NPS63-86-001

NAVAL POSTGRADUATE SCHOOL

Monterey, California

SODAR, RAWINSONDE, AND SURFACE LAYER MEASUREMENTS AT A COASTAL SITE: SCCCAMP DATA REPORT, PART II

by

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C. E. Skupniewicz, C. A. Vaucher, and G. T. Vaucher

April 1986

Technical Report

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(SCCCAMP)
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The work reported herein was supported in part by Western Oil and G
Association.

This report was prepared by:

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NPS63-86-001
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Sodar, Rawinsonde, and Surface Layer Measurements at a Coastal Site: SCCCAMP Data Report, Part II
5. TYPE OF REPORT & PERIOD COVERED: Technical Report July 1985-May 1986
6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): W.J. Shaw, S. Borrmann, S. Fellbaum, C.E. Skupniewicz, C.A. Vaucher, G.T. Vaucher
8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Environmental Physics Group, Dept. of Meteorology(Code 63), Dept. of Physics(61), Naval Postgraduate School, Monterey, CA 93943
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Western Oil and Gas Association, 727 West Seventh Street, Suite 850, Los Angeles, California 90017
12. REPORT DATE: April 1986
13. NUMBER OF PAGES: 105
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)
15. SECURITY CLASS. (of this report): Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
18. SUPPLEMENTARY NOTES
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Boundary Layer, Doppler Acoustic Sounder, Rawinsonde

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents data gathered by the Naval Postgraduate School (NPS) during the South Central Coast Aerometric Monitoring Project (SCCCAMP) in September and October of 1985. The data are from a triaxial monostatic doppler acoustic sounder and a 20-meter meteorological tower which were located at the Ellwood pier near Goleta, California and from rawinsondes launched from the R/V Acania in the Santa Barbara Channel.

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ACKNOWLEDGMENTS

The authors are most grateful for the assistance given to this project by Steve Blankschein and Dick Littlefield. In addition, our deepest appreciation goes to the crew of the R/V Acania: Skipper Woody Reynolds, First Mate Oscar Hastinada, Boatswain John Kusmire, Engineer Bob Winton, and Cook Tom Roberson. The efficiency, cheerfulness, and experience of these five made the logistics of the cruise nearly transparent. This work was supported by the Western Oil and Gas Association.

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1. INTRODUCTION

The Naval Postgraduate School (NPS) participated in the South Central Coast Cooperative Aerometric Monitoring Project (SCCCAMP) using a shore-based complement of instrumentation and measurement systems on board the R/V Acania. This report focuses on the data gathered by the shore instrumentation. Ship-based data, with the exception of those from the rawinsonde system, are reported elsewhere (Skupniewicz, et al., 1986). The rawinsonde information is presented in the this report with the sodar data because of the profiling nature of both systems.

The shore station was located at the Ellwood pier, just west of Goleta, California and consisted of two independent measurement systems. A doppler sodar system continuously monitored the atmospheric boundary layer (ABL) height and C_T^2 structure and provided hourly profiles of mean wind speed and direction over the depth of the ABL. The second system was a 20-meter meteorological tower which provided 10-minute averages of temperature at three levels and of wind speed and direction at a single level. It also provided the variances of wind speed and of angles of azimuth and elevation. The doppler sodar was located on shore at the foot of the 450 m pier, and the tower was mounted on a trailer at the end of the pier.

2. MEASUREMENT SYSTEMS

2.1 The Doppler Acoustic Sounder

The sodar system (an Echosonde III unit manufactured by Radian Corporation of Austin, Texas) is a three-axis monostatic doppler acoustic sounder which provides vertical profiles of the horizontal wind vector and of the small-scale temperature structure from which boundary layer height may be inferred. The acoustic sounder operates by emitting a 2 kHz pulse of 100 ms duration sequentially from three antennas, two of which are tilted 18° from the vertical. The sound interacts with acoustic refractive index (density) variations in the ABL, and a portion of the sound is scattered directly back to the antenna and measured. The received sound at the antenna is time-gated to obtain the vertical profiles. The intensity of the backscattered sound is directly related to the strength of the small-scale density (temperature, primarily) fluctuations, and the frequency of the backscattered sound is doppler-shifted slightly due to the radial velocity of each scattering volume.

Resolution for the sodar was 20 gates per profile for doppler winds and 200 gates per profile for backscatter intensities. The frequency of sampling is limited by the speed of sound and the sampling height. During SCCCAMP the system was set to sample doppler winds to 525 m and backscatter intensities to nearly 1 km. This setting required approximately 20 seconds per sample profile.

Sodar data were recorded on both 8-inch floppy disks and on a line printer display terminal. The line printer produces a shaded-character time-height cross section of acoustic backscatter intensity, which can be used to visualize boundary layer structure and to determine inversion height in real time. In addition, the three components of the mean wind (hourly averages for SCCCAMP) are printed as a 24-hour summary at midnight each day. The printed record is the only record which the sodar system produces for the winds. Consequently, these data must be transferred to computer files by hand for plots and other manipulation. The 200-gate acoustic intensity profiles, however, are stored on the disks together with a header for each profile which includes its date, time, and system settings necessary for subsequent scaling. Acoustic intensity profiles were averaged for approximately 2 minutes prior to line printer display and recording on disk. This allowed almost 66 hours of backscatter data to be recorded per disk. Specifics of the sodar measurements are summarized in Table 2-1 below.

Table 2-1. Sodar Measurements

Quantity Measured	Vertical Resolution	Maximum Height	Sample Period
Backscatter intensity	4.75 m	975 m	2 min
Wind speed, direction	23.75 m	525 m	1 hr

2.2 The Meteorological Tower

The tower, which was located at the end of the Ellwood pier, provided measurements of mean values and variances of horizontal and vertical wind speed and the wind azimuth at a height of 20.5 m above the water surface. Additionally, measurements were made of air temperature (20 m and 5.5 m) and of the sea surface temperature. Measurement heights were chosen to correspond as closely as possible to the measurement heights of the same variables on the R/V Acania.

Wind measurements were made using a bivane manufactured by R. M. Young (Model 21003). The bivane consists of a gimballed vane with a propeller anemometer mounted on the nose of the vane. The anemometer transducer is the generator type. An additional potentiometer linked to the vane provides angles of elevation as well as azimuth.

Both air and water temperatures were measured using Rosemount (Model 0078SOLN1200) platinum resistance thermometers (PRT's). Thermometers measuring air temperature were shielded from radiation and aspirated. The sea surface temperature thermometer was mounted on a buoy suspended from a boom extending from the pier. The thermal mass was lowered to a position just below the sea surface. These temperature measurements rely on the well-known relationship between platinum conductance and temperature as the principle of operation. All temperatures were measured with four-wire resistance techniques to eliminate lead effects.

All data from the tower were recorded as 10-minute averages on 3.5-inch disks via an HP-86 data acquisition system (DAS). Records were output at the top of the hour, 10 minutes after, etc. to achieve chronological matching with the acquisition system running in parallel on the R/V Acania. The shore station DAS recorded on two disk drives, automatically switching from one to the other when one was filled. This procedure eliminated any loss of data when fresh disks were supplied, and minimized service calls. Specifics of the tower measurements are summarized in Table 2-2 below.

Table 2-2. Tower Measurement Summary

Variable	Sensor	Height	Resolution	Response
Mean wind,	Bivane	20.5 m	0.1 m/s	0.2 m/s[1]
direction	"		1.0 deg	--
Wind speed variance	Bivane	20.5 m	0.01 m/s	1.0 m[2]
Direction variance	"		0.1 deg	1.0 m[2]
Temperature	PRT	20.0 m	0.01 °C	0.1 Hz
"	"	5.5 m	"	"
Sea surface temperature	PRT	0.0 m	0.01 °C	0.1 Hz

[1] Instrument threshold
[2] Distance constant

2.3 Rawinsonde Measurements

Atmospheric dynamic and thermodynamic profiles were obtained from rawinsonde launches from the R/V Acania using a VIZ W-8000RP+ system. This system yielded pressure, temperature, humidity, wind speed, and wind direction for heights up to 300 mb. The balloons were inflated to provide rawinsonde ascent rates of 3 ms^{-1}. The system samples all five variables every 15 seconds providing 45 m vertical resolution for SCCCAMP. Pressure is determined to within 2 mb using a factory-calibrated aneroid cell connected to a baroswitch. Temperature is obtained to within 0.4 K from a resistance element, and relative humidity is obtained to within 4% over the range 5 - 100% using a carbon element. Wind speed and direction are obtained using LORAN-C navigational aids. The sensor package receives LORAN time differences to establish balloon position, which is then differentiated with respect to time to obtain balloon velocity. It is assumed that the balloon moves at the speed of the local mean wind.

Specifics of the rawinsonde measurements are summarized in Table 2-3 below.

Table 2-3. Rawinsonde Sensor Summary

Variable	Sensor	Range	Accuracy
Pressure	Wind capsule (Ni-Span-C)	1080 - 5 mb	±2 mb
Temperature	Rod-type thermistor	50° C to 90° C	±0.4° C
Relative humidity	Carbon resistance element	5% to 100% (+40° C to -60° C)	±4% (rms)
Wind vector	LORAN-C navaids	--	±1 ms^{-1}

2.4 Data Archiving

Data from the three systems described above are part of the SCCCAMP data archive and are provided on nine-track computer tape. The tape formats used for storing data from the three systems are described in the tables in Appendix A.

3. MEASUREMENT SITES

As stated in section 1, NPS operated a single fixed station at the Ellwood pier (34° 25' 20" N, 119° 55' 43" W) just west of Goleta. The sodar was set up at the foot of the pier in a 30-meter break in the bluffs which almost continuously line the north shore of the Santa Barbara Channel. Between the bluffs and the water lies a beach which is 10 meters wide. The bluffs rise approximately 30 meters above the water and the level of the sodar antennas was approximately 6 meters above the water surface. The two tilted antennas were oriented south and west using solar positioning and a theodolite. The instrumented tower and its associated data acquisition system were located at the head of the pier, 450 meters from shore. Figure 3-1 shows schematically the relative locations of the sodar and the tower. Figure 3-2 shows the tower arrangement in more detail.

The shoreline orientation provided undisturbed flow for wind directions ranging from southeast to southwest. For easterly or westerly flow, some topographical influence was possible from the shoreline, with the effect expected to be much more pronounced for the sodar on shore than for the tower. For flow with a northerly component, severe topographical influences should be expected in the data.

The sampling pattern for the R/V Acania, from which the rawinsondes were launched, is described in Skupniewicz, et al. (1986). Rawinsondes were launched twice daily from the Acania, regardless of its location, at 1030 and 2130 PDT. During intensive periods (tracer releases) rawinsondes were launched additionally at 0500 and at 1600 PDT. Figure 3-3 maps the launch points for the 54 successful releases from the Acania during SCCCAMP.

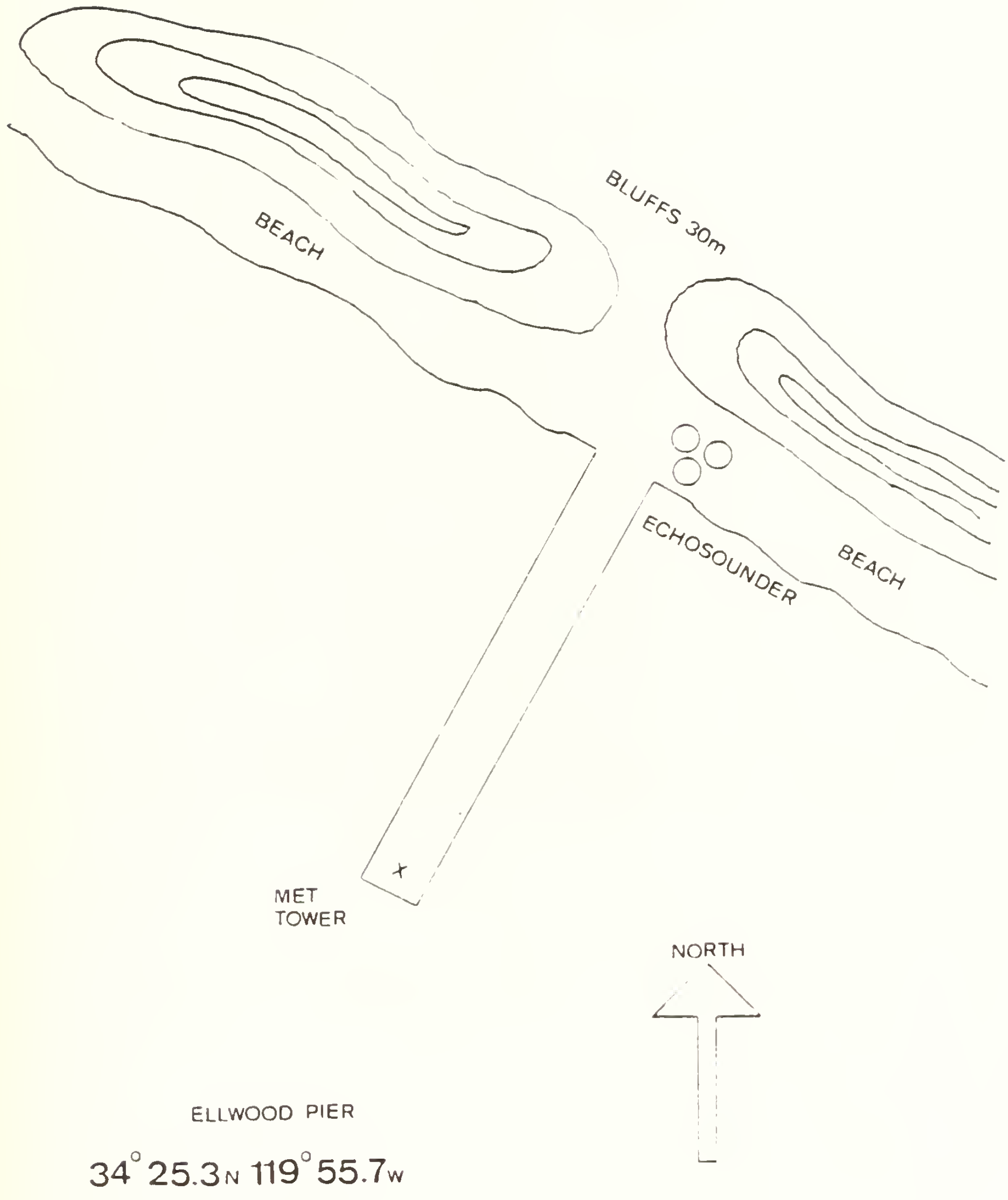

Figure 3-1. Relative locations of the acoustic sounder and the meteorological tower at the Ellwood pier during SCCCAMP.

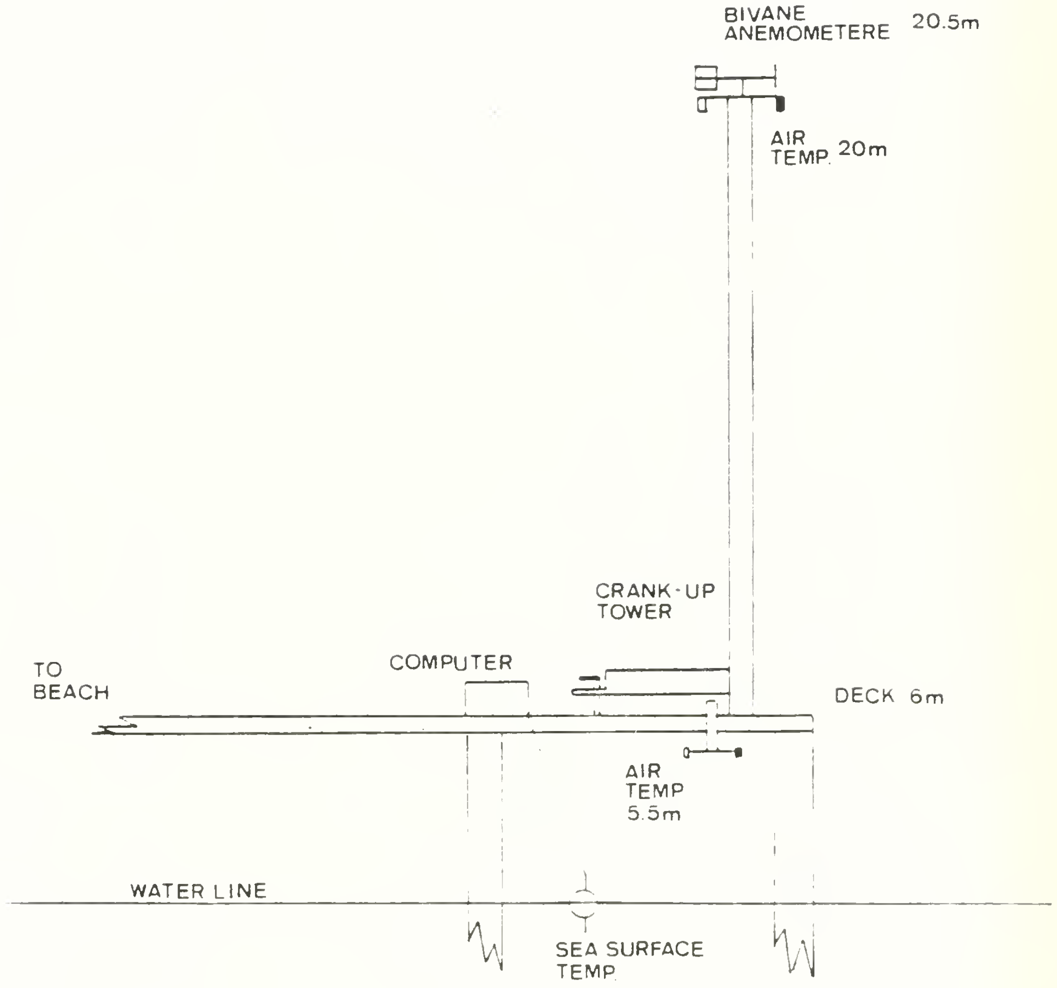

Figure 3-2. Schematic of the sensor locations on the meteorological tower at the end of the Ellwood pier.

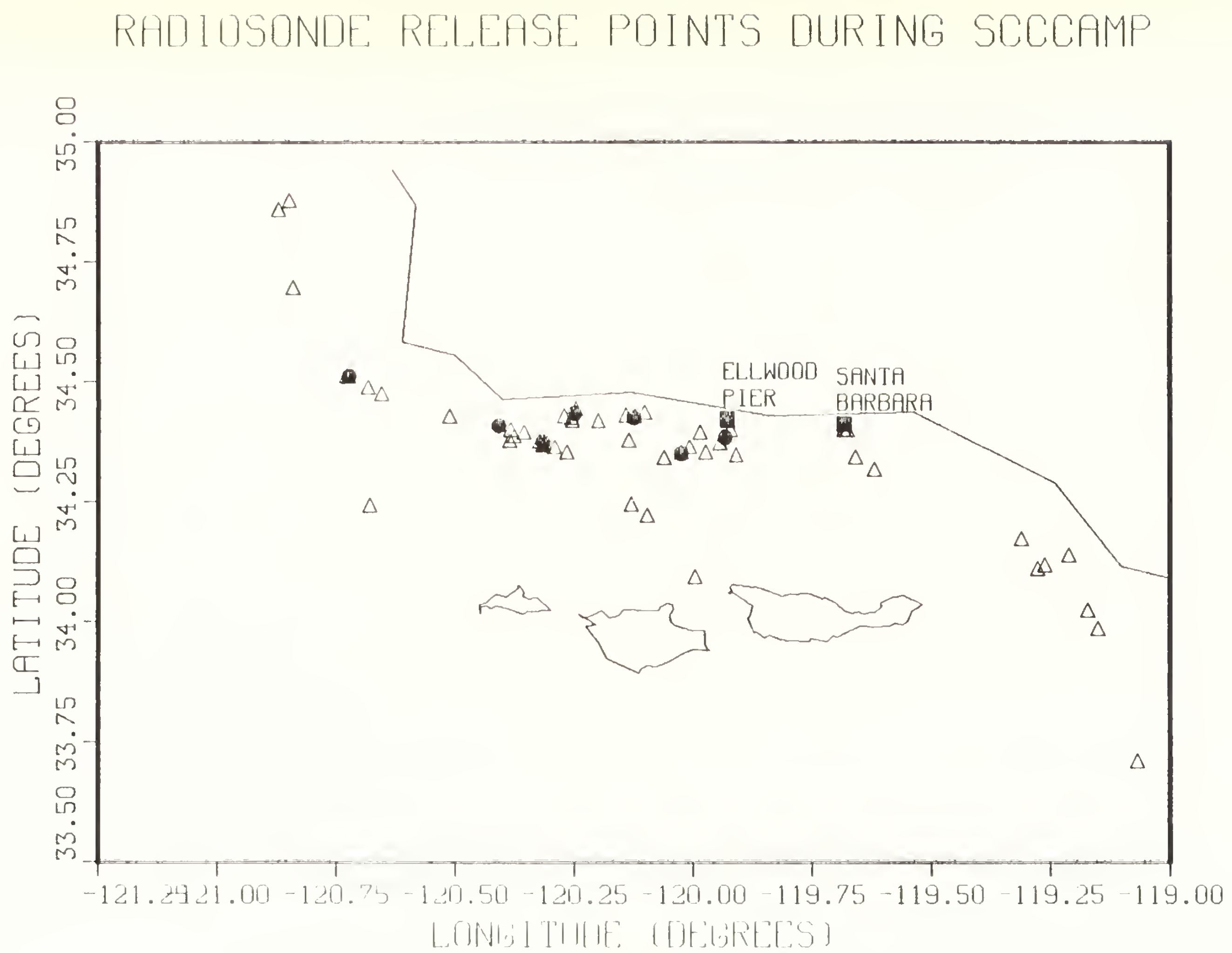

Figure 3-3. Rawinsonde release points during SCCCAMP. Triangles are actual release points, and solid circles are measurement stations of the R/V Acania.

4. SUMMARY OF FIELD OPERATIONS

4.1 Shore Station Observations

Observations of current weather conditions were made daily at the Ellwood pier during the course of monitoring the operation of the sodar and the tower systems. These included recording wet-bulb and dry-bulb temperature readings from a sling psychrometer and the qualitative observation of current weather. These observations are tabulated in Appendix B.

4.2 Sodar Measurements

The shore station was installed in late August, 1985 and began actual operation on August 28. Except for the period 13 - 19 September when the sodar system was inoperative, the sodar gathered data nearly continuously.

The sodar system was operational about 75% of the time that it was on station. The primary difficulty which developed was a pervasive dust generated periodically by the wind at the Ellwood pier which caused disk read/write errors and required several regenerations of the sodar program disk. A speaker diaphragm also failed during the project and was replaced. Because the doppler wind data were output to the line printer rather than being stored on disk, they were often available when the backscatter data were not.

The major period for which doppler winds were unavailable was from 0000 PDT on 13 September until 1800 PDT on 19 September. Other periods for which doppler wind profiles are unavailable are primarily due to levels of turbulence in the atmosphere which were too low to provide sufficient acoustic backscatter for wind calculations. Table 4-1 summarizes the operational periods for the sodar for which C_T^2 profiles were recorded on disk.

TABLE 4-1. Operational Periods for Sodar C_T^2

System Up Date	System Up Time (PDT)	System Down Date	System Down Time (PDT)
08/28/85	1900	09/03/85	0300
09/03/85	0600	09/05/85	1800
09/06/85	1100	09/10/85	0400
09/10/85	0430	09/12/85	1200
09/19/85	1200	10/02/85	2000
10/05/85	1100	10/09/85	0400

4.3 Tower Measurements

The meteorological tower was installed at the same time as the sodar, and began data collection on 28 August. The tower operated almost continuously from the time of installation, with only short breaks in data acquisition due to power failures. Additionally, the sea surface temperature was lost for a period due to a damaged sensor resulting from a collision with the pier. The operational periods for the tower instrumentation are detailed in Table 4-2.

TABLE 4-2. Operating Periods for Meteorological Tower

System Up Date	System Up Time (PDT)	System Down Date	System Down Time (PDT)
08/27/85	2000	08/29/85	1130
09/02/85	1330	09/10/85	1250
09/11/85	1700	09/12/85	1250
09/12/85	1720	09/16/85	1340
09/16/85	2320	09/19/85	0000
09/19/85	1150	09/27/85	1630
09/28/85	2300	10/05/85	2300

4.4 Rawinsonde Measurements

The rawinsonde system produced launches from the R/V Acania two to four times daily during the period September 5 through September 25. Of the 62 launches attempted, 54 have successfully yielded profiles of both wind and thermodynamic data. (Figure 3-3 showed the locations of successful launches relative to the Acania's sampling stations.)

Reasons for the failure of rawinsonde launches fell primarily into two categories. The first was balloon failure--either underinflation (one went into the channel) or bursting of the balloon at launch. Unsuccessful launches in this category were followed immediately by a second launch. Other failures resulted from interference with the rawinsonde's 403 MHz frequency band from unknown sources which overwhelmed data transmission. Nevertheless, an 87% success rate was achieved.

5. QUALITY ASSURANCE AND QUALITY CONTROL

5.1 Sodar System

The quality of data obtained from the sodar system depends partly upon atmospheric conditions and partly upon the variable being measured. In general, the strength of the sodar return is greater in regions of the boundary layer where the potential temperature gradient is larger and less in regions which have a more nearly neutral stratification. These mean temperature gradients are largest near the surface and in the interfacial layer (inversion) for unstable stratification. For stable stratification, the gradients can be appreciable at all heights in the turbulent boundary layer. Therefore, the signal-to-noise ratio (SNR) of the acoustic signal exhibits substantial height variation.

The implications for data quality due to the vertically variable SNR are greatest for the mean wind measurements. If the acoustic backscatter intensity in any of the 20 doppler gates for a given pulse falls below a preset minimum, then that gate's information is discarded in the computation of the hourly-averaged wind. (Other gates in the profile are retained, however.) The effect of this in a convective boundary layer is that little information is discarded in the computation of doppler winds near the surface. As height increases fewer and fewer points are retained in the wind average, and the uncertainty in the mean wind estimates increases. Despite strong returns from the interfacial layer, the uncertainty does not improve appreciably in this region since the layer height often varies substantially over an hour. In spite of the reduction in the number of valid data with height, intercomparisons with rawinsonde launches from an AN-GMD1 system at the Naval Postgraduate School have shown excellent agreement in the wind field measurements over all sodar measurement heights. System processing for doppler frequency shifts does not require recalibration, and wind estimates at any level are within 1 m/s for each component.

The measurement of the temperature structure parameter, C_T^2, is also influenced by the SNR. For this variable, the system needs an absolute value for acoustic backscatter intensity rather than simply a sufficiently large intensity to determine a doppler frequency shift. Therefore, the system is preset to return a zero value for C_T^2 when the signal level drops below a minimum value. This corresponds to a C_T^2 value of about 3×10^{-5} K^2 $m^{-2/3}$. The calibration of the sodar system for C_T^2 is still tentative in that its calibration has been derived from a comparison with C_T^2 measurements determined from Monin-Obukhov similarity theory applied to a surface layer data set.

Sodar performance was assessed at the time of system setup through visual inspection of printer output to confirm reasonable wind and backscatter values and through tests to verify that data were in fact being recorded on disk. In addition, the system was checked daily to ensure that fresh data disks were supplied if needed and that the system was still operating. Periodically, personnel from NPS made further inspections of sodar output to assure that the system was producing realistic values.

5.2 Tower

The tower sensor package used at the Ellwood pier comprises a set of instrumentation with a much longer history of validated performance (e.g., Davidson, et al., 1980) than the doppler sodar. These sensors are the same as those which were used on board the Acania and have also been used in numerous other NPS field projects with stable, satisfactory performance. The sensors are calibrated on a routine schedule.

At the time of installation of the tower, the 10-minute averages were inspected to assure reasonable readings of all measured variables. Further, the tower DAS was examined daily to ensure that it was operating and the readings remained reasonable. Further screening of the data was performed at NPS after the field phase of SCCCAMP. The editing description follows in section 6.2.

5.3 Rawinsonde System

Quality of measurements for the VIZ WL-8000RP system depended heavily on the individual factory calibration of the microsondes, which is presumed to be invariant over time and transportation. The calibration for each microsonde was available on a bar code attached to the sonde itself. Prior to each launch a bar wand was used to transfer the calibration values into the data acquisition system, and these values were used later in the data reduction. Each flight was continuously monitored, since the transmission frequency from the microsonde is prone to drift about 403 MHz. We tuned the receiver when necessary to prevent premature loss of signal.

6. DATA PROCESSING AND EDITING PROCEDURES

6.1 Sodar System

As described in section 2, data from the sodar are displayed on a printer terminal, and the backscatter intensities are recorded on 8-inch floppy disks. Except for applying the C_T^2 calibration to the data, the backscattered acoustic intensities are processed in real time. Automated processing of the signal for doppler winds during acquisition employs complex covariant analysis (Kleppe and Dunsmore, 1978) after rejection of backscatter intensities which fall below a preset threshold. Editing of winds (beyond the rejection of data based on noise level) is left for the scientific analysis, since winds may be quite variable near the surface due to topographic influences. Likewise, apart from flagging (with values of 32767) profiles for which the background noise saturated the system making the SNR too low, editing of the C_T^2 data was left to later analysis.

The calibration which is used to convert from acoustic backscatter intensity to values of C_T^2 was determined by de Rouge (1985). The relation which is used is

$$\log(C_T^2) = 8.63 \log(V) - 25.66$$

where V is the value representing acoustic backscatter intensity which is stored on disk. The relation was obtained by comparing the lowest levels of backscatter return with C_T^2 determined from surface layer similarity theory.

6.2 Tower Instrumentation

Data processing for the tower was the most straightforward of the three systems. Meteorological variables were computed by the simple application of calibration gains and biases to output voltages of the various sensors. The tower instrumentation operated nearly flawlessly for the duration of the project. The devices for which erroneous data exist are sea surface temperature, which failed when the float supporting the sensor struck the pier, and the bivane, which could be induced to indicate slightly negative wind speeds under conditions of high directional variability. Bad surface temperature data are flagged with a value of 99.999999. Erroneous wind data are flagged by setting wind direction to 999.999 and all other wind information to zero.

6.3 Rawinsonde System

Application of the calibration constants for the various sensors of the rawinsonde package is completely automated on the Apple IIe computer which drives the system. However, two operations are involved in the editing and processing of the data which are only partially automated.

The first is the calculation of the exact time of balloon launch. This information is necessary to accurately establish the physical height of each temperature, humidity, and wind vector observation. Timing is important because the baroswitch contact crossing times during balloon ascent do not coincide with the 15-second sampling intervals for temperature, humidity, and position. Time of launch is calculated by either linear or quadratic extrapolation from the lowest few baroswitch contact crossing times to the time of surface pressure recorded independently at launch.

The second operation is editing of data. Incorrect values result primarily from interference or temporary loss of signal during the balloon's ascent. Rather than flagging bad data, these points are identified subjectively during processing and replaced by automated linear interpolation over the specified vertical interval. Surface values are similarly corrected using extrapolation from the first good data above the surface. Because these procedures replace all known bad data with reasonable estimates, no data are flagged in the final data set.

7. PRESENTATION OF DATA

7.1 Sodar Results

7.1.1 Boundary layer structure

Inspection of the backscatter returns (not plotted in this report) from the acoustic sounder allows several observations regarding the structure of the turbulent boundary layer during SCCCAMP. Returns indicating a classical, convective, well-mixed ABL capped by a pronounced inversion were virtually nonexistent. The data were generally more indicative of a stable layer which varied in depth from 50 m to 400 m. Occasional periods (4-5 September and 25-28 September) exhibited very weak acoustic backscatter suggesting that stratification during those periods may have been more nearly neutral. The stronger returns often displayed a complex vertical structure, and very strong returns were sometimes obtained from layers which extended only 50 m above the surface. The indication of such shallow boundary layers is consistent with some of the rawinsonde profiles obtained in launches from the R/V Acania, described below.

7.1.2 Doppler wind profiles

As discussed in section 5, the sodar winds decrease in statistical significance with height since the number of returns with good SNR decreases. The height to which the sodar produces good winds also varies depending upon boundary layer stratification. Following is a brief day-by-day description of sodar wind profiles for SCCCAMP. Accompanying plots of hourly-averaged wind speed and direction are included in Appendix C.

7-9 September:

7 September is the first day for which doppler wind data are available from the sodar during the SCCCAMP operating period. Data are available only from an 11:00 AM local time restart, since the sodar system had been down for the previous several days. The winds on this day were characterized by fairly low magnitudes (< 5 m/s) below 100 m with a strong speed shear layer between 100 m and 200 m in which the wind speed increased to typically 15 m/s. The wind direction also exhibited shear in the layer between 100 m and 200 m, particularly at midday when there was a complete reversal of direction in the layer from southwesterly to northeasterly.

8 September qualitatively was very similar to the previous day, with rather low wind speeds at the immediate surface and with a substantial jump in wind speed between 100 m and 300 m. Profiles from the early morning hours

(0500 to 0800 PDT) showed low winds extending higher from the surface than they had for other hours. This suggests that the boundary layer was stably stratified so that the momentum from upper levels was not being mixed effectively to the surface.

The profiles for 9 September continue the pattern for the previous two days. Nighttime hours show low winds at higher levels than daytime hours while gradients of wind speed in particular tend to be more pronounced during the day.

10-12 September:

The sodar profiles from 10 September reveal a substantial change in behavior in the low-level flow. Nighttime wind speeds remained low to several hundred meters, but the daytime speeds no longer exhibited the large shear between 100 m and 200 m of the previous three days. Daytime wind speed maxima were about 10 m/s and occurred at a height of approximately 100 m. In addition, the flow had a strong westerly component at the maximum which tended to shift to northerly at higher levels.

On 11 September, winds remained low, but the maximum in the wind speed at 100 m was still present at midday. However, on this day, the nighttime wind speed also exhibited a maximum at 100 m. The wind at the speed maximum for the nighttime profiles was northeasterly in contrast to the daytime direction for the maximum, which was generally westerly.

Winds for 12 September were again light during the night hours, but the daytime values were stronger than on the previous two days. Suggestions of a maximum again appear in a number of the profiles, but the height at which it occurred appears to be more variable. The fact that the maximum occurred during both the day and the night suggests that it was perhaps not so much a diurnal phenomenon as a result of topographic influences or, perhaps, mesoscale circulations in the Santa Barbara Channel.

20-24 September:

This measurement period was characterized by relatively low winds throughout the profiles at night and at the lowest profile levels in the daytime. Above 200 m during the daytime, however, the wind speeds were typically quite large, with 15 m/s common. Wind direction varied dramatically with height and with time of day. Daytime profiles did not show the low-level wind speed maximum observed during previous periods. However, night profiles for several days showed a nocturnal-jet-like maximum at the top of the backscatter return.

25-27 September:

The period was characterized by generally northeasterly winds during the daytime at the upper levels of the sodar doppler profiles (200 m or higher). Below 200 m the wind direction was frequently quite variable with height. Wind speeds were again generally low below 200 m. Above 200 m the speeds were occasionally quite large, as observed in previous periods. However, there appeared to be no particular dependence for the large winds upon time of day, as had been suggested in the profiles for other periods.

28-29 September:

These two days are distinguished primarily by large variations in wind direction. On 28 September the winds were light at low levels and from the southeast throughout the night and early morning hours. About noon there was a shift to northerly followed by hour-to-hour variations of the wind between northerly and southerly through easterly. By midnight the winds were more consistently from the north or northeast. Winds increased in speed as the 29 September progressed to range between 5 and 10 m/s during the daytime. In the late afternoon, the wind again shifted to south-southeasterly.

1-3 October:

This period was also characterized by a high degree of variability of wind direction both in time of day and in the vertical. In addition, the data show that on 3 October there was very large wind speed shear from 200 m to 300 m between 0900 and 1400 local time.

6-7 October:

6 October and 7 October were again characterized by substantial diurnal variability in wind direction. 6 October exhibited the substantial midday speed shear noted on several other days while 7 October showed the low-level maximum in wind speed which was also noted above for other days. Although SCCCAMP officially ended on 7 October, the sodar continued to operate through 11 October, and data for the additional days are also included in the plots of Appendix C.

7.2 Tower Time Series

Appendix D contains time series (three-hour intervals) of vertical and horizontal turbulence intensities ($\sigma w/u$ and $\sigma u/u$) and root mean square wind direction. Also included are wind barbs and stability categories based on the gradient Richardson number. Table 7-1 below indicates periods during the operation of the tower system which were primarily stable, unstable, or marked by substantial diurnal variability of stratification.

Table 7-1. Stratification at the Ellwood pier during SCCCAMP (based on Ri).

DATE From	DATE To	STRATIFICATION
08/28	09/03	stable
09/03	09/07	unstable
09/08	09/16	stable
09/17	09/18	unstable
09/19	09/23	mixed
09/24	09/27	stable
09/29	10/01	mixed
10/02	10/04	stable

Inspection of these time series provides several interesting observations.

The first observation is that throughout the measurement period, there is a strong diurnal variation in the turbulence intensity and in the standard deviation of wind direction. This daily variation is present regardless of overall stratification, and the maxima tend to occur during the nighttime hours.

A second observation relates the stratification to the turbulence intensities. The intensity of vertical velocity and horizontal wind speed variations are generally quite comparable during the unstable periods (within about 20%), suggesting a more or less even division of turbulence kinetic energy among the three velocity components, as one would expect. Under stable conditions, however, the horizontal velocity variations are often several times as large as those in the vertical, suggesting that the flow is dominated by perhaps two-dimensional mesoscale flows in the Channel.

A final feature of these data is that the horizontal wind field is quite variable under all conditions. The variability appears to have a diurnal component and is not obviously related to the stratification. Consistent with the sodar observations, the flow generally has a strong east-west component.

7.3 Rawinsonde Profiles

All data from the 54 successful rawinsonde launches which NPS executed from the R/V Acania during SCCCAMP are plotted in Appendix E. Section E.1 contains plots of temperature and relative humidity, and section E.2 contains plots of wind speed and direction.

While the editing process described in section 6.2 eliminates virtually all erroneous data, occasionally it will pass data with other problems which are apparent only upon inspection of final plots. Such is the case for the temperature and humidity profiles of 6 September at 2129 PDT and 23 September at 2131 PDT and for the wind speed and direction plots of 6 September at 2129 PDT, 7 September at 2128 PDT, 23 September at 2131 PDT. These profiles are included in the data set and are plotted with the rest in Appendix E.

For the 6 September launch, the problem was simply that the balloon burst early in the flight. Since the baroswitch responds to pressure changes rather than to pressure magnitude, the only clue to the problem is the obvious symmetry in the profiles of all variables measured. (This is also reassurance that the system is actually responding to real atmospheric structure!)

Difficulties with the other days stem from light interference with the the 403 MHz data transmission frequency. The interference was not sufficient to produce obviously errant data in the temperature and humidity profiles 23 September, but rather produced the sawtooth-like characteristics of each variable. There is much good data remaining in this profile, and careful smoothing should render it completely useful. This interference also caused brief losses in the LORAN-C lock on 7 and 23 September. When the signal was re-acquired, sharp jumps in wind velocity and/or direction occurred for small parts of the profiles.

The following discussion serves to highlight the gross features of the atmospheric structure measured by the rawinsondes. Comments are grouped by rough location of the Acania in the Santa Barbara Channel.

5-6 September:

The three soundings from 1305 PDT on 5 September to 1252 on 6 September were made in the extreme eastern Santa Barbara Channel. These soundings indicate substantial moisture below 2 km with an inversion at the top of the moist layer. The later two soundings indicate a pair of moist layers below 2 km with an inversion in temperature at the top of each. Upper-level moisture was quite variable, indicating that significant advection was occurring.

The wind speed and direction profiles from these launches indicated generally northerly flow at upper levels at speeds on the order of 20 m/s. The wind direction backed substantially with height below 3 km and was generally less than 5 m/s below this altitude.

6 September:

The profile of 2129 PDT was obtained from a launch in the vicinity of the harbor at Santa Barbara. Both the thermodynamic and the wind profiles indicate that the balloon burst in the vicinity of 1800 m. The information to this altitude indicates that there was considerable moisture at low levels and that conditions were stable. Winds were less than 5 m/s and the wind direction changed from westerly to easterly at 500 m.

7 September:

The profile of 1029 PDT was made in the vicinity of the Acania's standard triangular sampling patterns between the Ellwood pier and Pt. Concepcion. The thermodynamic information from this launch showed that there was a layer of clouds between 1.0 and 1.5 km with a second moist layer between 3.0 and 4.5 km. The wind increased from the surface to a maximum of 10 m/s at 1 km with backing of about 90° also occurring in this lowest layer. Upper level winds were southwesterly.

7-8 September:

Three radiosondes were launched from 2128 PDT on 7 September until 2127 PDT on 8 September in the vicinity of the Pt. Sal buoy. During this period, the boundary layer was nearly saturated and extended to 1.0-1.5 km. Between 3.0 and 4.5 km there was a second moist layer which disappeared over the 24-hour period. Humidity levels above the boundary layer decreased to less than 25% by the end of the period. Wind speeds were less than 5 m/s at the surface and increased steadily with height in all profiles. Winds aloft were from the southwest during the period.

9-12 September:

During this period, which comprised 5 rawinsonde ascents, the Acania traveled from the extreme western part of the Santa Barbara Channel to the extreme eastern part. All profiles showed a very dry air mass having relative humidities less than 30% above 2 km. The profile of 1109 PDT on 9 September showed a cloud-topped mixed layer about 800 m deep with a second thin moist layer at 2 km in the western end of the Channel. At 2136 PDT the Acania was in the middle of the Channel, but the vertical atmospheric structure was qualitatively the same. There was a pair of moist layers in the vicinity of 2 km. The maximum humidity at the top of the mixed layer was about 90%, and the mixed layer was about 500 m deep. The profile of 1122 PDT on 10

September was made in the vicinity of Santa Barbara and showed more moisture between 1.0 and 2.5 km with the strongest inversion at the top of this layer. However, the turbulent boundary layer was probably less than 500 m deep, corresponding to the humidity maximum at that level. The remaining two profiles, 1107 PDT on 11 September and 1201 PDT on 12 September, were made in the easternmost part of the Channel. Neither of these profiles shows a maximum in moisture above the shallow mixed layer at the surface. Both show a maximum in humidity between 100 and 300 m and an inversion in temperature at that level. As height increases, the humidity decreases to less that 30% at 2 km, consistent with the previous profiles.

