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Report on the Field Phase with Examples of Measurements

Edited by

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Meteorologisches Institut
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3. *Research vessel VALDIVIA*

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3.1. *General remarks*

3.1.1. *The cruise and participants*

The scientific crew went on board the VALDIVIA in Bodø in Norway at noon of 26 February 1993. In the following two days the various instruments were installed and tested on board the ship. In the morning of 28 February VALDIVIA left Bodø to head for the designated position at 77.5°N, 5.0°E. Unfortunately, this position could never be occupied during the cruise because extreme icing of the ship was suspected in cold air outbreaks. To avoid this risk, the nautical staff decided to keep the ship much further south of the designated position. The actual cruise of VALDIVIA is shown in Figure 3.1.1 and summarized in Table 3.1.1. Accordingly, VALDIVIA operated between 6° and 12°E at three different latitudes (68.5°, 72° and 74°N) staying there for several days and following a manoeuvring strategy of steaming against the wind at small speeds (1-2 knots). During the period 03 -14 March 1993, which was dominated by extreme cold air advection from north, VALDIVIA operated on her southernmost positions between 68.5°N and 72°N. In the second part of the experiment from 15 to 25 March 1993, VALDIVIA operated at 74° N, north of the main cyclone tracks, where moderate synoptic activities could be expected. VALDIVIA left the experimental area on 24 March at 06 UT and arrived in Bodø on 26 March at 7 UT for bunkering. She departed from here after 10 hours. In the evening of 30 March 1993, VALDIVIA reached her home harbour in Hamburg.

Table 3.1.1: Table of events during VALDIVIA cruise V132

Date	Event
11. January 1993	Loading of instruments for cruise V132 in Hamburg
26 February, 12 UT	Embarkation of the scientific crew in Bodø/ Norway
1 March,14 UT - 6 March, 6 UT	Operating at 68.5 °N between 6° and 9° E (L1),
6 March,11-12 UT	Reaching northernmost latitude (76°N) of the cruise.
8 March,19 UT - 13 March, 6 UT	Operating at 72°N and between 9° and 12° E (L2)
14 March,11 UT - 24 March, 6 UT	Operating at 74°N, and between 6° and 13° E (L3)
26 March, 7 -17 UT	Bunkering in Bodø
30 March, 21 UT	Arrival at Hamburg

The scientific crew on board the VALDIVIA consisted of 12 members (Table 3.1.2), seven of them were students of the University of Hamburg. They kept highly motivated all time regardless of the mostly rough sea conditions.

Table 3.1.2.: The scientific crew on board the VALDIVIA

Name	Prename	Function and tasks
Carstensen	Maike	Student, MIHH, TEMP and SYNOP
Epstein	Alf-Thomas	Student, MIHH, TEMP and SYNOP
Fiedler	Lars	Student, MIHH, TEMP and SYNOP
Jessel	Ingo	Oceanographer, MPIfM, CTD -sounding
Jost	Volker	Student, MIHH, TEMP and SYNOP
Korries	Martin	Student, MIHH, TEMP and SYNOP
Kovar	Anke	Student, MIHH, TEMP and SYNOP
Kruspe, Dr.	Gottfried	Meteorologist, MPIfM, cruise leader
Madani	Navid	Student, MIHH, Data management
Offermann	Michael	Technician, MIHH
Schlüssel, Dr.	Peter	Meteorologist, MIHH, IR-radiometer, Satellite- images
Spangenberg	Andreas	Student, IfMHH, CTD-sounding

MIHH Meteorologisches Institut der Universität Hamburg
MPIfM: Max-Planck- Institut für Meteorologie, Hamburg
IfMHH: Institut für Meereskunde der Universität Hamburg

3.1.2. *Instrumentation and experimental program*

The main experimental task of VALDIVIA was to monitor continuously the mean vertical structure of wind, temperature, and moisture within the troposphere. These data will be used together with the data from the other five aerological stations involved in ARKTIS 1993 (POLARSTERN, PROF. MULTANOVSKY, NY ÅLESUND, DANMARKSHAVN, BEAR ISLAND) to evaluate large-scale field parameters such as divergence, baroclinicity, advection etc. Furthermore, sea temperature and salinity were measured down to 1.8 km depth following normally a 4-hourly schedule, provided that swell and sea waves were favourable for CTD soundings (Section 3.6).

The vertical sounding of atmosphere and ocean was accompanied by continuous sampling of surface layer data on the meteorological foredeck mast, to calculate the relevant parameters of air-sea interaction processes (heat, moisture and momentum fluxes and stability). Cloud base height up to a maximum altitude of 12000 feet was continuously detected by a Laser ceilometer (Section 3.4). To relate the automatically measured quantities to the visible meteorological phenomena, intensive observations of cloud type, could cover, visibility, precipitation and other phenomena were carried out at least every hour. An automatic APT-reception of polar orbiting NOAA satellites on board the VALDIVIA gave the opportunity to identify cloud systems and the sea ice edges in the wider environment of the ship. Sequences with convective cloud patterns in the measuring area were stored on PC-disc. Finally, an infrared radiation thermometer KT4, measured continuously the sea skin temperature (Section 3.5).

Two status reports per day were sent by telefax to the ARKTIS '93 operation center at Longyearbyen to inform about the actual meteorological situation at VALDIVIA. The equipment used on board the VALDIVIA is summarized in Table 3.1.3 and partly photographically documented in Figures 3.1.2.a - f.

Table 3.1.3.: Measuring devices on board the VALDIVIA during ARKTIS'93

Automatic Surface Layer Station (MINERVA) at Foredeck Station (h~ 15m)
Pressure: digiquartz Cup anemometer, wind vane Heated aspiration psychrometer Global shortwave radiation (Type: Kipp & Zonen) Total, shortwave and longwave radiation (Type: Schulze and Lange)
Additional Instrumentation for SFC-layer data
Hand-held ventilated psychrometer Hand-held cup anemometer Precision aneroid Pt100 water thermometer (~ 6m depth) Nautical equipment: MAGNAVOX satellite navigation system GPS: Global Positioning System Anschütz compass SAGEM-LOG
Upper Air
VAISALA DigiCora with Omega windfinding and RS80/15N radiosondes, deployed in the ASAP container (owner: Deutscher Wetterdienst). Launch Height: 3m

Table 3.1.3.: Measuring devices on board the VALDIVIA during ARKTIS'93

Cloudbases up to 12000 ft
Laser Ceilometer of type Impulstechnik-GmbH, λ = 0.91 µm Owner of the system: Deutscher Wetterdienst.
Radiometric sea surface temperature
IR-Radiometer (KT4) with attached calibration equipment (λ = 10-12 µm)
Oceanic Profiling
CTD- sonde (Kieler Multisonde, Salzgitter Sonde, Type Bathy 2000 LS) Temperature, conductivity, pressure Mean depth achieved: 1800m Owner of the system: Institute of Oceanography, University Hamburg
Polar Orbiting Satellite Reception
Technavia System, manufactured by SKYCEIVER SILVER for APT-reception of NOAA images (VIS,IR)

3.2. *Surface observations*

The automatic surface layer station was designed for continuous observations of the relevant meteorological parameters and mounted at 15 m height on the foredeck mast. Due to its height, the system provided undisturbed wind data from nearly all wind directions except for a small sector disturbed by the ship's superstructure. The wind was corrected for movements of the ship. Data of 10 minutes averages of the various quantities were recorded on PC disc, simultaneously with ship's heading and speed. The automatically recorded data were checked occasionally by measurements with hand-held instruments. Noticeable periods of data loss occurred due to psychrometer malfunction and due to PC hardware trouble.

Table 3.2.1: Periods of malfunction of the automatic surface layer station.

Periods of malfunction	Remarks
4 March 14:20 - 8 March 13:00 UT	Malfunction of heating and ventilation system of psychrometer; no continuous temperature and humidity data
15 March 10:50 - 11:20 UT	Calibration of T-sensors
16 March 14:00 - 17:00 UT	PC-trouble, no continuous data
18 March 11:30 - 18:30 UT	Crash of the PC- mother board, no cont. data
24 March 09:40 - 10:00 UT	Minerva- software problems, no cont. data

Phenomenological observations according to WMO code were made every full hour. SYNOP messages were telegraphed every three hours to the global network GTS. Time series of hourly 10-minutes mean values from the automatic surface station are shown in Figure 3.2.1a for the period from 01 to 25 March 1993. Data gaps in temperature, humidity and wind records were closed by data from the hand-held instruments. Figure 3.2.1b shows the time variation of the global and longwave radiation from above (10 minutes averages) and in the lower part longitude and latitude of VALDIVIA every 10 minutes from the GPS navigation system.

