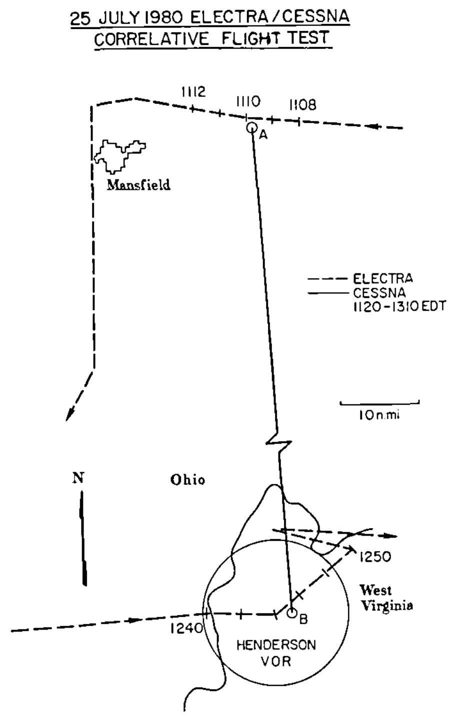


(a) Flight paths.

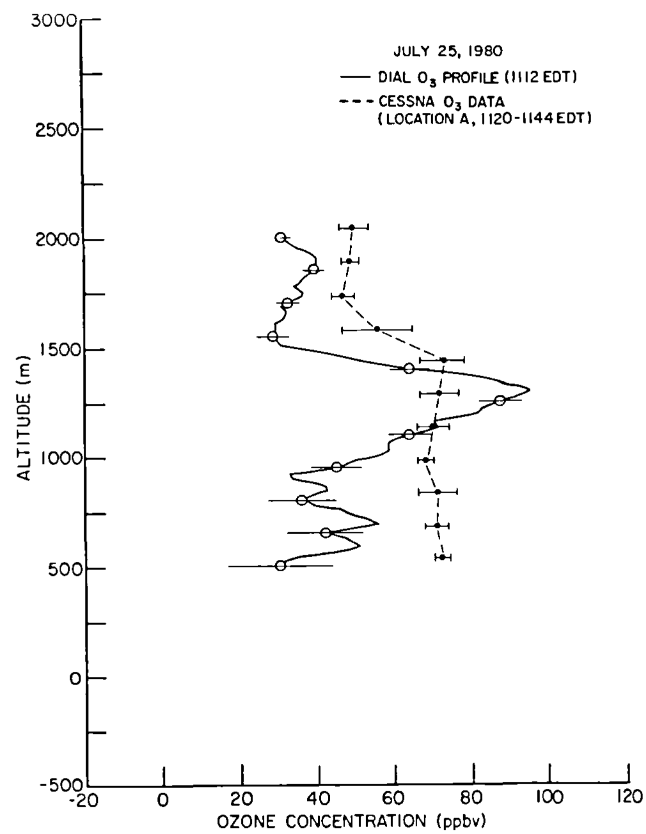


(b) Ozone profile comparison.

Figure 6.1. Correlative flight test of Electra and Cessna aircraft for July 24, 1980.

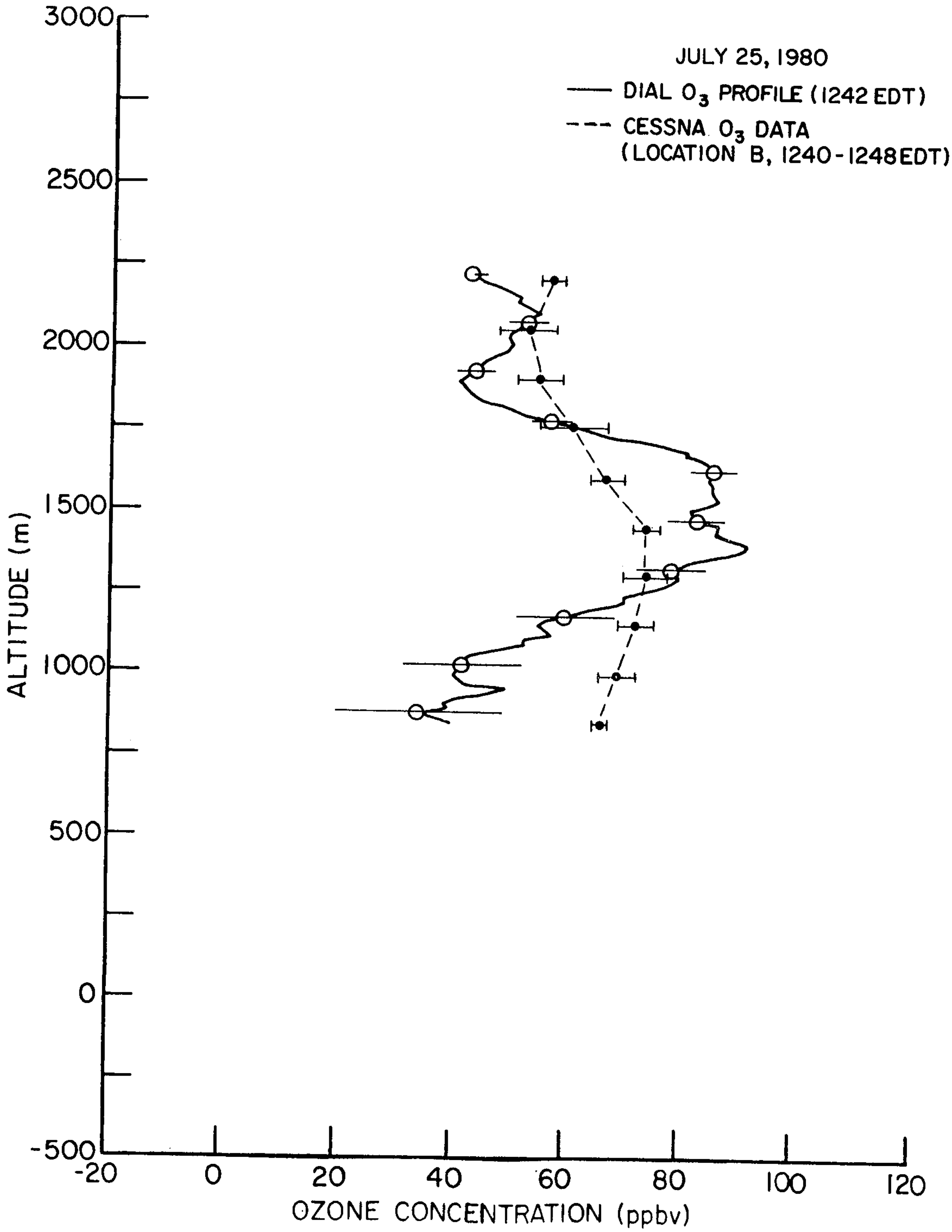


(a) Flight paths.



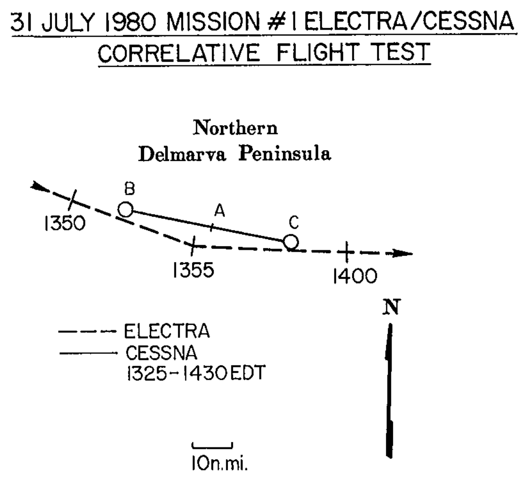
(b) Ozone profile comparison for location A.

Figure 6.2. Correlative flight test of Electra and Cessna Aircraft for July 25, 1980.

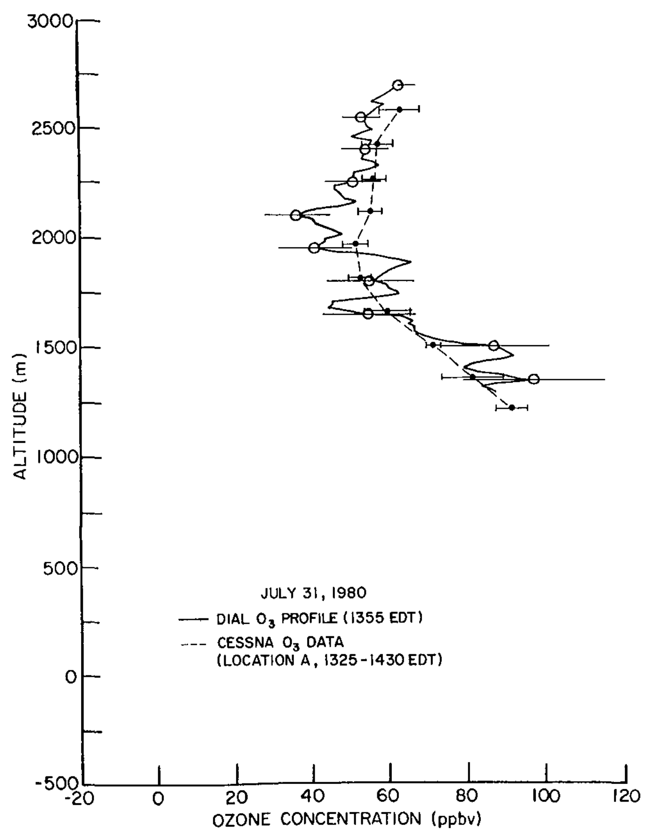


(c) Ozone profile comparison for location B.

Figure 6.2. Concluded.

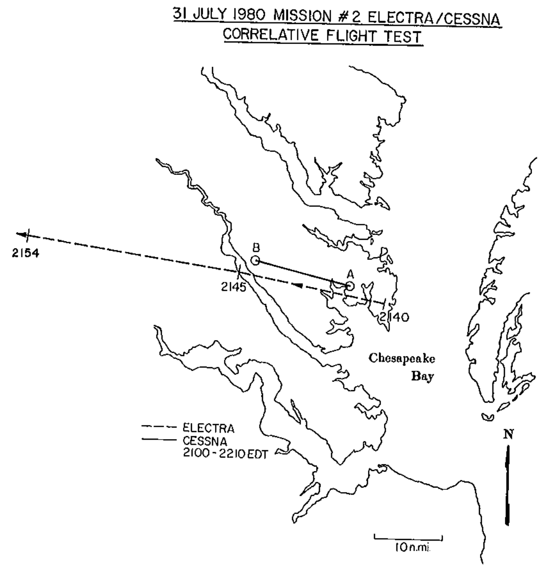


(a) Flight paths.

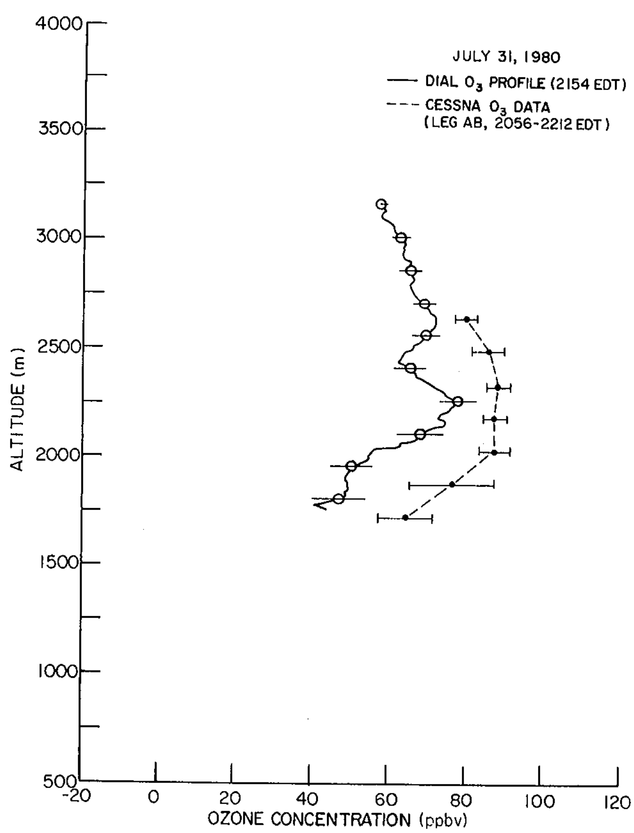


(b) Ozone profile comparison.

Figure 6.3. Correlative flight test of Electra and Cessna aircraft for July 31, 1980 (mission no. 1).

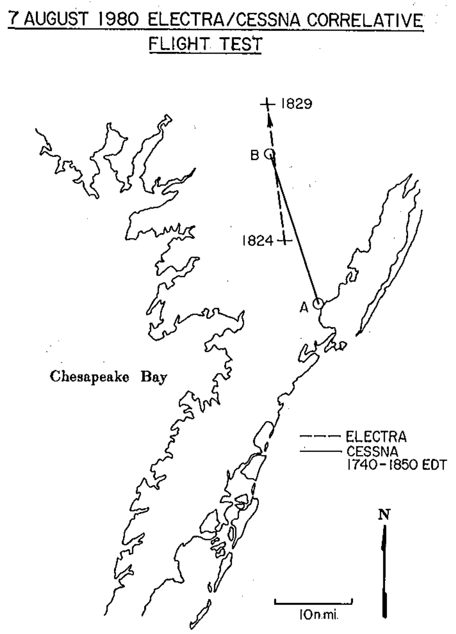


(a) Flight paths.

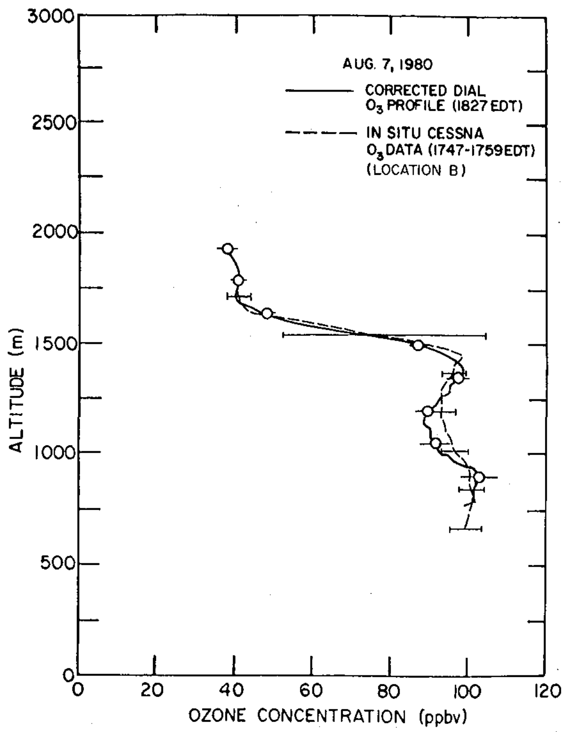


(b) Ozone profile comparison.

Figure 6.4. Correlative flight test of Electra and Cessna aircraft for July 31, 1980 (mission no. 2).

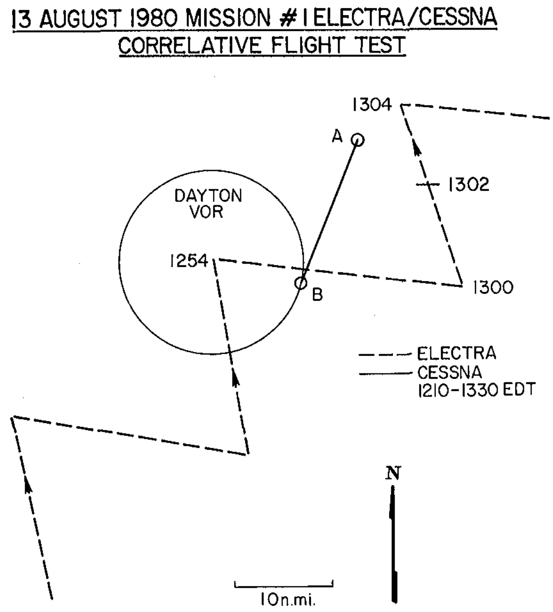


(a) Flight paths.

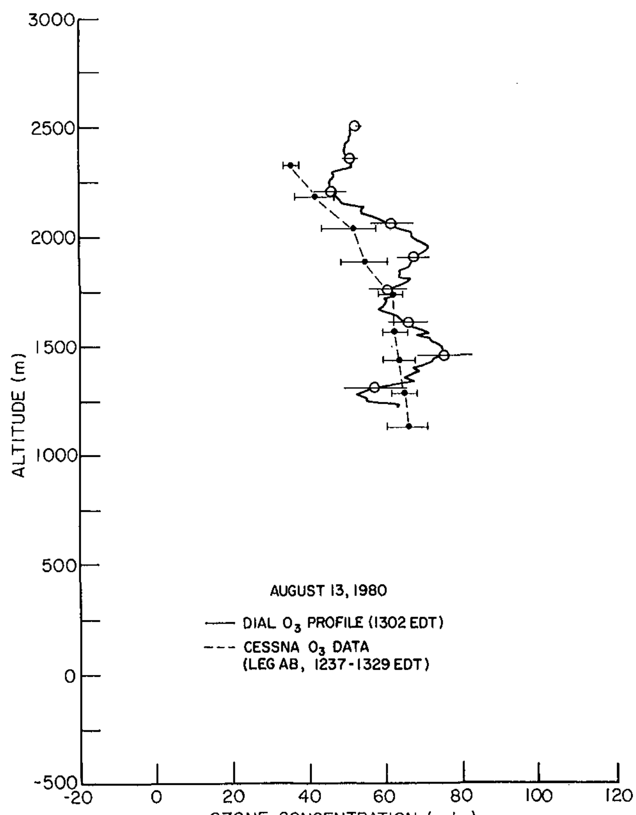


(b) Ozone profile comparison.

Figure 6.5. Correlative flight test of Electra and Cessna aircraft for August 7, 1980.

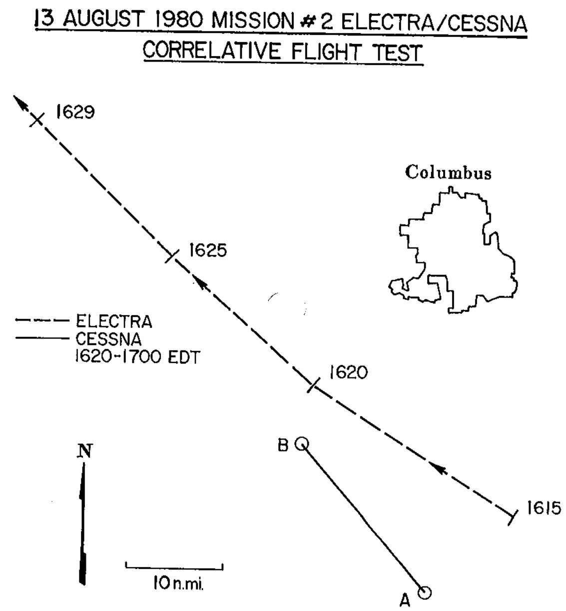


(a) Flight paths.

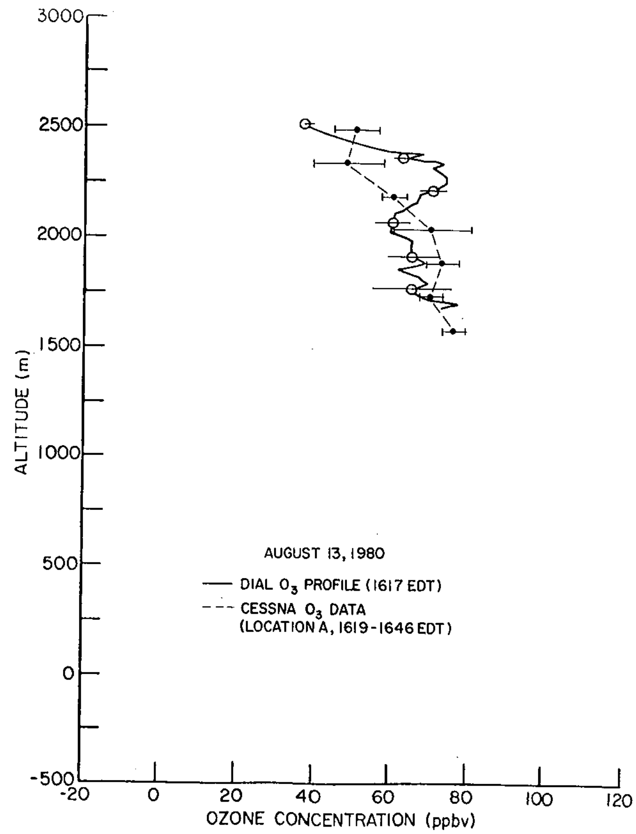


(b) Ozone profile comparison.

Figure 6.6. Correlative flight test of Electra and Cessna aircraft for August 13, 1980 (mission no. 1).

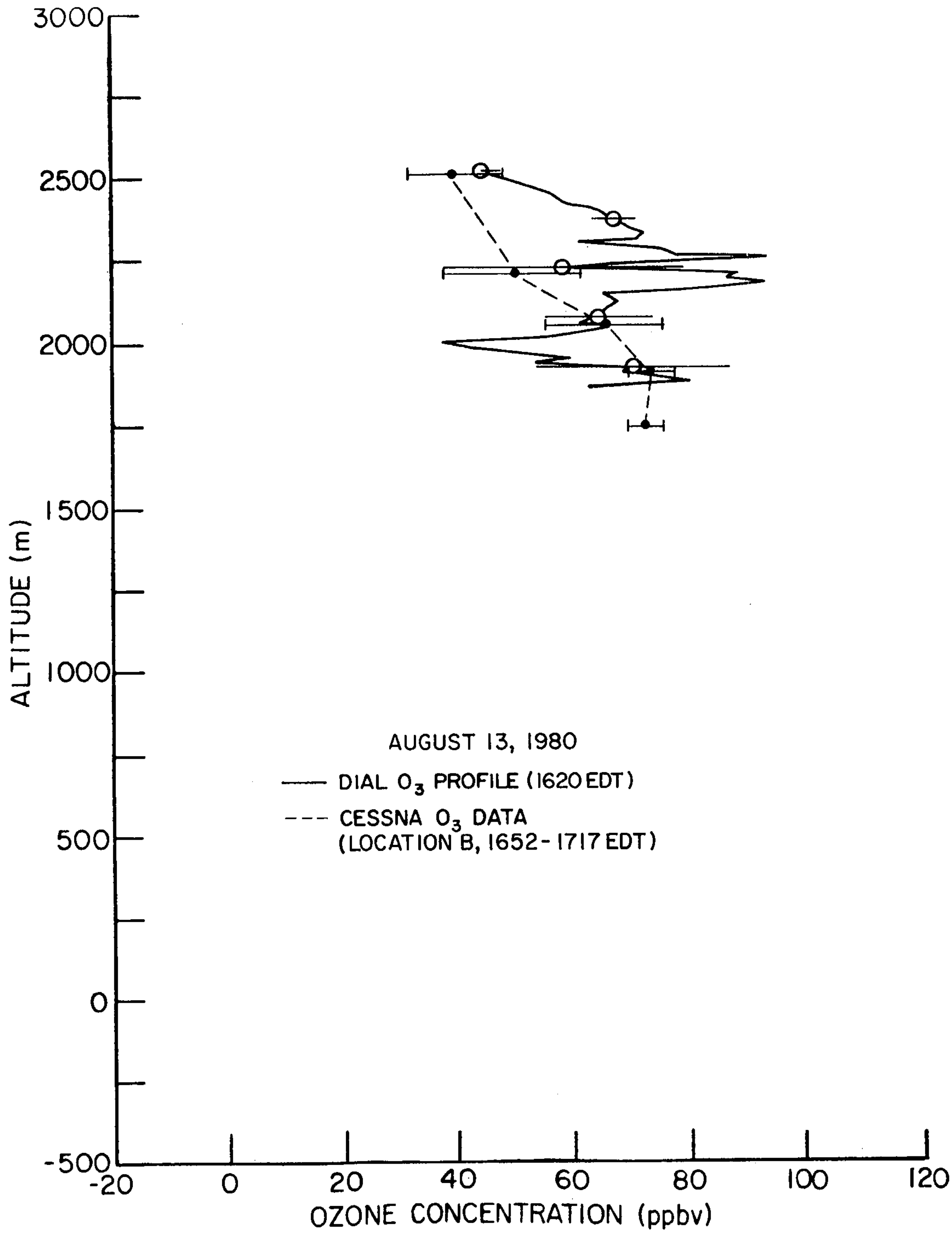


(a) Flight paths.



(b) Ozone profile comparison for location A.

Figure 6.7. Correlative flight test of Electra and Cessna aircraft for August 13, 1980 (mission no. 2).



(c) Ozone profile comparison for location B.

Figure 6.7. Concluded.

UV DIAL measured O_3 near 1300 m. Because of the lack of spatial and temporal coincidence between the two profiles, a conclusion about the differences in these measurements should not be attempted. A second correlative test was conducted on the same day near location B. There was better spatial and temporal coincidence, with a UV DIAL measurement at 1242 EDT being very close to location B. Figure 6.2(c) shows that the UV DIAL measurements of mean $O_3 \pm 1\sigma$ are within 15 ppbv of the Cessna data. At the lower altitudes the mean UV DIAL O_3 profile is about 30 ppbv less than the Cessna profile, with a variability of about 15 ppbv. A localized variation in O_3 could account for this difference.

6.2.3 July 31, 1980, profiles. Two correlations were obtained on July 31, 1980, the first mission being conducted over the northern Delmarva Peninsula. The relative flight paths are shown in figure 6.3(a). The Electra aircraft made its closest approach to location A at 1355 EDT. The resulting comparison of measurements is shown in figure 6.3(b). There is excellent agreement between the UV DIAL and Cessna data, with the Cessna data falling within the 1σ variability (5 to 15 ppbv) of the UV DIAL measurement over the entire profile. The second mission was conducted along the Electra flight path shown in figure 6.4(a). The UV DIAL data were not available until 2154 EDT, which put the Electra about 85 km (46 n.mi.) west of the Cessna measurement leg AB. The resulting O_3 profiles are shown in figure 6.4(b). There is a relative similarity between the two curves; however, the UV DIAL data are consistently below the Cessna data by 25 ppbv. This comparison is inconclusive because of the large distance between the two measurement locations.

6.2.4 August 7, 1980, profiles. As shown in figure 6.5(a), the August 7, 1980, correlative flight test was again conducted over the northern Delmarva Peninsula. The closest UV DIAL measurement was made at 1827 EDT near location B. As shown in figure 6.5(b), the UV DIAL measurements are in excellent agreement with the Cessna spiral data (mean values are within 4 ppbv). Ozone concentrations vary from 40 ppbv above the boundary layer to 97 ppbv within the boundary layer.

6.2.5 August 13, 1980, profiles. A correlative measurement flight test was conducted during the first mission on August 13, 1980, near Dayton, Ohio. The Electra and Cessna flight paths are shown in figure 6.6(a). The data for the entire Cessna leg AB were used for comparison with the UV DIAL O_3 measurements made at 1302 EDT. Figure 6.6(b) shows good agreement between these data. Since the Cessna did not fly above 2350 m altitude, the apparent divergence in the profiles above 2200 m cannot be evaluated.

The last opportunity for a correlative flight test was on the second mission on August 13, 1980, near Columbus, Ohio. Figure 6.7(a) presents the flight paths of the Electra and the Cessna, and figures 6.7(b) and 6.7(c) show the comparisons between the measurements made near locations A and B, respectively. The UV DIAL profile $\pm 1\sigma$ at 1620 EDT agrees with the Cessna profile to within 10 ppbv at location A. The presence of clouds near location B resulted in a UV DIAL measurement of O_3 which has large uncertainties below 2300 m altitude. The high degree of UV DIAL O_3 spatial variability can also be seen in the statistical variations measured with the Cessna.

6.3 Conclusion

The UV DIAL mean O_3 profiles $\pm 1\sigma$ generally agree with the in situ measurements to within ± 10 ppbv when both measurements are made at the same time and location. The UV DIAL measurements display increasing uncertainty near the bottom of the measurement range (at lower altitudes), where the 1σ variability is often greater than 15 ppbv. It is concluded that UV DIAL O_3 concentrations should be used with caution when the 1σ variability exceeds 15 ppbv.

7 Recommendations for Future UV DIAL Flight Operations

Many of the technical difficulties encountered by the UV DIAL team during the 1980 PEPE/NEROS Summer Field Experiment were typical of experiments which are flown in aircraft for the first time. Most of these problems were solved or obviated during the experiment by the individual efforts of the UV DIAL flight team members. Rather than dwell on such technical problems, this section will address those additional data sources and instrument improvements which would significantly enhance UV DIAL data quality and real-time operations.

7.1 Aircraft Attitude

The aircraft pitch and roll information can be obtained from an inertial navigation system (INS). Such data, recorded on a shot by shot basis, could be used to correct vertical profiles for slant-range variations when the aircraft enters a turn or executes a bank. This improvement is not necessary when data are being taken over water, since the position of the "ground" reflection can then be used to estimate the roll angle to the required degree of accuracy. Most problems resulting from the lack of roll information are associated with altitude measurements above ground level over variable-height terrain.

7.2 Pressure Altitude

The Electra pressure altitude was not automatically recorded during the field experiment. This shortcoming made altitude determinations above mean sea level rather difficult and made corrections for aircraft altitude changes during data acquisition impractical.

7.3 Laser Energy Monitor

The aerosol cross sections often display shot-to-shot variations in signal intensity because of real variations in laser output energy. An accurate laser energy monitor which measures output (in joules) on a per-shot basis would allow calibrated lidar measurements and could be used to avoid gray-scale "hash" due to laser output variations.

7.4 Dual Magnetic-Tape Drives

Much information is lost during the time it takes a magnetic-tape drive to rewind and unload a data tape and then to reload a new tape. Software which automatically closes a tape file, rewinds and unloads the closed tape, and then notifies the operator to insert a new tape will also reduce data time lost because of operator unavailability.

7.5 Dual Data Processor

The UV DIAL concept is well adapted to a dual processor concept, in which one processor (the "master") is responsible for data acquisition and the other (the "slave") is used for real-time calculations and data display. Such a system also provides equipment backup provided that both processors are full duplicates of each other.

7.6 Laser-Triggered Digitizers

Control of laser firing during the PEPE/NEROS experiment was attempted through a form of "digital" control of the Pockels Cell Q-switch with a local oscillator. This method is difficult to implement and results in poor control over time correlation between the UV DIAL on- and off-wavelength signals. It is far easier to derive a laser trigger signal from the output laser pulse directly and then use this signal to phase lock the digitizer internal clock cycle.

7.7 Additional Measurements

As shown by Shipley and Browell (1984), additional information on clouds and mixed layer humidity can be obtained when nadir-directed lidars are operated in concert with IR radiometers and photographic equipment. Images of cloud cover taken from the Electra during the PEPE/NEROS program were obtained on video tape, but later use of these data was not feasible because of tape signal variations and tape memory degradation. Power frequencies varied among the various ground and aircraft power supplies, and acceptable image replay was not achieved.

7.8 Current Airborne DIAL Capabilities

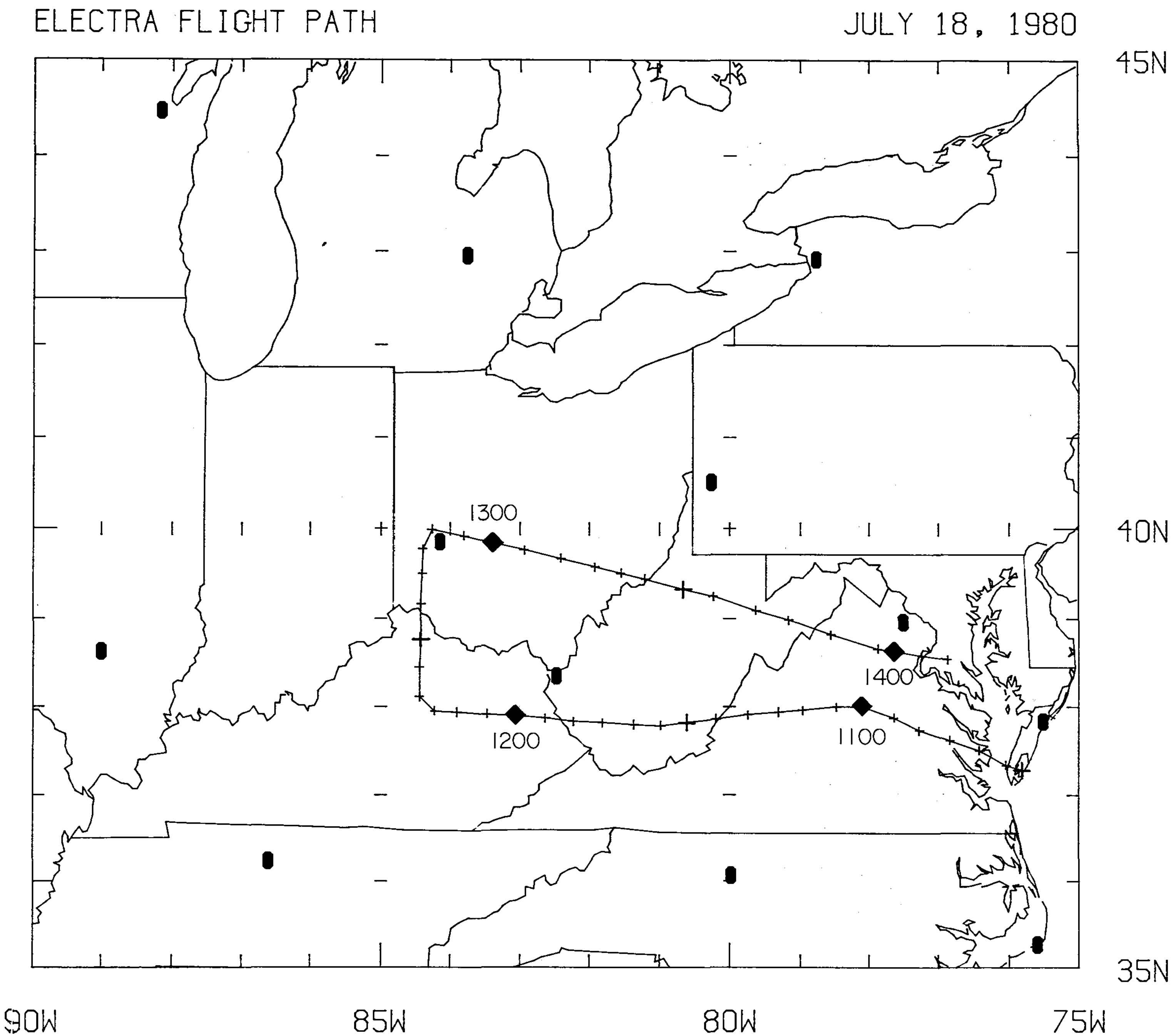
All the instrument improvements indicated as deficiencies during the PEPE/NEROS field experiment (with the exception of automatic aircraft attitude recording) have been incorporated into the current NASA airborne DIAL system. (See Browell et al. 1983; Butler 1984.) Aircraft pressure altitude and laser output energy are inserted automatically into the lidar data stream. Dual magnetic-tape units are used for continuous data recording, and dual computers are used for data storage and real-time DIAL calculations. A "lase coherent" time base was developed to synchronize DIAL signal digitization with actual laser firing to ±4 ns. A formatted 35-mm time-lapse camera was installed on the Electra aircraft in 1982, and continuous records of the visual scene below the aircraft are now obtained routinely. A Barnes Model PRT-5 12-μm-band IR radiometer was installed on the Electra in 1981. This instrument now allows correlated observations of cloud heights and cloud-top temperatures with direct PRT-5 data storage onto the lidar data tape on a shot-by-shot basis. Spare Nd:YAG laser output at 1.06 μm is now directed into the atmosphere and detected with an avalanche photodiode. Visible "radiometer" measurements are obtained by integration of lidar background data at 300 nm, 600 nm, and 1.06 μm.

NASA Langley Research Center
Hampton, VA 23665-5225
May 1, 1985

Appendix A

UV DIAL PEPE/NEROS ARCHIVE

The UV DIAL PEPE/NEROS archive is organized as follows:


ELECTRA FLIGHT PATH
JULY 18, 1980
45N
40N
35N
90W
85W
80W
75W
1300
1400
1200
1100

Instrument Parameters for July 18, 1980, Flight

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
1	1115	1125	5	5	2300	0.2	5	2235	0.5	Yes	3982
2	1131	1147	5	5	2300	.2	5	2235	.5	Yes	3982
3	1202	1224	1	5	2410	.2	5	2304	.5	Yes	3291
4	1229	1240	5	5	2210	.2	5	2340	.5	Yes	3328
5	1250	1302	1	5	2562	.2	5	2300	.5	Yes	3655 to 3001
6	1306	1315	5	5	2362	.2	5	2241	.5	Yes	3005
7	1328	1405	1	5	2581	.2	5	2200	.5	Yes	3592

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR JULY 18, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 7/18/80 18 0

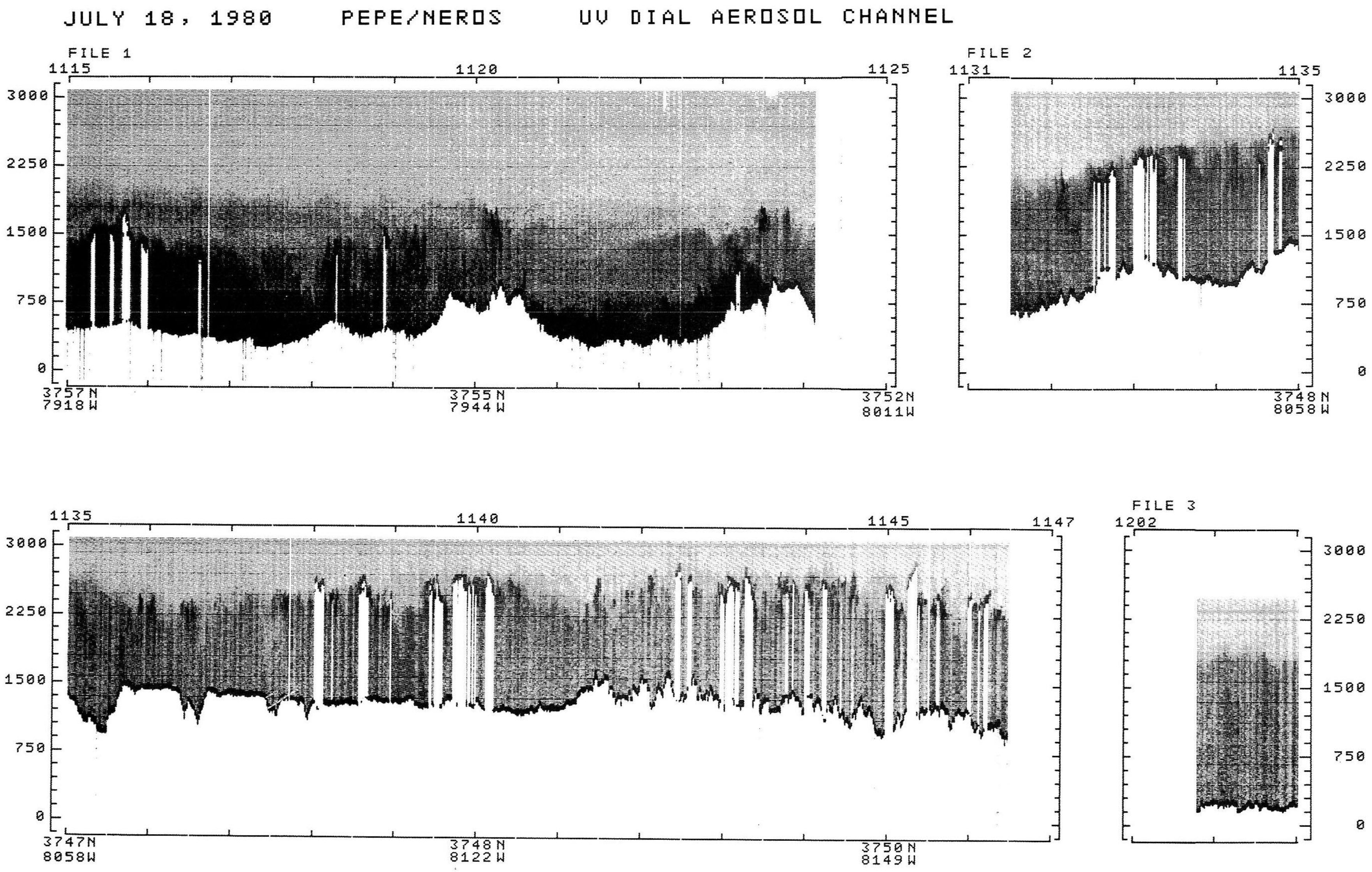
TIME	LAT	LAT	LONG	LONG	ALT	K	MIXHT	L	H2SIG	LWCCL	M	MXCLD	N+	TPUSL	N1+	MAXSG	C
EDT	DEG	MIN	DEG	MIN	MMSL		MAGL		M	MAGL		MAGL		MAGL		MMSL	
1030	37.	00.	75.	00.	82.		600.		40.	600.		1200.		1400.		2200.	
1410	39.	59.	84.	59.	770.		2700.		260.	2300.		2900.		2300.		3300.	
		45															
1030	37.0	17.0	75.0	49.0													
1035	37.0	20.5	76.0	02.5													
1040	37.0	30.6	76.0	25.0													
1045	37.0	37.5	76.0	50.2													
1050	37.0	43.8	77.0	16.5													
1055	37.0	52.8	77.0	38.5													
1100	38.0	00.2	78.0	06.0													
1105	38.0	00.0	78.0	28.0													
1110	37.0	58.0	78.0	58.0													
1115	37.0	56.5	79.0	18.0	457.		880.		210.	600.		1200.		1650.		3230.	
1120	37.0	54.6	79.0	44.0	610.	V	1880.	S	150.	1430.	S	1790.	S	NA		3230.	
1125	37.0	52.0	80.0	11.5													
1130	37.0	49.6	80.0	36.5													
1135	37.0	47.5	80.0	58.4	762.	V	2630.	S	150.	2180.	S	2630.	S	NA		3230.	
1140	37.0	48.0	81.0	22.0	762.	V	2650.	S	130.	2170.	S	2770.	S	NA		3230.	
1145	37.0	49.5	81.0	48.8		V	2450.	S	200.	2230.	S	2890.	S	NA		3230.	
1150	37.0	50.0	82.0	14.0													
1155	37.0	52.5	82.0	38.0													
1200	37.0	54.0	83.0	03.5													
1205	37.0	55.0	83.0	28.5	305.		1500.		80.	1240.		1700.		NA		2540.	
1210	37.0	56.5	83.0	54.0	433.		1600.		80.	NA		NA		NA		2540.	
1215	37.0	57.5	84.0	13.5	303.		1520.		70.	NA		NA		NA		2540.	
1220	38.0	07.0	84.0	27.0	293.		1440.		160.	NA		NA		NA		2540.	
1225	38.0	27.5	84.0	26.8													
1230	38.0	46.0	84.0	26.0	247.		750.		160.	NA		NA		1470.		2580.	1
1235	39.0	10.0	84.0	25.5	256.		990.		260.	NA		NA		1500.	M	2580.	2
1240	39.0	30.0	84.0	24.5	198.		620.		80.	NA		NA		1780.	M	2580.	1
1245	39.0	46.5	84.0	24.0													

Concluded

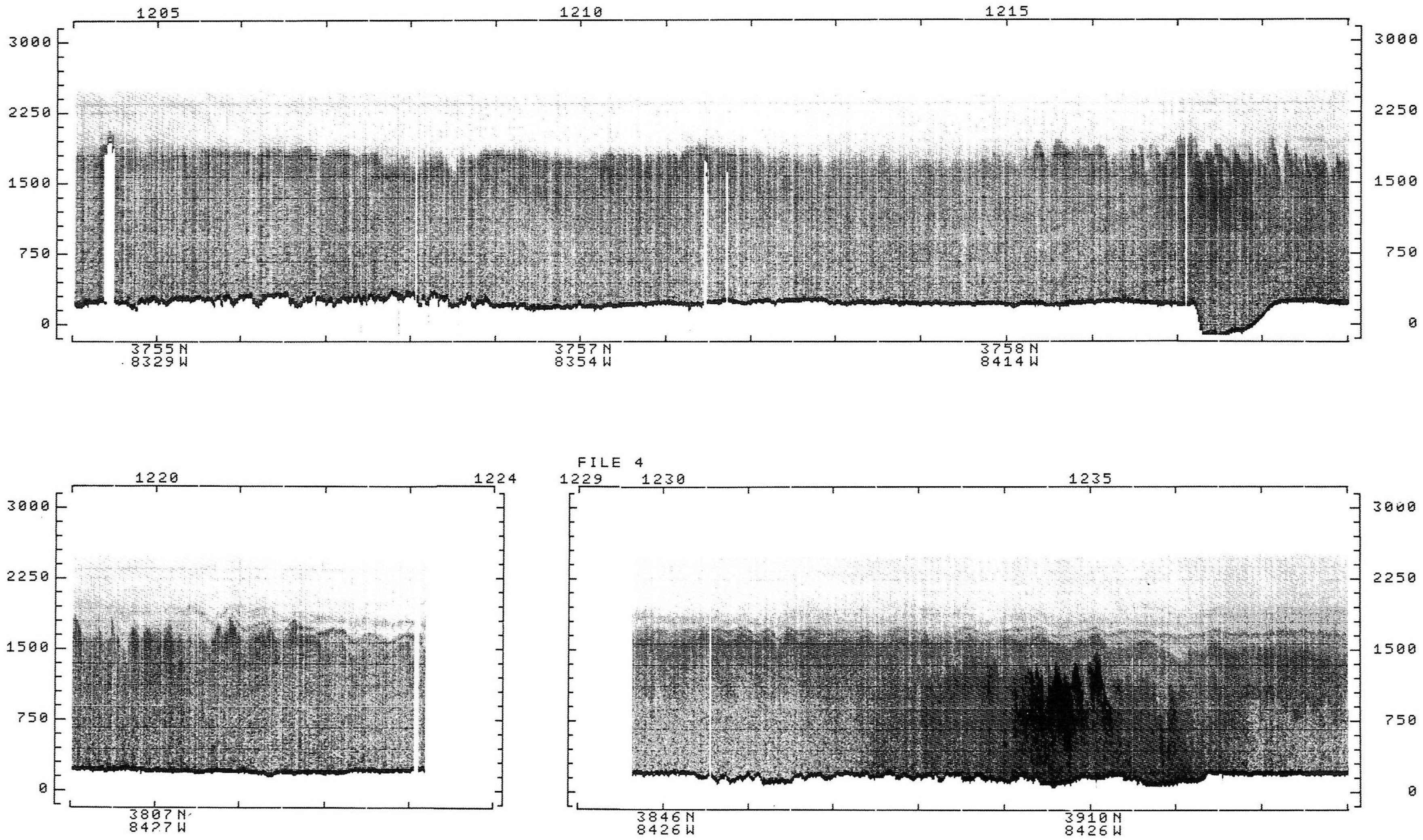
PROJECT PEPE/PEPE-NEROS STUDY UVDA01 7/18/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	C
1250	39.0	59.8	84.0	16.0													
1255	39.0	55.0	80.0	48.5	310.		990.		80.	NA		NA		1460.	M	2900.	
1300	39.0	50.5	83.0	23.4	330.		750.		ND	NA		NA		1500.		2250.	
1305	39.0	45.8	82.0	56.0													
1310	39.0	40.0	82.0	24.4	310.		1520.		40.	1050.		1520.		NA		2260.	
1315	39.0	34.5	81.0	55.0													
1320	39.0	30.5	81.0	33.0													
1325	39.0	26.5	81.0	12.0													
1330	39.0	19.8	80.0	39.4	305.		1880.		150.	1200.		1880.		NA		2840.	
1335	39.0	15.0	80.0	14.0	432.		2020.		140.	1230.		2060.		NA		2840.	
1340	39.0	05.6	79.0	37.4	914.	V	2560.	S	200.	1700.	S	2580.	S	NA		2840.	
1345	38.0	59.0	79.0	09.0	457.	V	ND		ND	ND		ND		NA		2840.	
1350	38.0	49.0	78.0	33.0		V	2420.	S	90.	1970.	S	2320.	S	NA		2840.	
1355	38.0	39.5	77.0	52.5	152.	V	2300.	S	80.	1630.	S	2450.	S	NA		2840.	
1400	38.0	37.5	77.0	38.5	82.		1500.		200.	1350.		1800.		2250.		2840.	3
1405	38.0	34.6	77.0	14.8													
1410	38.0	32.2	76.0	53.0													

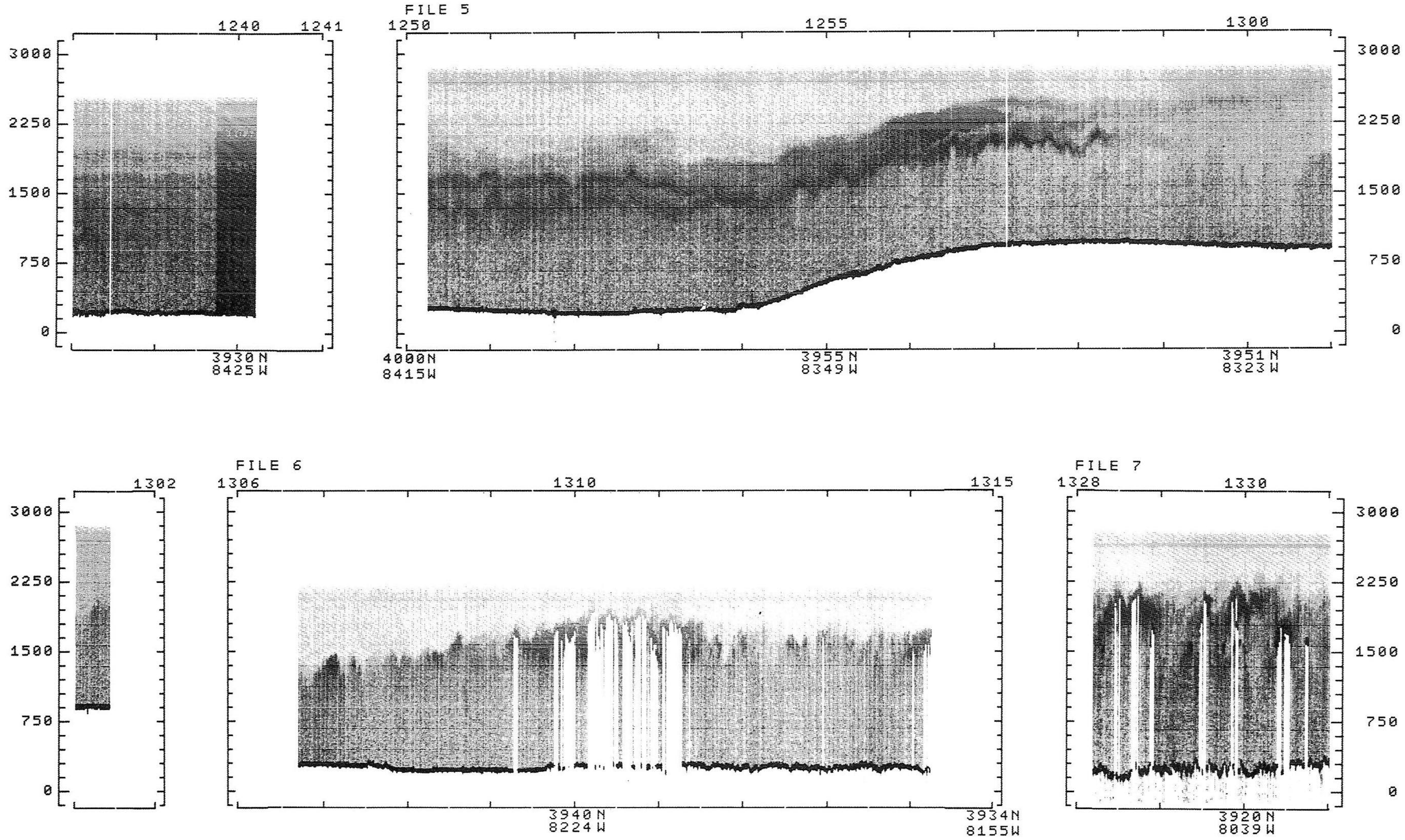
(1) CLEAR PLANETARY BOUNDARY LAYER MIXING INTO HAZY AIR ALOFT
(2) CINCINATTI URBAN PLUME
(3) STRATO-CUMULUS CLOUD DECK ABOVE PLANETARY BOUNDARY LAYER


JULY 18, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL
FILE 1
1115
1120
1125
3000
2250
1500
750
0
3757N 7918W
3755N 7944W
3752N 8011W
FILE 2
1131
1135
3748N 8058W
1135
1140
1145
1147
3747N 8058W
3748N 8122W
3750N 8149W
FILE 3
1202

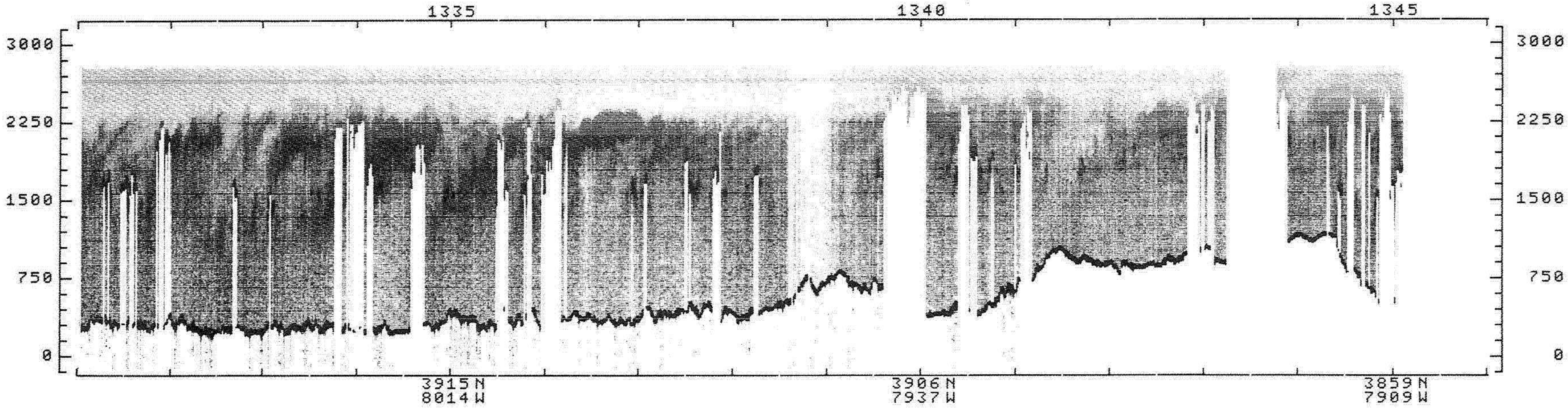
JULY 18, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

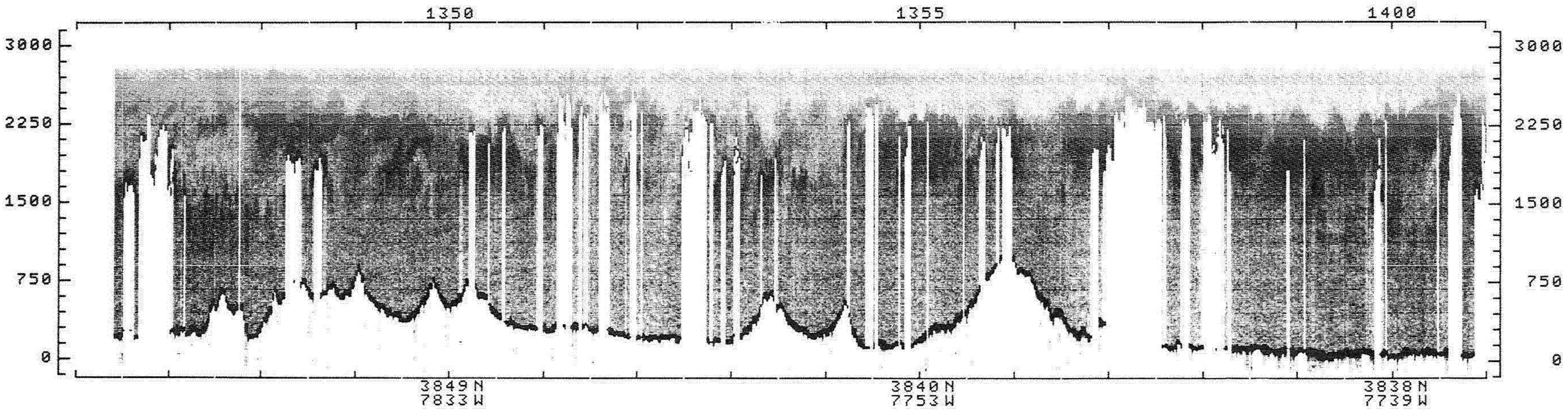


JULY 18, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

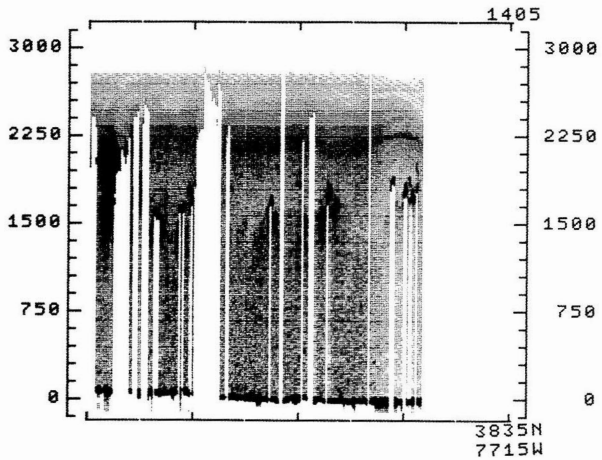


JULY 18, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

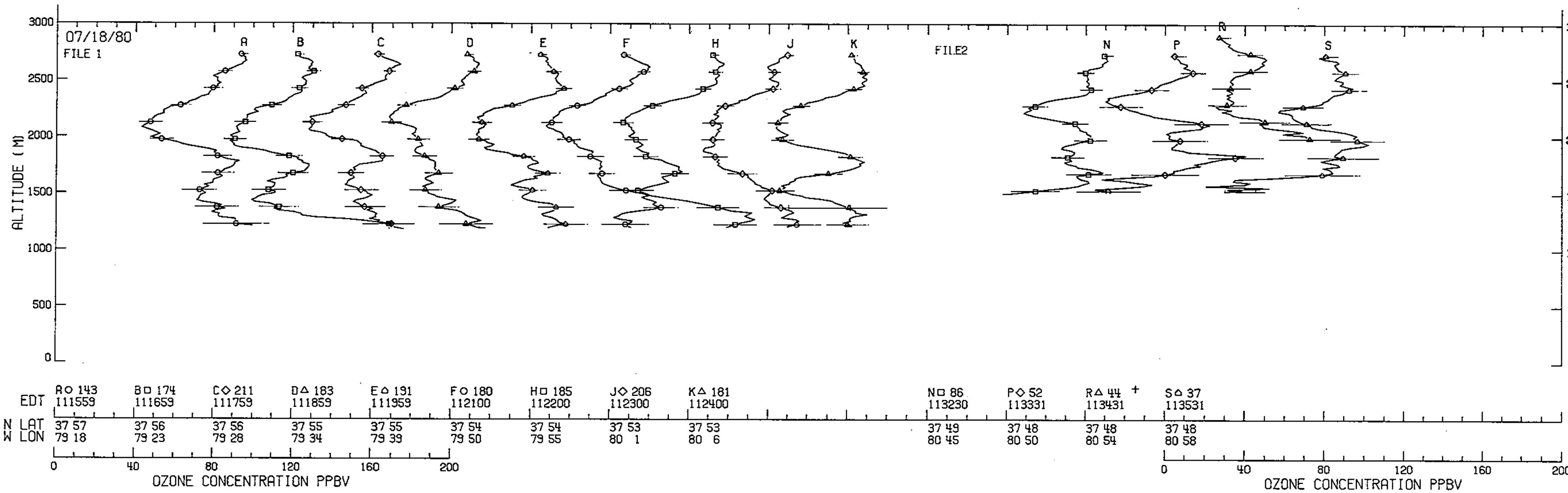


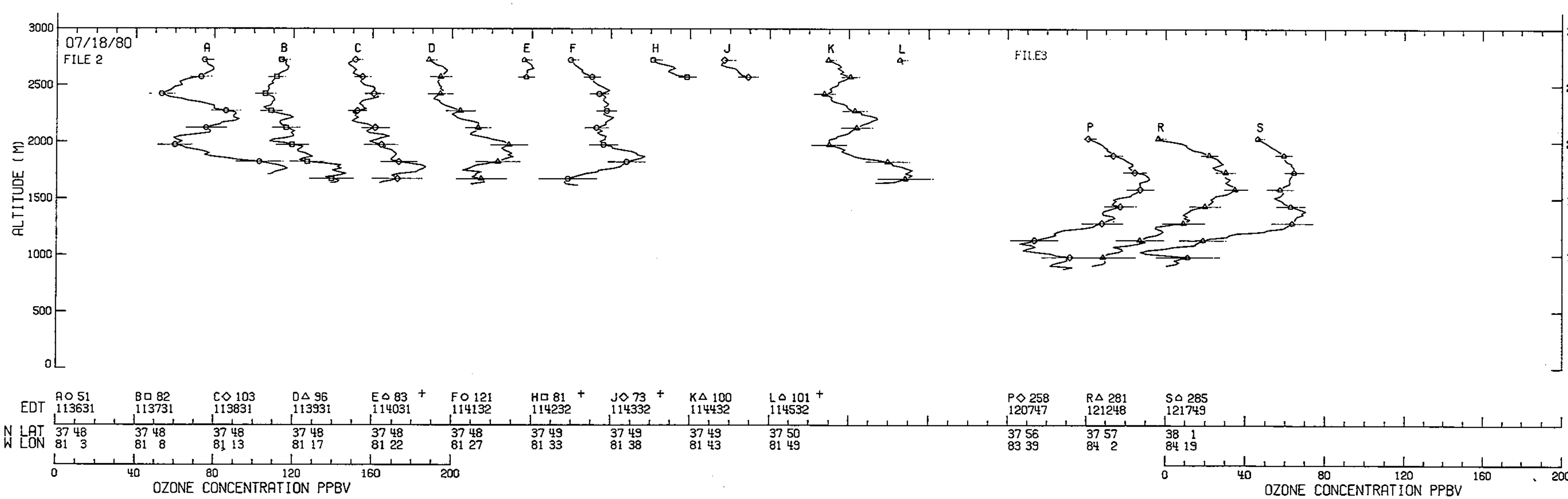


JULY 18, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

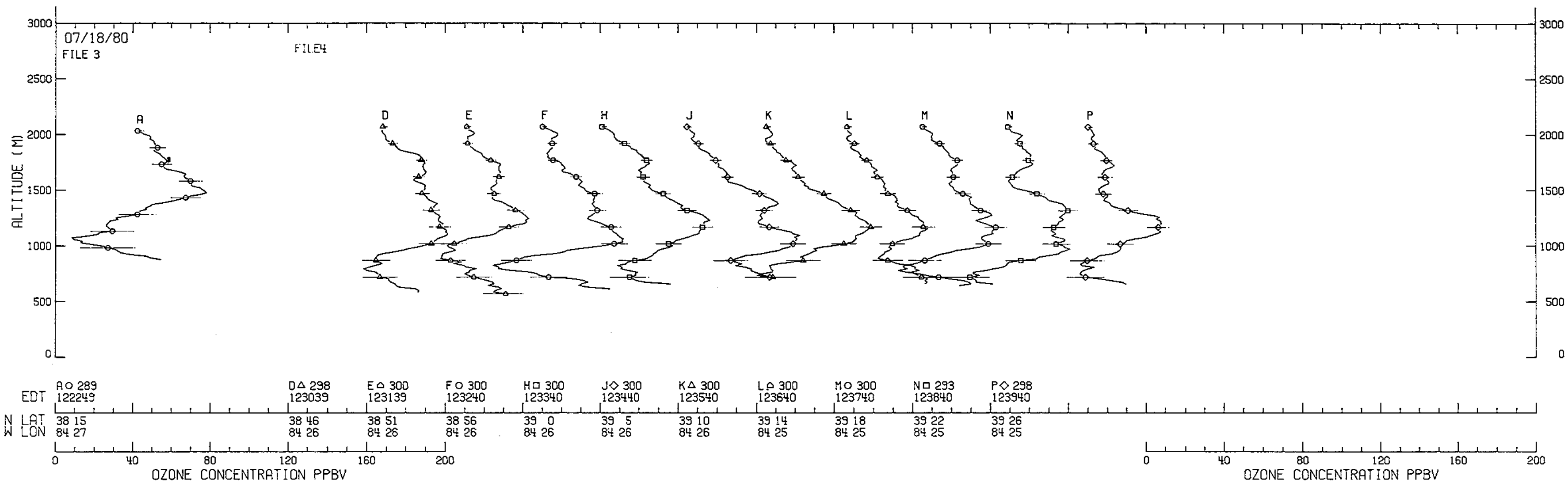


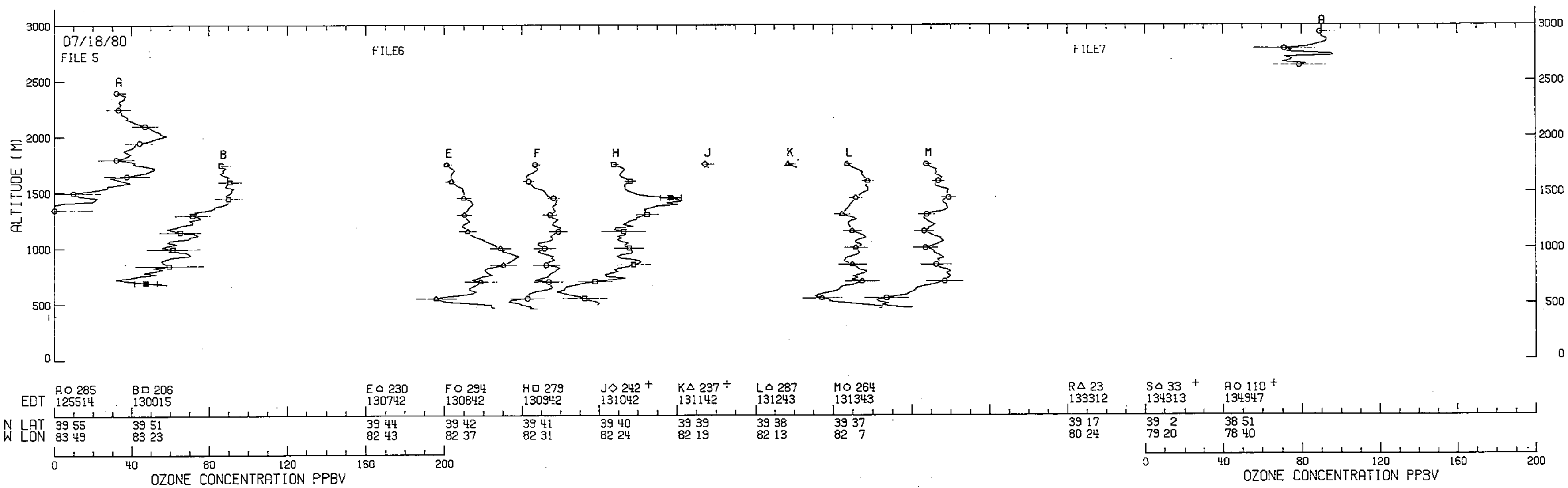
O_3 PROFILES FOR JULY 18, 1980, FLIGHT



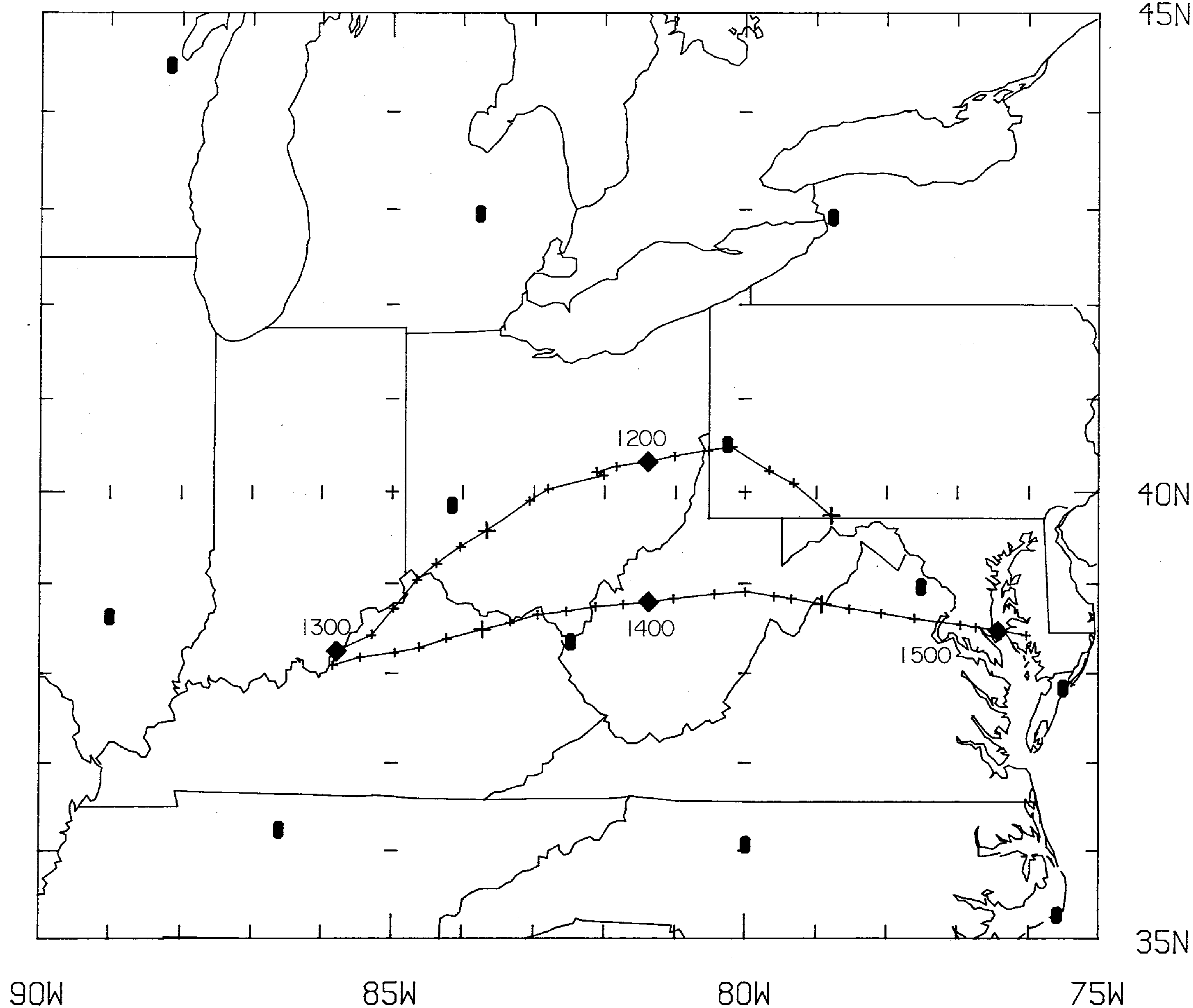


Concluded


07/18/80
FILE 3
FILE4
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
A D E F H J K L M N P
EDT
N LAT
W LON
A○ 289 122249 38 15 84 27
D△ 298 123039 38 46 84 26
E⌂ 300 123139 38 51 84 26
F○ 300 123240 38 56 84 26
H□ 300 123340 39 0 84 26
J◇ 300 123440 39 5 84 26
K△ 300 123540 39 10 84 26
L⌂ 300 123640 39 14 84 25
M○ 300 123740 39 18 84 25
N□ 293 123840 39 22 84 25
P◇ 298 123940 39 26 84 25
0 40 80 120 160 200
OZONE CONCENTRATION PPBV


07/18/80
FILE 5
FILE6
FILE7
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
A B E F H J K L M
EDT
N LAT
W LON
A○ 285 125514 39 55 83 49
B□ 206 130015 39 51 83 23
E⌂ 230 130742 39 44 82 43
F○ 294 130842 39 42 82 37
H□ 279 130942 39 41 82 31
J◇ 242 + 131042 39 40 82 24
K△ 237 + 131142 39 39 82 19
L⌂ 287 131243 39 38 82 13
M○ 264 131343 39 37 82 7
R△ 23 133312 39 17 80 24
S⌂ 33 + 134313 39 2 79 20
A○ 110 + 134947 38 51 78 40
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

ELECTRA FLIGHT PATH JULY 24, 1980



Instrument Parameters for July 24, 1980, Flight

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
1	1125	1150	5	6	2340	0.2/0.2	6	2300	0.5	Yes	3327
2	1158	1224	5	7	2437	.2/.2	6	2300	.5	Yes	3327
3	1239	1254	5	7	2500	.2/.1[a]	6	2300	.5	Yes	3260
4	1326	1343	5	7	2500	.2/.1[a]	6	2200	.5	Yes	3235
5	1350	1409	1,5	7	2579	.2/.1[a]	6	2200	.5	Yes	3305
6	1419	1510	1	7	2573	.2/.1[a]	6	2400	.5	Yes	4200

[a]The PMT signal was put into two Model 1010's simultaneously.

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR JULY 24, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 7/24/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
1130	38.	00.	80.	00.	0.		500.		50.	400.		900.		1500.		2300.
1510	40.	60.	80.	59.	900.		2900.		300.	2000.		3300.		2600.		3300.

