VEÐURSTOFA ÍSLANDS

Report

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Torfi Karl Antonsson
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Additional Wind and Stability Observations at Sómastaðagerði in Reyðarfjörður II

November 1999 - April 2000

VÍ-G00007-TA03
Reykjavík
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Contents

1. Introduction

From the beginning of May 1998 Veðurstofa Íslands – The Icelandic Meteorological Office - has made wind and stability observations in a 38 m high mast at Sómastaðagerði in Reyðarfjörður to provide necessary information in connection with plans for a proposed aluminium plant.

Two Reports have earlier been issued. The former, Wind and Stability Observations at Sómastaðagerði in Reyðarfjörður (VÍ-G99018-TA04), presents data for the period May 1998 - April 1999. The second Report, Additional Wind and Stability Observations at Sómastaðagerði in Reyðarfjörður (VÍ-G00001-TA01), covers the six month period May 1999-October 1999. The present Report contains the results of observations carried out during the six month period November 1999-April 2000 as well as comparison between the two 12 month periods May 1998-April 1999 and May 1999-April 2000. Three other Reports issued by Veðurstofa Íslands also contain meteorological information for the Reyðarfjörður area (Ref. 3-5).

A map of Reyðarfjörður is shown in Fig. 1. Present and former observation stations as well as new stations, mentioned in this report, are indicated on the map.

2. Observation Site and Instrumentation

The observation mast at Sómastaðagerði is located on a low gravel platform (65° 02.0' N, 14° 06.7' W), elevation of the platform 32 m above mean sea level. The instruments used in the mast have been the same from the beginning of the observations. Platinum resistance thermometers Logan 100PRT have been used for air temperature observations at 3.0 m, 10.5 m and 36.5 m above the platform. For protection from radiation and precipitation 6-plate Gill radiation shields have been used. For observations of wind direction and wind velocity a Wind Monitor-MA 05106, Marine Model, from R.M. Young has been used at 10.3 m height. Two Gill UVW anemometers are also installed at 10.8 m and 36.6 m and a Vaisala temperature and relative humidity sensor HMP-35D at 3.0 m, but data from these instruments are not used in this report. A Measurement and Control Module CR10X from Campbell Scientific, Inc. has been used for collecting the observation data. The observation mast is shown in Fig. 2 and the instruments at the 10 m level in Fig. 3.

A recalibration of the temperature sensors on 1 July 1999 and again on 19 January 2000 indicated that the measurements at 3.0 m height were underestimating temperature by 0.1° C compared to the temperature sensors at 10.5 m and 36.5 m heights. Stability has accordingly been slightly overestimated. Due to the small size of this correction and as only one recalibration was then available it was not applied in the former Reports (Ref. 1 and 2), but it has been used throughout the present Report. Absolutely speaking the temperature corrections are now believed to be + 0.1° C at 10.5 m and 36.5 m and + 0.2° C at 3.0 m height.

Fig. 1. Map of the Reyðarfjörður area.
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Current proposed and former observation weatherstations:

- □ Sómastaðagerði
- ■ Kollaleira
- △ Hillside, approx. 276 m.a.s.l.
- ● Vattarnes
- ▼ Eskifjörður
- ▲ Oddskarð
- ○ Former Station Eyri
- ▽ Seley
- ☒ Former Station Leirur
- ✦ Fagridalur

Fig. 2. The anemometer mast at Sómastaðagerði.
Photo: Flosi Hrafn Sigurðsson, 1999.

Fig. 3. Anemometers and thermometer at 10.3 - 10.8 m above the ground at Sómastaðagerði.
Photo: Flosi Hrafn Sigurðsson, 1999.

3. Wind Observations at Sómastaðagerði, November 1999-April 2000

Wind observations are unfortunately missing from15 March at 05:10 GMT to 28 March at 09:10 GMT. No other wind observations and no temperature observations were missing during the period November 1999-April 2000.

The frequency of the wind directions (in %) for each of the months November 1999-April 2000 is presented in Table 1 and as wind roses in the upper part of Annexes 1-6. For comparison the corresponding frequency for each month in the period November 1998-April 1999 is also shown in Table 1. As seen in the table westerly winds are by far the most common at Sómastaðagerði during these months of the year.

Table 1. Frequency of wind directions at Sómastaðagerði,
November 1999 - April 2000 and November 1998-April 1999, %

		November		December		January		February		March		April	
	Dir.	1999	1998	1999	1998	2000	1999	2000	1999	2000	1999	2000	1999
N	360	2.1	2.8	1.3	1.9	2.0	3.2	2.2	1.4	1.9	5.4	5.1	2.9
	10	1.2	1.5	1.3	1.4	1.2	1.5	1.5	1.0	0.7	1.6	1.7	1.8
	20	1.4	0.9	1.6	1.1	1.0	1.0	0.9	0.9	0.4	0.8	1.1	1.5
	30	1.7	0.8	1.5	1.5	1.3	0.9	1.1	1.1	0.9	0.7	0.9	1.0
	40	2.1	1.6	1.6	2.1	1.8	1.4	0.9	1.6	0.9	0.9	1.2	1.0
	50	3.0	3.2	2.1	2.9	2.5	2.4	1.7	2.3	1.4	1.6	1.4	2.1
	60	3.6	6.0	4.1	4.5	2.9	3.3	3.7	2.9	2.3	1.7	2.5	3.4
	70	3.0	6.8	4.7	3.8	3.0	4.0	4.7	3.8	4.2	1.6	2.2	3.5
	80	1.9	6.4	6.4	4.0	2.4	3.9	5.7	2.6	4.7	1.8	1.9	2.5
E	90	1.1	4.4	7.0	3.9	1.4	3.5	4.6	2.3	4.9	2.0	1.6	2.1
	100	0.7	1.7	3.0	2.5	1.0	3.0	2.9	1.1	1.8	1.5	0.9	1.3
	110	0.6	1.6	2.0	2.2	0.8	1.6	1.2	0.5	1.4	1.5	0.9	1.7
	120	0.7	1.6	1.6	2.1	0.4	2.5	0.8	0.2	0.8	1.1	1.0	1.5
	130	0.5	1.1	1.3	1.5	0.4	1.4	0.8	0.3	2.2	0.5	1.0	1.1
	140	0.2	0.7	0.4	1.0	0.2	0.6	0.5	0.2	0.3	0.3	0.5	0.7
	150	0.2	0.6	0.2	0.5	0.2	0.5	0.3	0.2	0.1	0.1	0.5	0.8
	160	0.2	0.5	0.1	0.5	0.3	0.2	0.3	0.2	0.1	0.1	0.3	0.5
	170	0.3	0.4	0.0	0.6	0.2	0.4	0.3	0.3	0.1	0.2	0.3	0.3
S	180	0.1	0.4	0.1	0.7	0.2	0.2	0.4	0.6	0.1	0.2	0.3	0.4
	190	0.3	0.4	0.1	0.6	0.2	0.3	0.5	0.5	0.0	0.1	0.3	0.5
	200	0.3	0.5	0.2	0.6	0.3	0.3	0.5	0.6	0.2	0.4	0.6	0.5
	210	0.4	0.7	0.2	0.7	0.5	0.6	0.4	0.7	0.0	0.2	0.7	1.0
	220	0.3	0.9	0.4	0.8	0.6	1.1	0.6	1.0	0.6	0.4	1.1	1.6
	230	1.2	1.6	0.8	1.1	1.2	1.9	1.1	1.6	0.9	1.4	2.3	4.0
	240	2.1	3.8	1.6	2.2	2.0	3.8	1.9	2.7	2.2	3.5	3.9	6.5
	250	4.0	4.7	3.3	4.4	4.7	5.5	3.0	4.4	4.2	5.9	5.5	8.3
	260	7.5	7.2	5.6	7.3	6.6	7.1	6.2	6.0	5.1	8.9	7.2	8.7
W	270	13.1	9.2	11.7	11.6	11.4	10.3	9.1	9.8	10.6	15.6	12.2	7.4
	280	14.6	9.1	10.7	10.3	17.4	8.3	10.3	15.9	16.7	10.8	9.7	7.7
	290	12.7	5.8	8.3	6.7	12.5	5.1	10.2	11.7	9.0	8.6	6.9	6.7
	300	6.4	3.5	5.5	3.9	5.7	4.1	6.5	7.2	5.7	5.4	4.3	2.9
	310	3.4	2.2	3.5	3.3	4.4	3.0	5.1	4.3	4.7	3.9	4.0	2.7
	320	2.0	2.0	1.6	2.0	2.8	2.3	2.9	3.4	2.6	2.6	3.5	1.8
	330	1.6	1.4	1.5	1.6	2.1	2.5	2.2	2.8	1.6	2.1	3.2	2.3
	340	2.1	1.4	1.7	1.4	1.7	3.0	1.8	1.9	2.1	1.9	3.1	2.5
	350	1.7	2.2	1.6	2.8	1.7	4.1	1.7	1.9	1.9	4.0	3.8	2.6
Calm		1.6	0.3	1.5	0.3	1.0	0.9	1.7	0.1	2.3	0.6	2.5	2.2

The average wind velocity for the months November 1999-April 2000 is shown in Table 2 and for each wind direction during these months in the lower part of Annexes

1-6. For comparison the averages for the months November 1998- April 1999 are also presented in Table 2.