The variations of the various meteorological quantities have to be seen in context with the synoptic situation, the distance from the ice edge and the actual hydrographic situation. The pressure curve demonstrates the intensive synoptic activities, to which VALDIVIA was exposed (see also weather maps in Appendix A). Air mass advection from North (5, 9-10, 14-15, 24-26 March 1993) corresponds to strong pressure increase, rapid decrease of air temperature, low relative humidities and decreasing wind speeds from >15 to <5 m/s. Situations of easterly flow, instead, which were met in most of time (6, 11-14, and 17-23 March 1993) led mostly to weaker air-sea temperature contrasts and higher relative humidities because of the long fetch of the air over the warm water. VALDIVIA operated most of the time within the warm Atlantic current, where the water temperature was about 4-6°C. Therefore, during periods of cold air advection from North remarkable air-sea differences ΔT = Ta - Tw of less then -10 K were observed. Turbulent sensible and latent heat fluxes up to 300 W/m^2 were derived during these events. During the remaining time ΔT values of about -5 K were frequently observed as far as no warm-frontal events occurred. On 14 March 1993, 12 UT, when VALDIVIA was on her westernmost position of the cruise (06°E at 73.5°N), the water temperature dropped to about -2°C in the region of the recirculation branch of the East Greenland Current.

The time series of the phenomenological parameters are given in Fig. 3.2.2. Most of the hydrometeorological events occurred as snow. The dominating low-level cloud type (CL) was stratocumulus (Sc); the total cloud coverage was most frequently 8 octas.

3.3. *Radiosonde measurements*

The upper air system used was a Vaisala DigiCora system with Omega wind finding. The Vaisala RS80/15N radiosondes were carried by 200g balloons filled with hydrogen, and launched automatically from the hydraulically steered platform of the ASAP (Automatic Shipboard Aerological Program) container. The radiosondes were adjusted to 405 MHZ carrier frequency. The aerological sounding frequency was normally 4 per day, with launch schedule 80 minutes before 00, 06, 12, 18 UT. These soundings were telegraphed as coded SHIP TEMP via a DCP (data collecting platform) to the global network GTS, to make them available for the routine forecasts

and archiving. The burst height of the balloons exceeded the average tropopause level at about 9 km by more than 10 km and was reached after about 90 minutes. The sounding software used was the "Sonde-program" of the DigiCora, which allowed for some checks and manipulation of the received data. Table F.2 in Appendix F summarizes all successful launches of radiosondes on board the VALDIVIA. Three intensive periods with three-hourly soundes were carried through: 17 March 00 UT - 18 March 21 UT, 20 March 00-21 UT and 25 March, 06-21 UT. The first two intensive periods were dedicated to stratocumulus situations, the third one to open cell conditions. The aerological profiles of temperature, relative humidity, wind speed and wind direction up to 12 km height are presented in Figures 3.3.1.a-d. For graphical reasons, the soundings at 03, 09, 15, 21 UT were not considered in the graphs of humidity, wind speed and wind direction. The most significant events of cold air advection up to higher levels of the troposphere occurred on 3-6, 8-9, 14-16 and 23-25 March 1993. Periods of pronounced warm air advection occurred during 6-7, 10, 11-14 and 22-23 March 1993. The top of the boundary layer during Sc-conditions is typically marked by a small inversion layer and vertically decreasing humidity at about 1.5 - 2.0 km height. The tropopause level varied according to the prevailing weather situation between about 11-12 km (1 and 2 March) and 7-8 km (9, 14, 25 March). The remarkable wind maximum near the tropopause level as mostly present during the period 06-15 March indicates the phase of cyclonic activity in the region around VALDIVIA.

3.4. *Cloud measurements with a ceilometer*

The Laser ceilograph, a widely used instrument, was mounted on the top of the control house at about 10 m height. Technical problems with a defective card of the instrument delayed the continuous measurements by 8 days. Ceilometer data are available from 08 March 12 UT until the end of the campaign. Intermediate data loss occurred on 10 March from 0-7 UT and on 21 March 10 UT - 22 March 6 UT. The data records on PC contain the raw backscattered intensities in 30 seconds intervals from up to 107 height levels between 25 and 12000 ft. The height steps were 25 ft between 0-600 ft, 50 ft between 600-1500 ft, 100 ft between 1500-4000 ft and 200 ft between 4000-12000 ft. Reliable cloud base measurements are restricted to situations without hydrometeors, dust or other particles in the atmosphere. The amplitudes of the backscattered signals were displayed one-line on a graphic screen, either as single shot data or as density records of seven steps of signal amplitudes depending on height and time. All scenes were plotted later on coloured hardcopies. In addition, the software system calculates cloud base heights of up to 3 cloud layers, which are detected during the 30 second cycle. The method is based on the detection of the strongest vertical gradients of the backscattered amplitudes. These data are presented as time plots day by day in Figures 3.4.1.

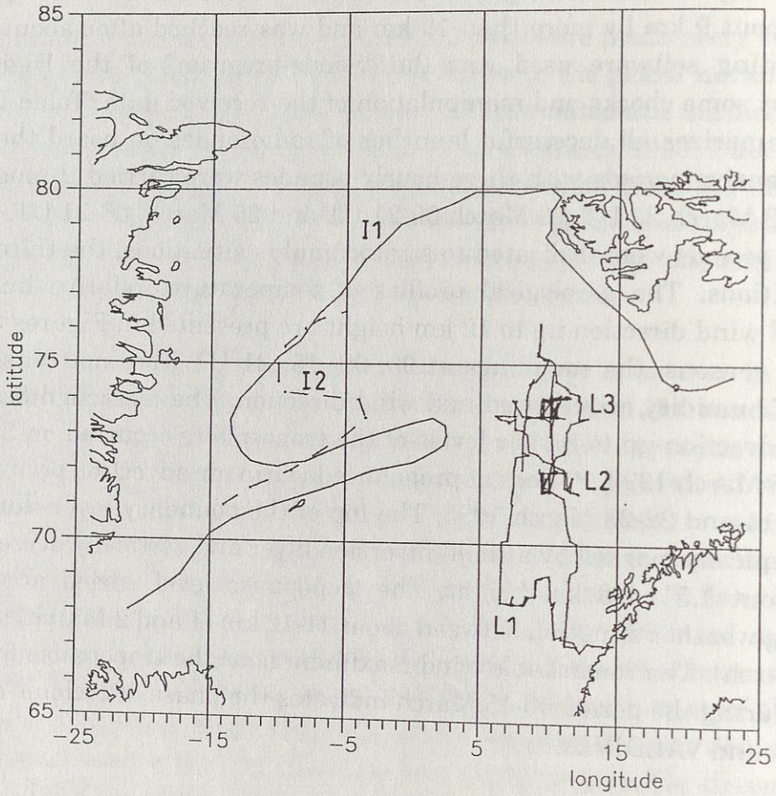

Fig. 3.1.1: Cruise V132 of VALDIVIA during ARKTIS 1993. I1: Average ice edge in March 1993 according to ice maps in Appendix E, I2: Ice-fields as discovered by PROF. MULTANOVSKY. L1, L2, L3: Positions for longer lasting measuring activities.

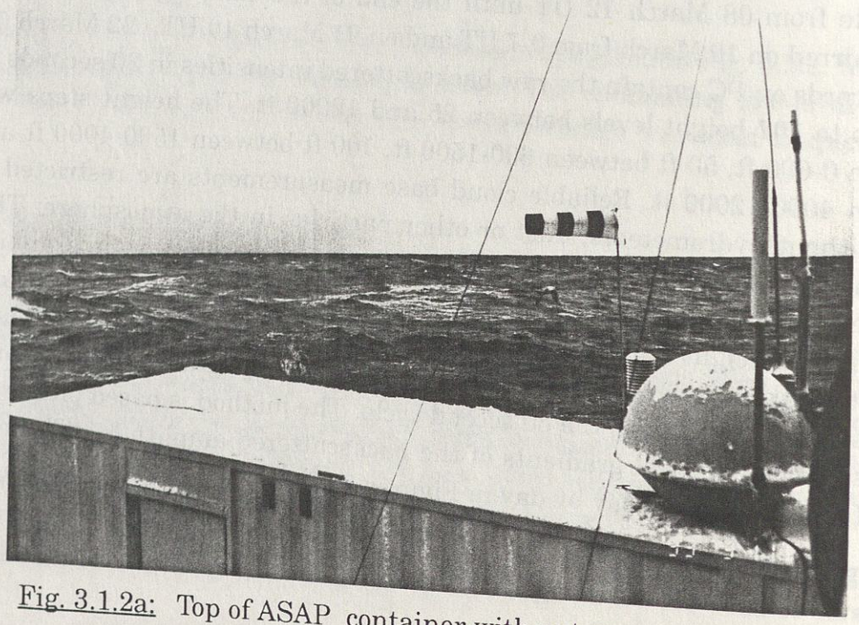

Fig. 3.1.2a: Top of ASAP container with antennas.

