The Meteorological Data of the Georg-von-Neumayer-Station (Antarctica) for 1988, 1989, 1990 and 1991

Gert König-Langlo

Ber. Polarforsch. 116 (1992)
ISSN 0176 - 5027

List of Contents

I. INTRODUCTION

All routine meteorological observations from the Georg-von-Neumayer-Station ("GvN", 70°37'S, 8°22'W) are archived in the **M**eteorological **I**nformation **S**ystem at the **A**lfred-**W**egener-**I**nstitute (**MISAWI**). This information system provides a quick and easy access to all archived data as well as to extensive background information. Data subsets, statistics or derived quantities can be retrieved with a small effort. Thus, AWI is now able to provide such data on request.

This report presents only a short description of the MISAWI and a brief overview on the meteorological conditions during the years 1988 through 1991. It does not cover special data analysis but it offers all nesessary information to any reader wishing to order data for his individual data analysis.

II. MEASUREMENTS, OBSERVATIONS and INSTRUMENTATION

The meteorological observatory was operated by:

1988/89	Heinrich Andreas Strunk and Guido Wolz
1989/90	Rudolf Mair and Karl-Heinz Pfaff
1990/91	Elisabeth Schlosser and Ulrike Wyputta
1991/92	Paul Rainer and Stephan Weber

The measurements and observations can be divided into three groups, namely synoptic observations, upper air soundings and additional measurements.

2.1) Synoptic Observations

Synoptic observations were carried out routinely every 3 hours. They include measurements of air temperature (at 2 m height), air pressure (values are reduced to mean sea level), wind vector (at 10 m height), dew point temperature (at 2 m height), clouds (cloud amount, type and height), horizontal visibility, present and past weather and snowdrift.

The full program was carried out at 0, 9, 12, 15, 18, 21 UTC. During night time at 3 and 6 UTC the visual observations were omitted. The data were coded (FM12-SYNOP) and transferred directly into the Global Telecommunication System (GTS) by a Data Collecting Platform (DCP). In this report all data (2 automatic and 6 full observations per day) are taken into account.

Temperature measurements were carried out with PT-100 platinum resistance sensors with an accuracy of 0.1°C (Thies 2.1265.10). The thermometers were ventilated artificially and protected against radiation effects.

Relative humidity was measured with two pernix hair hygrometers (Lambrecht 800L100) mounted in naturally ventilated radiation shields and by one Assmann psychrometer. The hygrometers were frequently regenerated alternately and checked against the psychometer. In spite of this procedure the uncertainty ranges from 5 to 10% due to the harsh polar environmental conditions.

Surface air pressure was obtained with the aid of two relative instruments (Hartmann&Braun 15241, Digiquartz 215-AW002) and two absolute instruments (Friedrichs normal barometer 2K, Fuess hypsometer). The digiquartz was exposed at a depth of about half a meter below the snow surface to avoid influences due to wind induced pressure fluctuations. Instruments within the station suffered slightly from effects caused by the air conditioning. Thus, mainly the digiquartz was used for the synoptic observations.

For the reduction of the pressure to mean sea level an instrument height of 32m was appliyed untill 6 August 1989 and 36m for the following time periode. Compared with the uncertainties of the instrument height other errors in the pressure measurements can be neglected.

The wind vector was determined by a combined instrument consisting of a cup anemometer and wind vane (Thies 4.3323.11.41).

2.2) Upper Air Soundings

Routinely once a day (before 12:00 UTC) a radiosonde was launched to measure vertical profiles of air pressure, temperature, relative humidity and wind vector. The resulting TEMP message was also transferred to the GTS via a DCP.

Upper air soundings were carried out with VAISALA RS80 radiosondes which directly measure air pressure, air temperature and relative humidity. The wind vector was determined with the aid of the OMEGA navigation system. Data reception and evaluation was carried out by a Micro Cora System (VAISALA, Finland).

2.3) Additional Measurements

The following radiation quantities were measured and stored in form of10 minute averages:

- global (solar) radiation
- reflected solar radiation
- downward and upward (total) radiation
- sunshine duration.

From these quantities other radiation components such as downward and upward long-wave radiation and albedo have been derived.

The radiation measurements were carried out with

- pyranometers (PSP, Eppley Laboratory, U.S.A. and CM11, Kipp&Zonen, Netherlands) for global and reflected solar radiation,
- pyrradiometers (Lange GmbH, F.R.G.) for upward and downward total radiation,
- a photoelectric sunshine recorder (Solar 111, Haenni and Cie., Switzerland).

Together with these data 10 minute averages of the surface air pressure, relative humidity (2m), air temperature (2m and 10m) and wind vector (2m and 10m) were stored as well.

III. DATA PROCESSING and ARCHIVING

3.1) Data Processing

Most of the meteorological instruments were recorded by a data aquisition system (SIC) once a minute. The electric signals were transformed into physical units and stored as averages over 10 minutes on magnetic cassettes and on magnetic tapes.

Every three hours a subset of data was transferred to a small computer (HP85), which processed the data for the synoptic meteorological observations. Together with visual informations the entire weather observation was handcoded according to the FM12-code (Deutscher Wetterdienst 82, WMO 83a, WMO 83b) and typed into the DCP for the GTS-communication. In parallel the data sets were copied on disks for later archiving at AWI.

The data processing of the upper air soundings was carried out almost automatically by the Micro Cora System. For the DCP a compressed data set according to the FM35 TEMP-code was prepared. The full data set consisting of pressure, temperature, humidity and wind vector measurements obtained in 10 second intervals was stored on tape.

3.2) Data Archiving

The 3-hourly weather observations and the upper air soundings are archived in MISAWI in the synoptic database called "ObseDB" and the upper air databases called "RadiosondenDB" respectively. Synoptic data are available since 28 January 1981, upper air data since 21 February 1983.

The "Additional Measurements" (see section 2.3) are not archived in a database, but they are available as files on magnetic tapes only.

3.3) Database Description

In this section the structur of MISAWI is described briefly to offer all nesessary information to any reader wishing to order data for his individual data analysis.

A "database" is a collection of information, whereas a "database information system" is a set of software tools that provides a single environment for storing, retrieving, changing and protecting data. A database system allows continuous access to the different data without being concerned about the structure of the files or how to access any single value within a record. The users only needs to give the identification of a particular piece of information (attributes like date, hour, temperature...) they want to select or work with.

For the "ObseDB" database the following attributes are stored in table "GemDaten":

FM12-Code	Attribute Name
(administration)	Obse_ID#
IIiii	Messort_ID#
Year, MiMi,YY,GG	DatumUhrzeit
h	Wolkenuntergrenze
VV	HorSicht
dd	Windrichtung
ff	Windgeschw
TTT	Temperatur
$T_dT_dT_d$	Taupunkt
PPPP	Luftdruck
a	ArtLuftdruckAenderung
ppp	BetragLuftdruckAenderung
ww	GegenWetter
W_1	VergWetter1
W_2	VergWetter2
C_L	TiefeWolken
C_M	MittlereWolken
C_H	HoheWolken
N	GesamtBedeckung
N_h	BedeckungClCm
(administration)	DatenValidiert

In table "Station" the following special observations are available:

FM12-Code	Attribute Name
(administration)	Obse_ID#
$T_xT_xT_x$	MaxTemperatur
$T_nT_nT_n$	MinTemperatur
S_8	GegenwSchneetreiben
S'_8	VergSchneetreiben
96111	Whiteout

Joins between the two tables can be constructed using the unique index Obse_ID#.

In the "RadiosondenDB" database each sounding is described with attributes such as Aufstieg_ID#, date, time, height of tropopause, precipitable water content, etc. in table "Aufstieg" (sounding). The profile data of each sounding are stored in the table "Messung" (measurement) containing up to 720 tuples with the following attributes:

Value	Attribute Name
(administration)	Aufstieg_ID#
(administration)	ZeilenNr#
pressure	Druck
height	Hoehe
temperature	Temperatur
rel. humidity	RelFeuchte
wind direction	Windrichtung
wind speed	Windgeschw
water vapour cont.	Wasserdampfgehalt

Other evaluative values such as potential temperature, specific humidity etc. are available using virtual tables. The additional table "HDF" contains interpolated values of the mean pressure values and table "FH" of fixed heights. Joins between the tables can be constructed using the unique index Aufstieg_ID#.

While the raw data are loaded into the database system they are subject to quality-control procedures by the database management system. The data are examined and checked under pre-defined conditions and all suspect cases are flagged for manual review, correction (if required) and updating of the data set. There are, for example:

- checks for impossible format codes,
- tolerance tests: many parameters which are reported by code have defined limits, e.g. wind direction, cloud amount, visibility. Other parameters may have implied upper or lower limits. For parameters with no definite limits, such as air temperature and atmospheric pressure, a table is established, according to location and time, of approximate limits beyond which the occurence of a value is unlikely,
- internal consistency tests: some parameters are checked for consistency against associated parameters within each observation.

Finally, a graphic quick-look helps to detect unreliable values. After correction the data are restored into the database and various computations are made:

- evaluation of related parameters,
- evaluation of mean and extreme values,
- interpolations.

All original (corrected) and a part of the derived values are stored in the database. With the aid of the database language SQL (Structured Query Language) it is rather easy to establish relations between the different tables and databases in order to increase the amount of information or export distinct data. These relations may not only be established between the various meteorological databases but also with existing databases of other disciplines.

IV. RESULTS

4.1) Synoptic Observations

Monthly and annual means and extrema for the years 1988, 1989, 1990 and 1991 are listed in Tabs. 1a-2d.

- Tabs. 1a-1d contain monthly and annual mean values and standard deviations based on the 3-hourly synoptic observations. In the previous report on this subject (Helmes, 89) the monthly values were based on daily means and the annual values on monthly means. Thus the standard deviations can not be compared directly.

- At 00 and 12 UTC the maximum and minimum temperature (Max.Temp and Min.Temp) of the last 12 hours are coded in the routine observations. The monthly and annual mean of Max.Temp. and Min.Temp. are included in Tabs. 1a-1d without standard deviations because these values were taken only twice a day.

- It is obvious that wind directions should not be averaged. Thus in Tabs. 1a-1d only the averaged wind speed (absolute values) and the averaged wind components (u>0 = wind from west to east, v>0 = wind from south to north) are listed. If desired, the resultant wind direction (see Helmes, 89) can be calculated from these components.

- Tabs. 2a-2d contain the extreme values with respect to the 3-hourly measurements, which represent averages over 10 minutes. Extremes between the synoptic observations are considered only for the temperature, because Max.Temp and Min.Temp cover periods and not just distinct times.

- Observations of cloud amount are difficult due to the darkness. Especially during the polar night (May through August) only observations with moon or stars visible can be assessed accurately. Therefore, means during this period are unrealistically low and the yearly means based on 3-hourly values may differ from yearly means based on unweighted monthly means.

Month	Temperature (°C)		Max. Temp. (°C)	Min. Temp. (°C)	Relative Humidity (%)		Pressure (hpa)		Wind speed (m/s)		U_Wind (m/s)	V_Wind (m/s)	Cloud amount (n/10)
1	-2,8	1,9	-1,5	-4,5	80	12,6	987,9	5,7	7,6	5,8	-5,4	1,1	8,4
2	-8,2	4,4	-5,1	-12,0	77	12,1	984,1	5,5	7,9	4,6	-4,0	2,3	6,7
3	-8,4	5,6	-6,4	-11,3	86	10,0	985,8	12,6	10,9	6,3	-8,5	1,6	8,0
4	-16,2	7,3	-13,4	-19,1	84	7,8	986,5	7,0	9,6	5,8	-7,4	1,4	7,5
5	-20,3	6,2	-17,4	-24,2	81	8,2	992,4	10,8	9,7	7,4	-7,6	0,7	7,3
6	-15,3	5,9	-13,0	-17,1	86	6,3	992,5	9,1	13,9	7,0	-12,3	2,0	7,8
7	-25,4	7,0	-22,2	-28,0	83	2,9	981,7	10,5	9,1	6,5	-5,9	1,5	7,3
8	-27,0	9,5	-23,8	-30,0	86	7,0	988,0	8,3	10,8	8,7	-8,0	0,1	5,9
9	-25,4	9,4	-21,9	-28,5	80	7,9	994,3	10,5	7,5	4,1	-4,4	2,3	4,1
10	-18,3	4,2	-15,0	-22,1	82	8,2	999,8	6,3	8,4	4,6	-2,4	2,1	5,9
11	-10,1	4,2	-8,1	-12,8	88	9,9	986,9	8,2	8,5	6,3	-5,4	-0,9	8,0
12	-4,6	2,8	-2,5	-7,3	86	2,3	986,7	6,9	8,1	4,9	-5,7	0,1	7,4
year	-15,3	10,1	-12,5	-18,1	83	9,7	988,9	10,0	9,4	6,4	-6,4	1,2	7,0

Tab.1a Monthly means for the year 1988 from synoptic observations. First value = mean, second value = standard deviation with respect to the 3-hourly observations.

Month	Temperature (°C)		Max. Temp. (°C)	Min. Temp. (°C)	Relative Humidity (%)		Pressure (hpa)		Wind speed (m/s)		U_Wind (m/s)	V_Wind (m/s)	Cloud amount (n/10)
1	-3,6	2,7	-1,6	-6,1	87	10,0	989,7	5,1	7,9	4,6	-5,9	1,1	7,5
2	-7,6	4,1	-5,3	-10,0	86	10,1	982,6	6,9	9,8	5,4	-5,5	2,3	7,1
3	-12,4	6,7	-9,7	-15,5	86	8,0	987,9	7,9	10,1	6,3	-6,7	2,6	6,9
4	-14,9	4,4	-12,6	-17,3	89	7,7	988,4	6,9	12,8	5,8	-10,3	2,0	8,9
5	-20,7	6,2	-17,7	23,5	89	4,3	982,6	8,2	9,6	6,3	-5,5	1,1	8,5
6	-21,8	7,3	-19,2	-23,9	87	7,3	985,5	6,8	10,1	5,6	-6,6	0,5	6,9
7	-29,6	7,3	-26,3	-32,6	84	4,2	985,4	9,0	8,1	6,1	-5,3	2,0	7,0
8	-33,4	5,8	-29,4	-37,2	82	3,7	993,3	12,6	6,5	3,8	-2,9	3,4	3,1
9	-24,0	6,5	-20,6	-27,3	83	6,2	993,3	11,8	7,5	5,4	-5,0	1,3	6,1
10	-20,7	6,0	-17,7	-24,6	81	9,2	983,6	11,3	8,2	5,5	-3,8	1,9	5,0
11	-9,7	5,1	-7,2	-12,7	86	10,1	985,3	9,6	9,5	5,1	-7,2	0,7	6,2
12	-5,5	3,7	-2,6	-9,2	85	10,6	990,0	4,3	5,0	2,7	-1,9	1,4	6,2
year	-17,1	10,8	-14,2	-20,0	85	8,3	987,3	9,4	8,7	5,6	-5,5	1,7	6,8

Tab.1b Monthly means for the year 1989 from synoptic observations. First value = mean, second value = standard deviation with respect to the 3-hourly observations.

Month	Temperature (°C)		Max. Temp. (°C)	Min. Temp. (°C)	Relative Humidity (%)		Pressure (hpa)		Wind speed (m/s)		U_Wind (m/s)	V_Wind (m/s)	Cloud amount (n/10)
1	-4,2	2,9	-1,7	-7,2	88	9,3	991,1	6,9	5,3	3,1	-1,2	1,2	5,6
2	-9,2	5,0	-5,7	-12,7	86	8,6	985,4	5,6	5,9	3,2	-2,9	2,1	6,5
3	-11,9	6,6	-9,5	-14,8	87	8,7	985,4	7,6	9,3	4,5	-7,1	0,3	7,0
4	-17,5	6,9	-14,8	-20,3	87	7,9	993,7	11,6	12,1	7,3	-8,7	0,6	5,3
5	-19,5	8,3	-16,6	-21,2	87	7,4	997,3	9,3	8,7	5,3	-6,5	0,9	6,4
6	-25,6	7,7	-22,7	-29,3	85	6,7	997,4	7,4	9,5	5,9	-6,8	0,5	4,0
7	-20,2	6,6	-17,4	-23,2	88	6,7	991,2	9,5	9,7	5,8	-5,6	1,9	5,8
8	-26,8	7,0	-23,8	-30,0	88	4,5	988,2	6,0	9,7	7,0	-7,3	-0,2	5,6
9	-27,0	6,2	-24,0	-29,8	84	7,1	982,5	6,0	10,3	7,1	-5,7	1,3	4,3
10	-14,0	5,3	-11,9	-16,3	87	9,0	982,5	8,2	12,4	8,2	-10,2	-0,8	6,8
11	-8,7	5,6	-8,2	-13,7	86	11,4	986,1	8,1	10,7	6,7	-8,6	-2,0	7,8
12	-3,8	2,4	-2,1	-5,7	88	9,5	990,7	9,3	6,6	4,3	-2,8	-0,4	8,4
year	-15,7	10,1	-13,2	-18,7	87	8,3	989,3	9,5	9,2	6,3	-6,1	0,4	6.5

Tab.1c Monthly means for the year 1990 from synoptic observations. First value = mean, second value = standard deviation with respect to the 3-hourly observations.

Month	Temperature (°C)		Max. Temp. (°C)	Min. Temp. (°C)	Relative Humidity (%)		Pressure (hpa)		Wind speed (m/s)		U_Wind (m/s)	V_Wind (m/s)	Cloud amount (n/10)
1	-4,2	2,7	-2,5	-6,2	86	10,0	985,6	5,4	6,1	3,4	-1,4	1,0	7,5
2	-7,0	5,1	-4,2	-10,0	84	8,3	989,5	7,6	8,3	5,5	-6,1	1,1	6,8
3	-15,1	6,9	-11,4	-18,3	81	7,2	984,2	8,1	7,7	5,3	-4,3	2,6	5,8
4	-19,1	7,7	-16,1	-21,9	83	7,4	992,2	6,0	8,5	5,5	-4,9	1,9	6,6
5	-20,1	8,3	-17,1	-23,0	84	6,7	985,7	10,5	9,4	6,1	-7,4	0,7	6,0
6	-17,7	7,0	-15,6	-20,2	88	5,5	987,7	9,8	12,3	6,8	-10,8	-0,9	6,4
7	-23,6	9,5	-20,5	-26,5	84	6,7	987,8	12,4	9,8	6,2	-7,2	1,1	4,5
8	-23,7	6,3	-21,2	-26,3	84	6,1	983,6	8,8	12,0	7,8	-8,8	1,0	7,0
9	-23,6	8,0	-20,3	-26,9	83	6,3	992,5	7,9	7,8	4,6	-3,0	1,7	6,8
10	-17,9	4,1	-15,7	-20,8	83	8,4	983,4	11,7	9,4	5,8	-6,7	1,9	6,8
11	-10,4	4,9	-9,2	-12,9	84	10,6	986,2	8,3	10,4	5,8	-9,5	1,1	6,6
12	-3,0	2,9	-0,8	-5,7	83	10,2	995,6	4,8	6,5	4,1	-5,2	1,2	6,8
year	-15,5	9,7	-12,9	-18,2	84	8,1	987,8	9,5	9,0	6,0	-6,3	1,2	6,5

Tab.1d Monthly means for the year 1991 from synoptic observations. First value = mean, second value = standard deviation with respect to the 3-hourly observations.

Month	Max. Temp. (°C) Maximum		Min. Temp. (°C) Minimum		Pressure (hpa) Maximum		Pressure (hpa) Minimum		Maximum Windspeed (m/s) Speed	(deg) Dir.	
1	0,5	3.1	-13,5	29.1	997,5	18.1	974,8	12.1	28,3	100	21.1
2	2,0	22.2	-21,8	14.2	991,3	22.2	965,8	24.2	27,8	90	24.2
3	0,0	17.3	-23,9	26.3	1011,2	28.3	959,2	12.3	28,3	90	12.3
4	-2,0	15.4	-36,4	20.4	1001,6	22.4	969,1	25.4	27,8	80	24.4
5	-8,3	19.5	-40,9	28.5	1012,0	19.5	965,5	10.5	26,8	90	12.5
6	-3,2	9.6	-33,2	25.6	1007,1	23.6	962,9	8.6	35,5	100	9.6
7	-11,7	24.7	-42,8	30.7	1002,5	31.7	958,5	10.7	30,4	90	10.7
8	-7,5	24.8	-44,9	6.8	1006,4	26.8	967,7	17.8	36,5	70	17.8
9	-7,8	21.9	-42,5	10.9	1012,4	30.9	970,6	20.9	20,6	70	19.9
10	-6,8	16.10	-30,4	12.10	1011,8	1.10	983,7	5.10	27,3	80	14.10
11	-2,7	27.11	-24,7	12.11	1000,6	2.11	961,7	21.11	24,7	80	21.11
12	-0,1	28.12	-18,5	1.12	999,2	18.12	968,5	19.12	23,2	90	22.12
year	2,0	22.2	-44,9	6.8	1012,4	30.9	958,5	10.7	36,5	70	17.8

Tab.2a Monthly extremes for the year 1988 from synoptic observations. First value = extreme, second value = date. Maximum windspeed is shown with the associated wind direction.

Month	Max. Temp. (°C) Maximum		Min. Temp. (°C) Minimum		Pressure (hpa) Maximum		Pressure (hpa) Minimum		Maximum Windspeed (m/s) Speed	(deg) Dir.	
1	2,1	12.1	-14,9	11.1	1000,6	18.1	976,8	5.1	21,6	90	5.1
2	-1,3	6.2	-20,7	23.2	997,0	7.2	960,1	16.2	28,8	100	16.2
3	0,7	14.3	-32,9	28.3	1003,5	29.3	970,1	3.3	27,8	100	12.3
4	-3,1	19.4	-29,5	21.4	1000,7	9.4	970,8	22.4	25,7	100	8.4
5	-3,4	11.5	-38,8	23.5	997,7	2.5	961,8	19.5	30,9	100	1.5
6	-6,4	7.6	-41,3	18.6	1001,1	5.6	961,4	28.6	25,7	90	8.6
7	-11,1	9.7	-44,8	26.7	1000,4	18.7	966,5	8.7	25,7	90	5.7
8	-18,9	26.8	-46,1	4.8	1029,2	29.8	971,6	16.8	19,6	100	19.8
9	-12,8	16.9	-41,0	12.9	1020,9	1.9	969,5	30.9	27,8	90	21.9
10	-5,0	27.10	-39,6	3.10	1001,9	13.10	950,6	28.10	22,1	80	7.10
11	1,5	29.11	-25,3	11.11	1002,3	13.11	958,4	1.11	25,7	90	1.11
12	2,2	31.12	-19,4	3.12	999,5	23.12	981,1	28.12	13,9	90	22.12
year	2,2	31.12	-46,1	4.8	1029,2	29.8	950,6	28.10	30,9	100	1.5

Tab.2b Monthly extremes for the year 1989 from synoptic observations. First value = extreme, second value = date. Maximum windspeed is shown with the associated wind direction.

