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CEAREX/Haakon Mosby Meteorology Atlas

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ABSTRACT

The Coordinated Eastern Arctic Experiment (CEAREX) was conducted in the vicinity of the Svalbard Island group from September 1988 to May 1989. Personnel aboard the R/V Haakon Mosby participated in the Seasonal Ice Zone Experiment (SIZEX) phase of the project, taking continuous surface and upper air measurements during the period 25 Feb-23 Mar 1989. This report describes equipment and methods used in data acquisition and analysis, and summarizes observations by presenting data in three forms: (1) Time series plots of surface pressure, wind speed and direction, air temperature, dew point temperature, and relative humidity; (2) Vertical soundings of potential temperature, potential dew point temperature, specific humidity, and wind speed and direction; and (3) Daily sea level pressure analyses.



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ACKNOWLEDGMENTS

The authors would like to thank Roger Helvey, Pacific Missile Test Center, Pt. Mugu, CA, who contributed greatly in the collection of data contained in this report. We would also like to thank Johnny Johannessen of the Nansen Remote Sensing Center, Bergen, Norway, for his role in this research as chief scientist on board the R/V *Haakon Mosby*.

The Fleet Numerical Oceanography Center, Monterey, CA, provided the sea-level pressure analyses included in this report.

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Observations taken on other platforms during CEAREX are presented in the Naval Postgraduate School reports "CEAREX/ Polarbjoern Meteorology Atlas" by Lackmann et al. (NPS63-89-005), which includes an overview of the CEAREX project; and the "CEAREX/ "O" and "A" Camp Meteorology Atlas" by Guest and Davidson (NPS63-89-0(7)).

TABLE OF CONTENTS

1.	INTRODUCTION	1
2.	INSTRUMENTATION AND DATA ACCURACY	1
	2.1 Surface Measurements	4
	2.2 Upper-Air Measurements	4
3.	DATA PLOTS	5
	3.1 Time Series Plots (TS)	5
	3.2 Sea Level Pressure Analyses (PA)	6
	3.3 Vertical Sounding Plots (VS)	6

CEAREX/HAAKON MOSBY METEOROLOGY ATLAS

1. INTRODUCTION

The *Haakon Mosby*'s participation in the Seasonal Ice Zone Experiment (SIZEX), a component of the Coordinated Eastern Arctic Experiment (CEAREX), began on 25 February 1989, when the ship left Tromsø, Norway, bound for regions in the Barents Sea. From 26 February to 7 March the ship operated in the general area between the northern coast of Norway and Spitzbergen (see Figure 1). On 7 March the *Haakon Mosby* headed northwest toward regions in the Fram Strait west and southwest of Spitzbergen, where the ship cruised seaward of the pack ice edge from 11 to 19 March. The *Haakon Mosby* then headed southeast into the Barents Sea, finally returning to port on 23 March. During the period 0800 UTC 25 February to 1400 UTC 23 March, 1989, observations of basic surface meteorological parameters were taken every ten minutes. During 2 to 23 March vertical soundings of the atmosphere were made approximately every six hours, weather and equipment permitting, and more frequently during interesting weather conditions.

The instrumentation employed during CEAREX and the methods used during data acquisition and analysis are described in Section 2, and the estimated accuracy of the data is discussed. The data plots are explained in Section 3, and presented in three groups: time series (TS), sea level pressure analyses (PA), and vertical sounding plots (VS).

2. INSTRUMENTATION AND DATA ACCURACY

A list of the meteorological measurements made during CEAREX and the various sensors used on the different platforms is shown in Table 1. The instruments used on board the *Haakon Mosby* during CEAREX and the methods used in data analysis are described below. The accuracies referred to in the following sections are absolute and are based on manufacturer's claims, field experience, and knowledge of instrument location. In general, the sensitivity of the instruments was about one order of magnitude greater than the absolute accuracy. No great effort

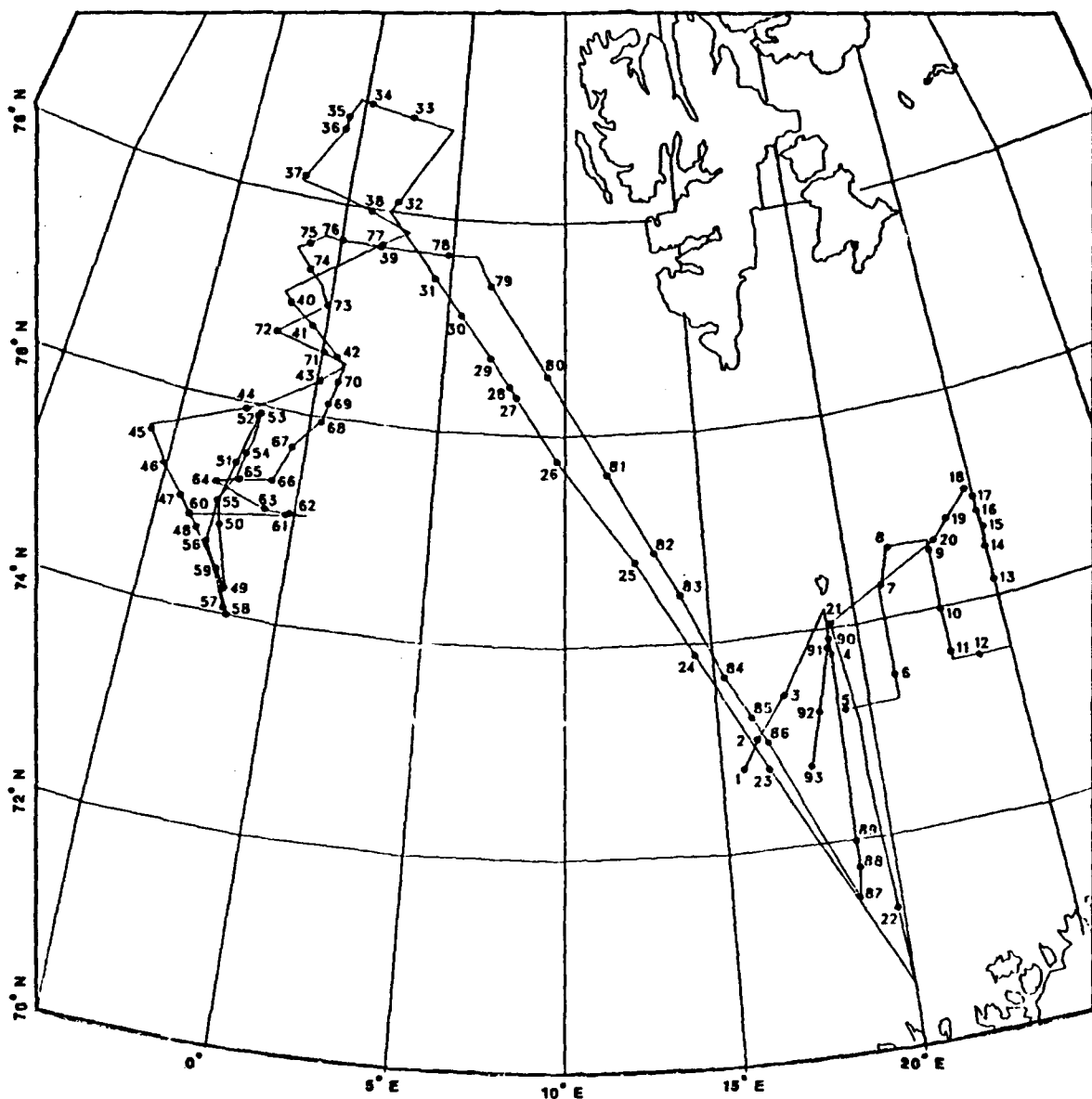


Figure 1. Track of R/V Haakon Mosby (solid line) and locations of rawinsonde flights (dot and flight number), 2-23 Mar 89. Flight times, dates, positions listed in Table 2.

Table 1. Meteorological measurements during CEAREX.

Sensor	Parameter(s) Measured	Platform Codes*
Met Station	Vector wind, temperature, humidity, wind gust, air pressure	1-8
Pyranometer	Downward Solar Radiation	1-6, 8
Radiometer	Downward Infrared Radiation	1-8
Hotfilm	Turbulent Wind, Wind Stress	1-6, 8
Miniature Cup Anemometer	Turbulent Wind, Wind Stress	5
Doppler Acoustic Sounder	Inversion Height, Boundary Layer Structure, Wind Profile	1
35 mm Camera	Sky and Surface Conditions	1-8
Human Observation	Sky and Surface Conditions, Visibility, Precipitation	1-8
All Sky Imager	Aurora, Sky Conditions	1-4, 8
Rawinsonde	Vector Wind Temperature and Humidity Profile	1-5, 7, 8
Profile Mast	Wind Speed, Wind Stress, Heat Flux	1, 6
Sonic Anemometer	Wind Stress (direct) Heat Flux (direct)	7

*Platform Codes

Code	Platform	CEAREX Phase	Dates
1	<i>Polarbjoern</i>	Drift	4 Sep. - 17 Nov. 88
2	<i>Polarbjoern</i>	Drift (break out)	17 Nov. - 10 Jan. 89
3	<i>Polarbjoern</i>	Whaler's Bay	17 Jan. - 4 Feb. 89
4	<i>Polarbjoern</i>	SIZEX	9 Feb. - 4 Apr. 89
5	<i>Haakon Mosby</i>	SIZEX	25 Feb. - 23 Mar. 89
6	Ice camp	"A"coustics	30 Mar. - 19 Apr. 89
7	Ice camp	"O"ceanography	27 Mar. - 24 Apr. 89
8	<i>Polarbjoern</i>	Biology	4 Apr. - 21 May. 89

has been made to check the data for errors, but obviously erroneous data detected by visual inspection of data plots have been removed.

2.1 Surface Measurements

A Coastal Climate WeatherPak meteorological station was used on board the *Haakon Mosby* to measure air temperature, relative humidity, atmospheric pressure and wind speed and direction. This station was mounted on a platform extending forward of the *Haakon Mosby's* bow mast at a height of 15 meters above sea level. All observations were averaged over 10 minute intervals. The temperature data obtained from this instrument are accurate to within 1.0 C and the relative humidity data to within 5%. The accuracy of the wind measurements depended upon the wind direction relative to the ship, since a "sheltering" effect was observed with winds blowing directly from the stern. Wind speeds are accurate to within 0.3 m/s and direction to within 10 degrees, although when winds were from the stern the errors are likely to be larger. All wind data have been corrected for ship motion based on ship speed and heading. The measurements of atmospheric pressure are accurate to within 2 millibars.

2.2 Upper-Air Measurements

Vertical soundings of the atmosphere were routinely obtained about every six hours, with rawinsonde flights at approximately 0000, 0600, 1200 and 1800 UTC every day, depending upon equipment or environmental conditions. During periods of unusual or exceptional weather conditions soundings were made more frequently. The number of soundings made in a single day varied from none to as many as nine.

The vertical profiles of temperature, dew point temperature and wind speed and direction were measured using rawinsondes manufactured by the Vaisala Corporation and software developed by Roger Helvey. The temperature data obtained from these rawinsondes have an accuracy of 0.2 C and the dewpoint temperatures are accurate to within 1.5 C. Wind data were obtained using an

omega navigation tracking system on each sonde. The vector wind speeds are considered to be accurate to within 1 m/s. Winds in the lower 500 meters of the rawinsonde flights were interpolated from surface and upper-level measurements, and therefore are likely to have larger errors. The heights are accurate to within 30 meters.

3. DATA PLOTS

Figures are arranged in three groups: time series of basic surface meteorological parameters for the entire deployment of the Haakon Mosby from 25 February to 23 March, overall and by week; vertical profiles of basic meteorological parameters from rawinsonde flights; and daily analyses of sea level pressure for the general CEAREX region. All plots are arranged in chronological order.

3.1 Time Series Plots (TS)

The time series plots are based on observations averaged over 10 minute intervals, and gaps in the time series are shown only when data were missing for more than one hour. Figure TS-1 shows data for the deployment overall, while Figures TS-2 through -5 show the data week by week.

The first (top) graph in each figure shows the time series of true wind direction measured from true north (0 degrees). Some wind direction values between 0 and 45 degrees were plotted as being in the corresponding 360 to 405 degree range (for example, a wind direction of 15 degrees might be plotted as being 375 degrees). This was done to avoid the "windshield wiper" effect, which is caused when winds fluctuate about 360 degrees and the resulting plot exhibits repeated streaks across the graph.

The second graph shows the time series of relative humidity in percent.

The third graph shows the time series of air temperature (solid line) and dew point temperature (dashed line) in degrees Celsius.

The fourth graph shows the time series of wind speed in meters per second at the bottom, and wind barbs depicting wind direction at the top. A barb pointing to the top of the page indicates a northerly (0 degrees) wind. In order to be distinguishable, the wind direction barbs were plotted only for every 30 minutes.

The fifth (bottom) graph shows the time series of sea level pressure in millibars.

3.2 Sea Level Pressure Analyses (PA)

Daily analyses of sea level pressure are presented, usually for 1200 UTC, otherwise for 0000 UTC. These analyses are based on North Atlantic sea level pressure analyses developed by the Fleet Numerical Oceanography Center, Monterey, CA. The locations of fronts are not shown in these analyses, which in some cases were subjectively redrawn during tracing. Isobars are drawn at 4 millibar intervals and are labelled at 8 millibar intervals with the last two whole digits of the pressure value (e.g. "24" equals 1024 millibars). The analyses for 6 and 7 March were not available for this report.

3.3 Vertical Sounding Plots (VS)

The left portions of the sounding plots show the vertical profiles of potential temperature (thick solid line) and potential dew point temperature (dashed line), which are both scaled at the bottom of the plot. The potential dew point temperature is defined as the potential temperature minus the dew point depression. The vertical profile of specific humidity is shown by the thin solid line and is scaled at the top of the plot. The right portions of the sounding plots display the true wind speed and direction, using the same vertical scale as the left portions of the plots. The true wind direction is shown by wind barbs; a barb pointing toward the top of the page indicates a northerly (0 degrees) wind. The soundings are plotted only up to 10000 meters above sea level, although data were sometimes obtained at higher levels. The time and position of rawinsonde

deployment are indicated below each plot -- launch positions were shown in Figure 1 -- and corresponding launch times are listed in Table 2.

Table 2. Times and locations of CEAREX/Haakon Mosby rawinsonde flights.

Flight No.	Time	Date	Position
1	1258	2 March	72° 47' N, 15° 43' E
2	1850	2 March	73° 03' N, 16° 15' E
3	0000	3 March	73° 26' N, 17° 16' E
4	1207	3 March	73° 46' N, 19° 00' E
5	1635	3 March	73° 13' N, 19° 13' E
6	2250	3 March	73° 28' N, 21° 00' E
7	0726	4 March	74° 19' N, 21° 04' E
8	1016	4 March	74° 40' N, 21° 34' E
9	1402	4 March	74° 34' N, 23° 00' E
10	1820	4 March	74° 00' N, 22° 58' E
11	2140	4 March	73° 35' N, 23° 00' E
12	0000	5 March	73° 30' N, 23° 54' E
13	0731	5 March	74° 09' N, 25° 00' E
14	1000	5 March	74° 28' N, 24° 59' E
15	1150	5 March	74° 40' N, 25° 06' E
16	1558	5 March	74° 49' N, 25° 00' E
17	1645	5 March	74° 57' N, 24° 59' E
18	1850	5 March	75° 03' N, 24° 46' E
19	2050	5 March	74° 49' N, 23° 51' E
20	2252	5 March	74° 38' N, 23° 15' E
21	0959	6 March	74° 05' N, 19° 08' E
22	1226	7 March	71° 19' N, 19° 51' E
23	1130	9 March	72° 46' N, 16° 31' E
24	1811	9 March	73° 53' N, 14° 23' E
25	2323	9 March	74° 48' N, 12° 30' E
26	0633	10 March	75° 45' N, 9° 39' E
27	1010	10 March	76° 21' N, 8° 01' E
28	1112	10 March	76° 21' N, 7° 44' E
29	1314	10 March	76° 43' N, 6° 53' E
30	1534	10 March	77° 06' N, 5° 36' E
31	1745	10 March	77° 25' N, 4° 20' E
32	2306	10 March	78° 06' N, 2° 18' E
33	1213	11 March	78° 54' N, 2° 31' E
34	1527	11 March	78° 58' N, 0° 23' E
35	1755	11 March	78° 49' N, 0° 36' W
36	1845	11 March	78° 41' N, 0° 41' W
37	2302	11 March	78° 11' N, 2° 06' W
38	0645	12 March	77° 58' N, 1° 10' E
39	1219	12 March	77° 41' N, 1° 51' E
40	2114	12 March	77° 00' N, 1° 36' W
41	2345	12 March	76° 49' N, 0° 34' W
42	0251	13 March	76° 34' N, 0° 37' E
43	0616	13 March	76° 19' N, 0° 07' E
44	1317	13 March	75° 56' N, 2° 29' W
45	2026	13 March	75° 33' N, 5° 51' W
46	0056	14 March	75° 16' N, 5° 06' W
47	0348	14 March	75° 01' N, 4° 12' W

Table 2 continued.

Flight No.	Time	Date	Positions
48	0621	14 March	74° 45' N, 3° 23' W
49	1217	14 March	74° 15' N, 1° 58' W
50	1715	14 March	74° 49' N, 2° 36' W
51	2329	14 March	75° 25' N, 2° 28' W
52	0347	15 March	75° 53' N, 2° 00' W
53	0622	15 March	75° 55' N, 1° 54' 54
54	1209	15 March	75° 31' N, 2° 10' W
55	1749	15 March	75° 03' N, 2° 50' W
56	2153	15 March	74° 39' N, 2° 56' W
57	0303	16 March	74° 04' N, 1° 52' W
58	0617	16 March	74° 00' N, 1° 43' W
59	1120	16 March	74° 25' N, 2° 23' W
60	1748	16 March	74° 52' N, 3° 45' W
61	2324	16 March	75° 01' N, 0° 18' W
62	0534	17 March	75° 03' N, 0° 10' W
63	0627	17 March	75° 03' N, 1° 04' W
64	1035	17 March	75° 13' N, 3° 03' W
65	1143	17 March	75° 16' N, 2° 12' W
66	1340	17 March	75° 19' N, 1° 01' W
67	1743	17 March	75° 40' N, 0° 30' W
68	2058	17 March	75° 56' N, 0° 26' E
69	2234	17 March	76° 07' N, 0° 36' E
70	0001	18 March	76° 21' N, 0° 51' E
71	0302	18 March	76° 36' N, 0° 06' E
72	0722	18 March	76° 43' N, 1° 58' W
73	1126	18 March	77° 02' N, 0° 04' W
74	1502	18 March	77° 21' N, 1° 04' W
75	1758	18 March	77° 35' N, 1° 19' W
76	2034	18 March	77° 40' N, 0° 04' E
77	2338	18 March	77° 40' N, 1° 48' E
78	0443	19 March	77° 39' N, 4° 48' E
79	0833	19 March	77° 23' N, 6° 47' E
80	1347	19 March	76° 33' N, 9° 17' E
81	1848	19 March	75° 37' N, 11° 34' E
82	2301	19 March	74° 52' N, 13° 11' E
83	0128	20 March	74° 28' N, 14° 03' E
84	0506	20 March	73° 40' N, 15° 19' E
85	0801	20 March	73° 16' N, 16° 07' E
86	0917	20 March	73° 01' N, 16° 34' E
87	1746	20 March	71° 28' N, 18° 47' E
88	2316	21 March	71° 45' N, 18° 55' E
89	0252	22 March	72° 00' N, 18° 55' E
90	1751	22 March	73° 54' N, 19° 00' E
91	2118	22 March	73° 49' N, 18° 53' E
92	0018	23 March	73° 15' N, 18° 22' E
93	0305	23 March	72° 45' N, 17° 53' E

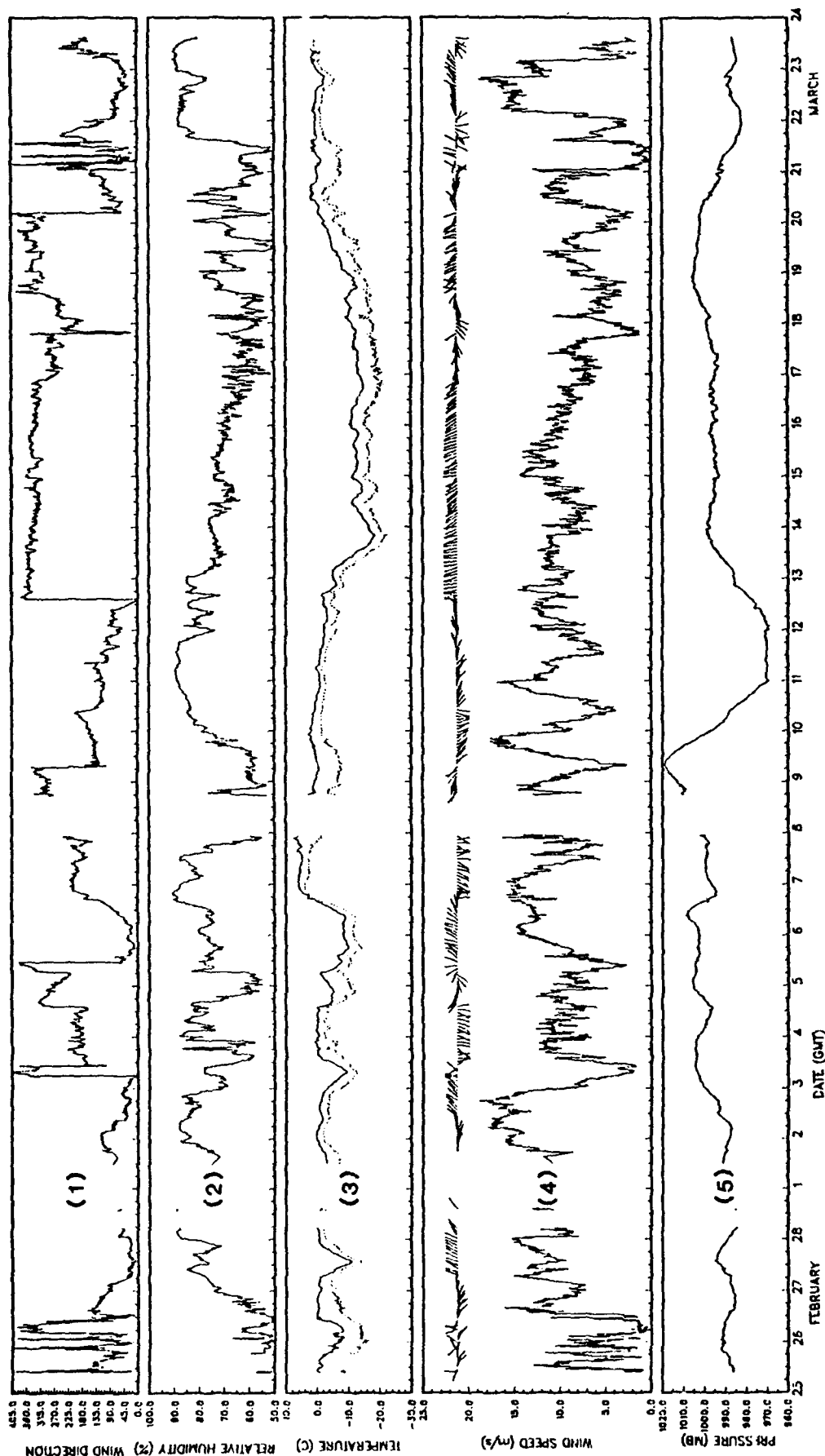


Fig. TS-1. Time series plots, R/V Haakon Mosby deployment 25 Feb-23 Mar 89.
 (1) Wind direction. (2) Relative humidity. (3) Air temperature, solid line; and dew point temperature, dashed line. (4) Wind speed, bottom; wind direction, top. (5) Sea level pressure. See text for discussion of parameters measured and units of measurement.

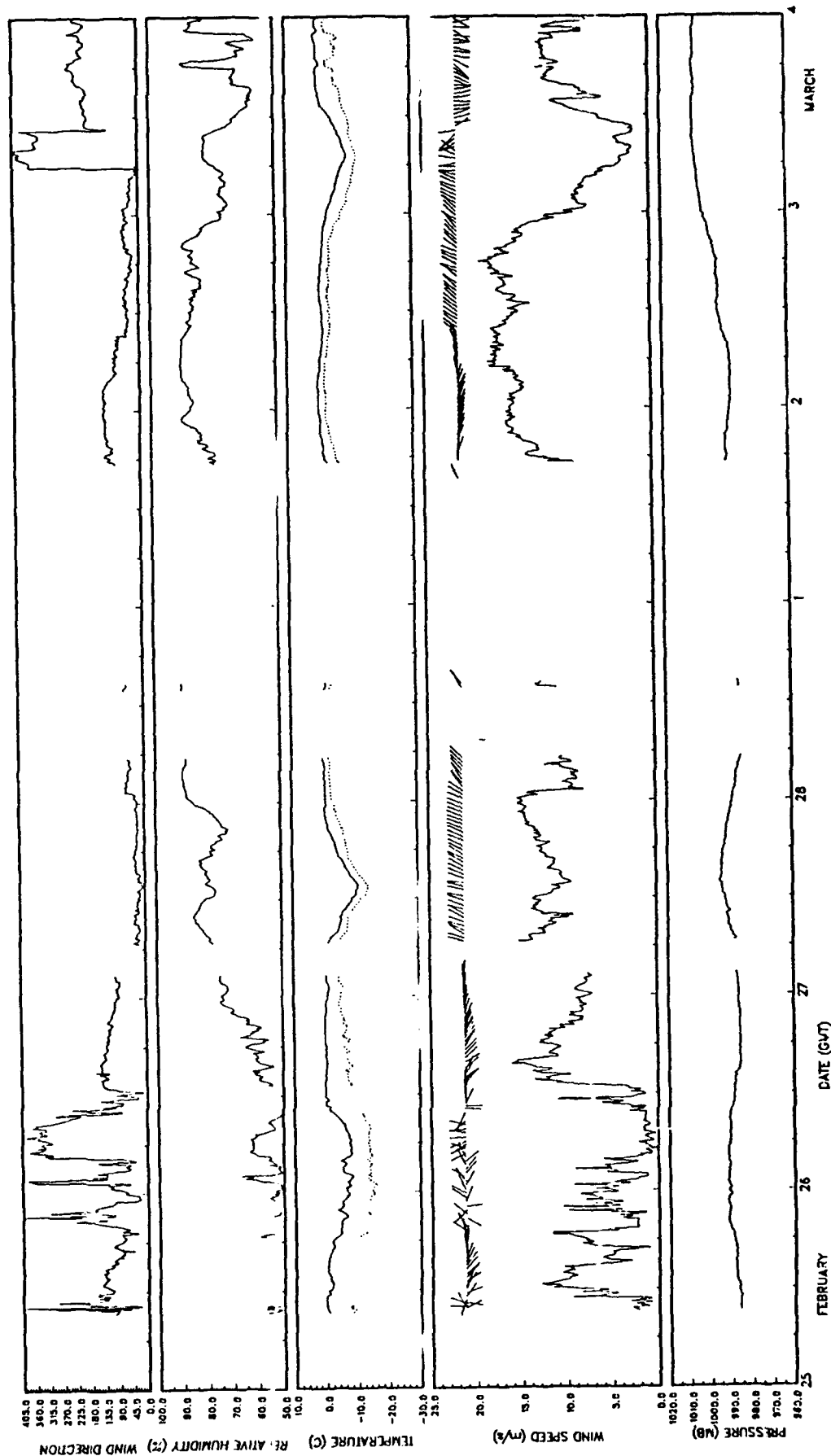


Fig. TS-2. Time series plots, week 25 Feb-4 Mar 89.