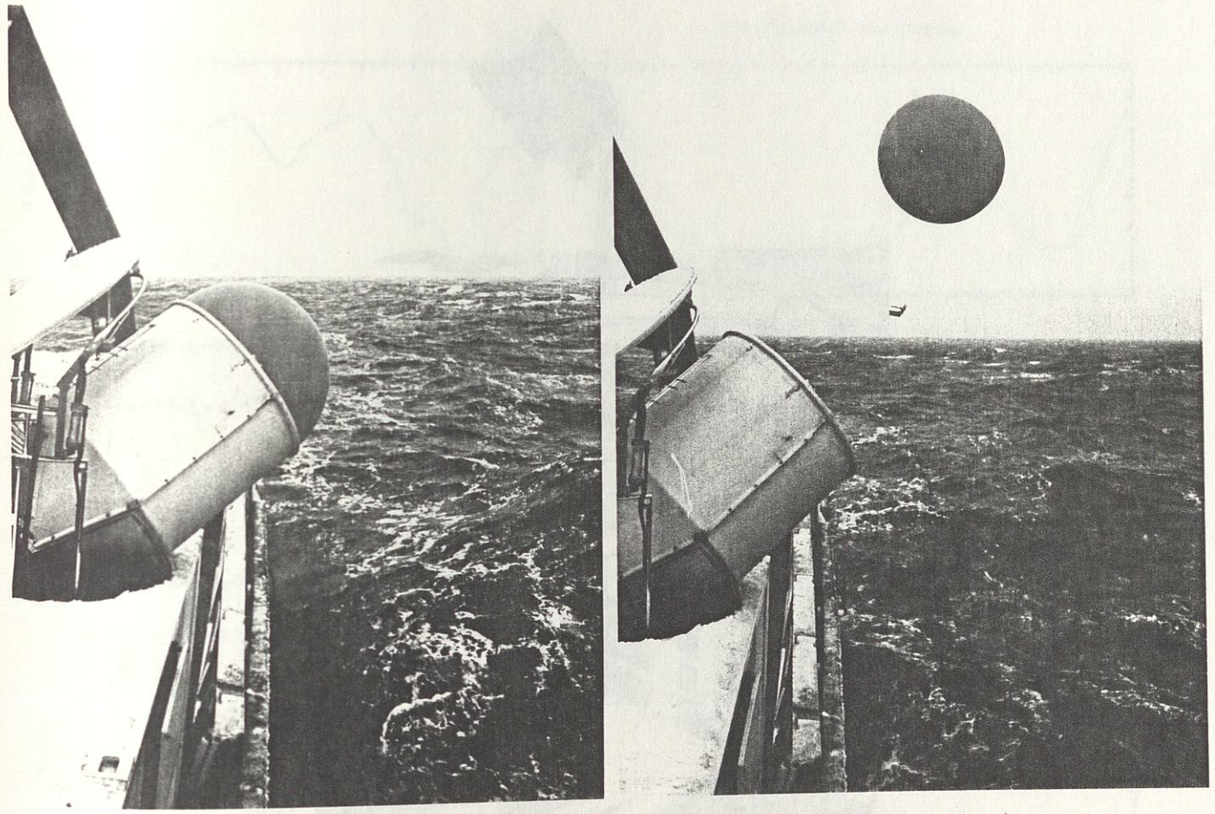

Fig. 3.1.2b-c: Automatic start of a radiosonde from ASAP container.

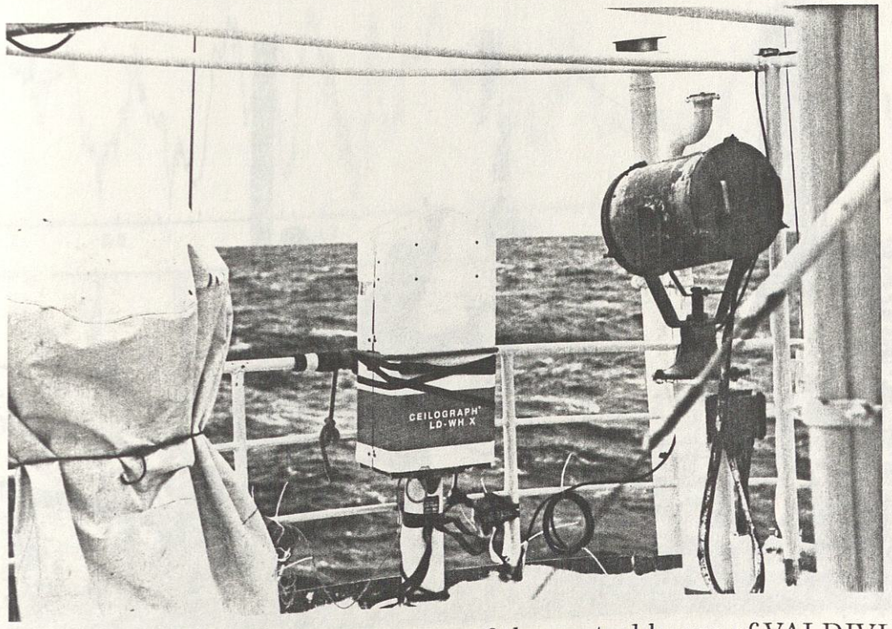

Fig. 3.1.2d: Laser ceilograph on top of the control house of VALDIVIA.

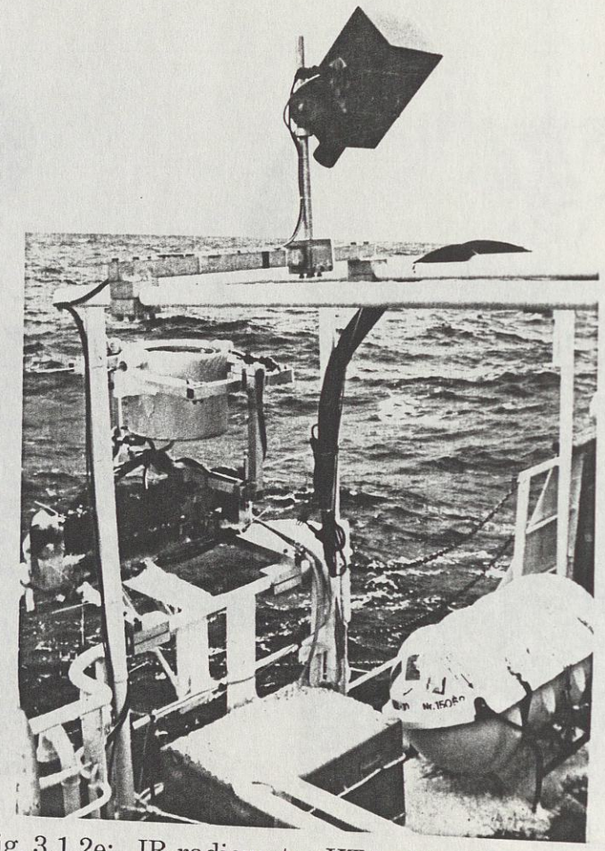

Fig. 3.1.2e: IR-radiometer KT4 with calibration pot.

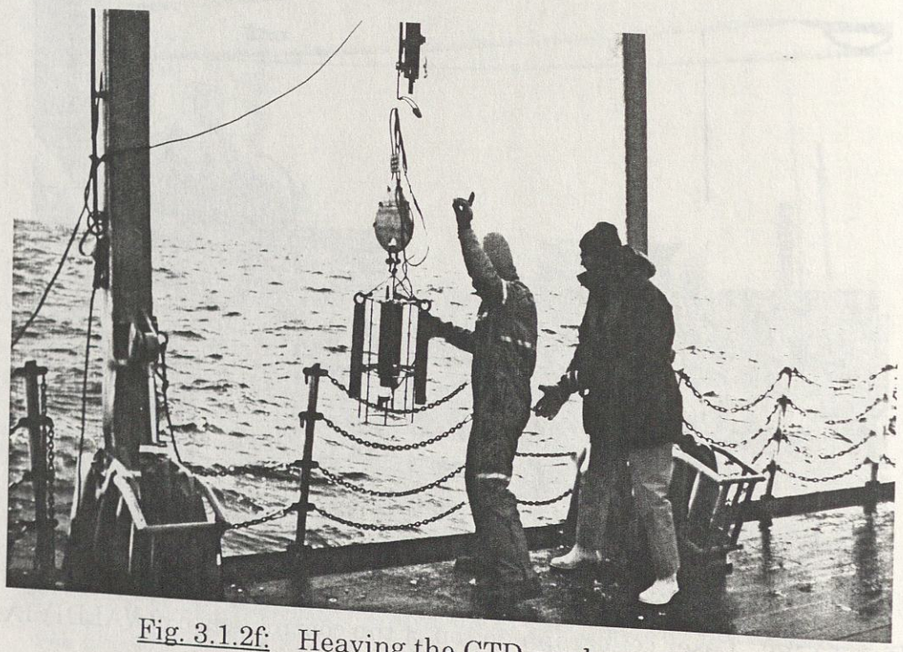

Fig. 3.1.2f: Heaving the CTD sonde on deck.

