Meteorological and Oceanographic Data of the Winter-Weddell-Sea Project 1986 (ANT V/3)

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Part 1: Drifting Buoy Data
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Part 2: Moored Instrument Data
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Summary

During the "Winter-Weddell-Sea-Project 1986" R.V. "Polarstern" worked from May to November 1986 in the Antarctic ice belt. The third leg which lasted from September to December was aimed at studying biology and physics in the Antarctic Coastal Current and its associated polynyas in the south-eastern Weddell Sea.

In order to obtain meteorological and ice drift data seven drifting buoys with ARGOS-transmitters were deployed on ice floes. Five of them provided data on wind speed and direction,air temperature, the temperature inside the hull and atmospheric pressure. One buoy carried a current meter. The tracks of all buoys from October 1986 to March 1987 and the measured meteorological time series are presented in this report.

Oceanographic time series were measured at four moored current meter arrays on the shelf and the continental slope off Drescher Inlet to study the kinematics and dynamics of the Antarctic Coastal Current. A short term mooring deployed in November under the fast ice of Drescher Inlet provided a two-day time series. The longer term arrays were installed in October. Two of the arrays, located on the shelf and upper slope, with one water level recorder, two thermistor cables and 15 current meters, were maintained for 34 days. On the lower slope 129-day time series were obtained from one thermistor cable and eight current meters. In this report we present the time series and simple statistics.

Introduction

In austral winter 1986 R.V."Polarstern" of the Alfred-Wegener-Institute for Polar and Marine Research conducted an eight-month-long multidisciplinary cruise, the "Winter-Weddell-Sea-Project 1986" (WWSP 1986) in the Antartic ice belt (S.SCHNACK-SCHIEL, 1987). During the third leg, lasting from 29 September to 14 December 1986, interest was focussed on the physical and biological conditions in the coastal polynya between Atka Bay and Filchner Trench. The physical research comprised a meteorological and an oceanographic component.

The meteorological programme was based on a drifting buoy experiment, vertical profile and fixed level measurements from the ship and land based stations at "Drescher" and "Halley" stations. In the present report the data obtained from the drifting buoys will be presented. Seven buoys with ARGOS-transmitters were deployed on ice floes. Five stations measured wind speed and direction, air temperature, the temperature inside the hull and atmospheric pressure. One of them provided data on the ocean currents under the ice floe. All buoys were located by the ARGOS-system.

The buoy programme was implemented with the following objectives:

- to study generation and maintenance of the coastal polynya

- to provide surface observations for the study of mesoscale atmospheric processes in the coastal region

- to investigate the wind force on the sea ice under various atmospheric flow conditions.

In addition, the drifting stations provided data on the long term atmospheric forcing and the related ice drift.

The oceanographic programme comprised the deployment and recovery of moored instruments, a CTD-survey of the coastal polynya including a number of sections perpendicular to the coastline and a series of stations along the coast.

This report contains the time series obtained during three mooring periods:

- a two-day time series of one array moored under the fast ice in Drescher Inlet with two currents meters and a thermistor chain

- a 34-day time series of two arrays on the shelf and the upper continental slope with one water level recorder, two thermistor chains and 15 current meters

- a 129-day time series of one array on the lower continental slope with one thermistor chain and eight current meters.

One mooring located on the continental slope could not be recovered.

The moored instrument programme was implemented with the following objectives:

- to study the structure of the Antarctic Coastal Current and its fluctuations

- to investigate the relationship between the current and the local wind fields with the interaction of the sea ice

- to obtain information on shelf and slope processes and their contribution to watermass transformation

- to study the transition from winter to summer conditions.

The combined meteorological and oceanographic data set will allow us to describe the physical background for a number of observations resulting from the multidisciplinary effort during WWSP 1986.

Part 1 : Drifting Buoy Data

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1. Description of the Buoys

The buoys (Fig.1) used during WWSP 1986 were manufactured by 'Polar Research Laboratories, Inc.'(PRL, 1985) in California, USA. They have an ice strengthened hull of a non-magnetic alloy, finished with a seawater resistant coating. The buoys are designed for operation on ice floes, but they are floatable so that the measurements continue after the ice has melted in open water.
The buoys are equipped with a data logging system and a transmitter (401.65 MHz) for digital data transfer. The power supply is provided by lithium batteries which last for approximately 12 months. During the second leg of the WWSP 1986 three different types of buoys were deployed.

two buoys with sensors for:

- surface air pressure,
- air temperature,
- hull temperature,
- battery voltage.

five buoys with sensors for:

- surface air pressure,
- air temperature,
- hull temperature,
- wind speed,
- wind direction,
- ice orientation.

one buoy with sensors for:

- surface temperature,
- air temperature,
- hull temperature,
- wind speed,
- wind direction,
- ice orientation,
- current speed,
- current direction.

The air temperature was measured approximately one meter above and the hull temperature approximately two meters below the ice surface. The anemometer was mounted on a tripod mast at height of 3 m and the current meter situated approximately 10 m below the ice surface. The buoy data were received by two polar orbiting NOAA satellites.
The location of each buoy was determined from the Doppler shift of the transmitter signal.

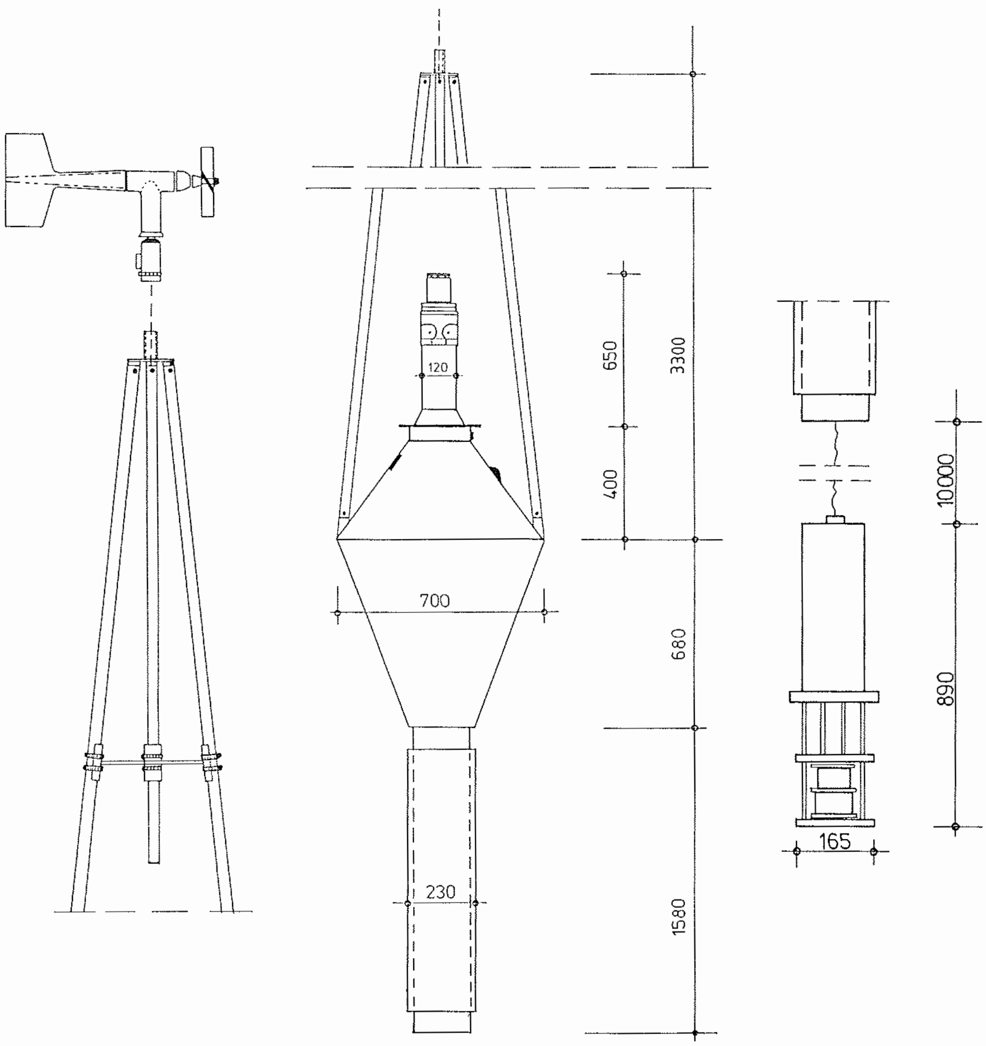


Fig. 1:
Scheme of ARGOS buoy with tripod
mast and current meter.

2. Sensor Specifications

For the meteorological/oceanographic measurements only proved sensors are mounted into the buoys. The sensor specificatios according to the manufacturer (PAROS,1976;TSK;YOUNG,1985) are listed below.

Air Temperature:
Thermistor of 'Yellow Spring Inc.'
Type: NET 44212 upgraded by use of 'Vishay' precision resistors (.02%).
Range: -50°C to +50°C (linear).
Resolution: 0.05°C.
Precision: 0.2°C.
Calibration points: -40°C and +40°C.
Mounted in self aspirating housing.

Hull Temperature:
Same sensor as above mounted on thermally isolated spring loaded arm in contact with inside of buoy hull.

Air Pressure:
Digiquarz pressure transducer of 'Paroscienific, Inc.'.
Type: 215-AW-002.
Range: 0-15 psia (0.1 MPa).
Resolution: 0.0375 hPa.
Precision: 0.1 hPa.
Operational temperature range: -54°C to 107°C
Repeatability: 0.005%
Hysteresis: 0.005%
Temperature null shift: 0.0007%/°C.
Vibration sensivity: Negligible.

Wind:
Propelleranemometer of 'R.M.Young'.
Type: 05103.
Range:
Azimuth - 360°mechanical,
352°electrical,
(8° open), continuous rotation.
Wind Speed - 0 to 50 m/s.
Threshold:
Sensitivity of propeller 0.3 m/s.
Sensitivity of vane 1.0 m.
Dynamic response:
Distance constant of propeller 3.3 m.
Delay distance of vane 1.3 m.
Damping ratio of vane 0.23.

Calibration points:

3600 rpm - 17.6 m/s
3000 rpm - 14.7 m/s
1800 rpm - 8.8 m/s
1500 rpm - 7.4 m/s
300 rpm - 1.5 m/s
250 rpm - 1.2 m/s

Current:

Savonius rotor and vane of 'Tsurumi Seiki Co., Ltd.'
Type: V-2, TSK Vane Type Current Meter.
Range: Azimuth 0-360½,
Speed 0.03-2.0 m/s.
Precision: Azimuth 6½,
Speed 0.03 m/s
Bearings: Jewel.
Depth Ranges: 0-50 m.

The listed specifications are in a few cases modified by PRL. Tab.1 summarizes ranges and resolutions as implemented by PRL. Compass readings are related to magnetic north.

Tab.1:
Ranges and resolutions of buoy sensors.

Parameter	Range	Resolution	Unit
Air pressure	920.0-1022.3	0.1	hPa
Air temperature	-45 - +6	0.2	½C
Hull temperature	-45 - +6	0.2	½C
Wind Speed	0 - 127.5	0.5	kn
Wind direction	0 - 360	1.5	deg
Ice orientation	0 - 360	1.5	deg
Current speed	0 - 2.55	0.01	m/s
Current direction	0 - 360	1.5	deg

3. Data Recording and Data Quality

The measuring schedule and the averaging are controlled by the central processing unit within the buoy. The averaging intervals for the various sensors are as follows:

Air pressure	-	1 min block average.
Air/hull temperature	-	10 min spot sample.
Battery voltage	-	---
Wind speed/direction	-	10 min vector average.
Ice orientation	-	10 min vector average.
Current speed/direction	-	10 min vector average.

All sensor outputs are linear. The second order and temperature corrections for the barometer are made on-board the buoy. All temperature sensors utilize the same coefficients so that they are interchangeable.

The following error sources determine the accuracy of the buoy location:

- the oscillator stability of the buoy transmitter,
- the movement of the buoy,
- inaccuracies in the satellite orbitephemeris

'Service ARGOS' assures us that in 95 % of cases an accuracy of 150 m is obtained for the buoy type we use (SERVICE ARGOS,1984;1985).

The 'European Center for Medium Range Weather Forecasts', (ECMWF) used the 0 h and 12 h surface pressure measurements for their southern hemispheric analysis. The number of accepted and rejected pressure measurements (Tab.2) gives a rough idea of the data quality.

According to Tab. 2 only a few measurements were rejected and all the buoys supplied almost the same number of data.

Tab.2:
The numbers of accepted (a) and rejected (r) pressure data for the ECMWF models between Nov '86 and Mar '87.

Buoy ID	Nov a/r	Dec a/r	Jan a/r	Feb a/r	Mar a/r
3310	60/2	56/0	62/1	51/1	46/0
3311	60/0	55/1	61/1	51/1	45/0
3312	60/1	55/2	62/2	51/3	46/0
3313	60/1	56/0	62/0	51/0	43/3
3314	60/0	56/0	62/0	51/2	45/0
3316	60/0	56/2	62/3	51/0	45/0
3317	59/2	55/2	27/1	-	-

4. The Station Network

The buoys were deployed in the southeastern Weddell Sea, parallel to the edge of the 'Riiser Larsen' ice shelf. Tab.3 gives the locations and the dates of deployment.

The buoys were placed directly from R.V.'Polarstern' on huge ice floes or carried by helicopter to their initial positions. They were mounted on the ice by drilling a 10-inch diameter hole through the floe and inserting the buoy shaft into the drill hole. The refreezing sea water ensured the firm position of the buoy on the floe.

After six months of operation six of the eight buoys are still performing successfully. The buoys' status at the end of March 1987 is presented in Tab.4.

Tab.3:
Dates, times and locations of buoy deployment.

Buoy ID	Date	Location
3310	12.10.86, 19:30h	69.640°S, 11.356°W
3311	10.10.86, 11:00h	69.194°S, 5.948°W
3312	12.10.86, 20:30h	70.649°S, 10.543°W
3313	11.10.86, 7:30h	70.005°S, 6.916°W
3314	17.10.86, 7:00h	72.421°S, 20.924°W
3315	13.10.86, 15:00h	70.586°S, 16.600°W
3316	13.10.86, 13:00h	71.404°S, 15.104°W
3317	14.10.86, 11:00h	72.721°S, 19.855°W

Tab.4:
Status of buoys at March 31, 1987.

Buoy ID	Status	Remark
3310	operating	with all sensors
3311	operating	with all sensors
3312	operating	buoy transmits momentary pressure data instead of 1 min averages, other sensors o.k.
3313	operating	with all sensors
3314	operating	with all sensors
3315	failed	on 13.10.86, cause: unknown
3316	operating	with all sensors
3317	failed	on 14.01.87, most likely cause: damaged by pack ice

5. Data Processing

5.1. Data Transfer

The NOAA satellites transmit the stored buoy data to ground stations located in Alaska (USA), Virginia (USA) and France. With the three stations it is guaranteed that the satellites do not lose contact with the ground for longer than one orbital period per day. The stations transmit the received data to the 'National Environmental Satellite and Data Information Service'(NESDIS, USA) in Suitland (Maryland, USA). Here ARGOS data are separated from the data of other experiments and transmitted to 'Service ARGOS' (Toulouse, France) via a permanent link.

The first step at the ARGOS data processing centre is to compress buoy data. Individual messages from a buoy are chronologically ordered and compared within the same telemetry data flow. The last of a series of identical messages is retained together with a compression index which indicates the number of identical messages in a series. The retained message is time-coded (in UTC) with reference to the clock on each satellite. The assigned time codes correspond to the times of message reception by a satellite and not the times when measurements were recorded by sensors on the buoy. Subsequently the binary sensor data are converted to physical values, using calibration information supplied by the user. Finally, the processed data are stored in files. ARGOS provides interactive attachments to the data files. Direct read out by computer link or telex is possible with a delay of approximately 5 hours. In addition ARGOS produces monthly data tapes . The tapes contain the complete buoy data set with quality and status indices.

For the benefit of other users (e.g. weather services) ARGOS feeds the buoy data into the GTS (Global Telecommunication System). The data are labelled with the WMO-Code DRIBU (Drifting Buoy). At present the data are used by the ECMWF (see Chap.3.) and the Meteorological Office, London.

5.2. Data Validation and Data Stock

The number of buoy messages depends on the contact frequency between buoy and satellite. For polar orbiting satellites the number of contacts is a function of the buoy latitude. Fig. 2 illustrates this relationship. ARGOS guarantees a minimum of six locations per day with two satellites in service. Our buoys, initially deployed between 69°S and

The contact between buoy and satellite usually lasts longer than the repetition of data transmission (1 min). Hence the buoys transmit multiple successive data records per pass (the period for which a satellite is above the buoy's horizon).

In order to validate the buoy data we reprocessed the ARGOS files, using a computer programme to:

- identify the record with the highest number of identical messages per satellite pass; only this record is stored in our data bank.

- correct compass bearings of wind, current and heading by the magnetic declination.

- identify erroneous data; these values are converted to the default '8888.00'.

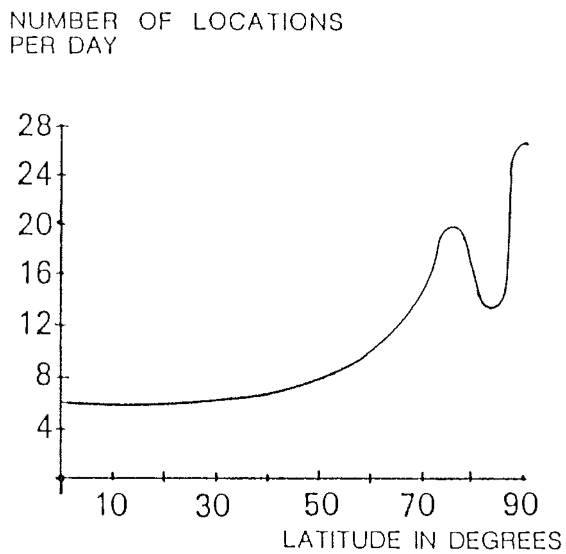


Fig.2:
Number of buoy messages and locations with two satellites in service (from: Service ARGOS , User's Guide).

6. Data Presentation

6.1. Data Availability

The availability of validated buoy data is sketched in Fig.3. During almost the whole period more than 10 data records were available per day . Only on Dec. 24/25, was there a data gap for all buoys, due to a computer malfunction at the ARGOS data processing centre in Toulouse.

Diurnal variations of the data frequency of buoy messages were observed. The data transmission rate of the northern buoys (3310, 3311, 3313) reached a minimum at noon but not the one of the southern buoys (3312, 3314, 3316, 3317) (Fig. 4). This is caused by the satellites' orbital geometry, which results in non-uniform frequency distributions of pass times during a day.

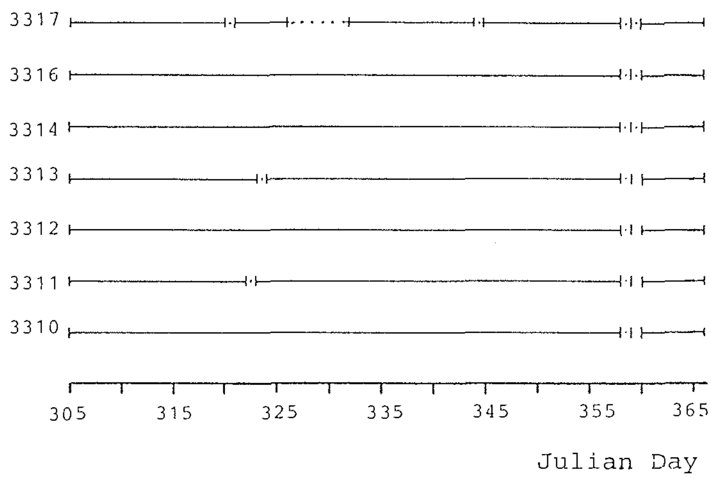
6.2. Buoy Tracks

The drift of the buoys is presented in Fig. 5 by the locations of the buoy in 10-day time intervals. Buoys 3310, 3311 and 3313 as well as buoys 3312, 3314 and 3316 are connected to triangles. Because the buoy movement is induced by sea ice drift, the deformation of the triangles is a measure of the inhomogenous motion within the sea ice in austral spring. All buoys follow the large-scale drift to WSW corresponding to the flow direction of the Weddell gyre.

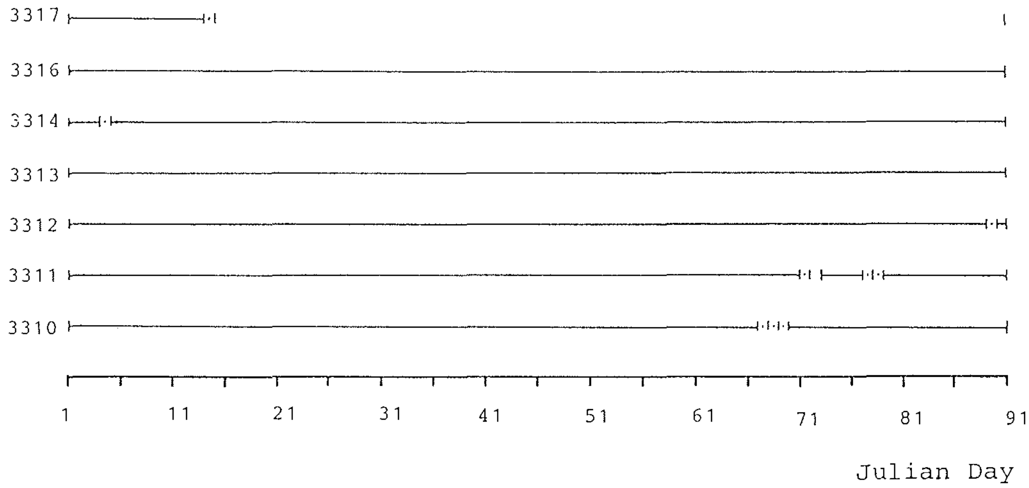
The initial buoy distribution in two parallel lines along the ice shelf was quickly abandoned. While the northern buoys propagated continuously to the west, the southern ones moved first to SW and then (since Feb.'87) turned to NW into the central Weddell Sea.

In Fig.6 the trajectories of the buoys are shown for the period October '86 to March '87. The velocity of the large scale buoy drift was about 20 cm/s. Sea ice deformation with different response time on various scales is to be observed.

Buoy Data-Availability 1986

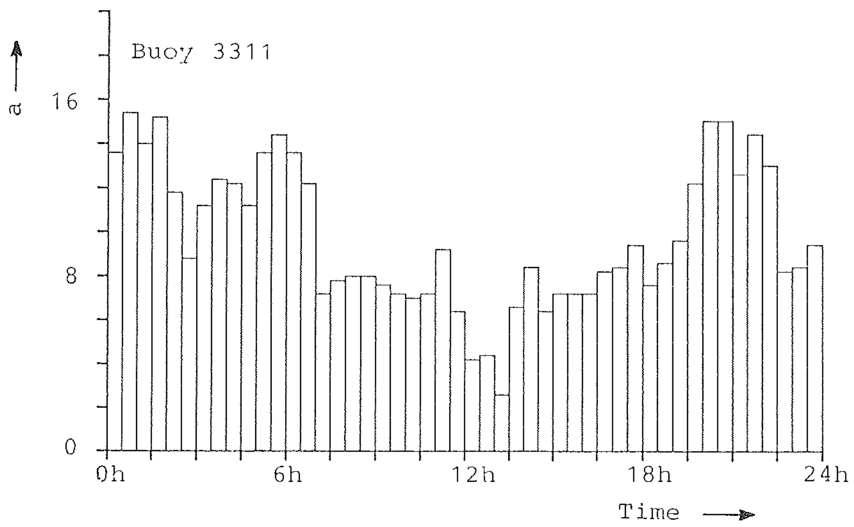


Buoy Data-Availability 1987



I—I Number of datarec. ≥ 10 per day
I···I Number of datarec. < 10 per day
I I No data recorded

Fig.3:
Availability of buoy observations for the period:
Nov.1, 1986 to Mar.31, 1987.



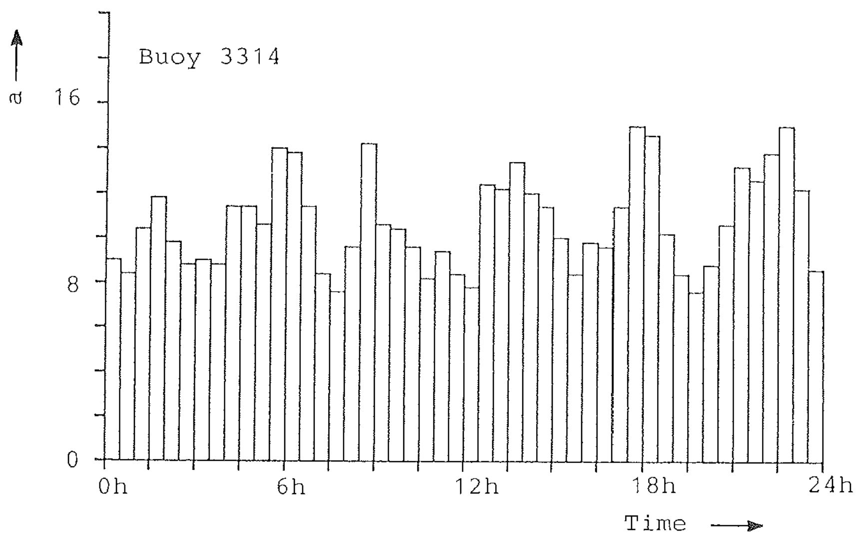


Fig.4:
Diurnal course of mean number (a) of buoy locations for the period from Nov.1, 1986 to Mar.31, 1987.

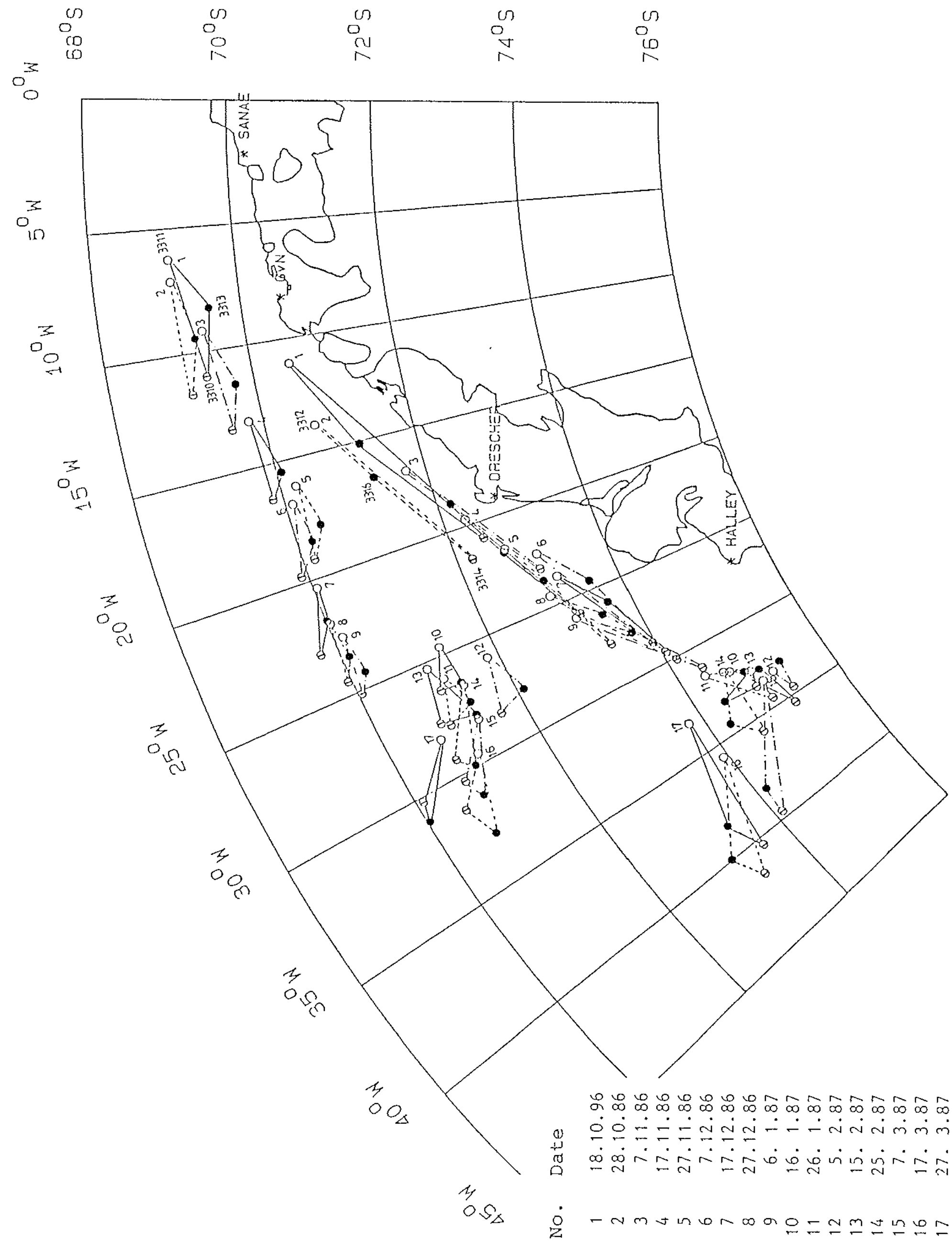
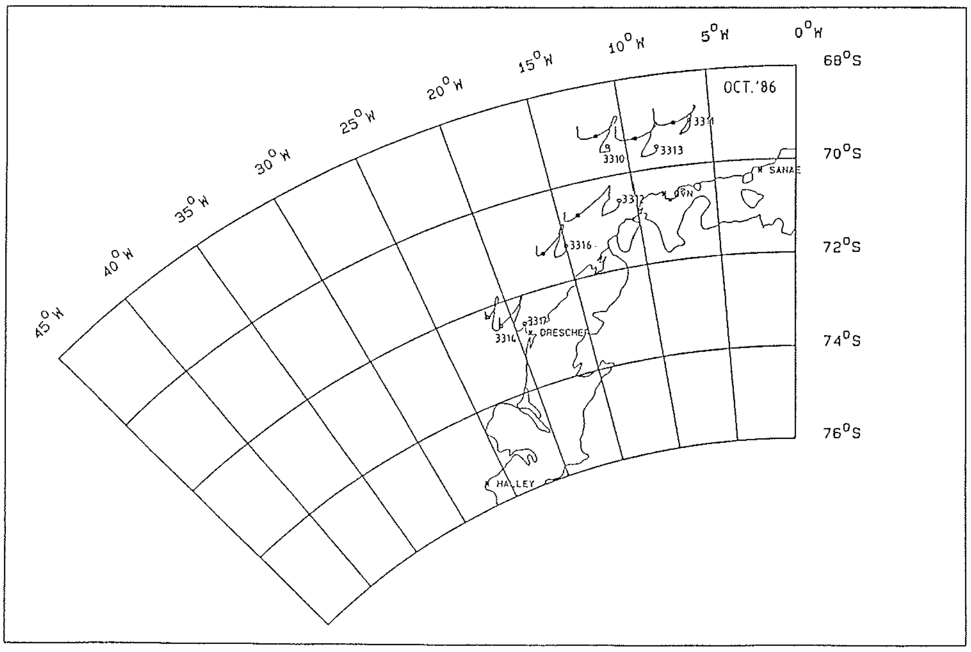


Fig.5:
Buoy station network. Stations are located at the corners of the triangles, drawn in 10-day intervals. First day is Oct.18, 1986 (Julian Day: 291).



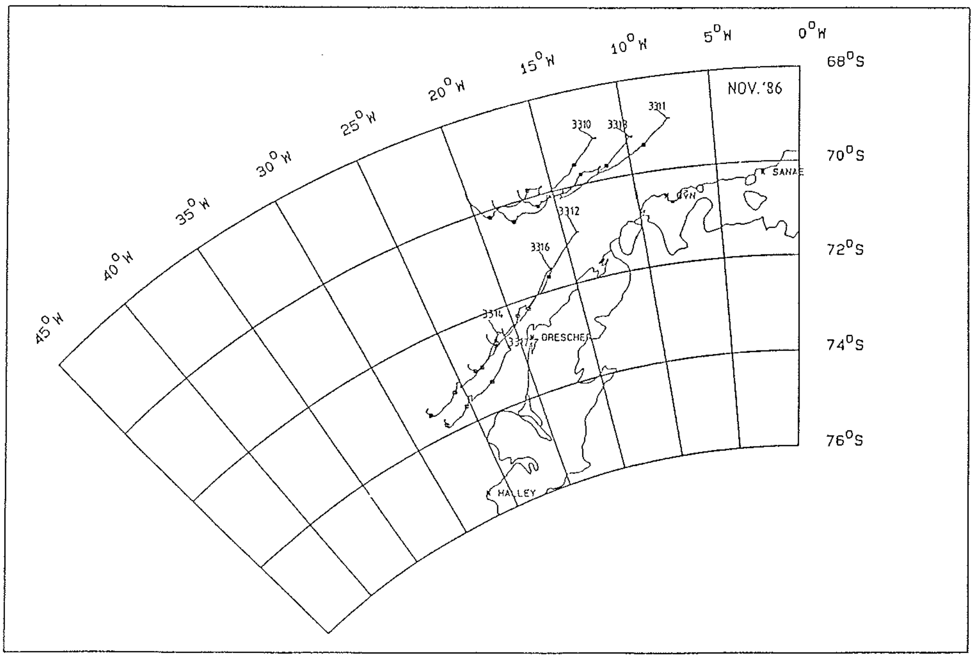
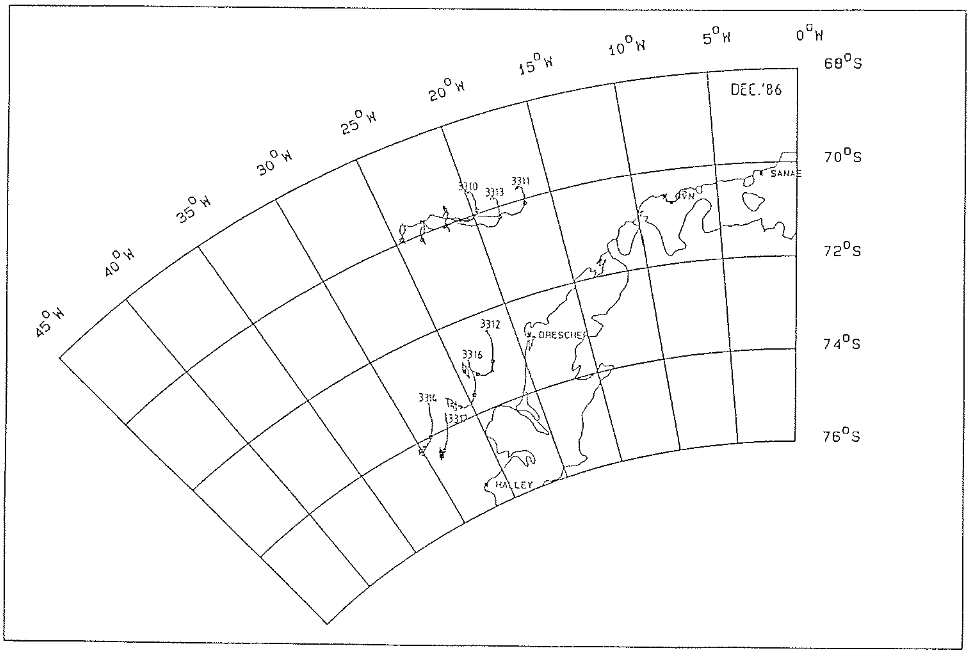


Fig.6:
Monthly trajectories of the ARGOS buoys for the period from Oct.18,1986 to Mar.31, 1987.



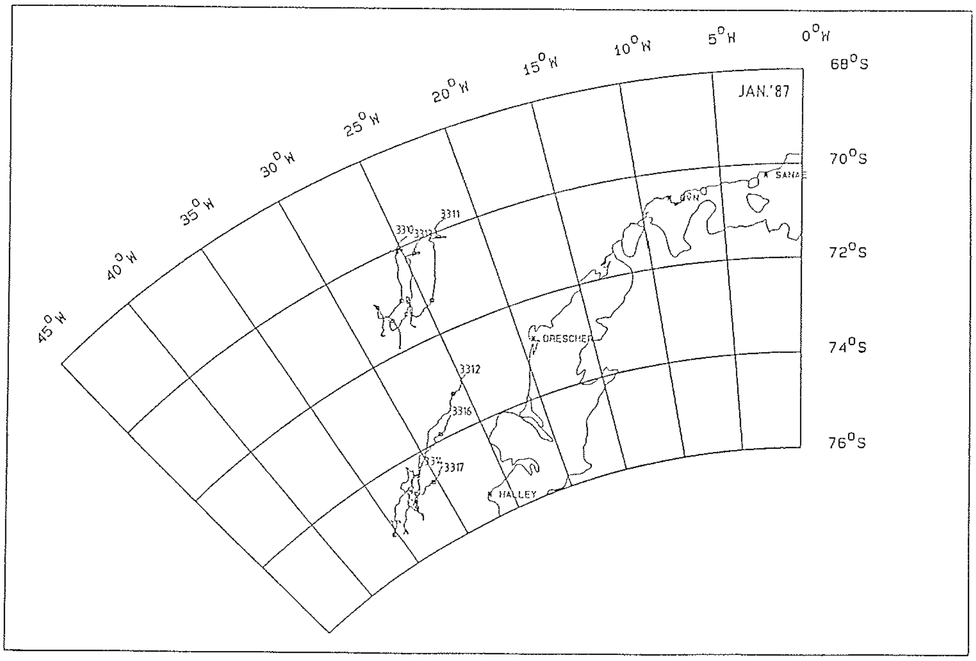


Fig.6:
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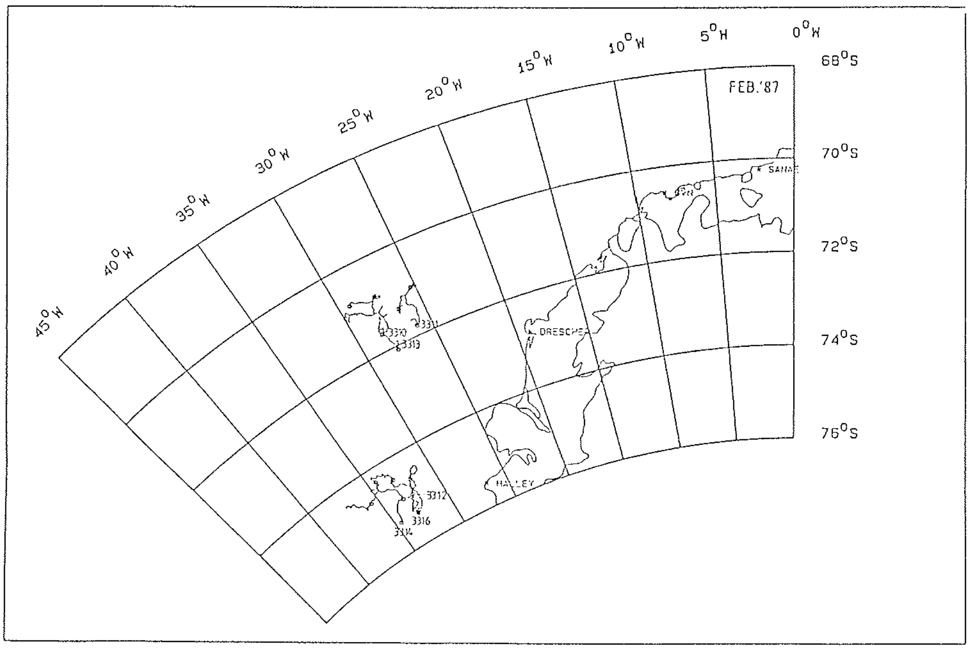

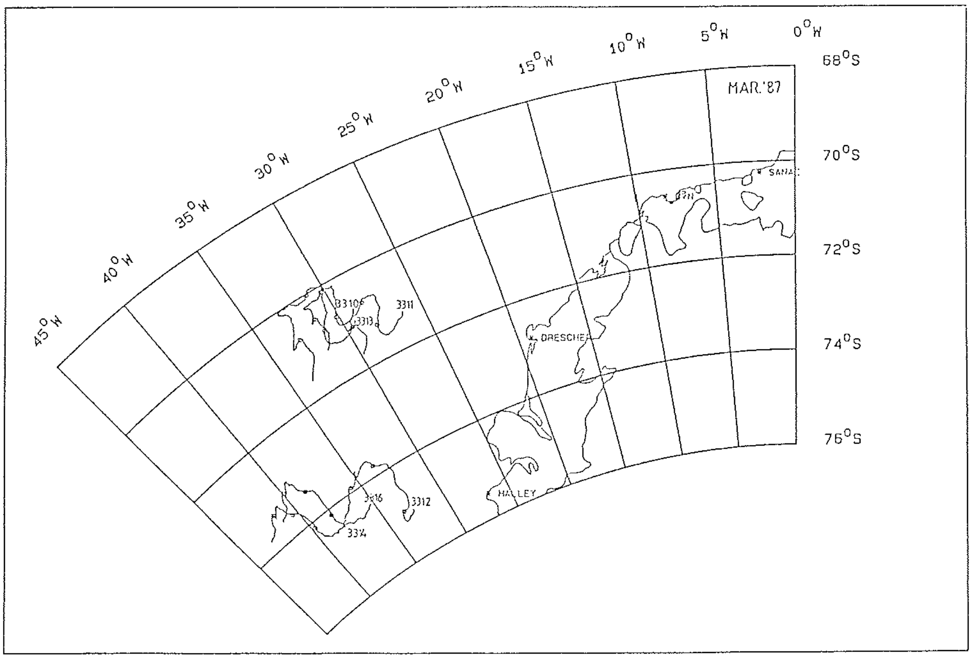

Fig.6:
Continued.

6.3. Meteorological Data

The meteorological measurements on the buoys are depicted in Fig. 7-13. They represent time series of air temperature, hull temperature, atmospheric pressure of all buoys, wind speed and direction when available in the original time intervals.

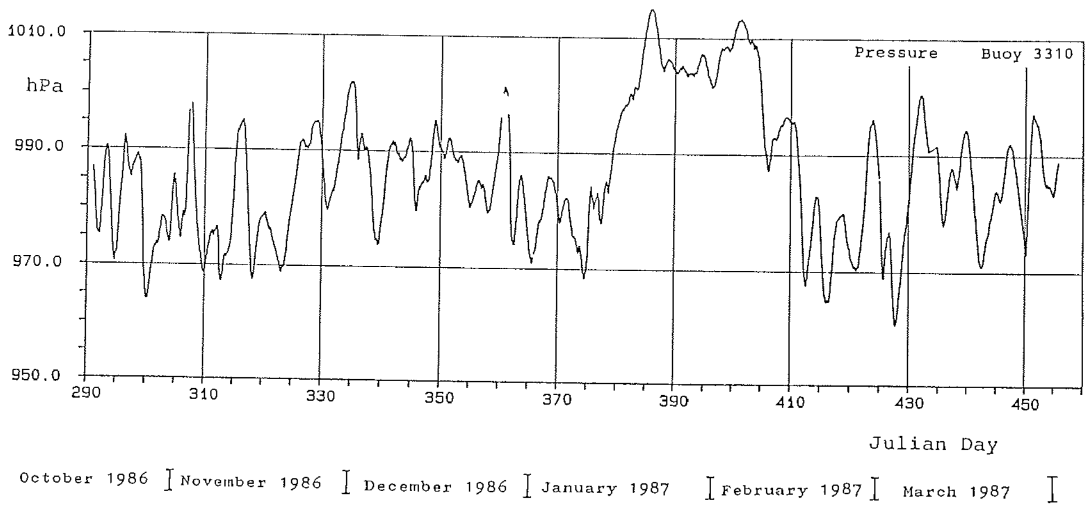

Fig.7:
Time series of meteorological data of buoy 3310.