Winds at upper levels were generally from the southwest becoming westerly at the end of the period. Speeds increased steadily with height above 2 km. Below 2 km both wind speed and direction were erratic.

12-14 September:

This period comprises seven profiles from 2207 PDT on 12 September until 1023 PDT on 14 September during which time the Acania was sampling at the tracer release point and in the triangular pattern between the Ellwood pier and Pt. Concepcion. Relative humidities during this period were very low with maximum values no larger than 70% at the immediate surface and with very large negative gradients at the surface. The temperature structure does not indicate that there was a turbulent mixed layer of any measurable depth.

An interesting feature of this sequence of profiles is the humidity maximum first observed at 2207 PDT on 12 September at an altitude of 7 km. During the next two days, the maximum lowered to a height of 2 km, suggesting that strong subsidence was occurring.

Winds during this period were westerly to southwesterly throughout above 3 km. Below this level there was again substantial variability in both wind speed and direction. The profiles of 2207 PDT on 12 September and 0500 and 2129 PDT on 13 September indicate a wind speed maximum in the vicinity of 100 to 200 m above the surface. The direction at the maximum was northerly. This result is quite similar the the wind speed maximum measured by the sodar at the Ellwood pier on 12 September.

14-15 September:

The Acania was in the vicinity of Santa Barbara for a scheduled crew change on these days. During this period five rawinsondes were launched. These indicated that conditions at upper levels were in general unchanged from the previous period's launches. At the surface, conditions were stable. During the period moisture increased in a shallow layer at the surface until the relative humidity was large enough to produce fog over a depth of 100 to 200 m by 0559 PDT on 15 September. Radiational effects associated with the increasing moisture produced a strong inversion at the top of this layer. In the subsequent profile, at 1030 PDT, the relative humidity had decreased to about 90% at its maximum in the vicinity of 200 m, the temperature profile was more adiabatic in the layer, and the surface humidity was down to about 70% -- consistent with radiation-induced mixing and associated entrainment. By 1615 PDT, the temperature profile shows that mixing had essentially disappeared, and humidity values were less than 70% at all heights in the profile.

Winds were also consistent with those of the previous period. Above 2 km the direction was still southwesterly and the winds increased steadily with height. Below this level, both wind speed and direction were highly variable. Wind speed maxima were observed in all profiles at heights of 1 km or less.

15-16 September:

The rawinsonde launches of 2125 PDT on 15 September and 1044 PDT on 16 September were executed in the eastern Santa Barbara Channel near Port Hueneme. These two launches produced profiles which indicated a moist layer near the surface that was about 300 m deep for the first profile and that grew to approximately 1 km by the time of the second profile. Above the moist layers at the surface, the relative humidity dropped rapidly to less than 40% at all upper levels. Temperature structure indicated that the layer at the surface was stable (nearly isothermal) in the initial profile of the pair. By the time of the second profile, however, temperature appeared more nearly adiabatic near the surface, again suggesting the possibility of radiation-induced mixing.

Wind profiles indicate that the wind continued to be southwesterly during this period at upper levels with speed maxima and strong gradients in both speed and direction occurring below 1 km.

17-25 September:

For this concluding period of SCCCAMP, the Acania continuously sampled the triangular patterns established in the western Santa Barbara Channel, with excursions to the tracer release station near Pt. Concepcion. There were two broad periods of distinct atmospheric thermodynamic structure during this time.

First, from 1031 PDT on 17 September until 2127 PDT on 19 September, the atmospheric humidity was frequently in excess of 60% up to 2 to 4 km above the surface. Above this height the humidity dropped to its typical values of 30% or less. There were no pronounced inversions, although in some cases the atmosphere was isothermal at the surface. The upper level wind direction for this period was southerly in the first profile but shifted to northerly for the remainder of the period. The direction was rather variable below 4 km. Wind data are unavailable for the rawinsonde launches at 1607 PDT on 19 September and 0513 PDT on 20 September. These are represented as blank plot frames in the appendix.

A transition in the thermodynamic structure coincided with the profile of 0513 PDT on 20 September made at the tracer release point northwest of the channel. This profile showed a nearly saturated mixed layer about 500 m deep capped by a strong temperature inversion. However, above 500 m the relative humidity was generally less than 40%.

The second distinct structure appeared in the data from the rawinsonde ascent at 1027 PDT on 20 September and its general characteristics were present through the profile of 1611 PDT on 24 September. For this period, relative humidities were often near saturation, but in a very shallow layer--generally less than 100 m deep--at the surface. For most of these profiles, the temperature structure is so stable that it is unlikely that there was any mixed layer at all. Levels above the very thin moist layer were in general very dry. However, during 23-24 September a moist layer appeared at 8 km.

Winds during this period at upper levels shifted from westerly to easterly and back again. Beginning with the profile at 2129 PDT on 20 September, winds became easterly between 1 and 4 km, veering to westerly at 7 km. The subsequent profile at 0501 PDT on 21 September shows easterly winds up to 7 km, with a sharp change to westerly above that level. In the next profile at 1031 PDT, winds were easterly at all levels above the surface. At 1039 PDT on 22 September, the data show a broad layer of westerly winds which appeared between 1 and 6 km above the surface. Above this, winds remained easterly. By the time of the next profile at 2145 PDT, winds were generally southwesterly above 3 km.

On 25 September, the Acania's last day on station, moisture appeared to be advecting in at all levels up to about 6 km. Although moisture was increasing, the immediate surface tended to remain quite dry and stable. The profile at 1029 PDT suggests that the layer from 200 m to 800 m was a cloud layer in which mixing occurred, since the temperature decreases with height. However, below this layer the temperature still increased with height. Winds for 25 September were southeasterly and generally light throughout the troposphere.

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Davidson, K. L., G. E. Schacher, C. W. Fairall, and D. E. Spiel, 1980: Verification of the bulk model for calculations of the overwater index of refraction structure function, C_N^2. Technical Report NPS-61-80-016, The Naval Postgraduate School, Monterey, California.

Kleppe, J. A. and H. L. Dunsmore, 1978: Digital signal processing of acoustic radar ampltude and doppler data. Preprints, 3rd Symposium on Turbulence, Diffusion, and Air Pollution, Am. Meteor. Soc., 549-553.

de Rouge, Etienne O., 1985: An investigation of the atmospheric boundary layer over the Arctic Ocean using sodar. M. S. Thesis, The Naval Postgraduate School, Monterey, California. 79 pp.

Skupniewicz, C. E., S. Borrmann, S. Fellbaum, W. J. Shaw, C. A. Vaucher, and G. T. Vaucher, 1986: Shipboard observations of mean and turbulent atmospheric surface layer quantities: SCCCAMP Data Report, Part I. NPS Technical Report (in press), The Naval Postgraduate School, Monterey, California. 64 pp.

APPENDIX A

The following tables describe tape formats in which data from the three measurement systems discussed in this report have been stored.

Table A-1. Tape Specifications for Doppler Sodar

Labels: None
Density: 1600 cpi
Characters: ASCII
Record size: 132 bytes*
Block size: 5280 bytes*

* Requested by the SCCCAMP archivist.

Files containing doppler wind data:

Julian date (YYDDD)	FORTRAN Format:
Time (HHMM)	(I6,1X,I4,
20 (Wind speed, Wind direction) pairs	20(F5.1,I5),
(m s^{-1}, degrees)	21x)

Files containing C_T^2 data:

Record 1:

Julian date (YYDDD)	
Time (HHMMSS)	
Number of backscatter gates	FORTRAN Format:
Height of lowest gate (tenths)	(I6,I7,6I5,2I6,78x)
System gain factor	
Number of bursts/backscatter gate	
Background noise (dB)	
Pulse length in milliseconds	

Records 2-10:

22 (C_T^2)	FORTRAN Format:
	(22I6)

Table A-2. Tape Specifications for Tower Data Files

Labels: None
Density: 1600 cpi
Characters: ASCII
Record size: 132 bytes*
Block size: 5280 bytes*

* Requested by the SCCCAMP archivist. Logical records will span physical records.

Logical Record Map[1]

Variable	Field[2]
Julian date (e.g., 85102 is Day 102, 1985)	I6
Beginning time (PDT)	I6
Ending time (PDT)	I6
T1 (sea surface temperature)	F9.6
T2 (temperature at 5.5 m)	F9.6
T3 (temperature at 20.5 m)	F9.6
Vertical velocity (m/s)	F9.6
Wind speed (m/s)	F9.6
Azimuth angle (deg)	F7.3
σ_w (m/s)	F8.6
σ_u (m/s)	F8.6
$\sigma_{azimuth}$ (deg)	F10.6
Number of samples	I3
Full scale voltage[3]	F8.6
T1 gain	F10.8
T2 gain	F10.8
T3 gain	F10.8
T1 bias	F11.6
T2 bias	F11.6
T3 bias	F11.6
Wind speed gain	F8.6
Elevation angle gain	F9.6
Azimuth gain	F9.6
Elevation bias	F10.6
Azimuth bias	F5.1

1 Each logical record spans two 132-byte physical (tape) records. The first record ends with "number of samples".
2 All quantities are separated by one space character (1X).
3 This and all following quantities are for calibration purposes. For more information, contact the authors.

Table A-3. Tape Specifications for Rawinsonde Data

Labels: None
Density : 1600 cpi
Characters: ASCII
Record size: 132 bytes*
Block size: 5280 bytes*

* Requested by the SCCCAMP archivist.

First record of each file (launch):

ID	
Launch latitude (DD.MMS)	Format:
Launch longitude (DDD.MMSS)	(40A1,F6.3,4X,F8.4,
Launch date (Julian -- YYDDD)	2X,I6,1X,I4,3X,
Launch time (PDT)	F6.2,52X)
Subsequent records in profile	

Subsequent records:

Time after launch	(minutes)	
Temperature	(° C)	
Dewpoint	(° C)	Format:
Relative humidity	(%)	(8F10.0,52X)
Pressure	(mb)	
Wind direction	(deg)	
Wind speed	(m s^{-1})	
Altitude	(m)	

APPENDIX B

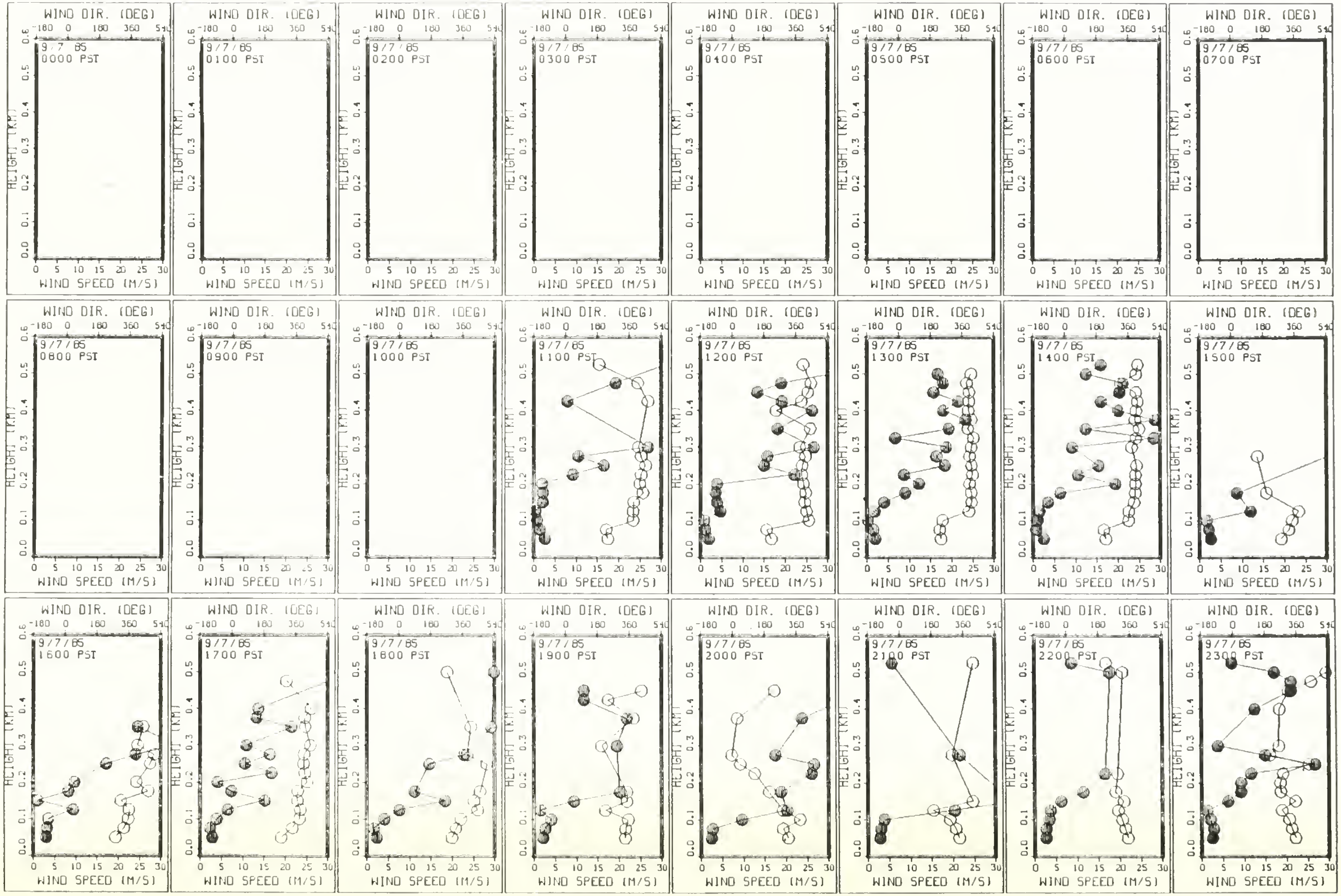
Following are temperature and wet-bulb temperature observations and the (nearly) verbatim comments logged by the SCCCAMP observer between 29 August 1985 and 6 October 1985 at the Ellwood pier.

Date	Time (PDT)	T (°F)	Tw (°F)	General Comments
08/29/85	1050	74.	67.	Sunny/Hazy/Visibility 5 miles
08/30/85	0655	69.	61.5	Sunny/Breezy/Hazy
08/31/85	0635	68.	62.5	Low breeze from west/ Visibility 3 miles/Hazy
09/01/85	0600	66.	60.5	Hazy/Very little breeze
09/02/85	1115	80.5	68.	Sunny/Slight breeze
09/03/85	0631	62.	59.	Very windy/Heavy clouds
09/04/85	0703	62.	59.	Partly sunny/Steady breeze/ Dark low clouds breaking up
09/05/85	0439	60.	59.	Windy/Misty
09/06/85	0530	61.	58.	Dark clouds/Damp/Light breeze
09/07/85	0615	63.	60.	Light breeze/Medium clouds/ Damp
09/08/85	1210	72.	63.	Sunny/Partly cloudy/Light breeze
09/09/85	2340	68.	60.	Breezy/Partly sunny
09/10/85	0448	60.5	54.	Breezy/Clear skies
09/11/85	1149	68.	57.	Very windy/Clear/High clouds/ Sunny
09/12/85	1223	65.5	62.	Sunny/Visibility 5 miles/ Slight breeze
09/13/85	1053	68.	62.	Sunny/Visibility 3 miles/Calm
09/14/85	1022	78.	65.	Sunny/Calm/Visibility poor
09/15/85	0637	59.	56.5	Cool/Damp/Hazy
09/16/85	1123	72.	64.	Light breeze/Sunny
09/17/85	0856	63.5	61.5	Cloudy/Damp/Slight breeze
09/18/85	0808	63.5	59.	Sunny/Very calm
09/19/85	1143	72.	63.	Sunny/Breezy
09/20/85	1215	70.	64.	Sunny/Medium breeze
09/21/85	1258	62.	62.	Sunny/Hazy/Light breeze
09/22/85	1139	65.	62.	Very slight breeze/Very hazy
09/23/85	0847	59.	59.	Breezy/Very foggy/Visibility 100 ft.
09/24/85	1015	70.	64.	Sunny/Almost no breeze/ Visibility 2 miles
09/25/85	1225	75.	67.	Sunny/Hazy/Light wind
09/26/85	1415	70.	64.	Rainy this AM/Foggy/Breeze
09/27/85	1330	70.	65.	Foggy/Light breeze/Visibility 5 miles
09/28/85	1047	62.	59.	Breezy/Clear
09/29/85	1930	68.	64.	Even fog/Very calm breeze (sic)

09/30/85	1500	70.	62.	Sunny/Steady winds/ High hazy (sic)
10/01/85	2105	66.	62.	Damp/Breezy/Light fog
10/02/85	2048	64.	62.	Calm/Cloudy
10/03/85	1649	78.	69.	Calm/Low haze
10/04/85	1920	71.	66.	Calm/Light haze
10/05/85	2300	69.	65.	Breeze/Light haze
10/06/85	1730	67.	64.	Very windy/Visibility 5 miles

APPENDIX C

This appendix contains the plots of sodar wind speed and direction profiles from SCCCAMP which were discussed in section 7. Each of the following pages contains 24 plots from a single day (local time, to reflect more clearly any diurnal variations). Solid circles are wind speed, and open circles are wind direction. The individual plots are labeled as to date and time, and therefore no further captions are given. Hourly periods for which data were unusable are represented by blank plots so that the relationship between time of day and position on the page is maintained for all plots.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9/7/85 0500 PST
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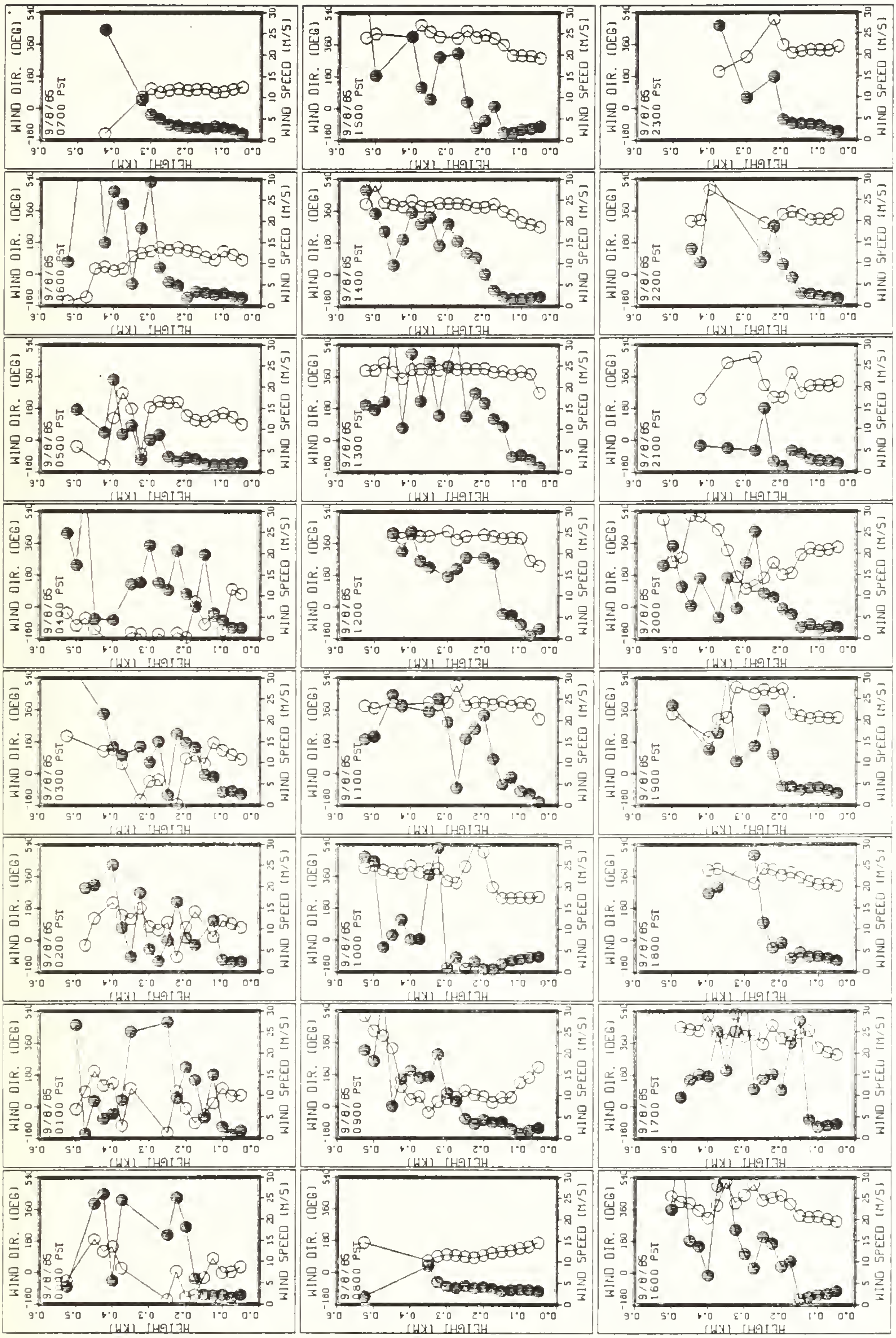

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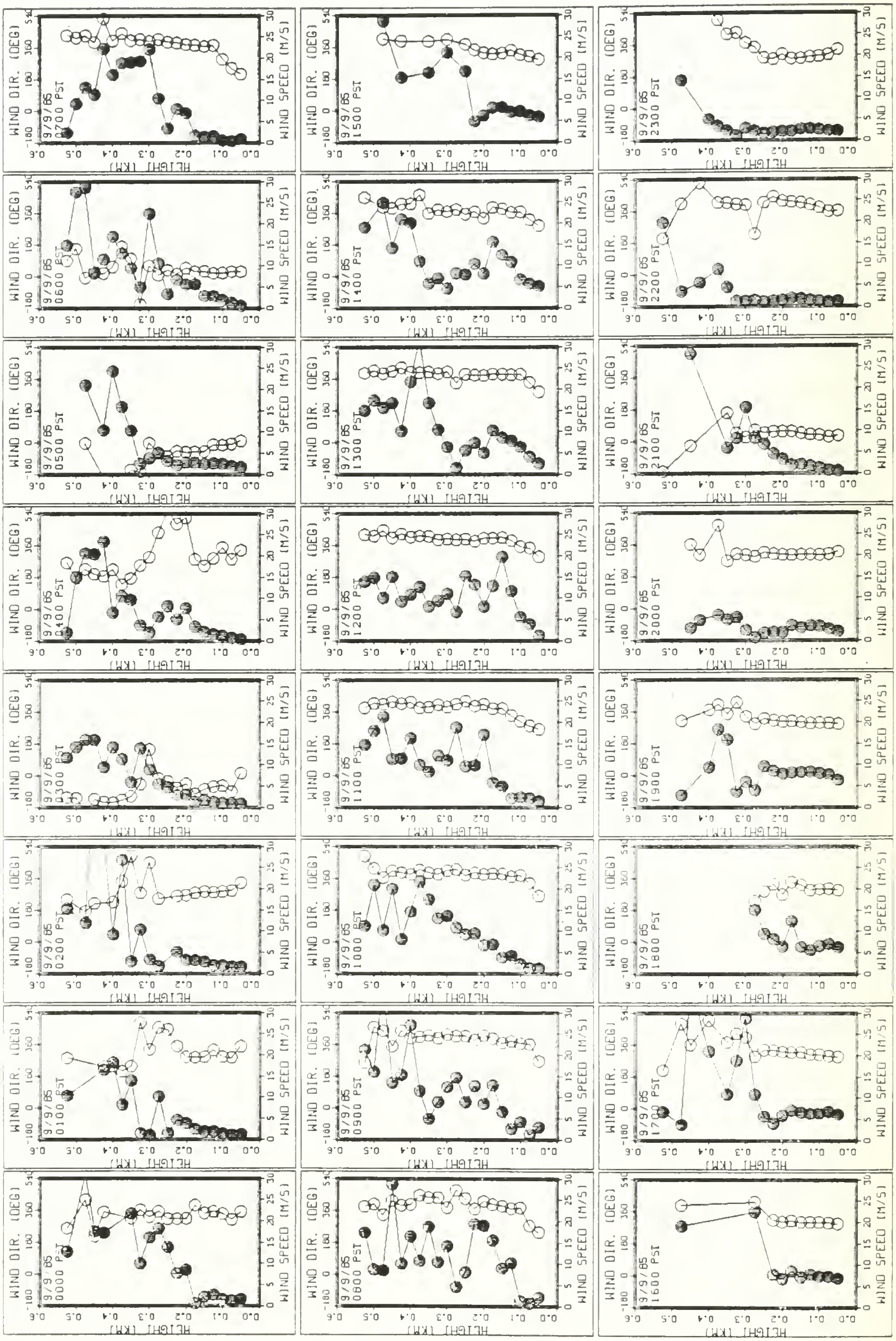
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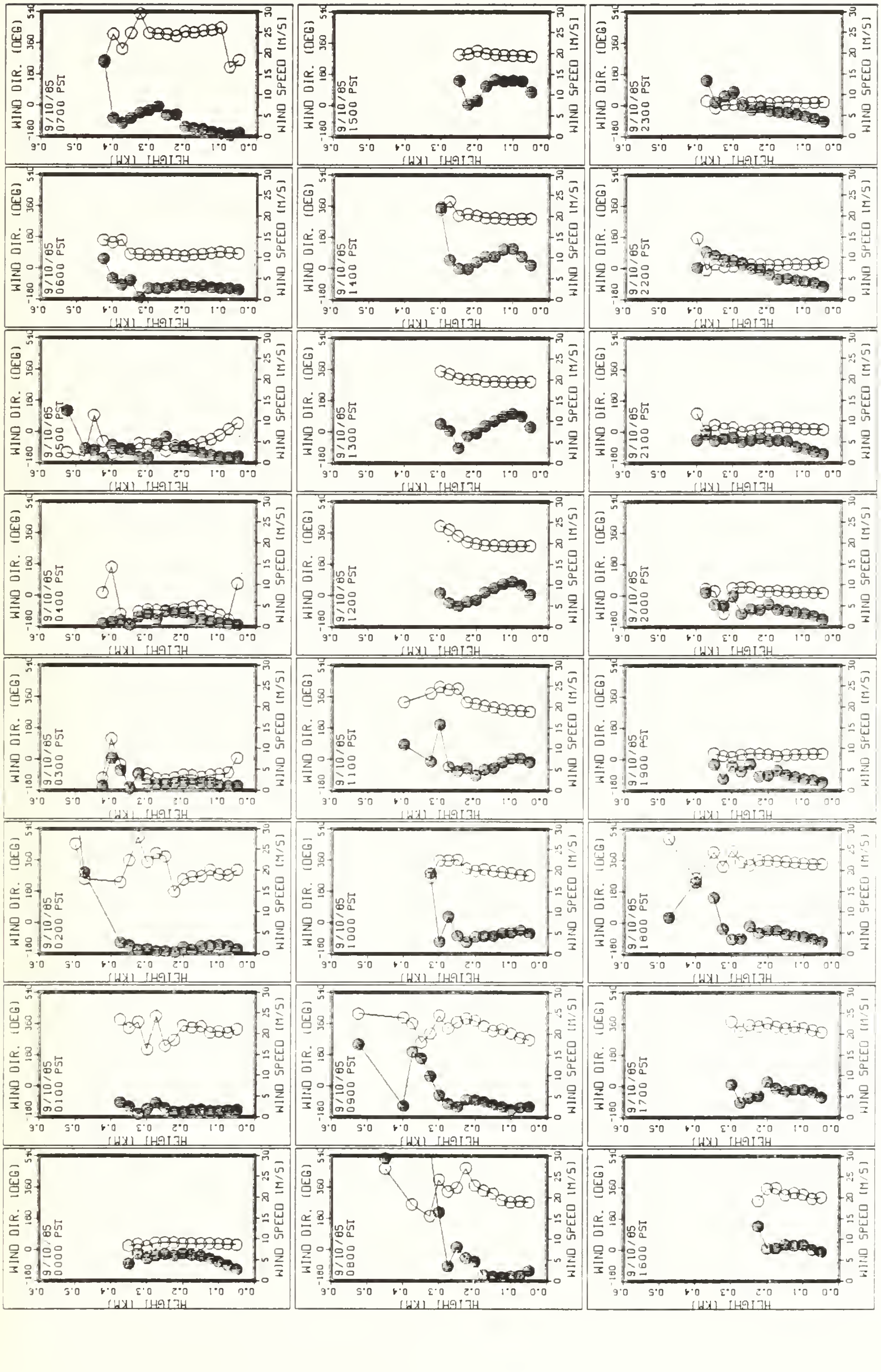
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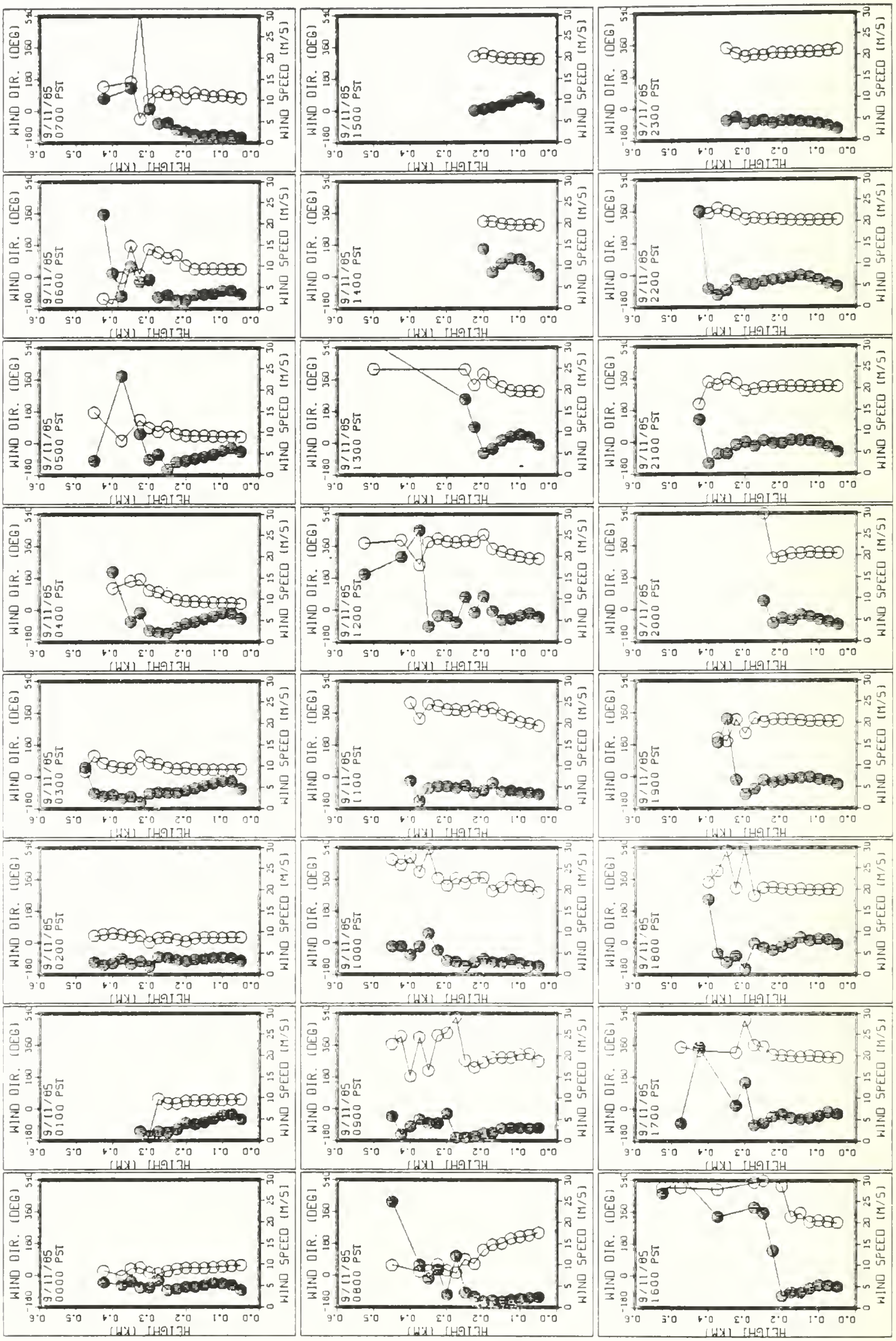

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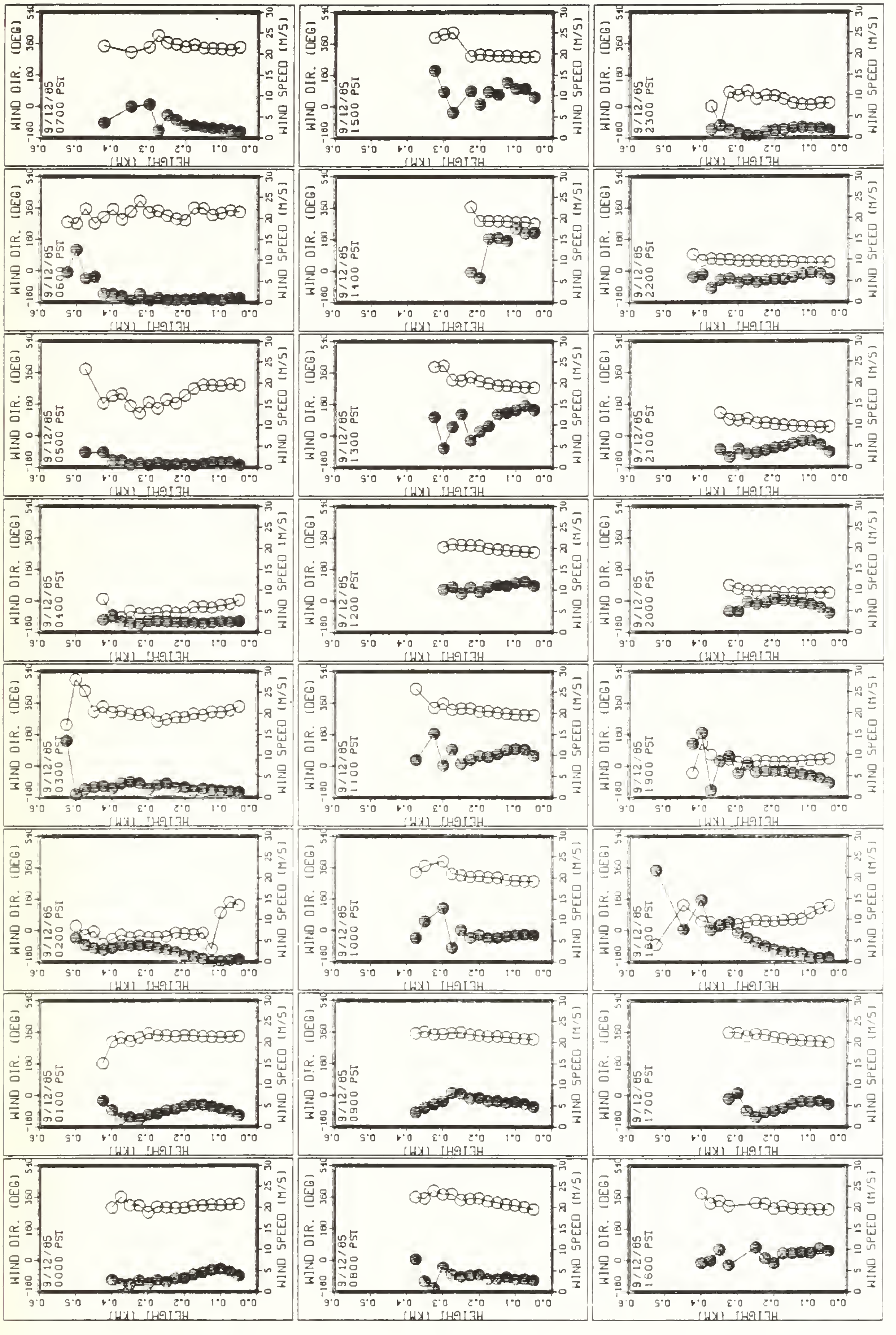
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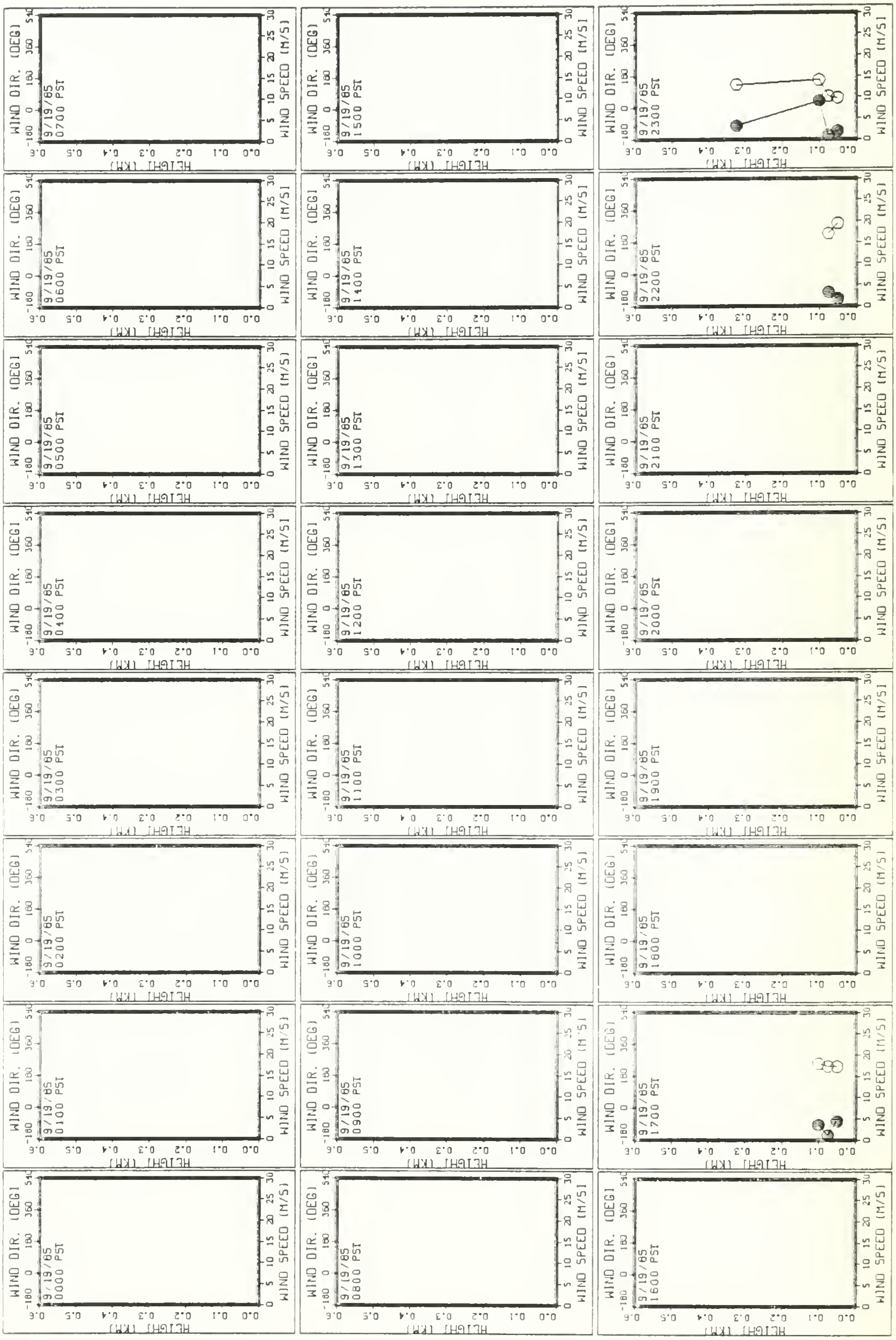
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HEIGHT (KM)
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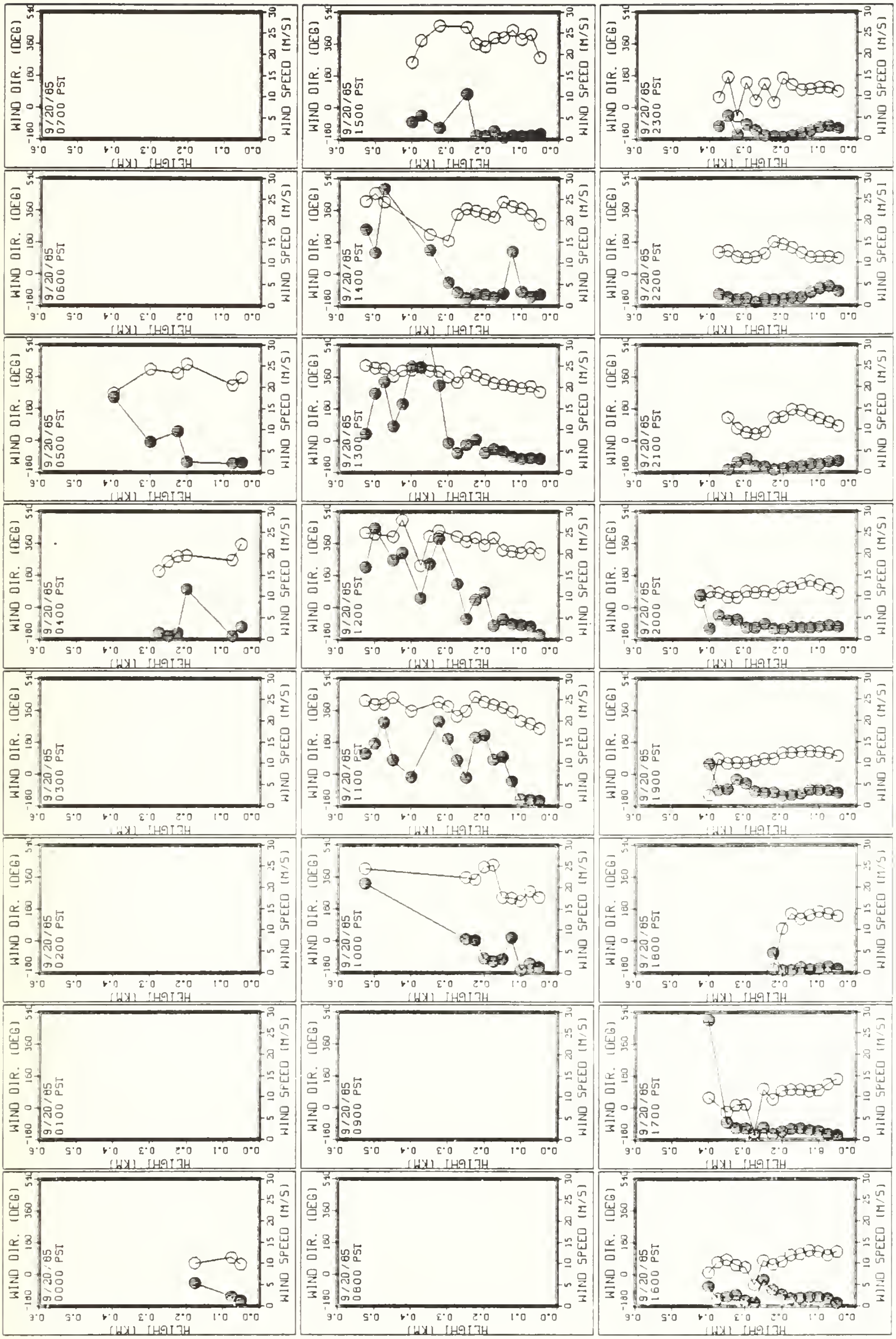