Table 2. Average wind velocity at Sómastaðagerði, 10.3 m height, November 1999-April 2000 and November 1998-April 1999, m/s.

November		December		January		February		March		April	
1999	1998	1999	1998	2000	1999	2000	1999	2000	1999	2000	1999
4.7	5.1	5.4	5.3	6.4	4.8	6.6	6.8	6.1	5.8	4.2	3.9

The highest 10 minute wind velocity, 29.5 m/s, was observed in westerly wind direction (288°) on 6 March 2000, between 00:00 and 00:10 GMT. The highest gust 45.2 m/s was observed the evening before, on 5 March between 21:10 and 21:20 GMT. This gives a gust factor of 1.53. No higher gusts or 10 minute windspeeds were observed in the period May-October 1999, so these extremes are also valid for the 12 month period May 1999-April 2000. During the 12 months before, May 1998-April 1999, the highest observed 10 minute wind velocity was 26.9 m/s and the highest gust was 42.9 m/s, gust factor 1.60.

To complete wind informations for the second 12 months of observations a wind rose for that year is presented in the upper part of Annex 7 and for the two six month periods, October 1999-March 2000, and May-September 1999 and April 2000 repectively in Annex 8 and Annex 9. In the lower part of these Annexes the average wind velocity of each wind direction is presented.

Finally the frequency of 10 minute wind velocity in the period May 1999-April 2000 is shown for selected velocity intervals in Table 3.

Table 3. Frequency of 10 minute wind velocity for selected intervals, Sómastaðagerði, May 1999-April 2000, %.

m/s	0.0-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	0.0-4.9	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	>25.0
Jan	6.2	10.1	10.1	9.7	9.5	45.6	34.7	13.5	4.6	1.6	0.0
Feb	6.9	8.6	7.5	7.2	8.5	38.7	39.1	19.1	2.8	0.3	
Mar	10.2	12.7	10.9	8.0	7.9	49.7	30.5	14.3	2.8	2.1	0.6
Apr	11.3	16.7	16.1	12.4	8.6	65.1	29.2	5.7	0.0		
May	11.0	15.6	15.9	13.1	15.5	71.1	27.3	1.6			
Jun	11.2	13.3	14.9	15.5	13.6	68.5	28.4	2.6	0.5		
Jul	15.6	15.4	13.6	13.6	9.0	67.2	30.8	1.9			
Aug	22.8	20.8	17.1	14.2	12.1	87.1	12.6	0.3			
Sep	15.8	17.7	13.3	11.8	10.8	69.4	27.8	2.5	0.3		
Oct	12.7	15.1	12.4	10.0	12.9	63.2	29.8	6.7	0.2		
Nov	12.0	16.8	11.6	8.4	6.9	55.7	36.5	7.2	0.6		
Dec	9.6	13.7	9.4	6.9	6.0	45.6	43.6	10.7	0.1		
Year	12.2	14.8	12.8	11.0	10.2	61.0	30.8	6.9	0.9	0.3	0.1

For the period as a whole the velocity distribution is very similar as for the 12 month period May 1998-April 1999.

We point out the extraordinary high frequency of low wind velocities in August 1999, when the 10 minute wind speed was below 2.0 m/s in 43.6 % of cases and below 5.0 m/s in 87.1 % of all cases.

4. Temperature and Stability Observations at Sómastaðagerði, November 1999-April 2000

The average monthly air temperature at 3.0 m, 10.5 m and 36.5 m above the ground is shown in Table 4 for the months November 1999-April 2000 and November 1998-April 1999. For comparison the monthly mean temperature at 2.0 m above the ground at the manned weather station Kollaleira (65° 02' N, 14° 14' W, 40 m a.m.s.l.) is also presented. The temperature sensor corrections + 0.1° C at 10.5 and 36.5 m heights and + 0.2° C at 3.0 m height have been applied at Sómastaðagerði.

Table 4. Average monthly air temperature at 3.0 m, 10.5 m 36.5 m heights, Sómastaðagerði, November 1999-April 2000 and November 1998-April 1999, ° C.

	November		December		January		February		March		April	
	1999	1998	1999	1998	2000	1999	2000	1999	2000	1999	2000	1999
$T_{3.0}$	2.11	1.88	-0.93	1.39	1.92	-0.20	-0.42	-0.99	-0.26	-1.57	-0.81	0.91
$T_{10.5}$	2.57	2.23	-0.59	1.78	2.36	0.17	-0.08	-0.68	0.13	-1.34	-0.59	1.11
$T_{36.5}$	2.79	2.35	-0.50	1.89	2.53	0.27	-0.03	-0.60	0.20	-1.34	-0.61	1.16
$T_{36.5}$-$T_{3.0}$	0.68	0.47	0.43	0.50	0.61	0.47	0.39	0.39	0.46	0.23	0.20	0.25
$T_{36.5}$-$T_{10.5}$	0.22	0.12	0.09	0.11	0.17	0.10	0.05	0.08	0.07	0.00	-0.02	0.05
$Kollaleira_{2.0}$	1.9	1.8	-1.4	1.1	1.5	-0.7	-1.0	-1.6	-0.6	-1.9	-1.0	0.7

The temperature difference between 36.5 m and 3.0 m heights and 36.5 m and 10.5 m heights are also presented in Annexes 10-15 for each of the months November 1999-April 2000. The data for the first day of the month begin where 1 is marked on the x-axis of the diagrams, the data for the second day where 2 is marked etc. For the same months the mean diurnal variation of the temperature difference between the observation levels is shown in Annexes 16-18.

It is noteworthy how stable the lowest air layer usually is at Sómastaðagerði during the wintertime. As seen in Table 3, the monthly mean temperature during the period November-April has always been higher at 36.5 m than at 3.0 m above the ground. The monthly mean temperture at the 36.5 m level has also in most cases been slightly higher than at the 10.5 m level. On average, there is accordingly a ground based inversion layer at Sómastaðagerði during this period. As shown in Annexes 10-14, the lowest air layer is practically always stable at Sómastaðagerði during the months November-March.

At the weather station Kollaleira, located near the end of the fiord and some 6 km west and inland from Sómastaðagerði, the monthly mean temperatures are somewhat lower than at Sómastaðagerði during the winter but higher during the summer.

5. Data Comparison between the Periods May 1998-April 1999 and May 1999-April 2000 for Sómastaðagerði

Data for each of the 24 consecutive months from May 1998 to April 2000 are now available in three Reports issued by Veðurstofa Íslands, the present one and the two previous Reports, ref. 1 and 2. Pairs or groups of months can therefore easily be

compared. In Fig. 4 a comparison is presented for the frequency and mean wind speed of the wind directions during the two 12 month periods (or whole years), May 1998-April 1999 and May 1999-April 2000. In Fig. 5 and 6 a similar comparison is presented for six month periods, on the one hand for autumn and winter (October-March), on the other for spring and summer (April-September).

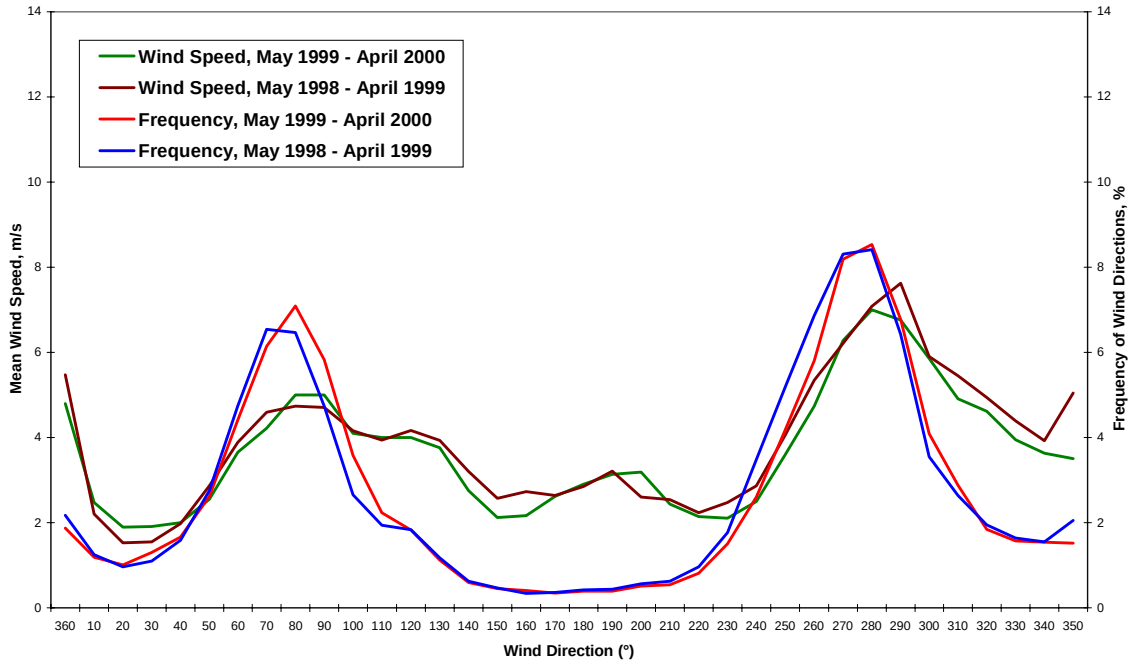


Fig. 4. Wind comparison, the whole year periods, May 1998-April 1999 and May 1999-April 2000.