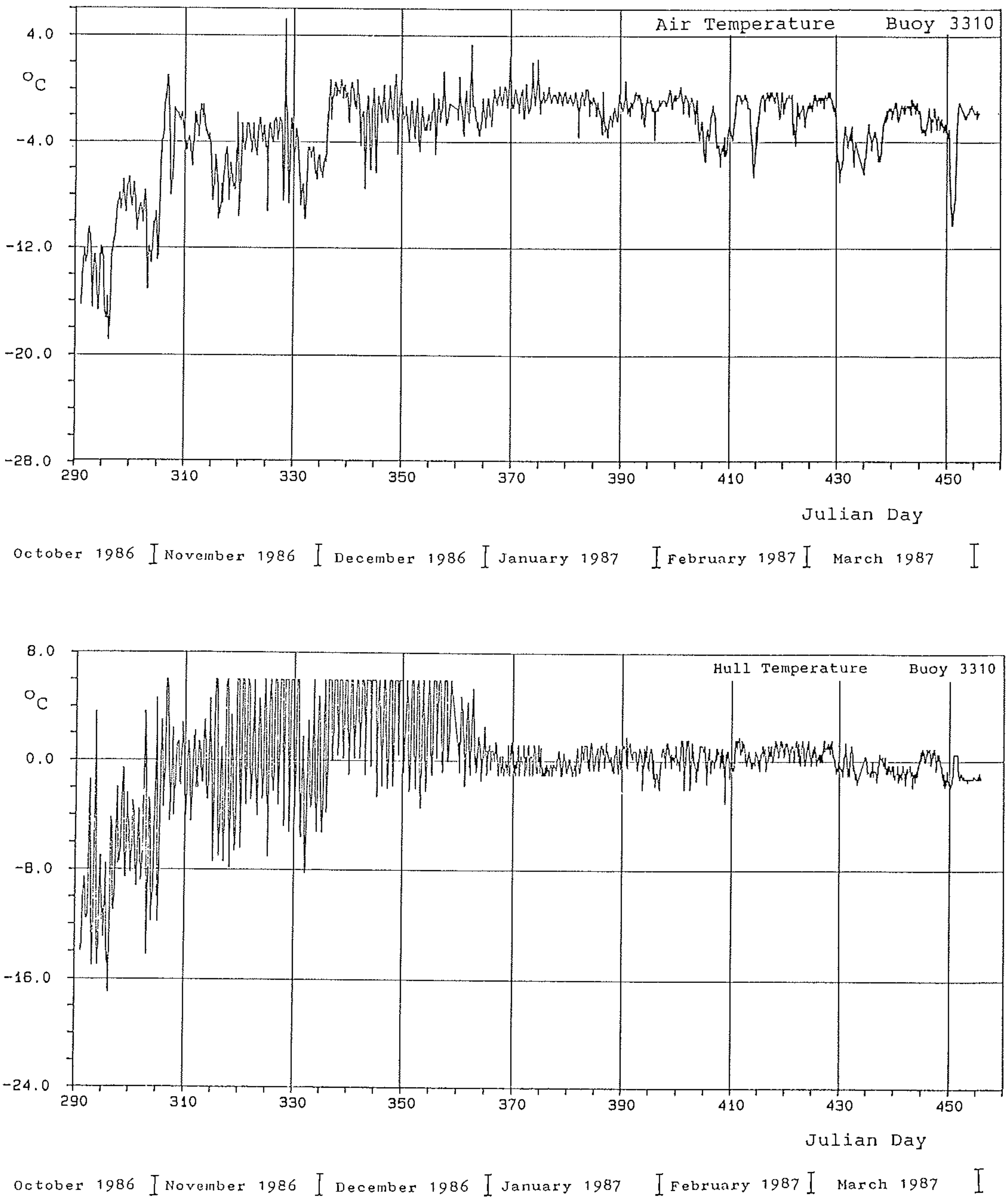

Fig.7:
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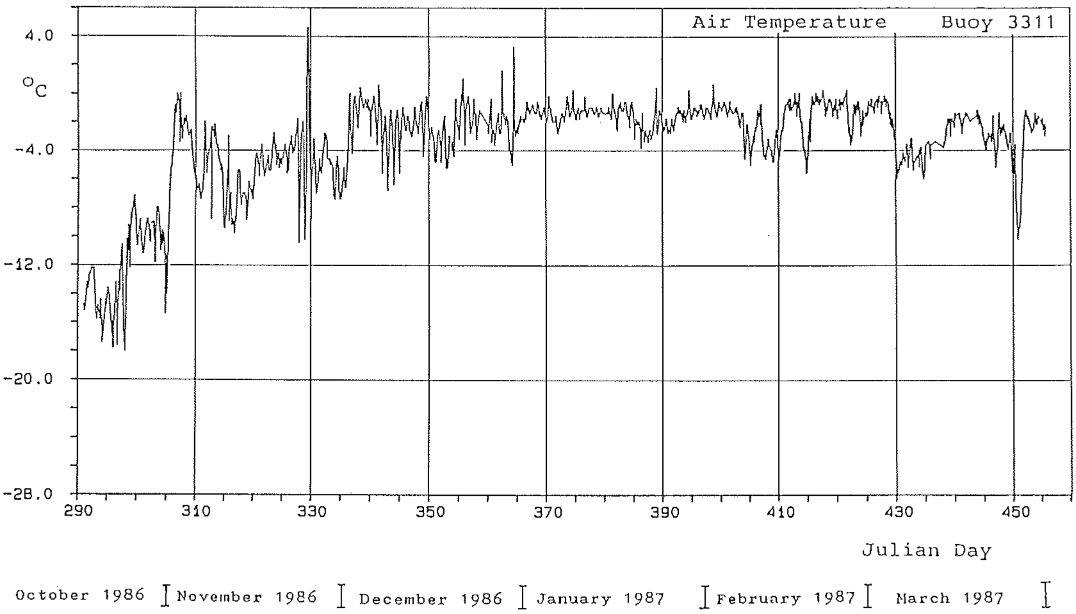

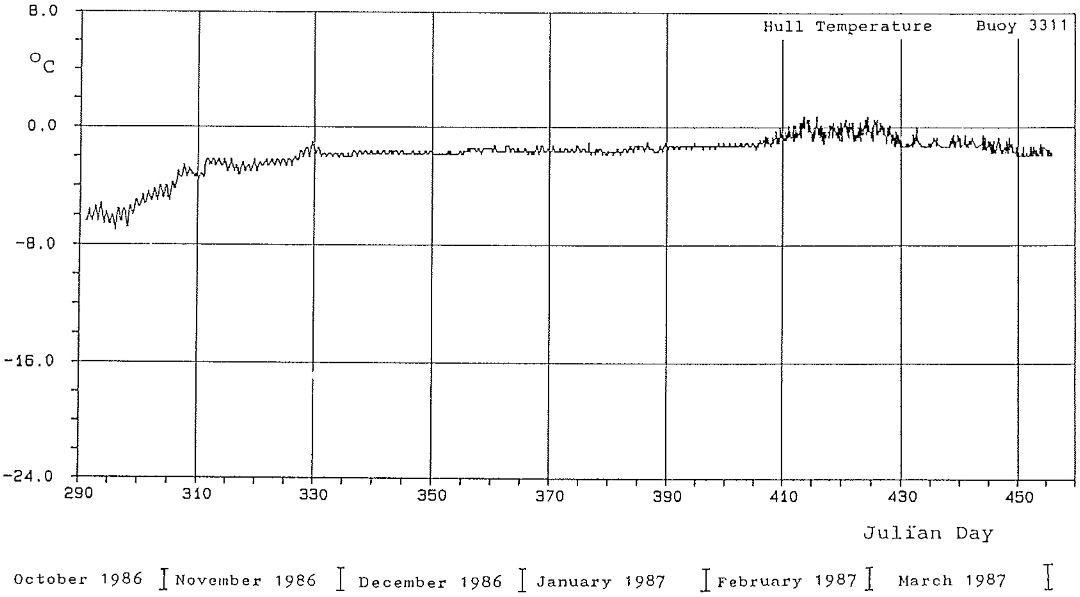

Fig.8:
Time series of meteorological data of buoy 3311.

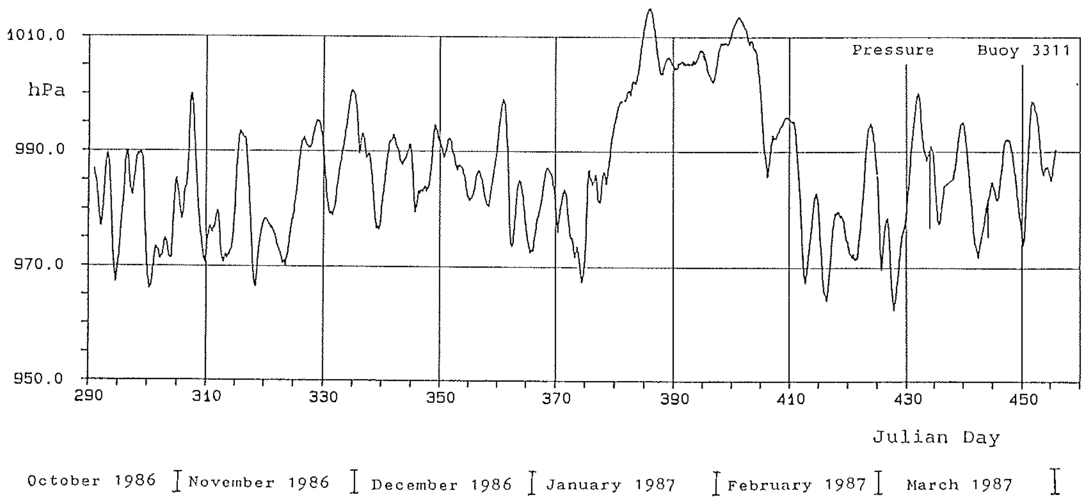

Fig.8:
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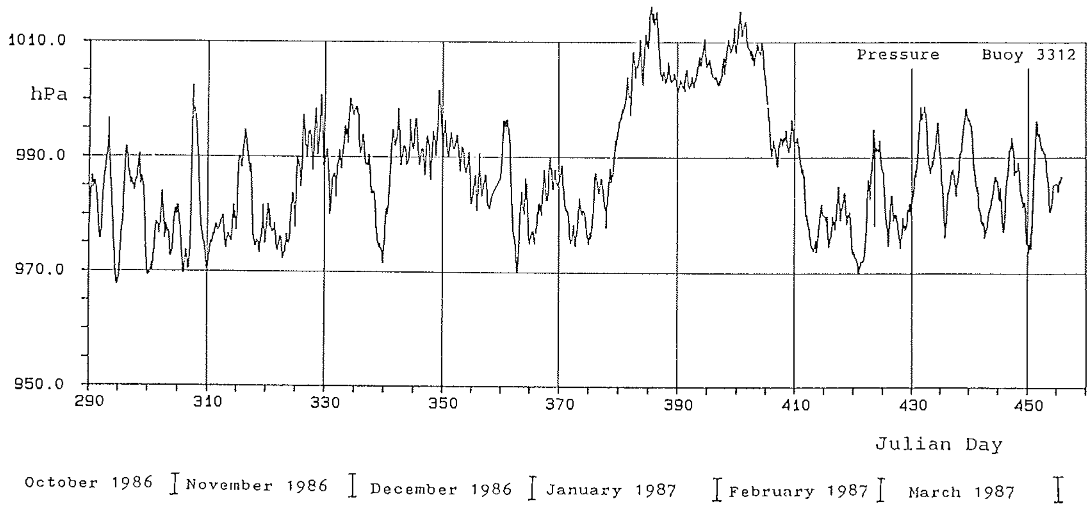
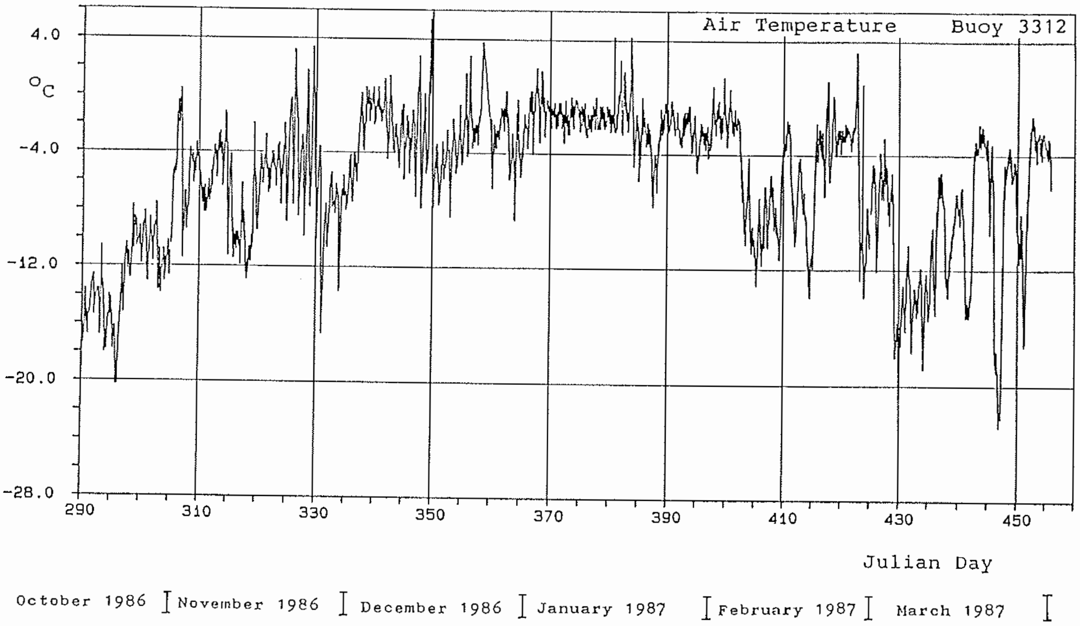


Fig.9:
Time series of meteorological data of buoy 3312.



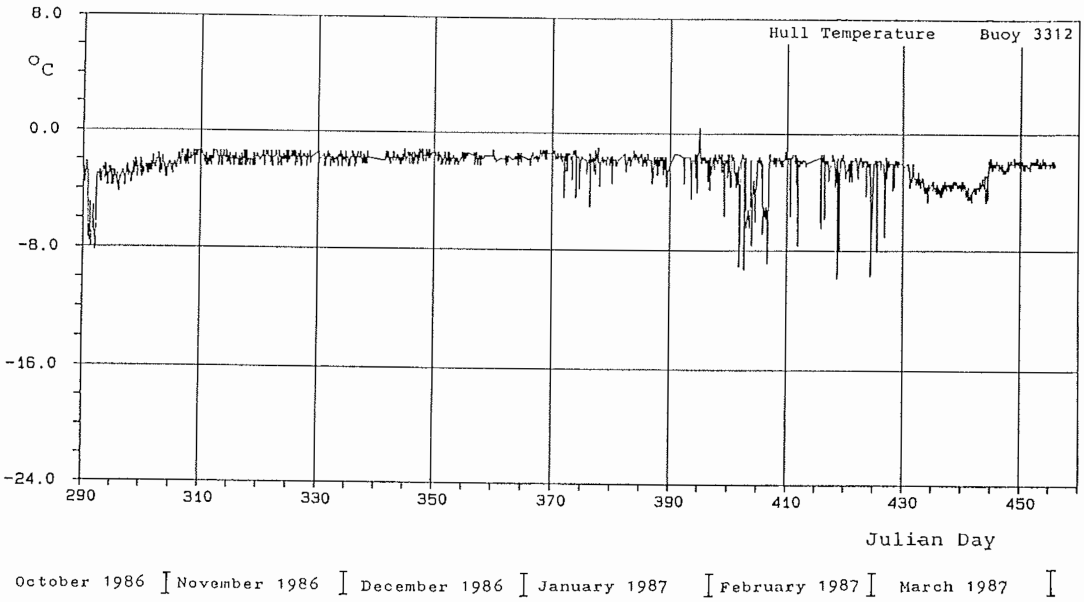


Fig.9:
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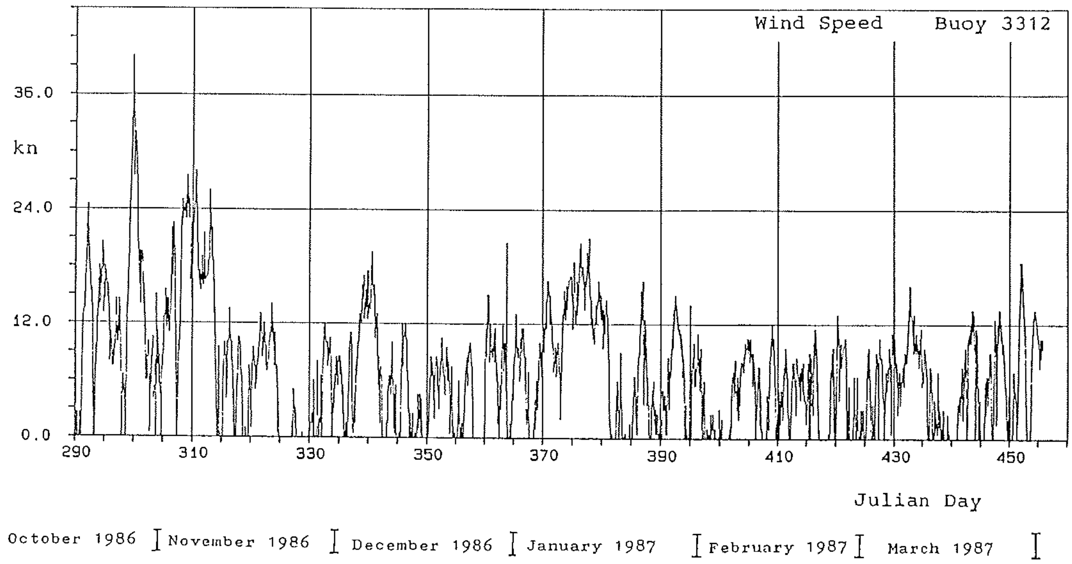

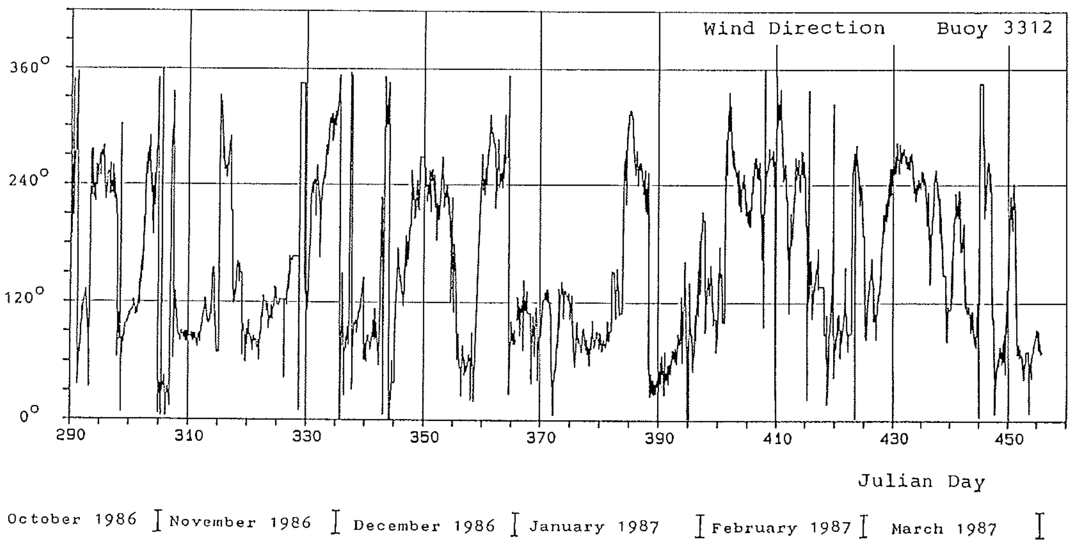

Fig.9:
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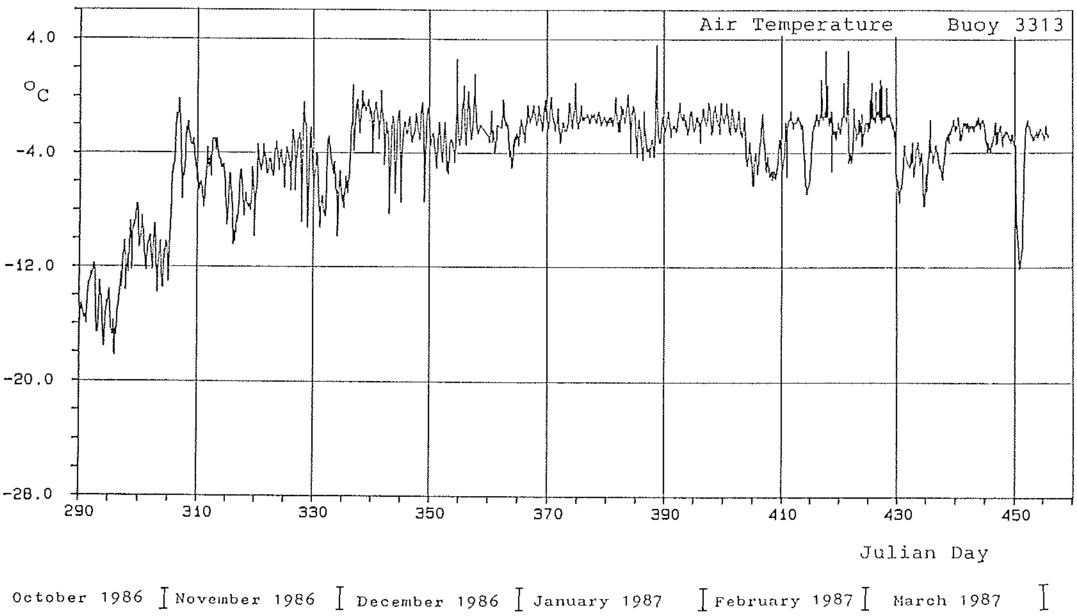


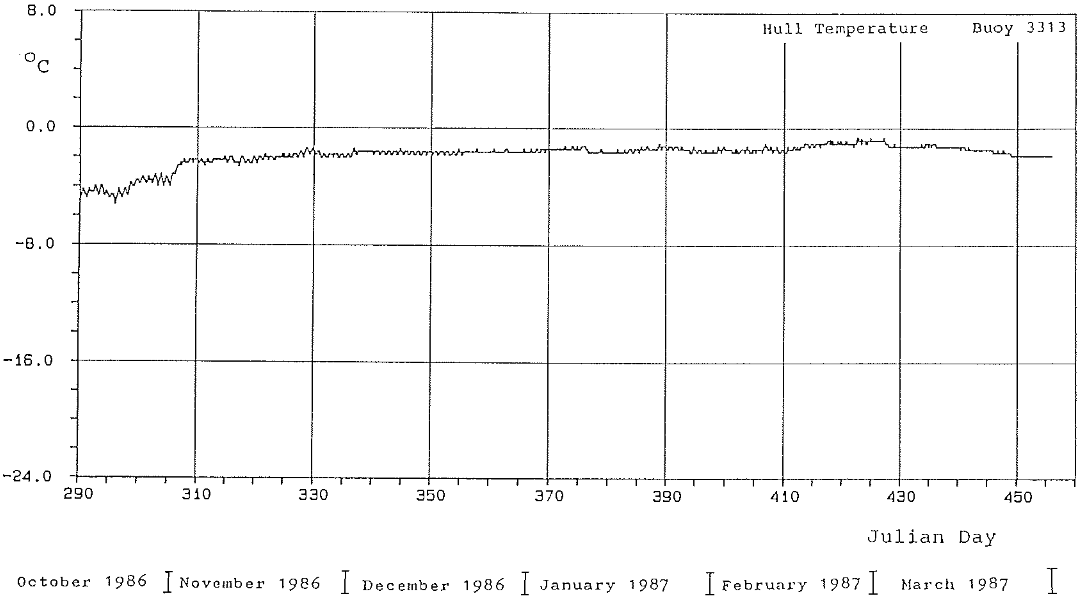
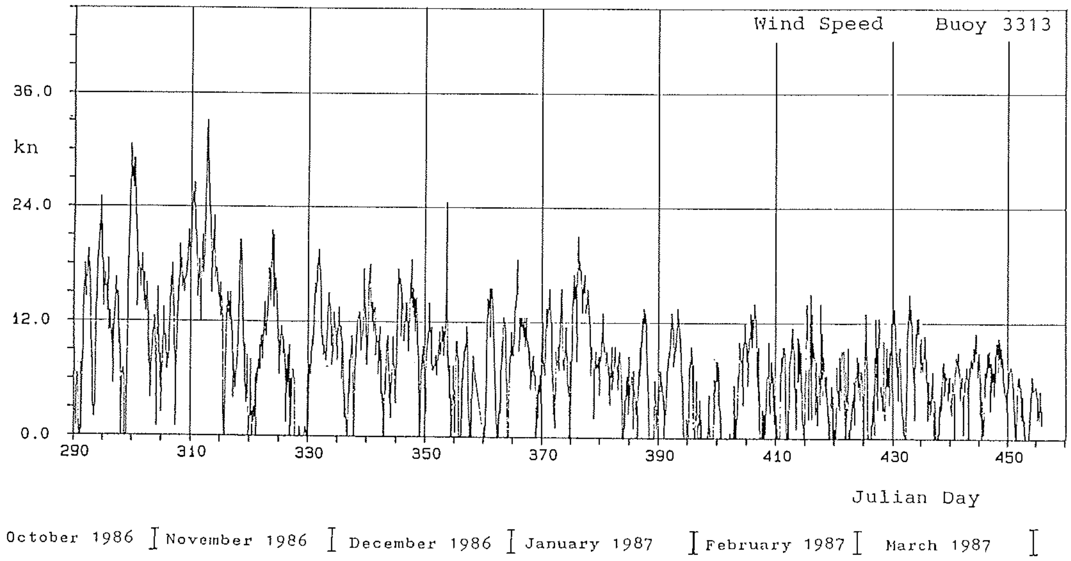


Fig.10:
Time series of meteorological data of buoy 3313.



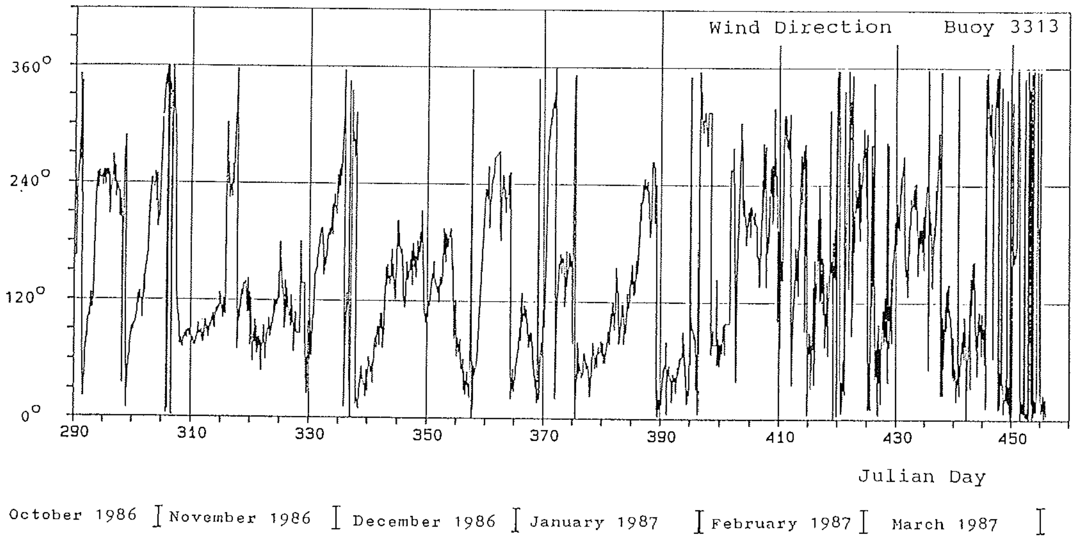


Fig.10:
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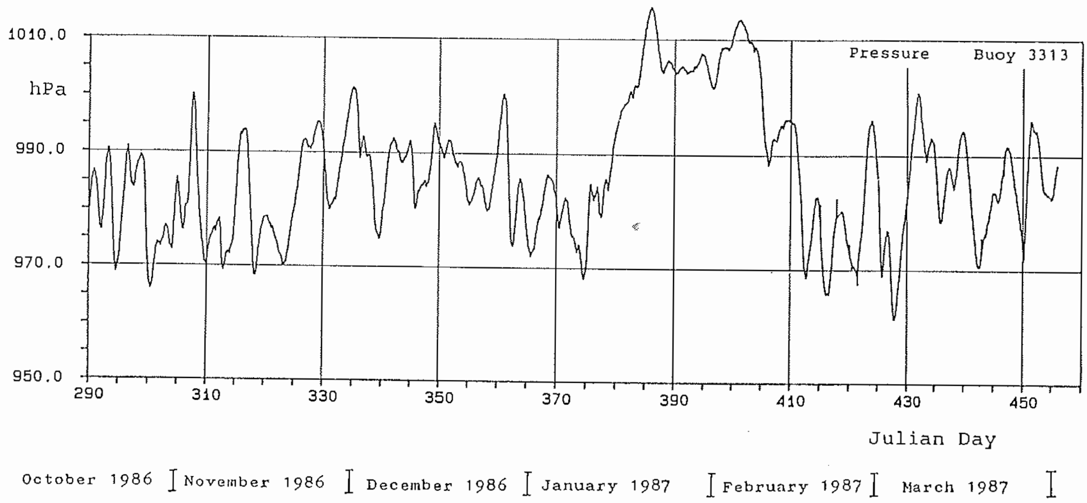

Fig.10:
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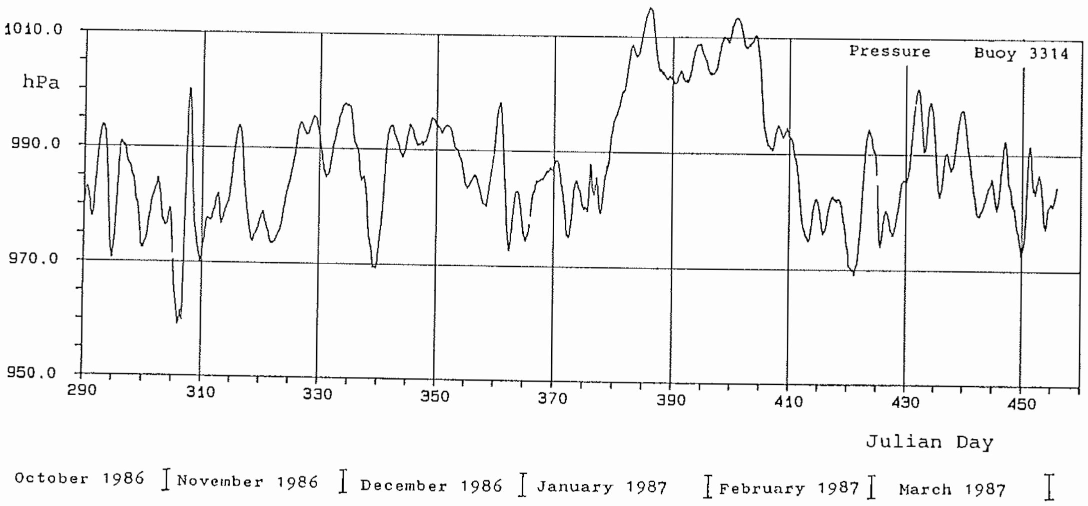
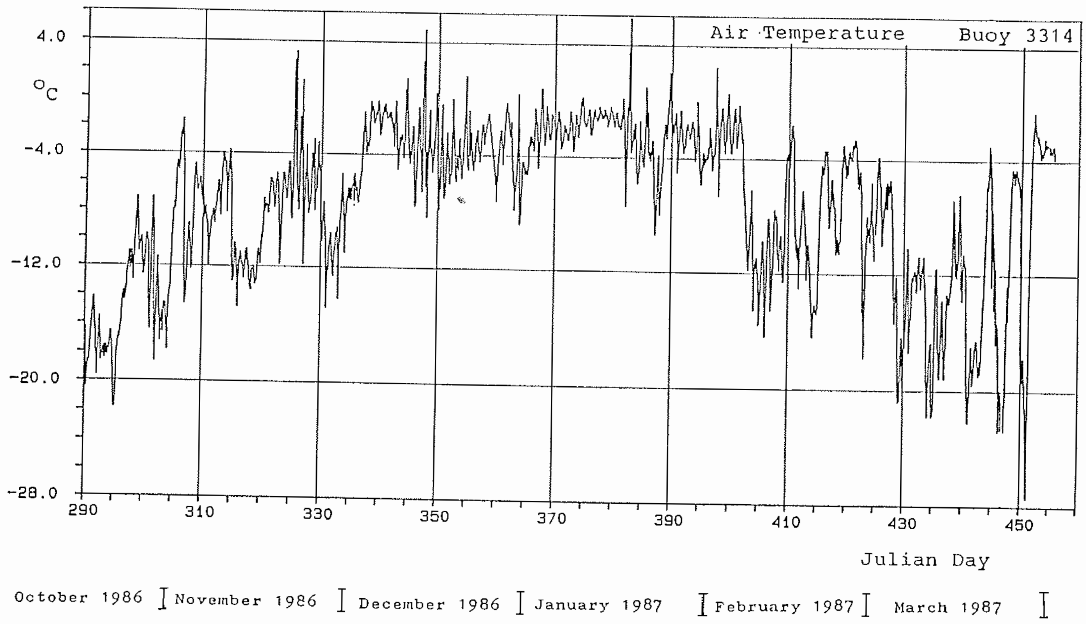


Fig.11:
Time series of meteorological data of buoy 3314.



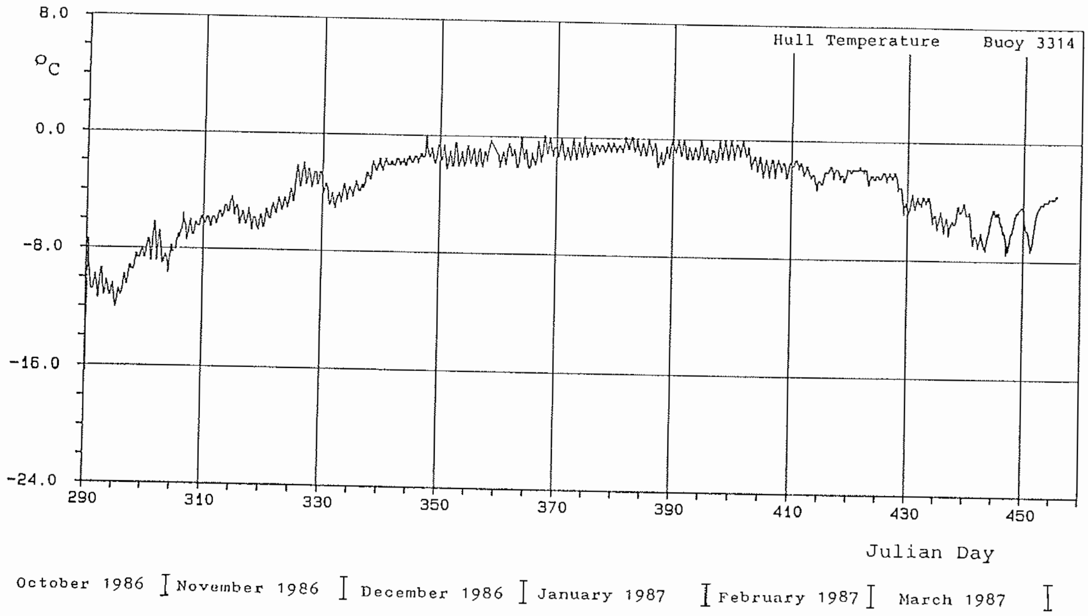


Fig.11:
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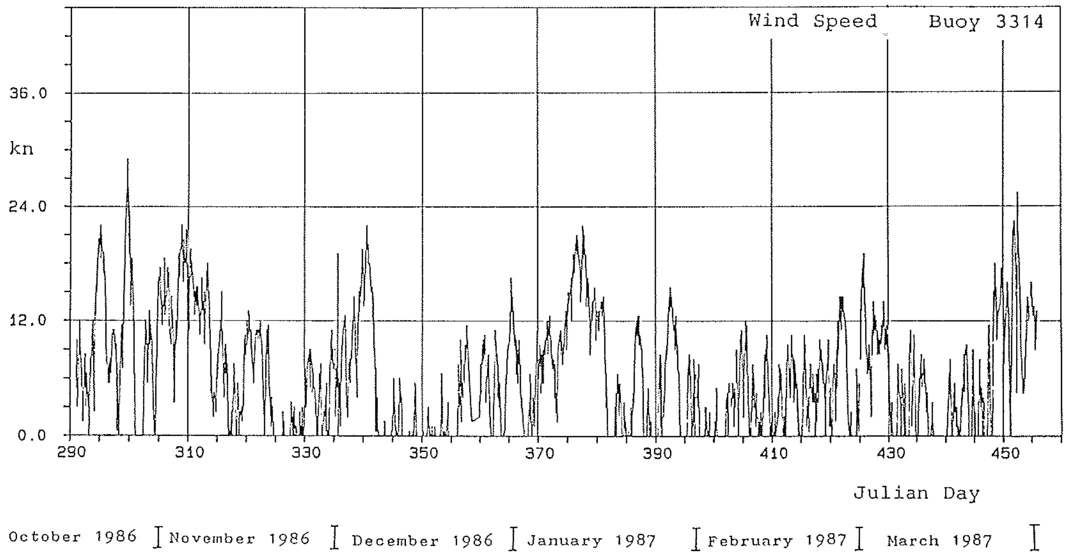

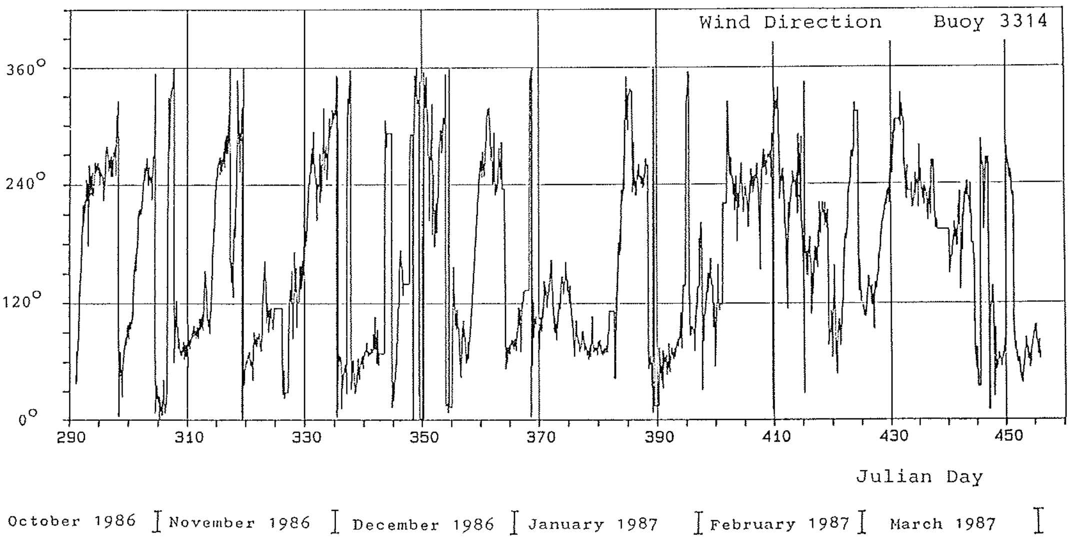

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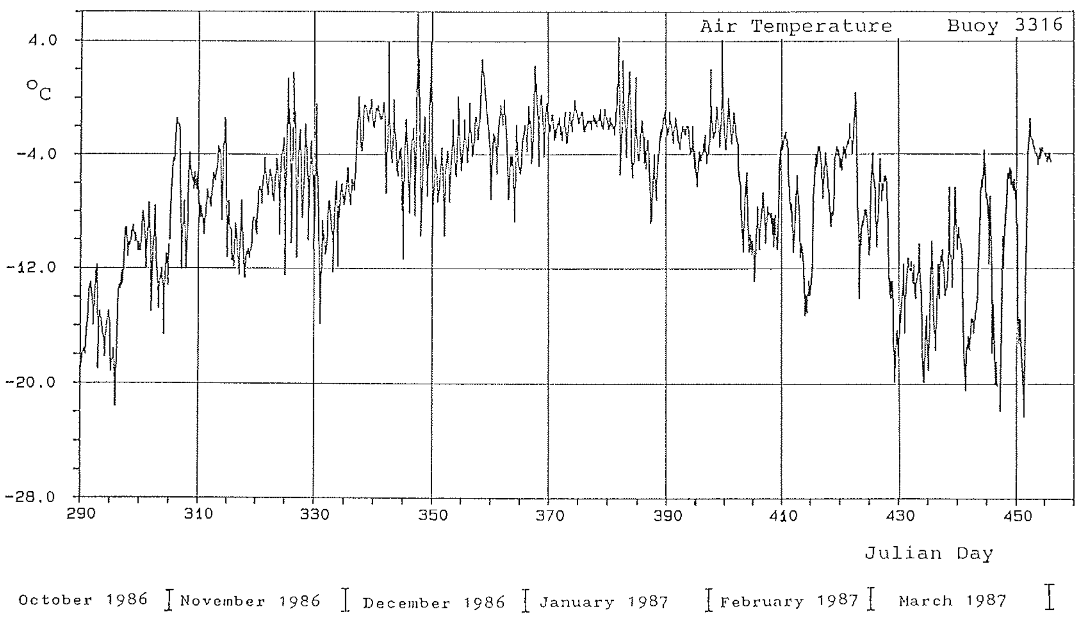


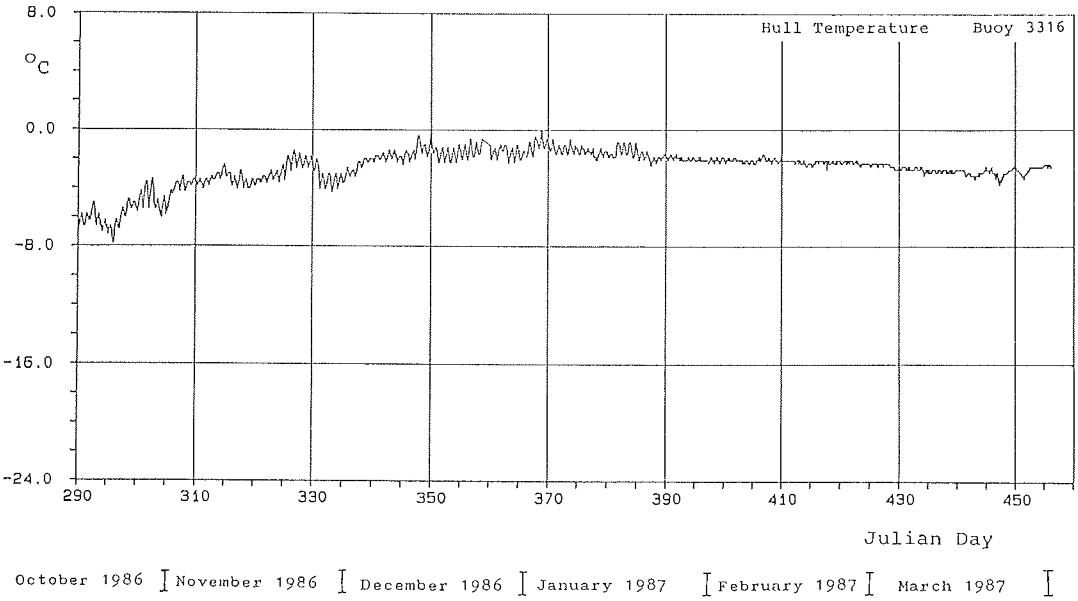
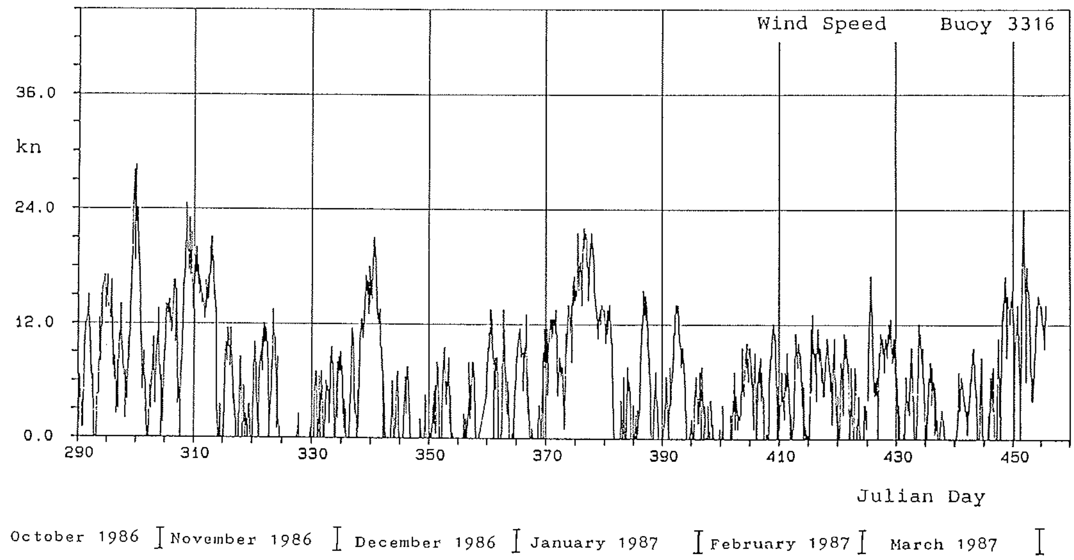


Fig.12:
Time series of meteorological data of buoy 3316.