44

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
1130	39.0	44.3	78.0	47.0	762.		750.		250.	750.		1170.		NA		2430.
1135	40.0	05.5	79.0	19.0	892.		560.		200.	450.		900.		1500.	M	2430.
1140	40.0	14.0	79.0	40.0	462.		1120.		250.	930.		1320.		1970.	M+	2430.
1145	40.0	29.0	80.0	11.5	447.		1200.		130.	920.		1300.		1800.		2430.
1150	40.0	27.0	80.0	31.5												
1155	40.0	23.0	81.0	01.0												
1200	40.0	19.5	81.0	24.0	403.		1100.		180.	820.		1340.		NA		2430.
1205	40.0	16.5	81.0	50.5	326.		870.		120.	740.		1200.		NA		2430.
1210	40.0	13.0	82.0	07.0	305.		900.		180.	740.		1180.		NA		2430.
1215	40.0	11.0	82.0	01.5	407.		900.		280.	860.		1100.		NA		2430.
1220	40.0	02.0	82.0	48.0	249.		870.		190.	NA		NA		1500.		2430.
1225	39.0	54.0	83.0	03.5												
1230	39.0	34.5	83.0	40.0												
1235	39.0	24.0	84.0	02.0												
1240	39.0	13.0	84.0	22.5	267.		750.		140.	NA		NA		1830.		2360.
1245	39.0	02.3	84.0	39.0	272.		1240.		160.	800.		1400.		1780.		2360.
1250	38.0	43.5	84.0	58.5	149.		1140.		140.	920.		1820.		1820.		2360.
1255	38.0	26.0	85.0	17.6												
1300	38.0	15.0	85.0	47.4												
1305	38.0	05.4	85.0	50.6												
1310	38.0	11.0	85.0	27.0												
1315	38.0	13.8	84.0	58.4												
1320	38.0	17.5	84.0	37.0												
1325	38.0	23.5	84.0	13.8												
1330	38.0	29.8	83.0	44.0	285.		990.		300.	990.		1960.		1820.		2340.
1335	38.0	34.2	83.0	20.4	305.		980.		260.	680.		1880.		1880.		2340.
1340	38.0	39.2	82.0	57.0	229.		1000.		300.	840.		2010.		1890.		2340.
1345	38.0	41.6	82.0	32.4												

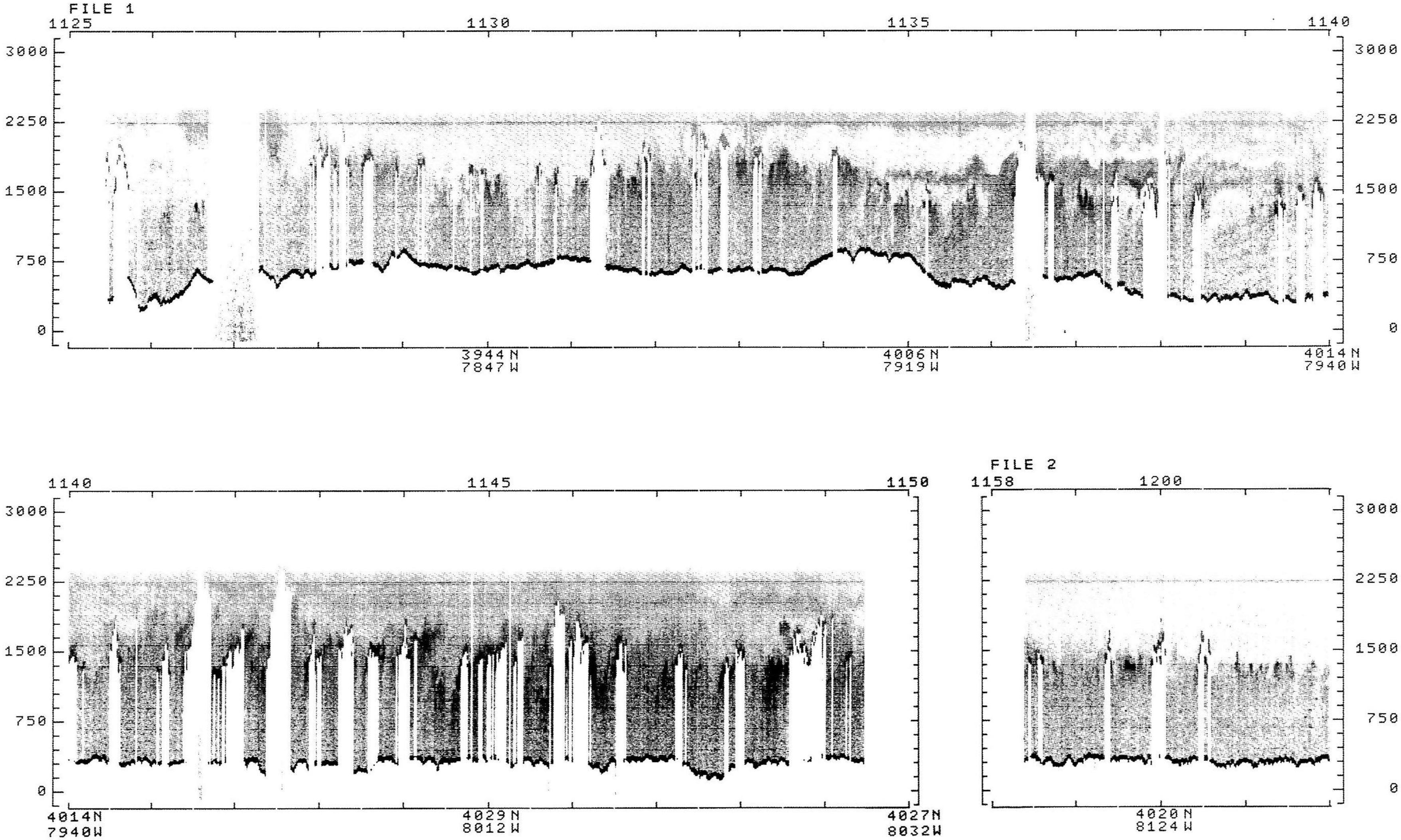
Concluded

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 7/24/80 18 0

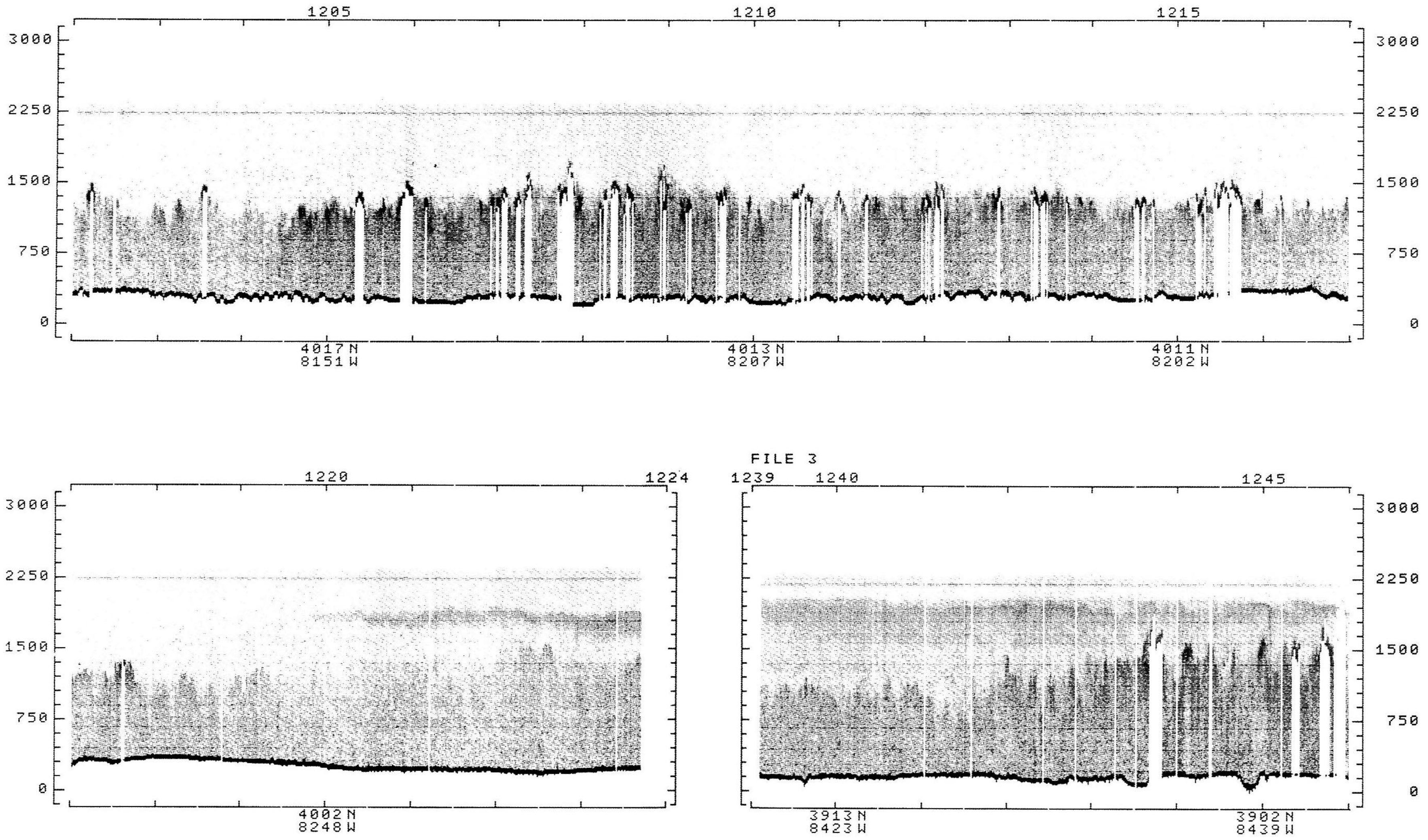
TIME	LAT	LAT	LONG	LONG	ALT	K	MIXHT	L	H2SIG	LWCCL	M	MXCLD	N+	TPUSL	N1+	MAXSG	
EDT	DEG	MIN	DEG	MIN	MMSL		MAGL		M	MAGL		MAGL		MAGL		MMSL	
1350	38.0	44.5	82.0	08.0													
1355	38.0	46.0	81.0	44.2	340.		1350.		300.	1170.		2060.	+	2060.	+	2400.	
1400	38.0	47.5	81.0	23.0	310.		1200.		200.	1050.		2090.	+	2090.	+	2400.	
1405	38.0	50.0	81.0	01.6	310.		900.		150.	820.		2090.	+	2090.	+	2400.	3
1410	38.0	53.0	80.0	26.0													
1415	38.0	54.5	80.0	00.5													
1420	38.0	51.5	79.0	35.5		V	2790.	S	150.	1650.	S	2970.	S	NA		3300.	
1425	38.0	50.0	79.0	21.0		V	2700.	S	200.	1650.	S	2780.	S	NA		3300.	
1430	38.0	46.0	78.0	55.0		V	2760.	S	150.	1950.	S	3000.	S	NA		3300.	
1435	38.0	43.0	78.0	31.0		V	2850.	S	90.	1950.	S	3300.	S+	NA		3300.	
1440	38.0	40.0	78.0	05.0		V	2600.	S	150.	1800.	S	2850.	S	NA		3300.	
1445	38.0	36.5	77.0	36.5		V	2660.	S	150.	1650.	S	2850.	S	NA		3300.	
1450	38.0	32.2	76.0	57.0	82.		2500.		150.	1600.		3200.		NA		3300.	
1455	38.0	30.8	76.0	45.0	46.		2460.		150.	1580.		2480.		NA		3300.	
1500	38.0	28.8	76.0	26.0	23.		900.		50.	NA		NA		2400.	M	3300.	
1505	38.0	25.5	76.0	02.2	6.		2800.		150.	1500.		2800.		2550.		3300.	

(3) STRATO-CUMULUS CLOUD DECK ABOVE PLANETARY BOUNDARY LAYER

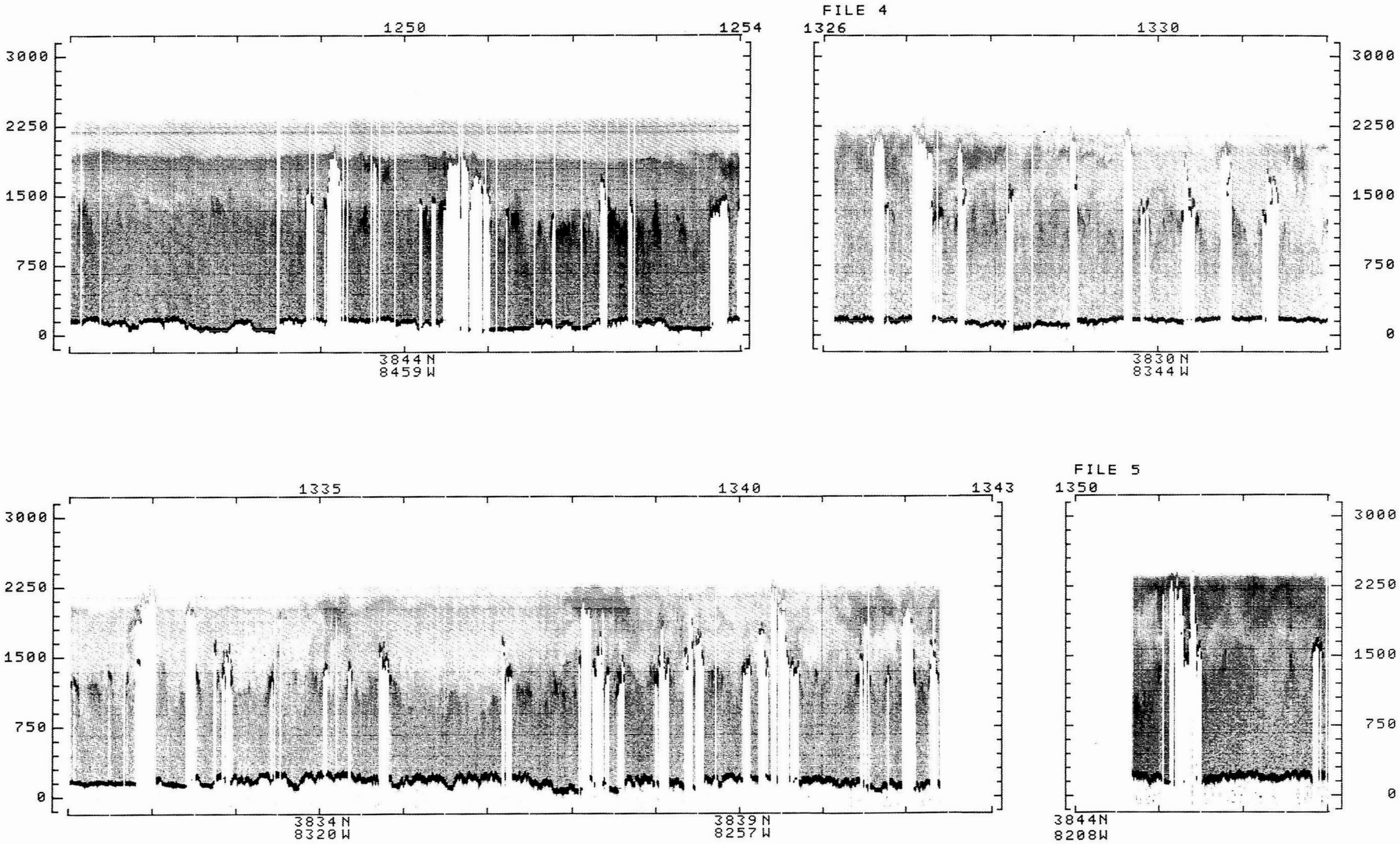
JULY 24, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



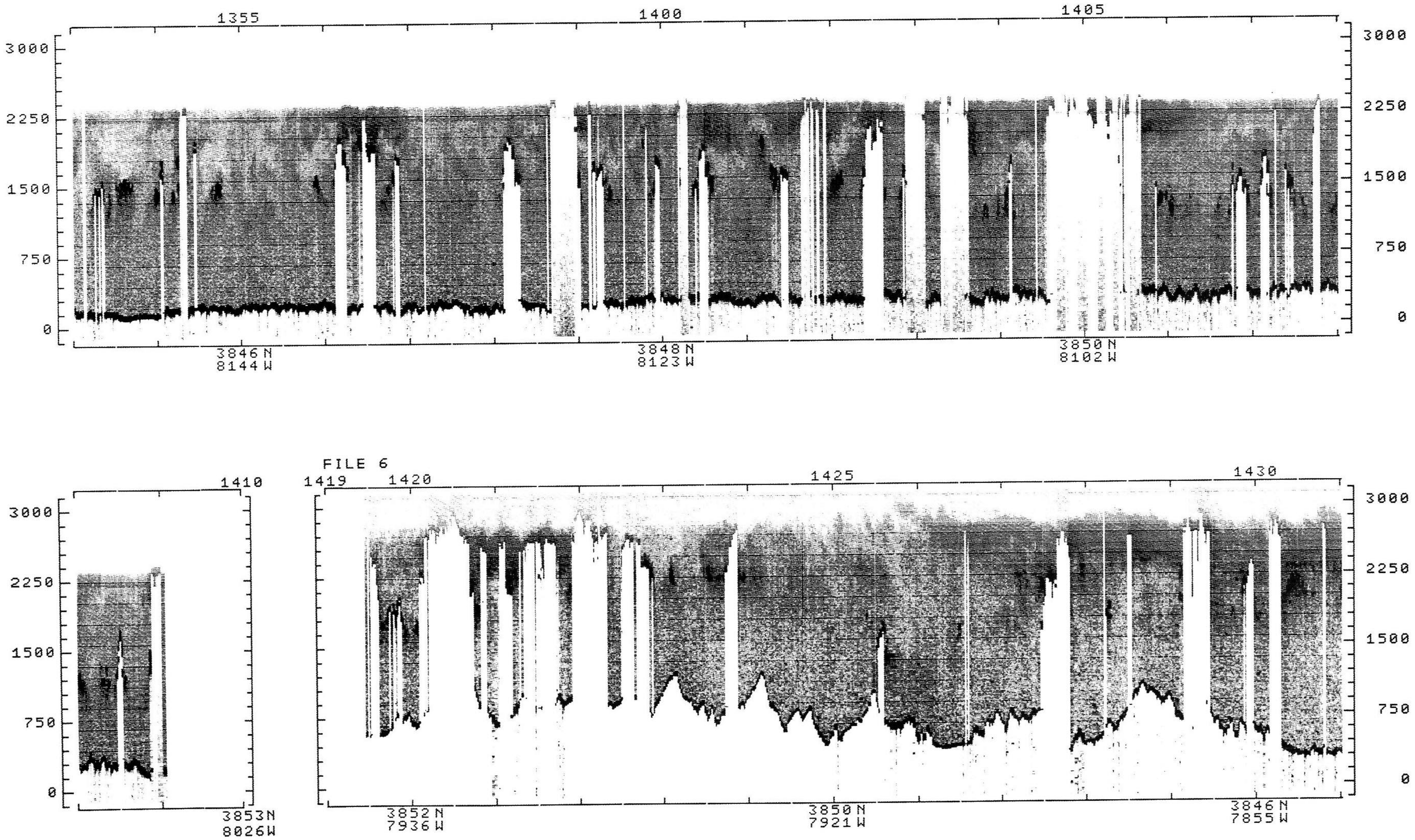
JULY 24, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



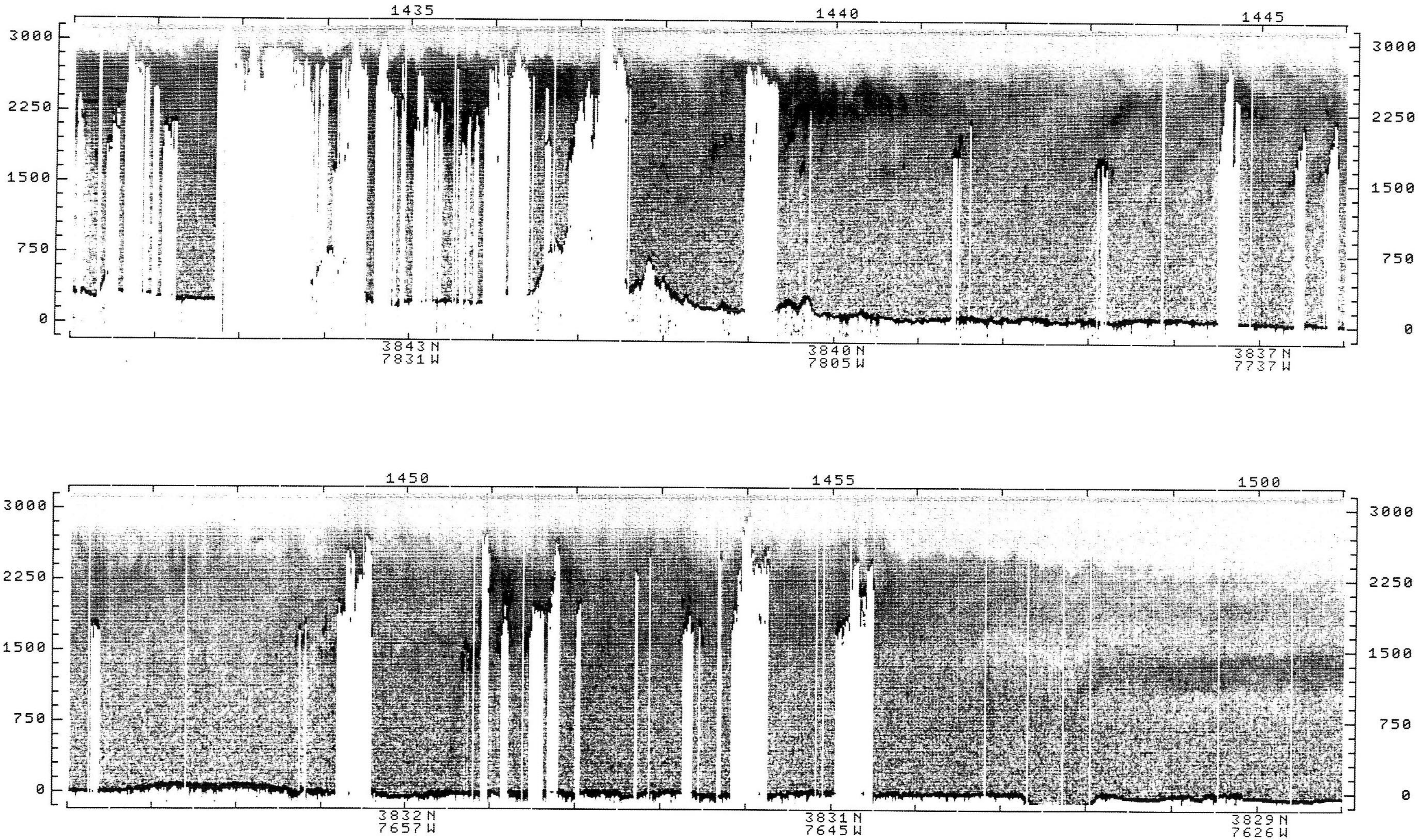
JULY 24, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



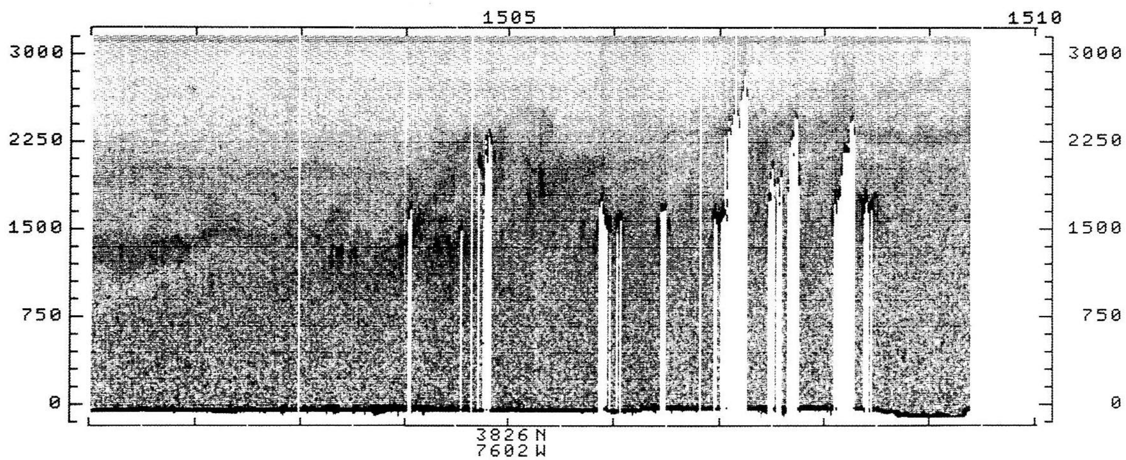
JULY 24, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



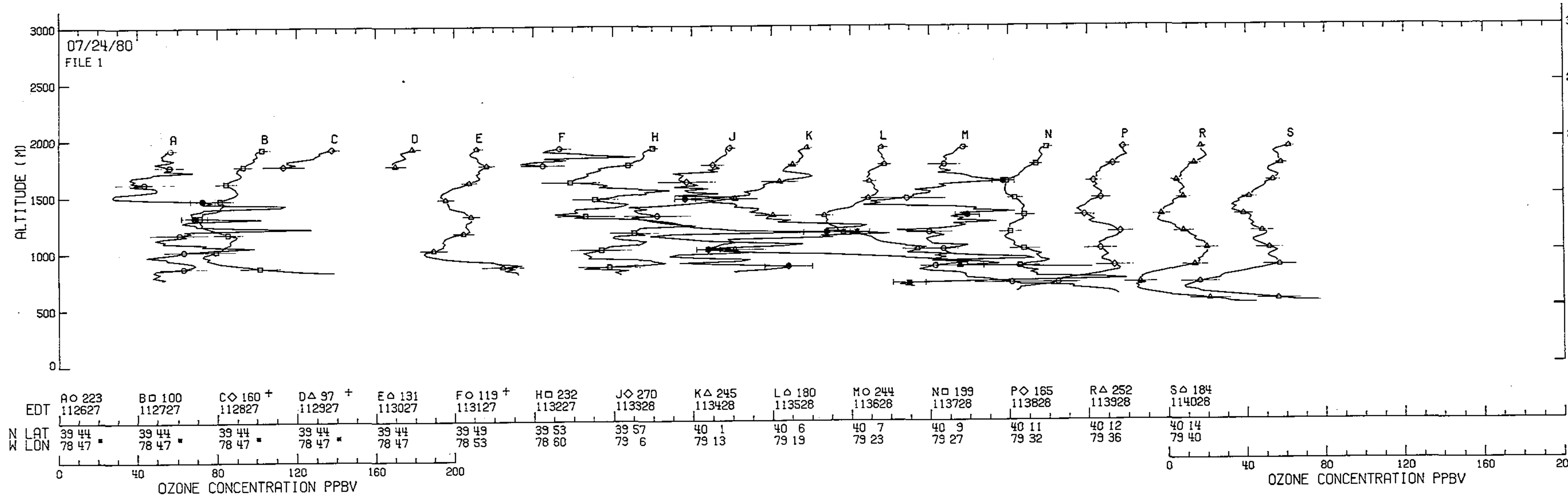
JULY 24, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

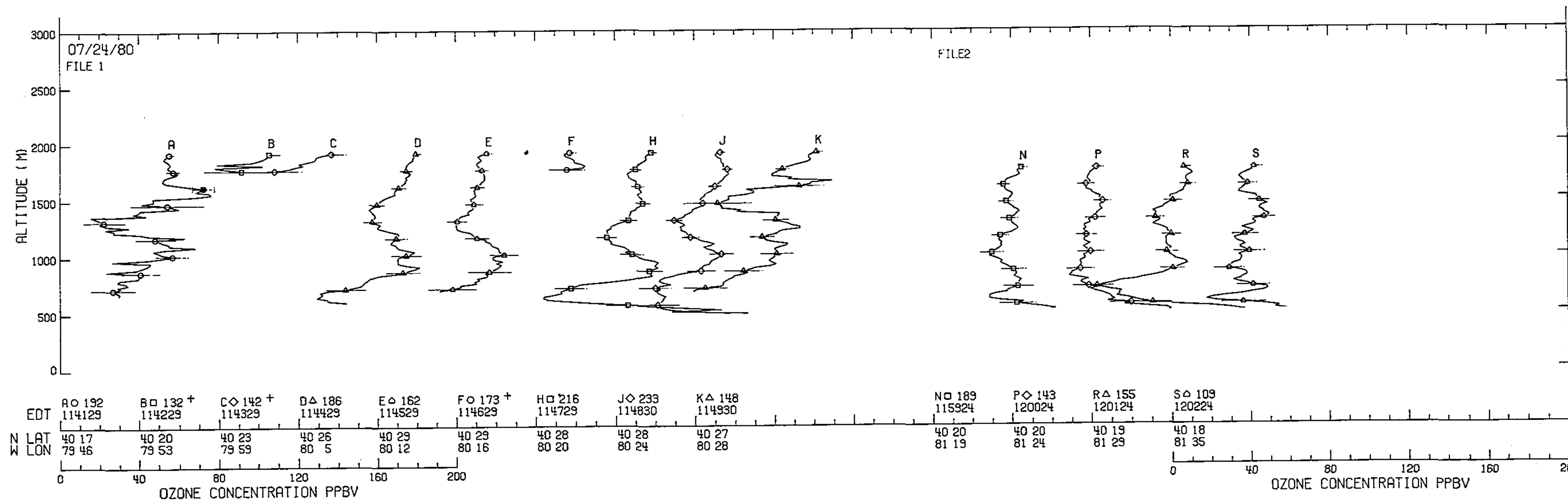


JULY 24, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

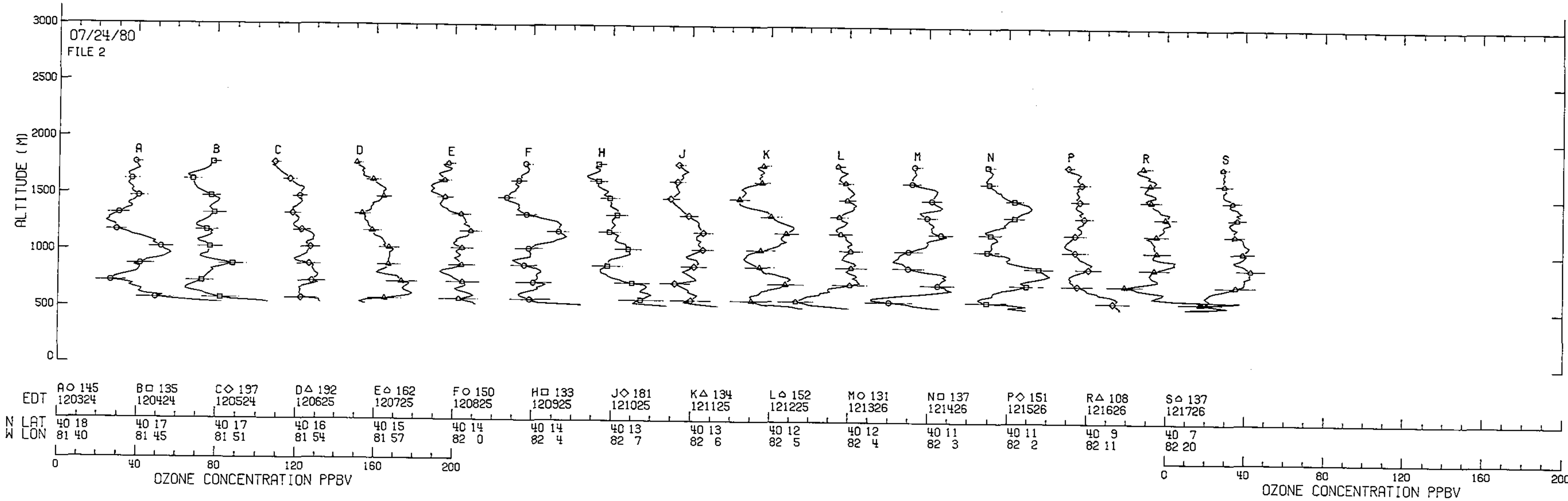


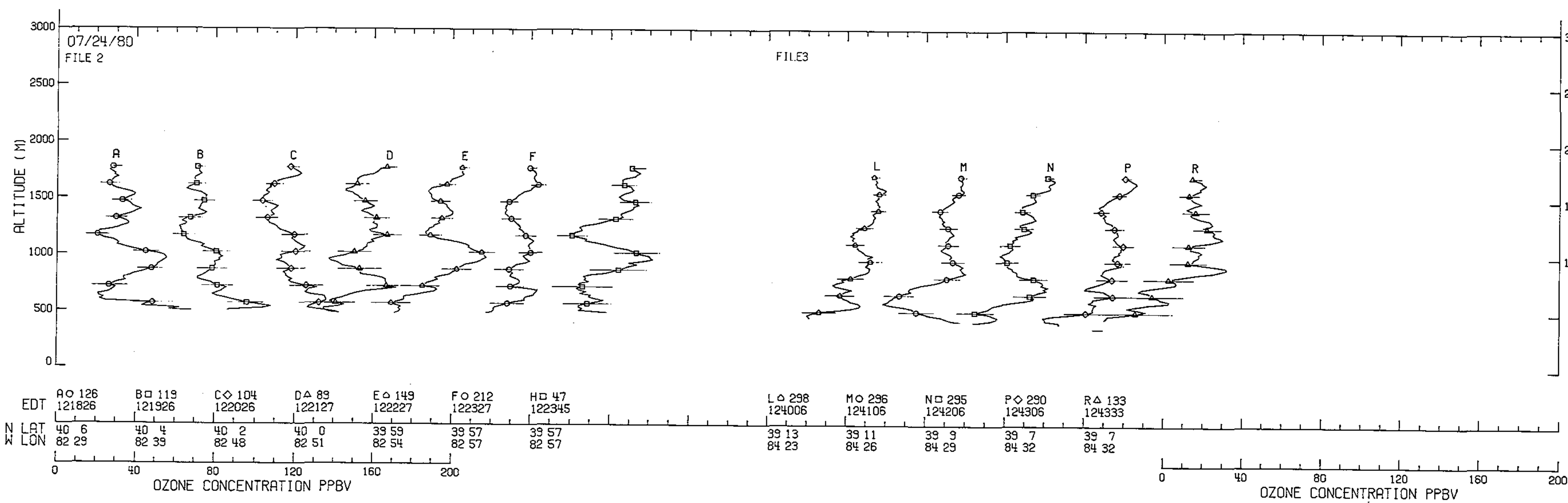
O_3 PROFILES FOR JULY 24, 1980, FLIGHT



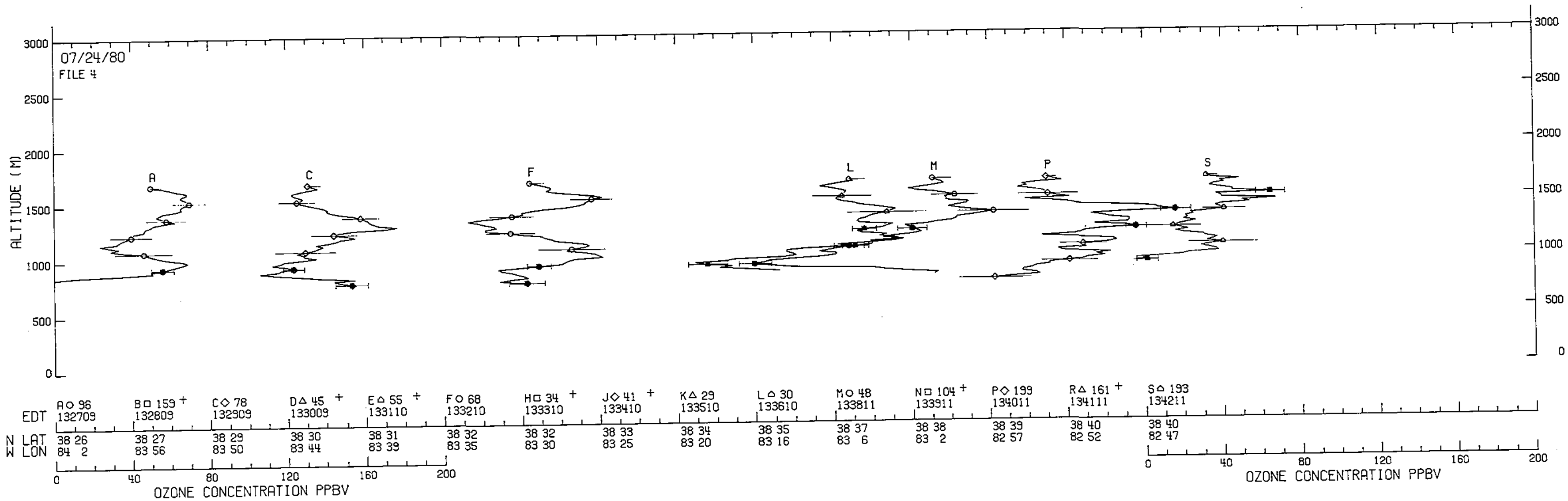


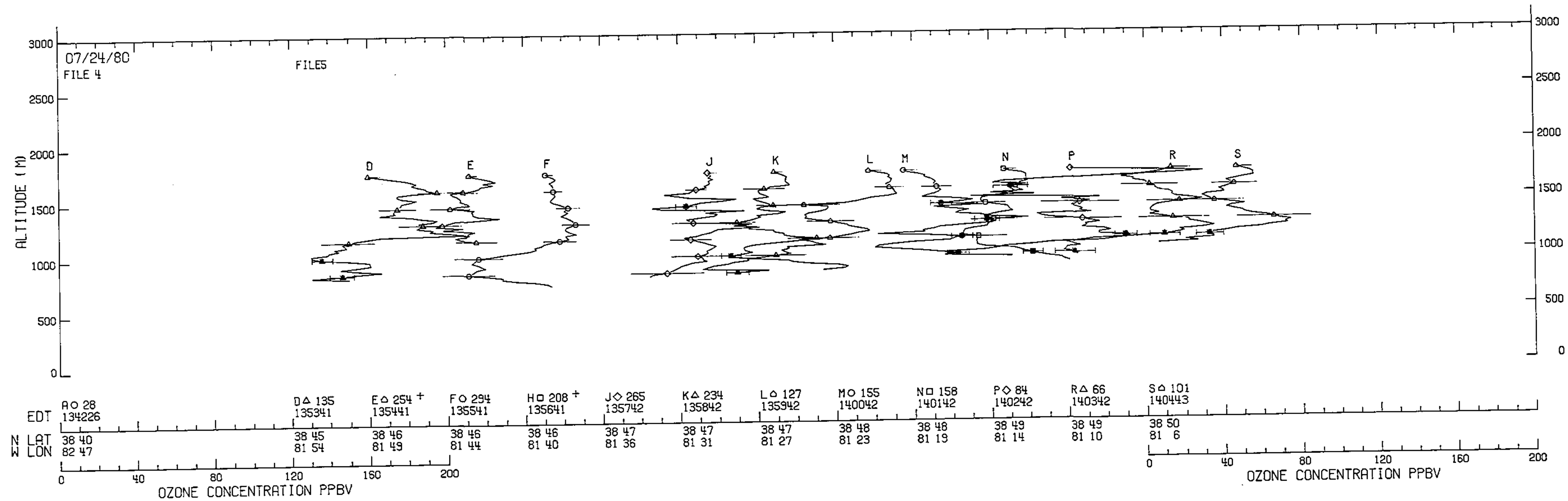
Continued


07/24/80
FILE 2
ALTITUDE (M)
0
500
1000
1500
2000
2500
3000
A B C D E F H J K L M N P R S
EDT
N LAT
W LON
A○ 145 120324 40 18 81 40
B□ 135 120424 40 17 81 45
C◇ 197 120524 40 17 81 51
D△ 192 120625 40 16 81 54
E○ 162 120725 40 15 81 57
F○ 150 120825 40 14 82 0
H□ 133 120925 40 14 82 4
J◇ 181 121025 40 13 82 7
K△ 134 121125 40 13 82 6
L○ 152 121225 40 12 82 5
M○ 131 121326 40 12 82 4
N□ 137 121426 40 11 82 3
P◇ 151 121526 40 11 82 2
R△ 108 121626 40 9 82 11
S○ 137 121726 40 7 82 20
0 40 80 120 160 200
OZONE CONCENTRATION PPBV
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

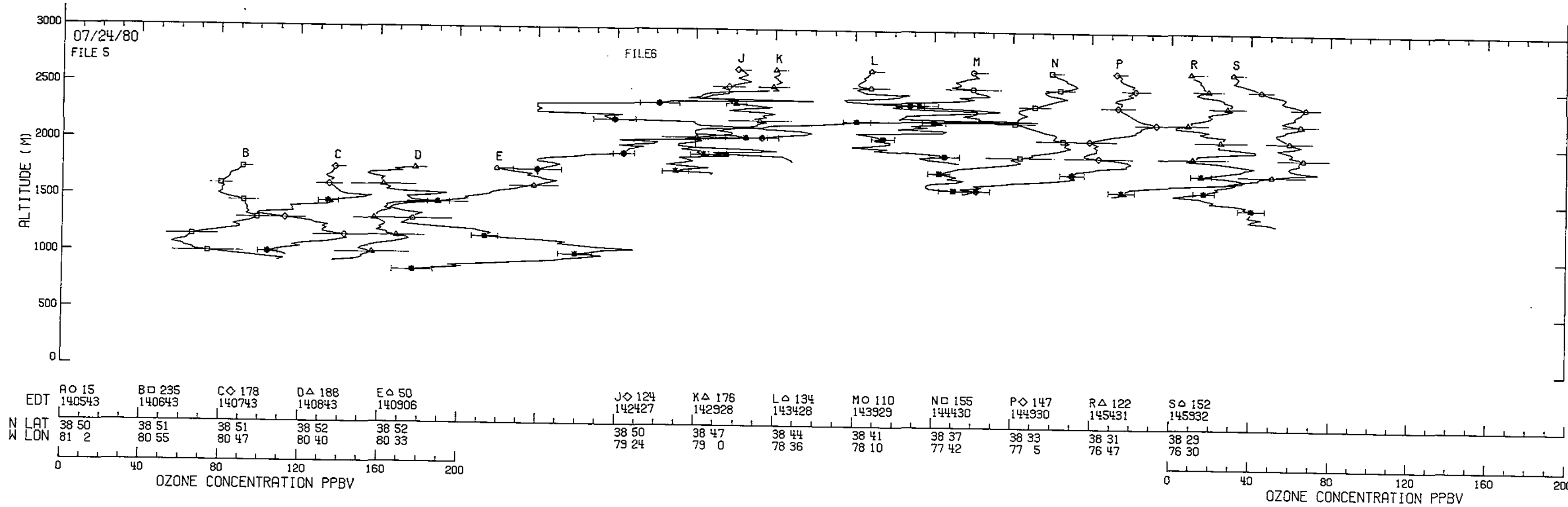

07/24/80
FILE 2
FILE3
ALTITUDE (M)
0
500
1000
1500
2000
2500
3000
A B C D E F L M N P R
EDT
N LAT
W LON
A○ 126 121826 40 6 82 29
B□ 119 121926 40 4 82 39
C◇ 104 122026 40 2 82 48
D△ 89 122127 40 0 82 51
E○ 149 122227 39 59 82 54
F○ 212 122327 39 57 82 57
H□ 47 122345 39 57 82 57
L○ 298 124006 39 13 84 23
M○ 296 124106 39 11 84 26
N□ 295 124206 39 9 84 29
P◇ 290 124306 39 7 84 32
R△ 133 124333 39 7 84 32
0 40 80 120 160 200
OZONE CONCENTRATION PPBV
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

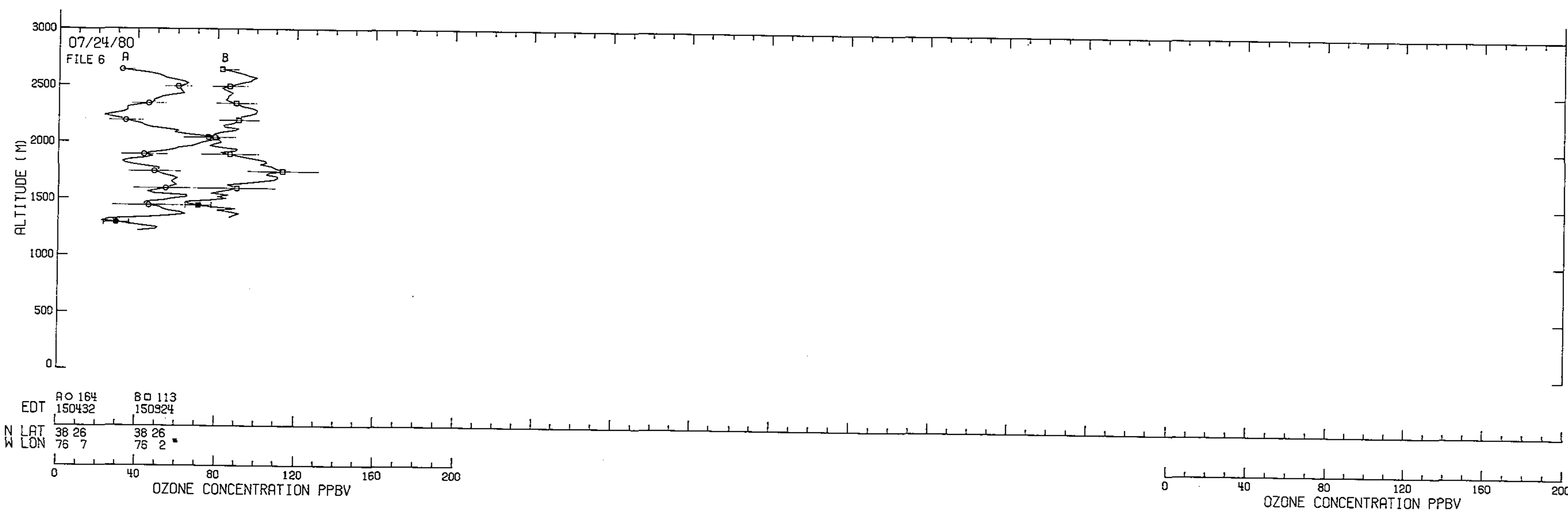
Continued


07/24/80
FILE 4
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
A
C
F
L
M
P
S
EDT
N LAT
W LON
A○ 96 132709 38 26 84 2
B□ 159 + 132809 38 27 83 56
C◇ 78 132909 38 29 83 50
D△ 45 + 133009 38 30 83 44
E△ 55 + 133110 38 31 83 39
F○ 68 133210 38 32 83 35
H□ 34 + 133310 38 32 83 30
J◇ 41 + 133410 38 33 83 25
K△ 29 133510 38 34 83 20
L△ 30 133610 38 35 83 16
M○ 48 133811 38 37 83 6
N□ 104 + 133911 38 38 83 2
P◇ 199 134011 38 39 82 57
R△ 161 + 134111 38 40 82 52
S△ 193 134211 38 40 82 47
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

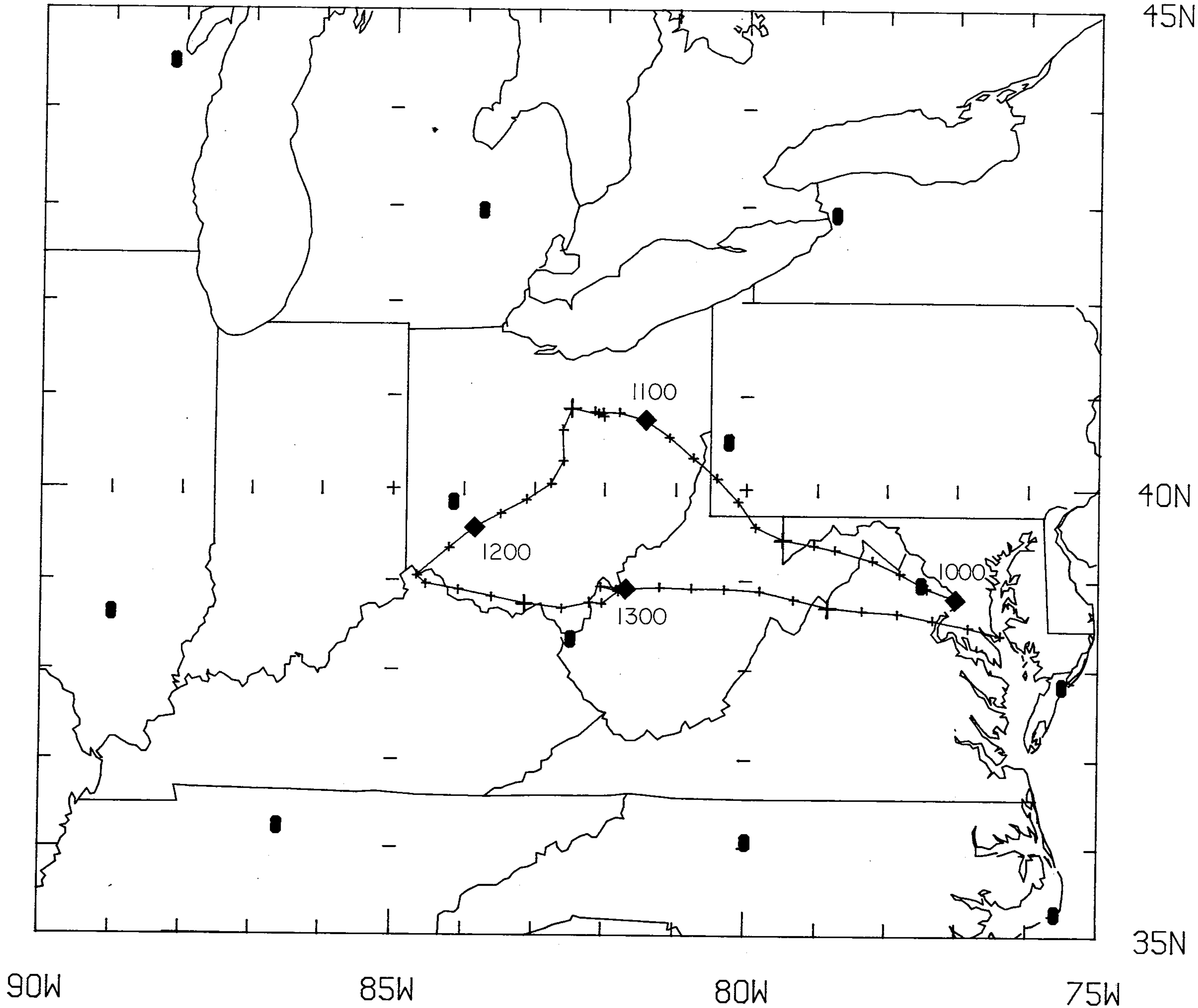

07/24/80
FILE 4
FILE5
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
D
E
F
J
K
L
M
N
P
R
S
EDT
N LAT
W LON
A○ 28 134226 38 40 82 47
D△ 135 135341 38 45 81 54
E△ 254 + 135441 38 46 81 49
F○ 294 135541 38 46 81 44
H□ 208 + 135641 38 46 81 40
J◇ 265 135742 38 47 81 36
K△ 234 135842 38 47 81 31
L△ 127 135942 38 47 81 27
M○ 155 140042 38 48 81 23
N□ 158 140142 38 48 81 19
P◇ 84 140242 38 49 81 14
R△ 66 140342 38 49 81 10
S△ 101 140443 38 50 81 6
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

Concluded


07/24/80
FILE 5
FILE6
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
B
C
D
E
J
K
L
M
N
P
R
S
EDT
N LAT
W LON
A○ 15
140543
38 50
81 2
B□ 235
140643
38 51
80 55
C◇ 178
140743
38 51
80 47
D△ 188
140843
38 52
80 40
E○ 50
140906
38 52
80 33
J◇ 124
142427
38 50
79 24
K△ 176
142928
38 47
79 0
L○ 134
143428
38 44
78 36
M○ 110
143929
38 41
78 10
N□ 155
144430
38 37
77 42
P◇ 147
144930
38 33
77 5
R△ 122
145431
38 31
76 47
S○ 152
145932
38 29
76 30
0
40
80
120
160
200
OZONE CONCENTRATION PPBV


07/24/80
FILE 6
A
B
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
EDT
N LAT
W LON
A○ 164
150432
38 26
76 7
B□ 113
150924
38 26
76 2
0
40
80
120
160
200
OZONE CONCENTRATION PPBV

ELECTRA FLIGHT PATH JULY 25, 1980



Instrument Parameters for July 25, 1980, Flight

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
1	1018	1027	5	6	2378	0.2/0.1	6	2200	0.5	Yes	3200
2	1042	1051	5	5	2386	.2/.1	5	2245	.5	Yes	3246
3	1112	1115	5	5	2386	.2/.1	5	2245	.5	Yes	3260
4	1128	1143	5	6	2376	.2/.1	6	2280	.5	Yes	3310
5	1150	1223	1	6	2376	.2/.1	6	2280	.5	Yes	3302 to 3561
6	1240	1250	5	6	2400	.2/.1	6	2310	.5	Yes	3679 to 3919 to 3635
7	1254	1309	5	6	2400	.2/.1	6	2310	.5	Yes	3695
8	1316	1354	1	6	2499	.2/.1	6	2310	.5	No	4159

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR JULY 25, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 7/25/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
1000	38.	00.	76.	00.	60.		300.		40.	900.		1200.		1100.		2300.	
1355	40.	58.	84.	53.	1000.		2400.		180.	2000.		2600.		2300.		3300.	

48

1000	38.0	48.8	77.0	01.2													
1005	38.0	55.4	77.0	25.9													
1010	39.0	05.1	77.0	49.0													
1015	39.0	13.6	78.0	12.6													
1020	39.0	20.7	78.0	44.6	305.		380.		80.	NA		NA		2000.	M+	2300.	
1025	39.0	23.7	79.0	02.8	457.	V	650.	S	100.	1250.	S	1550.	S	2300.	SM+	2300.	4
1030	39.0	26.9	79.0	28.7													
1035	39.0	35.2	79.0	52.6													
1040	39.0	51.8	80.0	07.2													
1045	40.0	07.3	80.0	25.1	305.		980.		80.	NA		NA		1230.		2500.	
1050	40.0	20.4	80.0	45.1	381.		690.		100.	NA		NA		1170.		2500.	
1055	40.0	33.4	81.0	05.8													
1100	40.0	45.2	81.0	26.0													
1105	40.0	49.4	81.0	48.4													
1110	40.0	50.2	82.0	09.1													
1115	40.0	49.5	82.0	02.5													
1120	40.0	46.9	82.0	01.3													
1125	40.0	48.6	82.0	05.8													
1130	40.0	52.6	82.0	28.6	329.		1280.		90.	1180.		1350.		NA		2410.	
1135	40.0	38.2	82.0	35.9	419.		1220.		80.	1150.		1350.		NA		2410.	
1140	40.0	18.0	82.0	35.6	366.		1460.		40.	1140.		1460.		NA		2410.	
1145	40.0	03.5	82.0	45.9													
1150	39.0	53.1	83.0	07.0													
1155	39.0	43.6	83.0	28.8	318.		1460.		80.	1160.		1460.		NA		2400.	
1200	39.0	34.4	83.0	51.5	308.		1350.		90.	1170.		1500.		NA		2400.	
1205	39.0	21.2	84.0	12.9	233.		1350.		140.	1050.		1470.		NA		2400.	
1210	39.0	03.0	84.0	40.0	272.		1800.		80.	1200.		1800.		1800.		2400.	
1215	38.0	57.5	84.0	32.1	270.		1200.		100.	930.		1200.		1800.		2400.	

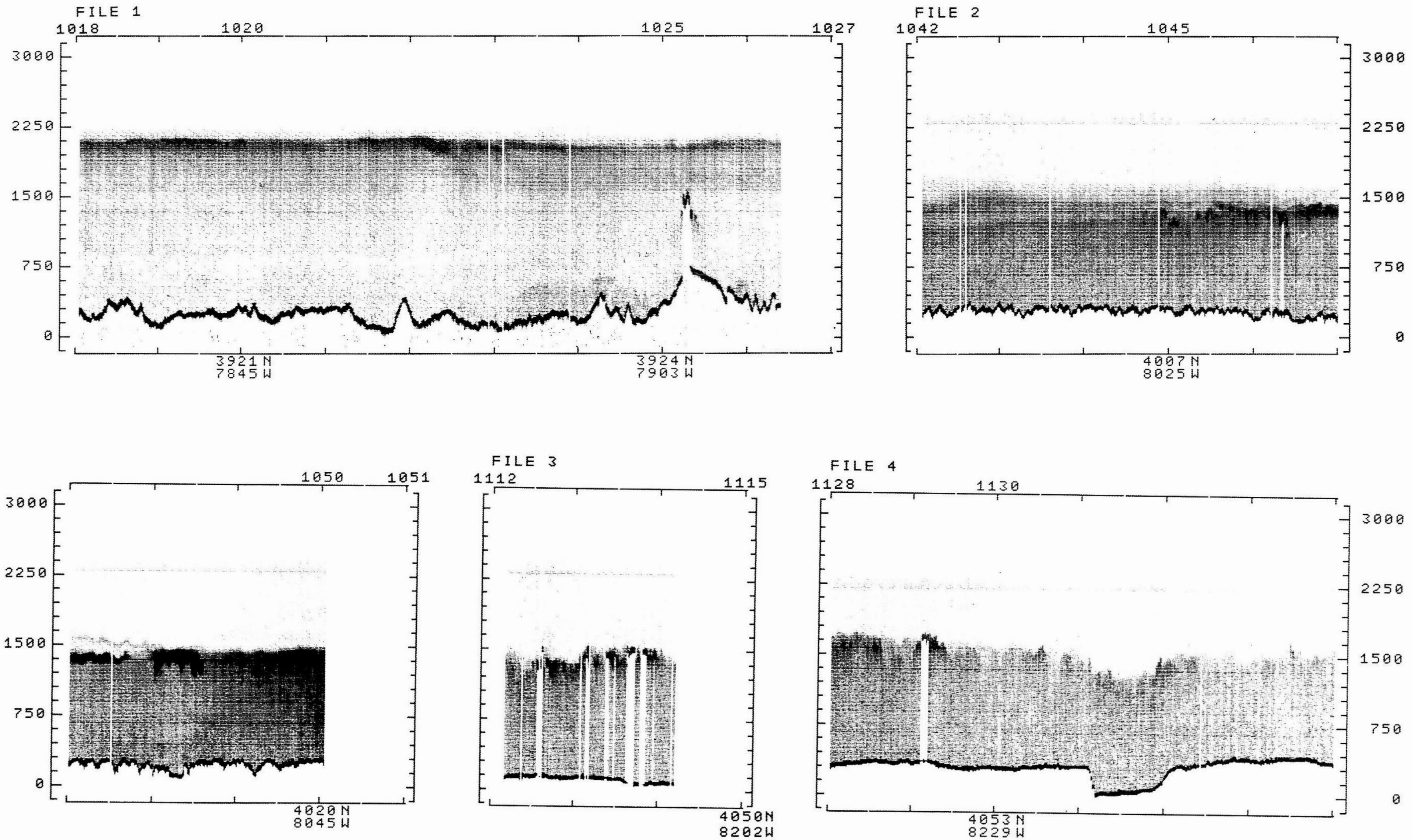
Concluded

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 7/25/80 18 0

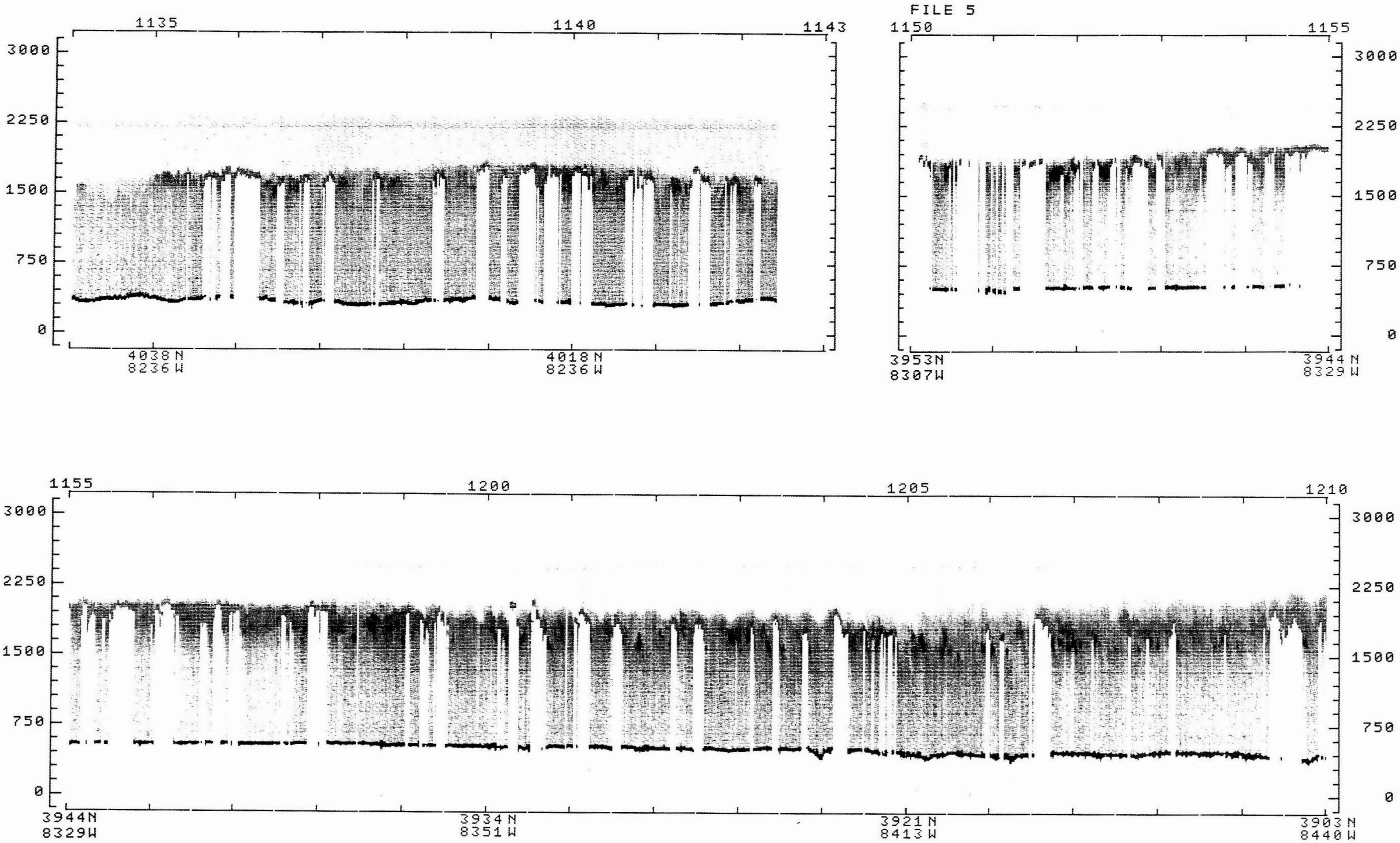
TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
1220	38.0	53.5	84.0	05.1	246.		1110.		120.	940.		1200.		1800.		2400.
1225	38.0	49.1	83.0	36.9												
1230	38.0	44.4	83.0	08.5												
1235	38.0	41.6	82.0	36.8												
1240	38.0	45.5	82.0	13.2												
1245	38.0	45.1	82.0	02.6	229.		1200.		150.	NA		NA		1740.		2740.
1250	38.0	53.1	81.0	48.6	229.		990.		140.	NA		NA		1500.		2740.
1255	38.0	56.1	82.0	03.3	229.		1350.		60.	NA		NA		1500.		2800.
1300	38.0	54.5	81.0	43.0	305.		1140.		100.	1160.		1350.		1650.		2800.
1305	38.0	55.6	81.0	13.0	305.		980.		120.	900.		1280.		1580.		2800.
1310	38.0	55.0	80.0	45.5	305.	V	1070.	S	100.	NA		NA		2000.	S	2800.
1315	38.0	54.4	80.0	18.3												
1320	38.0	53.3	79.0	48.8	585.	V	2100.	S	50.	1910.	S	2330.	S	NA		3260.
1325	38.0	47.7	79.0	20.0	610.	V	2220.	S	140.	1610.	S	2360.	S	NA		3260.
1330	38.0	42.1	78.0	50.8	457.	V	2360.	S	120.	1460.	S	2360.	S	NA		3260.
1335	38.0	40.3	78.0	21.1	914.	V	2360.	S	180.	1760.	S	2570.	S	NA		3260.
1340	38.0	38.5	77.0	51.0	82.		2200.		120.	1300.		2360.		NA		3260.
1345	38.0	34.1	77.0	21.1	76.		2250.		150.	1200.		2400.		NA		3260.
1350	38.0	29.3	76.0	50.2	62.		2250.		70.	1460.		2250.		NA		2760.
1355	38.0	24.3	76.0	23.3												

(4) OROGRAPHIC CLOUD

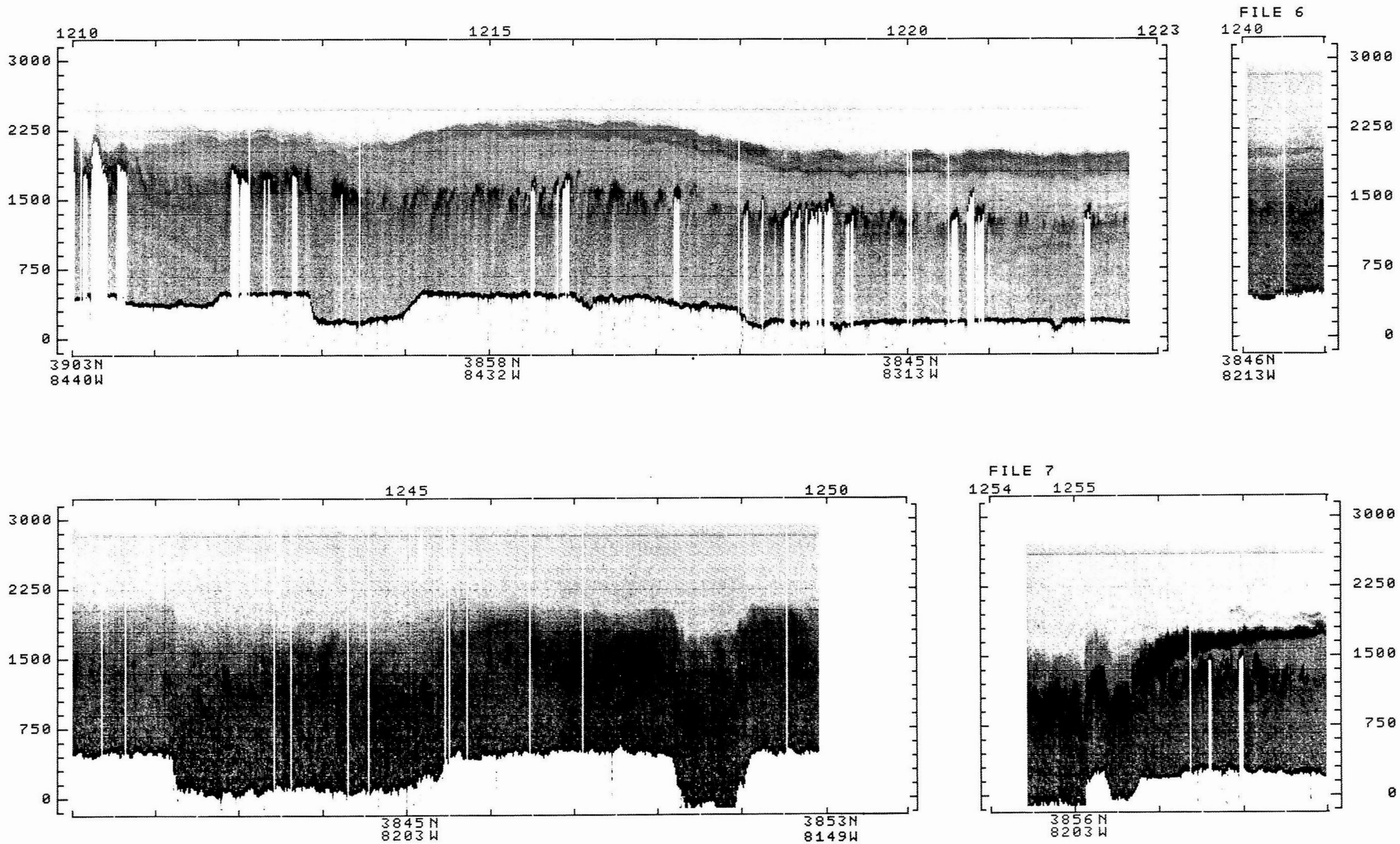
JULY 25, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



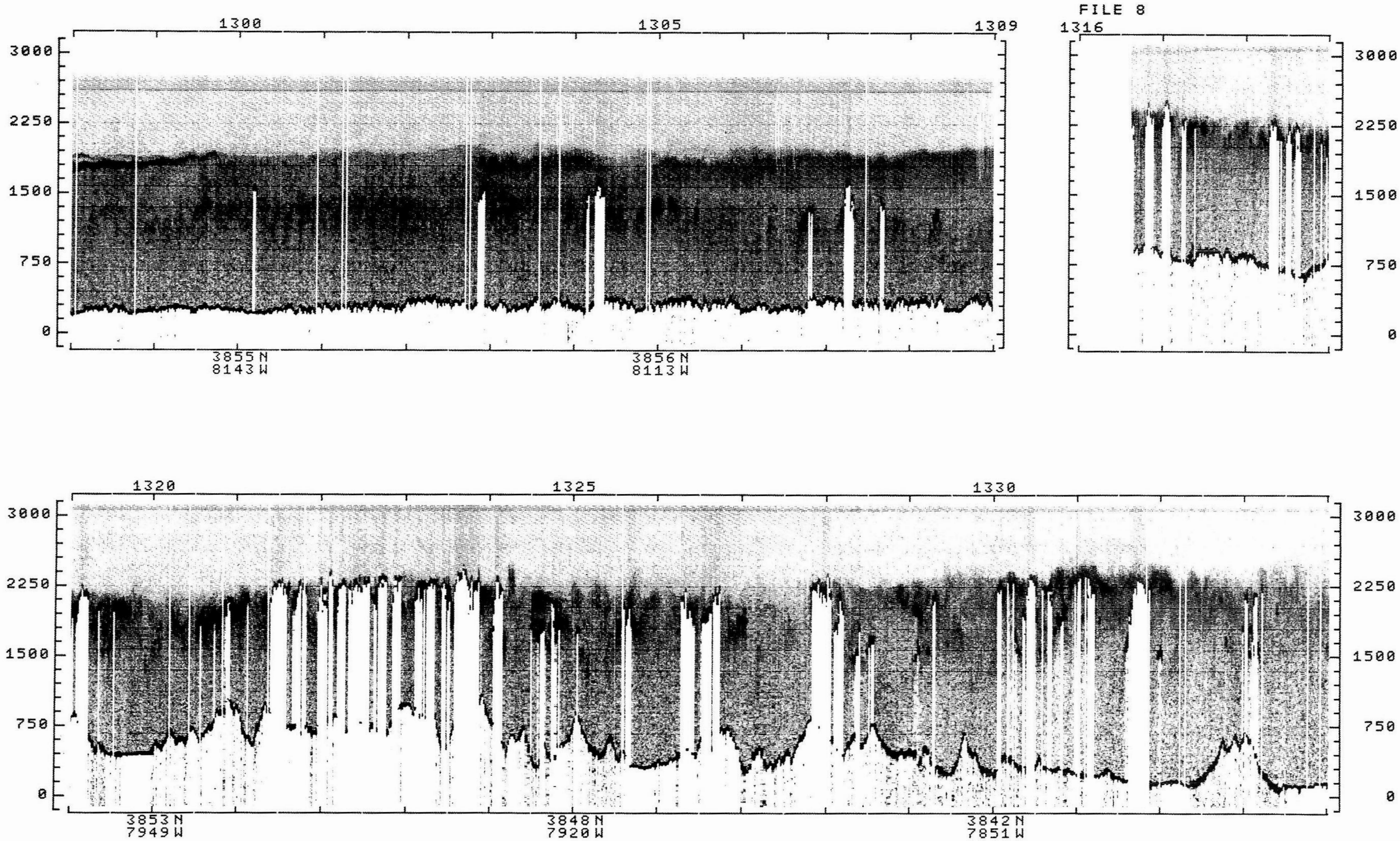
JULY 25, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



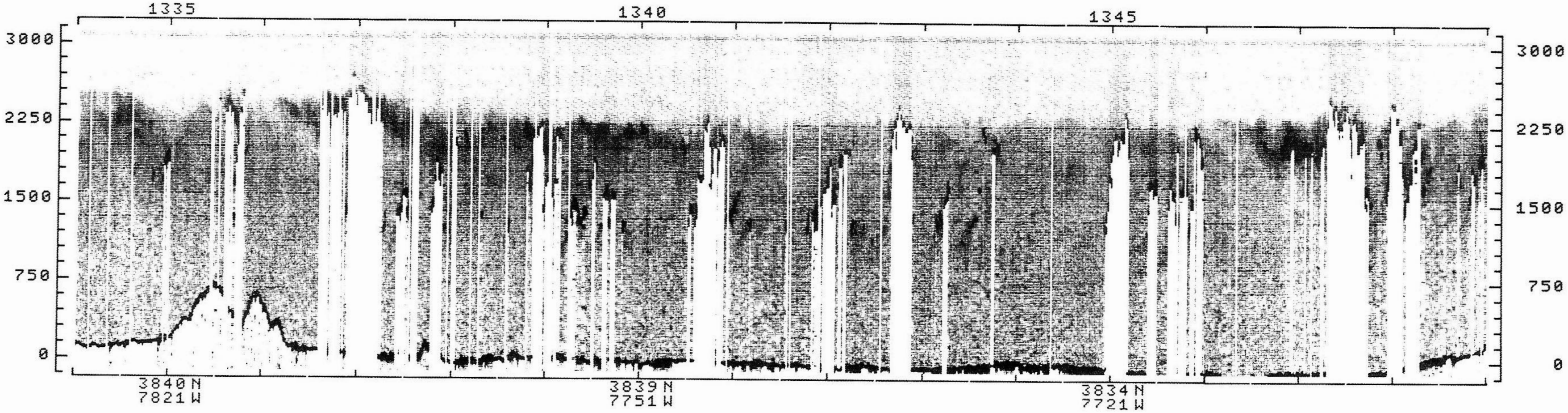
JULY 25, 1980   PEPE/NEROS   UV DIAL AEROSOL CHANNEL

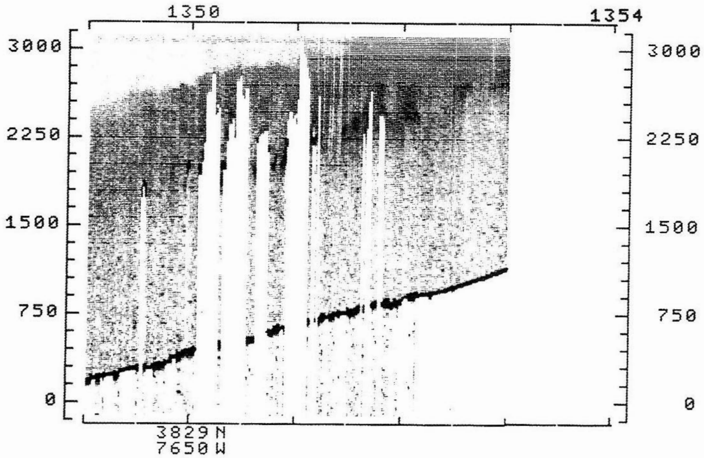


JULY 25, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

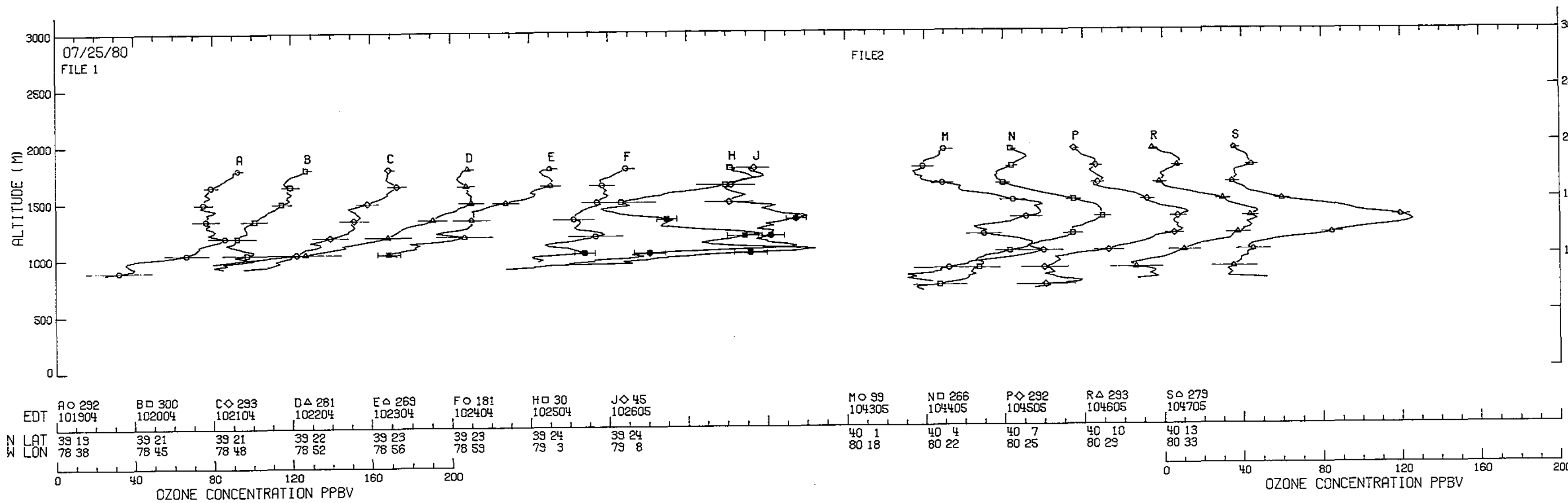


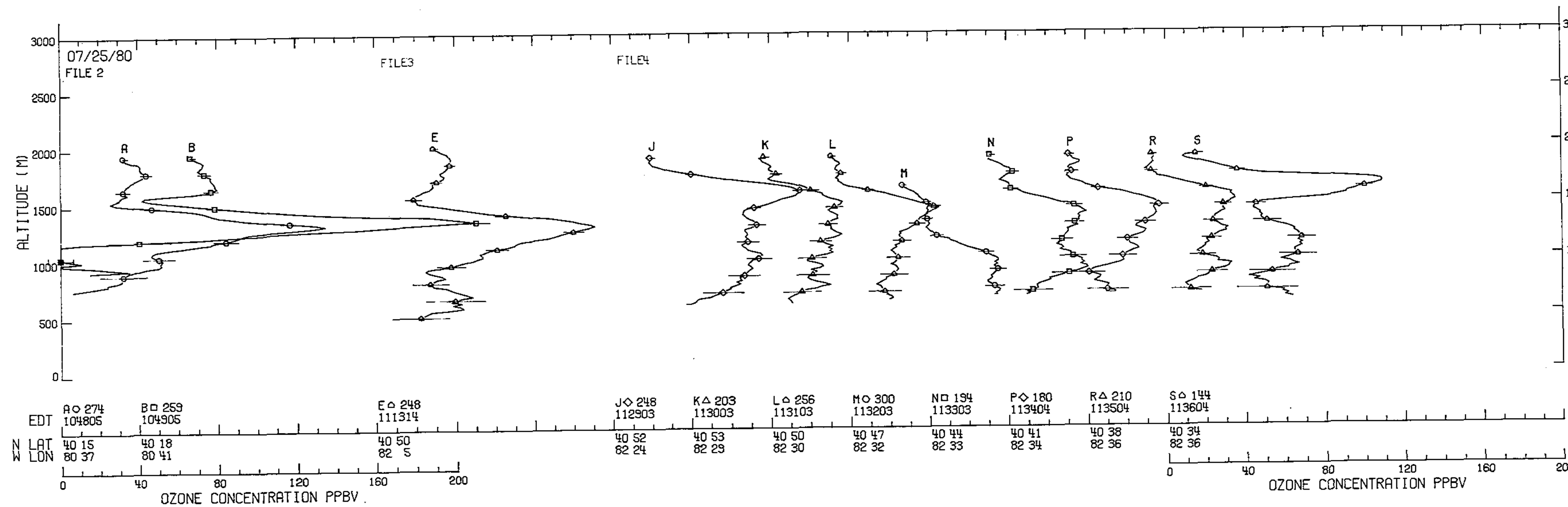
JULY 25, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