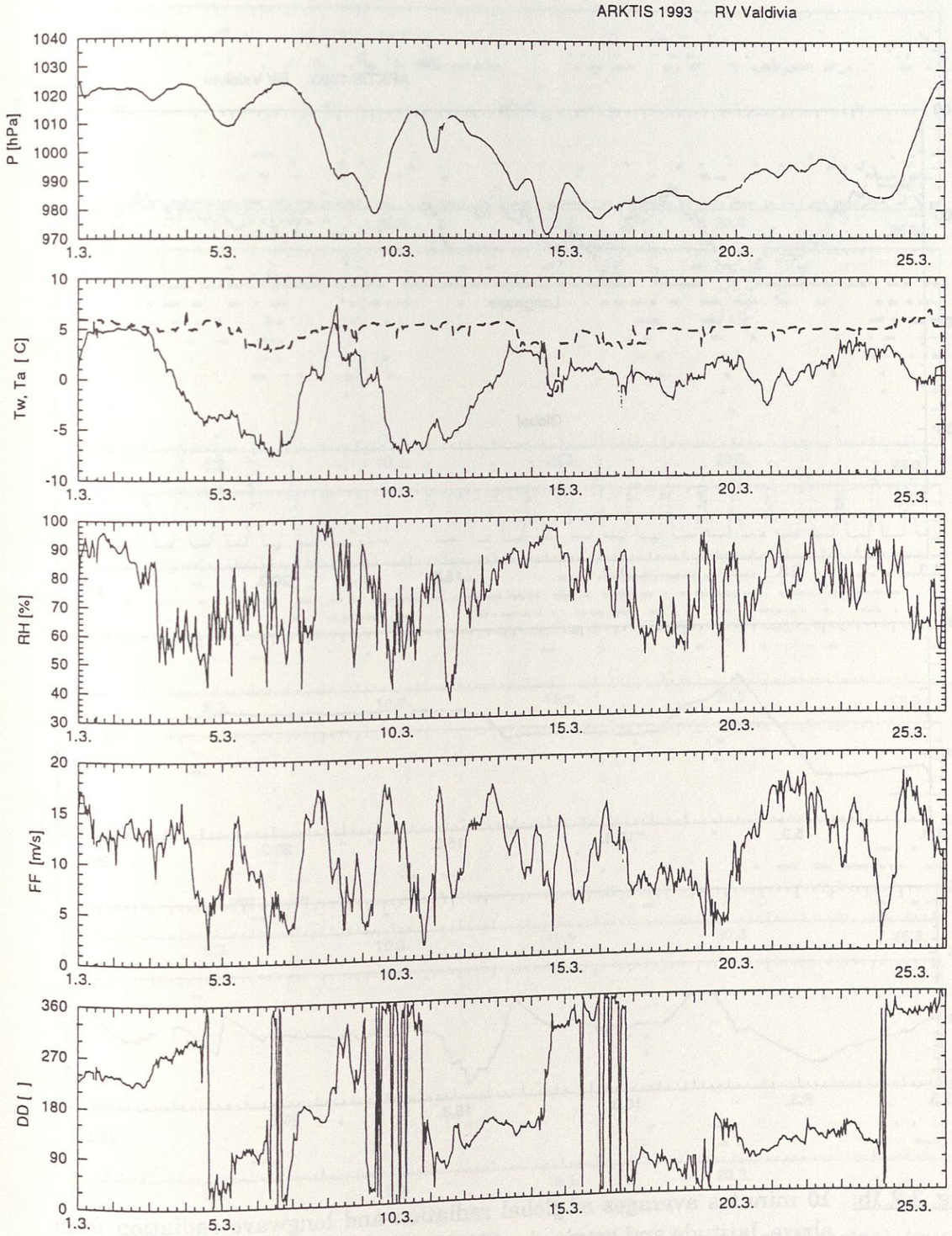

Fig. 3.2.1a: Hourly 10 minutes averages of pressure p at sea level, air temperature Ta (solid curve) reduced to 10 m height, water temperature Tw (dashed curve), relative humidity RH, wind speed FF and wind direction DD.

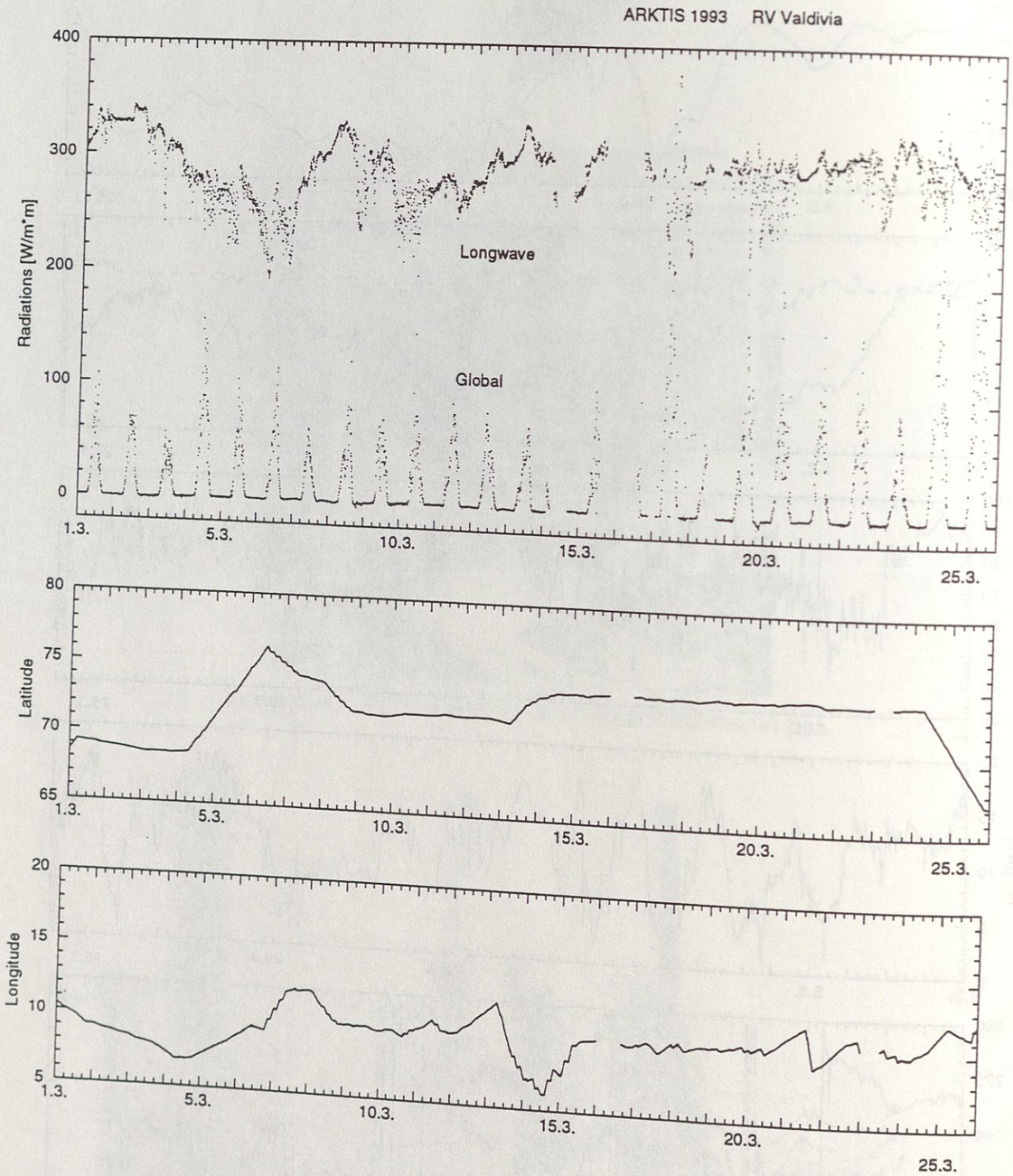

Fig. 3.2.1b: 10 minutes averages of global radiation and longwave radiation from above, latitude and longitude of VALDIVIA position.