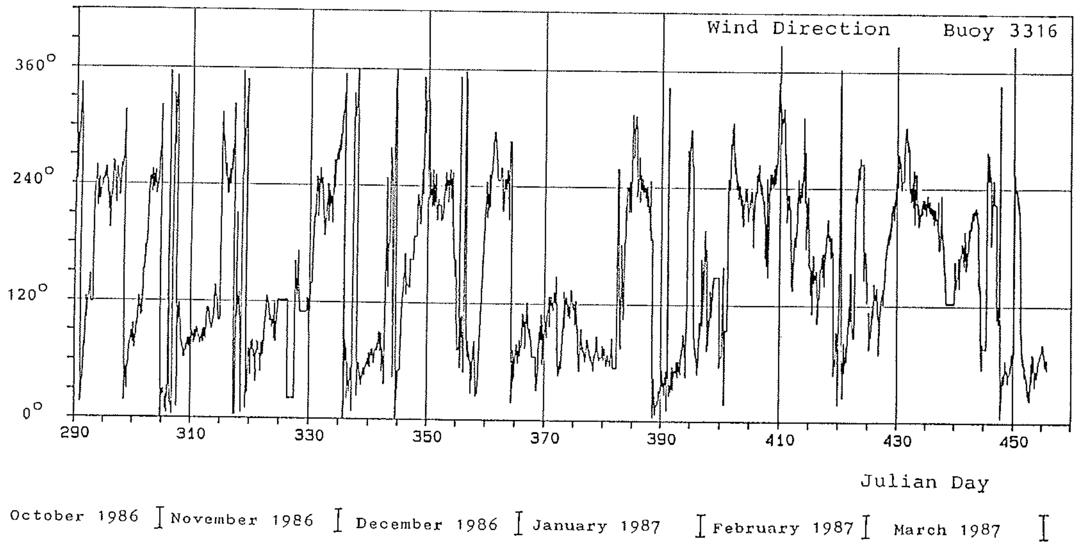


Fig.12:
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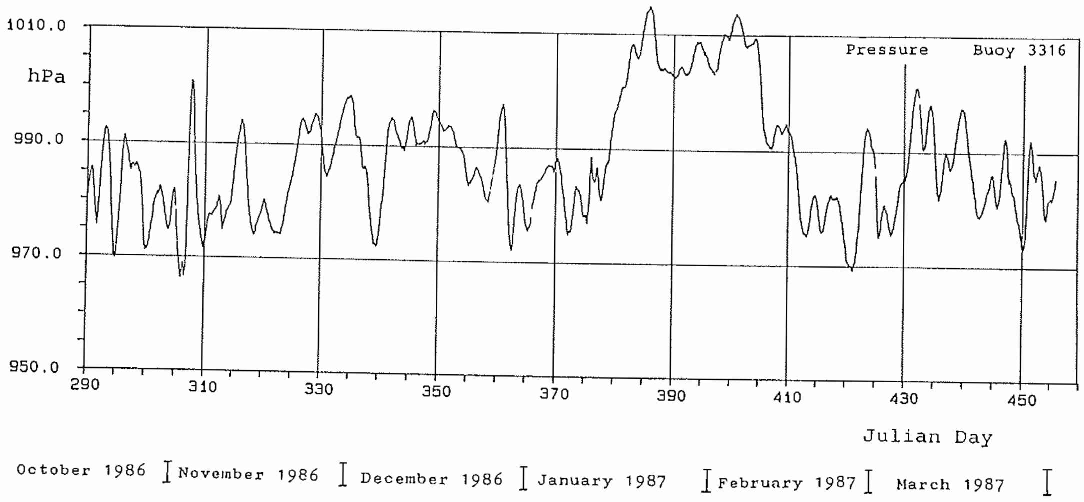

Fig.12:
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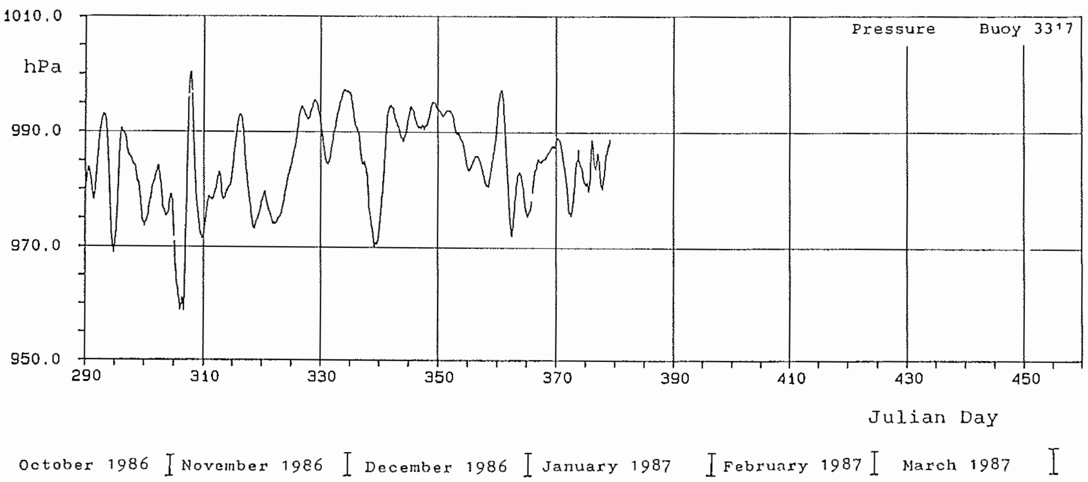
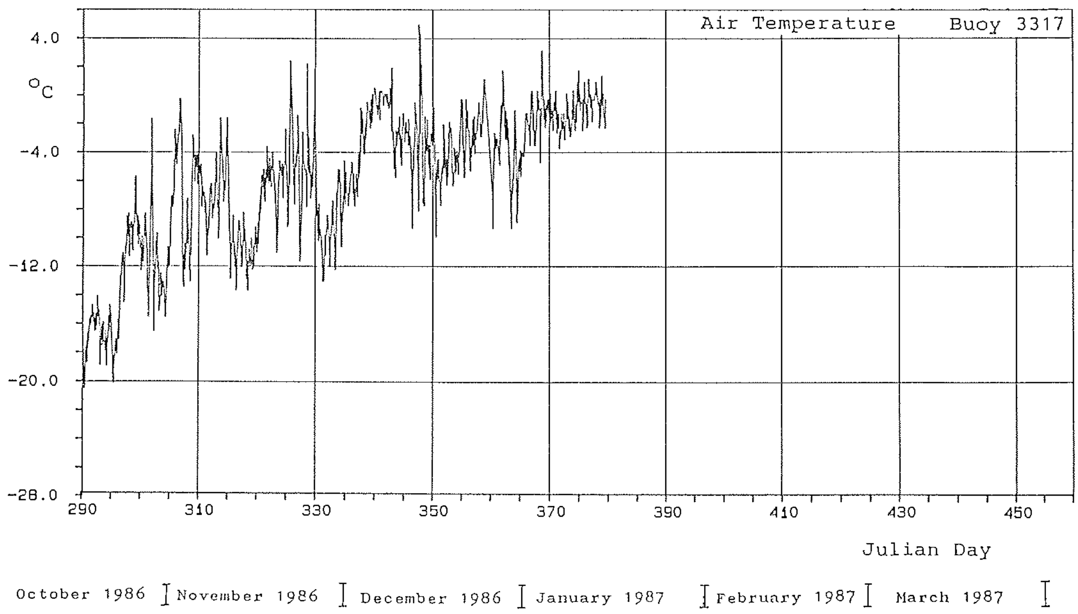


Fig.13:
Time series of meteorological data of buoy 3317.



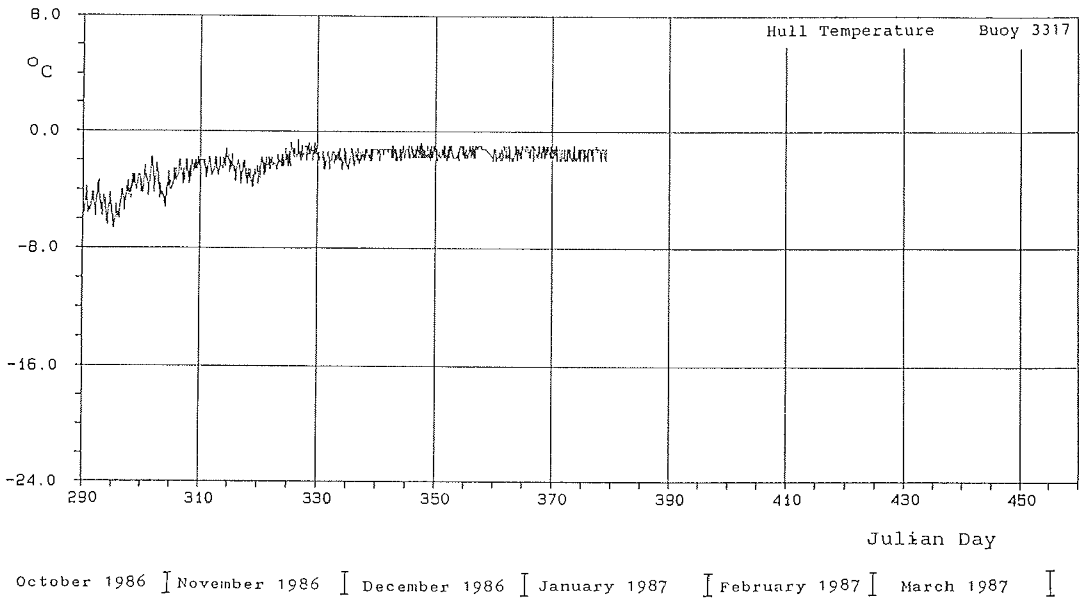


Fig.13:
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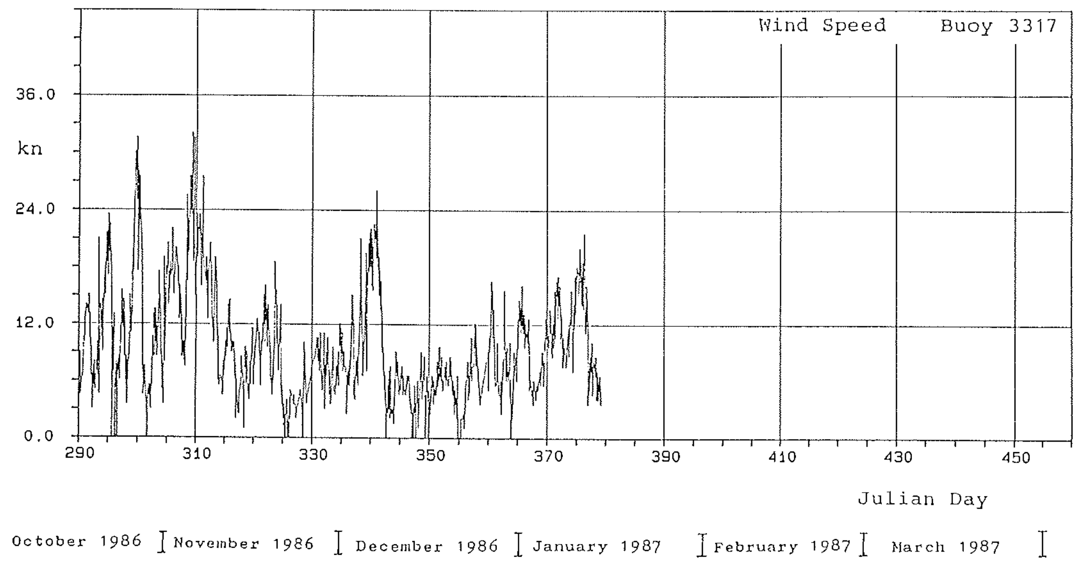

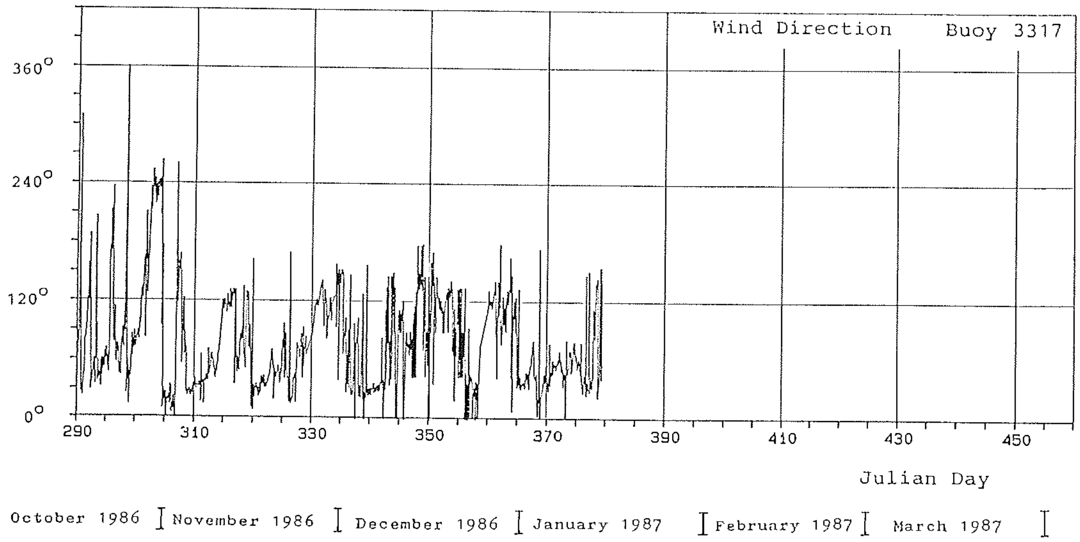

Fig.13:
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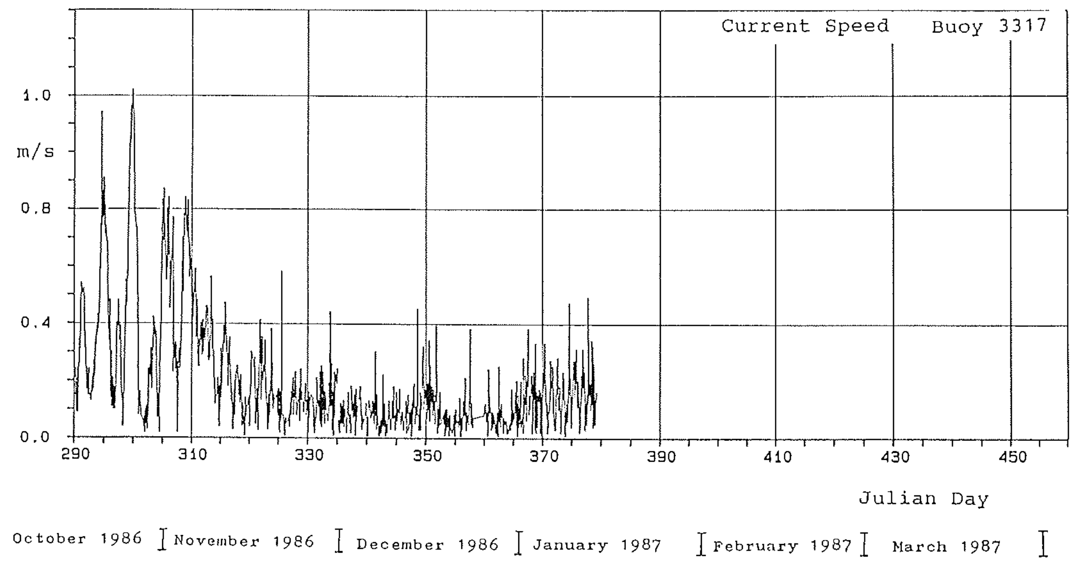

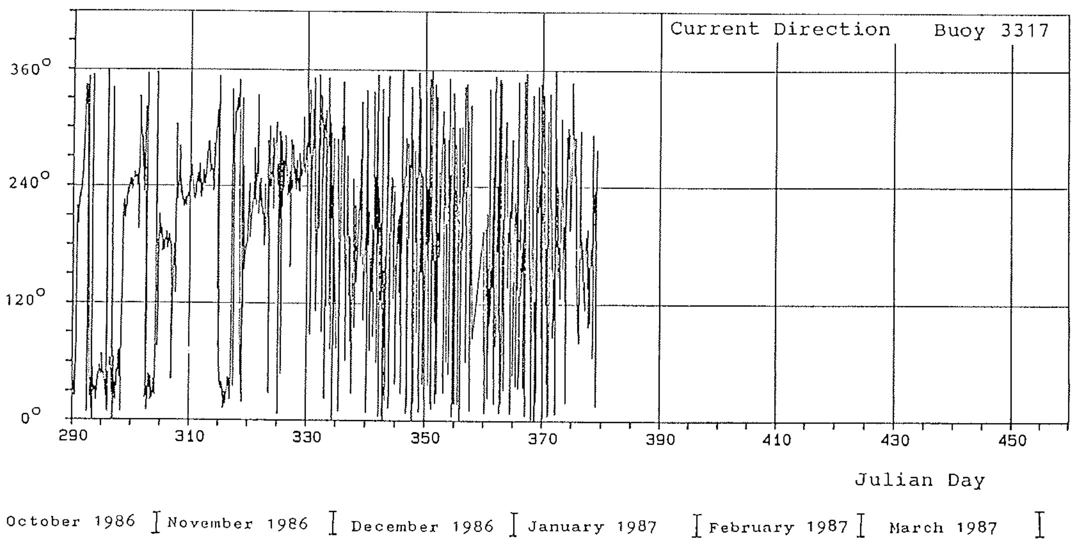

Fig.13:
Continued.

Part 2 : Moored Instrument Data

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1. Description of Moorings

The study oceanographic conditions in the coastal polynya required current and temperature measurements on a line perpendicular to the axis of the Antarctic Coastal Current. Therefore four moorings were deployed on the shelf, the upper, middle and deep part of the continental slope (Fig.14).

The measurements were supposed to reach into the surface mixed layer and to cover the thermocline between the Winter Water and the Warm Deep Water. The last requirement conflicts with the possibility that ice pressure ridges or icebergs may harm the array. For the long term moorings on the slope taut wire techniques were used with the top float in 30m to 40m depth below the surface. To reduce the risk of damage the main buoyancy was located in about 300m depth. This allowed the mooring to give way in case of an iceberg encounter. However it reduced the stability of the moorings. The static stability of the moorings was tested by calculations according to BREITENBACH and SCHRÖDER (1982). In the assumed depth of the thermocline thermistor chains were mounted on the moorings.

As the moorings were laid through holes in the pack ice anchor- first- technique had to be used. Because prefabricated SPECTRA 1000 mooring wires did not meet the length requirements, a modification of the two deep moorings was necessary.

One of the moorings (AWI 102) could not be recovered in spite of serious efforts during two legs. The moorings on the upper and lower slope (AWI 101 and 103) are presented in figures 15 and 16. They were recovered after 34 and 129 days, respectively.

The shelf mooring (AWI 201) contained a water level recorder. Its uppermost flotation was 235 m below the surface to avoid problems with icebergs (Fig.17). It provided a 34 days record.

During a two day long station in Drescher Inlet a mooring with two current meters and a thermistor chain in between (AWI 104) was lowered through a hole drilled through the fast ice (Figs.14 and 18).

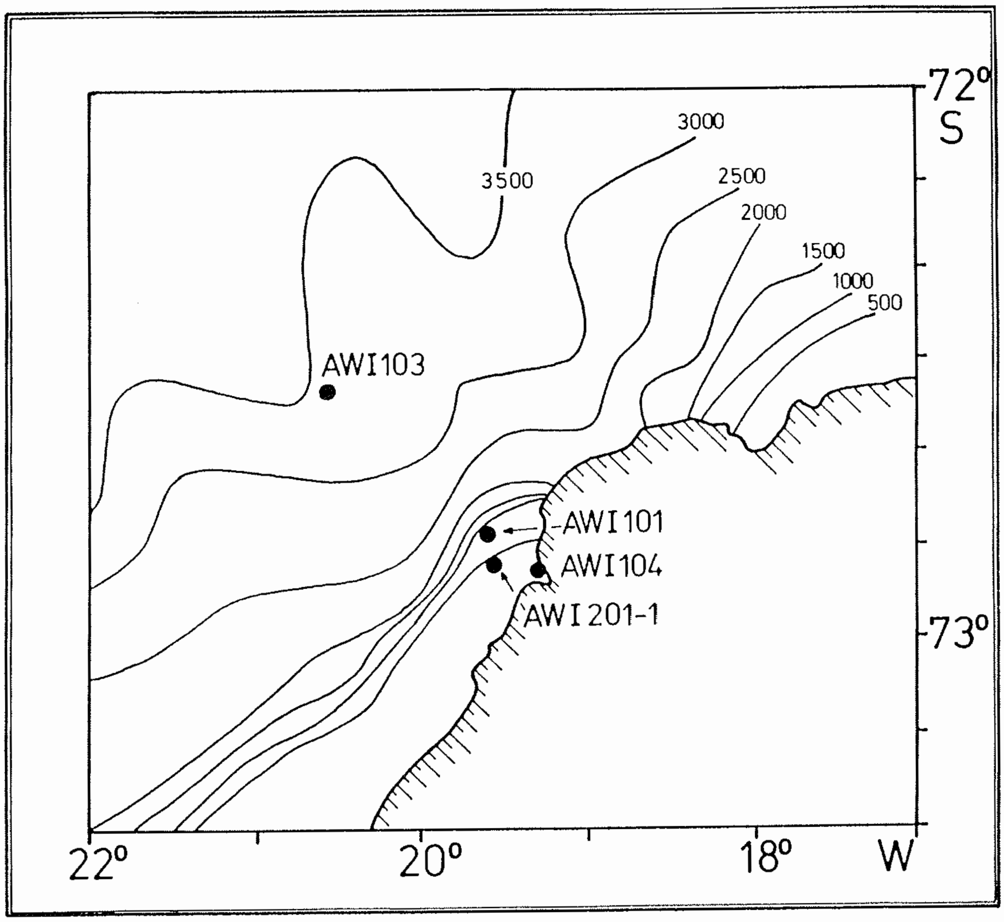

Fig.14:
Location of the current meter moorings in the Antarctic Coastal Current during WWSP 1986.

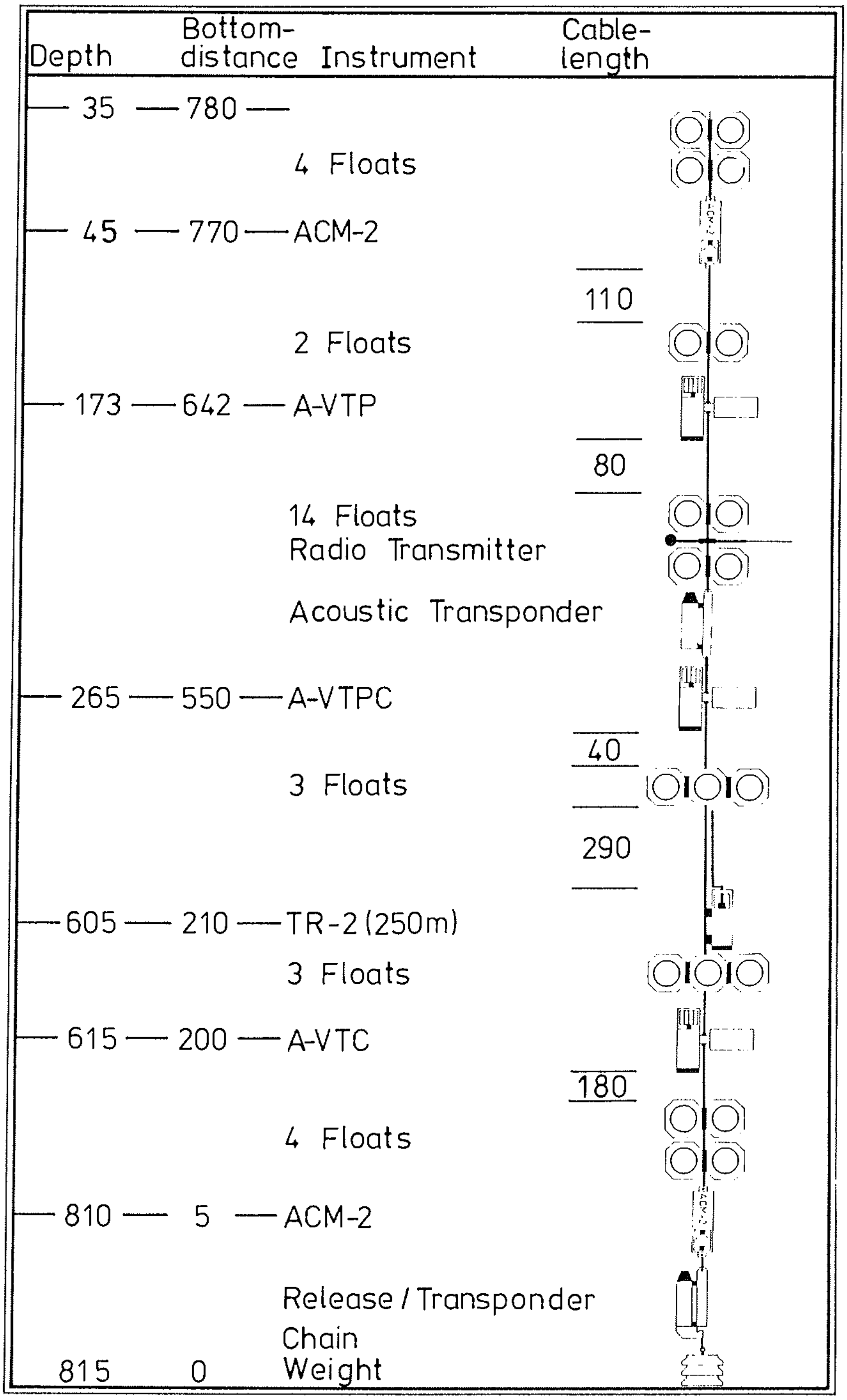

Fig.15:
Schematic representation of mooring AWI 101 on the upper continental slope.

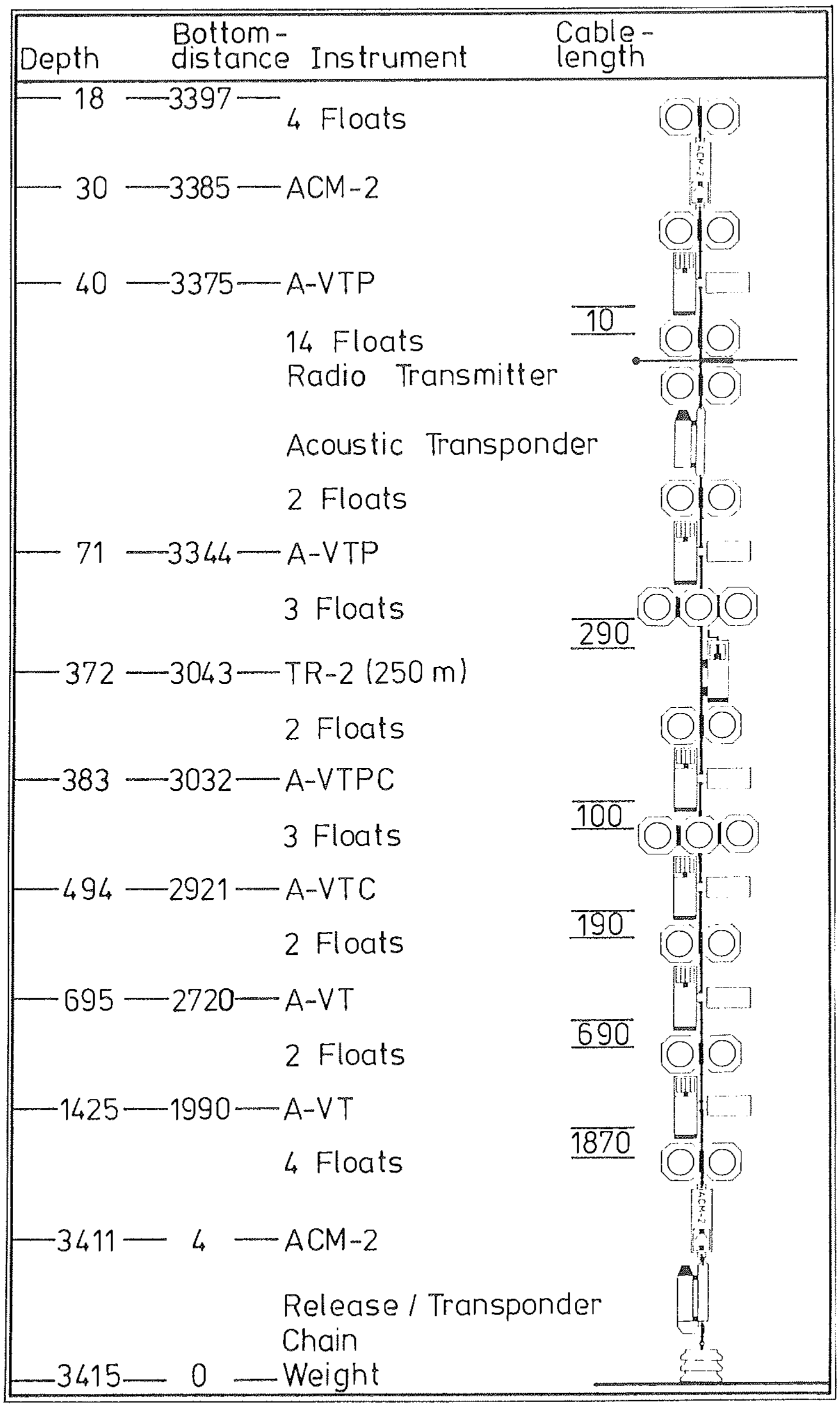

Fig.16:
Schematic representation of mooring AWI 103 on the lower continental slope.

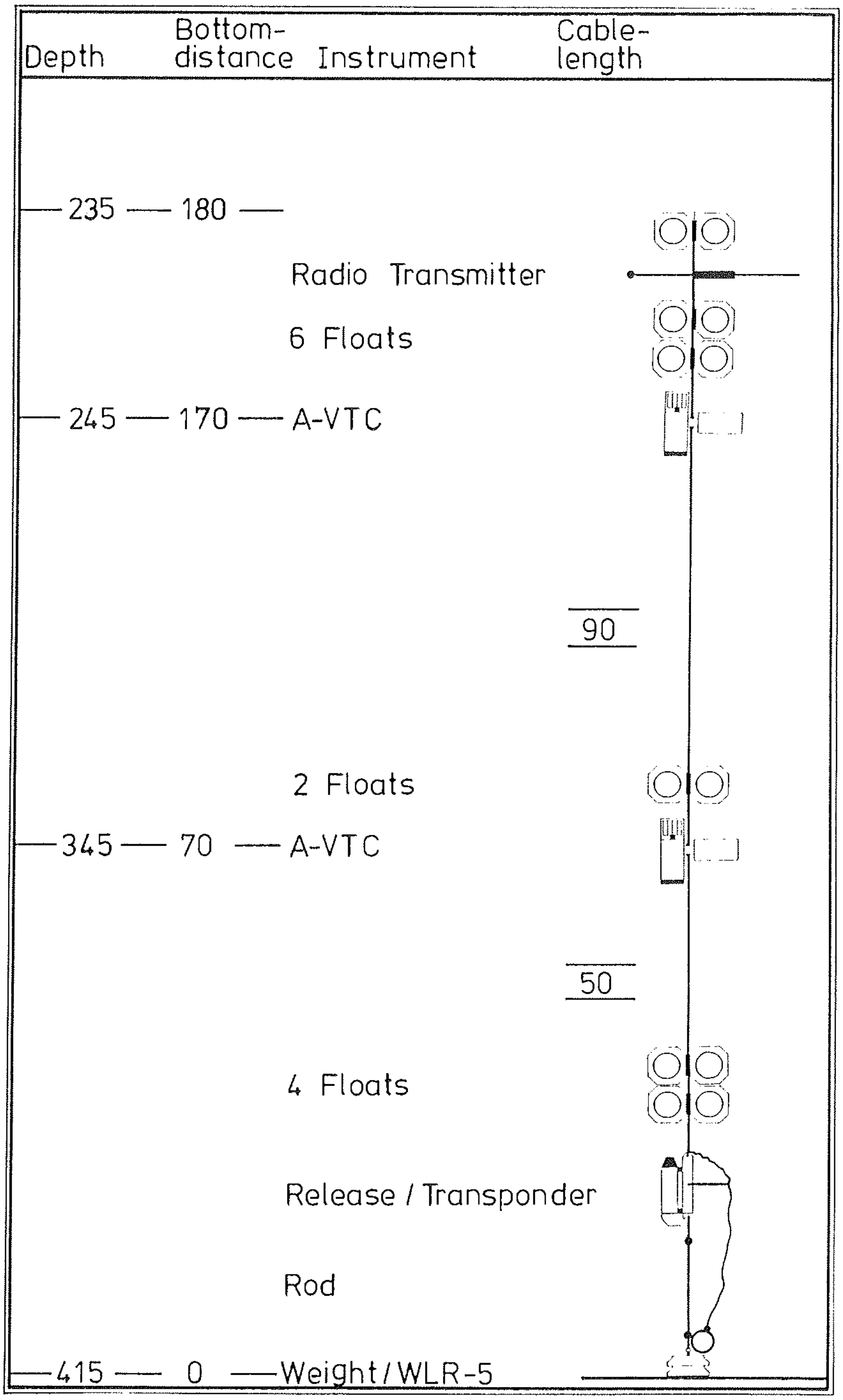

Fig.17:
Schematic representation of mooring AWI 201 on the continental shelf.

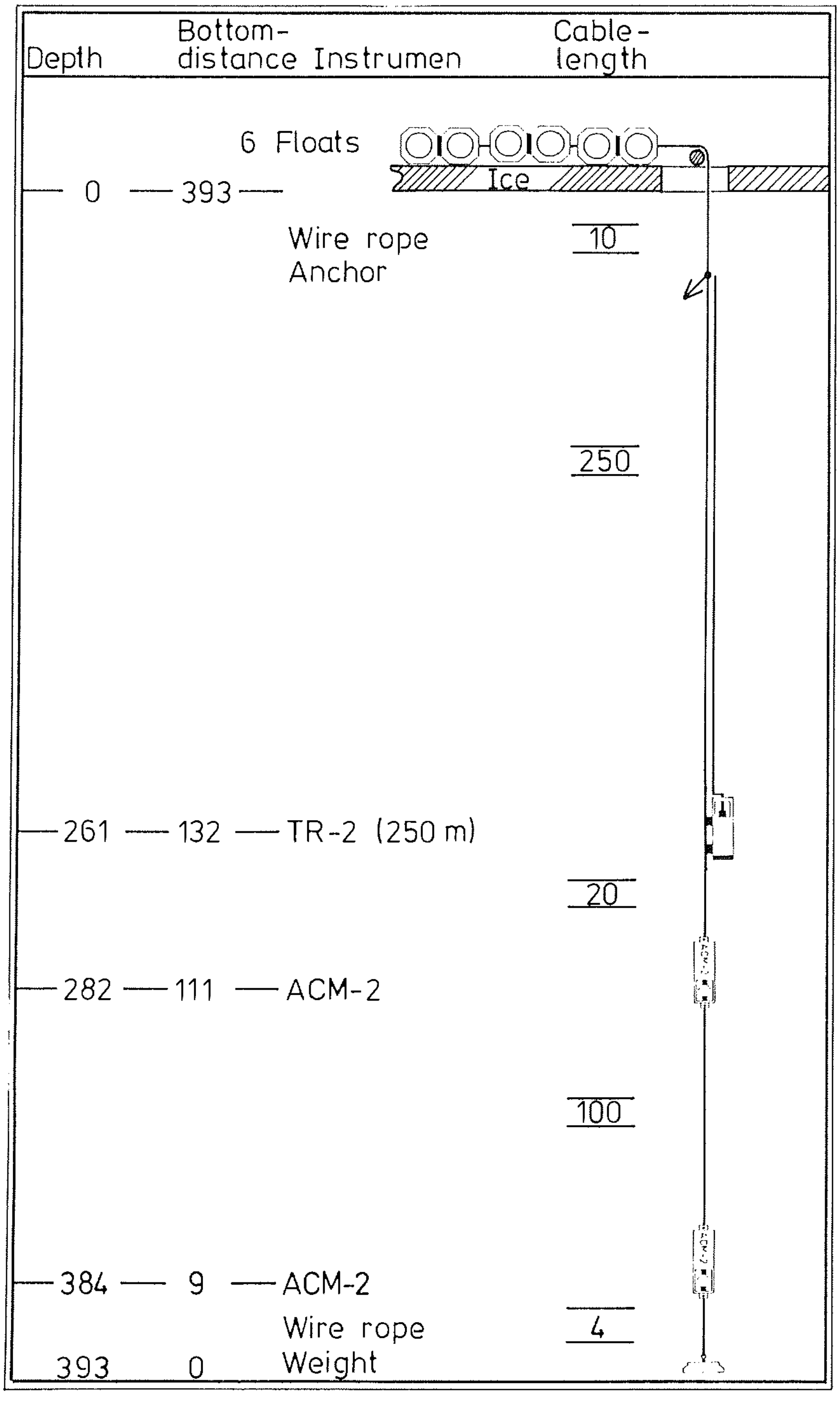

Fig.18:
Schematic representation of mooring AWI 104 lowered across the fast ice in Drescher Inlet.

2. Sensor Specifications

Four different types of instruments were used on the moorings:

- Aanderaa current meters RCM 4S
- Aanderaa temperature profile recorders TR-2
- Aanderaa water level recorder WLR-5
- Neil Brown (NB) current meters ACM-2

Acoustic vector averaging NB current meters (ACMs) were deployed in the near surface and the bottom boundary layer, whereas in the intermediate layers rotor revolution counting Aanderaa current meters (RCMs) were installed.

Temperature was measured with all RCMs and thermistor cables using arctic range high resolution type instruments. A low range system was used in the WLR-5. Only poor temperature records are available from the ACMs due to the coarse resolution of the instruments. Pressure sensors were installed in the upper package of the deep moorings to determine the vertical displacements of the instruments. In six RCMs conductivity cells were mounted. The sensor types available on the individual instruments are summarized in table 5.

The specifications of the sensors are given in table 6 according to the manufacturers indications (AANDERAA, 1986a,b,c; NEIL BROWN 1984). No laboratory calibrations were carried out because all instruments were moored for the first time. Therefore the manufacturers calibration were applied.

Type of instrument	Instrument S/N	Sample interval (min)	Parameter
AWI 201-1			
AVTC	8405	30	SPD,DIR,TEMP(1),COND(1)
AVTC	8419	30	SPD,DIR,TEMP(1),COND(1)
WLR-5	1044	30	TEMP(2),PRES(1)
AWI 101			
ACM-2	1289	5	V(North),V(East),TEMP(3)
AVTP	8402	30	SPD,DIR,TEMP(1),PRES(2)
AVTPC	8395	30	SPD,DIR,TEMP(1) PRES(3),COND(2)
TR-2	943	60	11 TEMP(1)
AVTC	8400	30	SPD,DIR,TEMP(1),COND(2)
ACM-2	1290	5	V(North),V(East),TEMP(3)
AWI 10			
ACM-2	1297	5	V(North),V(East),TEMP(3)
AVTP	8367	30	SPD,DIR,TEMP(1),PRES(2)
AVTP	8370	30	SPD,DIR,TEMP(1),PRES(2)
TR-2	944	60	11 TEMP(1)
AVTPC	8396	30	SPD,DIR,TEMP(1) PRES(3),COND(2)
AVTC	8399	30	SPD,DIR,TEMP(1),COND(2)
AVT	8417	30	SPD,DIR,TEMP(1)
AVT	8418	30	SPD,DIR,TEMP(1)
ACM-2	1291	5	V(North),V(East),TEMP(3)
AWI 104			
TR-2	943	5	11 TEMP(1)
ACM-2	1289	5	V(North),V(East),TEMP(3)
ACM-2	1290	5	V(North),V(East),TEMP(3)

AVT = Aanderaa current meter with thermistor
AVTP = Aanderaa current meter with thermistor and pressure sensor
AVTC = Aanderaa current meter with thermistor and conductivity sensor
AVTPC = Aanderaa current meter with thermistor, pressure and conductivity sensor
TR-2 = Aanderaa thermistor chain 250 m long with 11 therm.
WLR-5 = Aanderaa water level recorder with thermistor
ACM-2 = Neil Brown acoustic cur. meter with wide range therm.
SPD = current speed Aanderaa
DIR = current direction Aanderaa
V = current component NB
TEMP(1) = temperature Aanderaa arctic range
TEMP(2) = temperature Aanderaa low range
TEMP(3) = temperature NB
COND(1) = conductivity Aanderaa low resolution
COND(2) = conductivity Aanderaa high resolution
PRES(1) = pressure Aanderaa high resolution
PRES(2) = pressure Aanderaa small range
PRES(3) = pressure Aanderaa large range

Tab. 5: Sensor types and sample interval used in the individual instruments.

Tab.6:
Sensor specifications according to manufacturers indications

Sensor: SPD = current speed of RCM 4S

System: Electronic rotor revolution counter
Revolutions per count: 8
Range: 2.5 to 212.5 cm/s
Resolution 0.21 cm/s
Accuracy:+/-1cm/s or +/-2% of actual speed whatever is greater
Starting velocity: 2 cm/s
Sampling time: continous
Averaging interval: 30 min
Recording interval: 30 min

Sensor: DIR = current direction of RCM 4S

System: Magnetic compass with needle clamped on potentiometer ring
Range: 0° to 360°
Accuracy: +/-7,5° for speeds within 2.5 to 5 cm/s
+/-5° for speeds within 5 to 100 cm/s
Maximum tilt: 12°
Sampling time: momentary
Recording interval: 30 min

Sensor: V = current vector component of ACM-2

Velocity sensor system: acoustic
Range: 0 to 250 cm/s
Resolution: 0.14 cm/s
Accuracy: +/-1 cm/s or 5% whatever is greater
Noise: 0.05 cm/s quiescent, 2.0 cm/s at 250 cm/s
Direction sensor system: Magnetometer compass
Range: 0° to 360°
Resolution: 1.4°
Accuracy: +/-2°
Maximum tilt: 30°
For the velocity components:
Sampling time: continous
Averaging interval: 5 min (30 sec in AWI 104)
Recording interval: 50 min (5 min in AWI 104)

Sensor: TEMP(1) = Temperatures of RCM 4S and TR-2

System: Thermistor (Fenwal GB32JM19)
Range: -2.64 to 5.62 °C
Resolution: 0.008 K
Accuracy: +/- 0.05 K
Time constant: 63% response in 12 s
Sampling time : momentary
Recording time: 30 min in RCM 4S
60 min in TR-2 (5 min in AWI 104)

Sensor: TEMP(2) = Temperatures of WLR-5

System: Thermistor (Fenwal GB32JM19)
Range: -3.0 to 35.0°C
Resolution: 0.04 K
Accuracy: +/-0.1 K
Time constant: 63% response in 12 s
Sampling time: momentary
Recording interval: 30 min

Sensor: TEMP(3) = Temperatures of ACM-2

System: Thermistor
Range: -2.4 to 35.85 °C
Resolution: 0.15 K
Accuracy: +/- 0.5 K
Time constant: 63% response in 5 min
Sampling time: momentary
Recording interval: 50 min

Sensor: PRES(1) = pressure of WLR-5

System: Digiquarz
Range: 0 to 620.5 db
Resolution: 0.0062 db
Accuracy: +/- 0.005% of full range
Sampling time: Integration over 40 s
Recording interval: 30 min

Sensor: PRES(2) = small range pressure of RCM 4S

System: Bourdon tube driving a potentiometer
Range: 0 to 689.5 db
Resolution: 0.69 db
Accuracy: +/- 6.89 db
Sampling time: momentary
Recording interval: 30 min

Sensor: PRES(3) = large range pressure of RCM 4S

System: Bourdon tube driving a potentiometer
Range: 0 to 2068.0 db
Resolution: 2.1 db
Accuracy: +/- 20.7 db
Sampling time: momentary
Recording interval: 30 min

Sensor: COND(1) = conductivity of RCM 4S large range

System: Inductive cell
Range: 0 to 74 mS/cm
Resolution: 0.072 mS/cm
Accuracy: +/- 0.025 mS/cm
Sampling time: momentary
Recording interval: 30 min

Sensor: COND(2) = conductivity of RCM 4S small range

System: Inductive cell
Rangec: 24 to 36 mS/cm
Resolution: 0.013 mS/cm
Accuracy: +/- 0.025 mS/cm
Sampling time: momentary
Recording interval: 30 min

3. Data Recording

Aanderaa instruments use an electro-mechanical system to digitize the data and to record it on a 1/4 inch magnetic tape. A self balancing bridge with sequential measurements of six channels at the RCMs and of 12 channel at the TRs provides a 10-bit binary word for each channel consisting of short and long pulses. The water level recorder uses two channels for the pressure record to obtain the necessary resolution. Four seconds are needed for each channel. Every record starts with a reference word which allow a check on the performance of the semimechanical digitizer.

A quartz crystal clock with an accuracy of better than +/-2 s/d triggers the record. The record time was determined from the sequential number of the record on tape and the registered start and stop times. Additional control of the time base was executed by noting the times when the rotors are set free or locked and when the instruments went into the water or were returned onboard.

ACMs write the fully electronically digitized data by a MEMODYN 201 recorder on cassettes. Time is controlled by a quartz crystal clock with an accuracy of 0.002% and stored in Julian minutes for each recording interval. Ten averages of each current component are stored in one record. It consists of a header (8 bits), 10 velocity pairs (20x12 bits), temperature (8 bits), instrument reference axis heading (8 bits), status (4 bits) and time (20 bits).

To provide a safe power supply Lithium batteries were used in the RCMs. With the ACMs Alkaline batteries were sufficient.

4. Data Processing and Data Quality

The data were transferred from the original magnetic tapes or cassettes by special readout devices to a VAX 750 where the major data processing was carried out.

After a check of the reliability of the time base of the raw data the time series were reduced to periods of useful data. They began after deployment when the moorings were stable according to the pressure records and ended at the time of release. Whereas no missing data cycles were detected in the RCM records, two interuptions of nine and one records, respectively were found in the time series of ACM 1289. A cassette failure is the most likely reason, because no fault was detected in the instrument. The gaps were closed by linear interpolation.

Having corrected the time base the data were transformed into physical units using the calibration polynoms provided by the manufacturers. Whereas the ACMs calculate the current components internally, the RCMs need a conversion from rotor counts to speed which is given by the manufacturer as a linear relationship. However on this basis zero counts result in 1.1 cm/s. Therefore we did not use the calibration curve when zero counts were observed. The high threshold of 2 cm/s affected the records in mooring 103 where times with small currents were observed. Current direction was corrected by a compass deviation of 7°.

The accuracy of the ACMs depend on the accuracy of the sound speed. To obtain an accuracy in current of +/- 1% the temperature has to be known to +/- 1 K, the salinity to +/-6ppt and the depth of the instrument to +/- 500 m. Consequently temperature has to be measured at the location of instrument while salinity as well as water depth is taken as constant in time.

Salinity was calculated on the basis of the Practical Salinity Scale (UNESCO, 1981) from conductivity, temperature and pressure records. If no pressure sensor was on the instrument, the nominal depth of the instrument were used. The intercomparison of salinities derived from the conductivity records of the RCMs with the ones obtained from CTD-casts carried out in the vicinity of the moorings revealed significant deviations. Consequently corrections were necessary on the basis of the CTD-data. Because this method includes some uncertainties due to the differences in time and location of the casts, the accuracy of the salinity data is significantly reduced.