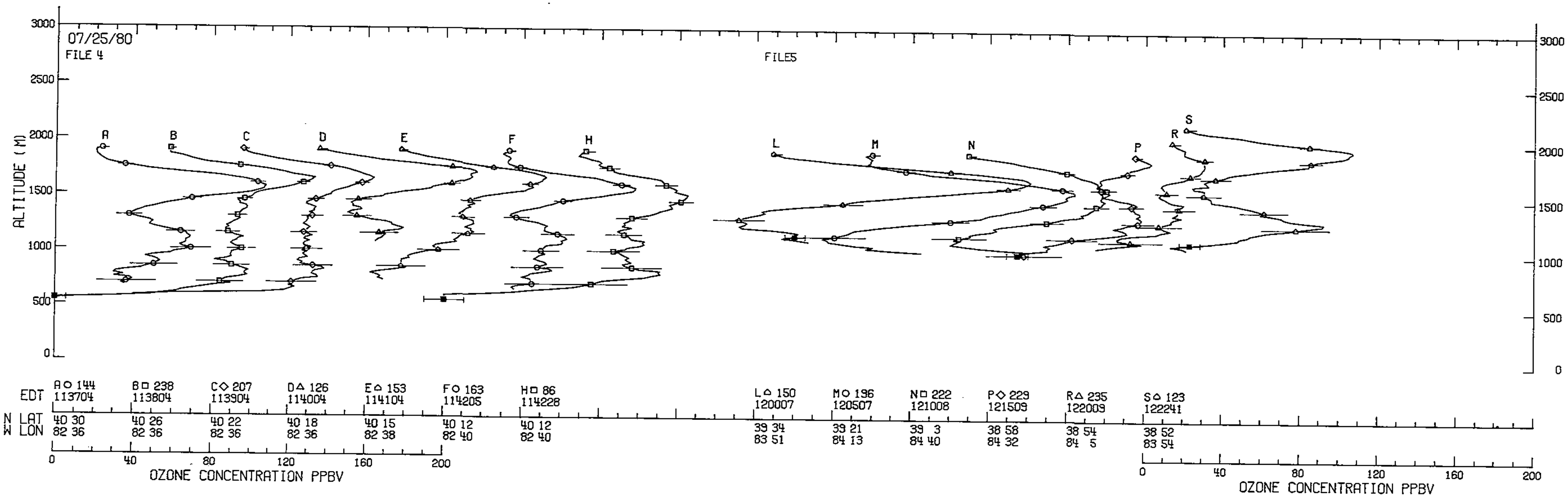


O_3 PROFILES FOR JULY 25, 1980, FLIGHT

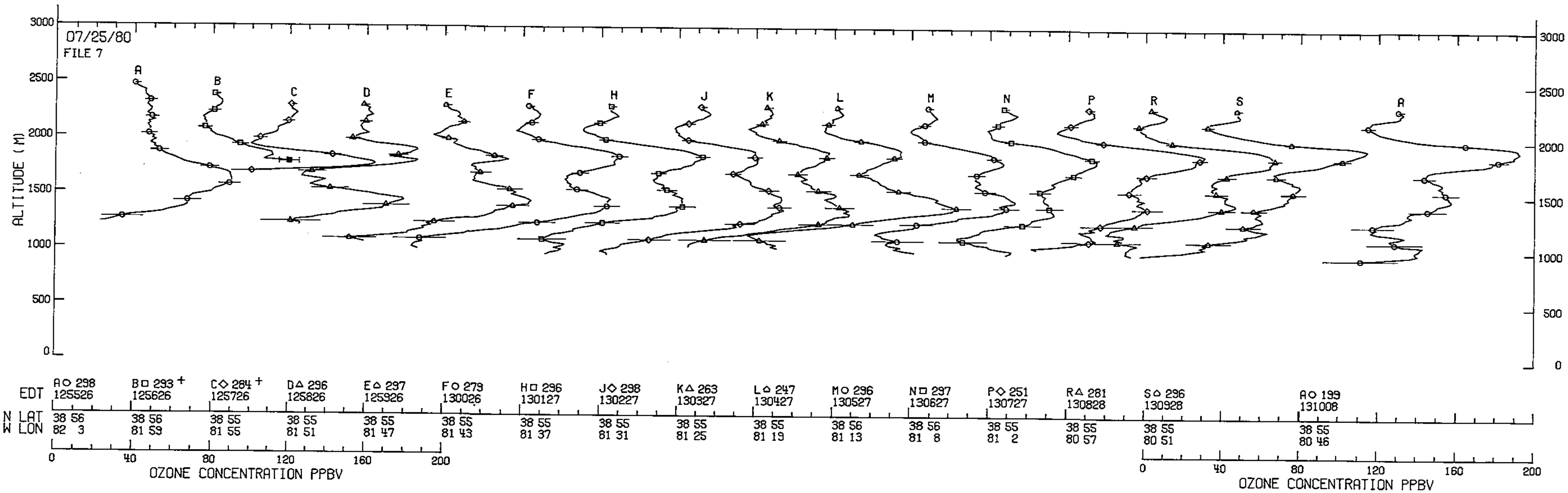




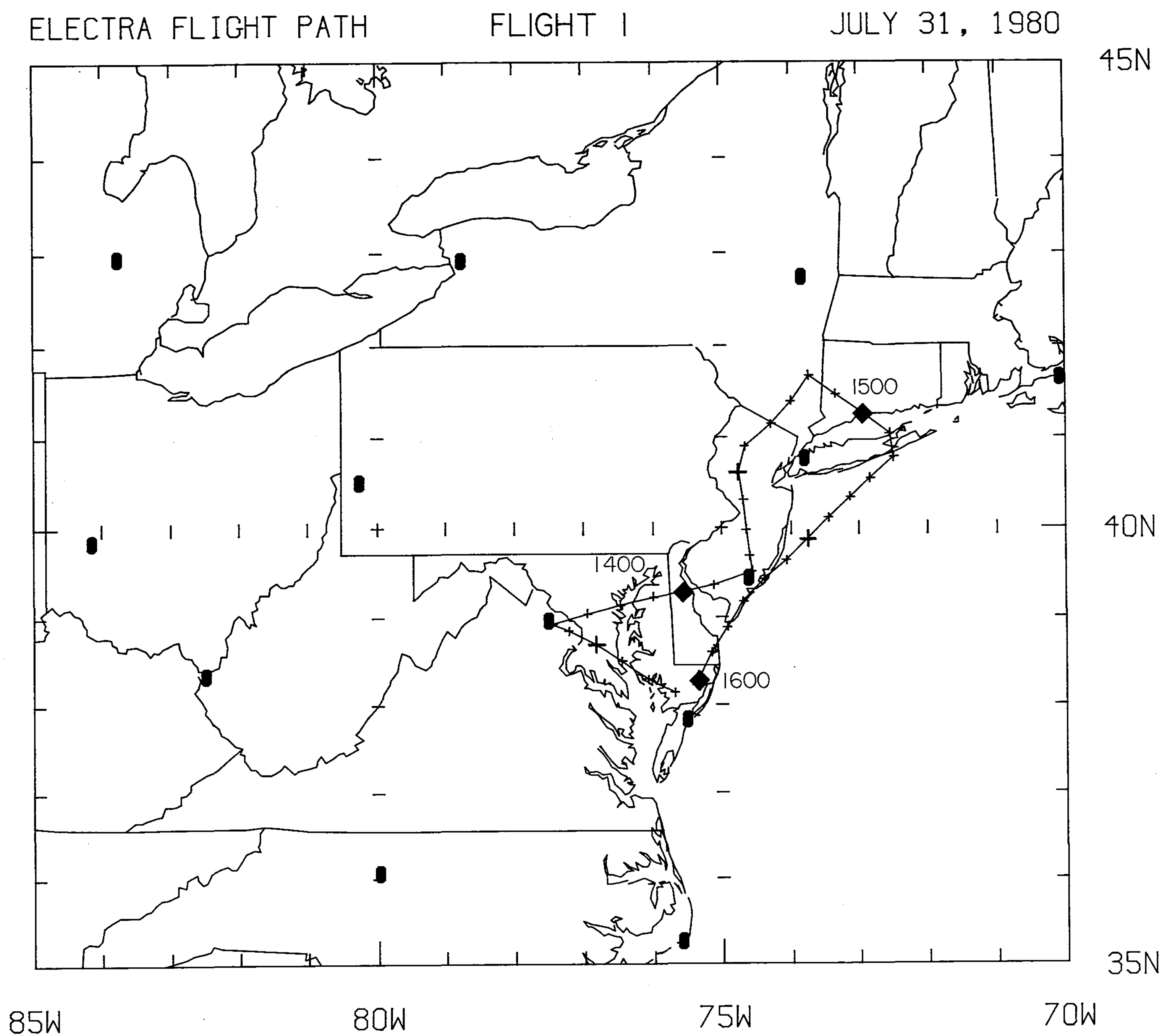
Concluded



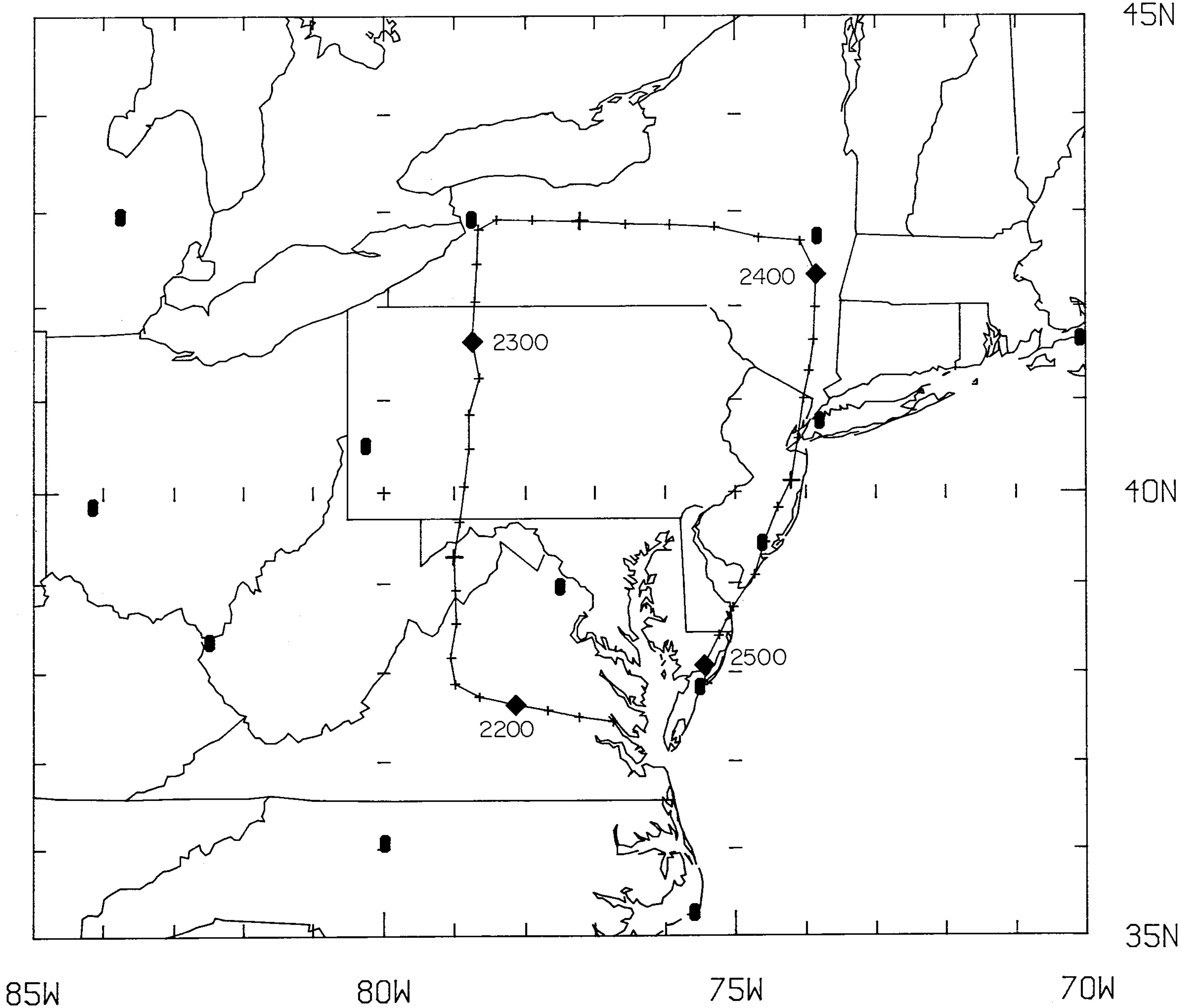
07/25/80
FILE 4
FILE5
ALTITUDE (M)
EDT
N LAT
W LON
A○ 144 113704 40 30 82 36
B□ 238 113804 40 26 82 36
C◇ 207 113904 40 22 82 36
D△ 126 114004 40 18 82 36
E○ 153 114104 40 15 82 38
F○ 163 114205 40 12 82 40
H□ 86 114228 40 12 82 40
L○ 150 120007 39 34 83 51
M○ 196 120507 39 21 84 13
N□ 222 121008 39 3 84 40
P◇ 229 121509 38 58 84 32
R△ 235 122009 38 54 84 5
S○ 123 122241 38 52 83 54
OZONE CONCENTRATION PPBV
OZONE CONCENTRATION PPBV



07/25/80
FILE 7
ALTITUDE (M)
EDT
N LAT
W LON
A○ 298 125526 38 56 82 3
B□ 293 + 125626 38 56 81 59
C◇ 284 + 125726 38 55 81 55
D△ 296 125826 38 55 81 51
E○ 297 125926 38 55 81 47
F○ 279 130026 38 55 81 43
H□ 296 130127 38 55 81 37
J◇ 298 130227 38 55 81 31
K△ 263 130327 38 55 81 25
L○ 247 130427 38 55 81 19
M○ 296 130527 38 56 81 13
N□ 297 130627 38 56 81 8
P◇ 251 130727 38 55 81 2
R△ 281 130828 38 55 80 57
S○ 296 130928 38 55 80 51
A○ 199 131008 38 55 80 46
OZONE CONCENTRATION PPBV
OZONE CONCENTRATION PPBV


ELECTRA FLIGHT PATH
FLIGHT 1
JULY 31, 1980
45N
40N
35N
85W
80W
75W
70W
1400
1500
1600

ELECTRA FLIGHT PATH FLIGHT 2 JULY 31, 1980



Instrument Parameters for July 31, 1980, Flights

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
Flight no. 1											
1	1308	1348	1	6	2534	0.2/0.1	6	2256	0.5	Yes	3969
2	1351	1411	5	6	2400	.1/.2	6	2273	.5	Yes	4235
3	1419	1448	1	6	2572	.1/.2	6	2273	.5	Yes	4212
4	1448	1540	1	6	2572	.1/.2	6	2273	.5	Yes	3600
5	1544	1607	1	6	2572	.1/.2	6	2273	.5	Yes	3600
Flight no. 2											
6	2152	2156	5	6	2572	0.2/0.1	6	2273	0.5	Yes	4570
7	2158	2210	5	7	2572	.2/.1	7	2273	.5	Yes	4576
8	2215	2219	1	7	2572	.2/.1	7	2273	.5	Yes	4360
9	2219	2231	1	7	2572	.2/.1	7	2273	.5	No	4275
10	2233	2235	1	7	2572	.2/.1	4	2273	.5	No	4275
11	2235	2333	1	7	2700	.2/.1	6	2200	.5	No	4275
12	2339	2424	1	7	2700	.2/.1	6	2200	.5	No	4275
13	2439	2502	1	7	2840	.2/.1	6	2310	.5	No	2363

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR JULY 31, 1980, FLIGHTS

FLIGHT NO. 1

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 7/31/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
1315	38.	00.	72.	00.	0.		100.		30.	700.		1000.		900.		2700.
1600	41.	59.	77.	60.	350.		2500.		260.	2200.		2500.		2200.		3400.

34

1315	38.0	08.7	75.0	41.5	6.		900.		100.	880.		1200.		2200.		3070.
1320	38.0	17.8	76.0	05.0	24.		880.		150.	750.		1000.		2100.		3070.
1325	38.0	30.0	76.0	26.9	46.		1240.		150.	NA		NA		NA		3070.
1330	38.0	41.6	76.0	49.3	60.		1740.		120.	1300.		1800.		NA		3070.
1335	38.0	50.7	77.0	13.3	153.		1460.		100.	1050.		1450.		NA		3070.
1340	38.0	55.6	77.0	27.5	76.		1260.		150.	810.		1710.		NA		3070.
1345	39.0	02.5	76.0	57.0	44.		1650.		220.	1220.		1950.		NA		3070.
1350	39.0	08.5	76.0	27.9												
1355	39.0	13.6	75.0	59.5	18.		1520.		120.	NA		NA		NA		3340.
1400	39.0	17.7	75.0	32.8	21.		1530.		100.	1500.		1650.		NA		3340.
1405	39.0	21.8	75.0	06.5	24.		1530.		150.	1500.		1680.		NA		3340.
1410	39.0	31.1	74.0	34.0	23.		1800.		100.	1650.		1830.		NA		3340.
1415	39.0	41.3	74.0	36.0												
1420	39.0	59.0	74.0	38.7	12.		1950.		150.	1520.		2120.		NA		3310.
1425	40.0	18.8	74.0	41.2	31.		1830.		150.	1920.		1950.		NA		3310.
1430	40.0	37.6	74.0	45.9	46.		1660.		150.	NA		NA		NA		3310.
1435	40.0	54.3	74.0	39.9	342.	V	1890.	S	140.	1870.	S	2080.	S	NA		3310.
1440	41.0	09.0	74.0	16.9	305.	V	1810.	S	100.	1660.	S	2040.	S	NA		3310.
1445	41.0	24.1	73.0	59.9	305.	V	2440.	S	150.	2140.	S	2490.	S	NA		3000.
1450	41.0	40.7	73.0	43.5	169.		1980.		140.	1580.		2100.		NA		2700.
1455	41.0	28.3	73.0	20.2	222.	V	1830.	S	150.	1650.	S	2020.	S	NA		2700.
1500	41.0	15.5	72.0	56.5	1.		1800.		100.	NA		NA		NA		2700.
1505	41.0	02.9	72.0	32.9	16.		1680.		90.	1460.		1700.		NA		2700.
1510	40.0	46.9	72.0	29.6	0.		150.		30.	NA		NA		1800.		2700.
1515	40.0	33.0	72.0	50.0	0.		150.		50.	NA		NA		1880.	M	2700.
1520	40.0	20.4	73.0	07.4	0.		150.		30.	NA		NA		900.	M	2700.
1525	40.0	06.6	73.0	26.5	0.		300.		30.	NA		NA		1500.		2700.
1530	39.0	52.5	73.0	45.0	0.		150.		30.	NA		NA		1800.		2700.

Continued

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 7/31/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
1535	39.0	38.3	74.0	03.8	0.		150.		30.	NA		NA		1800.		2700.
1540	39.0	25.3	74.0	23.4												
1545	39.0	10.3	74.0	41.2	2.		100.		30.	NA		NA		1500.		2700.
1550	38.0	53.4	74.0	55.3	0.		100.		30.	NA		NA		1400.		2700.
1555	38.0	36.0	75.0	09.1	3.		1700.		150.	NA		NA		NA		2700.
1600	38.0	17.2	75.0	20.8	11.		1520.		260.	NA		NA		NA		2700.

Continued

FLIGHT NO. 2

PROJECT PEPE/PEPE-NEROS STUDY UVDA02 7/31/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
2145	37.	00.	73.	00.	0.		100.		30.	1200.		1900.		800.		1400.	
2500	42.	60.	79.	60.	700.		2400.		250.	2000.		3400.		3400.		3700.	
		40															
2145	37.0	26.9	76.0	45.0													
2150	37.0	29.9	77.0	14.0													
2155	37.0	34.8	77.0	40.9	70.		300.		30.	NA		NA		2700.	M	3670.	
2200	37.0	38.5	78.0	08.6	76.		200.		30.	NA		NA		2610.	M	3520.	
2205	37.0	43.9	78.0	39.2	139.		200.		30.	NA		NA		2160.	M	3520.	
2210	37.0	52.4	78.0	59.7													
2215	38.0	10.6	79.0	03.0	490.	V	790.	S	100.	NA		NA		3000.	SM	3310.	
2220	38.0	33.6	78.0	58.4	762.	V	1280.	S	100.	NA		NA		NA		3220.	
2225	38.0	55.1	78.0	59.2	600.	V	1280.	S	80.	NA		NA		1580.	S	3220.	
2230	39.0	17.5	78.0	59.9	305.	V	1080.	S	120.	NA		NA		1530.	S	3220.	
2235	39.0	40.7	78.0	55.6													
2240	40.0	04.1	78.0	51.9	610.	V	1340.	S	90.	NA		NA		2540.	SM	3380.	
2245	40.0	28.2	78.0	47.3	610.	V	1410.	S	80.	NA		NA		2520.	SM	3380.	
2250	40.0	51.0	78.0	47.5	607.	V	1650.	S	ND	NA		NA		2460.	S	3380.	
2255	41.0	14.5	78.0	39.2	610.	V	ND		ND	NA		NA		2430.	SM	3380.	
2300	41.0	38.6	78.0	44.4	610.	V	2320.	S	80.	1940.	S	2380.	S	NA		3380.	
2305	42.0	03.5	78.0	42.5	457.	V	2320.	S	140.	1280.	S	2480.	S	NA		3380.	
2310	42.0	27.0	78.0	41.0	457.	V	2020.	S	90.	1580.	S	2020.	S	NA		3380.	
2315	42.0	49.0	78.0	39.5	206.	V	2020.	S	30.	1880.	S	2020.	S	2320.	S	3380.	
2320	42.0	54.8	78.0	24.0	408.	V	1880.	S	140.	1720.	S	2070.	S	2540.	S	3380.	
2325	42.0	54.5	77.0	53.5	305.		1820.		120.	1320.		1980.		2670.	M	3380.	
2330	42.0	54.0	77.0	12.5	221.		1470.		220.	NA		NA		3150.	M+	3380.	
2335	42.0	52.0	76.0	34.0													
2340	42.0	51.5	75.0	56.0	631.	V	1100.	S	200.	NA		3380.	S+	3380.	SM+	3380.	
2345	42.0	50.4	75.0	17.5	607.	V	1420.	S	200.	NA		3380.	S+	3380.	SM+	3380.	5
2350	42.0	43.3	74.0	39.6	677.	V	1280.	S	200.	NA		NA		3380.	SM+	3380.	5
2355	42.0	41.2	74.0	04.0	463.	V	1720.	S	90.	NA		NA		3380.	SM+	3380.	5
2400	42.0	20.5	73.0	50.5	44.	V	1640.	S	90.	NA		NA		3380.	SM+	3380.	5

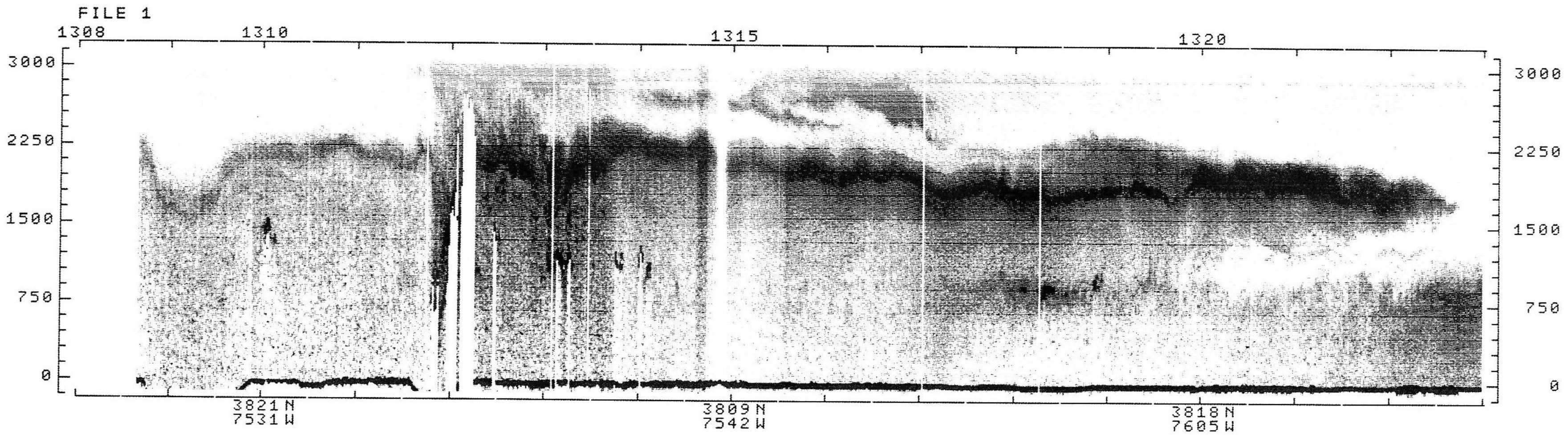
Concluded

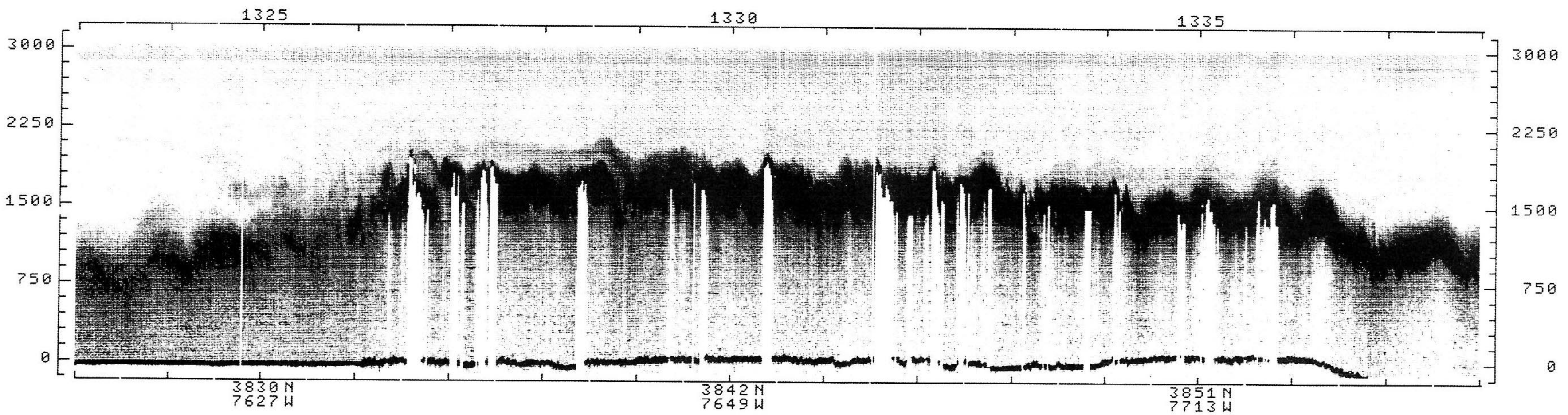
PROJECT PEPE/PEPE-NEROS STUDY UVDA02 7/31/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
2405	41.0	59.5	73.0	51.5	98.		1350.		80.	NA		NA		3280.	M+	3380.	5
2410	41.0	38.5	73.0	53.0	50.	V	820.	S	120.	NA		3380.	S+	3380.	SM+	3380.	5
2415	41.0	19.0	73.0	57.0	165.	V	520.	S	40.	NA		3380.	S+	3380.	SM+	3380.	
2420	41.0	01.0	74.0	01.0													
2425	40.0	35.0	74.0	06.0													
2430	40.0	08.0	74.0	12.0													
2435	39.0	50.0	74.0	23.5													
2440	39.0	27.0	74.0	34.5	15.		140.		ND	NA		NA		860.		1460.	
2445	39.0	05.6	74.0	43.3	8.		120.		ND	NA		NA		1050.	M	1460.	
2450	38.0	43.8	75.0	01.8	0.		420.		ND	NA		NA		1200.	M	1460.	
2455	38.0	25.0	75.0	14.0	9.		520.		ND	NA		NA		1450.	M+	1460.	
2500	38.0	05.0	75.0	26.5	9.		ND		ND	NA		NA		1450.	M+	1460.	

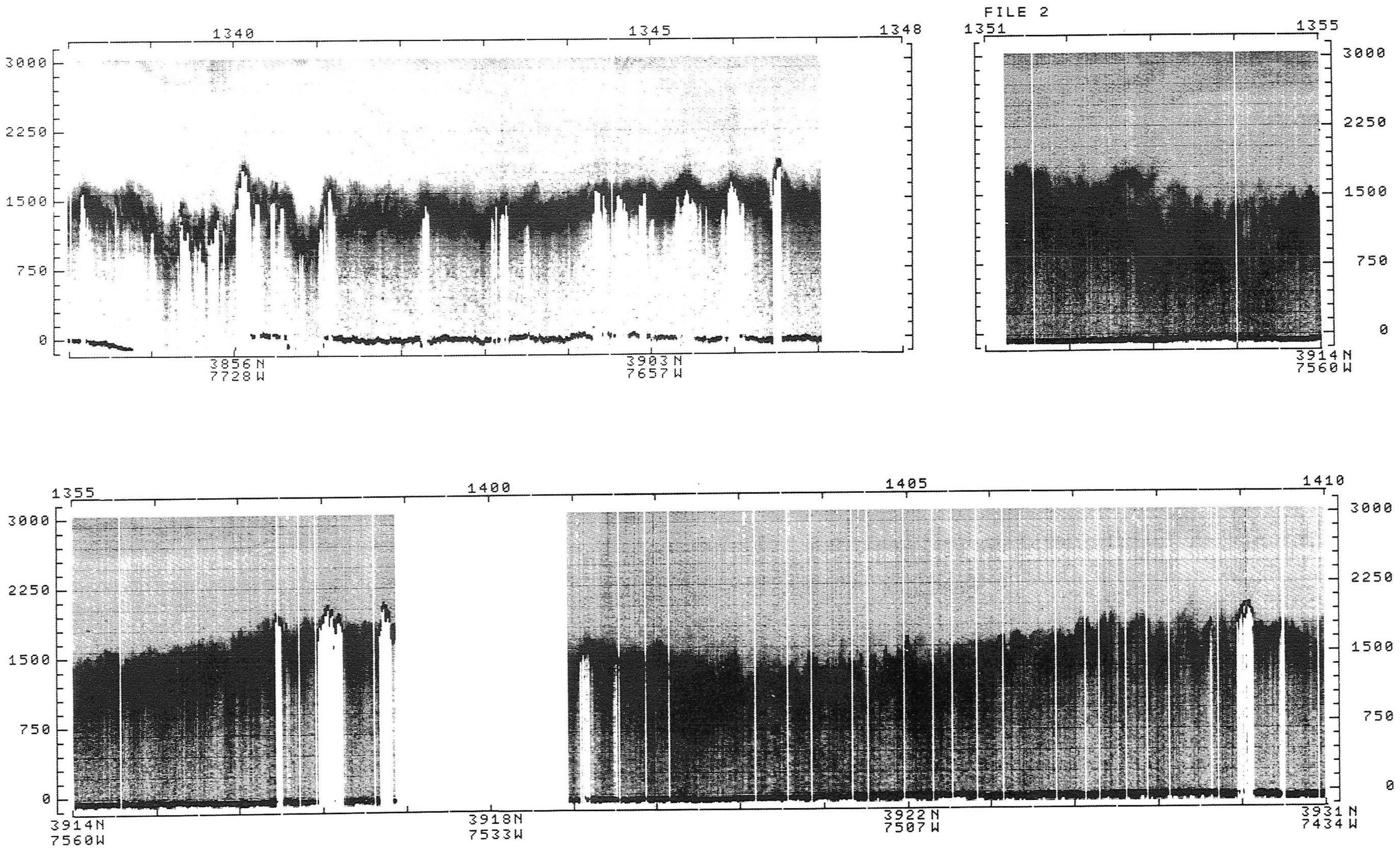
(5) REMNANTS OF PLANETARY BOUNDARY LAYER FROM PREVIOUS AFTERNOON HOURS; ACTUAL ACTIVE PBL LESS THAN 300 MAGL. HOWEVER, MECHANICAL MIXING IN PBL REMNANT PROBABLY STILL IN PROGRESS

JULY 31, 1980   PEPE/NEROS   UV DIAL AEROSOL CHANNEL

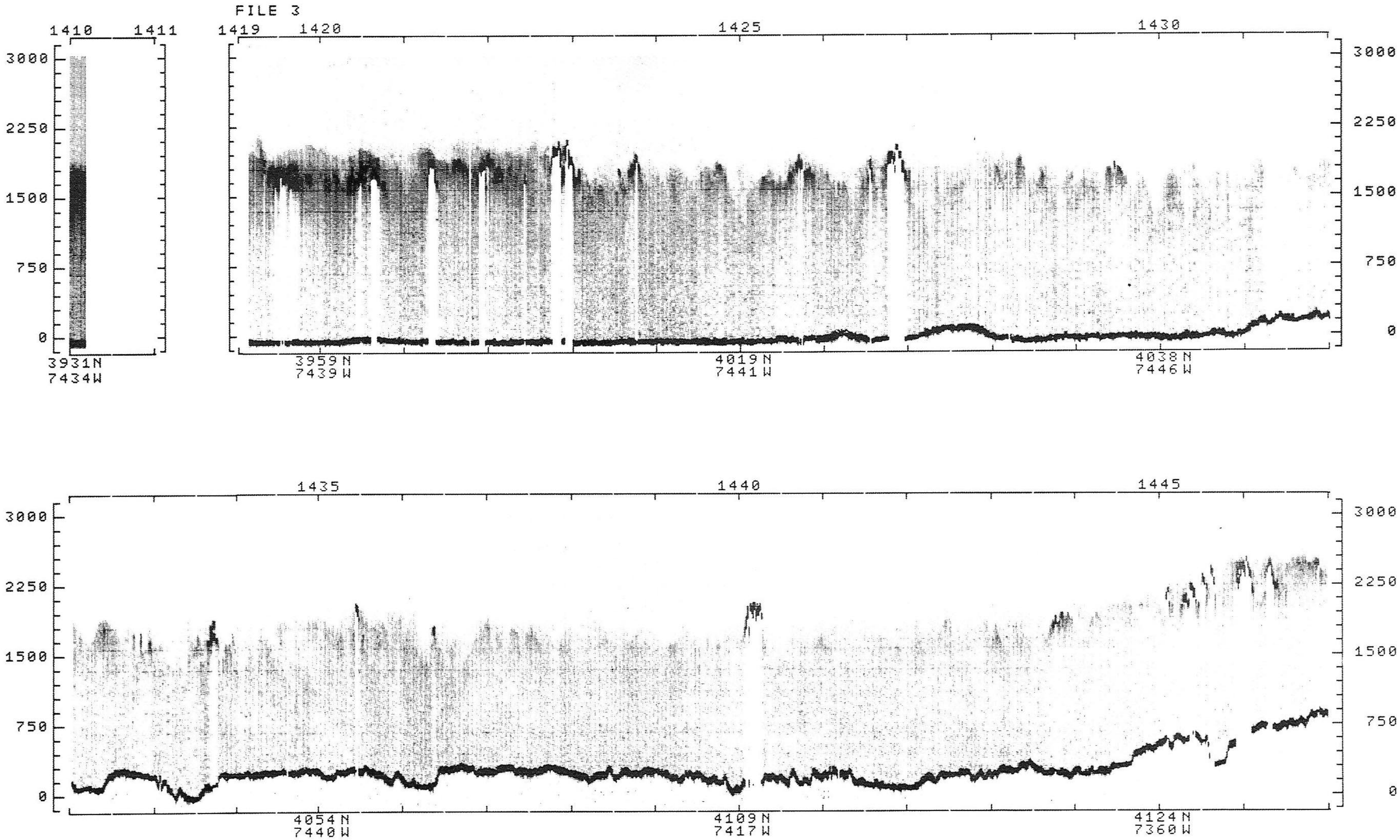




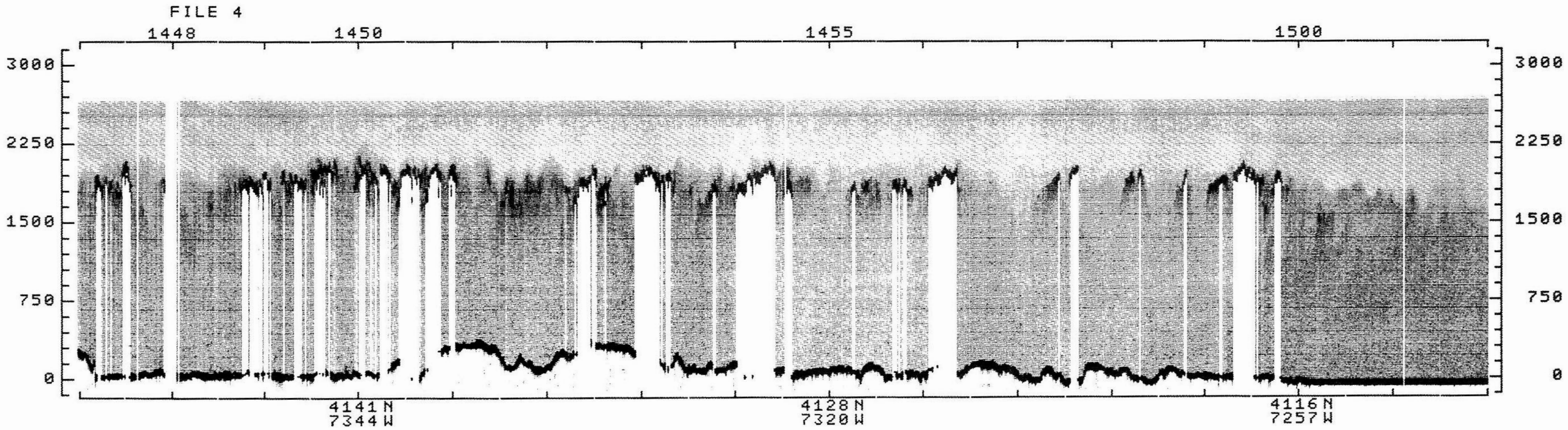
JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

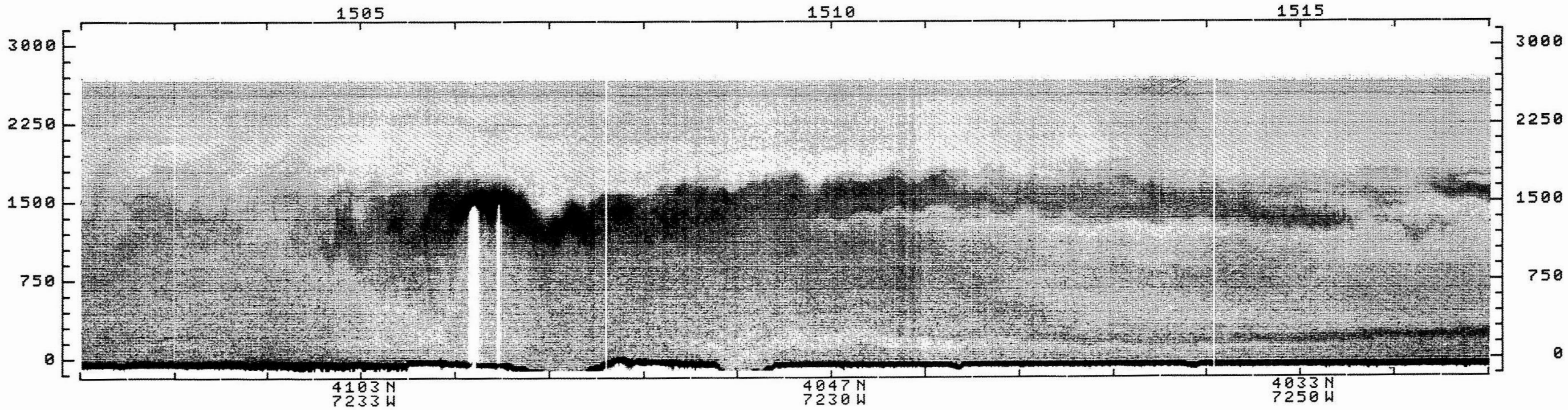


JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

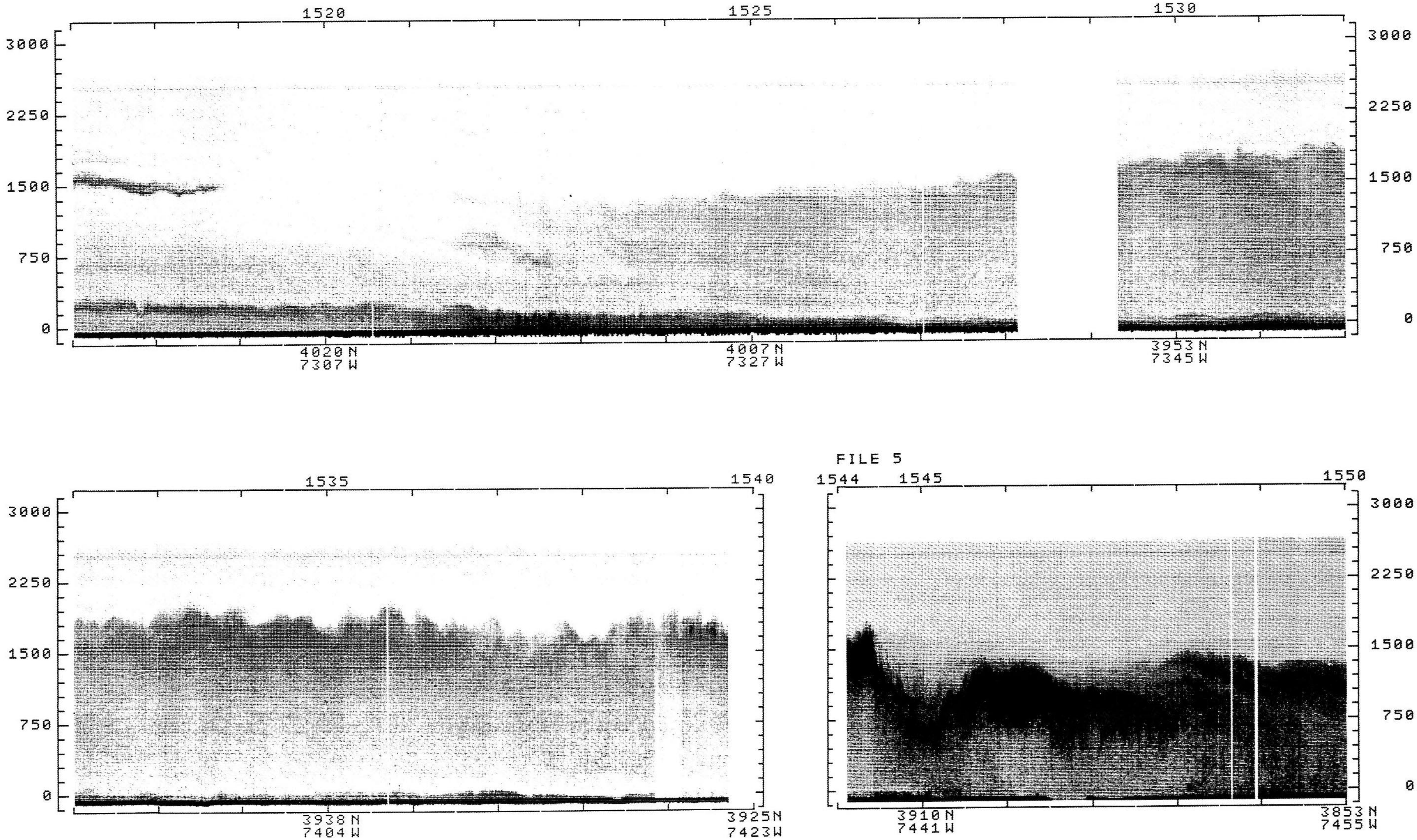


JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

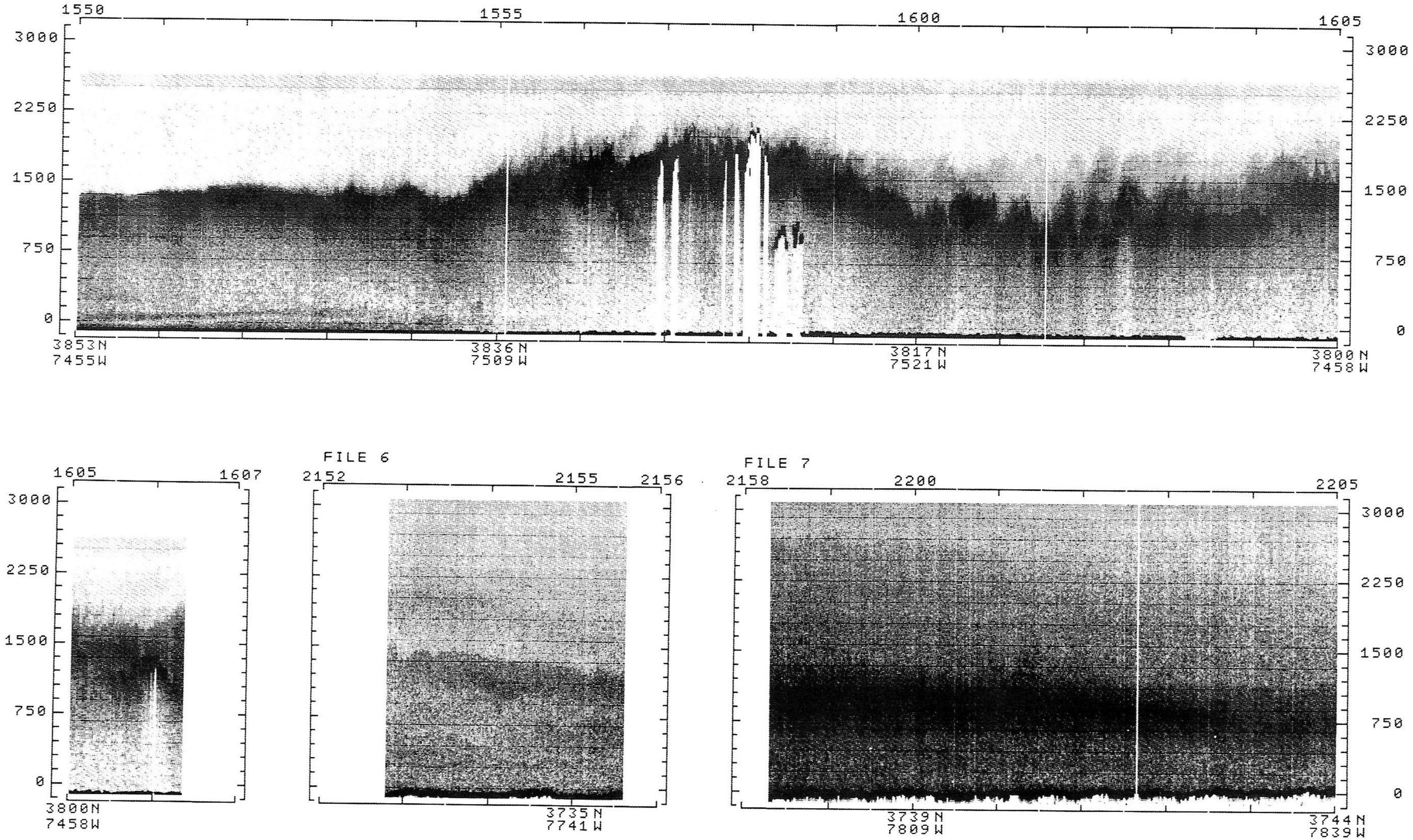




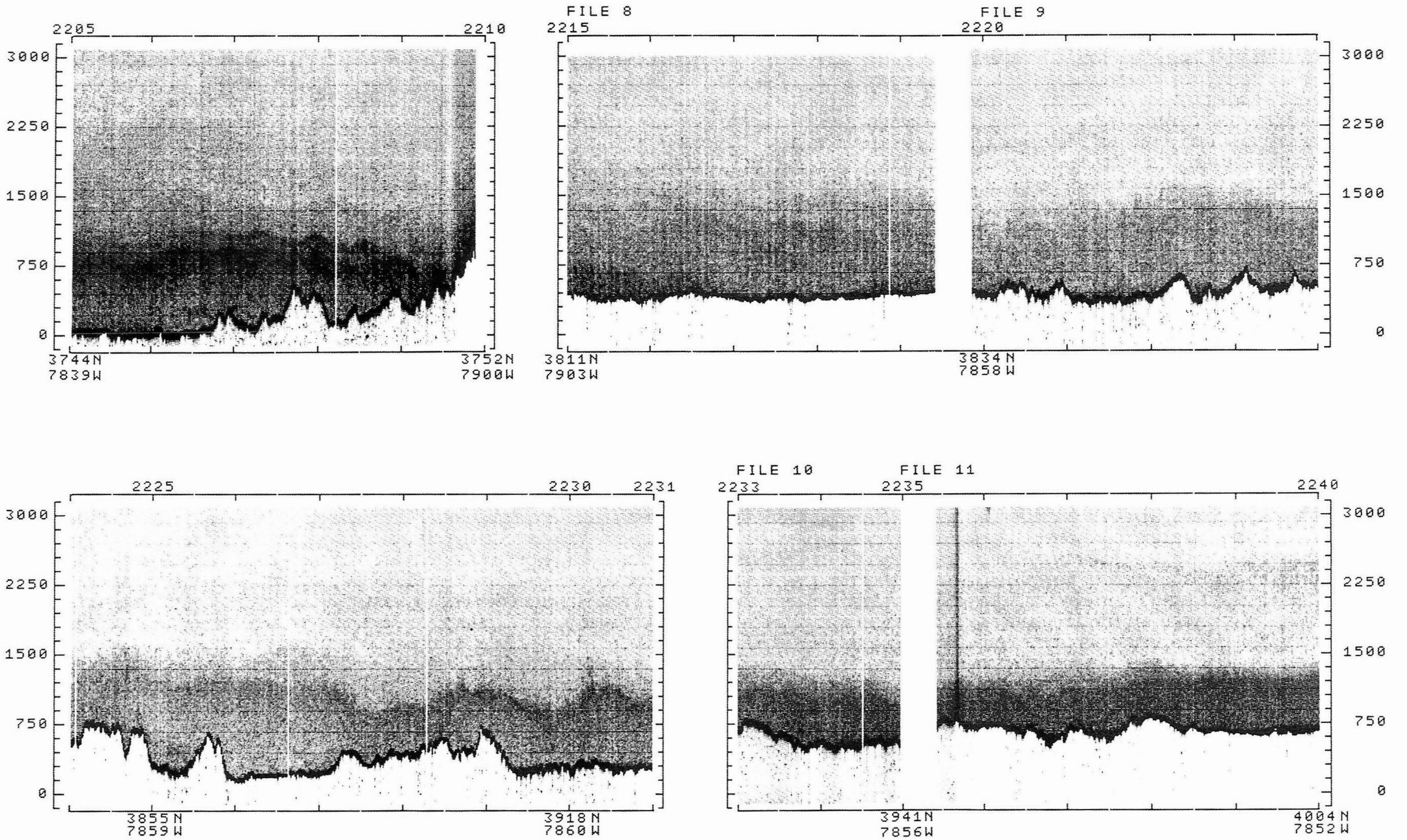
JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



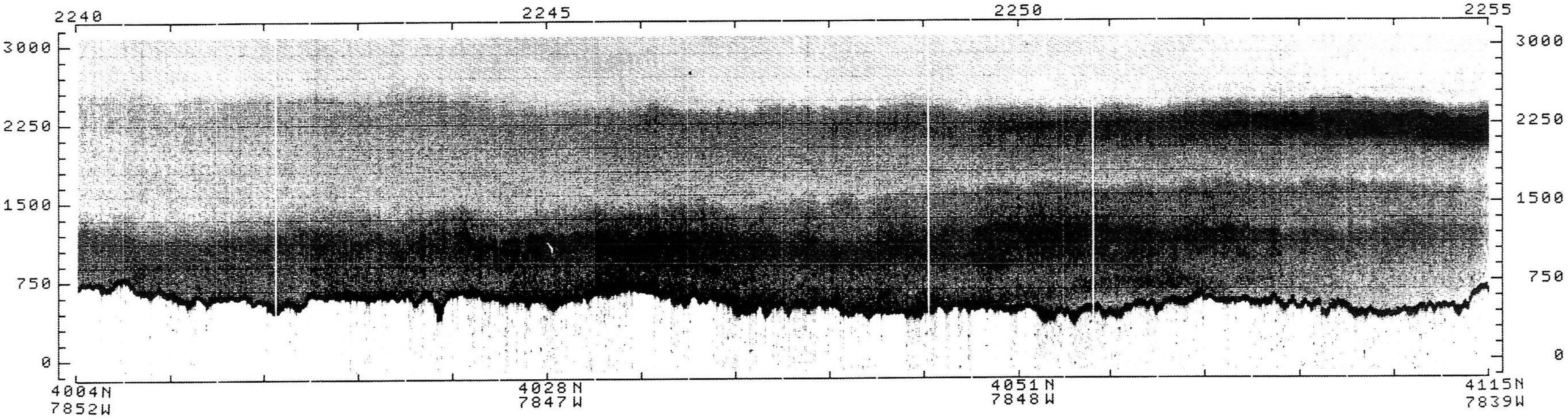
JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

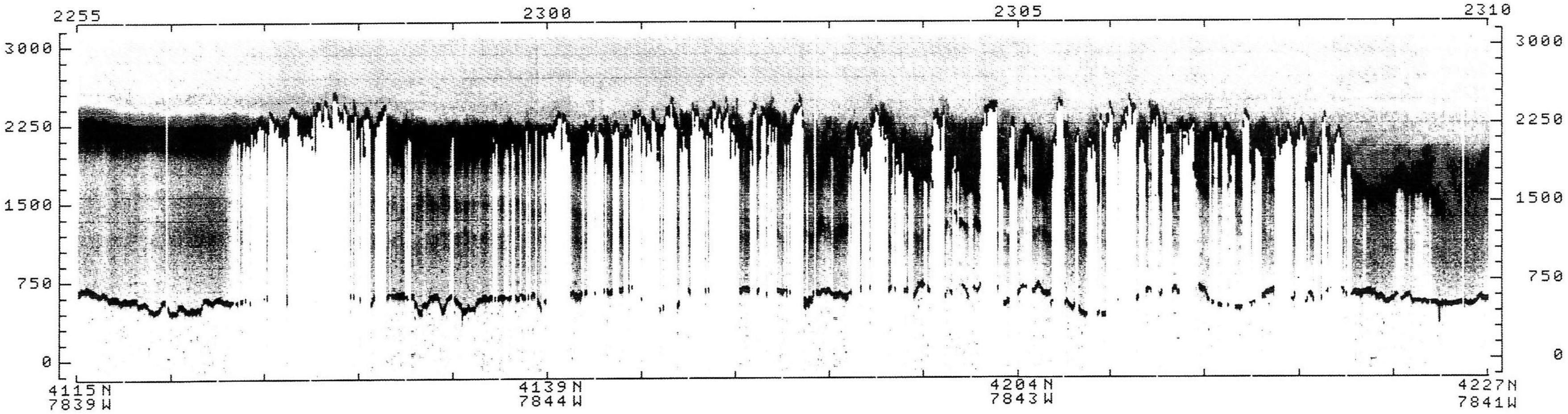


JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

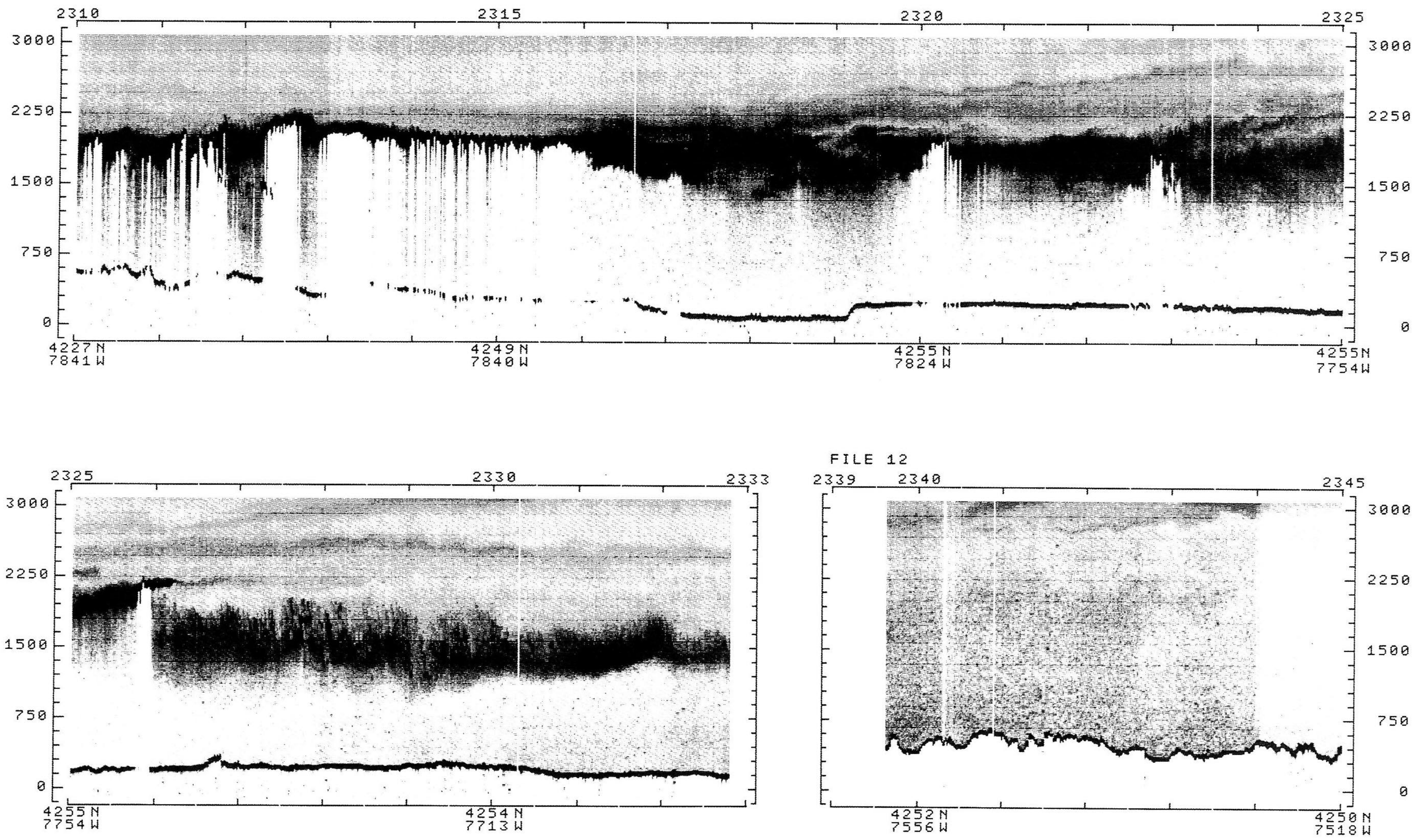


JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

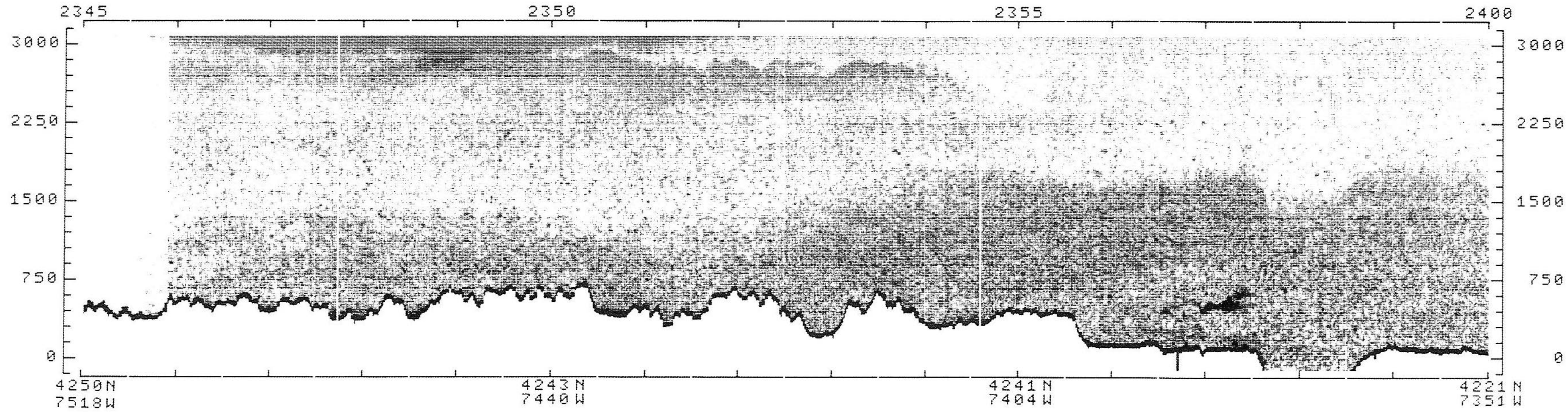


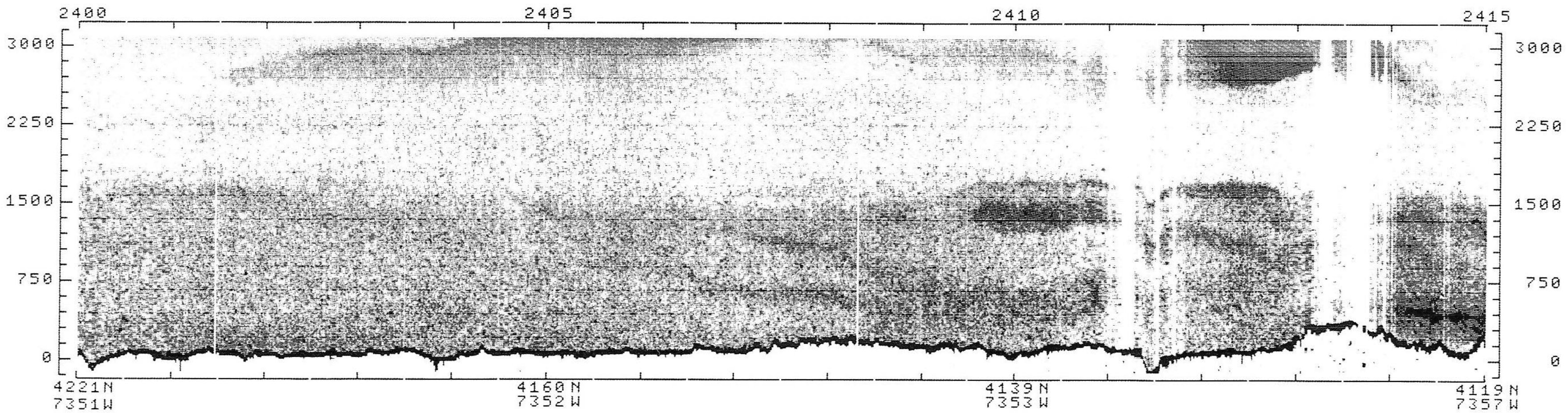


JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

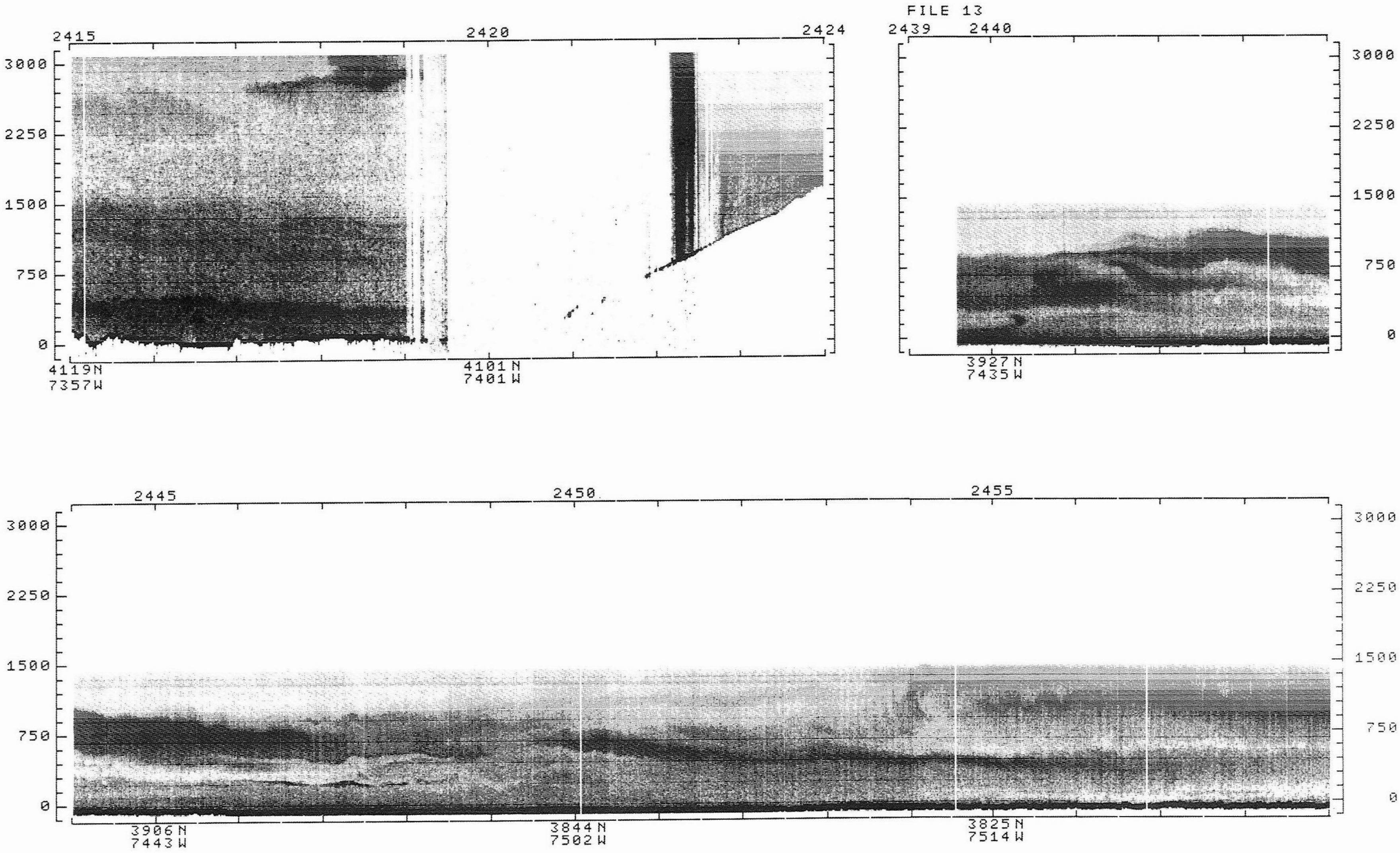


JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

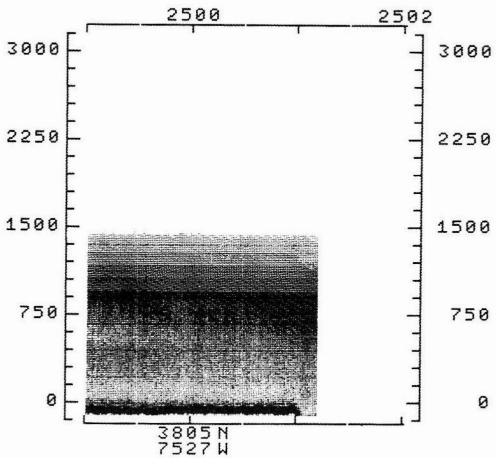




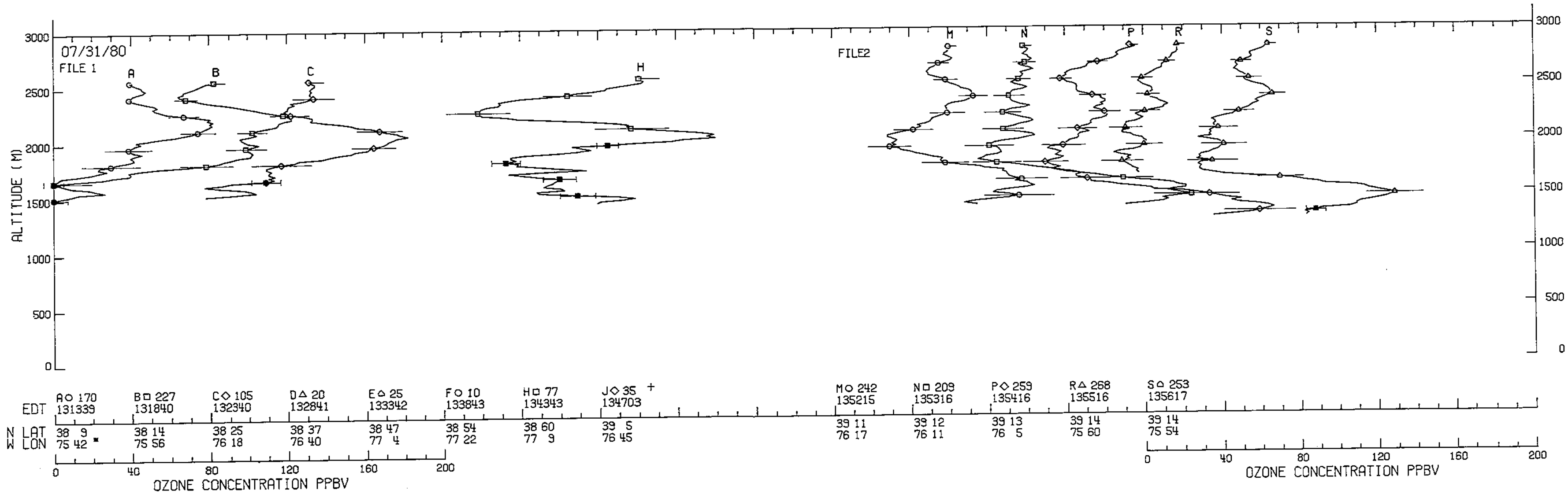
JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