WIND DIR. (DEG)
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WIND SPEED (M/S)
0 5 10 15 20 25 30
HEIGHT (KM)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
9/20/85 0000 PST
9/20/85 0100 PST
9/20/85 0200 PST
9/20/85 0300 PST
9/20/85 0400 PST
9/20/85 0500 PST
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9/20/85 1700 PST
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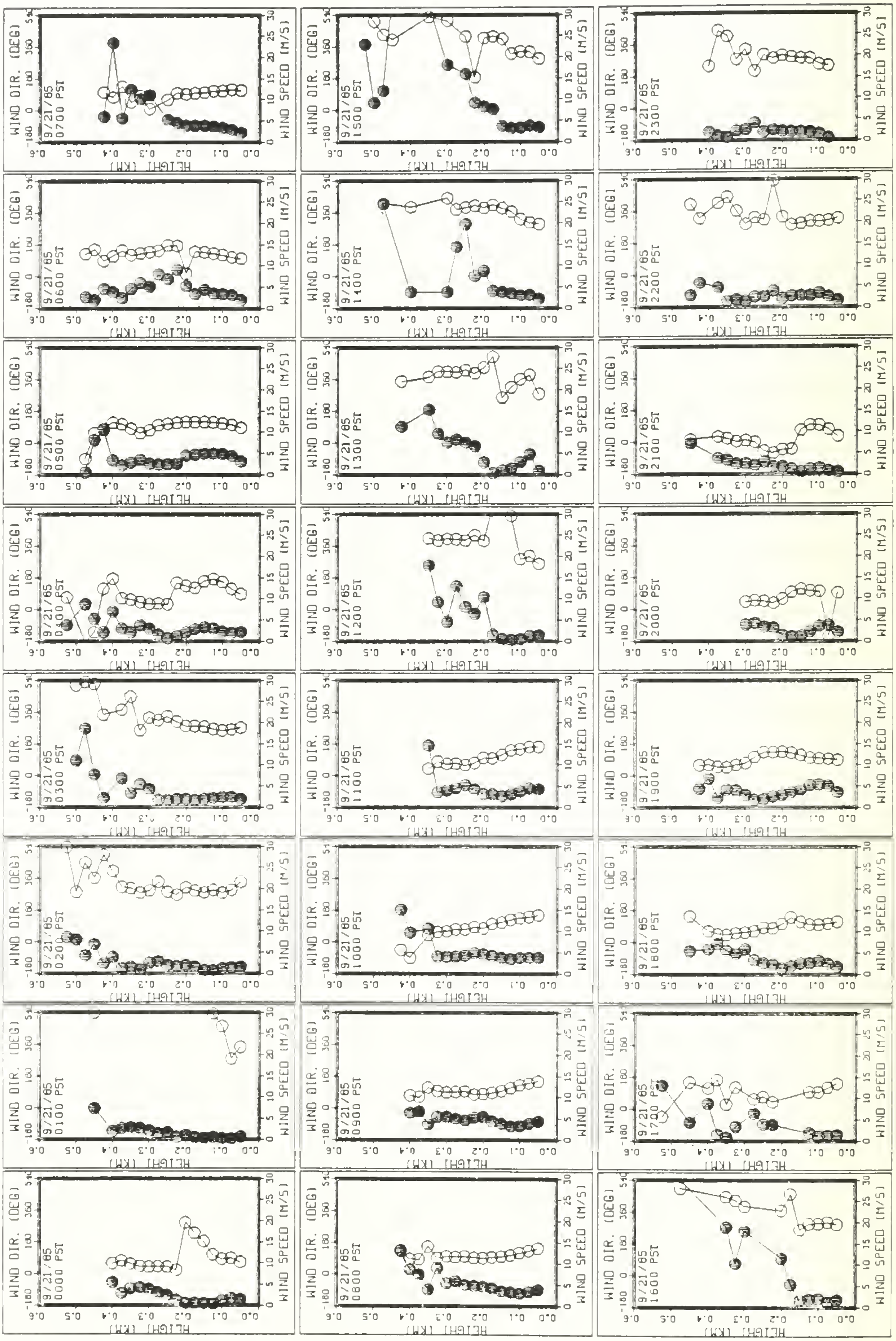

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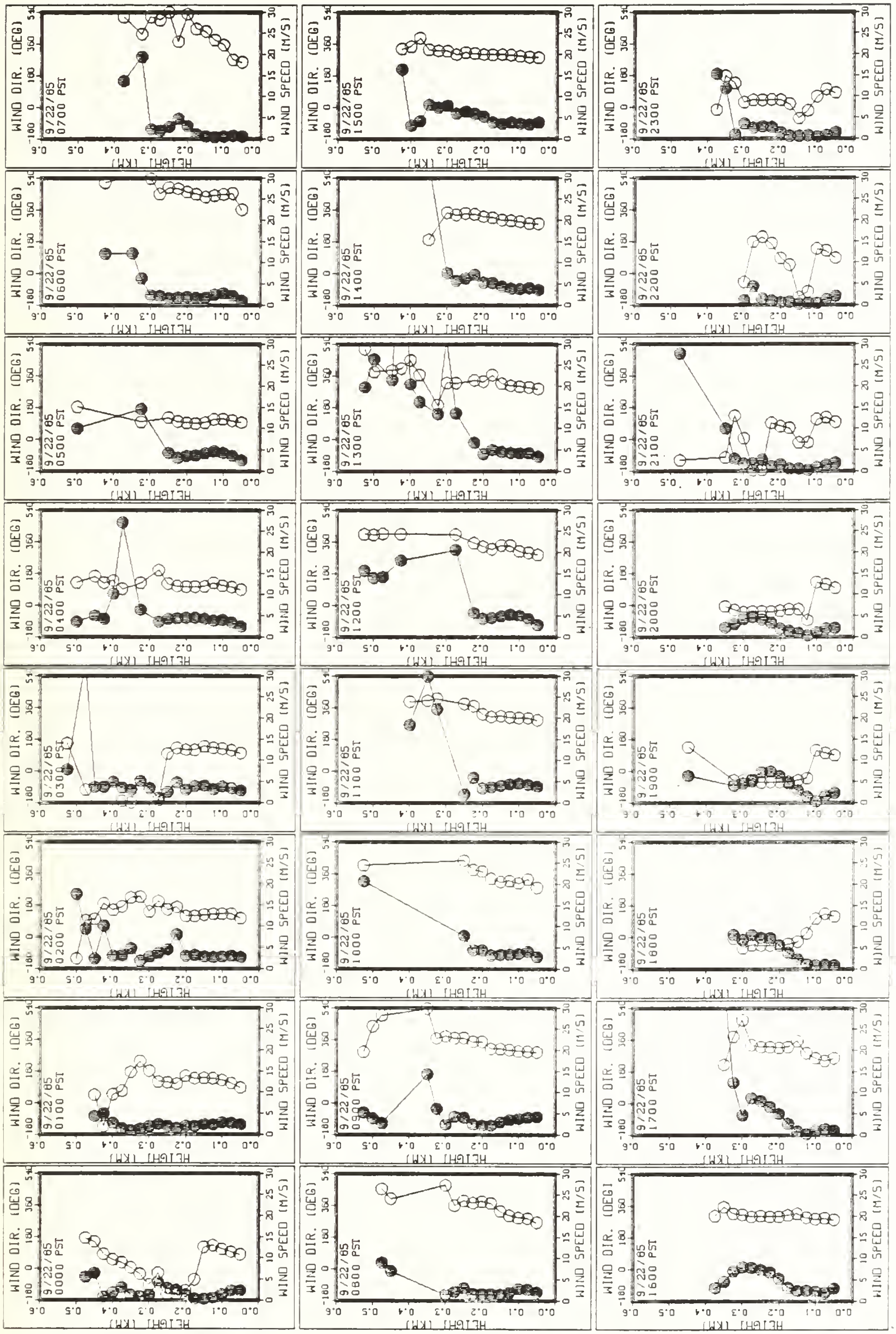
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9/22/85 1000 PST
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9/22/85 1700 PST
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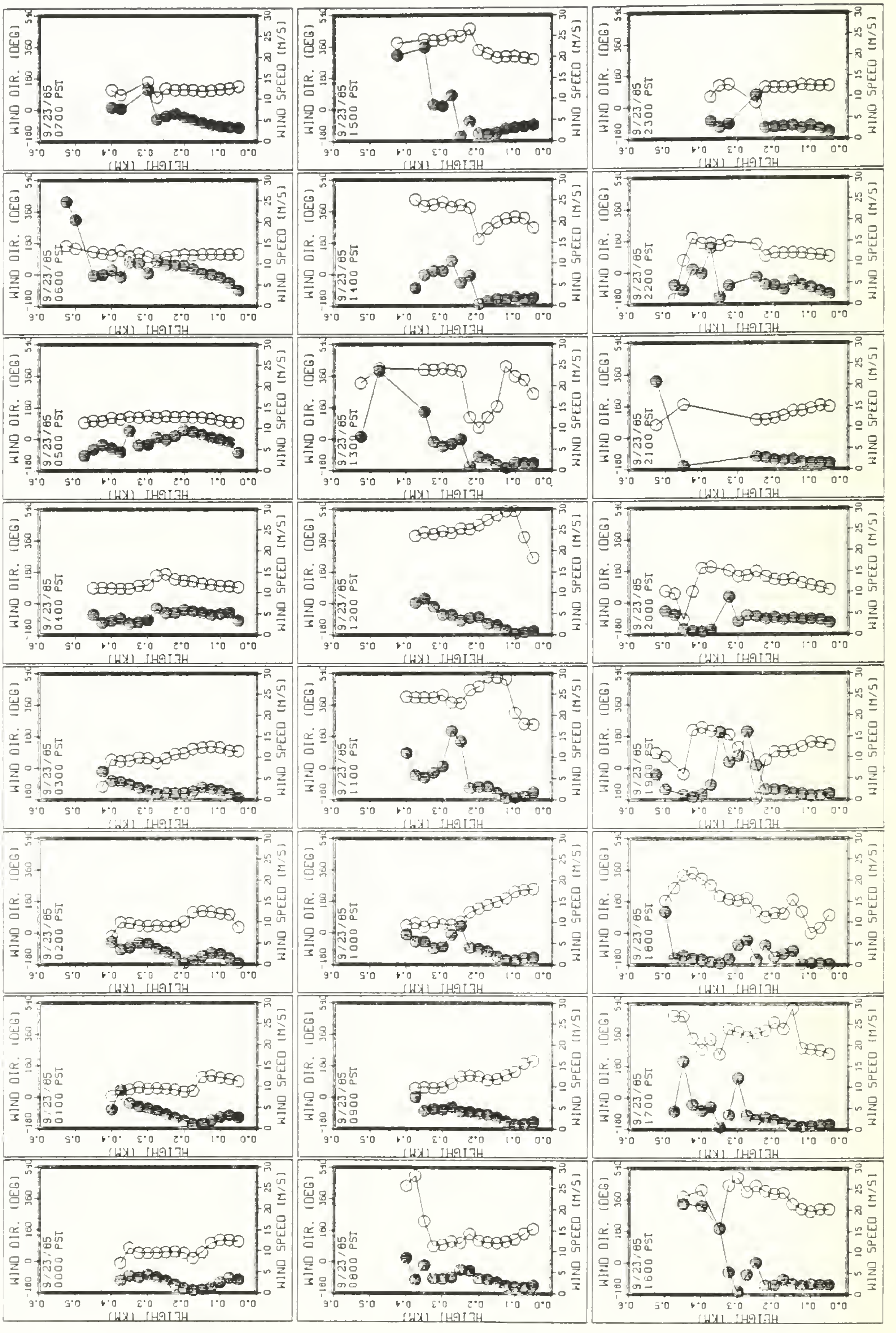
9/22/85 2300 PST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HEIGHT (KM)
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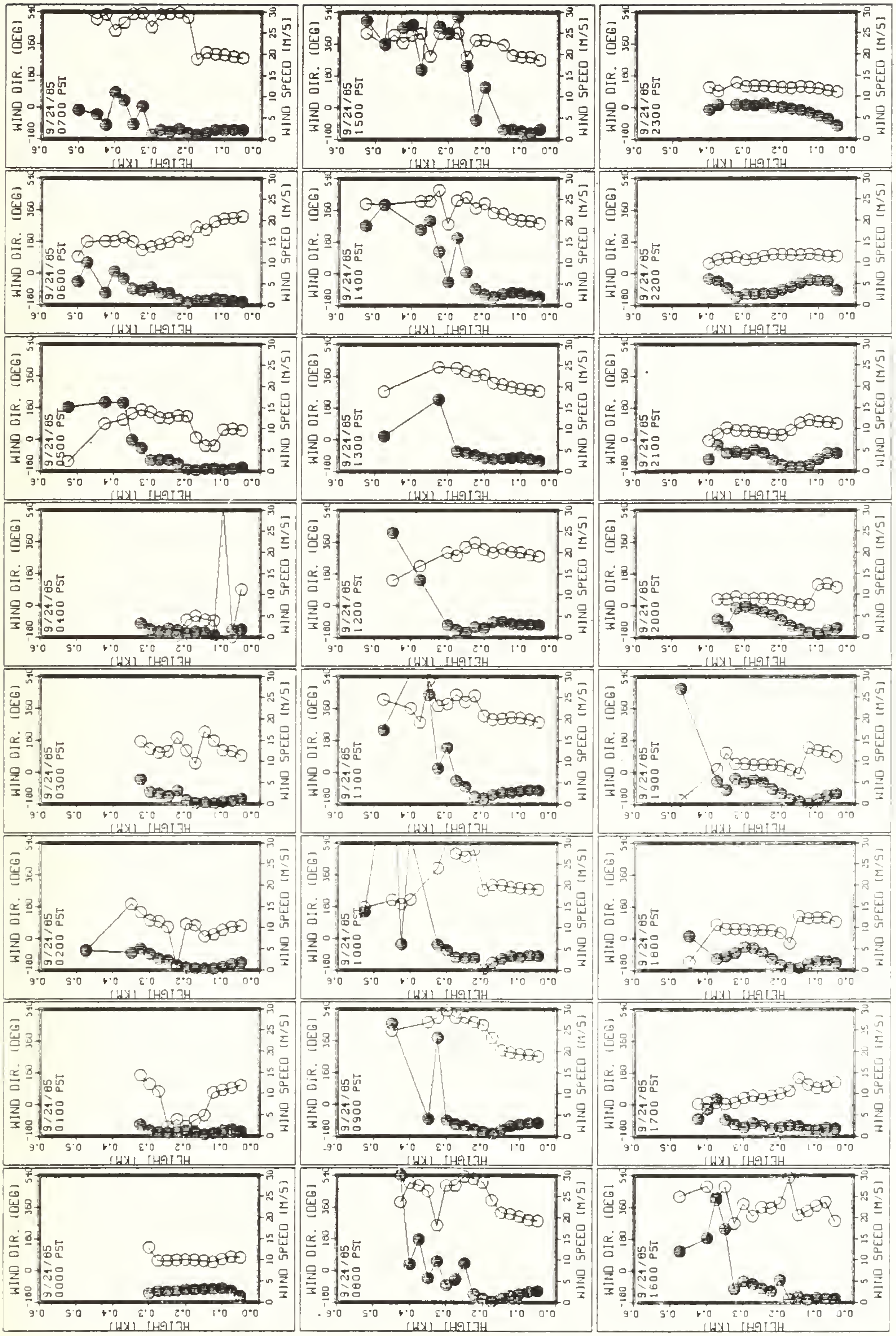
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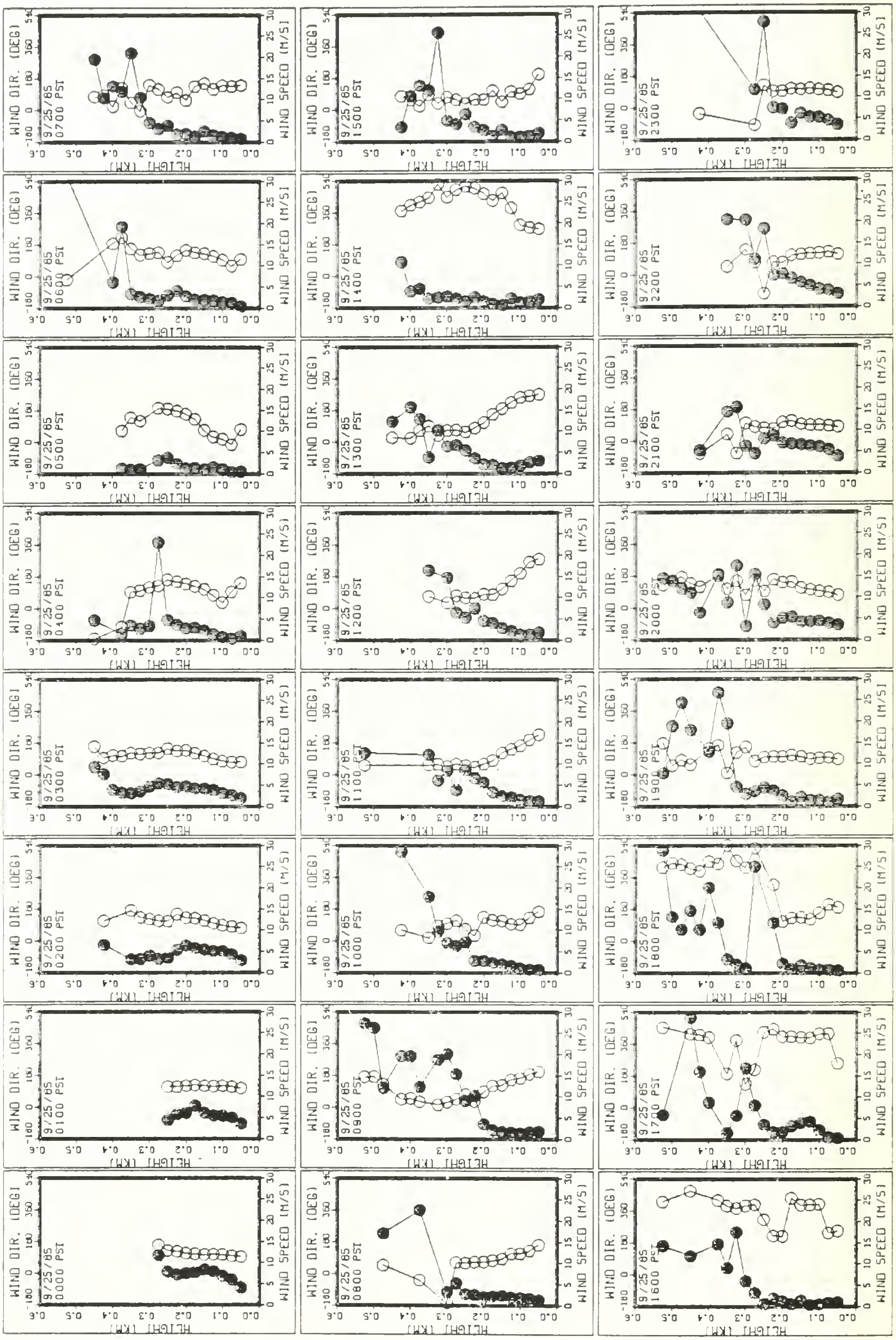

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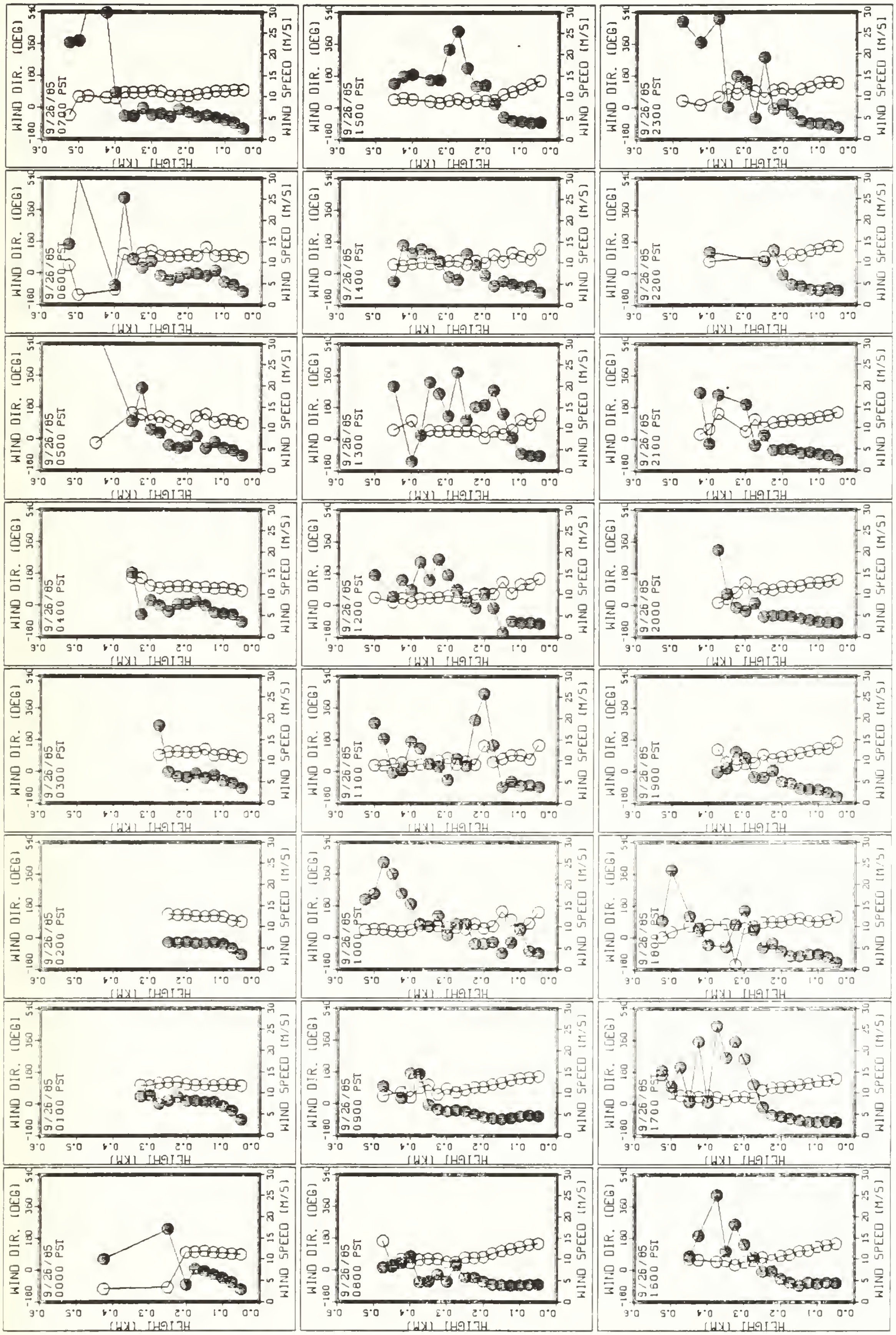
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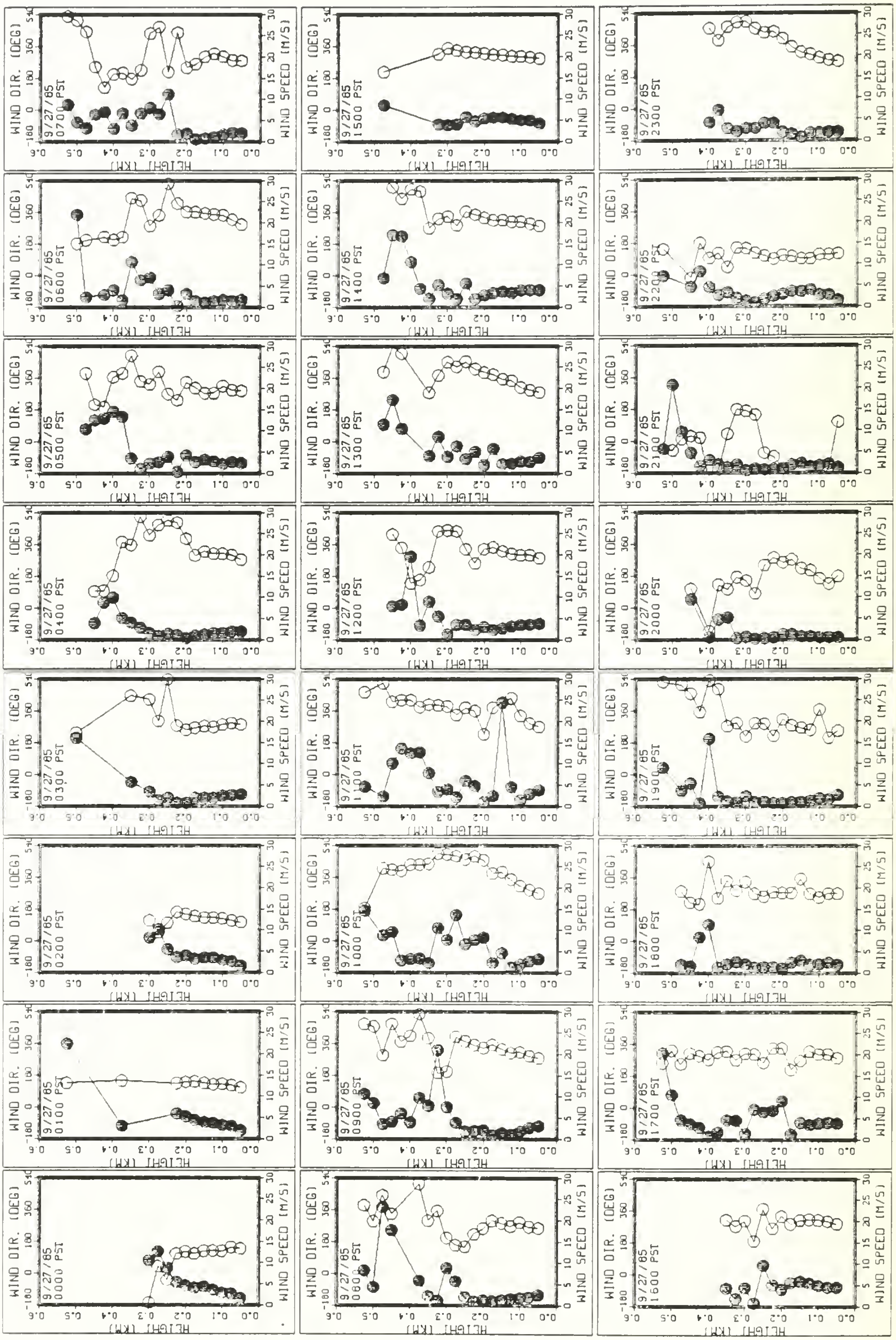
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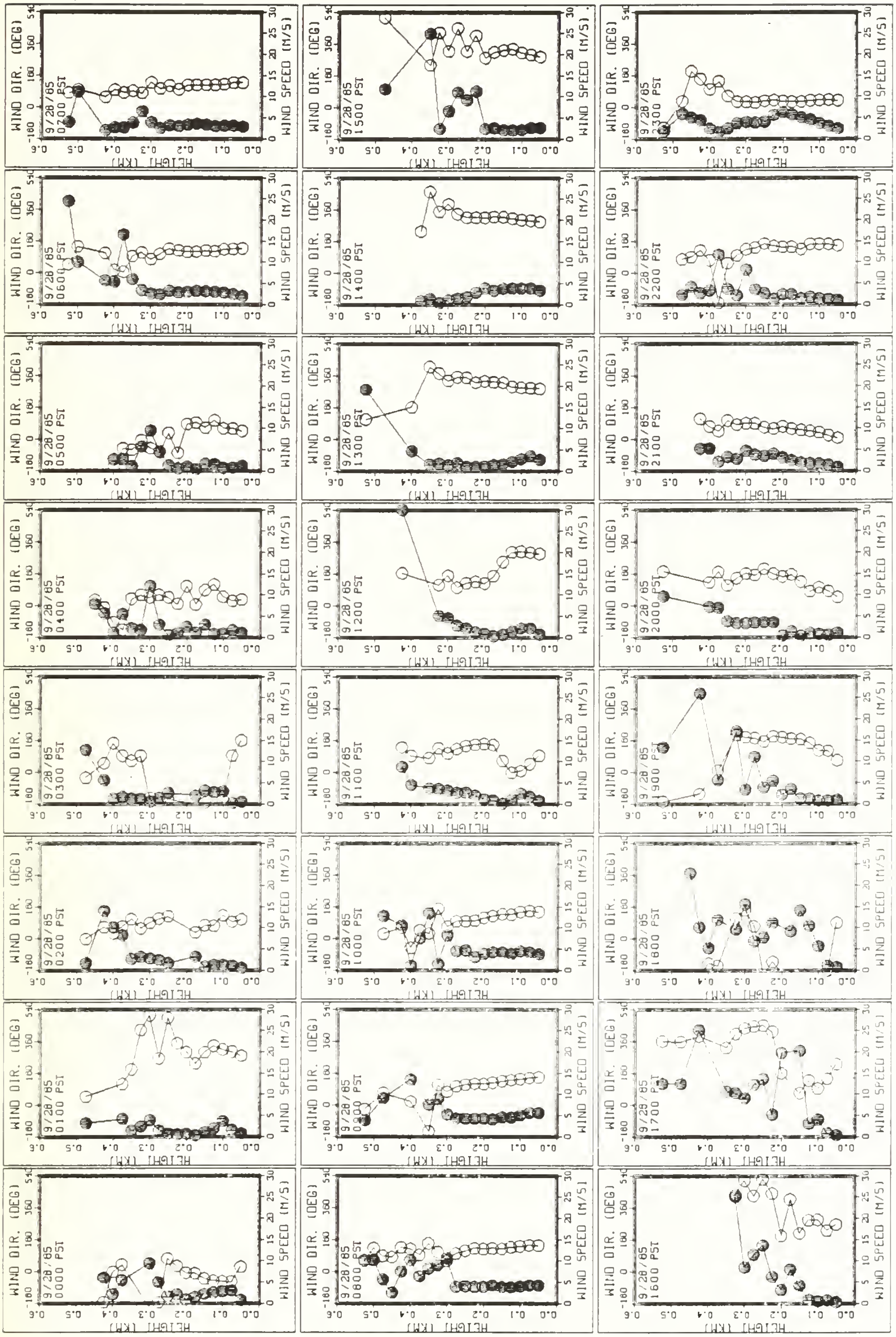
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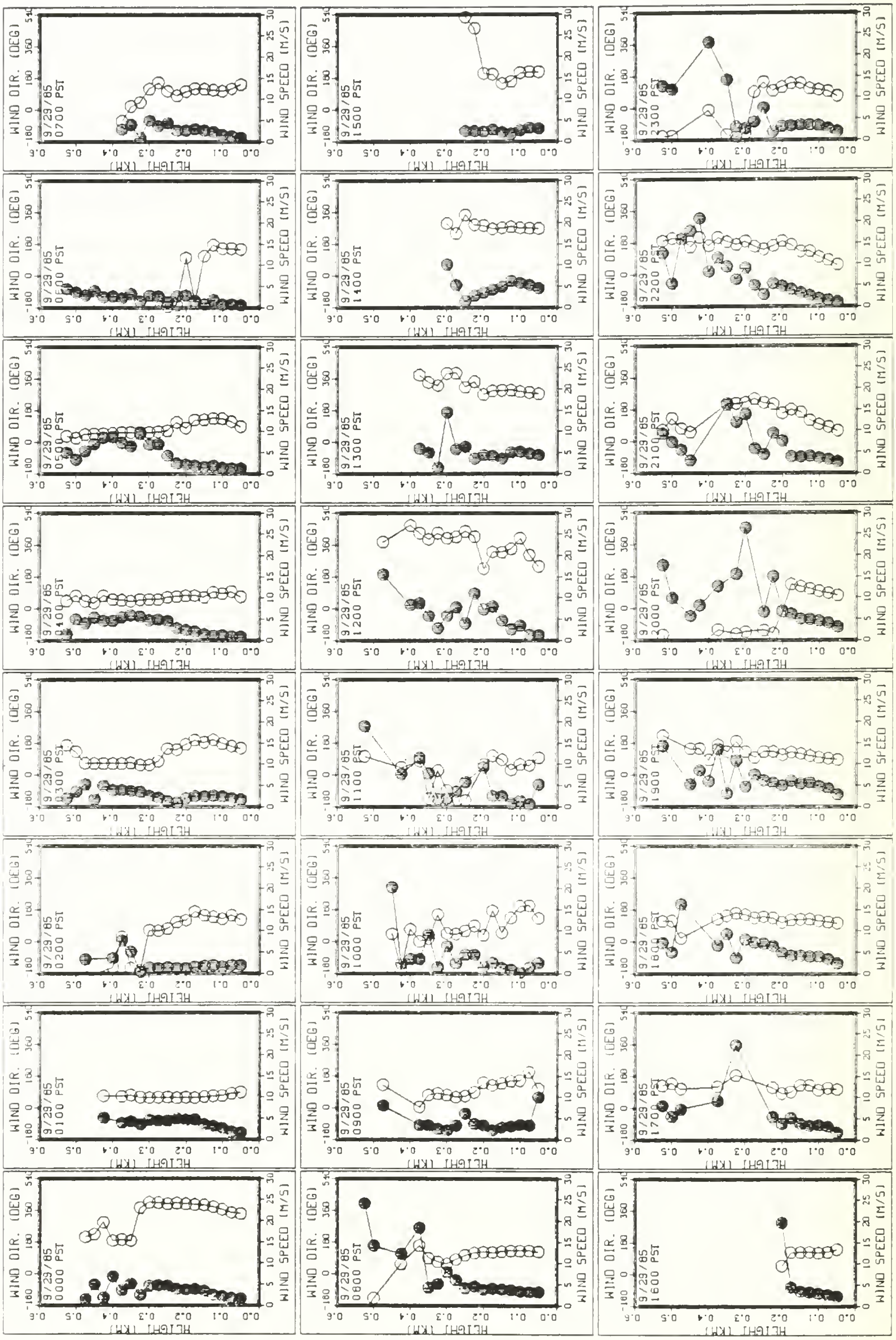

WIND DIR. (DEG)
WIND SPEED (M/S)
HEIGHT (KM)
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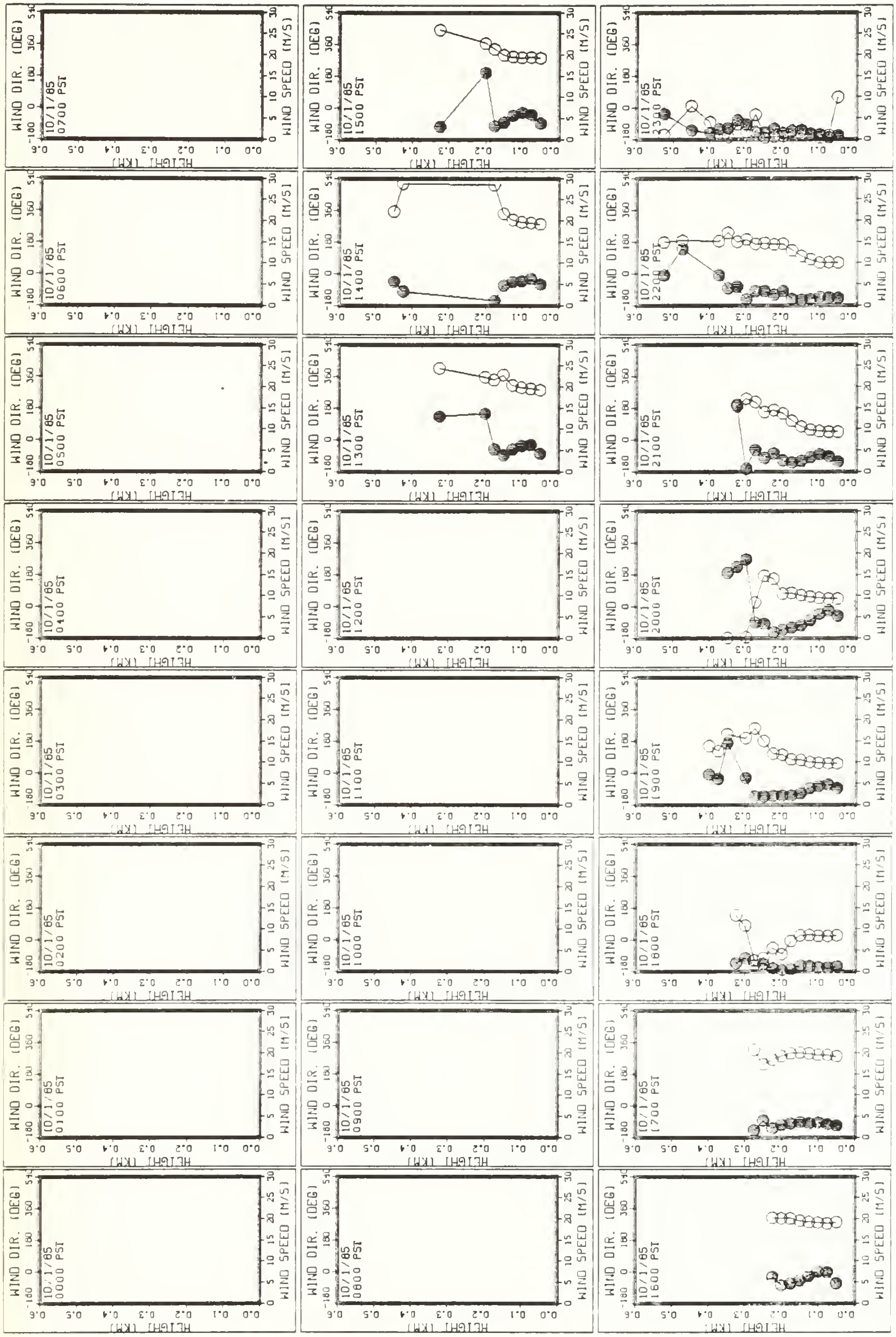
9/29/85 2300 PST