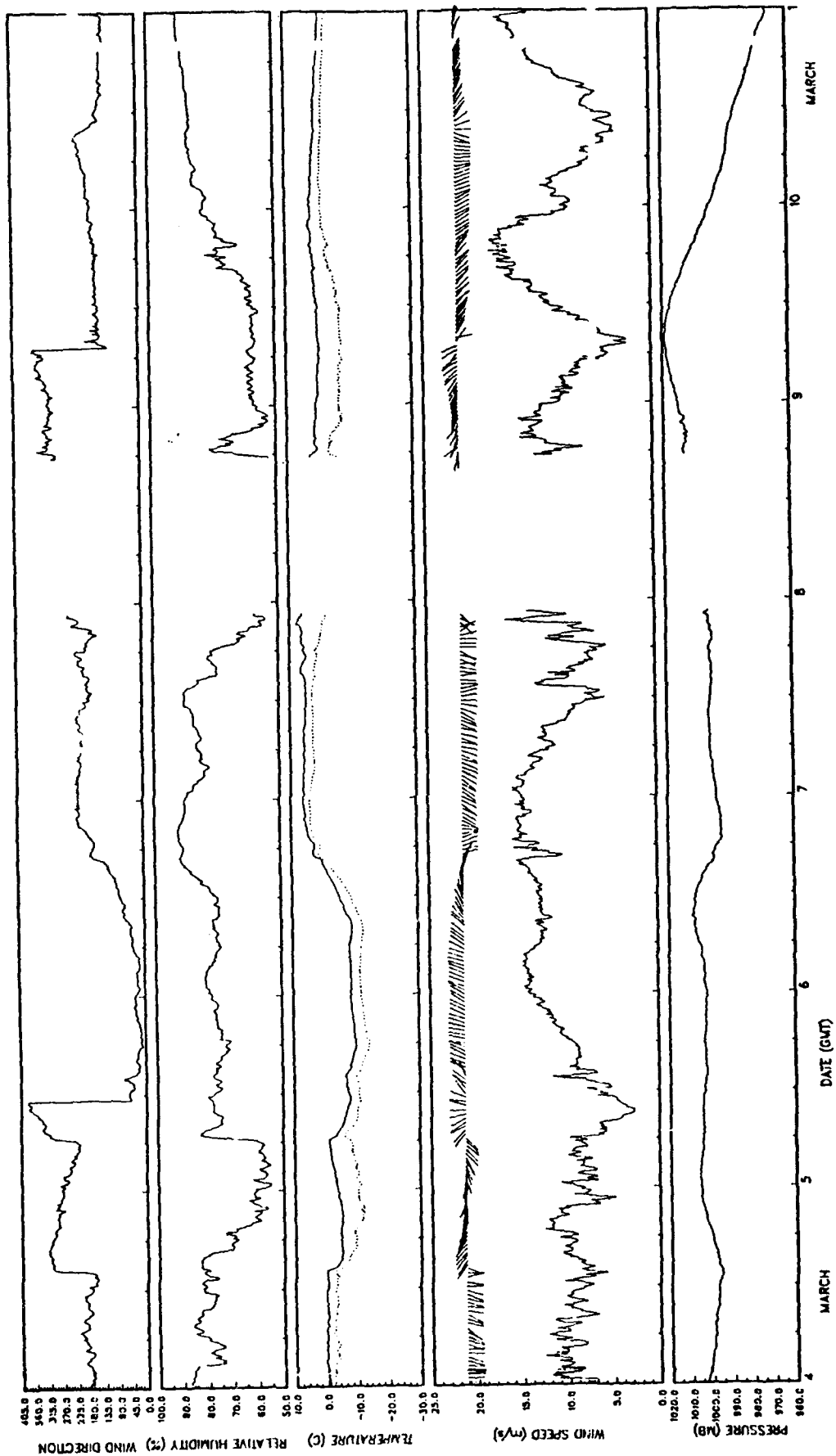


Fig. TS-3. Time series plots, week 4-11 Mar 89.

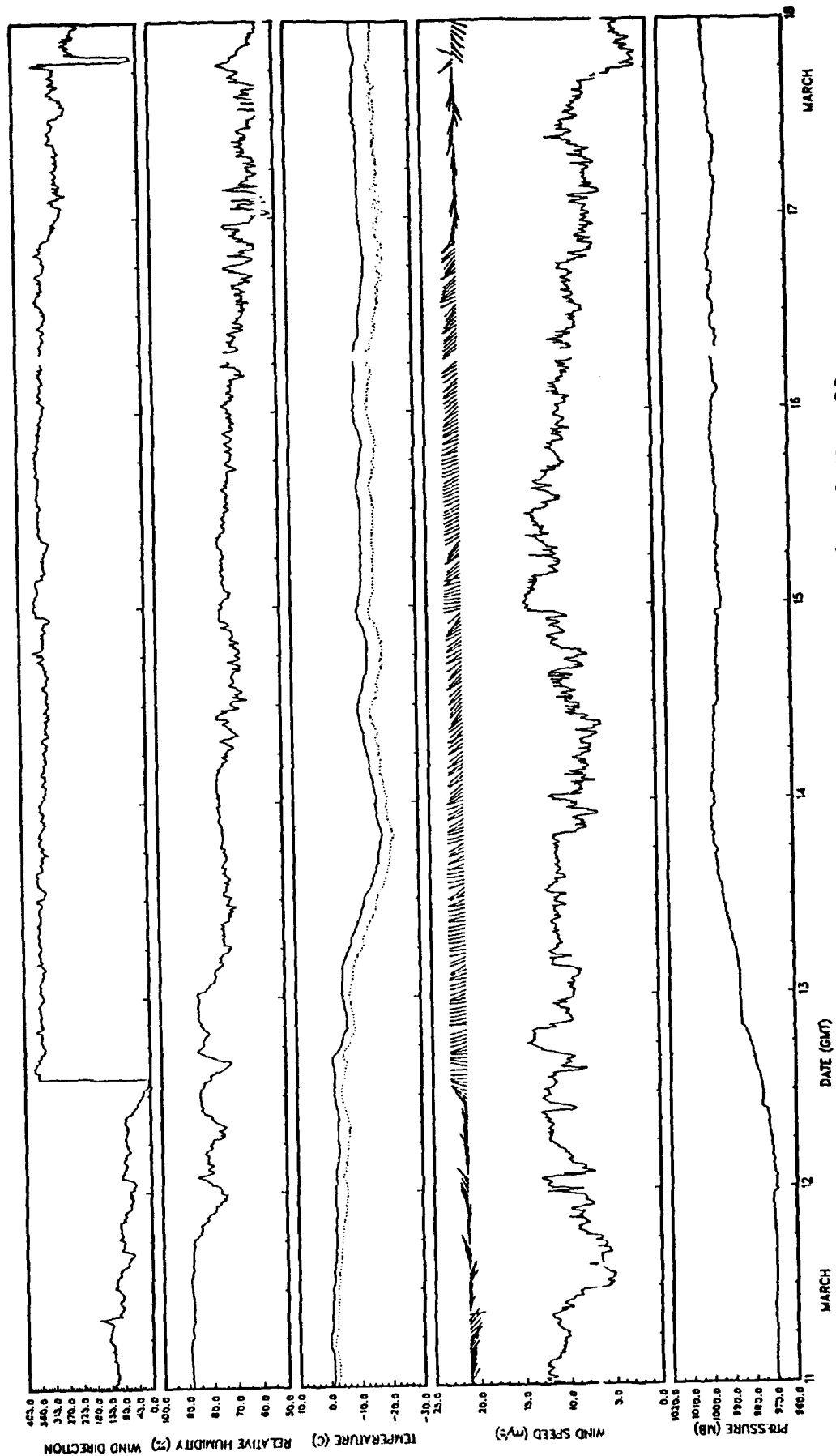


Fig. TS-4. Time series plots, week 11-18 Mar 89.

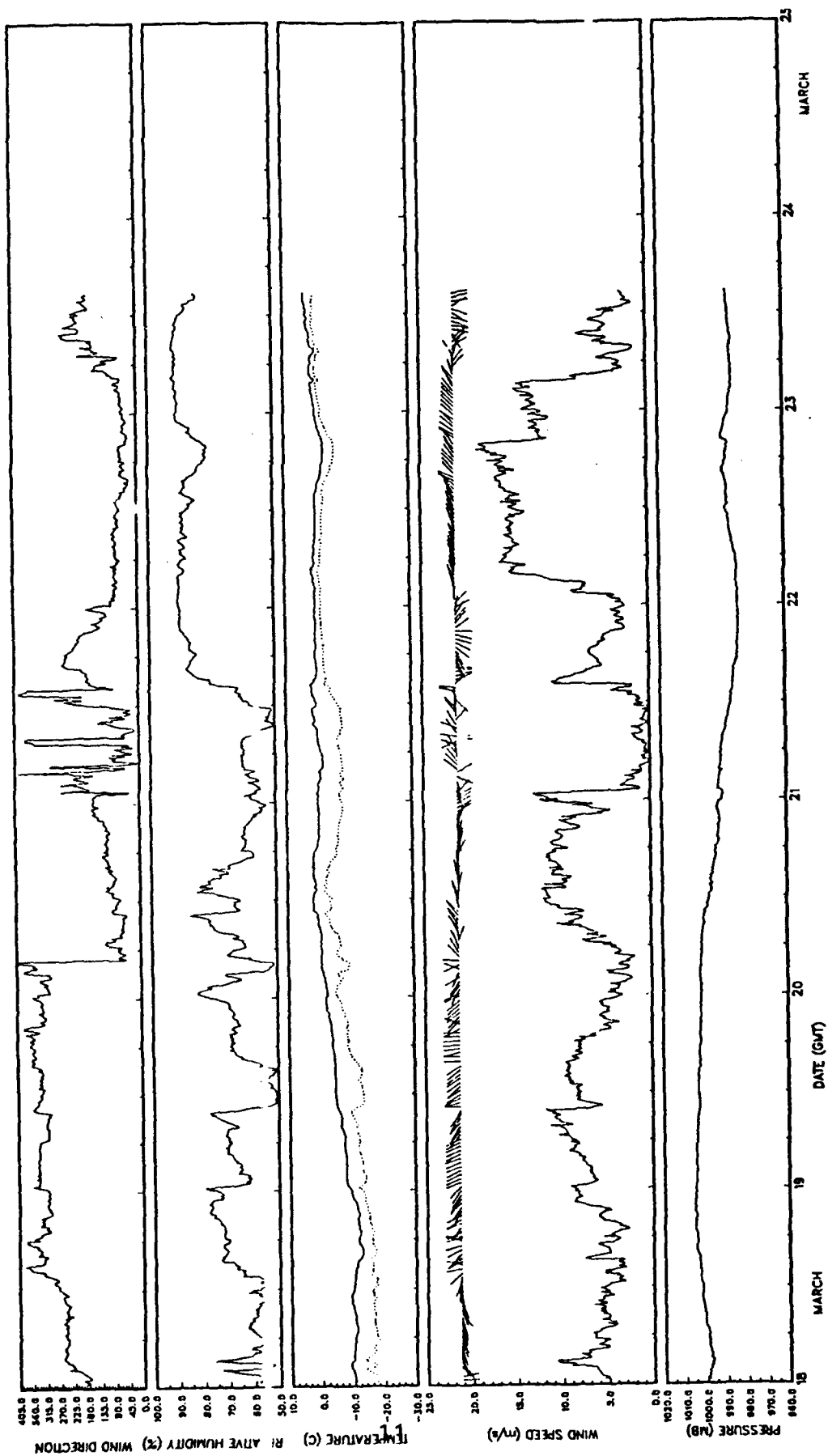
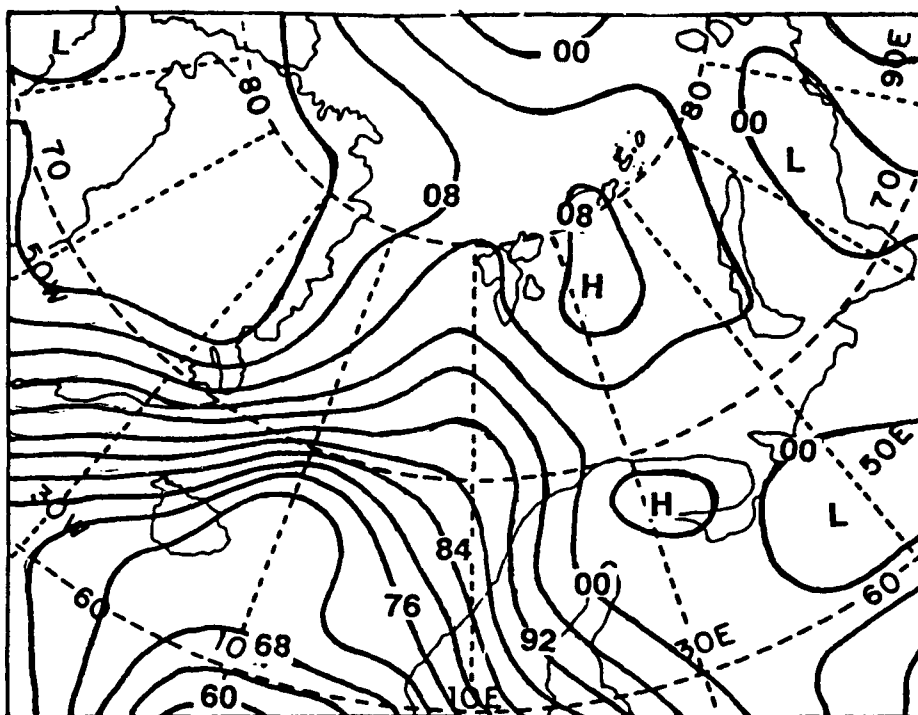
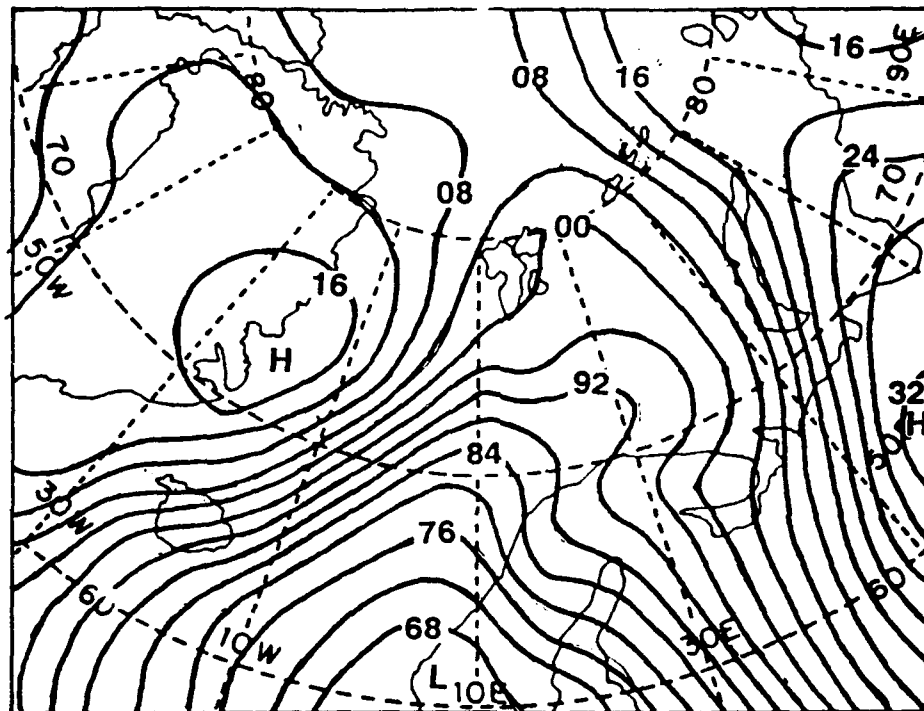
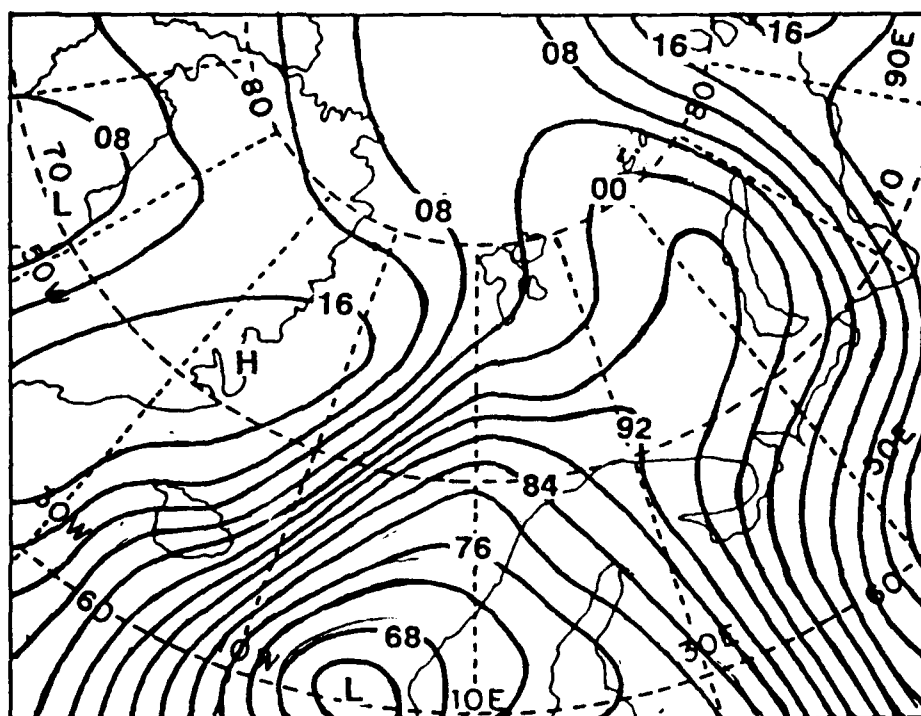


Fig. TS-5. Time series plots, week 18-25 Mar 89.



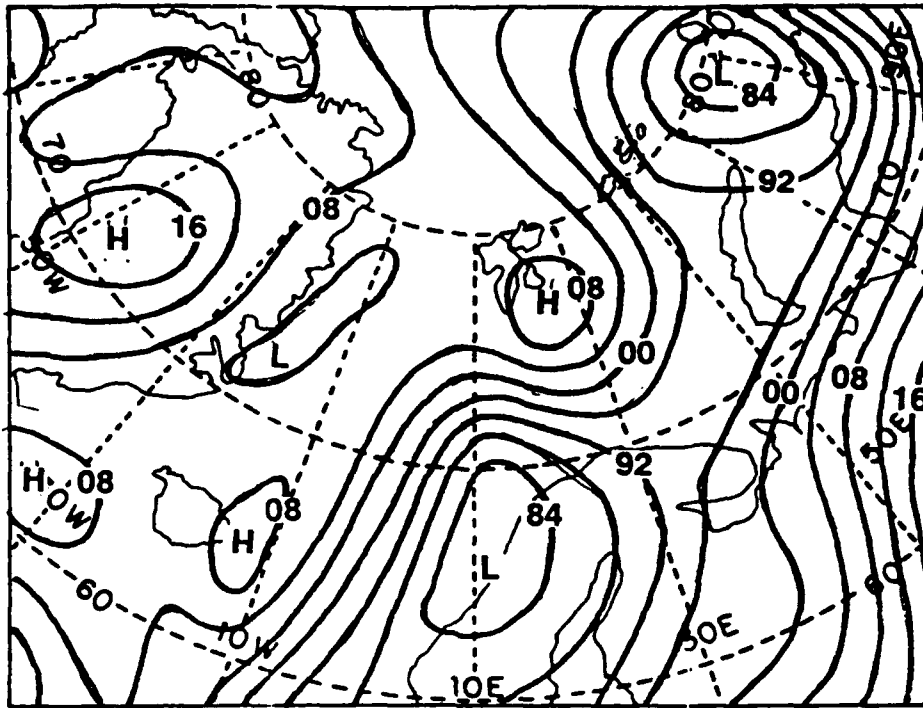


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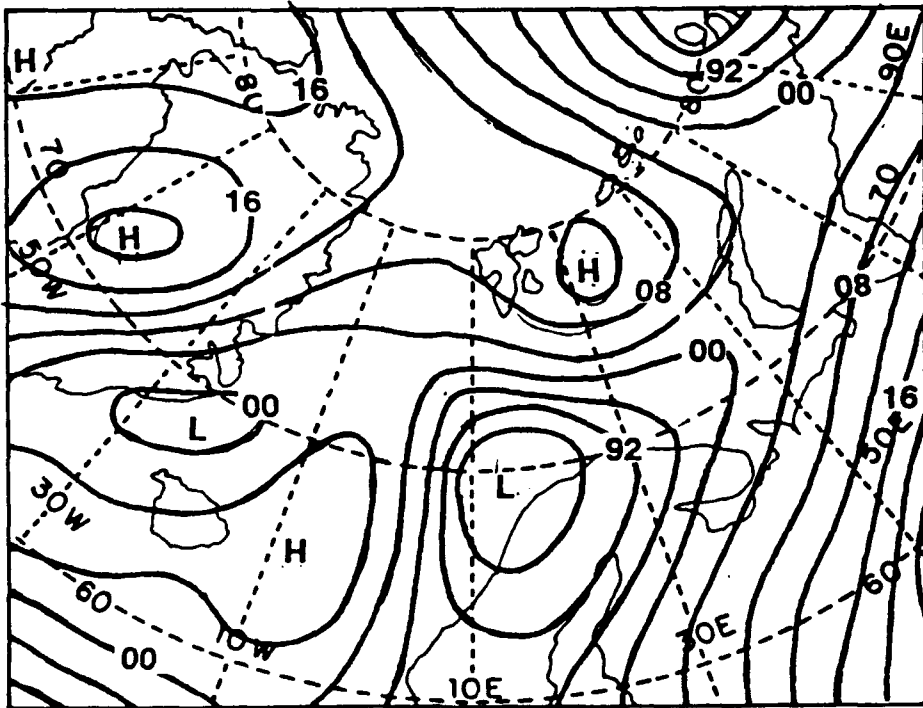


0000 UTC 28 Feb 89

Fig. PA-2. Sea level pressure analyses for 27,28 Feb 89.

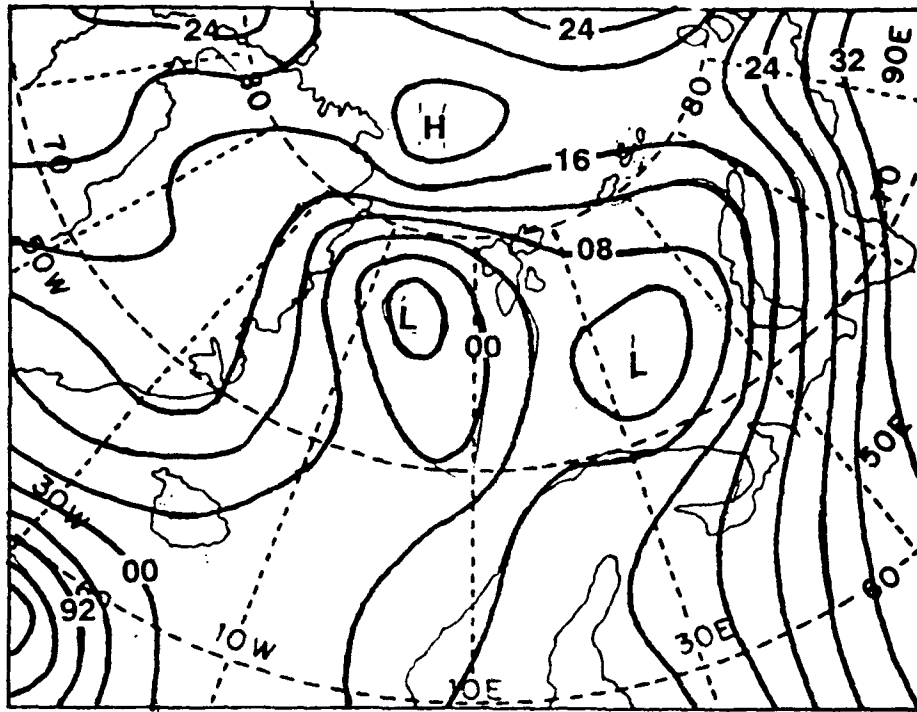


1200 UTC 1 Mar 89

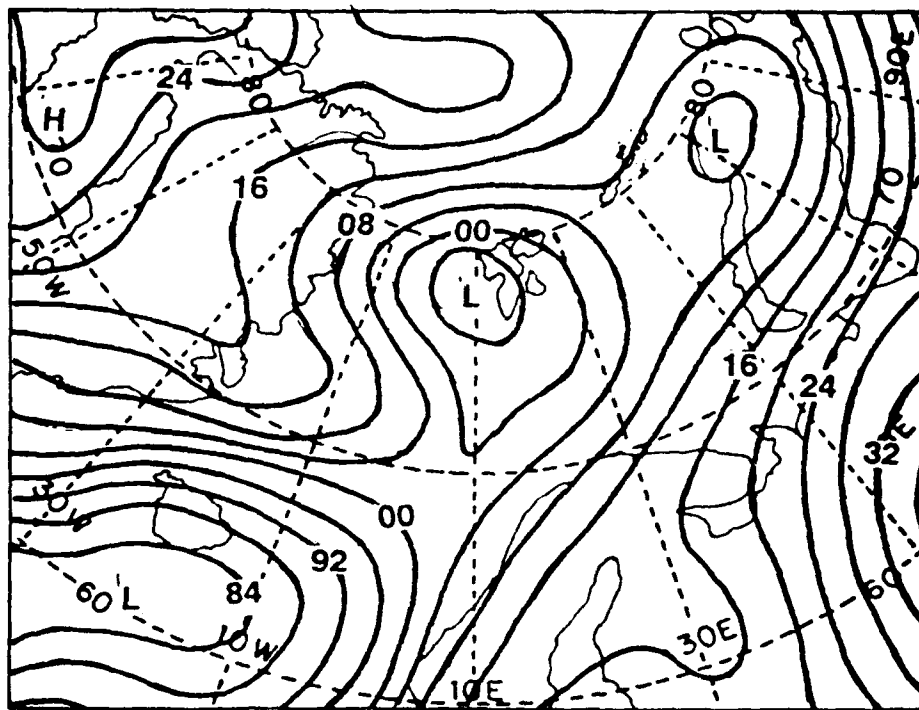


0000 UTC 2 Mar 89

Fig. PA-3. Sea level pressure analyses for 1,2 Mar 89.

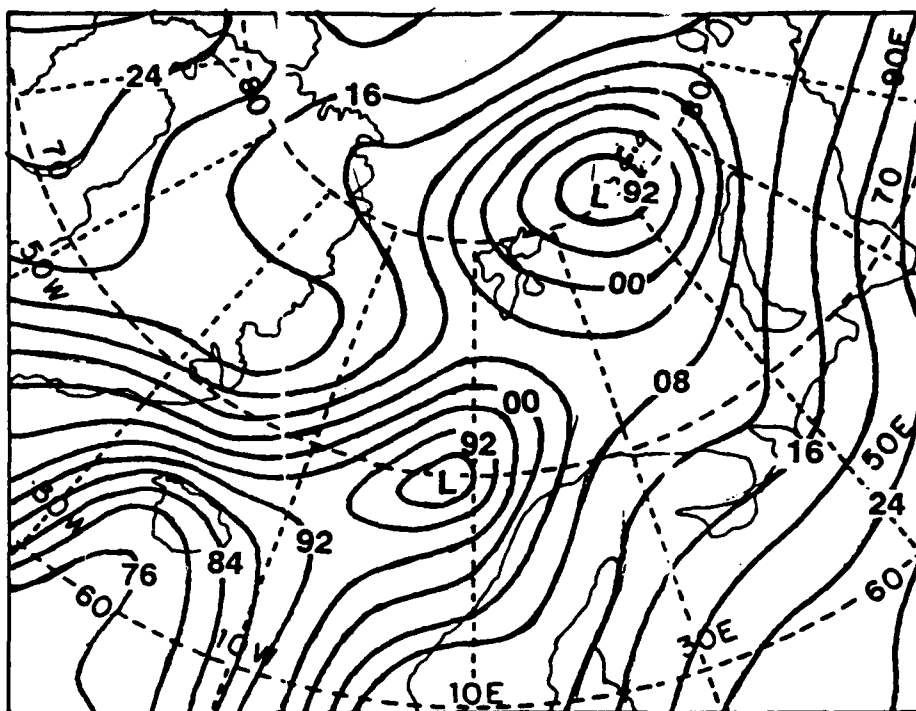


1200 UTC 3 Mar 89



1200 UTC 4 Mar 89

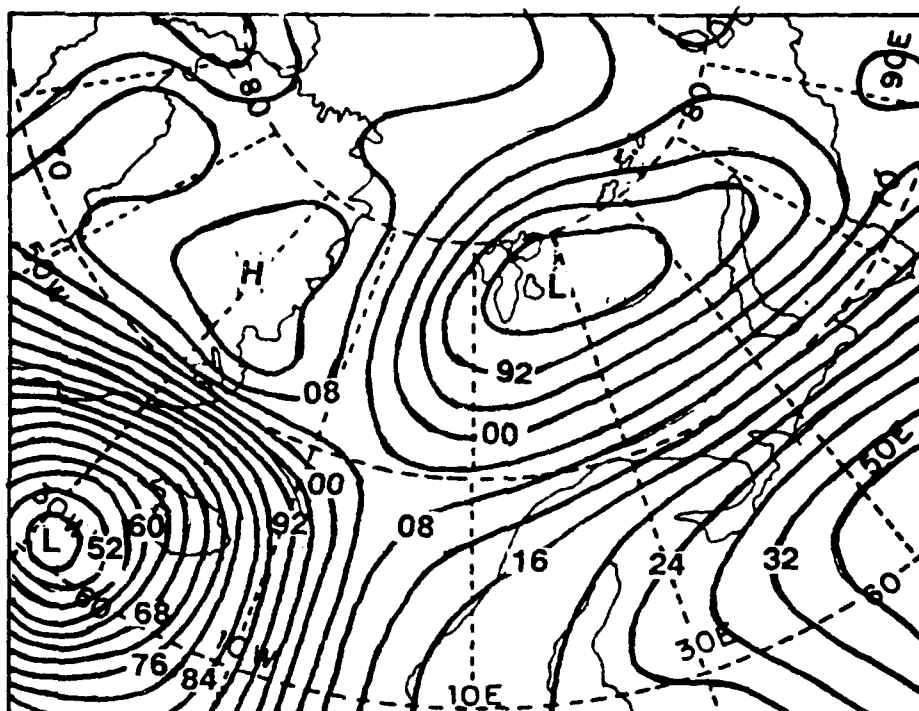
Fig. PA-4. Sea level pressure analyses for 3,4 Mar 89.