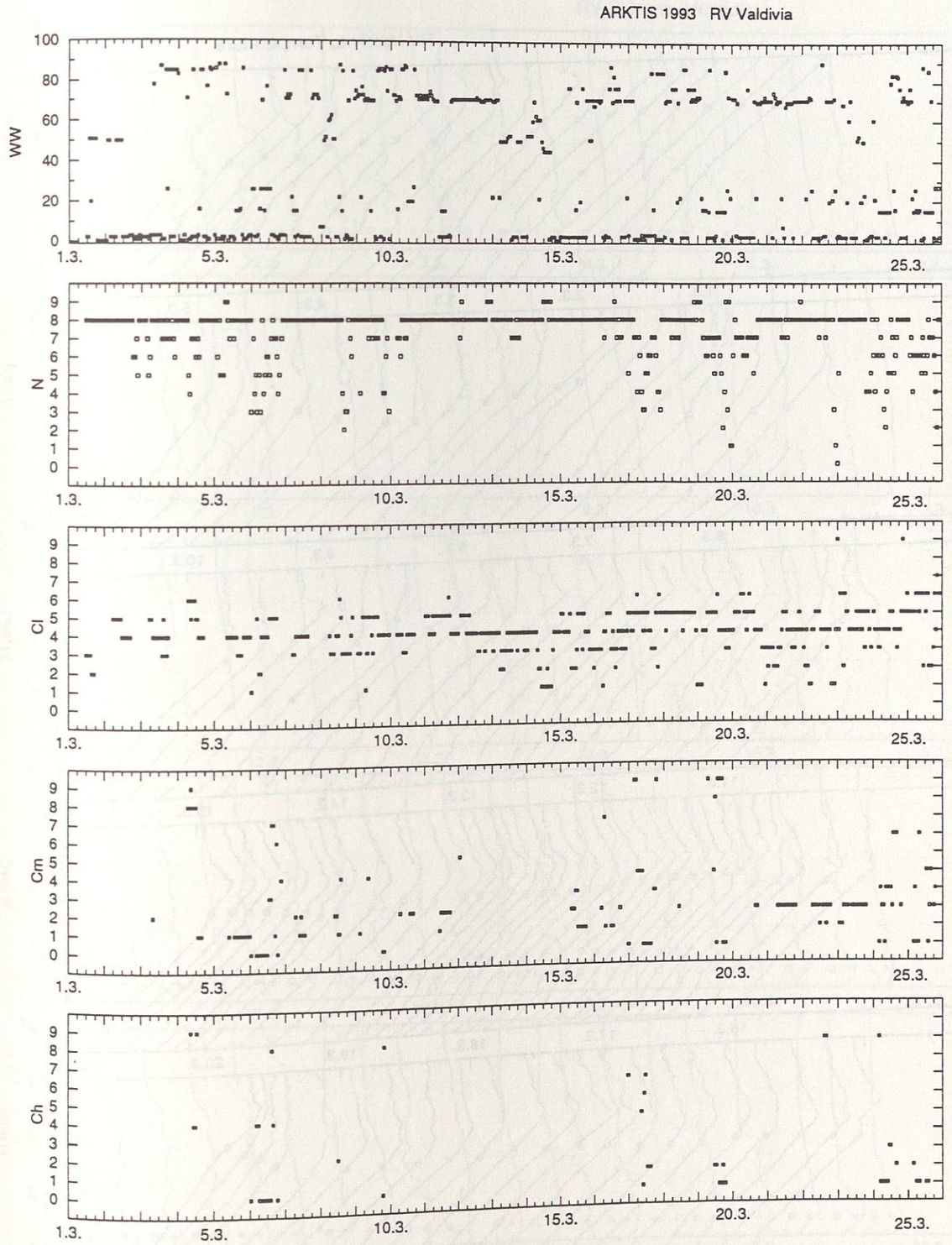

Fig. 3.2.2: Hourly values of weather situation WW, cloud coverage N (octas), type of low level (Cl), middle level (Cm) and height level (Ch) clouds according to WMO code.

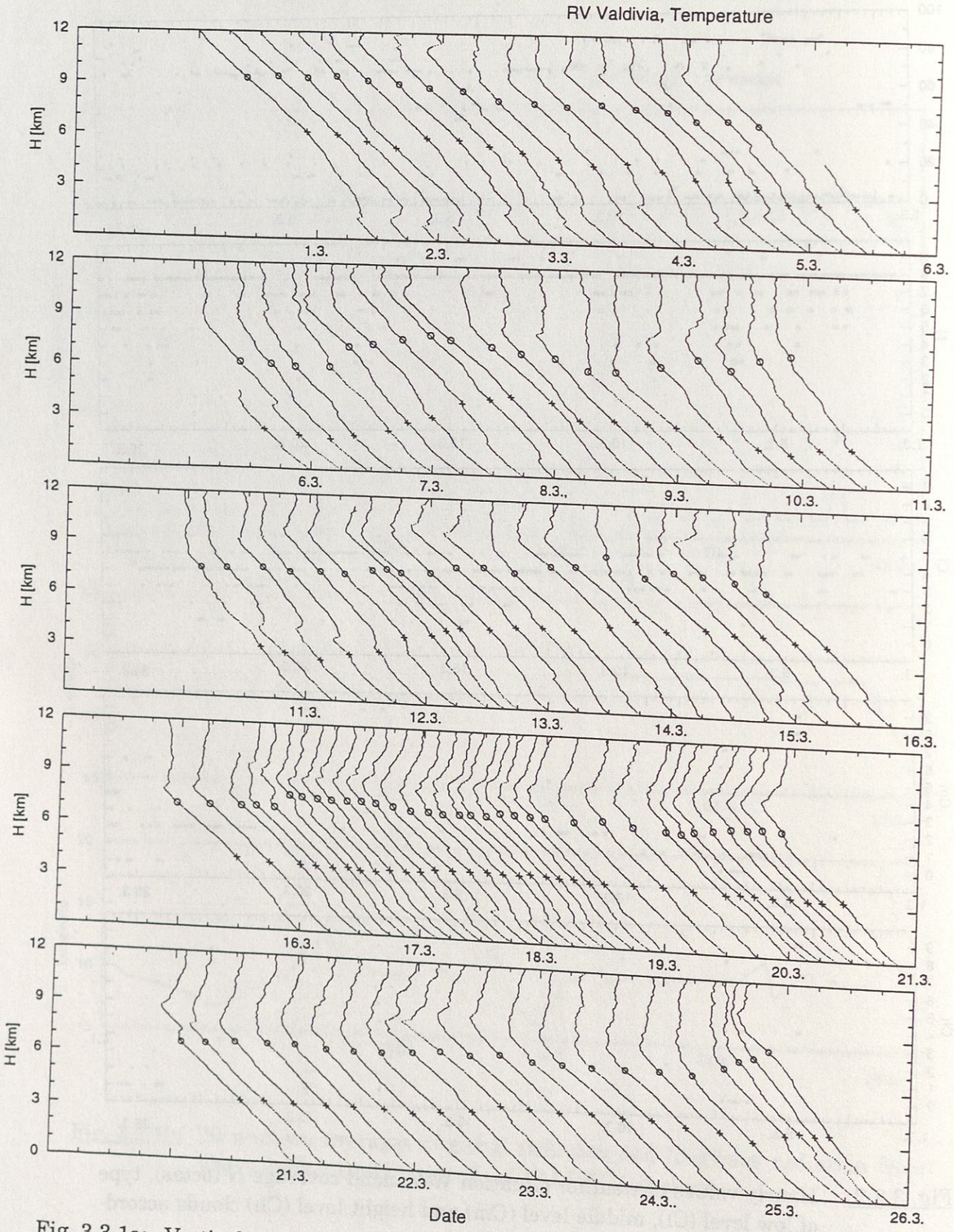

Fig. 3.3.1a: Vertical profiles of air temperature. Abscissa: date, temperature; ordinate: height in km. Tickmark every 6 hours coincides with the surface value. Symbols: circles: -50 °C, crosses: -25°C value.