Month	Max.Temp. (°C) Maximum		Min. Temp. (°C) Minimum		Pressure (hpa) Maximum		Pressure (hpa) Minimum		Maximum Windspeed (m/s) Speed	(deg) Dir.	
1	2,9	3.1	-15,1	23.1	1007,1	18.1	972,9	3.1	18,0	240	3.1
2	-0,4	1.2	-22,4	24.2	1000,2	19.2	973,6	7.2	18,0	90	21.2
3	-1,1	12.3	-33,0	29.3	998,0	22.3	968,0	27.3	25,7	100	14.3
4	-3,0	25.4	-33,7	5.4	1020,6	29.4	968,9	20.4	30,9	80	23.4
5	-6,7	5.5	-38,8	27.5	1014,6	6.5	981,4	14.5	34,0	100	28.5
6	-10,5	8.6	-40,5	10.6	1014,9	16.6	978,9	4.6	25,2	70	21.6
7	-8,7	18.7	-36,0	6.7	1011,4	15.7	960,6	31.7	27,3	80	22.7
8	-13,5	22.8	-45,3	8.8	1000,4	8.8	975,6	11.8	27,3	80	13.8
9	-15,4	11.9	-45,0	23.9	993,6	5.9	967,2	3.9	30,9	80	3.9
10	-4,6	16.10	-31,7	9.10	1001,9	14.10	961,3	26.10	31,9	70	15.10
11	-0,2	18.11	-24,5	7.11	1003,3	20.11	963,4	23.11	29,8	80	23.11
12	0,4	13.12	-14,7	3.12	1004,5	29.12	964,2	5.12	22,6	90	5.12
year	2,9	3.1	-45,3	8.8	1020,6	29.4	960,6	31.7	34,0	100	28.5

Tab.2c Monthly extremes for the year 1990 from synoptic observations. First value = extreme, second value = date. Maximum windspeed is shown with the associated wind direction.

Month	Max.Temp. (°C) Maximum		Min. Temp. (°C) Minimum		Pressure (hpa) Maximum		Pressure (hpa) Minimum		Maximum Windspeed (m/s) Speed	(deg) Dir.	
1	1,2	1.1	-16,2	10.1	995,4	24.1	974,5	18.1	17,0	90	14.1
2	3,6	4.2	-22,5	17.2	1002,5	2.2	966,1	28.2	23,2	90	25.2
3	5,6	28.3	-33,0	24.3	1008,5	22.3	964,7	11.3	27,8	90	10.3
4	-6,9	30.4	-34,7	22.4	1007,5	23.4	976,9	10.4	22,6	80	26.4
5	-3,2	23.5	-38,6	12.5	1002,2	1.5	959,6	27.5	27,3	80	31.5
6	-7,7	7.6	-42,6	26.6	1014,0	6.6	964,8	1.6	31,9	90	13.6
7	-8,2	4.7	-43,8	24.7	1013,2	23.7	963,0	5.7	27,3	90	4.7
8	-12,9	22.8	-40,5	3.8	1002,8	15.8	966,5	17.7	29,8	80	13.8
9	-4,6	14.9	-41,7	8.9	1011,3	18.9	976,1	23.9	21,6	100	24.9
10	-9,7	29.10	-31,8	7.10	1010,6	6.10	969,4	21.10	22,1	260	9.10
11	-2,4	18.11	-29,7	2.11	999,1	14.11	969,4	22.11	24,7	90	23.11
12	2,4	23.12	-12,2	9.12	1007,4	17.12	985,5	26.12	23,7	80	20.12
year	5,6	28.3	-43,8	24.7	1014,0	6.6	959,6	27.5	31,9	90	13.6

Tab.2d Monthly extremes for the year 1991 from synoptic observations. First value = extreme, second value = date. Maximum windspeed is shown with the associated wind direction.

4.1.1) Surface Air Temperature

Figs. 1a-1d show the annual course of mean surface temperatures as well as of the maximum and minimum values for 1988, 1989 and 1990 and 1991.

The standard deviations indicate a large temperature variability during winter months. The coldest month usually is August. A secondary temperature maximum appears around June/July, as also frequently observed during the previous years.

4.1.2) Relative Humidity

There is no distingish regular variation of relative humidity (Figs. 2a-2d) detectable. The monthly means range between 77% and 89%. Interannual changes are insignificantly small.

The currently existing methods for measuring air humidity yield large uncertainties especially at low air temperatures (see also section 2.1). Therefore, special attention has been given to humidity data at low (< -25°C) temperatures.

4.1.3) Air Pressure

Figs. 3a-3d present the annual course of monthly mean pressure data. The generally low values reflect the location of GvN close to the circumpolar low pressure belt. The expected half-year cycle (van Loon et al., 84a, 84b) in the pressure data exists only 1990.

4.1.4) Wind

Figs. 4a-4d contain monthly and annual averages of wind speed (absolute values of the wind vector) and the zonal (u) and meridional (v) components. During the summer months December, January and February the wind speed is mostly lower than in winter. A half-year cycle becomes obvious as in the surface pressure only in 1990. The result of predominant easterly winds due to low-pressure activities is a negative mean zonal wind component. The meridional component is weak but due to catabatic winds mainly positive.

As can be seen in the histograms of wind direction (Figs. 5a-5d) the easterly winds prefer a very distinct direction around 90 degrees. The catabatically influenced southerly winds occur with a much lower directional constancy. Northerly winds are very rare.

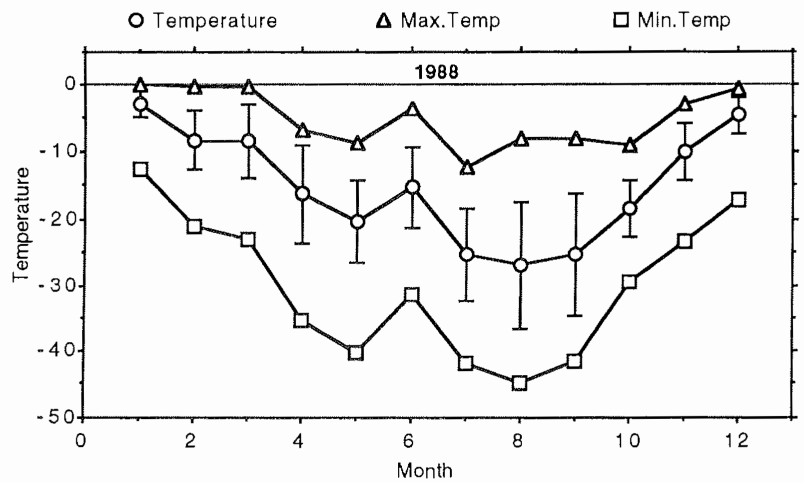
4.1.5) Present Weather Observations
According to the FM12 instructions (Deutscher Wetterdienst 82, WMO 83a, 83b) the present weather observations (ww) are coded in numbers between 0 and 99. In Figs. 6a-6d the annual courses of weather phenomena are shown. Codes between 36 and 39 - indicating snow drift - are predominant (see also Fig. 7). Longer intervals without snowdrift hardly exist. Also, snow fall — coded between 70 and 79 — occurs frequently troughout the year. Furthermore, significant phenomena such as fog (40 - 49) and showers (80 - 90) are seldom (0 - 3 denotes insignificant weather). Thunderstorms (91 - 99) do not exist.

4.1.6) Clouds
Clouds are classified into three cathegories with reference to their height (see FM12 code):

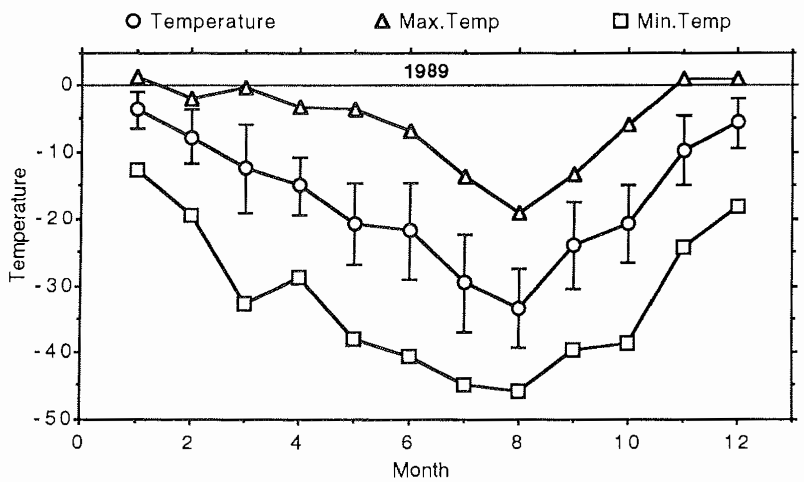
C_L: low clouds of the types Stratocumulus, Stratus, Cumulus and Cumulonimbus (0 - 2 km),
C_M: medium clouds of the types Altocumulus, Altostratus and Nimbostratus (2 - 4 km),
C_H: heigh clouds of the types Cirrus, Cirrocumulus and Cirrostratus (3 - 8 km).

Each layer is further divided into 10 different subclasses. Class 0 in Figs. 8a-8c means, that no clouds in the specified layer exist. Typical low clouds are Stratocumulus and Stratus (5, 6, 7), whereas Cumuli are rare (1, 2, 3). Cumulonimbi (9) do not exist. Typical medium clouds are Altocumulus (3, 7) and Altostratus (1, 2). In the highest layer Cirrus in the form of filaments, strands or hooks (1) are predominant.

As already mentioned in section 4.1 observations of clouds are hindered by darkness. Monthly mean observations during polar night are not comparable with values during polar day. Thus, no annual courses of these observations are plotted.

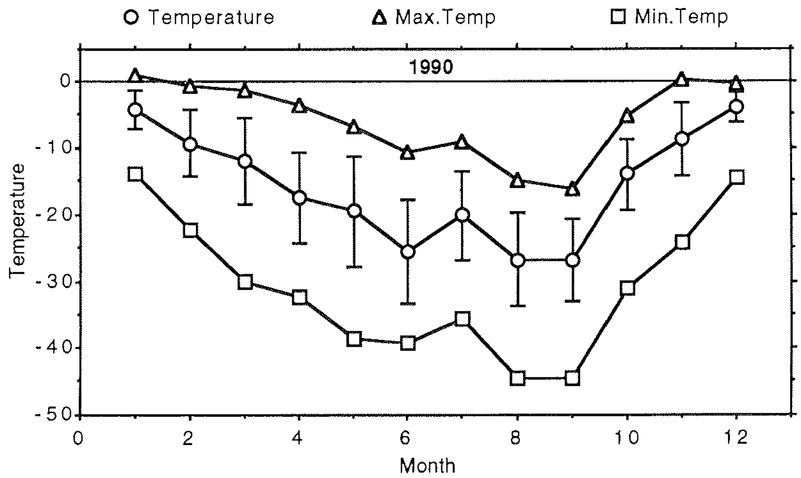


1a

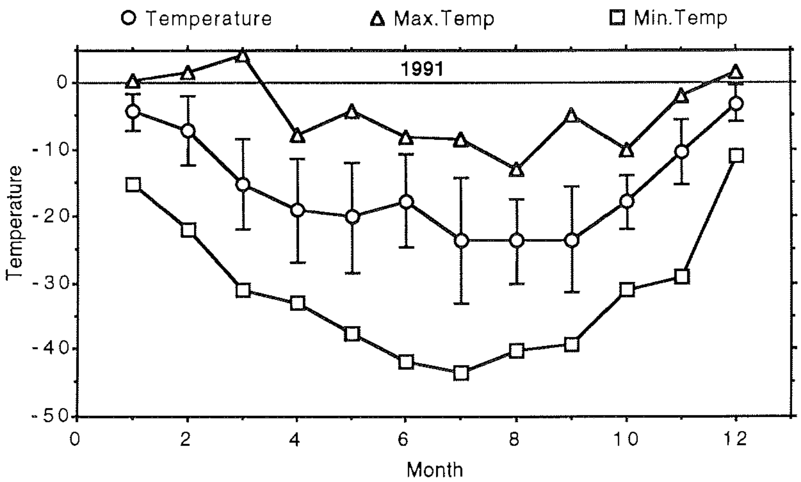


1b

Figs. 1a-1b Annual course of monthly mean, maximum and minimum values of surface air temperatures. Mean temperature values are plotted with standard deviation with respect to the routine 3-hourly synoptic observations.

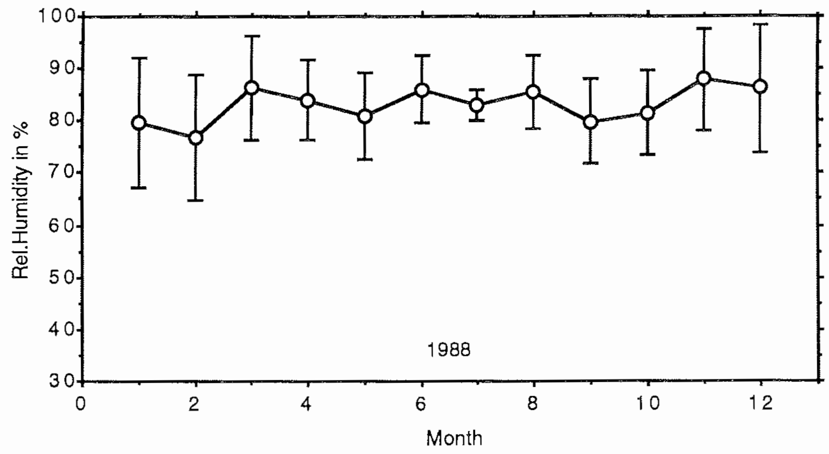


1c

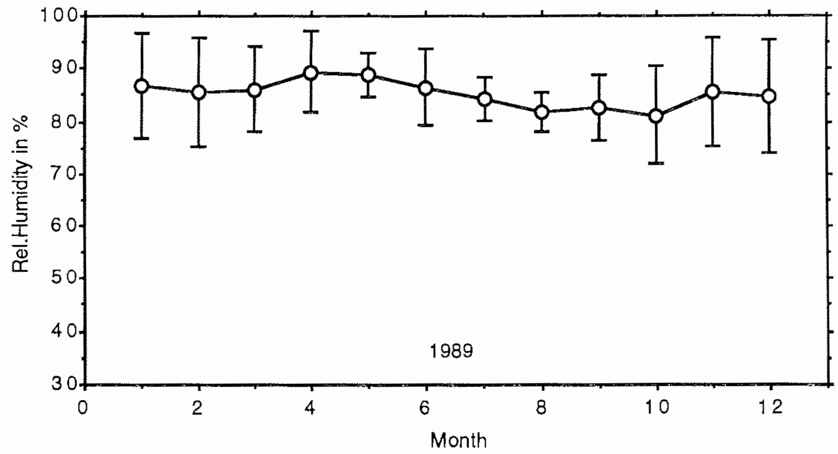


1d

Figs. 1c-1d Annual course of monthly mean, maximum and minimum values of surface air temperatures. Mean temperature values are plotted with standard deviation with respect to the routine 3-hourly synoptic observations.

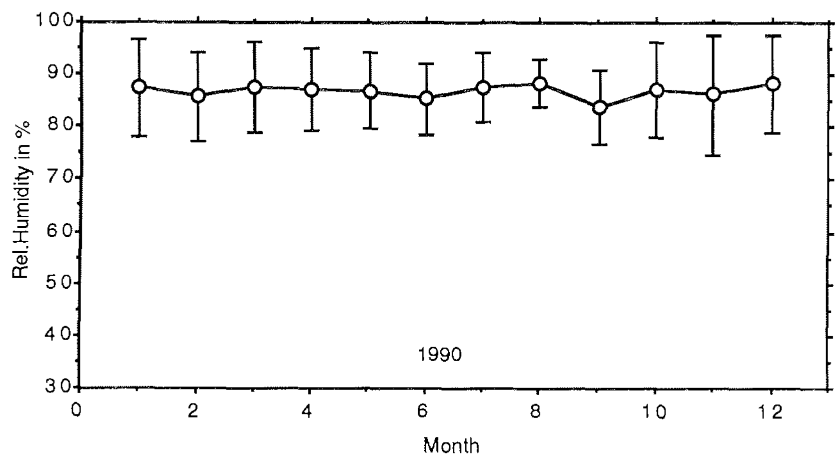


2a

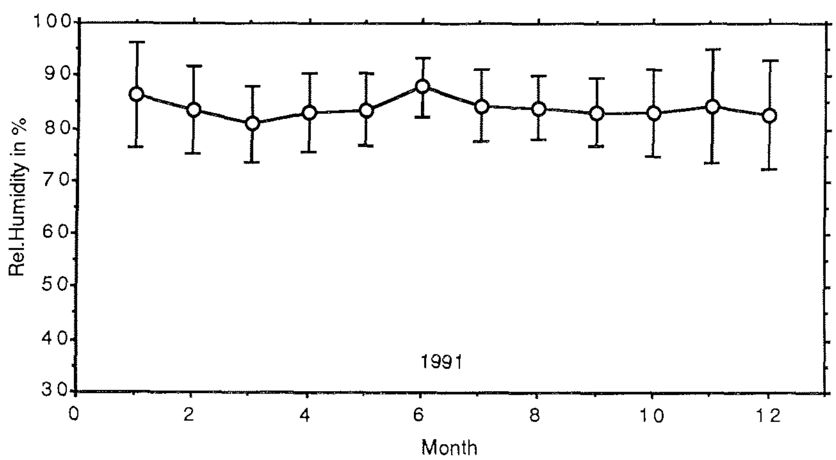


2b

Figs. 2a-2b Annual course of monthly mean values of relative humidity. Mean values are plotted with standard deviation with respect to the routine 3-hourly synoptic observations.

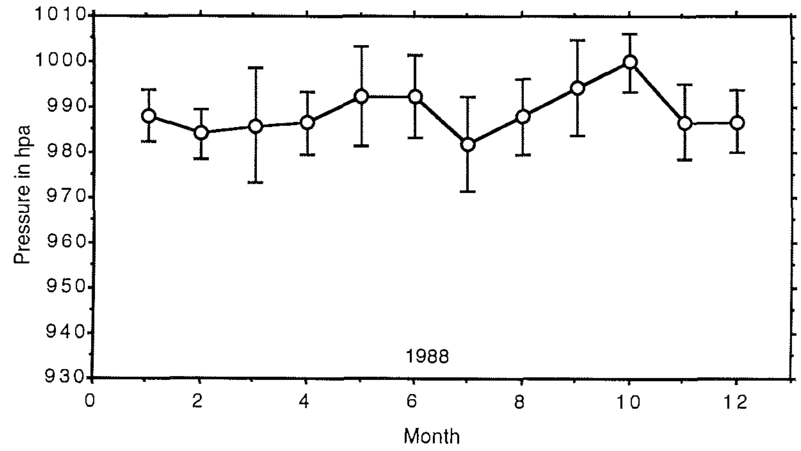


2c

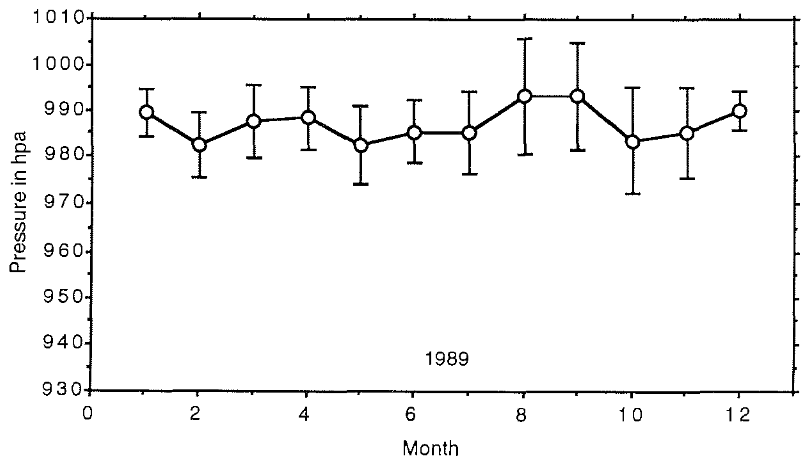


2d

Figs. 2c-2d Annual course of monthly mean values of relative humidity. Mean values are plotted with standard deviation with respect to the routine 3-hourly synoptic observations.