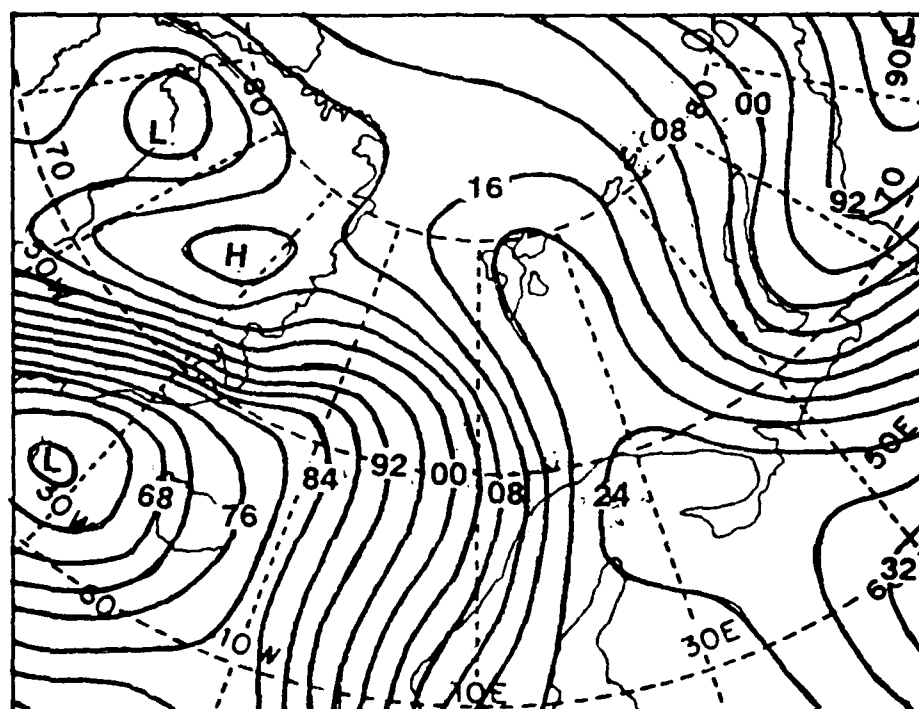
1200 UTC 5 Mar 89

Fig. PA-5. Sea level pressure analysis for 5 Mar 89.

(Analyses for 6,7 Mar 89 not available.)

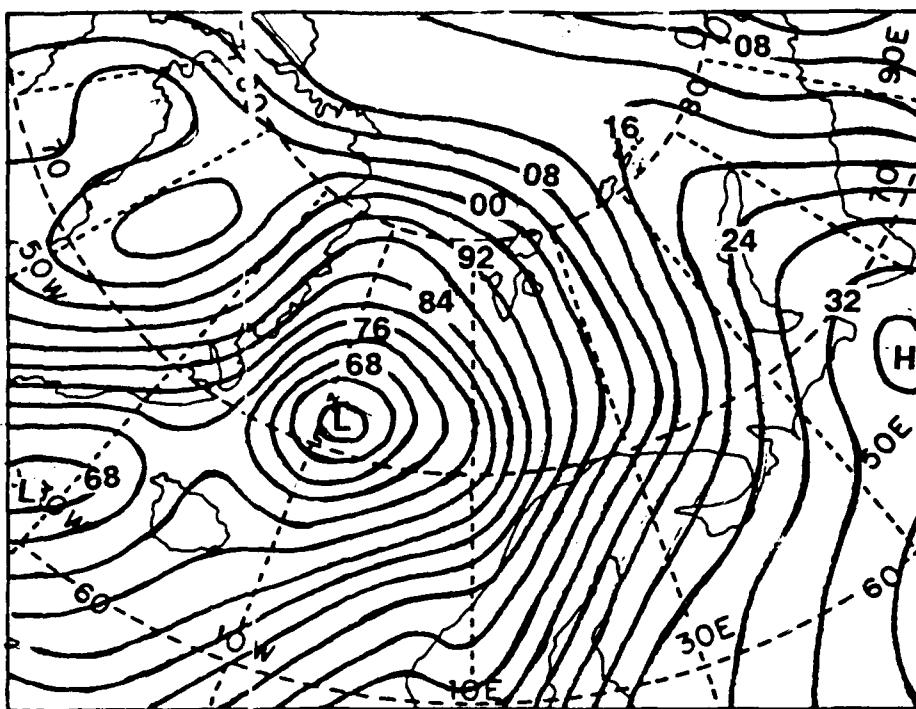


1200 UTC 8 Mar 89

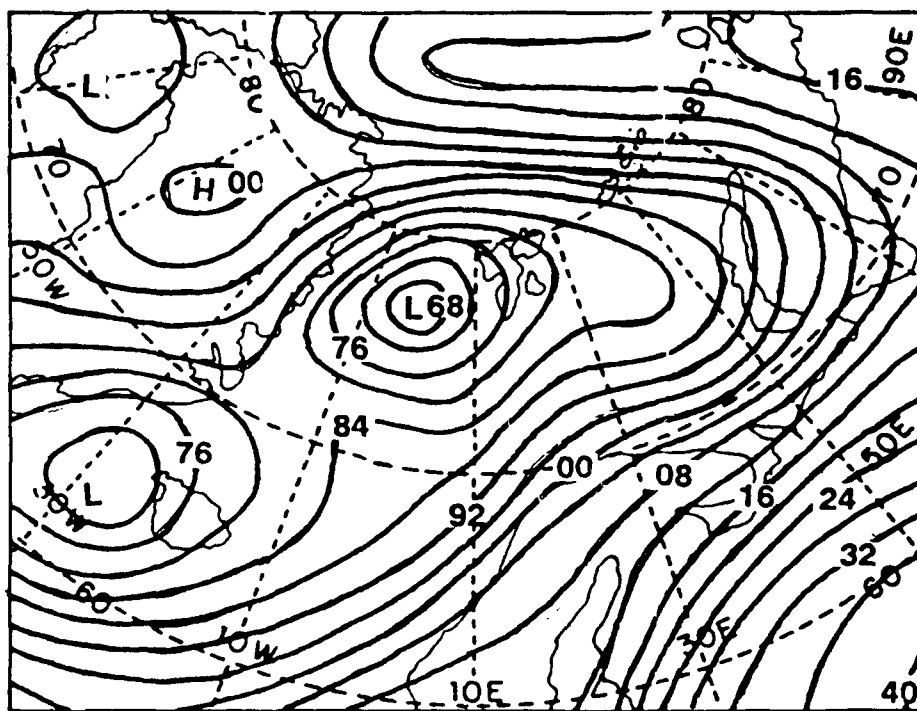


1200 UTC 9 Mar 89

Fig. PA-6. Sea level pressure analyses for 8,9 Mar 89.

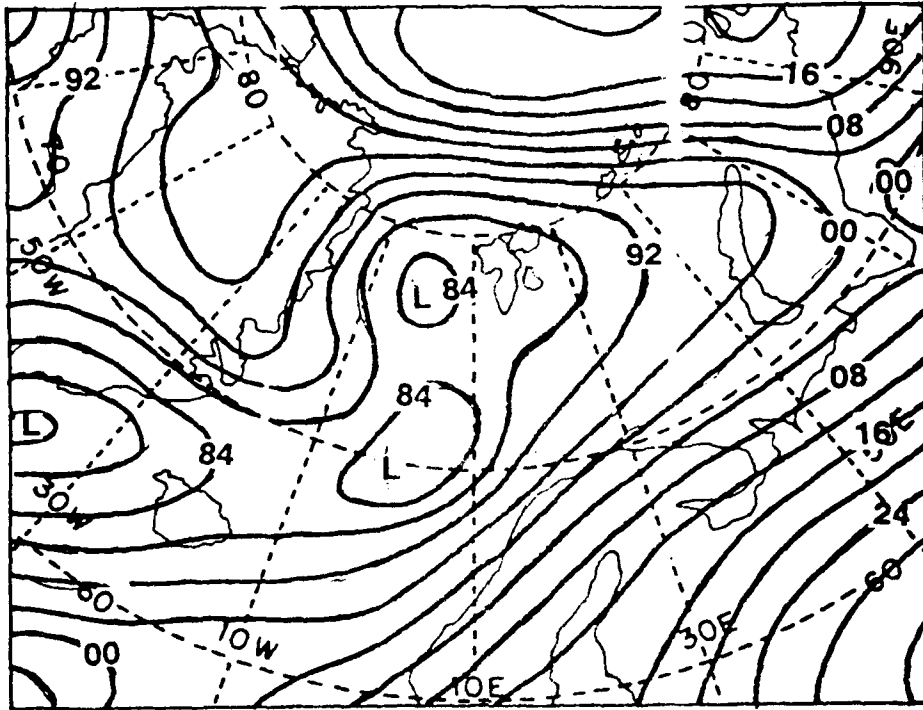


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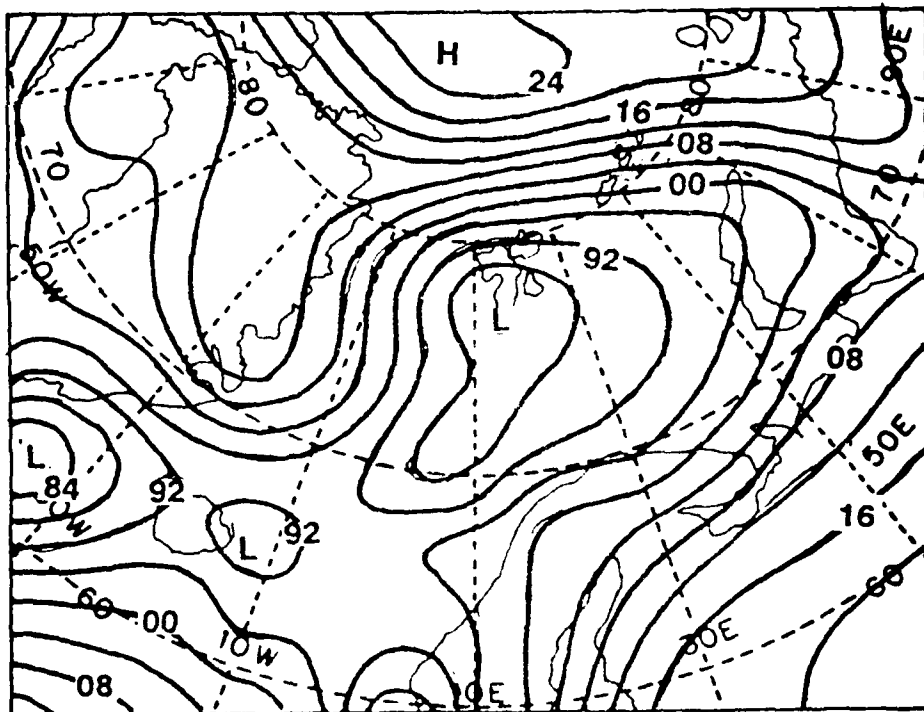


1200 UTC 11 Mar 89

Fig. PA-7. Sea level pressure analyses for 10,11 Mar 89.

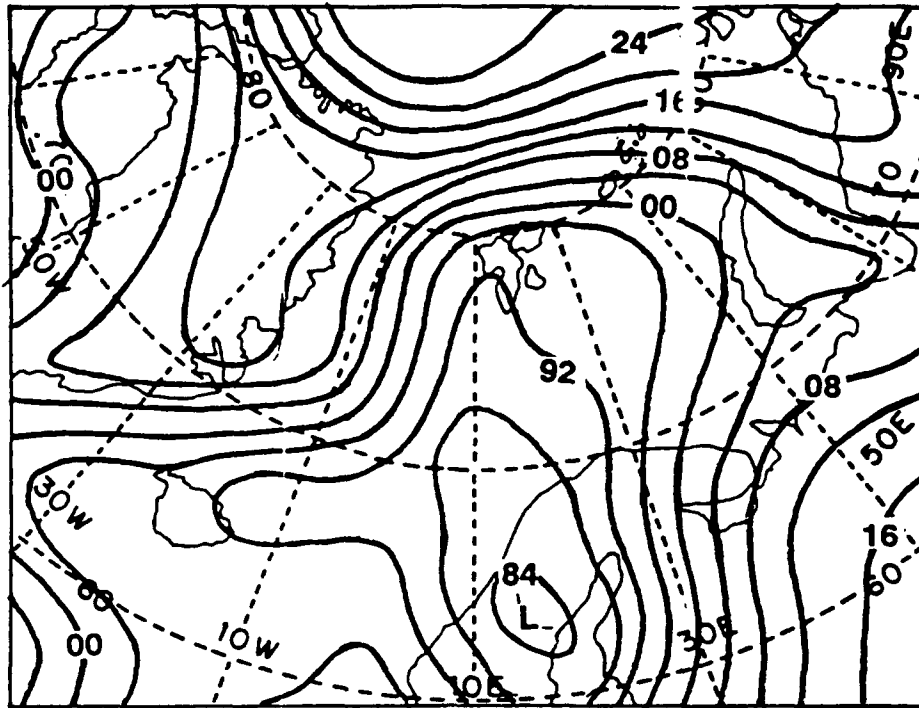


1200 UTC 12 Mar 89

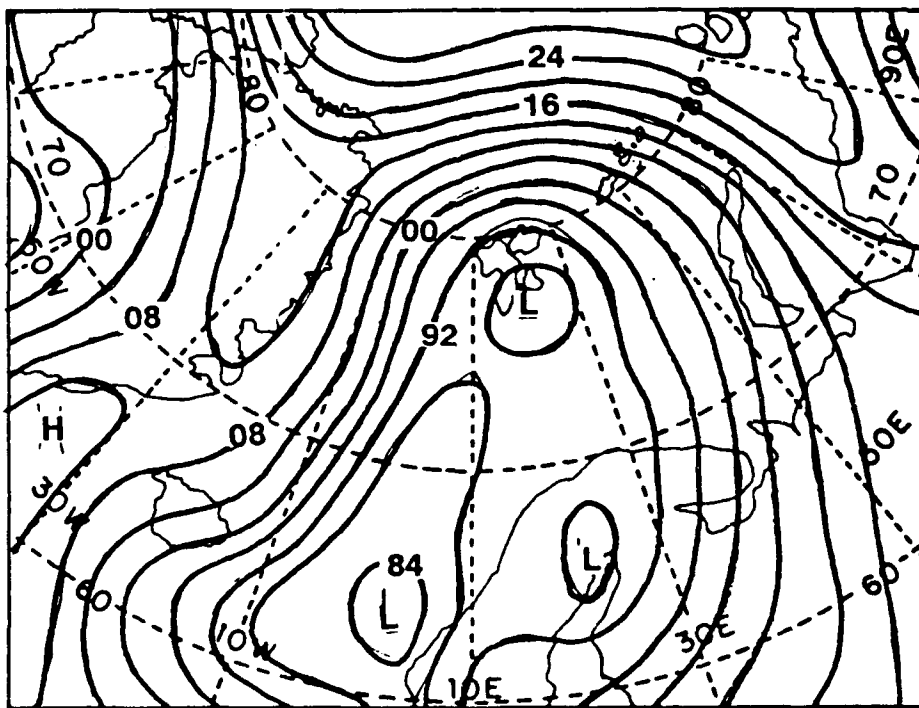


1200 UTC 13 Mar 89

Fig. PA-8. Sea level pressure analyses for 12,13 Mar 89.

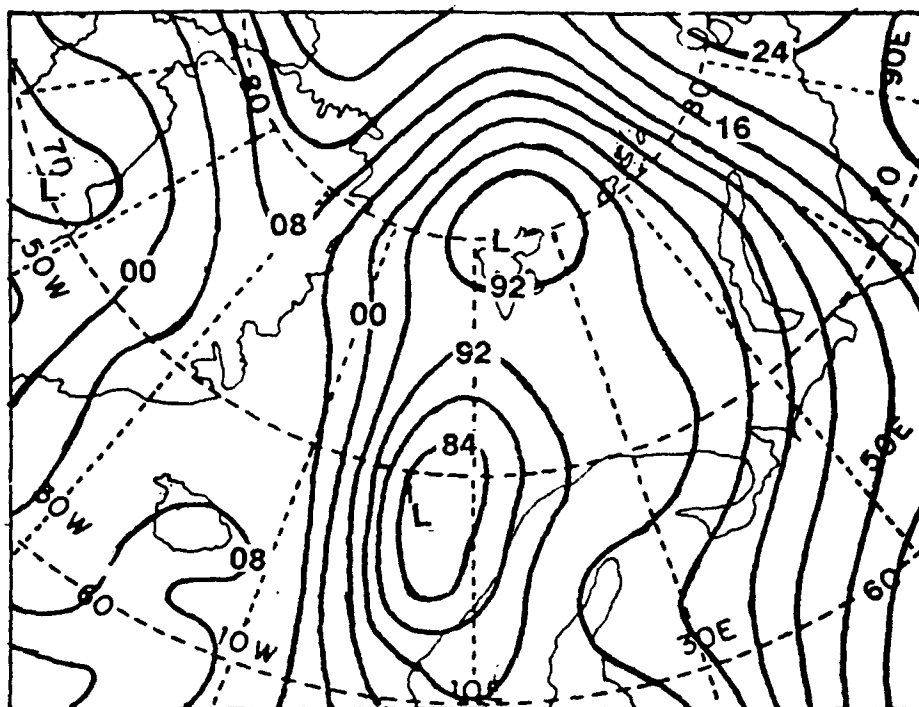


1200 UTC 14 Mar 89

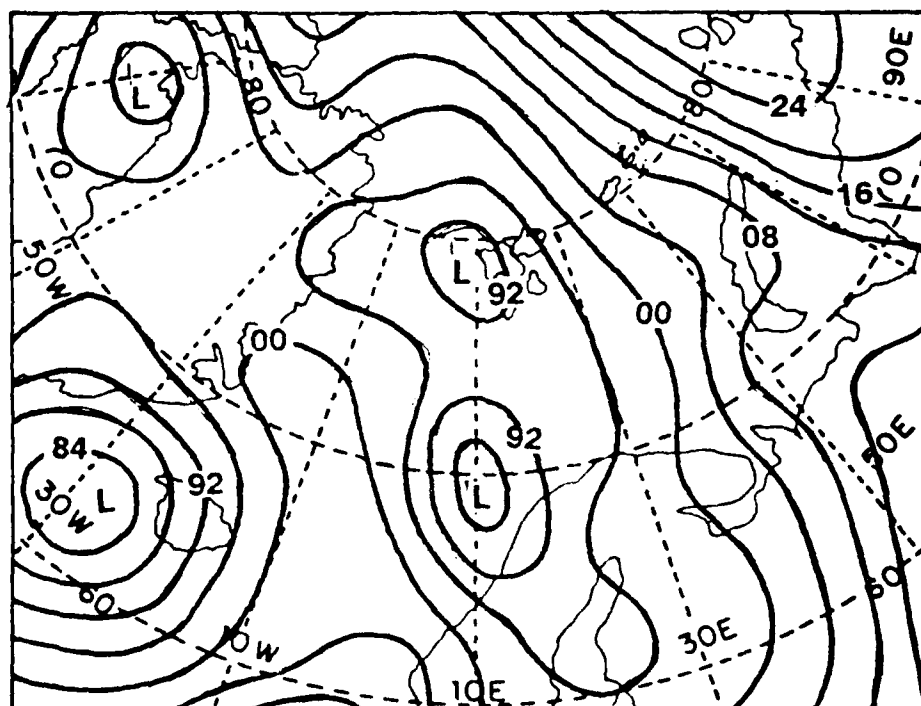


1200 UTC 15 Mar 89

Fig. PA-9. Sea level pressure analyses for 14,15 Mar 89.

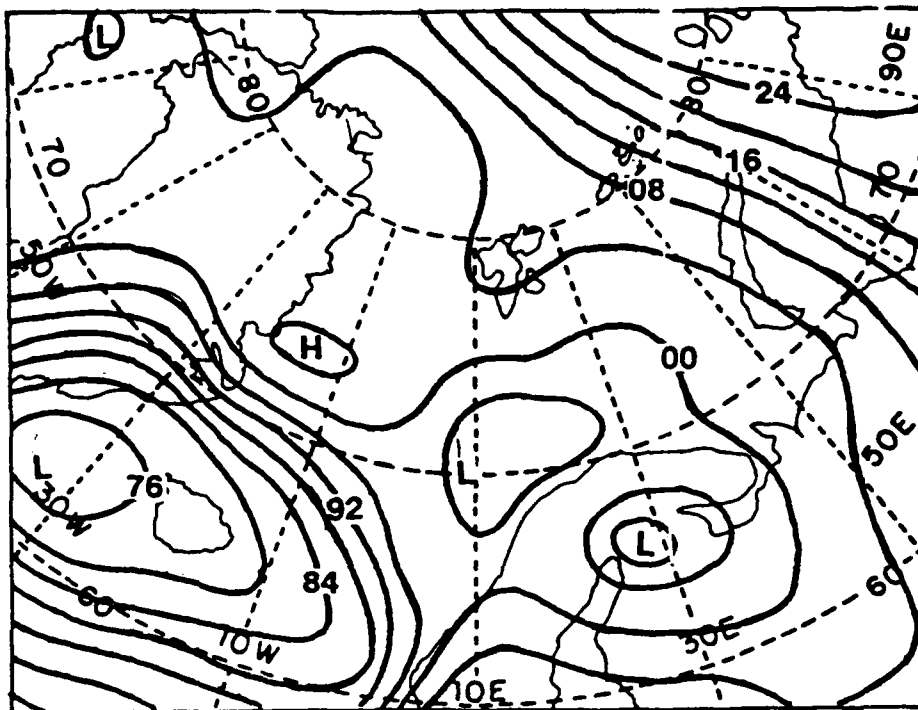


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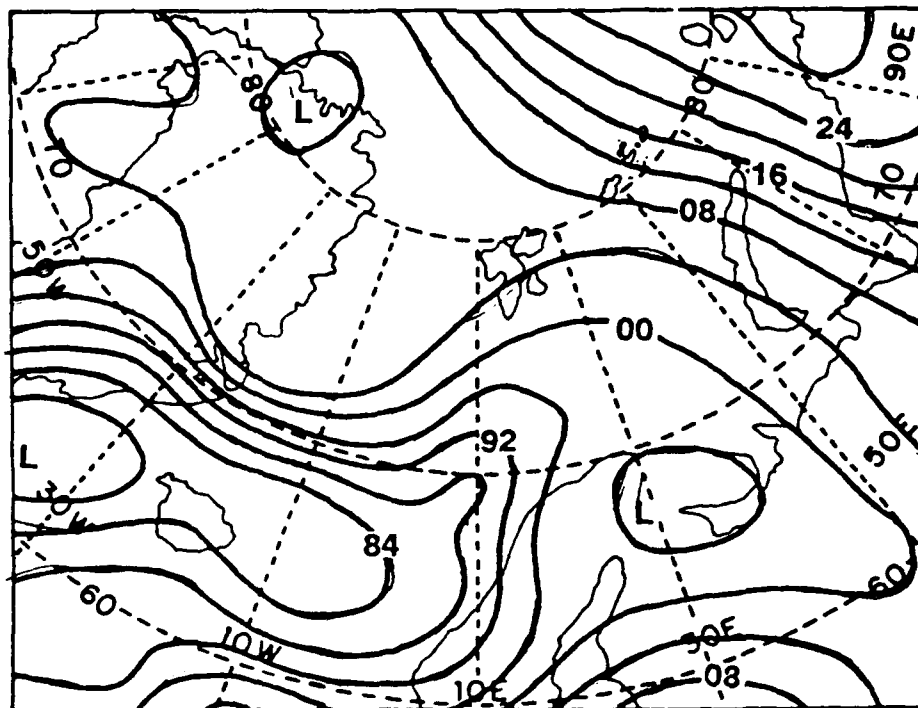


1200 UTC 17 Mar 89

Fig. PA-10. Sea level pressure analyses for 16,17 Mar 89.

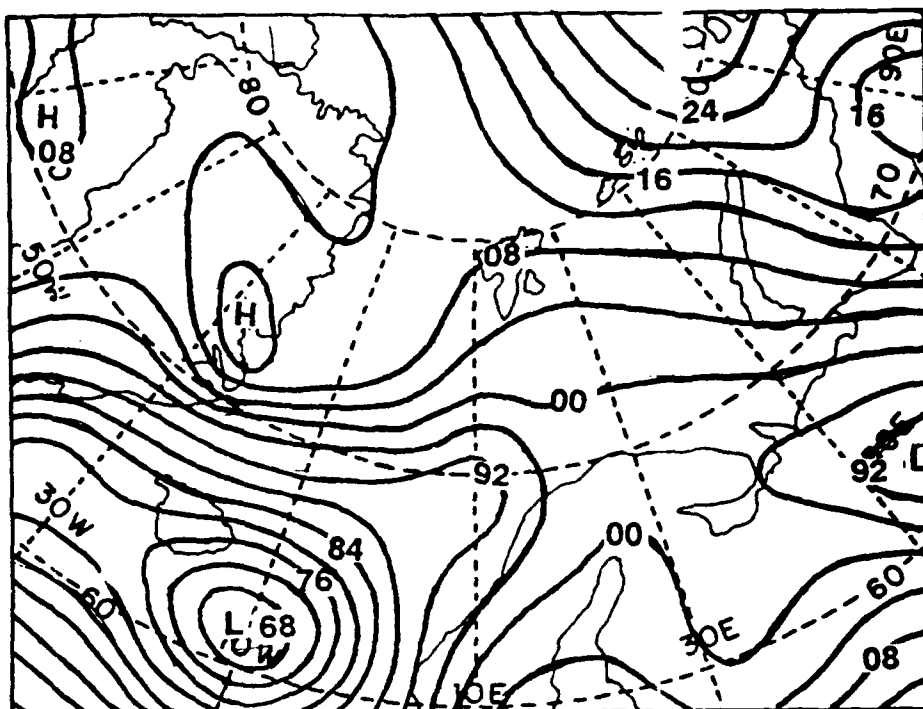


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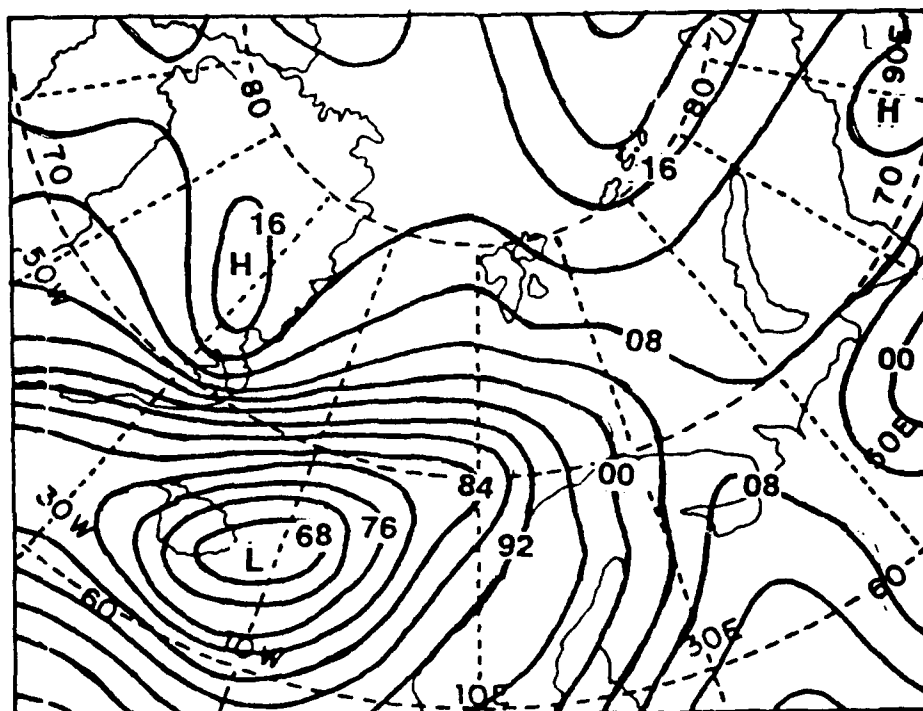


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Fig. PA-11. Sea level pressure analyses for 18,19 Mar 89.