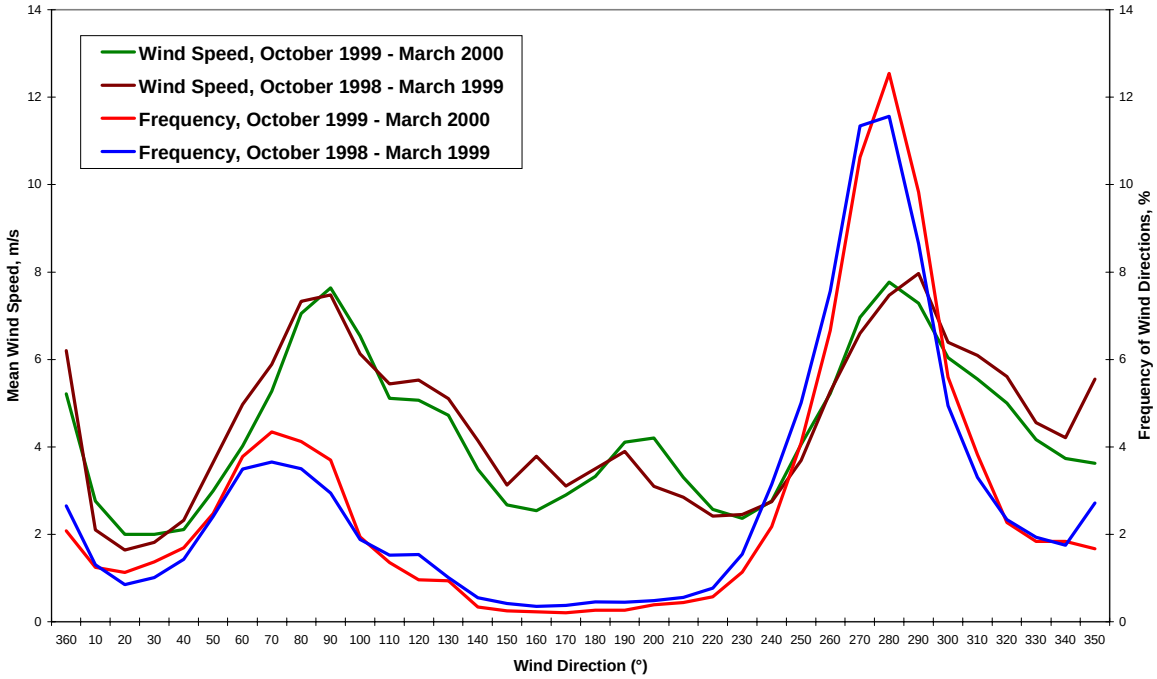


Fig. 5. Wind comparison, the six month autumn and winter seasons, October 1998-March 1999 and October 1999-March 2000.

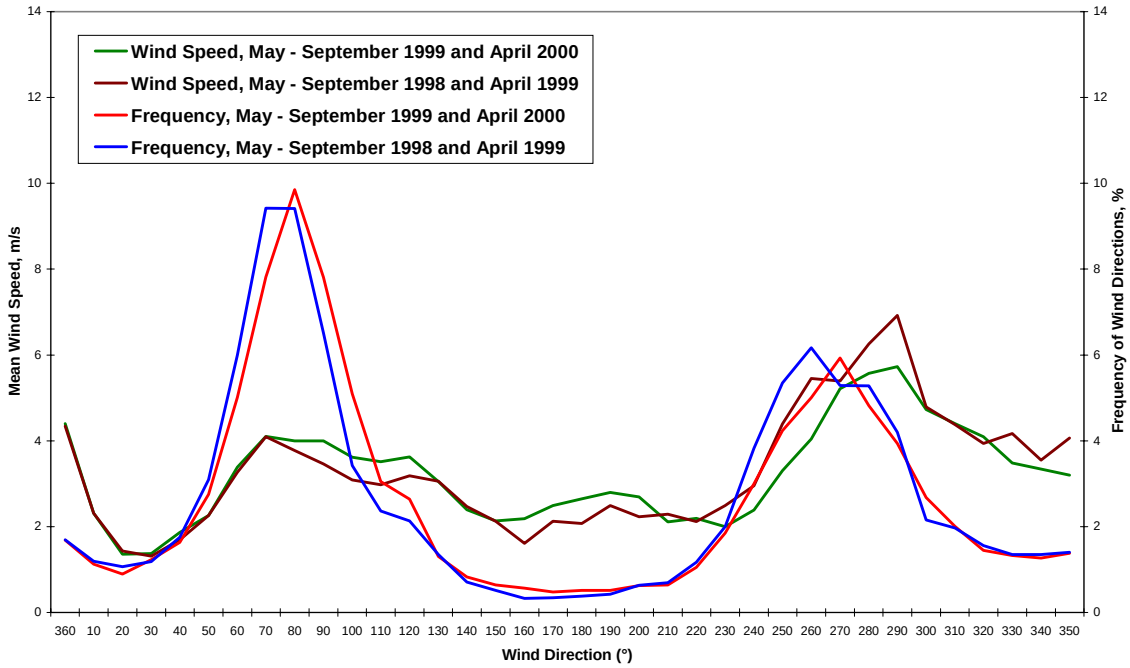


Fig. 6. Wind comparison, the six month spring and summer seasons, May-September 1998 and April 1999, May-September 1999 and April 2000.

As seen by Fig. 4-6 the mean wind conditions have been very similar during the compared periods. Earlier (Ref. 2) we have concluded that the wind data from Sómastaðagerði for the period May 1998-April 1999 probably are representative and near average for the 15 year period 1983-1997. This should then also be valid for the period May 1999-April 2000.

In a similar way and for the same periods a comparison is presented in Annexes 19-21 for the average diurnal temperature difference between the 36.5 m and 3.0 m levels in the mast at Sómastaðagerði.

As seen from these Annexes the mean diurnal temperature difference between the two levels, i.e. the stability conditions, have been very similar during the compared periods. The small difference between the graphs for the two years (Annexes 19-21) indicates the latter year has been slightly more stable than the former. However, the difference is small and of the same order of magnitude as the accuracy of the temperature observations.

6. Remarks

Wind and stability observations in the mast at Sómastaðagerði have now been performed during 24 consecutive months or two years, May 1998-April 2000. For the first year, May 1998-April 1999, Norwegian Institute for Air Research has carried out dispersion model calculations for the planned aluminium smelter at the former farms Hraun and Sómastaðagerði. Data for the second year, May 1999-April 2000 are now available for further model calculations.

7. The Need for Further Observations and Permanent Monitoring

It has now been decided to continue the observations in the mast at Sómastaðagerði for the additional year, May 2000-April 2001. For further clarification of the air circulation inside Reyðarfjörður it has also been decided to install three automatic wind and temperature stations in Reyðarfjörður, at Vattarnes at the mouth of the fiord, on a promontory in the hillside above Framnes (approx. 276 m a.m.s.l.) and at the recently slightly moved weather station Kollaleira. These three stations will be operated for one year and are planned to be operational from the beginning of June 2000.

If the planned aluminium plant will be built at Hraun/Sómastaðagerði, monitoring of pollution and weather will be necessary in Reyðarfjörður. Wind and stability observations, preferably between the aluminium smelter and Búðareyri, would be of great help in evaluating the results of the pollution monitoring. Perhaps the observation mast, presently at Sómastaðagerði, could then be moved to a suitable place near or shortly east of Teigargerði.

8. References

1. Flosi Hrafn Sigurðsson, Hreinn Hjartarson, Torfi Karl Antonsson and Þórður Arason: Wind and Stability Observations at Sómastaðagerði in Reyðarfjörður, May 1998-April 1999. Veðurstofa Íslands, Report VÍ-G99018-TA04, Reykjavík, October 1999, 55 p.

2. Flosi Hrafn Sigurðsson, Hreinn Hjartarson, Torfi Karl Antonsson and Þórður Arason: Additional Wind and Stability Observations at Sómastaðagerði in Reyðarfjörður. (May-October 1999). Veðurstofa Íslands, Report VÍ-G00001-TA01, Reykjavík, January 2000, 36 p.

3. Flosi Hrafn Sigurðsson, Hreinn Hjartarson, Torfi Karl Antonsson and Þórður Arason: Wind Observations at Eyri and Leirur in Reyðarfjörður. Veðurstofa Íslands, Report VÍ-G99015-TA03, Reykjavík, August 1999, 32 p.