On the basis of five intercomparisons the following corrections were applied:

RCM 8395: Diff = -0.45
RCM 8400: Diff = -0.50
RCM 8405: Diff = -0.10
RCM 8419: Diff = -0.20
RCM 8396: Diff = -0.25
RCM 8399: Diff = -0.50
corrected salinity = observed salinity by RCM + Diff

No significant trend could be determined for the salinity differences.

The data reliability was examined by visual inspection. Obvious erroneous records were eliminated. Eleven time series required special processing:

RCM 8395: Rotor blocking from 29 Oct. 14:30 to 7 Nov. 8:30. No correction possible.

TR-2 944 Channel 6 (479 m) no record during the first three days.Vertical linear interpolation between channels 5 and 7.

RCM 8370: Rotor blocking from record 5933 to 5985 (26.5 h). Because of the high correlation with the time series measured 31 m above, the gap was filled with the record of this instrument.

RCM 8396: Rotor blocking from record 5537 to 5569 (16.5 h). The gap was interpolated with artificial data showing the same variance than the 16.5 h before the gap.

The mooring design as described in chapter 1 showed a less stable performance a high current speeds than expected. The pressure records reveal a significant mooring motion at speeds higher than 30 cm/s. The critical inclination of 12° for RCMs was reached a few times. Consequently an additional error of about 1 cm/s has to be taken into account at high speeds due to the inclination of the instruments.

The data processing is summarized in a flow diagram (Fig.19).

Before calculating statistical parameters and drawing time series plots the data of the long time series were averaged to hourly values with the exception of the thermistor cables which were recorded hourly.

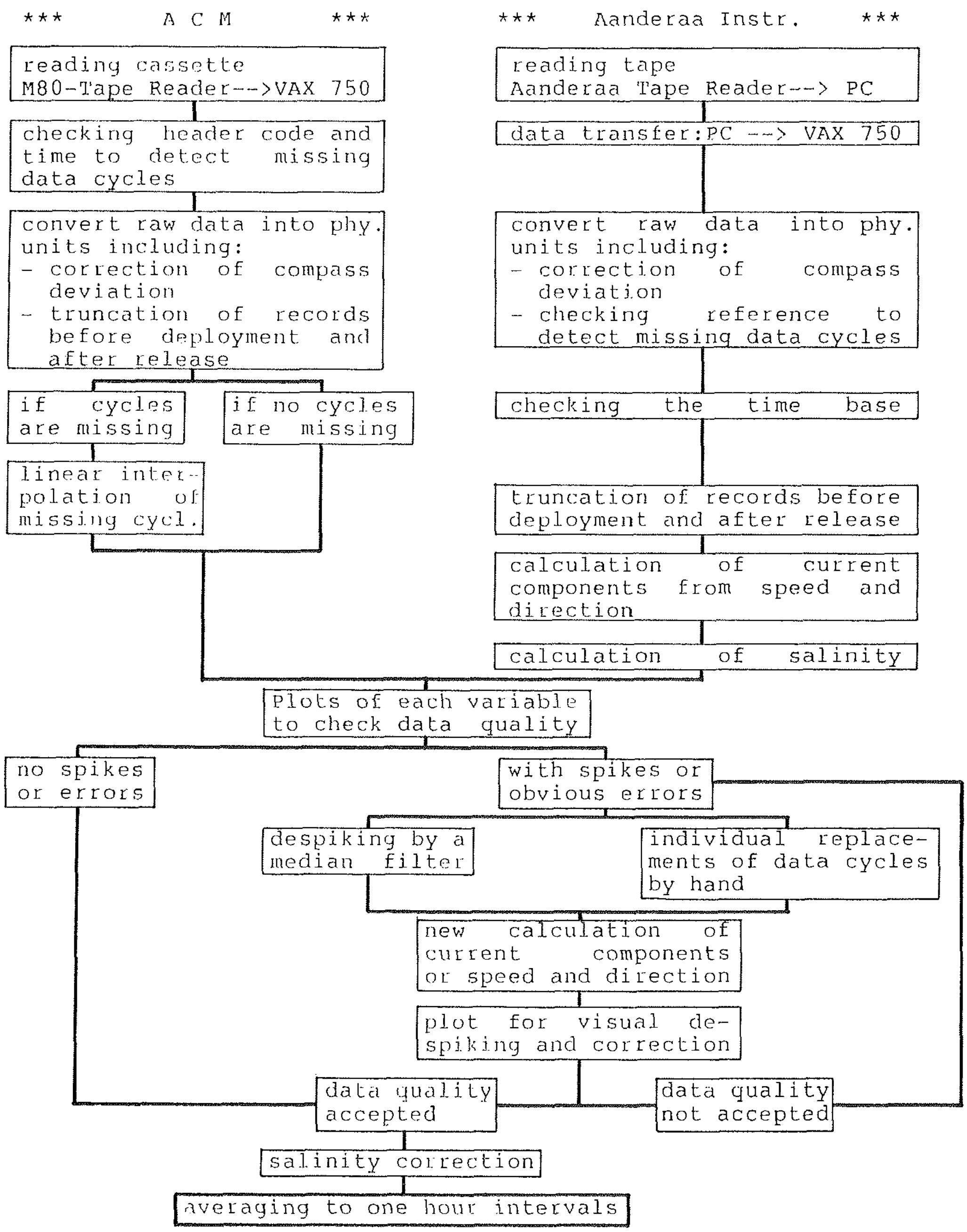

Fig.19:
Flow diagram of data processing

5. Data Presentation

5.1. Data Availability

The available data are summarized in table 7. In four moorings 21 instruments were installed yielding 97 time series.

The positions of the moorings could be determined to an accuracy of less than 200 m with use of GPS when available or by waiting for a satellite fix in combination with anchor-first-techniques. The echo sounder water depth was corrected by the ships draught and on the basis of observed sound velocity profiles.

Position	Water depth (m)	Mooring No.	Type of instru-ment	Instr. depth (m)	Rec.	First value date	Last value date
72 51.7 S	415	AWI201-1	AVTC	245	815	15.OCT.86	18.NOV.86
19 32.5 W			AVTC	345	815	15.OCT.86	18.NOV.86
			WLR-5	415	815	15.OCT.86	18.NOV.86
72 49.4 S	815	AWI101	ACM-2	45	811	16.OCT.86	19.NOV.86
19 36.1 W			AVTP	173	811	16.OCT.86	19.NOV.86
			AVTPC	265	811	16.OCT.86	19.NOV.86
			TR-2	354-604	812	16.OCT.86	19.NOV.86
			AVTC	615	811	16.OCT.86	19.NOV.86
			ACM-2	810	811	16.OCT.86	19.NOV.86
72 33.4 S	3415	AWI103	ACM-2	30	3062	17.OCT.86	22.FEB.87
20 35.7 W			AVTP	40	3062	17.OCT.86	22.FEB.87
			AVTP	71	3062	17.OCT.86	22.FEB.87
			TR-2	121-371	3062	17.OCT.86	22.FEB.87
			AVTPC	383	3062	17.OCT.86	22.FEB.87
			AVTC	494	3062	17.OCT.86	22.FEB.87
			AVT	695	3062	17.OCT.86	22.FEB.87
			AVT	1425	3062	17.OCT.86	22.FEB.87
			ACM-2	3411	3062	17.OCT.86	22.FEB.87
72 51.9 S	353	AWI104	TR-2	10-260	493	22.NOV.86	24.NOV.86
19 22.8 W			ACM-2	282	496	22.NOV.86	24.NOV.86
			ACM-2	384	494	22.NOV.86	24.NOV.86

AVT = Aanderaa Current meter with thermistor
AVTP = Aanderaa Current meter with thermistor and pressure sensor
AVTC = Aanderaa Current meter with thermistor and conductivity sensor
AVTPC= Aanderaa Current meter with thermistor, pressure- and conductivity
TR-2 = Aanderaa Thermistor chain 250 meter long with 11 thermistors
WLR-5= Aanderaa Water level recorder with thermistor
ACM-2= Neil Brown Acoustic current meter with wide range thermistor

Tab.7:
Available moored instrument data.

Available moored instrument data.

Some uncertainty in the instruments' depths resulted from the errors in wire length. The presented depths were derived from the pressure records. They were determined by averaging the periods of stable performance of the moorings to avoid the effect of short periods of strong vertical motion. Aditionally a creep stretching of the SPECTRA 1000 can be observed in the pressure records indicating an elongation at mooring AWI 103 of 15 m during 129 days.

The numbers of records indicated in table 7 gives the number of hourly values of the processed time series.

5.2. Statistics

Some basic statistical parameters which characterize the time series were calculated from the hourly data. They are presented in the Appendix as table 8 and 9 and histograms (Fig.20 and 21). They are especially interesting with respect to the current direction from which no statistics are calculated. For AWI 103 statistics are presented over the whole recording period of 129 days and over the first 32 days to be compared with AWI 101 and AWI 201.

5.3. Time Series

The processed hourly data are presented in figure 22 in the Appendix. It comprises time series plots of current components (U positive to east, V positive to north), temperature, salinity and pressure. The scales were selected for each record to obtain the best resolution for the plots.

Acknowledgments

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Appendix

Var.	Units	Cycles	Minimum	Maximum	Mean	Variance	STRDDEV
Mooring : AWI101							
ACM 1289 (45 m)							
VC	CM/S	811	-25.138	10.307	-6.620	0.5203E+02	0.7213E+01
UC	CM/S	811	-24.953	5.555	-8.570	0.3008E+02	0.5485E+01
RCM 8402 (173 m)							
PRES	DBAR	811	171.412	185.861	173.345	0.3501E+01	0.1871E+01
TEMP	DEG.C	811	-1.837	-1.602	-1.791	0.7152E-03	0.2674E-01
UC	CM/S	811	-34.750	0.000	-9.246	0.2747E+02	0.5242E+01
VC	CM/S	811	-27.797	6.182	-4.010	0.2220E+02	0.4712E+01
RCM 8395 (265 m)							
PRES	DBAR	811	263.040	273.820	266.036	0.2558E+01	0.1600E+01
TEMP	DEG.C	811	-1.844	-1.265	-1.784	0.2566E-02	0.5065E-01
S	1/1000	811	34.161	34.558	34.425	0.7745E-03	0.2783E-01
UC	CM/S	314	-20.920	5.387	-7.762	0.3148E+02	0.5611E+01
VC	CM/S	314	-27.617	8.422	-10.600	0.5525E+02	0.7433E+01
UC	CM/S	287	-17.912	0.000	-8.761	0.1714E+02	0.4140E+01
VC	CM/S	287	-23.419	6.495	-8.831	0.3922E+02	0.6263E+01
TR 943 (605,579,554,529,504,479,454,429,404,379,354 m)							
TEMP	DEG.C	812	-1.781	0.721	-0.929	0.5710E+00	0.7556E+00
TEMP	DEG.C	812	-1.805	0.671	-1.065	0.5501E+00	0.7417E+00
TEMP	DEG.C	812	-1.798	0.635	-1.169	0.5013E+00	0.7080E+00
TEMP	DEG.C	812	-1.805	0.439	-1.287	0.4373E+00	0.6613E+00
TEMP	DEG.C	812	-1.803	0.372	-1.380	0.3579E+00	0.5983E+00
TEMP	DEG.C	812	-1.800	0.250	-1.462	0.2800E+00	0.5292E+00
TEMP	DEG.C	812	-1.805	0.133	-1.548	0.2051E+00	0.4529E+00
TEMP	DEG.C	812	-1.805	0.075	-1.605	0.1394E+00	0.3733E+00
TEMP	DEG.C	812	-1.827	-0.020	-1.676	0.7969E-01	0.2823E+00
TEMP	DEG.C	812	-1.823	-0.309	-1.704	0.4231E-01	0.2057E+00
TEMP	DEG.C	812	-1.824	-0.389	-1.732	0.2443E-01	0.1563E+00
RCM 8400 (615 m)							
TEMP	DEG.C	810	-1.804	0.702	-0.899	0.5739E+00	0.7576E+00
UC	CM/S	810	-21.422	8.618	-8.057	0.2627E+02	0.5125E+01
VC	CM/S	810	-25.090	14.753	-9.456	0.3797E+02	0.6162E+01
S	1/1000	810	34.358	34.660	34.476	0.4643E-02	0.6814E-01
ACM 1290 (810 m)							
VC	CM/S	811	-15.655	10.092	-4.591	0.1626E+02	0.4032E+01
UC	CM/S	811	-16.777	9.460	-4.423	0.2168E+02	0.4656E+01
TEMP	DEG.C	811	-1.800	0.750	-0.140	0.3840E+00	0.6197E+00

Tab. 8: Basic Statistics of the complete time series.

Mooring : AWI103

Var.	Units	Cycles	Minimum	Maximum	Mean	Variance	STRDDEV
ACM 1297 (30 m)							
VC	CM/S	3062	-34.434	31.212	-0.551	0.8187E+02	0.9048E+01
UC	CM/S	3062	-33.787	17.106	-9.670	0.5254E+02	0.7249E+01
RCM 8367 (40 m)							
PRES	DBAR	3062	25.009	120.235	33.815	0.9460E+02	0.9726E+01
TEMP	DEG.C	3062	-1.846	0.285	-1.249	0.4146E+00	0.6439E+00
UC	CM/S	3062	-34.006	16.666	-8.608	0.4818E+02	0.6941E+01
VC	CM/S	3062	-21.752	27.882	0.229	0.1757E+02	0.4192E+01
RCM 8370 (71 m)							
PRES	DBAR	3062	59.640	144.760	69.265	0.7378E+02	0.8590E+01
TEMP	DEG.C	3062	-1.856	-0.453	-1.663	0.9843E-01	0.3137E+00
UC	CM/S	3062	-33.629	34.647	-6.784	0.7747E+02	0.8801E+01
VC	CM/S	3062	-8.900	28.647	2.197	0.1795E+02	0.4236E+01
TR 944 (371,346,321,296,271,246,221,196,171,146,121 m)							
TEMP	DEG.C	3062	-1.823	0.819	0.090	0.5094E+00	0.7137E+00
TEMP	DEG.C	3062	-1.781	0.824	-0.038	0.5786E+00	0.7606E+00
TEMP	DEG.C	3062	-1.794	0.821	-0.215	0.6288E+00	0.7930E+00
TEMP	DEG.C	3062	-1.801	0.785	-0.441	0.6538E+00	0.8086E+00
TEMP	DEG.C	3062	-1.813	0.711	-0.727	0.6107E+00	0.7815E+00
TEMP	DEG.C	3062	-1.798	0.603	-1.026	0.5367E+00	0.7326E+00
TEMP	DEG.C	3062	-1.823	0.422	-1.324	0.3933E+00	0.6271E+00
TEMP	DEG.C	3062	-1.830	0.212	-1.511	0.1975E+00	0.4444E+00
TEMP	DEG.C	3062	-1.839	-0.533	-1.653	0.6164E-01	0.2483E+00
TEMP	DEG.C	3062	-1.837	-1.046	-1.741	0.9957E-02	0.9979E-01
TEMP	DEG.C	3062	-1.841	-1.518	-1.785	0.1298E-02	0.3603E-01
RCM 8396 (383 m)							
PRES	DBAR	3062	382.410	467.880	395.696	0.9319E+02	0.9653E+01
TEMP	DEG.C	3062	-1.758	0.851	0.173	0.4564E+00	0.6756E+00
UC	CM/S	3062	-22.658	6.731	-6.248	0.2534E+02	0.5034E+01
VC	CM/S	3062	-23.500	15.868	-0.972	0.3121E+02	0.5587E+01
S	1/1000	3062	34.329	34.679	34.557	0.4985E-02	0.7060E-01
RCM 8399 (494 m)							
TEMP	DEG.C	3062	-0.894	0.871	0.614	0.6996E-01	0.2645E+00
UC	CM/S	3062	-17.853	7.569	-4.974	0.1531E+02	0.3912E+01
VC	CM/S	3062	-18.666	14.468	-0.986	0.1993E+02	0.4464E+01
S	1/1000	3062	34.471	34.680	34.613	0.9881E-03	0.3143E-01
RCM 8417 (695 m)							
TEMP	DEG.C	3062	0.354	0.837	0.632	0.7102E-02	0.8428E-01
UC	CM/S	3062	-14.256	6.079	-3.609	0.1051E+02	0.3242E+01
VC	CM/S	3062	-12.687	12.896	-0.746	0.1267E+02	0.3559E+01
RCM 8418 (1425 m)							
TEMP	DEG.C	3062	0.138	0.341	0.238	0.1586E-02	0.3983E-01
UC	CM/S	3062	-9.627	4.825	-1.872	0.5126E+01	0.2264E+01
VC	CM/S	3062	-8.560	14.374	-0.559	0.4867E+01	0.2206E+01
ACM 1291 (3411 m)							
VC	CM/S	3062	-10.488	11.253	-1.261	0.1327E+02	0.3643E+01
UC	CM/S	3062	-16.813	6.762	-2.859	0.7283E+01	0.2699E+01

Tab. 8: continued.

Mooring : AWI201							
Var.	Units	Cycles	Minimum	Maximum	Mean	Variance	STRDDEV
RCM 8405 (245 m)							
TEMP	DEG.C	815	-1.831	-1.543	-1.765	0.1892E-02	0.4350E-01
UC	CM/S	815	-17.006	14.011	-1.927	0.2500E+02	0.5000E+01
VC	CM/S	815	-19.232	21.169	-1.722	0.4836E+02	0.6954E+01
S	1/1000	815	34.299	34.451	34.379	0.8473E-03	0.2911E-01
RCM 8419 (345 m)							
TEMP	DEG.C	815	-1.827	-0.389	-1.625	0.6246E-01	0.2499E+00
UC	CM/S	815	-17.170	17.237	-1.690	0.3545E+02	0.5954E+01
VC	CM/S	815	-19.041	23.591	-1.925	0.5418E+02	0.7360E+01
S	1/1000	815	34.346	34.607	34.444	0.1605E-02	0.4006E-01
WLR 1044 (415 m)							
TEMP	DEG.C	815	-1.815	-0.035	-1.282	0.1942E+00	0.4407E+00
PRES	DBAR	815	451.970	455.079	453.702	0.3930E+00	0.6269E+00

Mooring : AWI104							
Var.	Units	Cycles	Minimum	Maximum	Mean	Variance	STRDDEV
TR 943 (260,235,210,185,160,135,110,85,60,35,10 m)							
TEMP	DEG.C	493	-1.795	-1.651	-1.733	0.2005E-02	0.4477E-01
TEMP	DEG.C	493	-1.820	-1.704	-1.780	0.9058E-03	0.3010E-01
TEMP	DEG.C	493	-1.827	-1.748	-1.790	0.3180E-03	0.1783E-01
TEMP	DEG.C	493	-1.833	-1.776	-1.809	0.2469E-03	0.1571E-01
TEMP	DEG.C	493	-1.839	-1.788	-1.811	0.1595E-03	0.1263E-01
TEMP	DEG.C	493	-1.833	-1.783	-1.809	0.6303E-04	0.7939E-02
TEMP	DEG.C	493	-1.834	-1.762	-1.819	0.6480E-04	0.8050E-02
TEMP	DEG.C	493	-1.833	-1.733	-1.825	0.2058E-03	0.1434E-01
TEMP	DEG.C	493	-1.848	-1.805	-1.832	0.1315E-03	0.1147E-01
TEMP	DEG.C	493	-1.852	-1.795	-1.829	0.2238E-03	0.1496E-01
TEMP	DEG.C	493	-1.867	-1.795	-1.849	0.3370E-03	0.1836E-01
ACM 1289 (282 m)							
VC	CM/S	496	-8.130	3.630	-1.468	0.6032E+01	0.2456E+01
UC	CM/S	496	-3.750	4.040	0.044	0.3870E+01	0.1967E+01
ACM 1290 (384 m)							
VC	CM/S	494	-4.580	5.550	1.570	0.6340E+01	0.2518E+01
UC	CM/S	494	-3.410	3.530	-0.266	0.2706E+01	0.1645E+01

Tab. 8: continued

Next page:

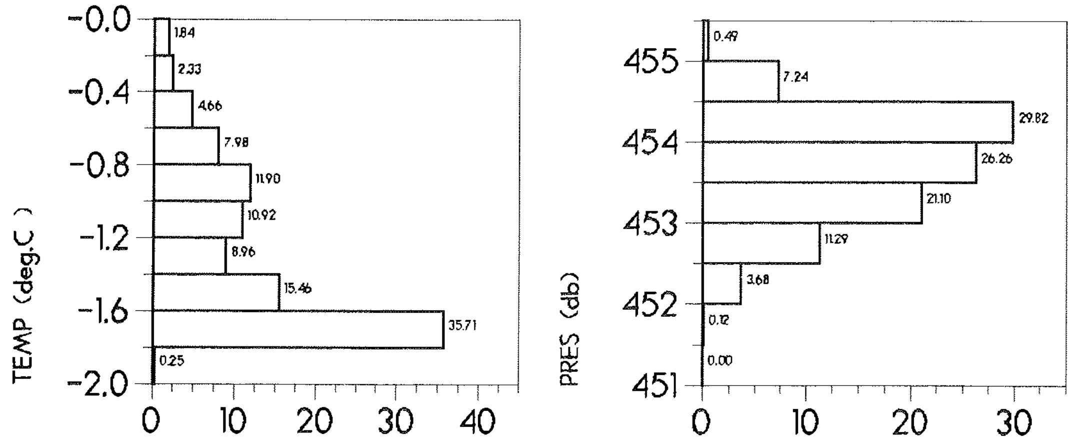
Tab. 9: Basic Statistics of the first 32 days of the time series obtained from AWI 103.

Mooring : AWI103

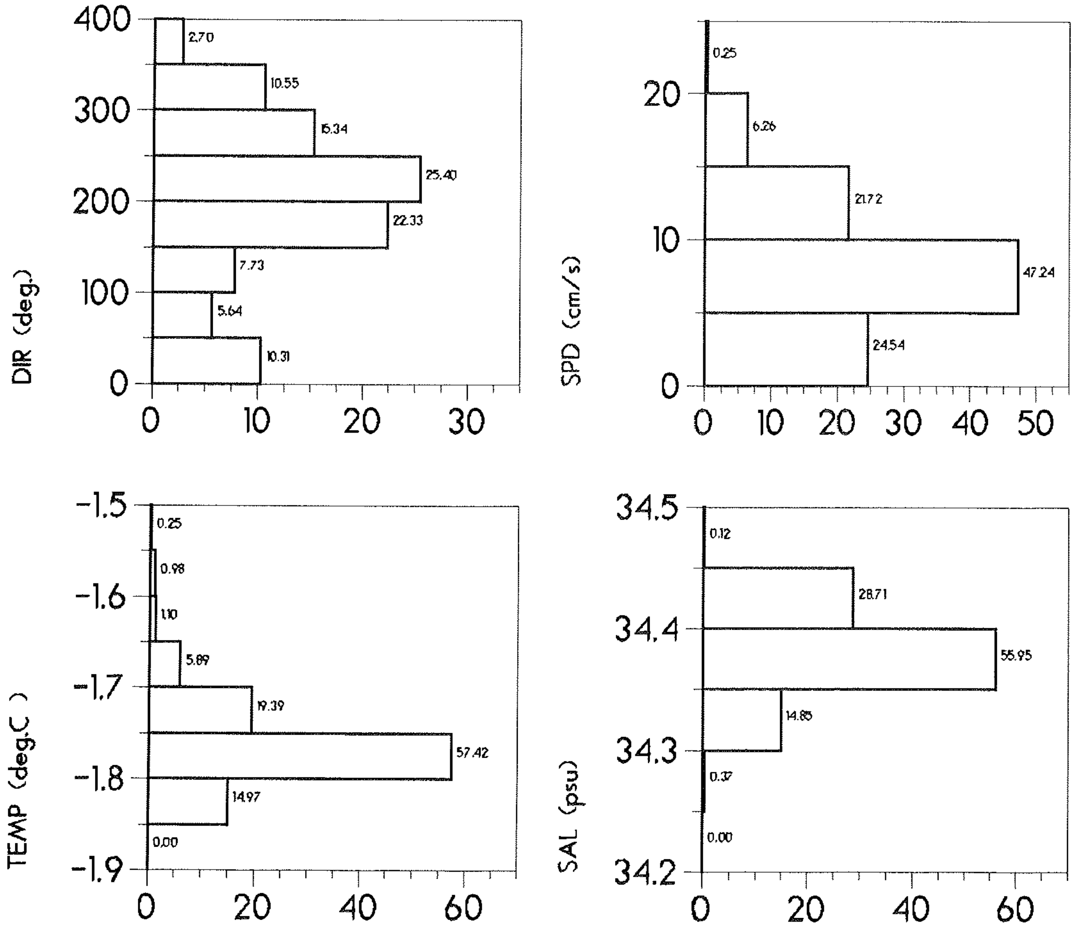
Var.	Units	Cycles	Minimum	Maximum	Mean	Variance	STRDDEV
ACM 1297 (30 m)							
VC	CM/S	782	-20.237	12.887	-0.980	0.4195E+02	0.6477E+01
UC	CM/S	782	-20.679	5.032	-7.902	0.2030E+02	0.4506E+01
TEMP	DEG.C	782	-2.100	-1.800	-1.946	0.1776E-02	0.4214E-01
RCM 8367 (40 m)							
PRES	DBAR	782	28.307	49.743	33.379	0.1032E+02	0.3212E+01
TEMP	DEG.C	782	-1.846	-1.700	-1.801	0.3919E-03	0.1980E-01
VC	CM/S	782	-5.877	6.246	0.070	0.4812E+01	0.2194E+01
UC	CM/S	782	-19.559	0.000	-7.525	0.1398E+02	0.3740E+01
RCM 8370 (71 m)							
PRES	DBAR	782	64.960	83.200	69.237	0.5287E+01	0.2299E+01
TEMP	DEG.C	782	-1.856	-1.714	-1.811	0.2889E-03	0.1700E-01
VC	CM/S	782	-3.244	7.132	1.191	0.4994E+01	0.2235E+01
UC	CM/S	782	-19.634	0.689	-7.537	0.1471E+02	0.3835E+01
TR 944 (371,346,321,296,271,246,221,196,171,146,121 m)							
TEMP	DEG.C	782	-1.823	0.717	0.138	0.4744E+00	0.6888E+00
TEMP	DEG.C	782	-1.781	0.678	-0.023	0.5560E+00	0.7457E+00
TEMP	DEG.C	782	-1.794	0.632	-0.250	0.5928E+00	0.7699E+00
TEMP	DEG.C	782	-1.801	0.436	-0.518	0.5539E+00	0.7443E+00
TEMP	DEG.C	782	-1.813	0.175	-0.885	0.4140E+00	0.6434E+00
TEMP	DEG.C	782	-1.798	-0.331	-1.328	0.2129E+00	0.4615E+00
TEMP	DEG.C	782	-1.816	-0.858	-1.707	0.2544E-01	0.1595E+00
TEMP	DEG.C	782	-1.823	-1.420	-1.772	0.2789E-02	0.5282E-01
TEMP	DEG.C	782	-1.839	-1.493	-1.786	0.1009E-02	0.3176E-01
TEMP	DEG.C	782	-1.830	-1.614	-1.789	0.5005E-03	0.2237E-01
TEMP	DEG.C	782	-1.841	-1.662	-1.795	0.2019E-03	0.1421E-01
RCM 8396 (383 m)							
PRES	DBAR	782	392.400	410.160	395.828	0.9918E+01	0.3149E+01
COND	MMHO/CM	782	27.457	29.775	29.276	0.3454E+00	0.5877E+00
TEMP	DEG.C	782	-1.758	0.758	0.237	0.3993E+00	0.6319E+00
VC	CM/S	782	-14.001	11.047	-1.047	0.1773E+02	0.4211E+01
UC	CM/S	782	-17.584	4.686	-6.445	0.1528E+02	0.3909E+01
S	1/1000	782	34.329	34.663	34.564	0.4564E-02	0.6756E-01
RCM 8399 (494 m)							
TEMP	DEG.C	782	-0.015	0.819	0.658	0.3040E-01	0.1744E+00
COND	MMHO/CM	782	29.016	29.835	29.685	0.2888E-01	0.1699E+00
TEMP	DEG.C	782	-0.005	0.830	0.675	0.3035E-01	0.1742E+00
VC	CM/S	782	-10.745	6.043	-1.031	0.1127E+02	0.3358E+01
UC	CM/S	782	-13.256	3.052	-5.338	0.1031E+02	0.3211E+01
S	1/1000	782	34.503	34.655	34.615	0.6583E-03	0.2566E-01
RCM 8417 (695 m)							
TEMP	DEG.C	782	0.519	0.773	0.645	0.2992E-02	0.5470E-01
VC	CM/S	782	-8.498	7.089	-0.778	0.6502E+01	0.2550E+01
UC	CM/S	782	-12.299	0.602	-4.220	0.9549E+01	0.3090E+01
RCM 8418 (1425 m)							
TEMP	DEG.C	782	0.207	0.316	0.254	0.7715E-03	0.2778E-01
VC	CM/S	782	-6.031	6.974	-0.567	0.4005E+01	0.2001E+01
UC	CM/S	782	-9.627	3.777	-2.689	0.6266E+01	0.2503E+01
ACM 1291 (3411 m)							
VC	CM/S	782	-10.488	10.139	-1.533	0.1842E+02	0.4292E+01
UC	CM/S	782	-16.475	6.762	-3.253	0.1214E+02	0.3485E+01
TEMP	DEG.C	782	-0.425	-0.150	-0.261	0.2888E-02	0.5374E-01

Fi. 20:
Histogram of the moored instruments complete time series.

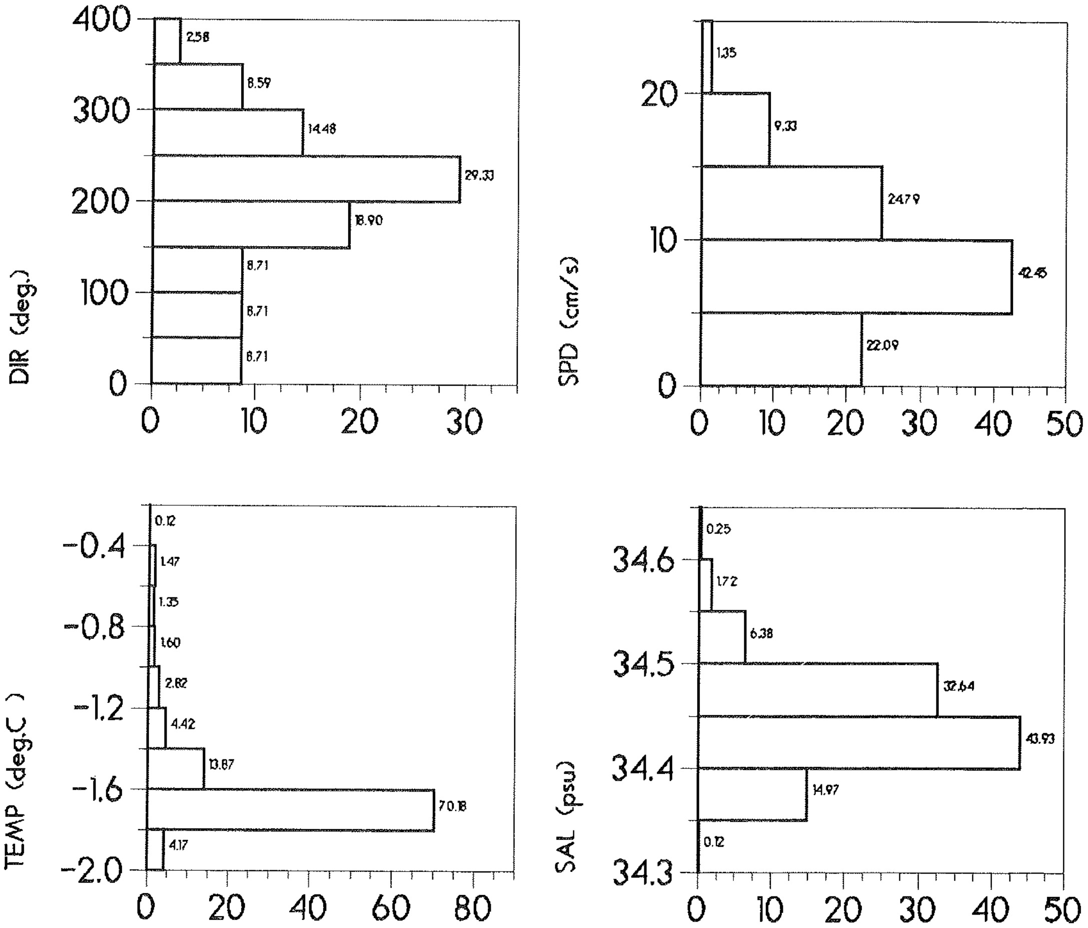
AWI201 WLR 1044 415m



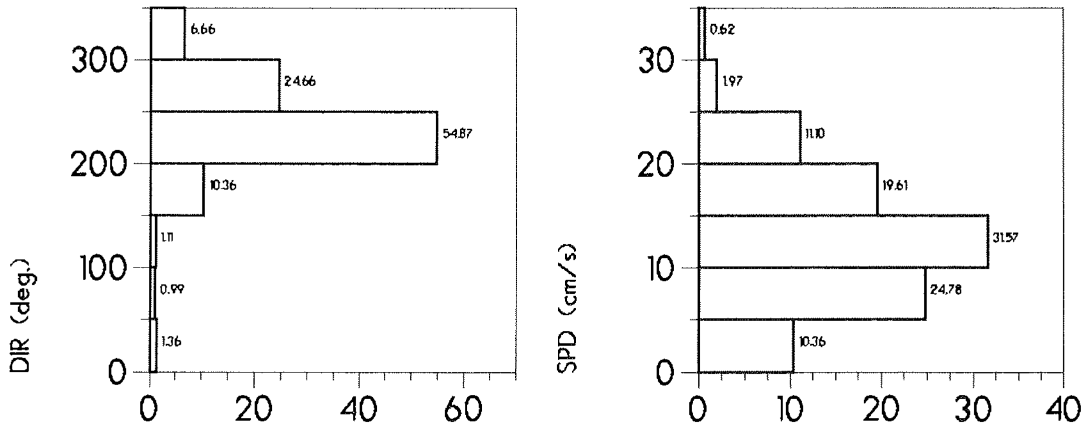
AWI201 RCM 8405 245m



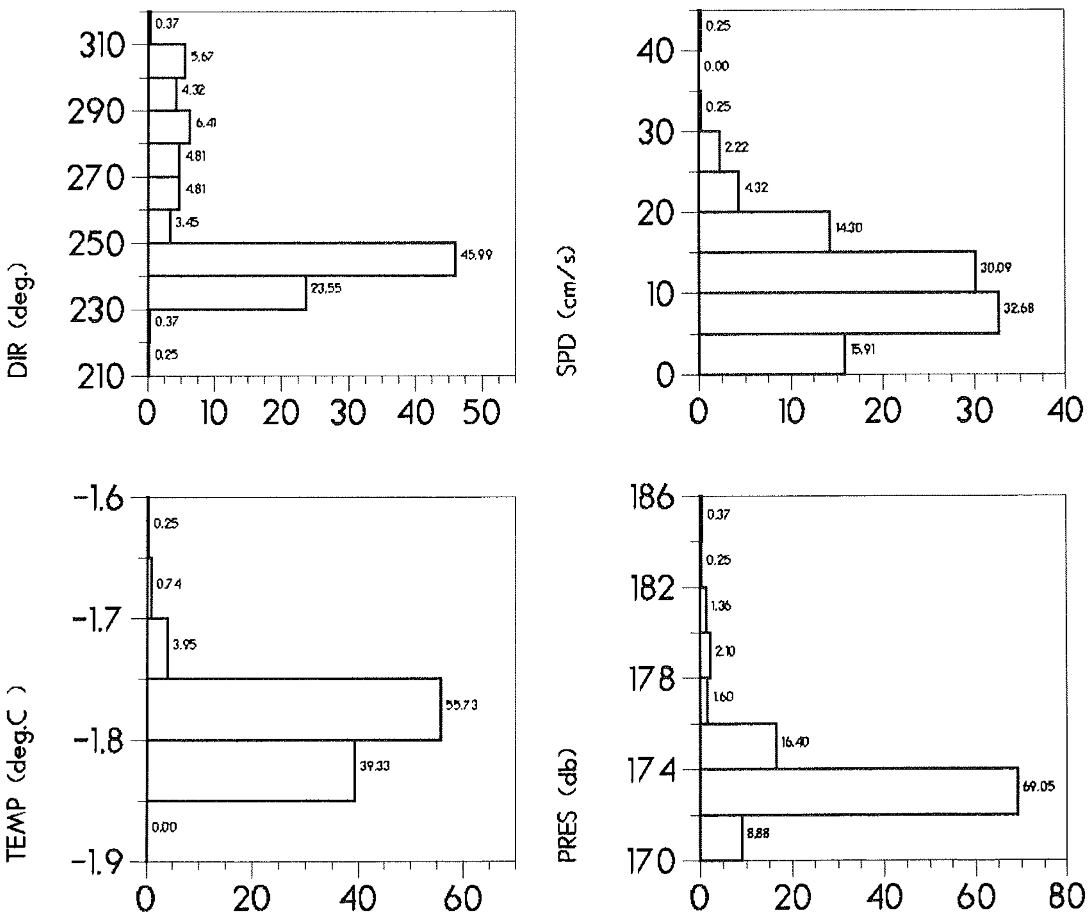
AWI201 RCM 8419 345m

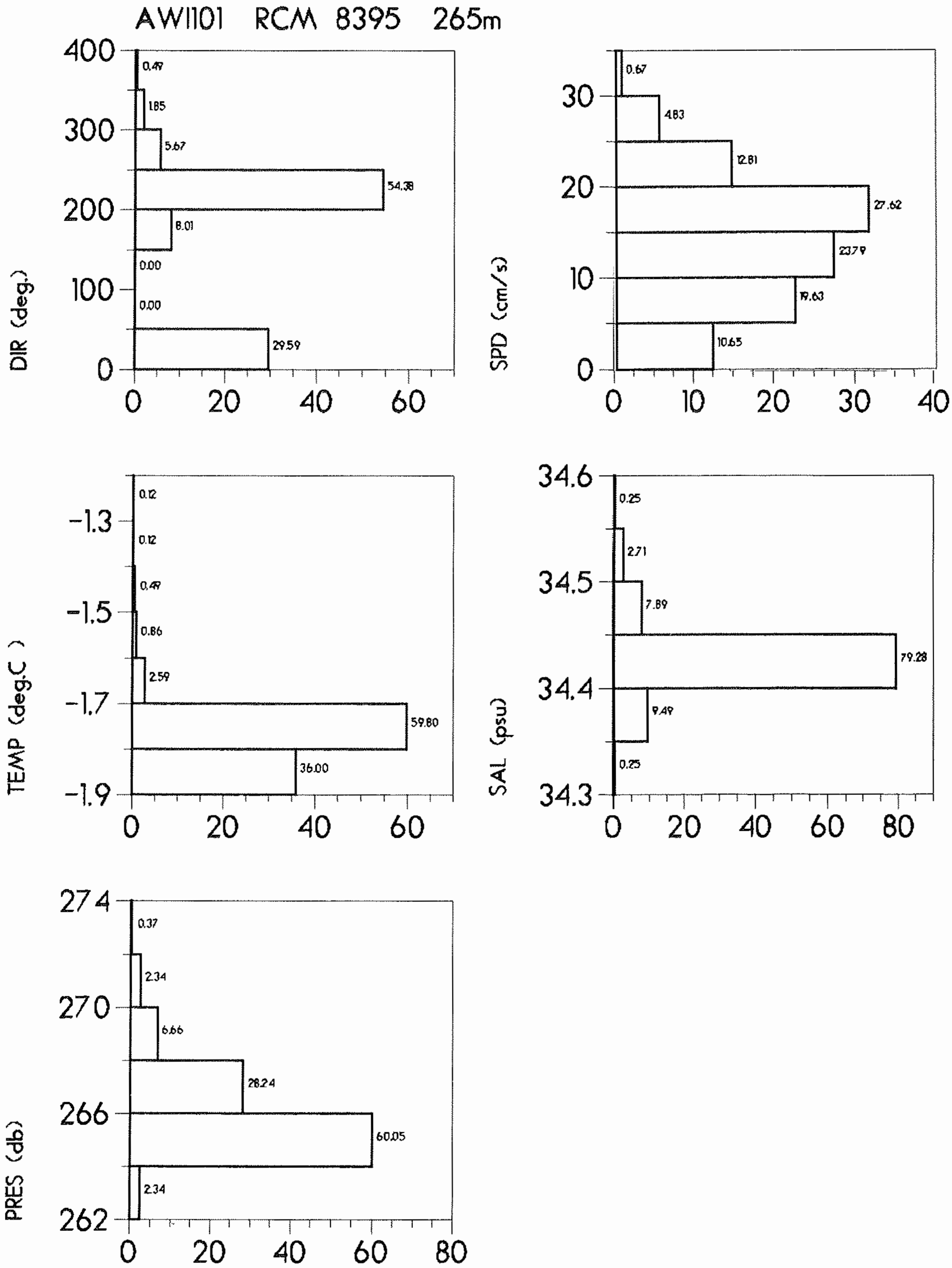


AWI101 ACM 1289 45m

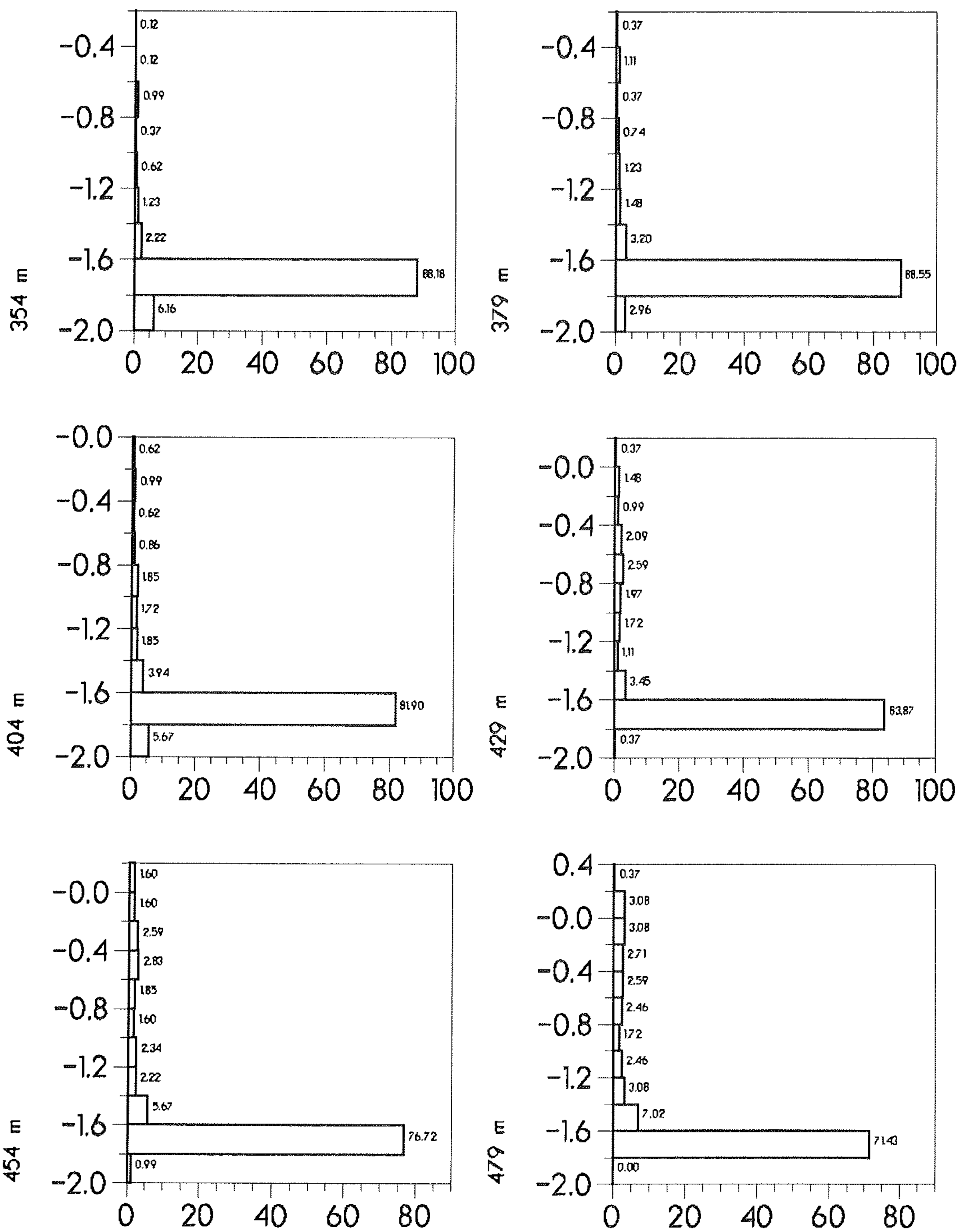


AWI101 RCM 8402 173m

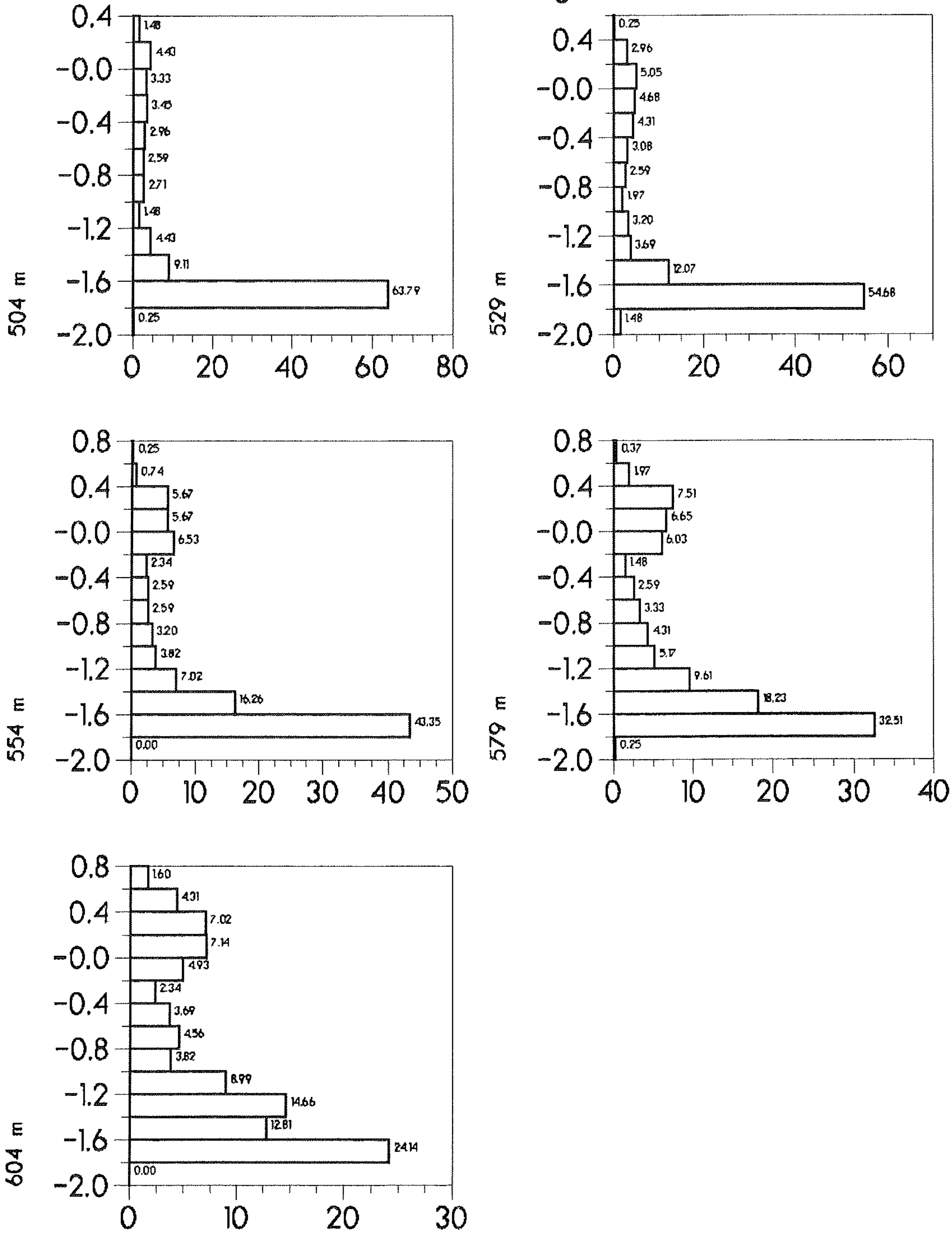



AWI101 RCM 8395 265m
DIR (deg.)
0.49
1.85
5.67
54.38
8.01
0.00
0.00
29.59
SPD (cm/s)
0.67
4.83
12.81
27.62
23.79
19.63
10.65
TEMP (deg.C)
0.12
0.12
0.49
0.86
2.59
59.80
36.00
SAL (psu)
0.25
2.71
7.89
79.28
9.49
0.25
PRES (db)
0.37
2.34
6.66
28.24
60.05
2.34