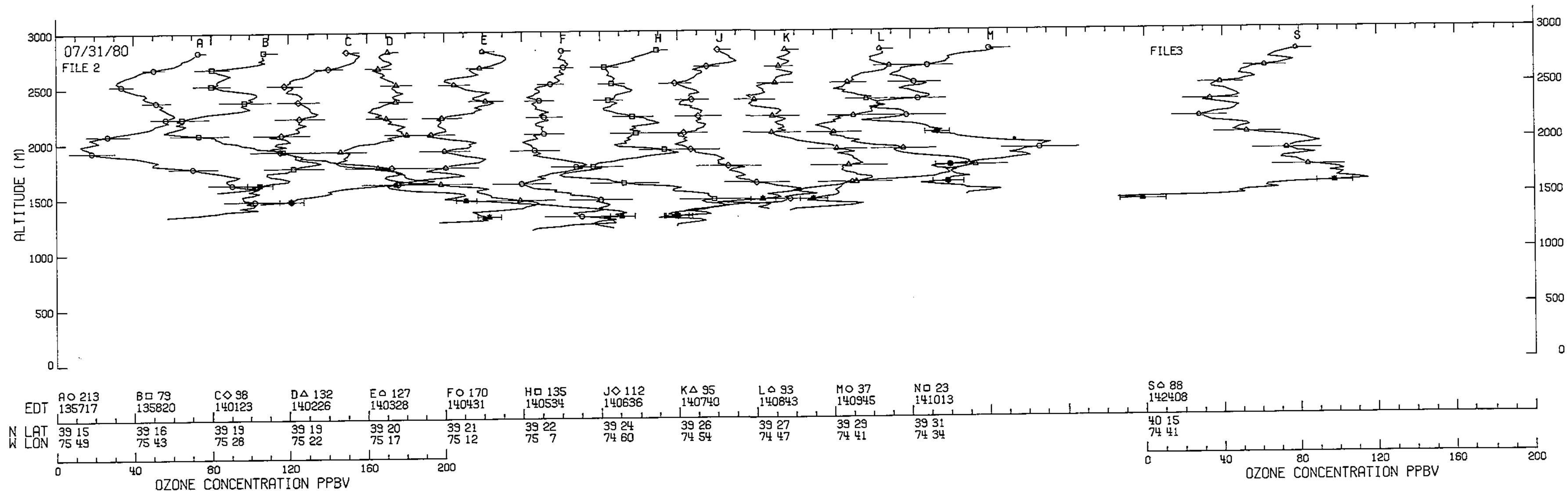


JULY 31, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

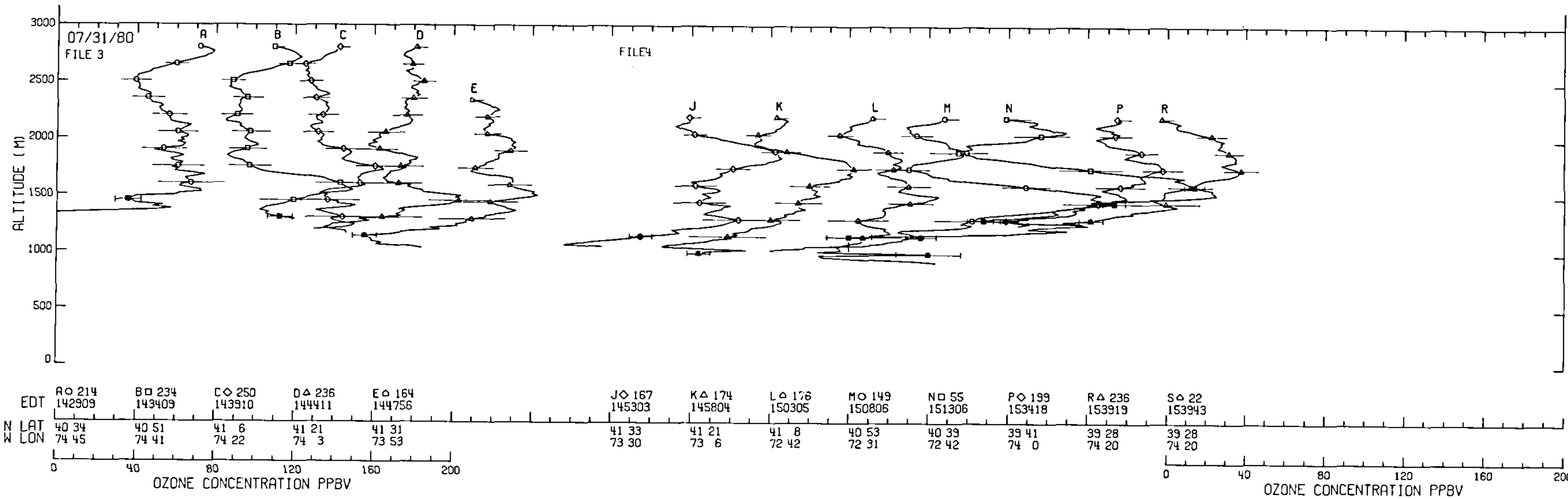


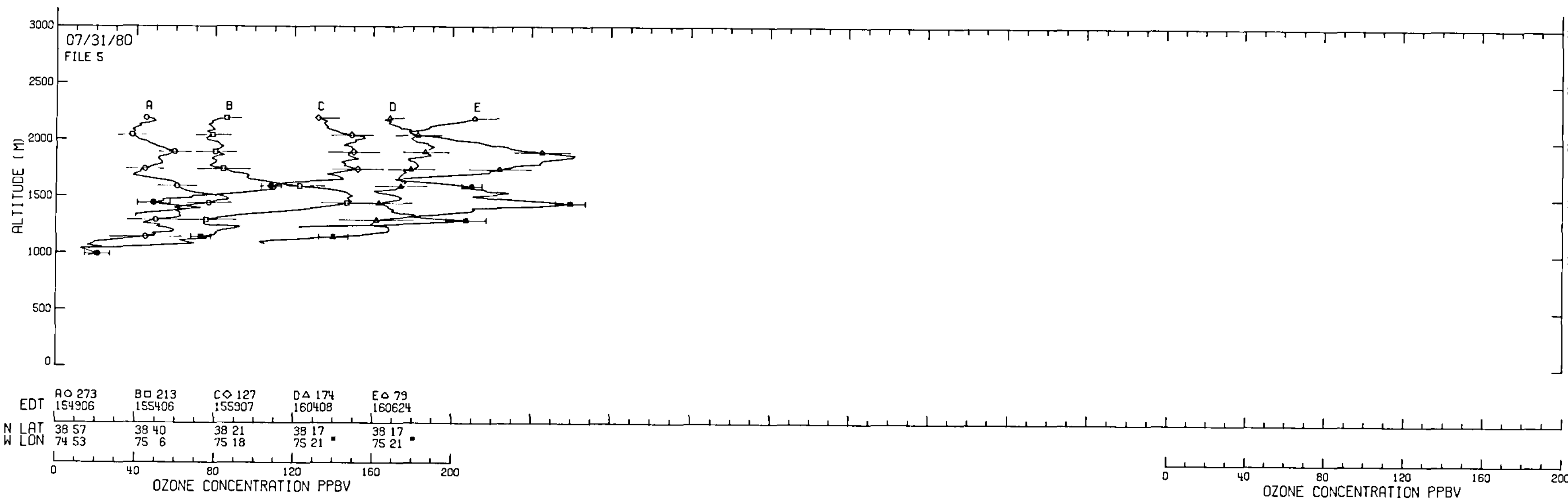
O_3 PROFILES FOR JULY 31, 1980, FLIGHTS



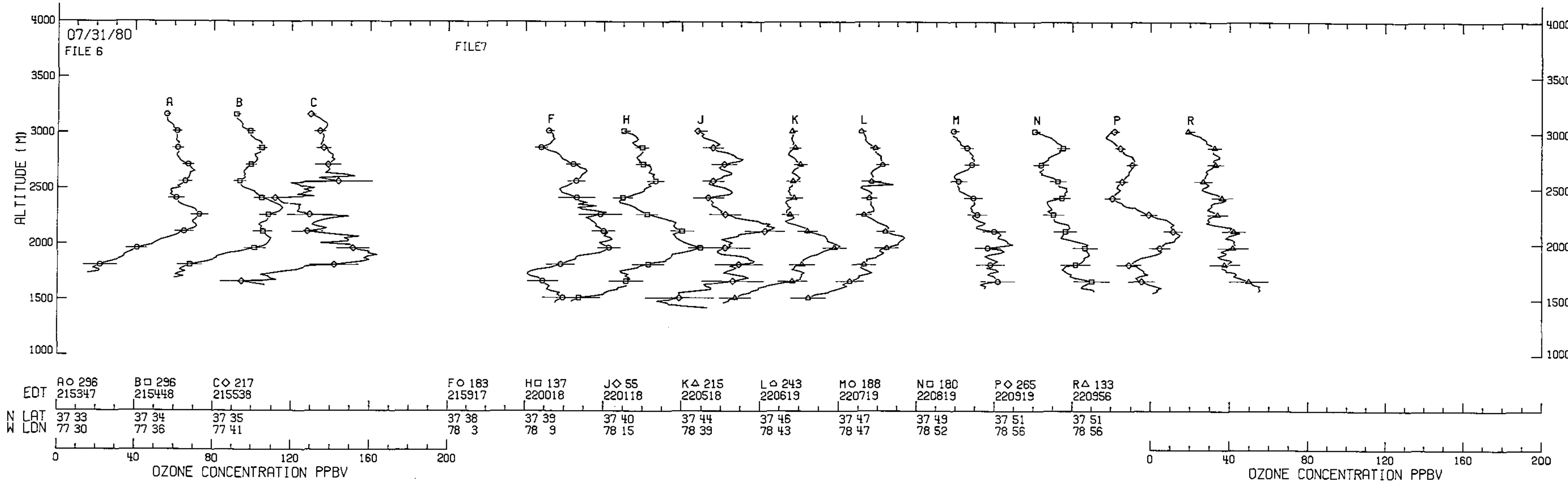


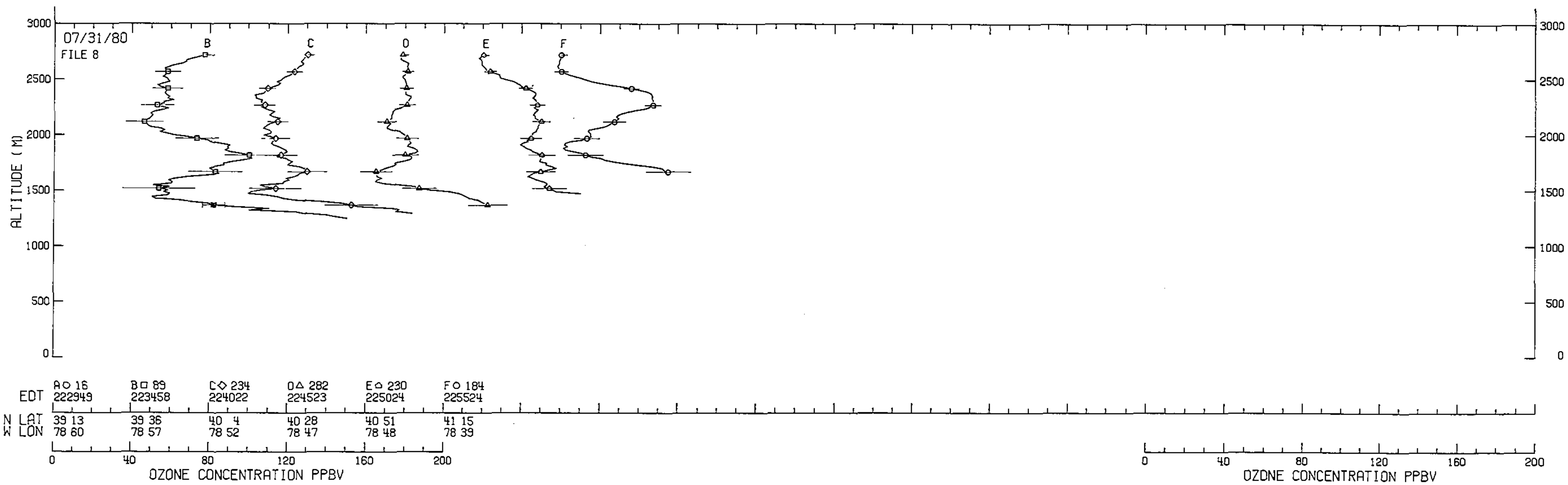
Continued

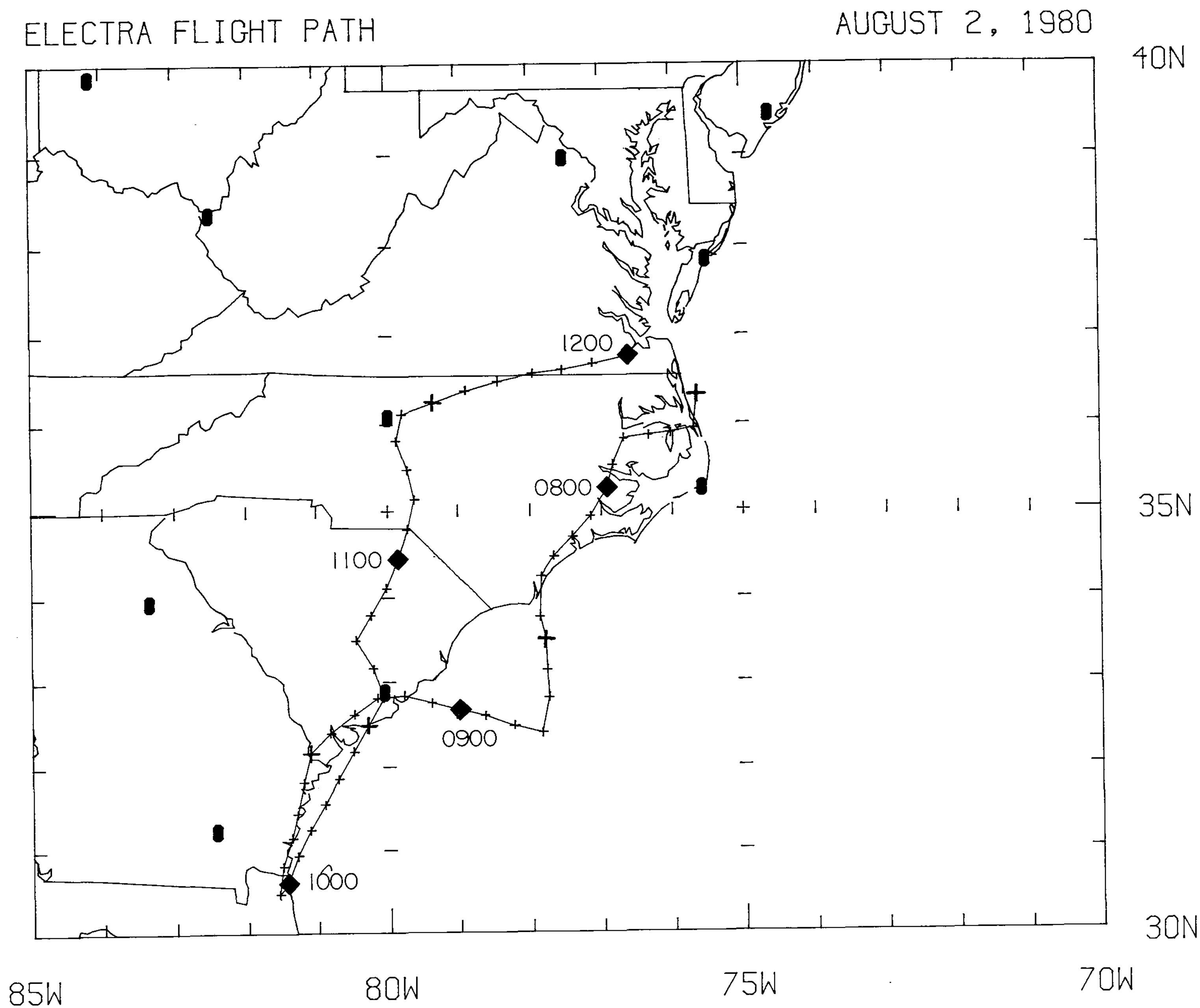

07/31/80
FILE 3
FILE4
ALTITUDE (M)
EDT
N LAT
W LON
A○ 214 142909 40 34 74 45
B□ 234 143409 40 51 74 41
C◇ 250 143910 41 6 74 22
D△ 236 144411 41 21 74 3
E△ 164 144756 41 31 73 53
J◇ 167 145303 41 33 73 30
K△ 174 145804 41 21 73 6
L△ 176 150305 41 8 72 42
M○ 149 150806 40 53 72 31
N□ 55 151306 40 39 72 42
P◇ 199 153418 39 41 74 0
R△ 236 153919 39 28 74 20
S△ 22 153943 39 28 74 20
OZONE CONCENTRATION PPBV


07/31/80
FILE 5
ALTITUDE (M)
EDT
N LAT
W LON
A○ 273 154906 38 57 74 53
B□ 213 155406 38 40 75 6
C◇ 127 155907 38 21 75 18
D△ 174 160408 38 17 75 21
E△ 79 160624 38 17 75 21
OZONE CONCENTRATION PPBV

Concluded


07/31/80
FILE 6
FILE7
ALTITUDE (M)
A B C F H J K L M N P R
EDT
N LAT
W LON
A○ 296 215347 37 33 77 30
B□ 296 215448 37 34 77 36
C◇ 217 215538 37 35 77 41
F○ 183 215917 37 38 78 3
H□ 137 220018 37 39 78 9
J◇ 55 220118 37 40 78 15
K△ 215 220518 37 44 78 39
L○ 243 220619 37 46 78 43
M○ 188 220719 37 47 78 47
N□ 180 220819 37 49 78 52
P◇ 265 220919 37 51 78 56
R△ 133 220956 37 51 78 56
OZONE CONCENTRATION PPBV


07/31/80
FILE 8
ALTITUDE (M)
B C D E F
EDT
N LAT
W LON
A○ 16 222949 39 13 78 60
B□ 89 223458 39 36 78 57
C◇ 234 224022 40 4 78 52
D△ 282 224523 40 28 78 47
E○ 230 225024 40 51 78 48
F○ 184 225524 41 15 78 39
OZONE CONCENTRATION PPBV


ELECTRA FLIGHT PATH
AUGUST 2, 1980
40N
35N
30N
85W
80W
75W
70W
1200
0800
1100
0900
1600

Instrument Parameters for August 2, 1980, Flight

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
1	0800	0830	5	(*a*)	(*a*)	(*a*)	6	2240	0.5	No	3615
2	0830	0839	5	7	2610	0.2/0.1	6	2240	.5	Yes	3945
3	0845	0924	1	(*a*)	(*a*)	(*a*)	6	2218	.5	No	3986
4	0926	0941	5	6	2700	.2/.1	6	2600	.5	Yes	3976
5	0953	1010	5	6	2760	.2/.1	6	2200	.5	Yes	3920[b] to 4262
6	1013	1029	5	6	2760	.2/.1	6	2200	.5	Yes	4305[c] to 4890
7	1033	1049	5	6	2600	.2/.1	7	2100	.5	Yes	4964 to 4220[d]
8	1103	1158	5	(*a*)	(*a*)	(*a*)	7	2300	.5	No	4266[e] to 3637[f]

[a] Aerosol only.
[b] 0953 to 0956 EDT.
[c] 1013 to 1020 EDT.
[d] 1039 to 1049 EDT.
[e] 1103 to 1138 EDT.
[f] 1143 to 1158 EDT.

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR AUGUST 2, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/02/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
0730	30.	00.	80.	00.	0.		0.		0.					2400.		2500.
1200	36.	57.	80.	56.	300.		900.		150.					4000.		4000.

55

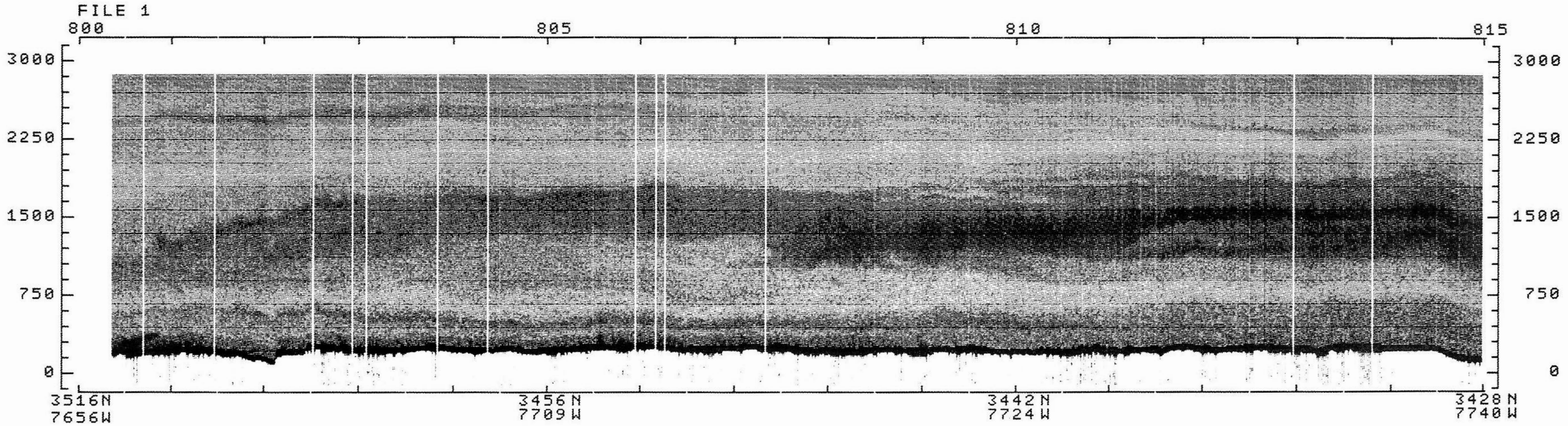
0730	36.0	19.2	75.0	38.3												
0735	35.0	56.8	75.0	41.4												
0740	35.0	53.0	76.0	00.8												
0745	35.0	51.5	76.0	19.6												
0750	35.0	49.4	76.0	40.6												
0755	35.0	31.4	76.0	50.9												
0800	35.0	15.6	76.0	55.7												
0805	34.0	55.9	77.0	09.2	10.		90.		20.	NA		NA		2690.	M+	2700.
0810	34.0	41.9	77.0	24.2	20.		150.		30.	NA		NA		2730.	M+	2750.
0815	34.0	28.1	77.0	40.1	20.		150.		60.	NA		NA		2830.	M+	2850.
0820	34.0	14.2	77.0	51.3	10.		200.		50.	NA		NA		2840.	M+	2850.
0825	33.0	45.8	77.0	52.3	0.		100.		40.	NA		NA		2850.	M+	2850.
0830	33.0	29.5	77.0	47.4												
0835	33.0	08.7	77.0	46.5	0.		500.		40.	NA		NA		3090.	M+	3580.
0840	32.0	48.8	77.0	45.5												
0845	32.0	23.8	77.0	50.5												
0850	32.0	29.2	78.0	14.4	0.	V	300.	S	60.	NA		NA		3090.	SM+	3090.
0855	32.0	36.3	78.0	39.0	0.	V	220.	S	60.	NA		NA		3090.	SM+	3070.
0900	32.0	40.4	79.0	00.3	0.	V	120.	S	60.	NA		NA		3090.	SM+	3090.
0905	32.0	45.2	79.0	24.0	0.		180.		60.	NA		NA		3090.	M+	3090.
0910	32.0	50.5	79.0	47.3	0.		360.		60.	NA		NA		3090.	M+	3090.
0915	32.0	48.8	80.0	10.1	20.		400.		50.	NA		NA		3050.	M+	3070.
0920	32.0	37.3	80.0	29.2	10.		450.		60.	NA		NA		3100.	M+	3110.
0925	32.0	24.1	80.0	49.2												
0930	32.0	10.3	80.0	06.1	20.		540.		40.	NA		NA		3110.	M+	3130.
0935	31.0	49.0	80.0	12.5	10.		300.		80.	NA		NA		3050.	M+	3060.
0940	31.0	26.8	80.0	18.0	0.		400.		60.	NA		NA		3050.	M+	3050.
0945	31.0	09.6	80.0	22.5												

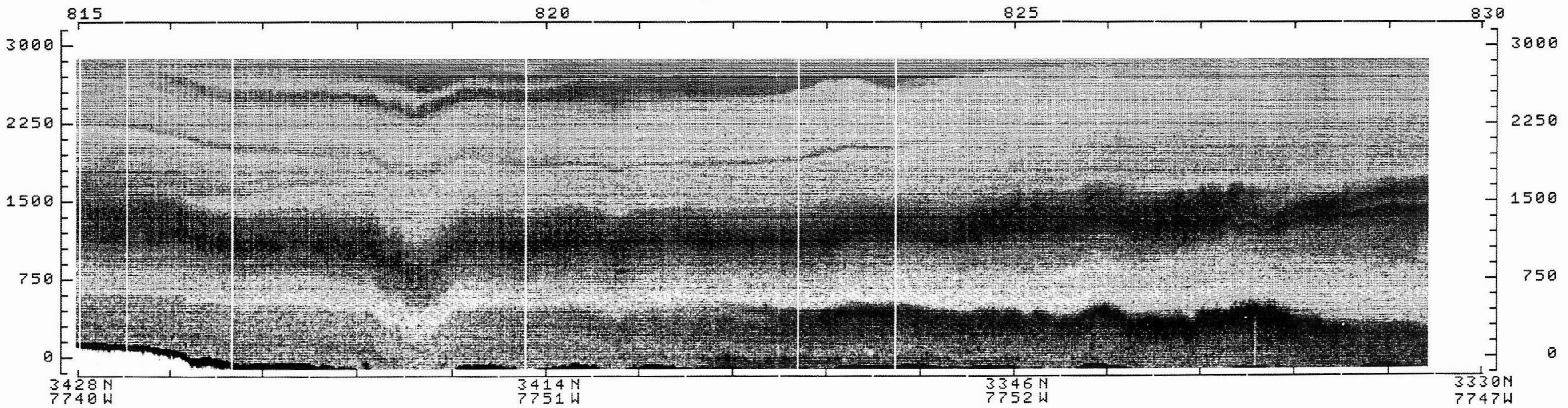
Concluded

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/02/80 18 0

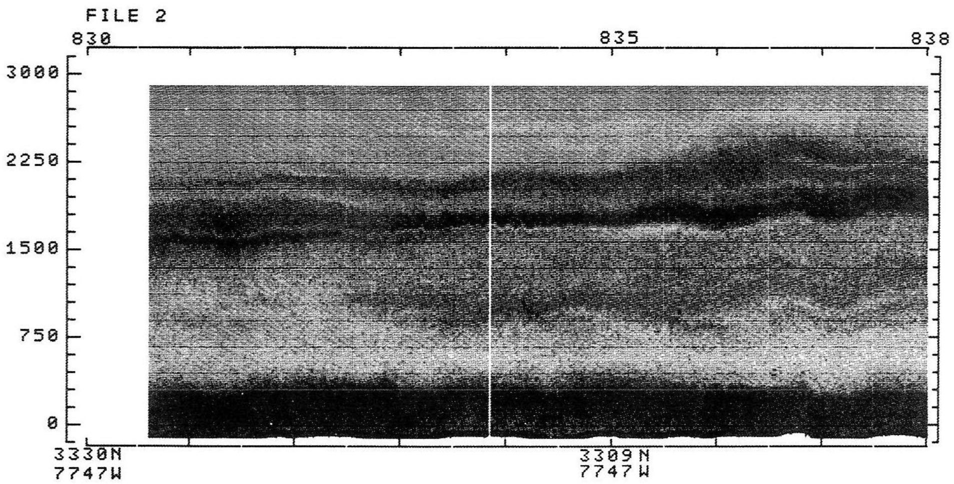
TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
0950	30.0	49.0	80.0	30.5												
0955	30.0	28.7	80.0	33.2	10.		300.		50.	NA		NA		3020.	M+	3030.
1000	30.0	37.0	80.0	26.8	10.		340.		50.	NA		NA		2850.	M+	2860.
1005	30.0	56.4	80.0	17.9	0.		570.		100.	NA		NA		3060.	M+	3060.
1010	31.0	15.0	81.0	06.9												
1015	31.0	33.3	80.0	54.8	0.		300.		50.	NA		NA		3410.	M+	3410.
1020	31.0	51.7	80.0	42.5	0.		450.		100.	NA		NA		3410.	M+	3410.
1025	32.0	10.9	80.0	30.1	0.		300.		50.	NA		NA		3990.	M+	3990.
1030	32.0	29.8	80.0	17.9												
1035	32.0	48.8	80.0	04.7	10.		480.		60.	NA		NA		3900.	M+	3910.
1040	33.0	09.8	80.0	13.0	20.		330.		50.	NA		NA		3100.	M+	3120.
1045	33.0	30.0	80.0	27.3	50.	V	440.		50.	NA		NA		3100.	M+	3150.
1050	33.0	47.5	80.0	14.8												
1055	34.0	06.4	80.0	01.7												
1100	34.0	26.8	79.0	51.5												
1105	34.0	47.3	79.0	43.4	80.		480.		50.	NA		NA		3170.	M+	3250.
1110	35.0	07.9	79.0	37.0	150.		420.		40.	NA		NA		3100.	M+	3250.
1115	35.0	28.4	79.0	43.4	190.		450.		40.	NA		NA		3110.	M+	3300.
1120	35.0	48.2	79.0	52.4	140.		450.		60.	NA		NA		3020.	M+	3160.
1125	36.0	06.8	79.0	47.6	280.		520.		90.	NA		NA		3020.	M+	3300.
1130	36.0	14.6	78.0	20.4	280.		460.		100.	NA		NA		3020.	M+	3300.
1135	36.0	22.8	78.0	53.6	150.		450.		60.	NA		NA		3020.	M+	3170.
1140	36.0	28.8	78.0	26.5	120.		600.		100.	NA		NA		3020.	M+	3140.
1145	36.0	34.2	77.0	57.0	80.		480.		130.	NA		NA		2480.	M+	2560.
1150	36.0	36.4	77.0	32.7	50.		870.		150.	NA		NA		2510.	M+	2560.
1155	36.0	40.6	77.0	06.9	40.		640.		100.	NA		NA		2520.	M+	2560.
1200	36.0	46.0	76.0	36.9												

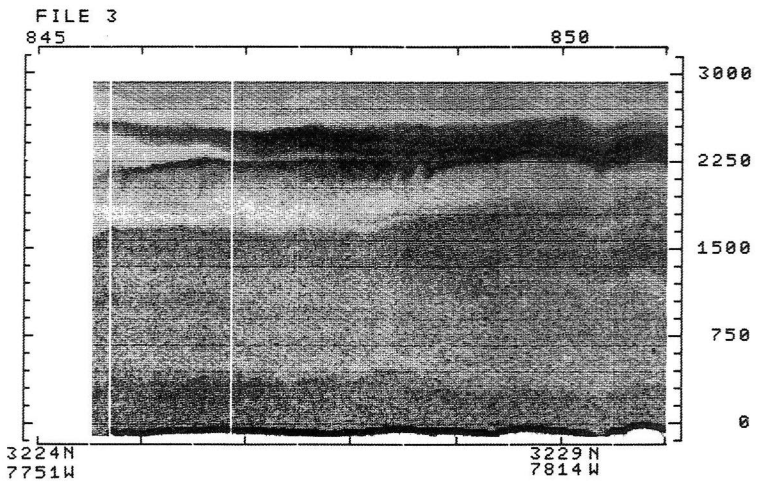
AUGUST 2, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

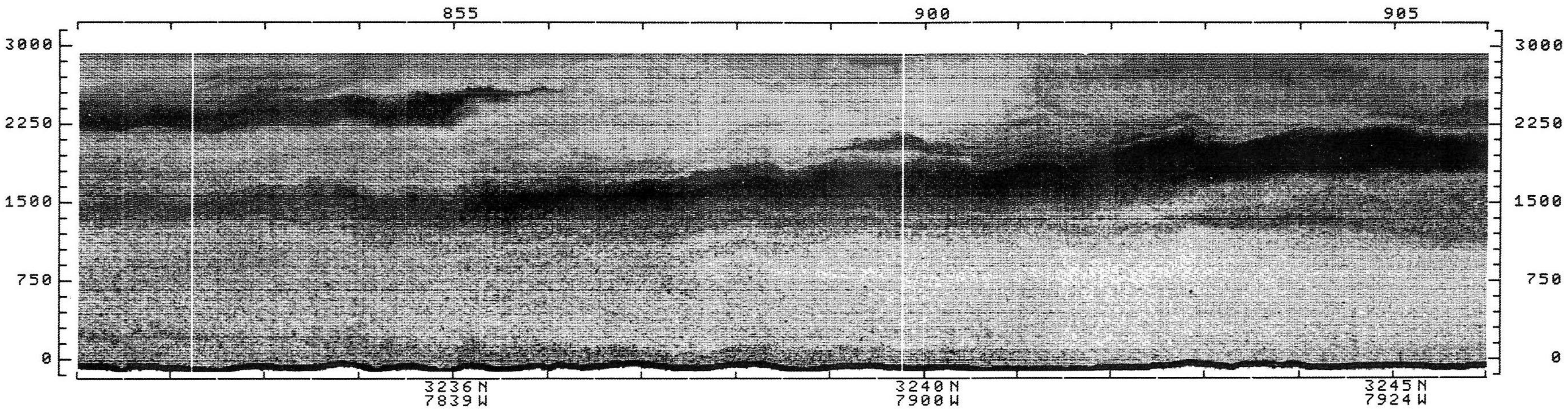




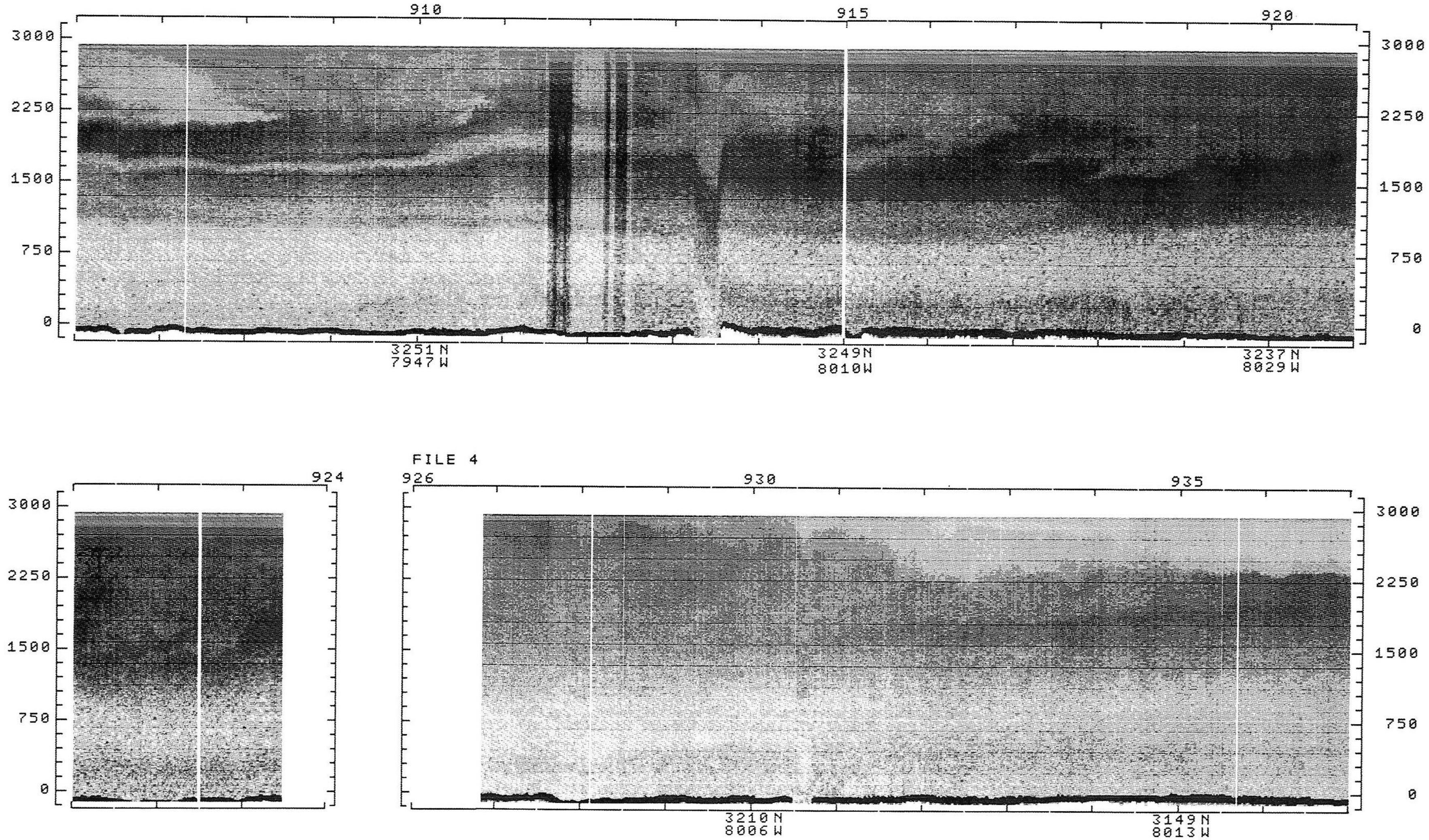
AUGUST 2, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



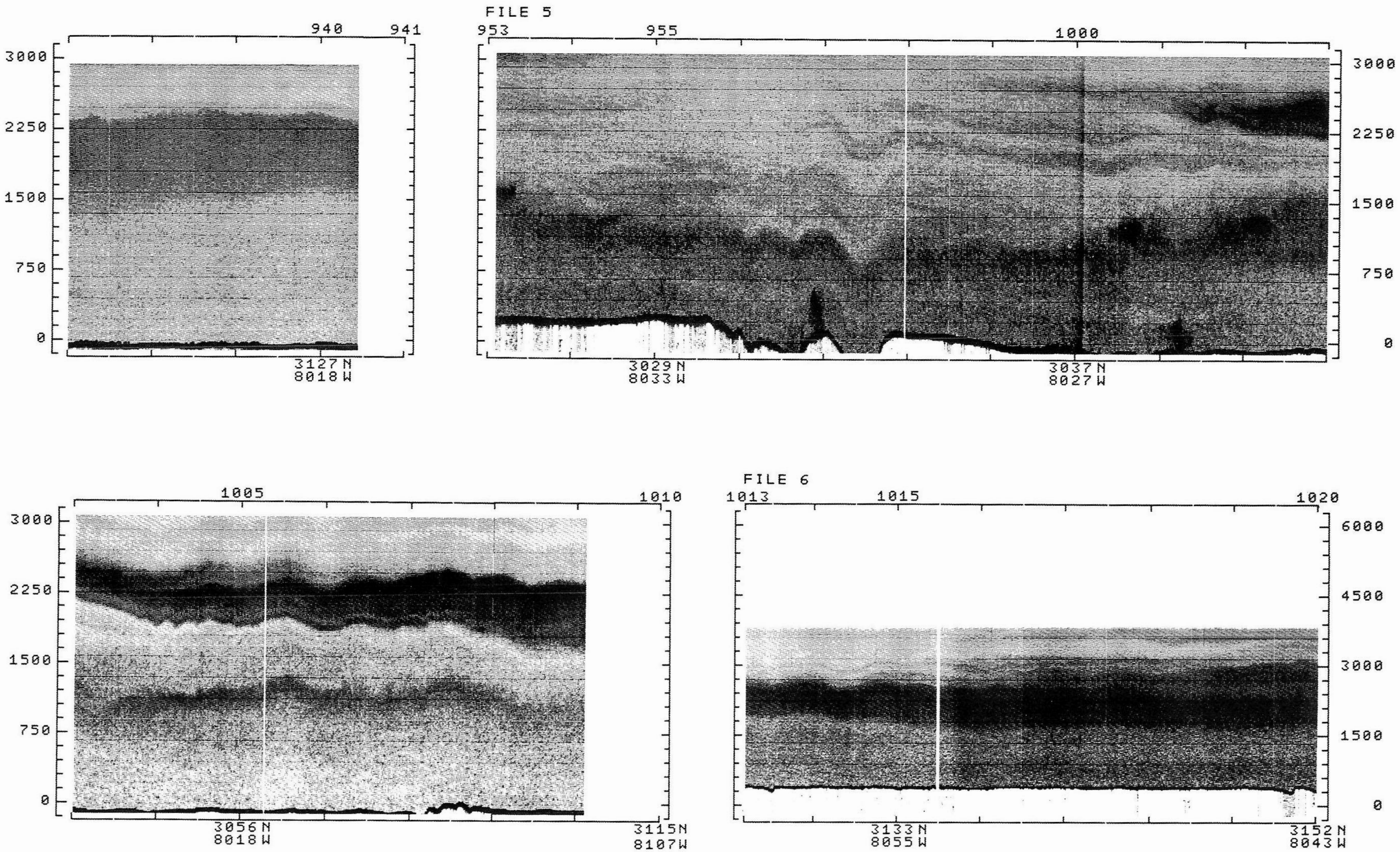




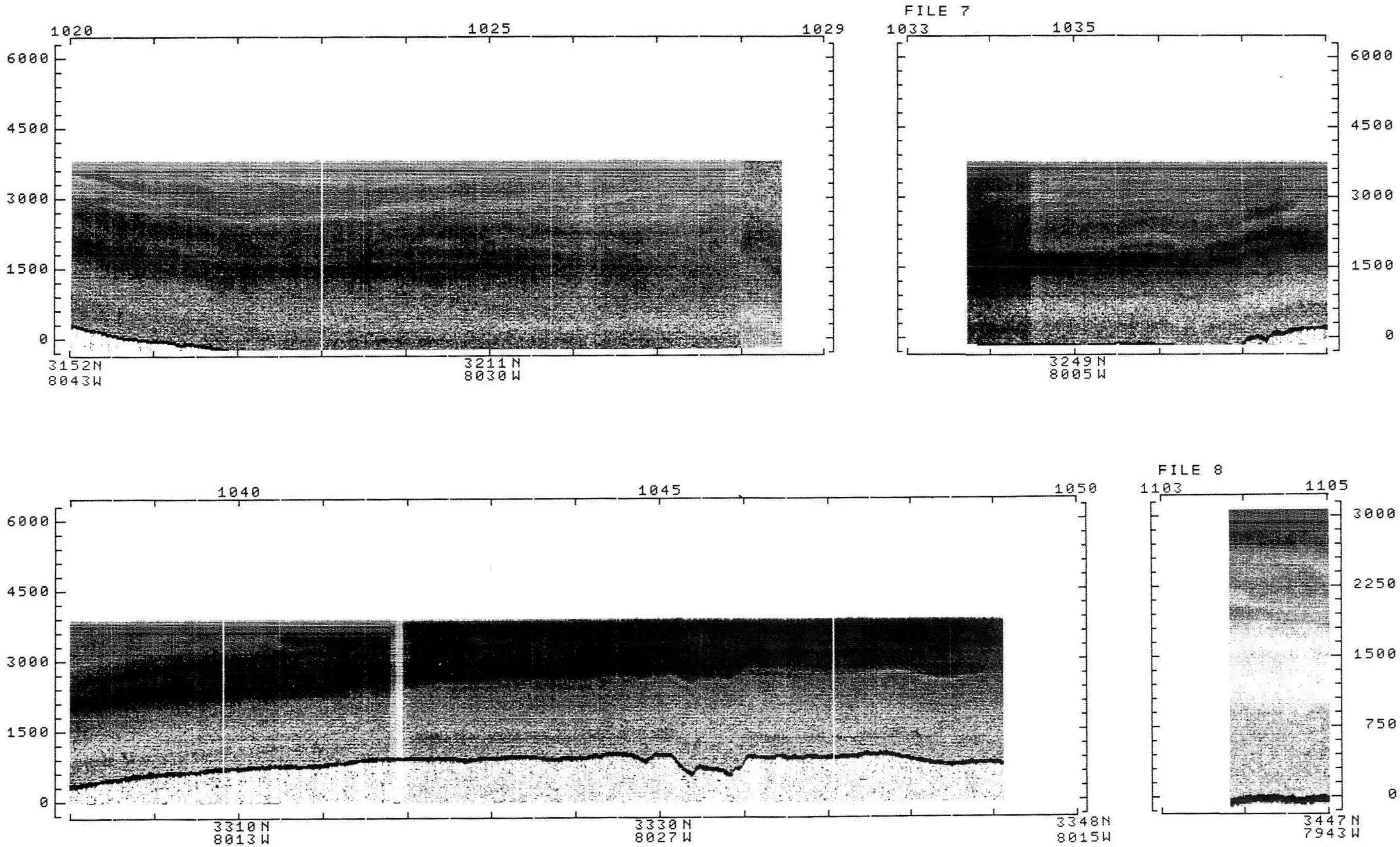
AUGUST 2, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



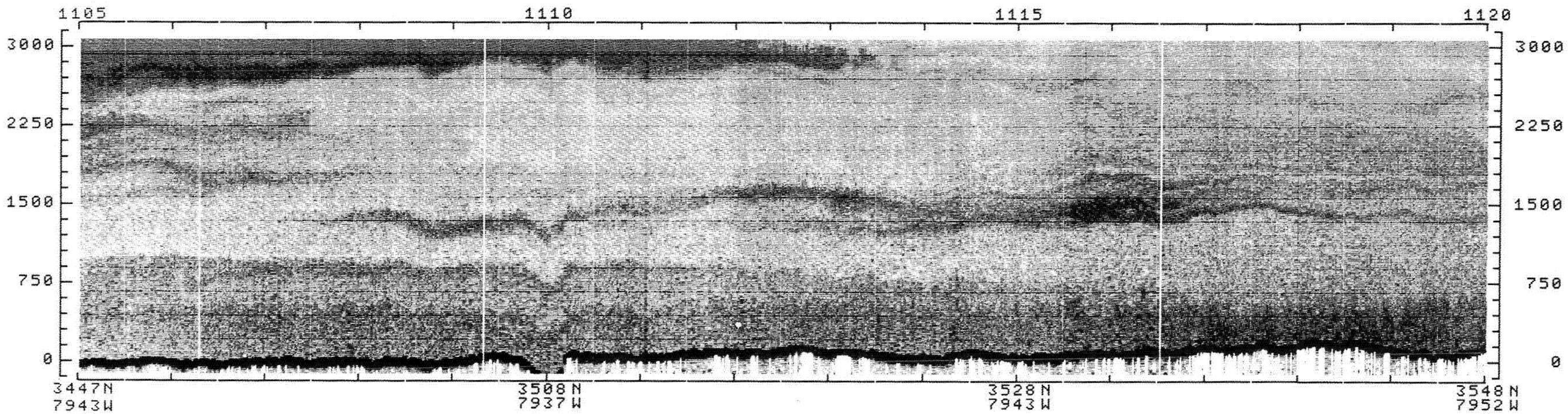
AUGUST 2, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

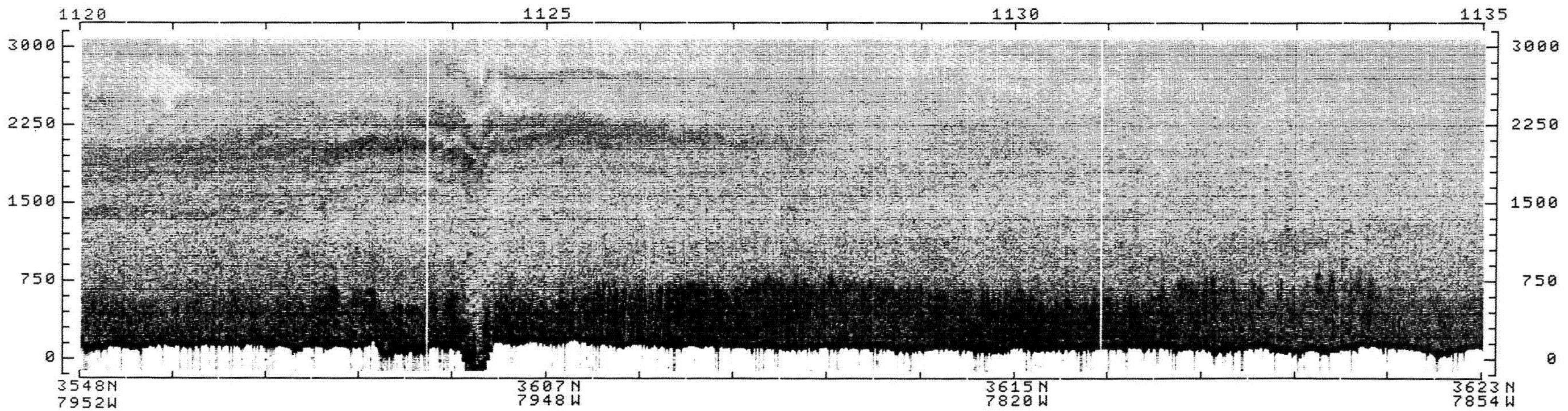


AUGUST 2, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

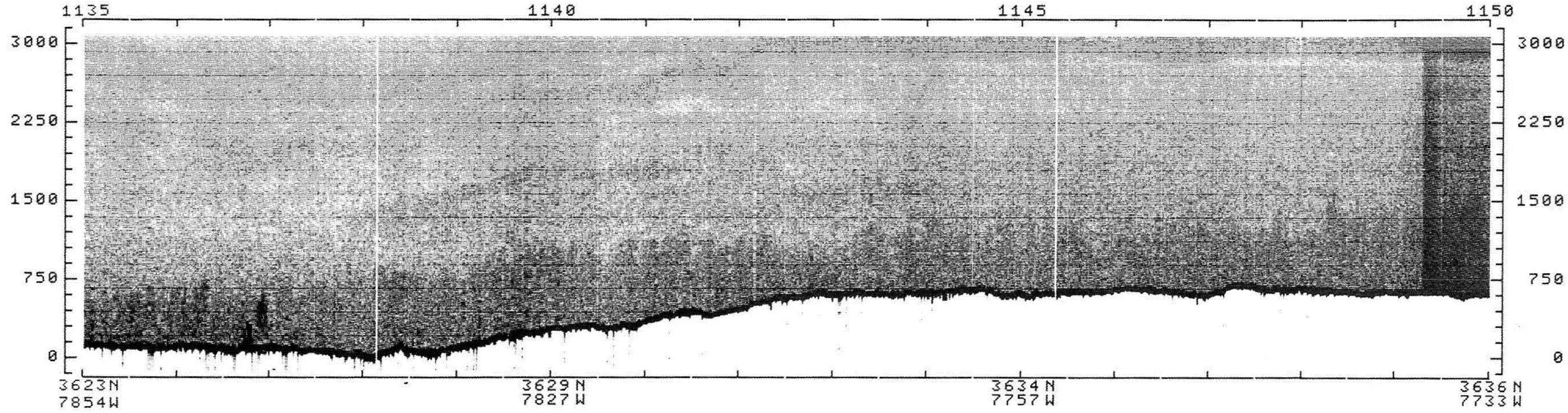


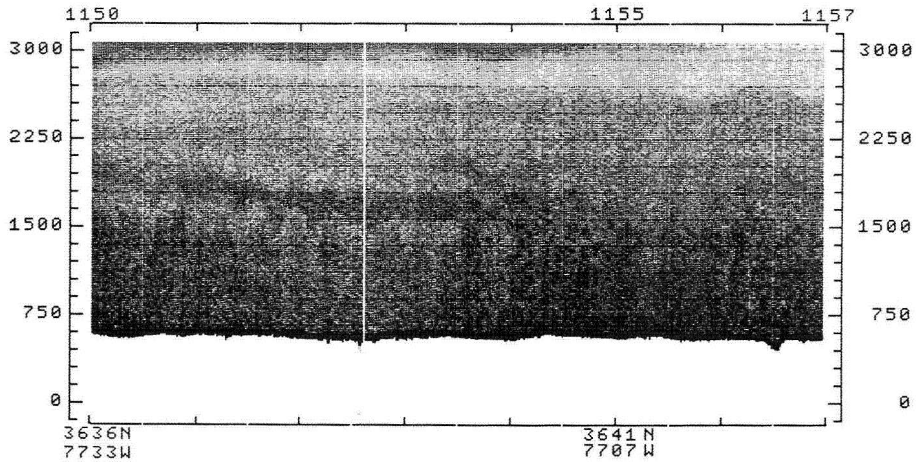
AUGUST 2, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



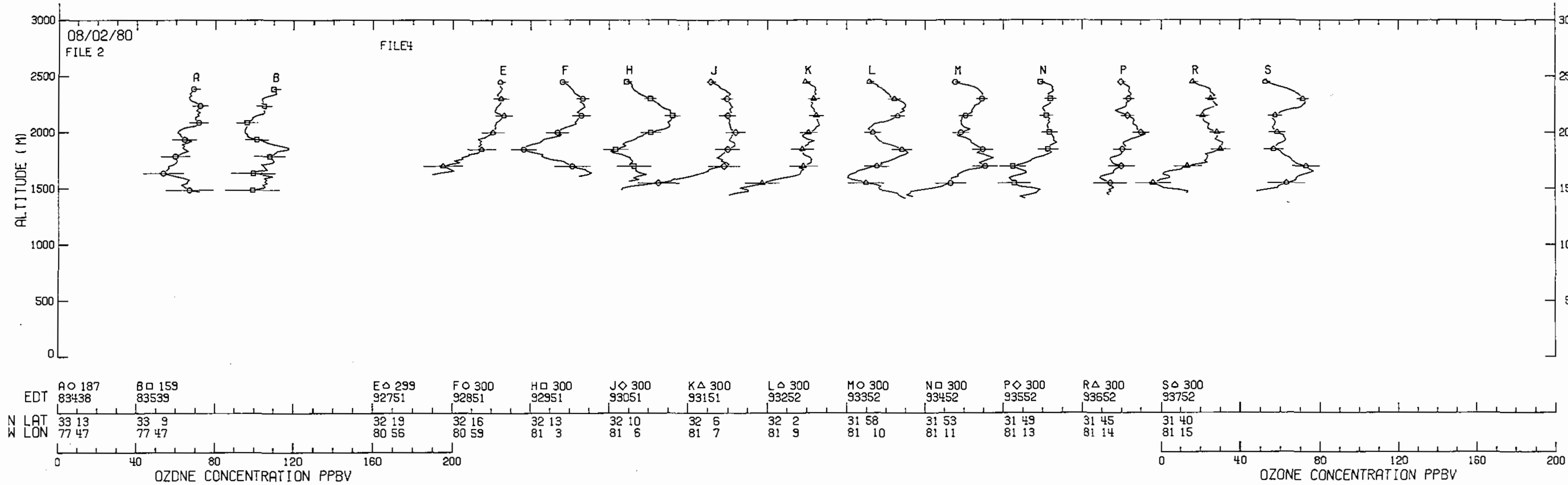


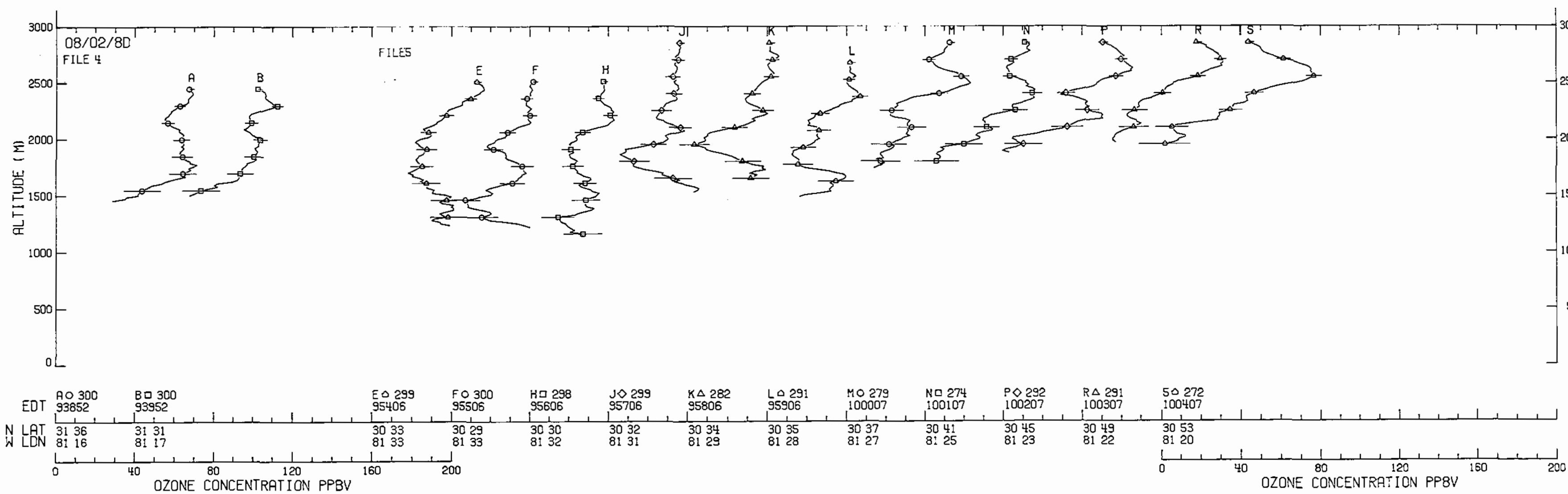
AUGUST 2, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



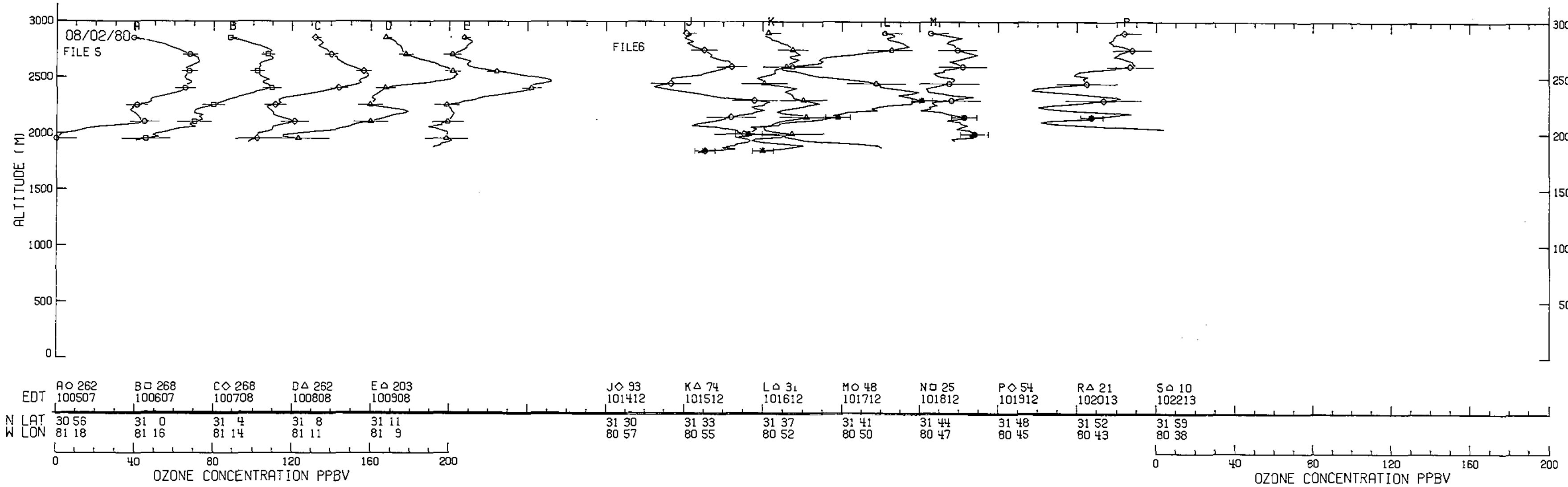


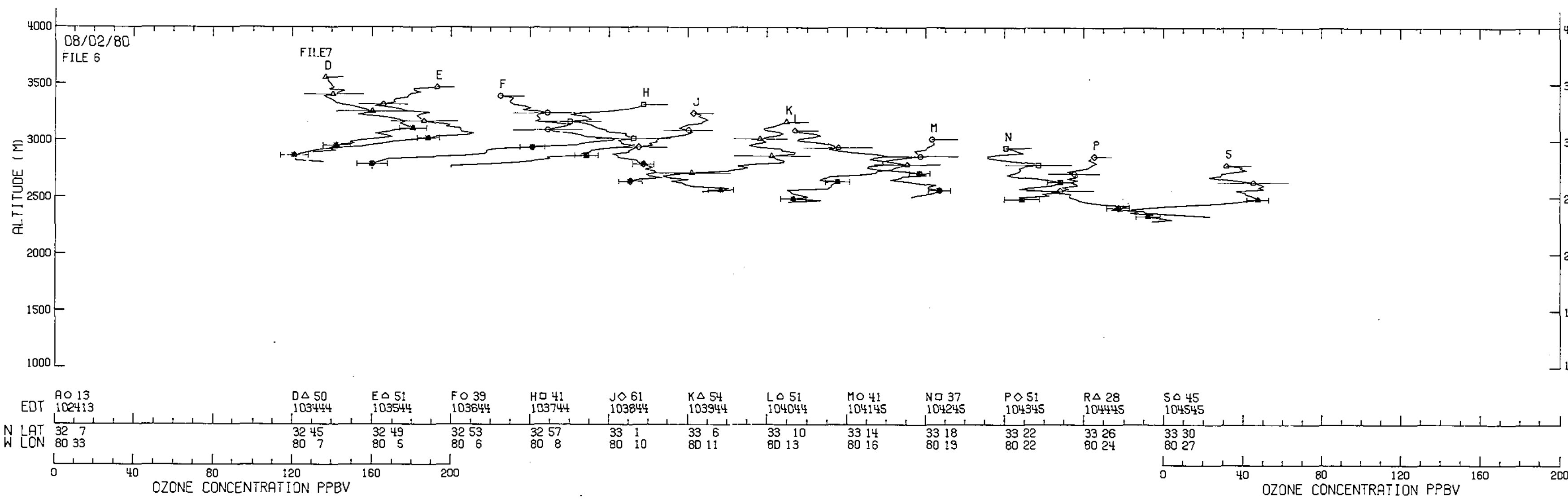
O_3 PROFILES FOR AUGUST 2, 1980, FLIGHT



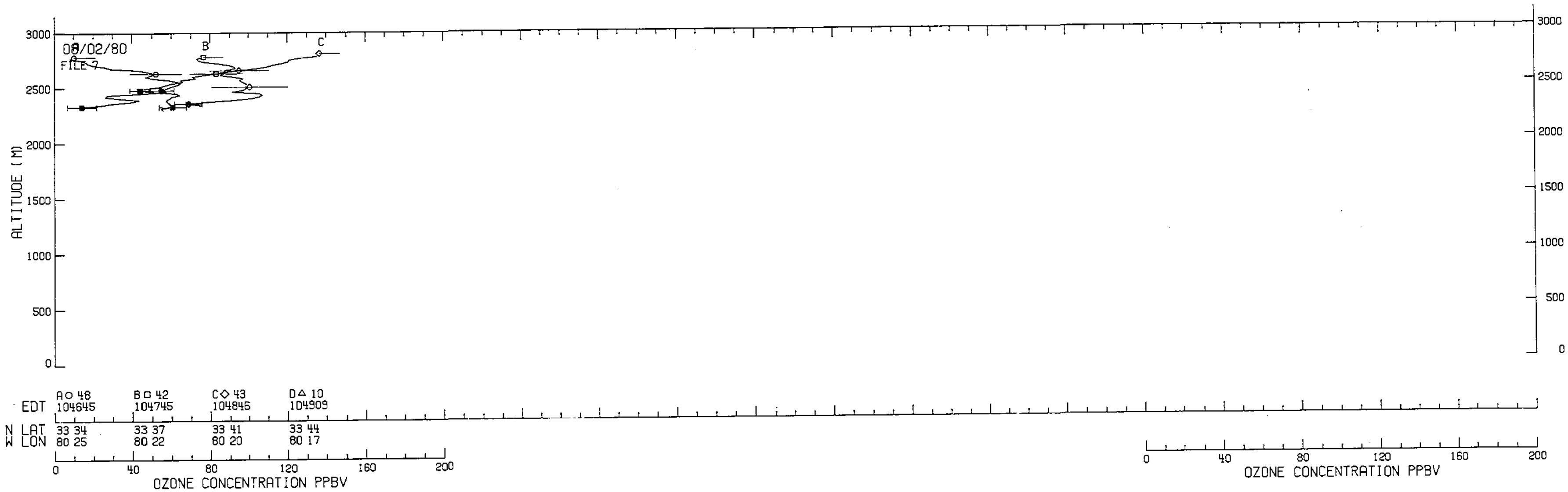


Continued

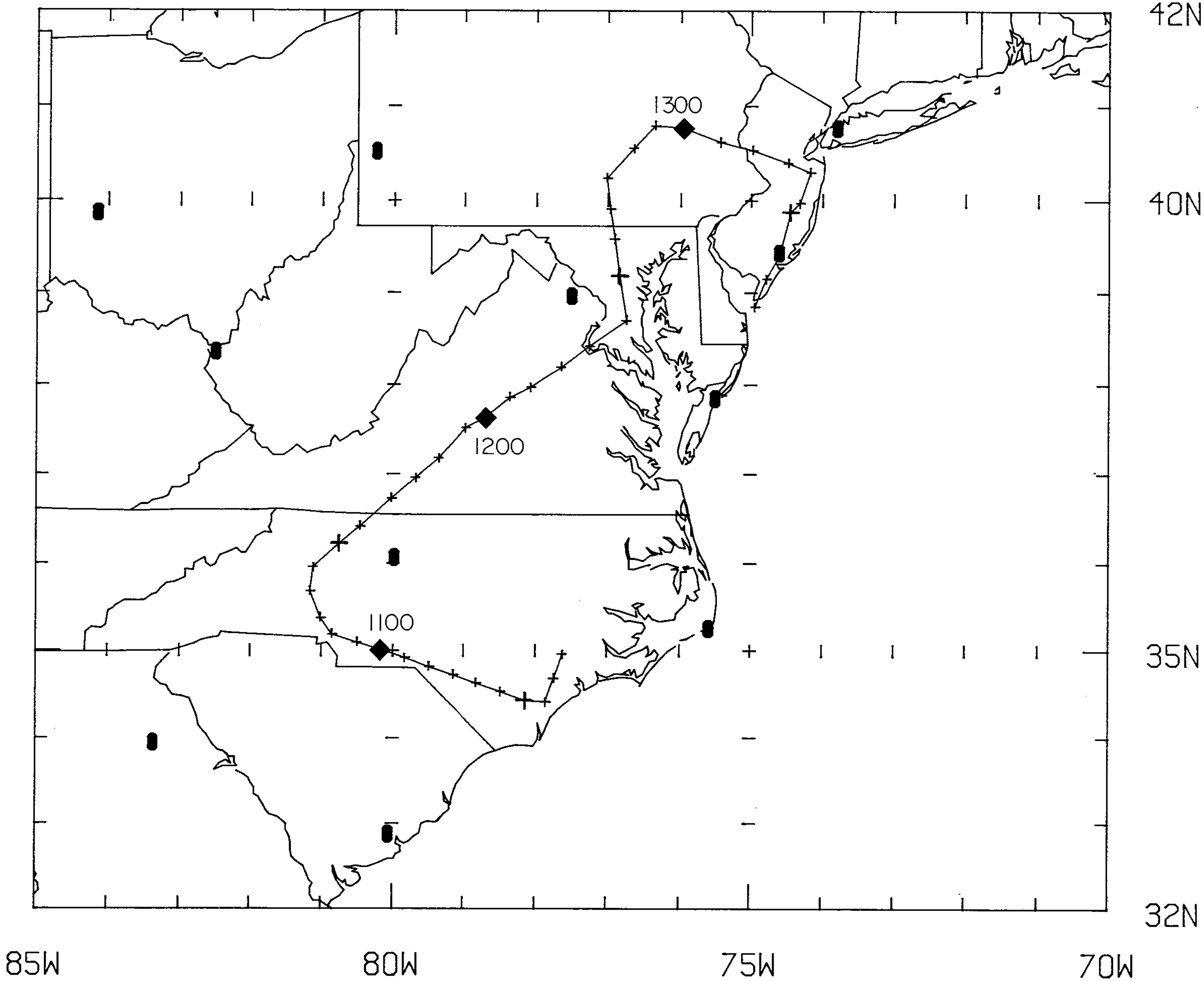

08/02/80
FILE 5
FILE6
ALTITUDE (M)
EDT
N LAT
W LON
A○ 262 100507 30 56 81 18
B□ 268 100607 31 0 81 16
C◇ 268 100708 31 4 81 14
D△ 262 100808 31 8 81 11
E⌂ 203 100908 31 11 81 9
J◇ 93 101412 31 30 80 57
K△ 74 101512 31 33 80 55
L⌂ 31 101612 31 37 80 52
M○ 48 101712 31 41 80 50
N□ 25 101812 31 44 80 47
P◇ 54 101912 31 48 80 45
R△ 21 102013 31 52 80 43
S⌂ 10 102213 31 59 80 38
OZONE CONCENTRATION PPBV


08/02/80
FILE 6
FILE7
ALTITUDE (M)
EDT
N LAT
W LON
A○ 13 102413 32 7 80 33
D△ 50 103444 32 45 80 7
E⌂ 51 103544 32 49 80 5
F○ 39 103644 32 53 80 6
H□ 41 103744 32 57 80 8
J◇ 61 103844 33 1 80 10
K△ 54 103944 33 6 80 11
L⌂ 51 104044 33 10 80 13
M○ 41 104145 33 14 80 16
N□ 37 104245 33 18 80 19
P◇ 51 104345 33 22 80 22
R△ 28 104445 33 26 80 24
S⌂ 45 104545 33 30 80 27
OZONE CONCENTRATION PPBV

Concluded


08/02/80
FILE 7
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
A○ 48
B□ 42
C◇ 43
D△ 10
EDT 104645 104745 104846 104909
N LAT 33 34 33 37 33 41 33 44
W LON 80 25 80 22 80 20 80 17
0 40 80 120 160 200
OZONE CONCENTRATION PPBV
OZONE CONCENTRATION PPBV

ELECTRA FLIGHT PATH AUGUST 5, 1980



Instrument Parameters for August 5, 1980, Flight

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
1	1012	1054	5	(*a*)	(*a*)	(*a*)	7	2230	0.5	No	3973
2	1107	1121	5	(*a*)	(*a*)	(*a*)	7	2310	.5	No	3963 to 3644
3	1131	1213	5	(*a*)	(*a*)	(*a*)	7	2230	.5	No	3588[b] to 4337
4	1311	1323	5	5	2500	0.2/0.1	7	2200	.5	No	4358 to 4032
5	1341	1347	5	5	2600	.2/.1	7	2200	.5	No	3936 to 3630

[a] Aerosol only.
[b] 1131 to 1205 EDT.

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR AUGUST 5, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/05/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
1015	34.	00.	74.	00.	0.		500.		70.	500.		700.		2100.		2600.	
1345	40.	58.	81.	60.	410.		1400.		220.	1400.		2100.		3000.		3200.	

43

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
1015	34.0	57.5	77.0	37.5	40.		620.		90.	NA		NA		2860.	M+	2900.	
1020	34.0	41.0	77.0	44.5	20.		620.		90.	NA		NA		2880.	M+	2900.	
1025	34.0	24.5	77.0	50.5	20.		600.		100.	NA		NA		2880.	M+	2900.	
1030	34.0	25.5	78.0	08.5	20.		690.		100.	NA		NA		2880.	M+	2900.	
1035	34.0	32.0	78.0	29.0	20.		630.		70.	630.		740.		2880.	M+	2900.	
1040	34.0	38.0	79.0	49.5	40.		630.		120.	540.		750.		2860.	M+	2900.	
1045	34.0	43.5	79.0	09.0	60.		520.		90.	NA		NA		2840.	M+	2900.	
1050	34.0	49.0	79.0	29.5	60.		600.		100.	NA		NA		2840.	M+	2900.	
1055	34.0	55.0	79.0	50.0													
1100	35.0	01.0	80.0	10.5													
1105	35.0	06.0	80.0	30.5													
1110	35.0	11.5	80.0	51.5	230.		570.		80.	NA		NA		2470.	M+	2700.	
1115	35.0	22.5	81.0	01.0	260.		ND		ND	NA		NA		2440.	M+	2700.	6
1120	35.0	41.0	81.0	10.0	300.		ND		ND	NA		NA		2400.	M+	2700.	6
1125	35.0	57.0	81.0	07.5													
1130	36.0	13.0	80.0	46.0													
1135	36.0	25.0	80.0	28.0	380.		1180.		ND	NA		NA		2220.	M+	2600.	
1140	36.0	44.0	80.0	01.5	310.		1040.		ND	NA		NA		2290.	M+	2600.	
1145	36.0	57.5	79.0	41.5	410.		940.		120.	NA		NA		2190.	M+	2600.	
1150	37.0	11.0	79.0	22.0	410.		1160.	S	100.	NA		NA		2600.	SM+	2600.	
1155	37.0	31.0	78.0	59.0	350.		1220.	S	220.	NA		NA		2600.	SM+	2600.	
1200	37.0	38.0	78.0	43.0	110.		780.		80.	NA		NA		2490.	M+	2600.	
1205	37.0	51.5	78.0	22.0	120.		900.		120.	1350.		1800.		2480.	M+	2600.	
1210	37.0	58.0	78.0	04.5	150.		630.		150.	1350.		1800.		2970.	M+	3120.	
1215	38.0	11.5	77.0	39.5													
1220	38.0	25.0	77.0	15.5													
1225	38.0	42.0	76.0	45.0													
1230	39.0	11.0	76.0	50.0													

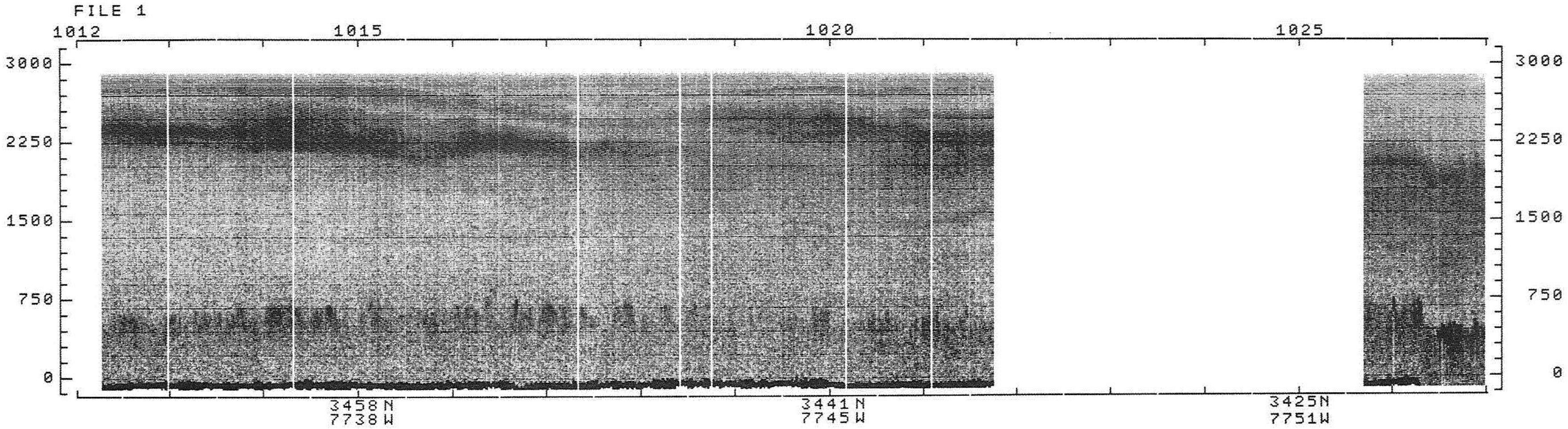
Concluded

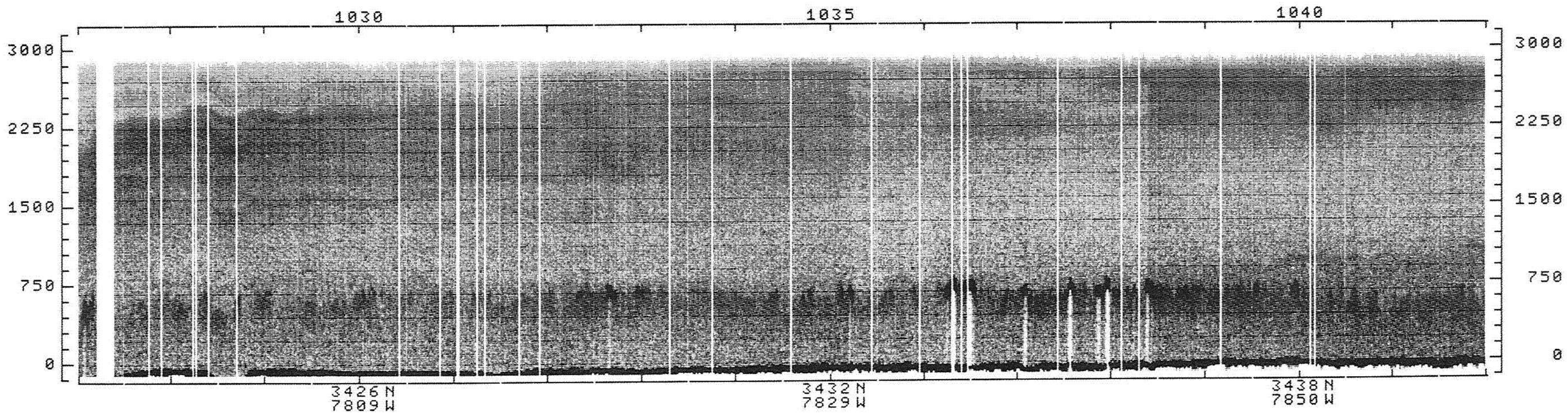
PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/05/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
1235	39.0	35.0	76.0	54.5												
1240	39.0	54.5	76.0	58.0												
1245	40.0	14.0	77.0	01.0												
1250	40.0	33.0	76.0	39.0												
1255	40.0	47.5	76.0	21.0												
1300	40.0	46.0	75.0	58.0												
1305	40.0	37.0	75.0	26.0												
1310	40.0	32.0	74.0	59.0												
1315	40.0	24.0	74.0	29.0	70.		690.		200.	NA		NA		2780.	M	3060.
1320	40.0	18.0	74.0	10.0	10.		1380.			1320.		2100.		2500.	M	3060.
1325	39.0	58.0	74.0	19.0												
1330	39.0	52.0	74.0	27.0												
1335	39.0	24.0	74.0	37.0												
1340	39.0	09.0	74.0	47.0												
1345	38.0	51.0	74.0	57.0												

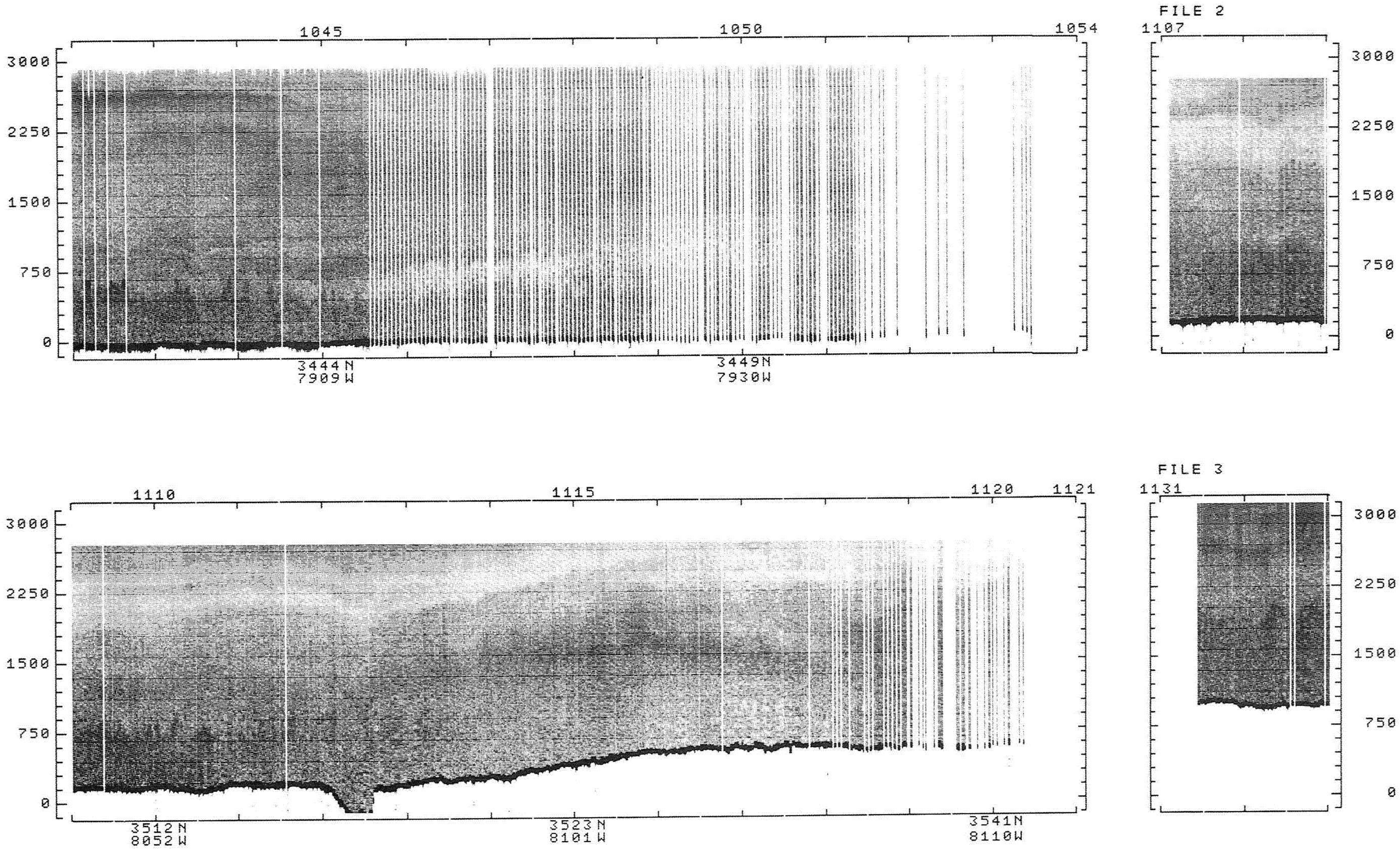
(6) NOT ABLE TO MEASURE MIXED HEIGHT OR 2-SIGMA VARIATION BECAUSE OF LOSS OF CONTRAST