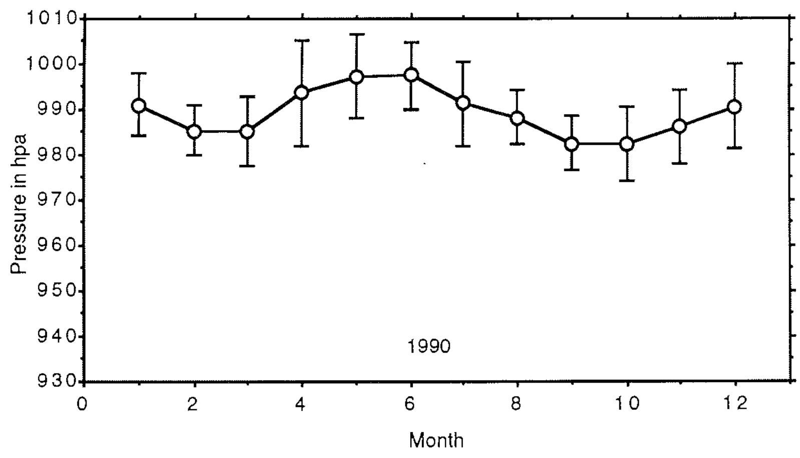


3a

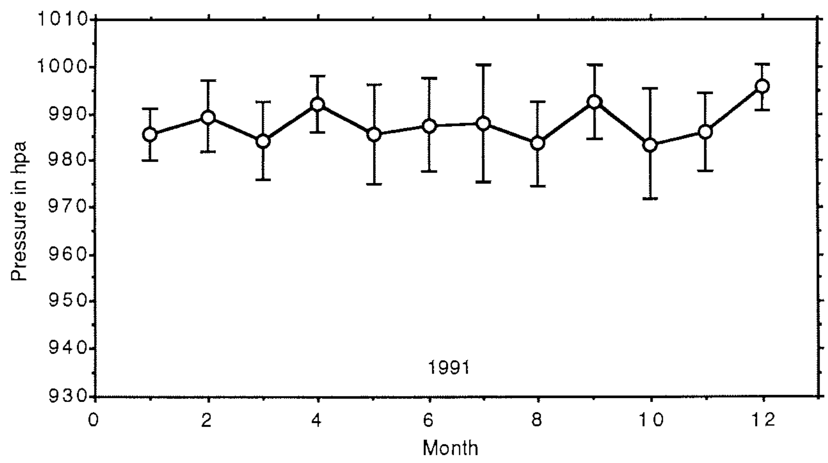


3b

Figs. 3a-3b Annual course of monthly mean values of air pressure. Mean values are plotted with standard deviation with respect to the routine 3-hourly synoptic observations.

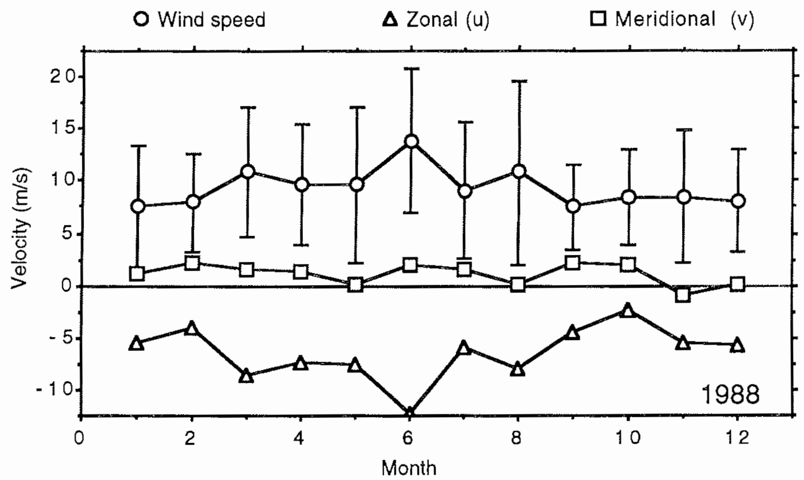


3c

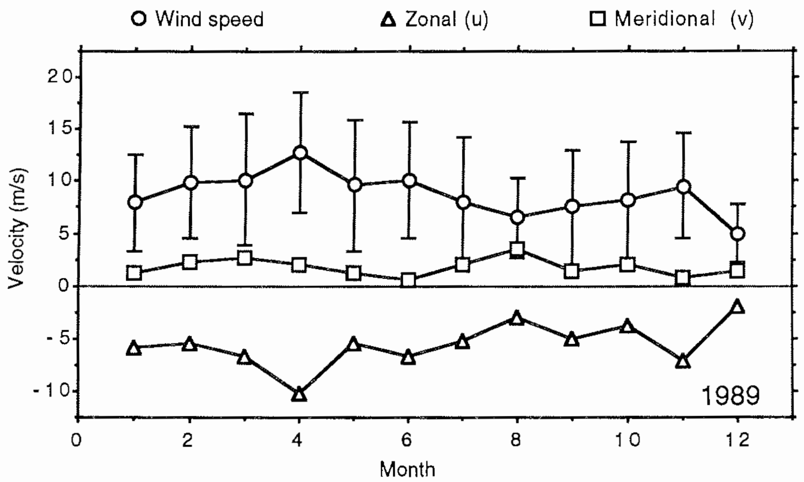


3d

Figs. 3c-3d Annual course of monthly mean values of air pressure. Mean values are plotted with standard deviation with respect to the routine 3-hourly synoptic observations.

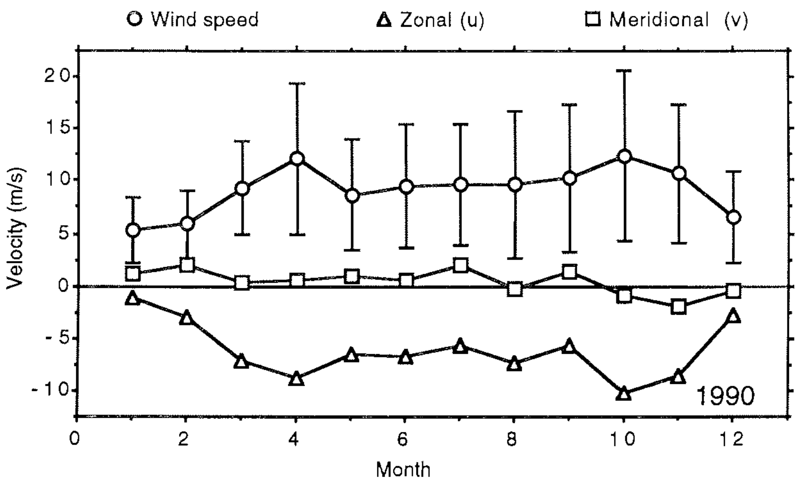


4a

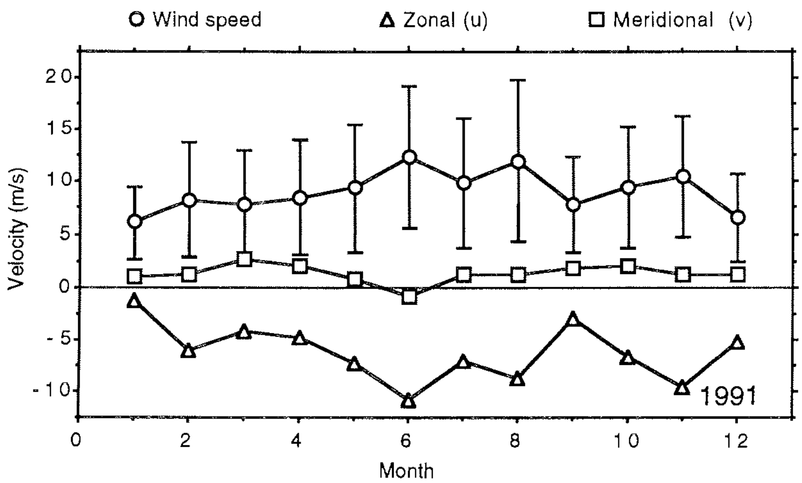


4b

Figs. 4a-4b Annual course of monthly mean values of wind speed and wind components. Mean wind speeds are plotted with standard deviation with respect to the routine 3-hourly synoptic observations.

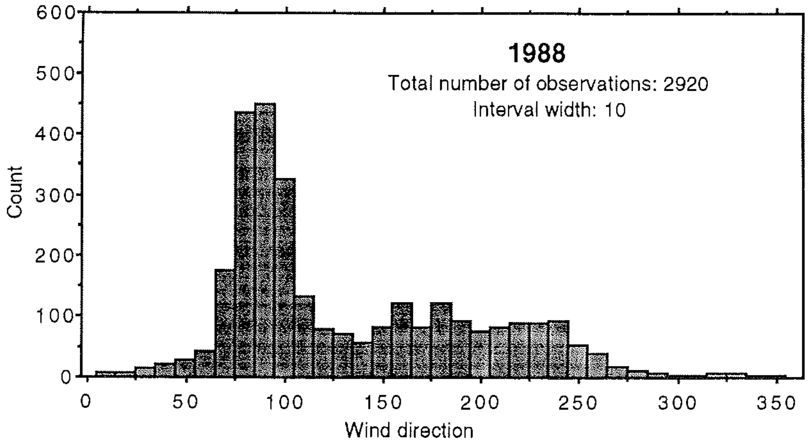


4c

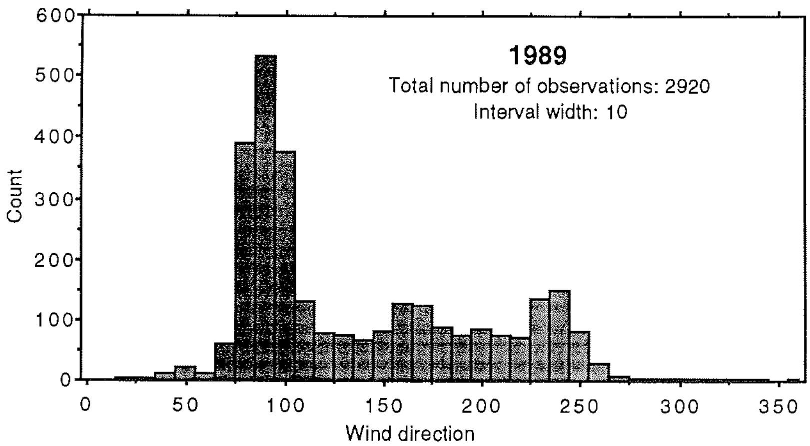


4d

Figs. 4c-4d Annual course of monthly mean values of wind speed and wind components. Mean wind speeds are plotted with standard deviation with respect to the routine 3-hourly synoptic observations.

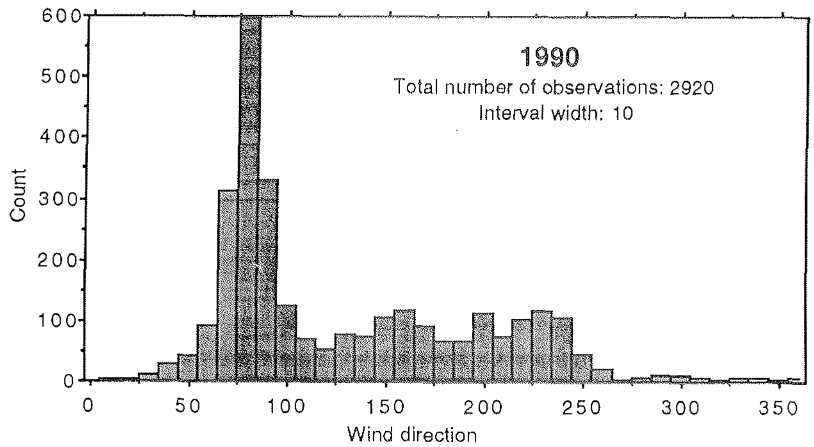


5 a

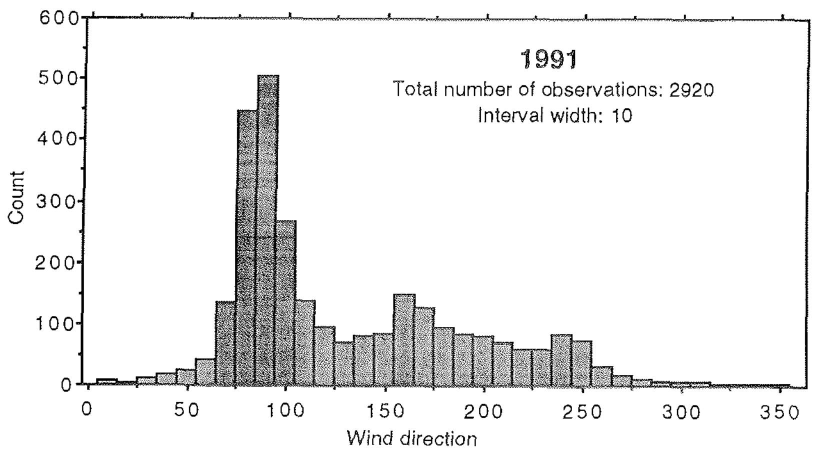


5 b

Figs. 5a-5b Frequency distribution of wind direction with respect to all routine 3-hourly synoptic observations during one year.

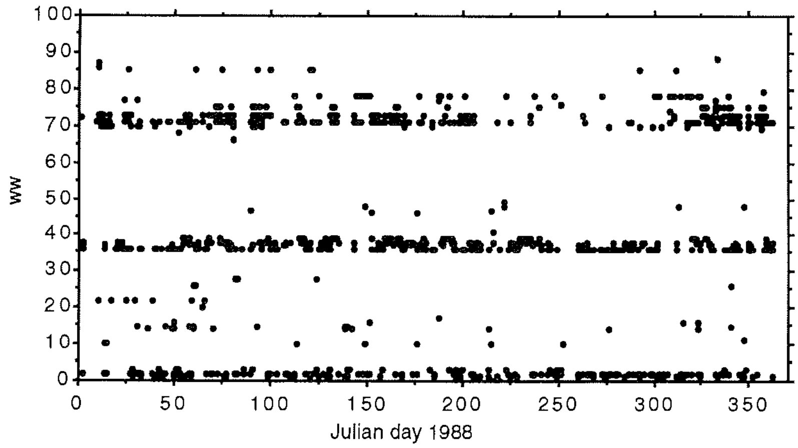


5c

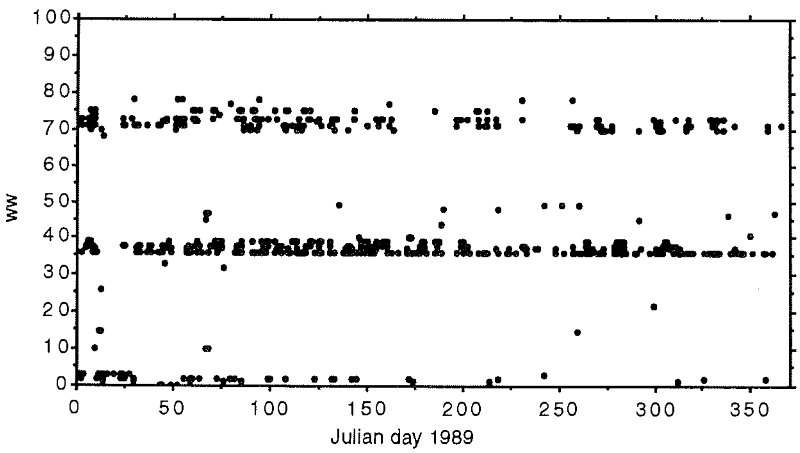


5d

Figs. 5c-5d Frequency distribution of wind direction with respect to all routine 3-hourly synoptic observations during one year.

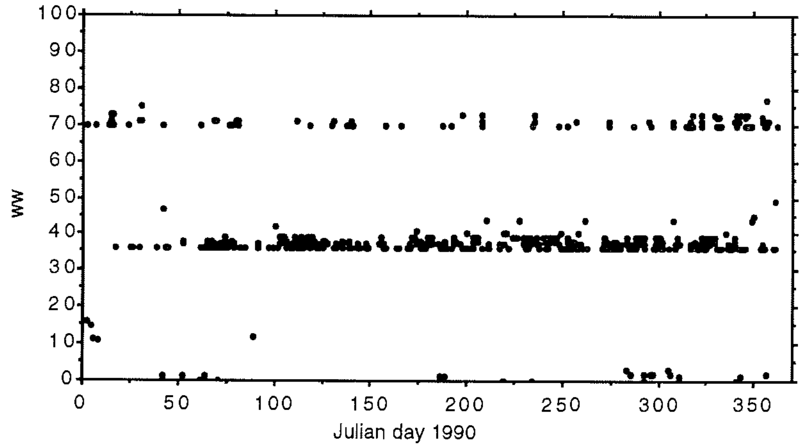


6a

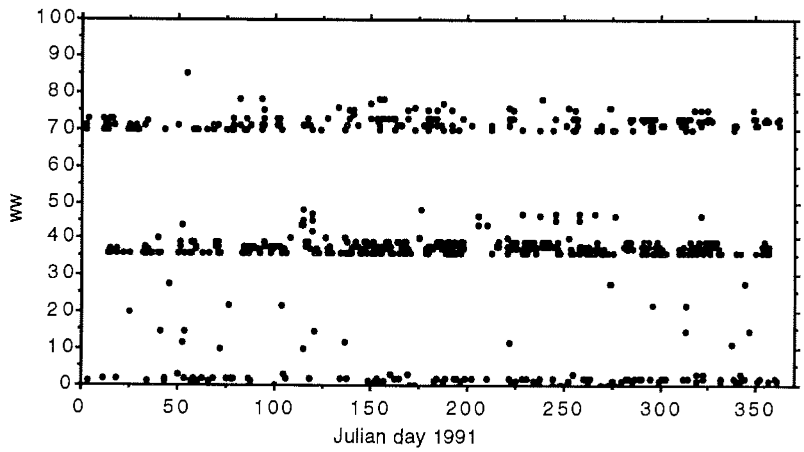


6b

Figs. 6a-6b Annual course of present weather phenomena from the routine 3-hourly synoptic observations according to the FM12-code.

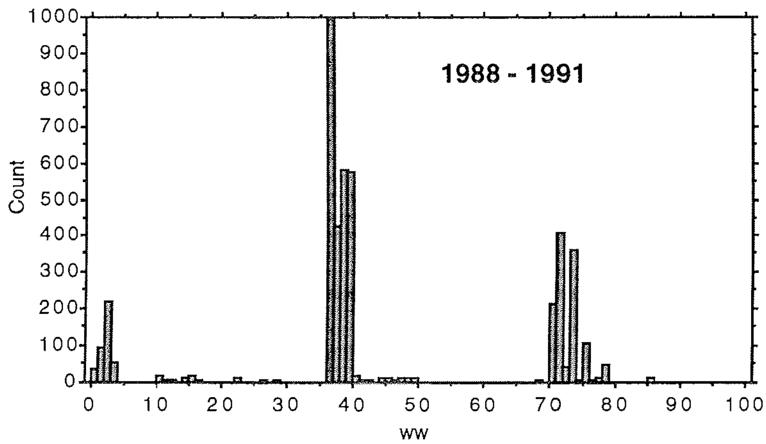


6c



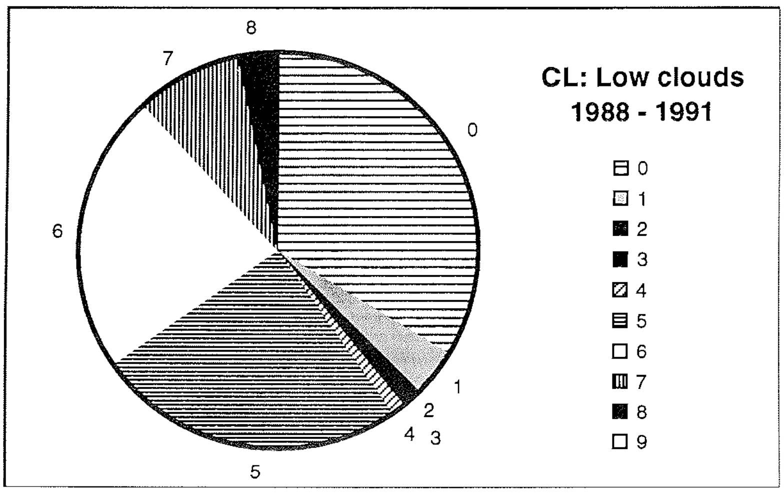
6d

Figs. 6c-6d Annual course of present weather phenomena from the routine 3-hourly synoptic observations according to the FM12-code.



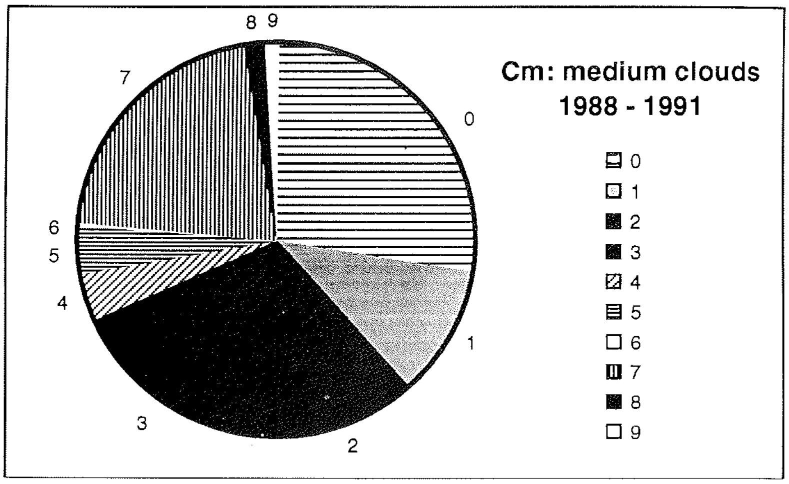
7

Fig. 7 Frequency distribution of present weather phenomenons from all routine 3-hourly synoptic observations during 1988 - 1991 according to the FM12-code.

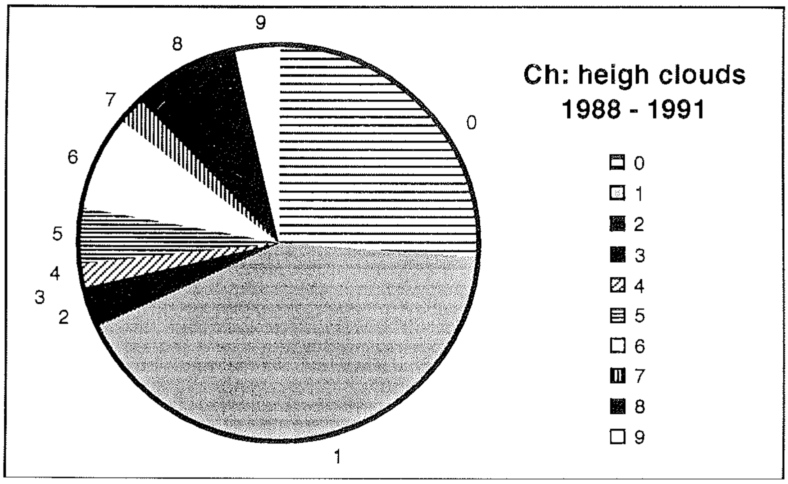


8 a

Fig. 8a Frequency distribution of low clouds from all routine 3-hourly synoptic observations during 1988 - 1991 according to the FM12-code.



8 b



8 c

Figs. 8b-8c Frequency distribution of medium and heigh clouds from all routine 3-hourly synoptic observations during 1988 - 1991 according to the FM12-code.