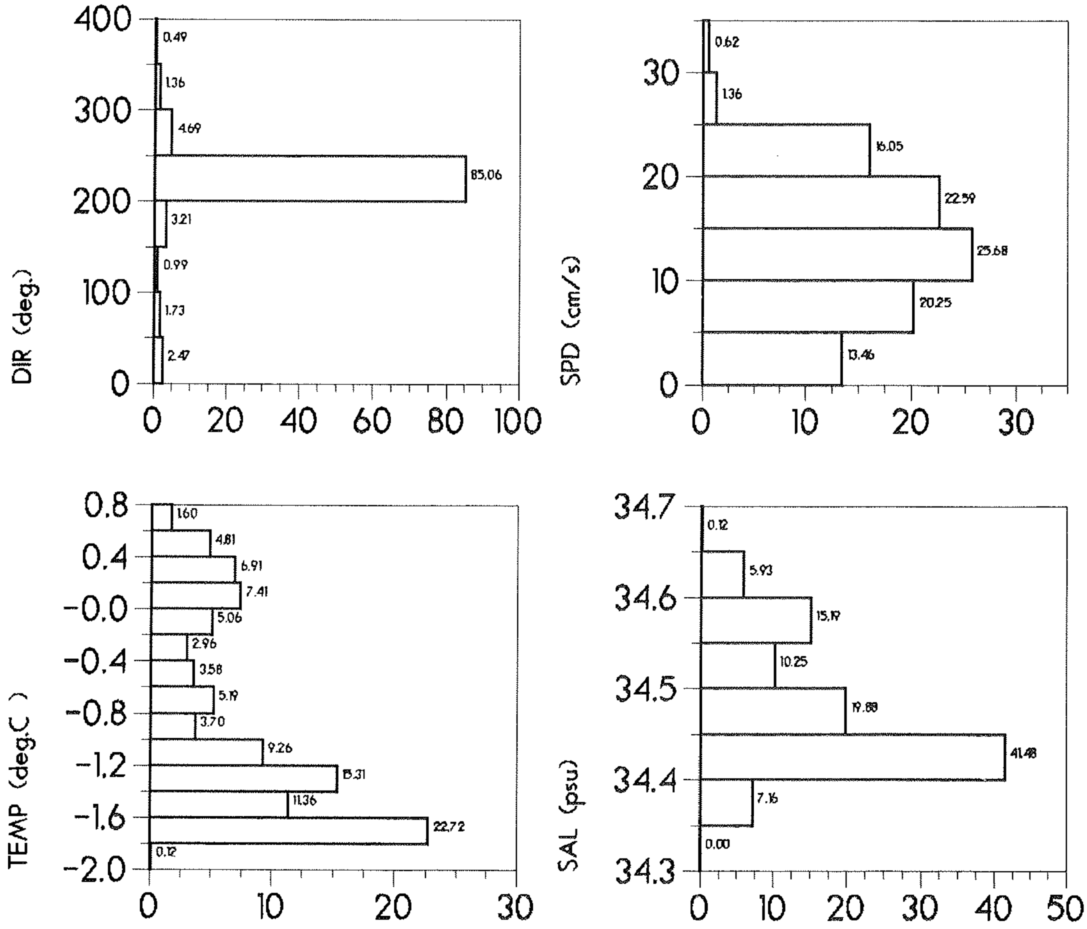
AWI101 TR-2 943 TEMP (deg.C)



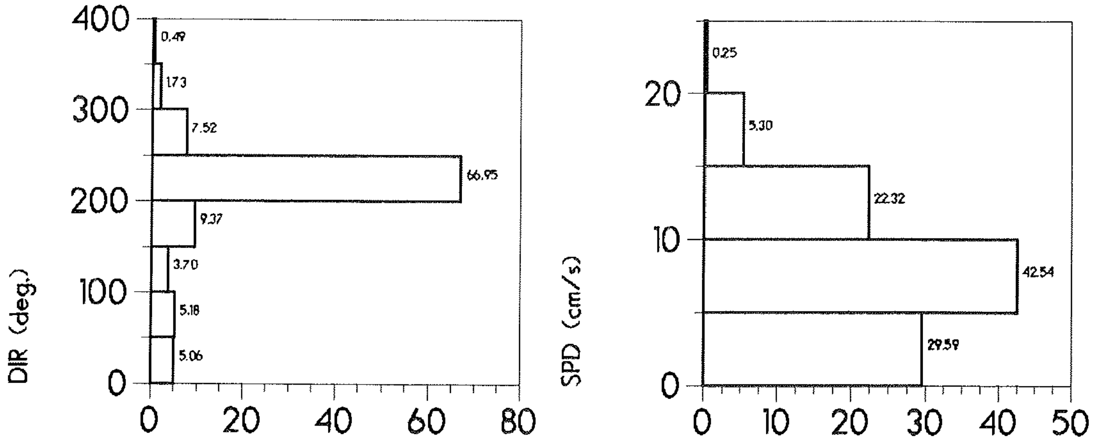
AWI101 TR-2 943 TEMP (deg.C)



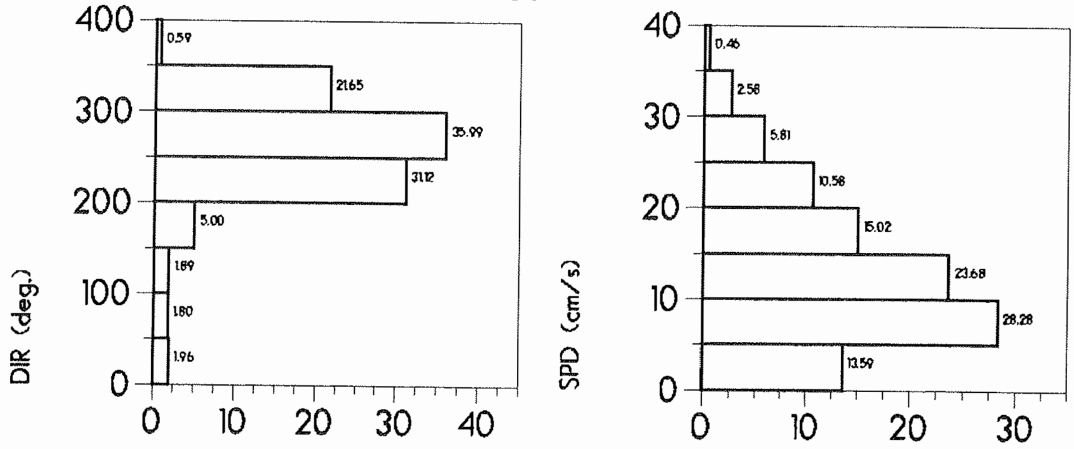
AWI101 RCM 8400 615m



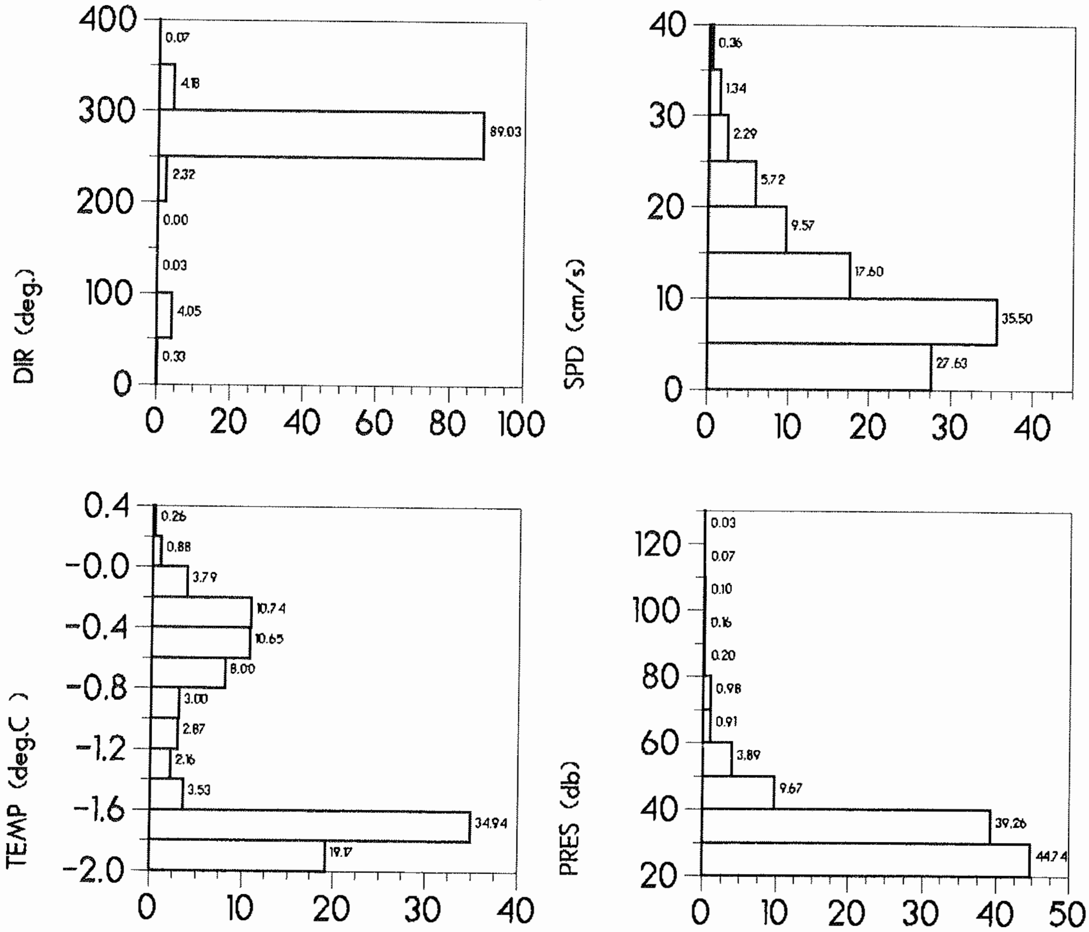
AWI101 ACM 1290 810m

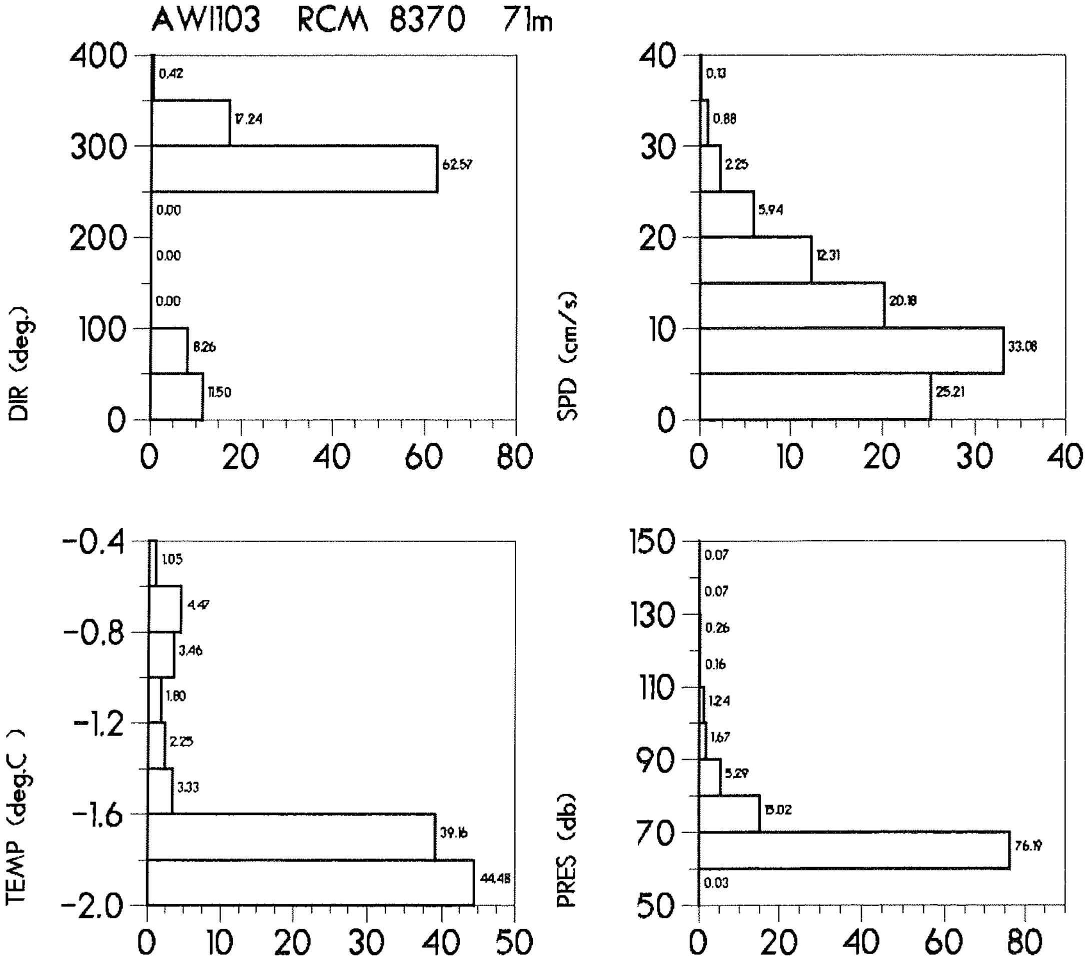


AWI103 ACM 1297 30m

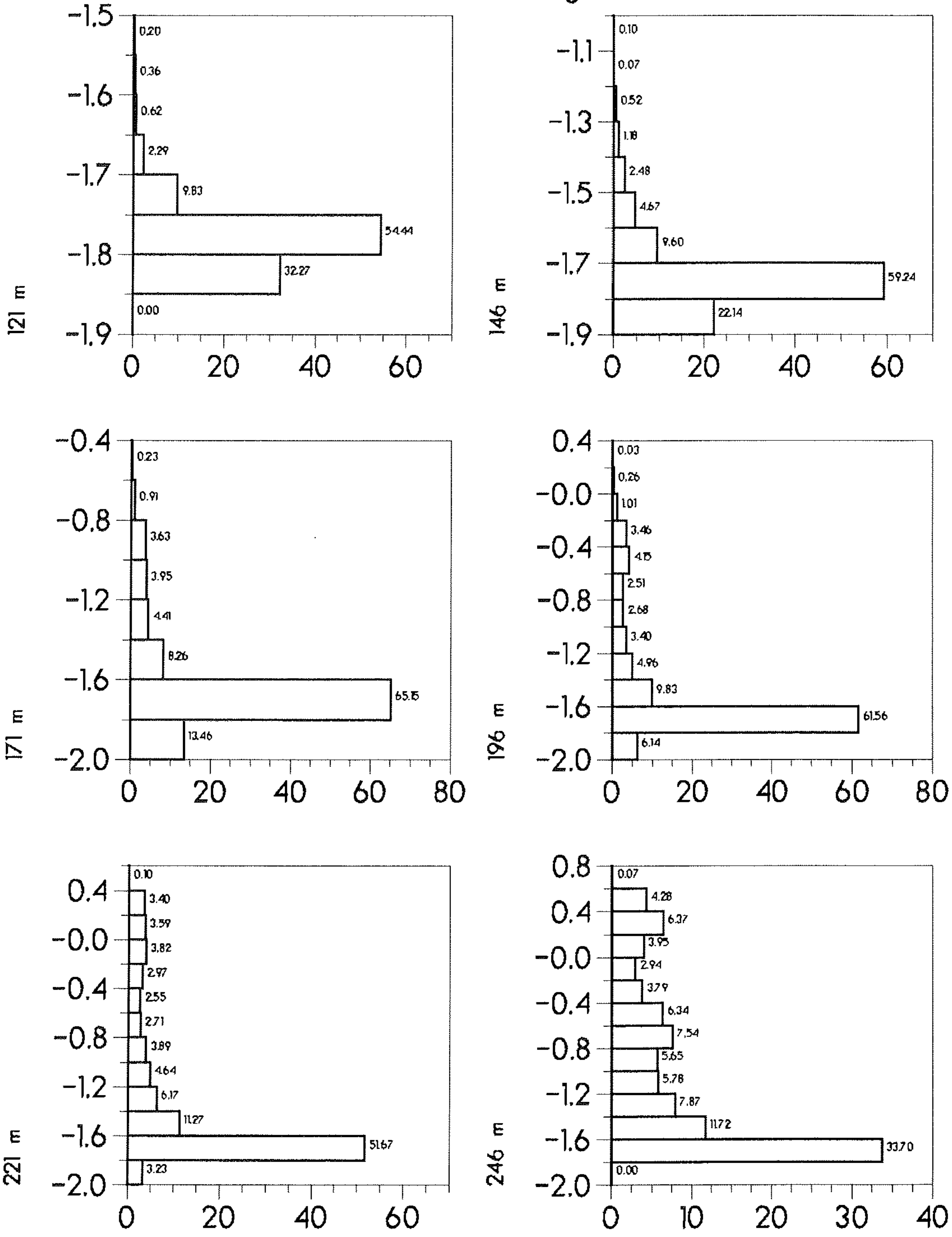


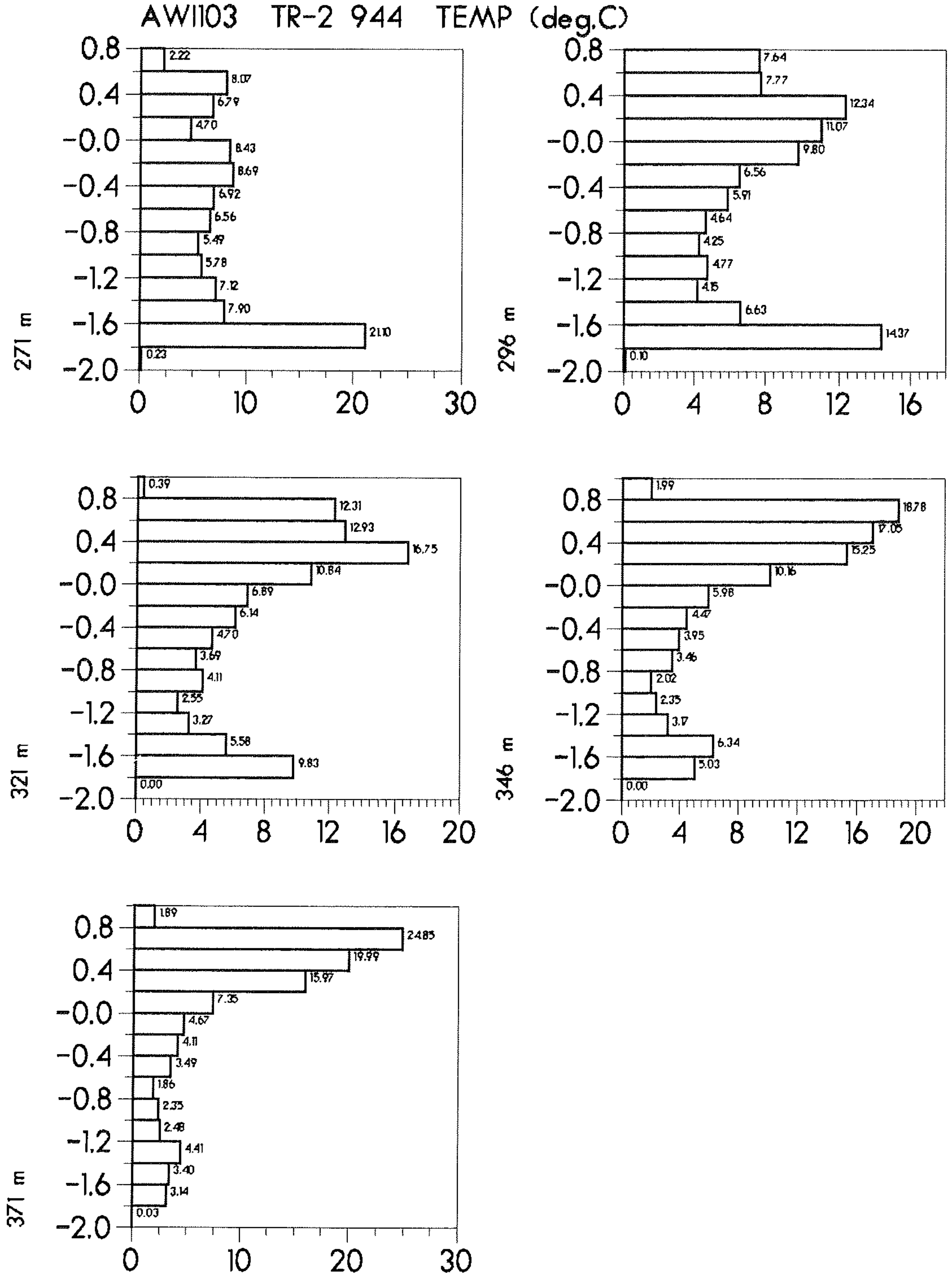
AWI103 RCM 8367 40m

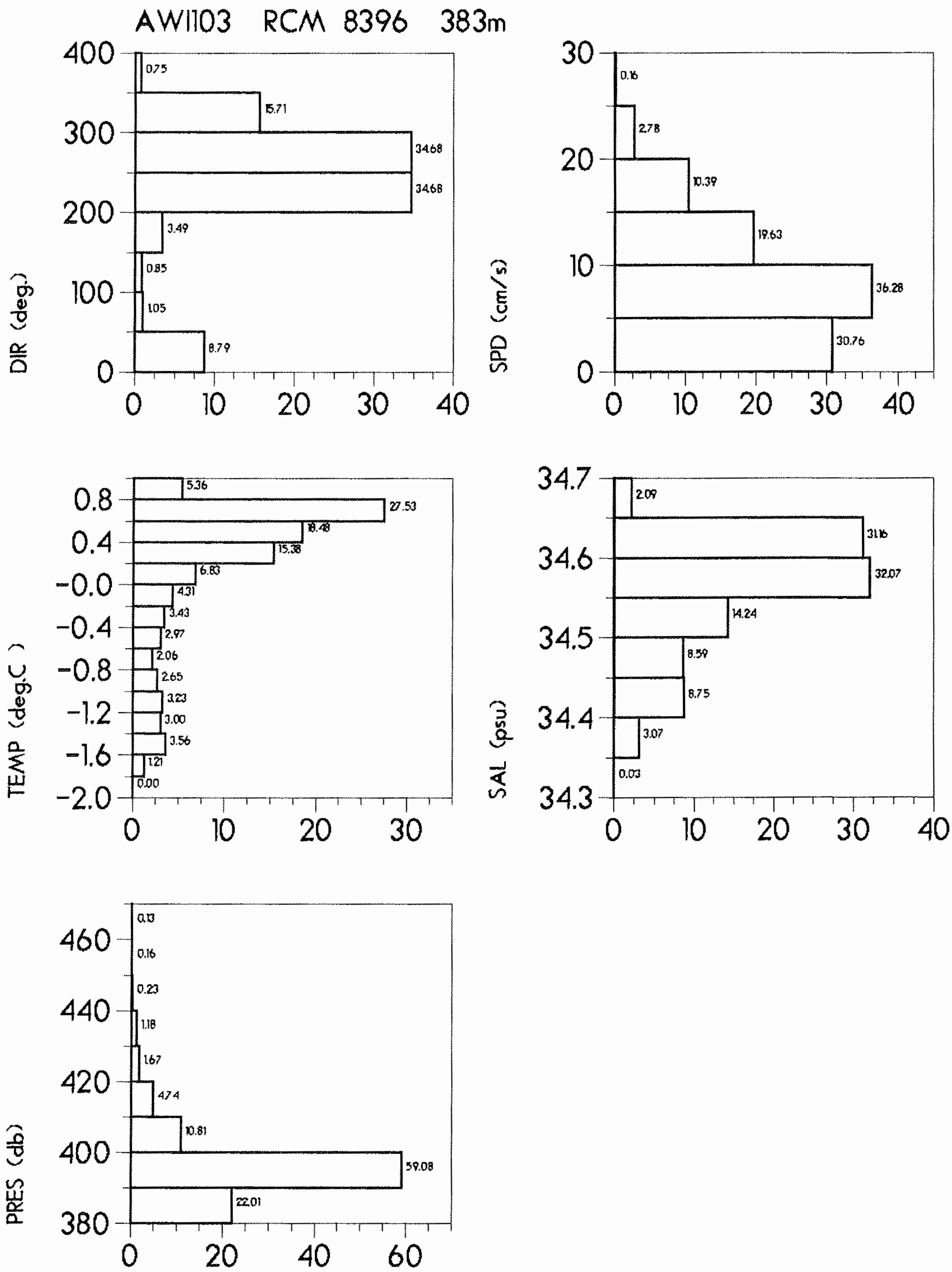


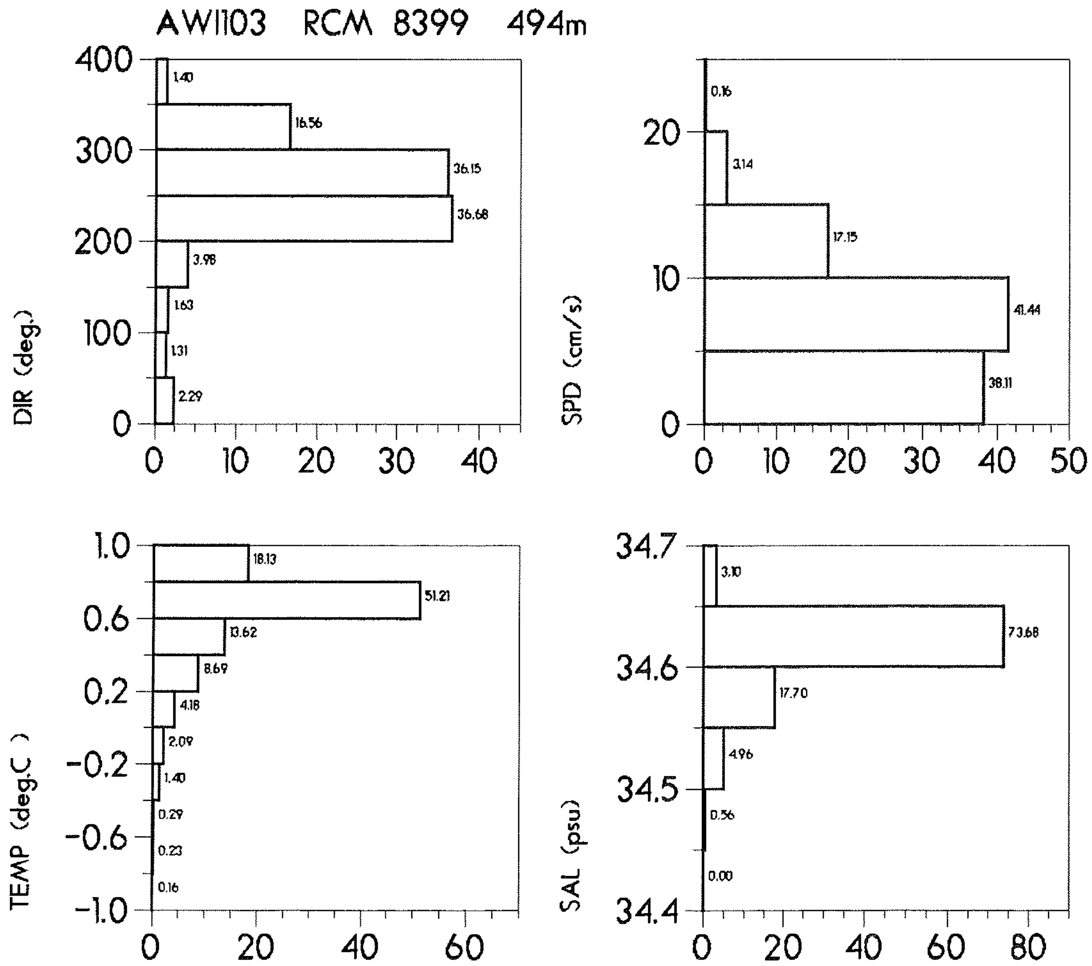

AWI103 RCM 8370 71m
DIR (deg.)
0.42
17.24
62.57
0.00
0.00
0.00
8.26
11.50
SPD (cm/s)
0.13
0.88
2.25
5.94
12.31
20.18
33.08
25.21
TEMP (deg.C)
1.05
4.47
3.46
1.80
2.25
3.33
39.16
44.48
PRES (db)
0.07
0.07
0.26
0.16
1.24
1.67
5.29
15.02
76.19
0.03

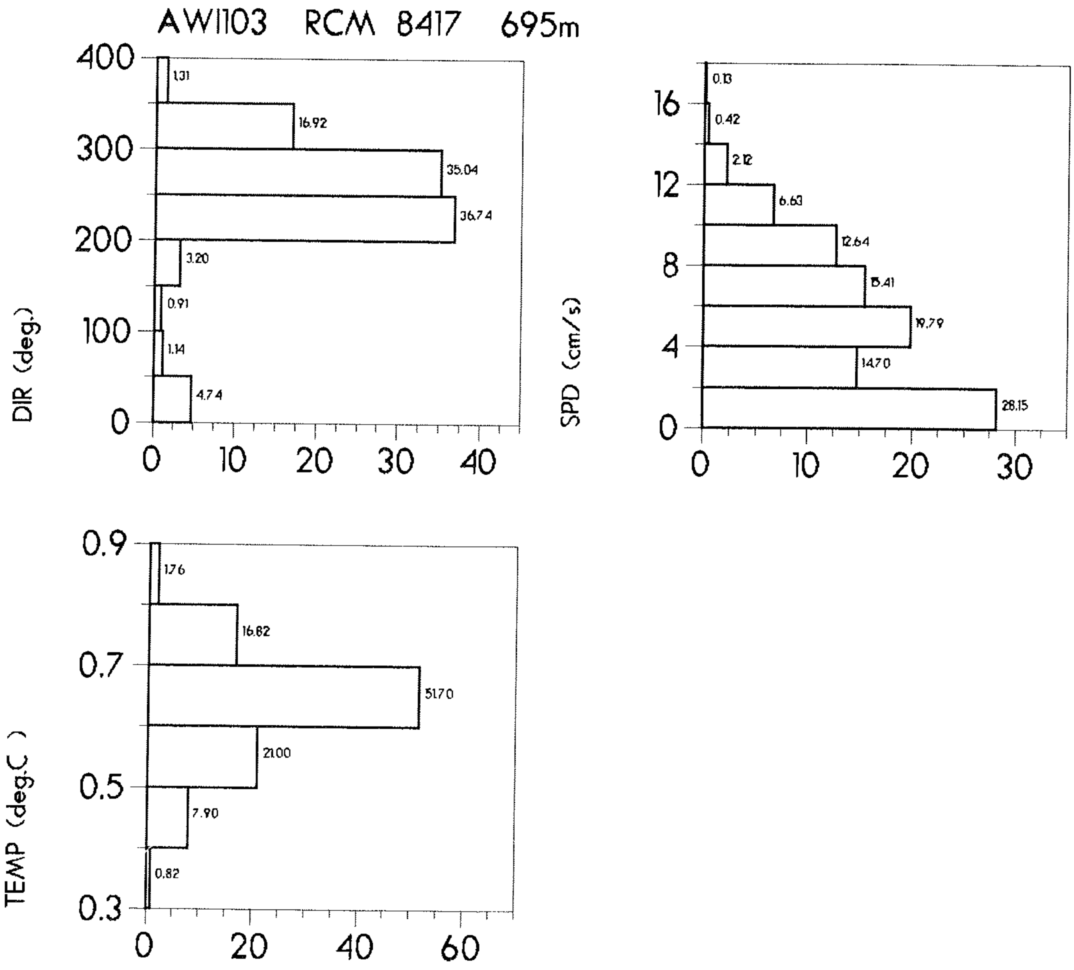
AWI103 TR-2 944 TEMP (deg.C)




AWI103 TR-2 944 TEMP (deg.C)
271 m
296 m
321 m
346 m
371 m
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
2.22
8.07
6.79
4.70
8.43
8.69
6.92
6.56
5.49
5.78
7.12
7.90
21.10
0.23
7.64
7.77
12.34
11.07
9.80
6.56
5.91
4.64
4.25
4.77
4.15
6.63
14.37
0.10
0.39
12.31
12.93
16.75
10.84
6.89
6.14
4.70
3.69
4.11
2.55
3.27
5.58
9.83
0.00
1.99
18.78
17.05
15.25
10.16
5.98
4.47
3.95
3.46
2.02
2.35
3.17
6.34
5.03
0.00
1.89
24.85
19.99
15.97
7.35
4.67
4.11
3.49
1.86
2.35
2.48
4.41
3.40
3.14
0.03
0
4
8
10
12
16
20
30

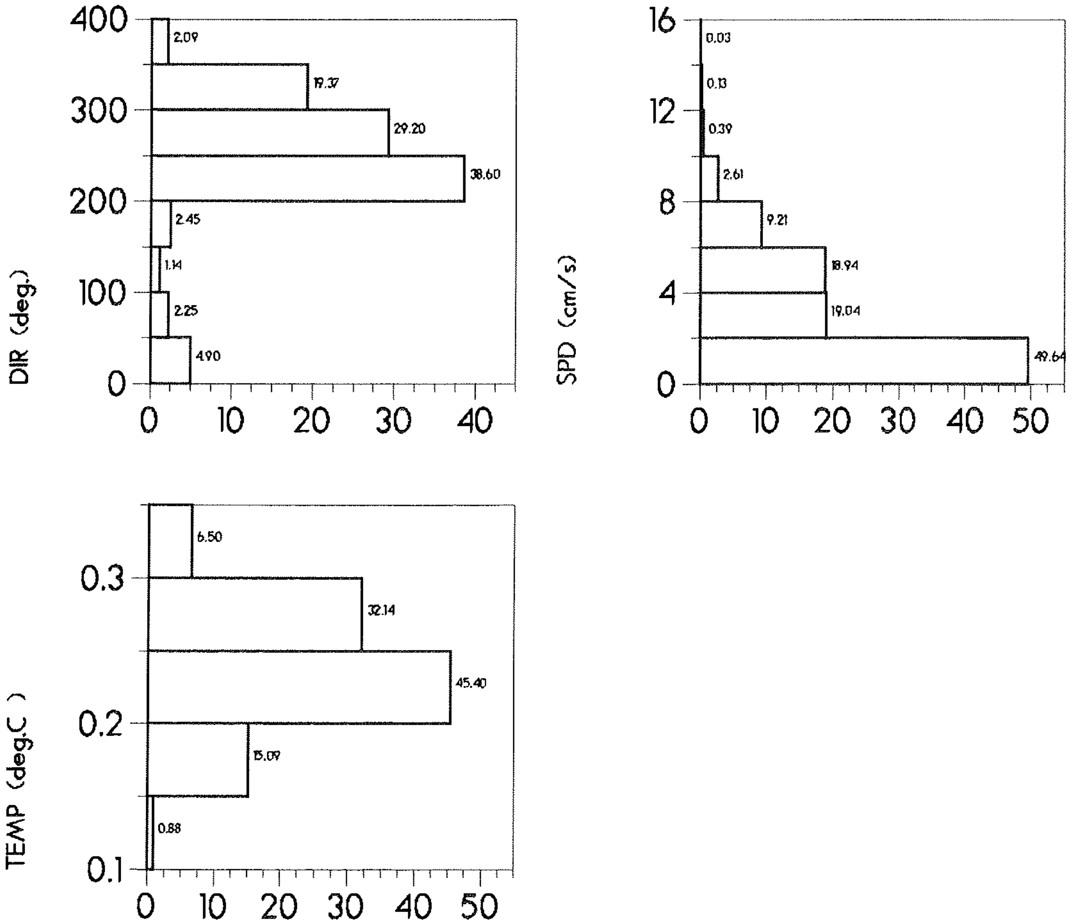

AWI103 RCM 8396 383m
DIR (deg.)
400
300
200
100
0
0.75
15.71
34.68
34.68
3.49
0.85
1.05
8.79
0 10 20 30 40
SPD (cm/s)
30
20
10
0
0.16
2.78
10.39
19.63
36.28
30.76
0 10 20 30 40
TEMP (deg.C)
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
5.36
27.53
18.48
15.38
6.83
4.31
3.43
2.97
2.06
2.65
3.23
3.00
3.56
1.21
0.00
0 10 20 30
SAL (psu)
34.7
34.6
34.5
34.4
34.3
2.09
31.16
32.07
14.24
8.59
8.75
3.07
0.03
0 10 20 30 40
PRES (db)
460
440
420
400
380
0.13
0.16
0.23
1.18
1.67
4.74
10.81
59.08
22.01
0 20 40 60


AWI103 RCM 8399 494m
DIR (deg.)
SPD (cm/s)
TEMP (deg.C)
SAL (psu)

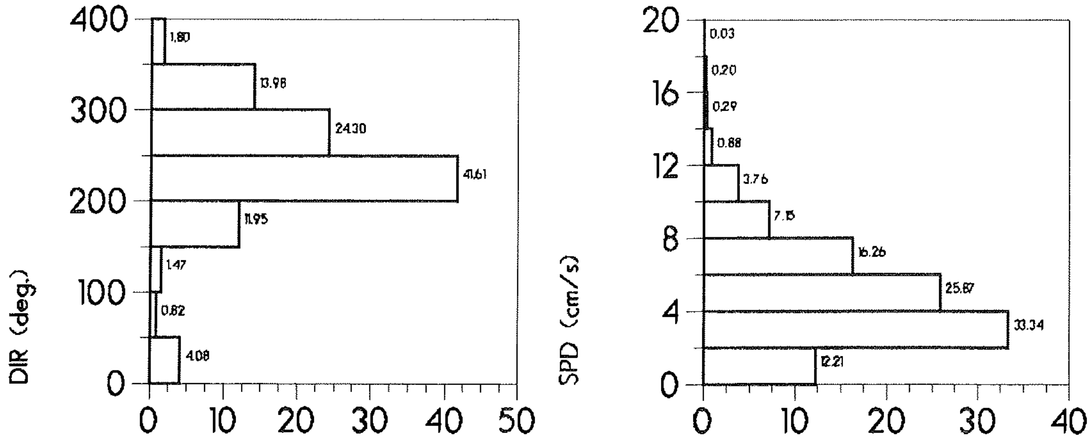


AWI103 RCM 8417 695m
DIR (deg.)
SPD (cm/s)
TEMP (deg.C)
1.31
16.92
35.04
36.74
3.20
0.91
1.14
4.74
0.13
0.42
2.12
6.63
12.64
15.41
19.79
14.70
28.15
1.76
16.82
51.70
21.00
7.90
0.82