AUGUST 5, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

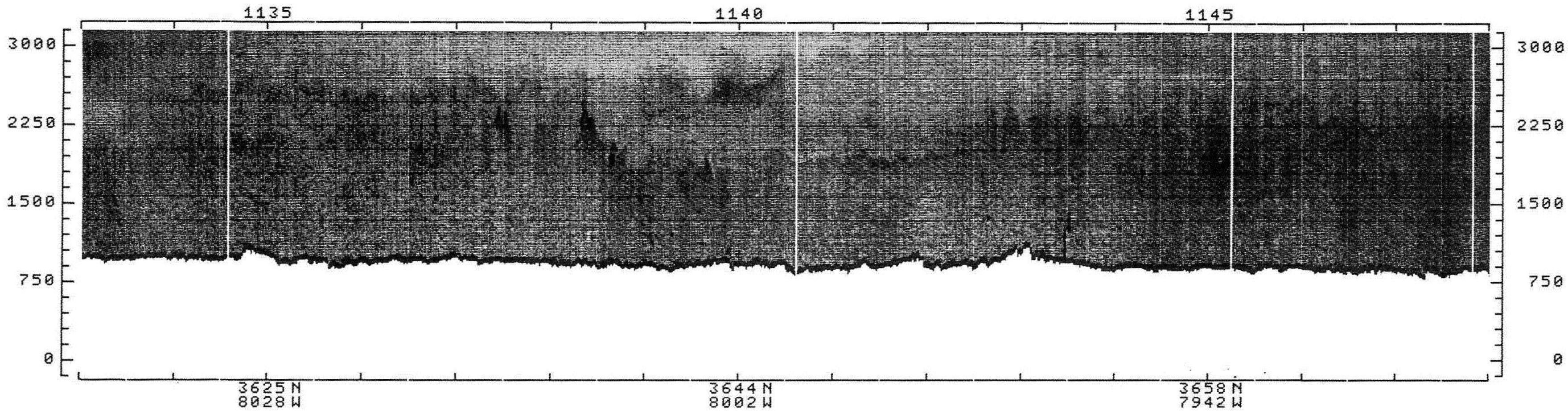


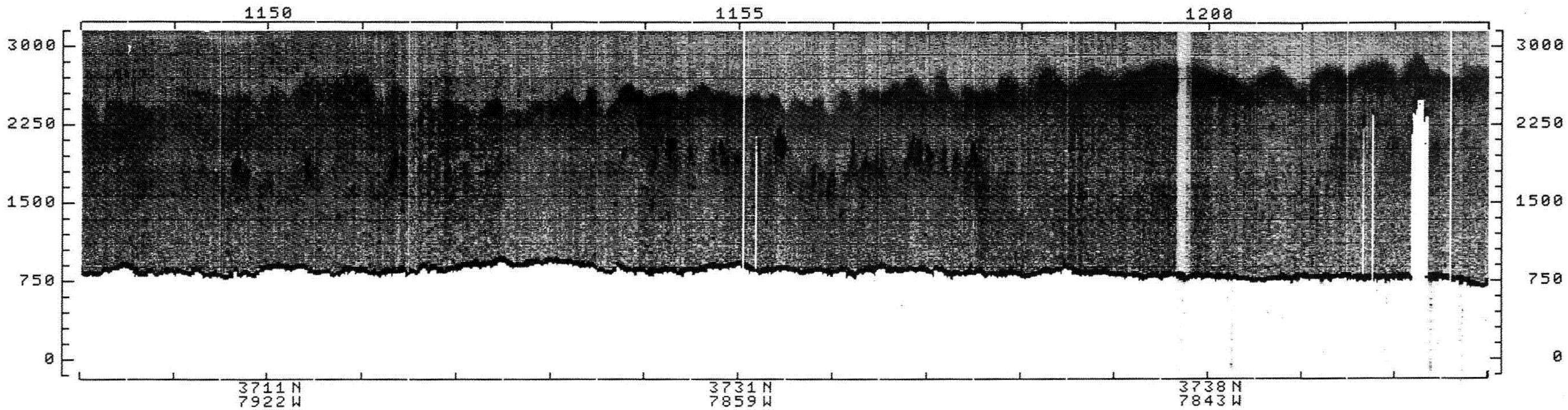


AUGUST 5, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

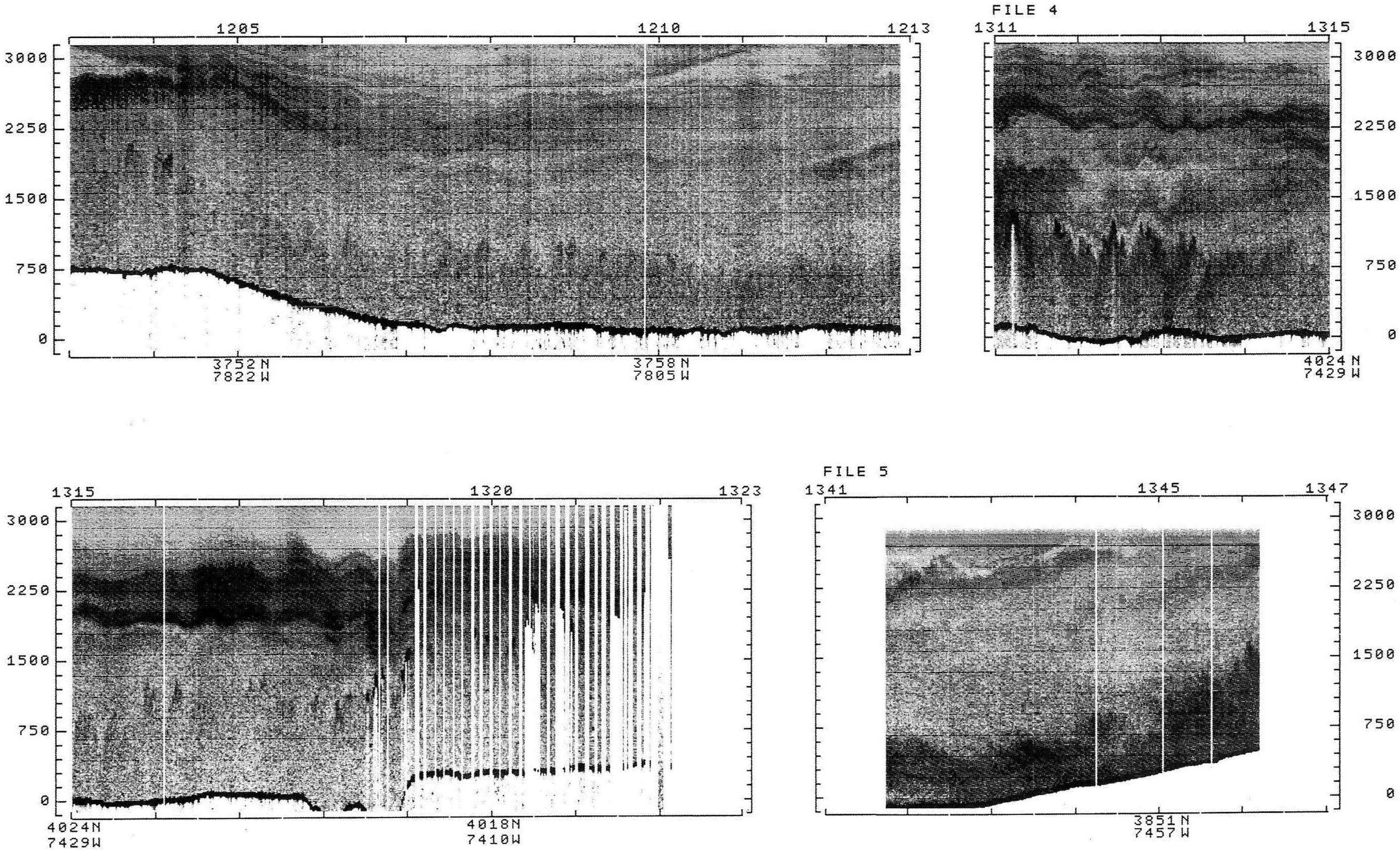


AUGUST 5, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

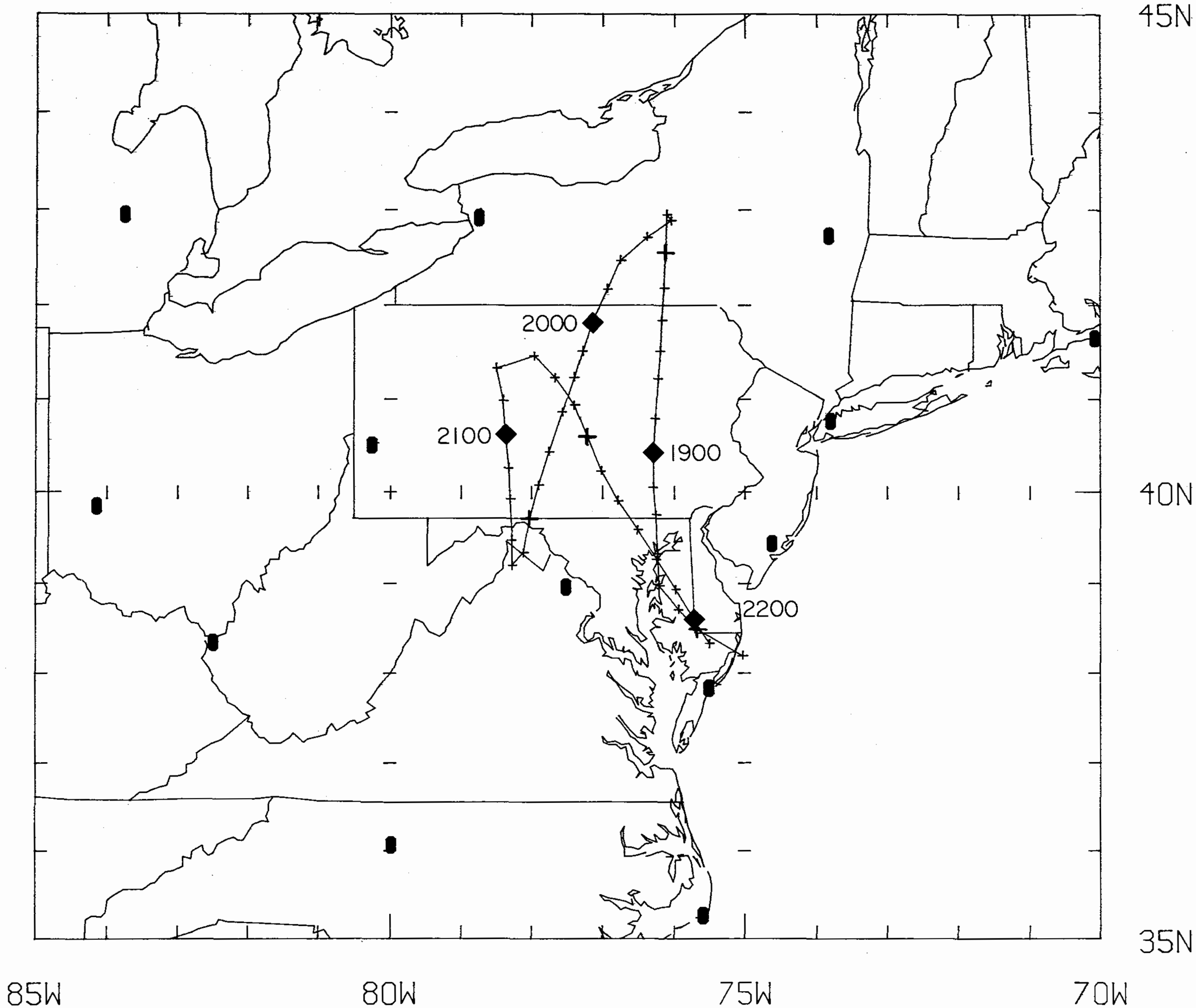




AUGUST 5, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



ELECTRA FLIGHT PATH AUGUST 7, 1980



Instrument Parameters for August 7, 1980, Flight

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
1	1823	1841	5	6	2396	0.2/0.1	7	2233	0.5	Yes	3361
2	1846	1903	5	6	2488	.2/.1	7	2233	.5	Yes	3309
3	1910	1940	5	6	2488	.2/.1	7	2233	.5	No	3309
4	1949	1953	5	6	2488	.2/.1	7,6	2233	.5	No	3957
5	1954	2002	5	6	2648	.2/.1	6	2233	.5	No	3374
6	2007	2022	5	6	2648	.2/.1	6	2100	.5	Yes	4195
7	2026	2041	5	6	2648	.2/.1	7	2300	.5	Yes	4040
8	2049	2105	5	6	2648	.2/.1	8	2300	.5	Yes	4057
9	2110	2114	5	6	2648	.2/.1	8	2300	.5	Yes	4057
10	2117	2139	1	6	2648	.2/.1	8,7	2300	.5	Yes	3679
11	2139	2145	5	6	2648	.2/.1	7	2300	.5	Yes	3679
12	2146	2154	5	6	2648	.2/.1	7	2300	.5	Yes	3680
13	2158	2205	5	6	2648	.2/.1	7	2300	.5	Yes	3639

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR AUGUST 7, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/07/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
1825	38.	00.	80.	00.	0.		100.		0.			2200.		1200.		2200.	
2205	42.	60.	78.	60.	700.		2000.		300.			2400.		3200.		3300.	
		45															
1825	38.0	12.0	75.0	02.0	17.		1530.		50.	NA		NA		NA		2310.	
1830	38.0	29.3	75.0	40.0	14.		1560.		30.	NA		NA		NA		2310.	
1835	38.0	42.8	75.0	56.0	14.		960.		30.	NA		NA		NA		2310.	
1840	38.0	58.5	76.0	12.0	0.		320.		60.	NA		NA		NA		2310.	
1845	39.0	19.6	76.0	13.5													
1850	39.0	45.0	76.0	15.0	76.	V	910.	S	100.	NA		NA		1360.	S	2260.	
1855	40.0	03.5	76.0	17.5	109.	V	1510.	S	150.	NA		NA		1810.	S	2260.	
1900	40.0	26.0	76.0	17.0	167.	V	1200.	S	300.	NA		NA		1810.	S	2260.	
1905	40.0	47.5	76.0	15.5													
1910	41.0	13.5	76.0	13.5													
1915	41.0	31.5	76.0	11.5	720.	V	1510.	S	120.	NA		NA		2260.	S +	2260.	
1920	41.0	50.8	76.0	10.0	256.	V	ND		ND	ND		2260.	S+	ND		2260.	7
1925	42.0	11.5	76.0	08.2	416.	V	1810.	S	120.	NA		NA		NA		2260.	
1930	42.0	33.5	76.0	07.0	457.	V	1810.	S	120.	NA		NA		NA		2260.	
1935	42.0	57.5	76.0	06.0	439.	V	ND		ND	ND		2260.	S+	ND		2260.	7
1940	42.0	53.5	76.0	02.5													
1945	42.0	43.0	76.0	23.0													
1950	42.0	28.8	76.0	45.5	560.	V	1210.	S	130.	NA		NA		1720.	SM	2260.	
1955	42.0	10.5	76.0	56.0													
2000	41.0	49.3	77.0	09.0	500.	V	ND		ND	ND		2320.	S+	ND		2320.	8
2005	41.0	31.2	77.0	17.2													
2010	41.0	14.5	77.0	24.0	460.	V	ND		ND	NA		NA		3140.	SM	3300.	
2015	40.0	52.0	77.0	33.5	610.	V	ND		ND	NA		NA		2280.	SM	3300.	
2020	40.0	26.5	77.0	45.0	310.	V	ND		ND	NA		NA		2470.	SM	3300.	
2025	40.0	44.5	77.0	53.5													
2030	39.0	42.5	78.0	01.4	305.	V	1850.	S	100.	NA		NA		2450.	S	3140.	
2035	39.0	20.3	78.0	06.5	305.	V	1700.	S	60.	NA		NA		1940.	S	3140.	
2040	39.0	12.0	78.0	16.0	299.	V	1910.	S	150.	NA		NA		NA		3140.	

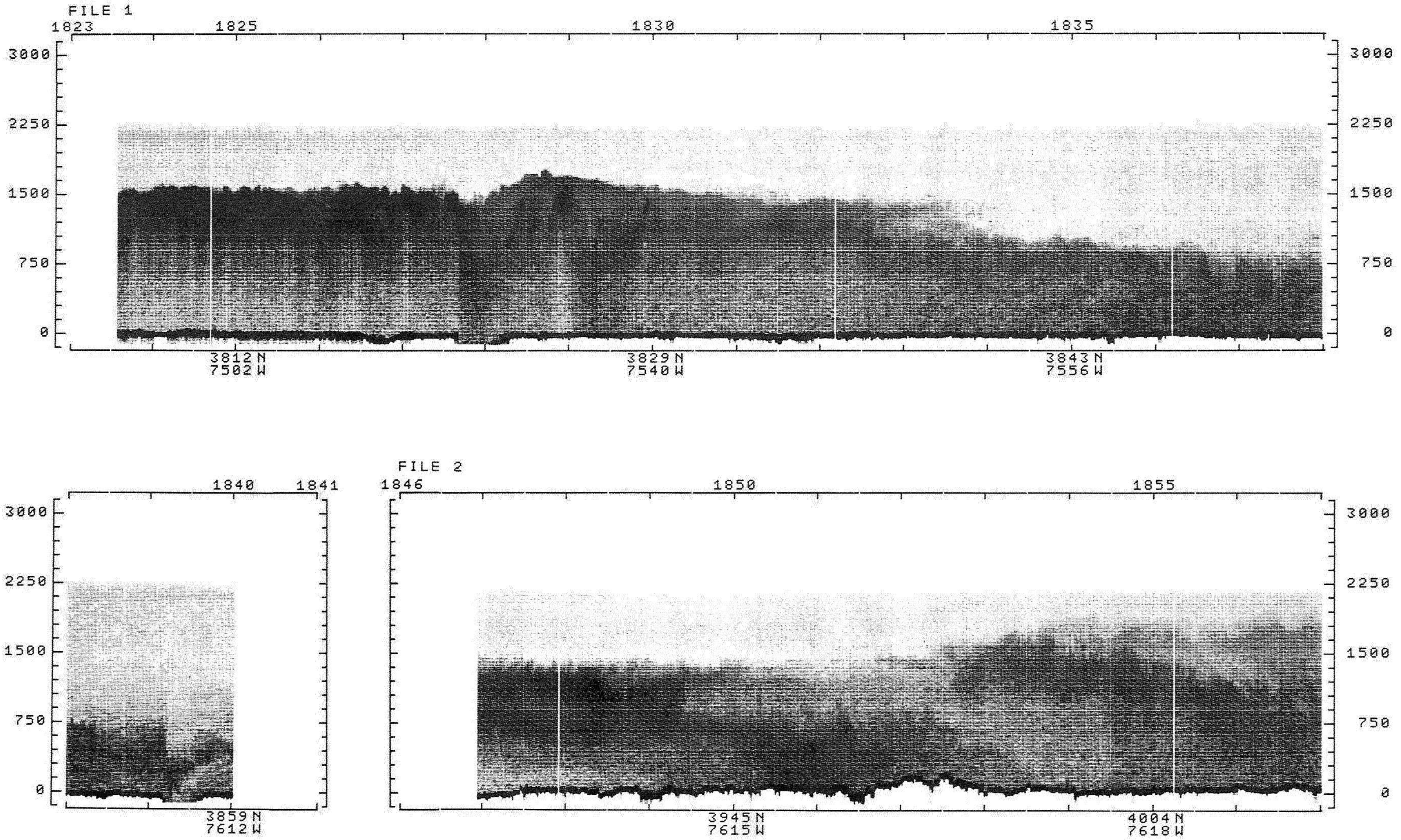
Concluded

PROJECT PEPE/PEPE-NEROS STUDY   UVDA01   8/07/80   18   0

TIME	LAT	LAT	LONG	LONG	ALT	K	MIXHT	L	H2SIG	LWCCL	M	MXCLD	N+	TPUSL	N1+	MAXSG
EDT	DEG	MIN	DEG	MIN	MMSL		MAGL		M	MAGL		MAGL		MAGL		MMSL
2045	39.0	28.8	78.0	16.5												
2050	39.0	55.5	78.0	18.0	305.	V	1900.	S	150.	NA		NA		NA		2860.
2055	40.0	15.9	78.0	19.6	457.	V	1810.	S	60.	NA		NA		2360.	SM	2860.
2100	40.0	37.9	78.0	22.1	457.	V	910.	S	100.	NA		NA		1810.	SM	2860.
2105	40.0	59.8	78.0	24.1												
2110	41.0	20.4	78.0	30.0	610.	V	1810.	S	60.	NA		NA		NA		2860.
2115	41.0	28.0	77.0	58.0												
2120	41.0	14.0	77.0	40.5	457.	V	1130.	S	120.	NA		NA		2480.	SM+	2480.
2125	40.0	56.6	77.0	23.6	457.	V	1200.	S	150.	NA		NA		2180.	SM	2480.
2130	40.0	36.2	77.0	13.3	229.	V	680.	S	130.	NA		NA		2210.	SM	2480.
2135	40.0	14.0	77.0	01.5	197.	V	830.	S	100.	NA		NA		2480.	SM+	2480.
2140	39.0	54.3	76.0	47.1												
2145	39.0	35.4	76.0	30.7												
2150	39.0	15.8	76.0	14.7	5.		280.		70.	NA		NA		1200.		2630.
2155	38.0	55.9	75.0	58.5												
2200	38.0	36.3	75.0	42.7	9.		160.		30.	NA		NA		1240.		2590.
2205	38.0	20.0	75.0	30.0												

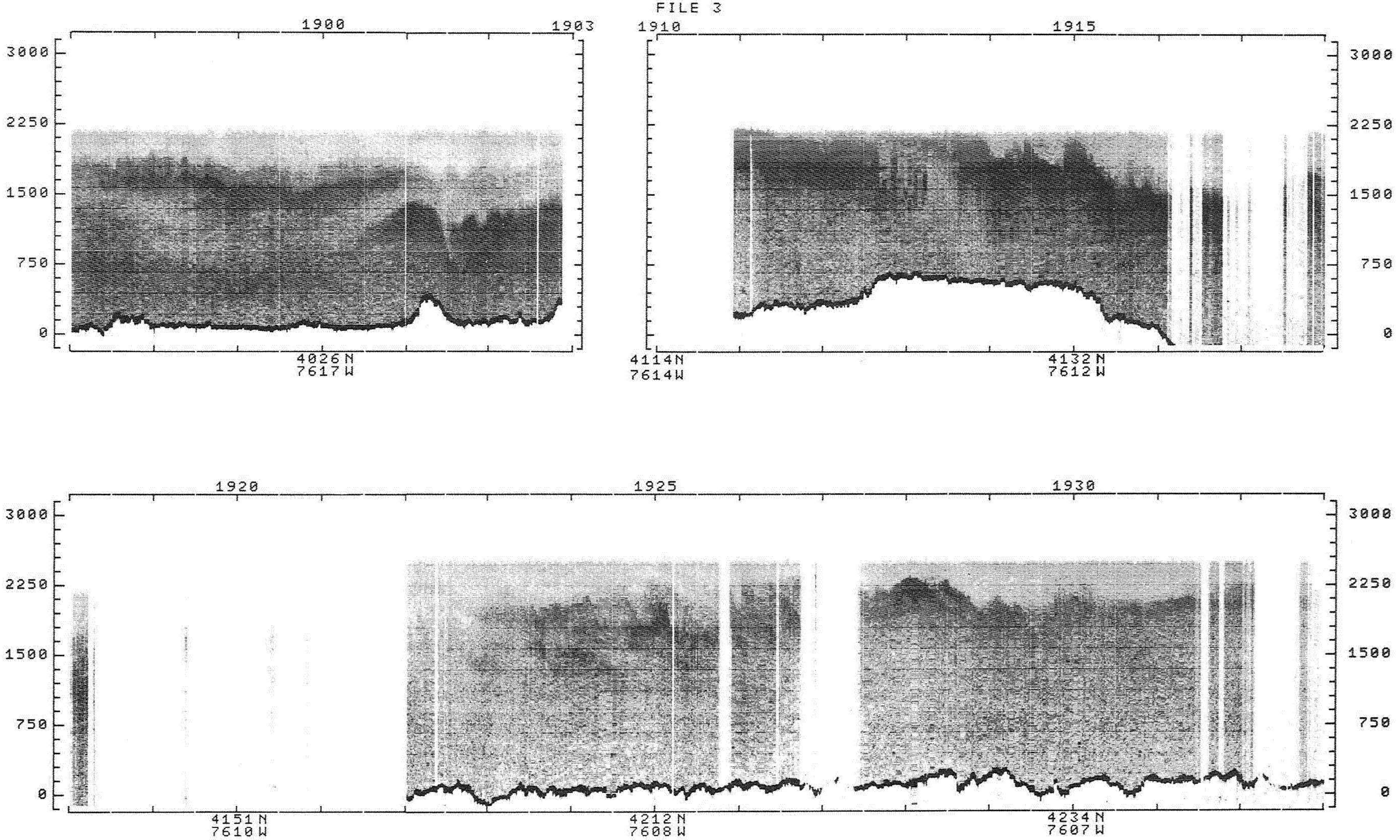
(7) OBSCURATION BY CLOUD
(8) RAIN

AUGUST 7, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

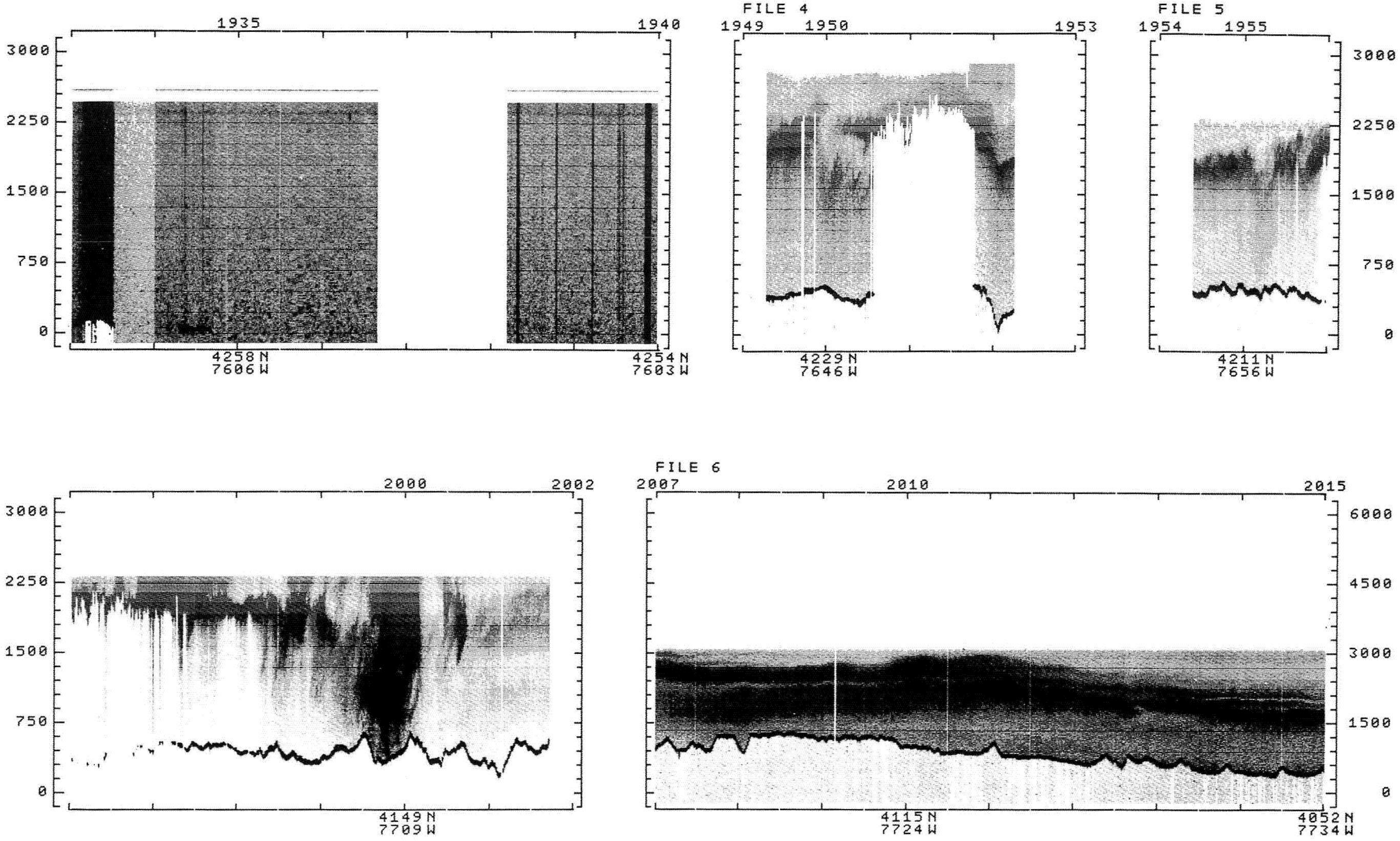


AUGUST 7, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

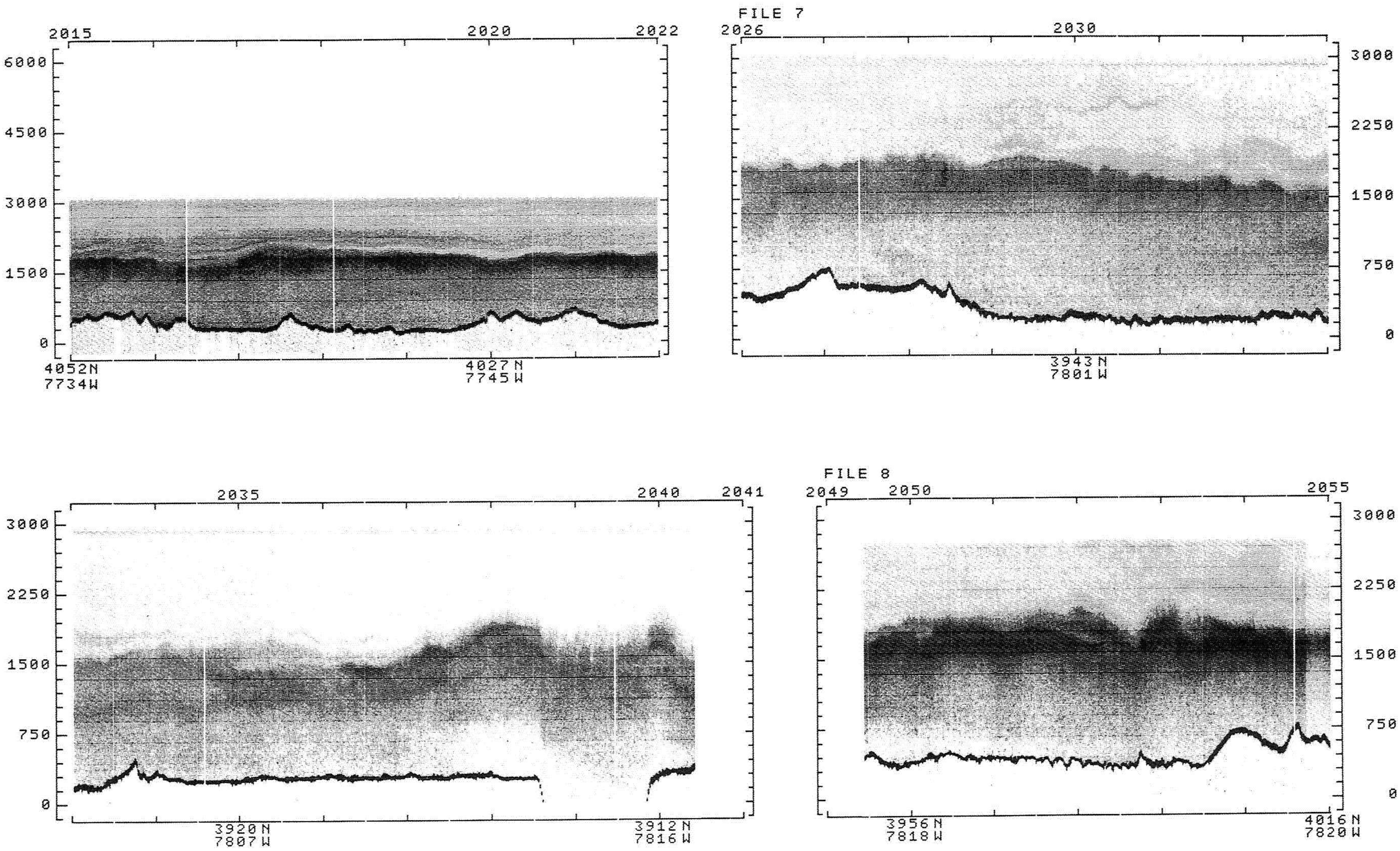
FILE 3



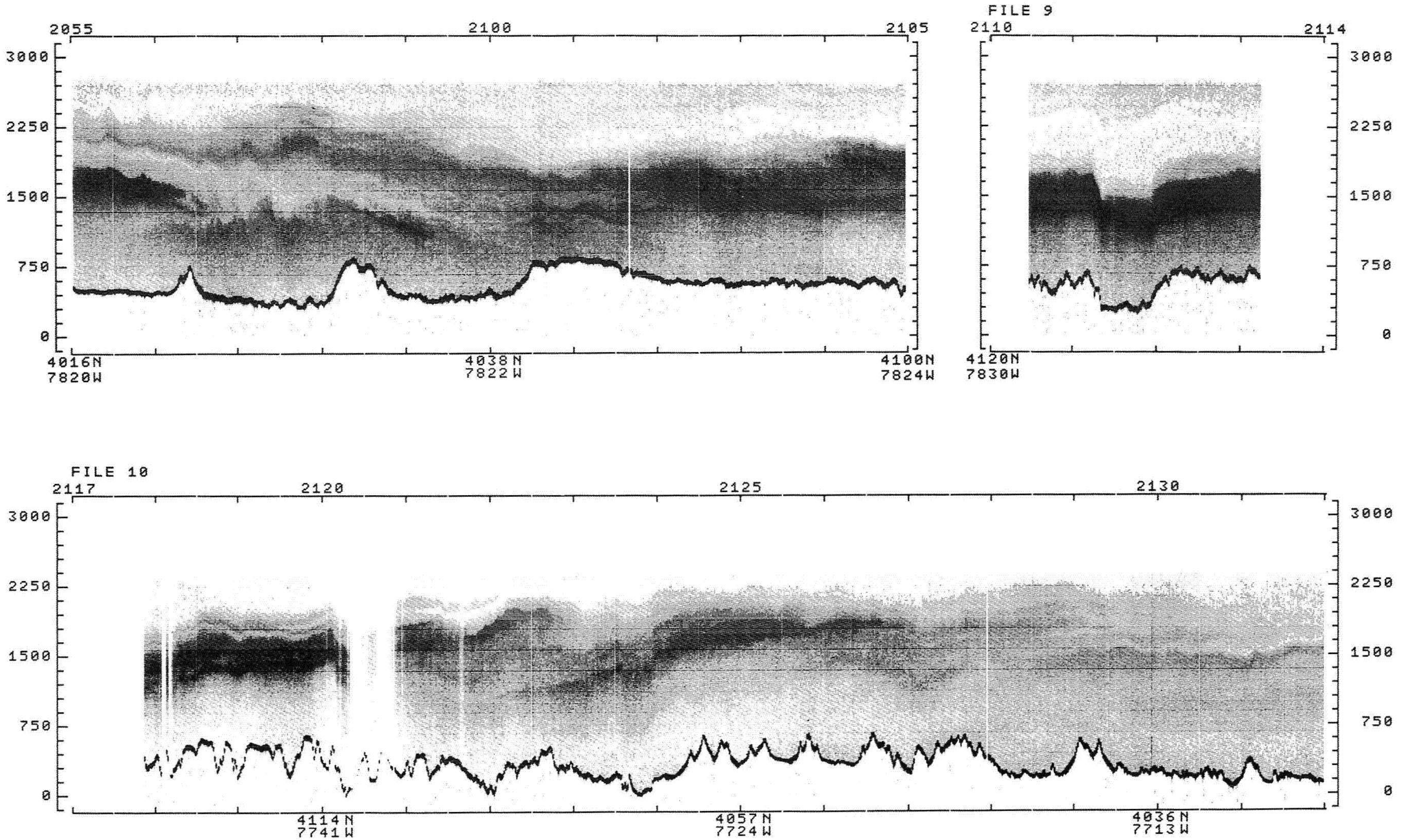
AUGUST 7, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



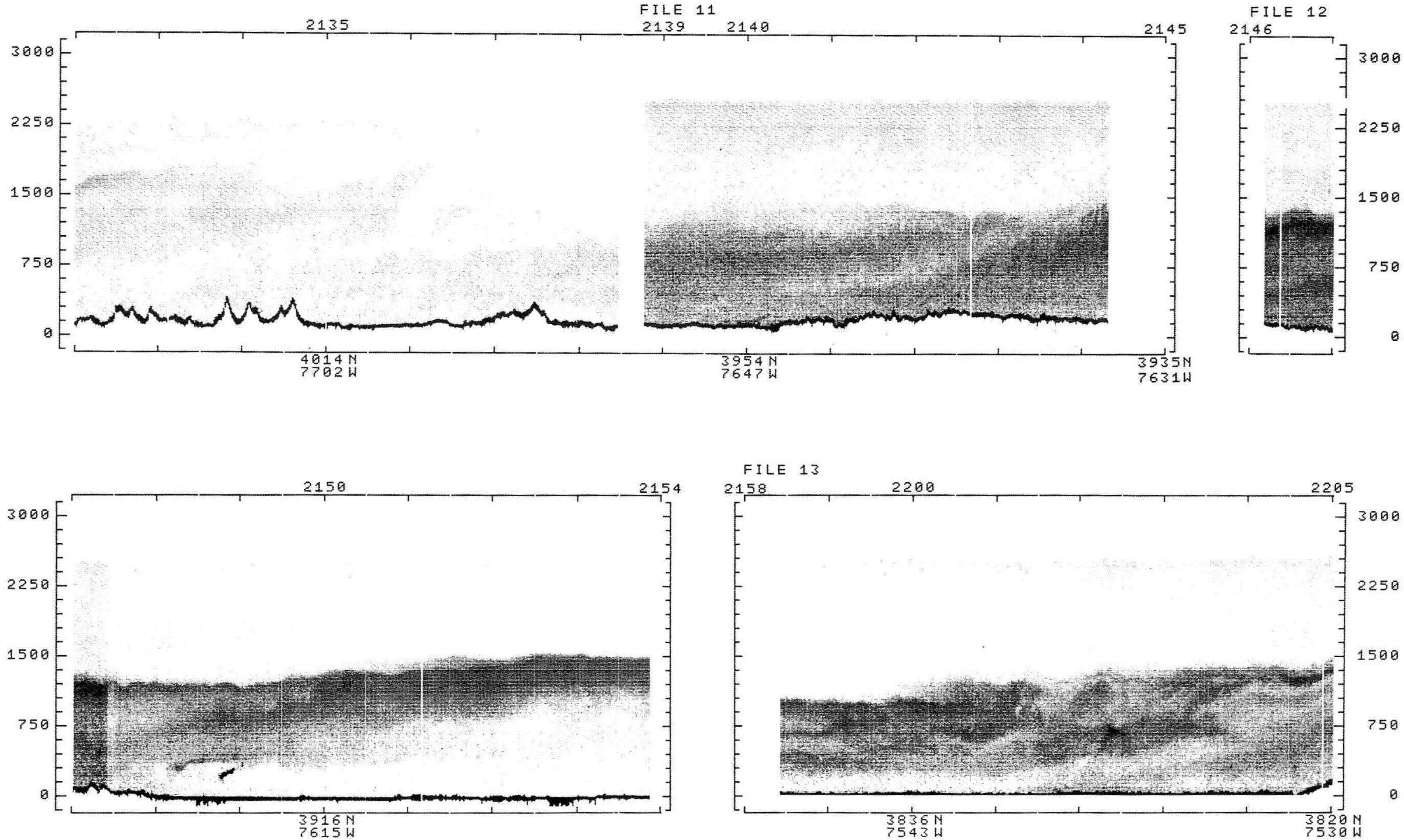
AUGUST 7, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



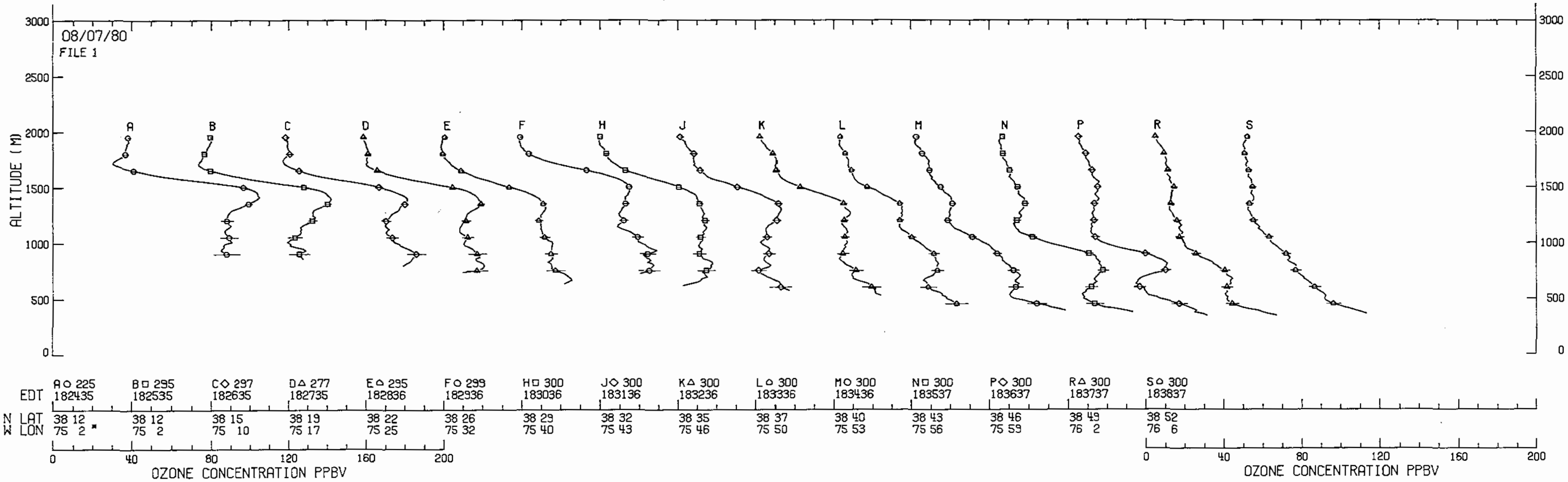
AUGUST 7, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

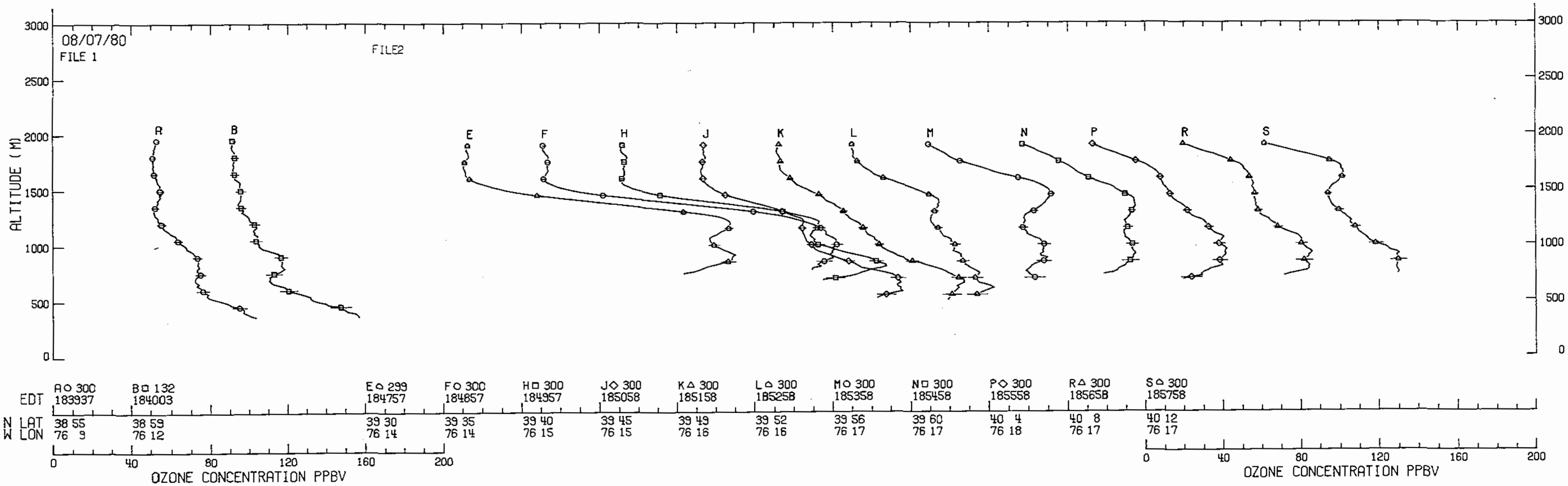


AUGUST 7, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

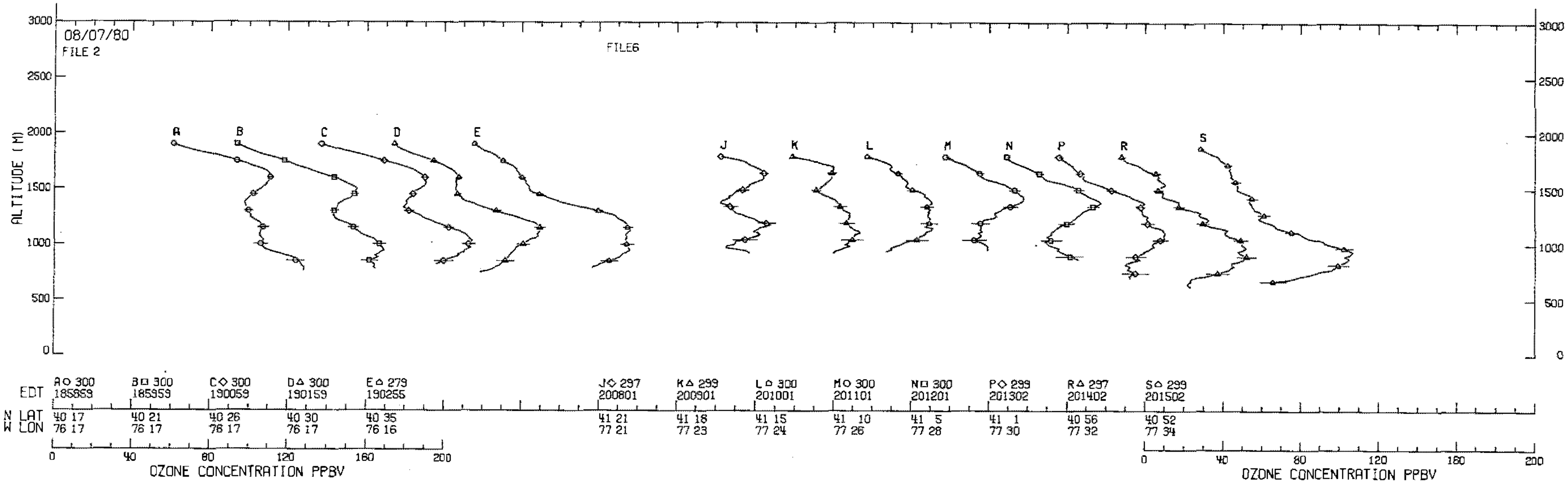


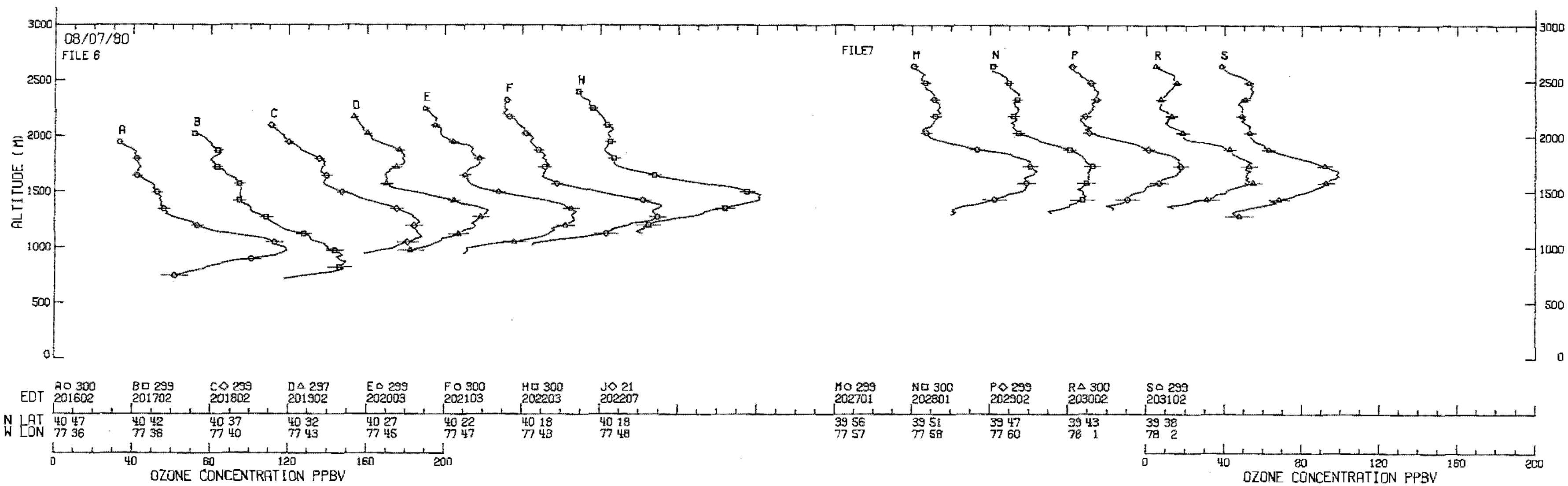
O_3 PROFILES FOR AUGUST 7, 1980, FLIGHT



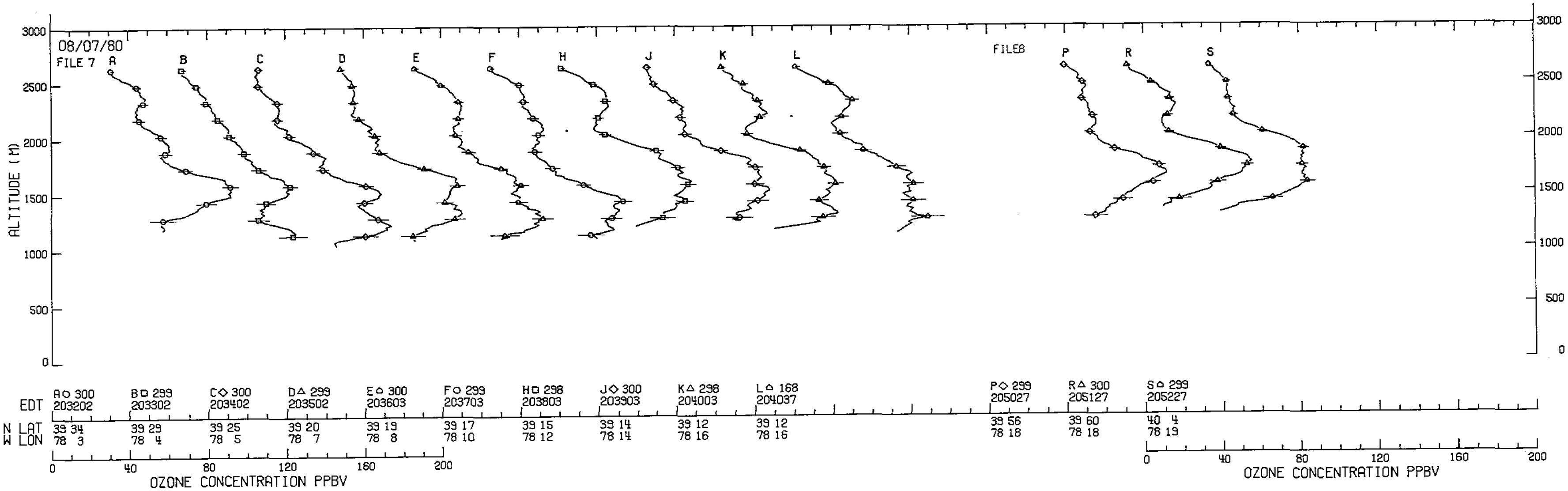


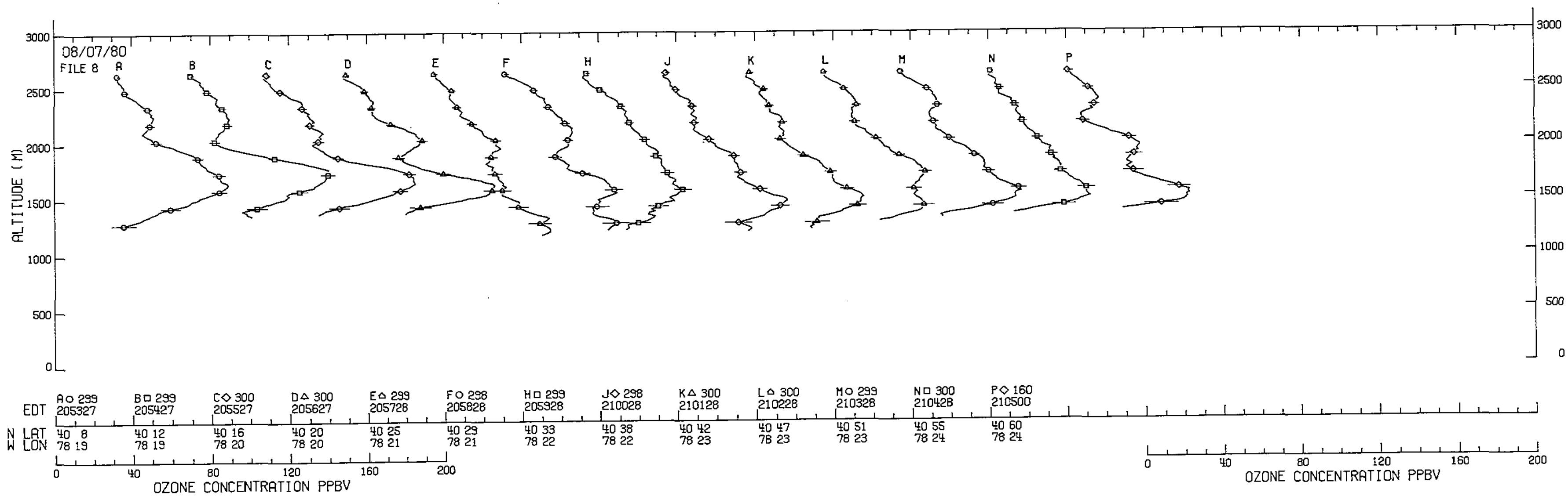
Continued


08/07/80
FILE 2
FILE6
ALTITUDE (M)
OZONE CONCENTRATION PPBV
EDT
N LAT
W LON
A○ 300 185859 40 17 76 17
B□ 300 185959 40 21 76 17
C◇ 300 190059 40 26 76 17
D△ 300 190159 40 30 76 17
E⌂ 279 190255 40 35 76 16
J◇ 297 200801 41 21 77 21
K△ 299 200901 41 18 77 23
L⌂ 300 201001 41 15 77 24
M○ 300 201101 41 10 77 26
N□ 300 201201 41 5 77 28
P◇ 299 201302 41 1 77 30
R△ 297 201402 40 56 77 32
S⌂ 299 201502 40 52 77 34

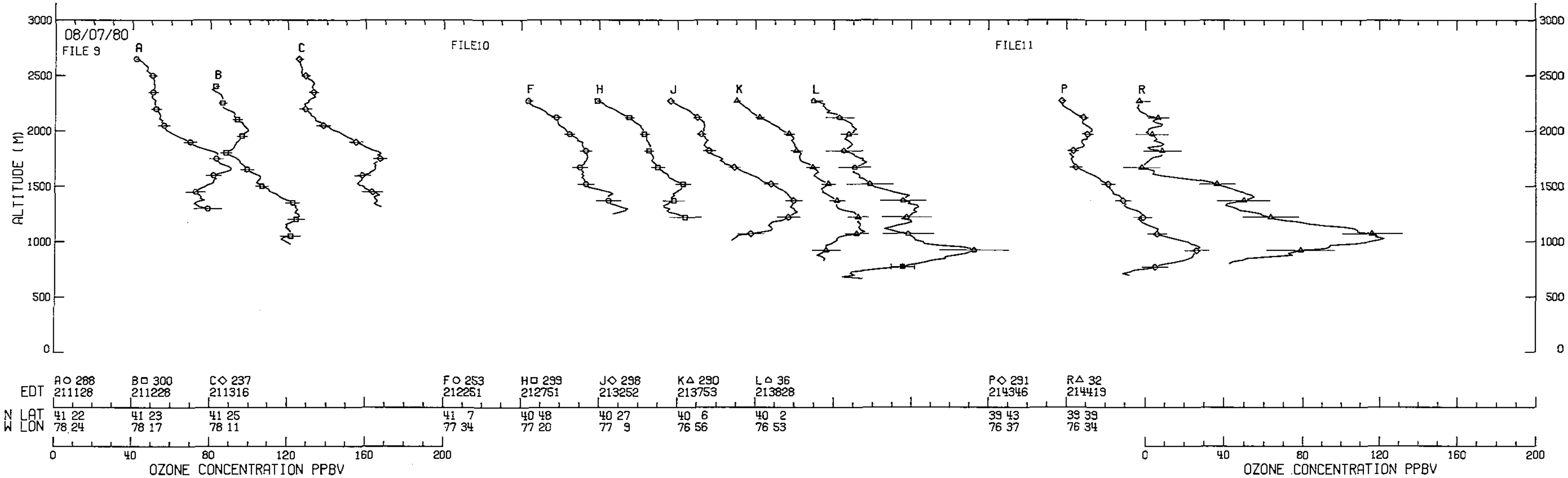

08/07/80
FILE 6
FILE7
ALTITUDE (M)
OZONE CONCENTRATION PPBV
EDT
N LAT
W LON
A○ 300 201602 40 47 77 36
B□ 299 201702 40 42 77 38
C◇ 299 201802 40 37 77 40
D△ 297 201902 40 32 77 43
E⌂ 299 202003 40 27 77 45
F○ 300 202103 40 22 77 47
H□ 300 202203 40 18 77 48
J◇ 21 202207 40 18 77 48
M○ 299 202701 39 56 77 57
N□ 300 202801 39 51 77 58
P◇ 299 202902 39 47 77 60
R△ 300 203002 39 43 78 1
S⌂ 299 203102 39 38 78 2

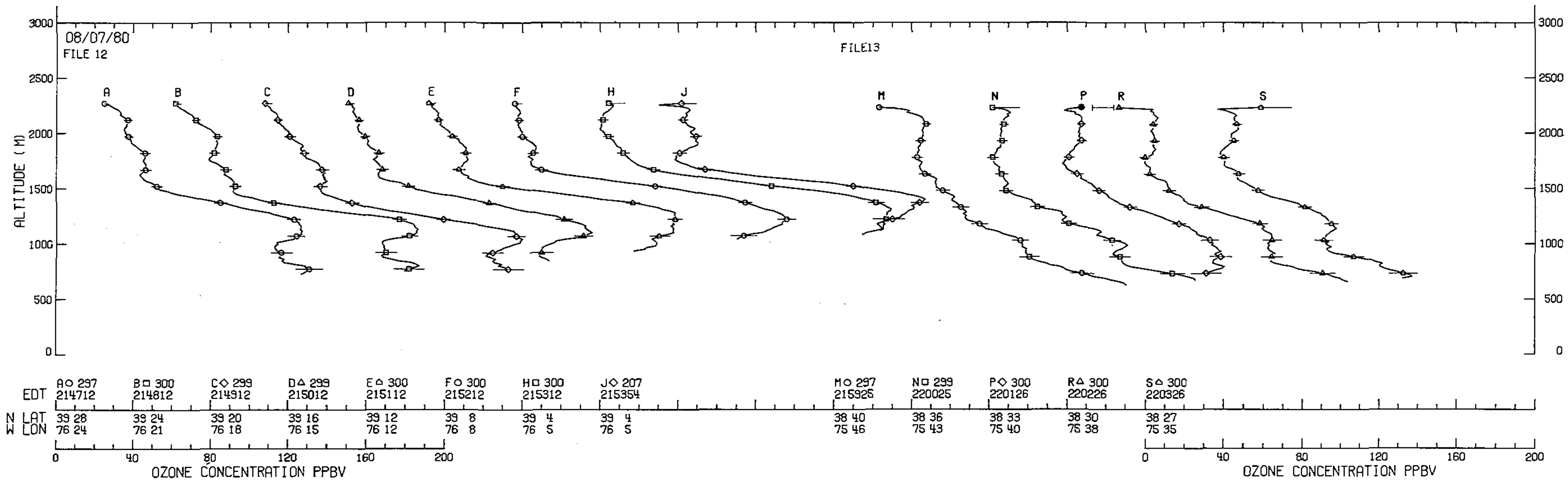
Continued


08/07/80
FILE 7
FILE8
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
A B C D E F H J K L P R S
EDT
AO 300 203202
B□ 299 203302
C◇ 300 203402
D△ 299 203502
E⌂ 300 203603
FO 299 203703
H□ 298 203803
J◇ 300 203903
K△ 298 204003
L⌂ 168 204037
P◇ 299 205027
R△ 300 205127
S⌂ 299 205227
N LAT
W LON
39 34 78 3
39 29 78 4
39 25 78 5
39 20 78 7
39 19 78 8
39 17 78 10
39 15 78 12
39 14 78 14
39 12 78 16
39 12 78 16
39 56 78 18
39 60 78 18
40 4 78 19
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

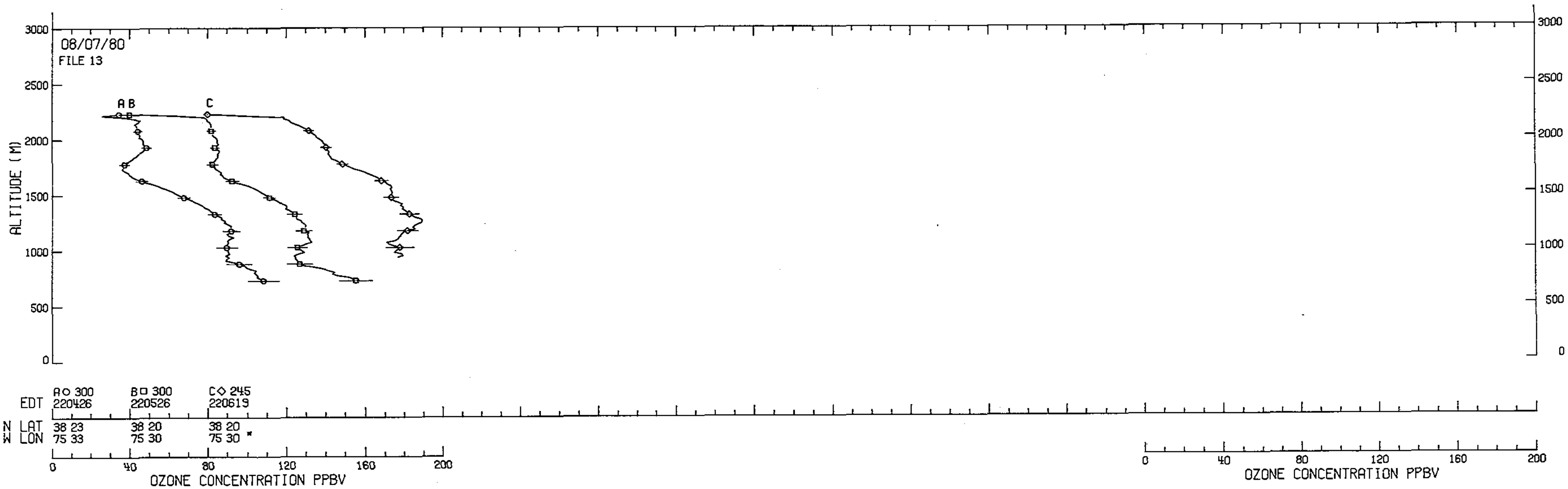

08/07/80
FILE 8
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
A B C D E F H J K L M N P
EDT
AO 299 205327
B□ 299 205427
C◇ 300 205527
D△ 300 205627
E⌂ 299 205728
FO 298 205828
H□ 299 205928
J◇ 298 210028
K△ 300 210128
L⌂ 300 210228
MO 299 210328
N□ 300 210428
P◇ 160 210500
N LAT
W LON
40 8 78 19
40 12 78 19
40 16 78 20
40 20 78 20
40 25 78 21
40 29 78 21
40 33 78 22
40 38 78 22
40 42 78 23
40 47 78 23
40 51 78 23
40 55 78 24
40 60 78 24
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

Continued

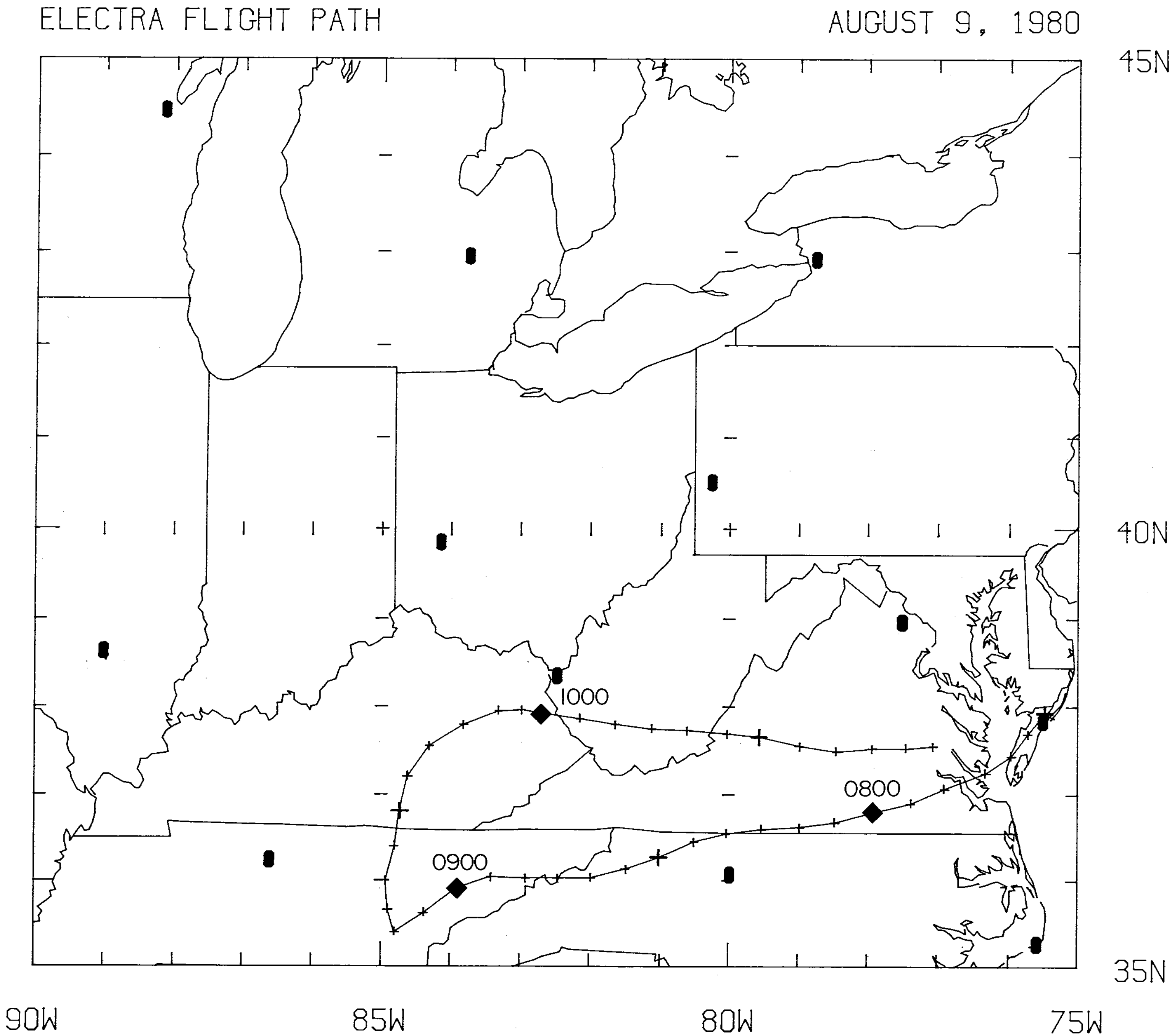

08/07/80
FILE 9
FILE10
FILE11
ALTITUDE (M)
A B C F H J K L P R
EDT
N LAT
W LON
A○ 288 211128 41 22 78 24
B□ 300 211228 41 23 78 17
C◇ 237 211316 41 25 78 11
F○ 253 212251 41 7 77 34
H□ 299 212751 40 48 77 20
J◇ 298 213252 40 27 77 9
K△ 290 213753 40 6 76 56
L△ 36 213828 40 2 76 53
P◇ 291 214346 39 43 76 37
R△ 32 214419 39 39 76 34
OZONE CONCENTRATION PPBV
OZONE CONCENTRATION PPBV


08/07/80
FILE 12
FILE13
ALTITUDE (M)
A B C D E F H J M N P R S
EDT
N LAT
W LON
A○ 297 214712 39 28 76 24
B□ 300 214812 39 24 76 21
C◇ 299 214912 39 20 76 18
D△ 299 215012 39 16 76 15
E△ 300 215112 39 12 76 12
F○ 300 215212 39 8 76 8
H□ 300 215312 39 4 76 5
J◇ 207 215354 39 4 76 5
M○ 297 215925 38 40 75 46
N□ 299 220025 38 36 75 43
P◇ 300 220126 38 33 75 40
R△ 300 220226 38 30 75 38
S△ 300 220326 38 27 75 35
OZONE CONCENTRATION PPBV
OZONE CONCENTRATION PPBV

Concluded



06/07/80
FILE 13
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
A B
C
A○ 300
220426
B□ 300
220526
C◇ 245
220619
EDT
N LAT
W LON
38 23
75 33
38 20
75 30
38 20
75 30
0
40
80
120
160
200
OZONE CONCENTRATION PPBV


ELECTRA FLIGHT PATH
AUGUST 9, 1980
45N
40N
35N
90W
85W
80W
75W
1000
0900
0800

Instrument Parameters for August 9, 1980, Flight

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
1	0725	0736	5	(a)	(a)	(a)	7	2562	0.5	No	4665
2	0736	0820	5	(a)	(a)	(a)	7	2472	.5	No	4909[b] to 3955[c]
3	0840	0906	5	(a)	(a)	(a)	7	2472	.5	No	3933
4	0920	1014	5	(a)	(a)	(a)	7	2328	.5	No	3630[d] to 4250[e]
5	1019	1059	5	(a)	(a)	(a)	7	2328	.5	No	4263

[a]Aerosol only.
[b]0736 to 0759 EDT.
[c]0806 to 0820 EDT.
[d]0920 to 0948 EDT.
[e]0955 to 1014 EDT.

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR AUGUST 9, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/09/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
0730	40.	00.	80.	00.	0.		100.		0.	1100.		1400.		2100.		2500.
1055	80.	60.	84.	60.	1100.		1700.		180.	1300.		3500.		3600.		3600.

42

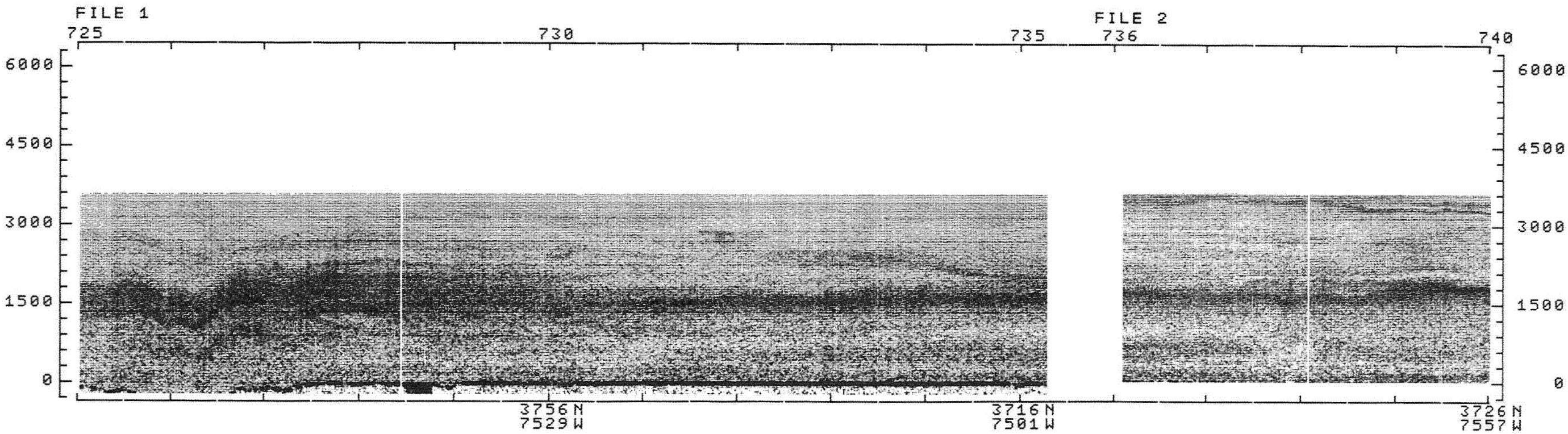
0730	37.0	56.0	75.0	29.0	10.		150.		30.	NA		NA		3540.	M+	3550.
0735	37.0	15.6	75.0	00.7	10.		100.		20.	NA		NA		3540.	M+	3550.
0740	37.0	26.4	75.0	57.4	10.		150.		30.	NA		NA		3510.	M+	3550.
0745	37.0	15.0	76.0	19.0	0.		180.		30.	NA		NA		3550.	M+	3550.
0750	37.0	04.0	76.0	54.2	30.		100.		30.	NA		NA		3520.	M+	3550.
0755	36.0	54.0	77.0	23.0	20.		100.		30.	ND		3530.	+	3530.	M+	3550.
0800	36.0	47.8	77.0	55.0	80.		120.		30.	ND		3470.	+	3470.	M+	3550.
0805	36.0	40.5	78.0	27.8	130.		560.		40.	NA		NA		2770.	M+	2700.
0810	36.0	37.2	78.0	58.5	150.		340.		150.	NA		NA		2750.	M+	2900.
0815	36.0	36.0	79.0	31.4	230.		680.		150.	NA		NA		2670.	M+	2900.
0820	36.0	32.8	80.0	02.5	310.	V	1150.	S	110.	NA		NA		2900.	SM+	2900.
0825	36.0	27.0	80.0	30.0												
0830	36.0	16.0	81.0	01.0												
0835	36.0	08.0	81.0	29.0												
0840	36.0	02.0	81.0	59.0												
0845	36.0	01.5	82.0	28.0	1067.	V	1460.	S	90.	NA		NA		2880.	SM+	2880.
0850	36.0	01.5	82.0	54.8	509.	V	600.	S	50.	NA		NA		2880.	SM+	2880.
0855	36.0	02.5	83.0	25.0	498.	V	540.	S	50.	NA		NA		2880.	SM+	2880.
0900	35.0	54.5	83.0	54.0	294.	V	530.	S	100.	NA		NA		2370.	SM	2880.
0905	35.0	37.6	84.0	23.0	305.	V	480.	S	50.	NA		NA		2130.	SM	2880.
0910	35.0	24.0	84.0	48.0												
0915	35.0	40.0	84.0	54.0												
0920	36.0	00.0	84.0	56.0												
0925	36.0	24.0	84.0	48.2	150.	V	720.	S	50.	NA		NA		2280.	SM	2580.
0930	36.0	48.0	84.0	44.5	310.	V	510.	S	50.	NA		NA		2580.	SM+	2580.
0935	37.0	12.5	84.0	37.4	310.	V	480.	S	50.	NA		NA		2580.	SM+	2580.
0940	37.0	33.0	84.0	18.5	340.		150.		30.	NA		NA		2580.	SM+	2580.
0945	37.0	47.8	83.0	49.5	310.		140.		30.	NA		NA		2580.	SM+	2580.