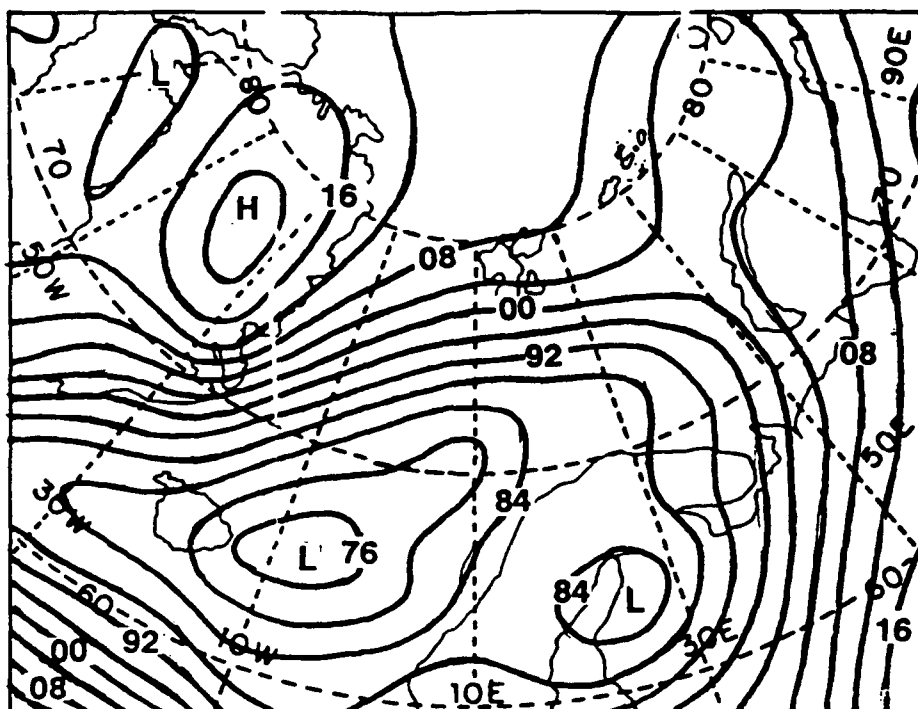


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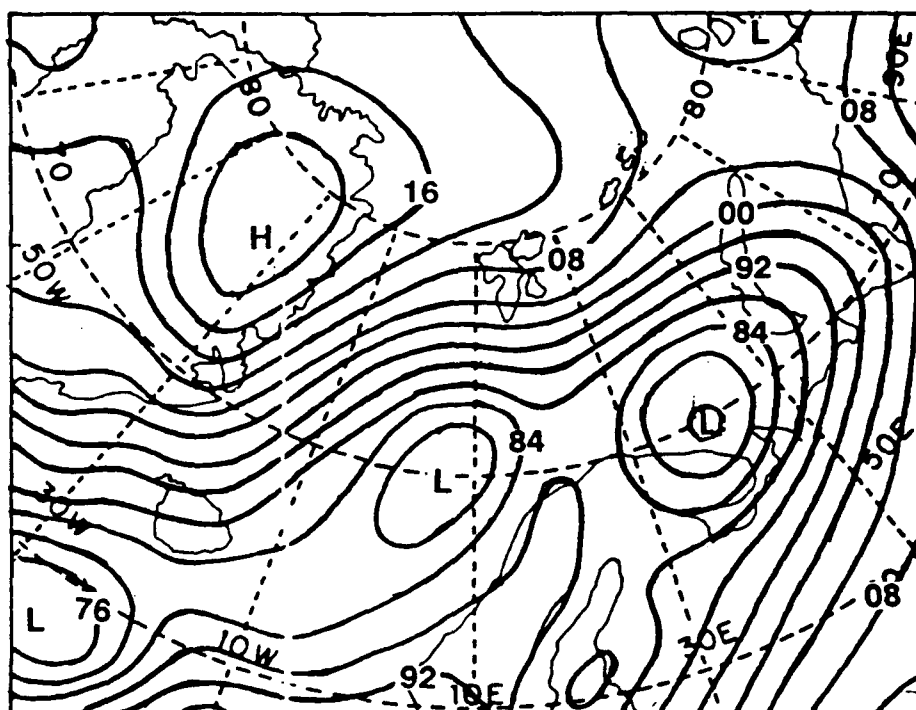


0000 UTC 21 Mar 89

Fig. PA-12. Sea level pressure analyses for 20,21 Mar 89.



1200 UTC 22 Mar 89



1200 UTC 23 Mar 89

Fig. PA-13. Sea level pressure analyses for 22,23 Mar 89.

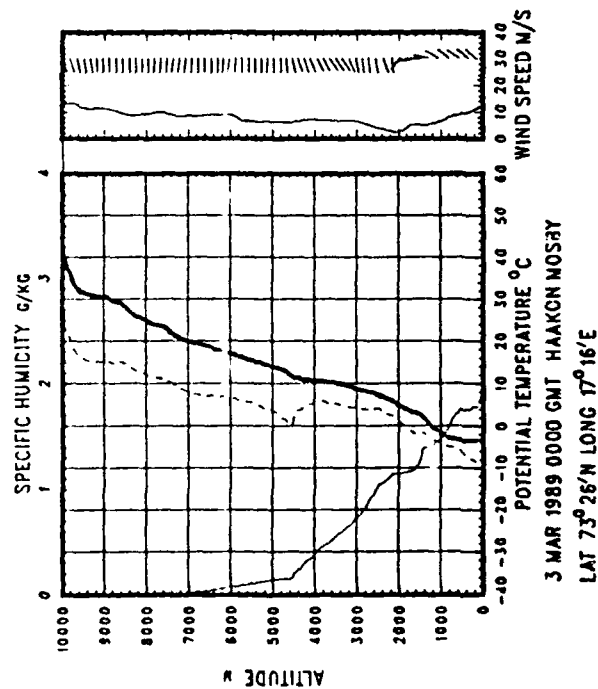
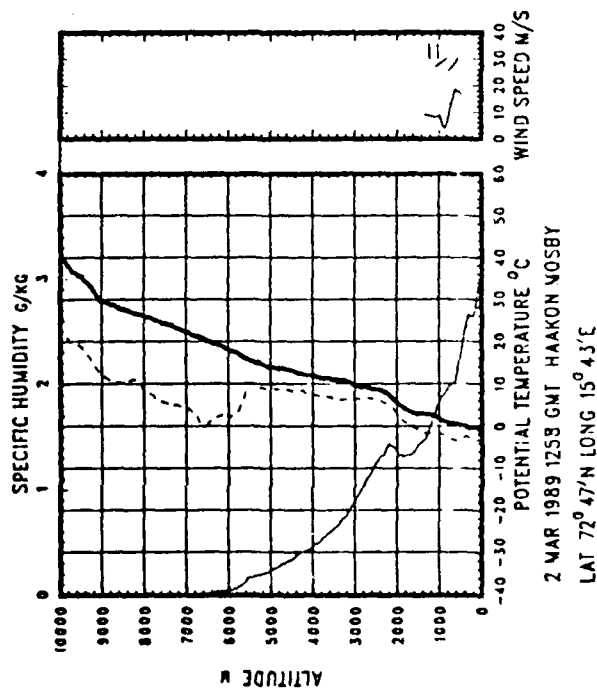
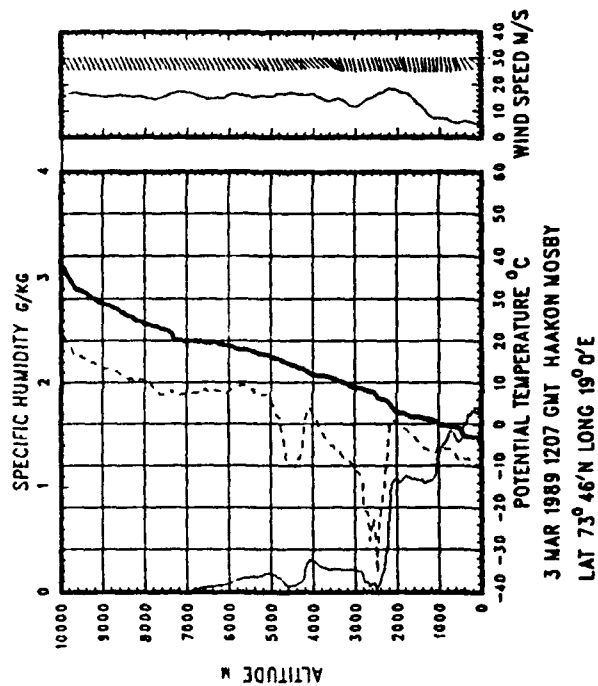
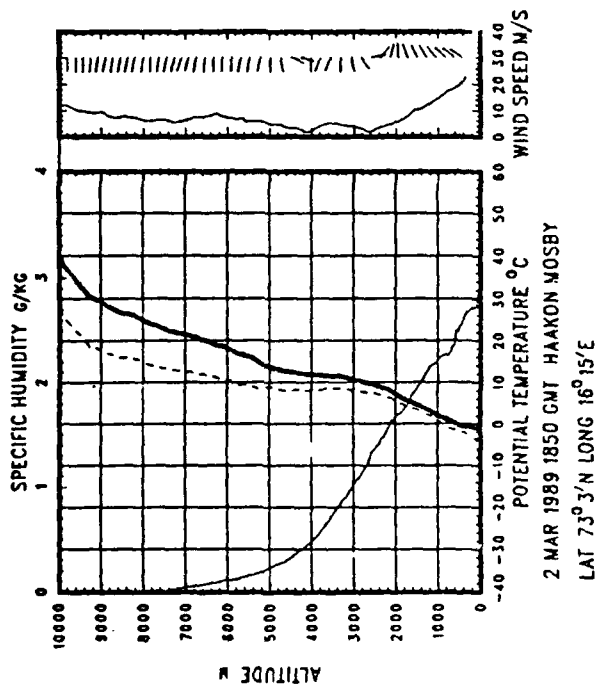


Fig. VS-1. Vertical sounding plots for 2,3 Mar 89, R/V Haakon Mosby deployment. See text for discussion of line codes and scales.

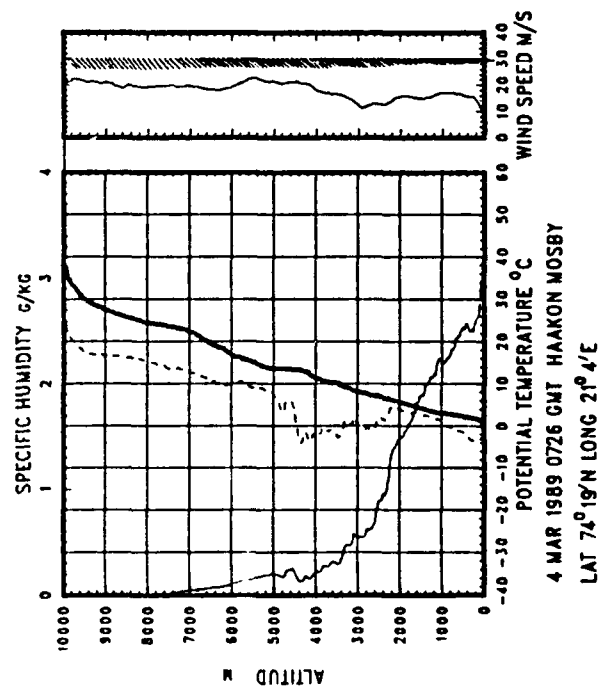
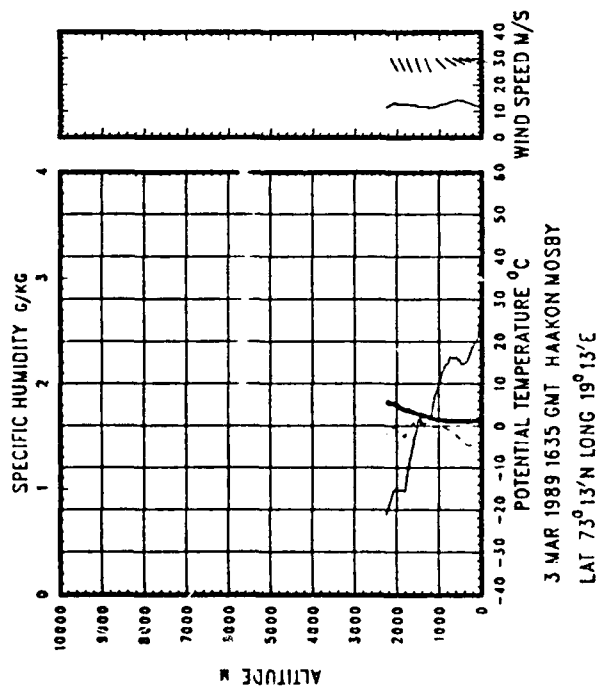
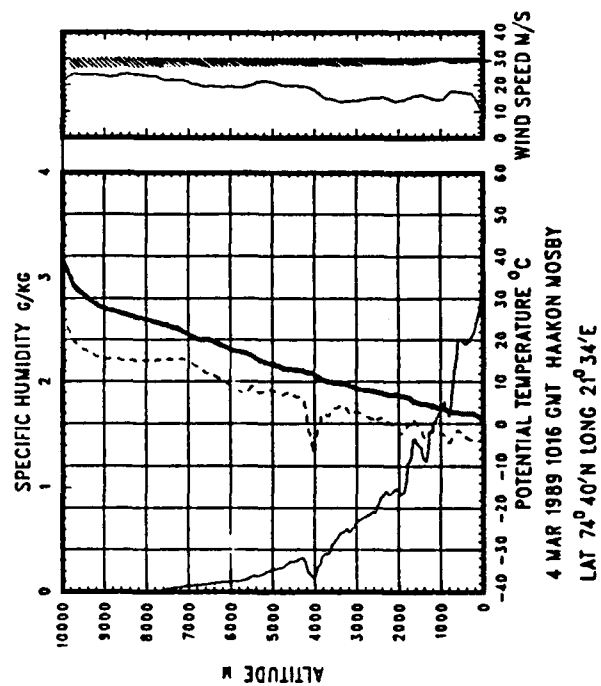
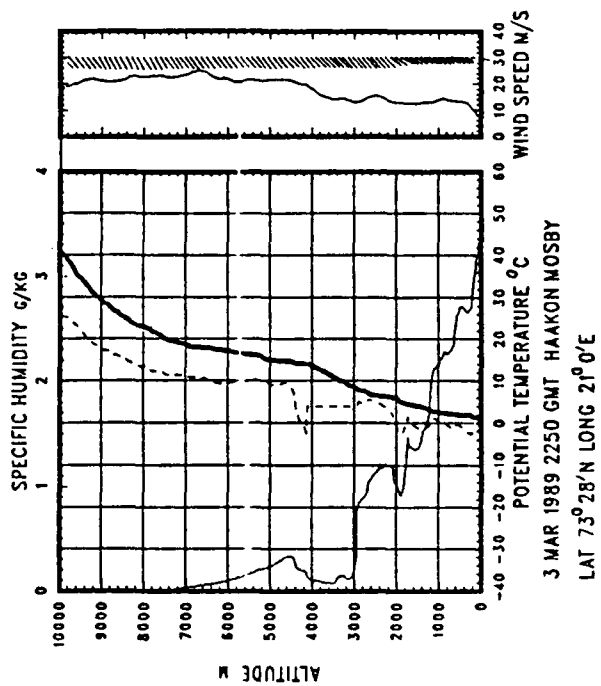


Fig. VS-2. Vertical sounding plots for 3,4 Mar 89.

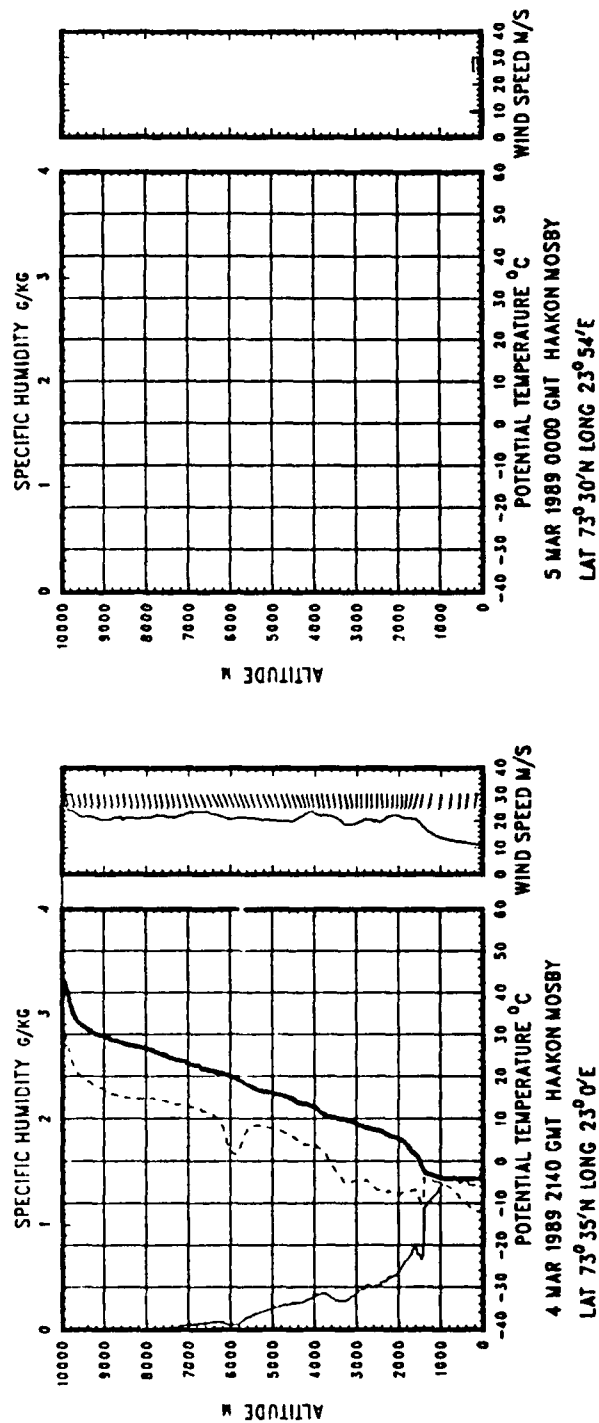
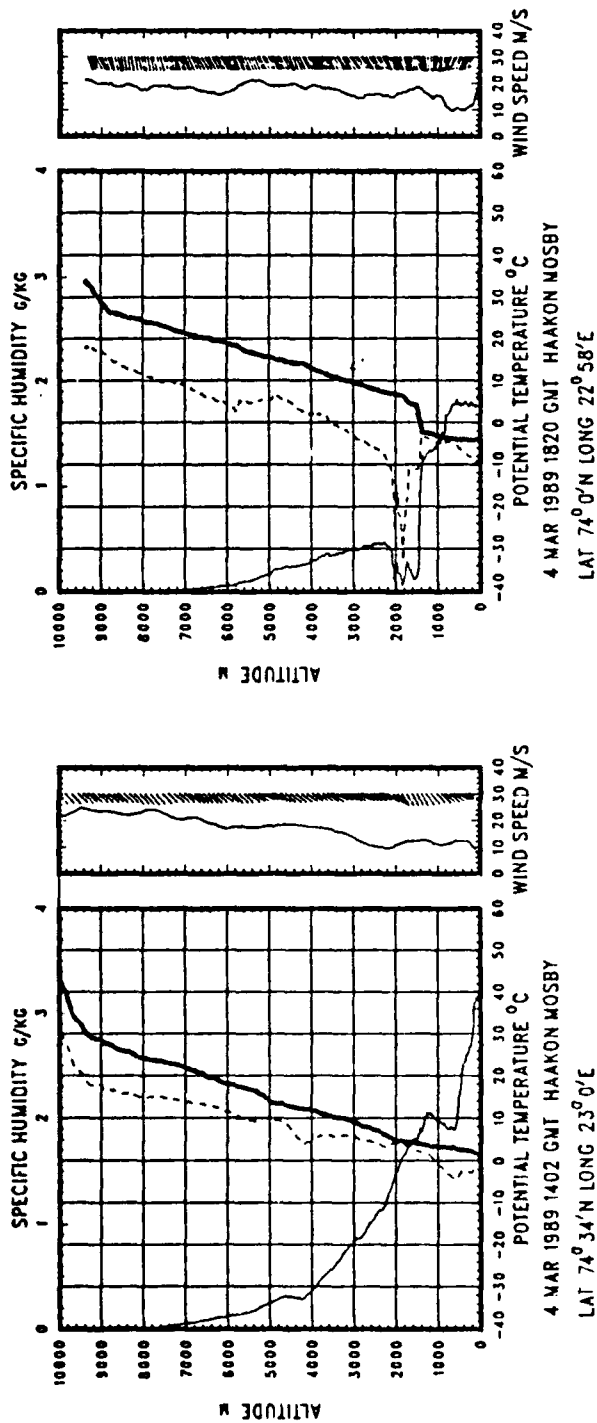


Fig. VS-3. Vertical sounding plots for 4, 5 Mar 89.

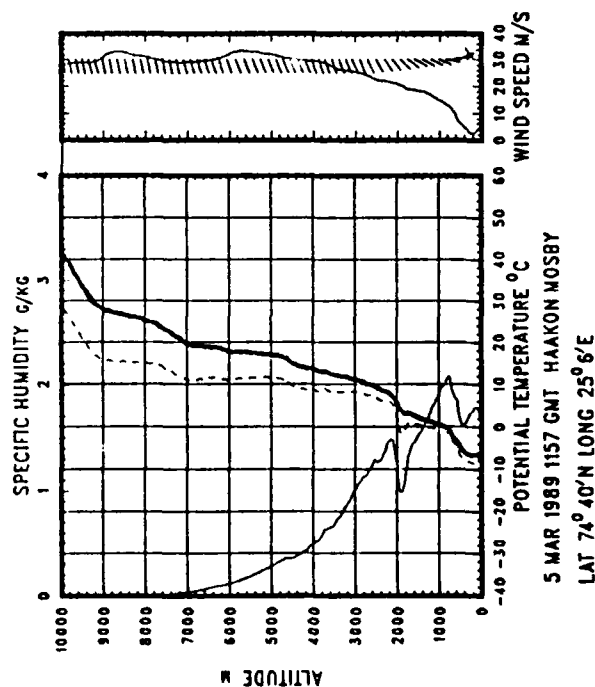
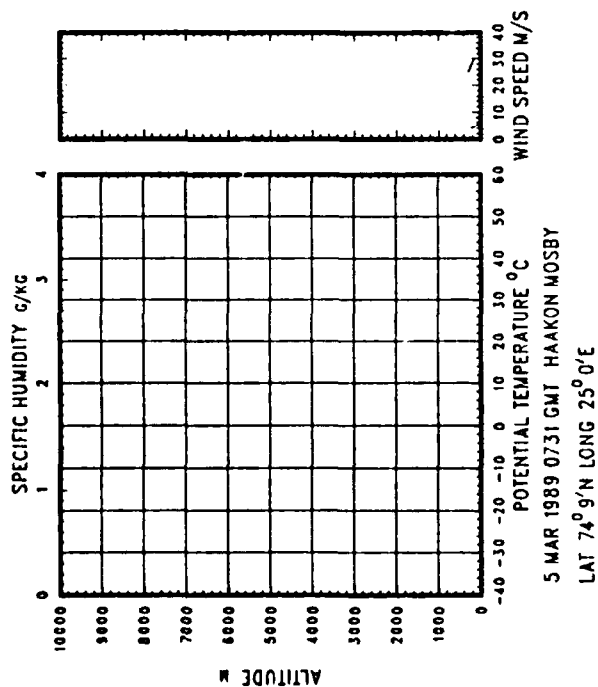
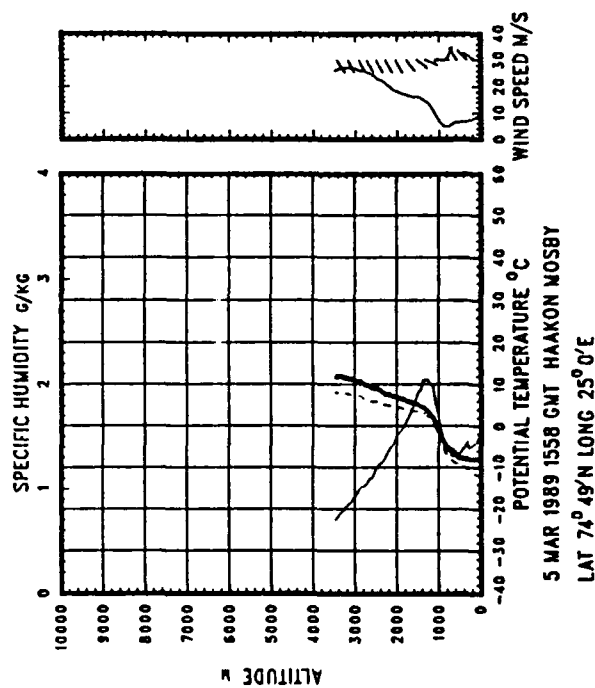
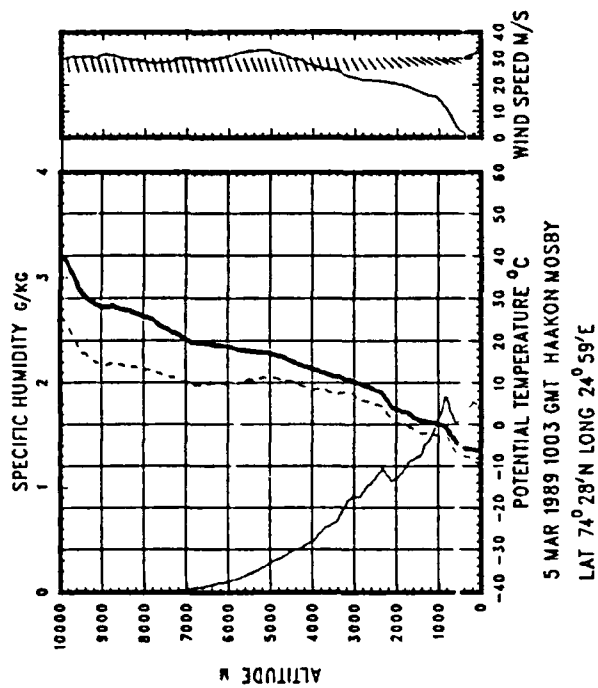


Fig. VS-4. Vertical sounding plots for 5 Mar 89.