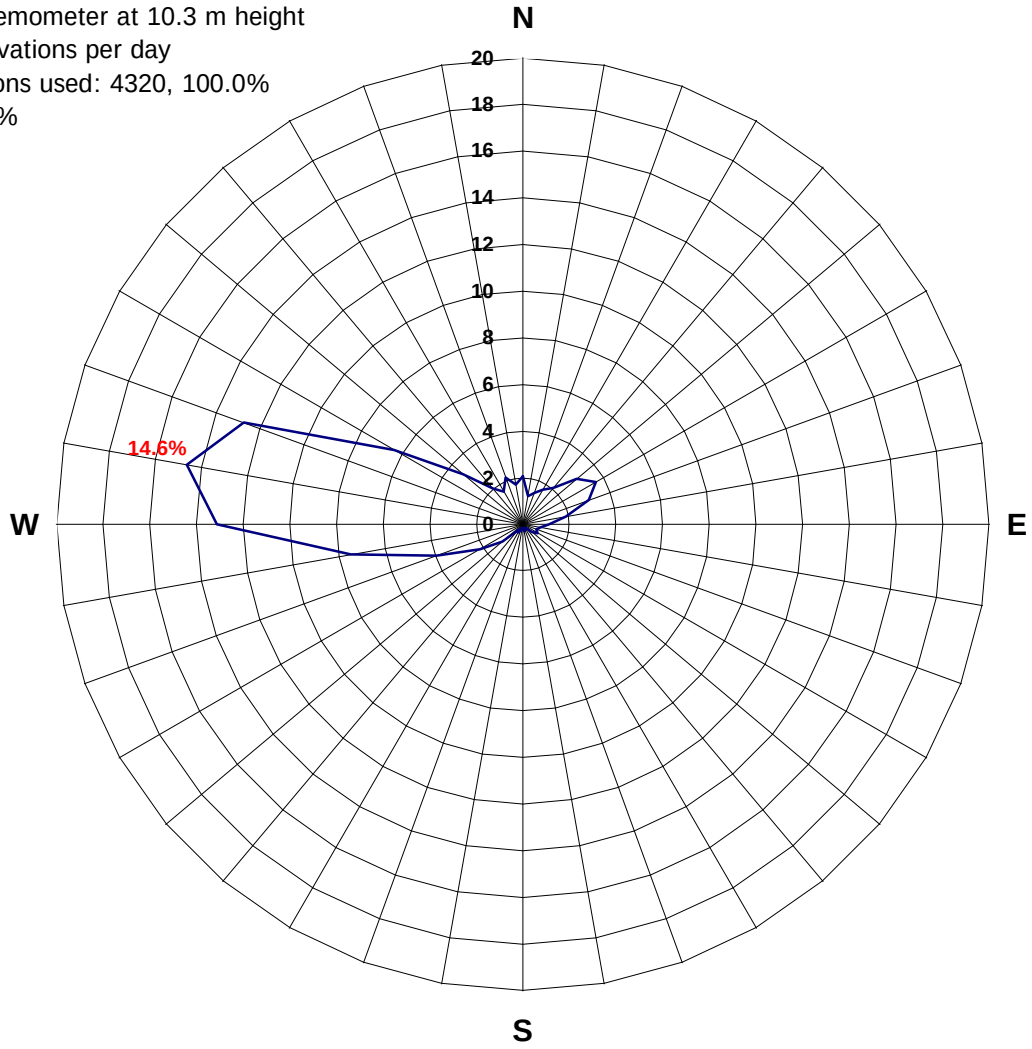
4. Flosi Hrafn Sigurðsson, Hreinn Hjartarson, and Torfi Karl Antonsson: Vindmælingar að Kollaleiru (Wind Observations at Kollaleira). Veðurstofa Íslands, Greinargerð VÍ-G99009-TA02, Reykjavík, June 1999, 41 p. (In Icelandic).

5. Flosi Hrafn Sigurðsson and Hreinn Hjartarson: Veðurathuganir á Reyðarfjarðarsvæðinu (Weather Observations in the Reyðarfjörður Area). Veðurstofa Íslands, Reykjavík 1986, 116 p. (In Icelandic).

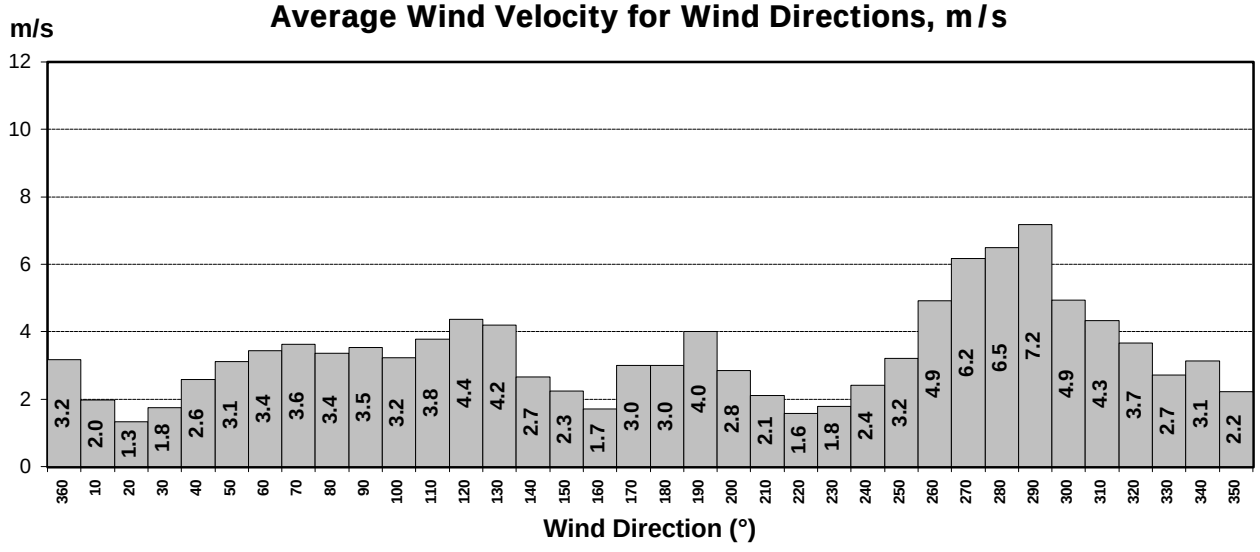
Annexes 1 - 21

Frequency of Wind Directions, %
November 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4320, 100.0%
Calm: 1.6%