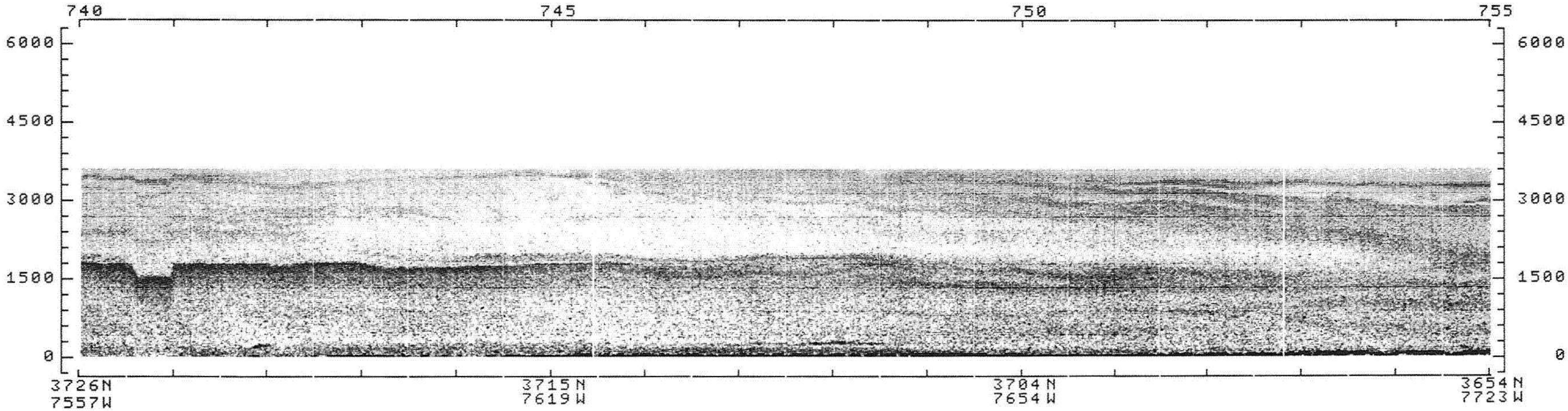
Concluded

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/09/80 18 0

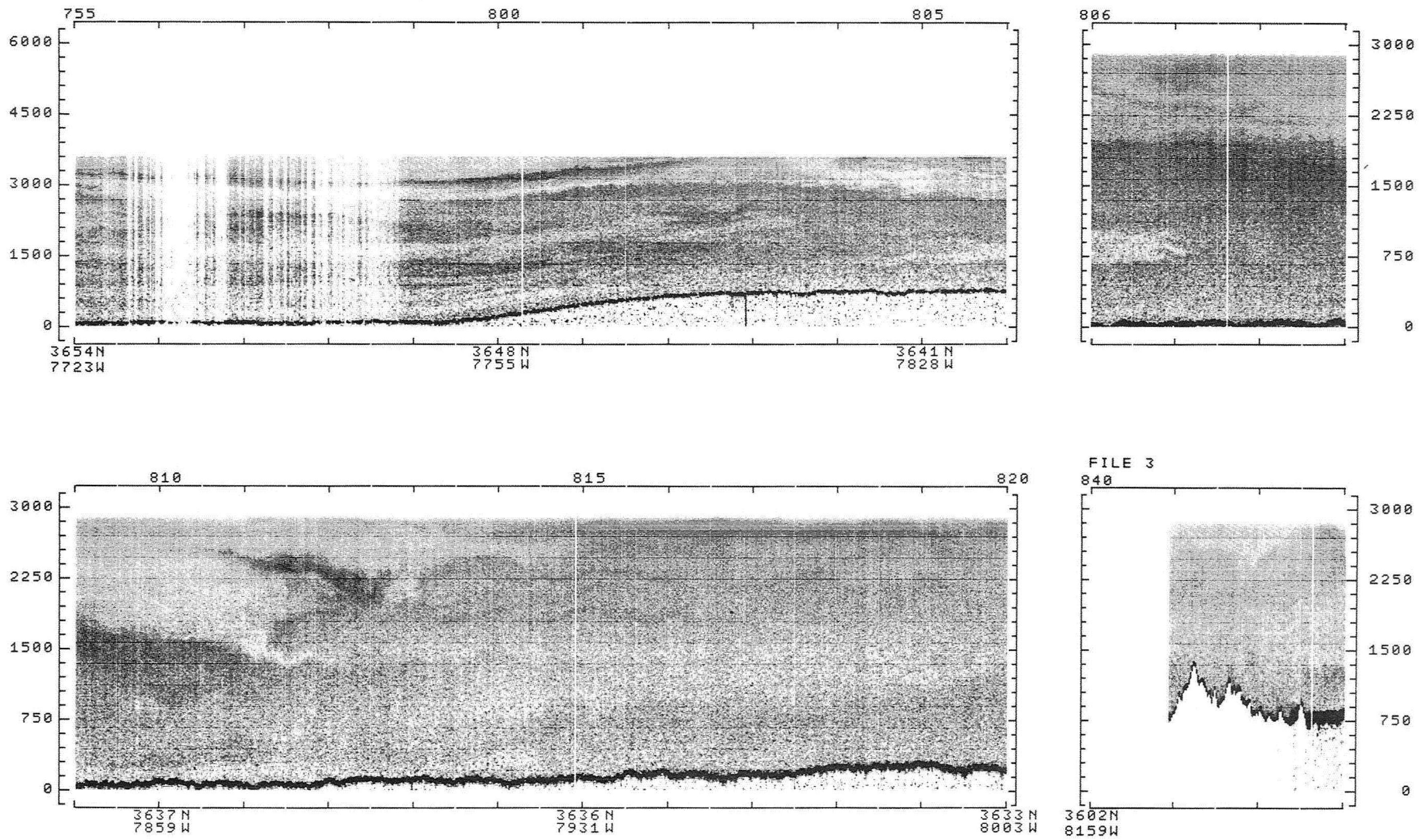
TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
0950	37.0	57.5	83.0	19.2	310.		200.		40.	NA		NA		2270.	M+	2580.
0955	37.0	58.0	82.0	59.0	310.	V	480.	S	20.	NA		NA		3200.	SM+	3200.
1000	37.0	56.0	82.0	43.0	310.	V	560.	S	50.	NA		NA		2750.	SM	3200.
1005	37.0	52.2	82.0	08.5	310.	V	900.	S	80.	NA		NA		2740.	SM	3200.
1010	37.0	47.8	81.0	38.4	610.	V	1130.	S	60.	NA		NA		2600.	SM	3200.
1015	37.0	45.0	81.0	07.0												
1020	37.0	43.8	80.0	36.8	690.	V	1290.	S	180.	1110.	S	1460.	S	2340.	SM	3210.
1025	37.0	41.8	80.0	02.5	1040.	V	1410.	S	90.	1260.	S	1460.	S	2250.	SM	3210.
1030	37.0	39.8	79.0	33.5	310.	V	1250.	S	110.	NA		NA		3210.	SM+	3210.
1035	37.0	33.0	78.0	58.8	230.	V	1370.	S	100.	NA		NA		3210.	SM+	3210.
1040	37.0	29.8	78.0	26.8	150.	V	1400.	S	100.	NA		NA		3210.	SM+	3210.
1045	37.0	31.5	77.0	56.0	80.	V	1640.	S	120.	NA		NA		3210.	SM+	3210.
1050	37.0	32.0	77.0	28.0	60.		200.		80.	NA		NA		3030.	M	3210.
1055	37.0	33.0	77.0	04.0												

AUGUST 9, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

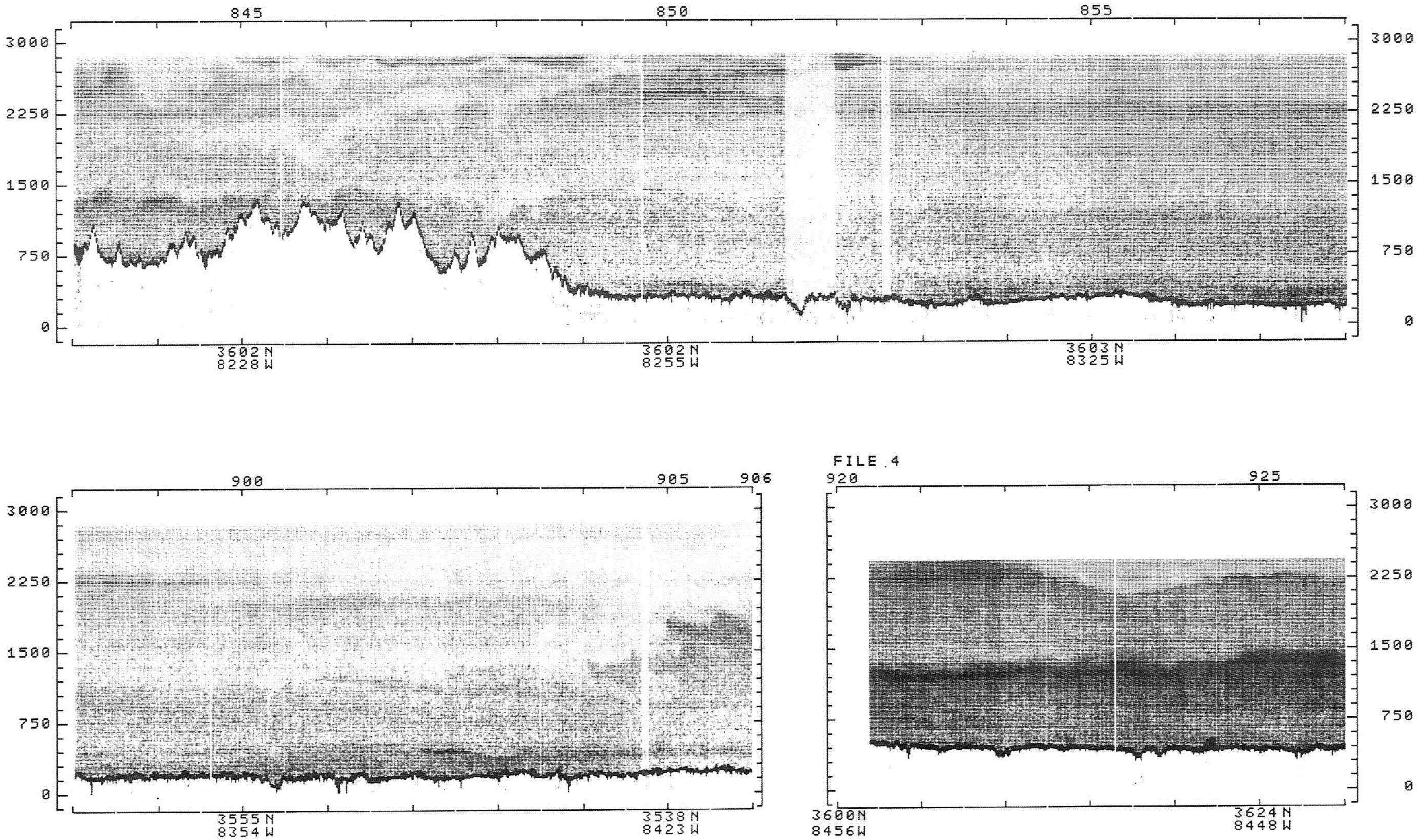




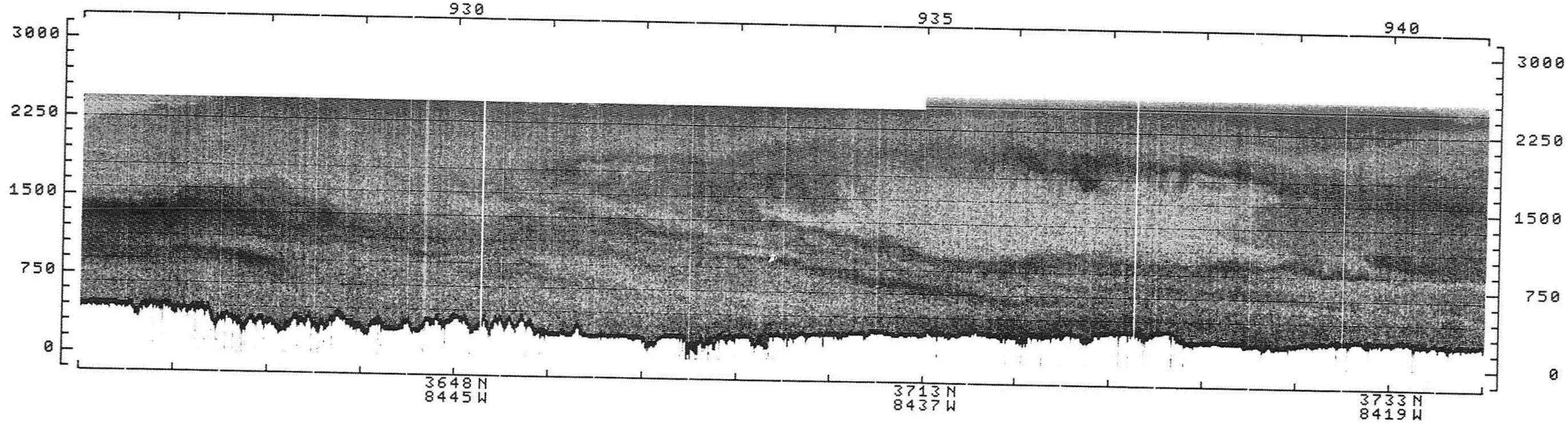
AUGUST 9, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

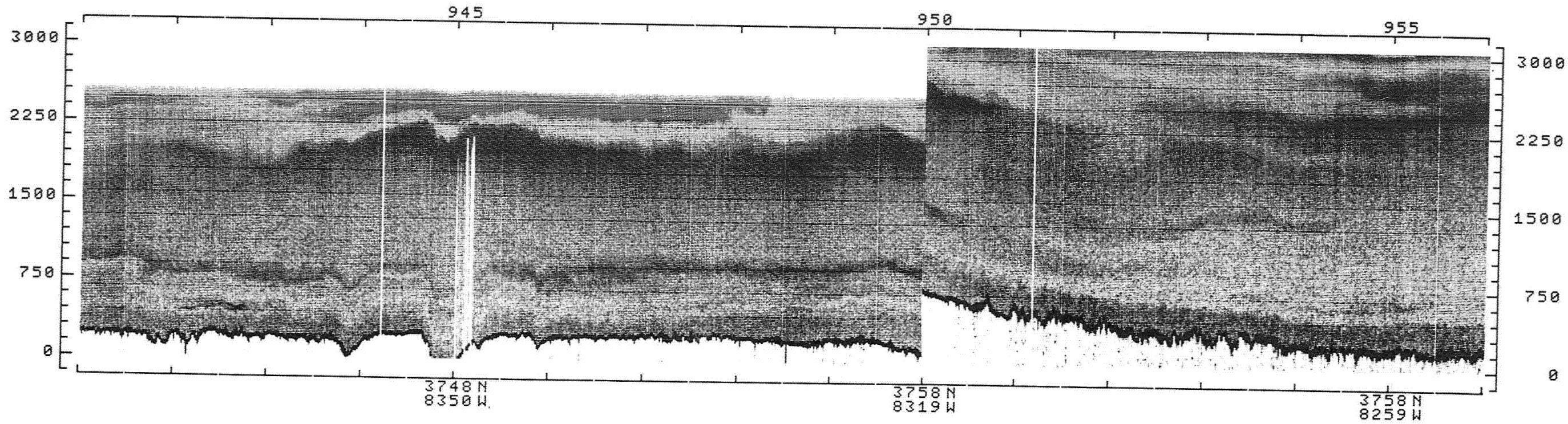


AUGUST 9, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

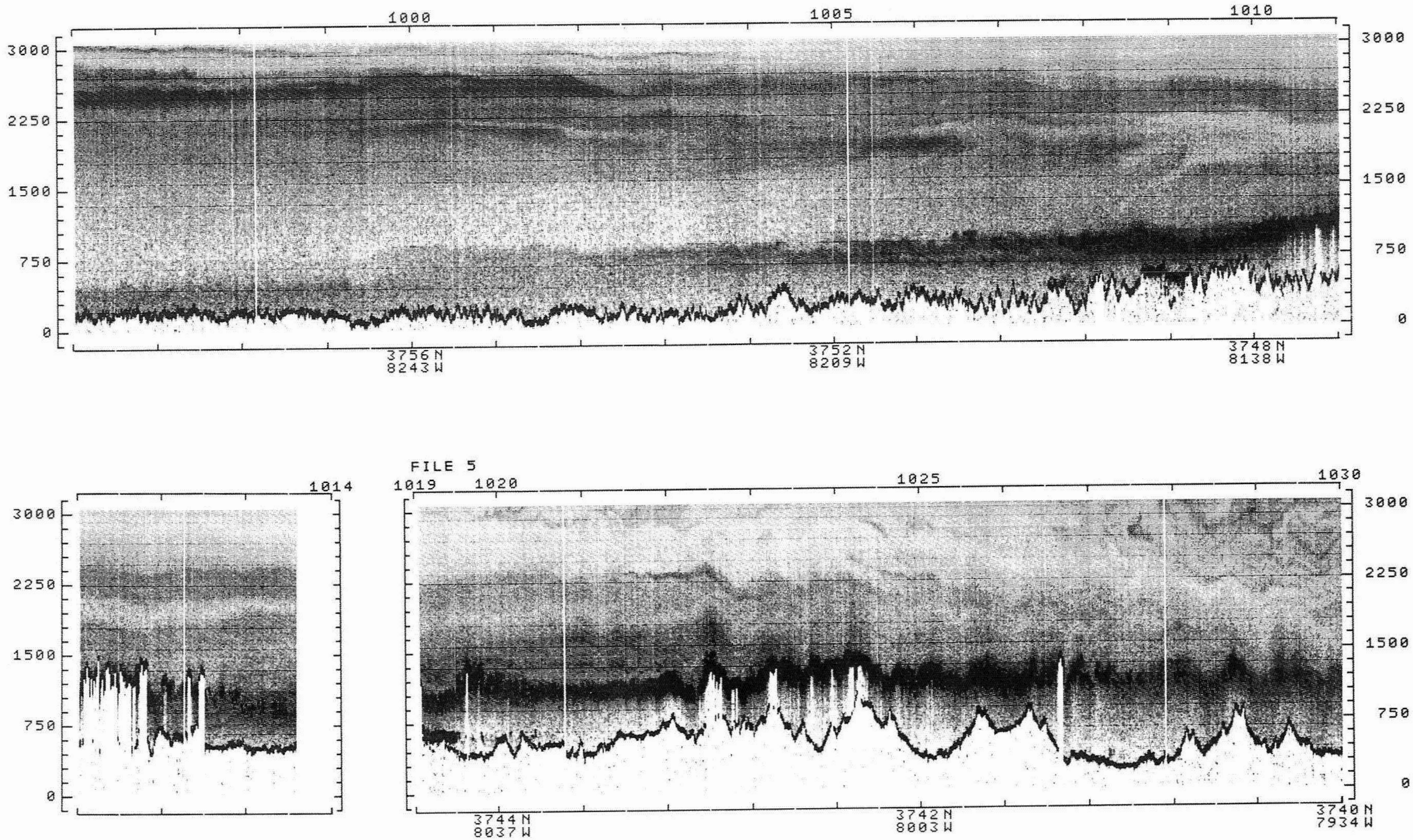


AUGUST 9, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

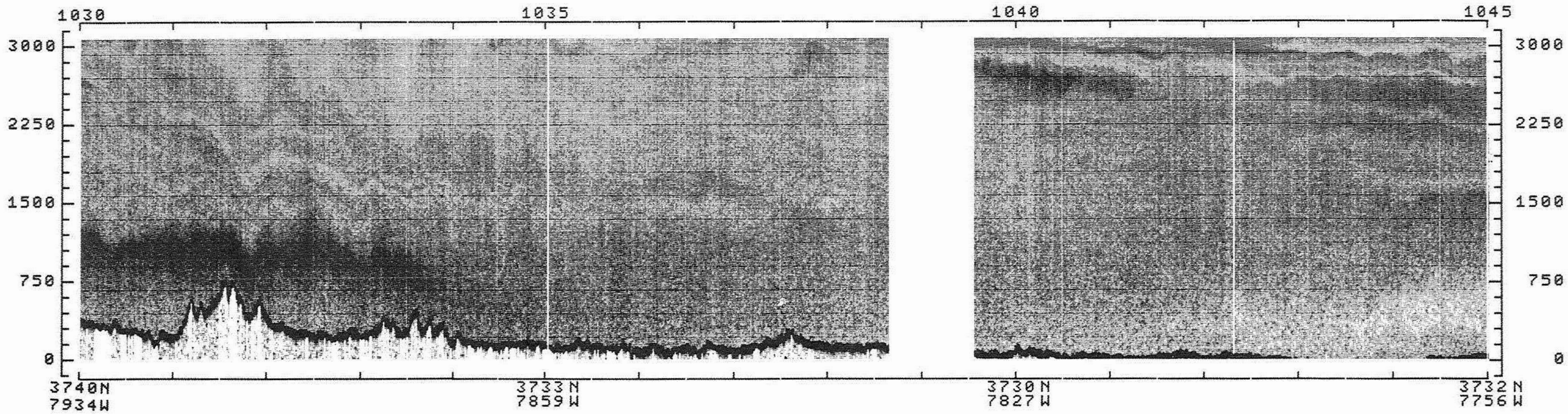


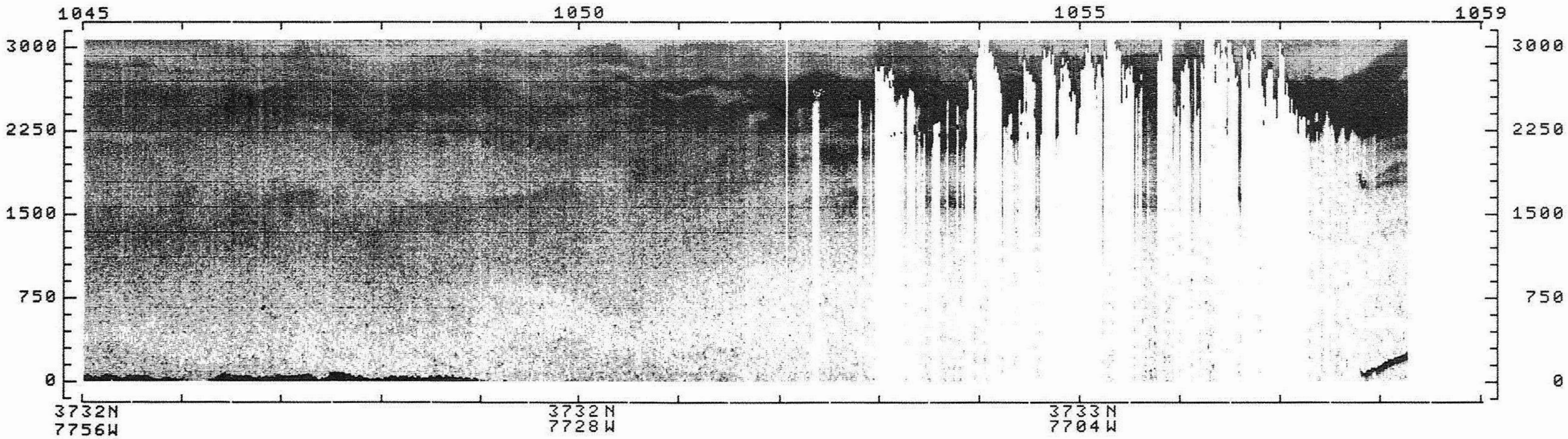


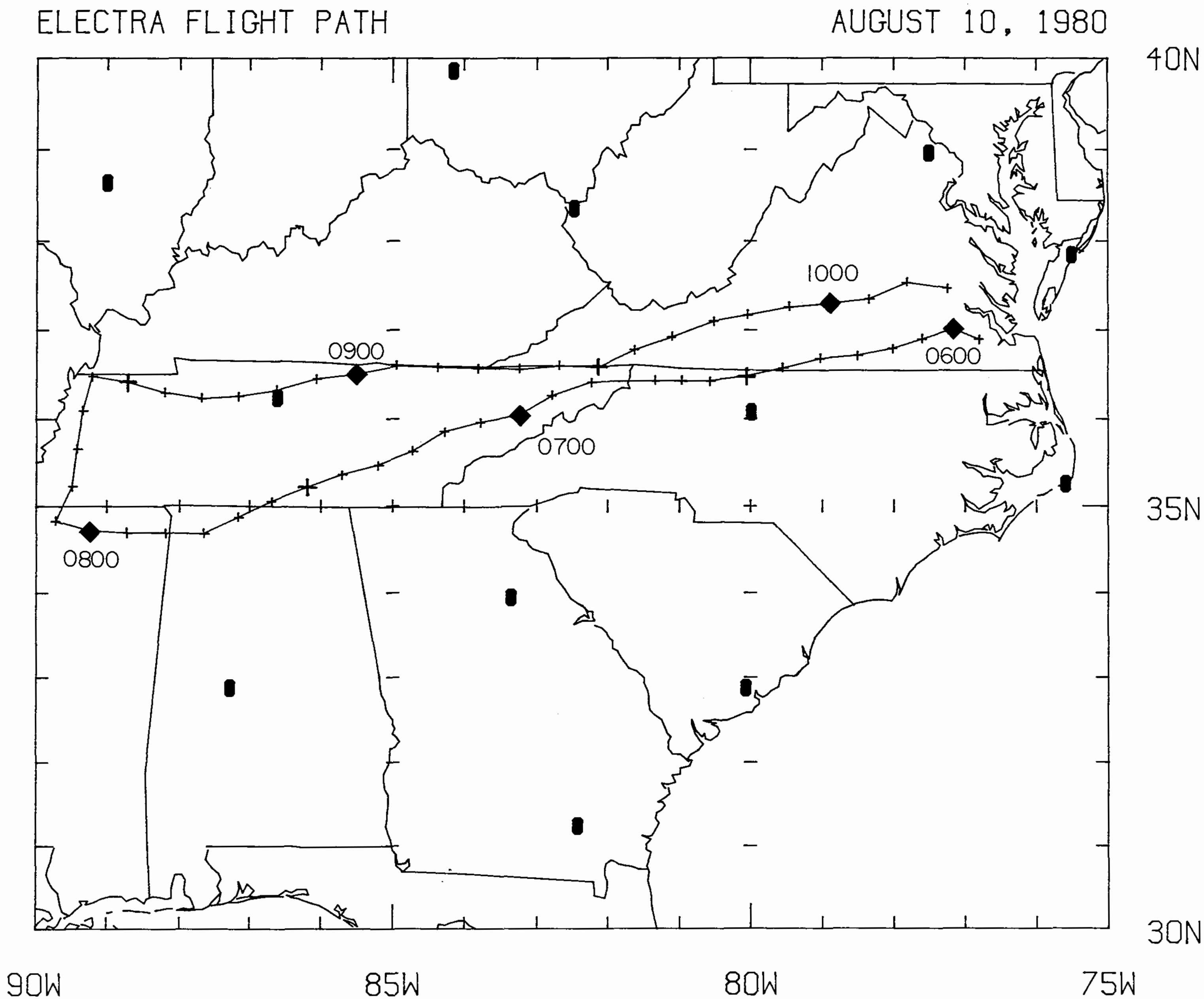
AUGUST 9, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



AUGUST 9, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL






ELECTRA FLIGHT PATH
AUGUST 10, 1980
40N
35N
30N
90W
85W
80W
75W
0600
0700
0800
0900
1000

Instrument Parameters for August 10, 1980, Flight

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
1	0636	0653	5	7	2681	0.2/0.1	7	2391	0.5	Yes	6089
2	0713	0729	5	7	2700	.2/.1	4	2174	.5	Yes	5830
3	0749	0829	1	7	3000	.2/.1	4	2158	.5	Yes	6462
4	0845	0855	5	7	2700	.2/.1	4	2100+	.2	Yes	6073
5	0858	0915	5	7	2700	.2/.1	4	2100	.2	Yes	5952
6	0920	0930	5	7	2700	.2/.1	4	2100	.2	Yes	6159
7	0942	1000	5	7	2728	.2/.1	4	2100	.2	Yes	6022
8	1003	1010	5	7	2728	.2/.1	4	2100	.2	No	6059

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR AUGUST 10, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/10/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
0555	34.	00.	76.	00.	0.		100.	-	100.					1900.		5000.	
1015	37.	60.	89.	60.	900.		1200.		120.					5200.		5500.	
		53															
0555	36.0	53.8	76.0	48.7													
0600	37.0	00.9	77.0	10.2													
0605	36.0	54.2	77.0	36.7													
0610	36.0	47.4	78.0	01.4													
0615	36.0	42.6	78.0	29.9													
0620	36.0	40.6	79.0	01.8													
0625	36.0	34.5	79.0	32.4													
0630	36.0	28.8	80.0	02.7													
0635	36.0	25.4	80.0	34.2													
0640	36.0	26.0	80.0	57.5	760.	V	100.	-	ND	NA		NA		2910.	SM	5050.	9
0645	36.0	26.0	81.0	20.4	890.	V	100.	-	ND	NA		NA		2940.	SM	5050.	9
0650	36.0	24.6	82.0	13.5	899.	V	100.	-	ND	NA		NA		2340.	SM	5050.	
0655	36.0	15.6	82.0	47.4													
0700	36.0	01.8	83.0	14.2													
0705	35.0	57.0	83.0	47.0													
0710	35.0	50.6	84.0	17.3													
0715	35.0	37.8	84.0	44.0	310.		100.	-	ND	NA		NA		4800.	M+	5110.	
0720	35.0	27.8	85.0	12.3	460.		100.	-	ND	NA		NA		4650.	M+	5110.	
0725	35.0	21.5	85.0	42.6	610.		100.	-	ND	NA		NA		4500.	M+	5110.	
0730	35.0	12.8	86.0	12.2													
0735	35.0	03.2	86.0	41.5													
0740	34.0	52.2	87.0	09.6													
0745	34.0	41.2	87.0	38.9													
0750	34.0	41.3	88.0	11.4	165.		100.	-	ND	NA		NA		2280.	M	5500.	
0755	34.0	41.6	88.0	43.2	223.		100.	-	ND	NA		NA		2220.		5500.	
0800	34.0	43.3	89.0	15.2	200.		100.	-	ND	NA		NA		2400.		5500.	
0805	34.0	50.0	89.0	43.3	115.		100.	-	ND	NA		NA		2550.		5500.	
0810	35.0	13.6	89.0	29.1	139.		100.	-	ND	NA		NA		2340.		5500.	

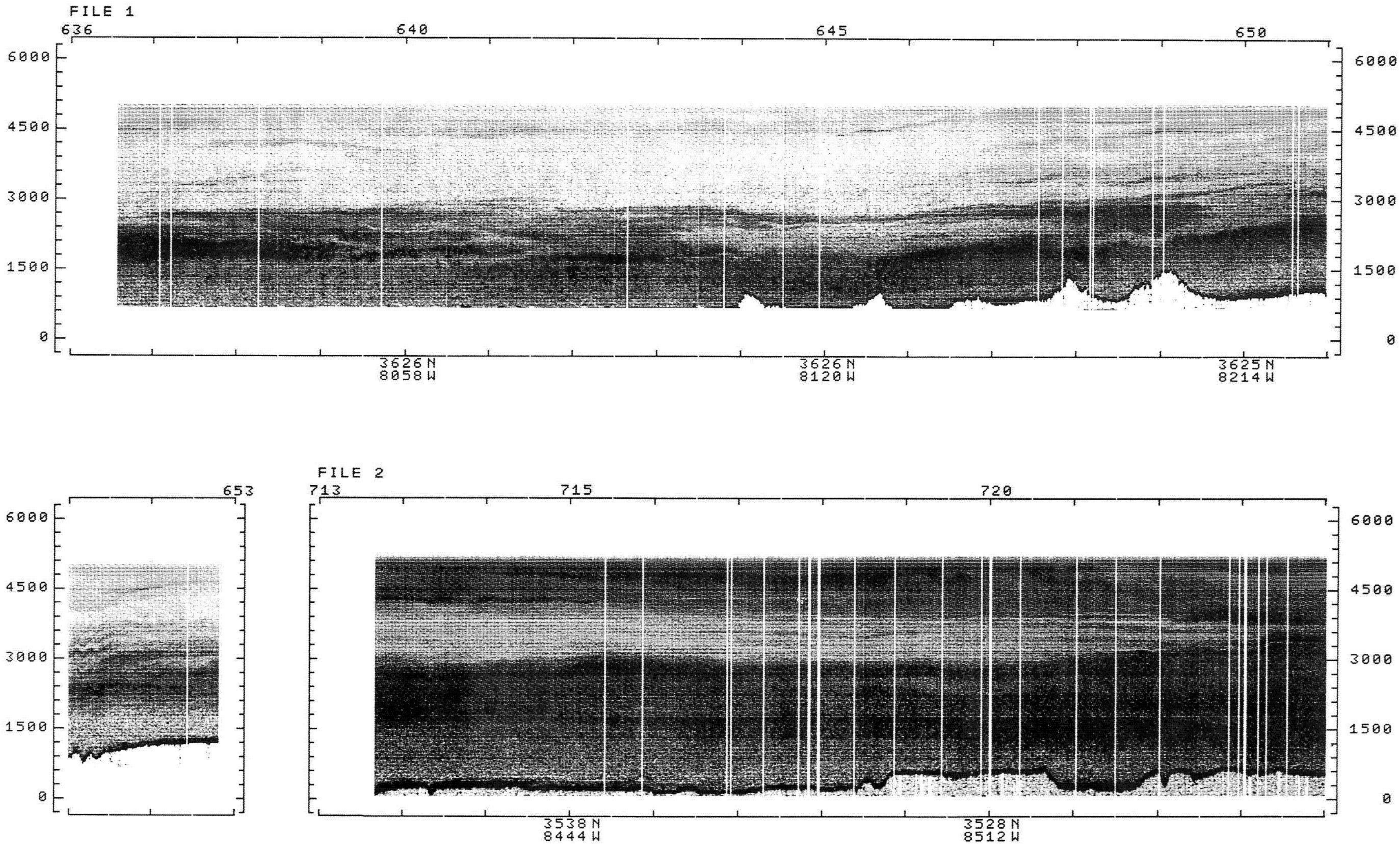
Concluded

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/10/80 18 0

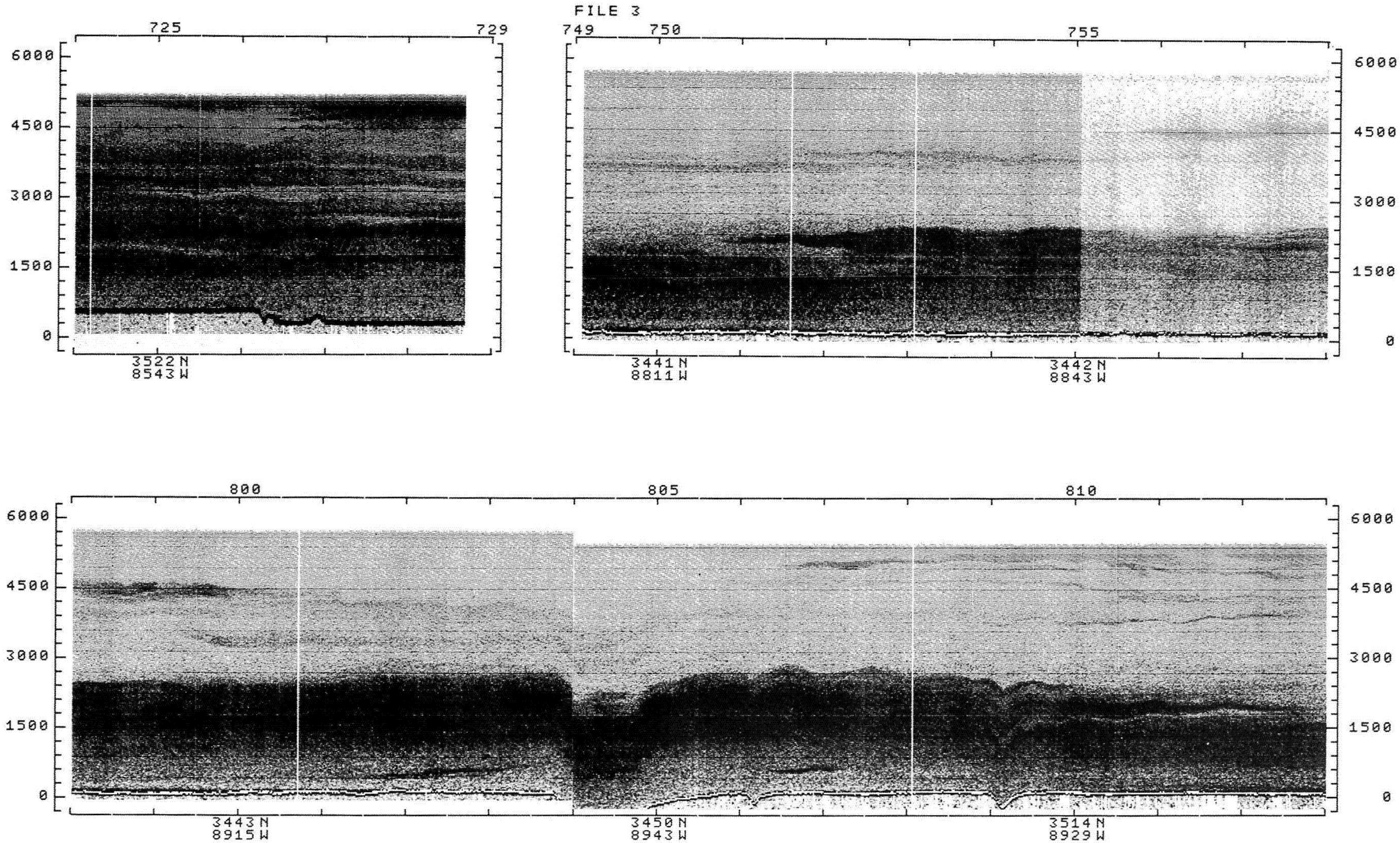
TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
0815	35.0	39.2	89.0	25.2	130.		100.	-	ND	NA		NA		2340.	M	5500.
0820	36.0	05.3	89.0	20.6	86.		100.	-	ND	NA		NA		2400.	M	5500.
0825	36.0	28.6	89.0	12.7	107.		100.	-	ND	NA		NA		2100.		5500.
0830	36.0	24.9	88.0	42.4												
0835	36.0	17.9	88.0	12.1												
0840	36.0	13.9	87.0	40.8												
0845	36.0	15.4	87.0	09.3												
0850	36.0	19.5	86.0	37.2	133.		100.	-	ND	NA		NA		2070.	M	5470.
0855	36.0	27.0	86.0	04.0												
0900	36.0	30.7	85.0	31.1	259.		100.	-	ND	NA		NA		2100.	M	5350.
0905	36.0	36.1	84.0	57.4	305.		100.	-	ND	NA		NA		1920.	M	5350.
0910	36.0	34.8	84.0	22.3	457.	V	100.	-	ND	NA		NA		4800.	SM	5350.
0915	36.0	34.1	83.0	49.0	610.	V	100.	-	ND	NA		NA		4950.	SM	5350.
0920	36.0	33.9	83.0	14.8												
0925	36.0	36.1	82.0	41.0	457.	V	100.	-	ND	NA		NA		5080.	SM	5440.
0930	36.0	35.4	82.0	07.6	582.	V	100.	-	ND	NA		NA		5080.	SM	5440.
0935	36.0	46.5	81.0	38.0	762.	V	100.	-						5110.	SM	5440.
0940	36.0	55.5	81.0	06.9												
0945	37.0	06.1	80.0	31.6	579.	V	100.	-	ND	NA		NA		4930.	SM	5420.
0950	37.0	10.5	80.0	02.6	610.	V	100.	-	ND	NA		NA		5180.	SM	5420.
0955	37.0	15.7	79.0	27.9	305.		1200.		100.	NA		NA		2360.	M	5420.
1000	37.0	18.0	78.0	54.1												
1005	37.0	20.8	78.0	20.3	128.		930.		120.	NA		NA		2340.	M	5460.
1010	37.0	32.1	77.0	49.4	140.		810.		100.	NA		NA		2370.	M	5460.
1015	37.0	28.0	77.0	15.1												

(9) SURFACE OUT OF DATA RANGE

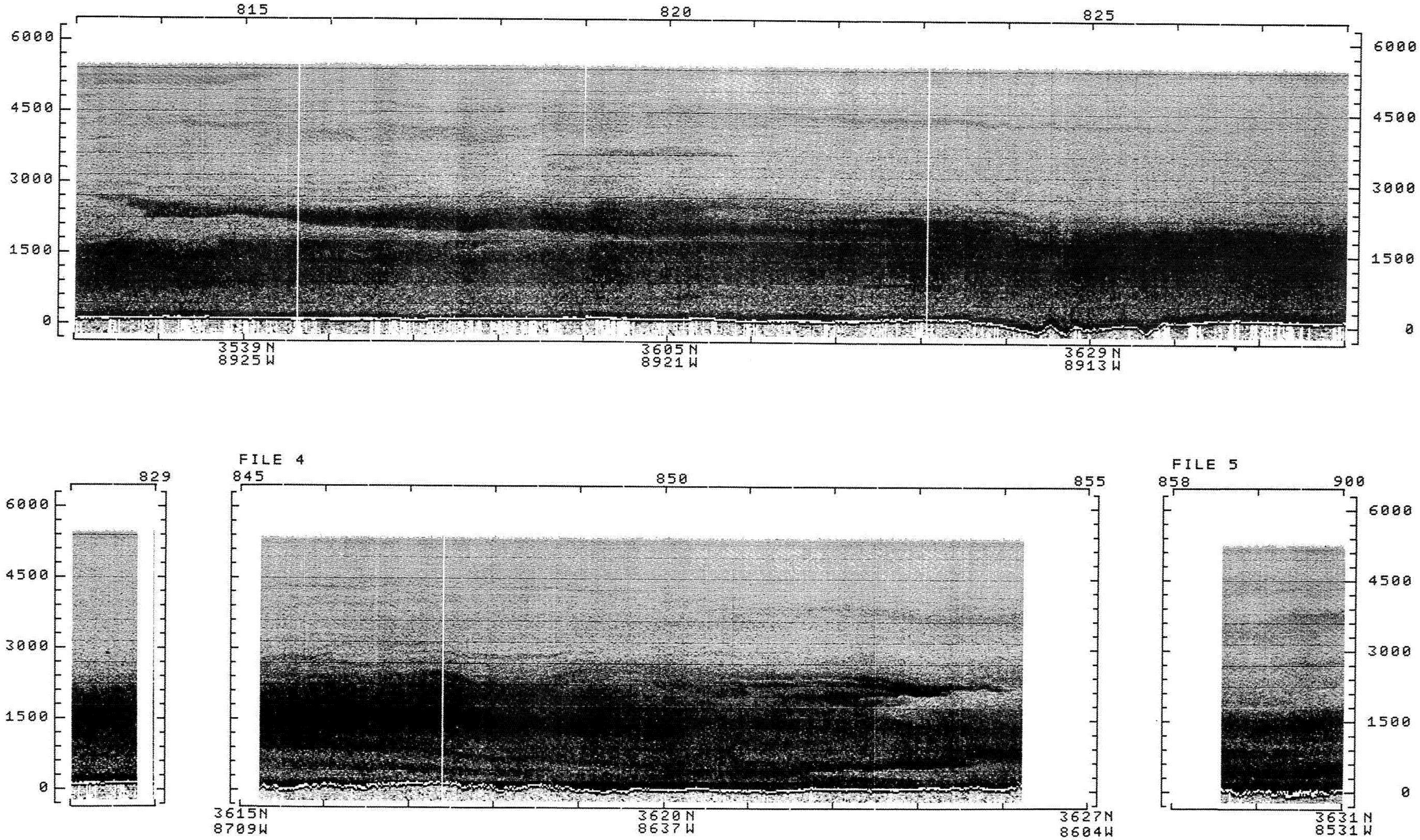
AUGUST 10, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



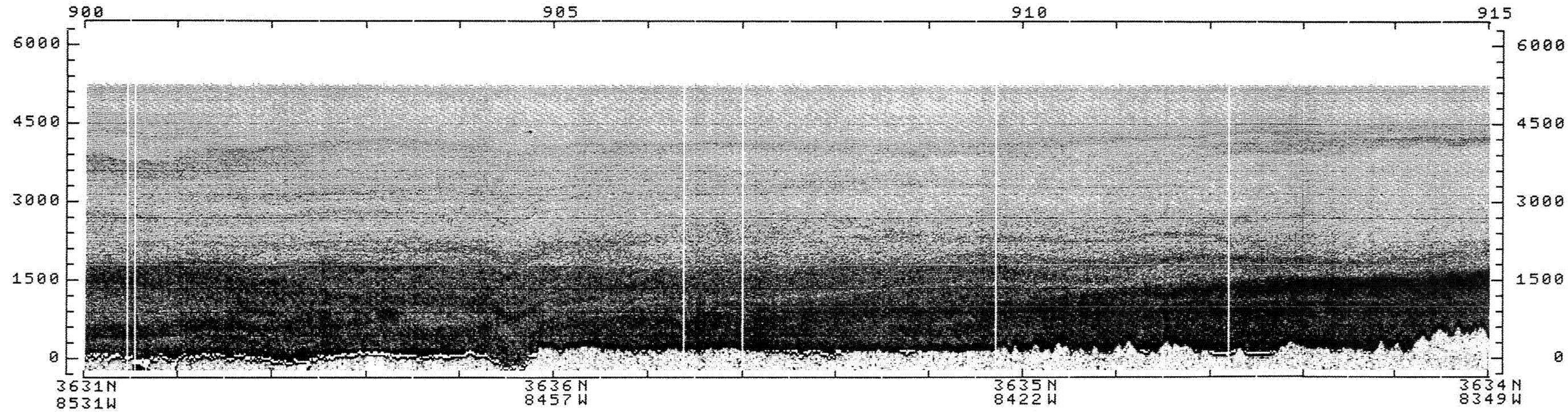
AUGUST 10, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



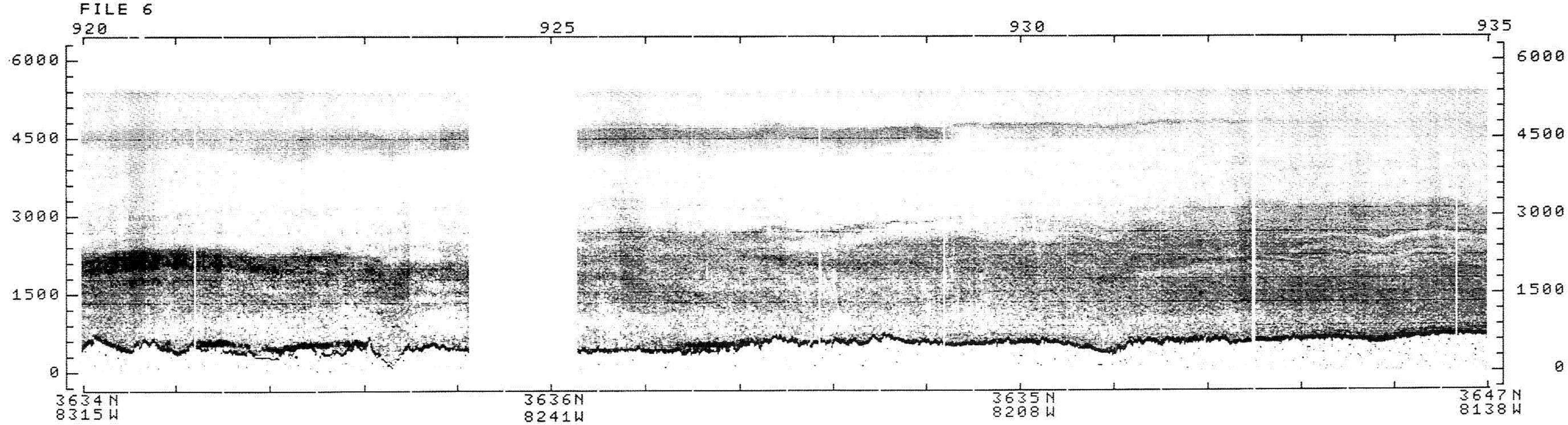
AUGUST 10, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



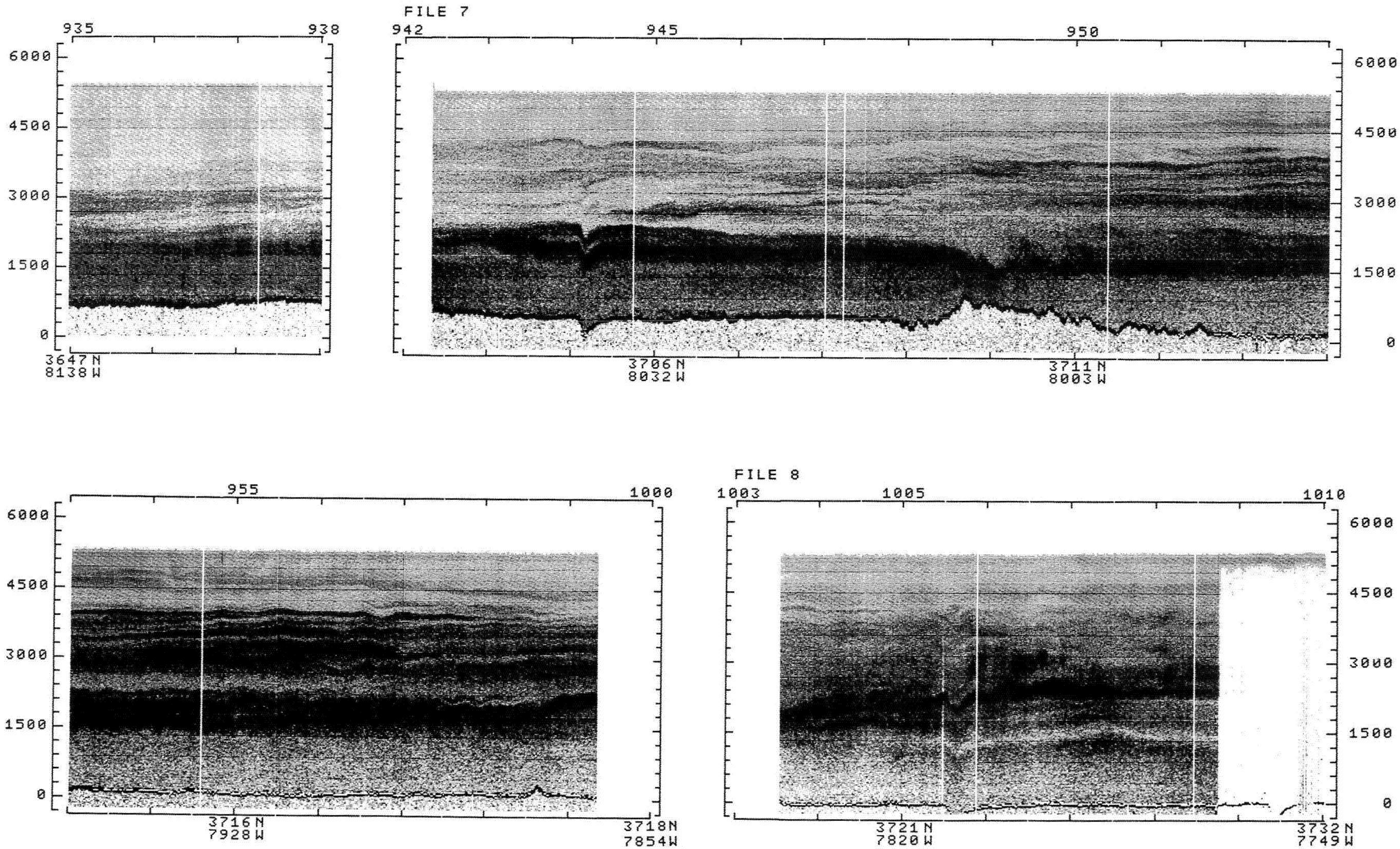
AUGUST 10, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



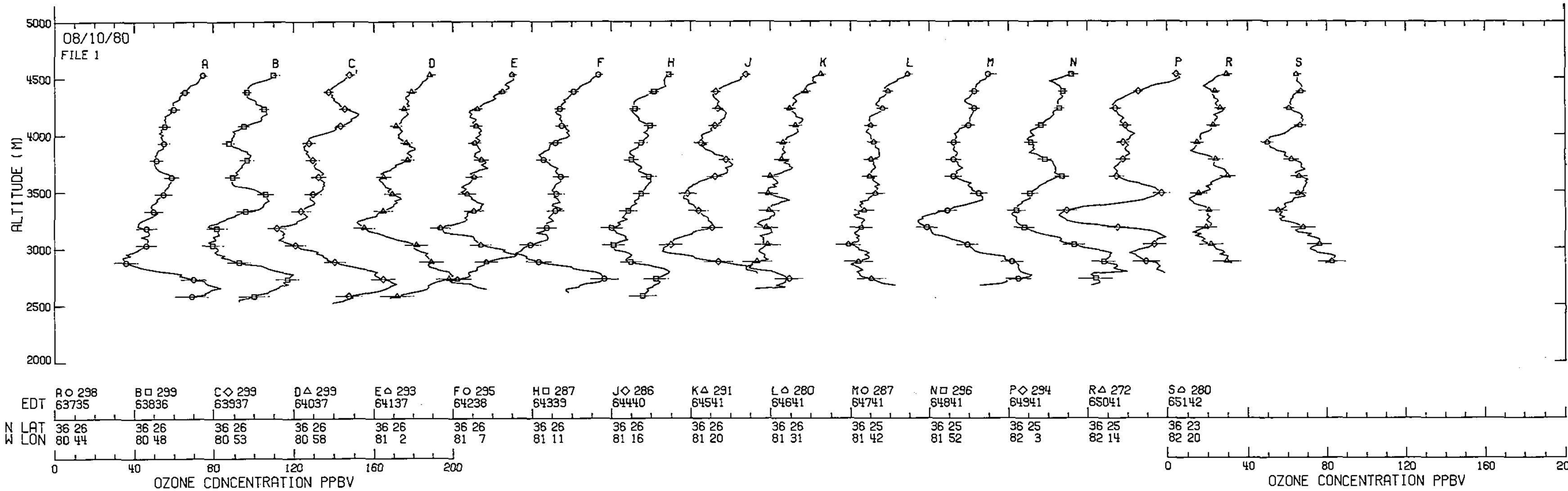
FILE 6

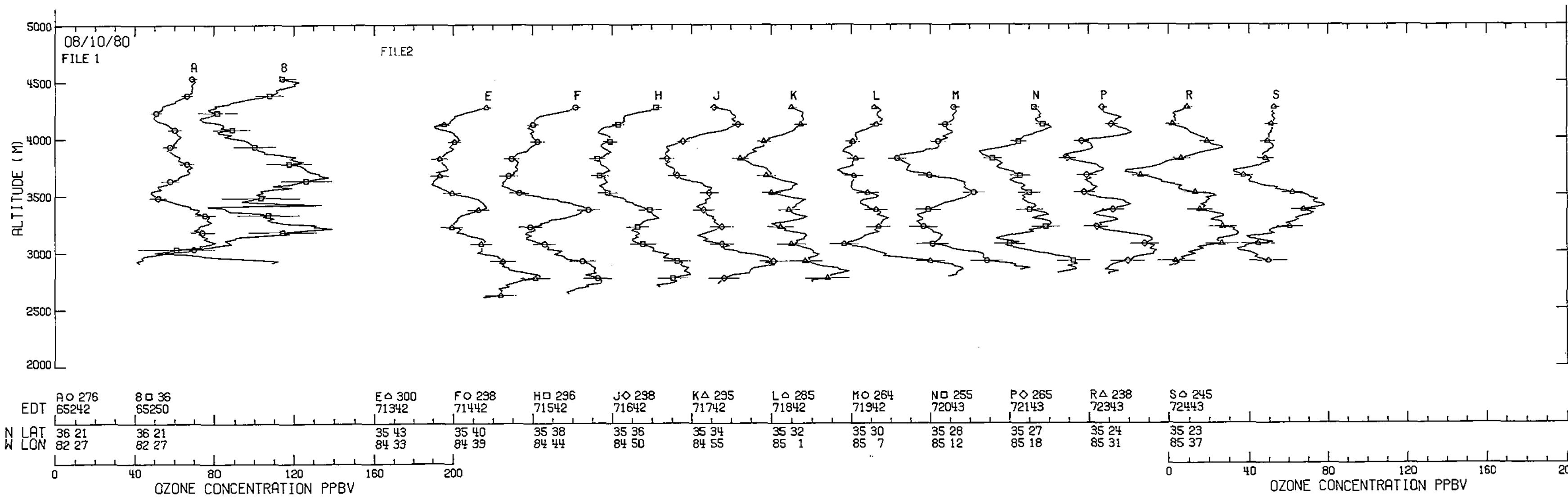


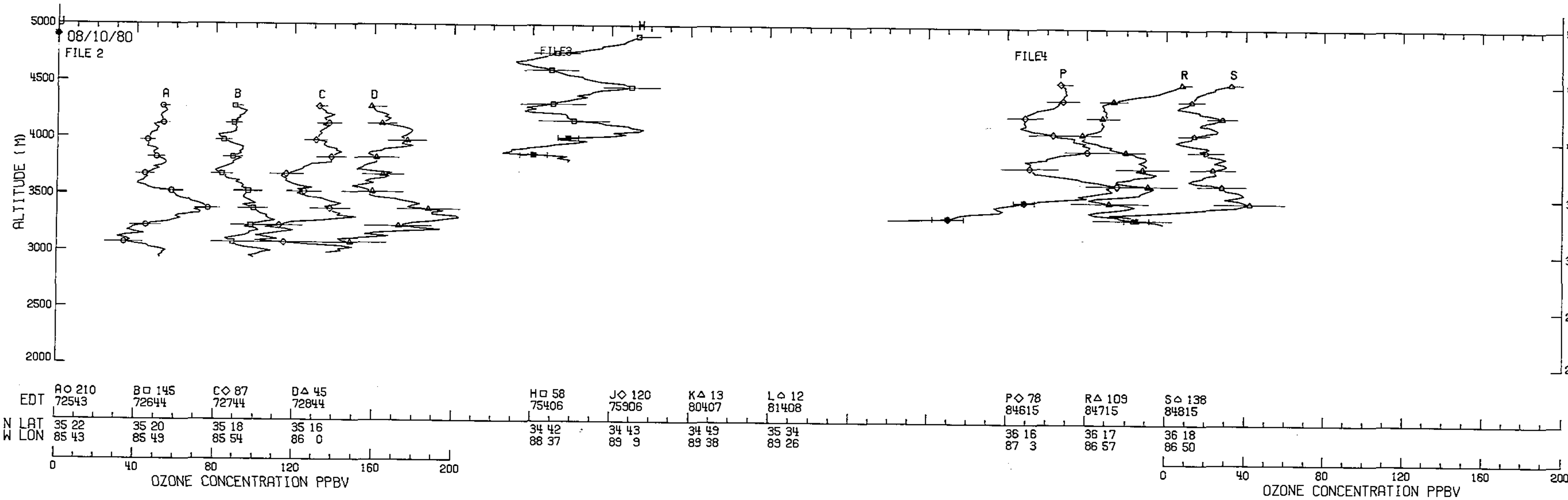
AUGUST 10, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

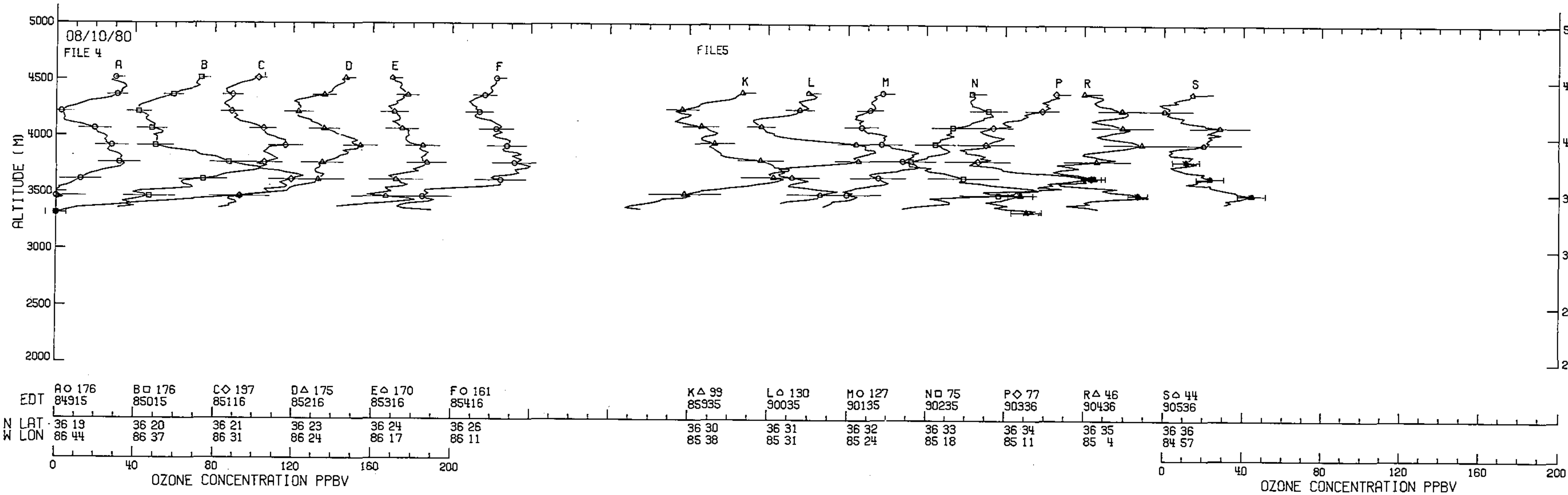


O_3 PROFILES FOR AUGUST 10, 1980, FLIGHT

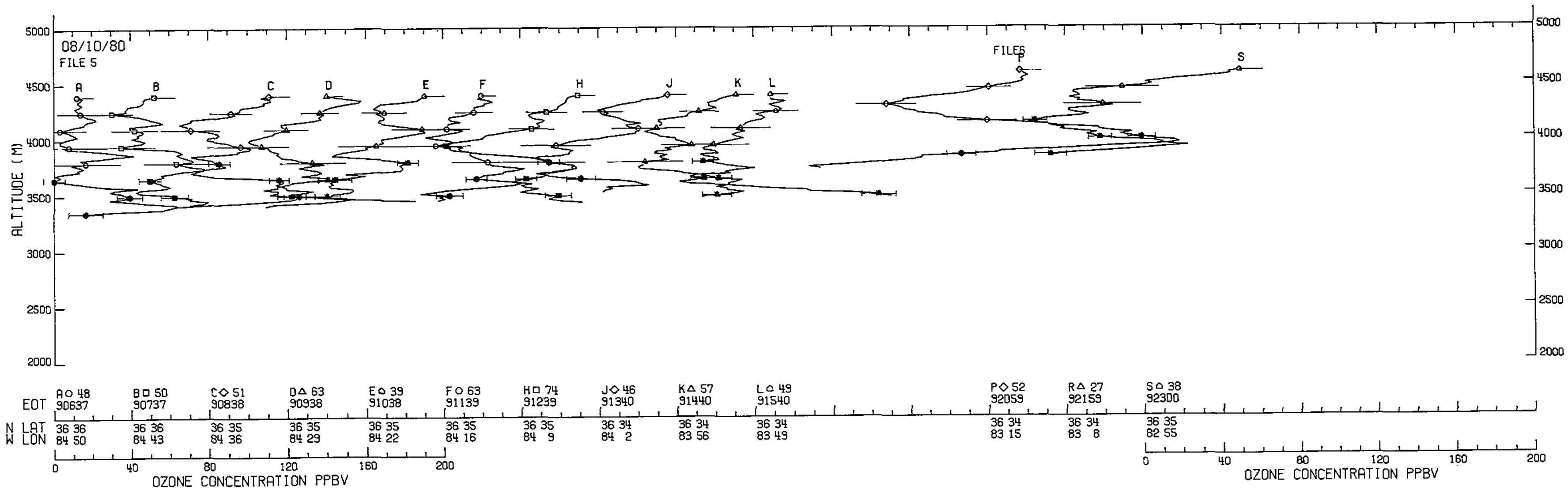


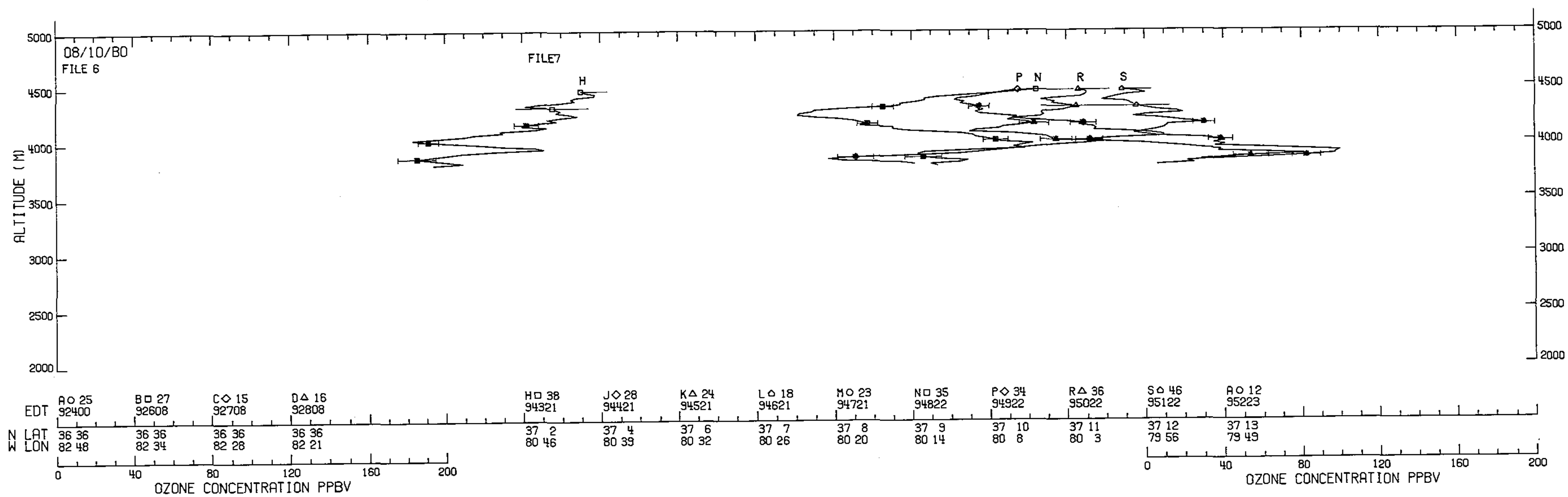



08/10/80
FILE 2
FILE3
FILE4
ALTITUDE (M)
5000
4500
4000
3500
3000
2500
2000
A B C D
H
P R S
EDT
N LAT
W LON
AO 210 72543 35 22 85 43
B□ 145 72644 35 20 85 49
C◇ 87 72744 35 18 85 54
DΔ 45 72844 35 16 86 0
H□ 58 75406 34 42 88 37
J◇ 120 75906 34 43 89 9
KΔ 13 80407 34 49 89 38
LO 12 81408 35 34 89 26
P◇ 78 84615 36 16 87 3
RΔ 109 84715 36 17 86 57
SO 138 84815 36 18 86 50
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

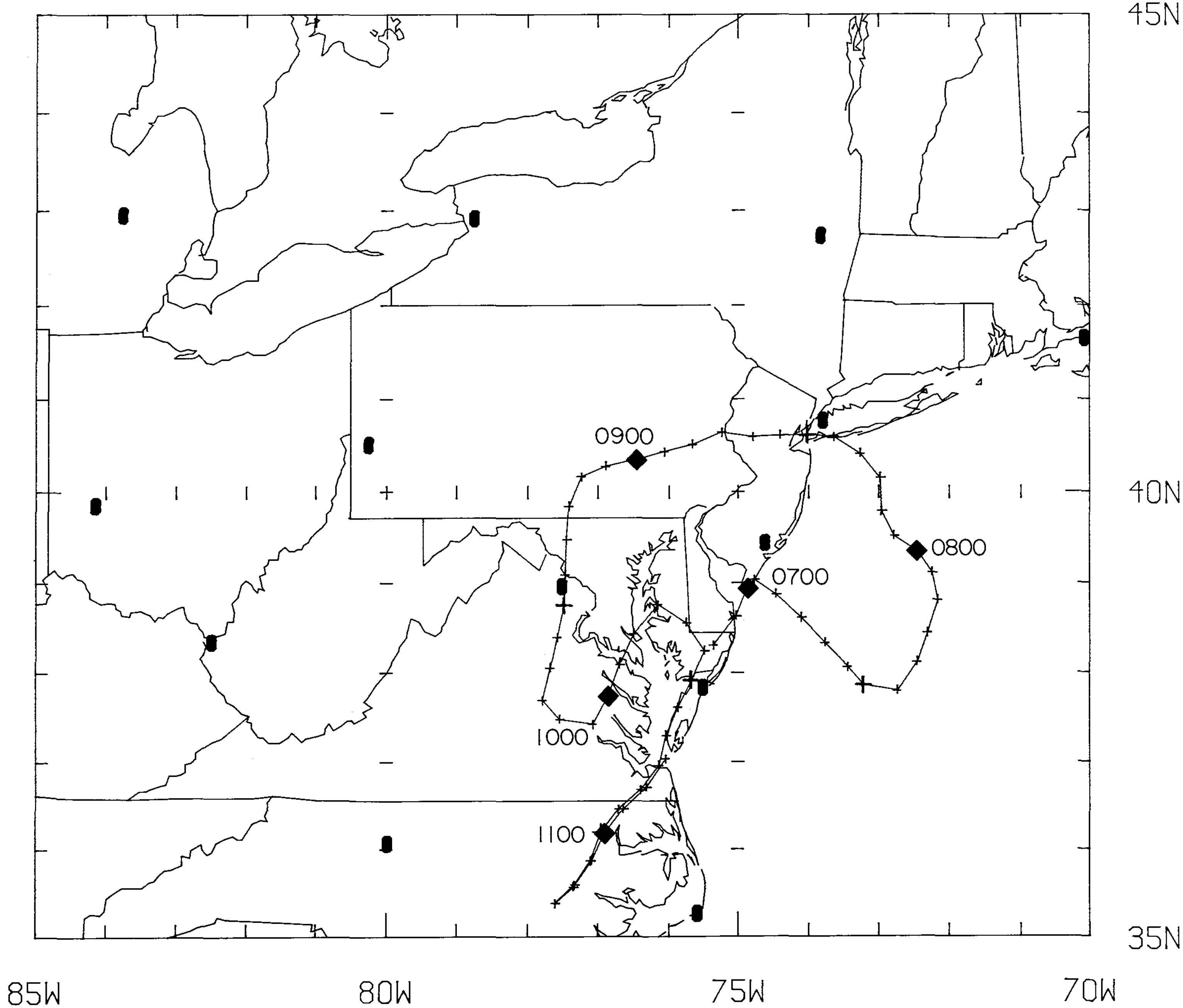

08/10/80
FILE 4
FILE5
ALTITUDE (M)
5000
4500
4000
3500
3000
2500
2000
A B C D E F
K L M N P R S
EDT
N LAT
W LON
AO 176 84915 36 19 86 44
B□ 176 85015 36 20 86 37
C◇ 197 85116 36 21 86 31
DΔ 175 85216 36 23 86 24
EO 170 85316 36 24 86 17
FO 161 85416 36 26 86 11
KΔ 99 85935 36 30 85 38
LO 130 90035 36 31 85 31
MO 127 90135 36 32 85 24
N□ 75 90235 36 33 85 18
P◇ 77 90336 36 34 85 11
RΔ 46 90436 36 35 85 4
SO 44 90536 36 36 84 57
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

Concluded


08/10/80
FILE 5
FILE6
ALTITUDE (M)
A B C D E F H J K L P S
AO 48 90637
BO 50 90737
C◇ 51 90838
D△ 63 90938
E○ 39 91038
FO 63 91139
H□ 74 91239
J◇ 46 91340
K△ 57 91440
L○ 49 91540
P◇ 52 92059
R△ 27 92159
S○ 38 92300
EDT
N LAT
W LON
36 36 84 50
36 36 84 43
36 35 84 36
36 35 84 29
36 35 84 22
36 35 84 16
36 35 84 9
36 34 84 2
36 34 83 56
36 34 83 49
36 34 83 15
36 34 83 8
36 35 82 55
OZONE CONCENTRATION PPBV


08/10/80
FILE 6
FILE7
ALTITUDE (M)
H P N R S
AO 25 92400
B□ 27 92608
C◇ 15 92708
D△ 16 92808
H□ 38 94321
J◇ 28 94421
K△ 24 94521
L○ 18 94621
MO 23 94721
N□ 35 94822
P◇ 34 94922
R△ 36 95022
S○ 46 95122
AO 12 95223
EDT
N LAT
W LON
36 36 82 48
36 36 82 34
36 36 82 28
36 36 82 21
37 2 80 46
37 4 80 39
37 6 80 32
37 7 80 26
37 8 80 20
37 9 80 14
37 10 80 8
37 11 80 3
37 12 79 56
37 13 79 49
OZONE CONCENTRATION PPBV

ELECTRA FLIGHT PATH AUGUST 12, 1980



Instrument Parameters for August 12, 1980, Flight

	Time, EDT			UV PMT			Aerosol PMT				
File no.	Start	End	Laser repetition rate, Hz	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V	O_3	Aircraft altitude, m MSL
1	0647	0657	5	7	2546	0.2/0.1	6	2300	0.5	Yes	5617
2	0657	0706	5	7	2546	.2/.1	4	2151	.5	No	5608
3	0713	0731	5	7	2546	.2/.1	4	2200	.5	Yes	5608
4	0737	0755	5	7	2635	.2/.1	4	2200	.5	Yes	5608
5	0915	0928	5	(*a*)	(*a*)	(*a*)	4	2200	.5	No	5624
6	0943	0957	5	5	2685	.2/.1	4	2080	.5	Yes	4911
7	1030	1051	5	5	2610	.2/.1	4	2100	.5	Yes	5640
8	1102	1110	5	5	2610	.2/.2	4	2100	.5	Yes	5640
9	1110	1118	5	5	2610	.2/.2	4	2100	.5	Yes	4999 to 3638
10	1121	1145	5	5	2610	.2/.2	4	2100	.5	No	3689

[a] Aerosol only.

NAVIGATION, CLOUD, AND MIXED LAYER HEIGHT SUMMARY FOR AUGUST 12, 1980, FLIGHT

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/12/80 18 0

TIME	LAT	LAT	LONG	LONG	ALT	K	MIXHT	L	H2SIG	LWCCL	M	MXCLD	N+	TPUSL	N1+	MAXSG	
EDT	DEG	MIN	DEG	MIN	MMSL		MAGL		M	MAGL		MAGL		MAGL		MMSL	
0650	40.	00.	72.	00.	0.		200.		50.	400.		600.		2800.		2900.	
1145	40.	60.	77.	60.	110.		1600.		500.	2400.		5000.		5000.		5000.	