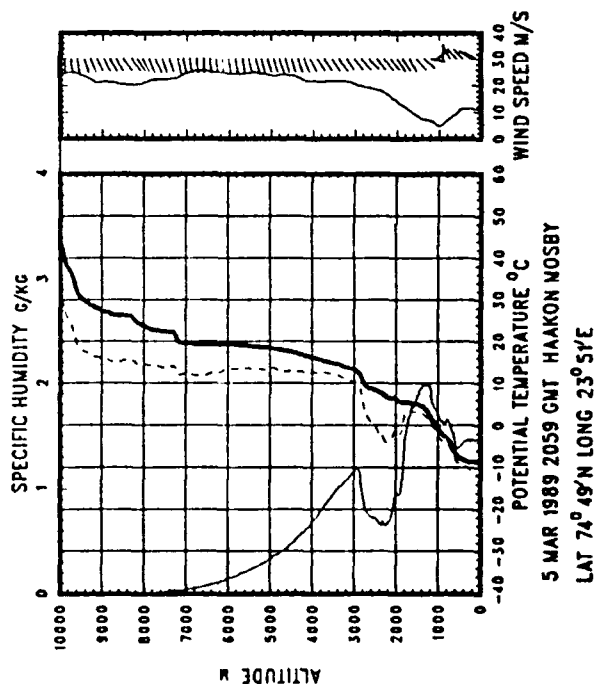
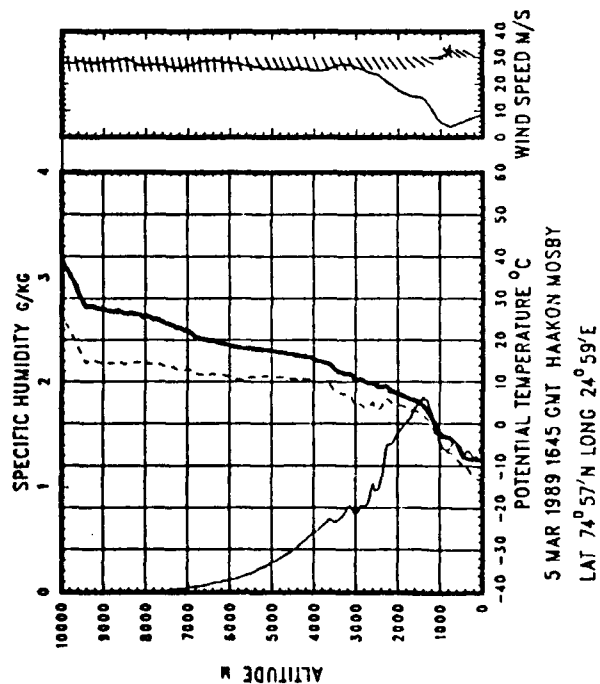
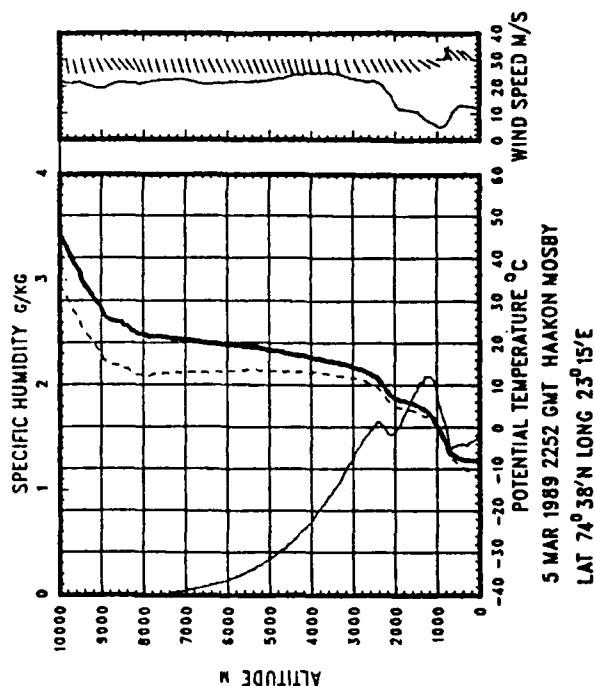
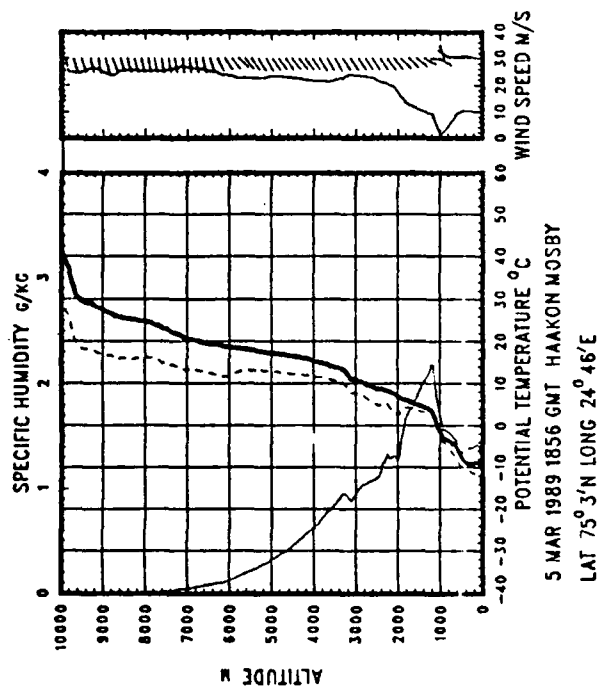


Fig. VS-5. Vertical sounding plots for 5 Mar 89.

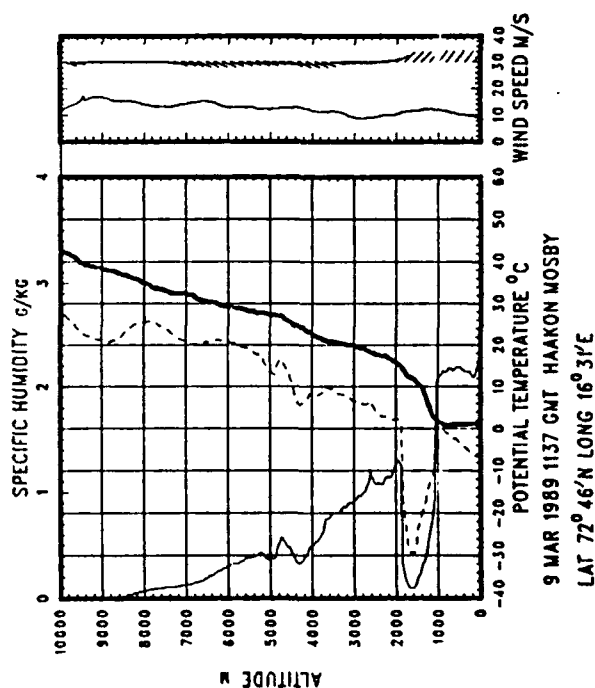
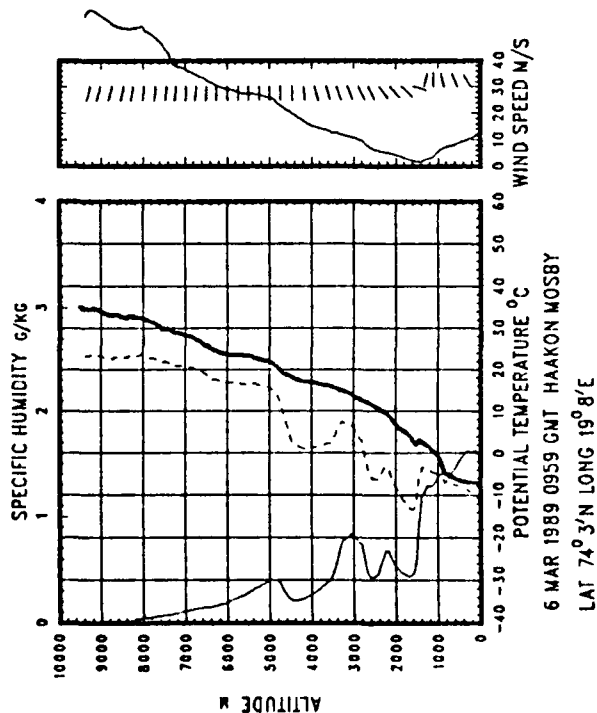
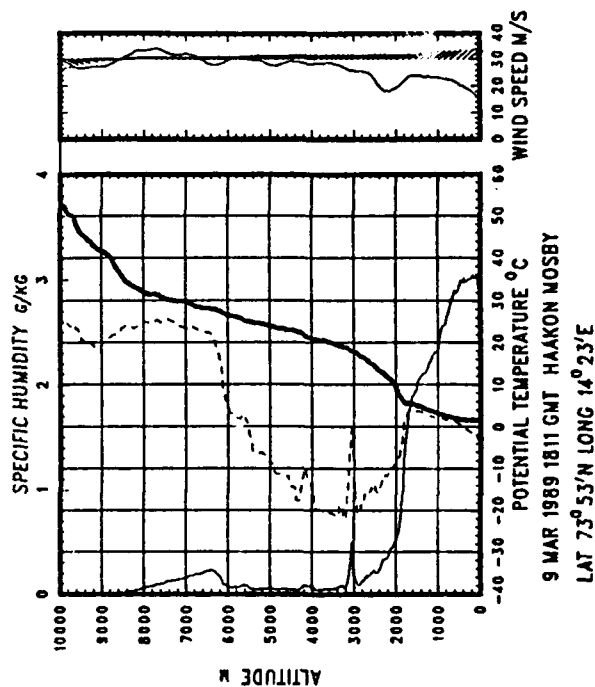
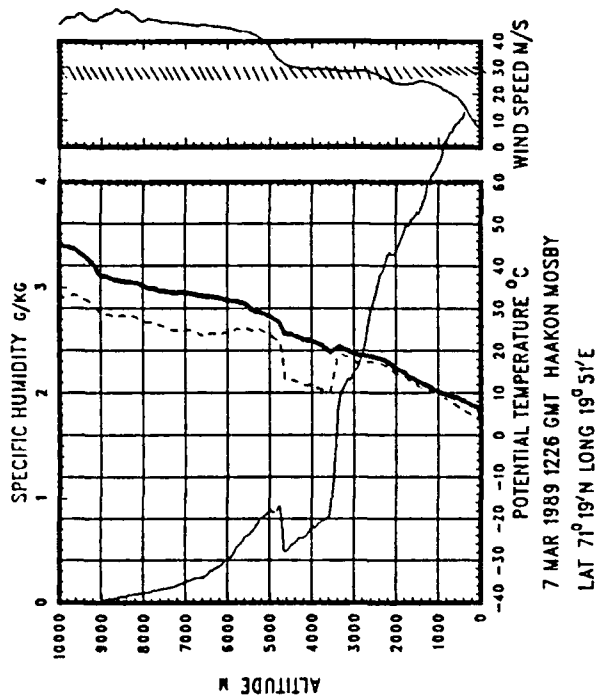


Fig. VS-6. Vertical sounding plots for 6,7,9 Mar 89.

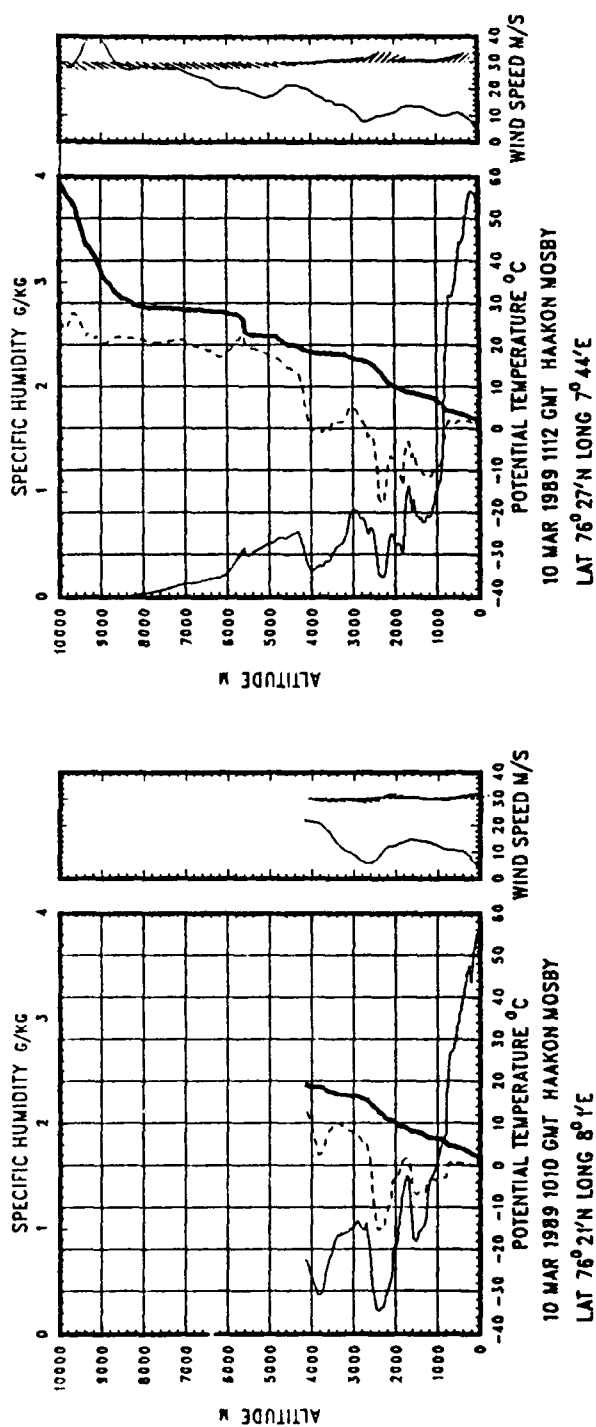
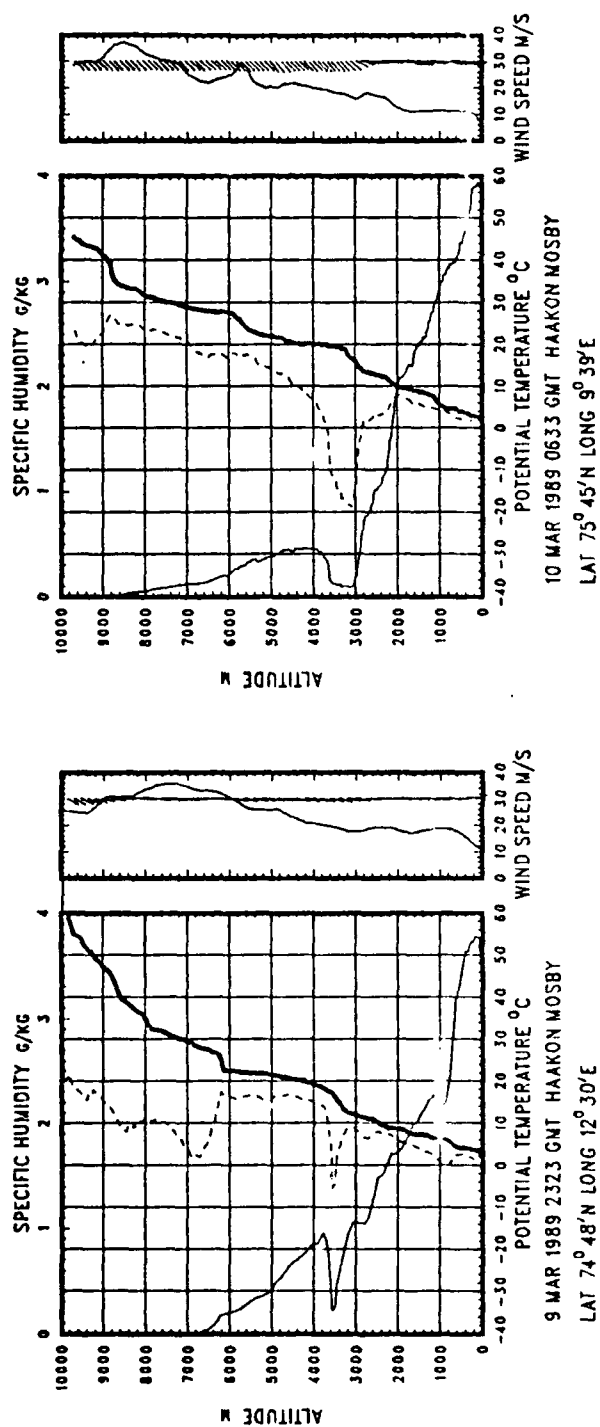


Fig. VS-7. Vertical sounding plots for 9,10 Mar 89.

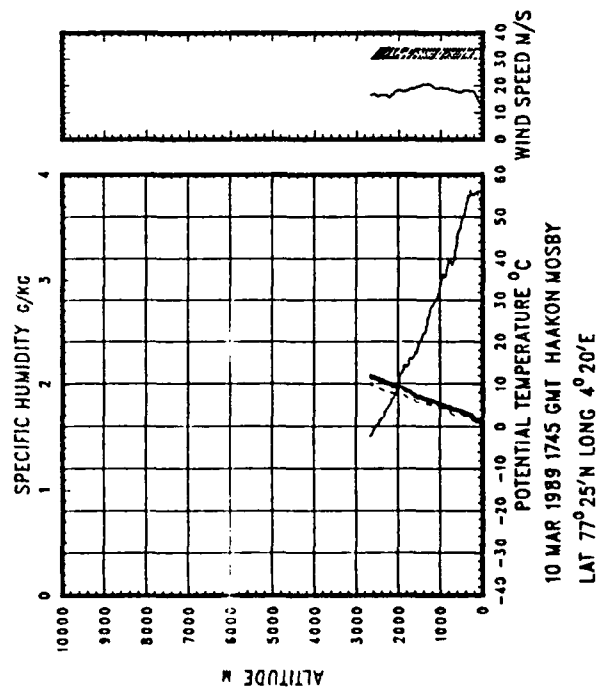
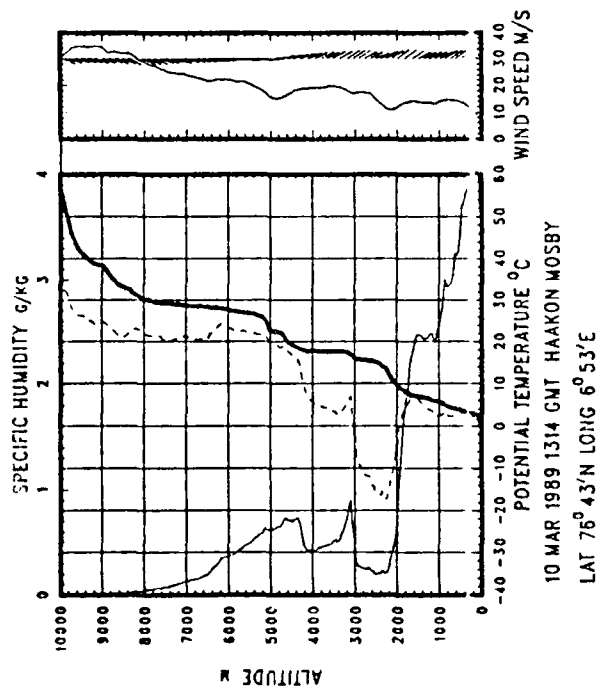
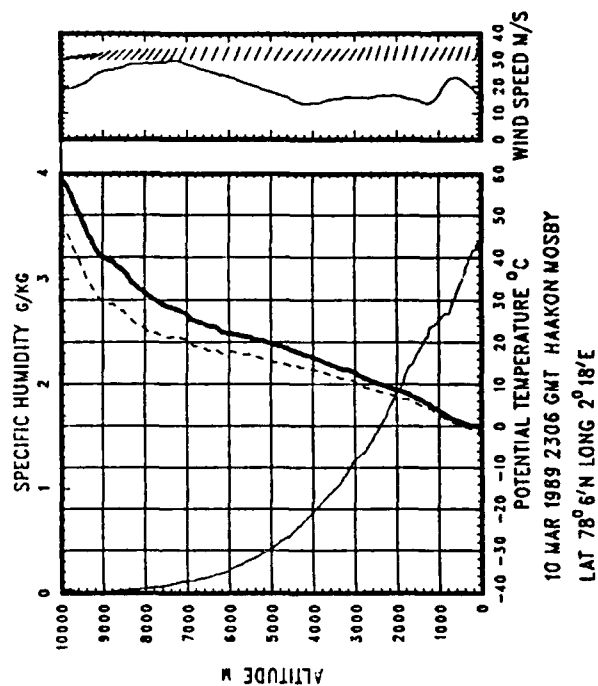
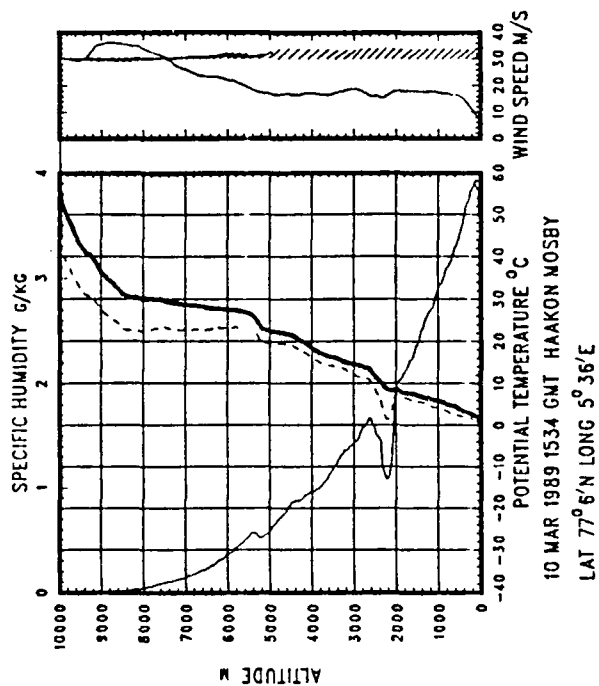


Fig. VS-8. Vertical sounding plots for 10 Mar 89.

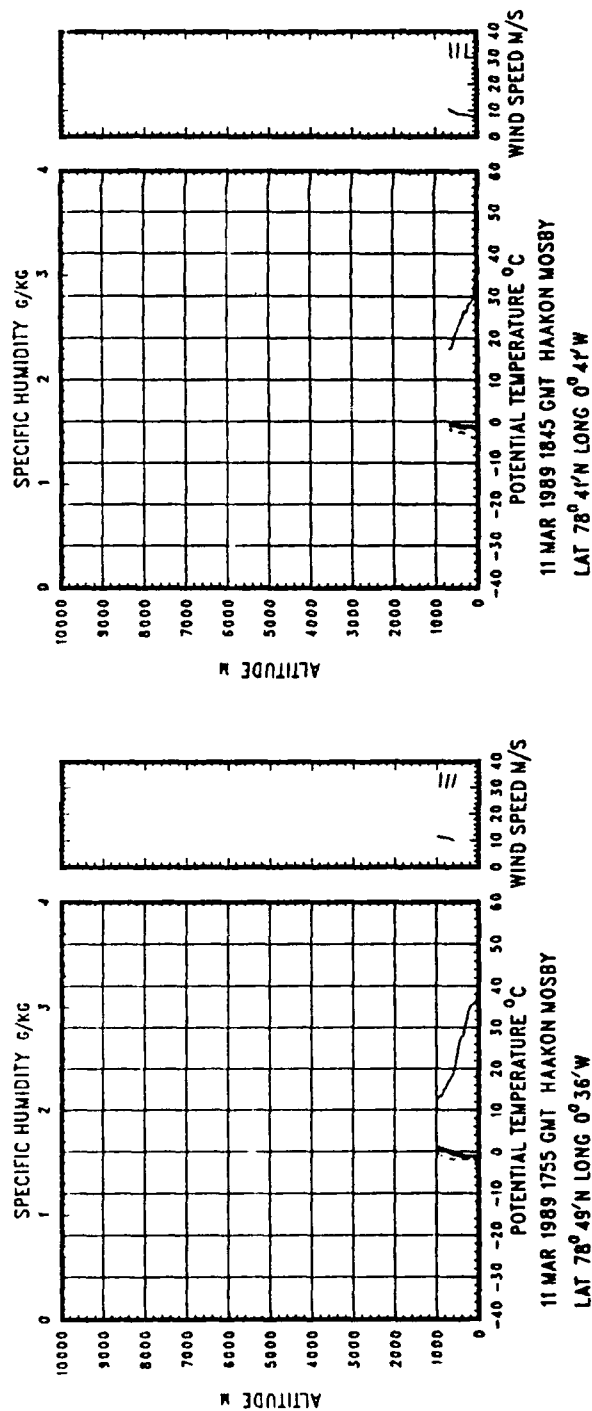
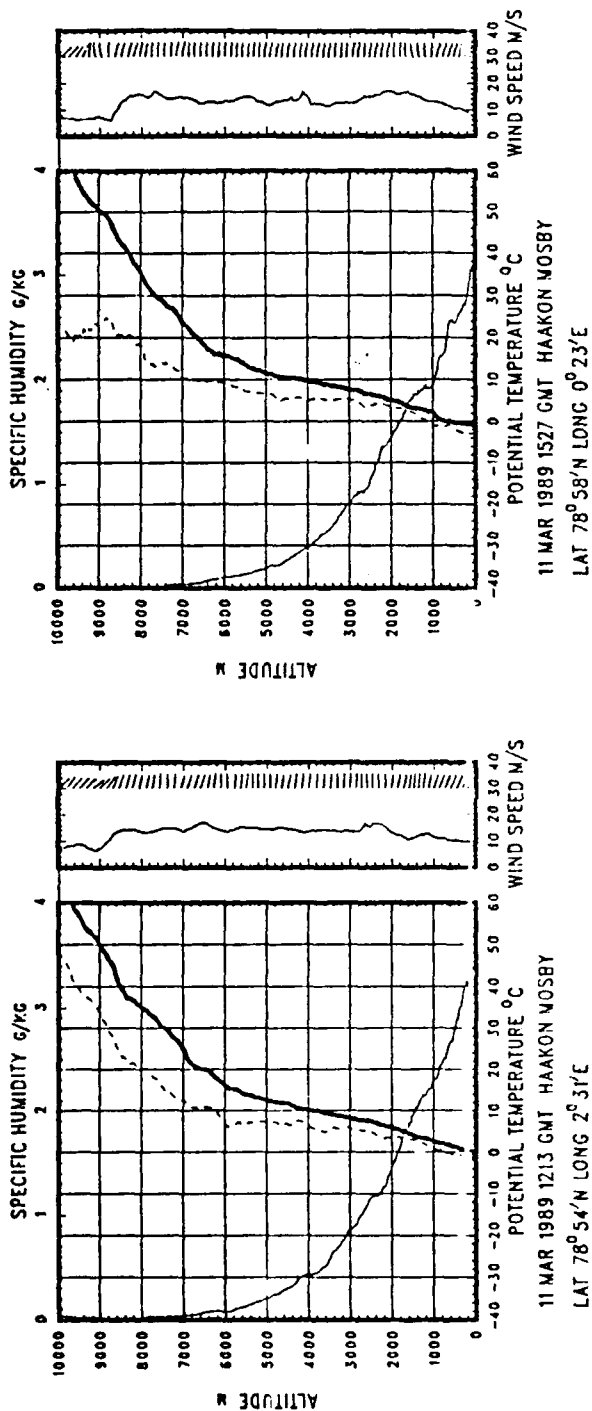


Fig. VS-9. Vertical sounding plots for 11 Mar 89.