4.2) Upper Air Soundings

4.2.1) Overview

Radiosonde were launched once daily. Due to a technical malfunction almost no measurements are available for the period 21 December 1989 to 27 February 1990. Figs. 9a-9d display time-height sections of temperature. In summertime the balloons usually reached heights above 25 km. In wintertime - when stratospheric temperatures drop below -80 °C - the balloons reached only about 15 km height. Since 1990 the balloons have been treated with an oil mixture before launch to ascend to heights of at least 20 km even during winter.

4.2.2) Temperatures

The mean temperature profiles show a relatively warm stratosphere in summer and low upper temperatures in winter. Rather distinct is the surface temperature inversion in winter (Figs. 10a-10b). The cooling of the stratosphere starts in the beginning of March. About 5 months later the minimum temperature is reached.

Date	Min.Temp (°C)	Height (m) of Min.Temp.
16 Aug 1988	-85.1	15925
23 Jul 1989	-88.6	21500
21 Jul 1990	-91.4	20808
09 Aug 1991	-91.1	20081

At the end of September sudden stratosperic warmings occur, indicating the breakdown of the stratospheric vortex over the Antarctic continent.

4.2.3) Tropopause

The height of the tropopause is defined as the lowest height above which the temperature decrease with height is less than 0.2 °C per 100 m. This condition must be fulfilled over a range of at least 2000 m. Figs. 12a-12d present the results according to this definition. During summer the tropopause is well pronounced at 9000 m height with only slight temporal variations. During winter the height of the tropopause varies considerably and occasionally it can not be determined, because the temperature change with height is less than -0.2 °C per 100 m up to the top level.

In general, the tropopause rises during the winter period and the stratosphere is then characterized by very small lapse rates. Clearly the tropopause temperature decreases with height (Figs. 13a-13d). The annual mean temperatures at the tropopause lie at about -60°C.

4.2.4) Standard Pressure Levels

Figs. 14a-14d depict the height variation of different standard pressure levels. There are no marked variations below the 300 hpa level. The annual period from the100 hpa level upwards is caused by the before mentioned strong stratospheric temperature cycle (see also Figs. 15a-15d).

4.2.5) Wind Components

Mean profiles of zonal and meridional wind components for summer and winter are shown in Figs. 11a-11b. Easterly winds dominate the lower tropospheric wind field up to a height of 4000 m during winter and of 6000 m during summer. In higher levels westerlies dominate with upward increasing values in winter. In summer the weak westerly regime ranges from 6000 to 24000 m height and turns to easterlies in the top layer. The meridional wind component is usually light from the souths at all heights during the entire year.

4.2.6) Humidity

The relative air humidity (Figs. 10a-10b, 17a-20*l*) continuously decreases with height in the troposphere and is close to zero in the stratosphere. This effect is partly caused by the fact that relative air humidity is defined with respect to the absolute water vapour pressure over a plain pure water surface which is always greater than the absolute water vapour pressure over ice. Thus, in a very cold atmospere, were no liquid water exists, the maximum relative air humidity must stay well below 100 %.

Figs. 16a-16d present the total amount of water vapour in the vertical air column over a horizontal reference area (precipitable water, ppw). 1 cm ppw is equivalent to 1 g H_2O/cm^2.

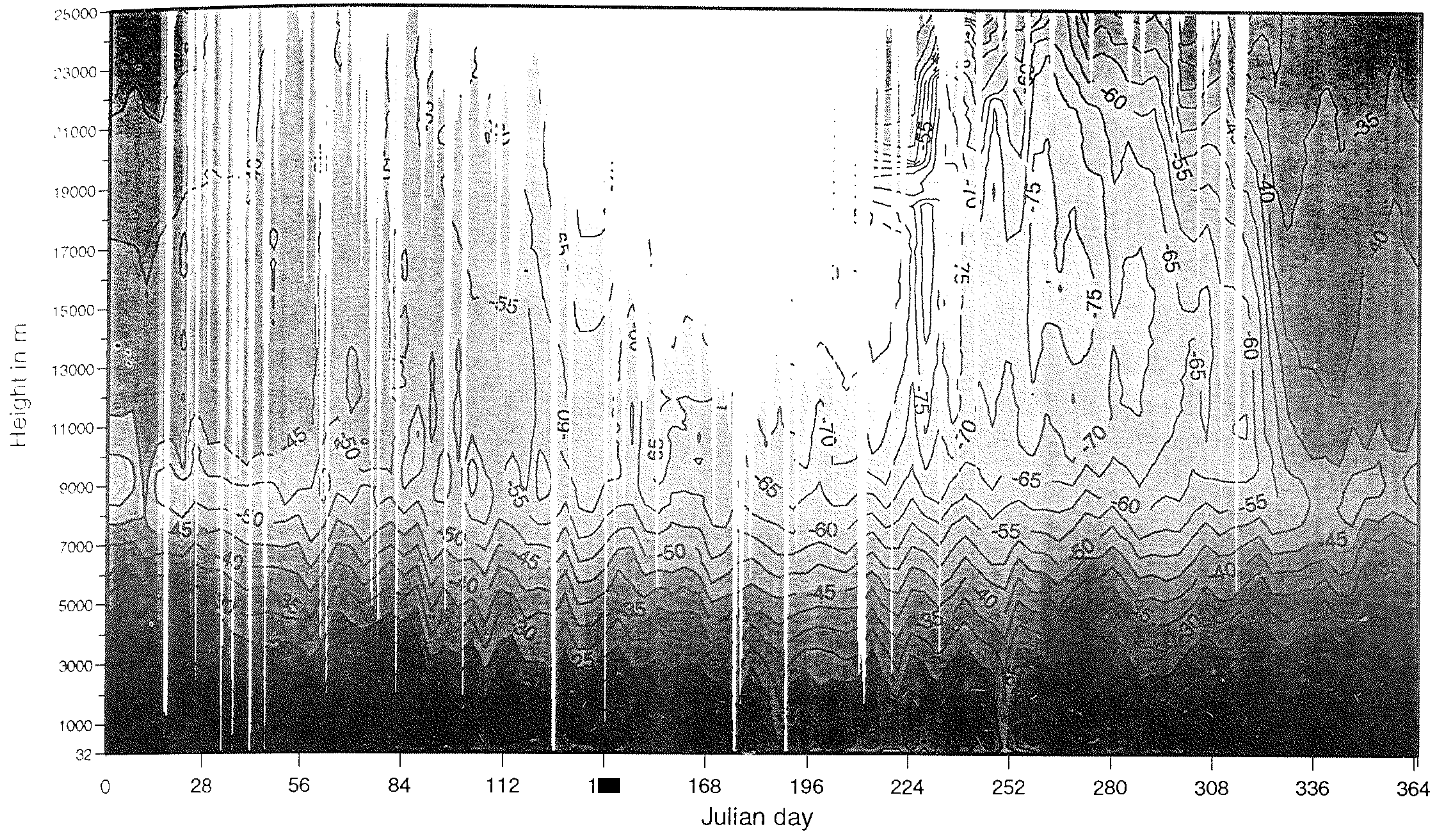


Fig. 9a Time - height section of temperature (°C) from daily radiosonde soundings 1988

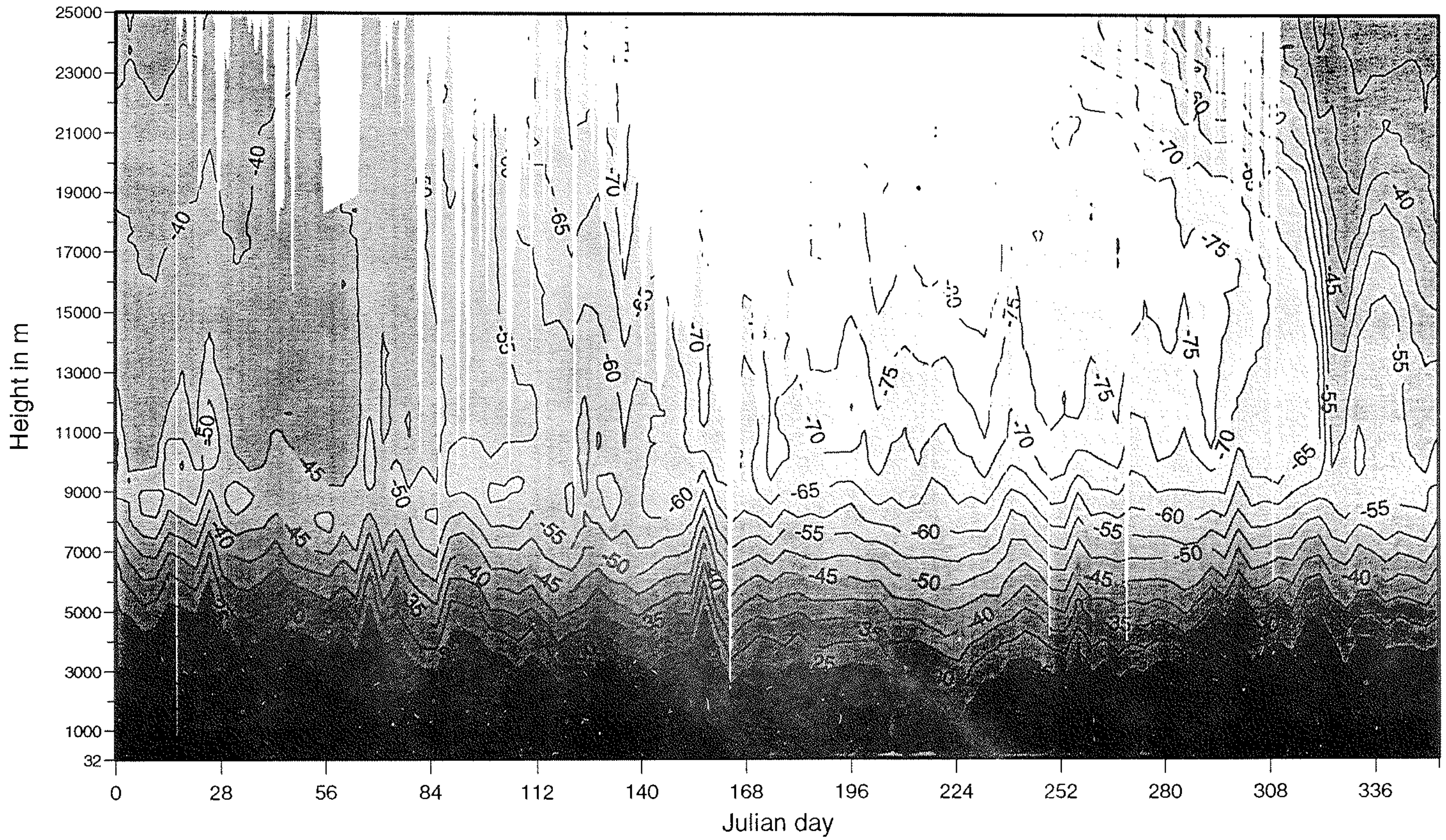


Fig. 9b Time - height section of temperature (°C) from daily radiosonde soundings 1989

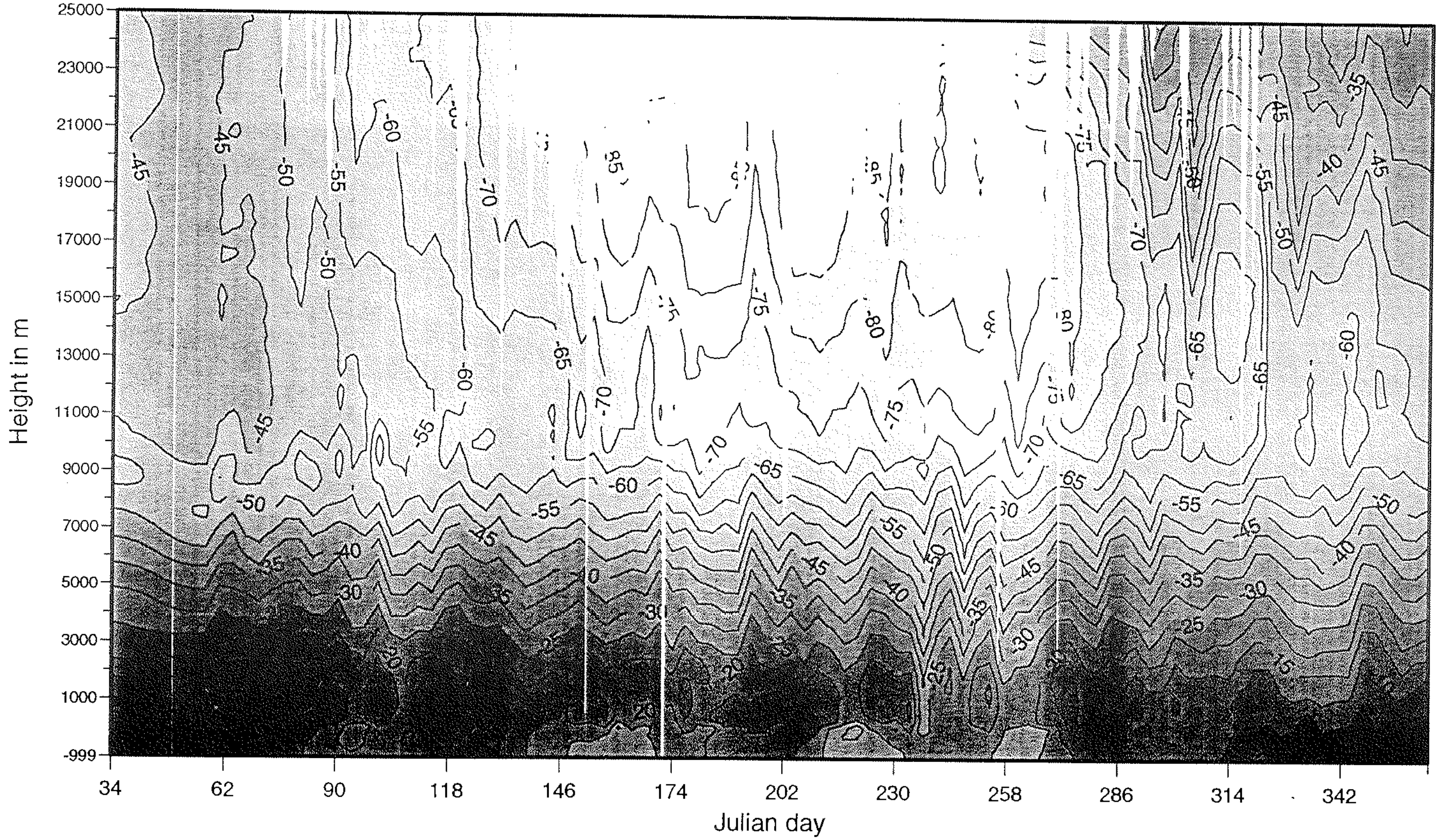


Fig. 9c Time - height section of temperature (°C) from daily radiosonde soundings 1990

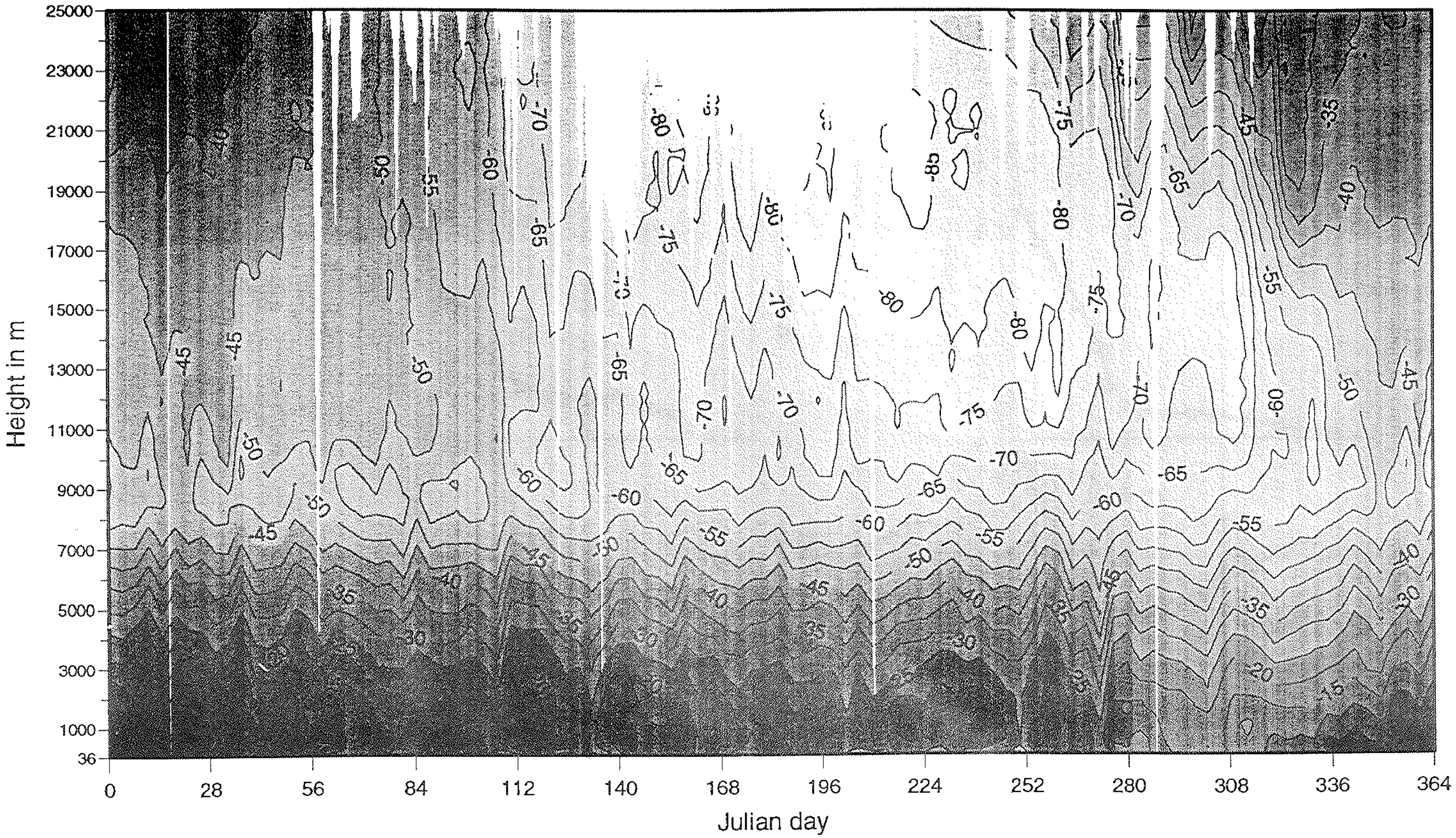
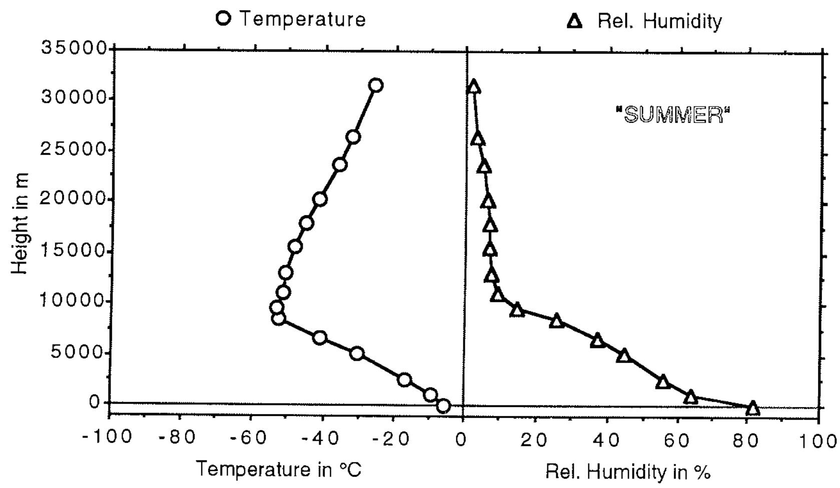
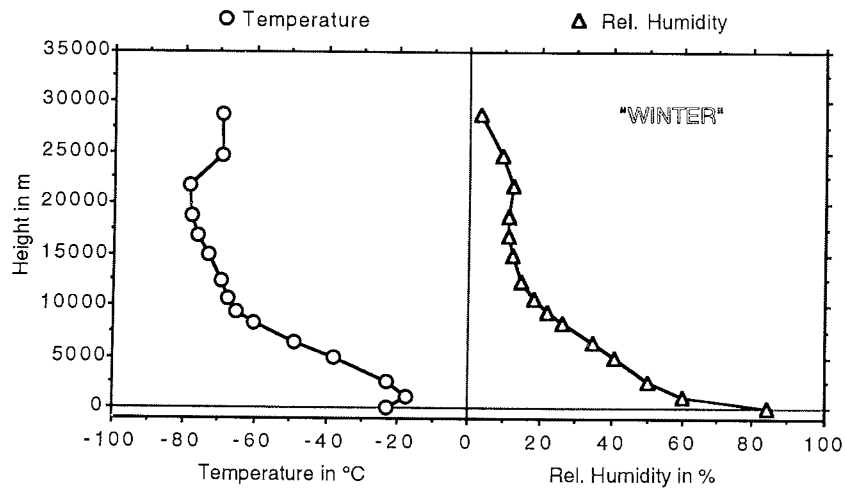


Fig. 9d Time - height section of temperature (°C) from daily radiosonde soundings 1991

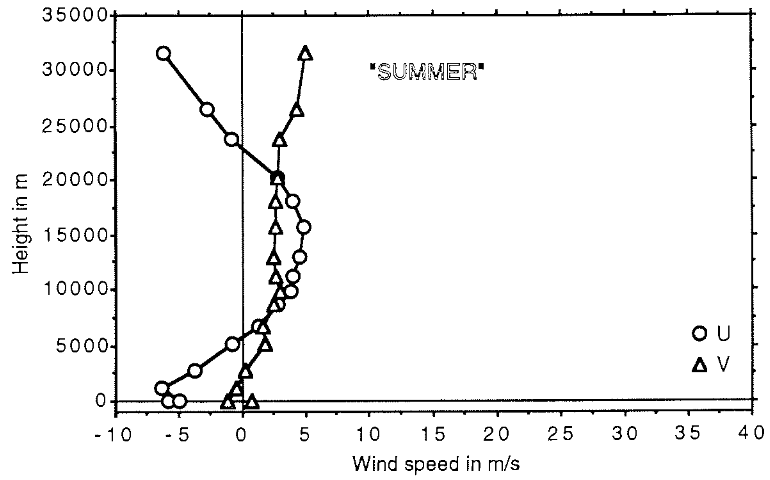


10a

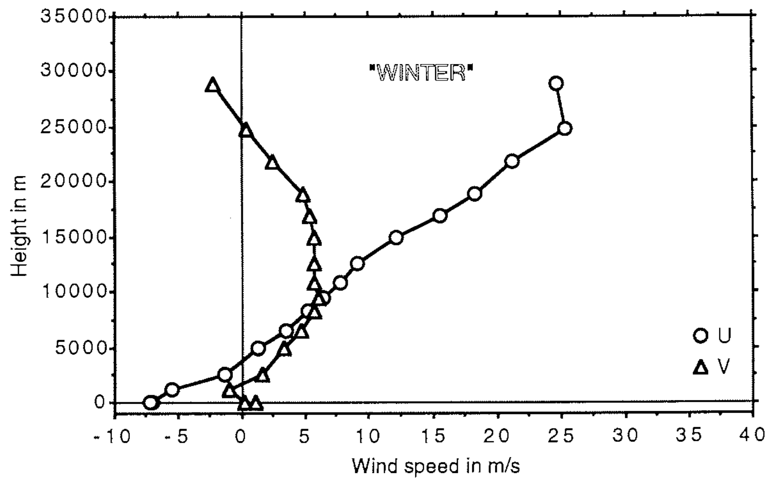


10b

Figs. 10a-10b Mean vertical variation of temperature and relative humidity from daily radiosonde data of the years 1988 - 1991. "Summer" = November - February (454 soundings); "Winter" = May - August (486 soundings).