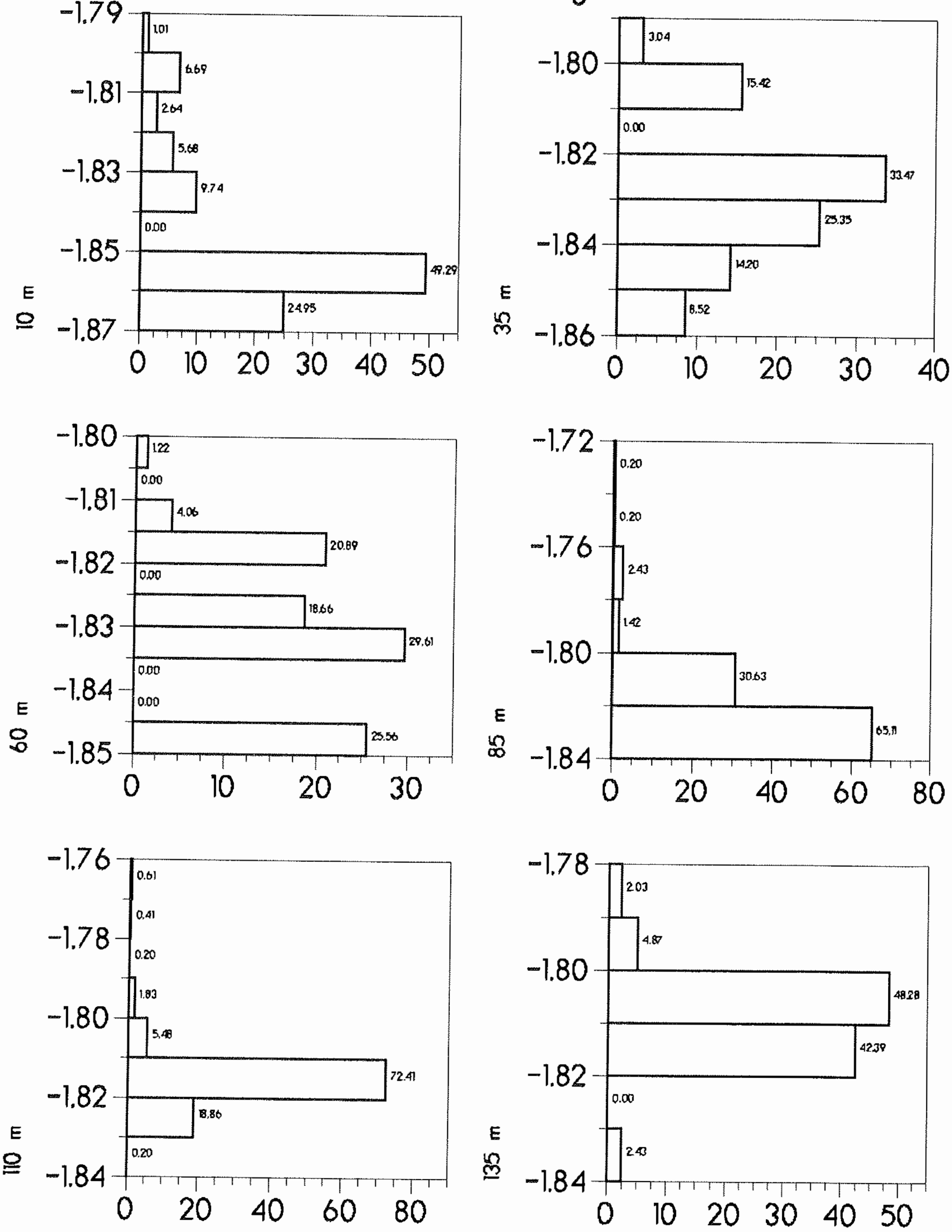
AW1103 RCM 8418 1425m

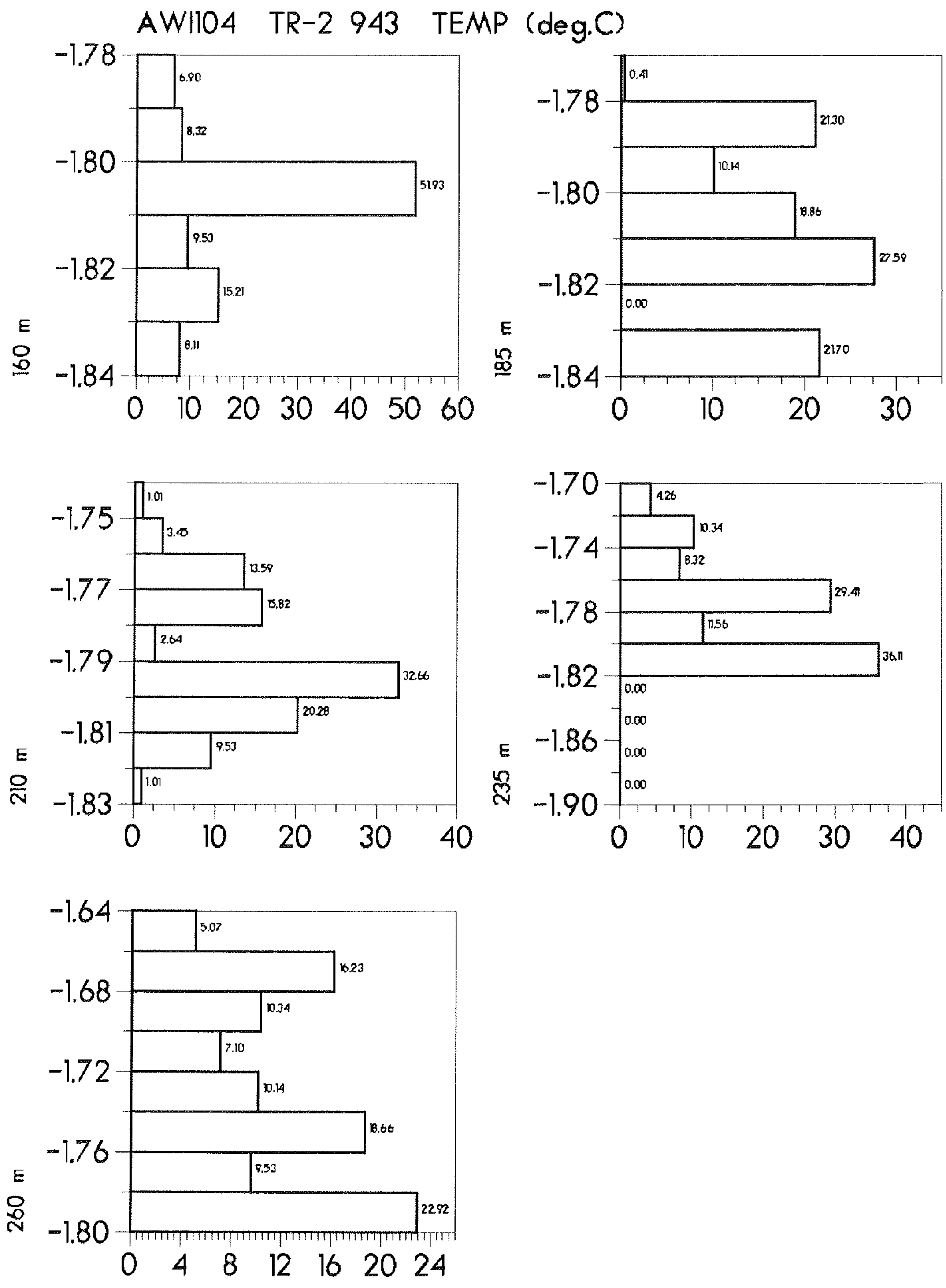


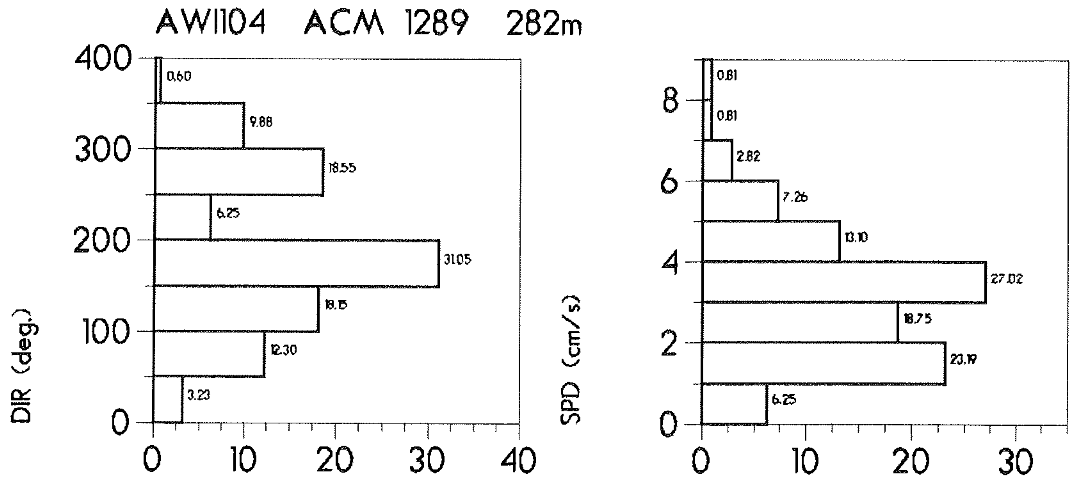
AW1103 ACM 1291 3411m



AWI104 TR-2 943 TEMP (deg.C)




AWI104 TR-2 943 TEMP (deg.C)
160 m
-1.78
-1.80
-1.82
-1.84
6.90
8.32
51.93
9.53
15.21
8.11
0 10 20 30 40 50 60
185 m
-1.78
-1.80
-1.82
-1.84
0.41
21.30
10.14
18.86
27.59
0.00
21.70
0 10 20 30
210 m
-1.75
-1.77
-1.79
-1.81
-1.83
1.01
3.45
13.59
15.82
2.64
32.66
20.28
9.53
1.01
0 10 20 30 40
235 m
-1.70
-1.74
-1.78
-1.82
-1.86
-1.90
4.26
10.34
8.32
29.41
11.56
36.11
0.00
0.00
0.00
0.00
0 10 20 30 40
260 m
-1.64
-1.68
-1.72
-1.76
-1.80
5.07
16.23
10.34
7.10
10.14
18.66
9.53
22.92
0 4 8 12 16 20 24


AWI104 ACM 1289 282m
DIR (deg.)
SPD (cm/s)
0.60
9.88
18.55
6.25
31.05
12.30
3.23
0.81
0.81
2.82
7.26
13.10
27.02
18.75
23.19
6.25

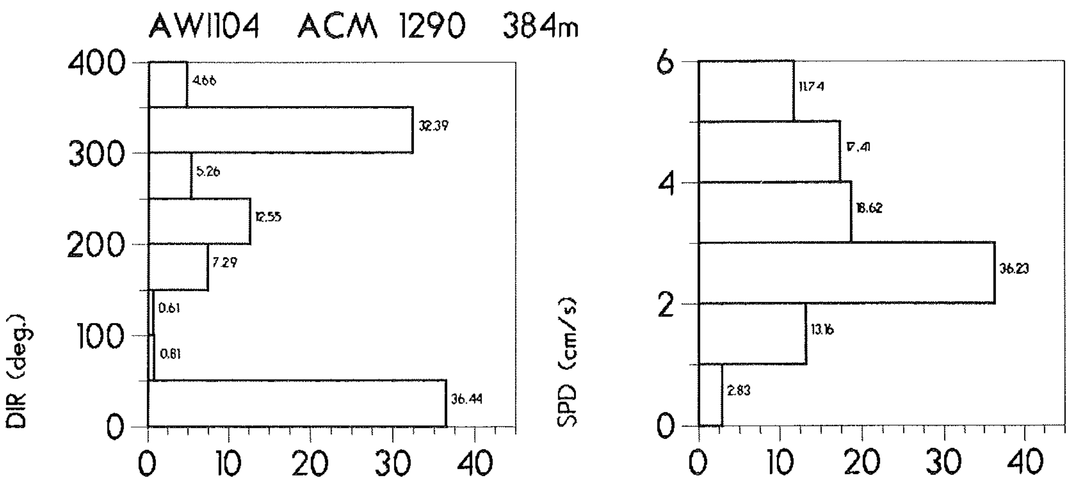
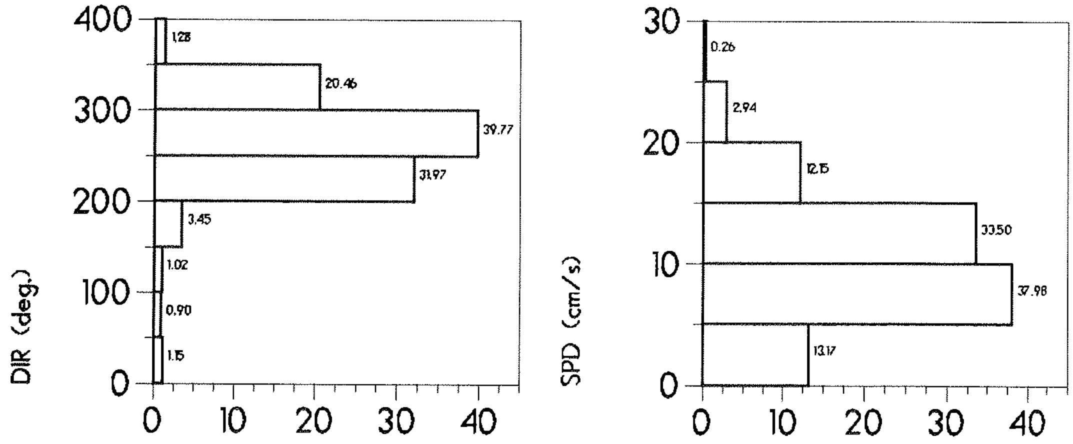
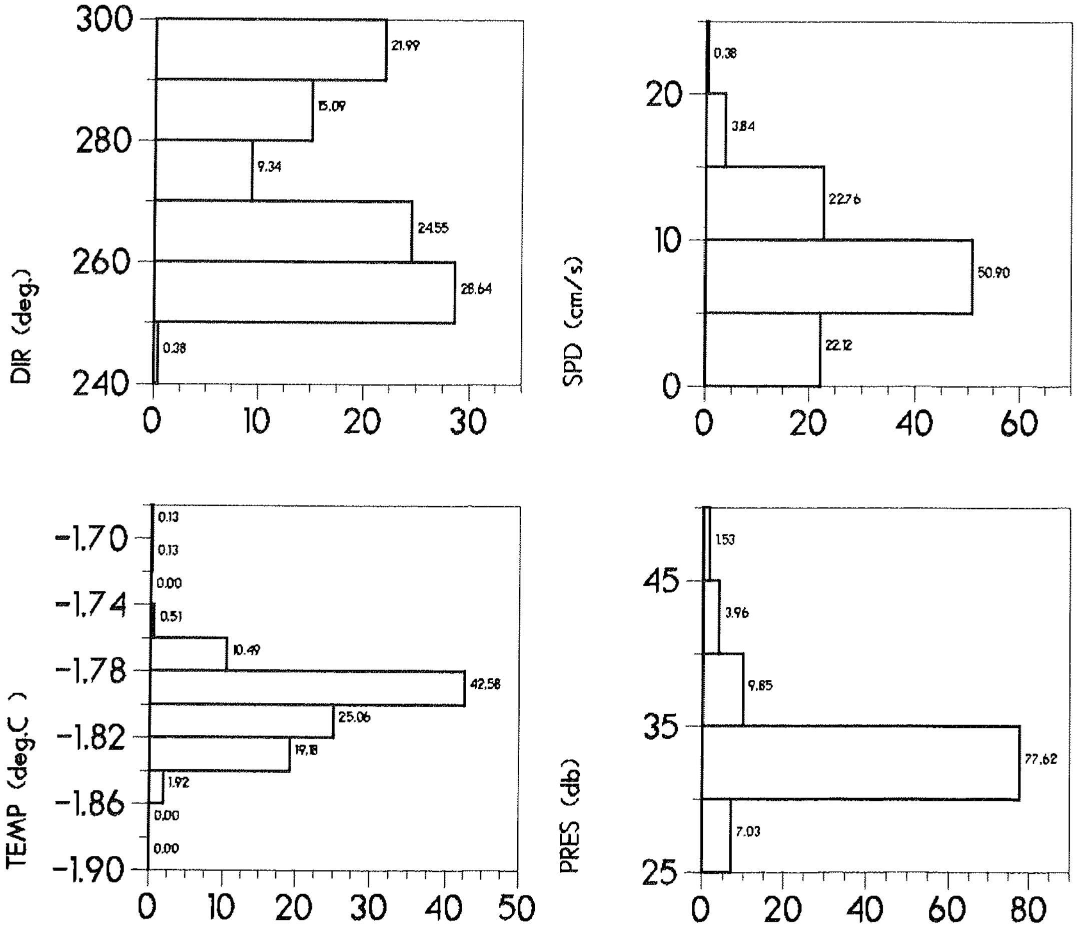

AWI104 ACM 1290 384m
DIR (deg.)
SPD (cm/s)
4.66
32.39
5.26
12.55
7.29
0.61
0.81
36.44
11.74
17.41
18.62
36.23
13.16
2.83

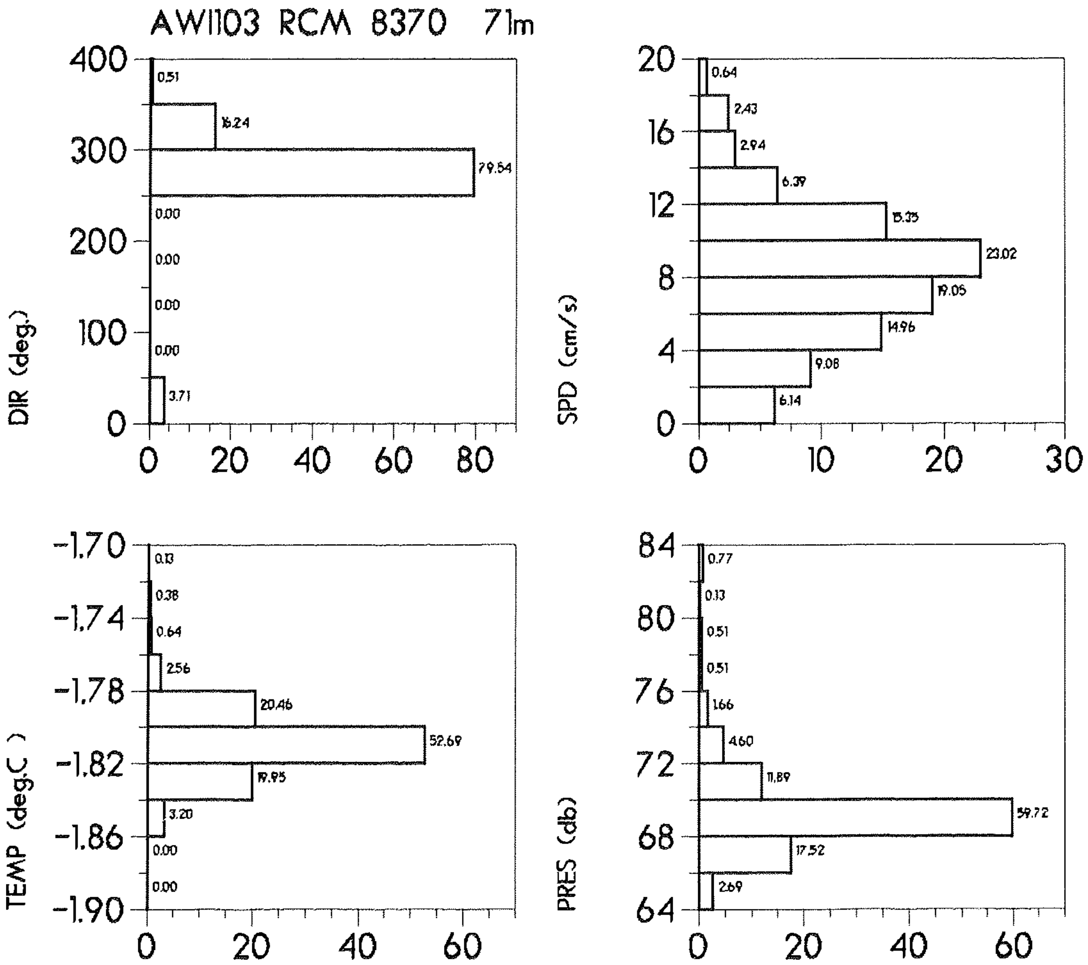
Fig. 21:
Histograms of the first 32 days of the time series obtained from AWI 103.

AW1103 ACM 1297 30m

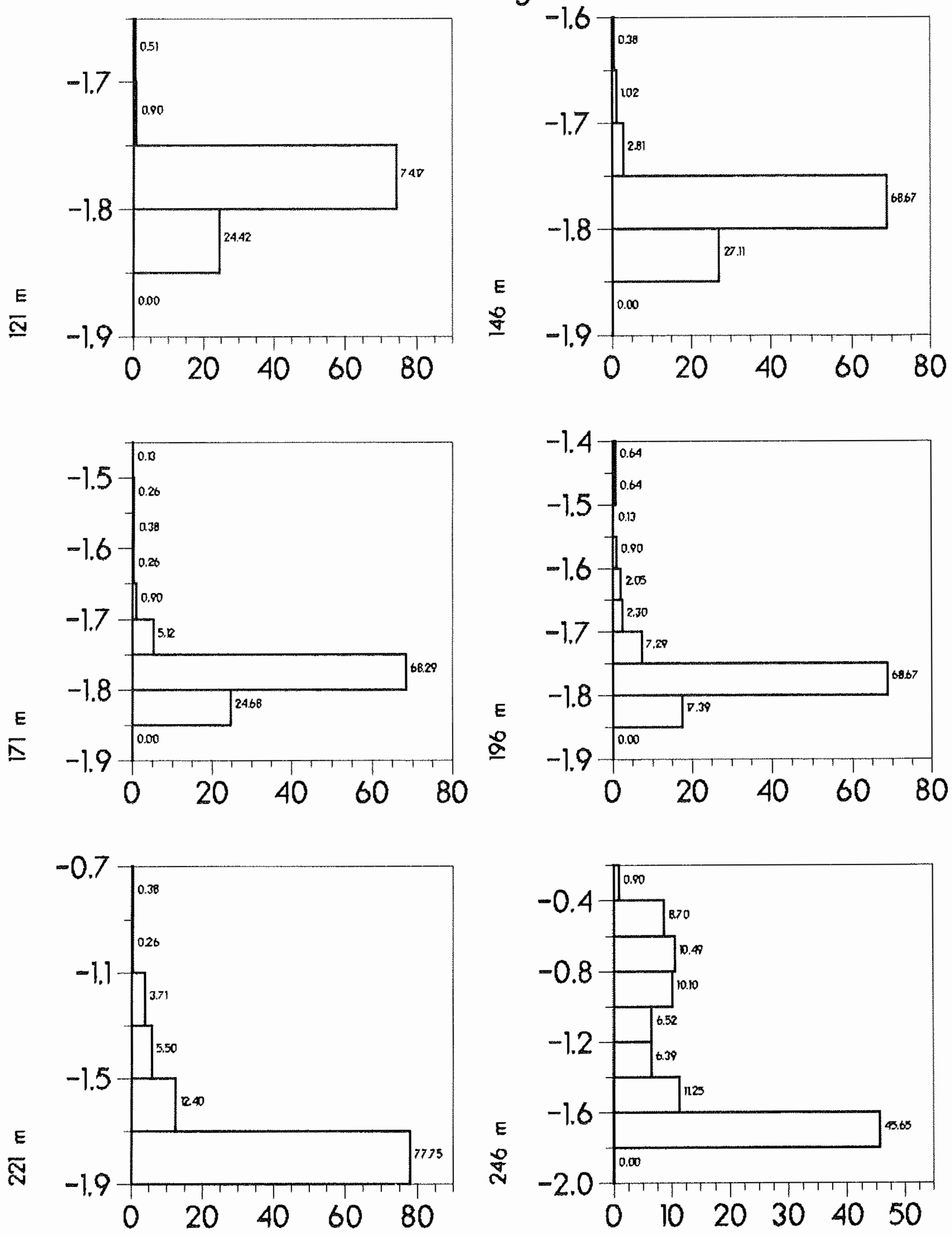


AW1103 RCM 8367 40m

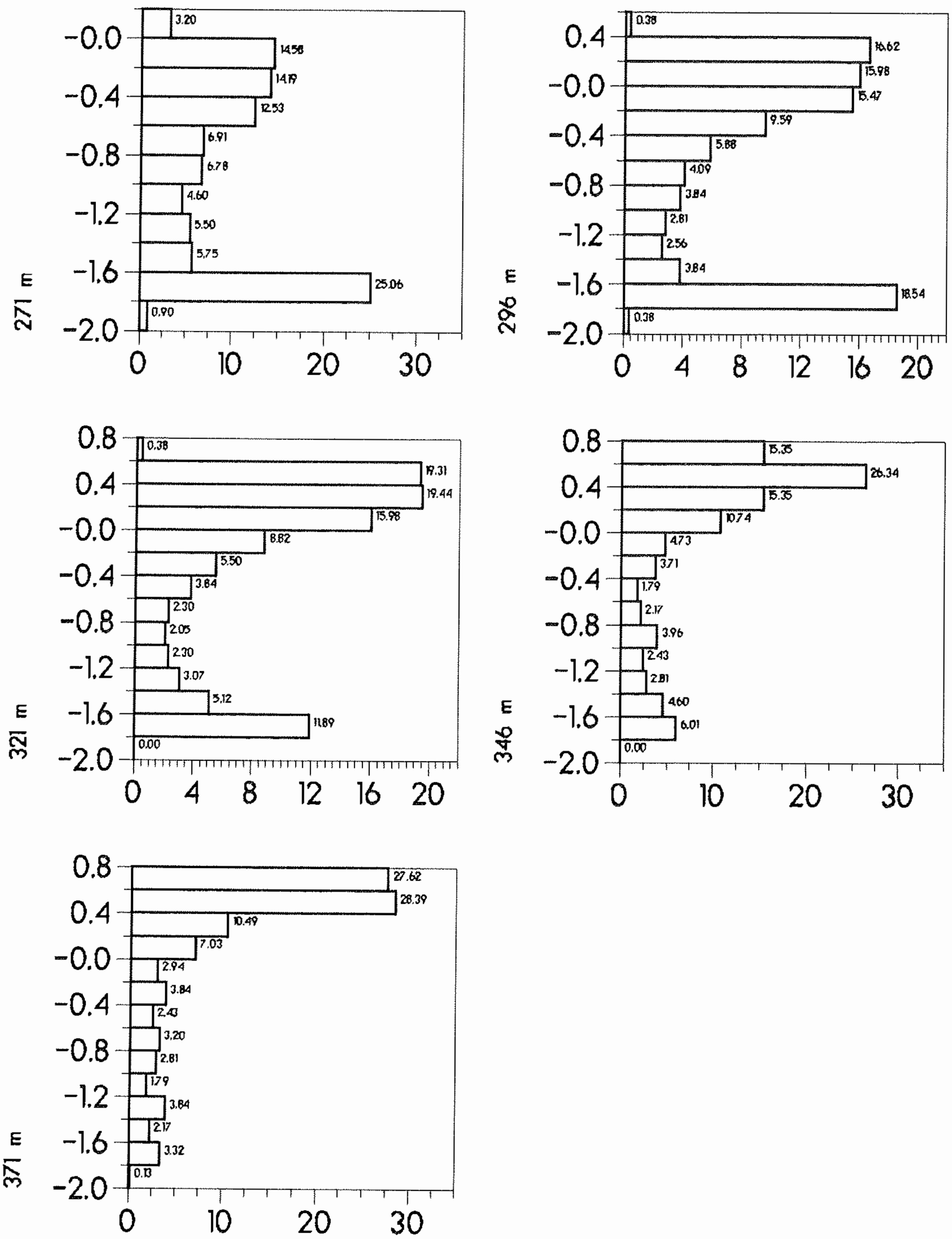


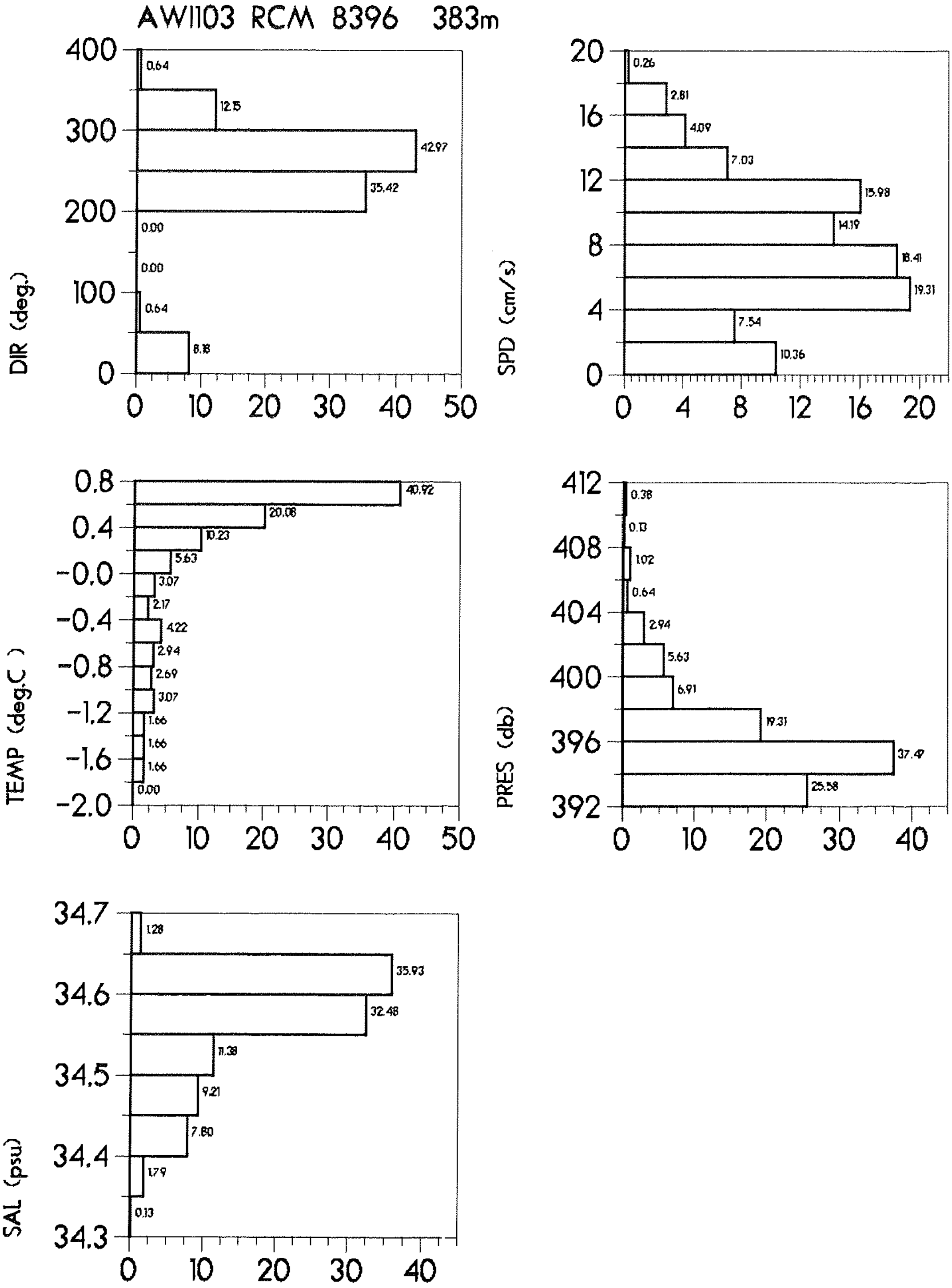

AWI103 RCM 8370 71m
DIR (deg.)
0.51
16.24
79.54
0.00
0.00
0.00
0.00
3.71
SPD (cm/s)
0.64
2.43
2.94
6.39
15.35
23.02
19.05
14.96
9.08
6.14
TEMP (deg.C)
0.13
0.38
0.64
2.56
20.46
52.69
19.95
3.20
0.00
0.00
PRES (db)
0.77
0.13
0.51
0.51
1.66
4.60
11.89
59.72
17.52
2.69

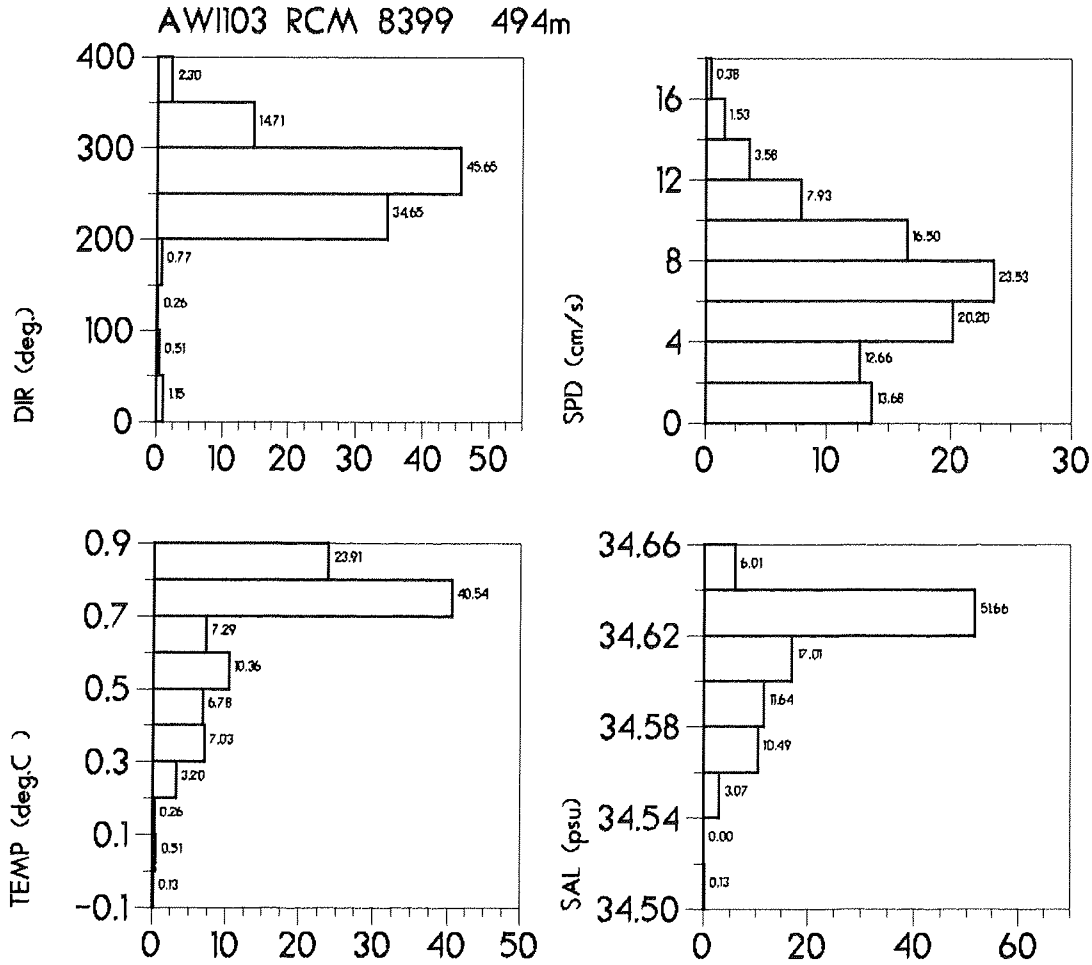
AWI103 TR 944 TEMP (deg.C)

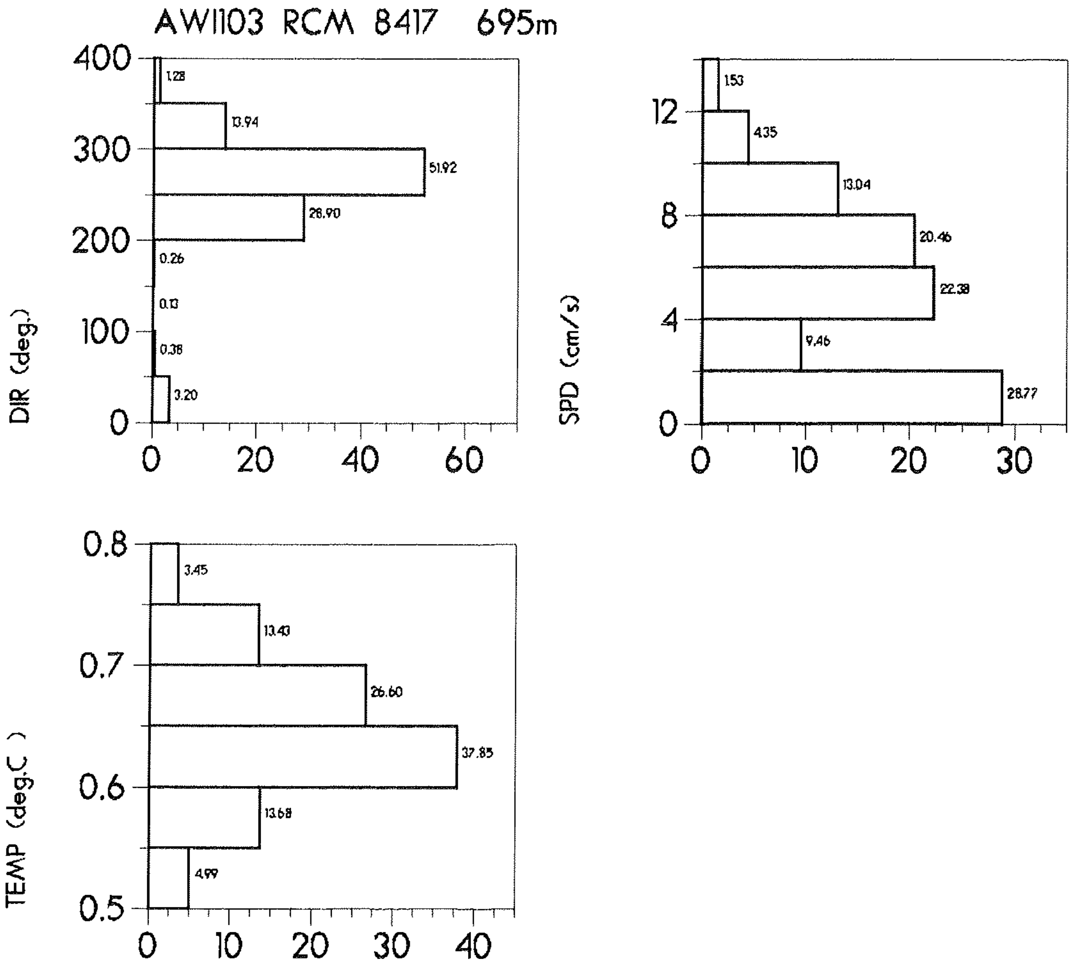


AW1103 TR 944 TEMP (deg.C)

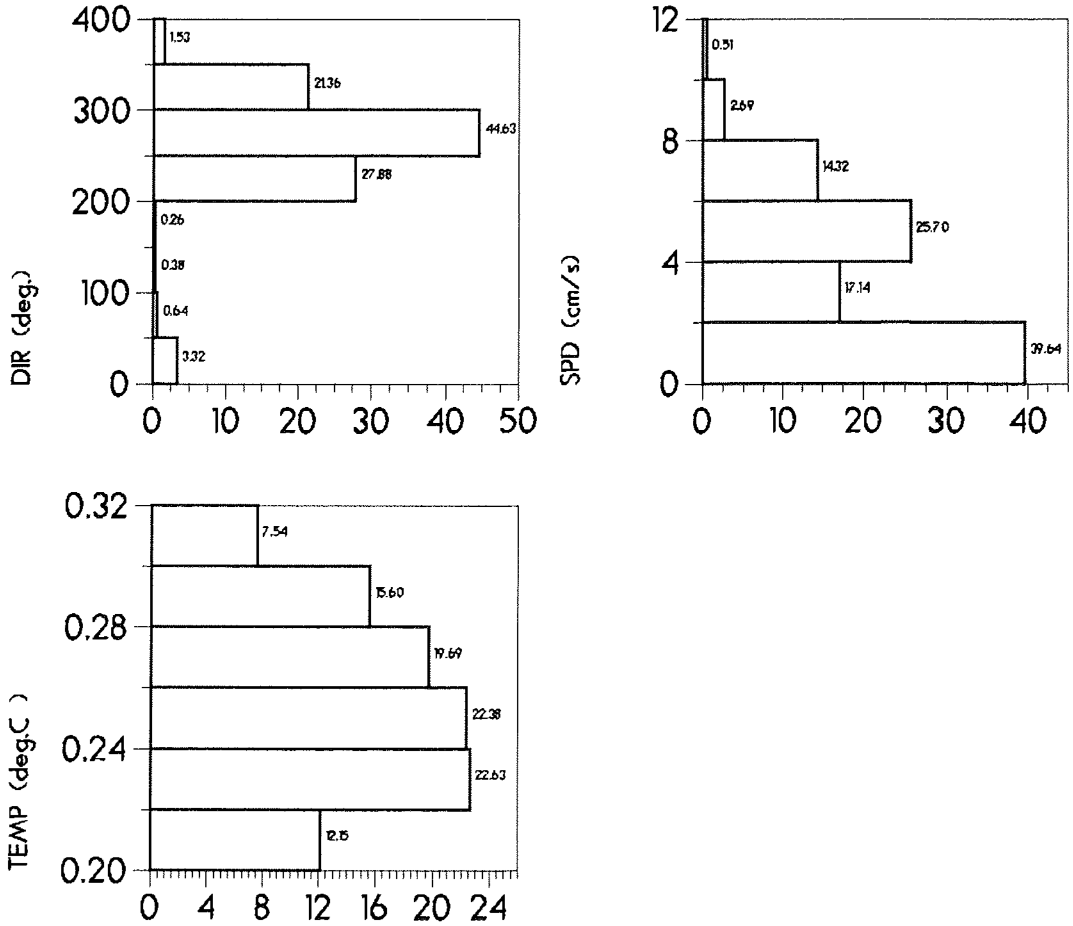



AWI103 RCM 8396 383m
DIR (deg.)
0.64
12.15
42.97
35.42
0.00
0.00
0.64
8.18
SPD (cm/s)
0.26
2.81
4.09
7.03
15.98
14.19
18.41
19.31
7.54
10.36
TEMP (deg.C)
40.92
20.08
10.23
5.63
3.07
2.17
4.22
2.94
2.69
3.07
1.66
1.66
1.66
0.00
PRES (db)
0.38
0.13
1.02
0.64
2.94
5.63
6.91
19.31
37.47
25.58
SAL (psu)
1.28
35.93
32.48
11.38
9.21
7.80
1.79
0.13


AW1103 RCM 8399 494m
DIR (deg.)
SPD (cm/s)
TEMP (deg.C)
SAL (psu)
2.30
14.71
45.65
34.65
0.77
0.26
0.51
1.15
0.38
1.53
3.58
7.93
16.50
23.53
20.20
12.66
13.68
23.91
40.54
7.29
10.36
6.78
7.03
3.20
0.26
0.51
0.13
6.01
51.66
17.01
11.64
10.49
3.07
0.00
0.13


AW1103 RCM 8417 695m
DIR (deg.)
400
300
200
100
0
0
20
40
60
1.28
13.94
51.92
28.90
0.26
0.13
0.38
3.20
SPD (cm/s)
12
8
4
0
0
10
20
30
1.53
4.35
13.04
20.46
22.38
9.46
28.77
TEMP (deg.C)
0.8
0.7
0.6
0.5
0
10
20
30
40
3.45
13.43
26.60
37.85
13.68
4.99