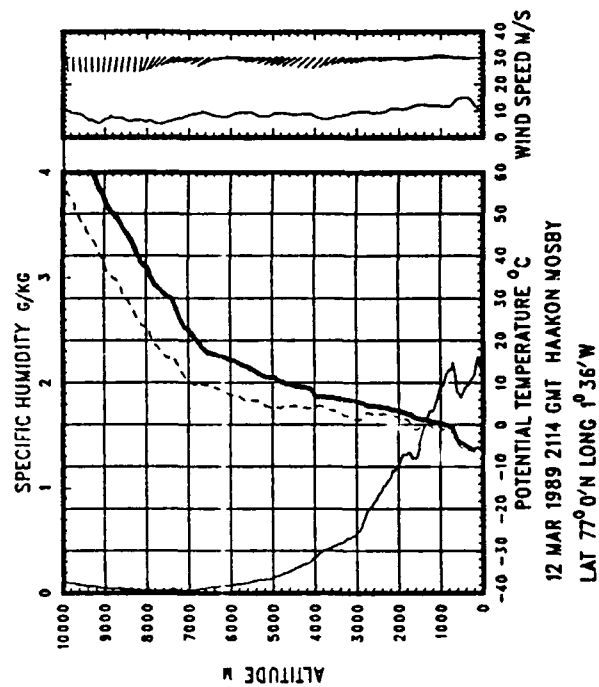
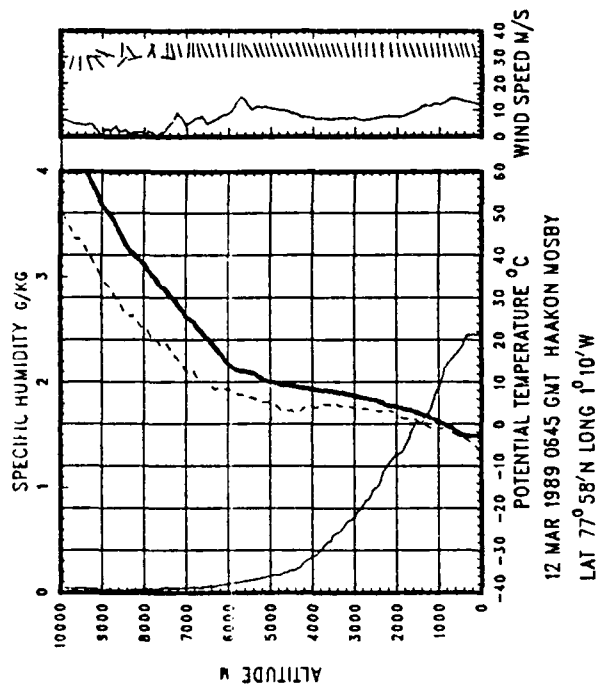
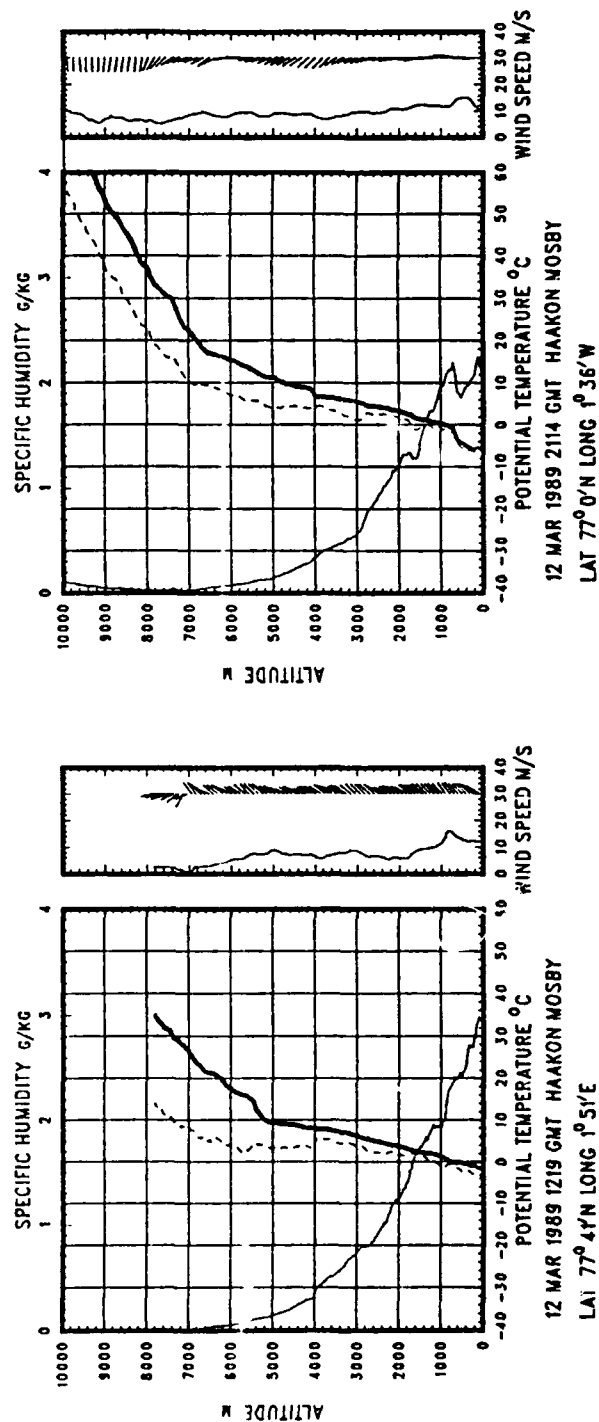
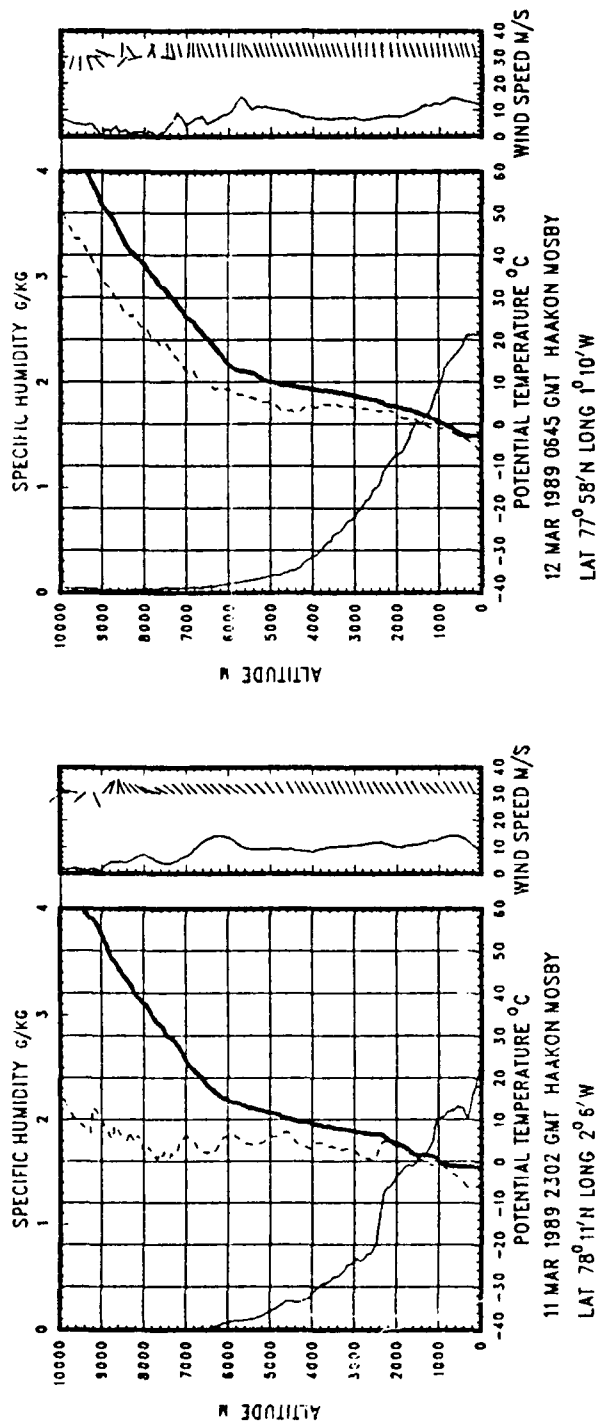


Fig. VS-10. Vertical sounding plots for 11,12 Mar 89.

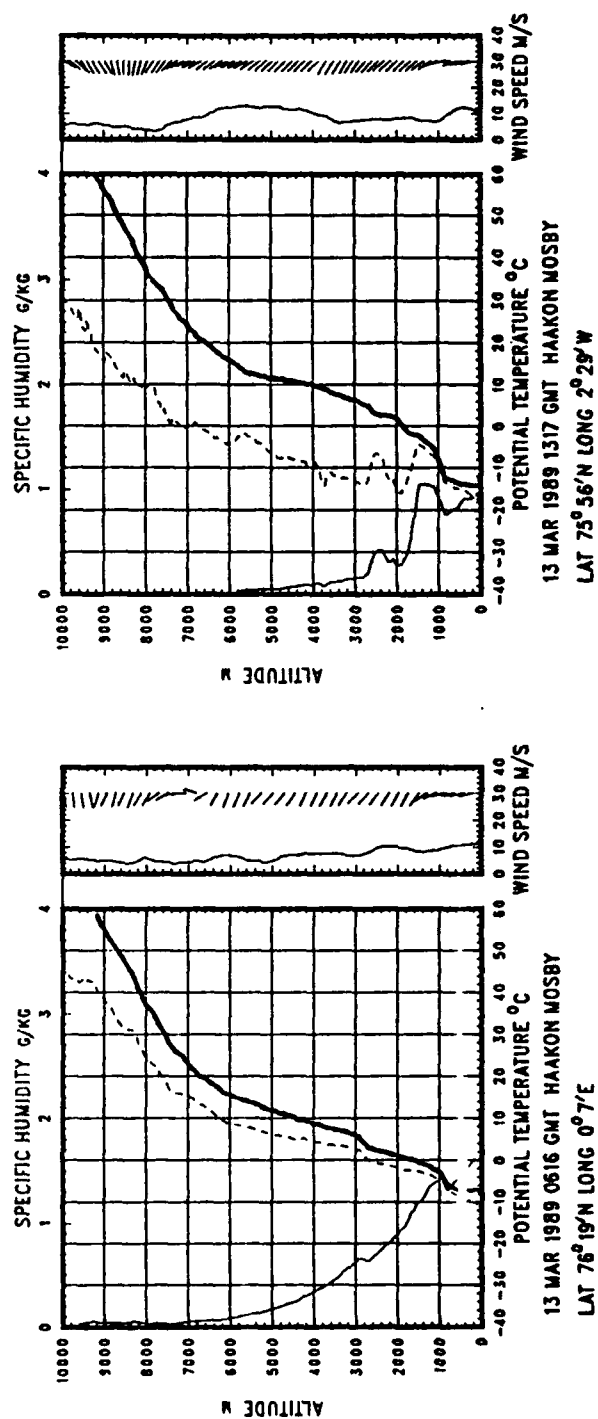
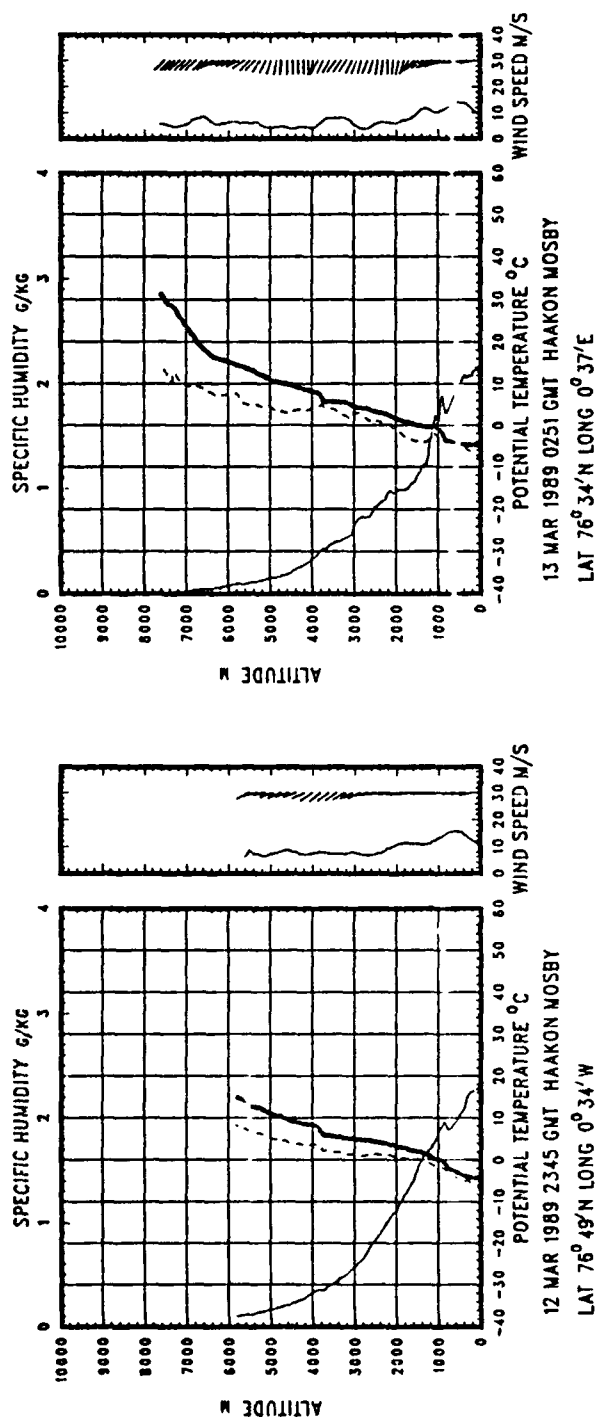


Fig. VS-11. Vertical sounding plots for 12,13 Mar 89.

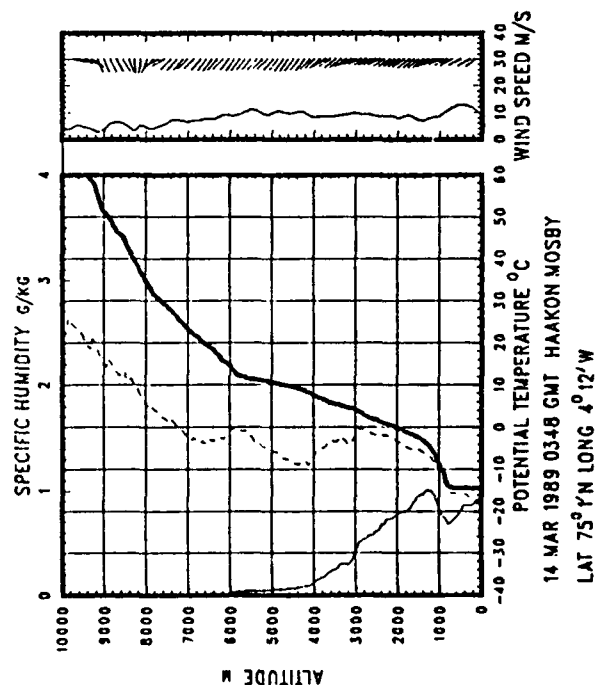
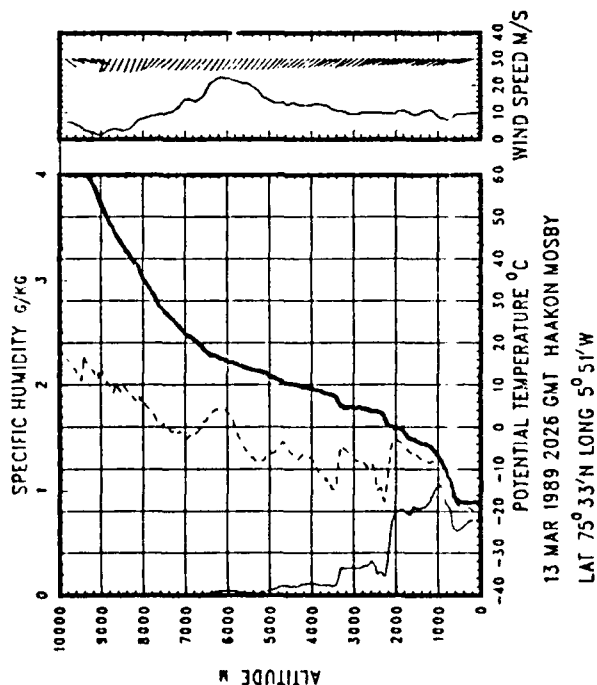
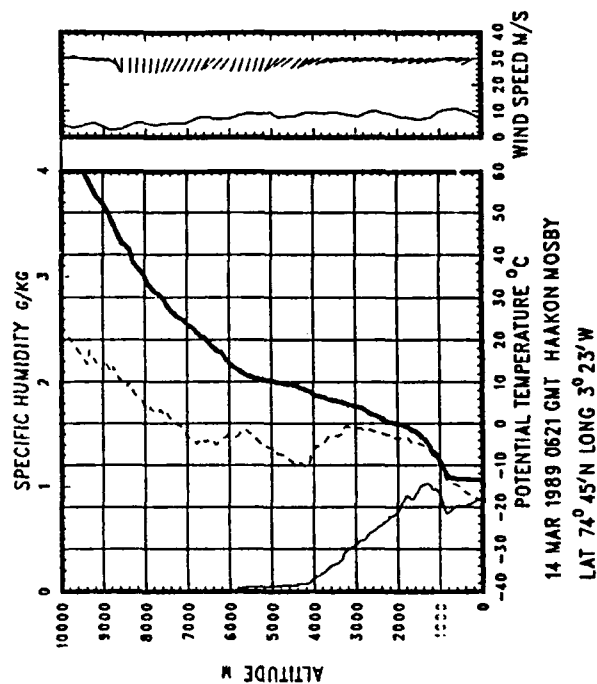
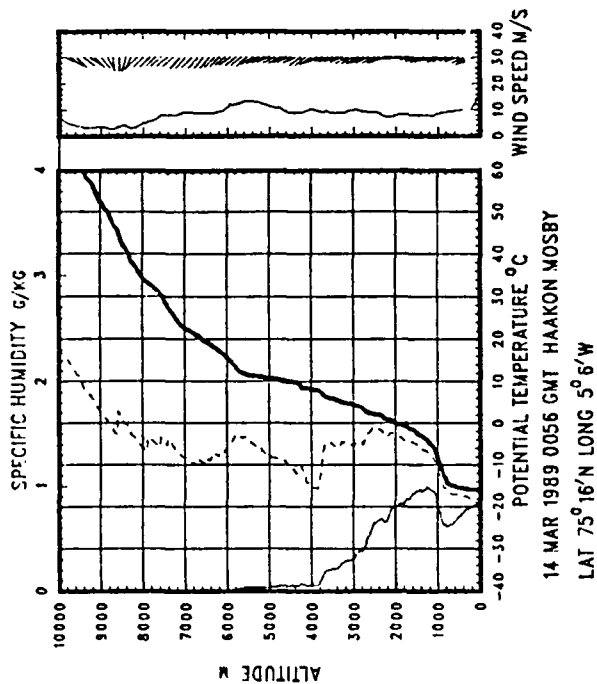


Fig. VS-12. Vertical sounding plots for 13, 14 Mar 89.

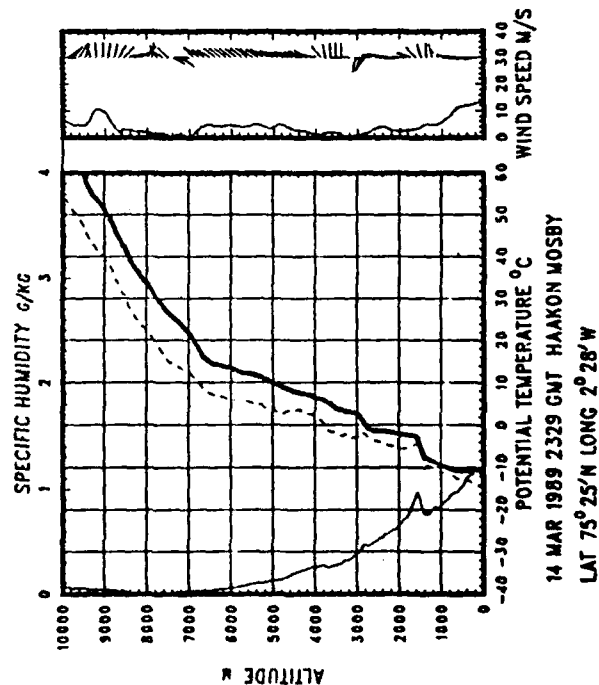
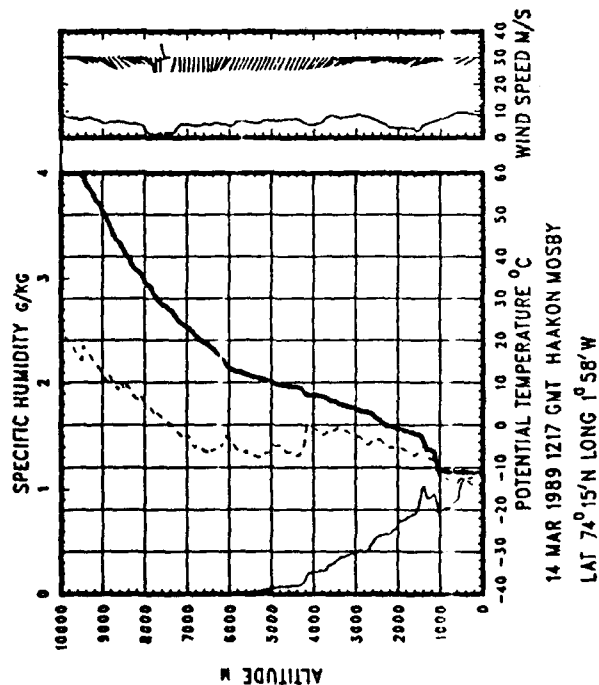
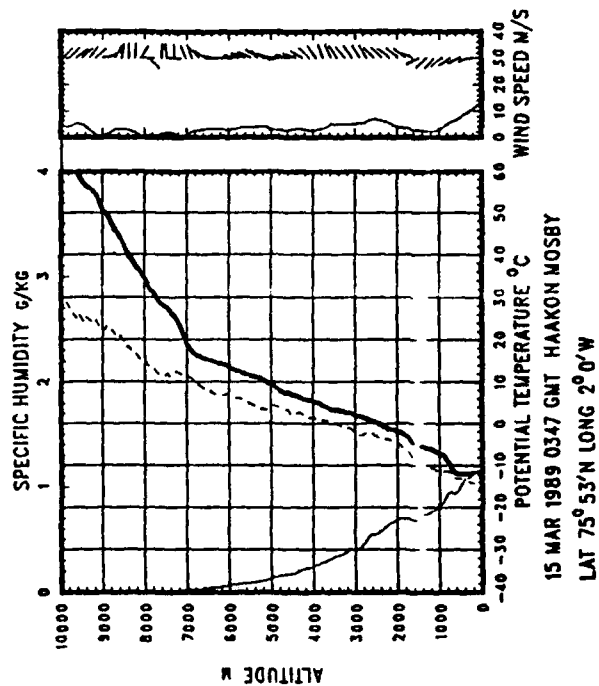
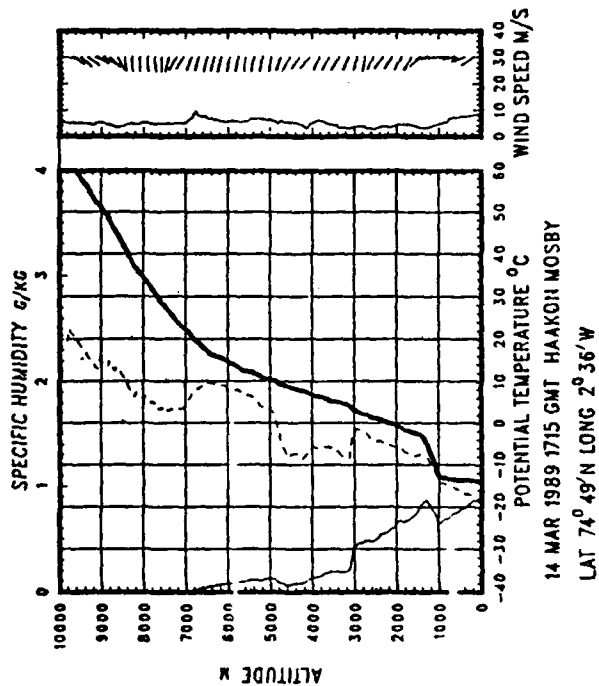


Fig. VS-13. Vertical sounding plots for 14, 15 Mar 89.

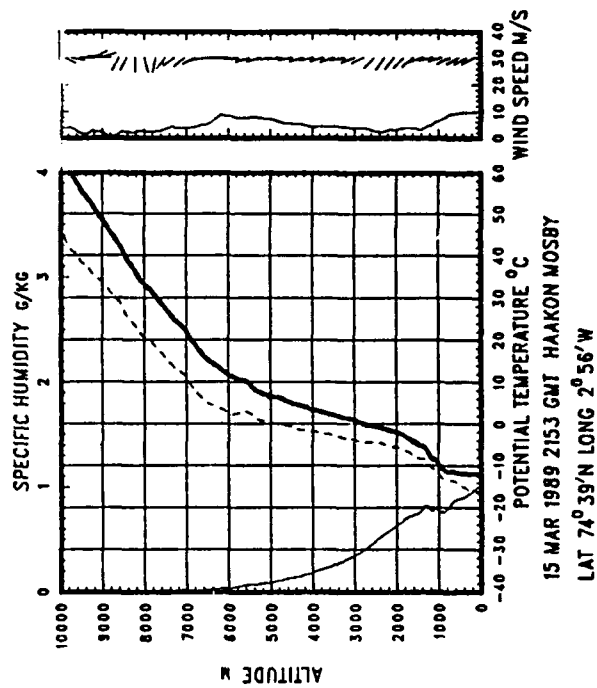
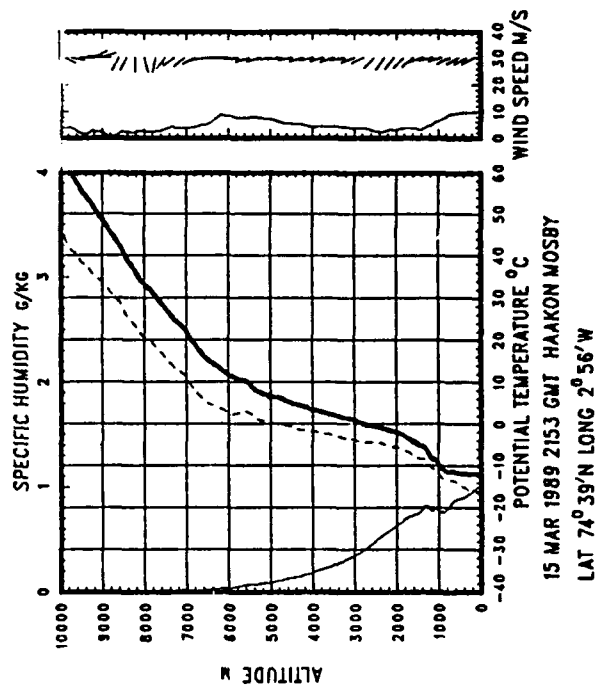
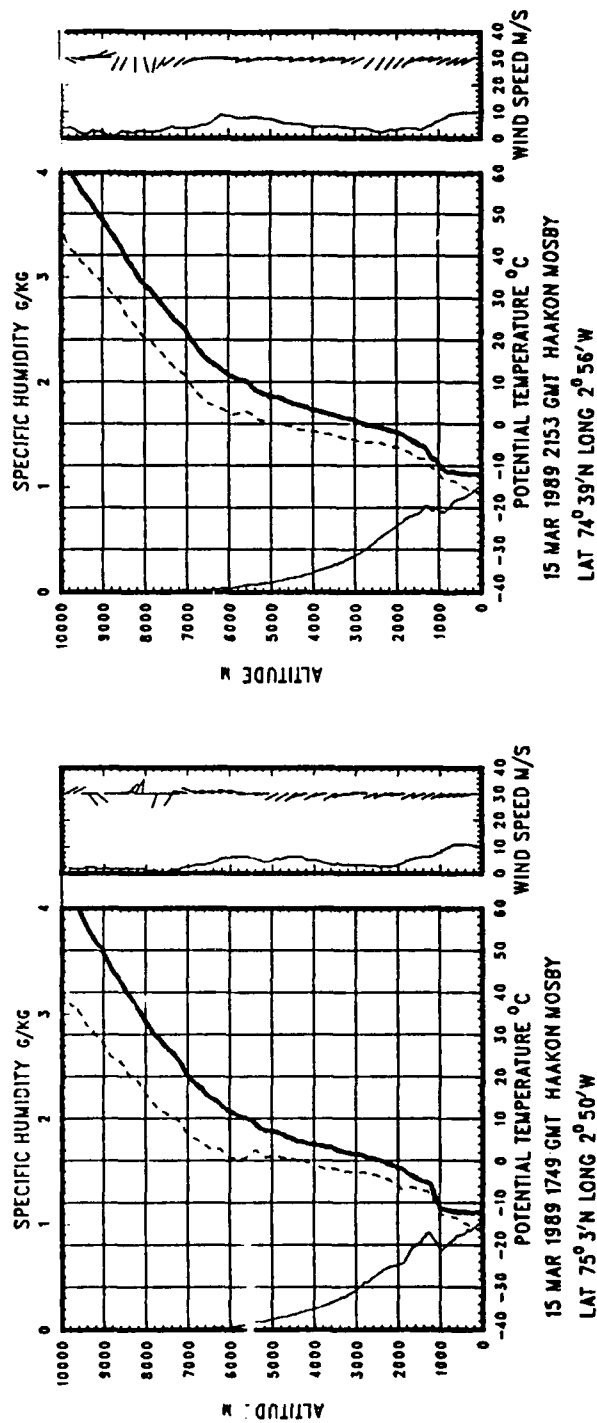
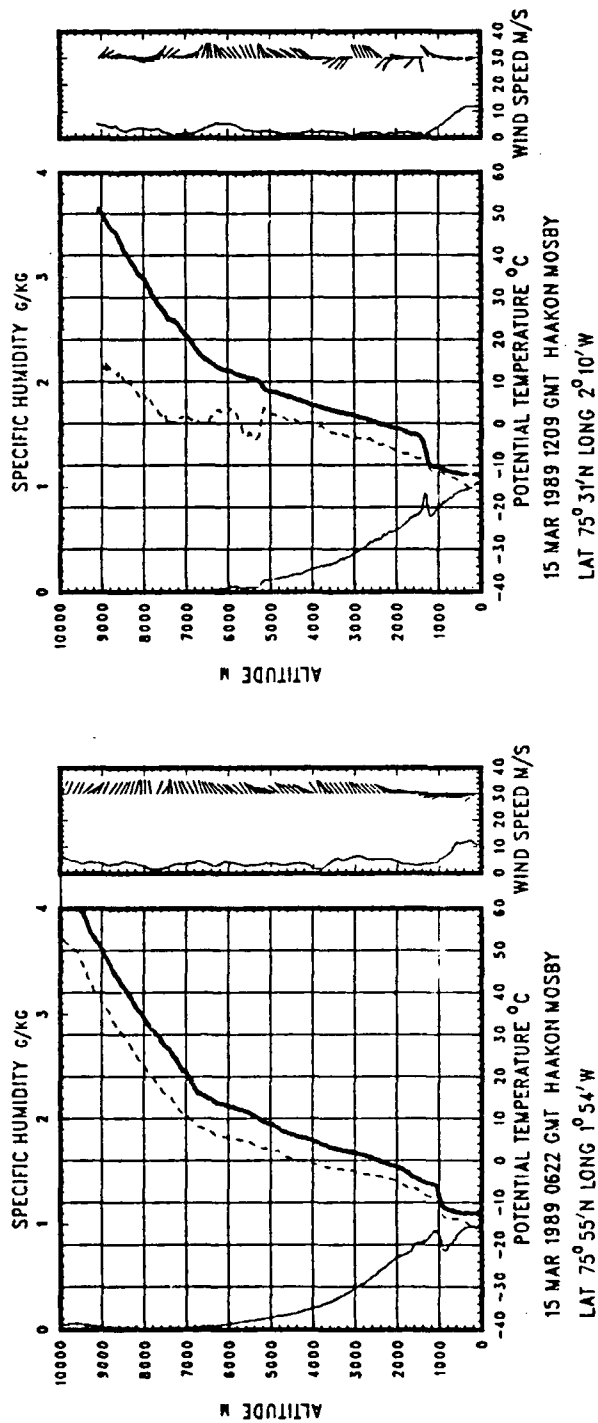


Fig. VS-14. Vertical sounding plots for 15 Mar 89.