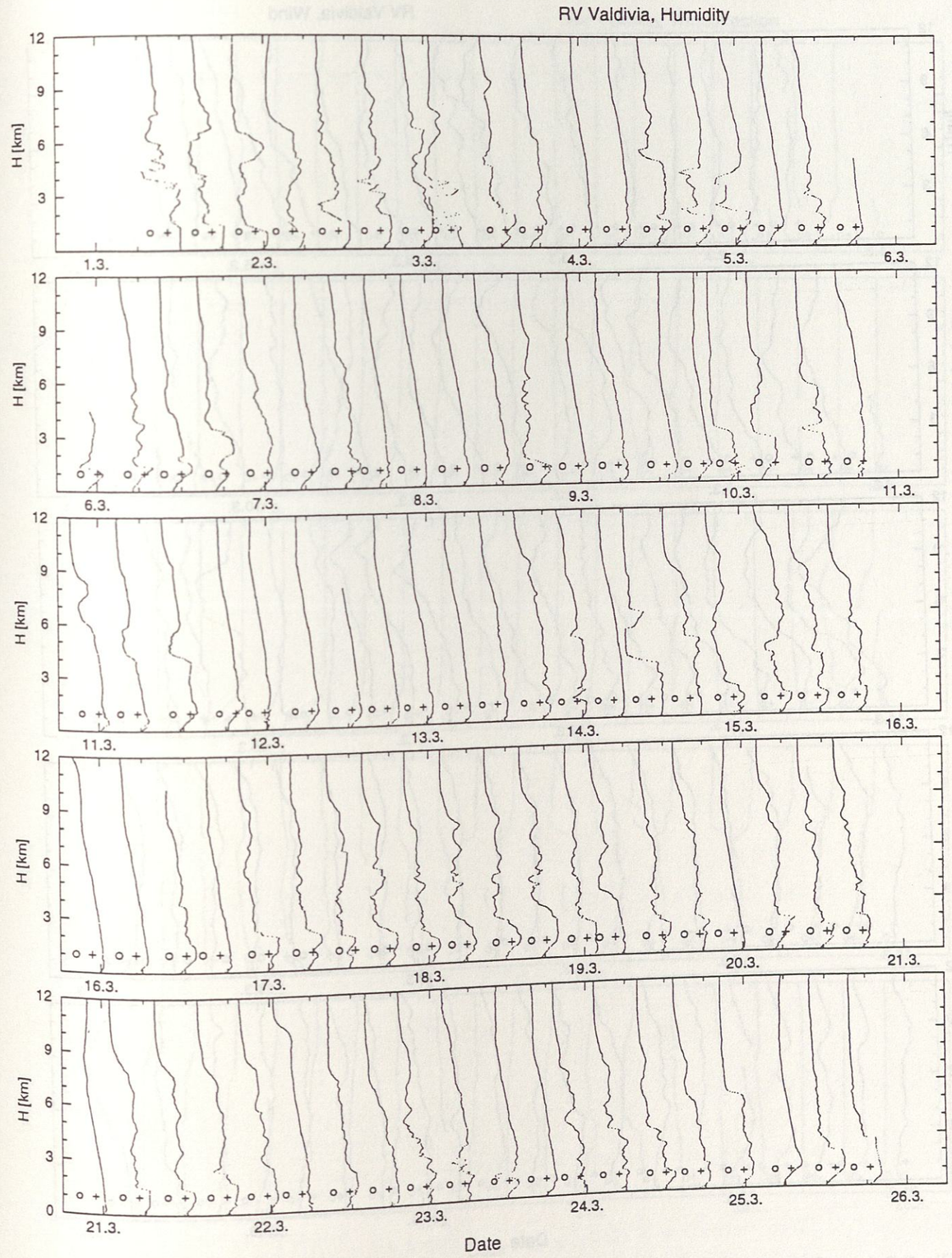

Fig. 3.3.1b: Vertical profiles of relative humidity. Abscissa: date, relative humidity; ordinate: height in km. Tickmark every 6 hours coincides with the surface value of relative humidity Symbols: circles: 30%, crosses: 80% value.

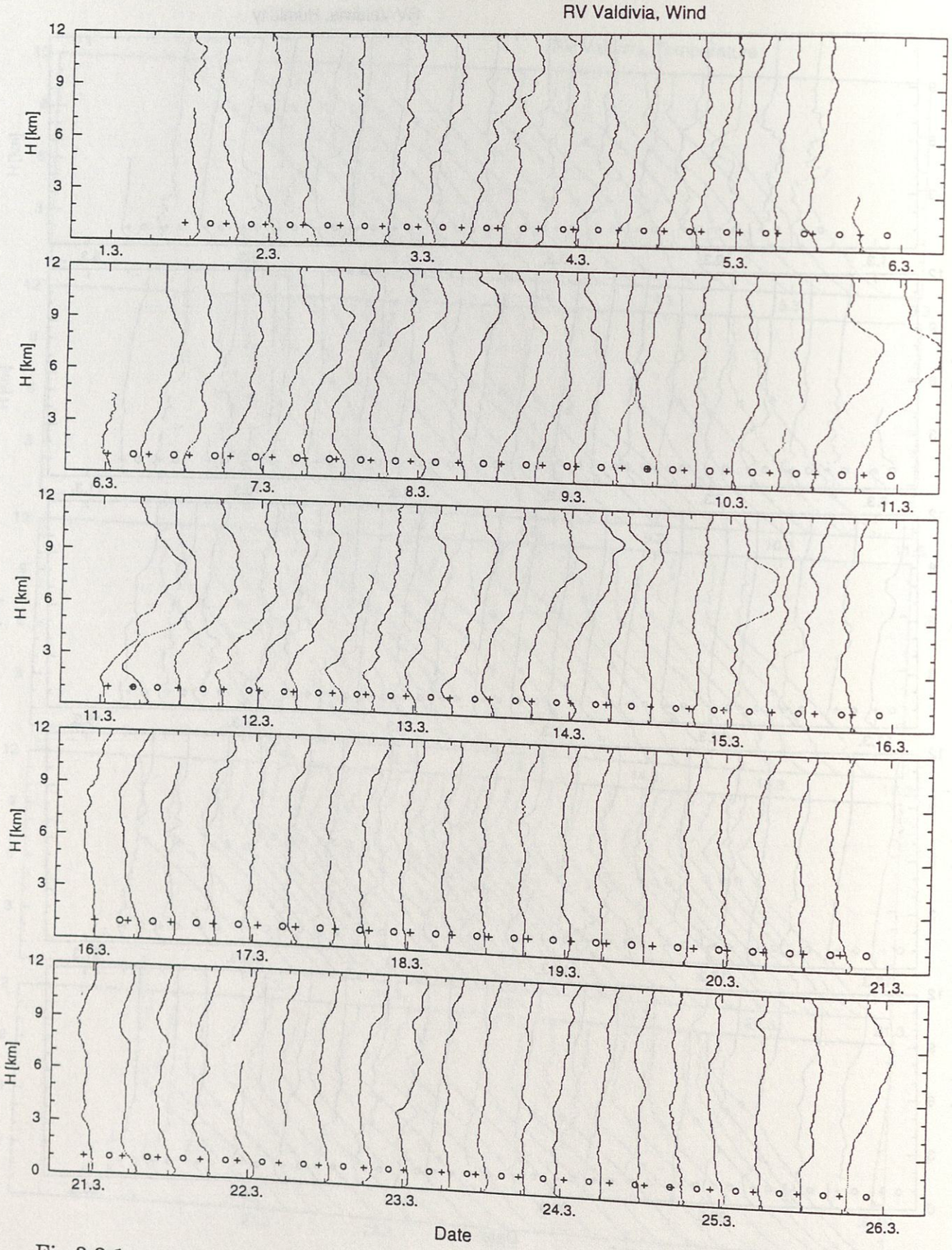

Fig.3.3.1c: Vertical profiles of wind speed. Abscissa: date, wind speed; ordinate: height in km. Tickmark every 6 hours coincides with the surface value of wind speed. Symbols: circles: 30 m/s, crosses: 10 m/s value.