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HEIGHT (KM)
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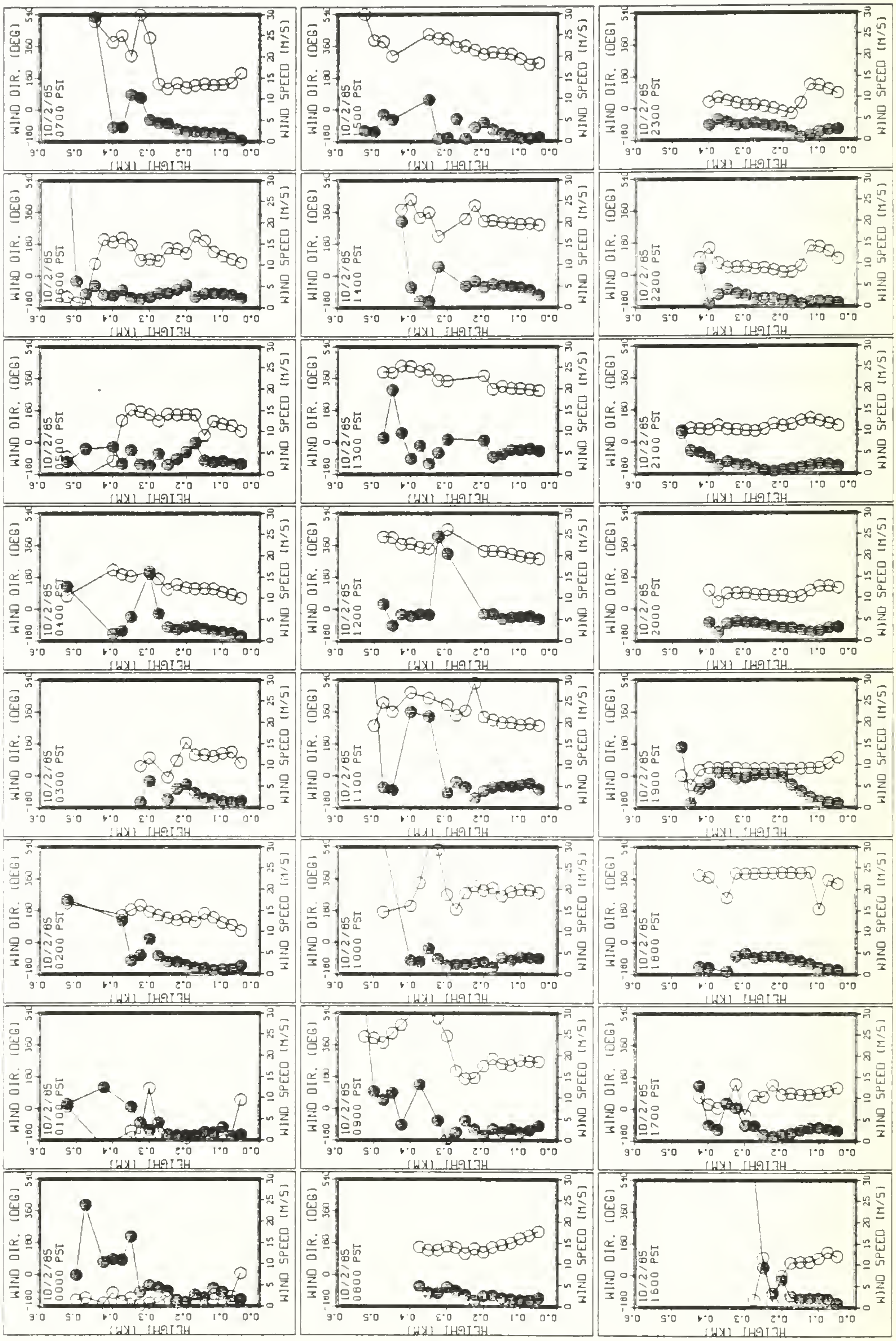
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WIND SPEED (M/S)
HEIGHT (KM)
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10/2/85 0400 PST
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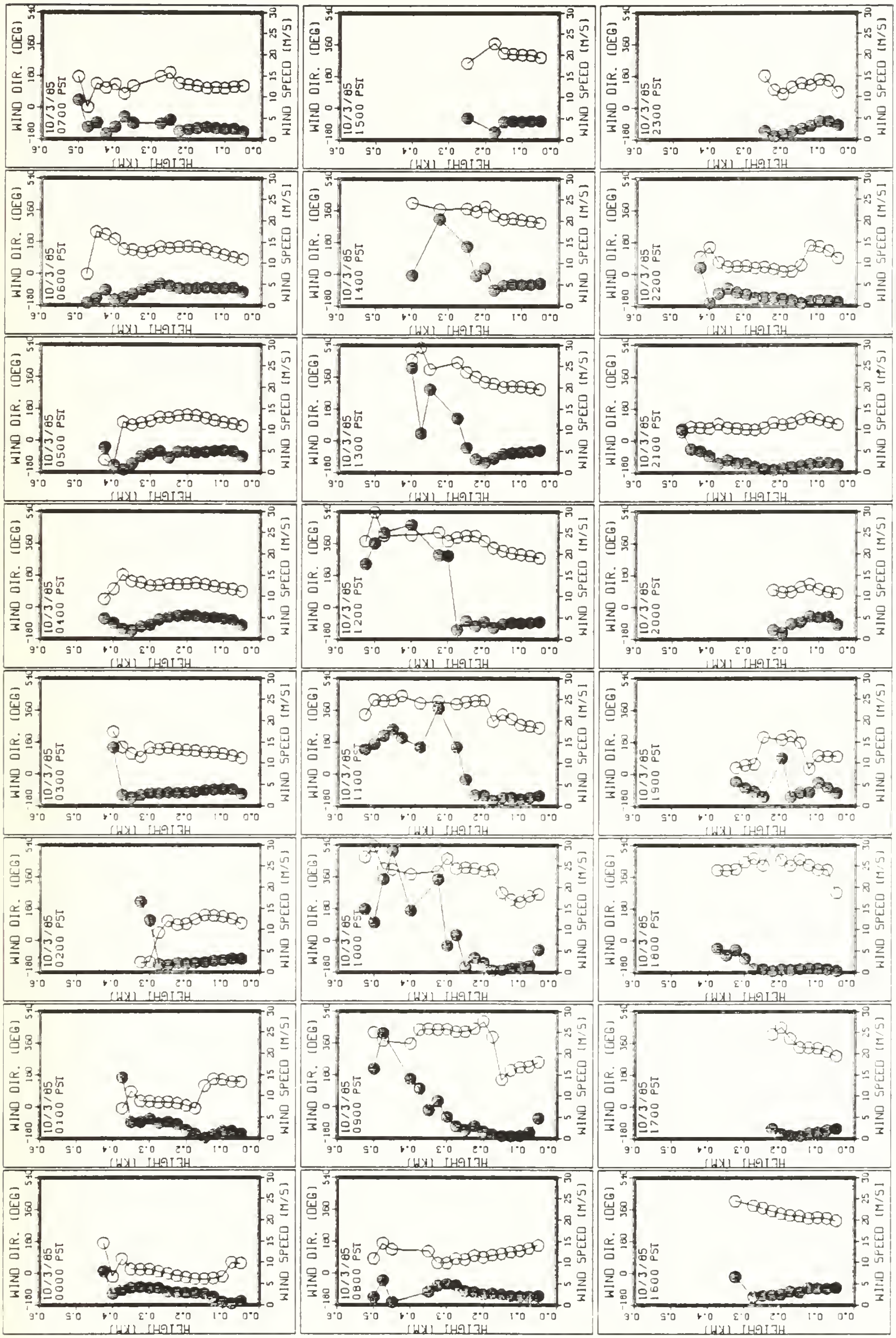
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10/3/85 2000 PST
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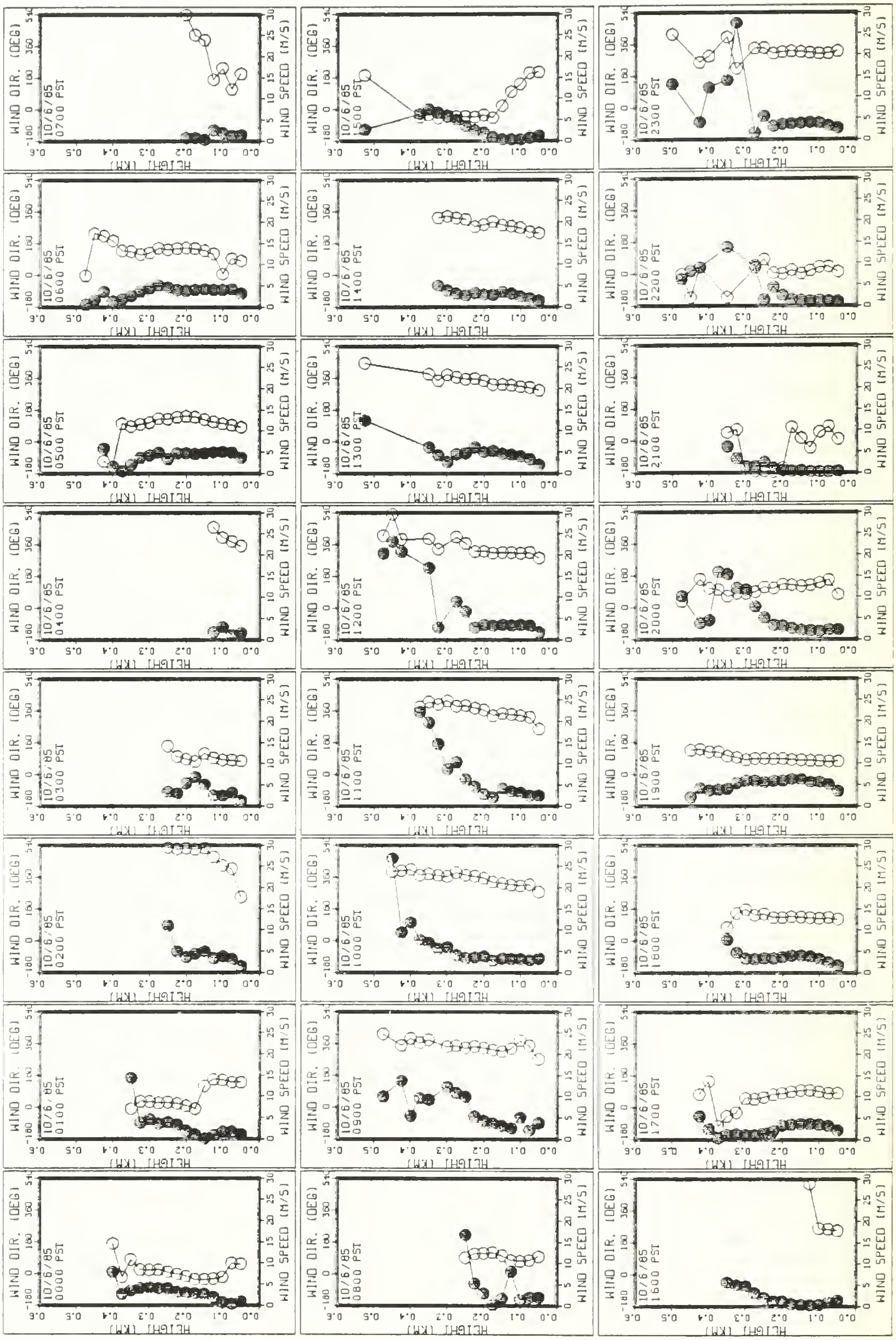
WIND DIR. (DEG)
WIND SPEED (M/S)
HEIGHT (KM)



WIND DIR. (DEG)
WIND SPEED (M/S)
HEIGHT (KM)
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10/6/85 1700 PST
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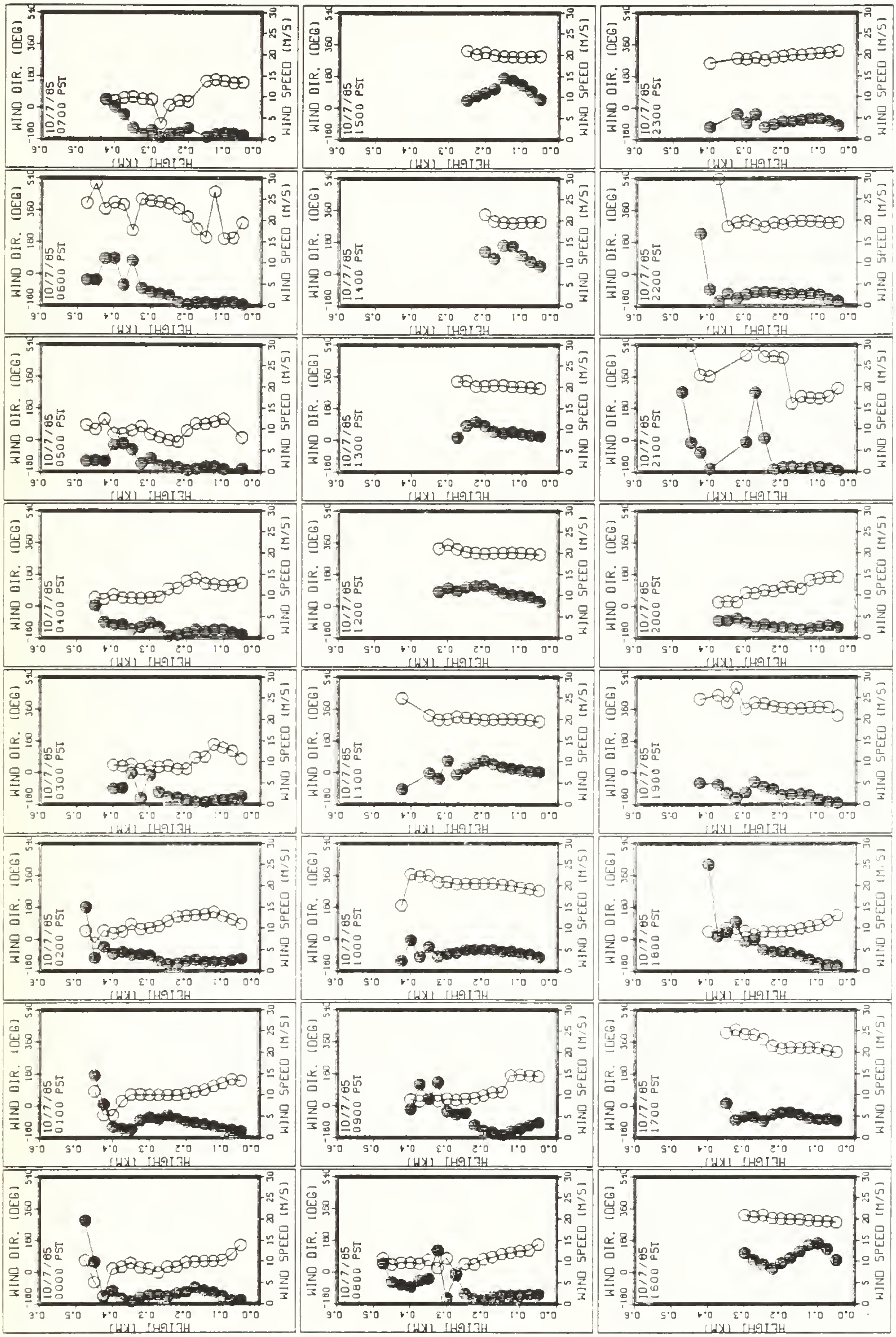

WIND DIR. (DEG)
WIND SPEED (M/S)
HEIGHT (KM)
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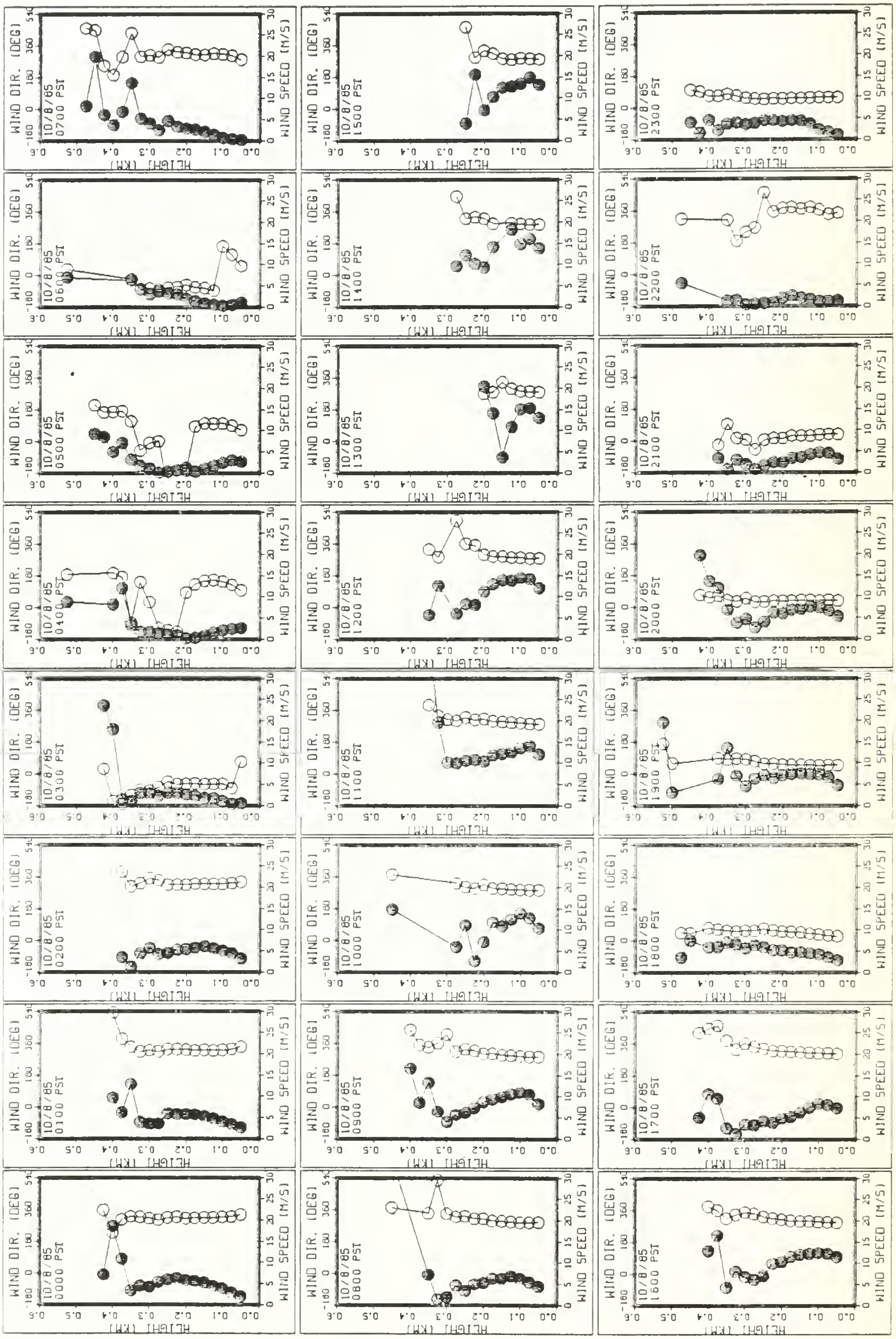
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10/8/85 1800 PST
10/8/85 1900 PST
10/8/85 2000 PST
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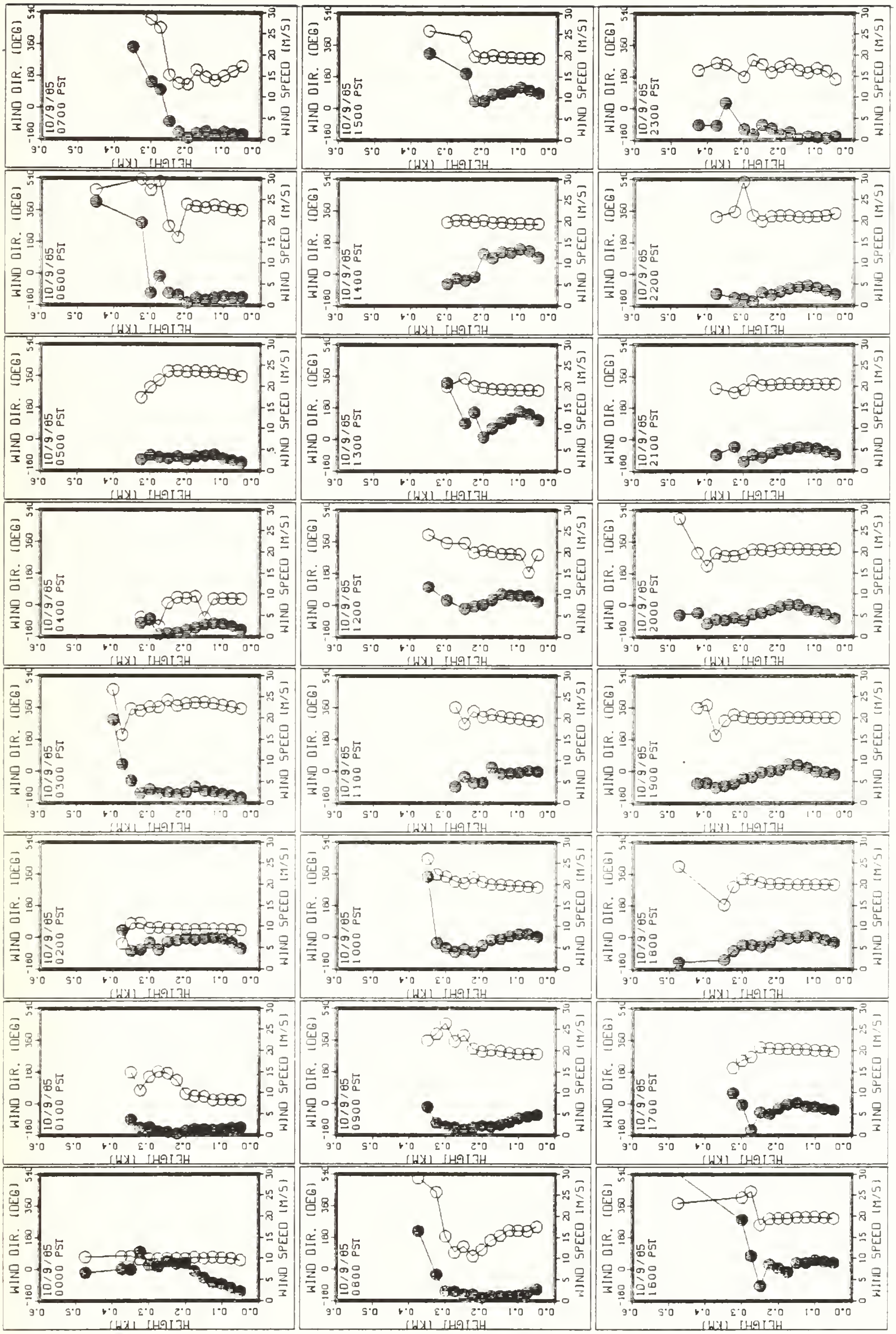
10/8/85 2200 PST
10/8/85 2300 PST
WIND DIR. (DEG)
WIND SPEED (M/S)
HEIGHT (KM)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HEIGHT (KM)
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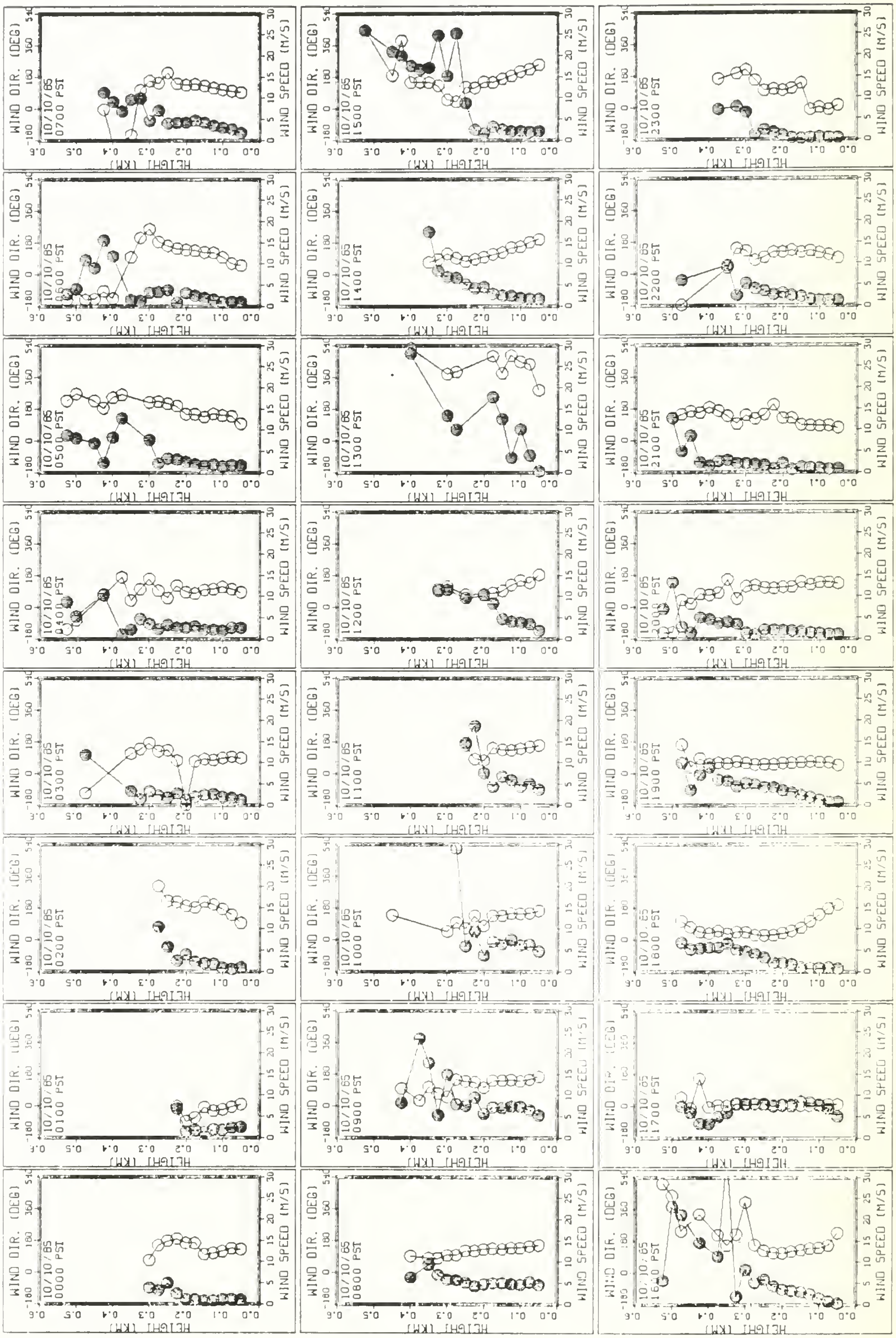
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HEIGHT (KM)
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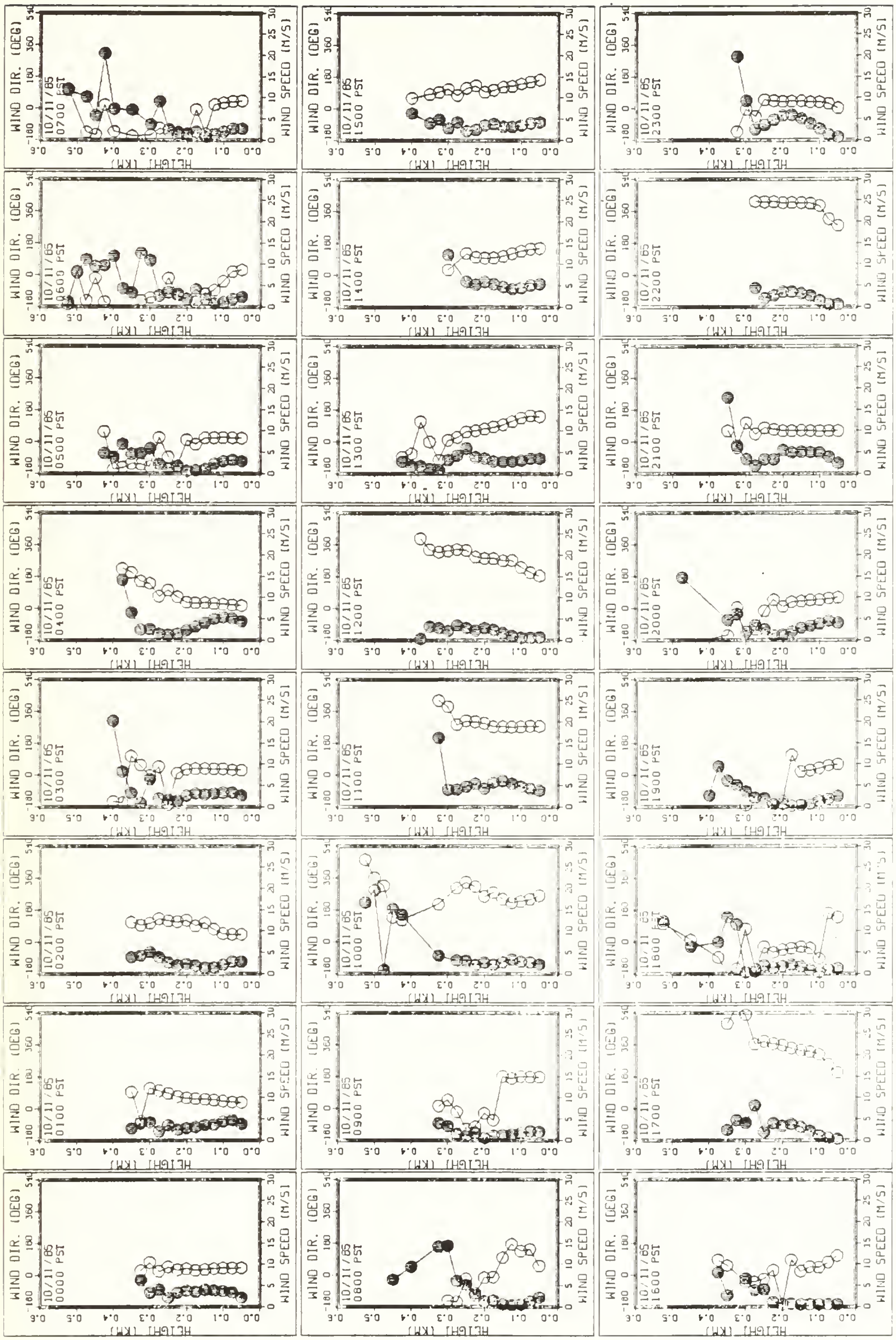
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10/11/85 1800 PST
10/11/85 1900 PST
10/11/85 2000 PST
10/11/85 2100 PST
10/11/85 2200 PST
10/11/85 2300 PST

APPENDIX D

This appendix contains time series of horizontal and vertical turbulence intensities measured by the tower at the Ellwood pier during SCCCAMP. Also included are wind barbs (knots) and stability categories based on Richardson number at three-hour intervals. Stability categories are summarized in table D-1.

Table D-1. Stability category definitions for plots in Appendix D.

Stability Category	Range
1	$Ri < -0.1$
2	$-0.1 \le Ri < -.04$
3	$-.04 \le Ri < 0.0$
4	$0.0 \le Ri < .04$
5	$.04 \le Ri < .25$
6	$Ri < .25$

The Richardson number was calculated using its gradient form and approximating the derivatives with simple differences between various levels of the tower system as follows:

$$Ri = \frac{g}{T} \frac{d\theta/dz}{(du/dz)^2} \approx \frac{g}{T} \frac{(\theta_3 - \theta_1)(z_3 - z_1)}{(u_3 - u_1)^2}$$

$$= \frac{g}{T} \frac{(T_3 + \Gamma z_3 - T_1) z_3}{u_3^2}$$

where

T_1 = sea surface temperature (K)

T_2 = air temperature at 5.5 m

T_3 = air temperature at 20.5 m

Γ = dry adiabatic lapse rate (9.76×10^{-3} K m^{-1})

z_1 = 0 m

$z_2 = 5.5$ m

$z_3 = 20.5$ m

When the sea surface temperature was unavailable, the lower air temperature was used in its place, i.e.,

$$Ri \approx \frac{2g}{(T_3 + T_2)} \frac{[(T_3 - T_2) + \Gamma(z_3 - z_2)]}{(z_3 - z_2)} \frac{(z_3 - z_1)^2}{u_3^2}$$

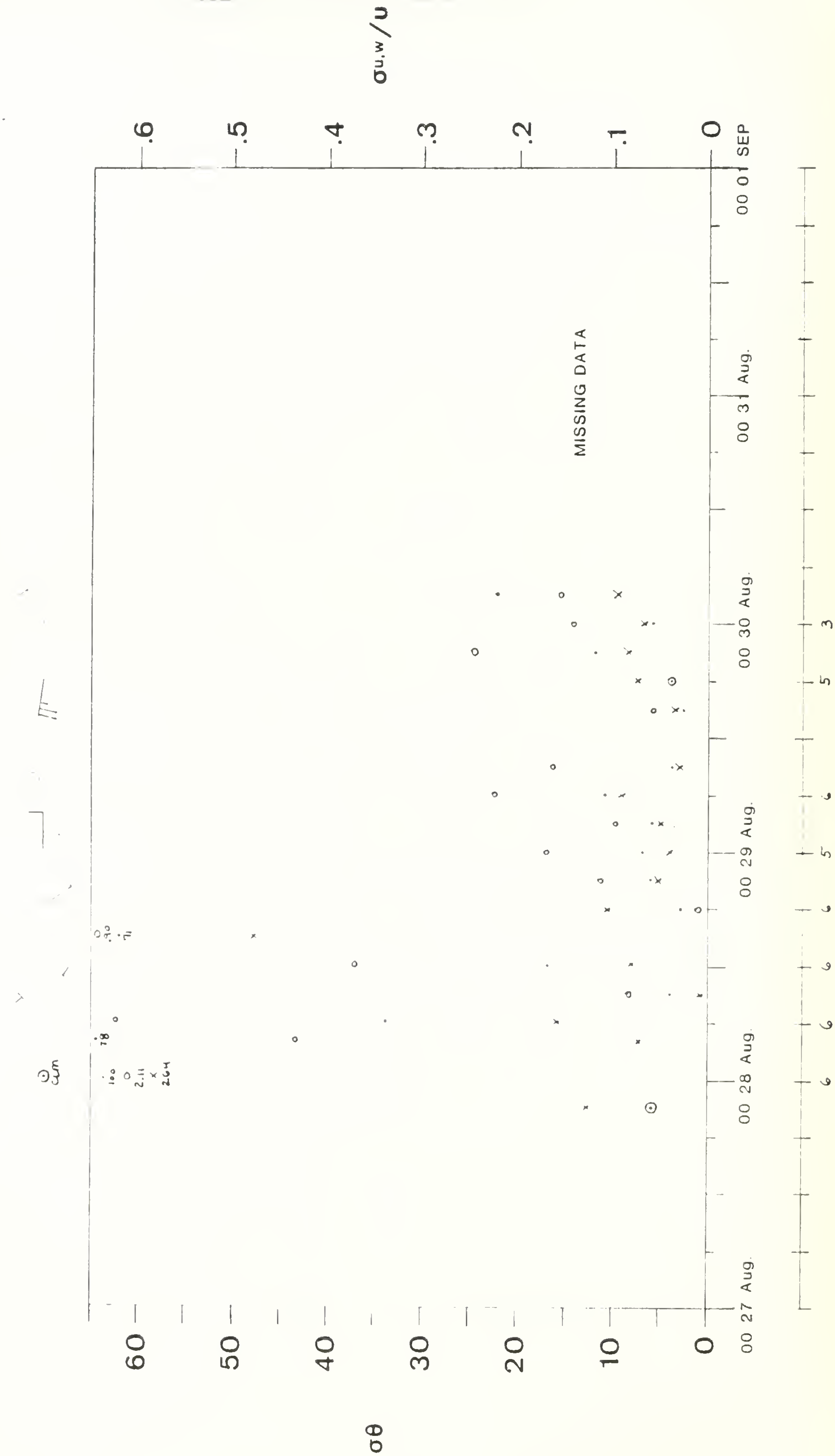
In the following plots, plotting symbols have the meanings listed below:

o -- σu / u (intensity of wind speed fluctuations)

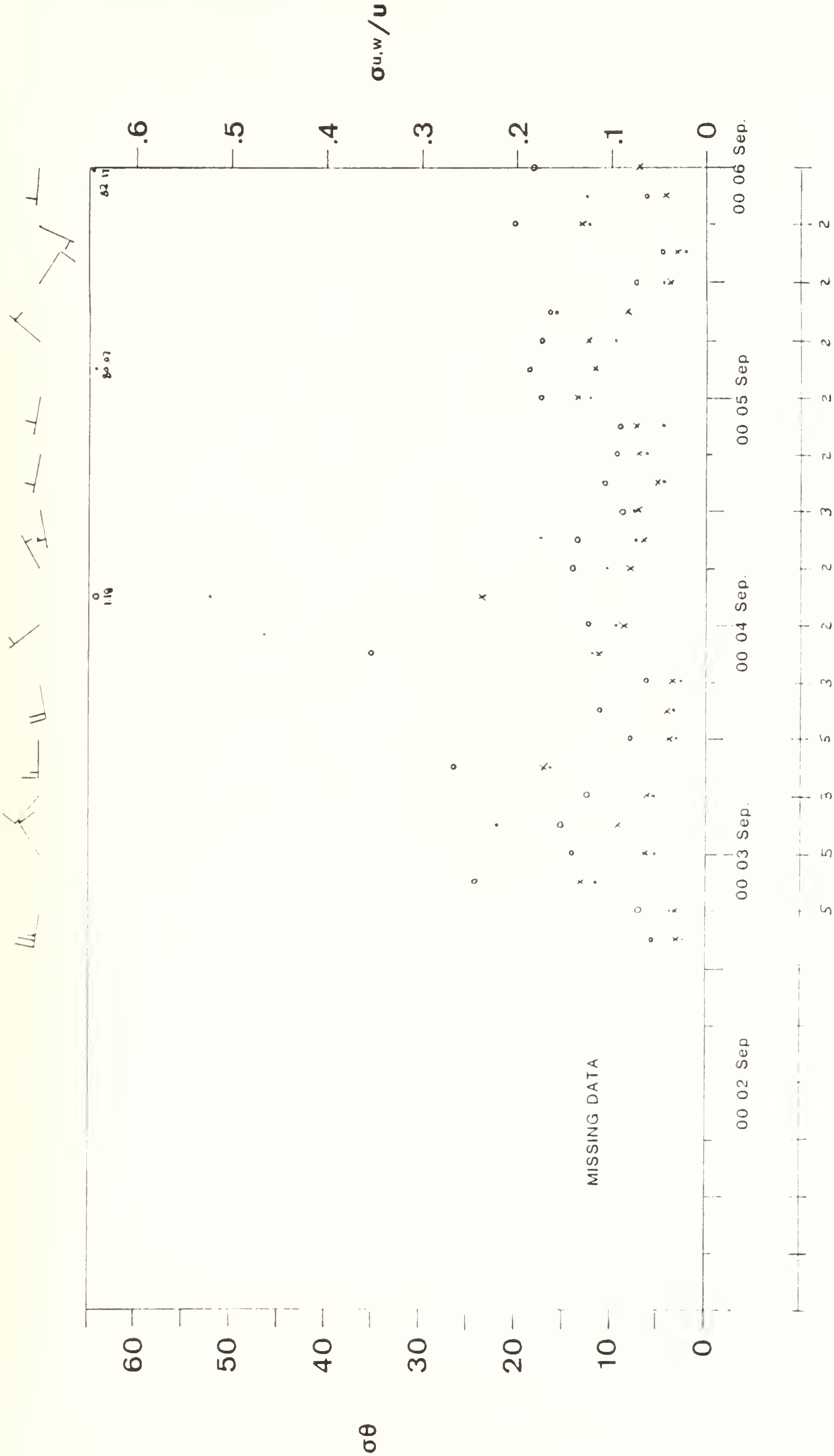
• -- σw / u (intensity of turbulent vertical velocity)

x -- $\sigma\theta$ (RMS variation of wind direction)

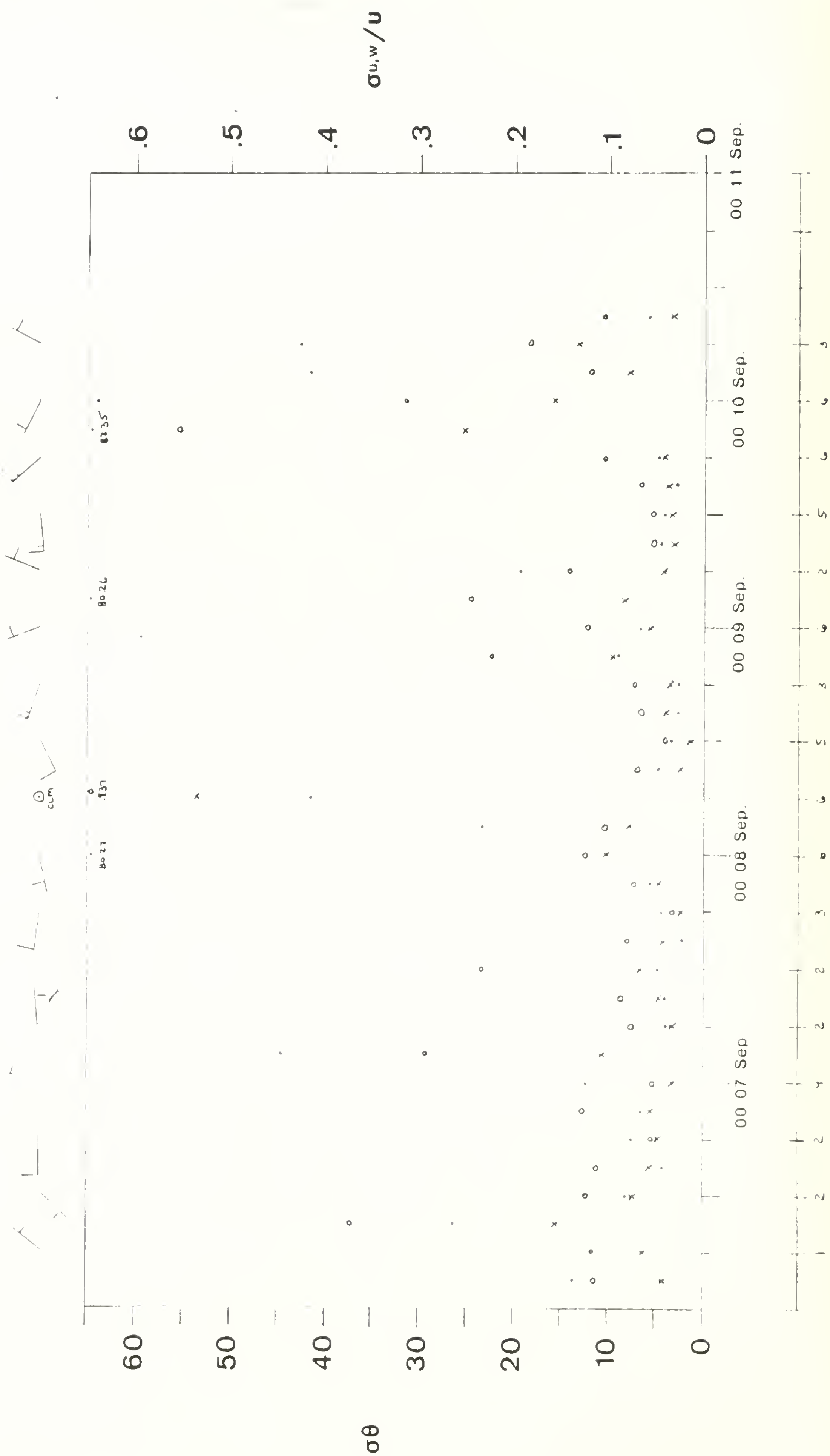
As with other appendices, the following plots constitute a time series, and no further captions are given.