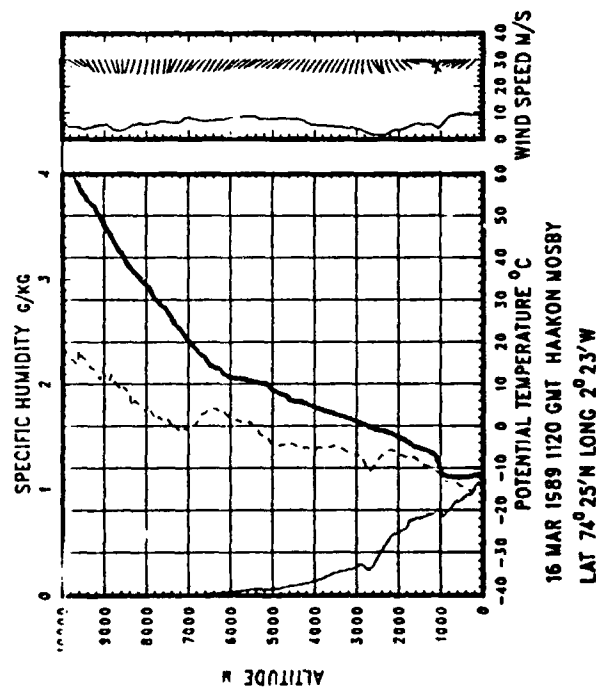
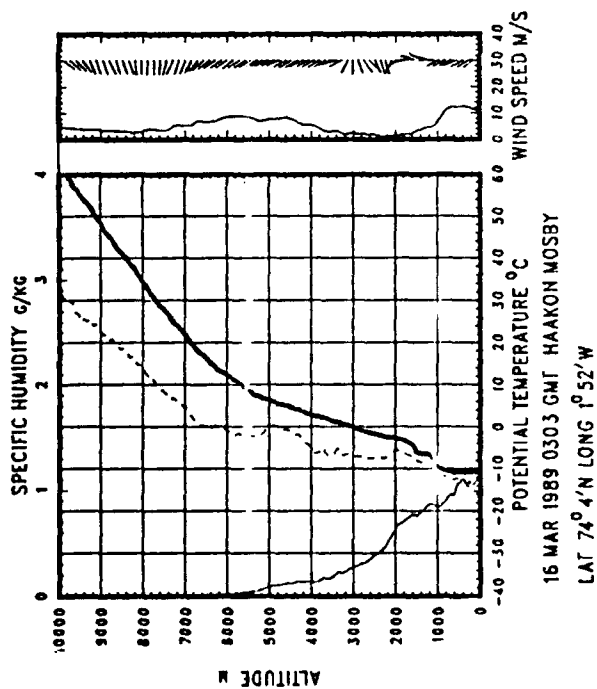
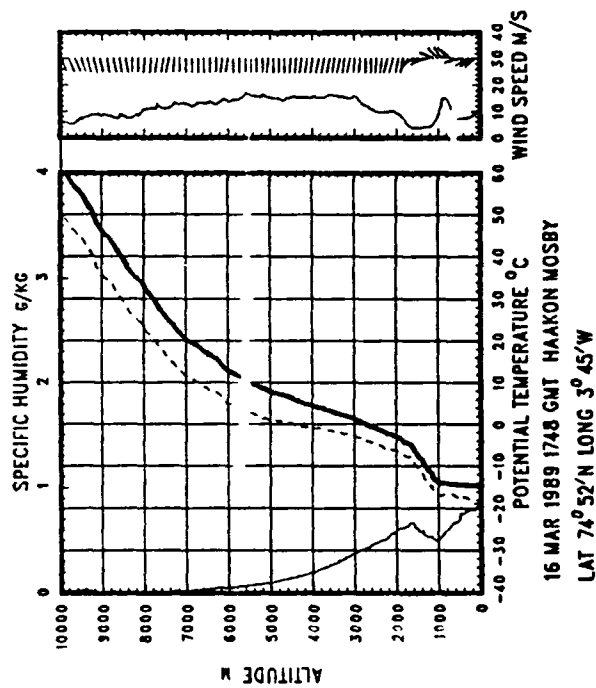
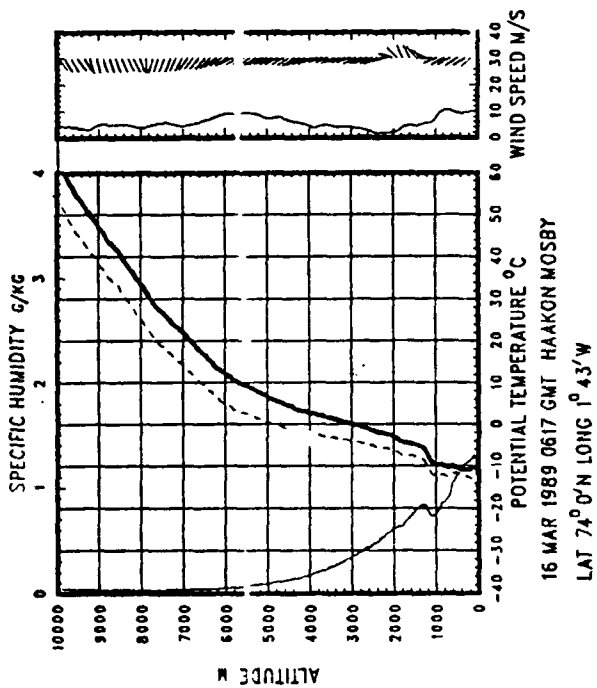


Fig. VS-15. Vertical sounding plots for 16 Mar 89.

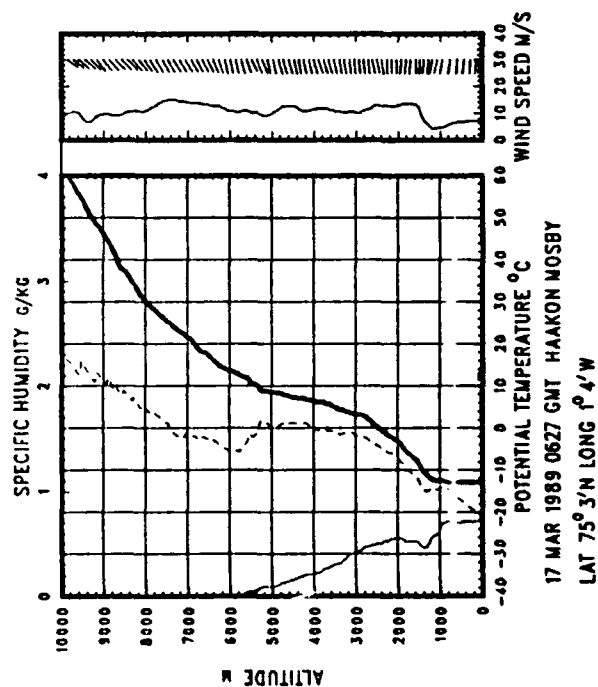
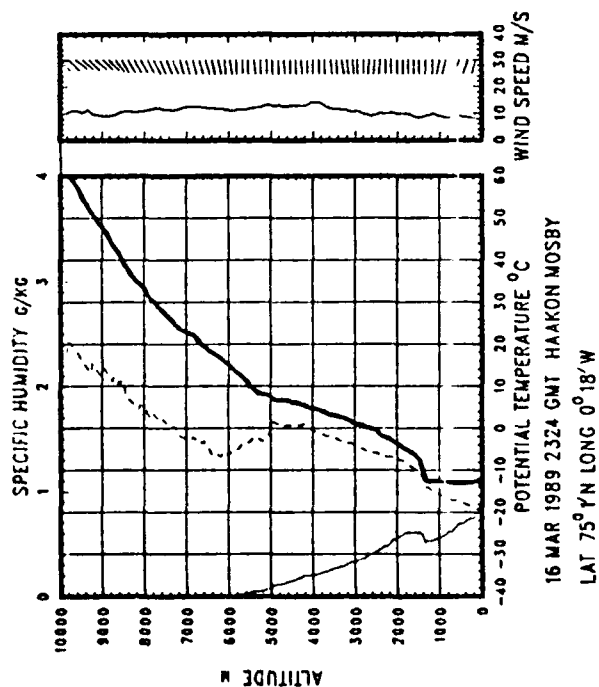
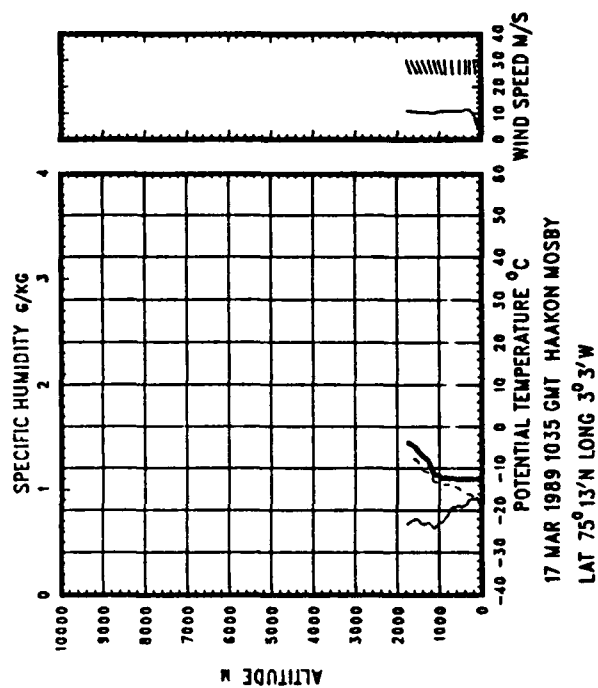
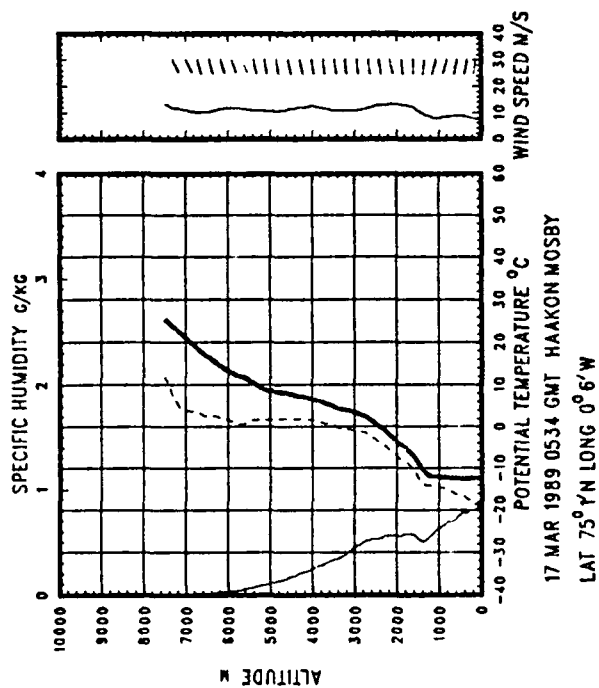


Fig. VS-16. Vertical sounding plots for 16, 17 Mar 89.

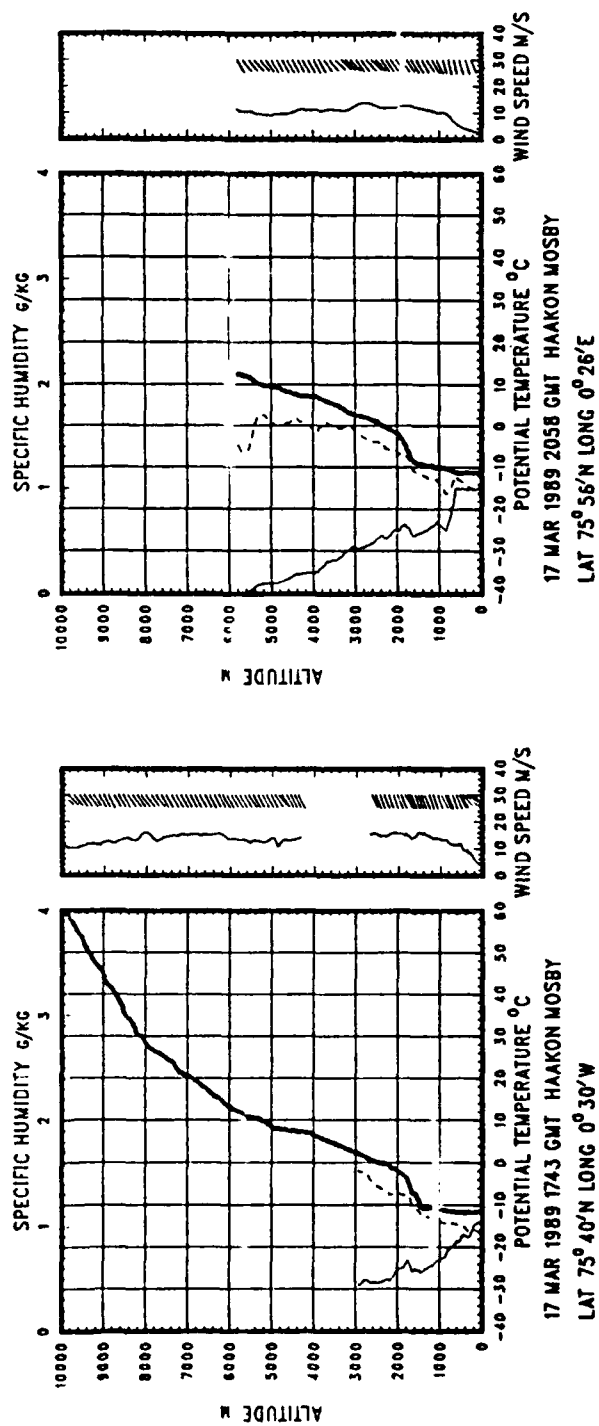
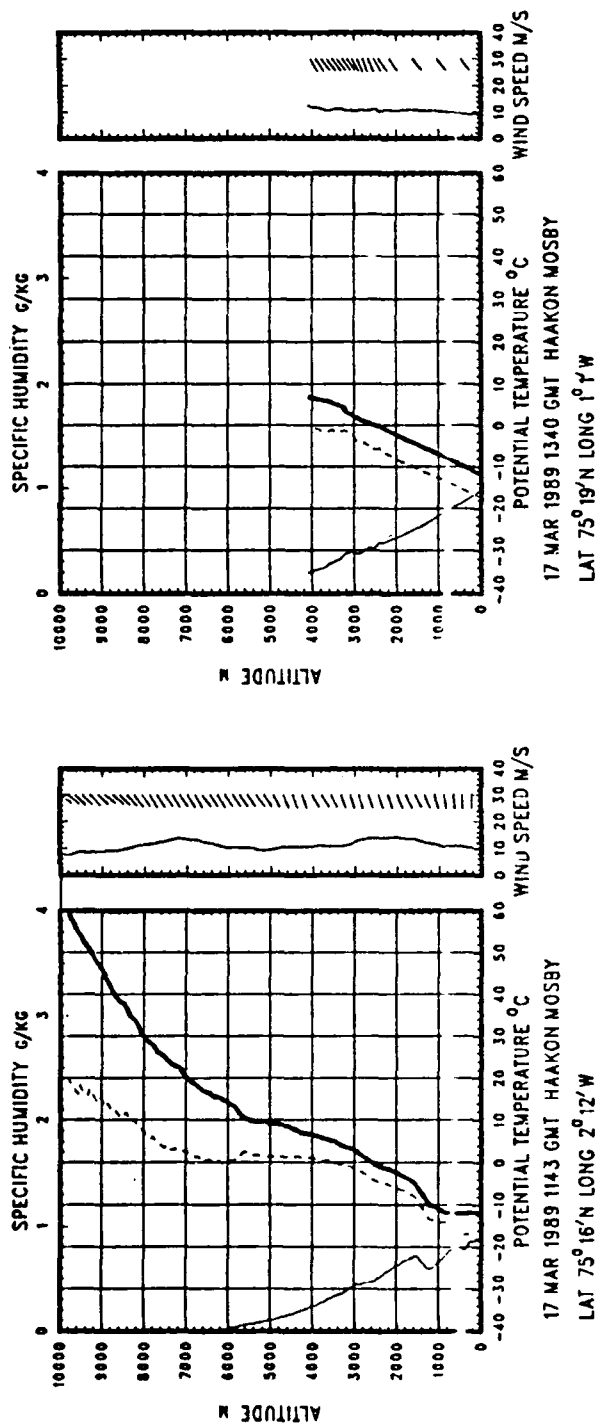


Fig. VS-17. Vertical sounding plots for 17 Mar 89.

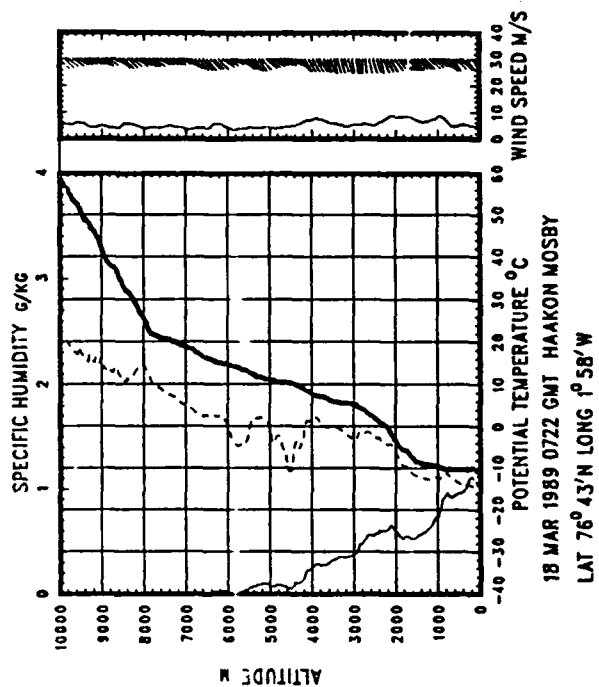
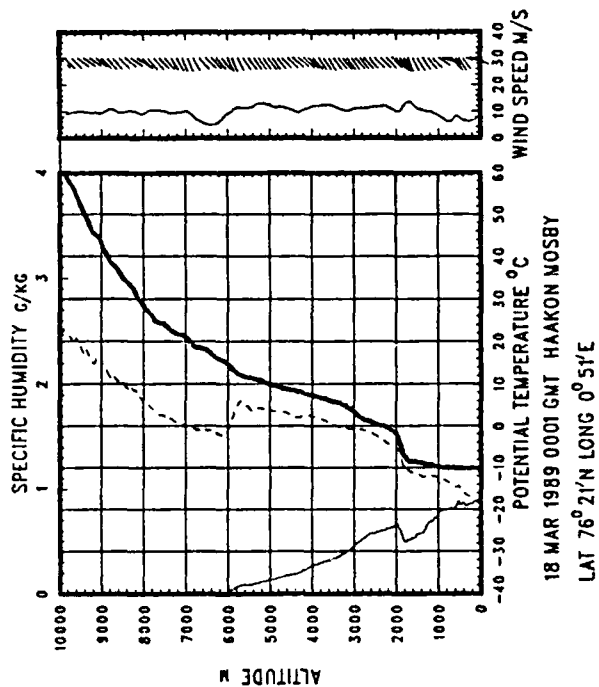
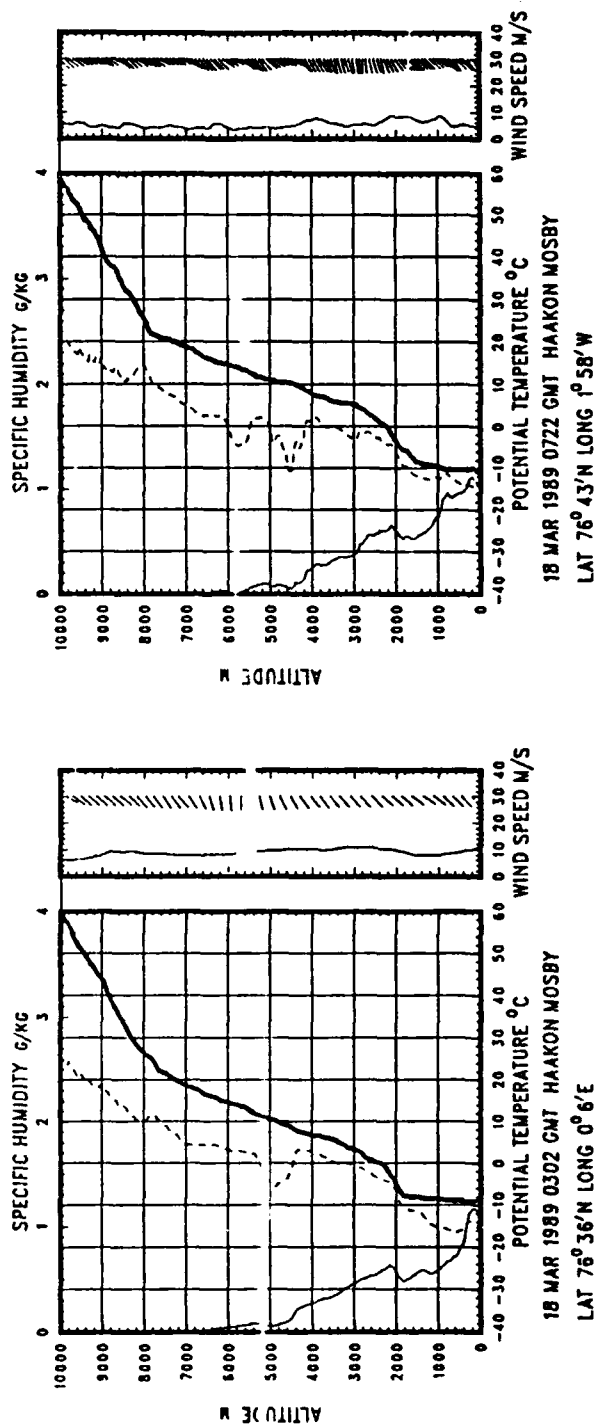
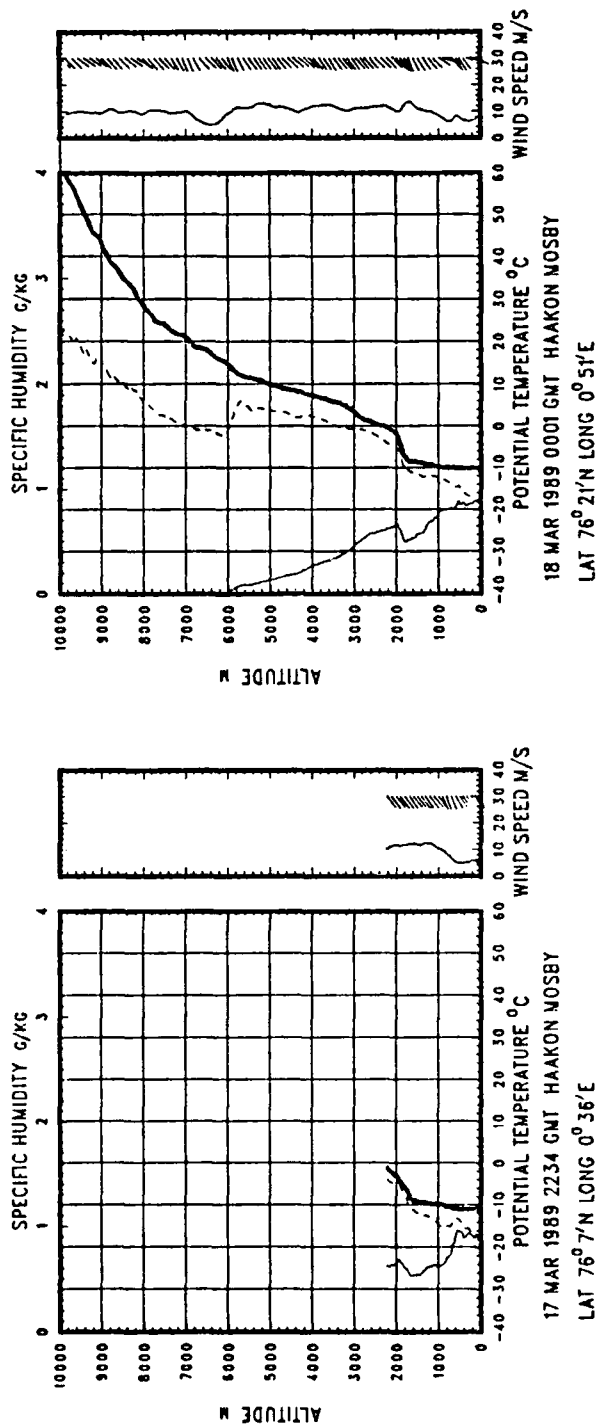


Fig. VS-18. Vertical sounding plots for 17, 18 Mar 89.