Average Wind Velocity for Wind Directions, m/s

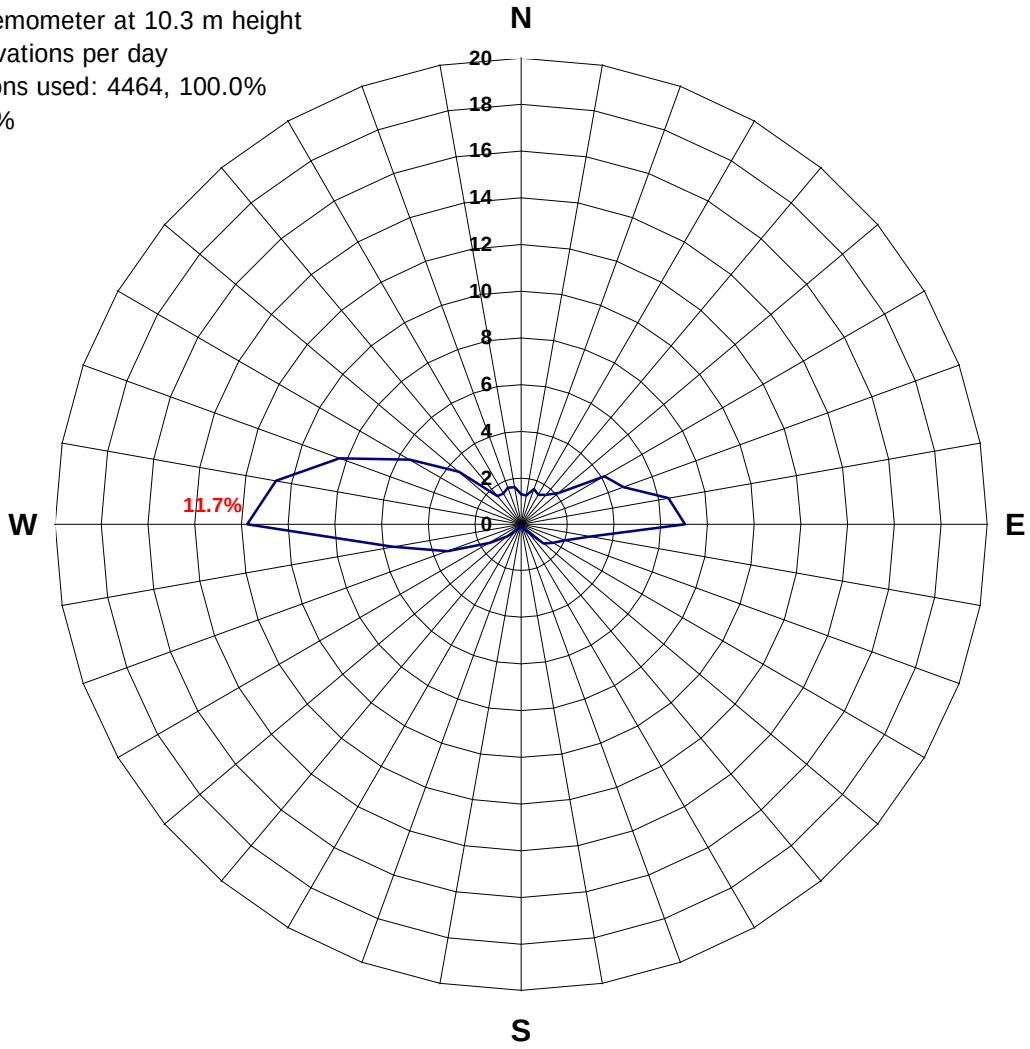


Annex 1

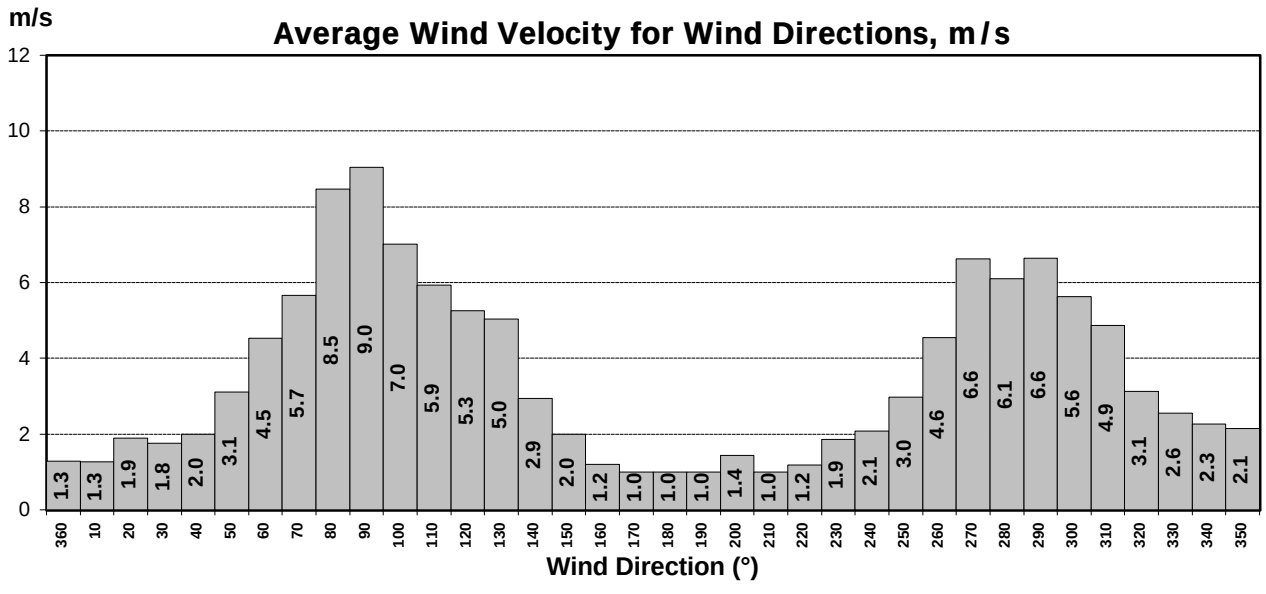
Reyðarfjörður

Frequency of Wind Directions, %
December 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 1.5%



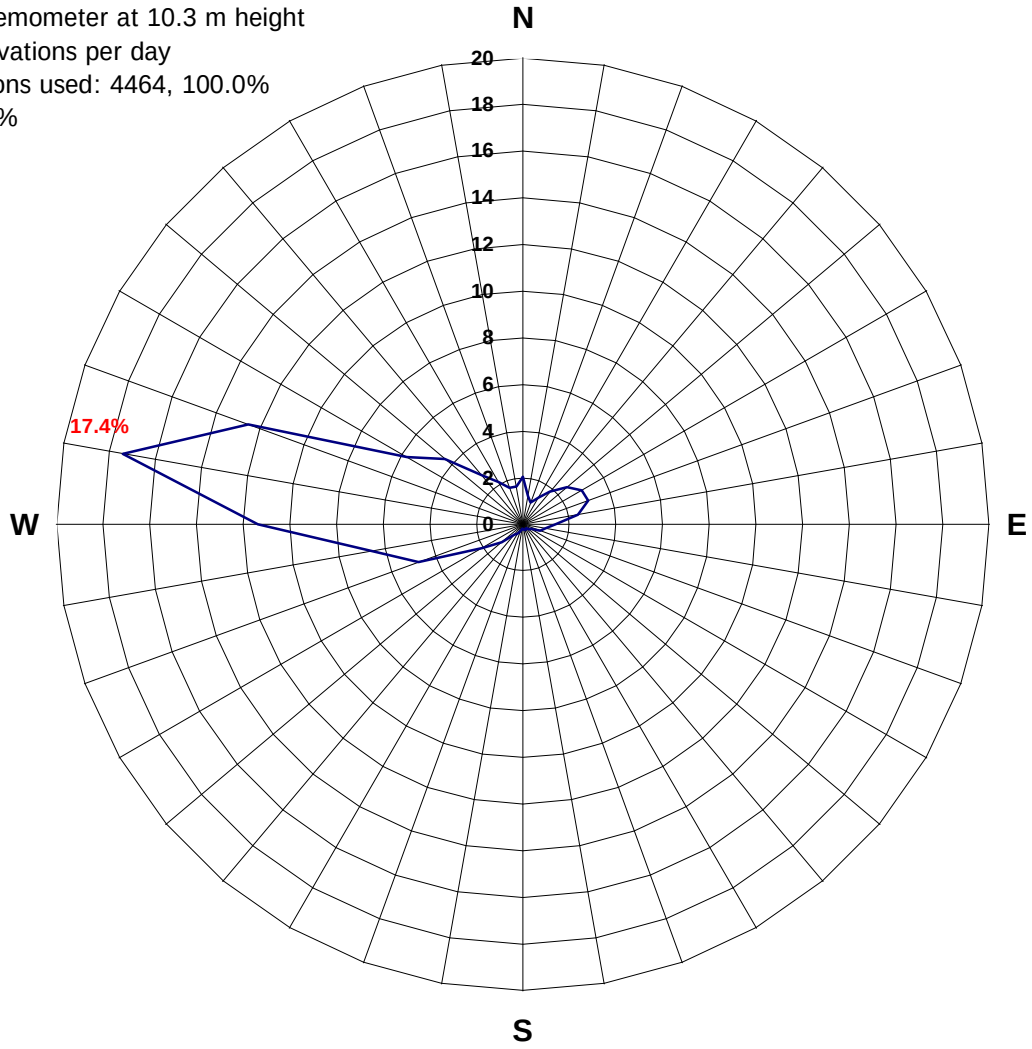
Average Wind Velocity for Wind Directions, m/s