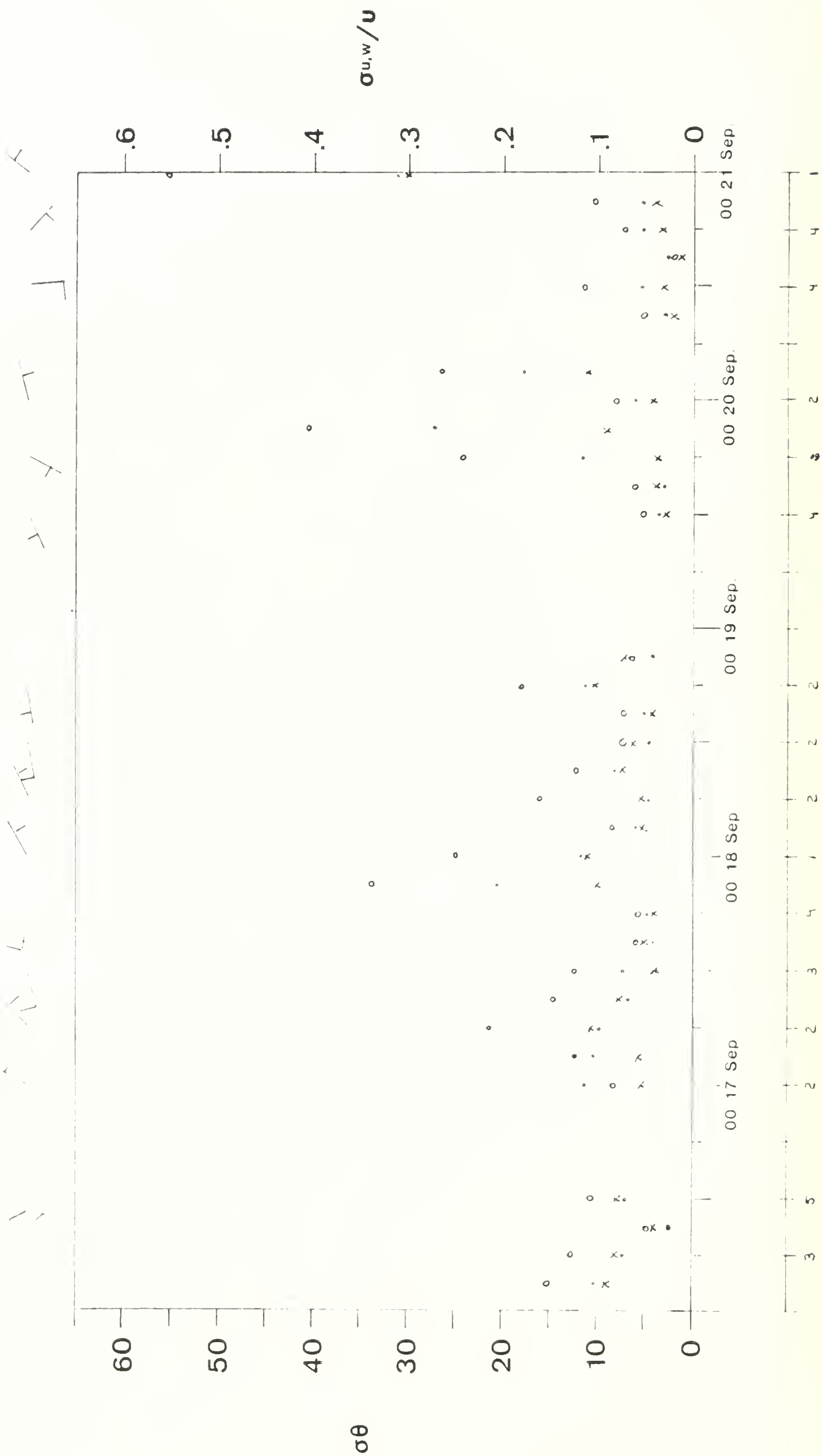
σu,w/u
.6
.5
.4
.3
.2
.1
0
σθ
60
50
40
30
20
10
0
MISSING DATA
00 27 Aug.
00 28 Aug.
00 29 Aug.
00 30 Aug.
00 31 Aug.
00 01 SEP

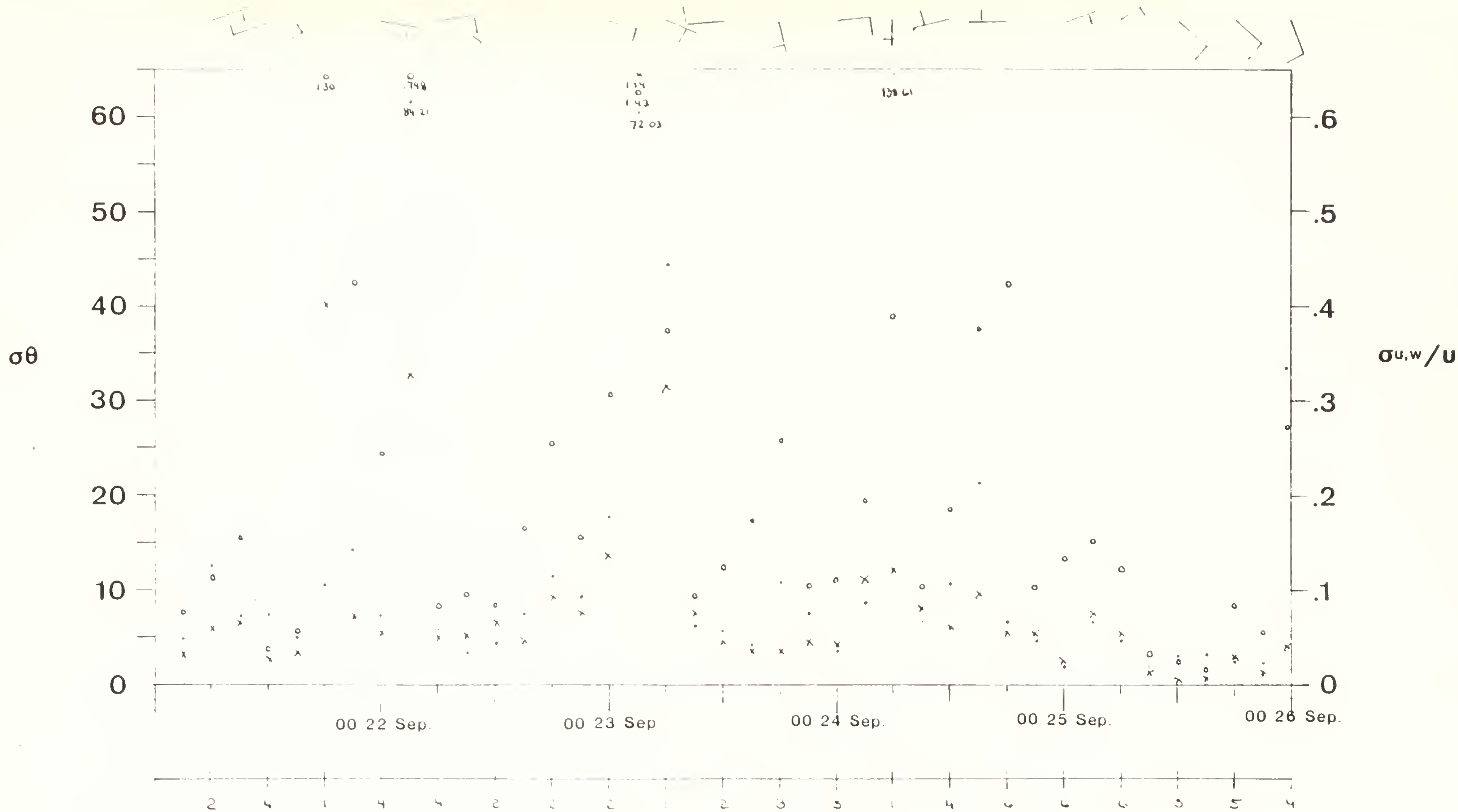


$\sigma_{u,w}/u$
.6
.5
.4
.3
.2
.1
0
00 06 Sep.
00 05 Sep
00 04 Sep.
00 03 Sep.
00 02 Sep
MISSING DATA
60
50
40
30
20
10
0
$\sigma\theta$


σu,w/u
.6
.5
.4
.3
.2
.1
0
00 11 Sep
00 10 Sep
00 09 Sep
00 08 Sep
00 07 Sep
60
50
40
30
20
10
0
σθ

σθ
σu,w/u
0
10
20
30
40
50
60
.1
.2
.3
.4
.5
.6
00 12 Sep
00 13 Sep.
00 14 Sep
00 15 Sep
00 16 Sep


σu,w/u
σθ
0
.1
.2
.3
.4
.5
.6
0
10
20
30
40
50
60
00 17 Sep
00 18 Sep
00 19 Sep
00 20 Sep
00 21 Sep


σθ
σu,w/u
60
50
40
30
20
10
0
.6
.5
.4
.3
.2
.1
0
00 22 Sep.
00 23 Sep
00 24 Sep.
00 25 Sep.
00 26 Sep.


σu,w/u
.6
.5
.4
.3
.2
.1
0
00 31 Sep.
00 30 Sep.
00 29 Sep.
00 28 Sep
00 27 Sep.
MISSING DATA
60
50
40
30
20
10
0
σθ

σθ
0
10
20
30
40
50
60
σu,w/u
0
.1
.2
.3
.4
.5
.6
00 01 Oct
00 02 Oct
00 03 Oct
00 04 Oct
00 05 Oct
MISSING DATA


σu,w/u
σθ
00 06 Oct
0
.1
.2
.3
.4
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.6
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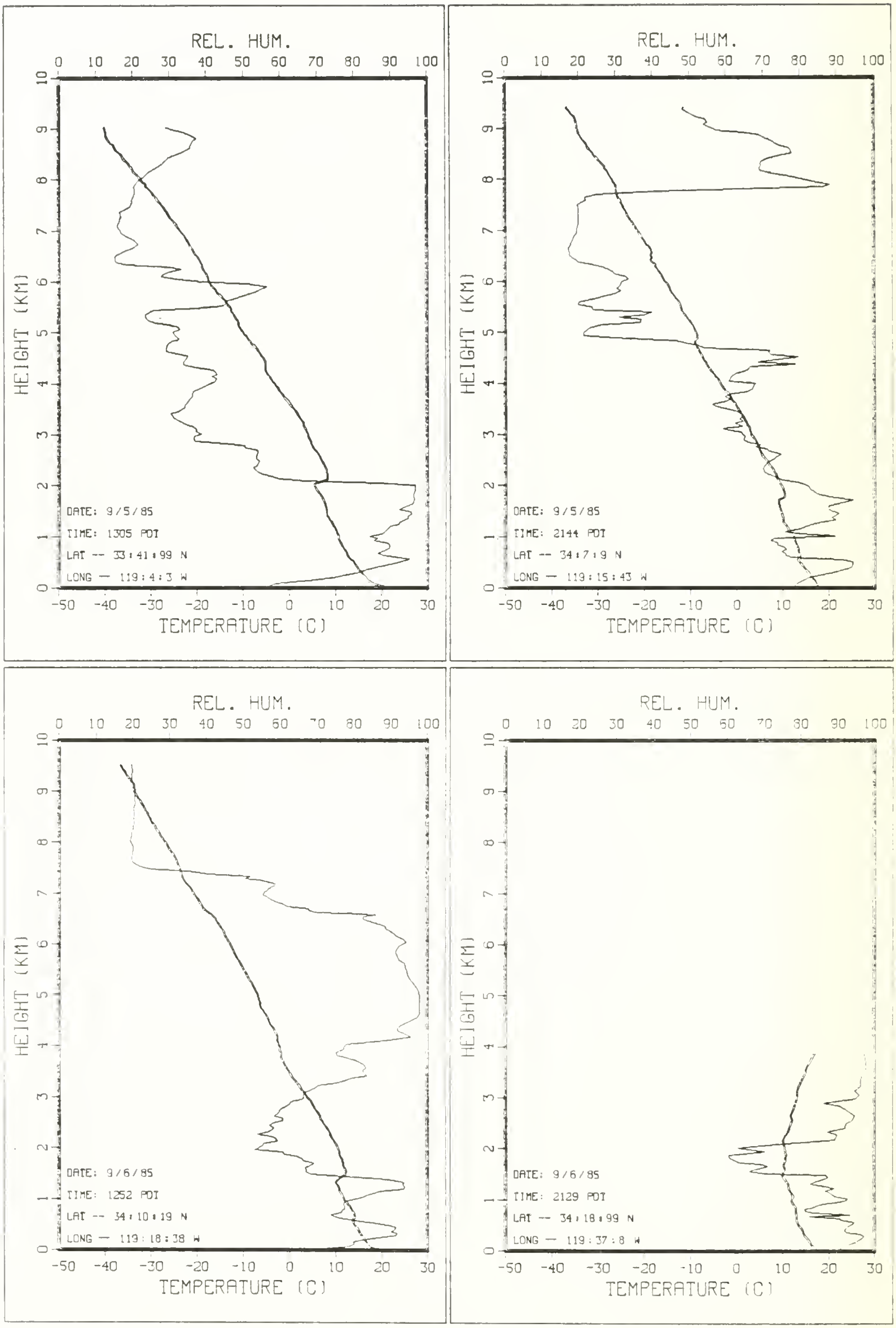
60

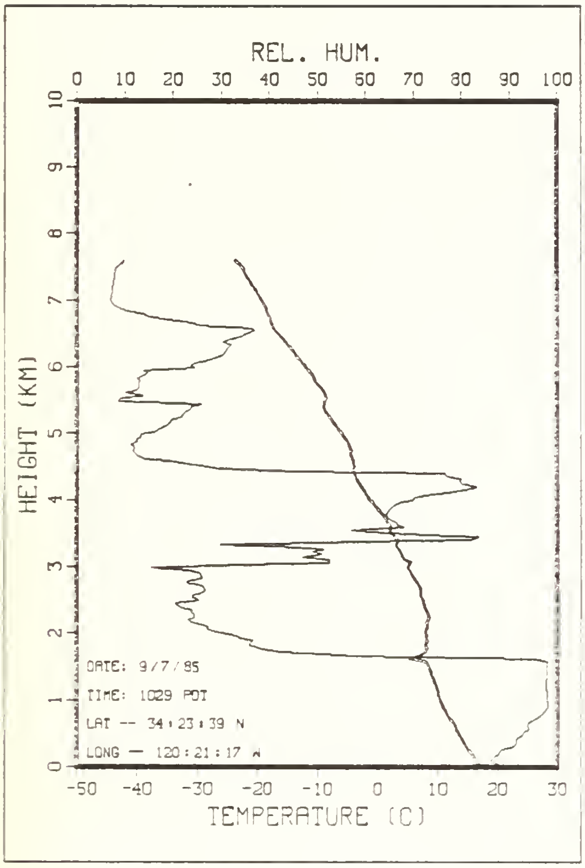
APPENDIX E

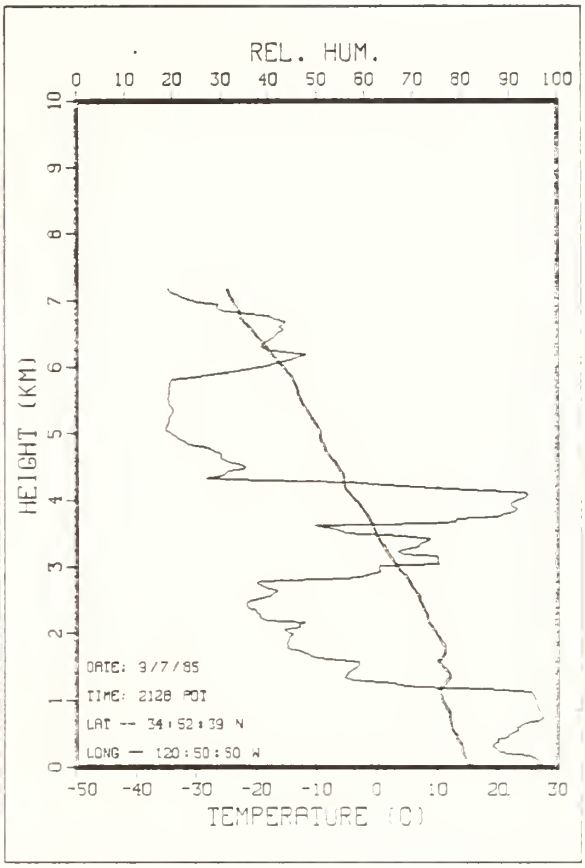
This appendix contains the plots of profiles from the rawinsonde system aboard the R/V Acania.

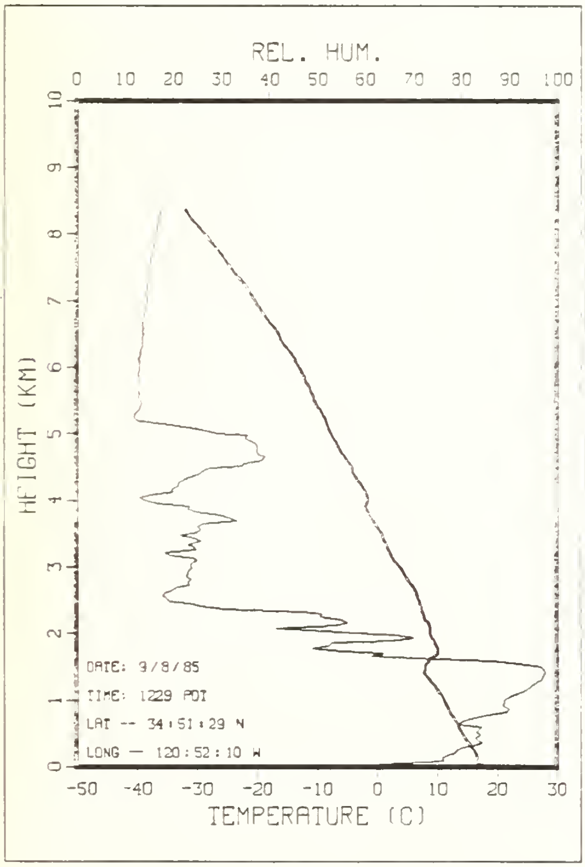
E.1 Thermodynamic Profiles

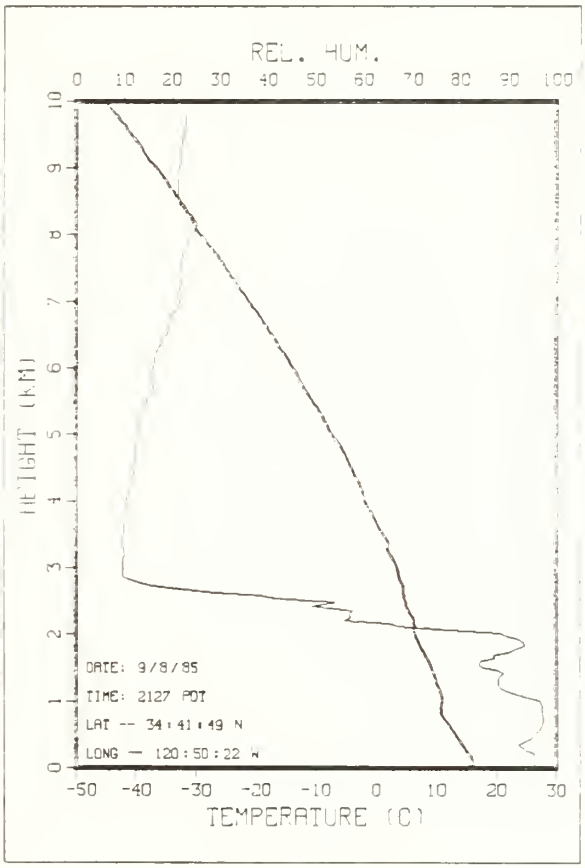
Plots on the following pages are of temperature (heavy solid line) and relative humidity to 10 kilometers. Date, time, and position are labeled on each plot and serve as the caption for each.

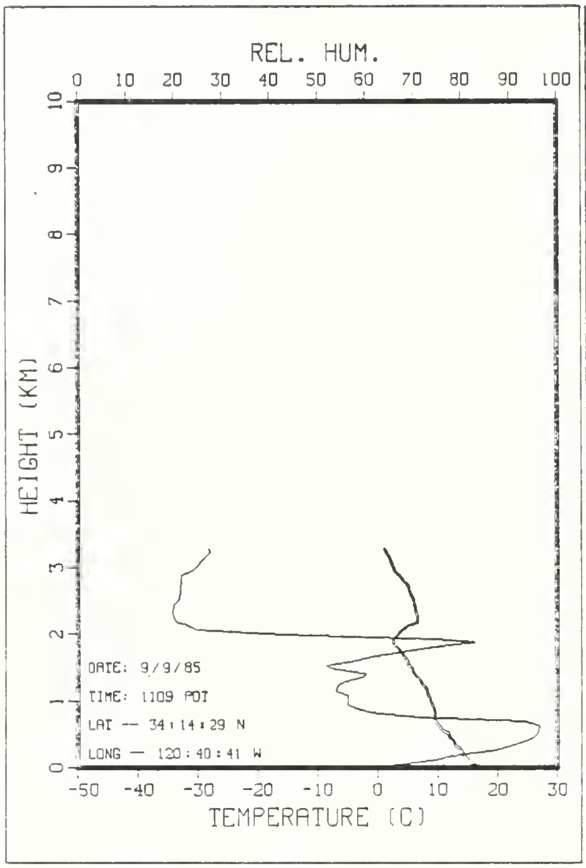

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/5/85
TIME: 1305 PDT
LAT -- 33:41:99 N
LONG — 119:4:3 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)
REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/5/85
TIME: 2144 PDT
LAT -- 34:7:9 N
LONG — 119:15:43 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)
REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/6/85
TIME: 1252 PDT
LAT -- 34:10:19 N
LONG — 119:18:38 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)
REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/6/85
TIME: 2129 PDT
LAT -- 34:18:99 N
LONG — 119:37:8 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

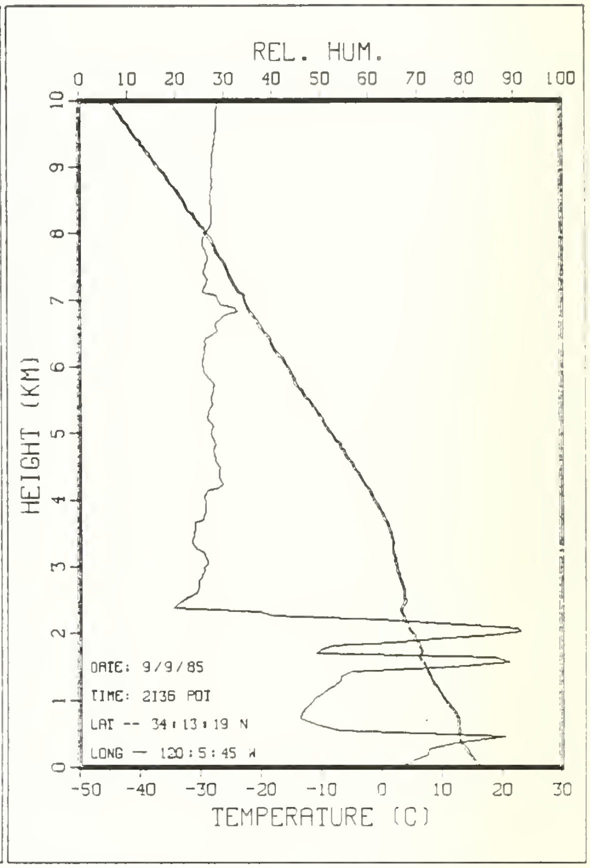

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/7/85
TIME: 1029 PDT
LAT -- 34:23:39 N
LONG — 120:21:17 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

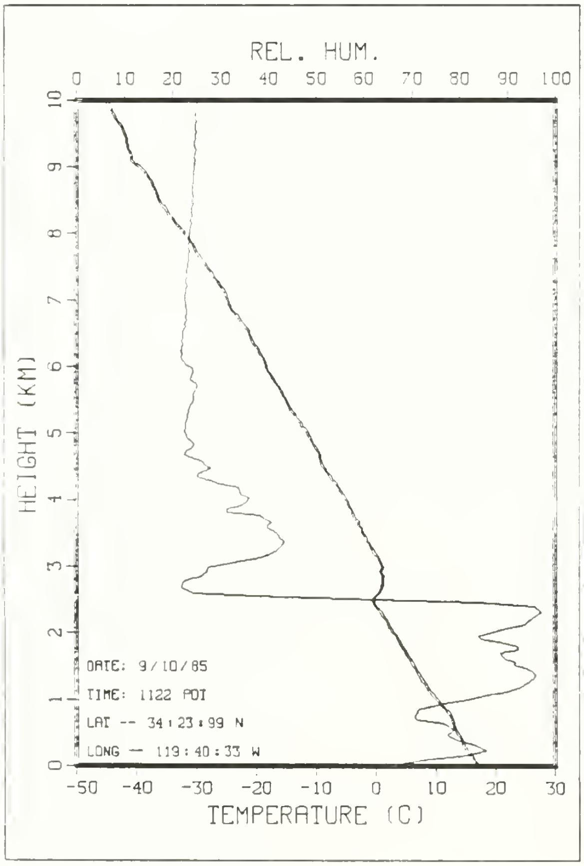

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/7/85
TIME: 2128 PDT
LAT -- 34:52:39 N
LONG — 120:50:50 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

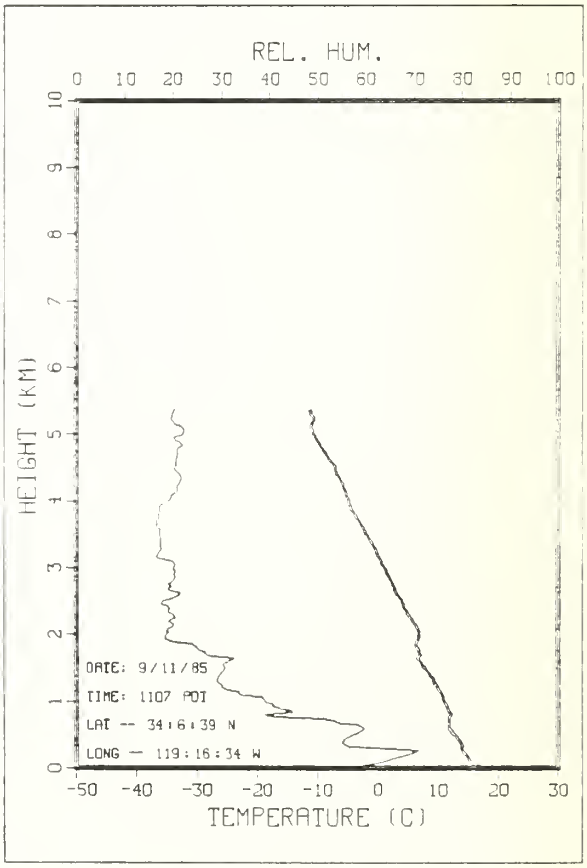

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/8/85
TIME: 1229 PDT
LAT -- 34:51:29 N
LONG — 120:52:10 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

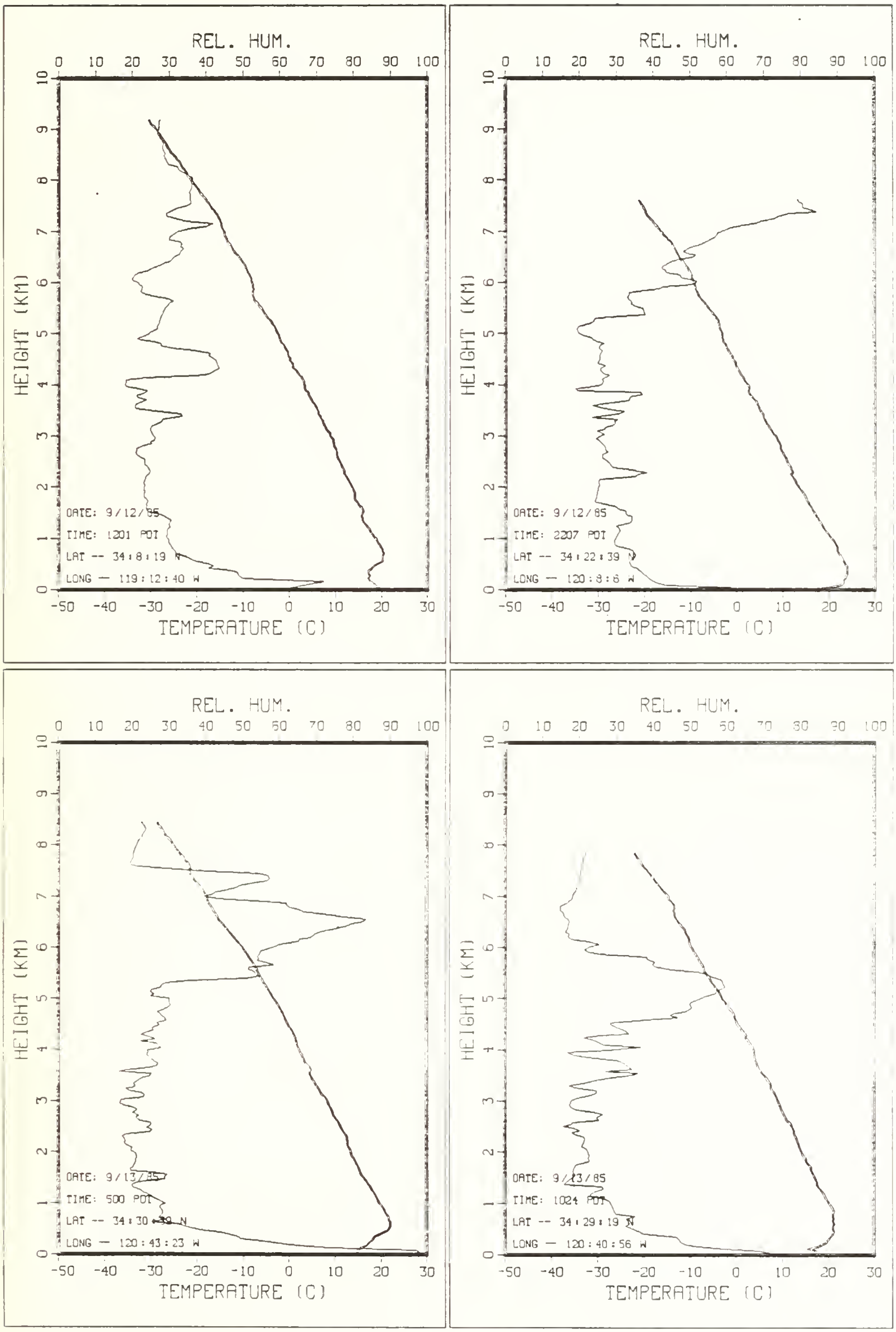

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/8/85
TIME: 2127 PDT
LAT -- 34:41:49 N
LONG — 120:50:22 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

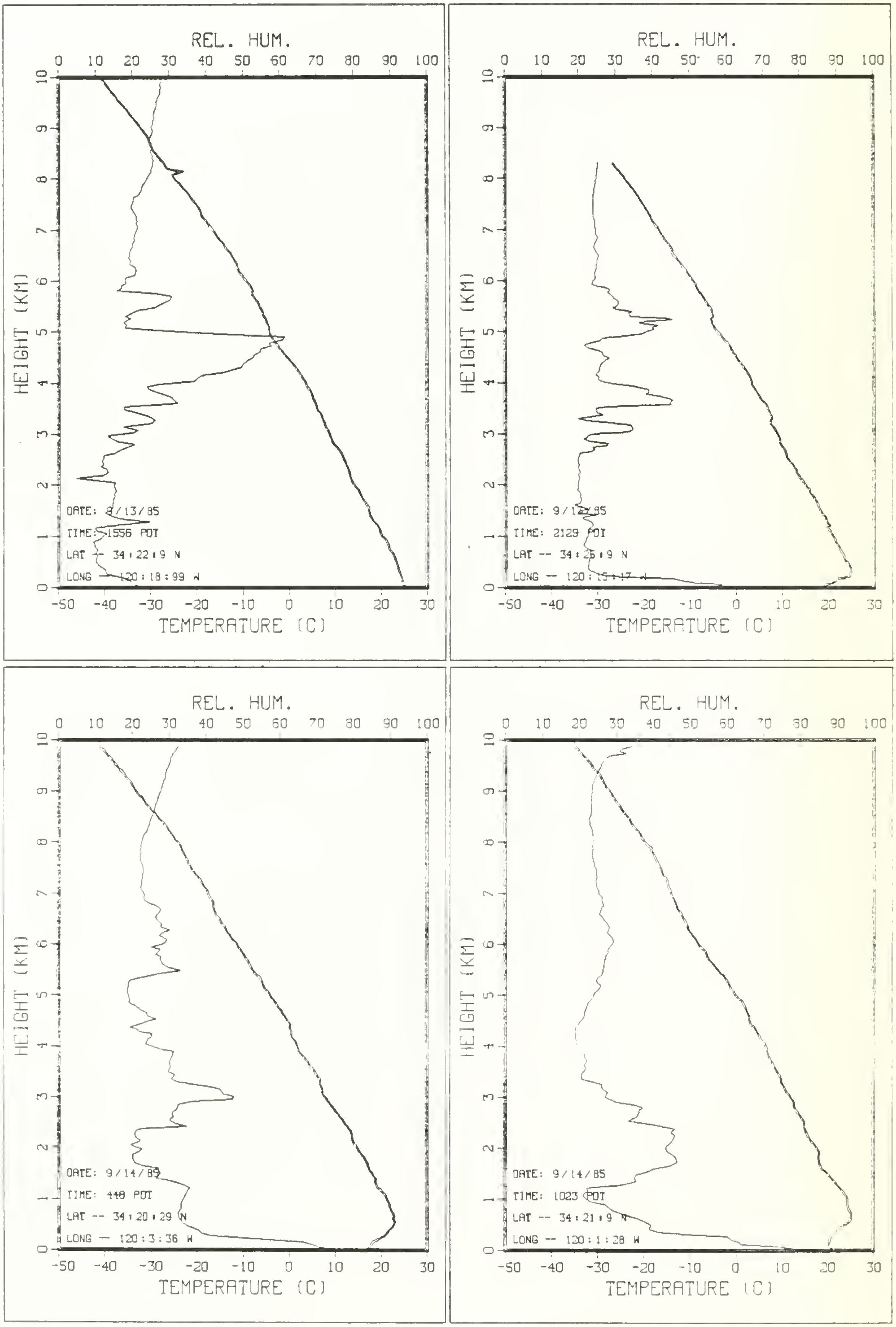

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/9/85
TIME: 1109 PDT
LAT -- 34:14:29 N
LONG — 120:40:41 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

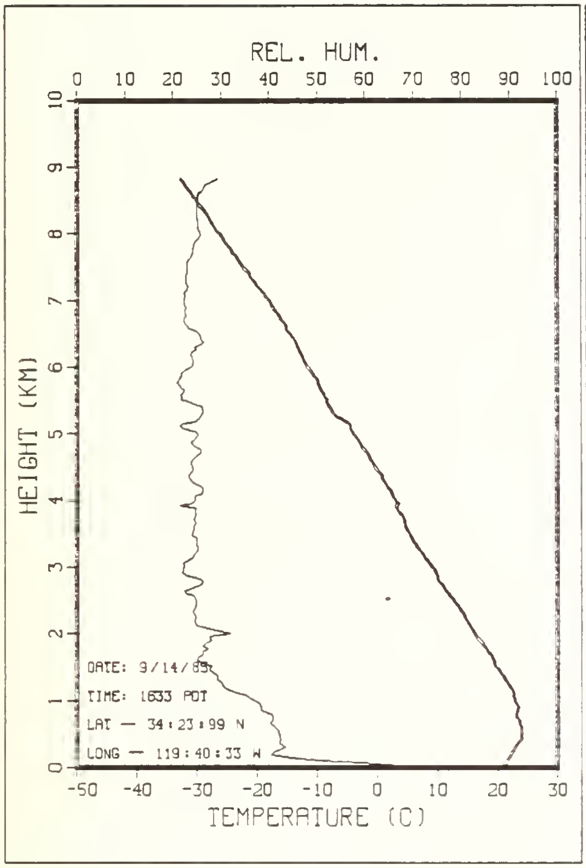

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/9/85
TIME: 2136 PDT
LAT -- 34:13:19 N
LONG — 120:5:45 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

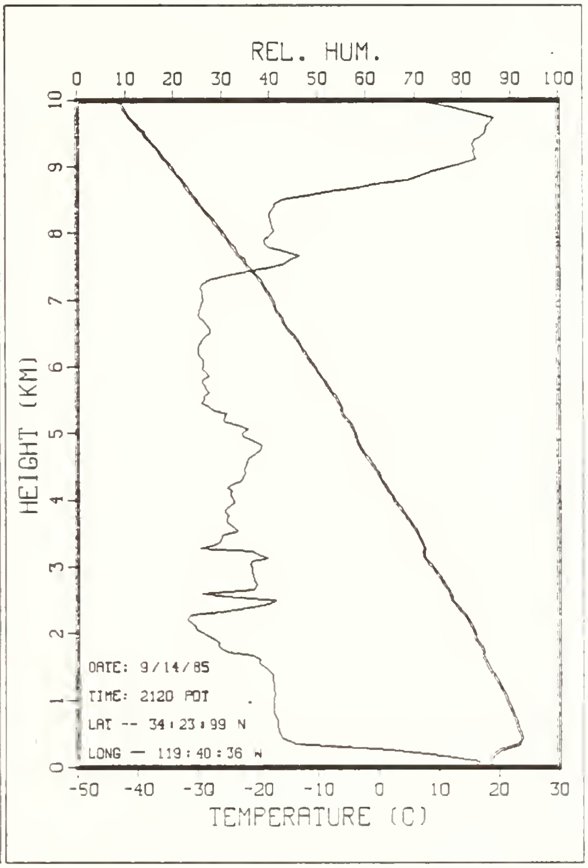

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/10/85
TIME: 1122 PDT
LAT -- 34:23:99 N
LONG — 119:40:33 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

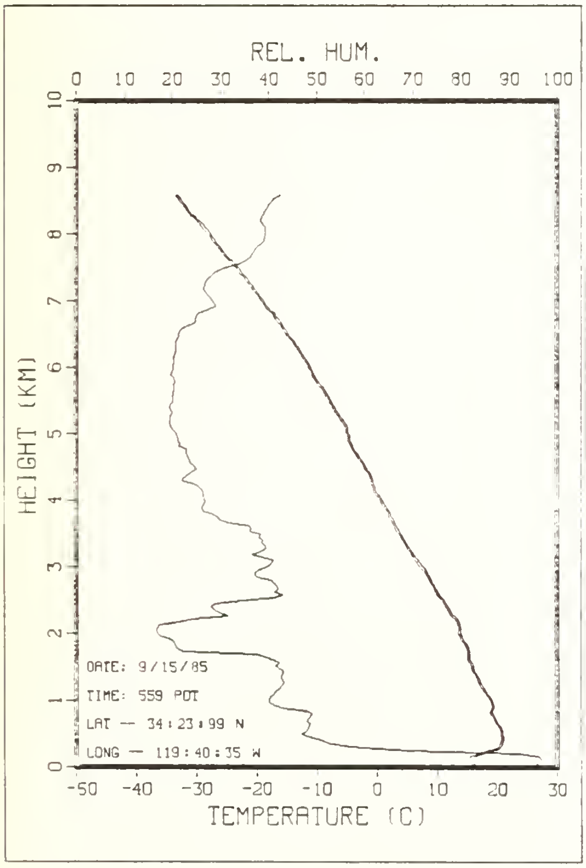

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/11/85
TIME: 1107 PDT
LAT -- 34:6:39 N
LONG — 119:16:34 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

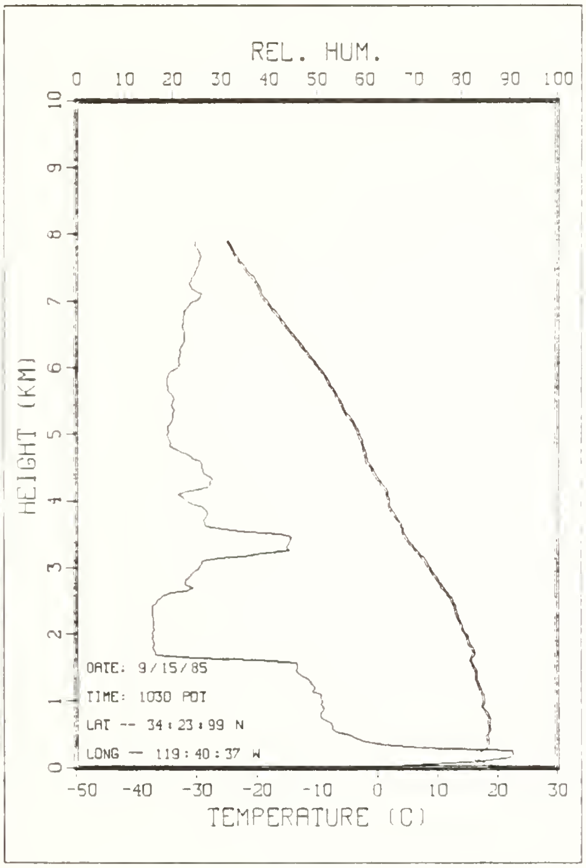

REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/12/85
TIME: 1201 PDT
LAT -- 34:8:19 N
LONG — 119:12:40 W
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/12/85
TIME: 2207 PDT
LAT -- 34:22:39 N
LONG — 120:8:6 W
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/13/85
TIME: 500 PDT
LONG — 120:43:23 W
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/13/85
TIME: 1024 PDT
LAT -- 34:29:19 N
LONG — 120:40:56 W

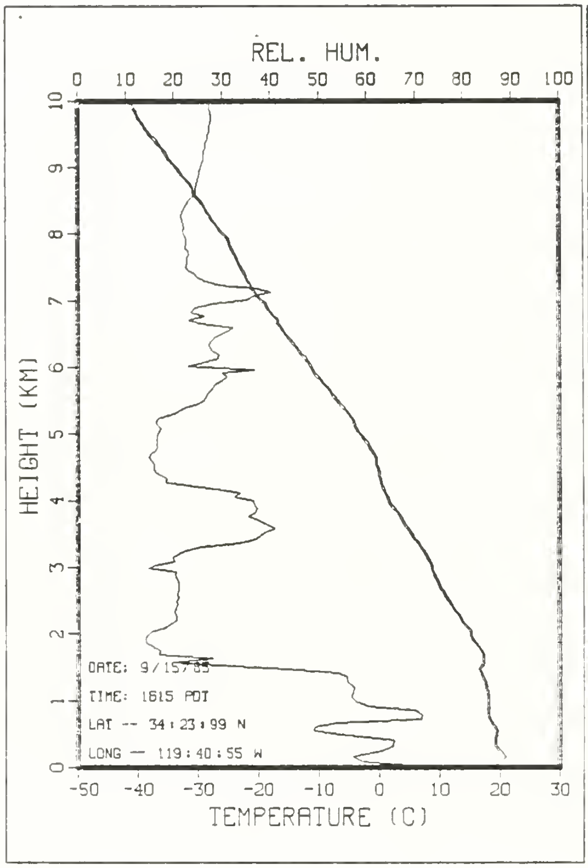

REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 8/13/85
TIME: 1556 PDT
LAT -- 34:22:9 N
LONG -- 120:18:99 W
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/12/85
TIME: 2129 PDT
LAT -- 34:25:9 N
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/14/85
TIME: 448 PDT
LAT -- 34:20:29 N
LONG -- 120:3:36 W
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/14/85
TIME: 1023 PDT
LAT -- 34:21:9 N
LONG -- 120:1:28 W


REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/14/85
TIME: 1633 PDT
LAT — 34:23:99 N
LONG — 119:40:33 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

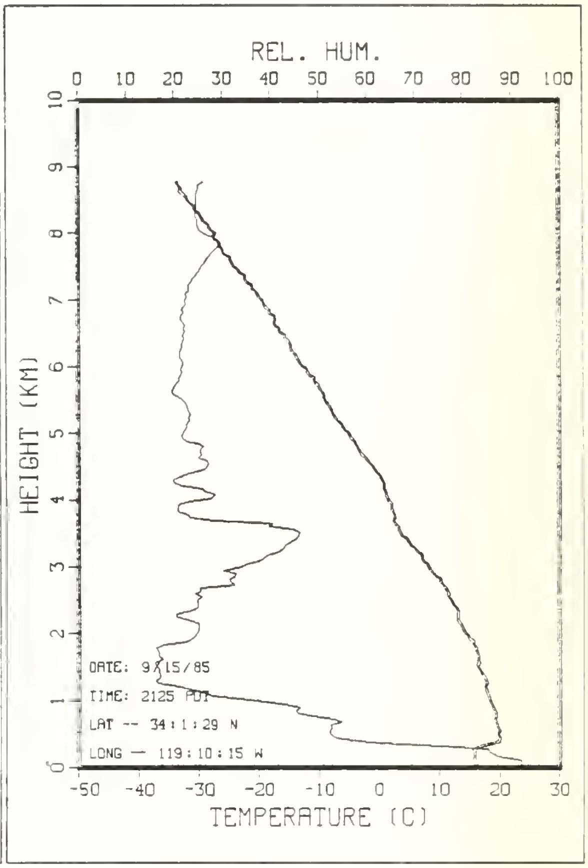

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/14/85
TIME: 2120 PDT
LAT -- 34:23:99 N
LONG — 119:40:36 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)


REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/15/85
TIME: 559 PDT
LAT -- 34:23:99 N
LONG — 119:40:35 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

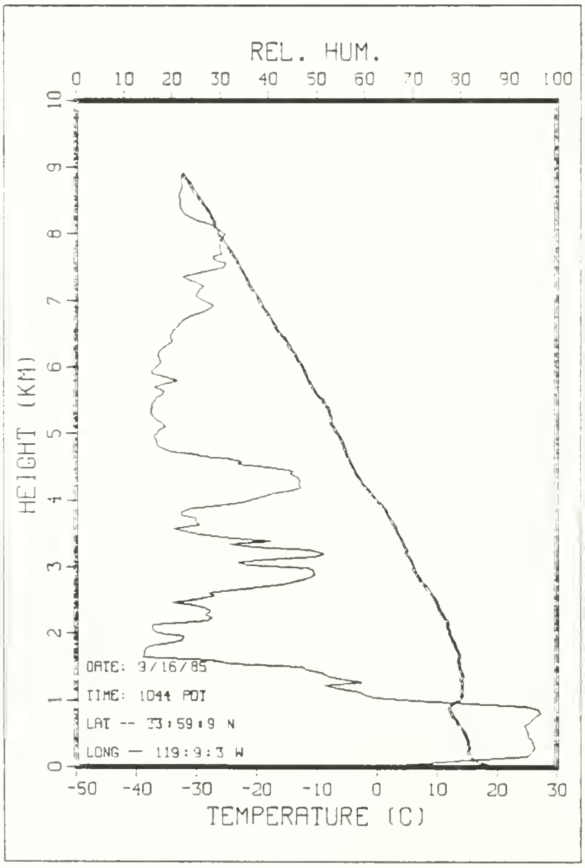

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/15/85
TIME: 1030 PDT
LAT -- 34:23:99 N
LONG — 119:40:37 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)



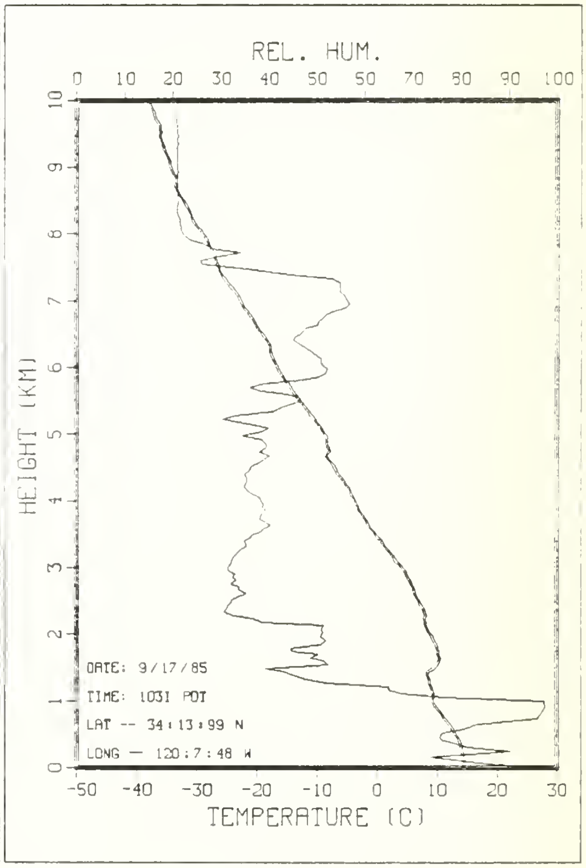
REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/15/85
TIME: 1615 PDT
LAT -- 34:23:99 N
LONG — 119:40:55 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)



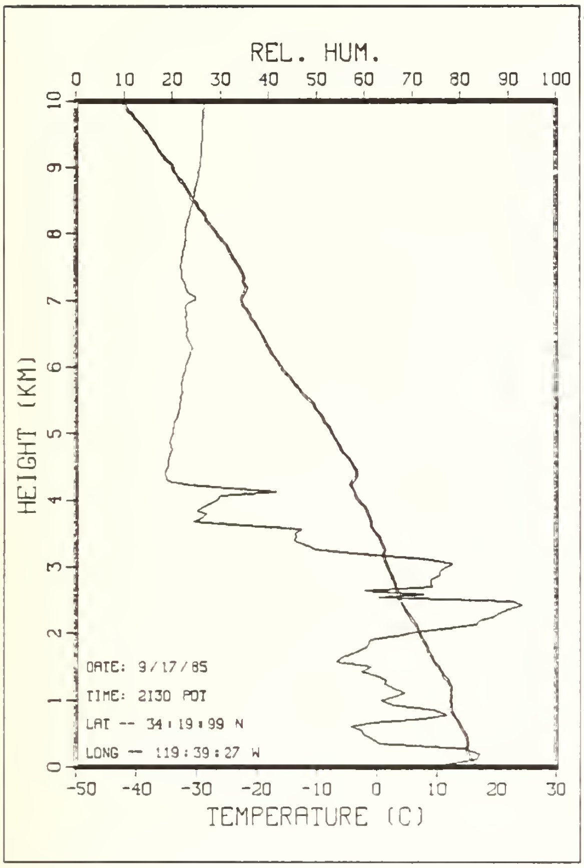
REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/15/85
TIME: 2125 PDT
LAT -- 34:1:29 N
LONG — 119:10:15 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

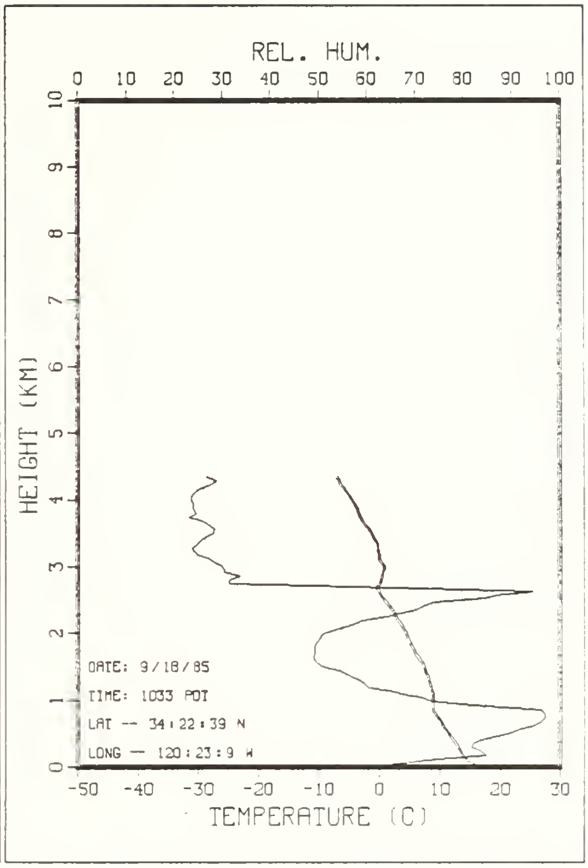


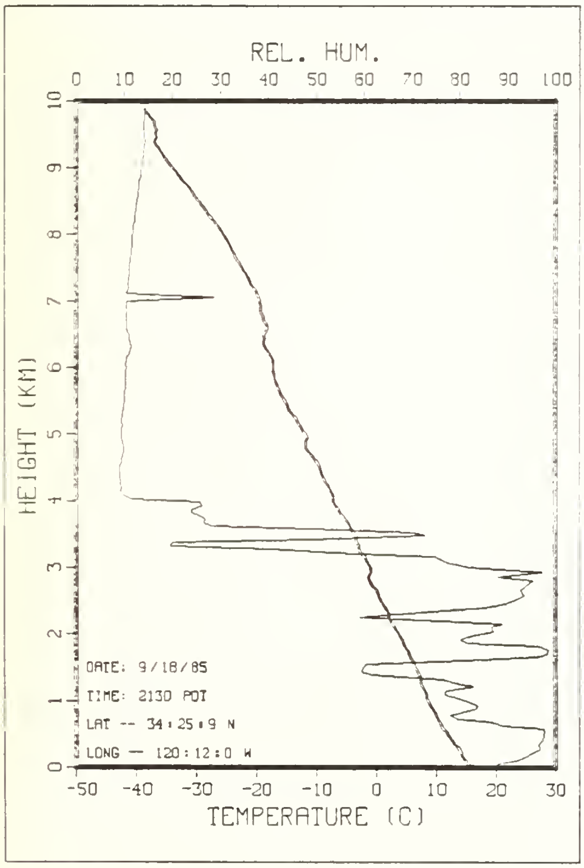
REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/16/85
TIME: 1044 PDT
LAT -- 33:59:9 N
LONG — 119:9:3 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

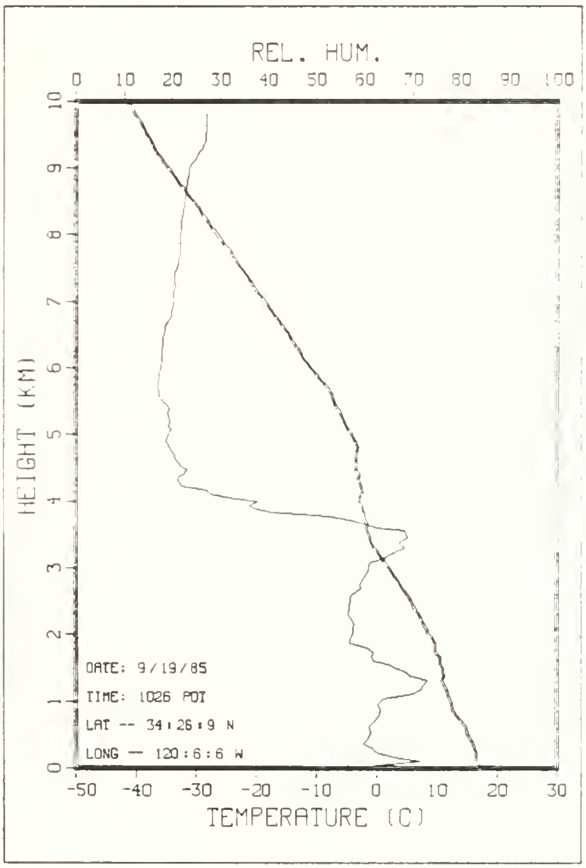


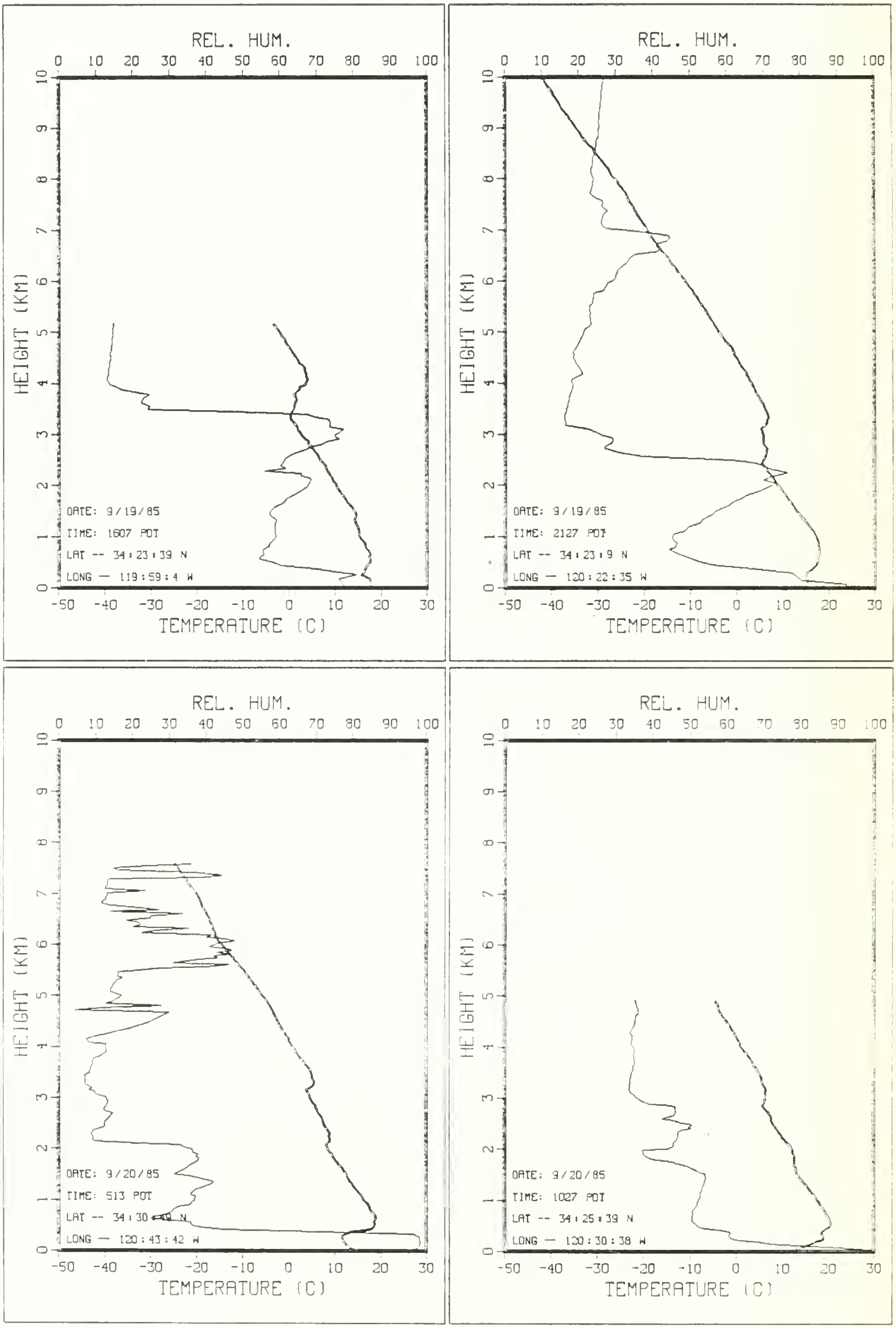
REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/17/85
TIME: 1031 PDT
LAT -- 34:13:99 N
LONG — 120:7:48 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

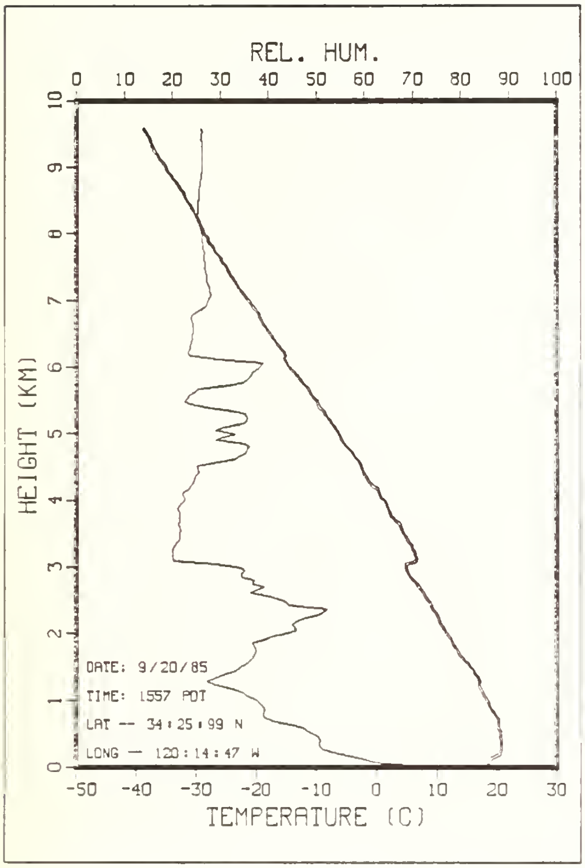

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/17/85
TIME: 2130 PDT
LAT -- 34:19:99 N
LONG — 119:39:27 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

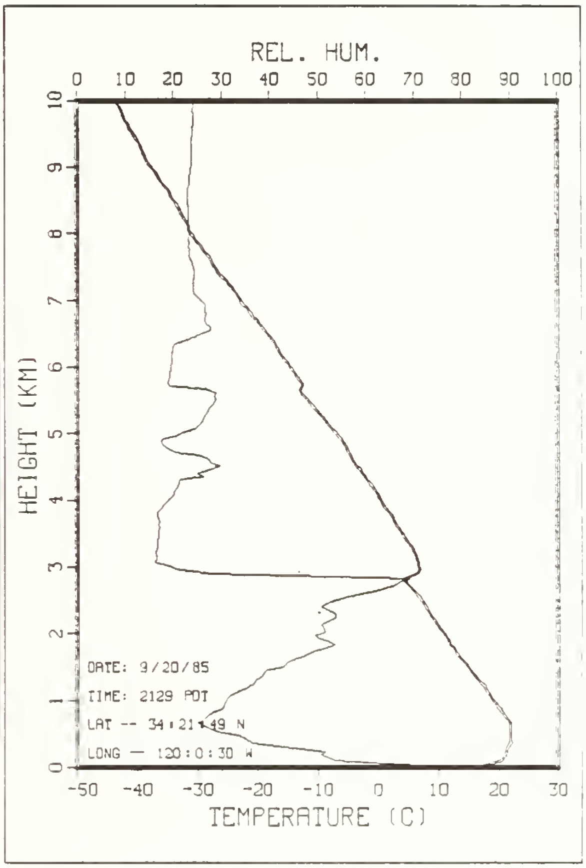

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/18/85
TIME: 1033 PDT
LAT -- 34:22:39 N
LONG — 120:23:9 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

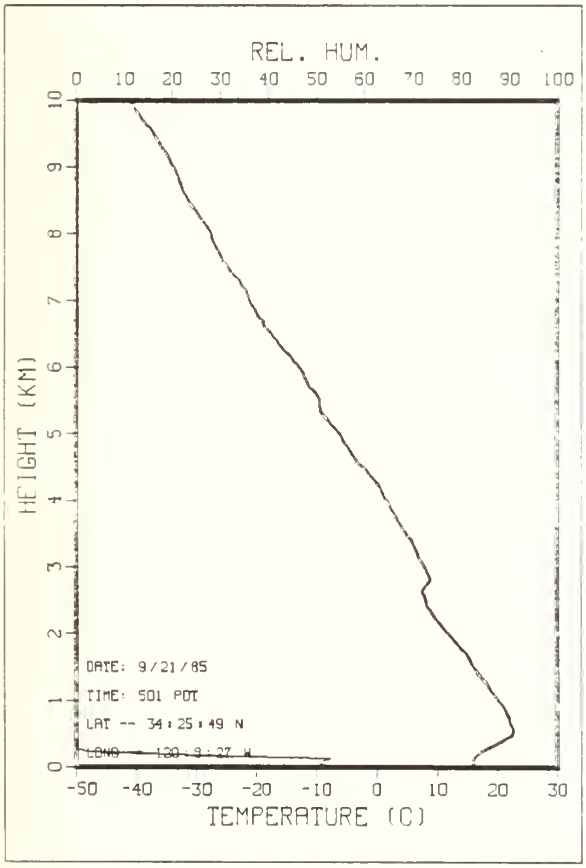

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/18/85
TIME: 2130 PDT
LAT -- 34:25:9 N
LONG — 120:12:0 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

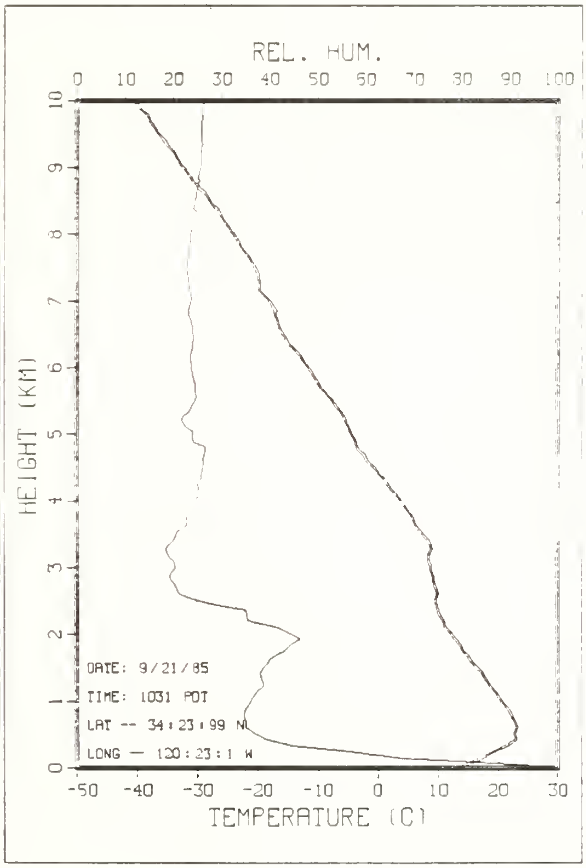

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/19/85
TIME: 1026 PDT
LAT -- 34:26:9 N
LONG — 120:6:6 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

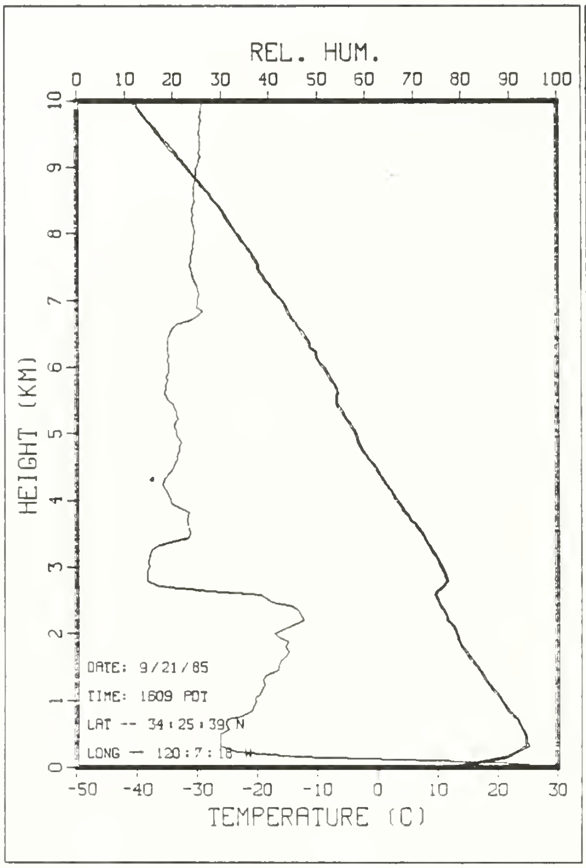

REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/19/85
TIME: 1607 PDT
LAT -- 34:23:39 N
LONG — 119:59:4 W
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/19/85
TIME: 2127 PDT
LAT -- 34:23:9 N
LONG — 120:22:35 W
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/20/85
TIME: 513 PDT
LONG — 120:43:42 W
REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/20/85
TIME: 1027 PDT
LAT -- 34:25:39 N
LONG — 120:30:38 W

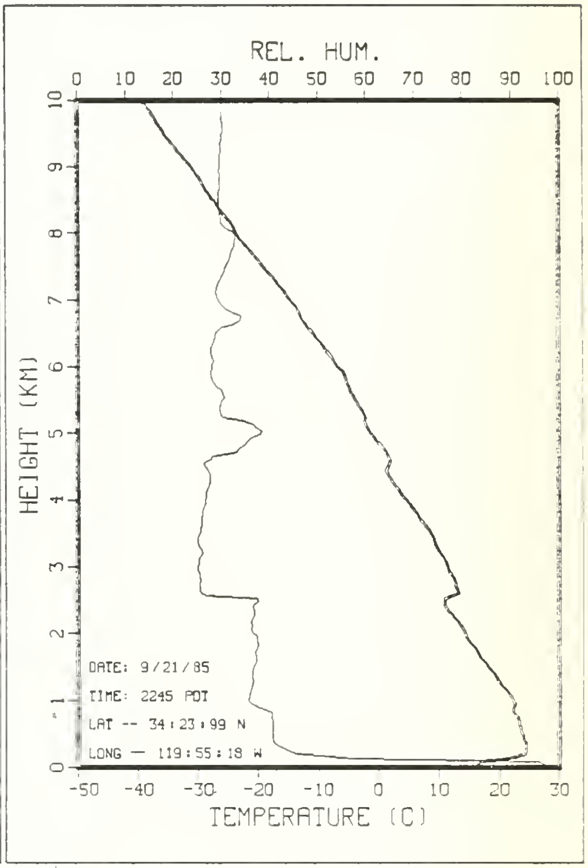

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/20/85
TIME: 1557 PDT
LAT -- 34 : 25 : 99 N
LONG — 120 : 14 : 47 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

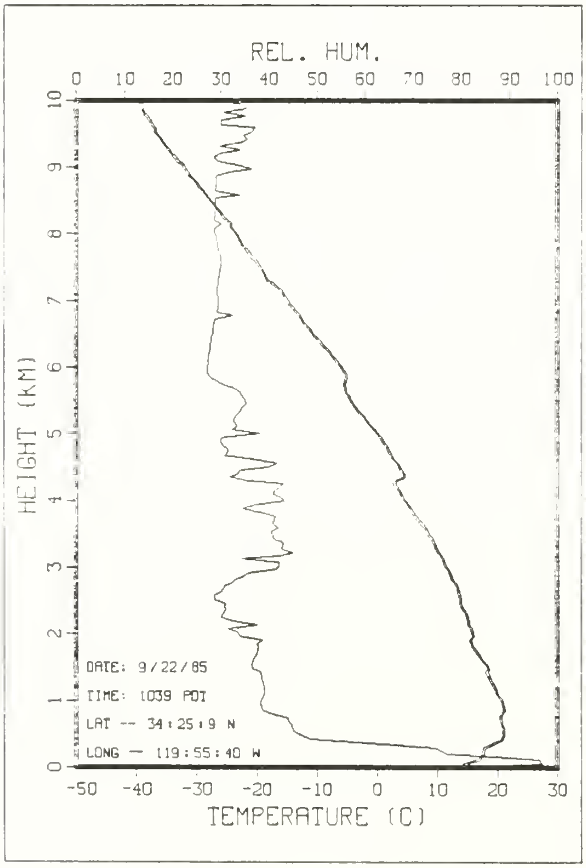

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/20/85
TIME: 2129 PDT
LAT -- 34 : 21 : 49 N
LONG — 120 : 0 : 30 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

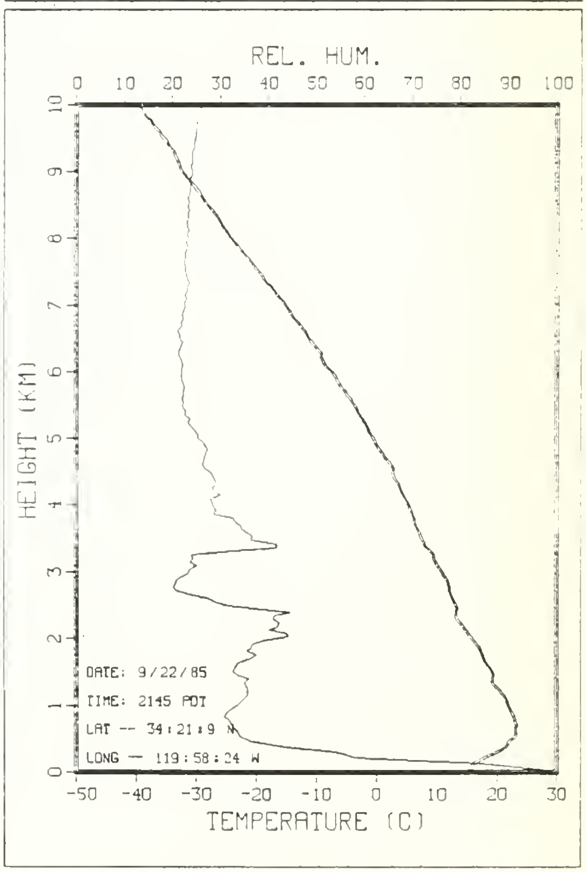

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/21/85
TIME: 501 PDT
LAT -- 34 : 25 : 49 N
LONG — 120 : 9 : 27 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

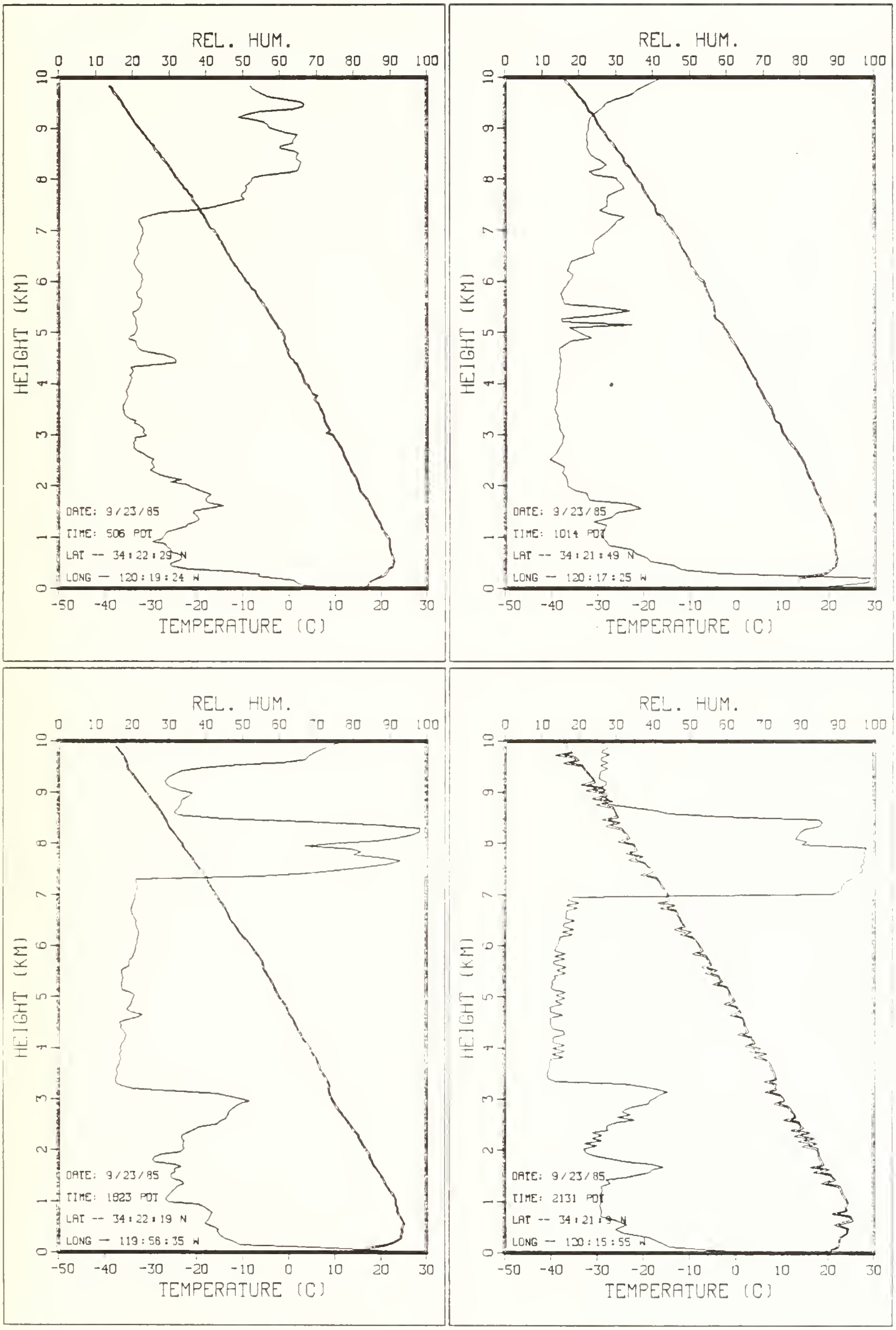

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/21/85
TIME: 1031 PDT
LAT -- 34 : 23 : 99 N
LONG — 120 : 23 : 1 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

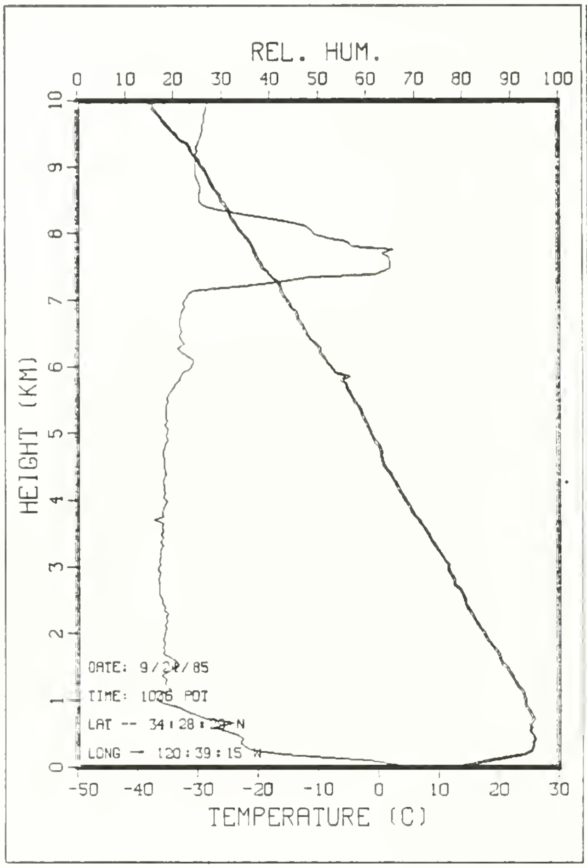
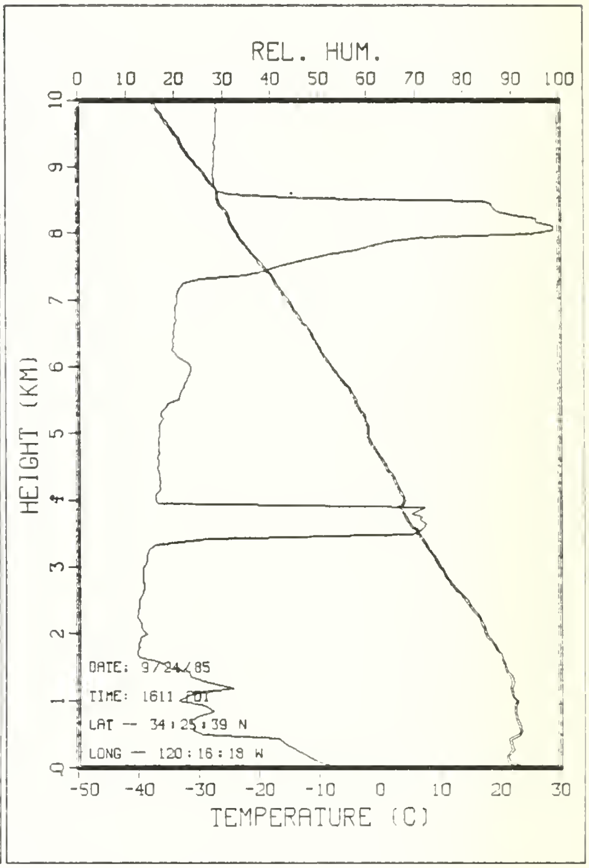
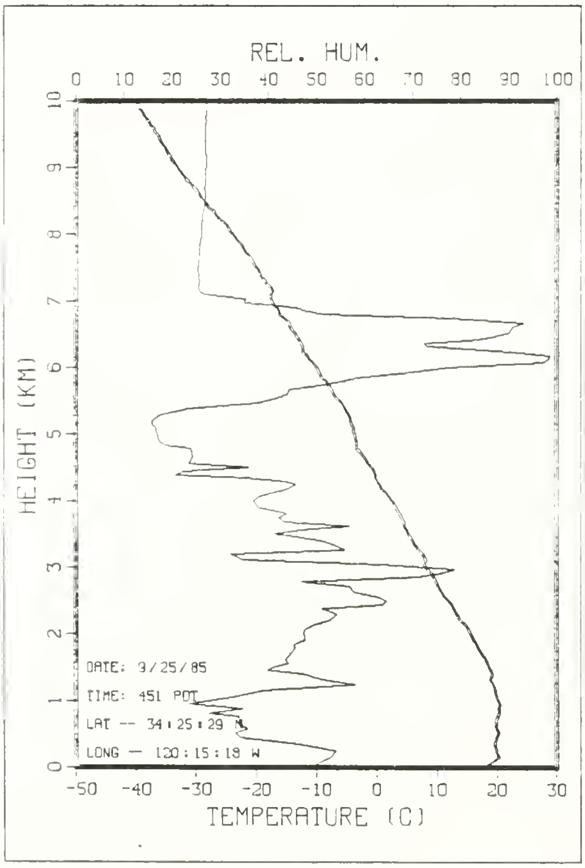
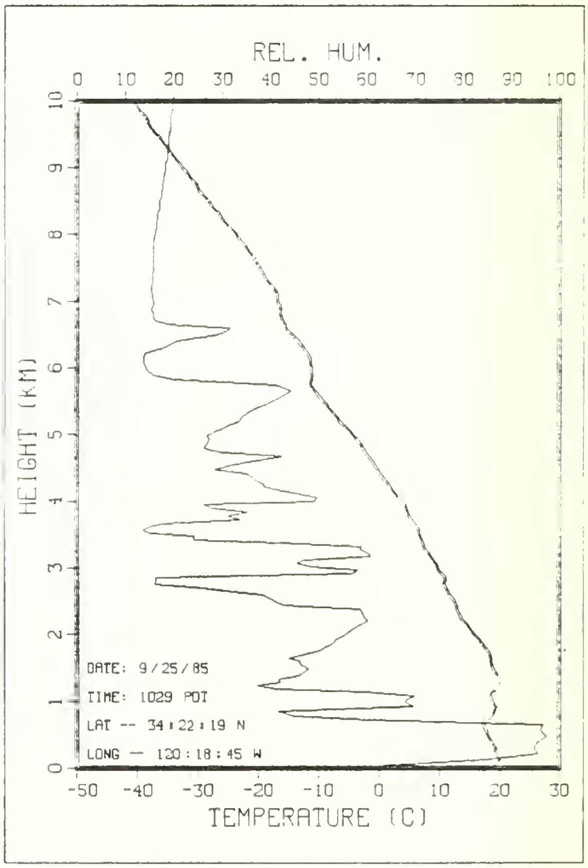

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/21/85
TIME: 1609 PDT
LAT -- 34:25:39 N
LONG — 120:7:18 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

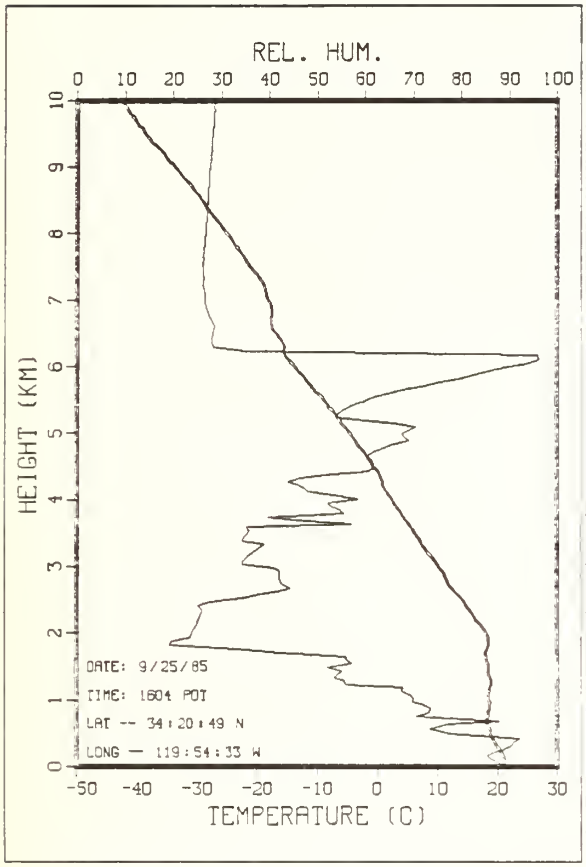

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/21/85
TIME: 2245 PDT
LAT -- 34:23:99 N
LONG — 119:55:18 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

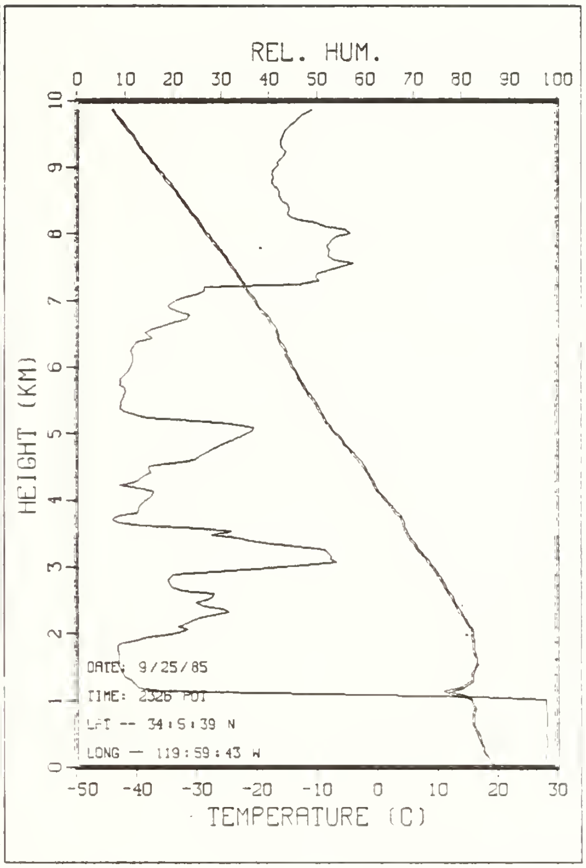

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/22/85
TIME: 1039 PDT
LAT -- 34:25:9 N
LONG — 119:55:40 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)


REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/22/85
TIME: 2145 PDT
LAT -- 34:21:9 N
LONG — 119:58:24 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)


REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/23/85
TIME: 506 PDT
LAT -- 34:22:29 N
LONG -- 120:19:24 W
DATE: 9/23/85
TIME: 1014 PDT
LAT -- 34:21:49 N
LONG -- 120:17:25 W
DATE: 9/23/85
TIME: 1823 PDT
LAT -- 34:22:19 N
LONG -- 119:56:35 W
DATE: 9/23/85
TIME: 2131 PDT
LONG -- 120:15:55 W

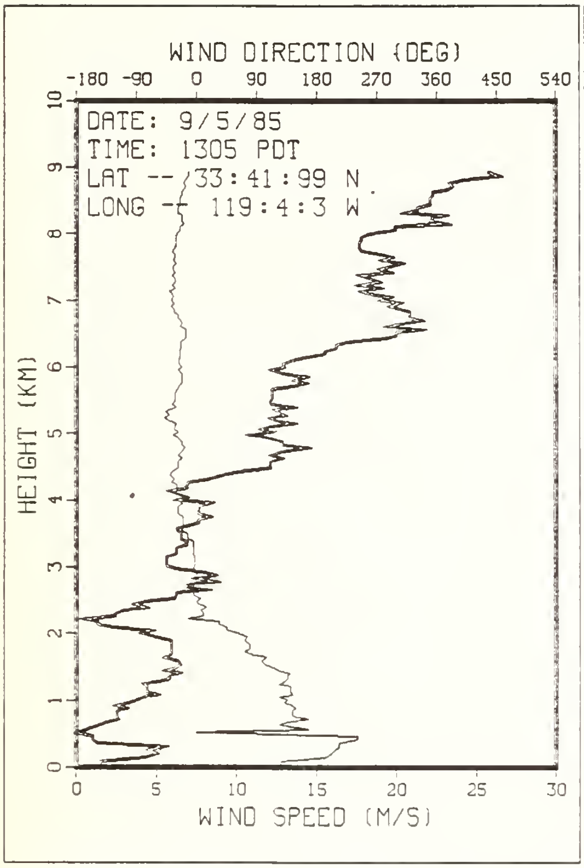

REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
TIME: 1036 PDT
LONG — 120:39:15 W

REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/24/85
TIME: 1611 PDT
LAT -- 34:25:39 N
LONG — 120:16:18 W

REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/25/85
TIME: 451 PDT
LAT -- 34:25:29 N
LONG — 120:15:18 W

REL. HUM.
HEIGHT (KM)
TEMPERATURE (C)
DATE: 9/25/85
TIME: 1029 PDT
LAT -- 34:22:19 N
LONG — 120:18:45 W

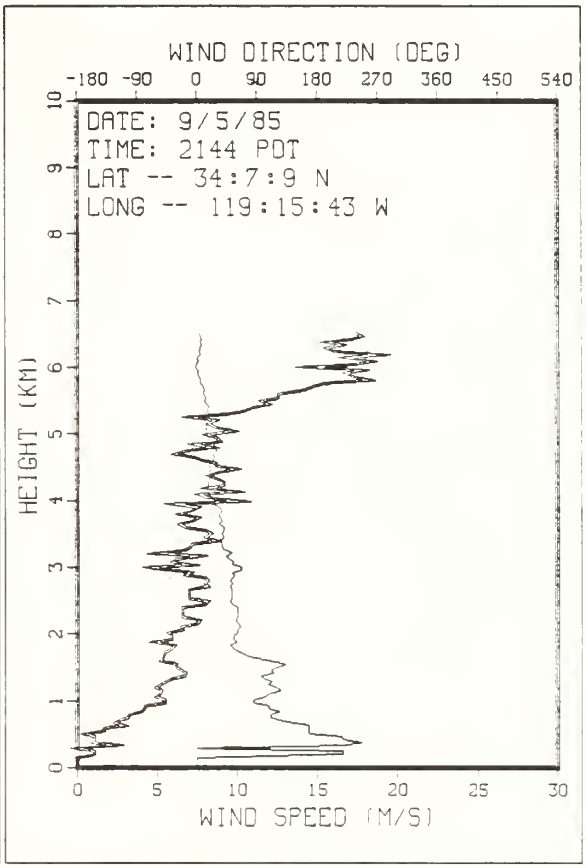

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/25/85
TIME: 1604 PDT
LAT -- 34:20:49 N
LONG — 119:54:33 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

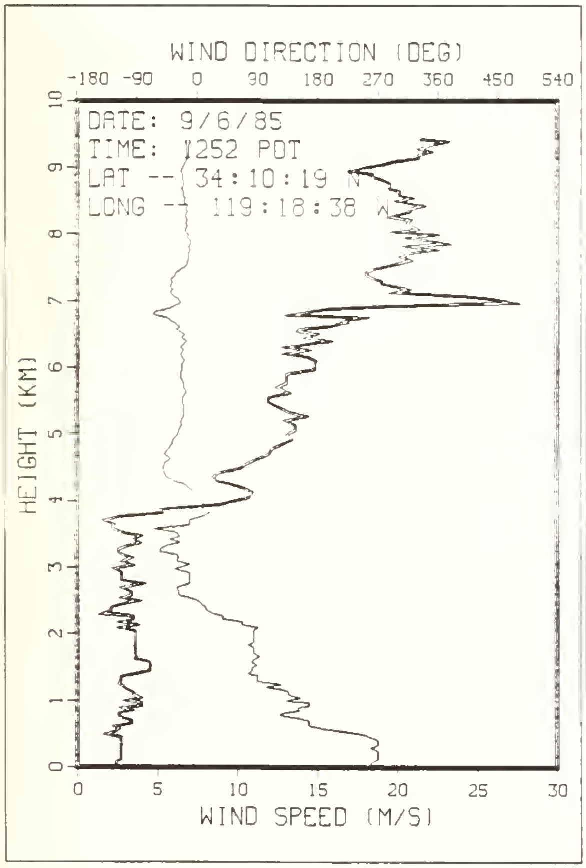

REL. HUM.
0 10 20 30 40 50 60 70 80 90 100
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
DATE: 9/25/85
TIME: 2326 PDT
LAT -- 34:5:39 N
LONG — 119:59:43 W
-50 -40 -30 -20 -10 0 10 20 30
TEMPERATURE (C)

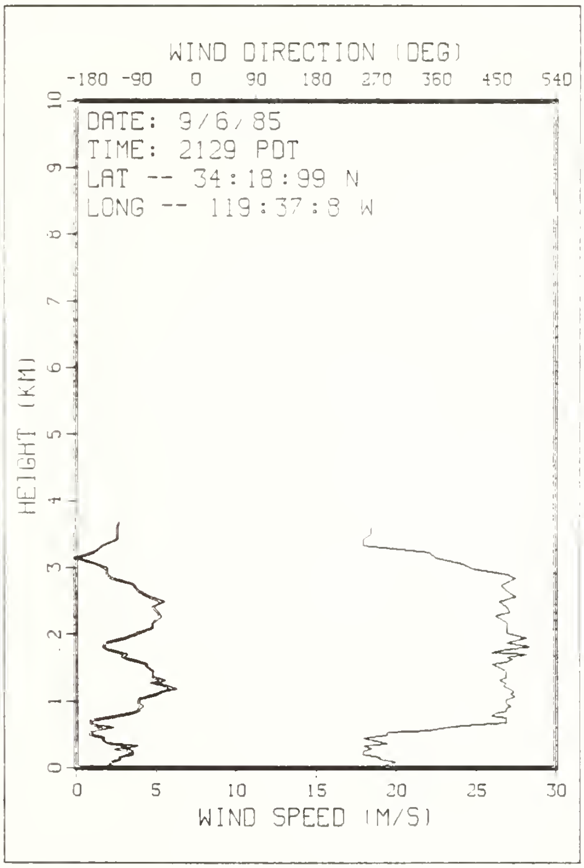
E.2 Dynamic Profiles

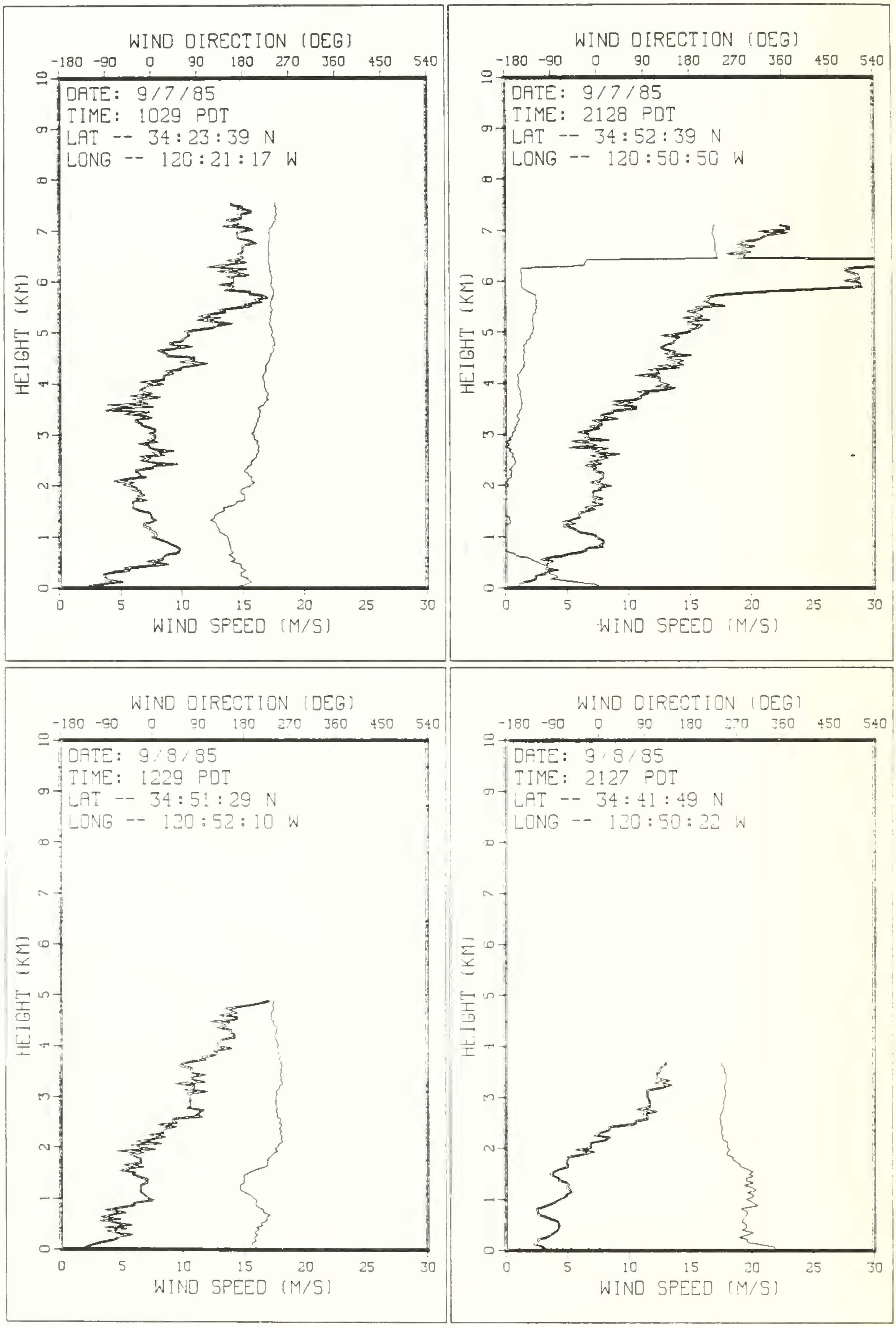
The following plots show wind speed (heavy solid line) and direction derived from LORAN-C tracking of the rawinsondes launched during SCCCAMP. There is a one-to-one correspondence between these plots and the thermodynamic plots shown in section E.1. Each plot is labeled individually with date, time, and launch position.

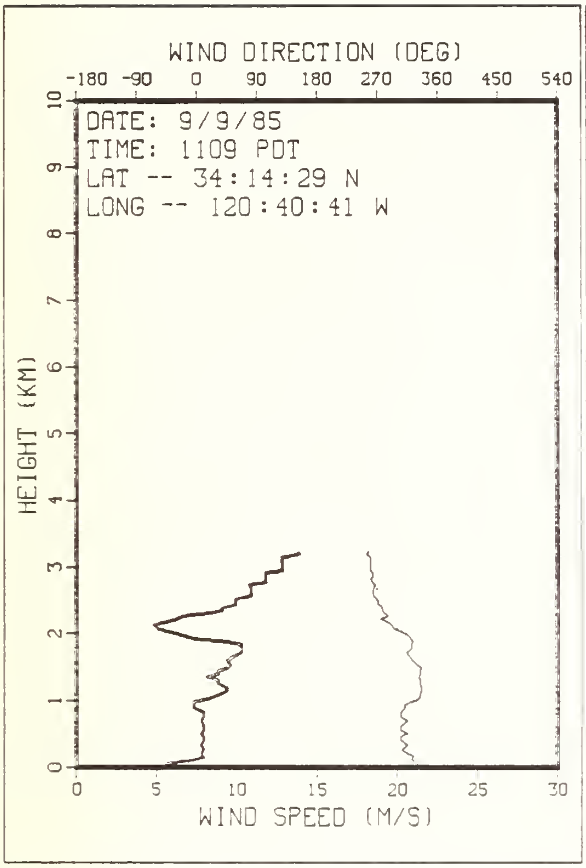

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/5/85
TIME: 1305 PDT
LAT -- 33:41:99 N
LONG -- 119:4:3 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

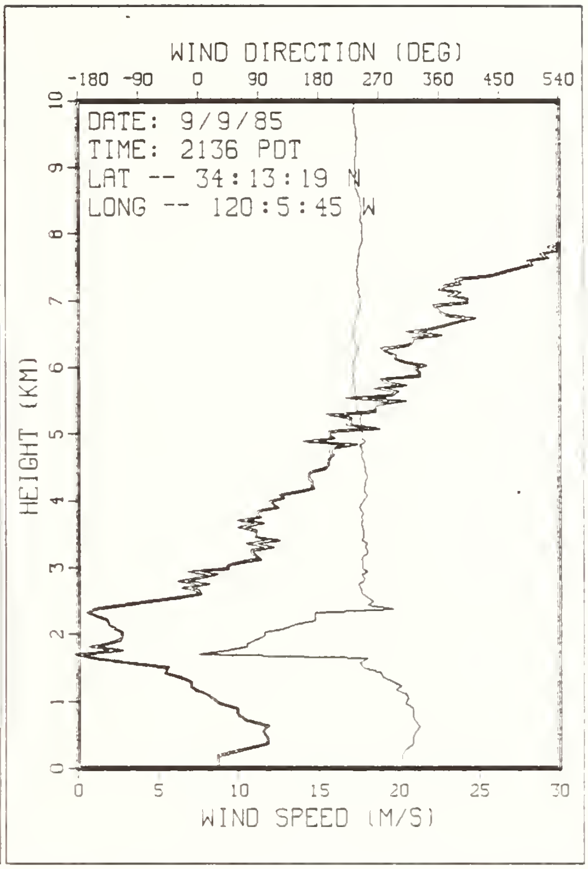

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/5/85
TIME: 2144 PDT
LAT -- 34:7:9 N
LONG -- 119:15:43 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

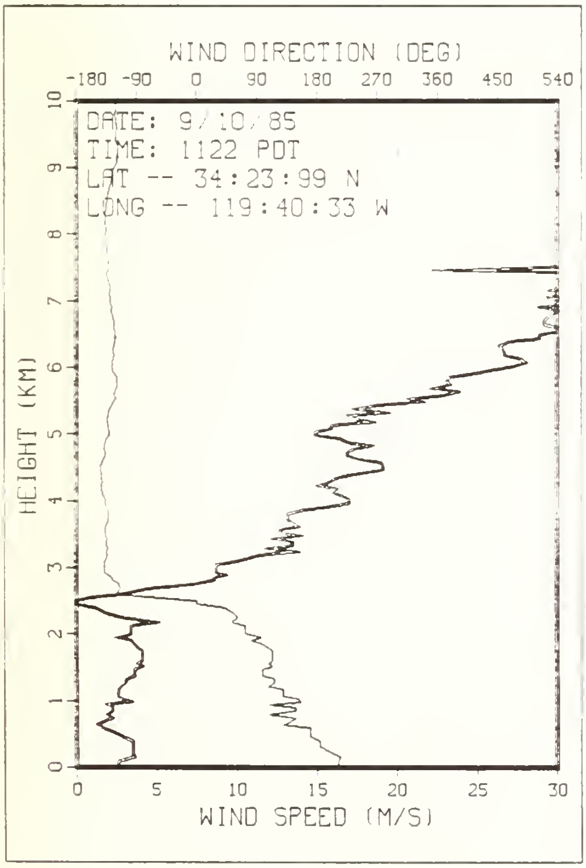

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/6/85
TIME: 1252 PDT
LAT -- 34:10:19 N
LONG -- 119:18:38 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

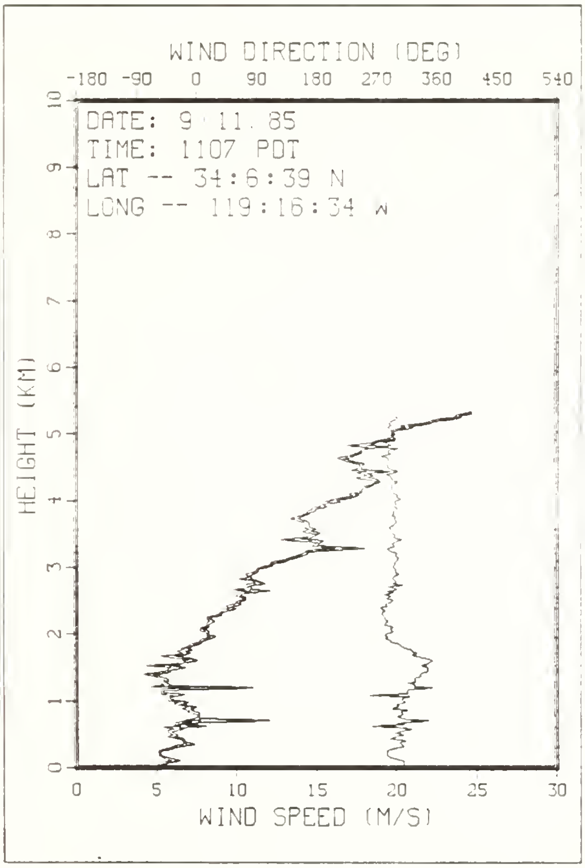

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/6/85
TIME: 2129 PDT
LAT -- 34:18:99 N
LONG -- 119:37:8 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

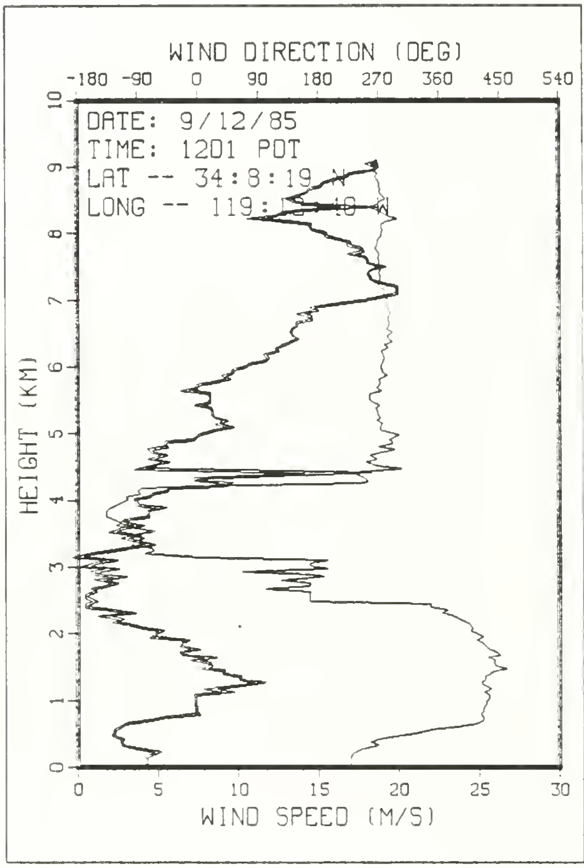

WIND DIRECTION (DEG)
DATE: 9/7/85
TIME: 1029 PDT
LAT -- 34:23:39 N
LONG -- 120:21:17 W
HEIGHT (KM)
WIND SPEED (M/S)
WIND DIRECTION (DEG)
DATE: 9/7/85
TIME: 2128 PDT
LAT -- 34:52:39 N
LONG -- 120:50:50 W
HEIGHT (KM)
WIND SPEED (M/S)
WIND DIRECTION (DEG)
DATE: 9/8/85
TIME: 1229 PDT
LAT -- 34:51:29 N
LONG -- 120:52:10 W
HEIGHT (KM)
WIND SPEED (M/S)
WIND DIRECTION (DEG)
DATE: 9/8/85
TIME: 2127 PDT
LAT -- 34:41:49 N
LONG -- 120:50:22 W
HEIGHT (KM)
WIND SPEED (M/S)

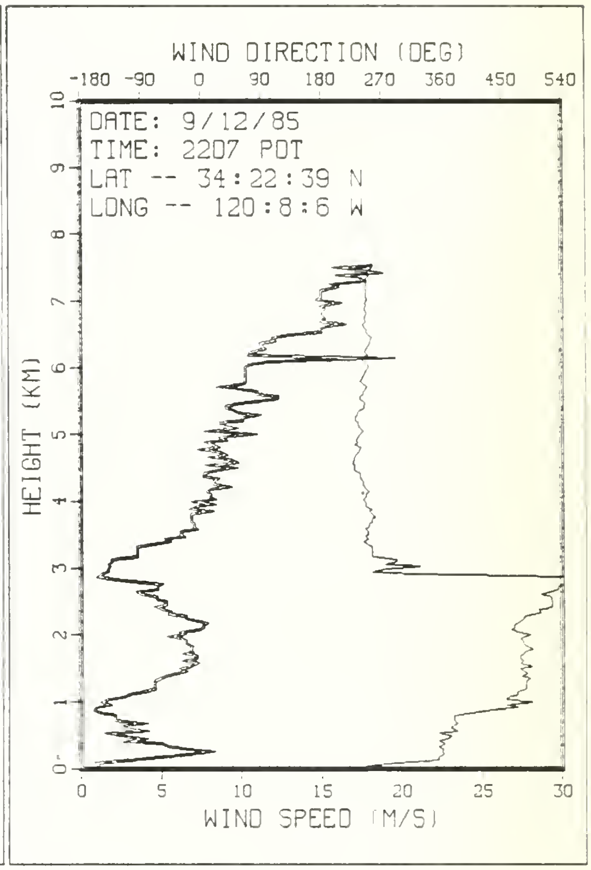

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/9/85
TIME: 1109 PDT
LAT -- 34:14:29 N
LONG -- 120:40:41 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

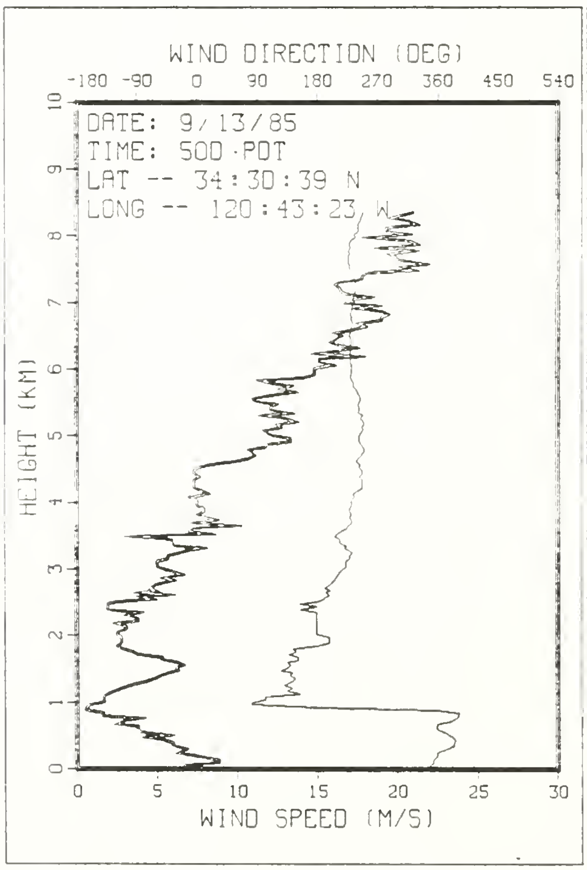

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/9/85
TIME: 2136 PDT
LAT -- 34:13:19 N
LONG -- 120:5:45 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

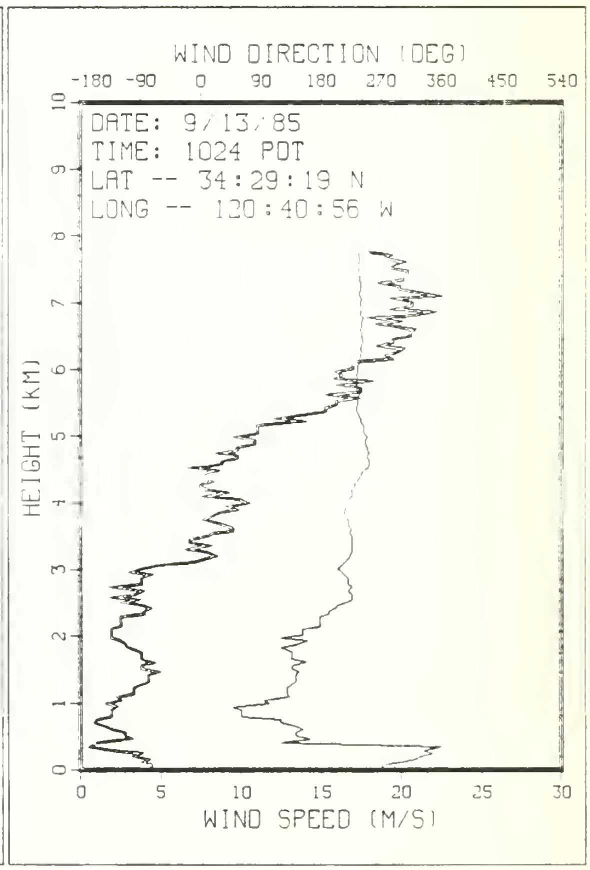

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/10/85
TIME: 1122 PDT
LAT -- 34:23:99 N
LONG -- 119:40:33 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

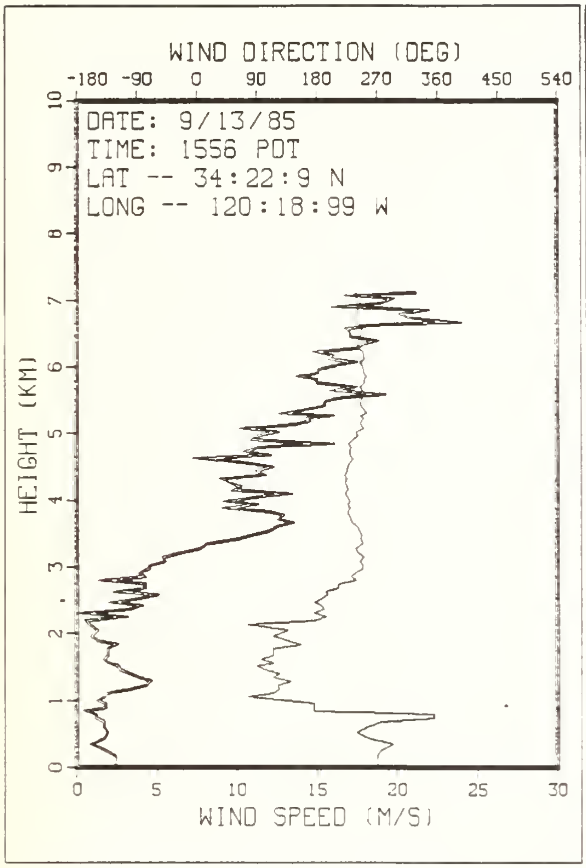

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/11/85
TIME: 1107 PDT
LAT -- 34:6:39 N
LONG -- 119:16:34 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

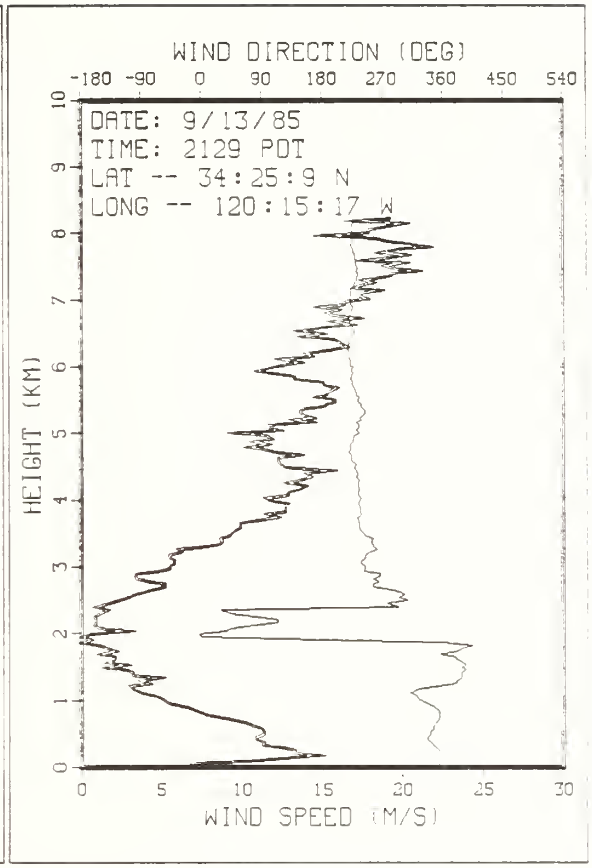

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/12/85
TIME: 1201 PDT
LAT -- 34:8:19 N
LONG -- 119:
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

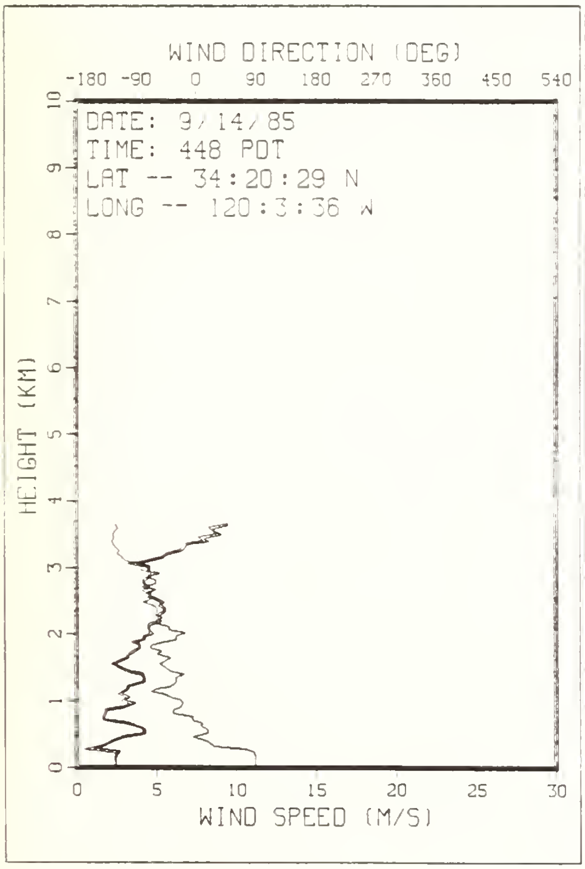

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/12/85
TIME: 2207 PDT
LAT -- 34:22:39 N
LONG -- 120:8:6 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

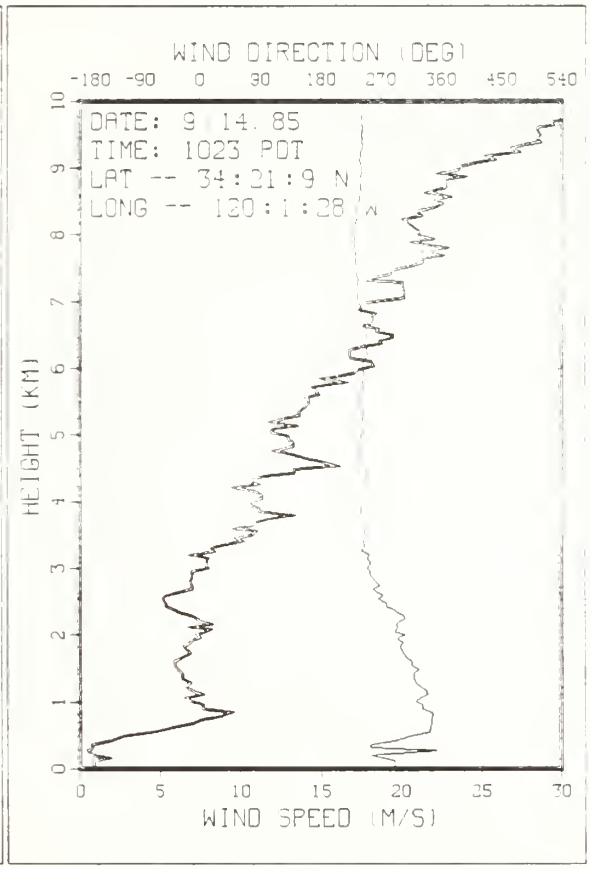

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/13/85
TIME: 500 PDT
LAT -- 34:30:39 N
LONG -- 120:43:23 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

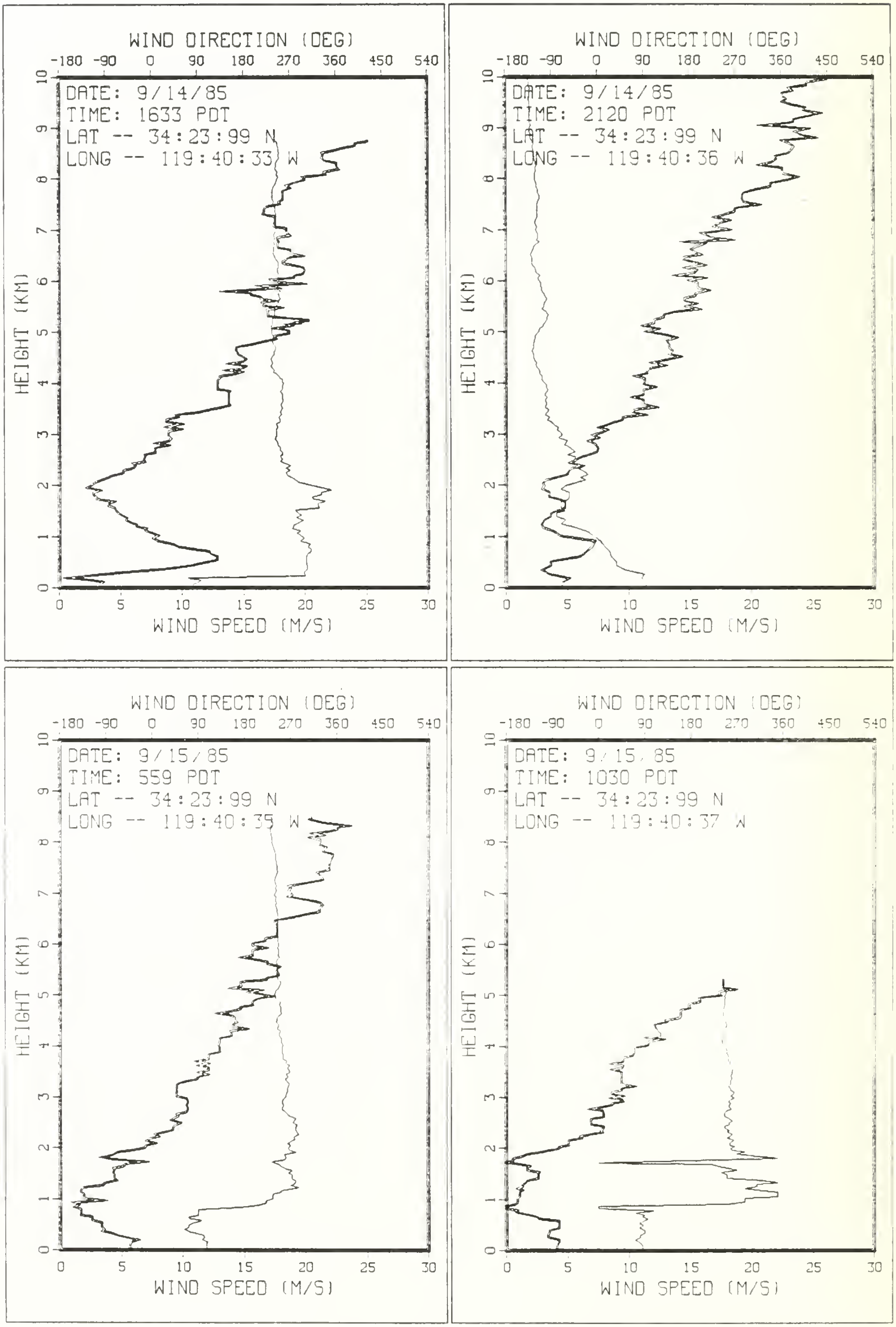

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/13/85
TIME: 1024 PDT
LAT -- 34:29:19 N
LONG -- 120:40:56 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

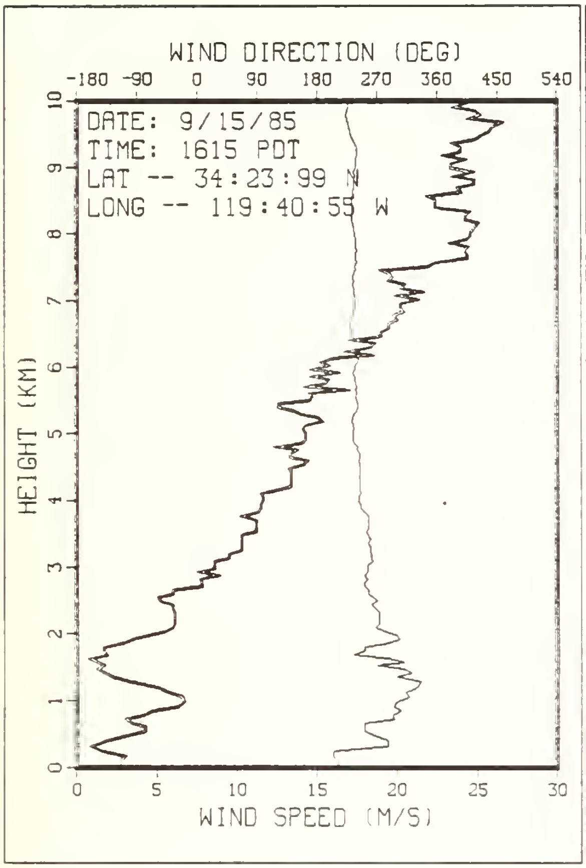

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/13/85
TIME: 1556 PDT
LAT -- 34:22:9 N
LONG -- 120:18:99 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

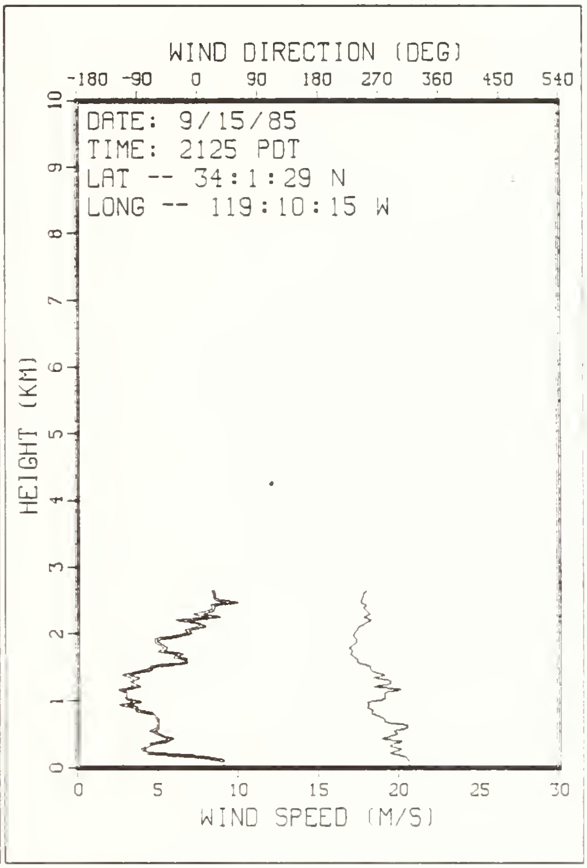

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/13/85
TIME: 2129 PDT
LAT -- 34:25:9 N
LONG -- 120:15:17 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

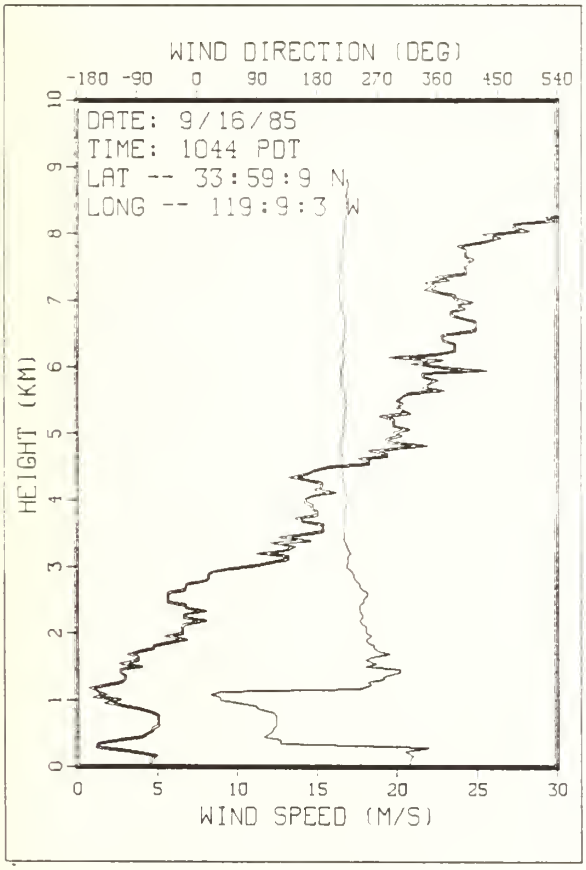

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/14/85
TIME: 448 PDT
LAT -- 34:20:29 N
LONG -- 120:3:36 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