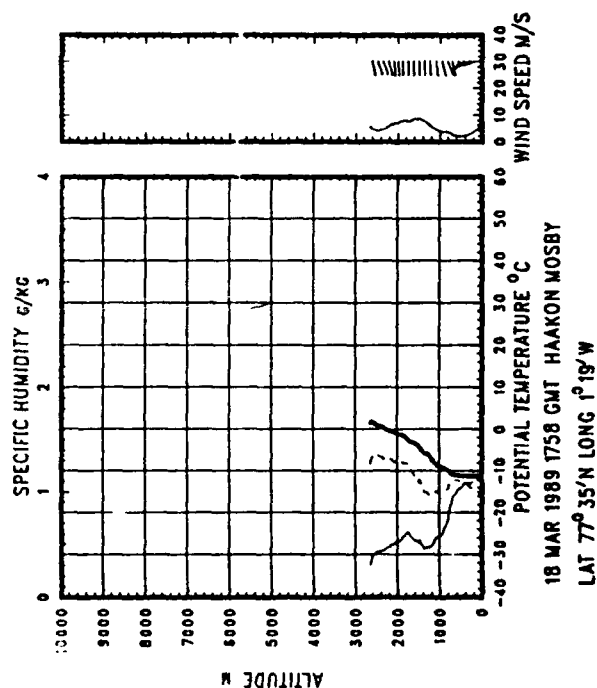
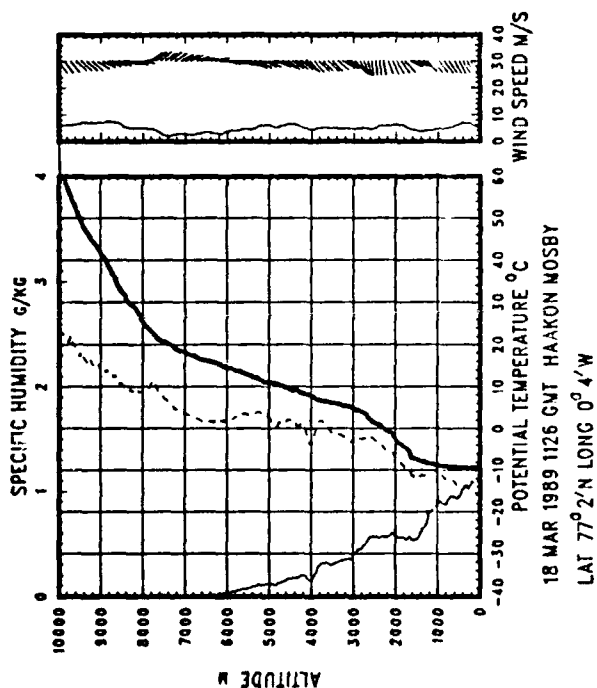
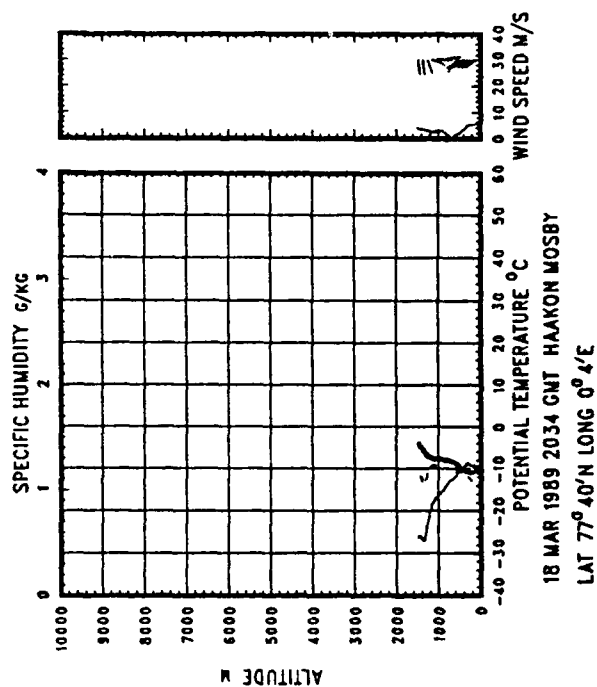
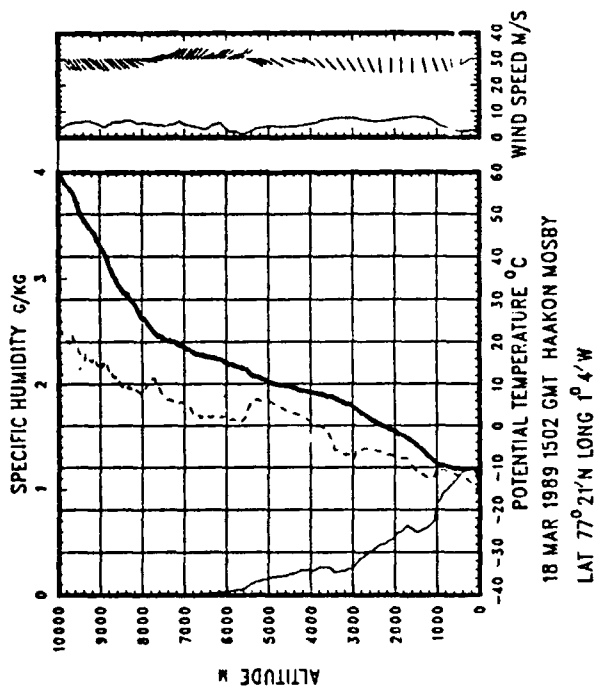


Fig. VS-19. Vertical sounding plots for 18 Mar 89.

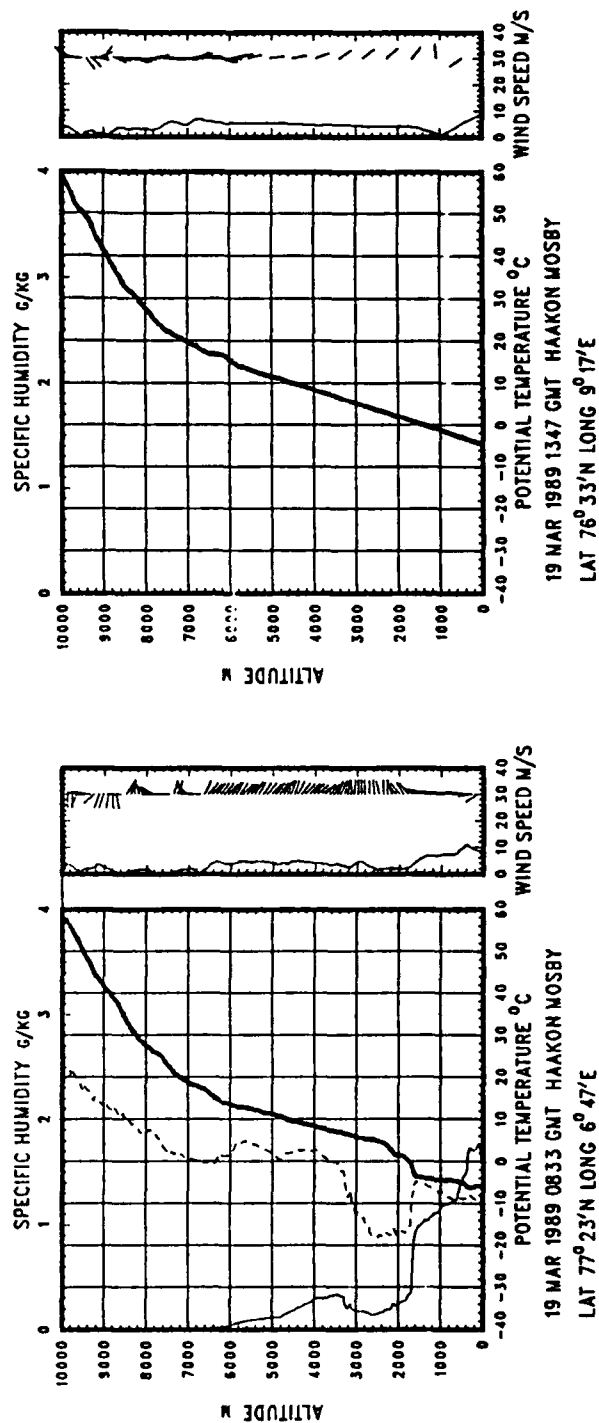
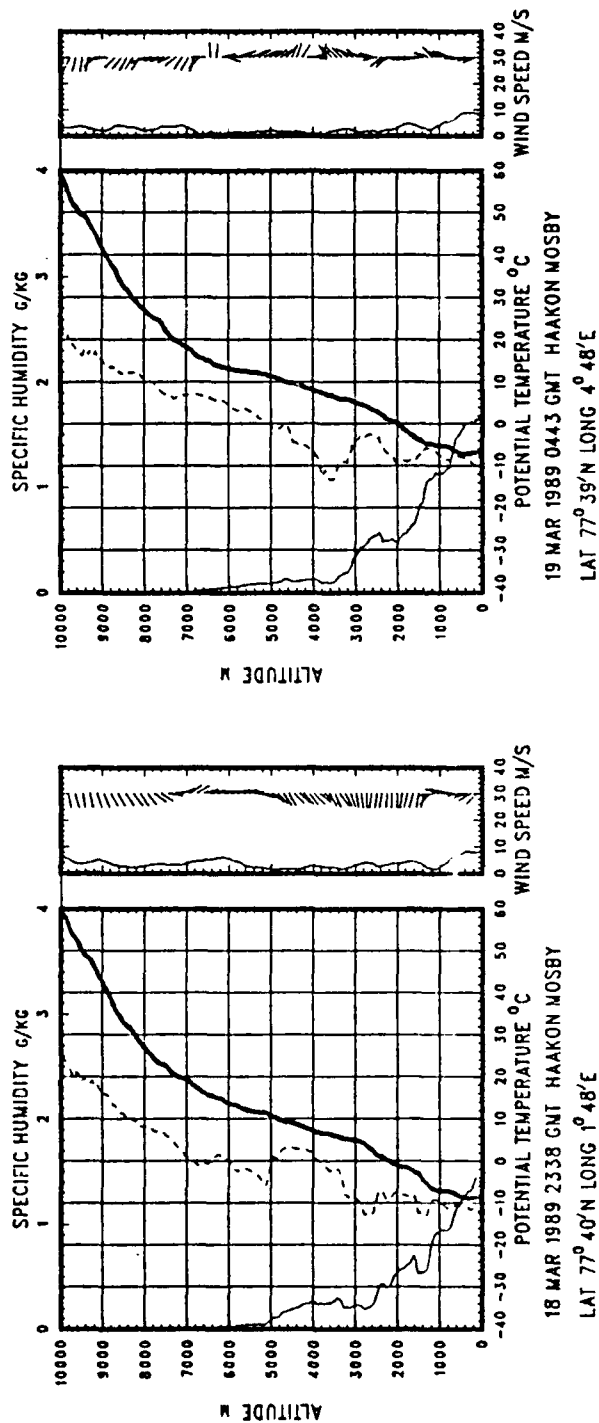


Fig. VS-20. Vertical sounding plots for 18,19 Mar 89.

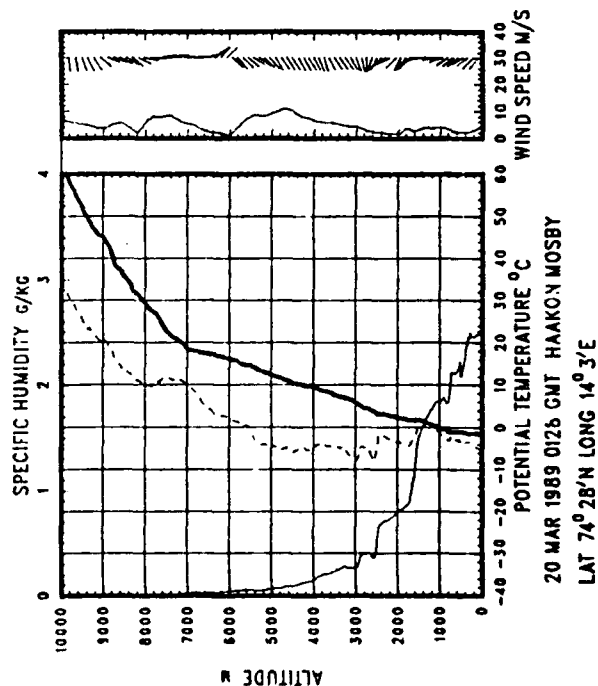
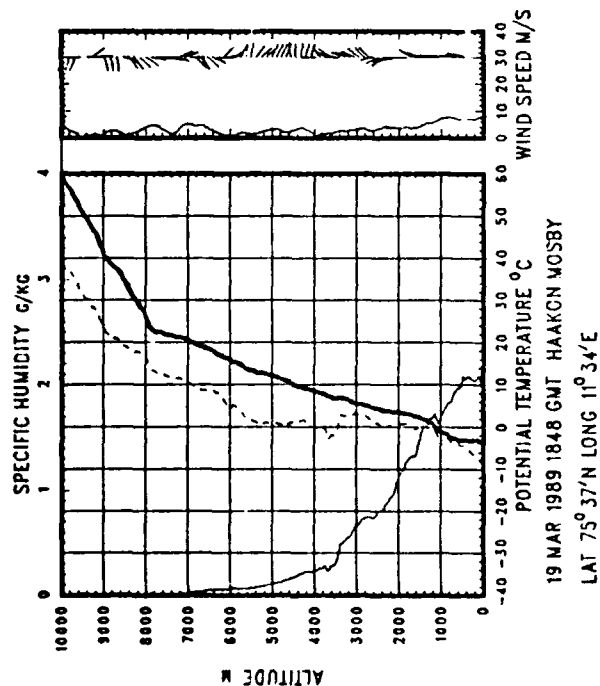
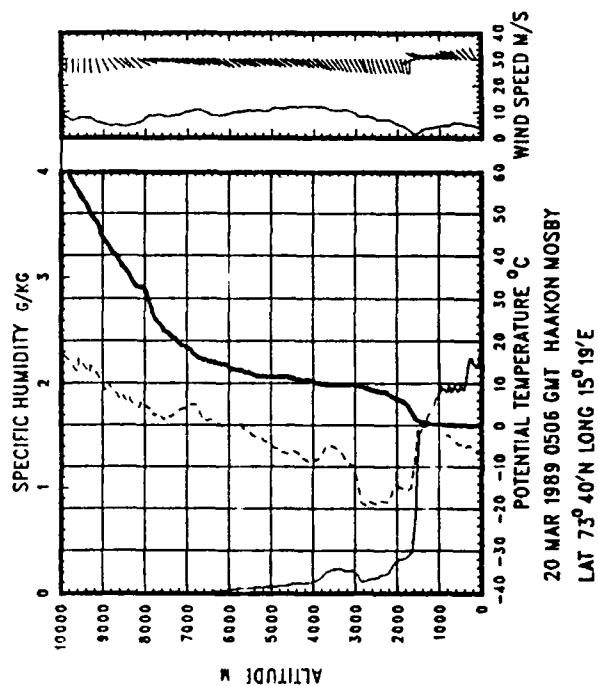
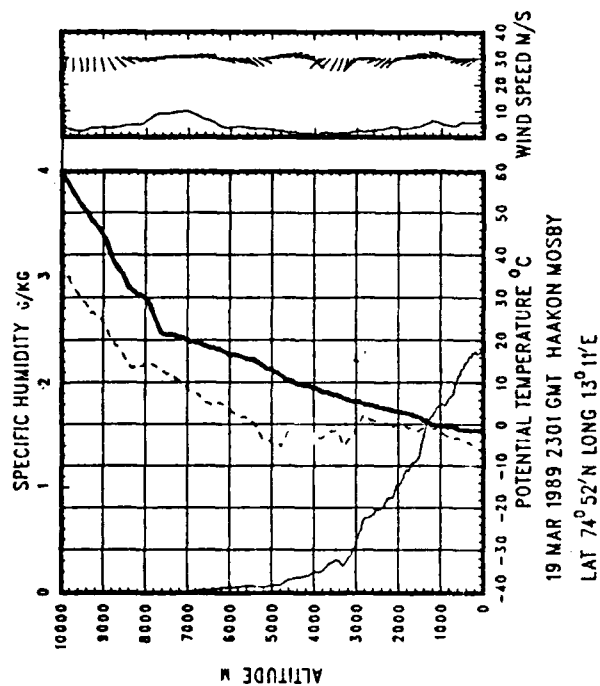


Fig. VS-21. Vertical sounding plots for 19,20 Mar 89.

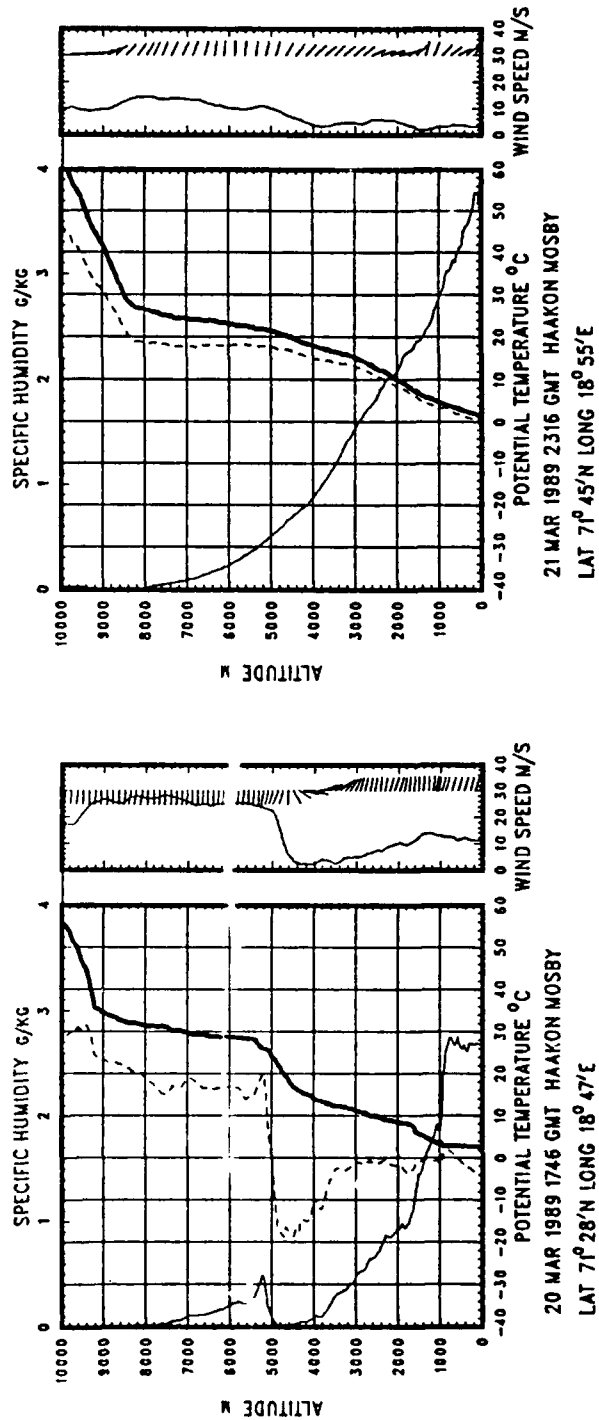
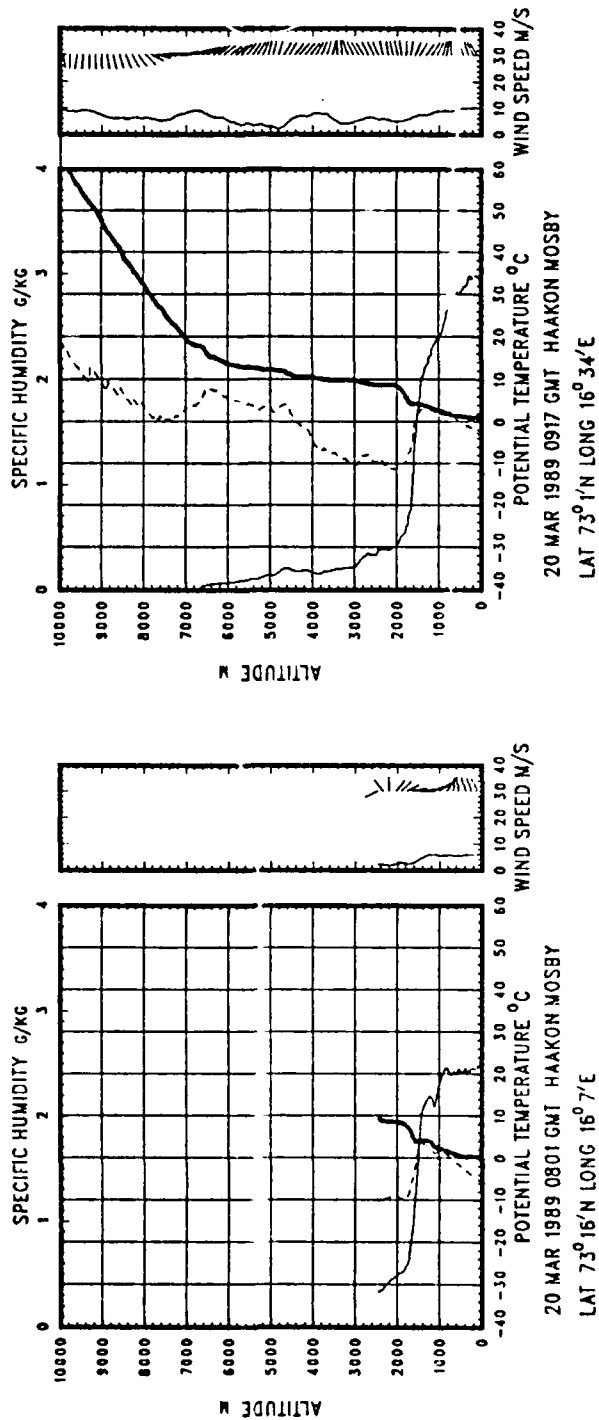


Fig. VS-22. Vertical sounding plots for 20,21 Mar 89.

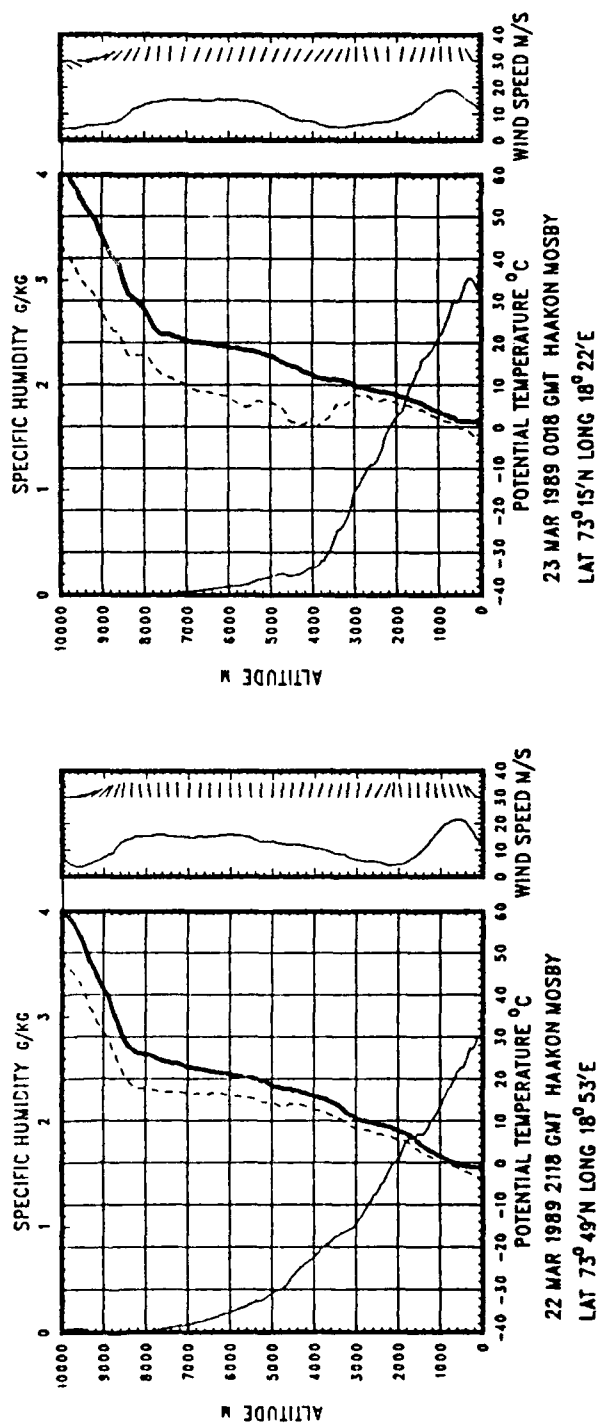
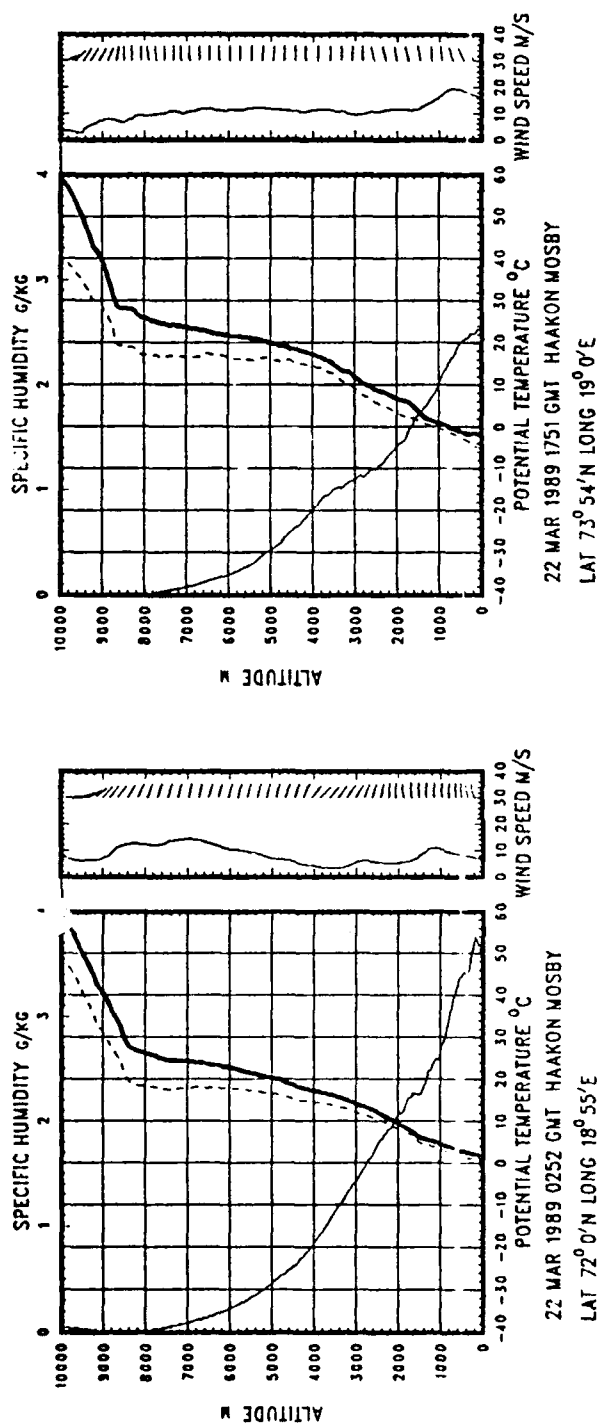


Fig. VS-23. Vertical sounding plots for 22,23 Mar 89.

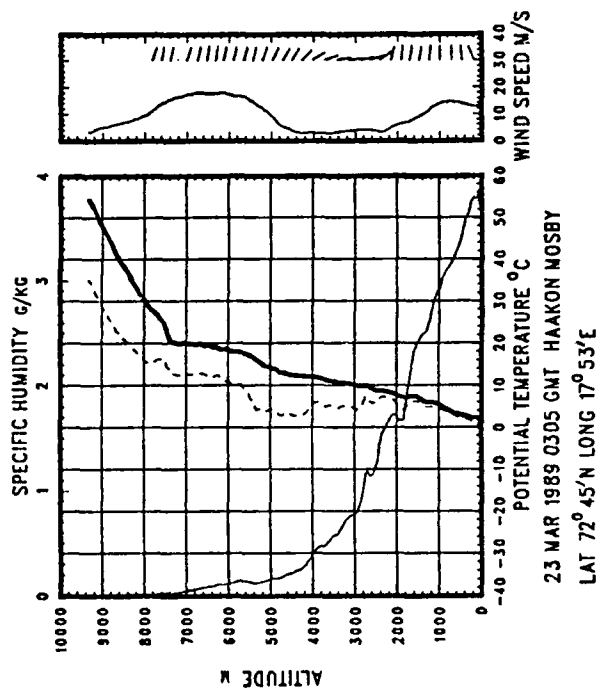


Fig. VS-24. Vertical sounding plots for 23 Mar 89.
(single set this page)

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