60

0650	38.0	18.5	75.0	21.8	20.		900.		150.	NA		NA		4520.	M+	4540.	1
0655	38.0	38.2	75.0	01.7	0.		600.		120.	NA		NA		4540.	SM+	4540.	1
0700	38.0	57.0	74.0	52.4	0.		720.		60.	NA		NA		4880.	SM+	4880.	
0705	39.0	02.2	74.0	46.2	0.		720.		60.	NA		NA		4880.	SM+	4880.	
0710	38.0	52.6	74.0	27.6													
0715	38.0	37.1	74.0	05.9	0.		210.		50.	1710.		2850.		4880.	M+	4880.	
0720	38.0	20.4	73.0	45.9	0.		300.		50.	1740.		2550.		4880.	M+	4880.	
0725	38.0	04.1	73.0	26.5	0.		450.		90.	450.		2100.		4880.	M+	4880.	
0730	37.0	52.1	73.0	12.7	0.		480.		90.	NA		NA		4880.	M+	4880.	
0735	37.0	48.2	72.0	44.5													
0740	38.0	48.5	72.0	28.0	0.		630.		110.	630.		1800.		4920.	M+	4920.	
0745	38.0	27.0	72.0	19.2	0.		510.		60.	510.		2790.		4920.	M+	4920.	
0750	38.0	48.7	72.0	10.3	0.		1380.		500.	900.		4920.		4920.	M+	4920.	
0755	39.0	07.1	72.0	14.9													
0800	39.0	20.9	72.0	28.1													
0805	39.0	31.1	72.0	47.0													
0810	39.0	47.4	72.0	57.9													
0815	40.0	09.2	72.0	58.8													
0820	40.0	25.2	73.0	15.6													
0825	40.0	35.7	73.0	37.7													
0830	40.0	37.5	74.0	00.3													
0835	40.0	37.0	74.0	24.0													
0840	40.0	35.8	74.0	47.6													
0845	40.0	38.9	75.0	14.0													
0850	40.0	30.8	75.0	39.3													
0855	40.0	26.2	76.0	04.0													
0900	40.0	21.3	76.0	28.2													
0905	40.0	17.0	76.0	53.4													

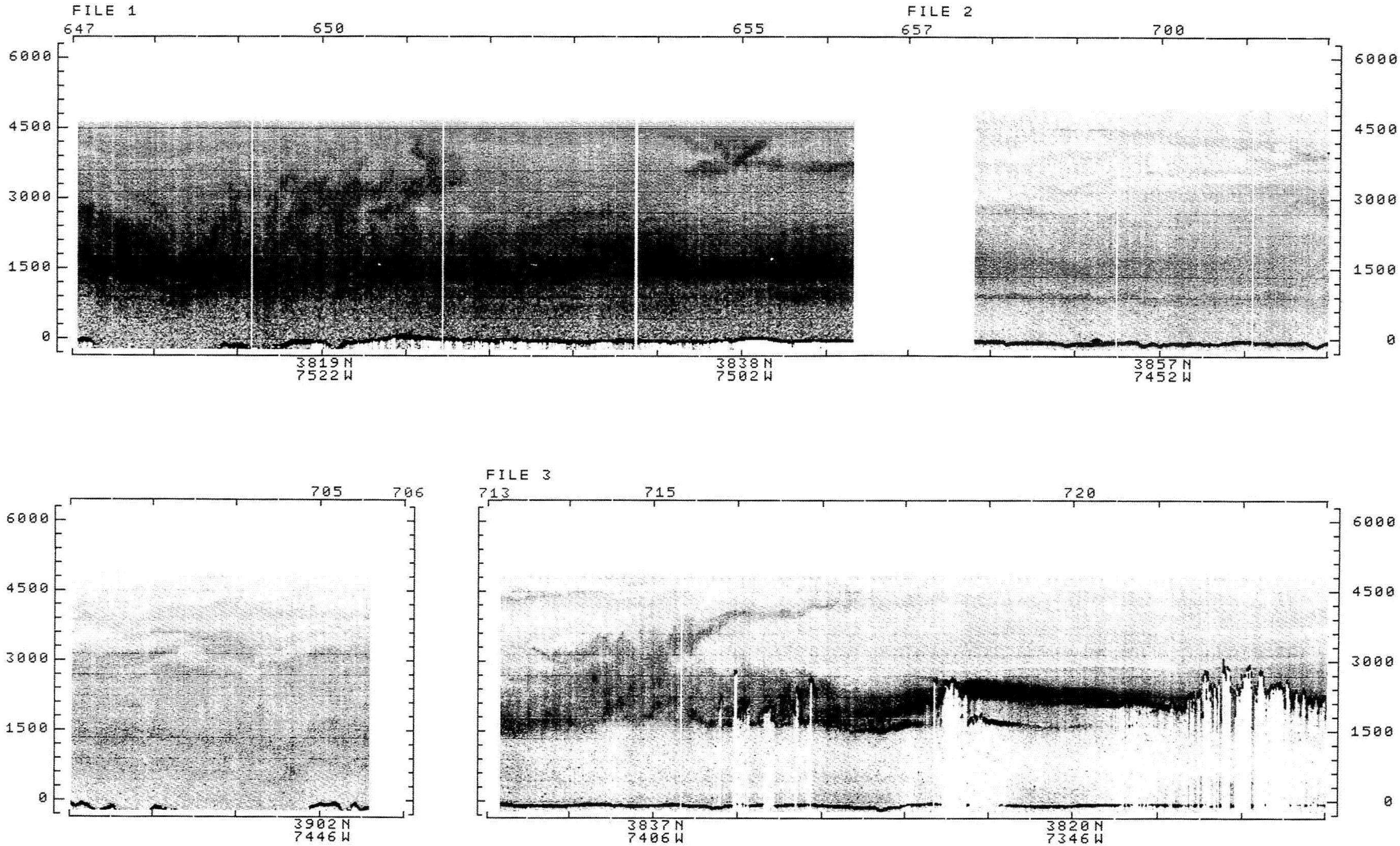
Concluded

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/12/80 18 0

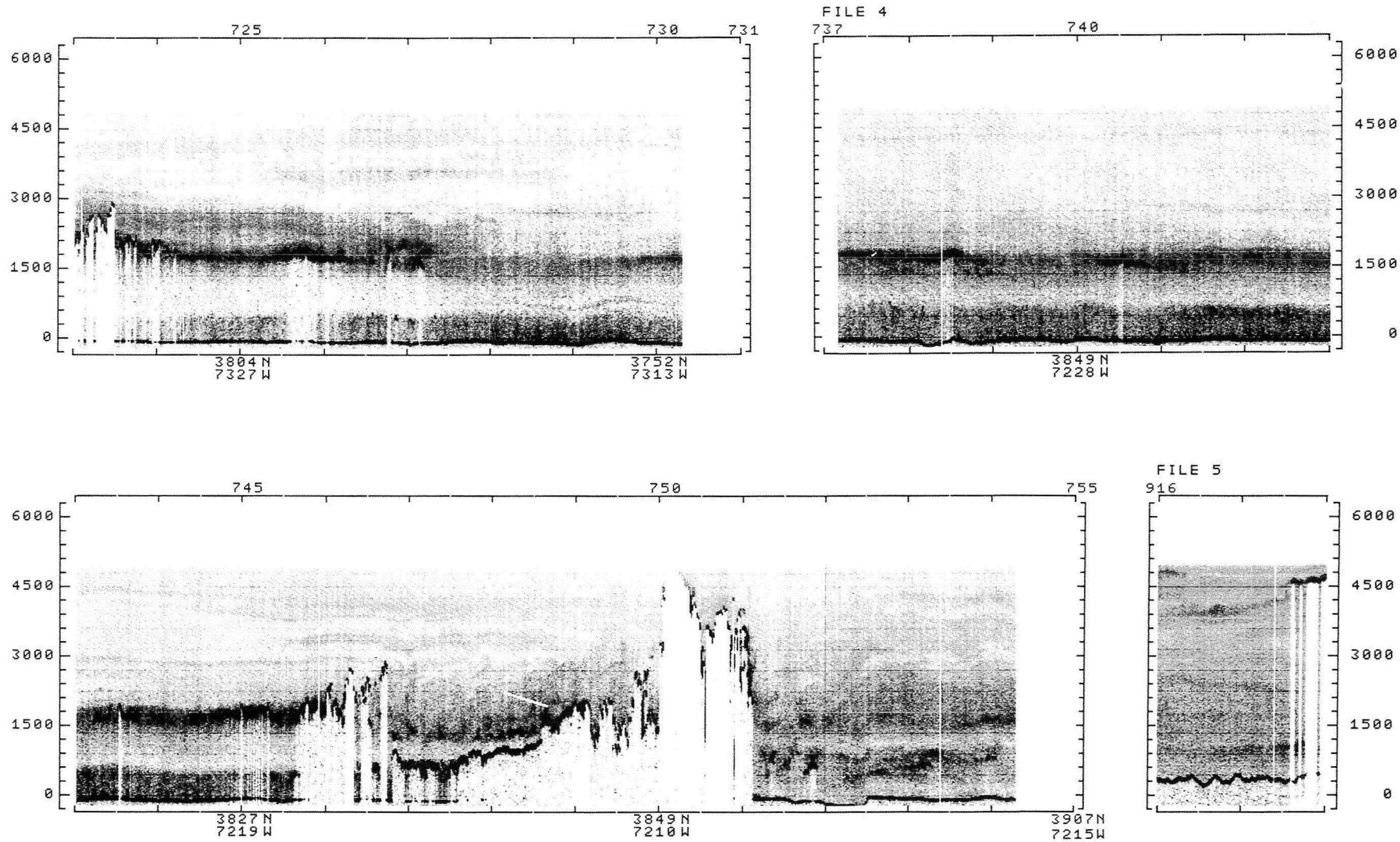
TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
0910	40.0	09.8	77.0	14.3													
0915	39.0	50.6	77.0	24.7													
0920	39.0	28.5	77.0	26.3	110.		960.		100.	NA		NA		4810.	M+	4920.	
0925	39.0	05.6	77.0	27.6	80.		1530.		90.	NA		NA		4840.	M+	4920.	
0930	38.0	44.8	77.0	28.2													
0935	38.0	24.1	77.0	34.8													
0940	38.0	03.5	77.0	40.5													
0945	37.0	41.5	77.0	47.5	80.		ND		ND	ND		ND		4840.	M+	4920.	7
0950	37.0	28.9	77.0	32.3	80.		ND		ND	ND		ND		4840.	M+	4920.	7
0955	37.0	25.5	77.0	04.4	30.		ND		ND	ND		ND		4890.	M+	4920.	7
1000	37.0	45.0	76.0	51.7													
1005	38.0	05.8	76.0	41.2													
1010	38.0	26.6	76.0	30.3													
1015	38.0	45.2	76.0	09.5													
1020	38.0	33.4	75.0	44.6													
1025	38.0	15.0	75.0	29.1													
1030	37.0	55.3	75.0	39.8													
1035	37.0	37.1	75.0	52.3	10.		ND		ND	2400.		4410.		4980.	M+	4990.	7
1040	37.0	17.8	76.0	02.4	0.		ND		ND	NA		NA		3330.	M	4990.	7
1045	36.0	57.6	76.0	08.9	0.		570.		60.	NA		NA		3000.	M	4990.	
1050	36.0	41.1	76.0	23.6	0.		540.		60.	NA		NA		3510.	M	4990.	
1055	36.0	27.7	76.0	42.2													
1100	36.0	11.9	76.0	56.9													
1105	35.0	52.3	77.0	05.8	0.		600.		60.	600.		600.		2700.	M	4980.	
1110	35.0	35.6	77.0	19.6													
1115	35.0	22.7	77.0	36.0	20.		750.		150.	600.		900.		3020.	M+	3040.	
1120	35.0	34.4	77.0	20.4													
1125	35.0	52.4	77.0	05.4	0.		600.		50.	NA		NA		2900.	M+	2900.	
1130	36.0	11.3	76.0	54.0	20.		680.		150.	680.		900.		2880.	M+	2900.	
1135	36.0	28.0	76.0	38.7	0.		630.		120.	600.		840.		2900.	M+	2900.	
1140	36.0	42.9	76.0	18.9	0.		570.		120.	480.		720.		2900.	M+	2900.	
1145	37.0	02.0	76.0	03.0	0.		600.		120.	600.		750.		2900.	M+	2900.	

(7) OBSCURATION BY CLOUD

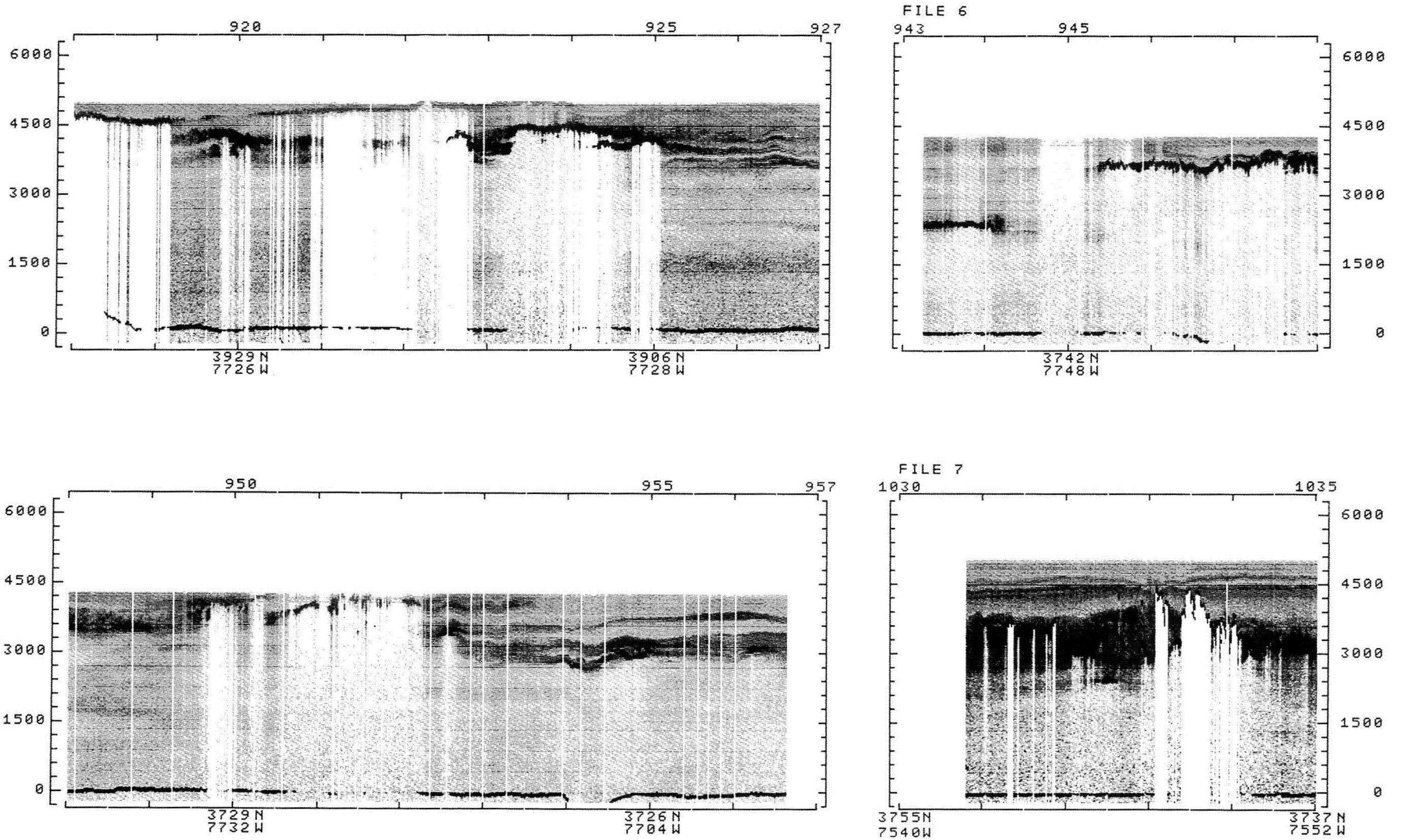
AUGUST 12, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



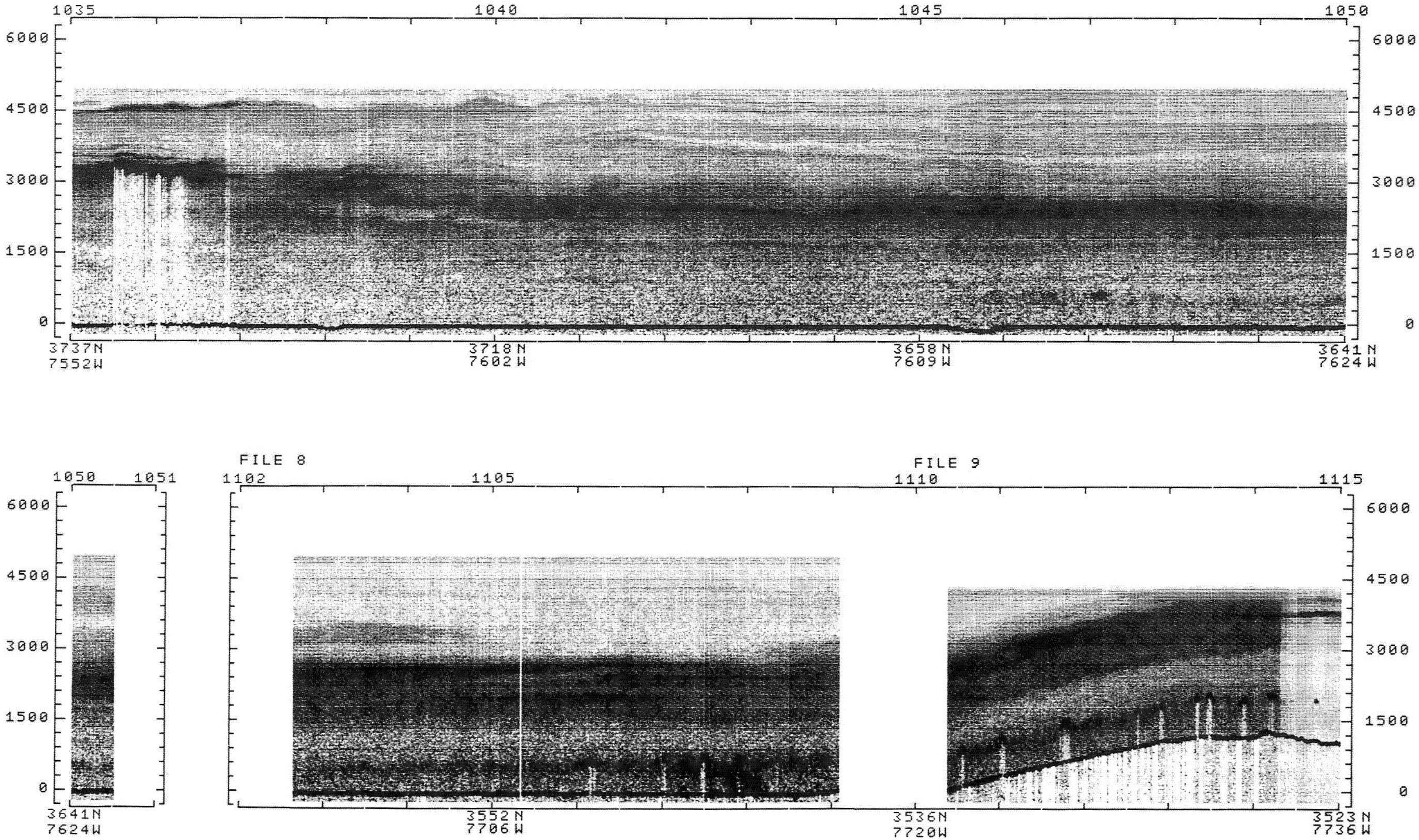
AUGUST 12, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



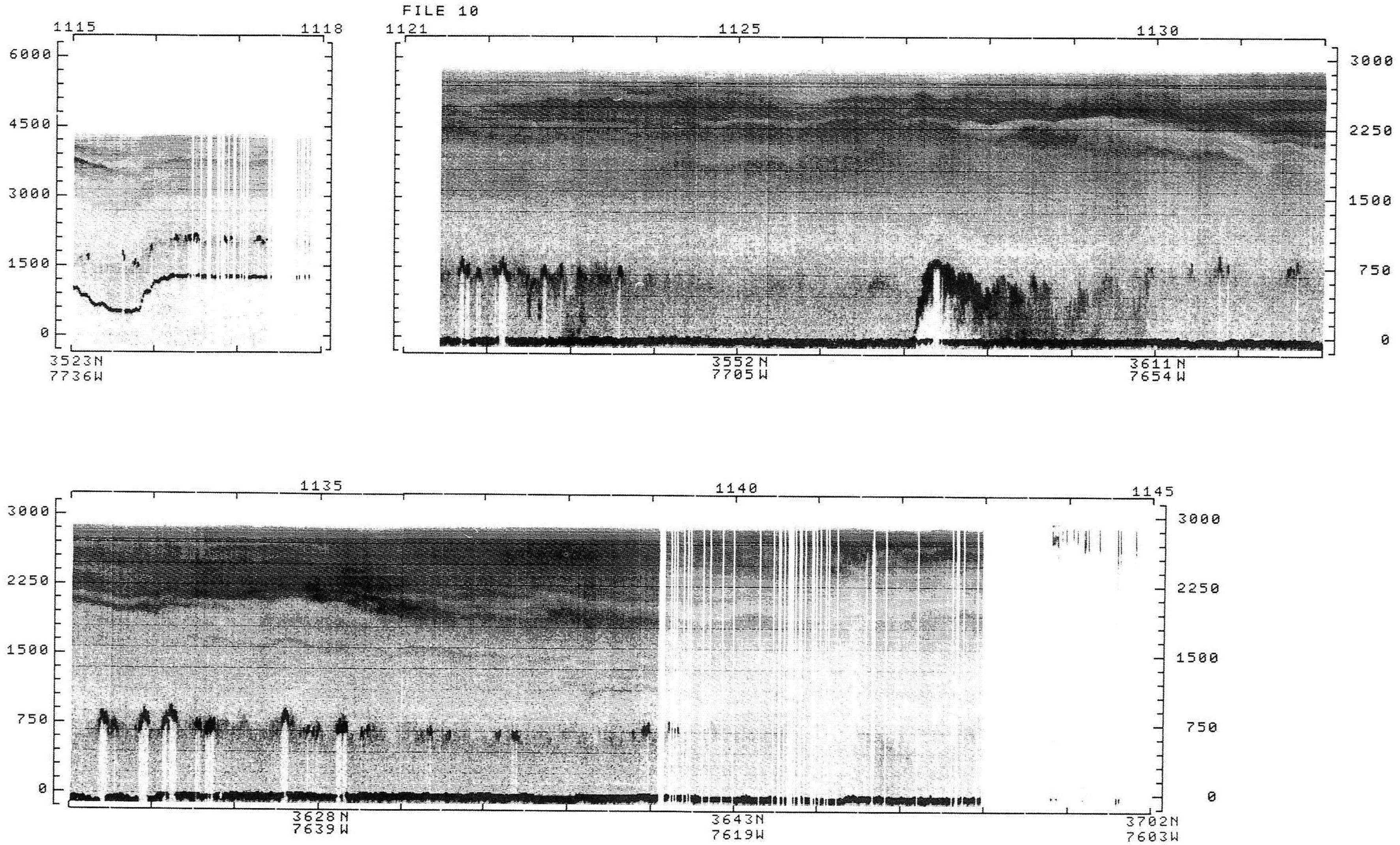
AUGUST 12, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



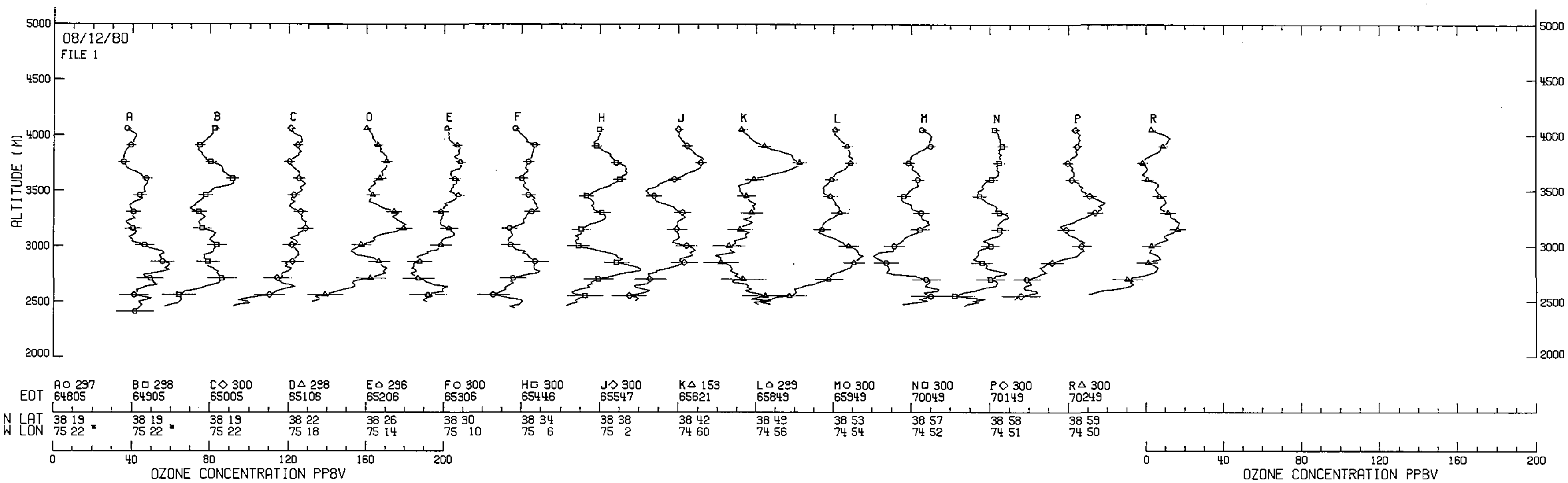
AUGUST 12, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

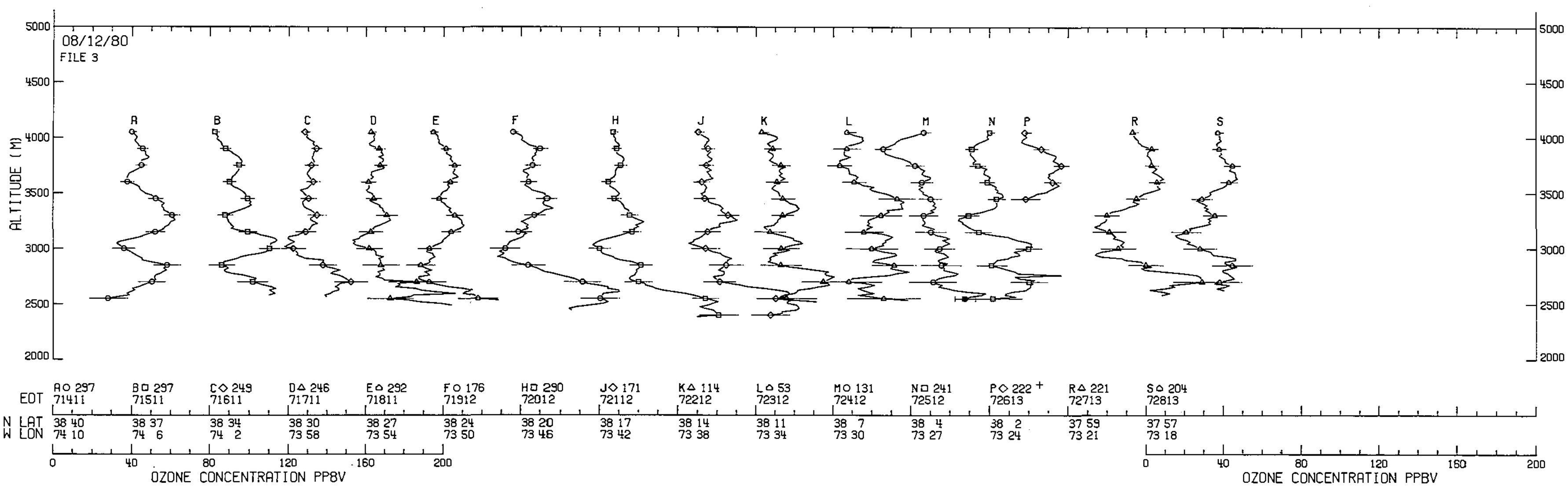


AUGUST 12, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

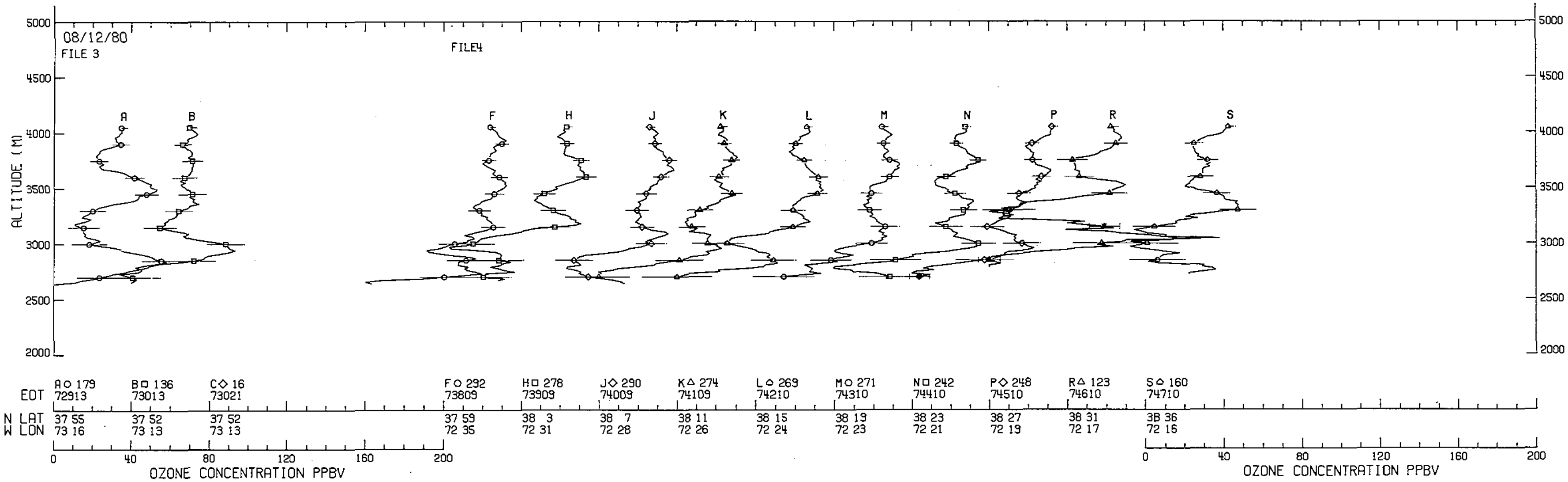


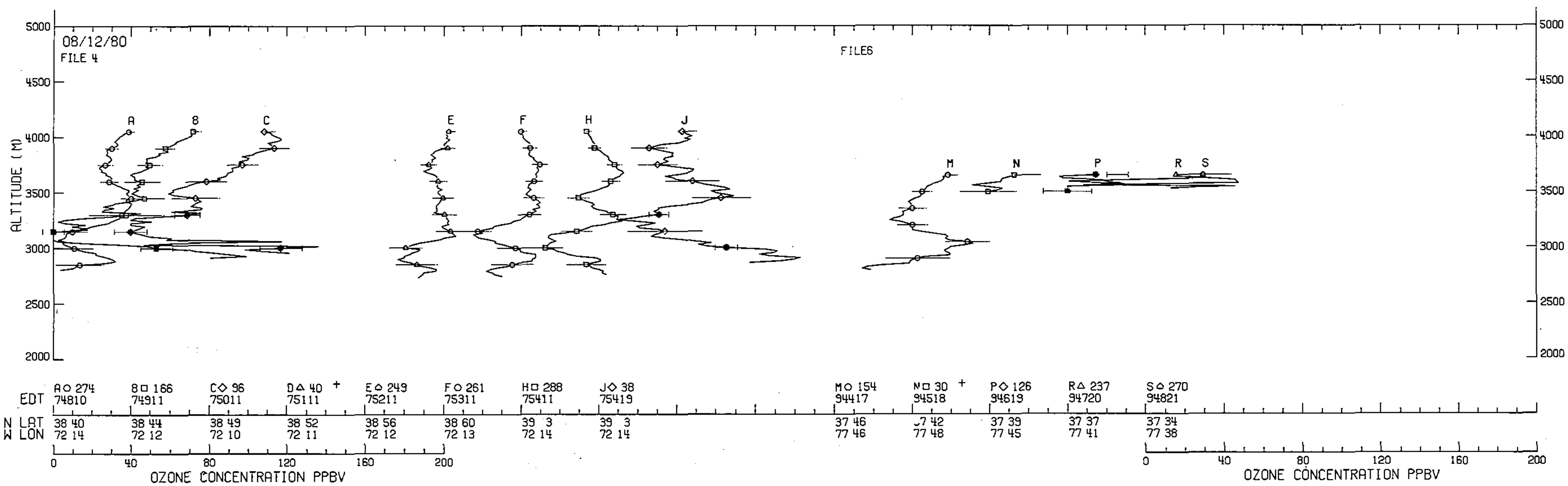
O_3 PROFILES FOR AUGUST 12, 1980, FLIGHT



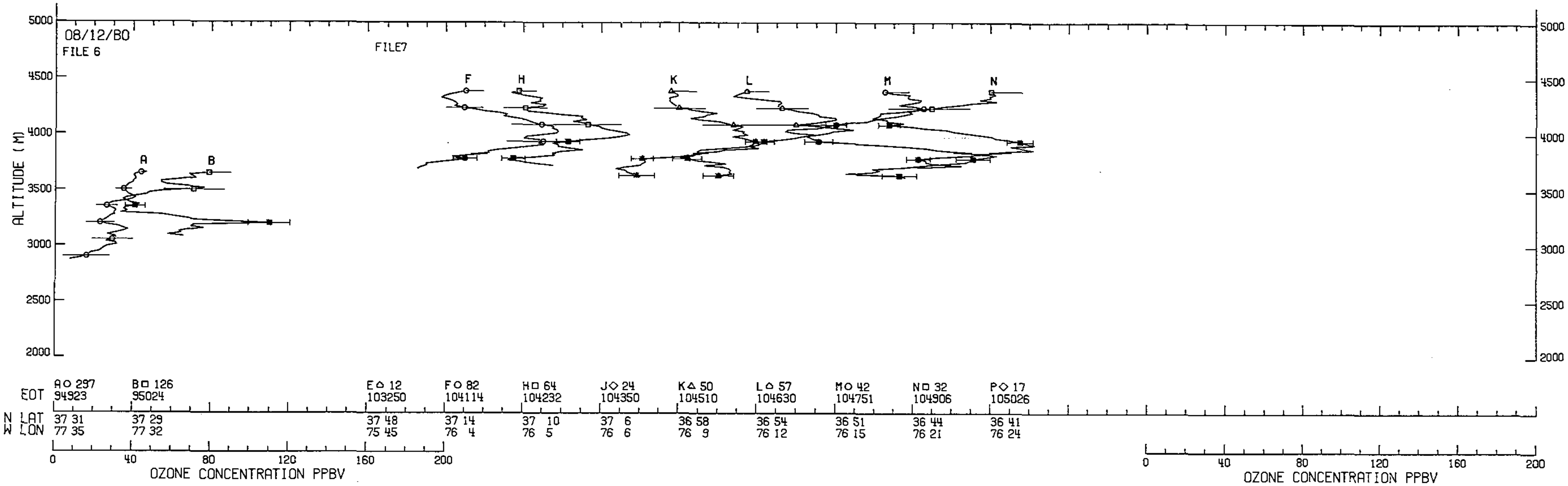


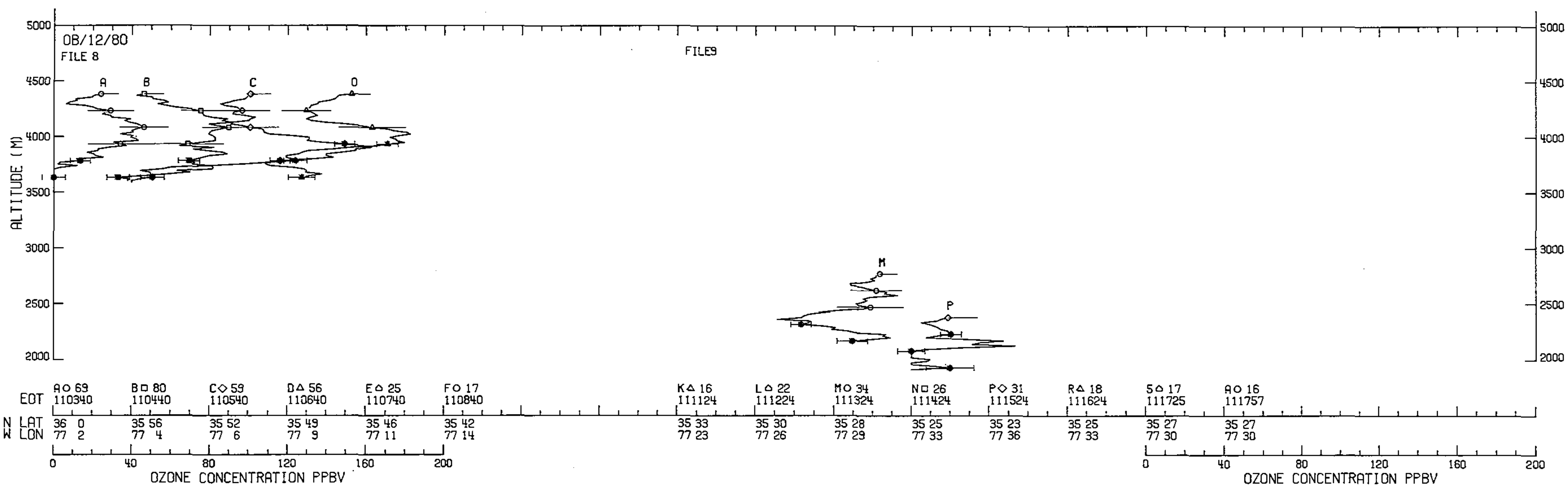
Continued


08/12/80
FILE 3
FILE4
ALTITUDE (M)
5000
4500
4000
3500
3000
2500
2000
A B F H J K L M N P R S
A○ 179 72913
B□ 136 73013
C◇ 16 73021
F○ 292 73809
H□ 278 73909
J◇ 290 74009
K△ 274 74109
L○ 269 74210
M○ 271 74310
N□ 242 74410
P◇ 248 74510
R△ 123 74610
S○ 160 74710
EDT
N LAT
W LON
37 55 73 16
37 52 73 13
37 52 73 13
37 59 72 35
38 3 72 31
38 7 72 28
38 11 72 26
38 15 72 24
38 19 72 23
38 23 72 21
38 27 72 19
38 31 72 17
38 36 72 16
0 40 80 120 160 200
OZONE CONCENTRATION PPBV
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

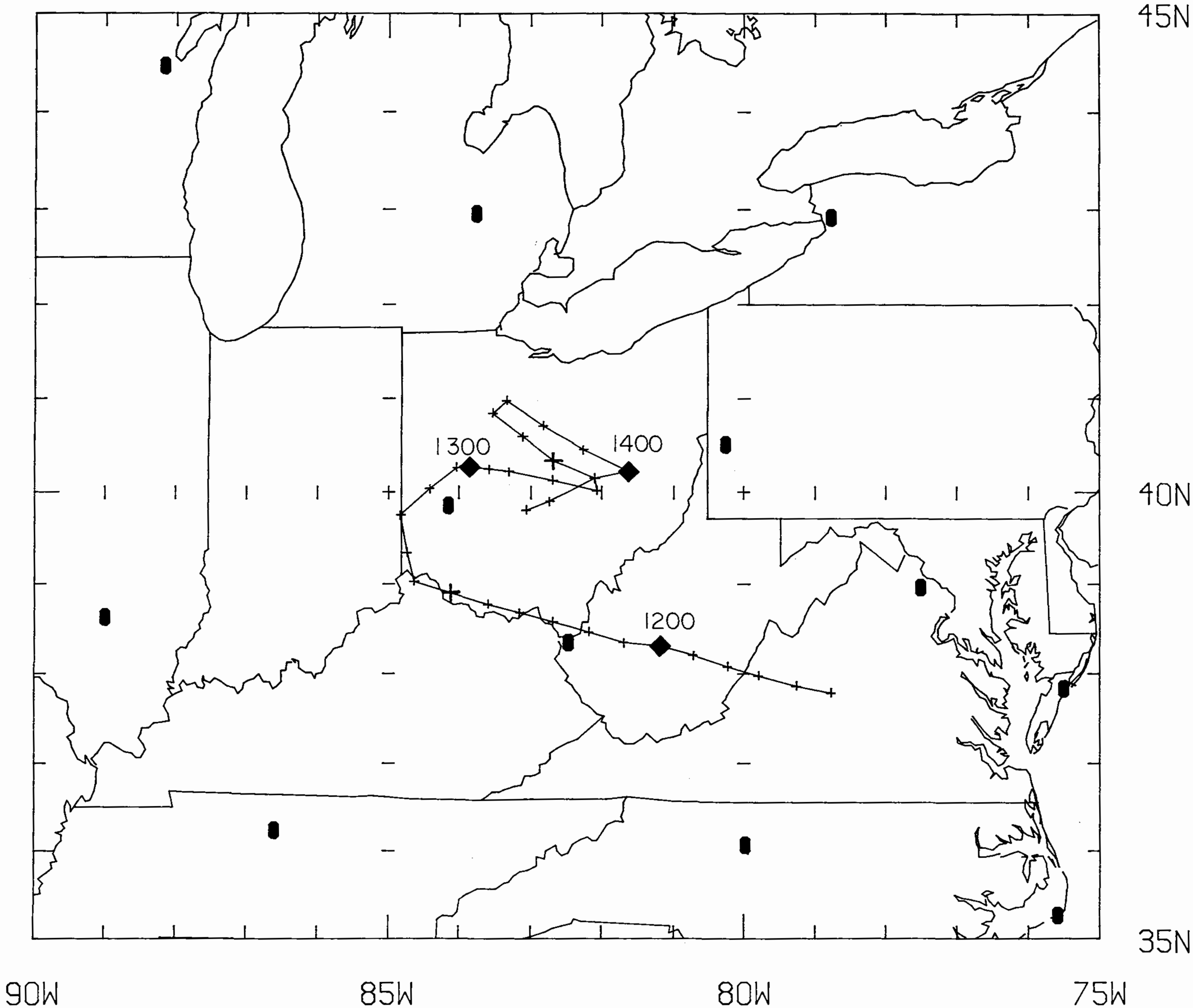

08/12/80
FILE 4
FILE6
ALTITUDE (M)
5000
4500
4000
3500
3000
2500
2000
A B C E F H J M N P R S
A○ 274 74810
B□ 166 74911
C◇ 96 75011
D△ 40 + 75111
E○ 249 75211
F○ 261 75311
H□ 288 75411
J◇ 38 75419
M○ 154 94417
N□ 30 + 94518
P◇ 126 94619
R△ 237 94720
S○ 270 94821
EDT
N LAT
W LON
38 40 72 14
38 44 72 12
38 49 72 10
38 52 72 11
38 56 72 12
38 60 72 13
39 3 72 14
39 3 72 14
37 46 77 46
37 42 77 48
37 39 77 45
37 37 77 41
37 34 77 38
0 40 80 120 160 200
OZONE CONCENTRATION PPBV
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

Concluded

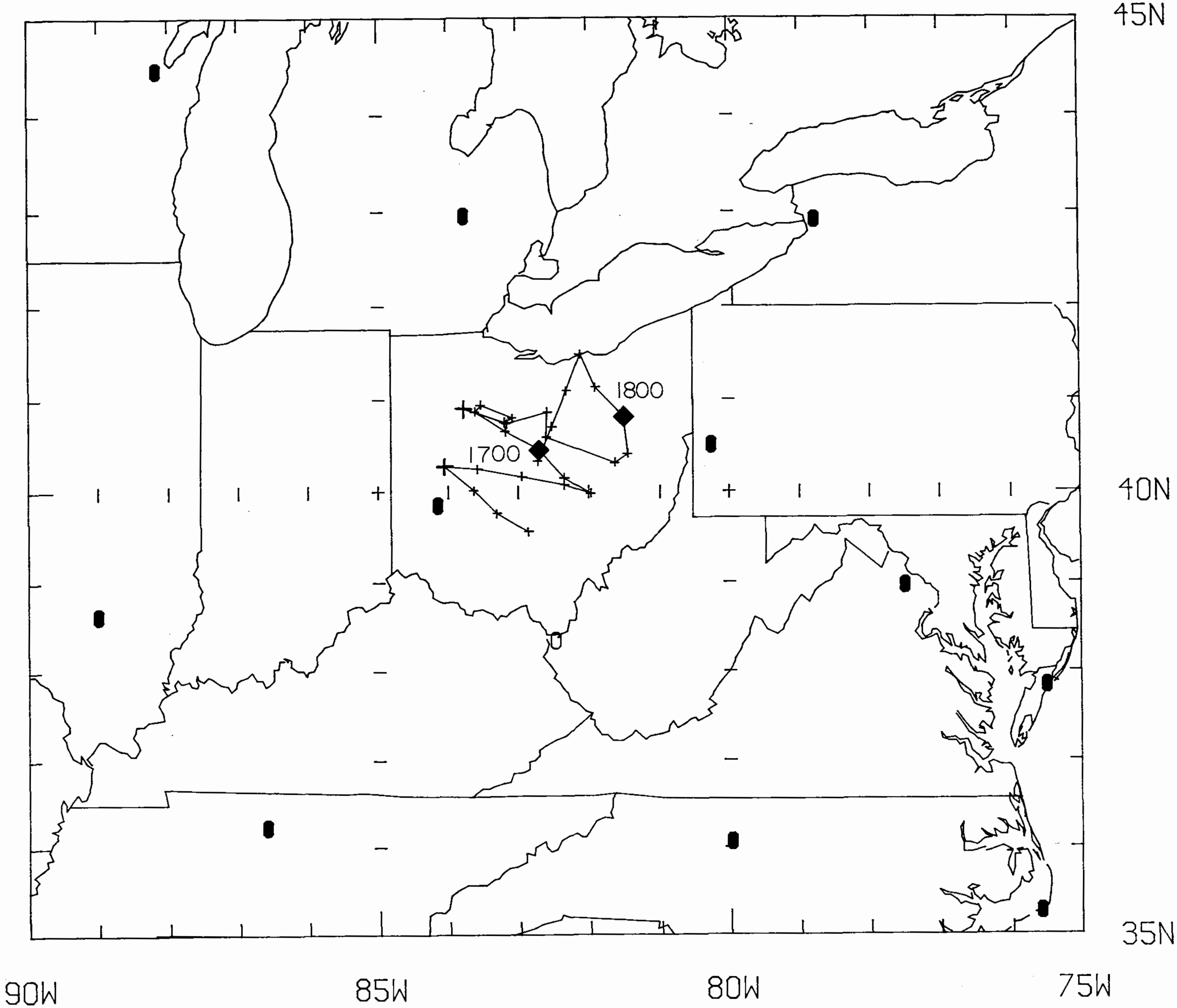

08/12/80
FILE 6
FILE7
ALTITUDE (M)
5000
4500
4000
3500
3000
2500
2000
A
B
F
H
K
L
M
N
EOT
A○ 297 94923
B□ 126 95024
E△ 12 103250
F○ 82 104114
H□ 64 104232
J◇ 24 104350
K△ 50 104510
L△ 57 104630
M○ 42 104751
N□ 32 104906
P◇ 17 105026
N LAT
W LON
37 31 77 35
37 29 77 32
37 48 75 45
37 14 76 4
37 10 76 5
37 6 76 6
36 58 76 9
36 54 76 12
36 51 76 15
36 44 76 21
36 41 76 24
0 40 80 120 160 200
OZONE CONCENTRATION PPBV


08/12/80
FILE 8
FILE9
ALTITUDE (M)
5000
4500
4000
3500
3000
2500
2000
A
B
C
D
M
P
EOT
A○ 69 110340
B□ 80 110440
C◇ 59 110540
D△ 56 110640
E△ 25 110740
F○ 17 110840
K△ 16 111124
L△ 22 111224
M○ 34 111324
N□ 26 111424
P◇ 31 111524
R△ 18 111624
S△ 17 111725
A○ 16 111757
N LAT
W LON
36 0 77 2
35 56 77 4
35 52 77 6
35 49 77 9
35 46 77 11
35 42 77 14
35 33 77 23
35 30 77 26
35 28 77 29
35 25 77 33
35 23 77 36
35 25 77 33
35 27 77 30
35 27 77 30
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

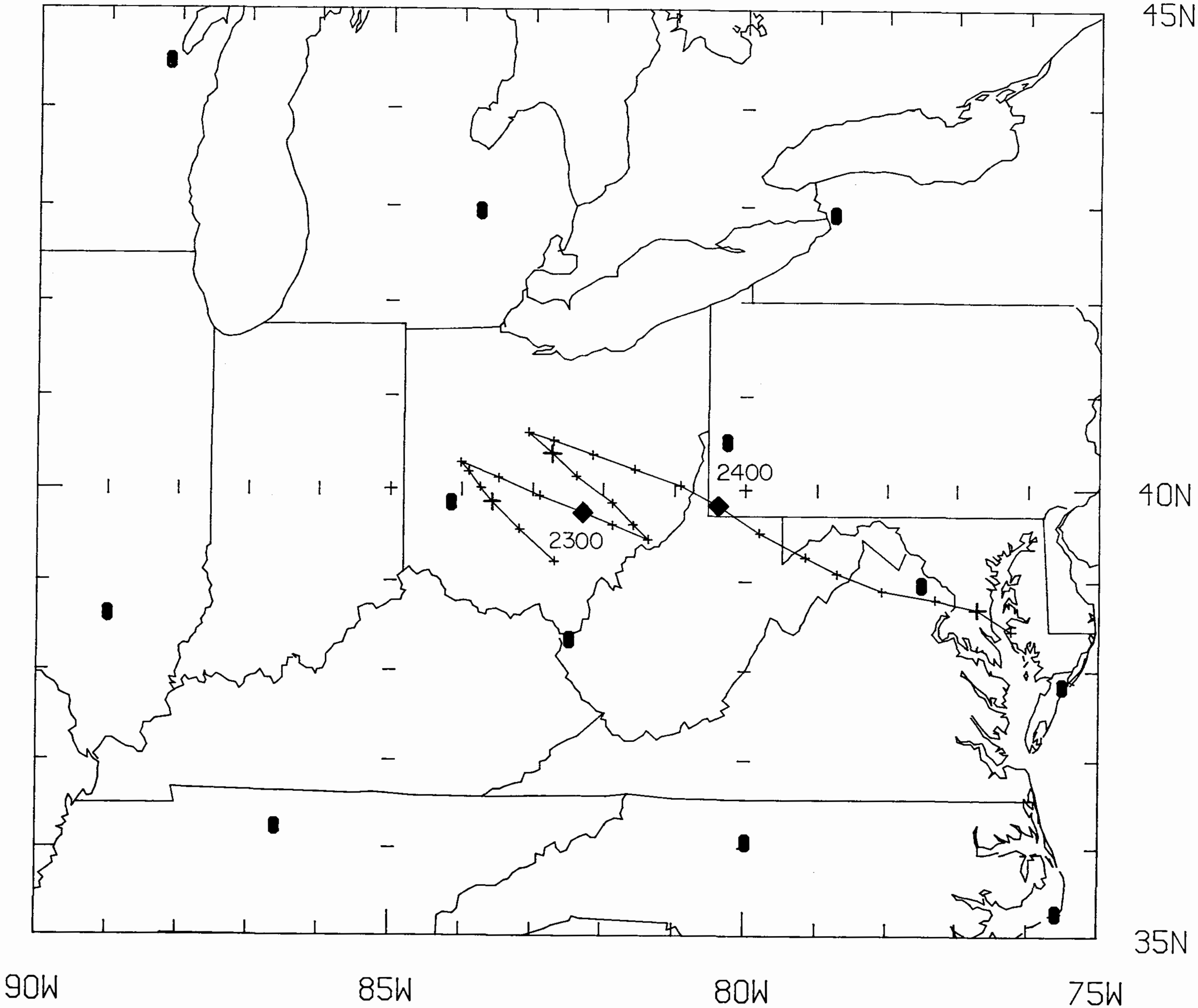
ELECTRA FLIGHT PATH FLIGHT I AUGUST 13, 1980



ELECTRA FLIGHT PATH FLIGHT 2 AUGUST 13, 1980



ELECTRA FLIGHT PATH FLIGHT 3 AUGUST 13, 1980



Instrument Parameters for August 13, 1980, Flights

File no.	Time, EDT		Laser repetition rate, Hz	UV PMT			Aerosol PMT			O_3	Aircraft altitude, m MSL
	Start	End		Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V, for no. 1/no. 2	Delay, μs	Voltage, V	Biomation Model 1010 sensitivity, V		
Flight no. 1											
1	1140	1219	1	6	2376	0.2/0.1	5	2330	0.5	Yes	5179
2	1222	1232	5	5	2300	.2/.1	5	2244	.5	Yes	3891
3	1236	1254	5	5	2300	.2/.1	5	2244	.5	Yes	3944
4	1259	1317	5	6	2480	.2/.1	6	2300	.5	Yes	3921
5	1321	1339	5	6	2480	.2/.1	6	2300	.5	Yes	3954
6	1343	1401	5	6	2480	.2/.1	6	2300	.5	Yes	3924
7	1406	1417	5	6	2480	.2/.1	6	2300	.5	Yes	3875
Flight no. 2											
8	1611	1629	5	6	2486	0.2/0.1	6	2300	0.5	Yes	3928
9[a]											
10	1704	1734	5	(*b*)	(*b*)	(*b*)	6	2317	.5	No	3899
11	1733	1741	5	6	2795	.2/.1	6	2300	.5	Yes	3890
12	1744	1803	5	6	2795	.2/.1	6	2300	.5	Yes	3858
13	1807	1825	5	(*b*)	(*b*)	(*b*)	6	2300	.5	No	3826
Flight no. 3											
14[a]											
15	2256	2306	1	5	2400	0.2/0.1	6	2300	0.5	No	3126
16	2310	2434	1	5	2500	.2/.1	4,7,4	2100	.5	No	3126[c] to 3500[d] to 6084[e]

[a]Blank file.
[b]Aerosol only.
[c]2310 to 2335 EDT.
[d]2340 to 2355 EDT.
[e]2405 to 2434 EDT.

NAVIGATION, CLOUD, AND MIXED-LAYER HEIGHT SUMMARY FOR AUGUST 13, 1980, FLIGHTS

FLIGHT NO. 1

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/13/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
1135	37.	00.	78.	00.	0.		1000.		50.	800.		1100.		1600.		2900.
1415	40.	60.	84.	60.	1100.		2200.		230.	2300.		2700.		3600.		4500.

33

1135	37.0	47.4	78.0	46.1												
1140	37.0	52.2	79.0	15.5												
1145	37.0	59.1	79.0	47.5	914.	V	1550.	S	200.	1430.	S	1760.	S	2060.	S	4430.
1150	38.0	05.1	80.0	13.9	1067.	V	2150.	S	60.	1640.	S	2240.	S	3530.	S	4430.
1155	38.0	12.6	80.0	43.1	823.	V	2150.	S	90.	2210.	S	2150.	S	3230.	S	4430.
1200	38.0	18.5	81.0	11.8	610.	V	1160.	S	150.	950.	S	1550.	S	2940.	S	4430.
1205	38.0	20.8	81.0	42.0	329.	V	1130.	S	150.	1130.	S	1310.	S	3230.	S	4430.
1210	38.0	28.2	82.0	11.0	229.	V	1040.	S	150.	1030.	S	1130.	S	3380.	S	4430.
1215	38.0	35.2	82.0	41.2	250.	V	1040.	S	150.	1030.	S	1130.	S	3350.	S	4430.
1220	38.0	40.6	83.0	09.1												
1225	38.0	46.3	83.0	36.3	229.		1050.		150.	900.		1880.		1700.		3140.
1230	38.0	53.9	84.0	06.7	246.		1680.		50.	930.		1830.		1700.		3140.
1235	39.0	01.8	84.0	38.4												
1240	39.0	20.6	84.0	44.6	177.		1500.		90.	1080.		1500.		NA		3190.
1245	39.0	45.0	84.0	50.0	374.		1350.		150.	900.		1530.		NA		3190.
1250	40.0	02.2	84.0	25.2	314.		1760.		150.	940.		1920.		NA		3190.
1255	40.0	16.0	84.0	02.0												
1300	40.0	16.3	83.0	51.8	322.		1950.		150.	990.		2020.		NA		3020.
1305	40.0	15.0	83.0	35.0	305.		1950.		230.	1120.		2260.		NA		3020.
1310	40.0	13.3	83.0	18.3												
1315	40.0	08.0	82.0	41.2												
1320	40.0	01.0	82.0	04.4												
1325	40.0	09.0	82.0	06.0	311.		1680.		150.	1050.		1720.		NA		3050.
1330	40.0	20.7	82.0	40.7	427.		1170.		200.	870.		1900.		1650.		3050.
1335	40.0	35.8	83.0	06.6	325.		1650.		150.	930.		1650.		NA		3050.
1340	40.0	51.1	83.0	32.3												
1345	40.0	59.0	83.0	20.3	253.		1530.		90.	1050.		1600.		NA		3020.
1350	40.0	43.0	82.0	49.1	327.		1650.		150.	1050.		2040.		NA		3020.

Continued

PROJECT PEPE/PEPE-NEROS STUDY UVDA01 8/13/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL
1355	40.0	27.6	82.0	15.5	310.		1880.		150.	1050.		2100.		NA		3020.
1400	40.0	13.3	81.0	38.1	310.		1700.		140.	990.		1920.		NA		3020.
1405	40.0	09.3	82.0	06.5												
1410	39.0	54.0	82.0	44.0	310.		1920.		120.	980.		2440.		NA		2980.
1415	39.0	48.3	83.0	04.1	310.		2180.		200.	840.		2660.	+	NA		2980.

Continued

FLIGHT NO. 2

PROJECT PEPE/PEPE-NEROS STUDY UVDA02 8/13/80 18 0

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
1615	39.	00.	81.	00.	100.		900.		80.	1000.		1300.		1100.		2900.	
1825	41.	60.	84.	60.	450.		2400.		150.	1600.		2500.		1200.		3100.	

27

TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
1615	39.0	33.9	82.0	51.9	229.		2370.		90.	1260.		2430.		NA		3030.	
1620	39.0	45.7	83.0	18.2	277.		2250.		80.	1140.		2370.		NA		3030.	
1625	40.0	00.7	83.0	38.1	394.		1500.		80.	1080.		1320.		NA		3030.	
1630	40.0	16.7	84.0	02.9													
1635	40.0	15.1	83.0	34.5													
1640	40.0	10.0	82.0	56.8													
1645	40.0	04.6	82.0	20.4													
1650	40.0	59.0	81.0	58.5													
1655	40.0	09.2	82.0	20.7													
1700	40.0	27.8	82.0	42.5													
1705	40.0	39.5	83.0	10.6	285.		1590.		120.	1100.		1600.		NA		3000.	
1710	40.0	52.5	83.0	36.9	256.		1050.		120.	NA		NA		NA		3000.	
1715	40.0	57.0	83.0	32.3	246.		1050.		90.	NA		NA		NA		3000.	10
1720	40.0	48.4	83.0	05.0	300.		1470.		100.	NA		NA		NA		3000.	
1725	40.0	45.6	83.0	11.8	307.		1400.		90.	NA		NA		NA		3000.	
1730	40.0	54.7	83.0	46.9	290.		1050.		60.	NA		NA		NA		3000.	8
1735	40.0	44.8	83.0	09.8	260.		900.		100.	NA		NA		1140.		2990.	
1740	40.0	52.5	82.0	35.0	352.		1400.		110.	NA		NA		NA		2990.	
1745	40.0	36.0	82.0	36.0	305.	V	1880.	S	90.	1420.	S	1920.	S	NA		2960.	
1750	40.0	19.0	81.0	38.0	305.	V	1940.	S	150.	1580.	S	1940.	S	NA		2960.	
1755	40.0	25.0	81.0	27.4	305.	V	2040.	S	80.	1490.	S	1730.	S	NA		2960.	
1800	40.0	49.5	81.0	31.2	328.	V	1760.	S	100.	1310.	S	1910.	S	NA		2960.	
1805	41.0	08.2	81.0	54.0													
1810	41.0	29.6	82.0	07.2	191.		1120.		90.	NA		NA		NA		2930.	
1815	41.0	06.0	82.0	18.5	298.		1350.		120.	NA		NA		NA		2930.	
1820	40.0	43.0	82.0	31.0	419.		1600.		150.	NA		NA		NA		2930.	
1825	40.0	20.0	82.0	43.4													

(8) RAIN
(10) VIRGA

Continued

FLIGHT NO. 3

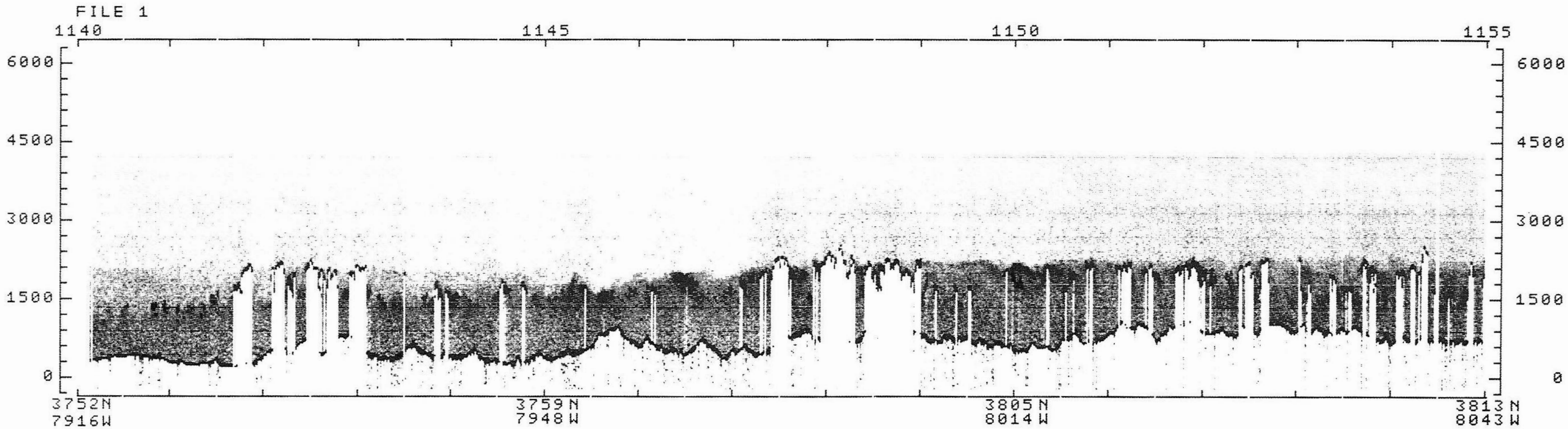
PROJECT PEPE/PEPE-NEROS STUDY UVDA03 8/13/80 18 0

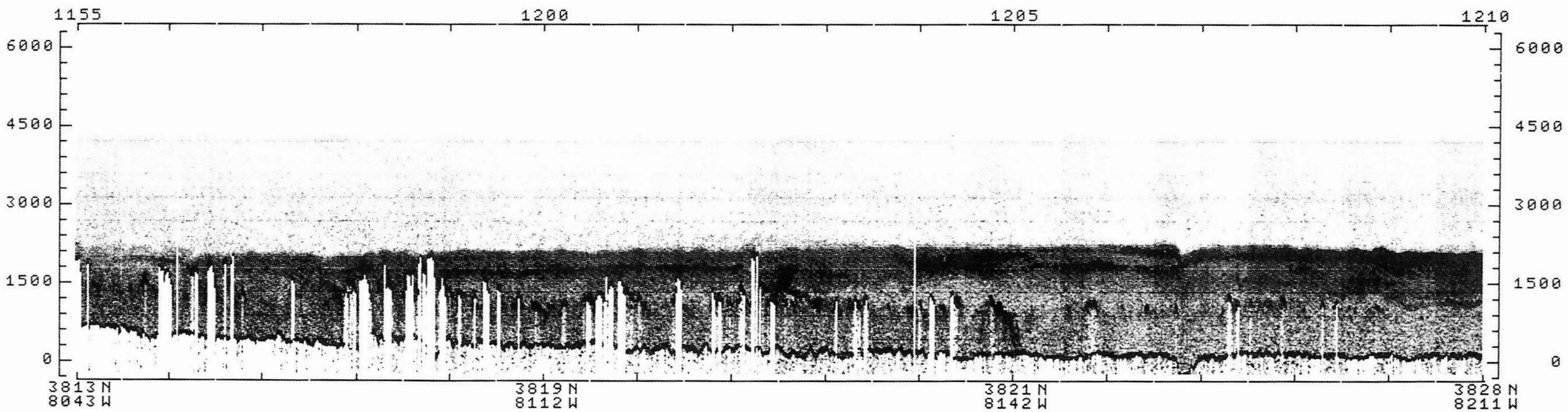
TIME EDT	LAT DEG	LAT MIN	LONG DEG	LONG MIN	ALT MMSL	K	MIXHT MAGL	L	H2SIG M	LWCCL MAGL	M	MXCLD MAGL	N+	TPUSL MAGL	N1+	MAXSG MMSL	
2220	38.	00.	76.	00.	0.		100.	-	50.			2100.		1000.		2200.	
2435	40.	60.	84.	60.	1000.		1000.		150.			2500.		2500.		5500.	
	28																
2220	39.0	13.0	82.0	41.5	229.		NA										
2225	39.0	34.0	83.0	11.4	266.		NA										
2230	39.0	52.0	83.0	35.0	340.		NA										
2235	40.0	01.0	83.0	44.2	301.		NA										
2240	40.0	11.6	83.0	54.5	370.		NA										
2245	40.0	17.2	84.0	01.0	314.		NA										
2250	40.0	07.5	83.0	29.5	305.		NA										
2255	39.0	56.0	82.0	54.0	233.		NA										
2300	39.0	45.0	82.0	18.2	305.		NA										
2305	39.0	36.6	81.0	52.4	310.		200.		80.	NA		NA		1920.	+	2230.	
2310	39.0	27.4	81.0	22.5													
2315	39.0	36.8	81.0	35.0	230.	V	440.	S	50.	NA		NA		2030.	SM	2530.	
2320	39.0	51.0	81.0	52.4	320.	V	940.	S	150.	NA		NA		1930.	SM	2530.	
2325	40.0	08.5	82.0	23.0	320.	V	450.	S	50.	NA		NA		1350.	S	2530.	11
2330	40.0	23.4	82.0	43.4	370.		180.		50.	ND		2160.	+	2160.	M+	2530.	10
2335	40.0	37.0	83.0	03.5	290.		150.		50.	ND		2240.	+	2240.	M+	2530.	8
2340	40.0	31.5	82.0	41.8	410.		150.		50.	ND		2420.	+	2420.	M+	2830.	8
2345	40.0	22.4	82.0	08.6	310.		220.		50.	NA		NA		1080.	M	2830.	12
2350	40.0	13.0	81.0	33.5	310.		150.		50.	NA		NA		1320.	M	2830.	
2355	40.0	02.5	80.0	55.2	380.		120.		50.	NA		NA		1360.	M	2900.	
2400	39.0	49.6	80.0	23.6	500.		100.	-	ND	NA		NA		1350.	M	3700.	
2405	39.0	32.0	79.0	48.0	610.		100.	-	ND	NA		NA		1650.	M	5500.	
2410	39.0	16.0	79.0	09.4	990.	V	100.	-	ND	NA		NA		1970.	S	5500.	
2415	39.0	05.0	78.0	43.2	610.	V	600.		80.	NA		NA		2390.	S	5500.	
2420	38.0	53.5	78.0	04.6	310.		600.		80.	NA		NA		1800.		5500.	
2425	38.0	48.0	77.0	18.8	130.		600.		80.	NA		NA		1920.		5500.	
2430	38.0	41.8	76.0	42.6	70.		600.		80.	NA		NA		1860.		4870.	
2435	38.0	27.4	76.0	14.0													

Concluded

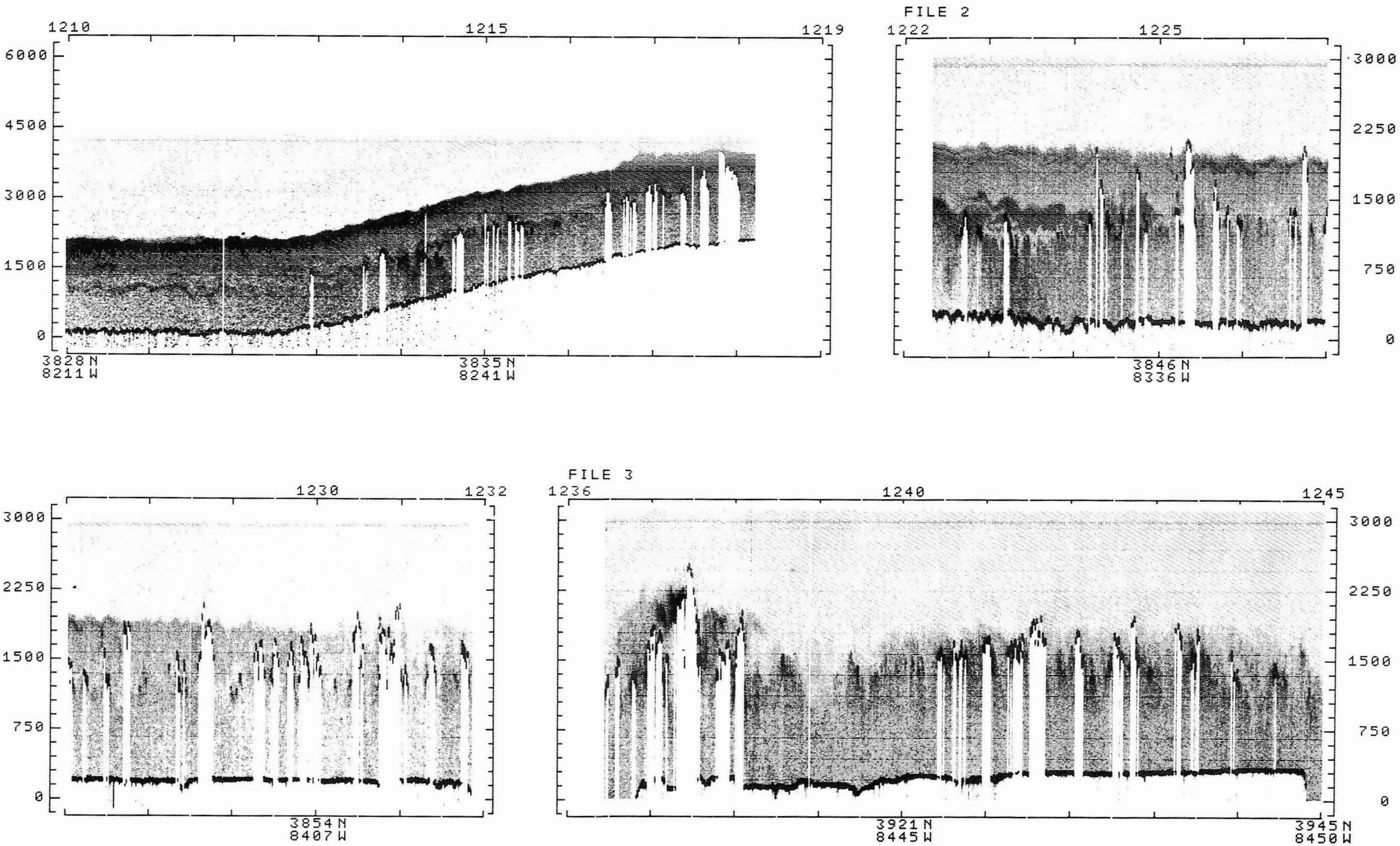
```
PROJECT PEPE/PEPE-NEROS STUDY                              UVDA03  8/13/80    18  0.
TIME LAT  LAT  LONG LONG ALT  K MIXHT L H2SIG LWCCL M MXCLD N+ TPUSL N1+ MAXSG
EDT  DEG  MIN  DEG  MIN  MMSL   MAGL     M    MAGL    MAGL     MAGL      MMSL
     (8) RAIN
    (10) VIRGA
    (11) FRONTAL DEPRESSION TO SURFACE
    (12) FRONTAL ASCENSION FROM SURFACE
```

AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

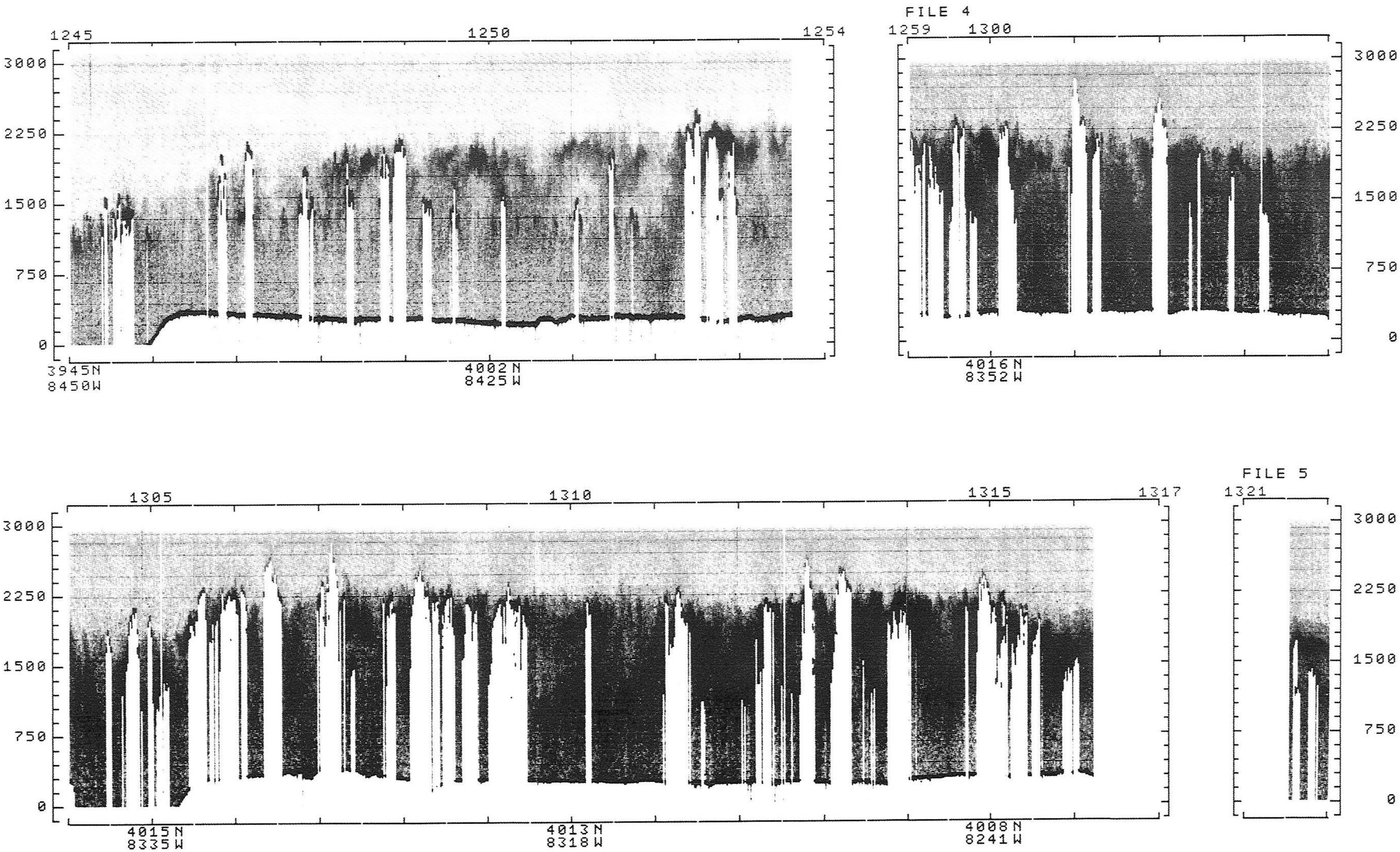




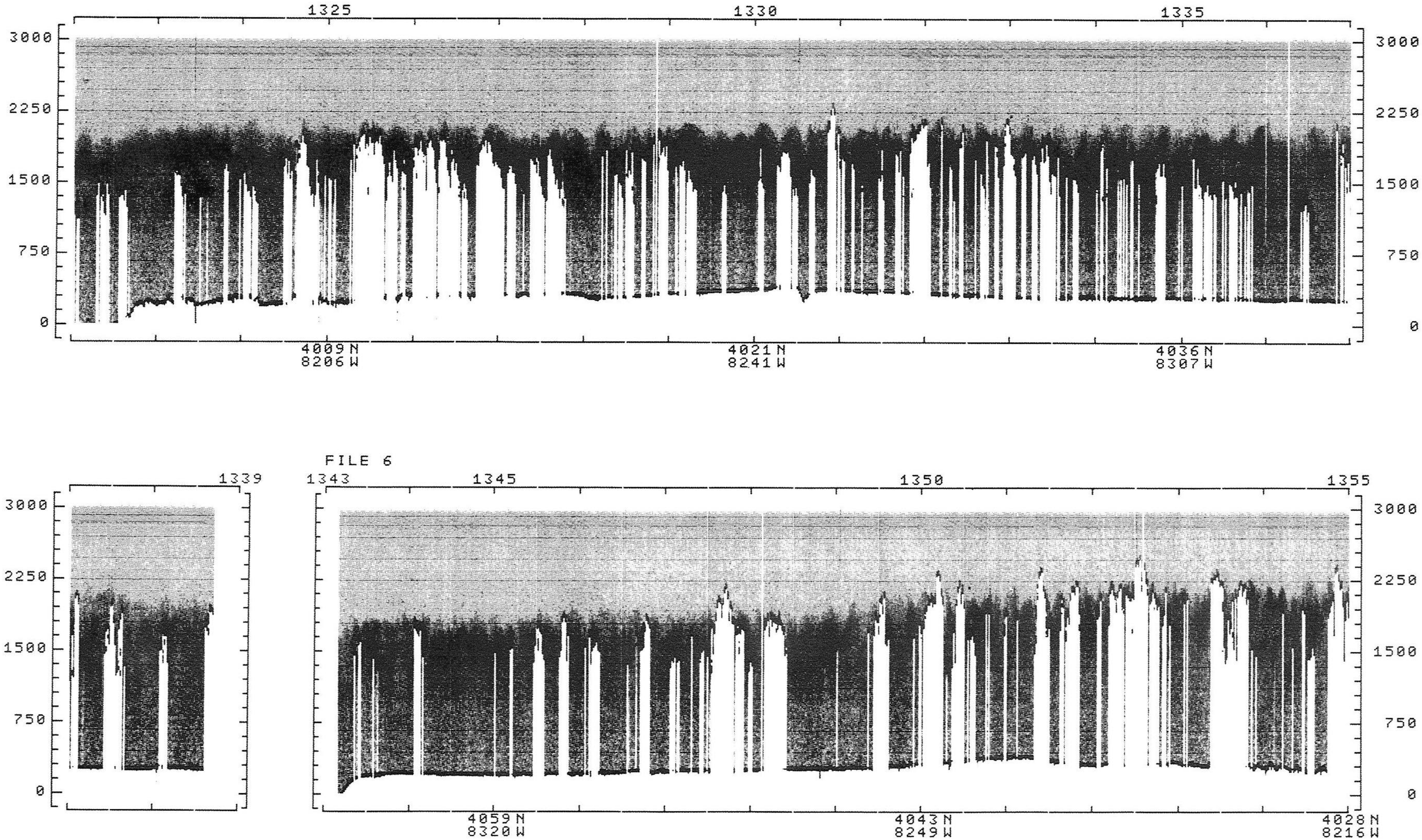
AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