AWI103 RCM 8418 1425m



AWI103 ACM 1291 3411m

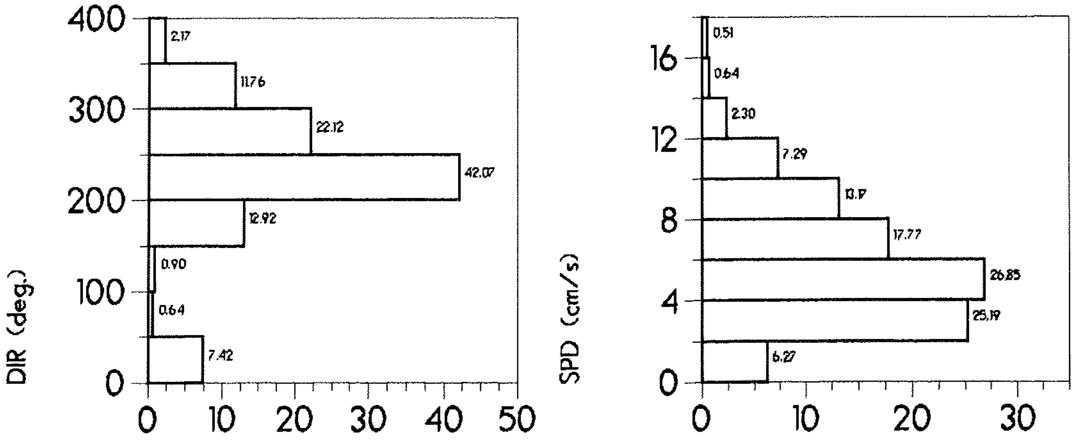
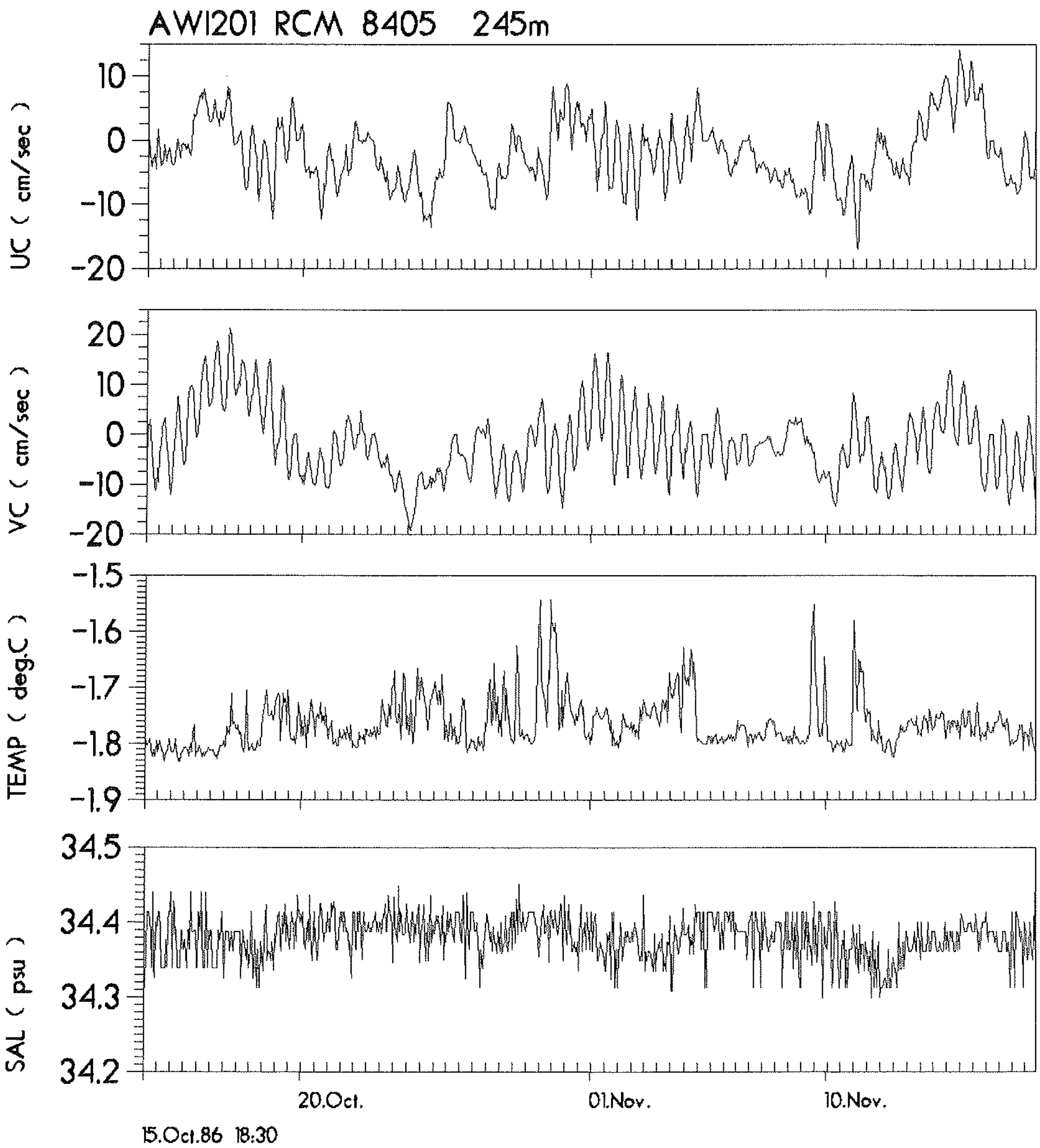
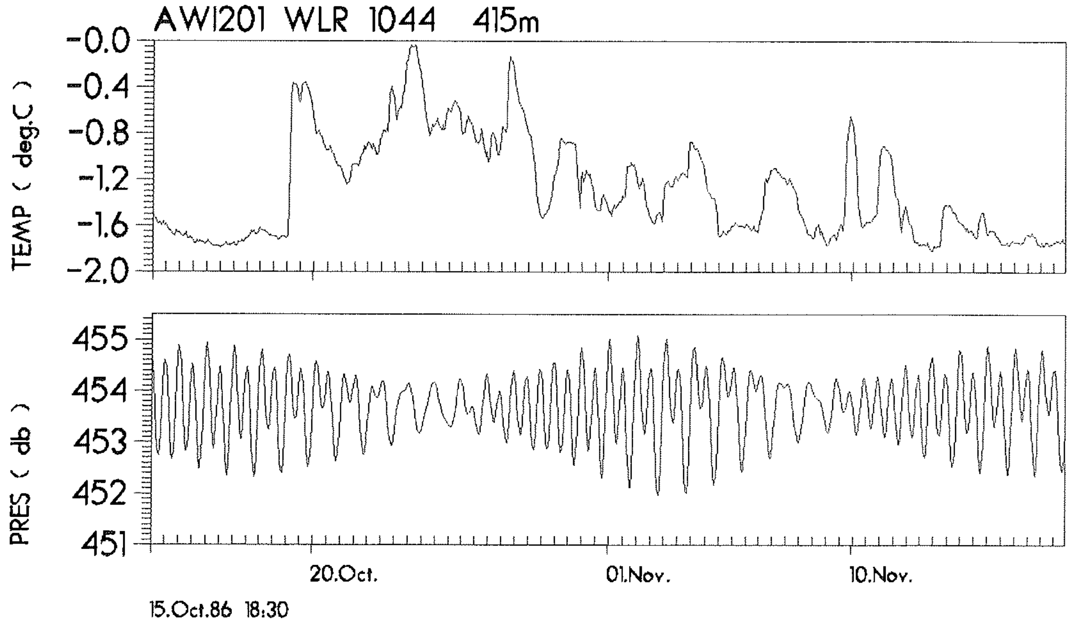
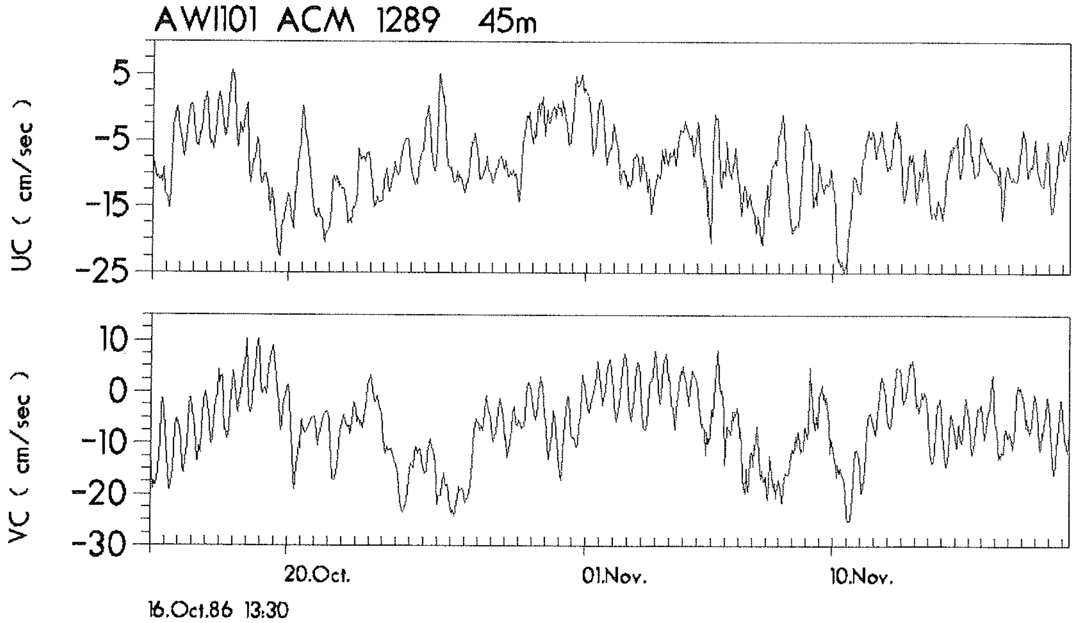
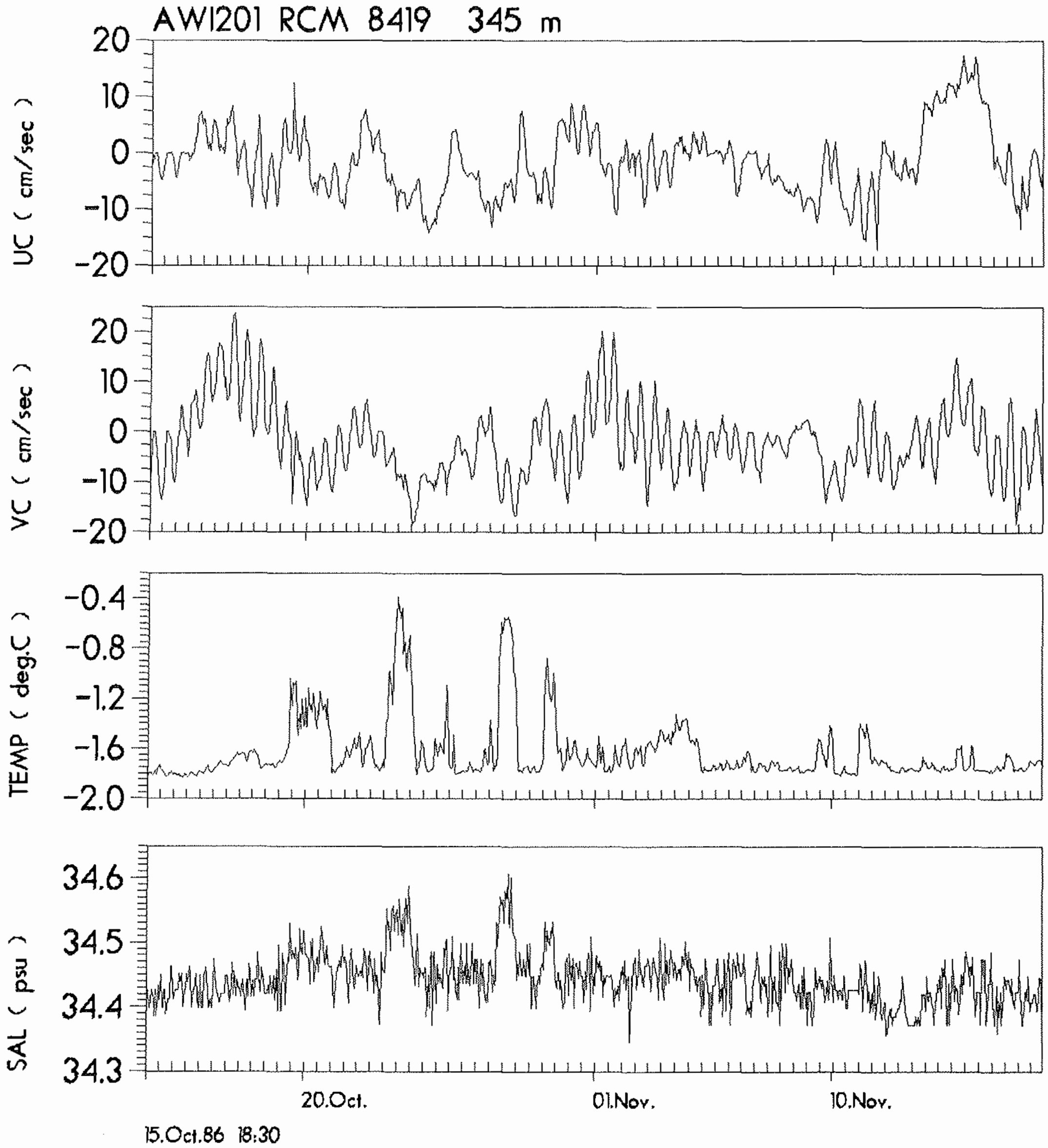


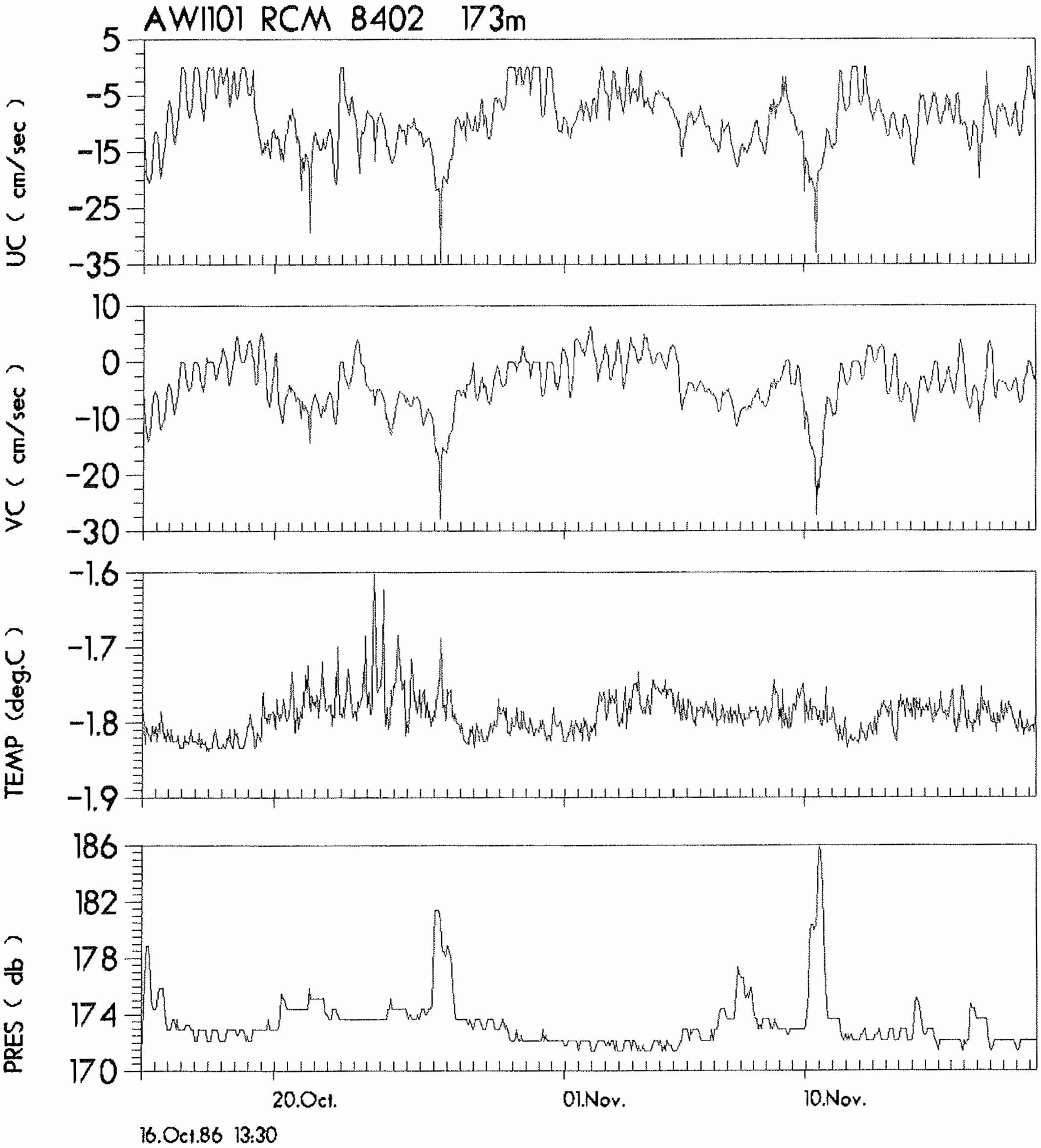
Fig.22:
Time series plots of the moored instruments data.

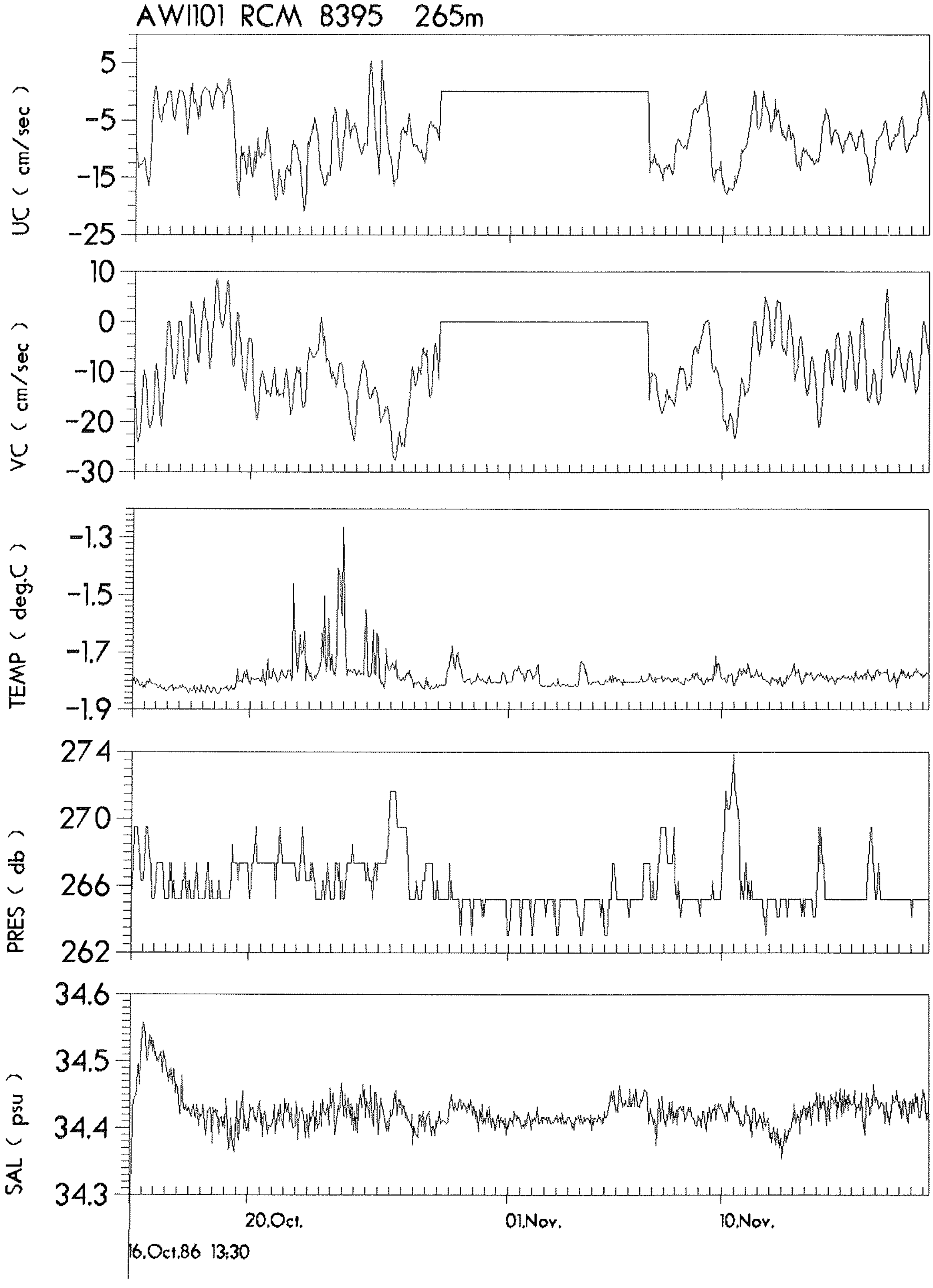

AWI201 RCM 8405 245m
UC (cm/sec)
10
0
-10
-20
VC (cm/sec)
20
10
0
-10
-20
TEMP (deg.C)
-1.5
-1.6
-1.7
-1.8
-1.9
SAL (psu)
34.5
34.4
34.3
34.2
20.Oct.
01.Nov.
10.Nov.
15.Oct.86 18:30

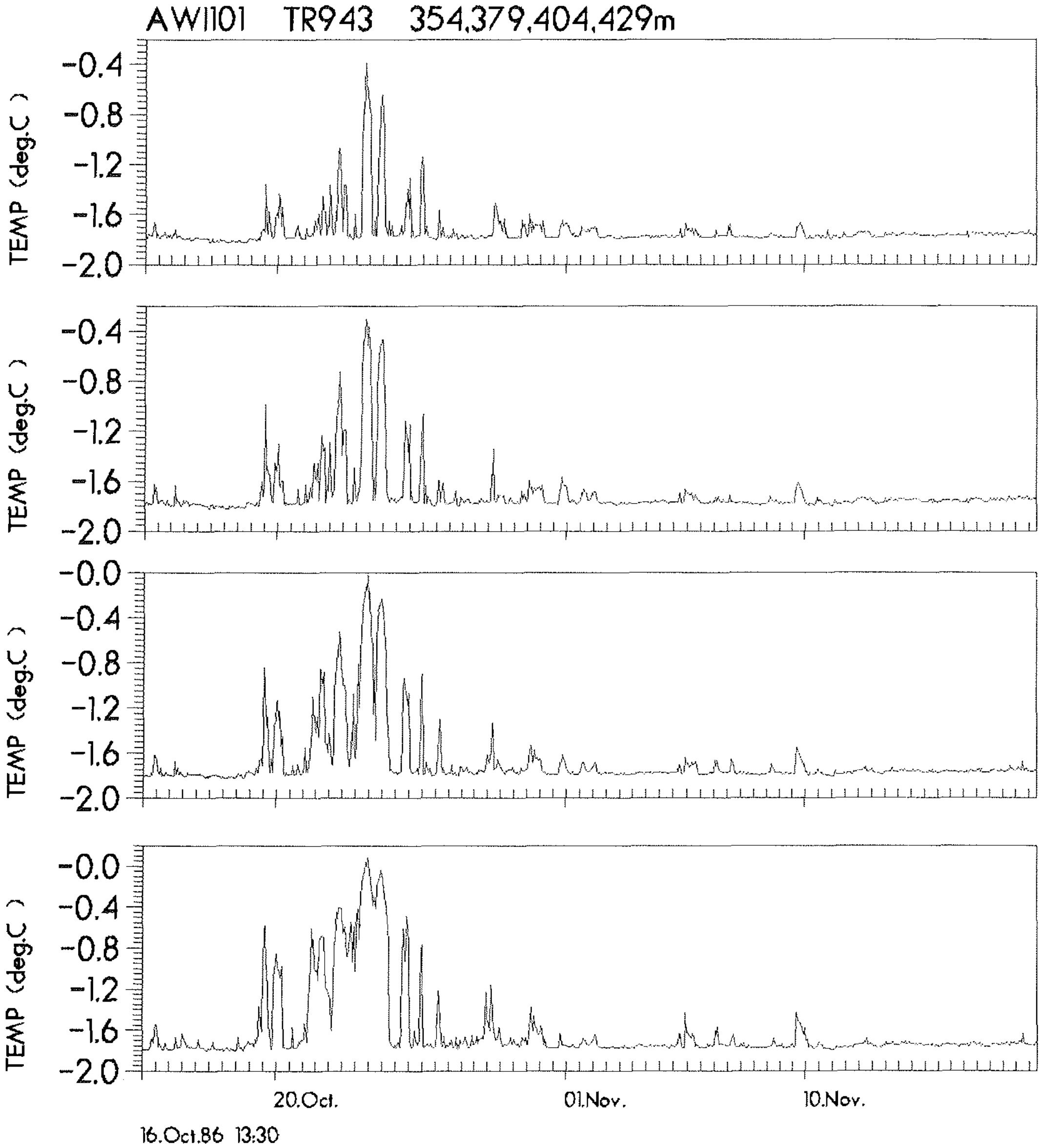

AWI201 WLR 1044 415m
TEMP (deg.C)
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
PRES (db)
455
454
453
452
451
20.Oct.
01.Nov.
10.Nov.
15.Oct.86 18:30

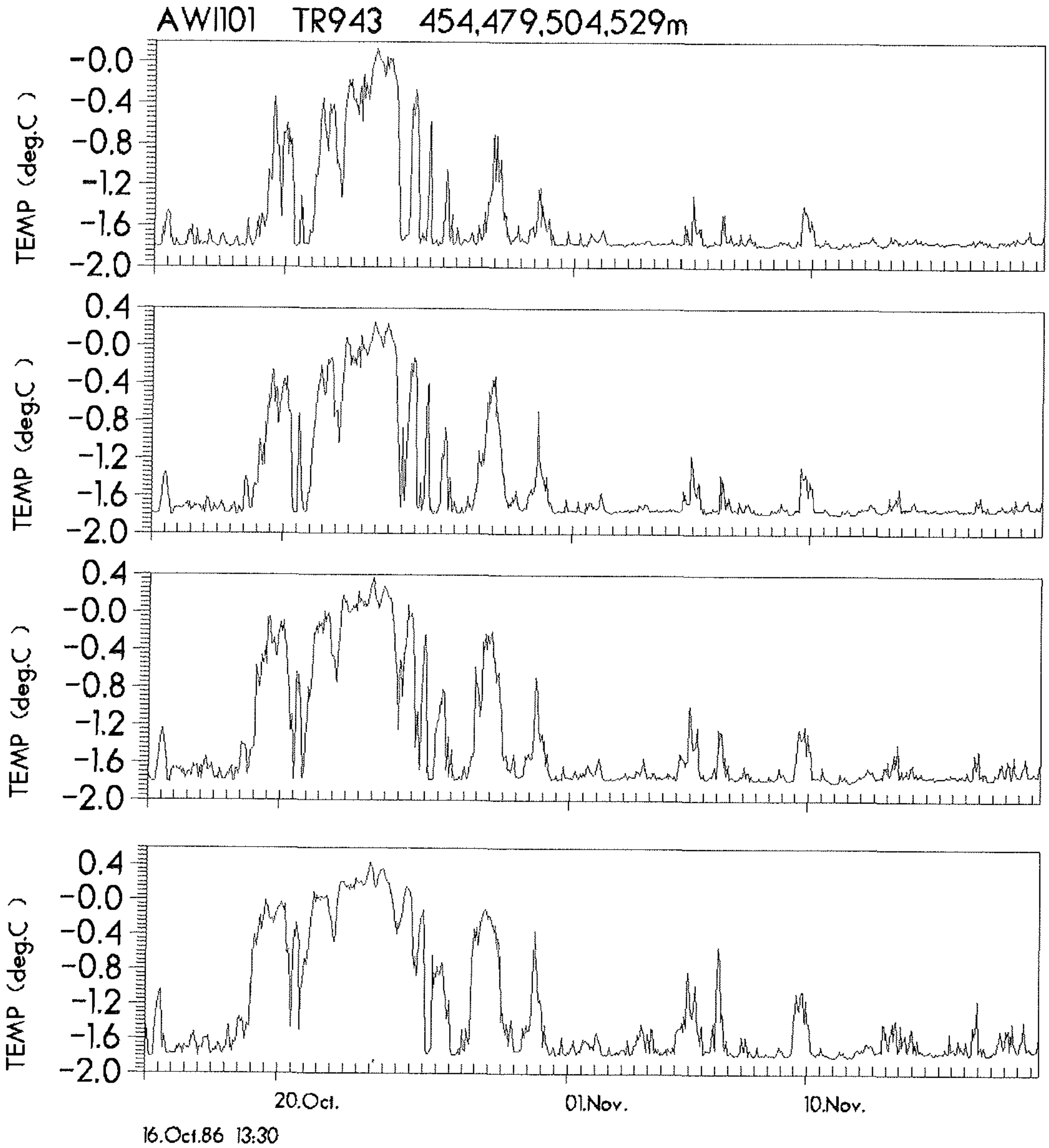

AWI101 ACM 1289 45m
UC (cm/sec)
5
-5
-15
-25
VC (cm/sec)
10
0
-10
-20
-30
20.Oct.
01.Nov.
10.Nov.
16.Oct.86 13:30

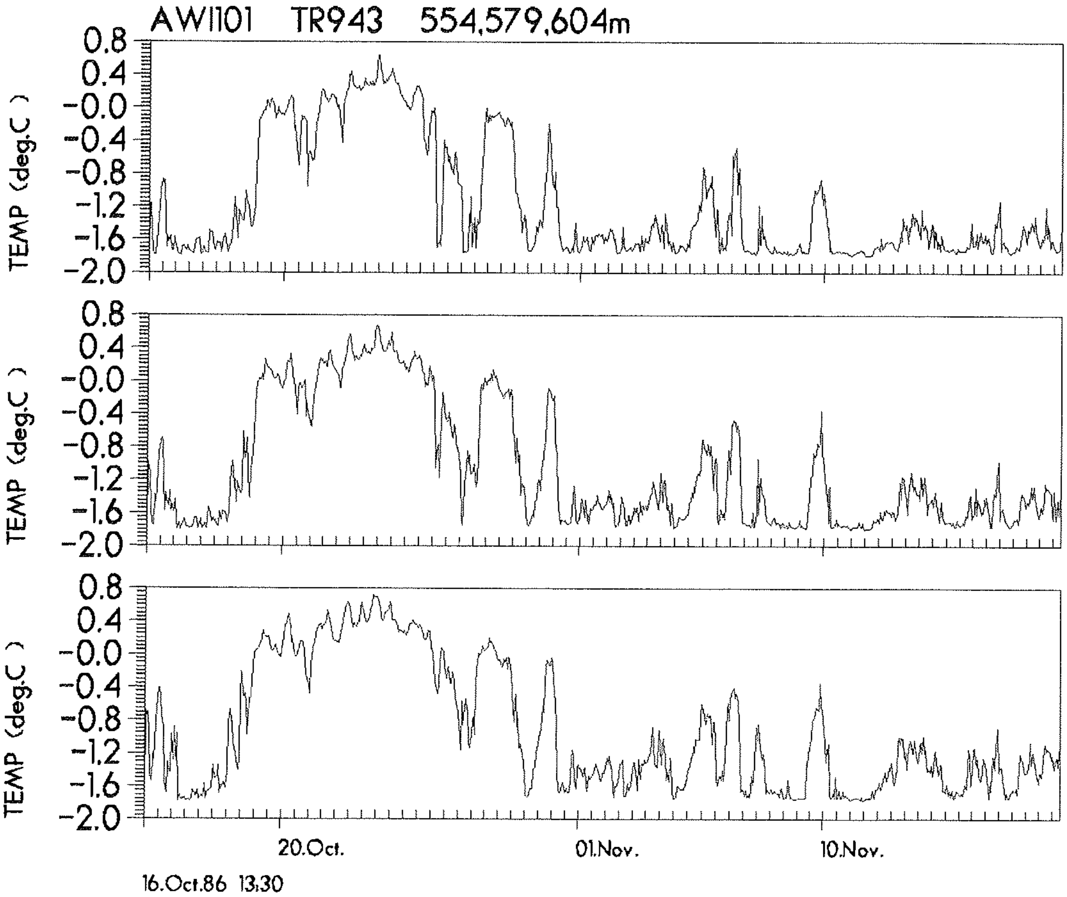

AWI201 RCM 8419 345 m
UC (cm/sec)
20
10
0
-10
-20
VC (cm/sec)
20
10
0
-10
-20
TEMP (deg.C)
-0.4
-0.8
-1.2
-1.6
-2.0
SAL (psu)
34.6
34.5
34.4
34.3
20.Oct.
01.Nov.
10.Nov.
15.Oct.86 18:30


AWI101 RCM 8402 173m
UC (cm/sec)
5
-5
-15
-25
-35
VC (cm/sec)
10
0
-10
-20
-30
TEMP (deg.C)
-1.6
-1.7
-1.8
-1.9
PRES (db)
186
182
178
174
170
20.Oct.
01.Nov.
10.Nov.
16.Oct.86 13:30

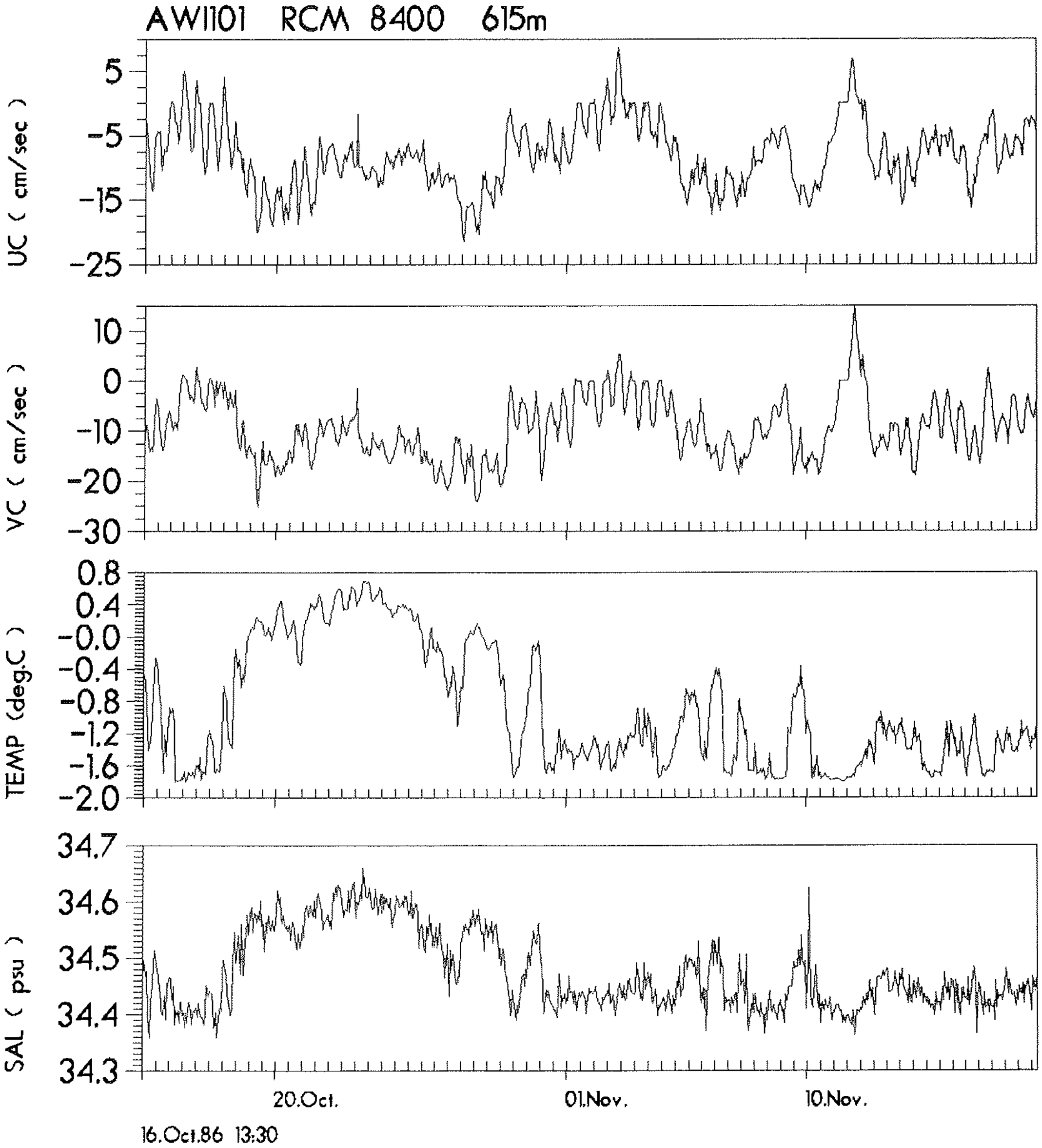

AWI101 RCM 8395 265m
UC (cm/sec)
5
-5
-15
-25
VC (cm/sec)
10
0
-10
-20
-30
TEMP (deg.C)
-1.3
-1.5
-1.7
-1.9
PRES (db)
274
270
266
262
SAL (psu)
34.6
34.5
34.4
34.3
20.Oct.
01.Nov.
10.Nov.
16.Oct.86 13:30

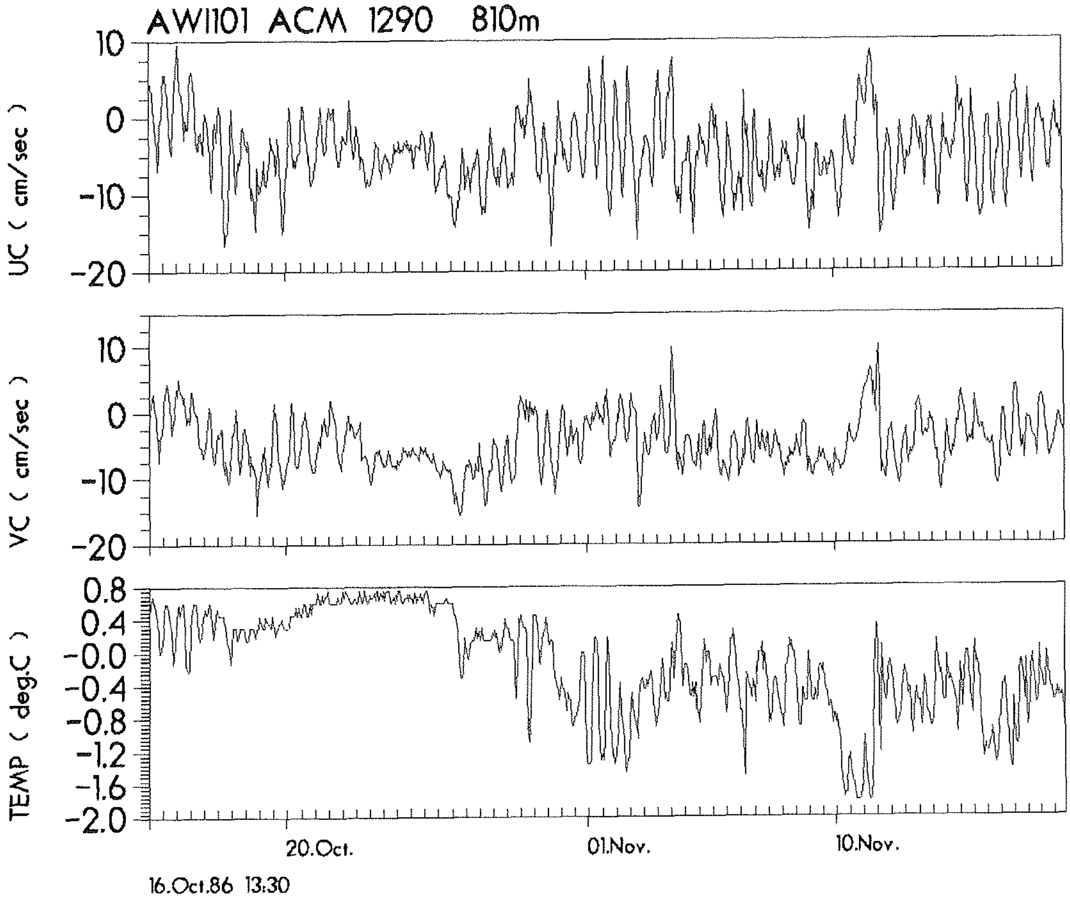

AWI101 TR943 354,379,404,429m
TEMP (deg.C)
-0.4
-0.8
-1.2
-1.6
-2.0
TEMP (deg.C)
-0.4
-0.8
-1.2
-1.6
-2.0
TEMP (deg.C)
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
TEMP (deg.C)
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
20.Oct.
01.Nov.
10.Nov.
16.Oct.86 13:30

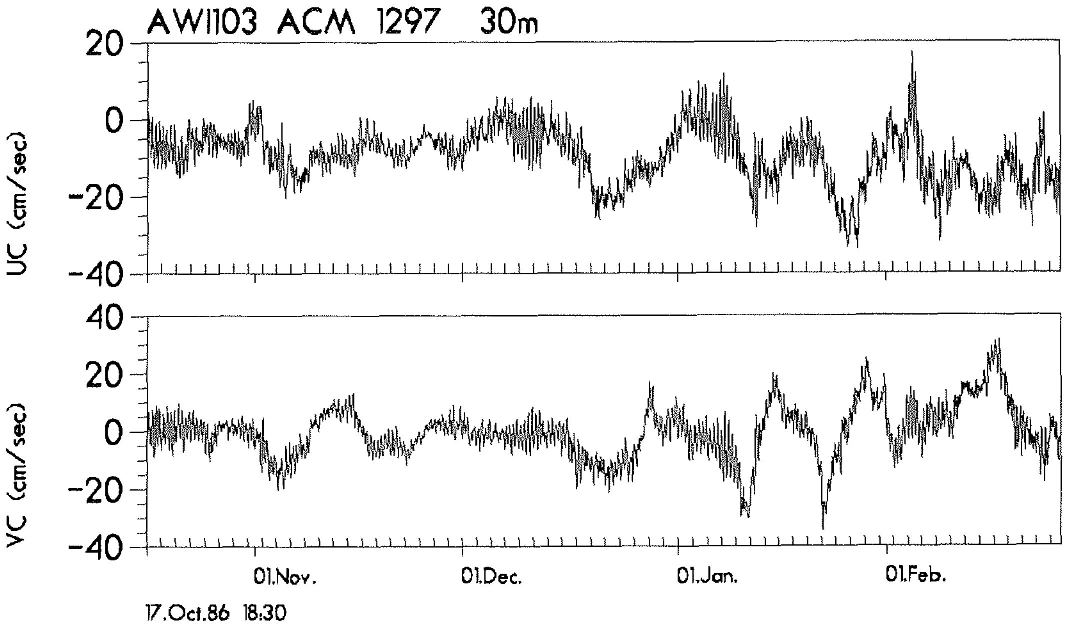

AWI101 TR943 454,479,504,529m
TEMP (deg.C)
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
0.4
20.Oct.
01.Nov.
10.Nov.
16.Oct.86 13:30

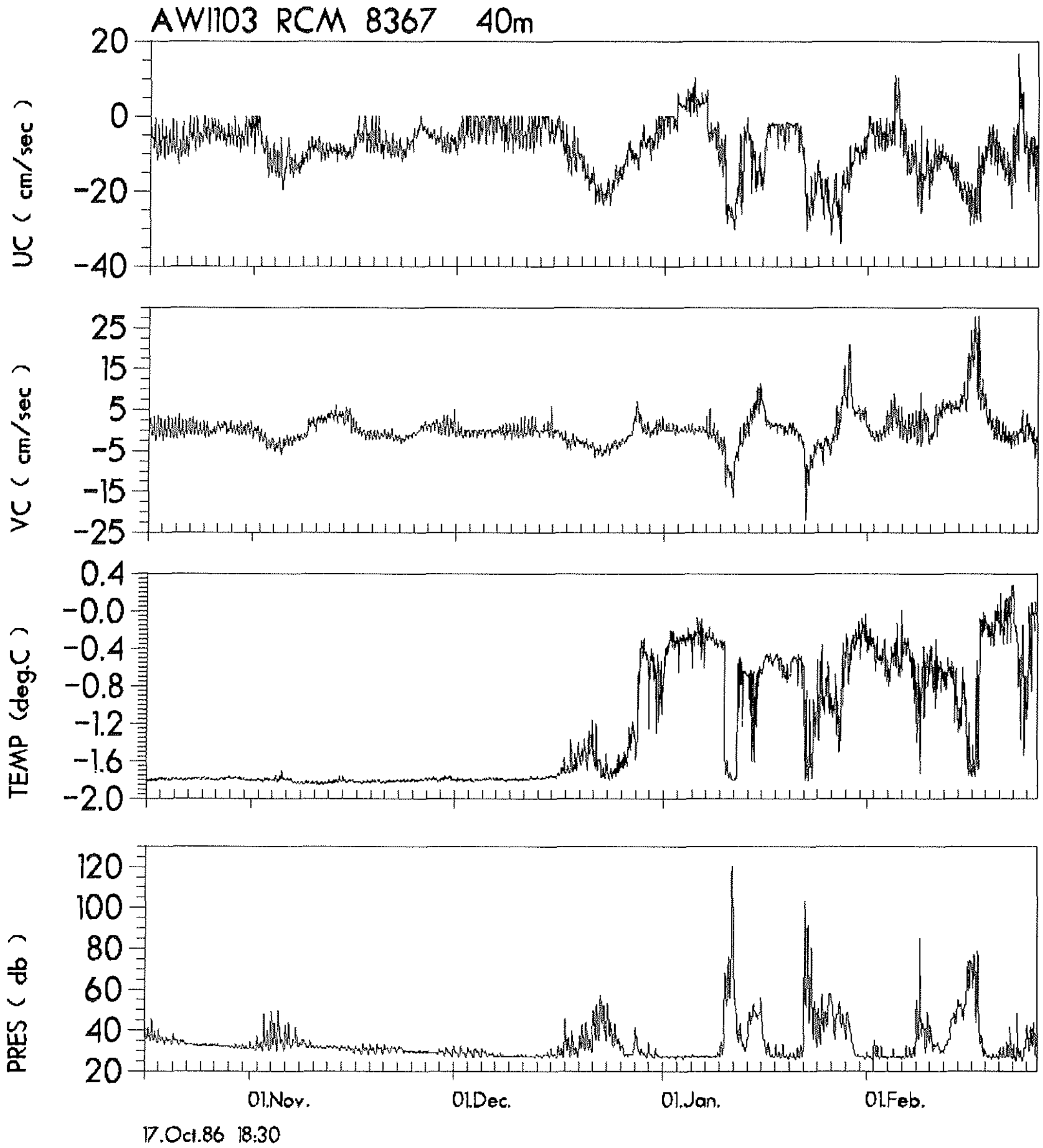


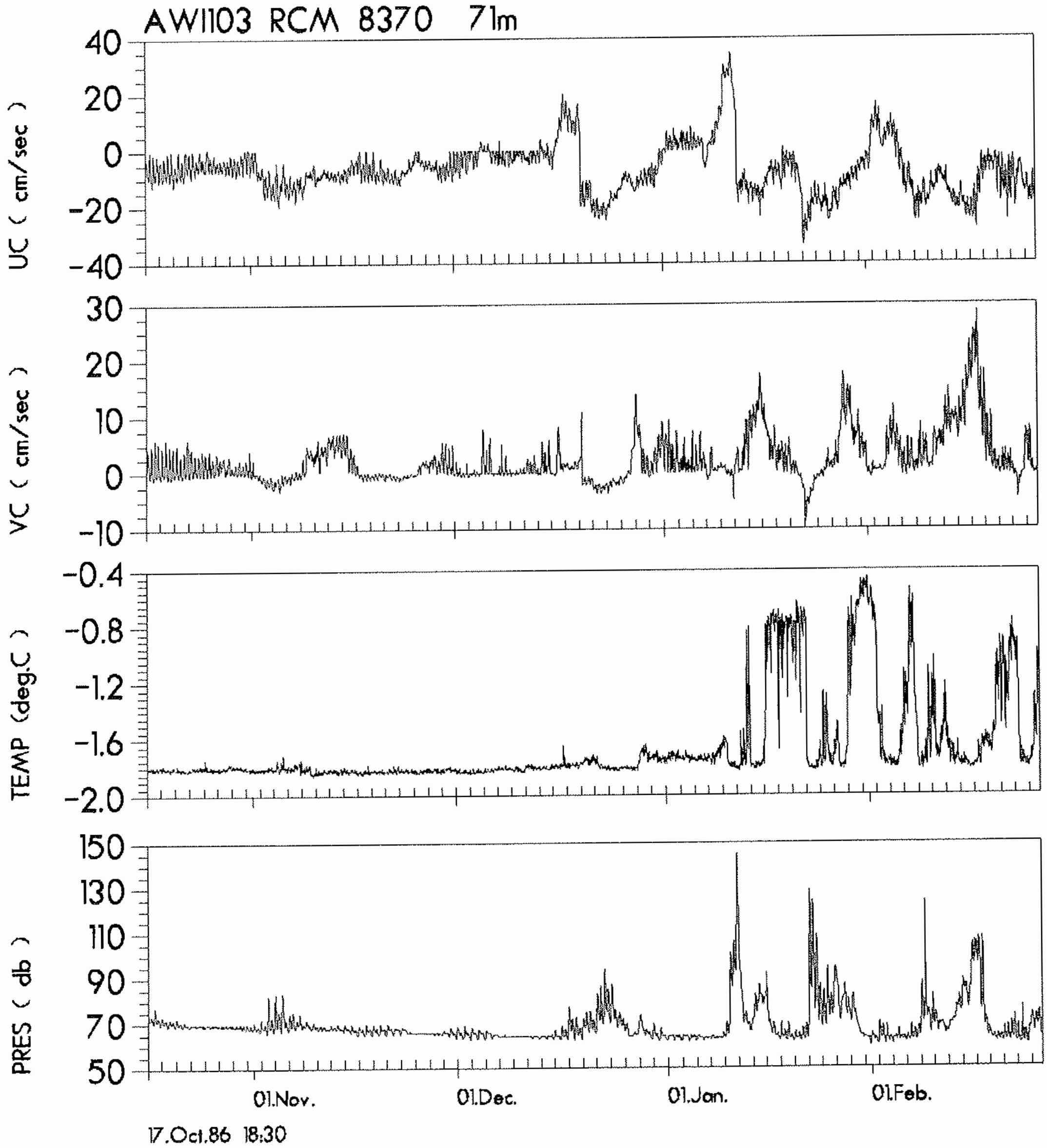
AWI101 TR943 554,579,604m
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
TEMP (deg.C)
20.Oct.
01.Nov.
10.Nov.
16.Oct.86 13:30