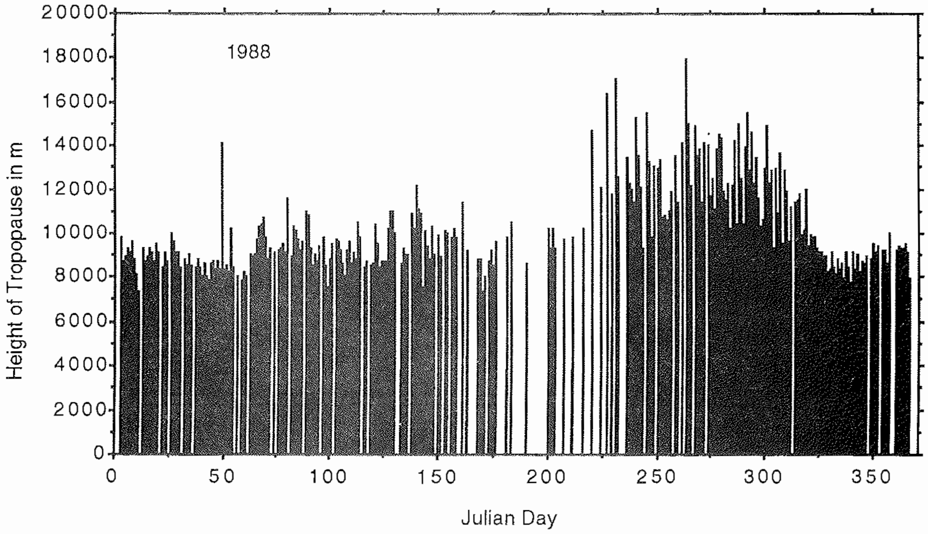


11a

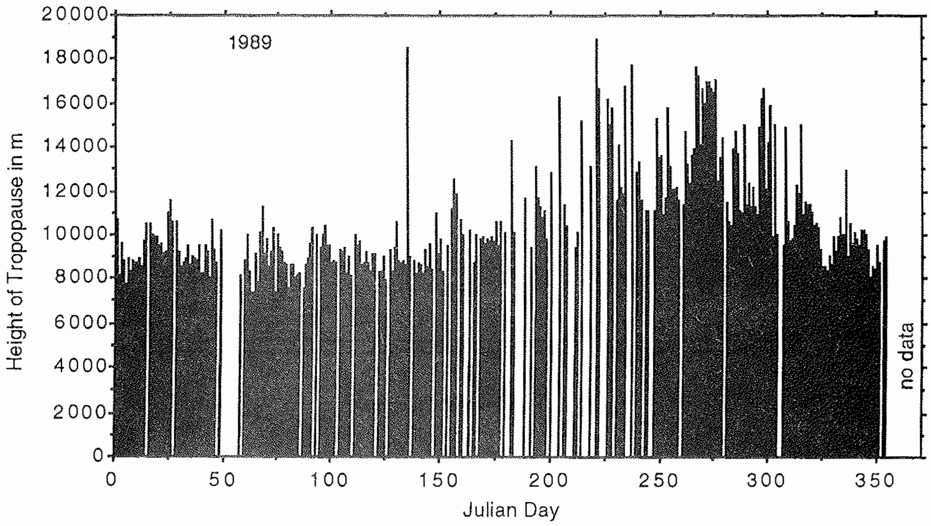


11b

Figs. 11a-11b Mean vertical variation of zonal (u) and meridional (v) wind components, from daily radiosonde data of the years 1988 - 1991. Summer" = November - February (454 soundings); "Winter" = May - August (486 soundings).

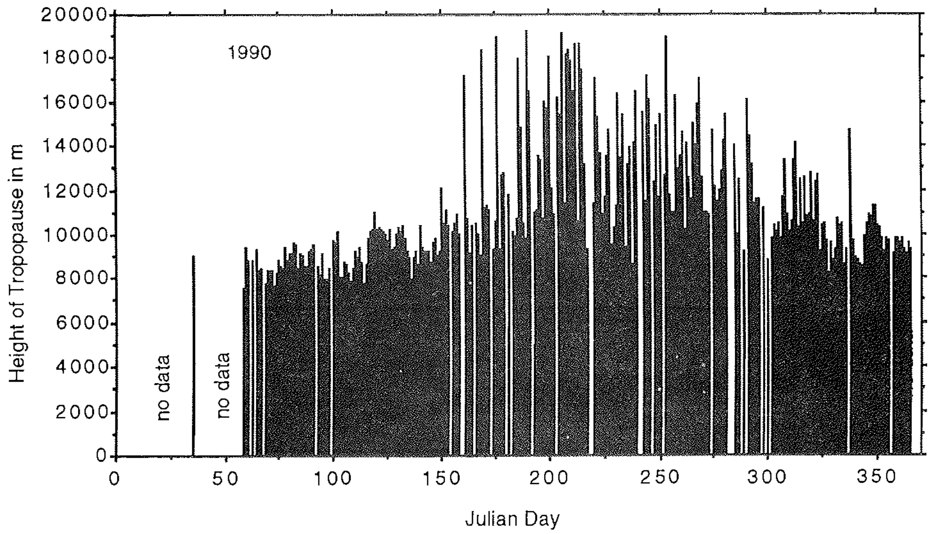


12a

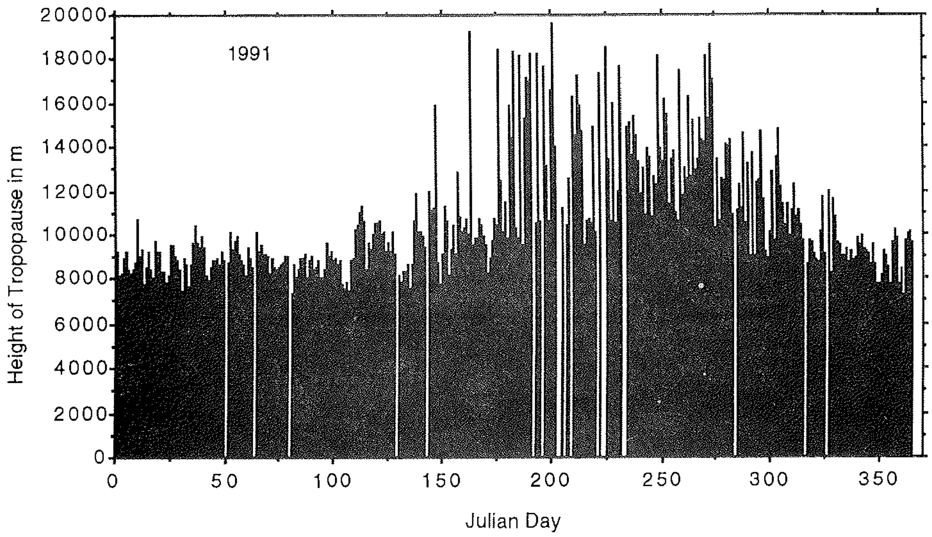


12b

Figs. 12a - 12b Height of tropopause calculated from daily radiosonde data for the years 1988 and 1989. If there are gaps in the bar charts, the tropopause could not be determined.

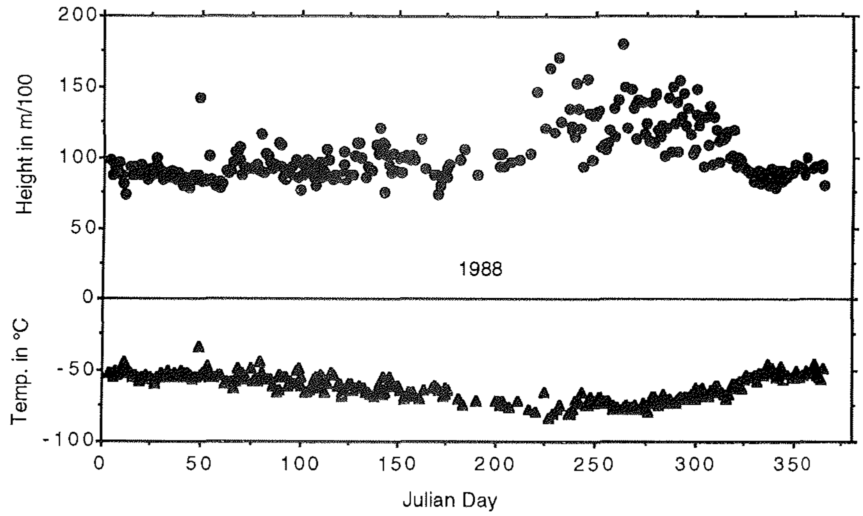


12c

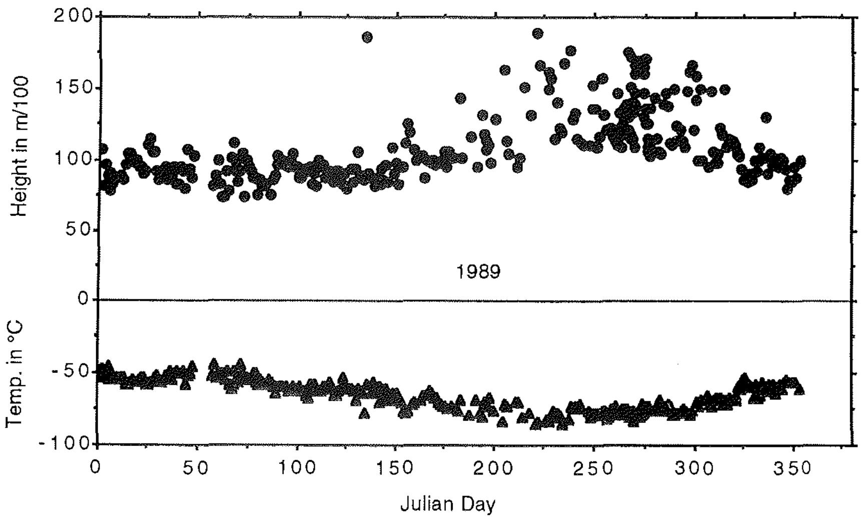


12d

Figs. 12c- 12d Height of tropopause, calculated from daily radiosonde data for the years 1990 and 1991. If there are gaps in the bar charts, the tropopause could not be determined.

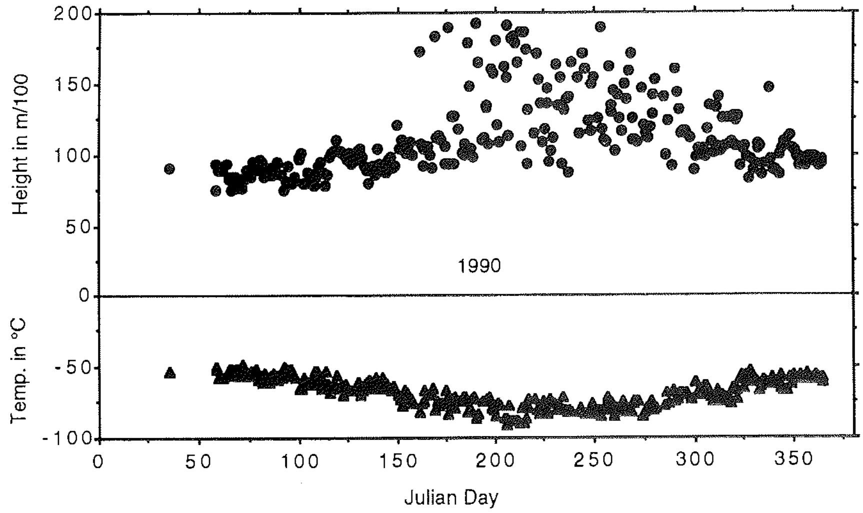


13a

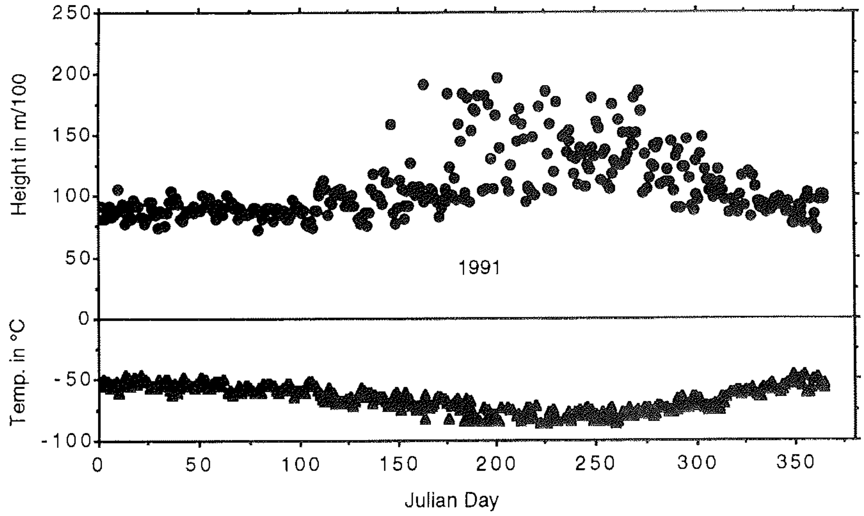


13b

Figs. 13a-13b Annual changes of tropopause height and tropopause temperature based on daily radiosonde data of the years 1988 and 1989.

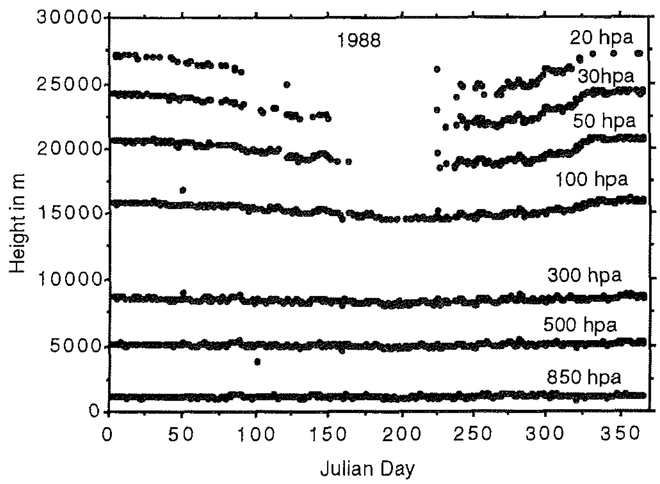


13c

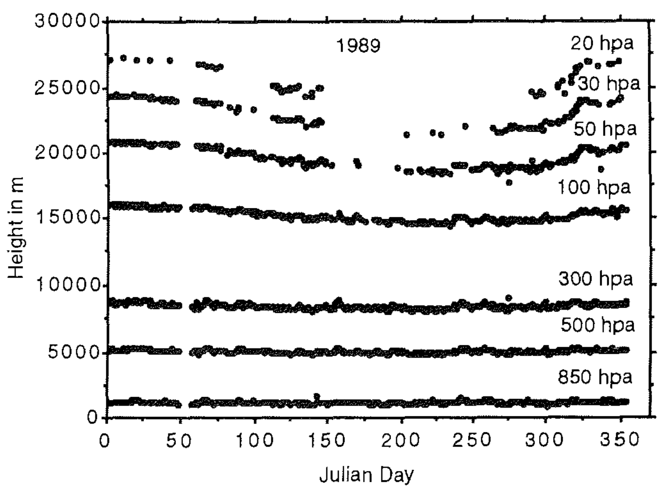


13d

Figs. 13c-13d Annual changes of tropopause height and tropopause temperature based on daily radiosonde data of the years 1990 and 1991.

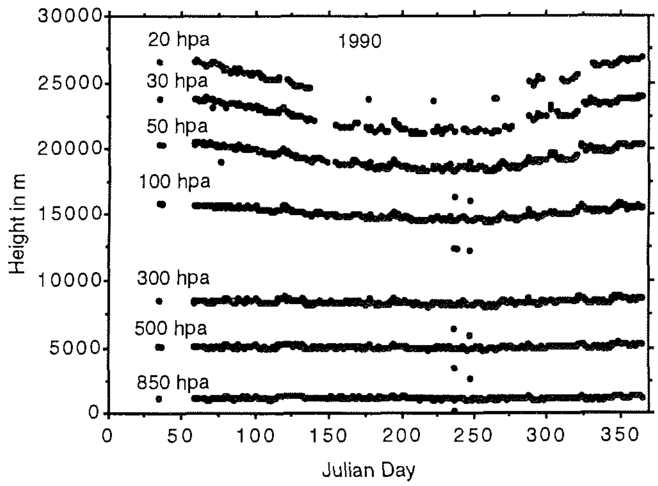


14a

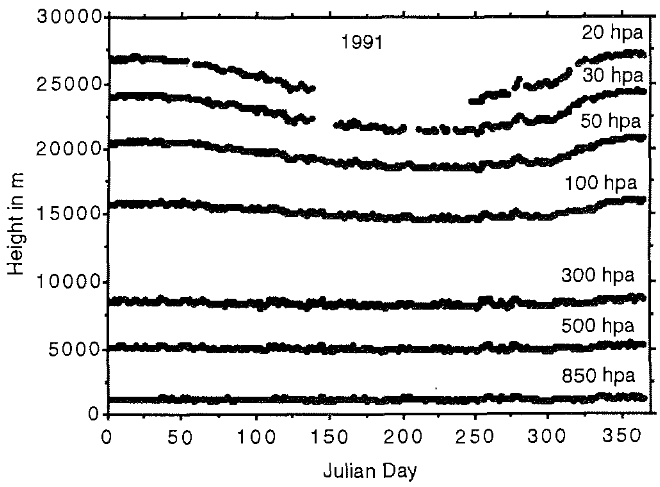


14b

Figs. 14a-14b Annual variation of heights at different standard pressure levels from daily radiosonde data of the years 1988 and 1989.

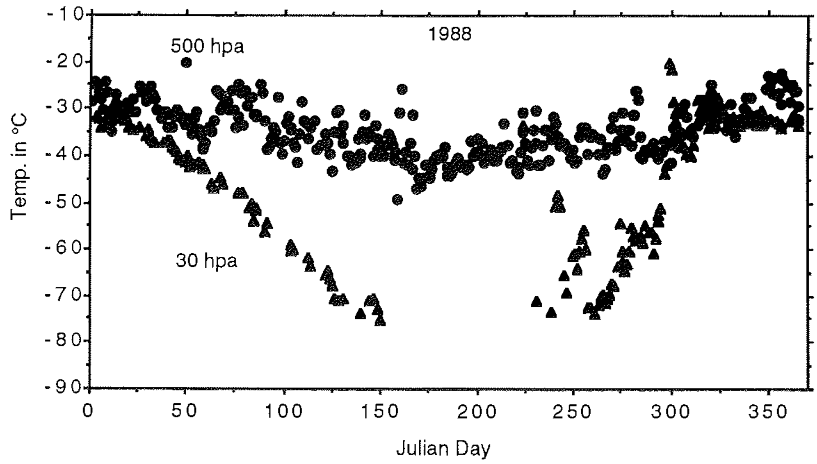


14c

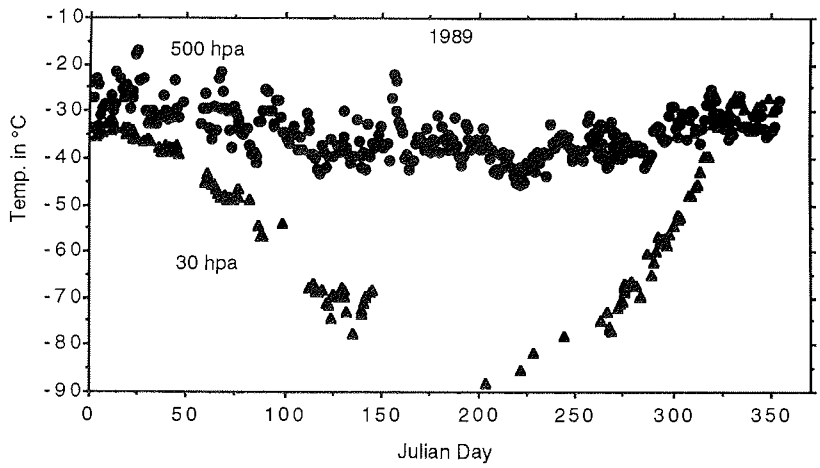


14d

Figs. 14c-14d Annual variation of heights at different standard pressure levels from daily radiosonde data of the years 1990 and 1991.