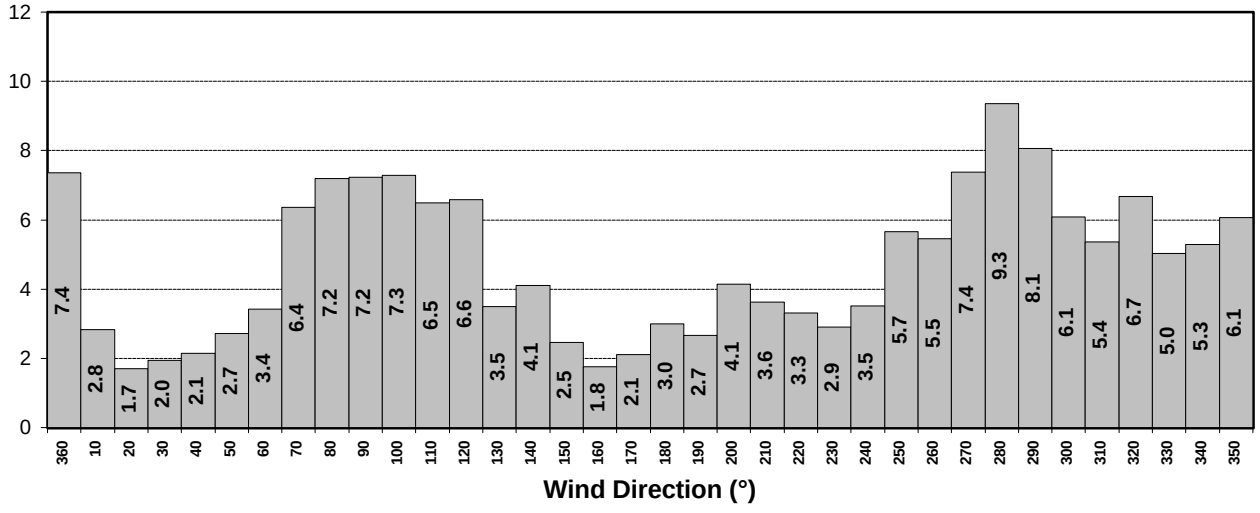
Annex 2

Frequency of Wind Directions, %
January 2000

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 1.0%

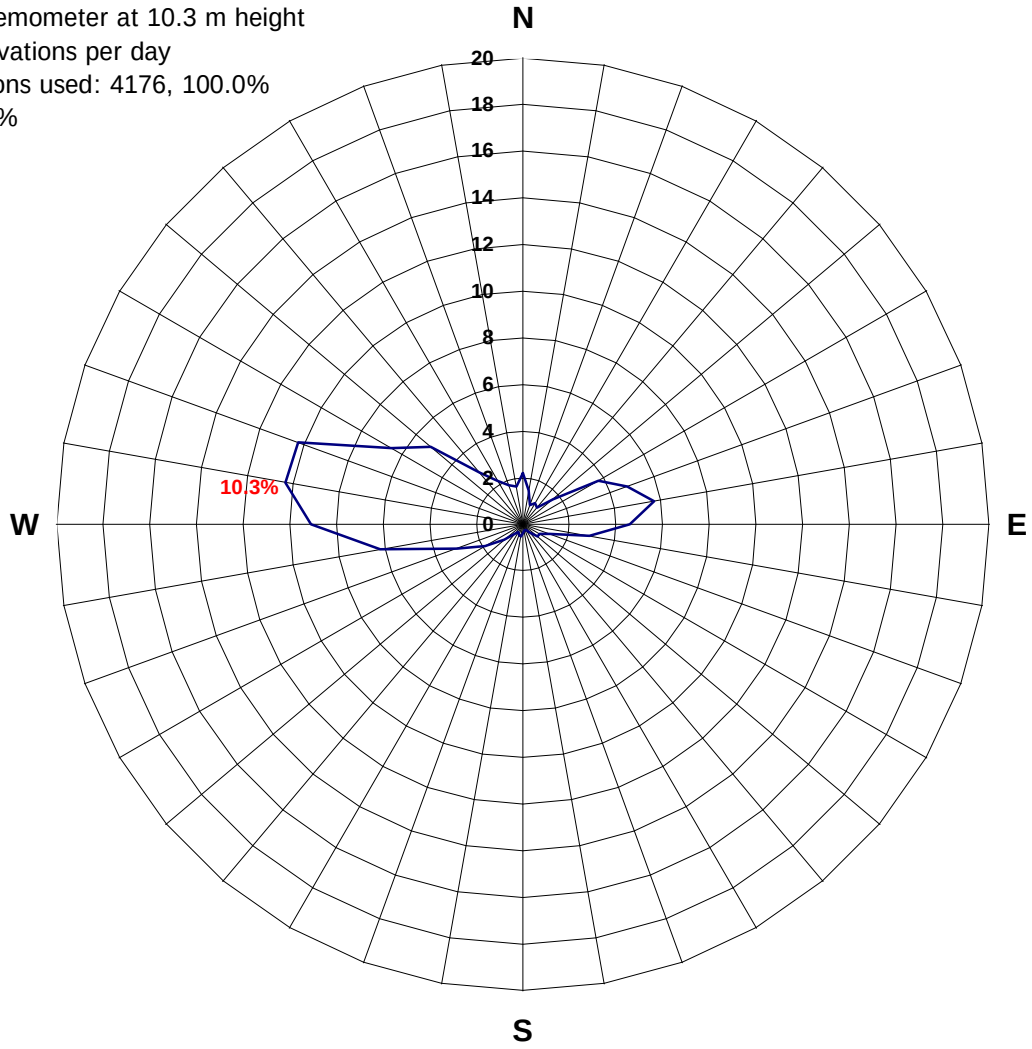


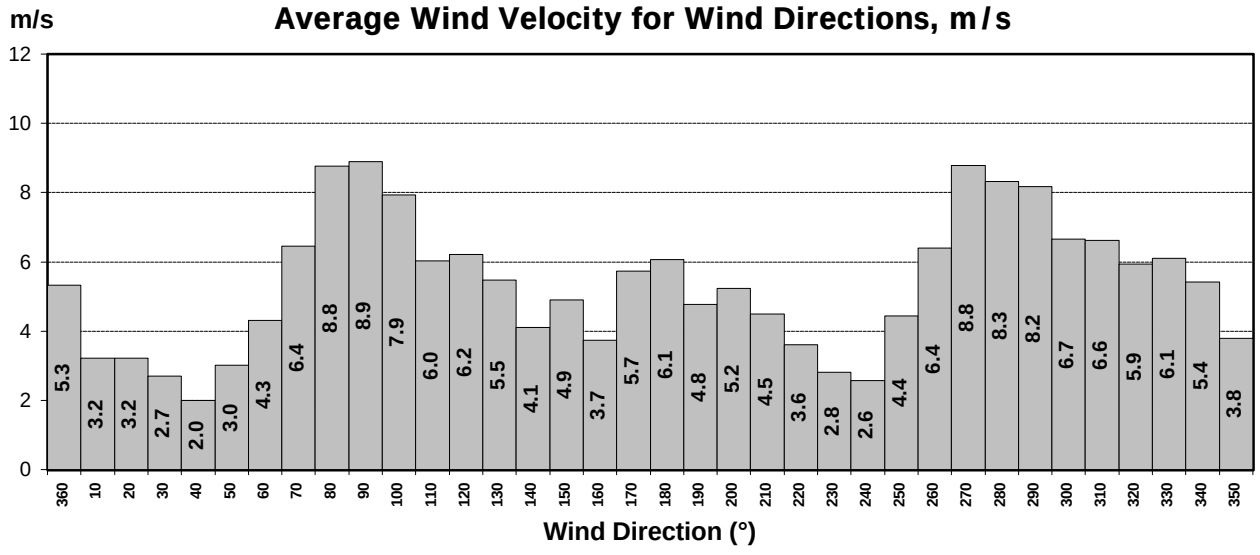
Average Wind Velocity for Wind Directions, m/s



Frequency of Wind Directions, %
February 2000

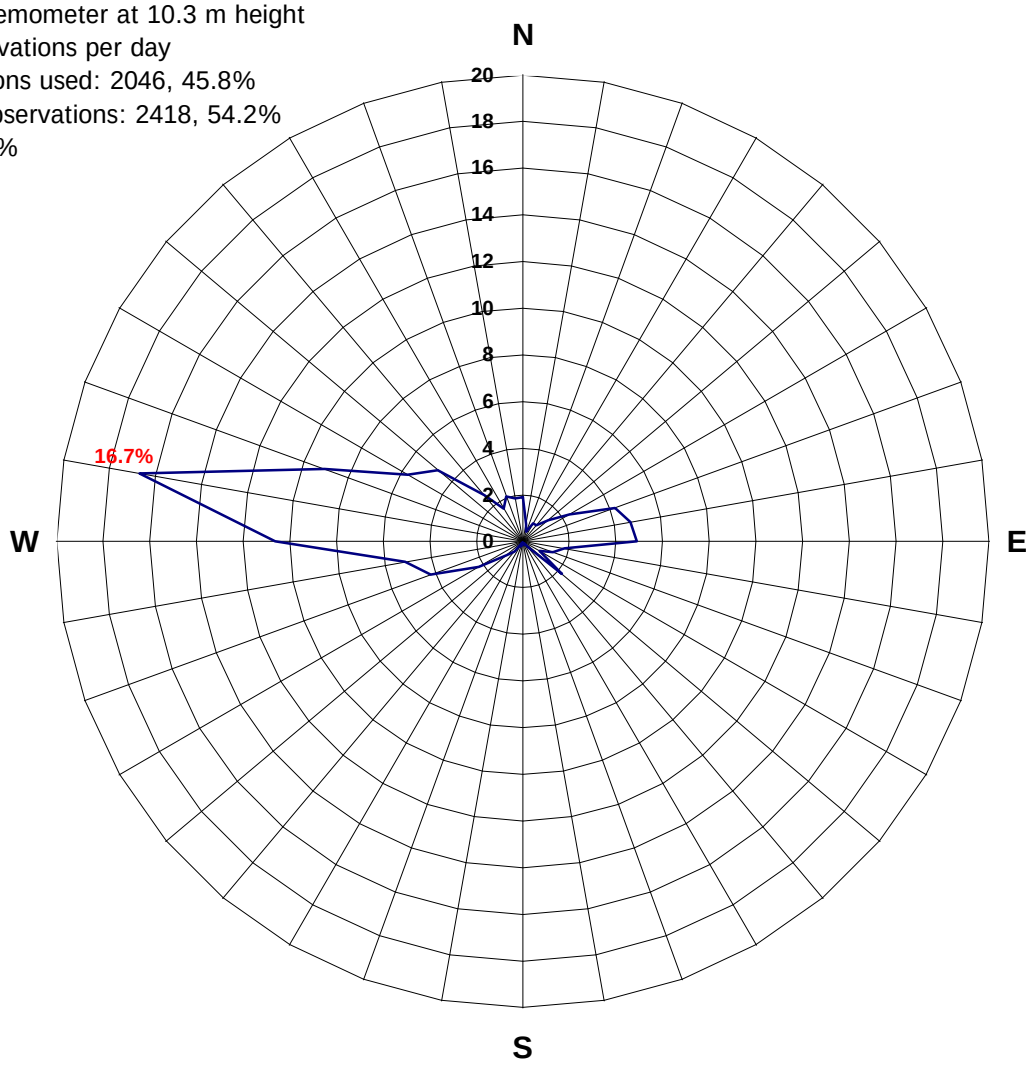
Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4176, 100.0%
Calm: 1.7%





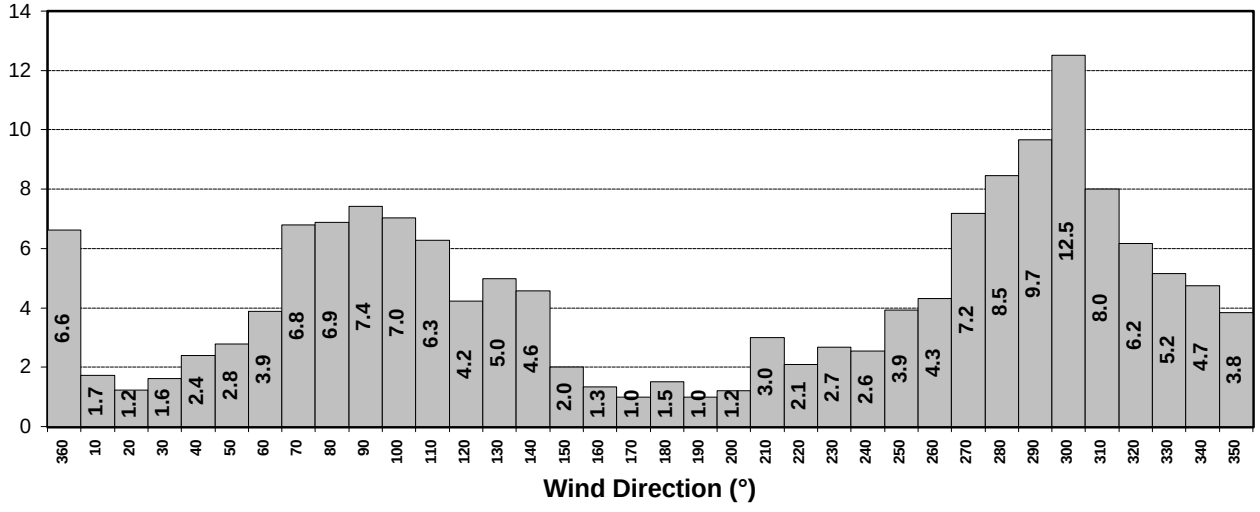
Frequency of Wind Directions, %
March 2000