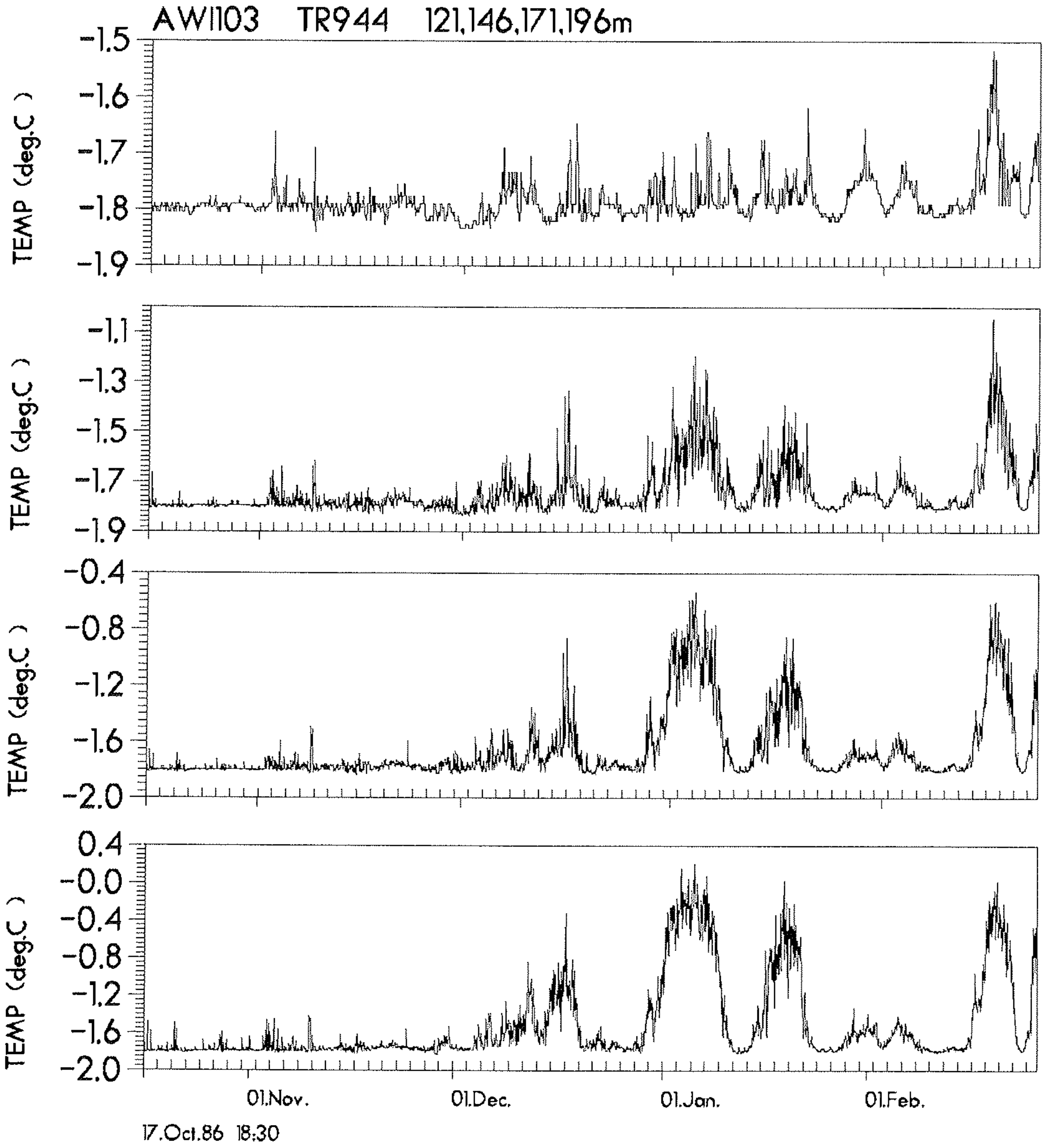

AWI101 RCM 8400 615m
UC (cm/sec)
5
-5
-15
-25
VC (cm/sec)
10
0
-10
-20
-30
TEMP (deg.C)
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
SAL (psu)
34.7
34.6
34.5
34.4
34.3
20.Oct.
01.Nov.
10.Nov.
16.Oct.86 13:30

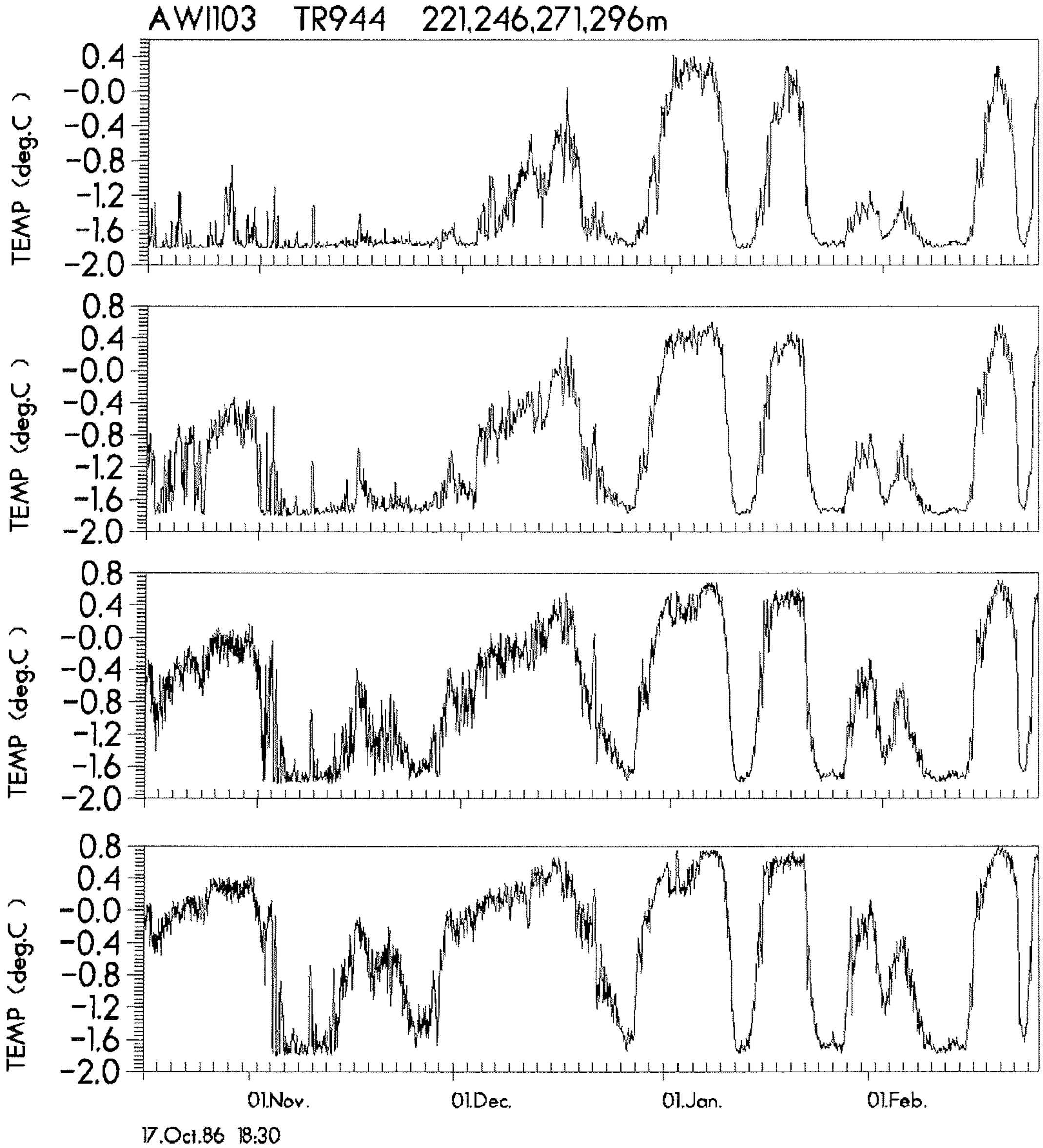

AWI101 ACM 1290 810m
UC (cm/sec)
VC (cm/sec)
TEMP (deg.C)
10
0
-10
-20
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
20.Oct.
01.Nov.
10.Nov.
16.Oct.86 13:30

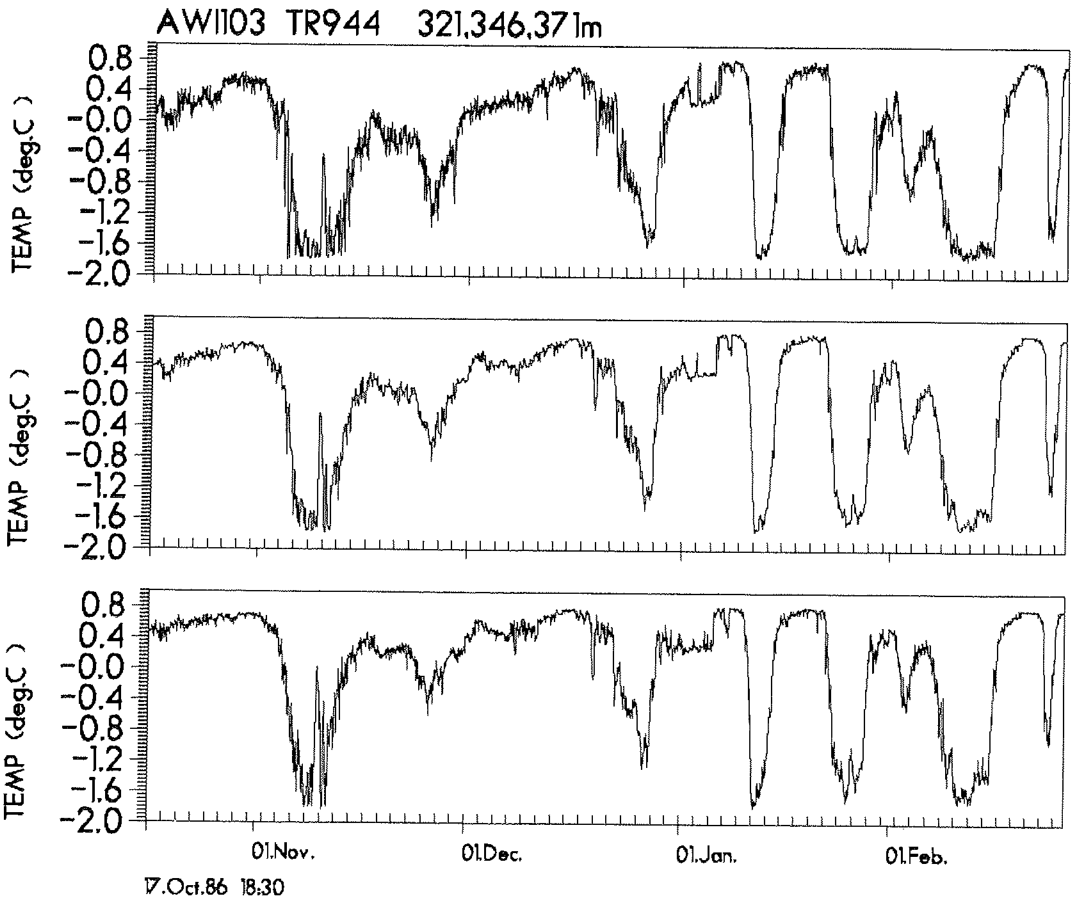

AWI103 ACM 1297 30m
20
0
-20
-40
UC (cm/sec)
40
20
0
-20
-40
VC (cm/sec)
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

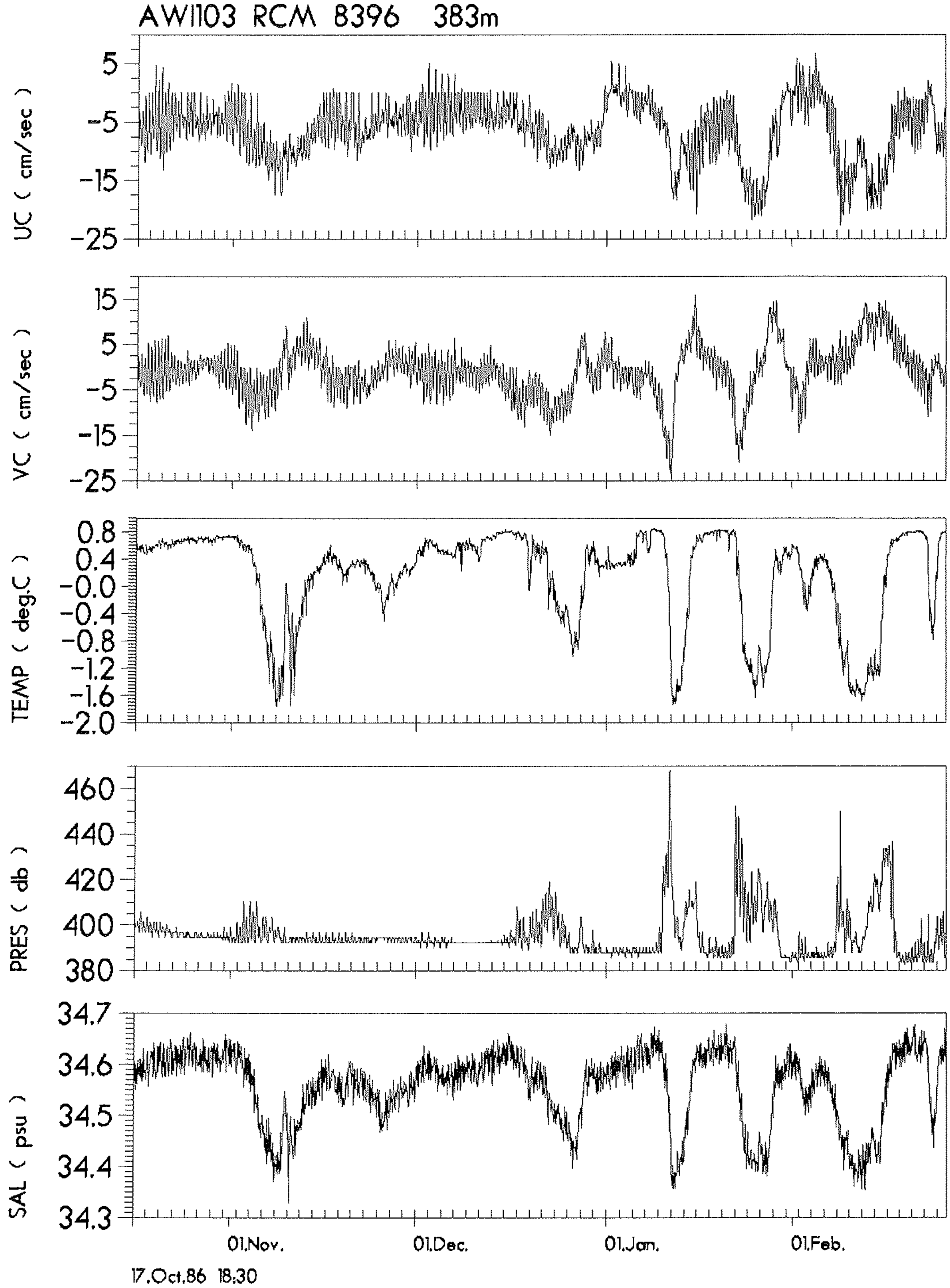

AWI103 RCM 8367 40m
UC (cm/sec)
VC (cm/sec)
TEMP (deg.C)
PRES (db)
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

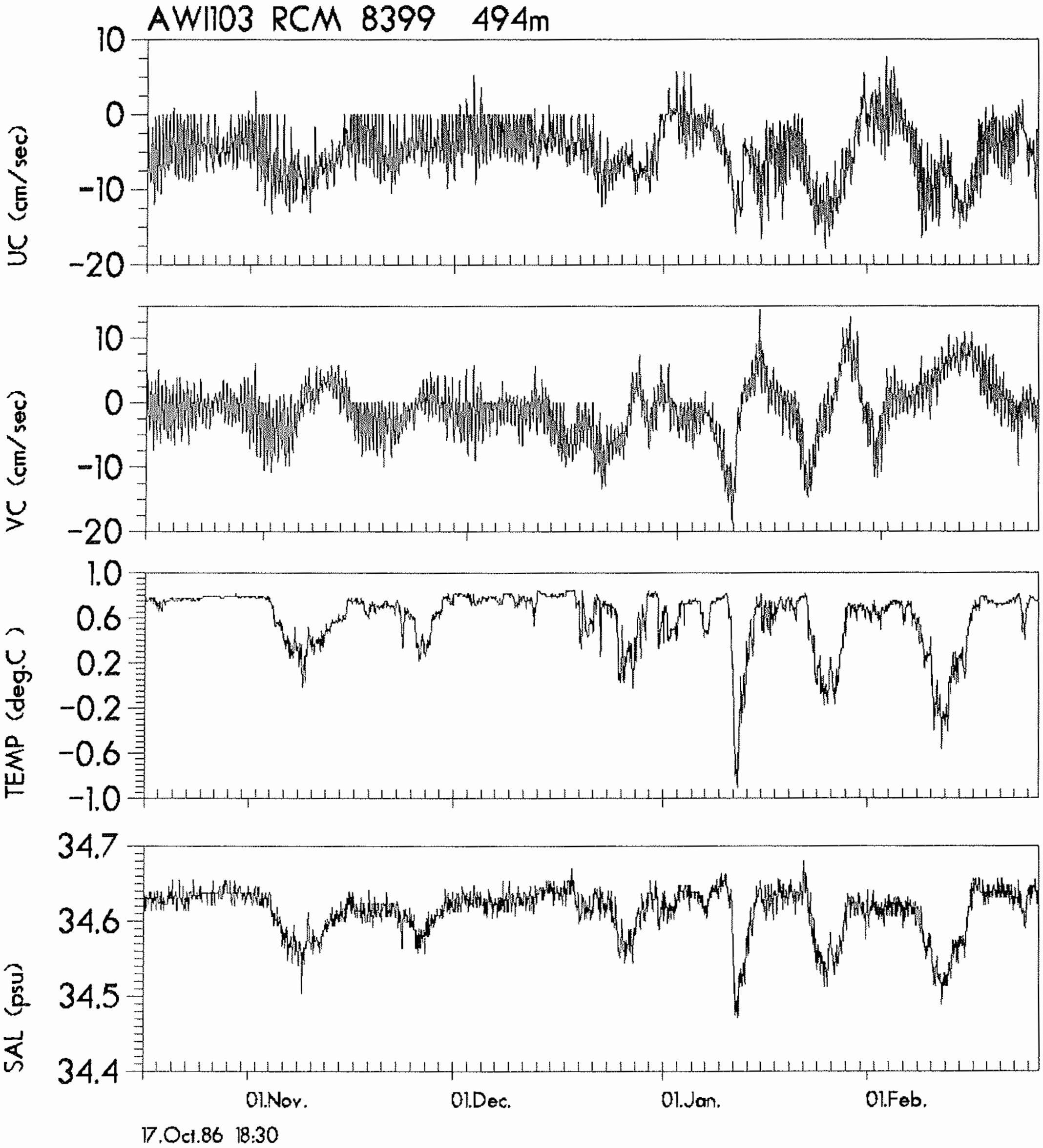

AWI103 RCM 8370 71m
UC (cm/sec)
40
20
0
-20
-40
VC (cm/sec)
30
20
10
0
-10
TEMP (deg.C)
-0.4
-0.8
-1.2
-1.6
-2.0
PRES (db)
150
130
110
90
70
50
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

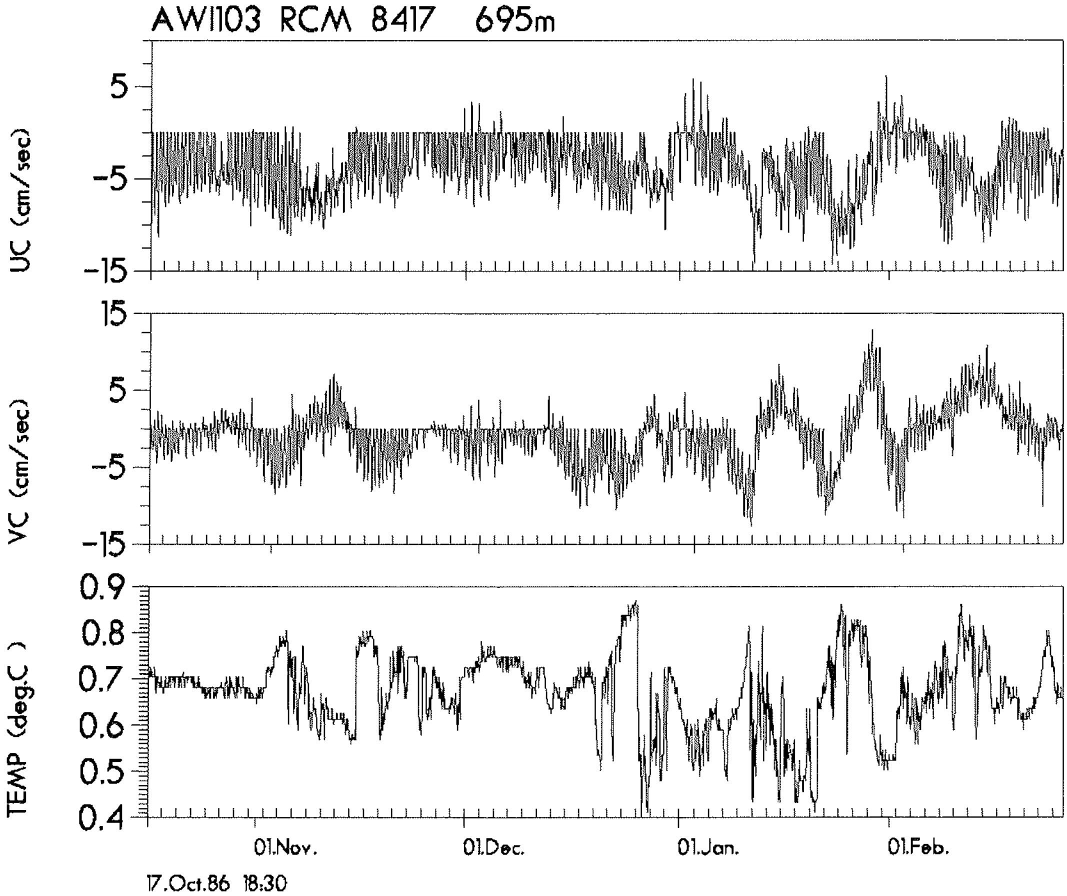

AWI103 TR944 121,146,171,196m
TEMP (deg.C)
-1.5
-1.6
-1.7
-1.8
-1.9
-1.1
-1.3
-1.5
-1.7
-1.9
-0.4
-0.8
-1.2
-1.6
-2.0
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30


AWI103 TR944 221,246,271,296m
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
TEMP (deg.C)
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
TEMP (deg.C)
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
TEMP (deg.C)
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
TEMP (deg.C)
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

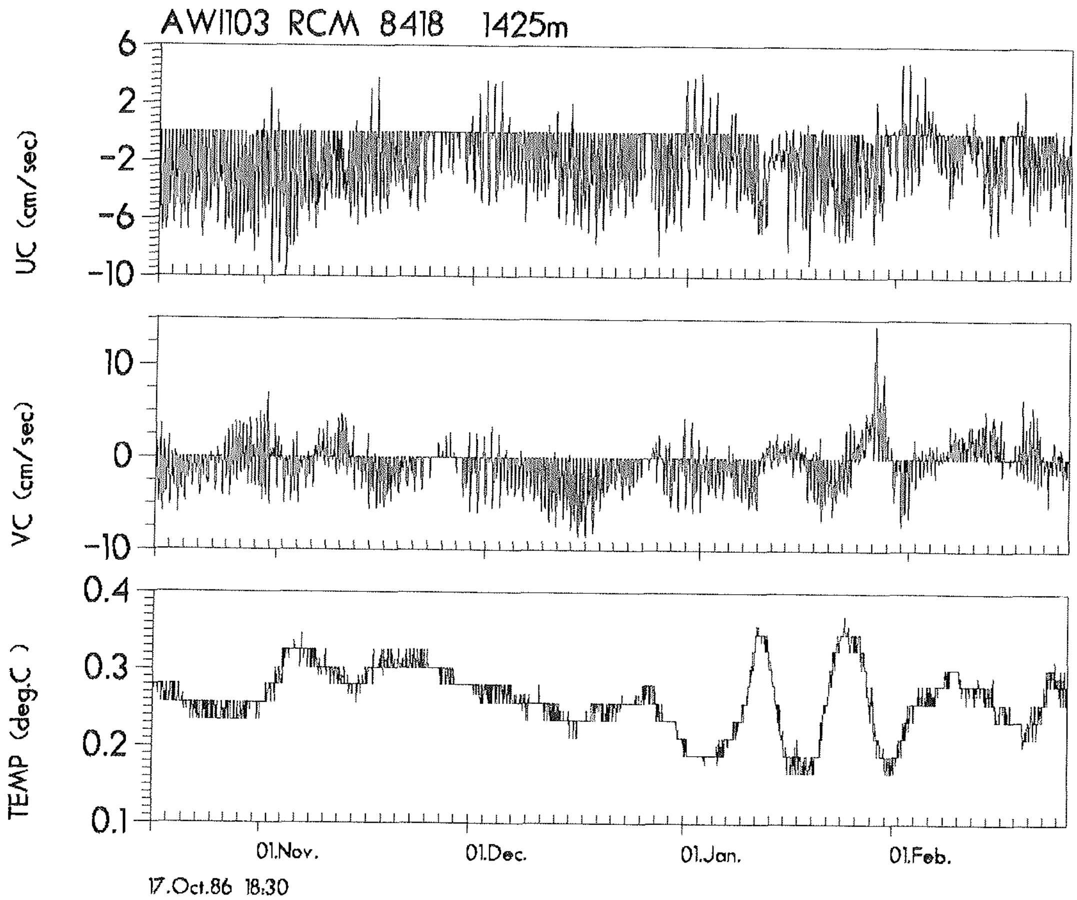

AWI103 TR944 321,346,371m
TEMP (deg.C)
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

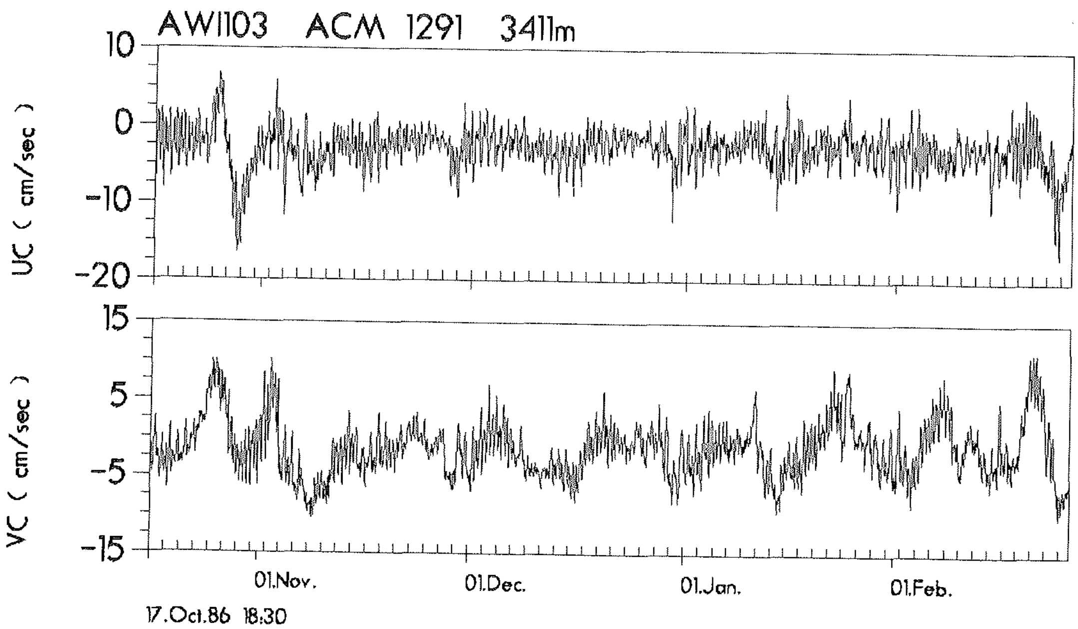

AWI103 RCM 8396 383m
UC (cm/sec)
5
-5
-15
-25
VC (cm/sec)
15
5
-5
-15
-25
TEMP (deg.C)
0.8
0.4
-0.0
-0.4
-0.8
-1.2
-1.6
-2.0
PRES (db)
460
440
420
400
380
SAL (psu)
34.7
34.6
34.5
34.4
34.3
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

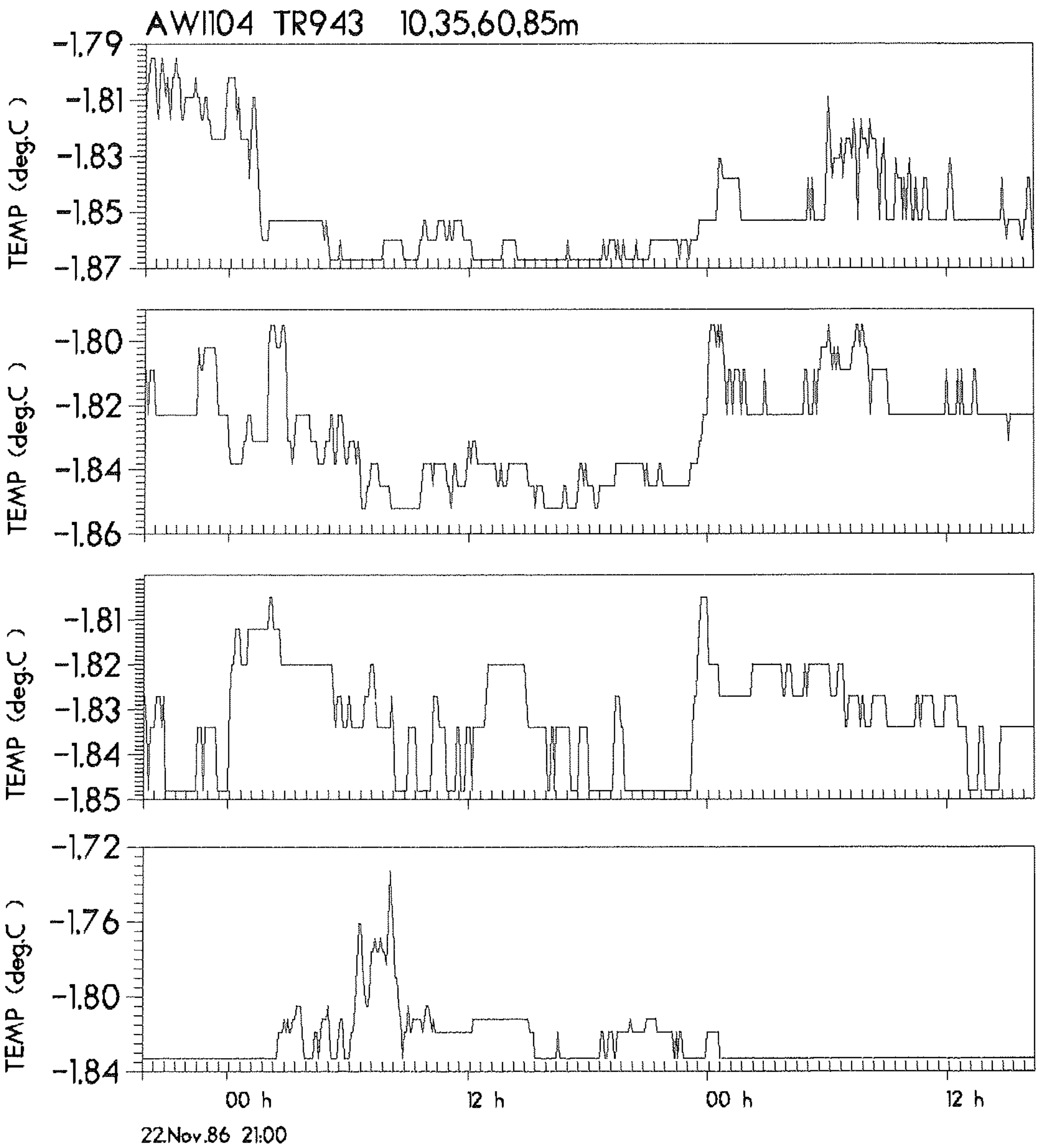

AWI103 RCM 8399 494m
UC (cm/sec)
10
0
-10
-20
VC (cm/sec)
10
0
-10
-20
TEMP (deg.C)
1.0
0.6
0.2
-0.2
-0.6
-1.0
SAL (psu)
34.7
34.6
34.5
34.4
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30



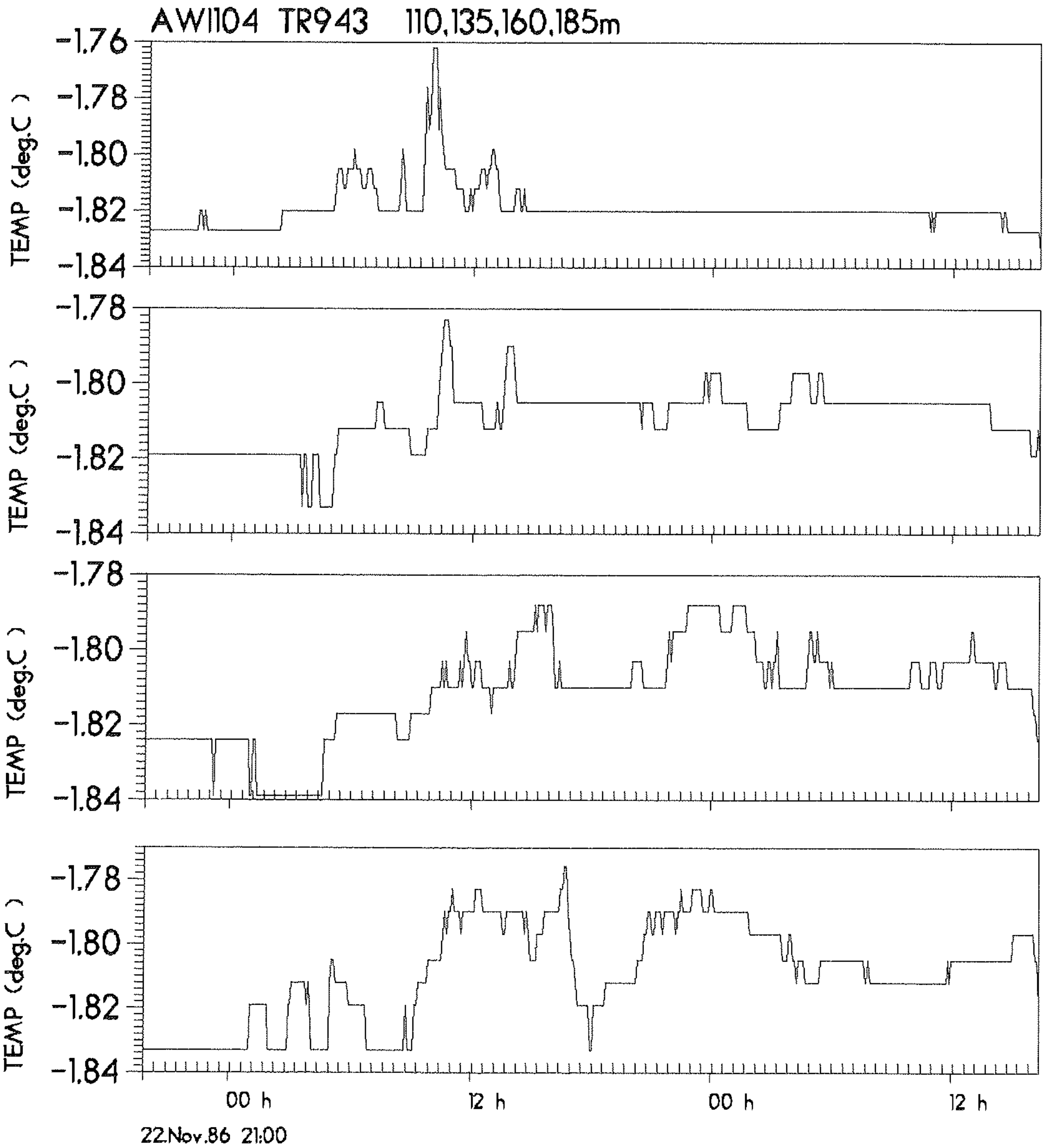
AWI103 RCM 8417 695m
5
-5
-15
UC (cm/sec)
15
5
-5
-15
VC (cm/sec)
0.9
0.8
0.7
0.6
0.5
0.4
TEMP (deg.C)
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

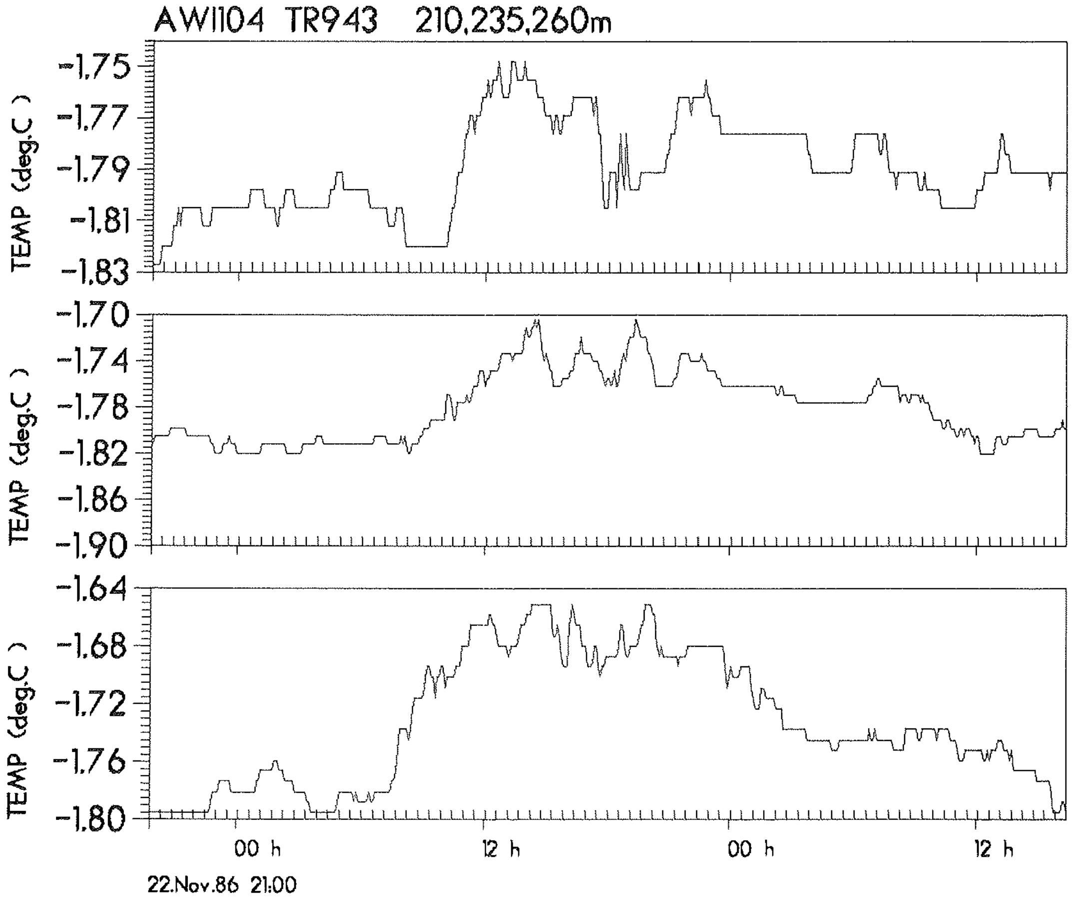

AWI103 RCM 8418 1425m
UC (cm/sec)
6
2
-2
-6
-10
VC (cm/sec)
10
0
-10
TEMP (deg.C)
0.4
0.3
0.2
0.1
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

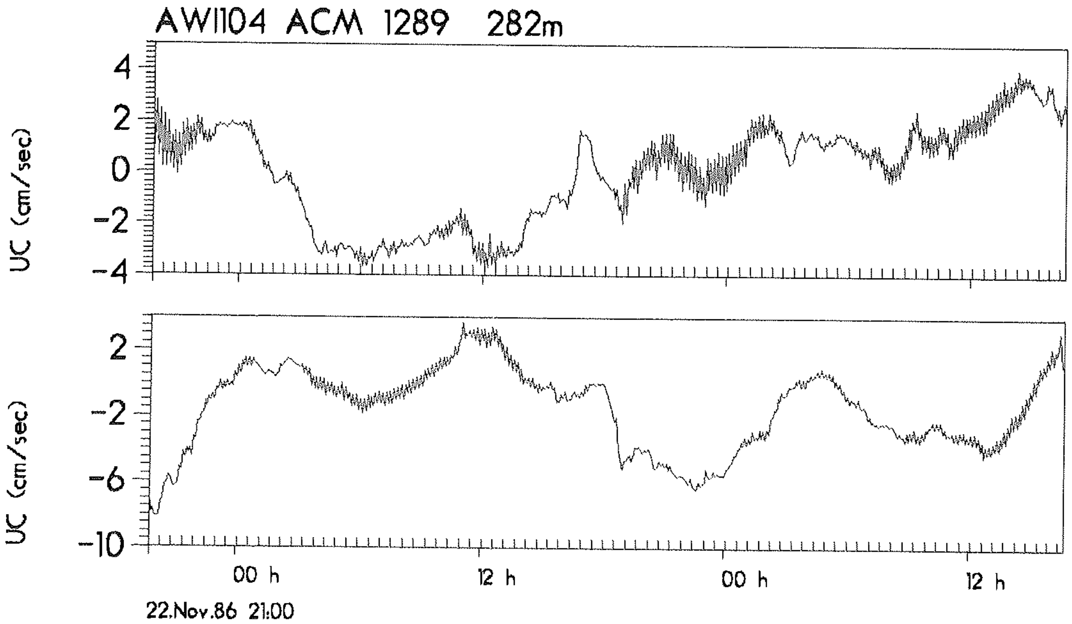

AWI103 ACM 1291 3411m
UC (cm/sec)
10
0
-10
-20
VC (cm/sec)
15
5
-5
-15
01.Nov.
01.Dec.
01.Jan.
01.Feb.
17.Oct.86 18:30

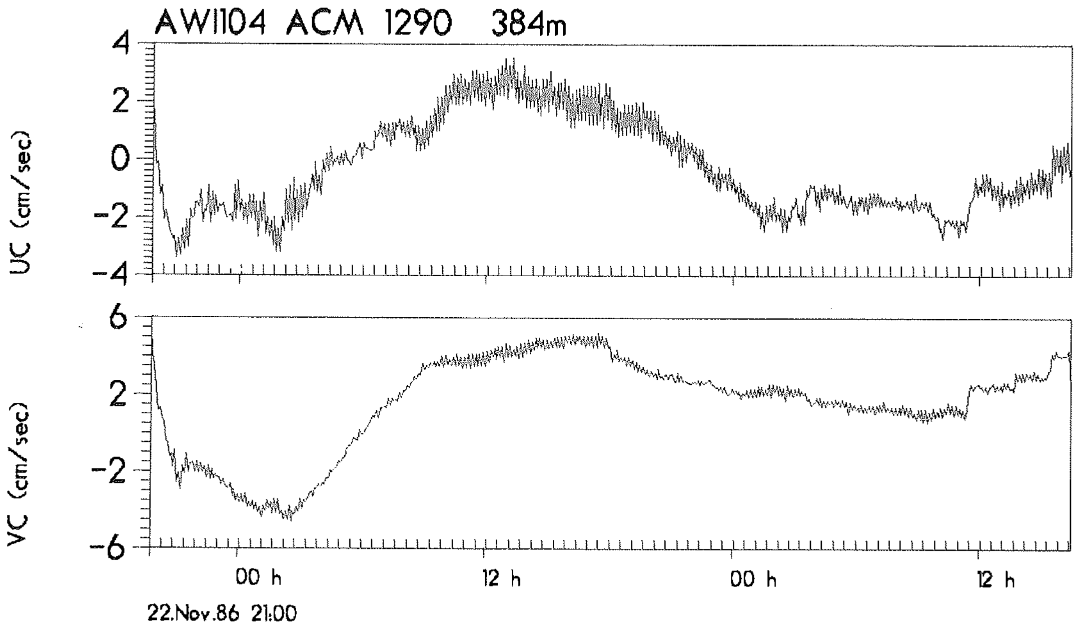


AWI104 TR943 10,35,60,85m
-1.79
-1.81
-1.83
-1.85
-1.87
TEMP (deg.C)
-1.80
-1.82
-1.84
-1.86
TEMP (deg.C)
-1.81
-1.82
-1.83
-1.84
-1.85
TEMP (deg.C)
-1.72
-1.76
-1.80
-1.84
TEMP (deg.C)
00 h
12 h
00 h
12 h
22.Nov.86 21:00


AWI104 TR943 110,135,160,185m
-1.76
-1.78
-1.80
-1.82
-1.84
TEMP (deg.C)
-1.78
-1.80
-1.82
-1.84
TEMP (deg.C)
-1.78
-1.80
-1.82
-1.84
TEMP (deg.C)
-1.78
-1.80
-1.82
-1.84
TEMP (deg.C)
00 h
12 h
00 h
12 h
22.Nov.86 21:00


AWI104 TR943 210,235,260m
TEMP (deg.C)
-1.75
-1.77
-1.79
-1.81
-1.83
TEMP (deg.C)
-1.70
-1.74
-1.78
-1.82
-1.86
-1.90
TEMP (deg.C)
-1.64
-1.68
-1.72
-1.76
-1.80
00 h
12 h
00 h
12 h
22.Nov.86 21:00


AWI104 ACM 1289 282m
UC (cm/sec)
UC (cm/sec)
00 h
12 h
00 h
12 h
22.Nov.86 21:00


AWI104 ACM 1290 384m
UC (cm/sec)
VC (cm/sec)
00 h
12 h
00 h
12 h
22.Nov.86 21:00

Folgende Hefte der Reihe „Berichte zur Polarforschung“ sind bisher erschienen:

Verkaufspreis/