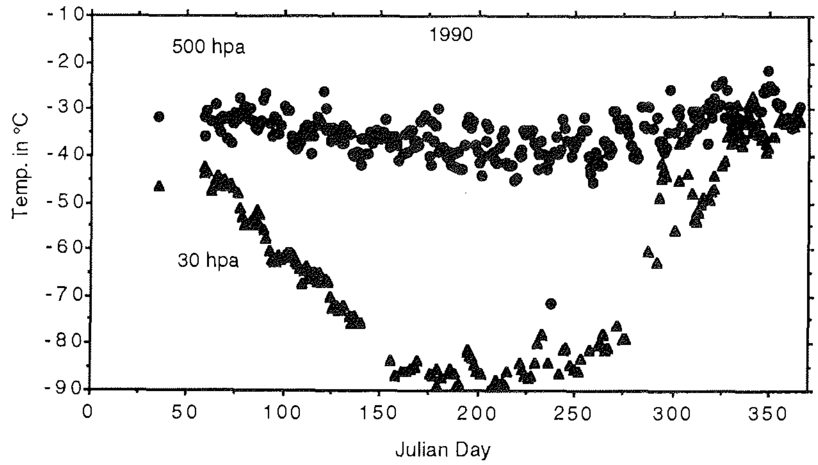


15a

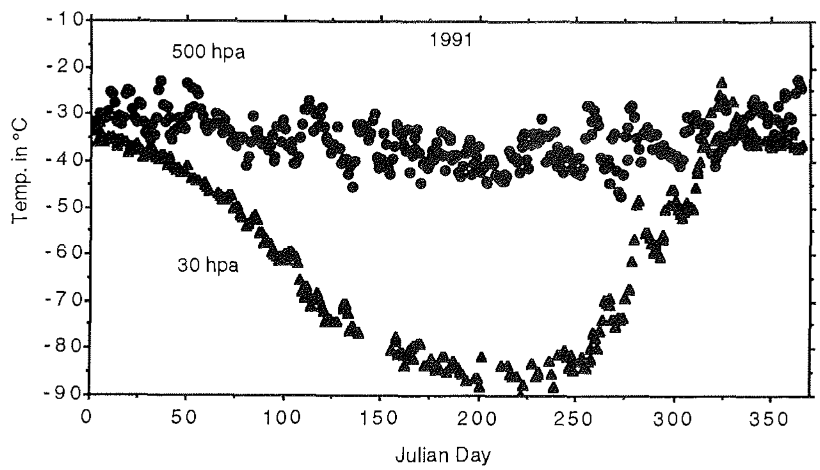


15b

Figs. 15a-15b Annual variation of temperature at 500 hpa and 30 hpa levels from daily radiosonde data of the years 1988 and 1989. In winter, 30 hpa are mostly not reached (the extreme low stratospheric temperatures cause balloons to burst early).

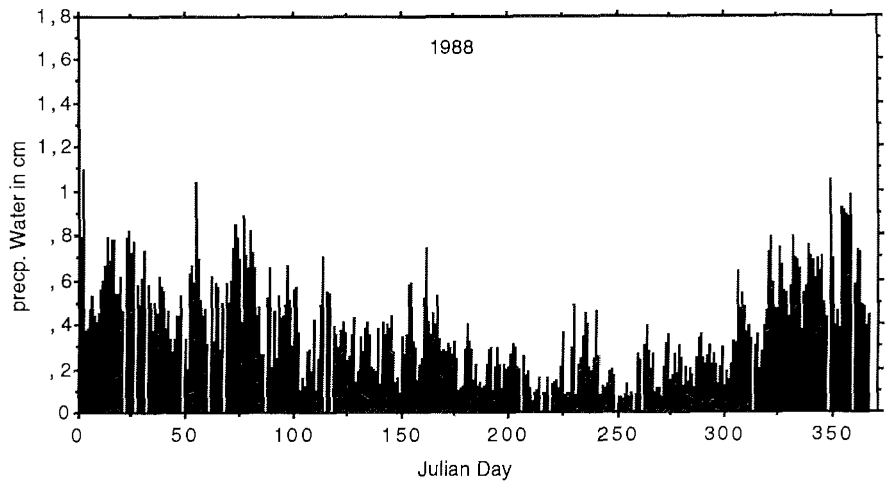


15c

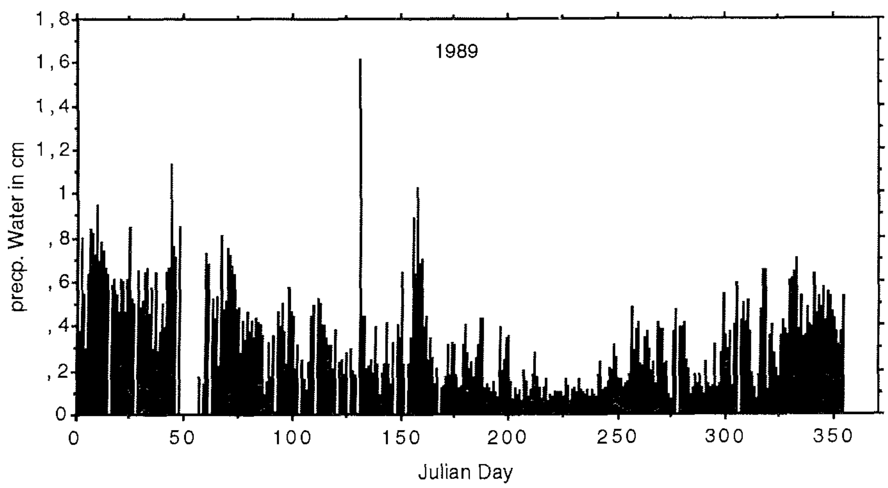


15d

Figs. 15c-15d Annual variation of temperature at 500 hpa and 30 hpa levels from daily radiosonde data of the years 1990 and 1991. Due to special balloon treatments 30 hpa was reached at any season.

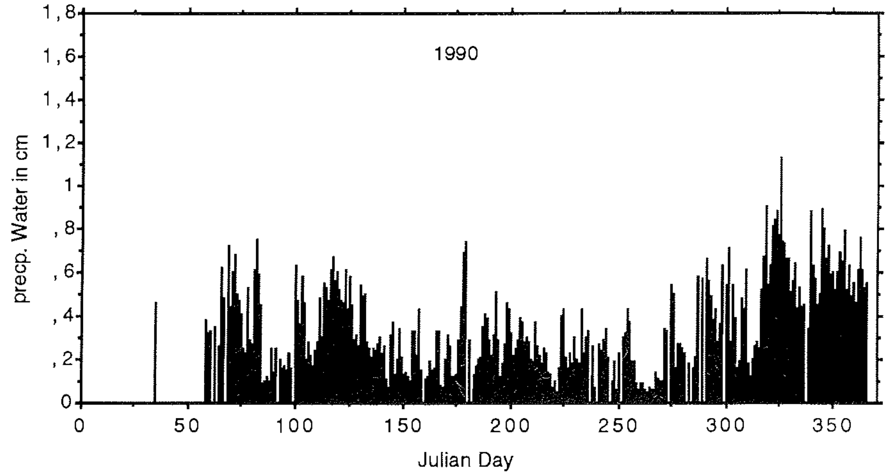


16a

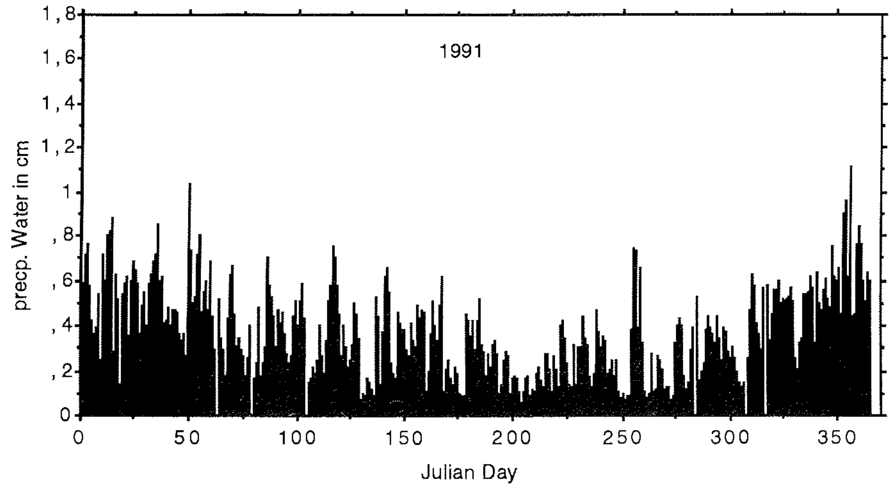


16b

Figs. 16a-16b Annual change of "precipitable water" (content of water vapour in a vertical column) from daily radiosonde data of the years 1988 and 1989.

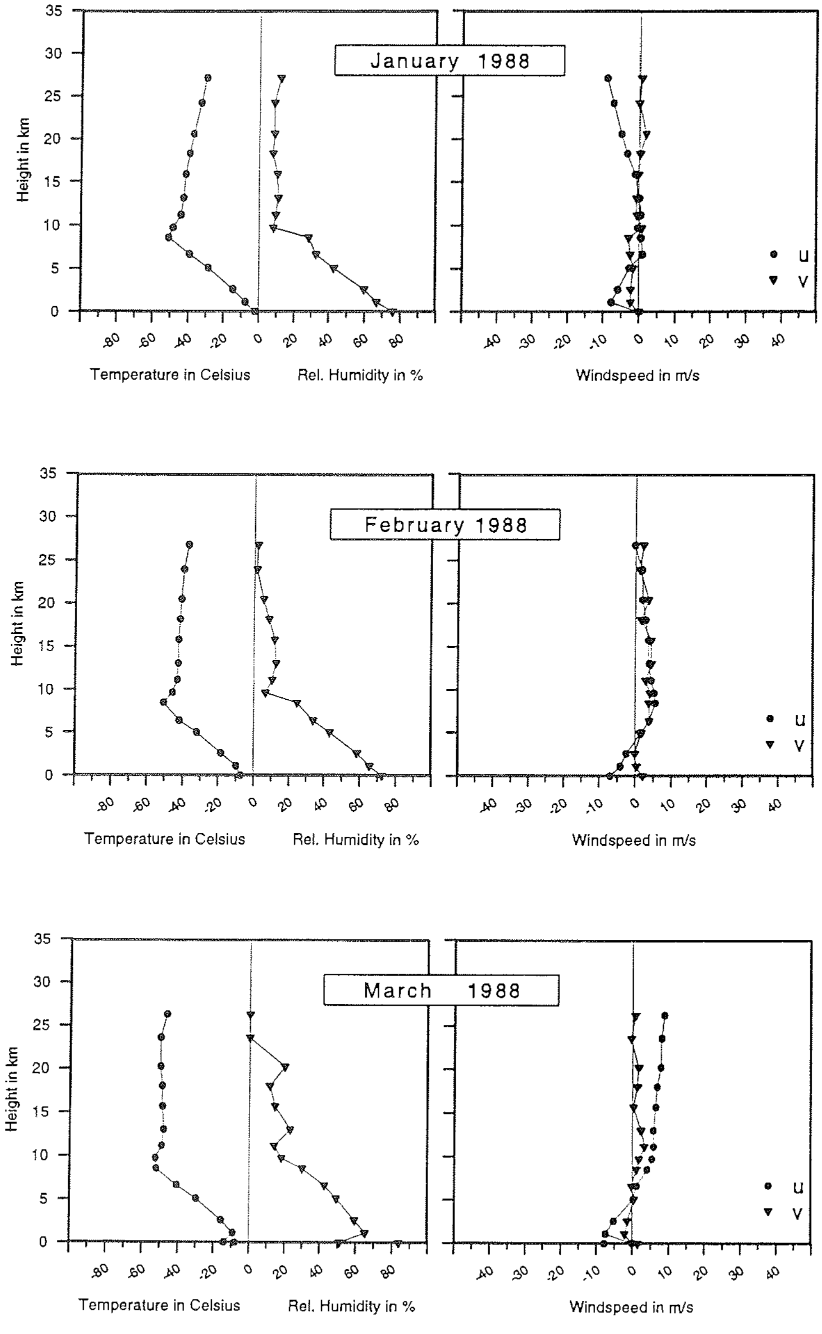


16c

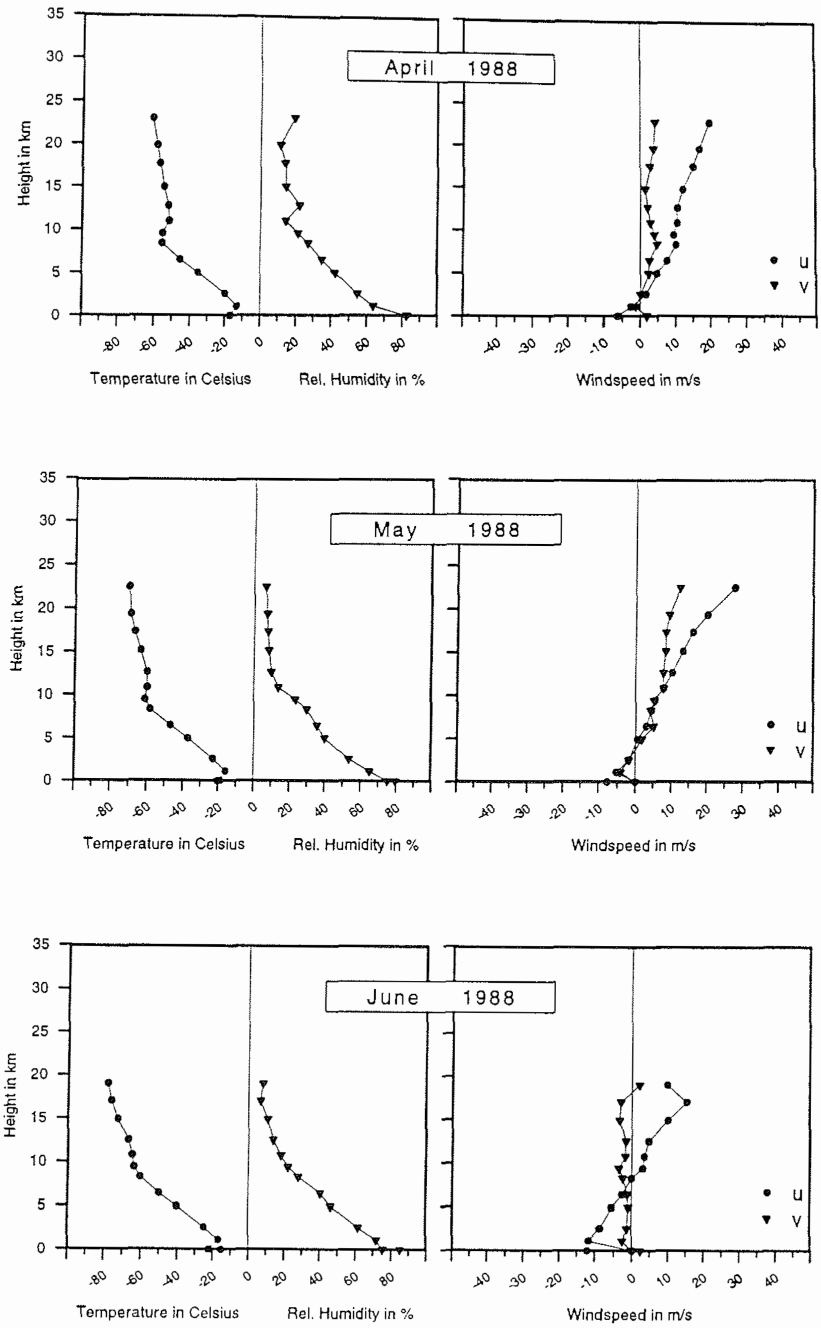


16d

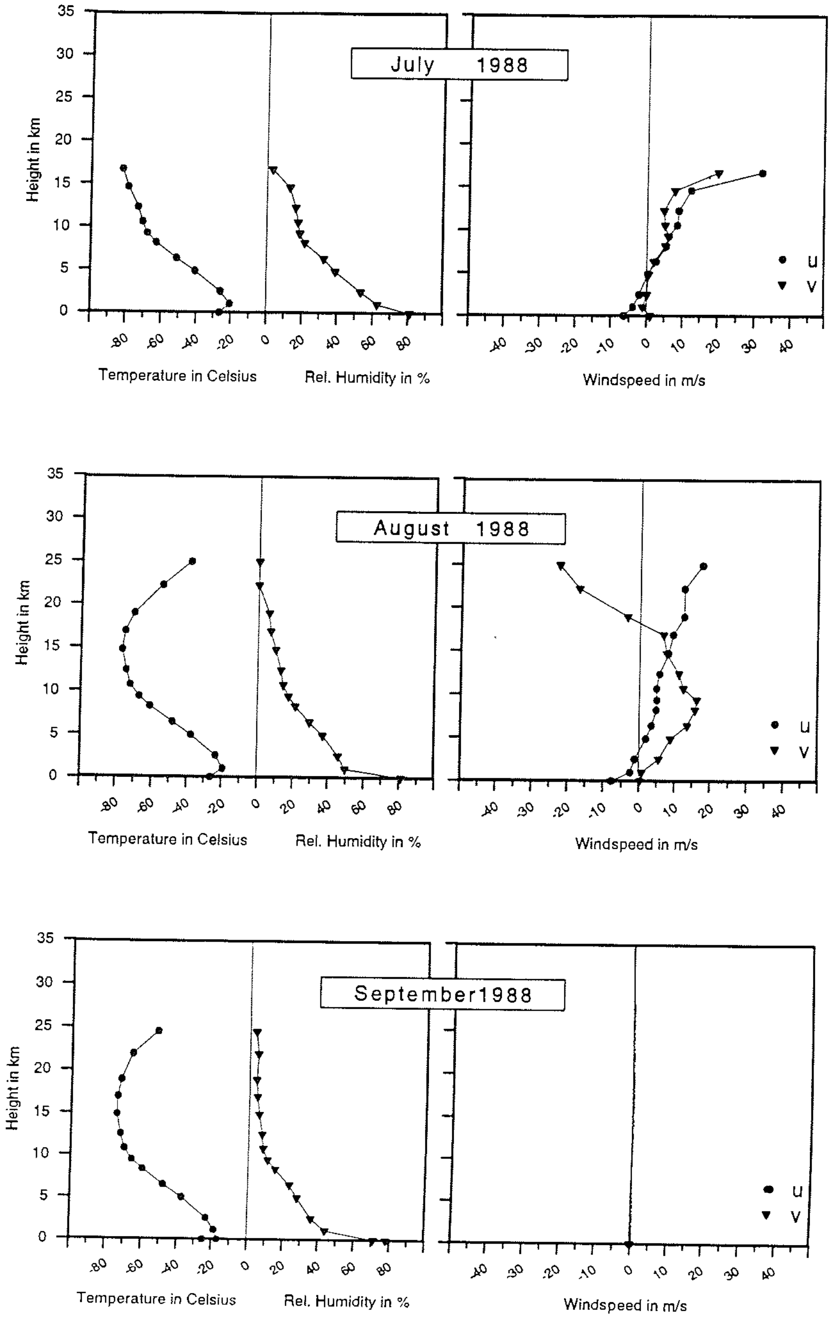
Figs. 16c-16d Annual change of "precipitable water" (content of water vapour in a vertical column) from daily radiosonde data of the years 1990 and 1991.



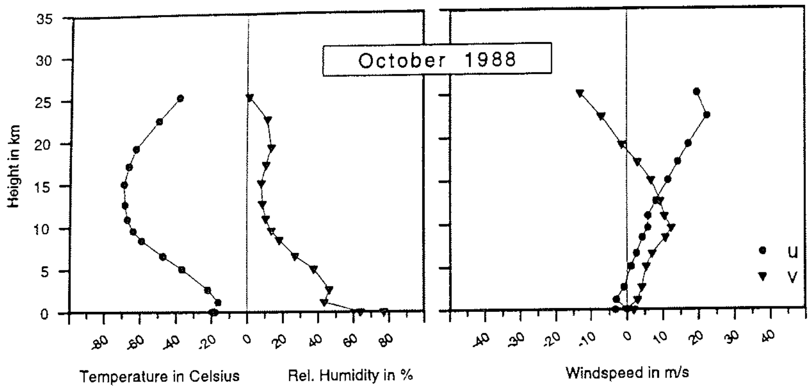
Figs. 17a-17c Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.