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 2046, 45.8%
Missing observations: 2418, 54.2%
Calm: 2.3%



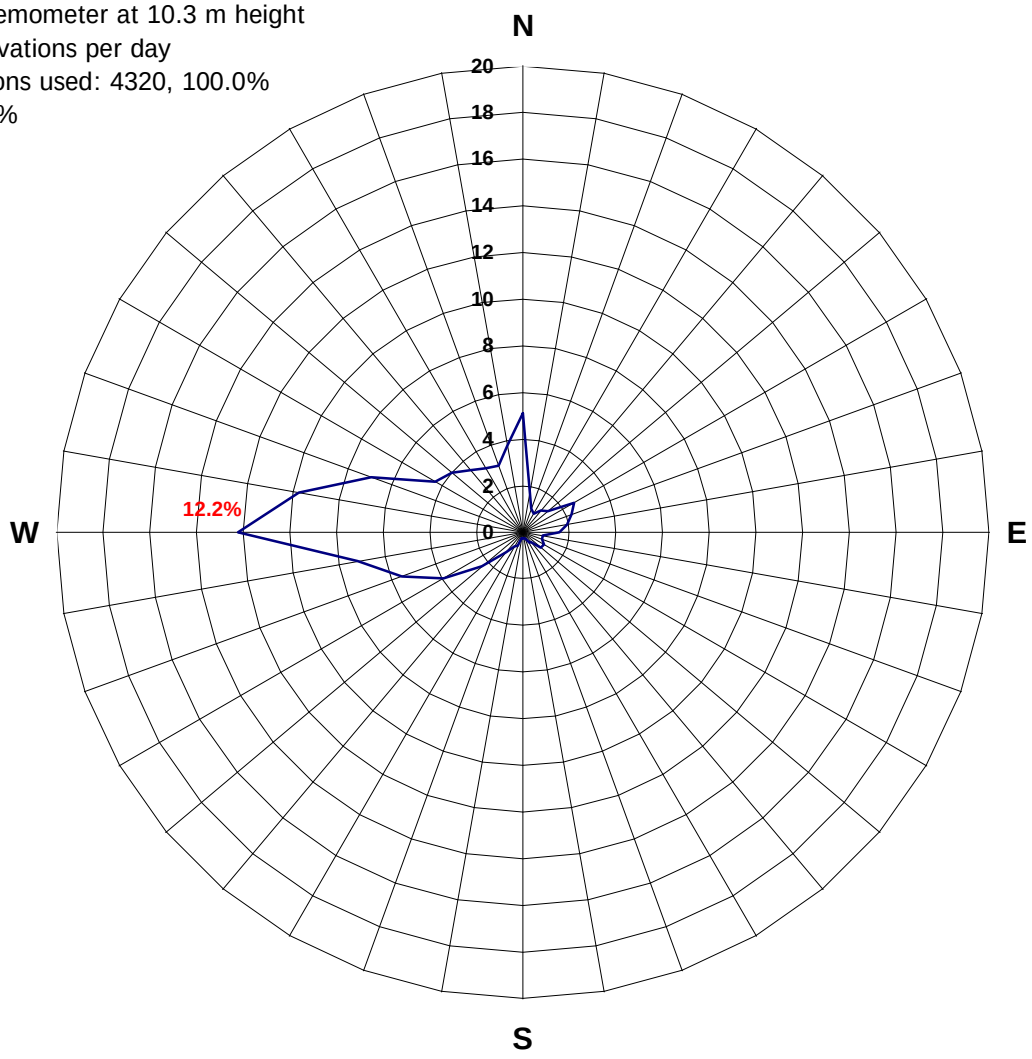
m/s

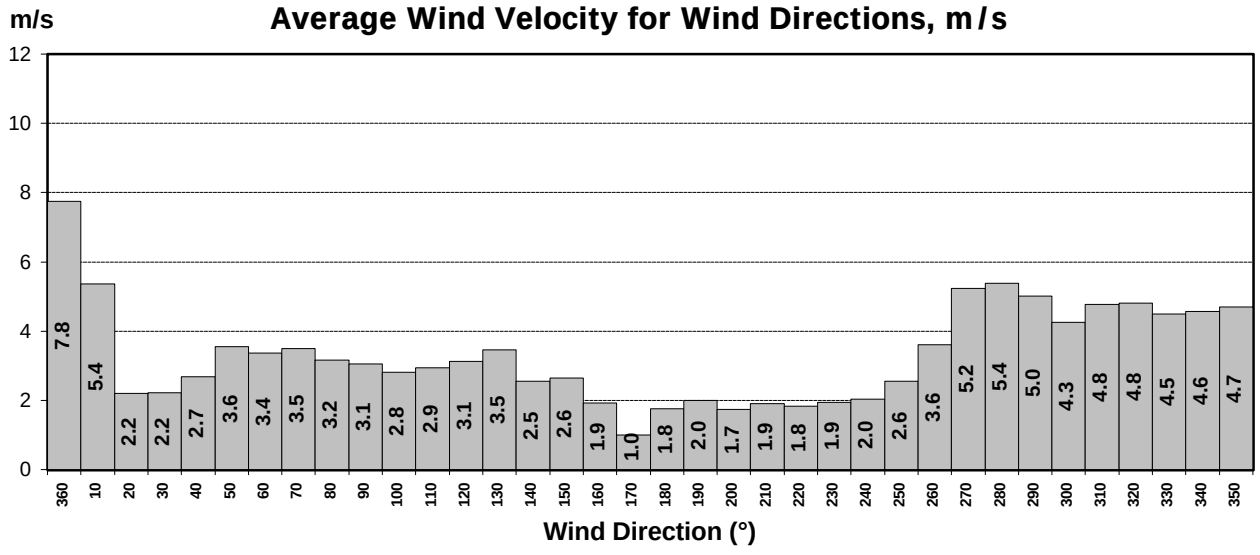
Average Wind Velocity for Wind Directions, m/s



Frequency of Wind Directions, %
April 2000

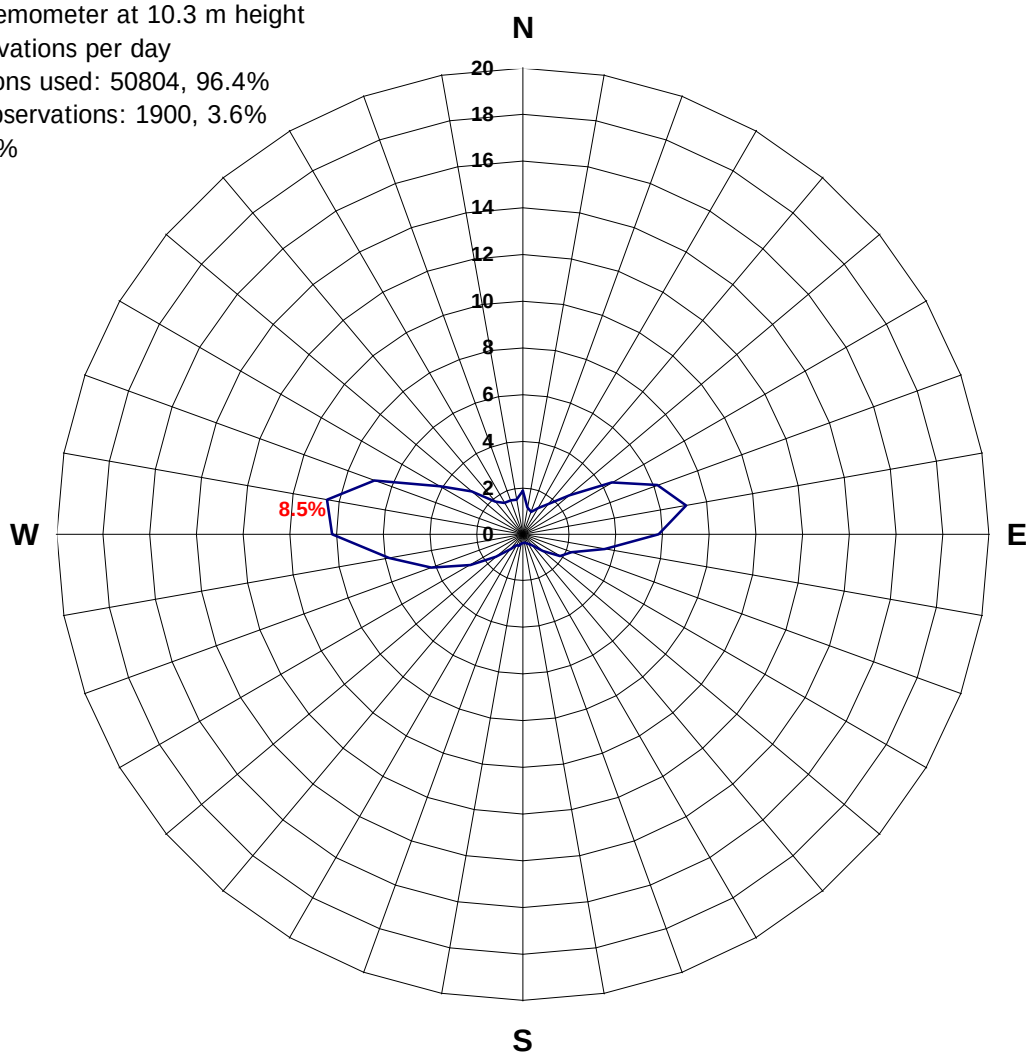
Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4320, 100.0%
Calm: 2.5%