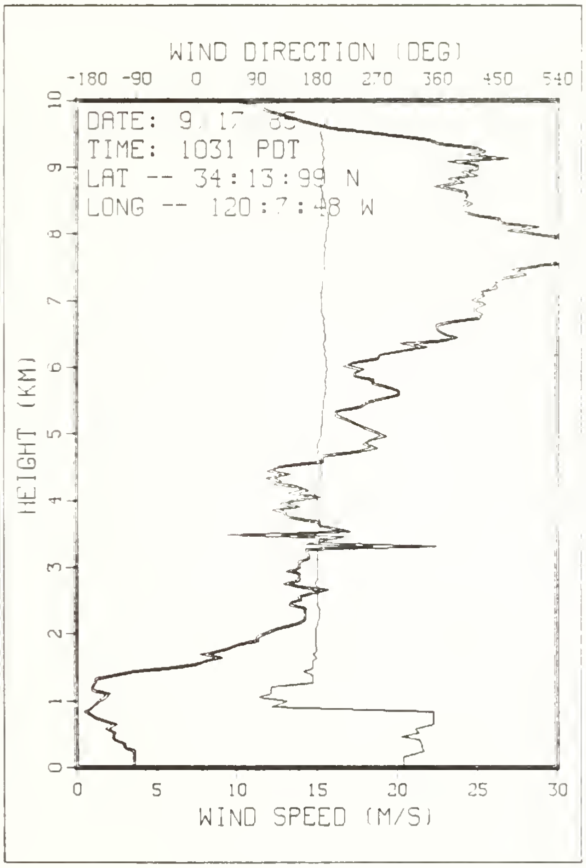

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/14/85
TIME: 1023 PDT
LAT -- 34:21:9 N
LONG -- 120:1:28 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

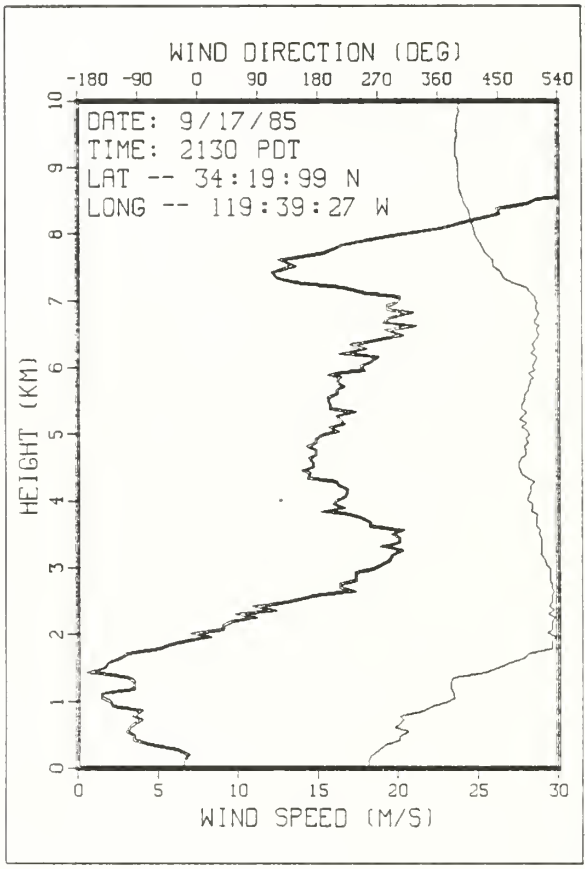

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
HEIGHT (KM)
WIND SPEED (M/S)
DATE: 9/14/85
TIME: 1633 PDT
LAT -- 34:23:99 N
LONG -- 119:40:33 W
DATE: 9/14/85
TIME: 2120 PDT
LAT -- 34:23:99 N
LONG -- 119:40:36 W
DATE: 9/15/85
TIME: 559 PDT
LAT -- 34:23:99 N
LONG -- 119:40:35 W
DATE: 9/15/85
TIME: 1030 PDT
LAT -- 34:23:99 N
LONG -- 119:40:37 W

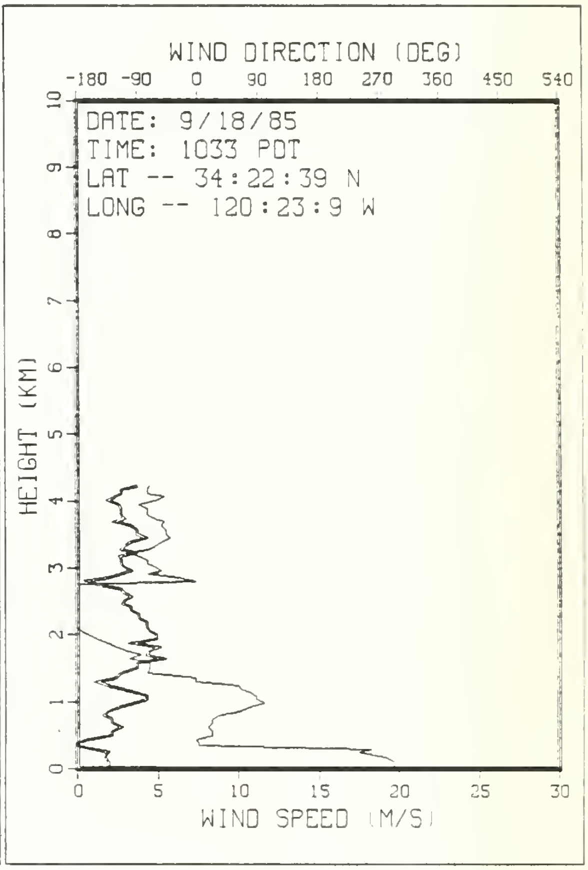

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/15/85
TIME: 1615 PDT
LAT -- 34:23:99 N
LONG -- 119:40:55 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

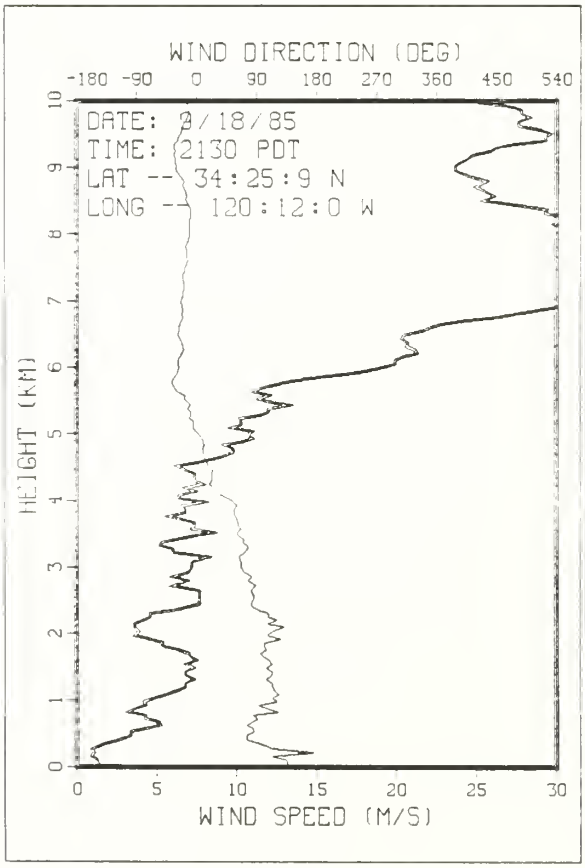

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/15/85
TIME: 2125 PDT
LAT -- 34:1:29 N
LONG -- 119:10:15 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

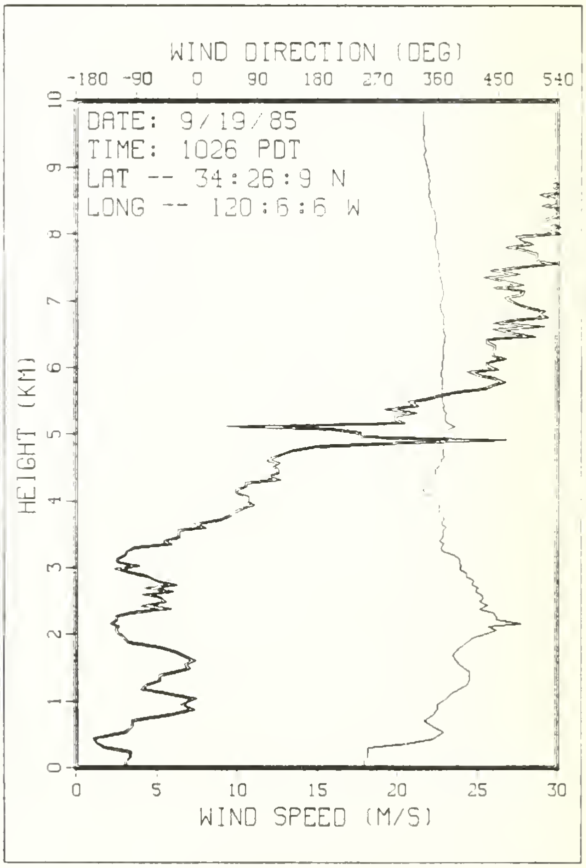

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/16/85
TIME: 1044 PDT
LAT -- 33:59:9 N
LONG -- 119:9:3 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

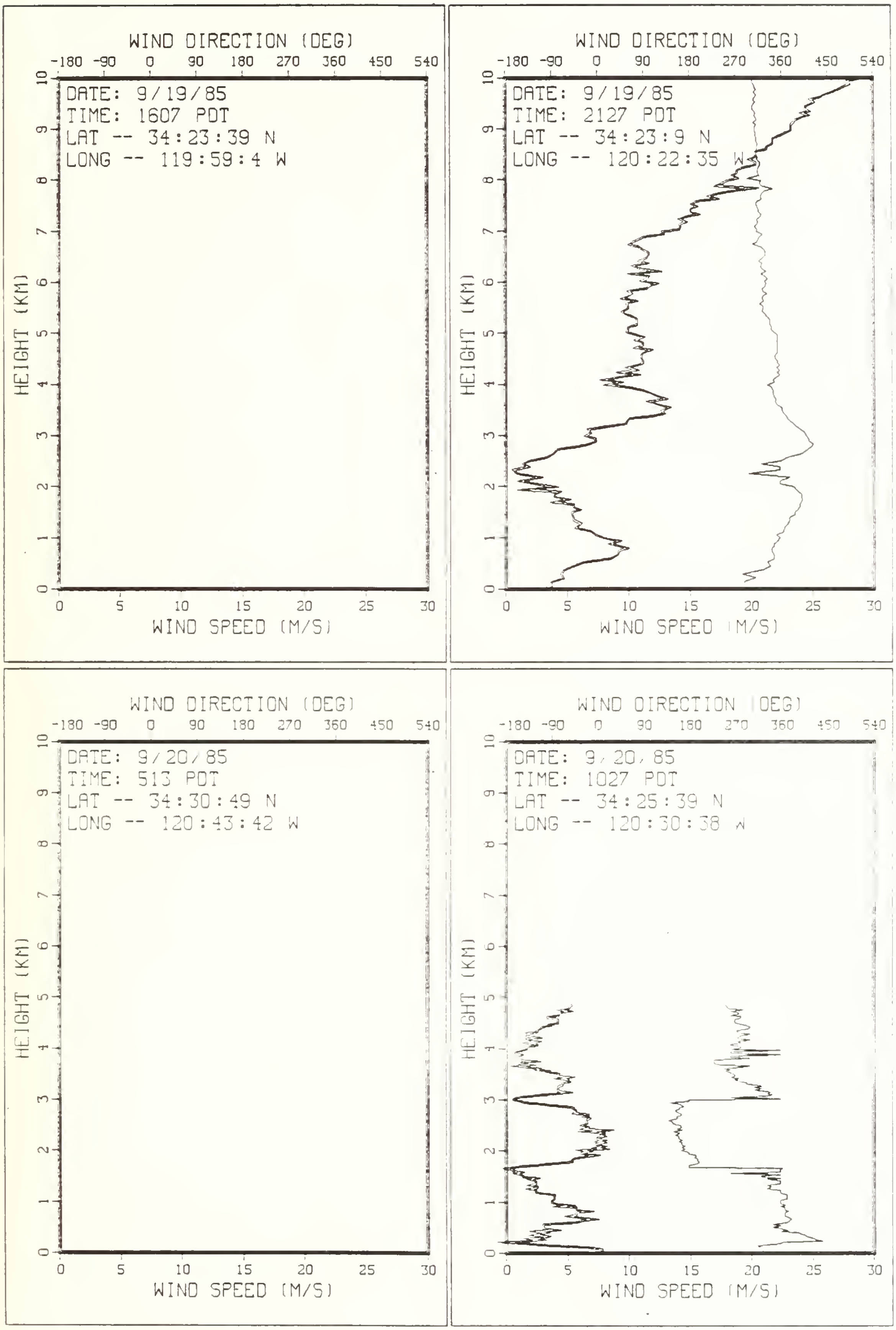

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9 17
TIME: 1031 PDT
LAT -- 34:13:99 N
LONG -- 120:7:48 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

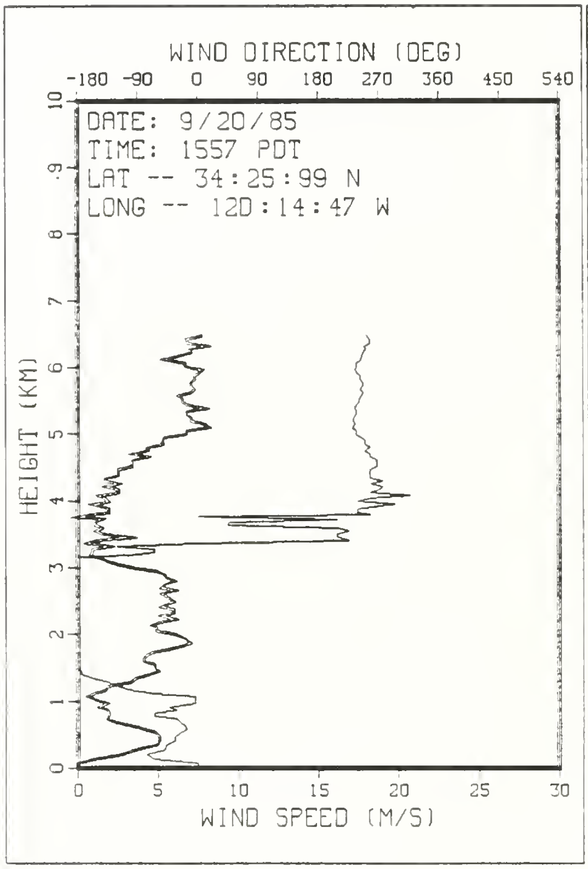

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/17/85
TIME: 2130 PDT
LAT -- 34:19:99 N
LONG -- 119:39:27 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

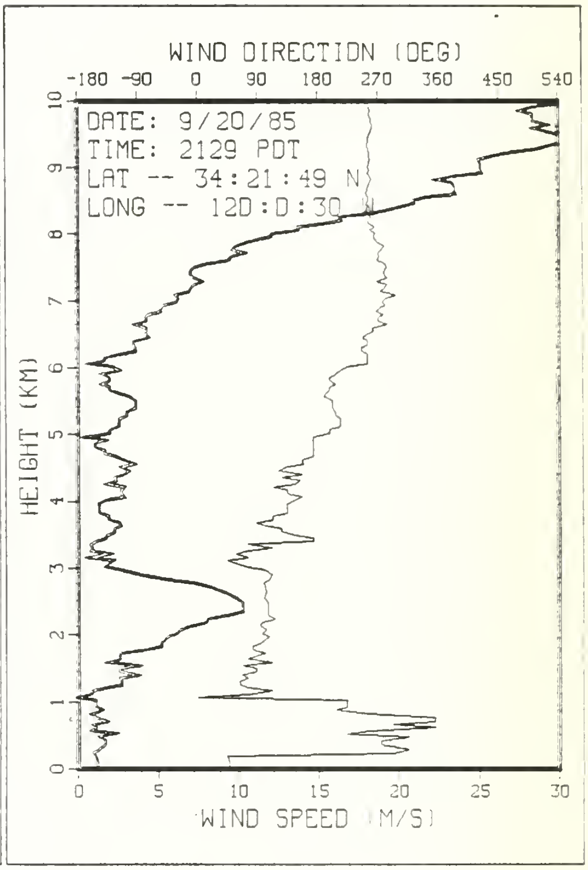

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/18/85
TIME: 1033 PDT
LAT -- 34:22:39 N
LONG -- 120:23:9 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

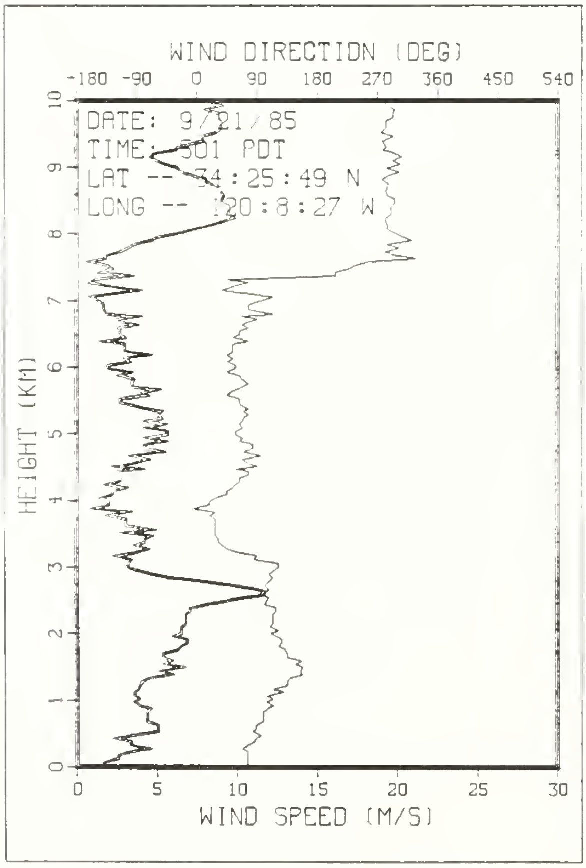

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/18/85
TIME: 2130 PDT
LAT -- 34:25:9 N
LONG -- 120:12:0 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

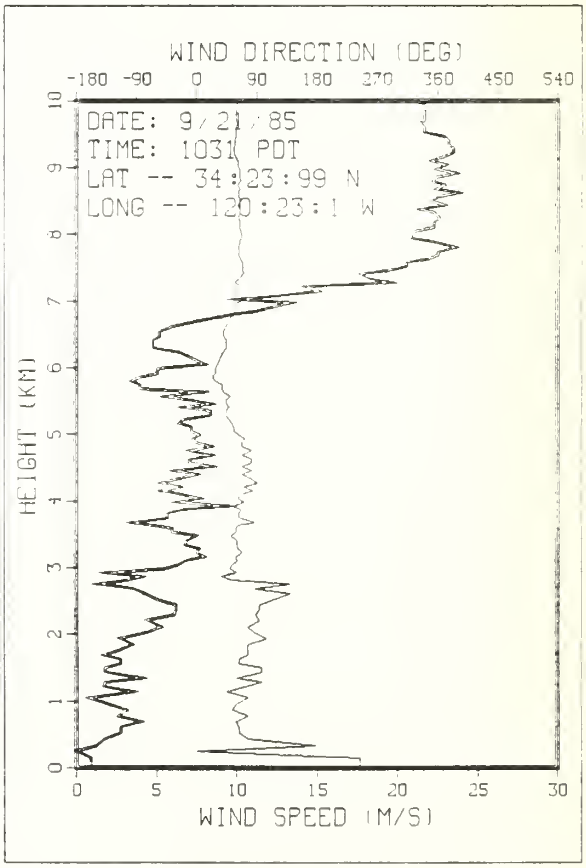

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/19/85
TIME: 1026 PDT
LAT -- 34:26:9 N
LONG -- 120:6:6 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

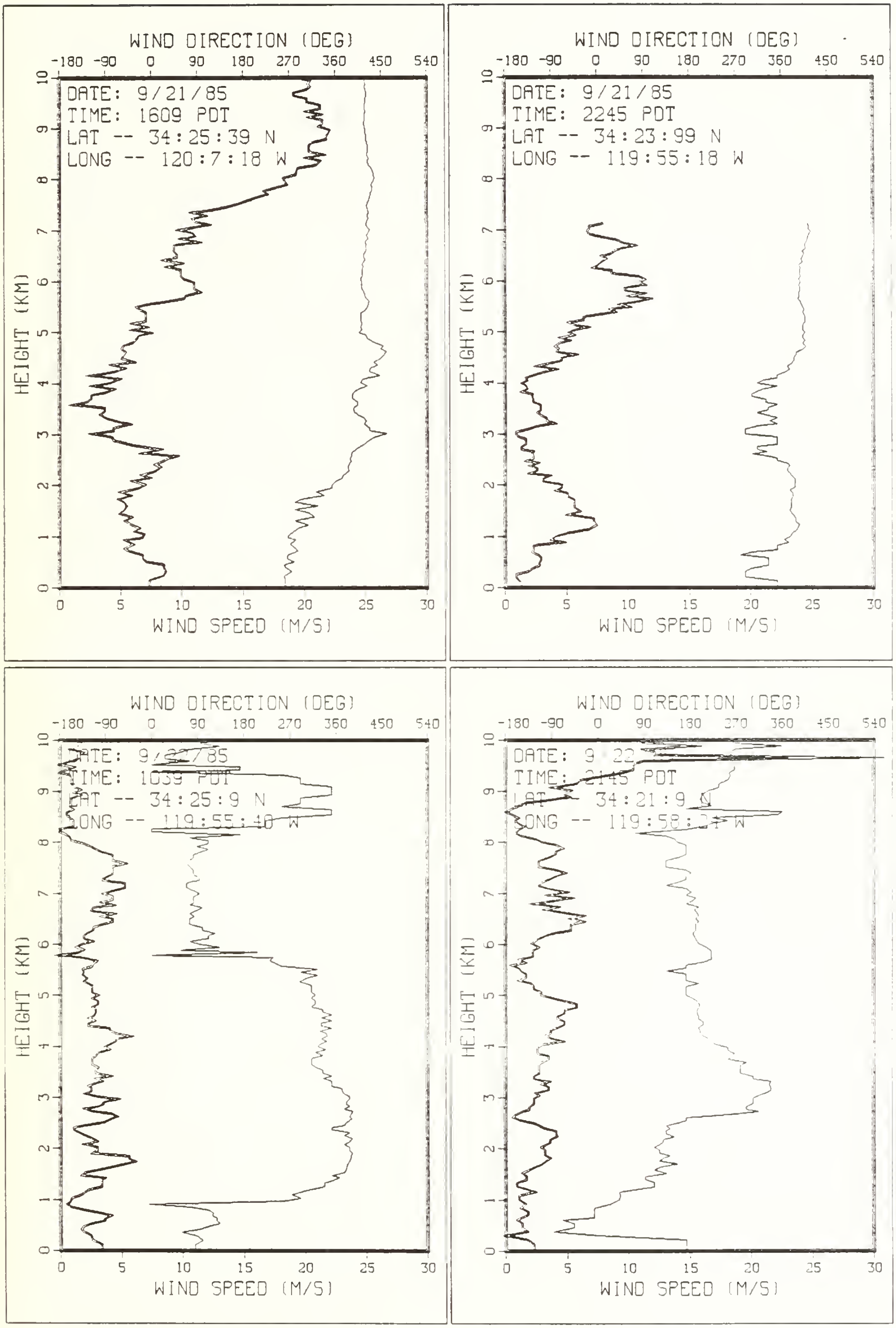

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/19/85
TIME: 1607 PDT
LAT -- 34:23:39 N
LONG -- 119:59:4 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)
WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/19/85
TIME: 2127 PDT
LAT -- 34:23:9 N
LONG -- 120:22:35 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)
WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/20/85
TIME: 513 PDT
LAT -- 34:30:49 N
LONG -- 120:43:42 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)
WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/20/85
TIME: 1027 PDT
LAT -- 34:25:39 N
LONG -- 120:30:38 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

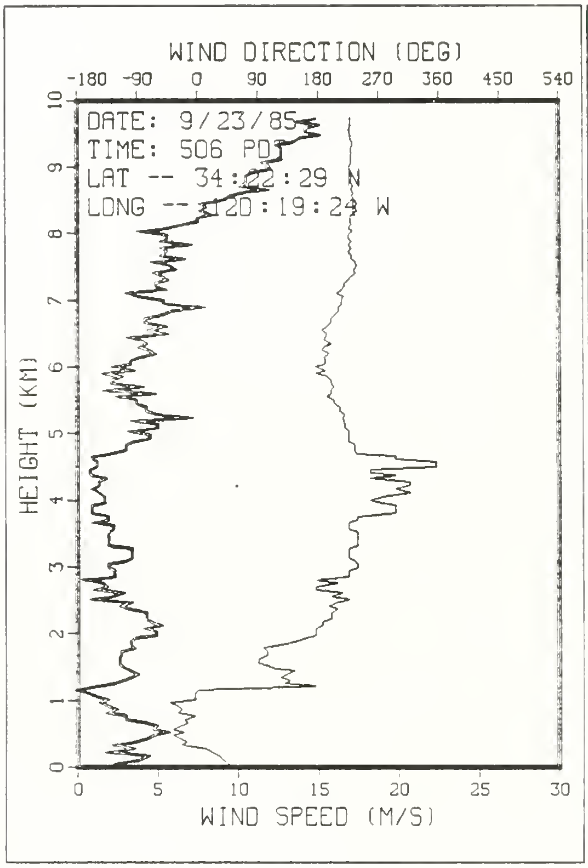

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/20/85
TIME: 1557 PDT
LAT -- 34:25:99 N
LONG -- 120:14:47 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

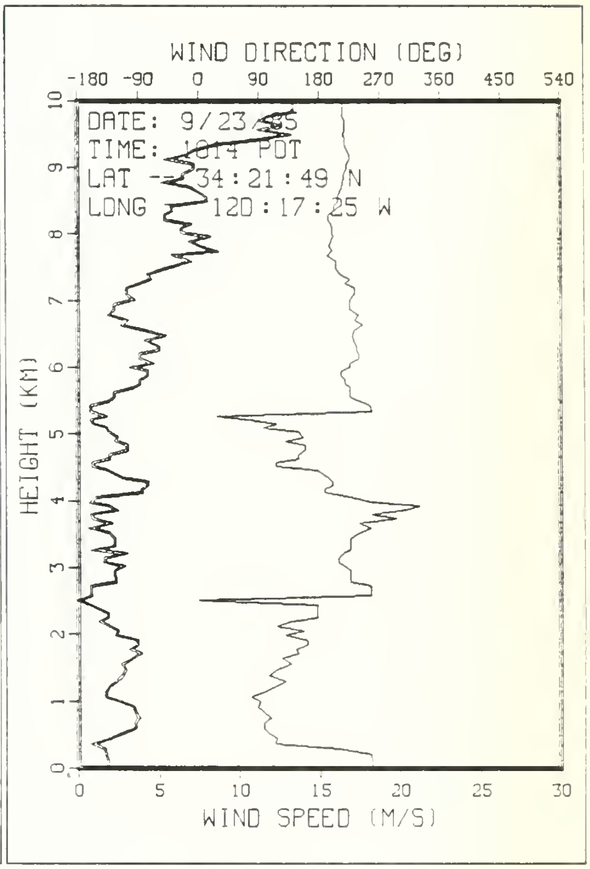

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/20/85
TIME: 2129 PDT
LAT -- 34:21:49 N
LONG -- 120:0:30 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

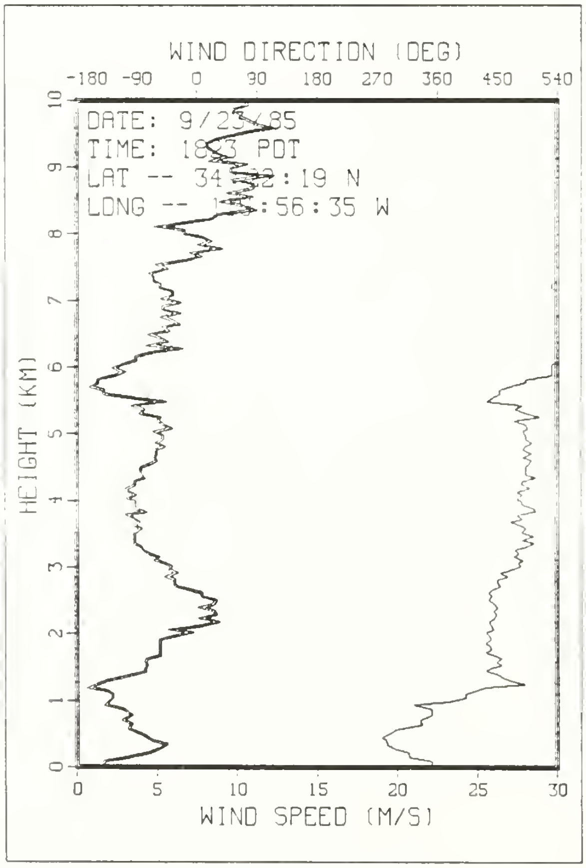

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/21/85
TIME: 501 PDT
LAT -- 34:25:49 N
LONG -- 120:8:27 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

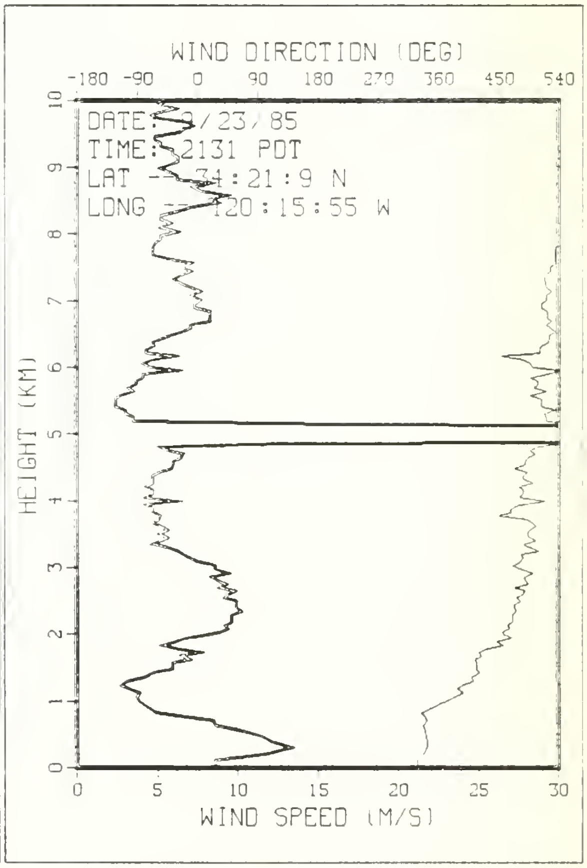

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/21/85
TIME: 1031 PDT
LAT -- 34:23:99 N
LONG -- 120:23:1 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

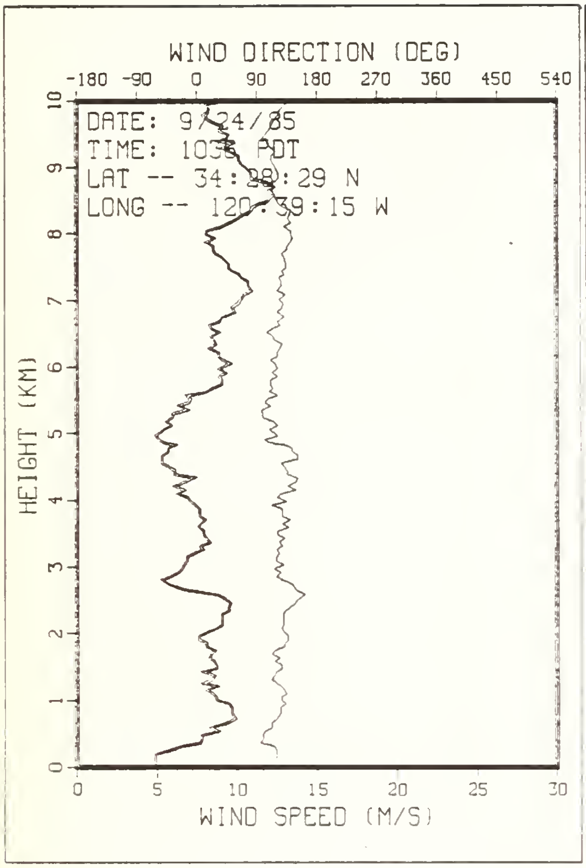

WIND DIRECTION (DEG)
HEIGHT (KM)
WIND SPEED (M/S)
DATE: 9/21/85
TIME: 1609 PDT
LAT -- 34:25:39 N
LONG -- 120:7:18 W
WIND DIRECTION (DEG)
HEIGHT (KM)
WIND SPEED (M/S)
DATE: 9/21/85
TIME: 2245 PDT
LAT -- 34:23:99 N
LONG -- 119:55:18 W
WIND DIRECTION (DEG)
HEIGHT (KM)
WIND SPEED (M/S)
LAT -- 34:25:9 N
WIND DIRECTION (DEG)
HEIGHT (KM)
WIND SPEED (M/S)
DATE:
TIME:
PDT

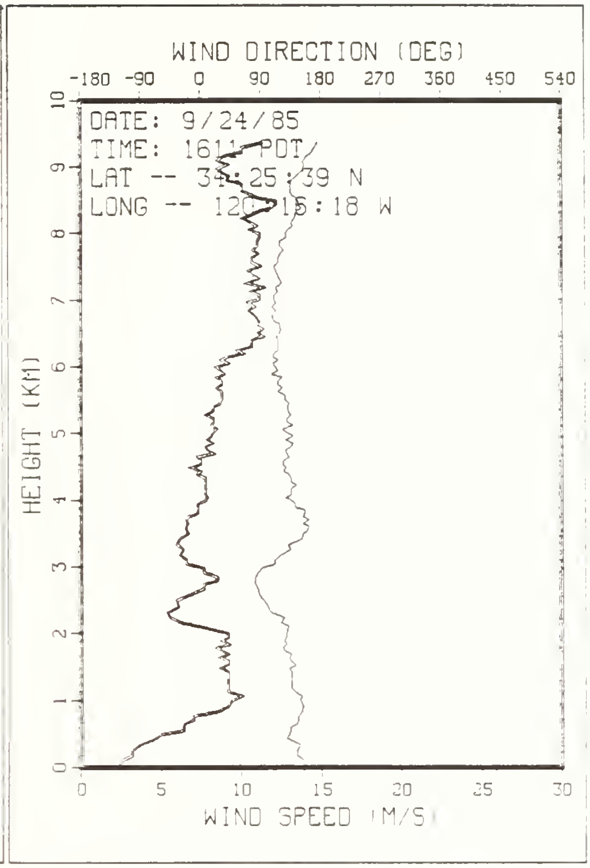

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/23/85
TIME: 506 PDT
LAT -- 34:22:29 N
LONG -- 120:19:24 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

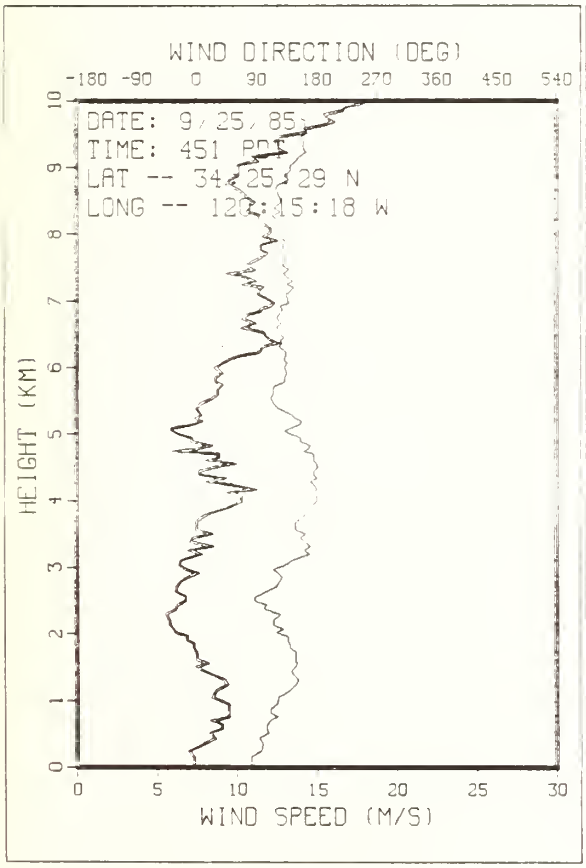

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/23/
TIME: PDT
LAT -- 34:21:49 N
LONG -- 120:17:25 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

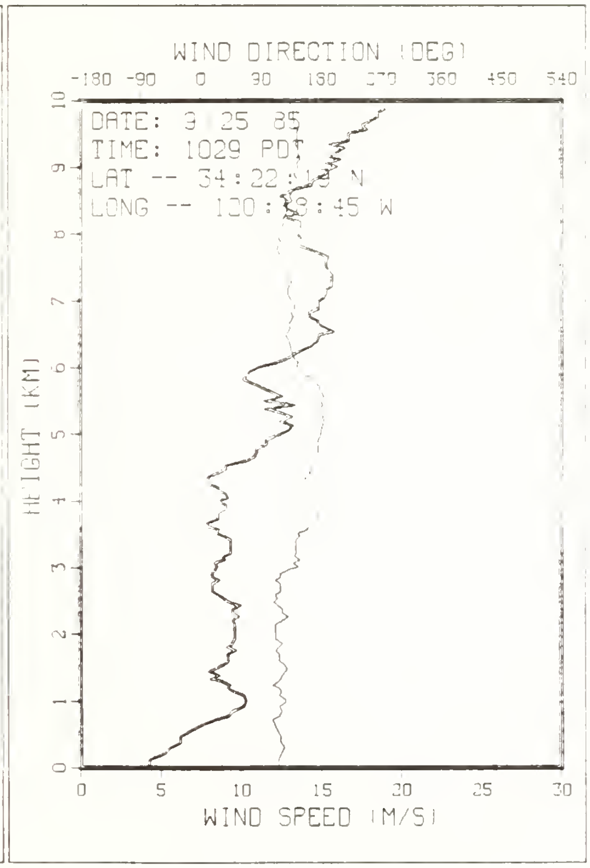

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/2 /85
TIME: PDT
LAT -- 34 :19 N
LONG -- :56:35 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

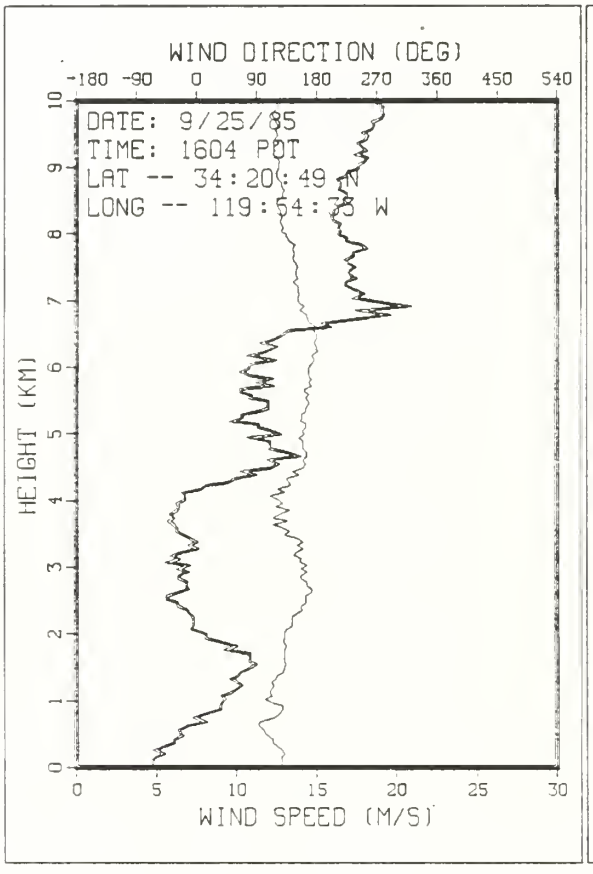

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: /23/85
TIME: 2131 PDT
LAT -- :21:9 N
LONG -- 120:15:55 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

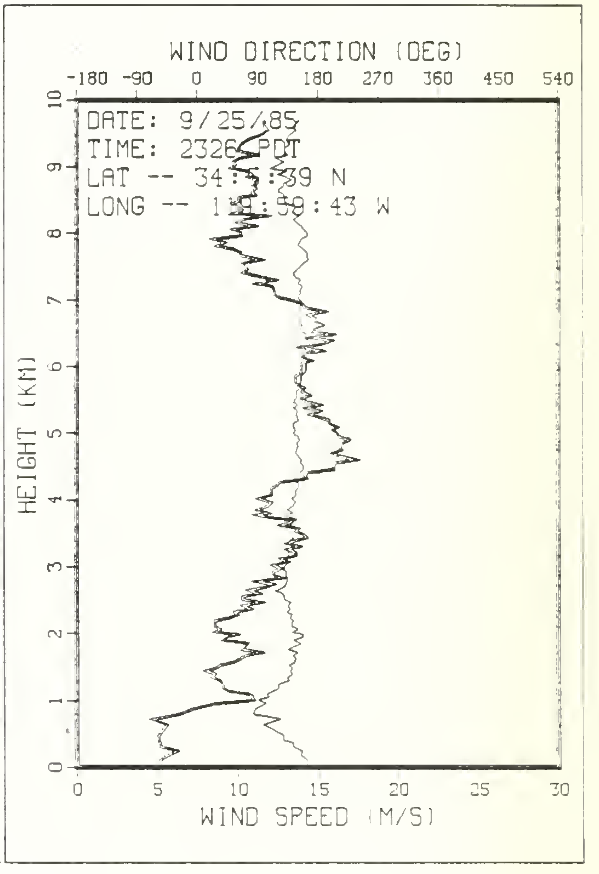

WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/24/85
TIME: 1036 PDT
LAT -- 34:28:29 N
LONG -- 120:39:15 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)


WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/24/85
TIME: 1611 PDT
LAT -- 34:25:39 N
LONG -- 120:15:18 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)


WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/25/85
TIME: 451 PDT
LAT -- 34:25:29 N
LONG -- 120:15:18 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)


WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/25/85
TIME: 1029 PDT
LAT -- 34:22
LONG -- 120
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)


WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/25/85
TIME: 1604 PDT
LAT -- 34:20:49 N
LONG -- 119:54:35 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)


WIND DIRECTION (DEG)
-180 -90 0 90 180 270 360 450 540
DATE: 9/25/85
TIME: 2326 PDT
LONG -- 1 :59:43 W
HEIGHT (KM)
0 1 2 3 4 5 6 7 8 9 10
0 5 10 15 20 25 30
WIND SPEED (M/S)

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