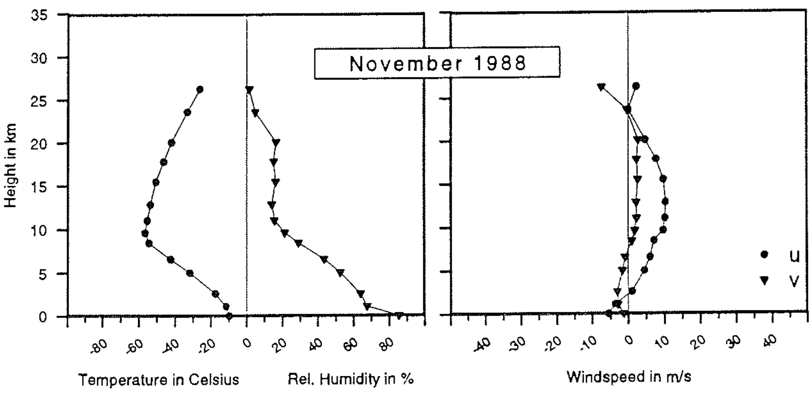


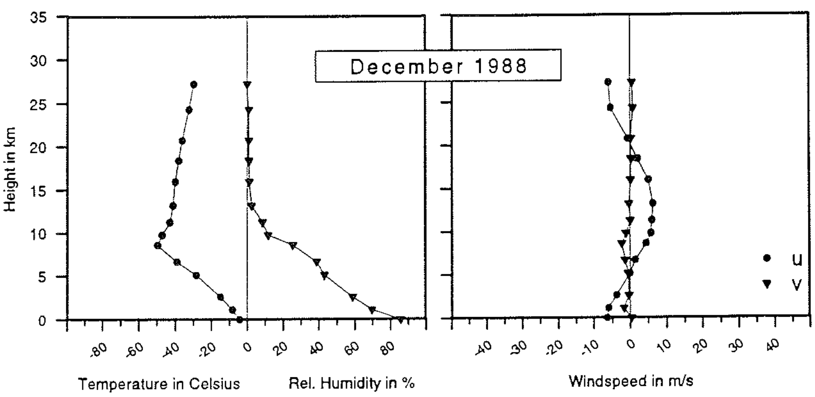
Figs. 17d-17f Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



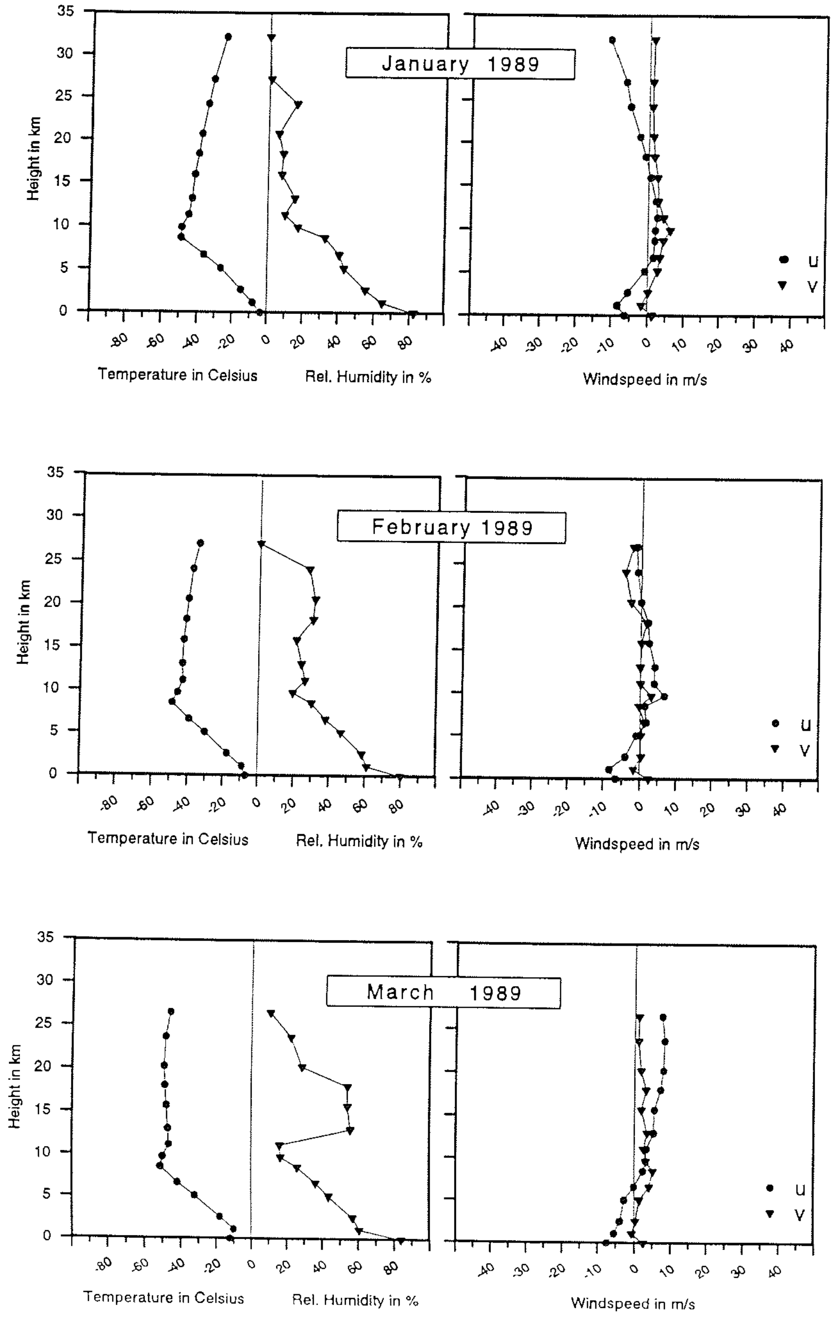
Figs. 17g-17i Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



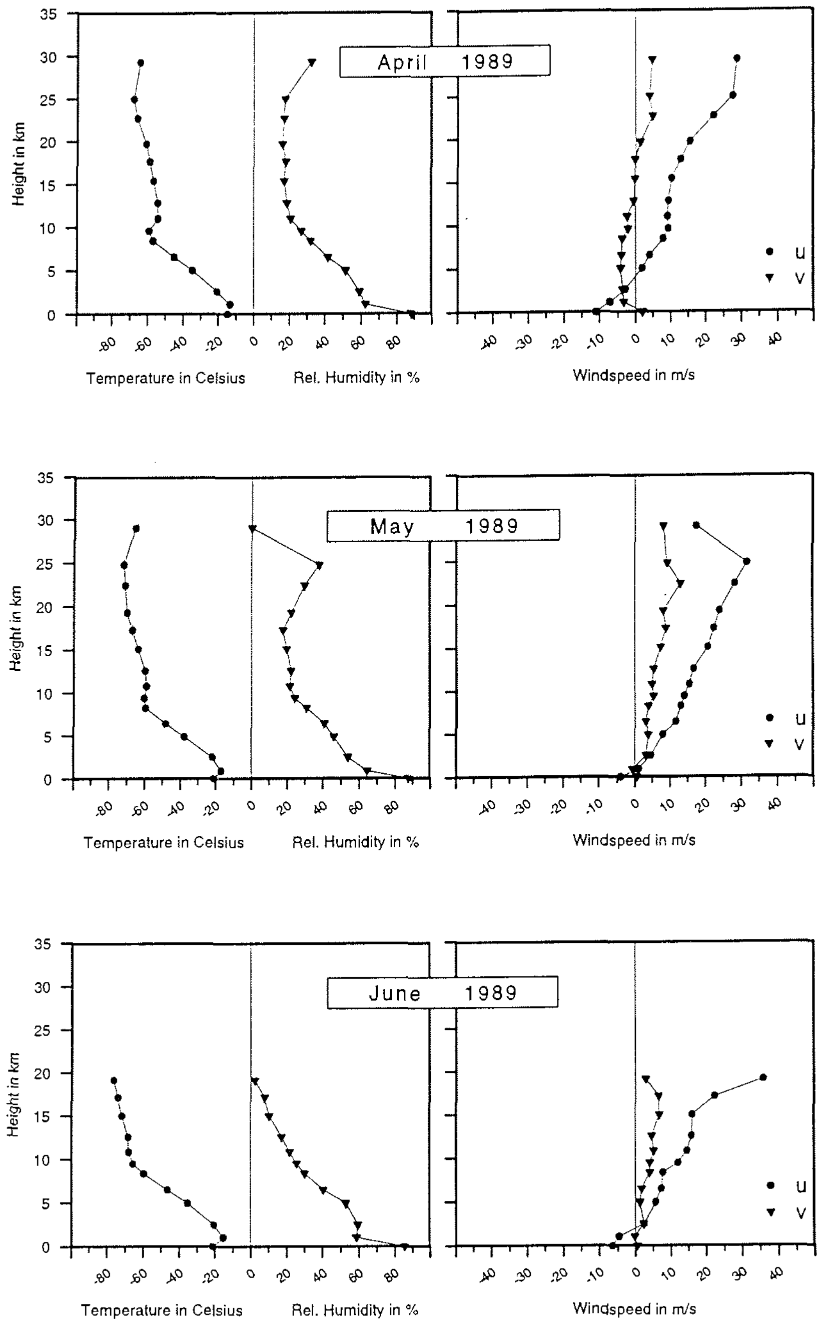




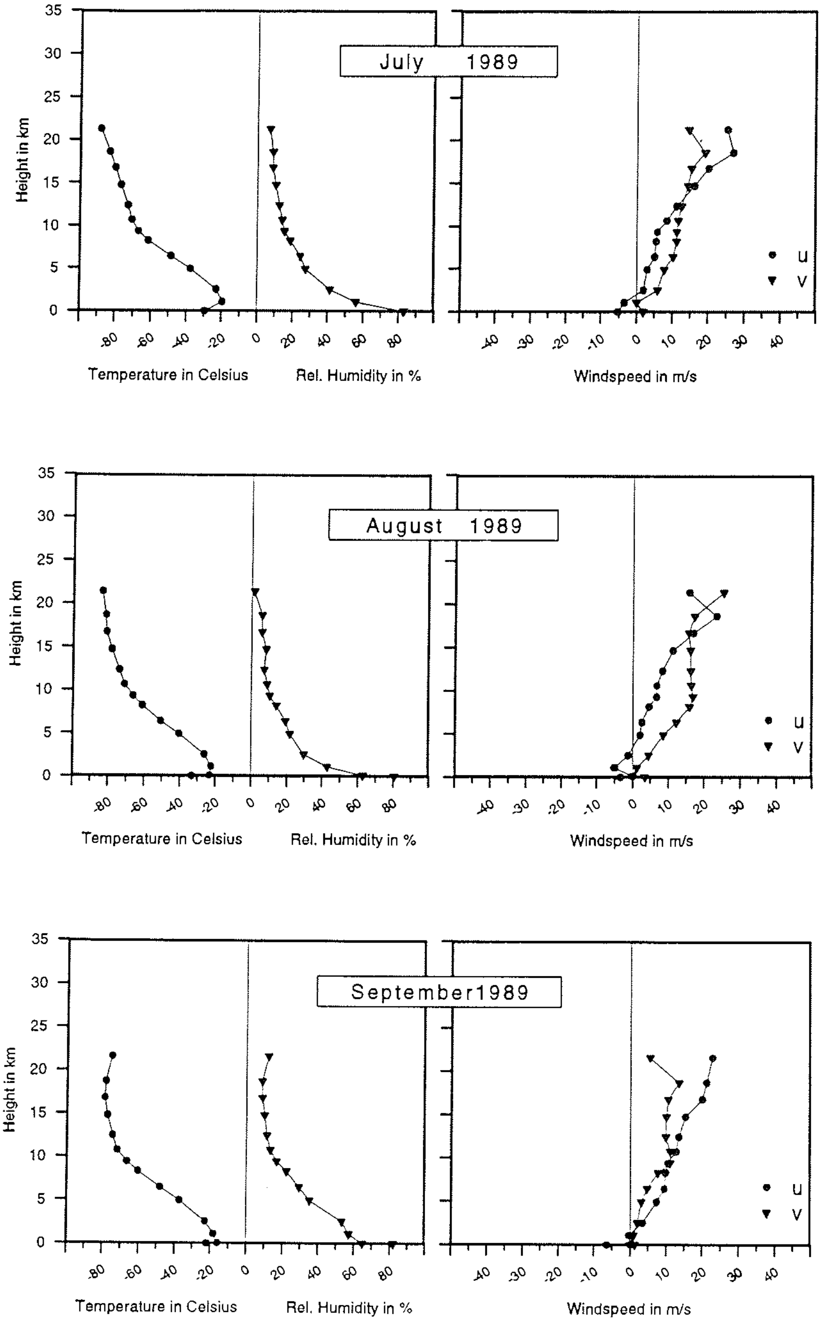
Figs. 17j-17*l* Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



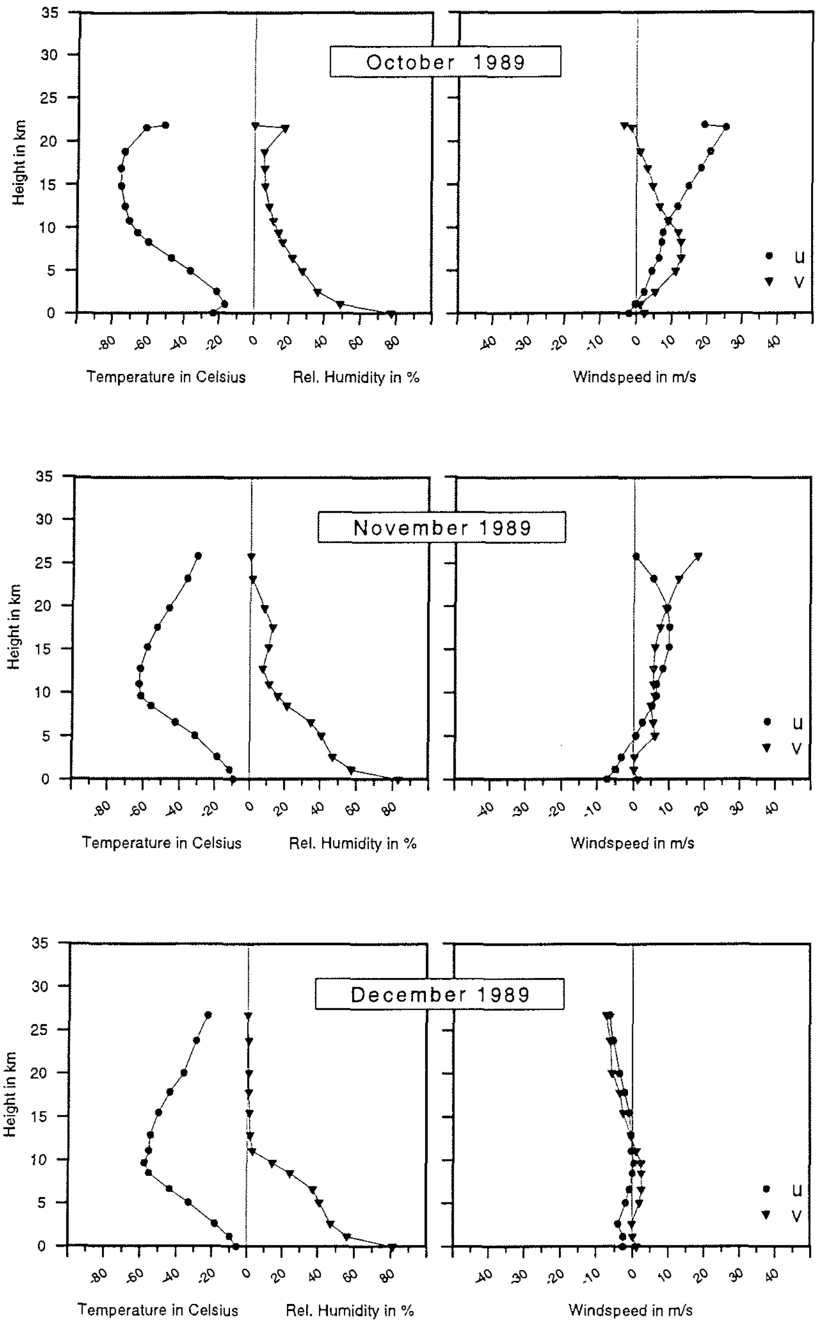
Figs. 18a-18c Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



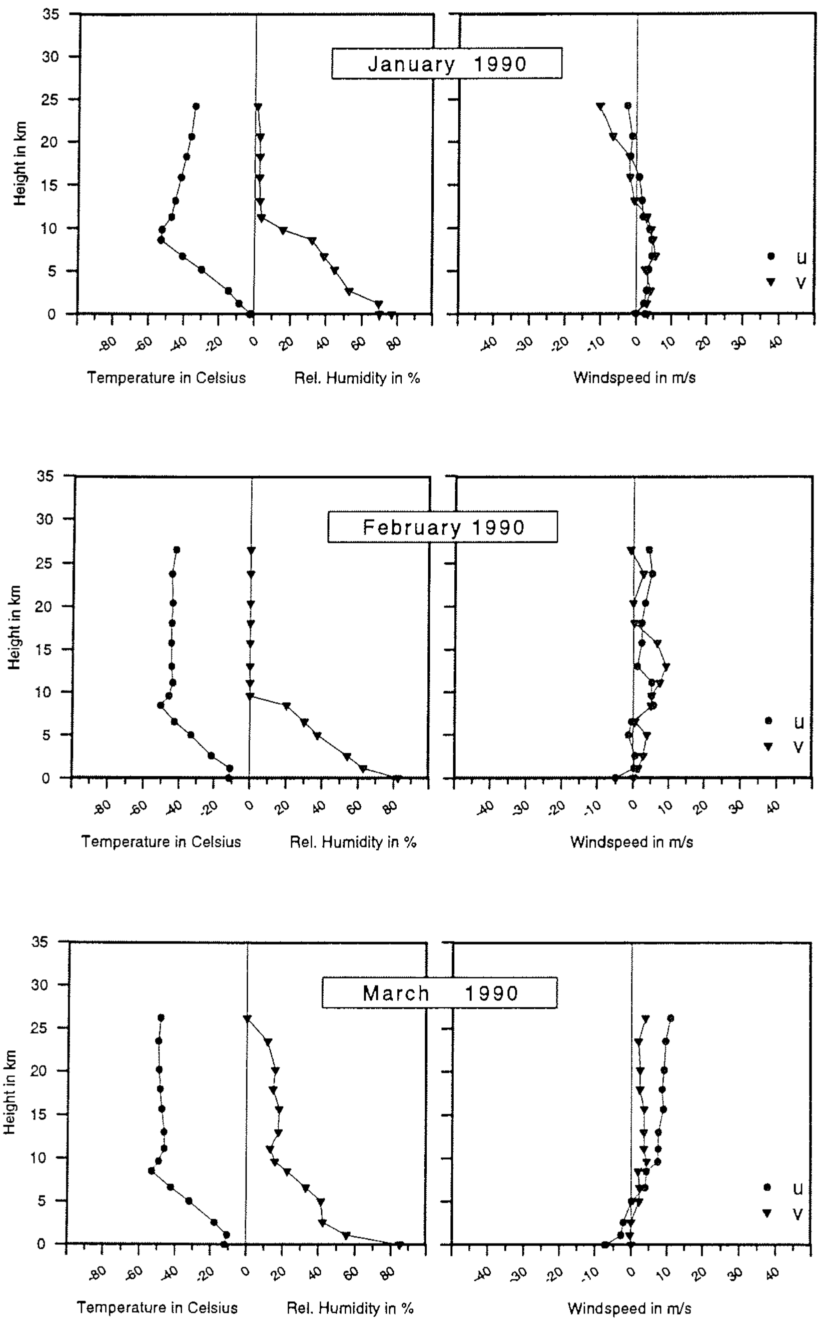
Figs. 18d-18f Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



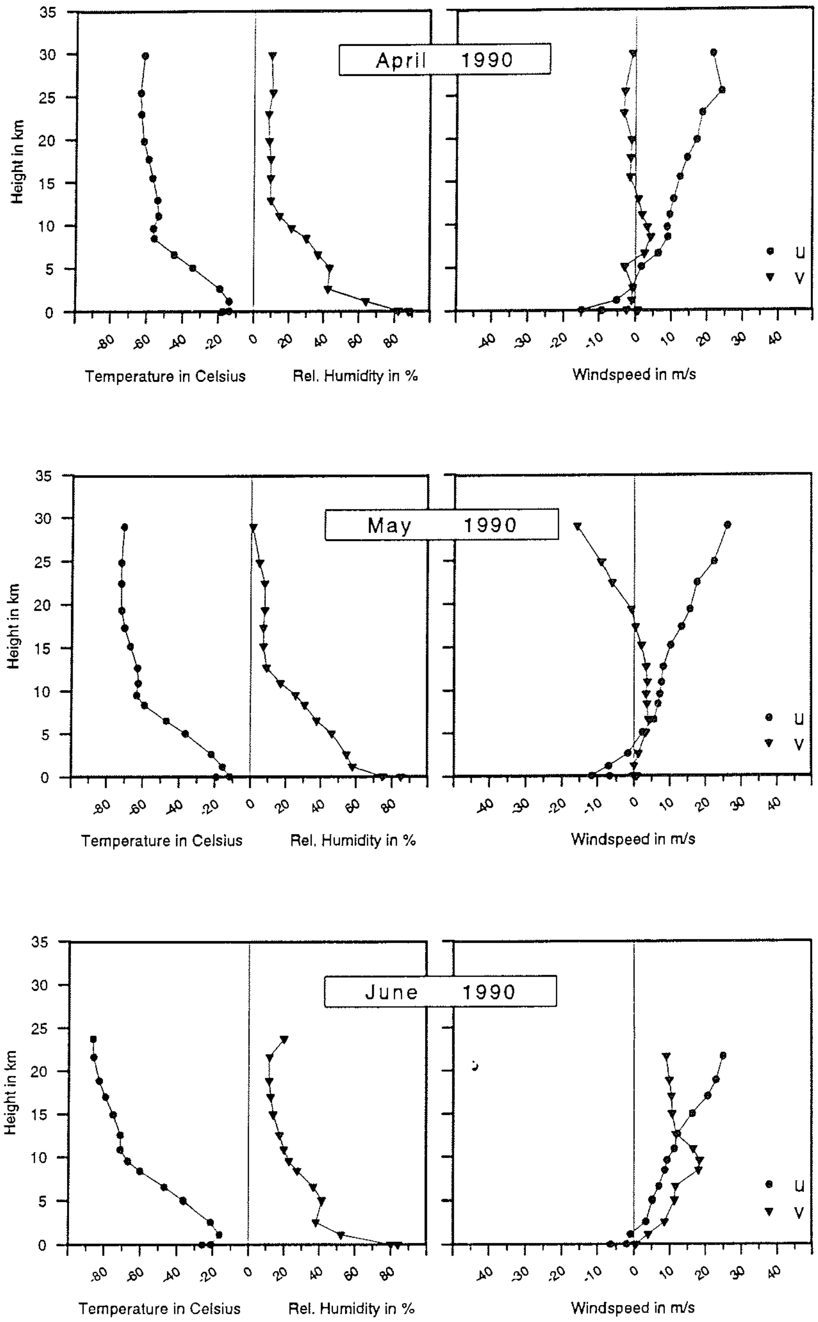
Figs. 18g-18i Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