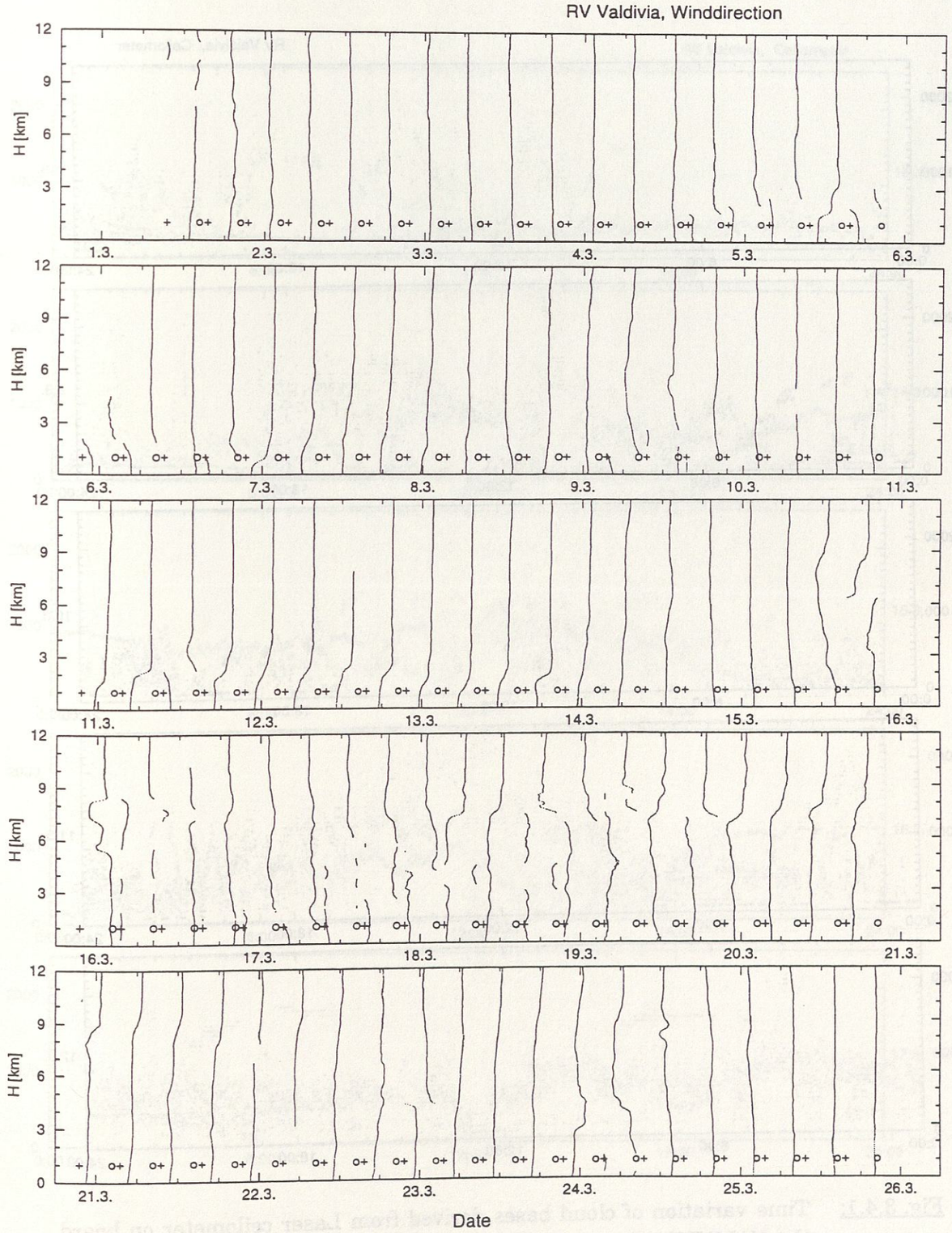

Fig. 3.3.1d: Vertical profiles of wind direction. Abscissa: date, wind direction; ordinate: height in km. Tickmark every 6 hours coincides with 180° wind direction. Symbols: circles: 0°, crosses: 360° value.

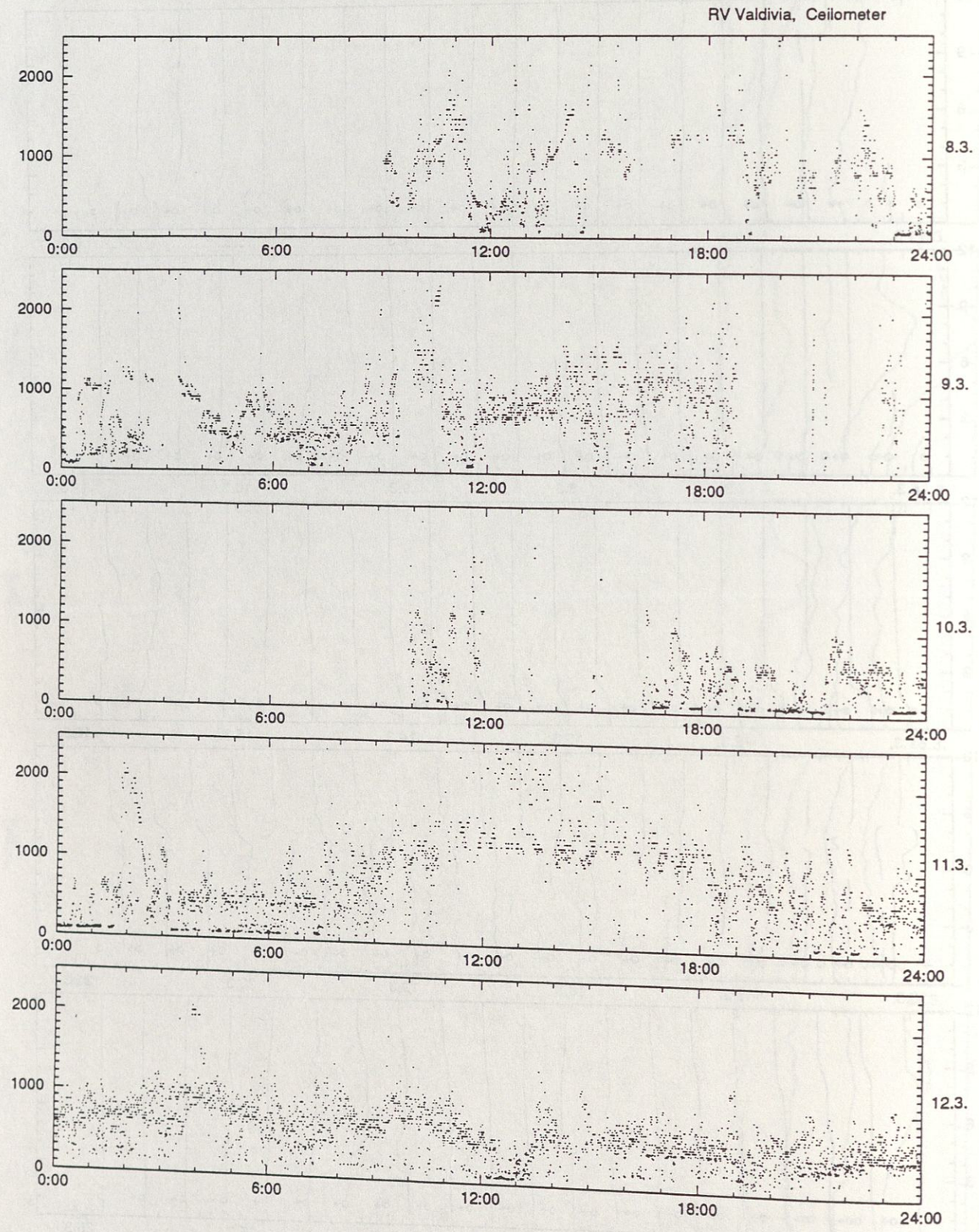

Fig. 3.4.1: Time variation of cloud bases derived from Laser ceilometer on board the VALDIVIA during ARKTIS 1993. Abscissa: Time in UT, ordinate: Height in m.