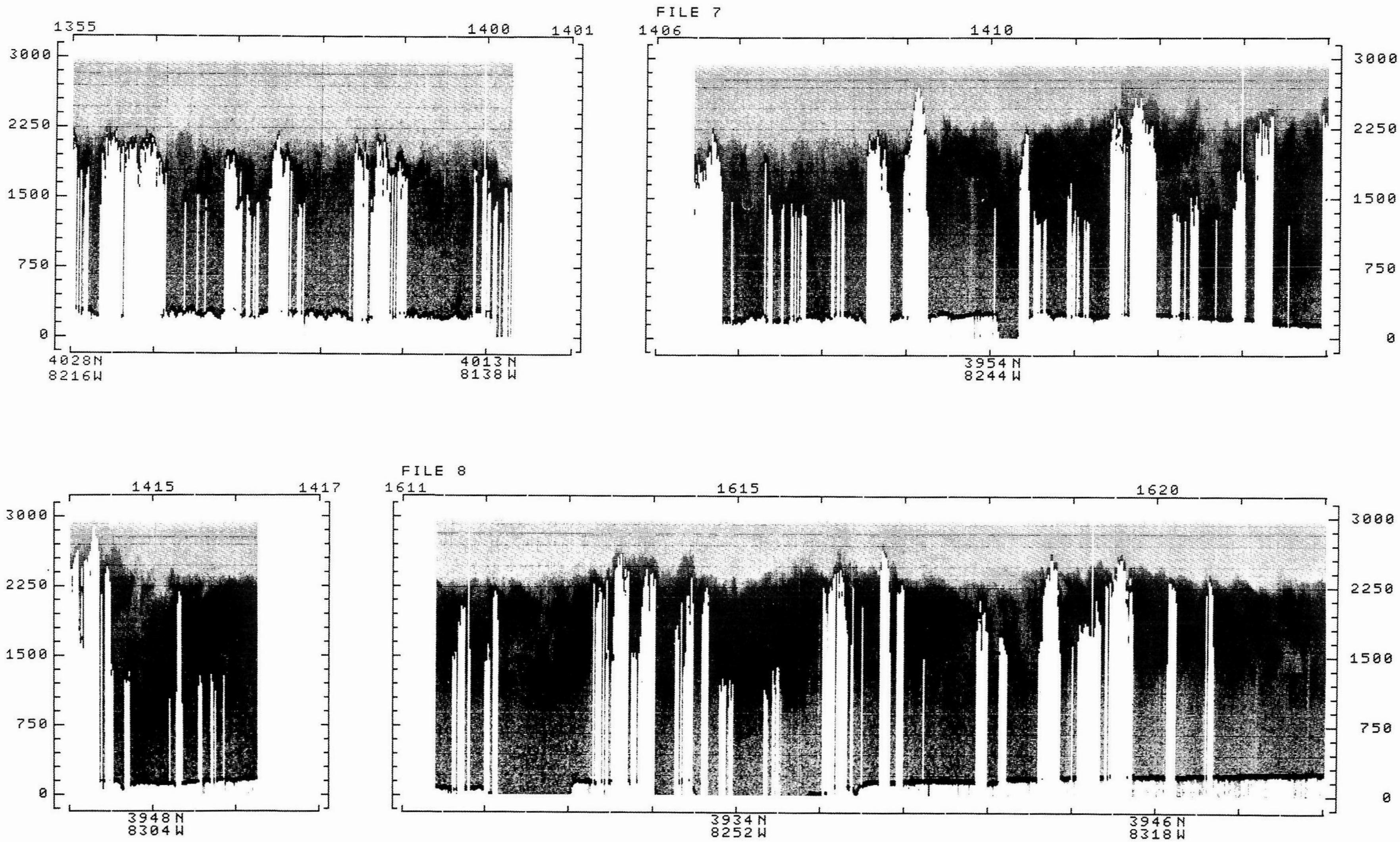
AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

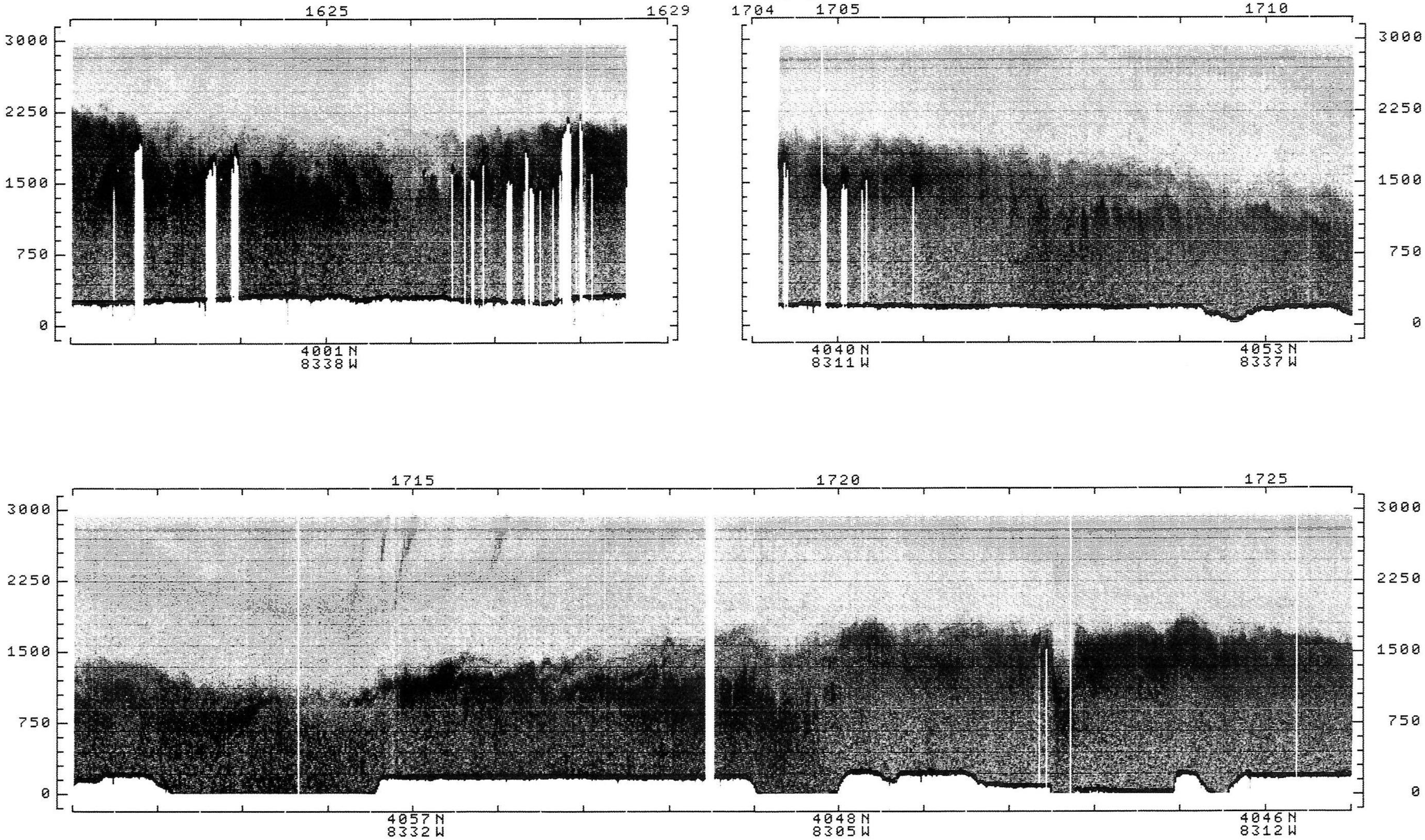


AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

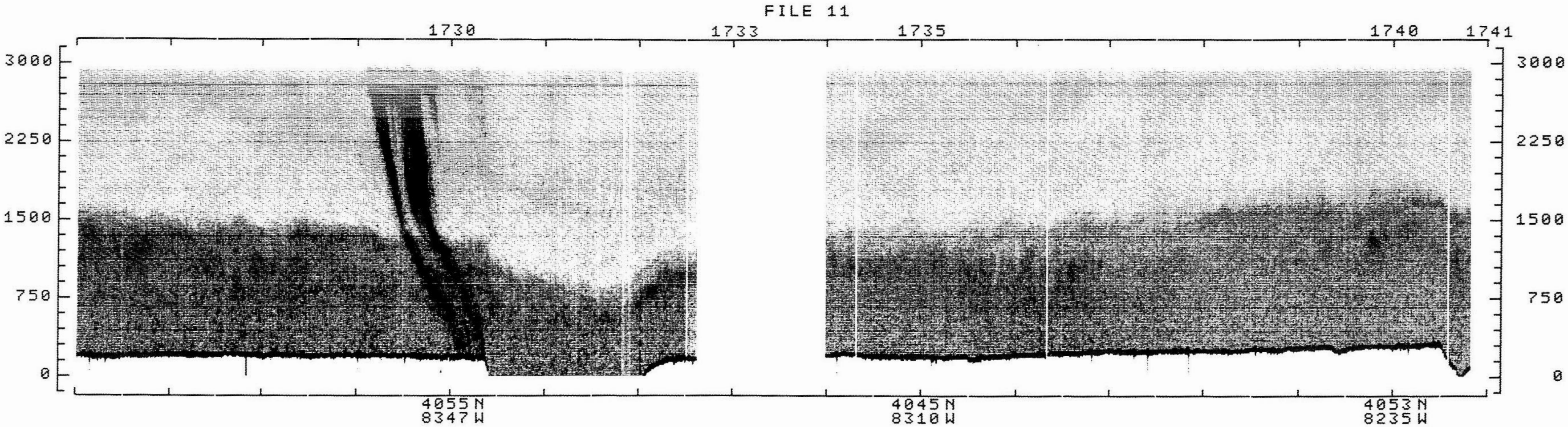


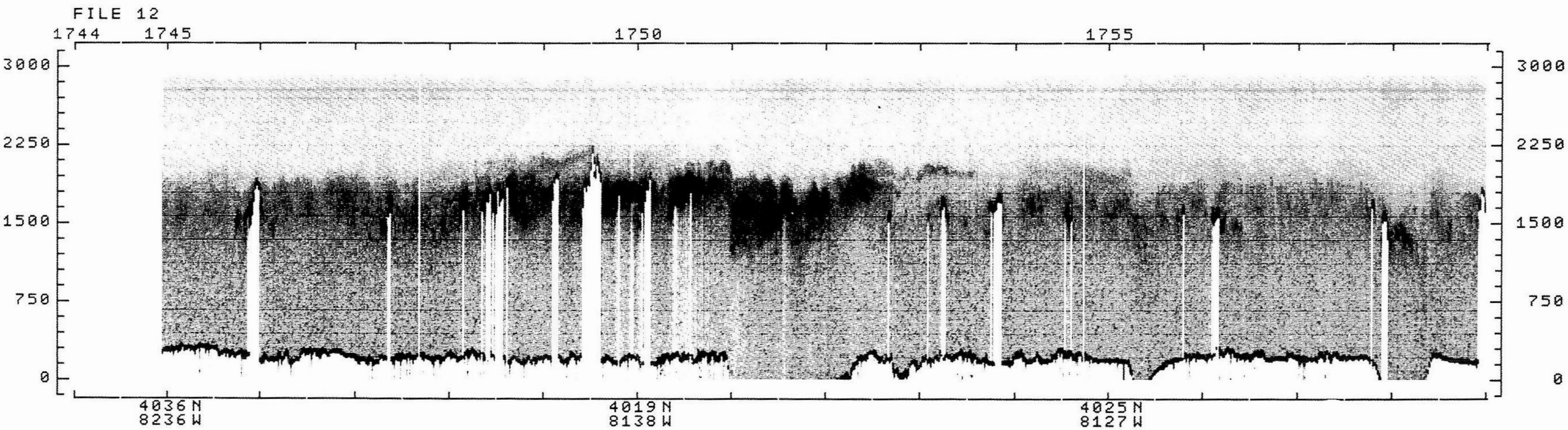
AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

FILE 10

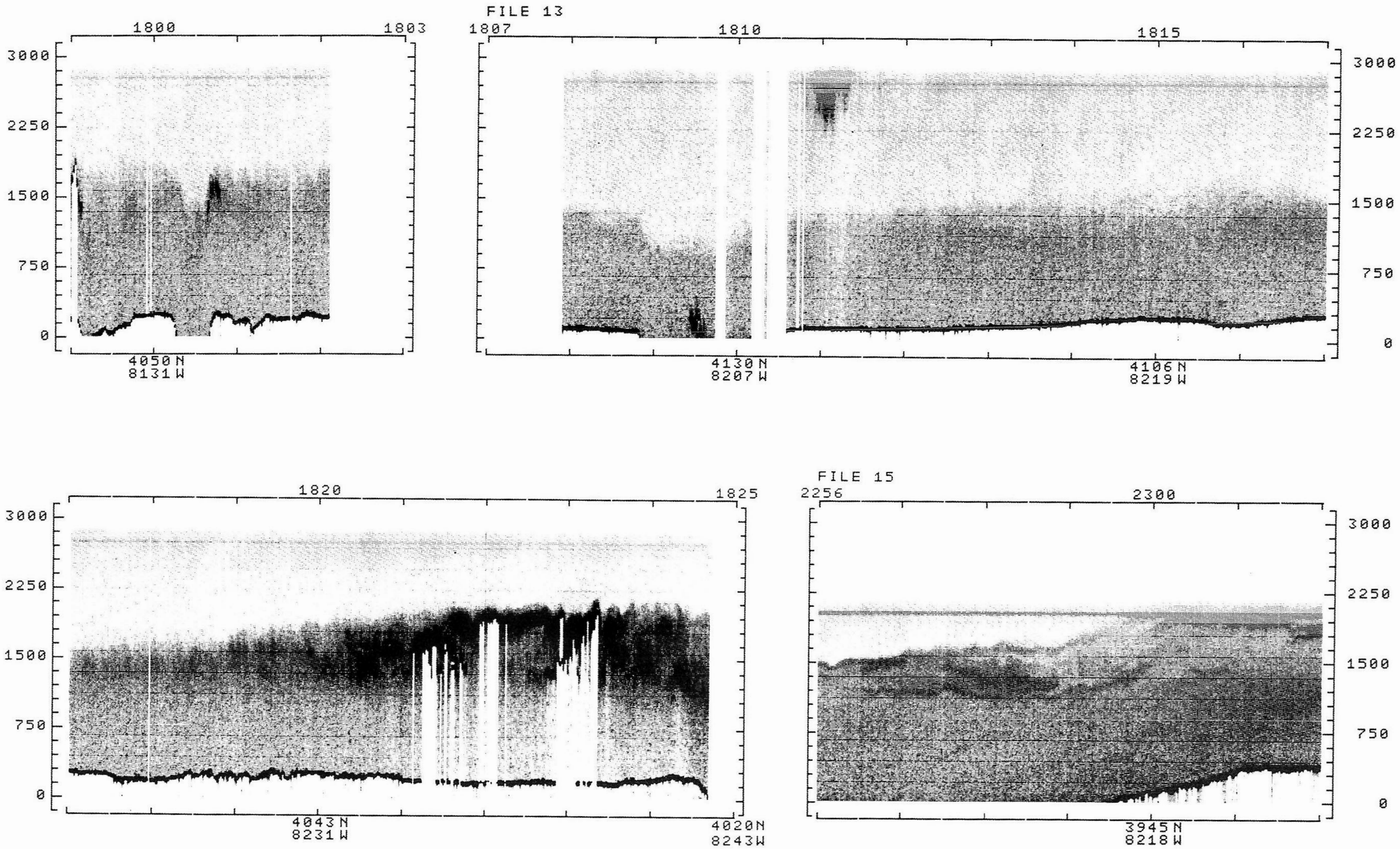


AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

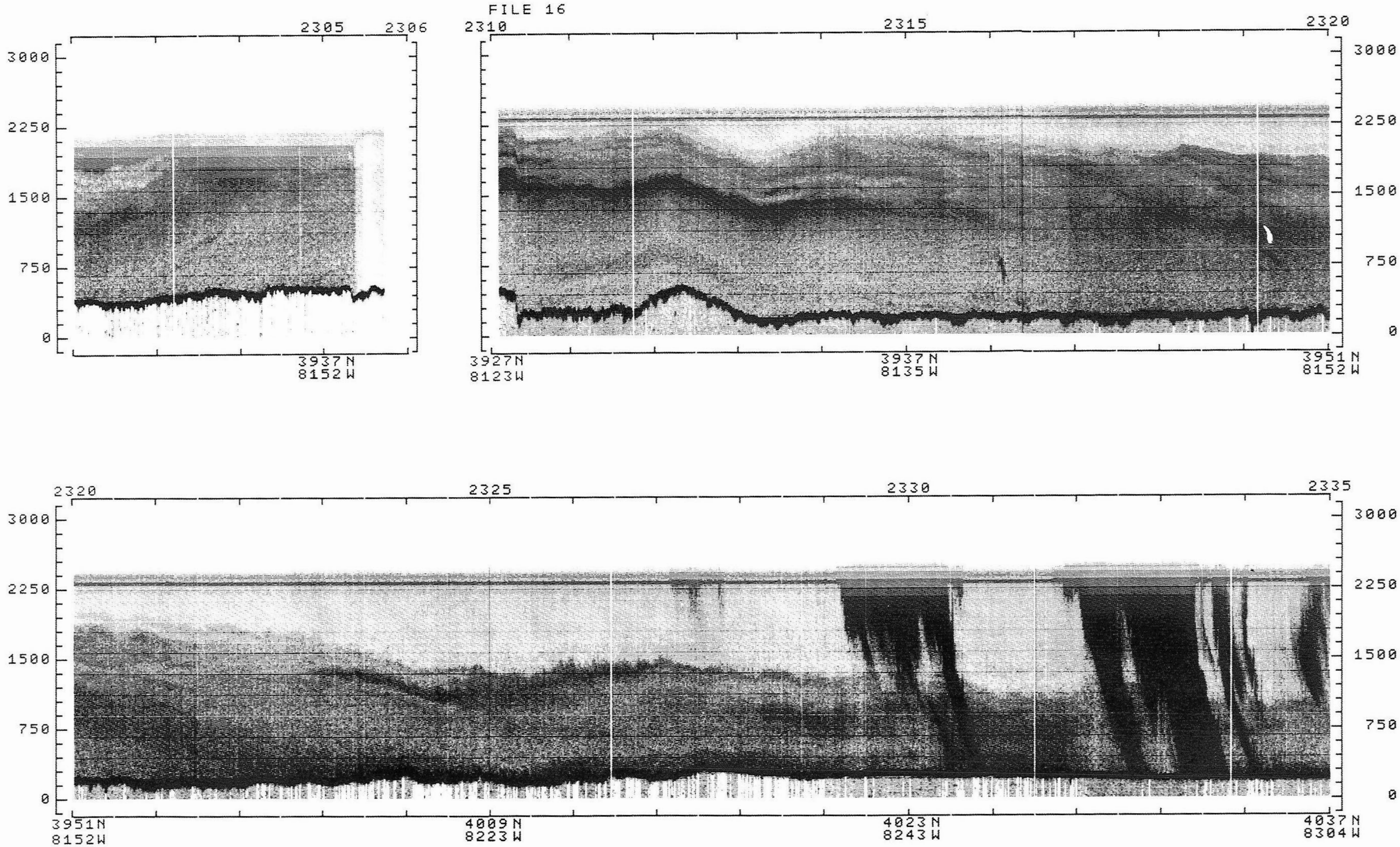




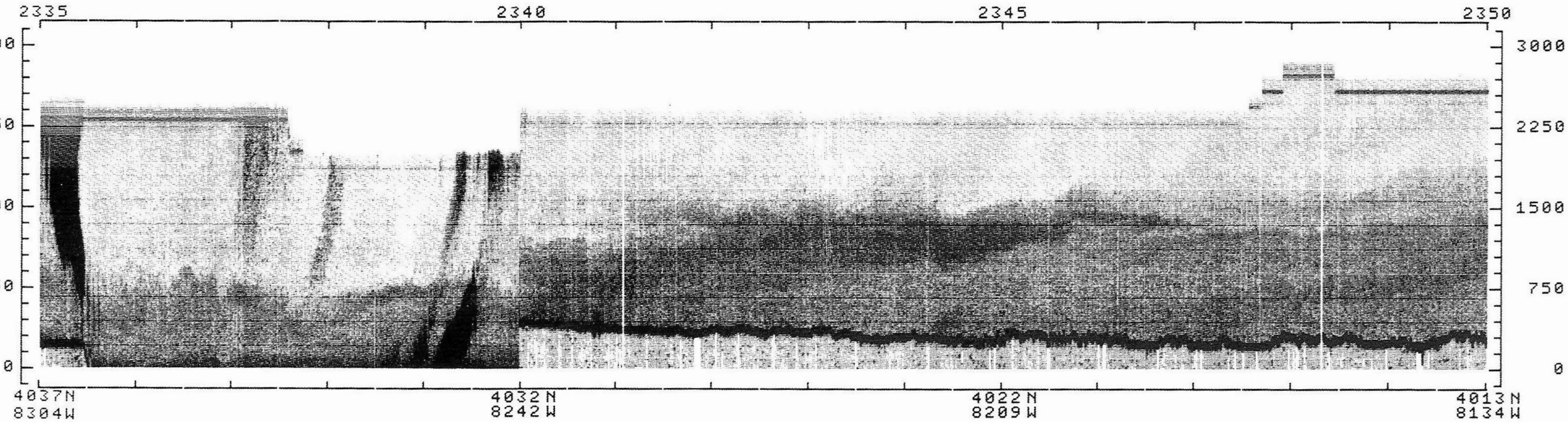
AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

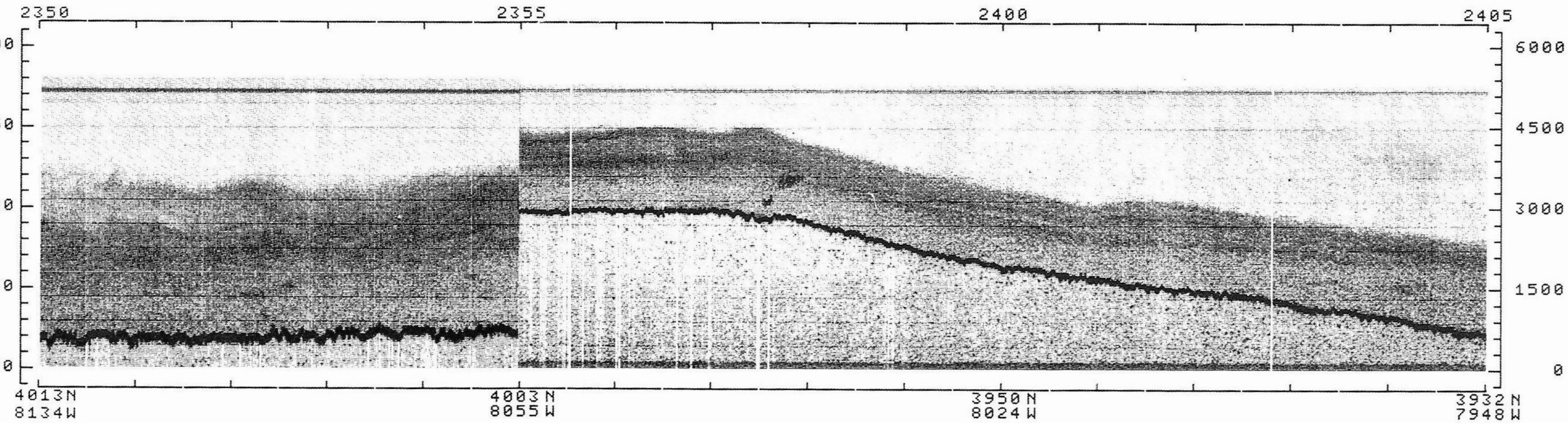


AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL

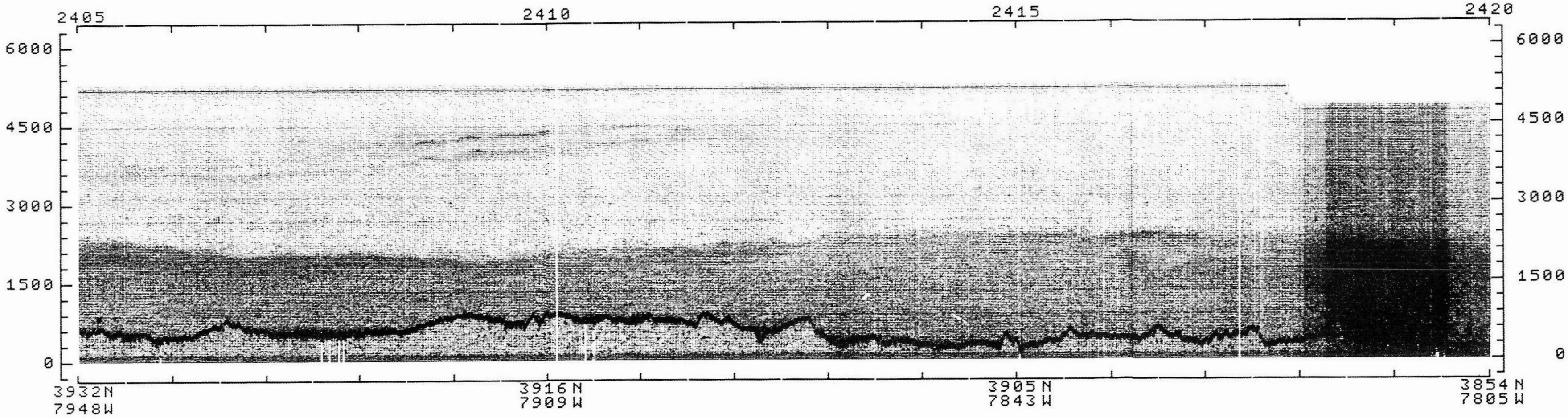


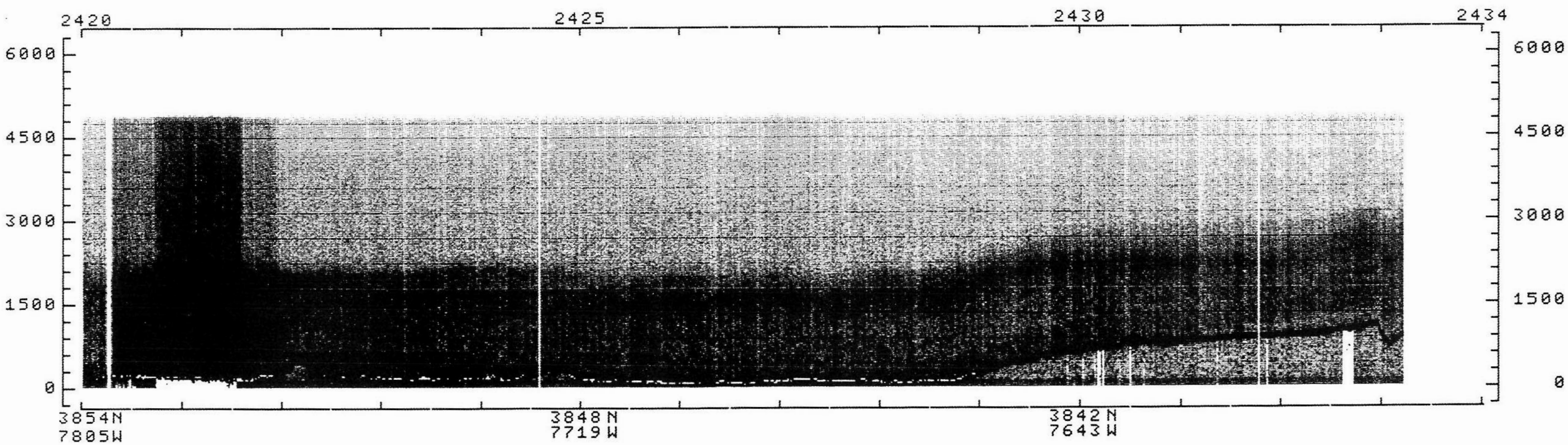
AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



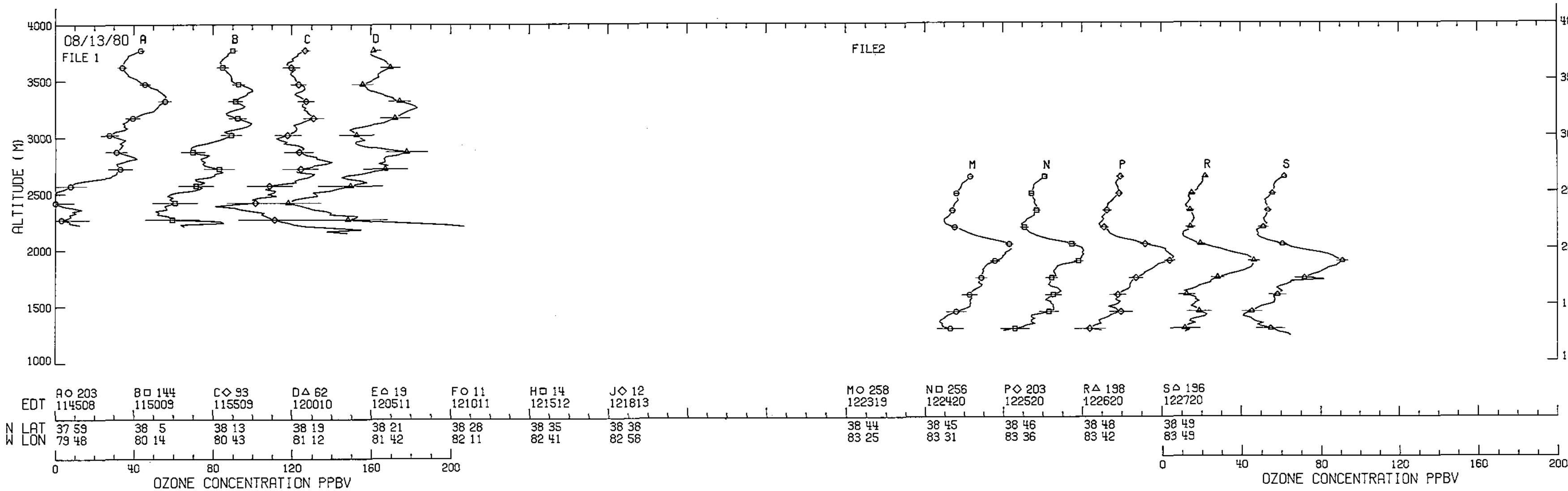


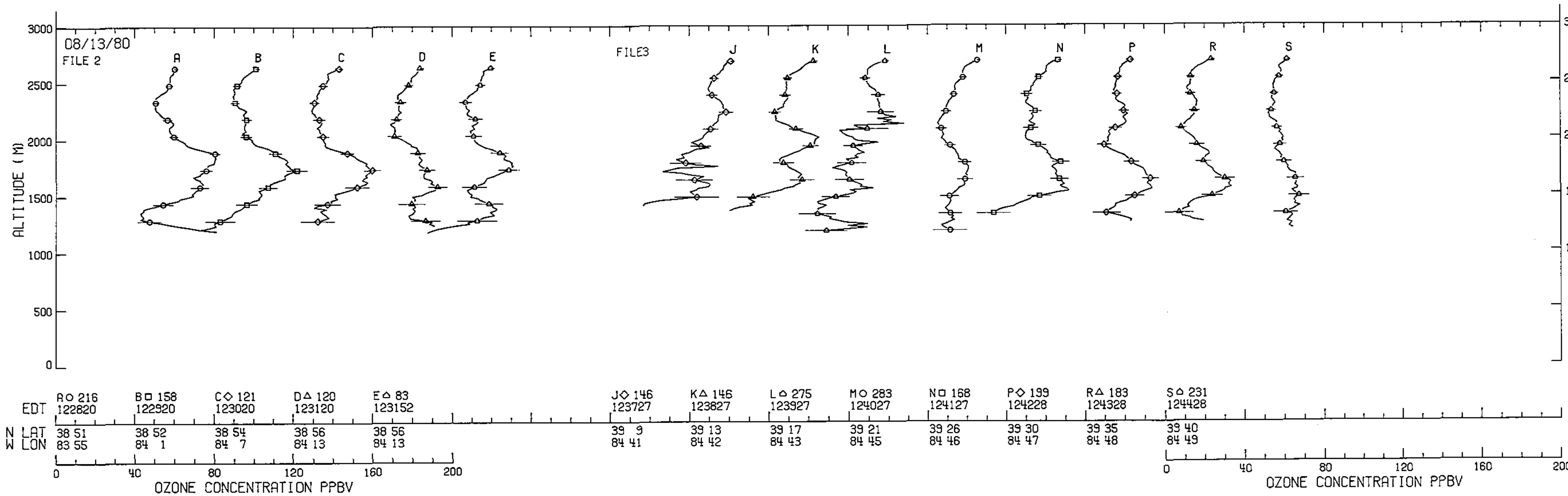
AUGUST 13, 1980 PEPE/NEROS UV DIAL AEROSOL CHANNEL



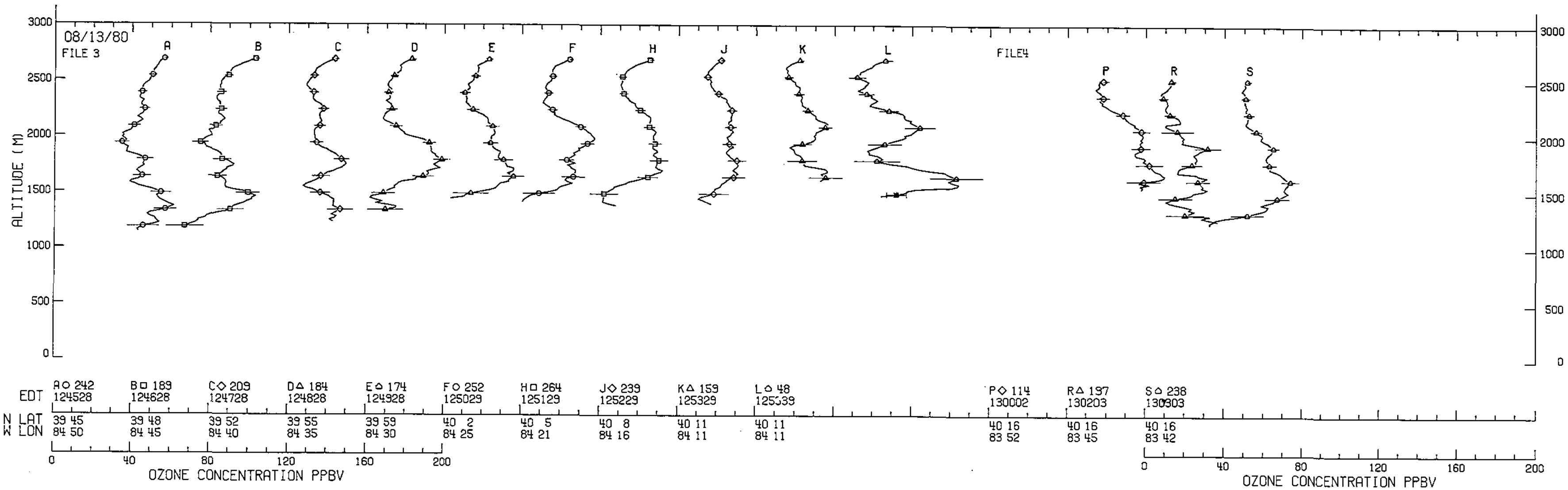


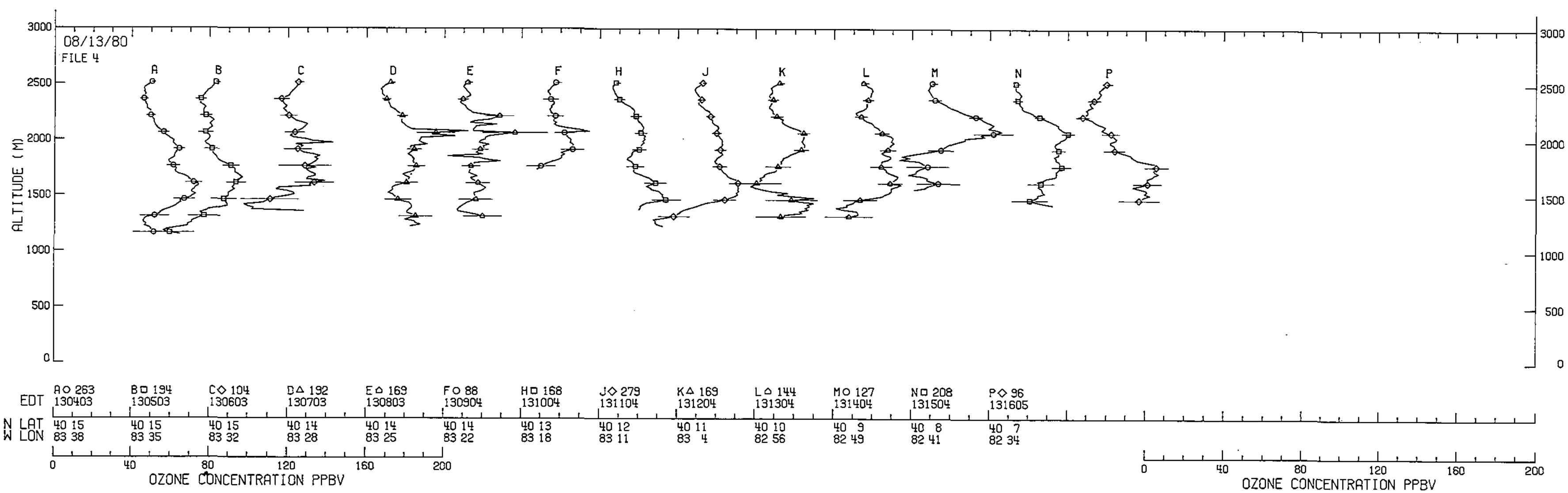
O_3 PROFILES FOR AUGUST 13, 1980, FLIGHTS



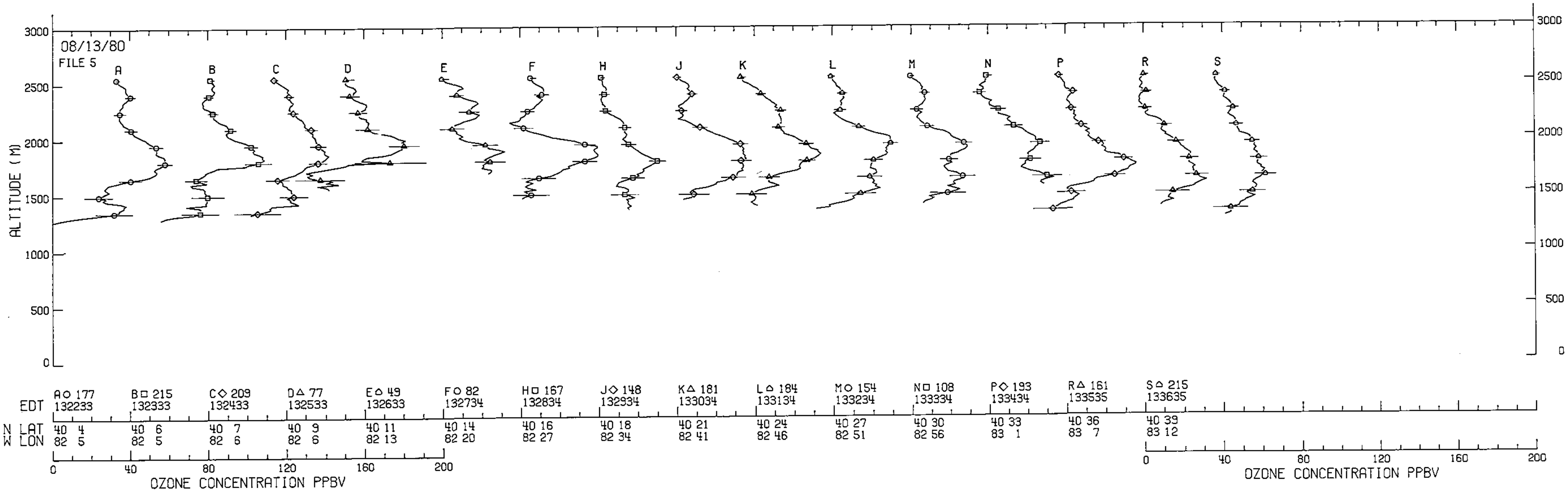


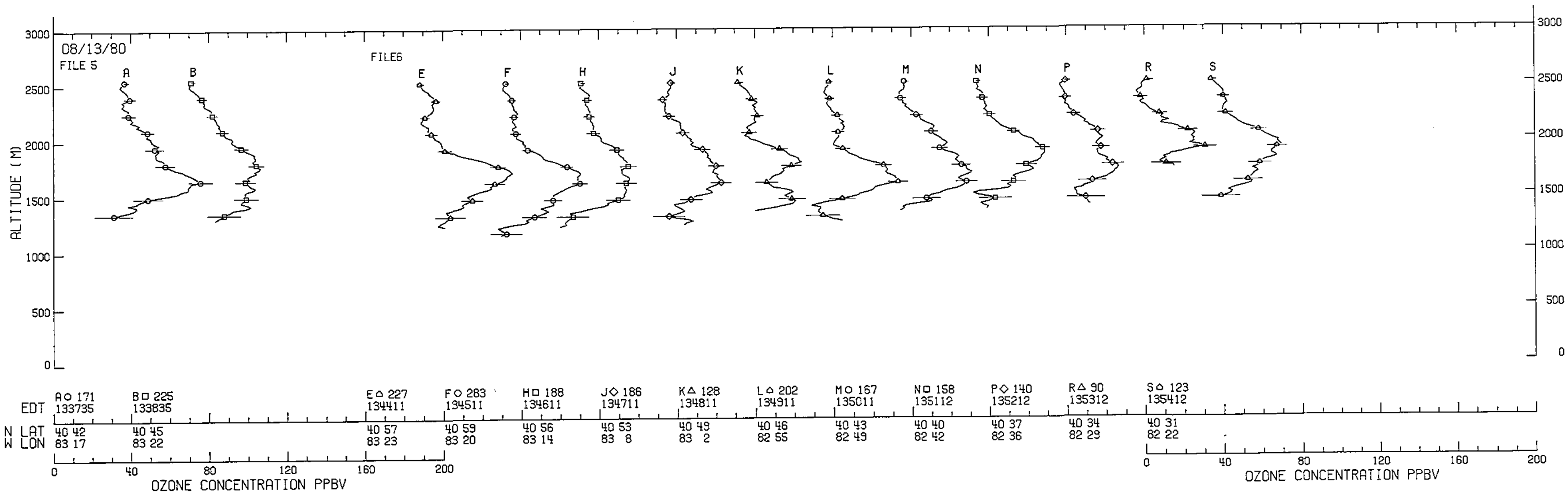
Continued


08/13/80
FILE 3
FILE4
A B C D E F H J K L P R S
ALTITUDE (M)
3000 2500 2000 1500 1000 500 0
EDT
A○ 242 124528
B□ 189 124628
C◇ 209 124728
D△ 184 124828
E△ 174 124928
F○ 252 125029
H□ 264 125129
J◇ 239 125229
K△ 159 125329
L△ 48 125339
P◇ 114 130002
R△ 197 130203
S△ 238 130303
N LAT
W LON
39 45 84 50
39 48 84 45
39 52 84 40
39 55 84 35
39 59 84 30
40 2 84 25
40 5 84 21
40 8 84 16
40 11 84 11
40 11 84 11
40 16 83 52
40 16 83 45
40 16 83 42
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

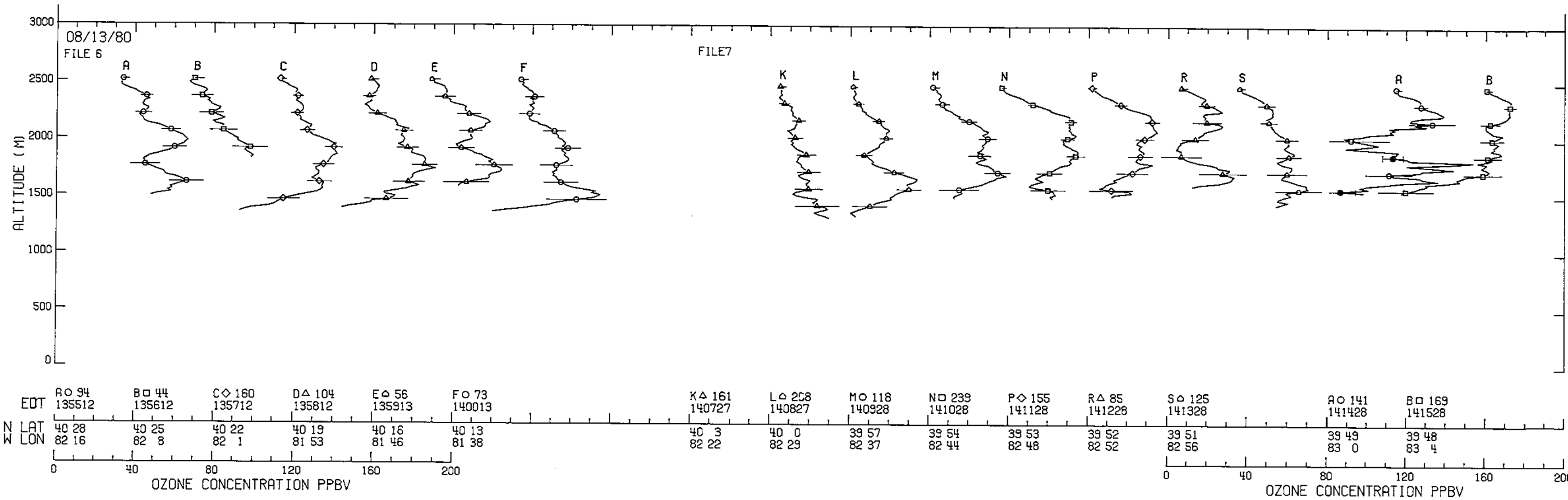

08/13/80
FILE 4
A B C D E F H J K L M N P
ALTITUDE (M)
3000 2500 2000 1500 1000 500 0
EDT
A○ 263 130403
B□ 194 130503
C◇ 104 130603
D△ 192 130703
E△ 169 130803
F○ 88 130904
H□ 168 131004
J◇ 279 131104
K△ 169 131204
L△ 144 131304
M○ 127 131404
N□ 208 131504
P◇ 96 131605
N LAT
W LON
40 15 83 38
40 15 83 35
40 15 83 32
40 14 83 28
40 14 83 25
40 14 83 22
40 13 83 18
40 12 83 11
40 11 83 4
40 10 82 56
40 9 82 49
40 8 82 41
40 7 82 34
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

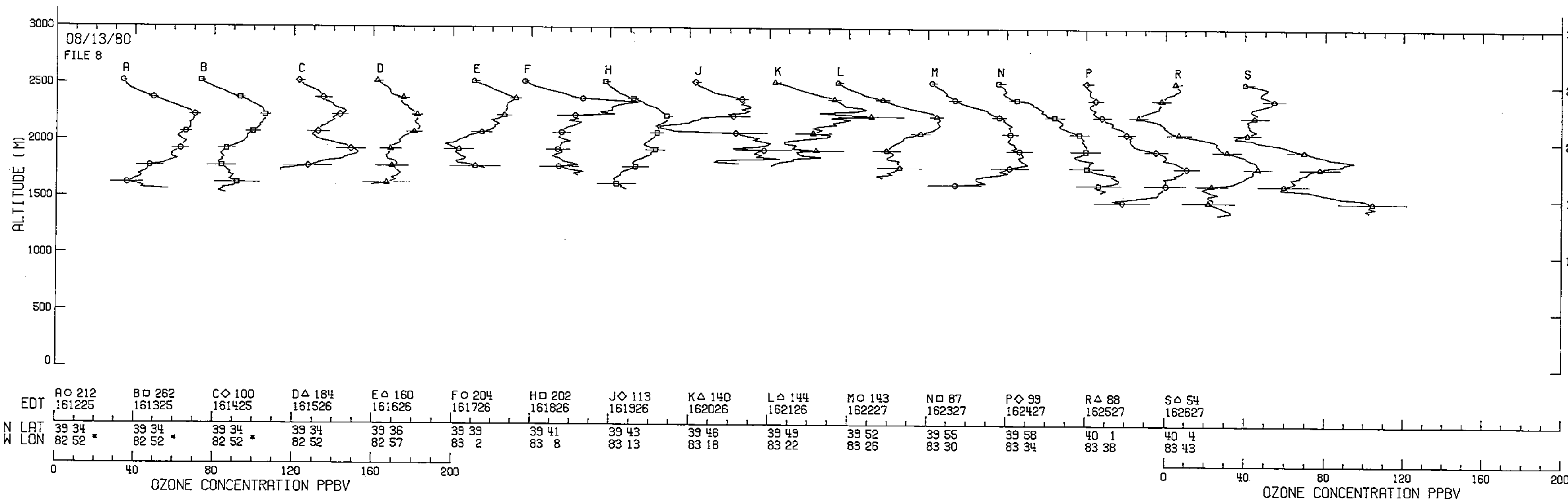
Continued


08/13/80
FILE 5
A B C D E F H J K L M N P R S
ALTITUDE (M)
3000 2500 2000 1500 1000 500 0
EDT
N LAT
W LON
A○ 177 132233 40 4 82 5
B□ 215 132333 40 6 82 5
C◇ 209 132433 40 7 82 6
D△ 77 132533 40 9 82 6
E○ 49 132633 40 11 82 13
F○ 82 132734 40 14 82 20
H□ 167 132834 40 16 82 27
J◇ 148 132934 40 18 82 34
K△ 181 133034 40 21 82 41
L○ 184 133134 40 24 82 46
M○ 154 133234 40 27 82 51
N□ 108 133334 40 30 82 56
P◇ 193 133434 40 33 83 1
R△ 161 133535 40 36 83 7
S○ 215 133635 40 39 83 12
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

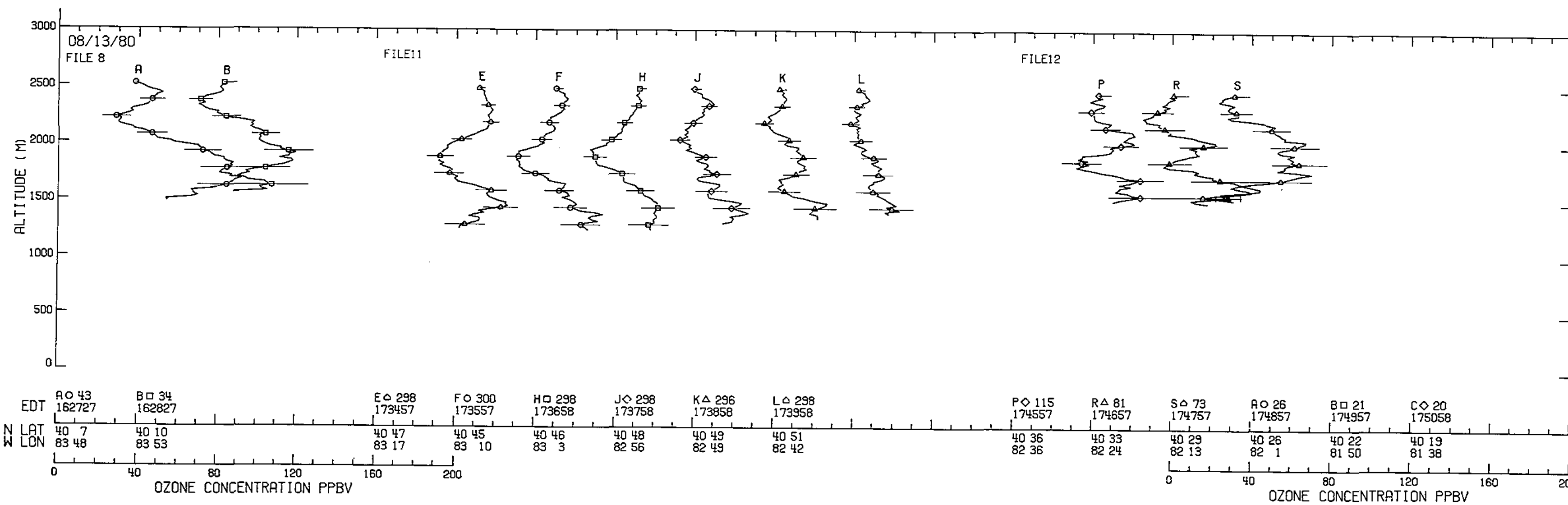

08/13/80
FILE 5
FILE6
A B E F H J K L M N P R S
ALTITUDE (M)
3000 2500 2000 1500 1000 500 0
EDT
N LAT
W LON
A○ 171 133735 40 42 83 17
B□ 225 133835 40 45 83 22
E○ 227 134411 40 57 83 23
F○ 283 134511 40 59 83 20
H□ 188 134611 40 56 83 14
J◇ 186 134711 40 53 83 8
K△ 128 134811 40 49 83 2
L○ 202 134911 40 46 82 55
M○ 167 135011 40 43 82 49
N□ 158 135112 40 40 82 42
P◇ 140 135212 40 37 82 36
R△ 90 135312 40 34 82 29
S○ 123 135412 40 31 82 22
0 40 80 120 160 200
OZONE CONCENTRATION PPBV

Continued


08/13/80
FILE 6
FILE7
ALTITUDE (M)
OZONE CONCENTRATION PPBV
EDT
N LAT
W LON
A○ 94 135512 40 28 82 16
B□ 44 135612 40 25 82 8
C◇ 160 135712 40 22 82 1
D△ 104 135812 40 19 81 53
E△ 56 135913 40 16 81 46
F○ 73 140013 40 13 81 38
K△ 161 140727 40 3 82 22
L△ 208 140827 40 0 82 29
M○ 118 140928 39 57 82 37
N□ 239 141028 39 54 82 44
P◇ 155 141128 39 53 82 48
R△ 85 141228 39 52 82 52
S△ 125 141328 39 51 82 56
A○ 141 141428 39 49 83 0
B□ 169 141528 39 48 83 4


08/13/80
FILE 8
ALTITUDE (M)
OZONE CONCENTRATION PPBV
EDT
N LAT
W LON
A○ 212 161225 39 34 82 52
B□ 262 161325 39 34 82 52
C◇ 100 161425 39 34 82 52
D△ 184 161526 39 34 82 52
E△ 160 161626 39 36 82 57
F○ 204 161726 39 39 83 2
H□ 202 161826 39 41 83 8
J◇ 113 161926 39 43 83 13
K△ 140 162026 39 46 83 18
L△ 144 162126 39 49 83 22
M○ 143 162227 39 52 83 26
N□ 87 162327 39 55 83 30
P◇ 99 162427 39 58 83 34
R△ 88 162527 40 1 83 38
S△ 54 162627 40 4 83 43

Concluded



08/13/80
FILE 8
FILE11
FILE12
A
B
E
F
H
J
K
L
P
R
S
ALTITUDE (M)
3000
2500
2000
1500
1000
500
0
EDT
N LAT
W LON
A○ 43
162727
40 7
83 48
B□ 34
162827
40 10
83 53
E△ 298
173457
40 47
83 17
F○ 300
173557
40 45
83 10
H□ 298
173658
40 46
83 3
J◇ 298
173758
40 48
82 56
K△ 296
173858
40 49
82 49
L△ 298
173958
40 51
82 42
P◇ 115
174557
40 36
82 36
R△ 81
174657
40 33
82 24
S△ 73
174757
40 29
82 13
A○ 26
174857
40 26
82 1
B□ 21
174957
40 22
81 50
C◇ 20
175058
40 19
81 38
0
40
80
120
160
200
OZONE CONCENTRATION PPBV

Appendix B

Aerosol Tape Archive Format

This appendix presents the format for data stored on the 1-Hz aerosol tape archive. (See section 4.6.3.) The 1-Hz aerosol tape archive numbers, dates, and file numbers are shown in table 4.2. These tapes were generated with a PDP-11 series minicomputer (16 bits per word) combined with a Digital Equipment Corporation TM11 magnetic-tape drive. The tape is stored in an unlabeled, binary, 9-track format at 1600 bpi.

Each data file on tape begins with a 256-word banner record with DIAL information as shown in table B.1. The data from each laser shot are packed into one large record. Each data record begins with a 10-word identification message which defines the time of signal acquisition and the shot number. Note that all files begin with an EOF (end of file) including the first file on tape. Some specially formatted banner word entries are defined as follows:

IBAN(5) Date. The year value in bits 4 to 0 is the actual year minus 72. The date setup is as follows:

Bit 14...10	9...5	4...0
month	day	year

IBAN(8) Words per return. Each aerosol set consists of two returns. The first return is a laser blocked-background return and the second is the return from the laser transmitted signal. The number of words stored on tape varied from 400 to 500 per return. The actual number of words on each data record is equal to $2 \times$ IBAN(8) + 10.

IBAN(14) Gate delay, in microseconds.

IBAN(15) Altitude of plane, in feet. A corrected plane altitude has been substituted for the pressure altitude. These altitudes were determined by calculating the number of words between the breakthrough pulse and the ground return and adding the sea level value at that point.

IBAN(18) Sampling frequency. All data taken during PEPE/NEROS were digitized at 10 MHz, which corresponds to 15 m per word.

IBAN(19) Pretrigger delay (word no.): This word is not accurate in the banner records. It represents the word number where the laser fired. This word can readily be determined by searching each shot for the breakthrough pulse.

The data record format is defined in Table B.2. A graphical presentation of a single lidar aerosol signal is given in figure B.1.

TABLE B.1 BANNER RECORD WORD ASSIGNMENTS

Item order	Word no. (decimal and octal location)	Description
IBAN:		
.WORD 1	1–0	Banner record and tape format no.
.WORD 0	2–2	Tape identification no.
.WORD 0	3–4	File identification no.
.WORD 10.	4–6	No. words in shot header
.WORD 0	5–10	Date
.WORD 0	6–12	Words/return Biomation-1
.WORD 0	7–14	Words/return Biomation-2
.WORD 500.	8–16	Words/return Biomation-3
.WORD 0	9–20	Returns/Biomation-1
.WORD 0	10–22	Returns/Biomation-2
.WORD 2	11–24	Returns/Biomation-3
.WORD 0	12–36	Post-trigger delay, μs, Biomation-1
.WORD 0	13–30	Post-trigger delay, μs, Biomation-2
.WORD 5	14–32	Post-trigger delay, μs, Biomation-3
.WORD 10500.	15–34	Altitude of plane, ft
.WORD 0	16–36	Shots in calibration average
.WORD 0	17–40	Interval between calibrations
.WORD 10.	18–42	Sampling frequency, MHz
.WORD 59.	19–44	Pretrigger delay, words
.WORD 5	20–46	Pulse repetition frequency, Hz
.RAD50 /03/	21–50	Biomation-1 species, rad 50
.RAD50 /03/	22–52	Biomation-2 species, rad 50
.RAD50 /AER/	23–54	Biomation-3 species, rad 50
.WORD 0	24–56	Differential amplifier gain Biomation-1
.WORD 0	25–60	Differential amplifier gain Biomation-2
.WORD 0	26–62	Differential amplifier gain Biomation-3
.WORD 0	27–64	PMT voltage 1
.WORD 0	28–66	PMT voltage 2
.WORD 0	29–70	PMT voltage 3
.WORD 0	30–72	Focus voltage 1
.WORD 0	31–74	Focus voltage 2
.WORD 0	32–76	Focus voltage 3
.WORD 0	33–100	Electronic filter 1
.WORD 0	34–102	Electronic filter 2
.WORD 0	35–104	Electronic filter 3
.WORD 0	36–106	On wavelength
.WORD 0	37–110	Off wavelength
.WORD 0	38–112	No. statistical points per return
.WORD 314.	39–114	Absorption coefficient mantissa, atm^{-1}-cm^{-1}
.WORD −25.	40–116	Absorption coefficient exponent
.WORD 0	41–120	No. bytes in comment field
.BLKB 654	42–122	Comments, ASCII

TABLE B.2 DATA RECORD STRUCTURE FOR M-WORD SIGNAL BUFFERS[1]

Word number	Description
1	Shot number
2	Number shots in buffer average
3,4	Time of day in units of 1/60 sec past midnight (32-bit integer)
5	Unused
6	Unused
7	High-order latitude[2]
8	Low-order latitude[2]
9	High-order longitude[2]
10	Low-order longitude[2]
11 to $11 + M - 1$	Background[1]
$11 + M$ to $11 + 2M - 1$	Signal[1]

[1] M = IBAN(8) from table B.1.

[2] LAT = IBUF(7) degrees + IBUF(8)/10 minutes; LON = IBUF(9) degrees + IBUF(10)/10 minutes.

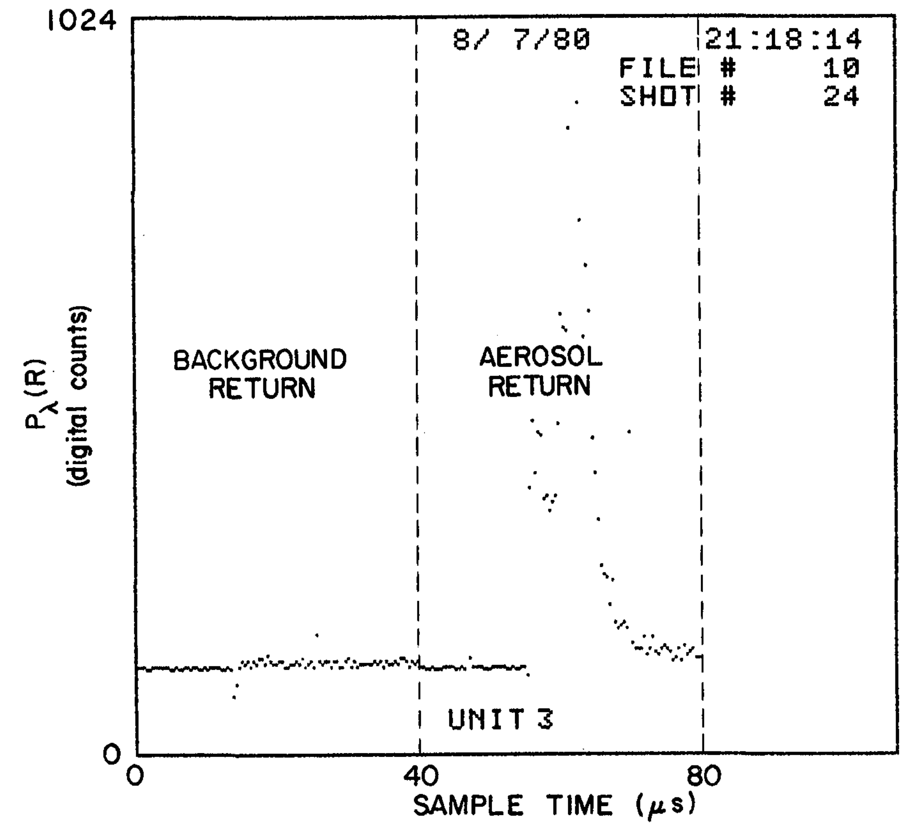


Figure B.1 Sample data shot for 800-word aerosol record (400-word background and 400-word aerosol); every fourth point plotted.

References

Brewer, Dana A.; Remsberg, Ellis E.; Loar, Gladys R.; and Bendura, Richard J. 1982: *NASA Participation in the 1980 PEPE/NEROS Project: Data Archive.* NASA TM-83189.

Browell, E. V.; Wilkerson, T. D.; and McIlrath, T. J. 1979: Water Vapor Differential Absorption Lidar Development and Evaluation. *Appl. Opt.*, vol. 18, no. 20, Oct. 15, pp. 3474–3483.

Browell, Edward V.; Carter, Arlen F.; and Shipley, Scott T. 1980: An Airborne Lidar System for Ozone and Aerosol Profiling in the Troposphere and Lower Stratosphere. Paper presented at the International Association of Meteorologists and Atmospheric Physicists (IAMAP) Symposium on Atmospheric Ozone (Boulder, Colorado), Aug. 4–9.

Browell, Edward V. 1982: Lidar Measurements of Tropospheric Gases. *Opt. Eng.*, vol. 21, no. 1, Jan./Feb., pp. 128–132.

Browell, E. V.; and Shipley, S. T. 1982: Airborne Lidar Investigations of Ozone and Aerosols in the Nonurban Troposphere. *2nd Symposium—Composition of the Nonurban Troposphere*, American Meteorological Soc., pp. 296–301.

Browell, E. V.; Carter, A. F.; Shipley, S. T.; Allen, R. J.; Butler, C. F.; Mayo, M. N.; Siviter, J. H., Jr.; and Hall, W. M. 1983: The NASA Multipurpose Airborne DIAL System and Measurements of Ozone and Aerosol Profiles. *Appl. Opt.*, vol. 22, no. 4, Feb. 15, pp. 522–534.

Browell, Edward V.; Ismail, Syed; and Shipley, Scott T. 1985: Ultraviolet DIAL Measurements of O_3 Profiles in Regions of Spatially Inhomogeneous Aerosols. *Appl. Opt.*, vol. 24, no. 17, Sept. 1, pp. 2827–2836.

Butler, Carolyn F.; Shipley, Scott T.; and Allen, Robert J. 1981: *Investigation of Potential of Differential Absorption Lidar Techniques for Remote Sensing of Atmospheric Pollutants.* Tech. Rep. GSTR-81-8 (Grant NSG-1477), Old Dominion Univ. Research Foundation, July. (Available as NASA CR-164645.)

Butler, C. 1983: *Development and Operation of a Real-Time Data Acquisition System for the NASA-LaRC Differential Absorption Lidar.* Tech. Rep. GSTR-83-5 (Grant NCCI-28), Old Dominion Univ. Research Foundation, May. (Available as NASA CR-172664.)

Butler, Carolyn 1984: *Development and Operation of a Real-Time Data Acquisition System for the NASA-LaRC Differential Absorption Lidar.* Tech. Rep. GSTR-84-5 (Grant NCCI-28), Old Dominion Univ. Research Foundation, Mar. (Available as NASA CR-173397.)

Byer, Robert L.; and Garbuny, Max 1973: Pollutant Detection by Absorption Using Mie Scattering and Topographic Targets as Retroreflectors. *Appl. Opt.*, vol. 12, no. 7, July, pp. 1496–1505.

Collis, R. T. H.; and Russell, P. B. 1976: Lidar Measurement of Particles and Gases by Elastic Backscattering and Differential Absorption. *Laser Monitoring of the Atmosphere*, E. D. Hinkley, ed., Springer-Verlag, pp. 71–151.

DeLuisi, J. J.; Schuster, B. G.; and Sato, R. K. 1975: Separation of Dust and Molecular Scattering Contributions to the Lidar Observation: A Method. *Appl. Opt.*, vol. 14, no. 8, Aug., pp. 1917–1923.

Greco, R. V., ed. 1980: *Atmospheric Lidar Multi-User Instrument System Definition Study.* NASA CR-3303.

Gregory, Gerald L.; Beck, Sherwin M.; and Mathis, Joe J., Jr. 1981: *In Situ Correlative Measurements for the Ultraviolet Differential Absorption Lidar and the High Spectral Resolution Lidar Air-Quality Remote Sensors: 1980 PEPE/NEROS Program.* NASA TM-83107.

Harris, J. E.; and Browell, E. V. 1979: Evolutionary Shuttle Atmospheric Lidar Program. *9th International Laser Radar Conference on Laser Atmospheric Studies (9ILRC)—Conference Abstracts*, Ch. Werner and F. Köpp, eds., DFVLR, German Aerosp. Est., Inst. Atmos. Phys., Federal Republic of Germany, July, pp. 180–181.

Hitschfeld, Walter; and Bordan, Jack 1954: Errors Inherent in the Radar Measurement of Rainfall at Attenuating Wavelengths. *J. Meteorol.*, vol. 11, no. 1, Feb., pp. 58–67.

Husar, R. B.; Gillani, N. V.; Husar, J. D.; and Patterson, D. E. 1976: A Study of Long Range Transport From Visibility Observations, Trajectory Analysis and Local Air Pollution Monitoring Data. *Proceedings of the Seventh International Technical Meeting on Air Pollution Modeling and Its Application*, Rep. 51, NATO Committee on the Challenges to Modern Soc., Sept., pp. 468–486.

Husar, R. B.; Gillani, N. V.; Husar, J. D.; Paley, C. C.; and Turcu, P. N. 1976: Long Range Transport of Pollutants Observed Through Visibility Contour Maps, Weather Maps and Trajectory Analysis. Washington Univ. paper presented at Third Symposium on Atmospheric Turbulence, Diffusion and Air Quality (Raleigh, North Carolina), Oct.

Klett, James D. 1981: Stable Analytical Inversion Solution for Processing Lidar Returns. *Appl. Opt.*, vol. 20, no. 2, Jan. 15, pp. 211–220.

Lamb, Robert G. 1982: *A Regional Scale (1000 km) Model of Photochemical Air Pollution. Part I: Theoretical Formulation.* EPA-600/3-83-035, Feb.

Lyons, W. A.; Dooley, J. C., Jr.; and Whitby, K. T. 1978: Satellite Detection of Long-Range Pollution Transport and Sulfate Aerosol Hazes. *Atmos. Environ.*, vol. 12, no. 1–3, pp. 621–631.

Maddrea, G. L., Jr.; and Bendura R. J. 1981: *NASA Participation in the 1980 Persistent Elevated Pollution Episode/Northeast Regional Oxidant Study (PEPE/NEROS) Project: Operational Aspects.* NASA TM-83170.

Measures, Raymond M.; and Pilon, Gilles 1972: A Study of Tunable Laser Techniques for Remote Mapping of Specific Gaseous Constituents of the Atmosphere. *Opto-Electronics*, vol. 4, no. 2, May, pp. 141–153.

NASA 1979: *Shuttle Atmospheric Lidar Research Program—Final Report of Atmospheric Lidar Working Group.* NASA SP-433.

Remsberg, Ellis E.; and Gordley, Larry L. 1978: Analysis of Differential Absorption Lidar From the Space Shuttle. *Appl. Opt.*, vol. 17, no. 4, Feb., pp. 624–630.

Russell, Philip B.; Swissler, Thomas J.; and McCormick, M. Patrick 1979: Methodology for Error Analysis and Simulation of Lidar Aerosol Measurements. *Appl. Opt.*, vol. 18, no. 22, Nov. 15, pp. 3783–3797.

Russell, Philip B.; Morley, Bruce M.; Livingston, John M.; Grams, Gerald W.; and Patterson, Edward M. 1981: *Improved Simulation of Aerosol, Cloud, and Density Measurements by Shuttle Lidar.* NASA CR-3473.

Schotland, R. M. 1966: Some Observations of the Vertical Profile of Water Vapor by Means of a Laser Optical Radar. Proceedings of the Fourth Symposium on Remote Sensing of Environment, Rev. ed., 4864-11-X, Willow Run Lab., Inst. Sci. & Technol., Univ. of Michigan, Dec., pp. 273–283.

Schotland, Richard M. 1974: Errors in the Lidar Measurement of Atmospheric Gases by Differential Absorption. *J. Appl. Meteorol.*, vol. 13, no. 1, Feb., pp. 71–77.

Shettle, Eric P.; and Fenn, Robert W. 1979: *Models for the Aerosols of the Lower Atmosphere and the Effects of Humidity Variations on Their Optical Properties.* AFGL-TR-79-0214, U.S. Air Force, Sept. (Available from DTIC as AD A085 951.)

Shipley, Scott T.; and Browell, Edward V. 1984: Airborne Lidar: Potential for Mixed Layer Measurements and Observations of Long-Range Transport. *The Meteorology of Acid Deposition*, Perry J. Samson, ed., Air Pollution Control Assoc., pp. 140–166.

Spinhirne, J. D.; Reagan, J. A.; and Herman, B. M. 1980: Vertical Distribution of Aerosol Extinction Cross Section and Inference of Aerosol Imaginary Index in the Troposphere by Lidar Technique. *J. Appl. Meteorol.*, vol. 19, no. 4, Apr., pp. 426–438.

Thompson, Richard T., Jr. 1976: *Differential Absorption and Scattering LIDAR Sensitivity Predictions by Least Squares With Application to Shuttle, Aircraft, and Ground Based Systems.* NASA CR-2627.

Vaughan, William M.; Chan, Michael; Cantrell, B.; and Pooler, F. 1982: A Study of Persistent Elevated Pollution Episodes in the Northeastern United States. *Bull. American Meteorol. Soc.*, vol. 63, no. 3, Mar., pp. 258–266.

Wolff, George T.; Kelly, Nelson A.; and Ferman, Martin A. 1981: On the Sources of Summertime Haze in the Eastern United States. *Science*, vol. 211, no. 4483, Feb. 13, pp. 703–705.

Wright, M. L.; Proctor, E. K.; Gasiorek, L. S.; and Liston, E. M. 1975: *A Preliminary Study of Air-Pollution Measurement by Active Remote-Sensing Techniques.* NASA CR-132724.

Zakharov, V. M.; Kostko, O. K.; and Portasov, V. S. 1974: Two-Frequency Laser Probing of the Troposphere and Stratosphere. *Atmos. & Oceanic Phys.*, vol. 10, no. 10, Oct., pp. 1101–1104.

Standard Bibliographic Page

1. Report No. NASA RP-1143	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Airborne Lidar Measurements of Aerosols, Mixed Layer Heights, and Ozone During the 1980 PEPE/NEROS Summer Field Experiment		5. Report Date December 1985
		6. Performing Organization Code 176-40-04-70
7. Author(s) Edward V. Browell, Scott T. Shipley, Carolyn F. Butler, and Syed Ismail		8. Performing Organization Report No. L-15943
9. Performing Organization Name and Address NASA Langley Research Center Hampton, VA 23665-5225		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546-0001		13. Type of Report and Period Covered Reference Publication
		14. Sponsoring Agency Code

15. Supplementary Notes

Edward V. Browell and Scott T. Shipley: Langley Research Center, Hampton, Virginia.
Carolyn F. Butler: Old Dominion University Research Foundation, Norfolk, Virginia.
Syed Ismail: SASC Technologies, Inc., Hampton, Virginia.

16. Abstract

This document presents a detailed summary of the NASA Ultraviolet Differential Absorption Lidar (UV DIAL) data archive obtained during the EPA Persistent Elevated Pollution Episode/Northeast Regional Oxidant Study (PEPE/NEROS) Summer Field Experiment Program (July–August 1980). The UV DIAL data set consists of remote measurements of mixed layer heights, aerosol backscatter cross sections, and sequential ozone profiles taken during 14 long-range flights onboard the NASA Wallops Flight Center Electra aircraft. These data are presented in graphic and tabular form, and they have been submitted to the PEPE/NEROS data archive on digital magnetic tape. The derivation of mixing heights and ozone profiles from UV DIAL signals is discussed, and detailed intercomparisons with measurements obtained by in situ sensors are presented.

17. Key Words (Suggested by Authors(s)) Lidar; Aerosol measurements; Mixed layer heights; Ozone measurements; PEPE/NEROS Program	18. Distribution Statement Unclassified—Unlimited Subject Category 45

19. Security Classif.(of this report) Unclassified	20. Security Classif.(of this page) Unclassified	21. No. of Pages 198	22. Price A09

For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-Langley, 1985

National Aeronautics and
Space Administration
Code NIT-3

Washington, D.C.
20546-0001

Official Business
Penalty for Private Use, $300

SPECIAL FOURTH CLASS MAIL
BOOK

Postage and
National Ae
Space Admi
NASA-451

U.S. MAIL

NASA

eliverable (Section 158
Manual) Do Not Return

DO NOT DETACH FROM REPORT
PLEASE LINE THROUGH YOUR NAME
BEFORE RETURNING TO THE LIBRARY

Name	Mail Stop

NASA Langley (May 1979) MSD-TLB N-75