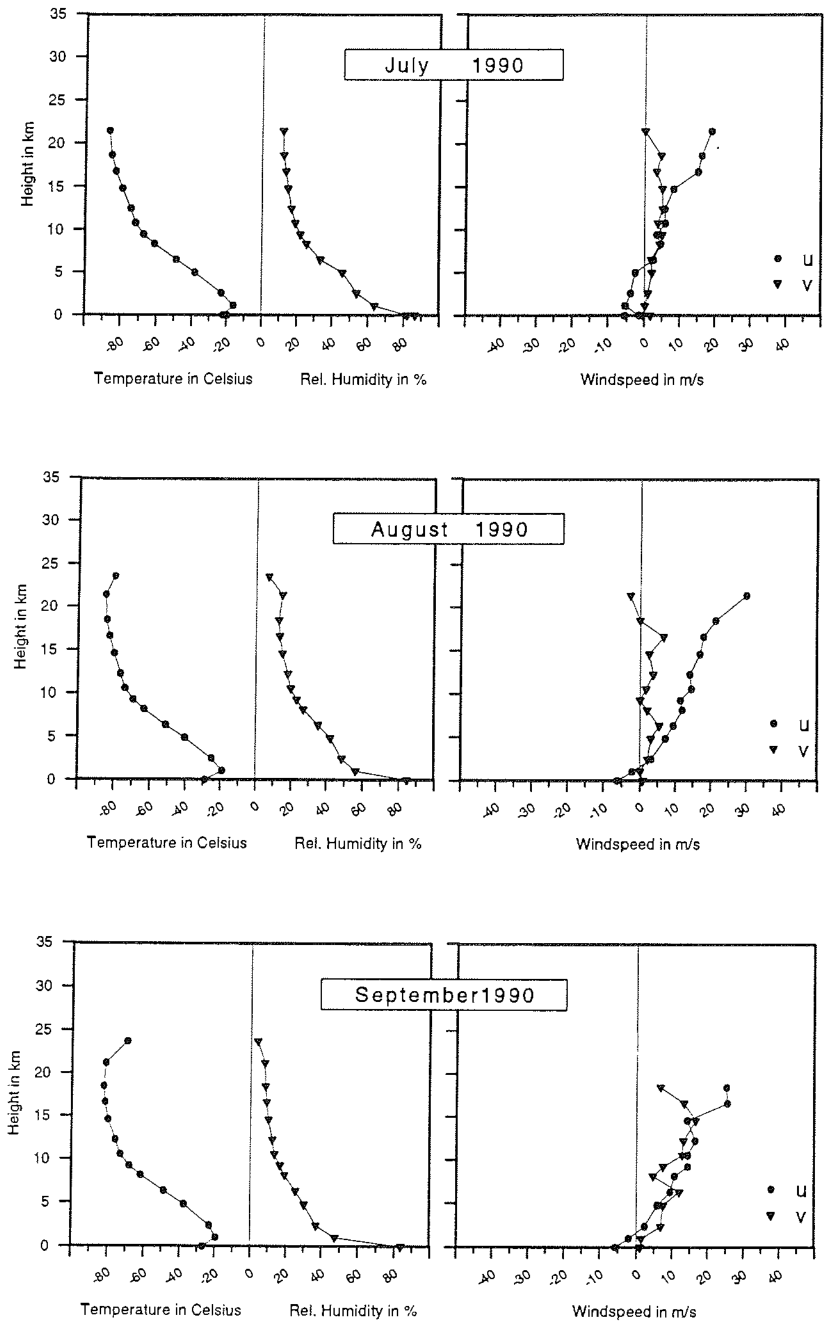
Figs. 18j-18*l* Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



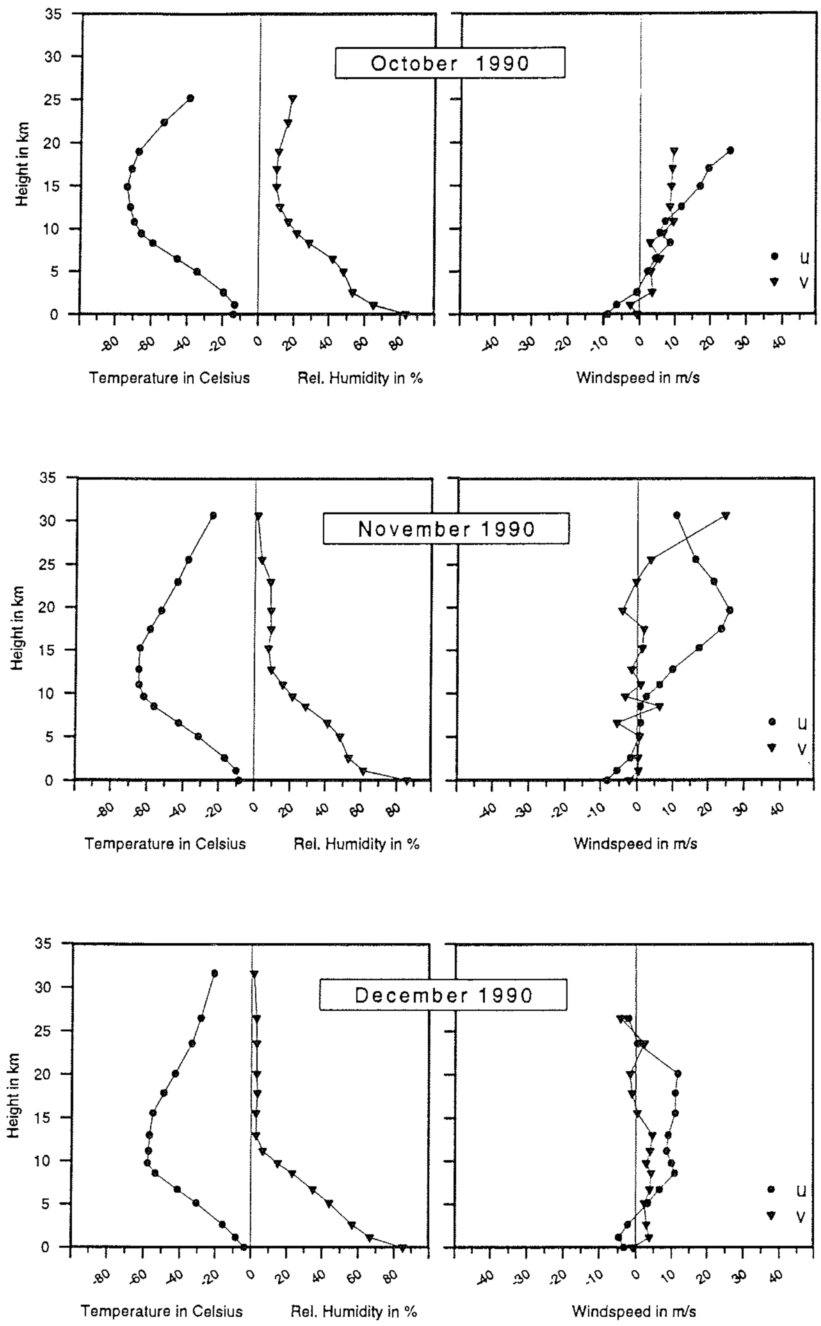
Figs. 19a-19c Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



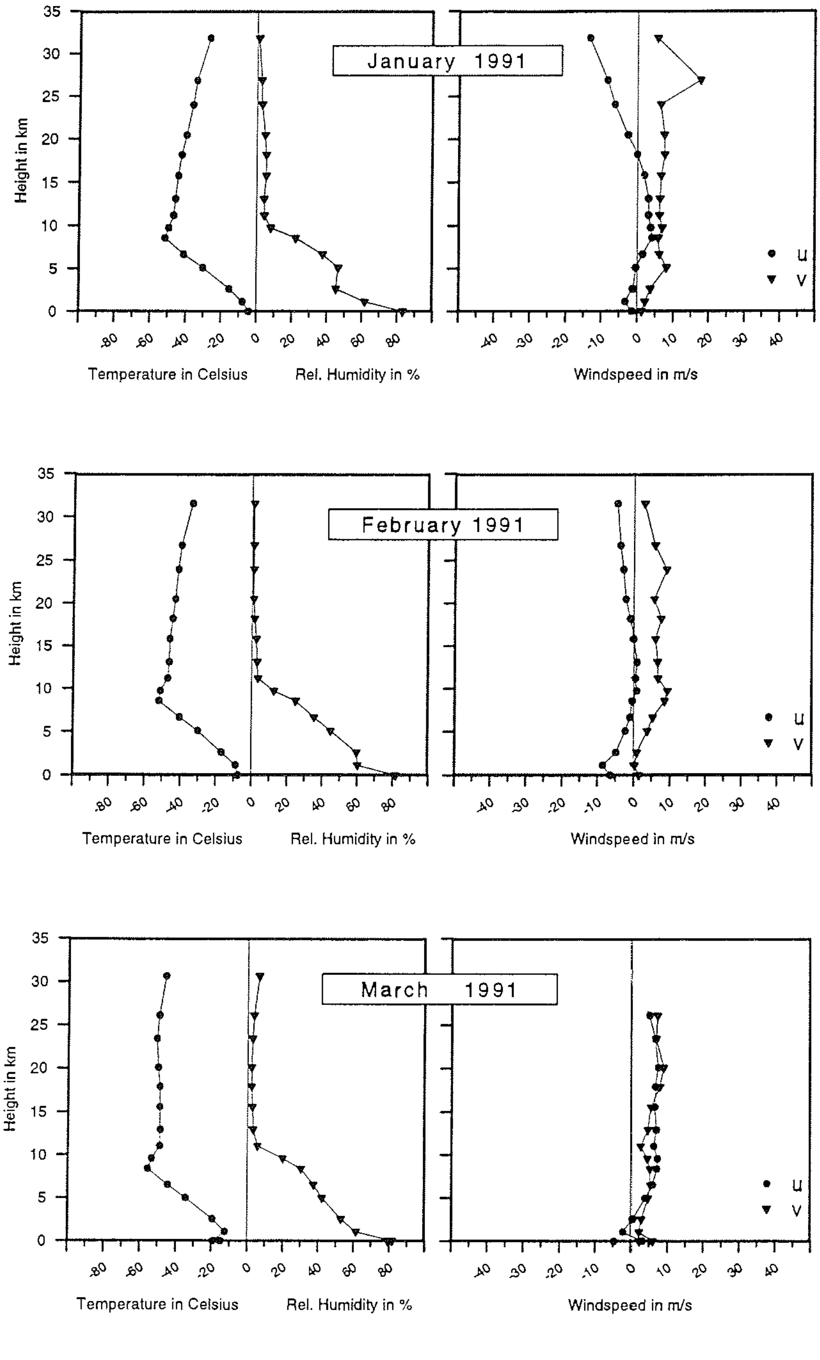
Figs. 19d-19f Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



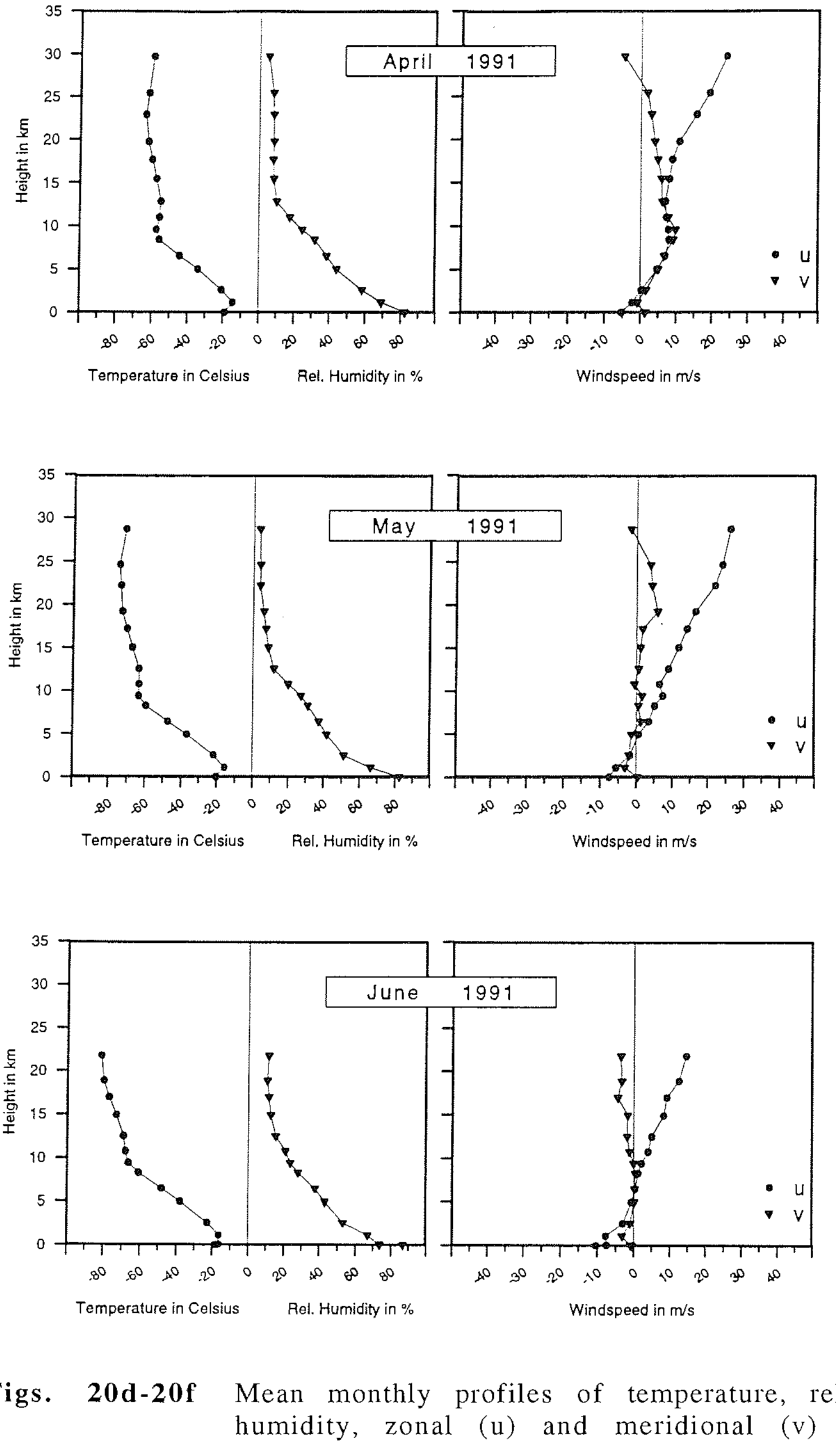
Figs. 19g-19i Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



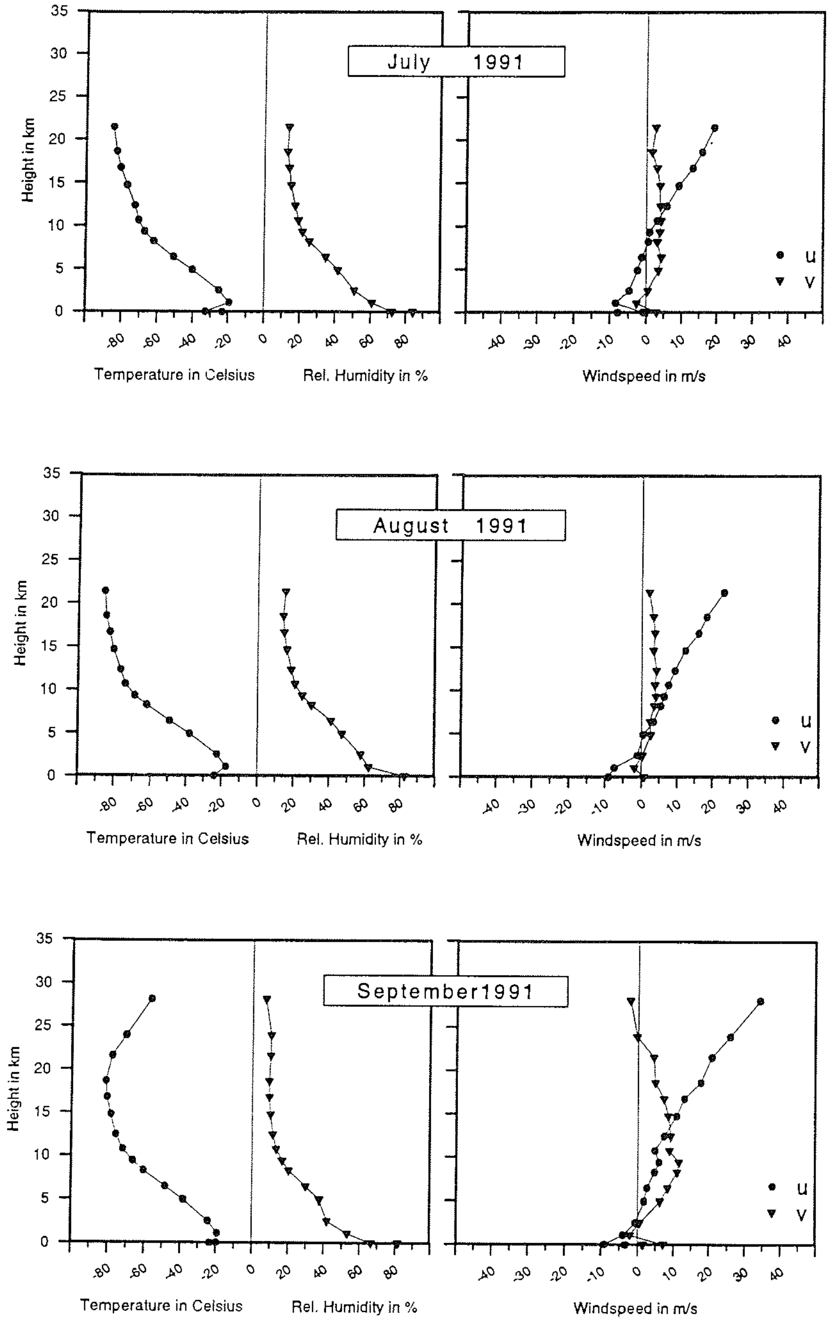
Figs. 19j-19*l* Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



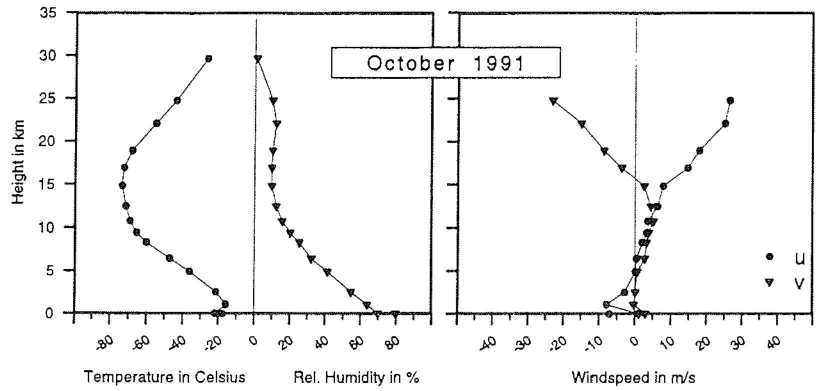
Figs. 20a-20c Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.

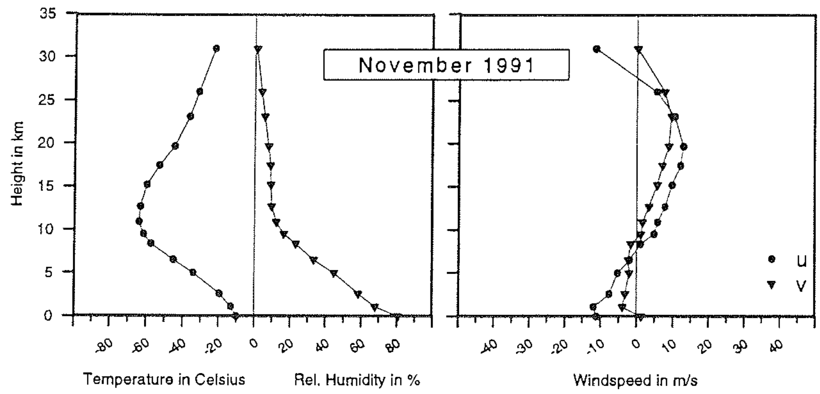


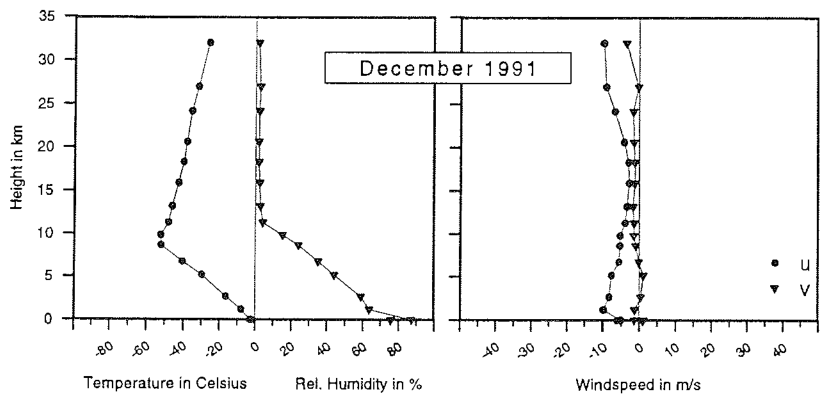
Figs. 20d-20f Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.



Figs. 20g-20i Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.







Figs. 20j-20*l* Mean monthly profiles of temperature, relative humidity, zonal (u) and meridional (v) wind component.

V. Acknowledgements

Thanks are due to all wintering crews at GvN, to Dr. S. El Naggar who took care of the scientific instrumentation, T. Götz for the development of the database management system, B. Loose and S. Wyrwa for their help in programming and data processing.

VI. References

Deutscher Wetterdienst (1982):
Wetterschlüsselhandbuch VuB2, Band A+B, Offenbach.

Gube, M. and Obleitner, F. (1986):
The meteorological data of the Georg-von-Neumayer Station for 1981 and 1982, Berichte zur Polarforschung 30.

Gube-Lenhardt, M. (1987):
The meteorological data of the Georg-von-Neumayer Station for 1983 and 1984, Berichte zur Polarforschung 38.

Helmes, L. (1989):
The meteorological data of the Georg-von-Neumayer Station for 1985, 1986 and 1987, Berichte zur Polarforschung 64.

Van Loon, H. and Rogers, J.C. (1984a):
The yearly wave in pressure and zonal geostrophic wind at sea level on the Southern Hemisphere and its interannual variability.
- Tellus 36 A, pp 348-354.

Van Loon, H. and Rogers, J.C. (1984b):
Interannual variations in the half-yearly cycle of pressure gradients and zonal wind at sea level on the Southern Hemisphere.
- Tellus 36 A, pp 76-86.

WMO (1983a):
Guide to climatological practices, WMO-No.100, World Meteorological Organization, Geneva.

WMO (1983b):
Guide to meteorological instruments and methods of observation, WMO-No.8, World Meteorological Organization, Geneva.