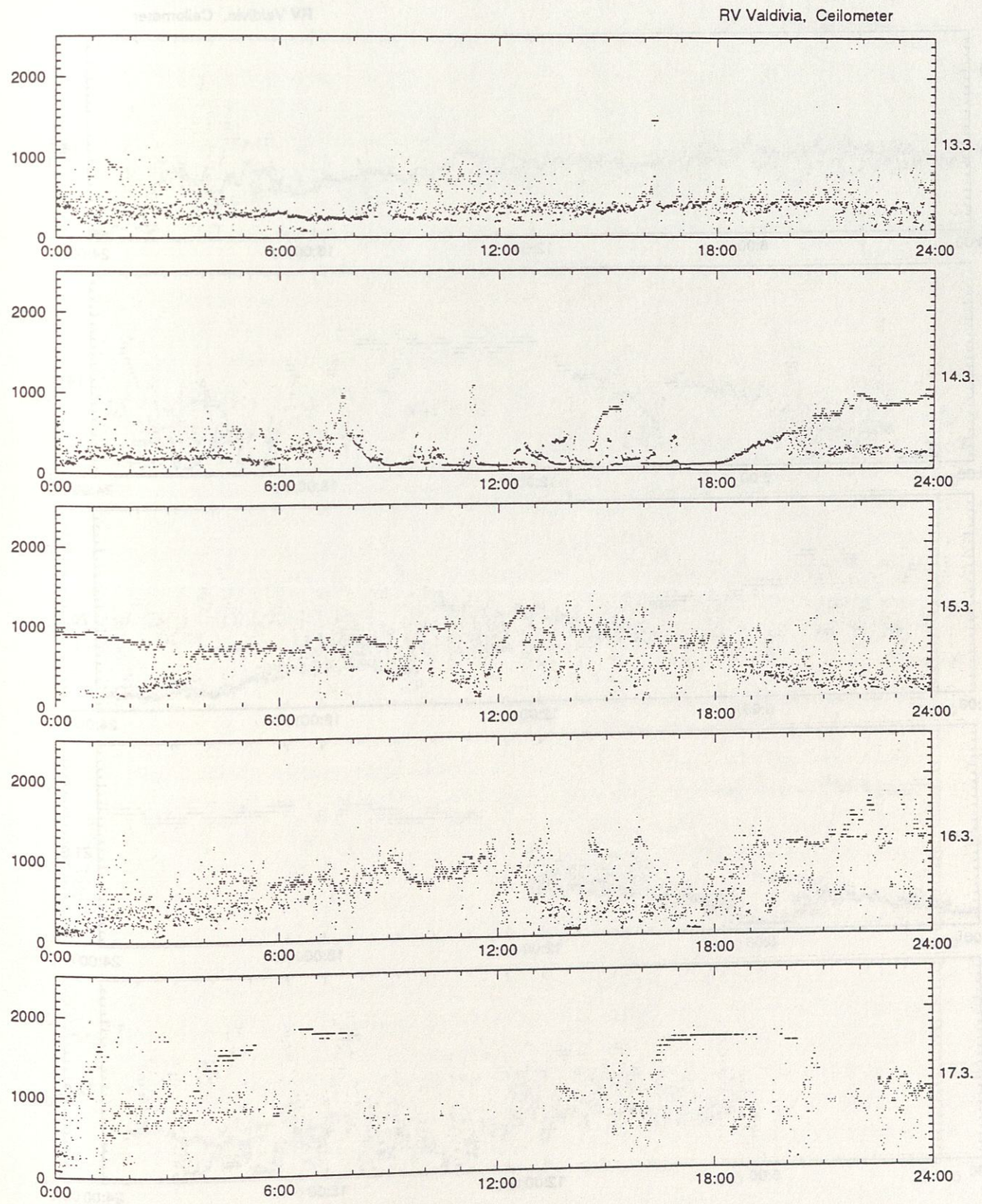

Fig. 3.4.1: continued

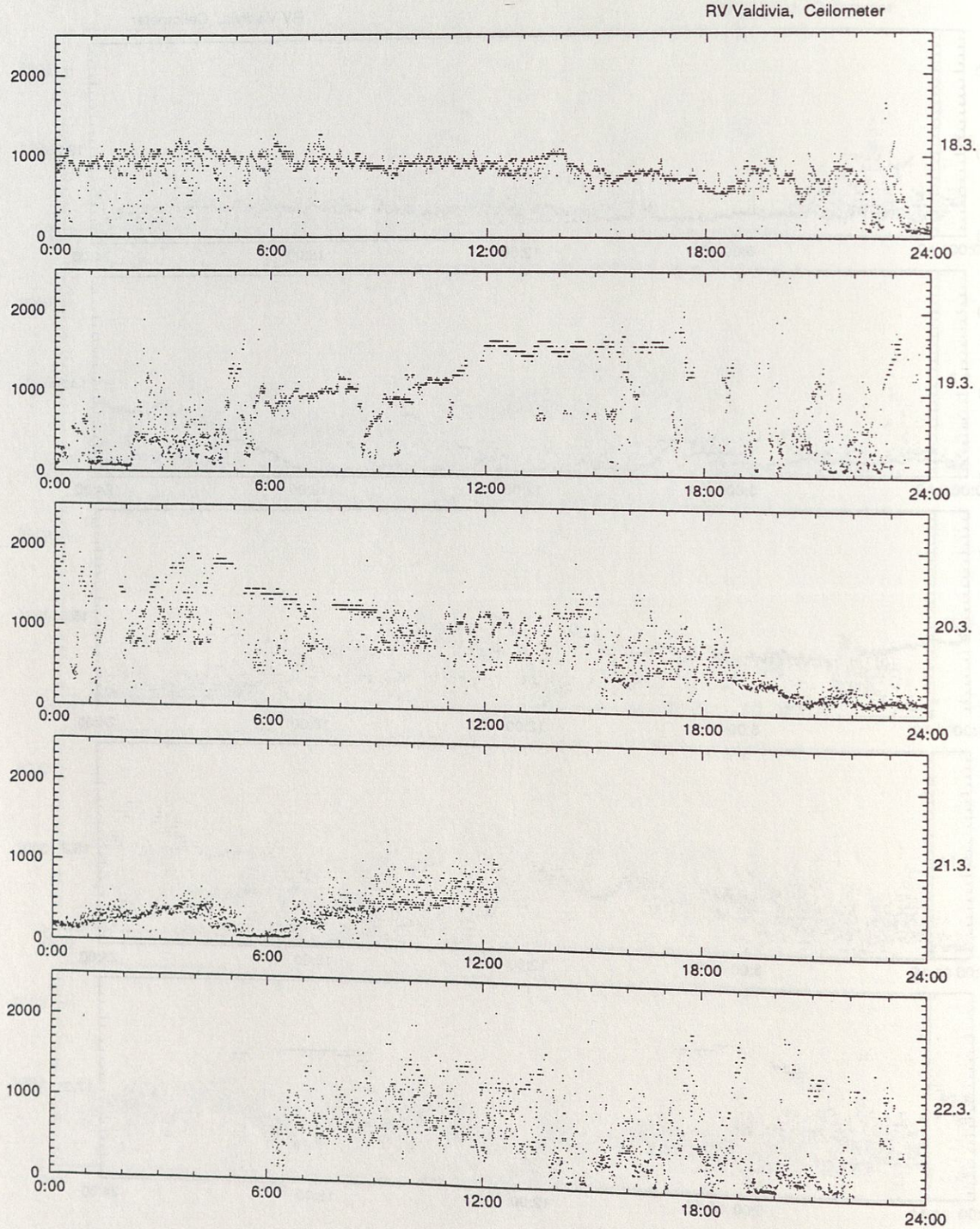

Fig. 3.4.1: continued

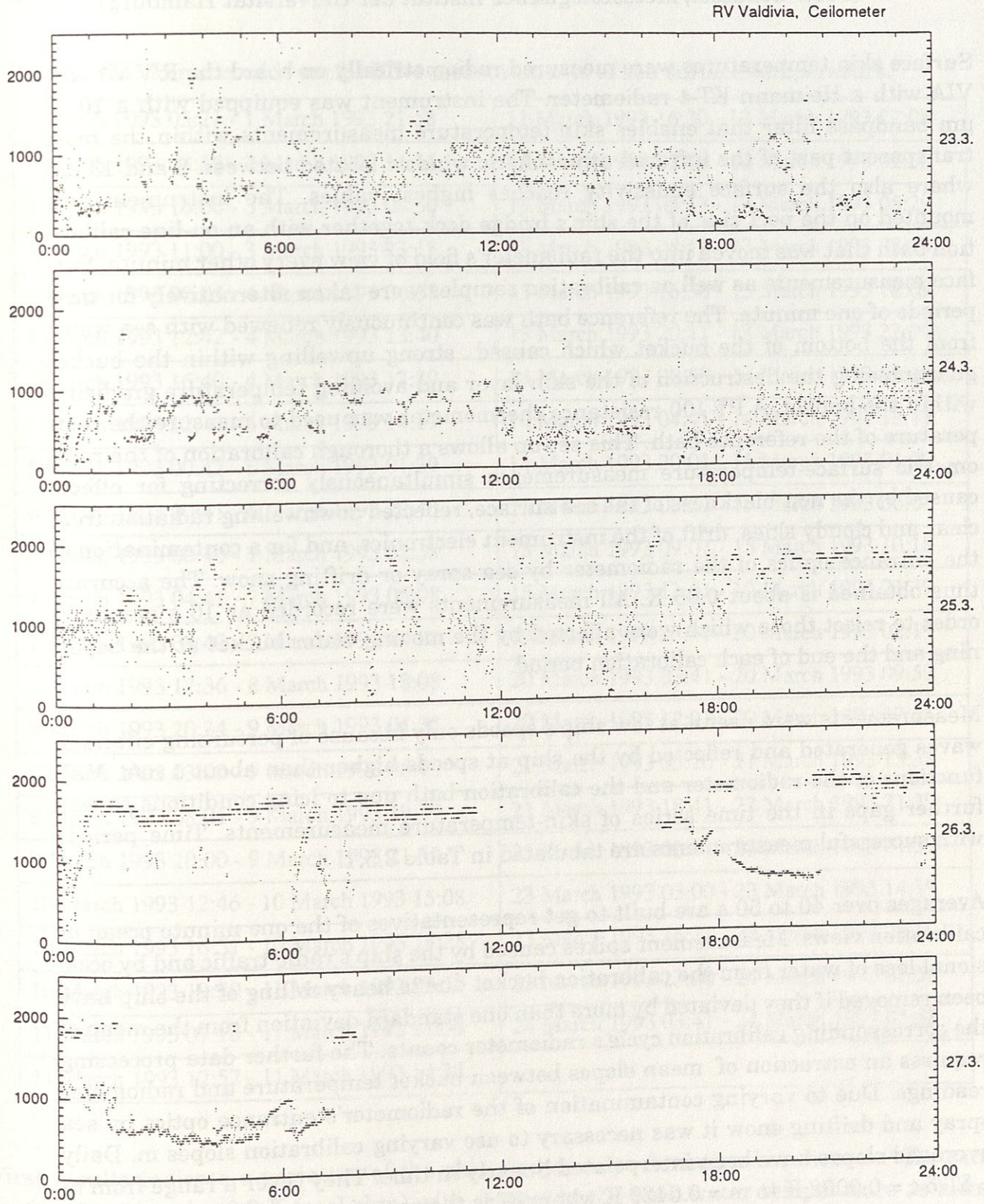

Fig. 3.4.1: continued