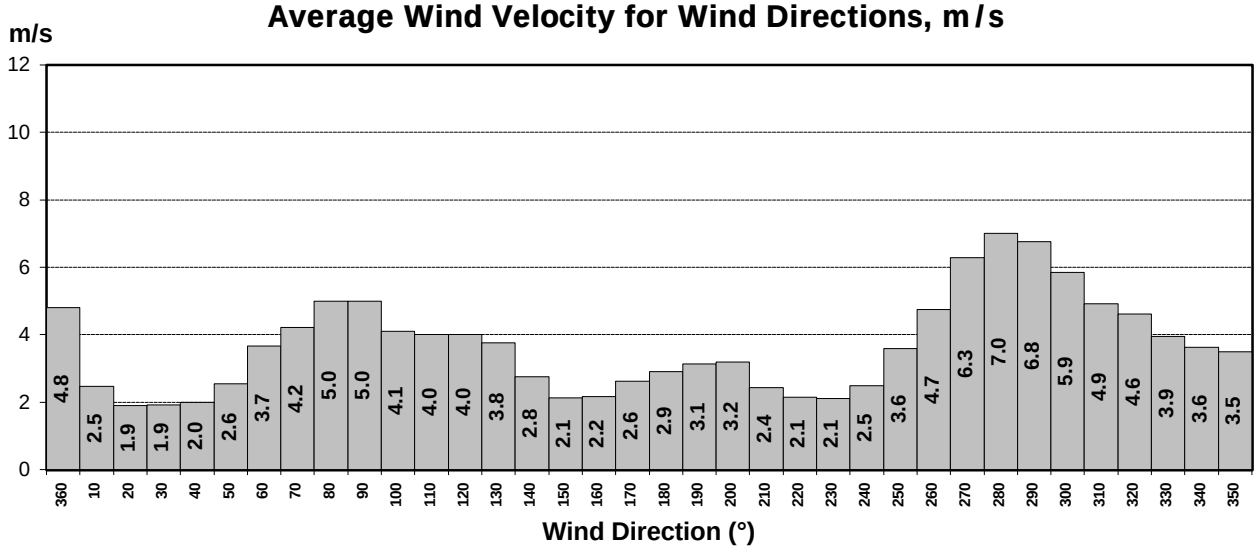


Frequency of Wind Directions, %
Year, May 1999 - April 2000

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 50804, 96.4%
Missing observations: 1900, 3.6%
Calm: 2.6%

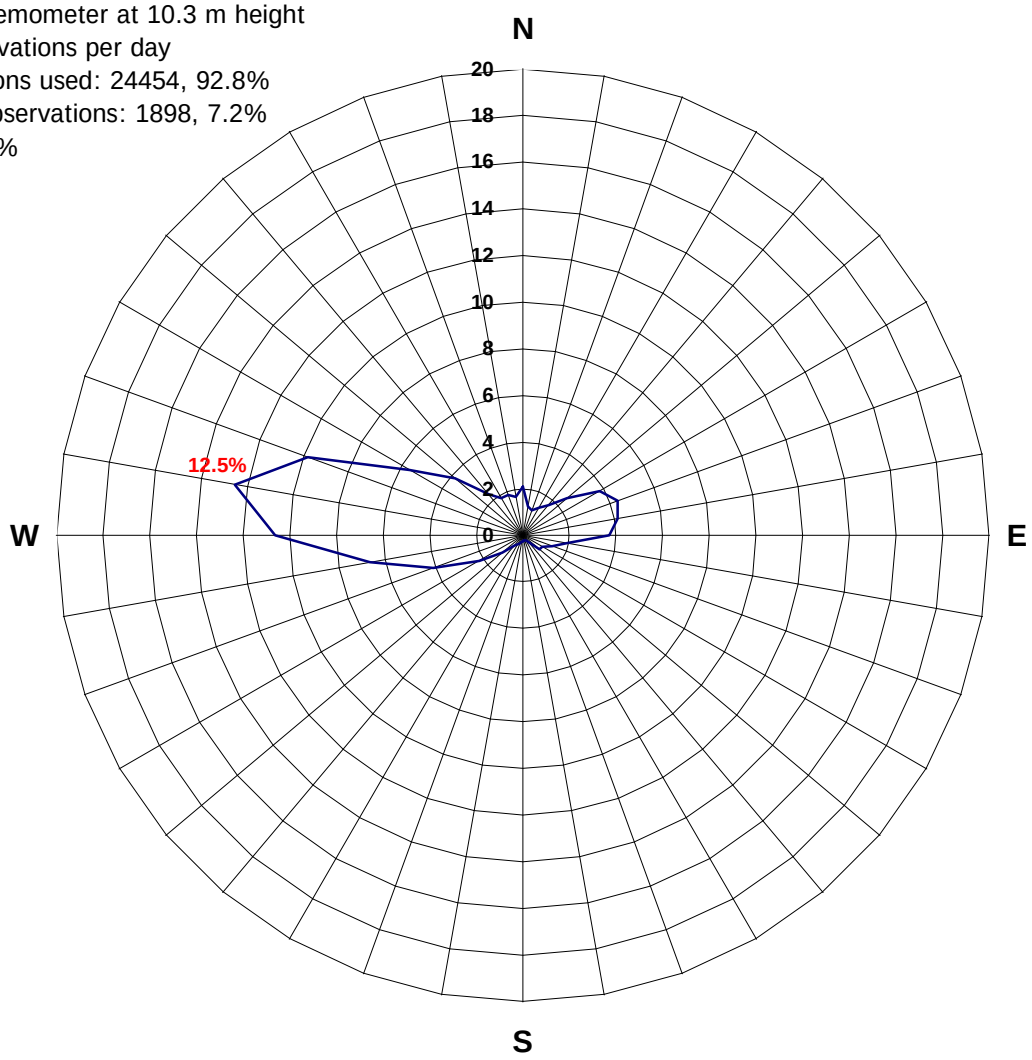


Average Wind Velocity for Wind Directions, m/s

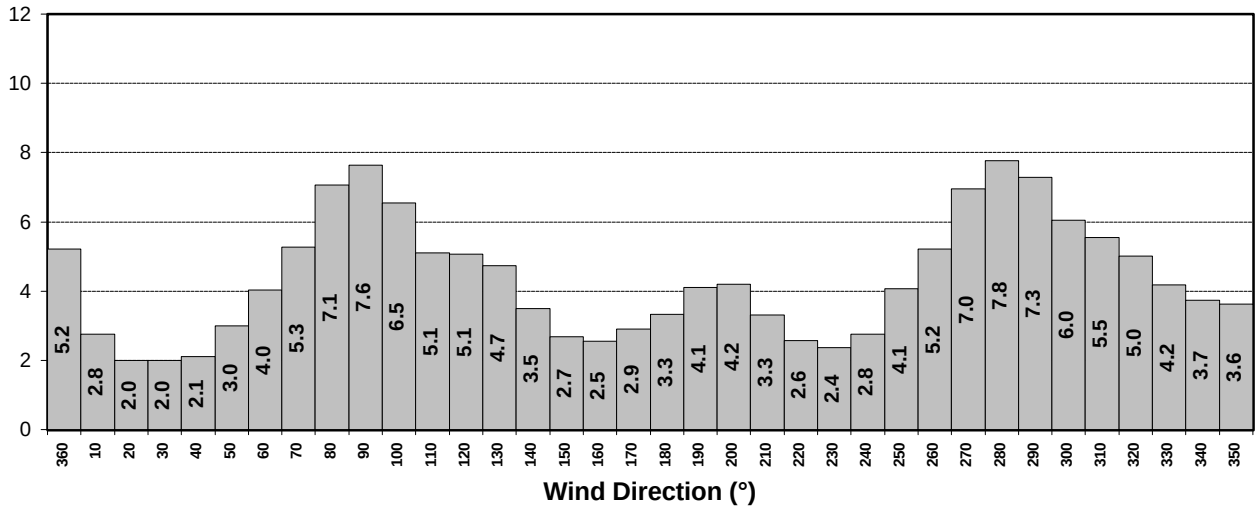


Frequency of Wind Directions, %
Autumn and Winter, October 1999 - March 2000

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 24454, 92.8%
Missing observations: 1898, 7.2%
Calm: 1.8%

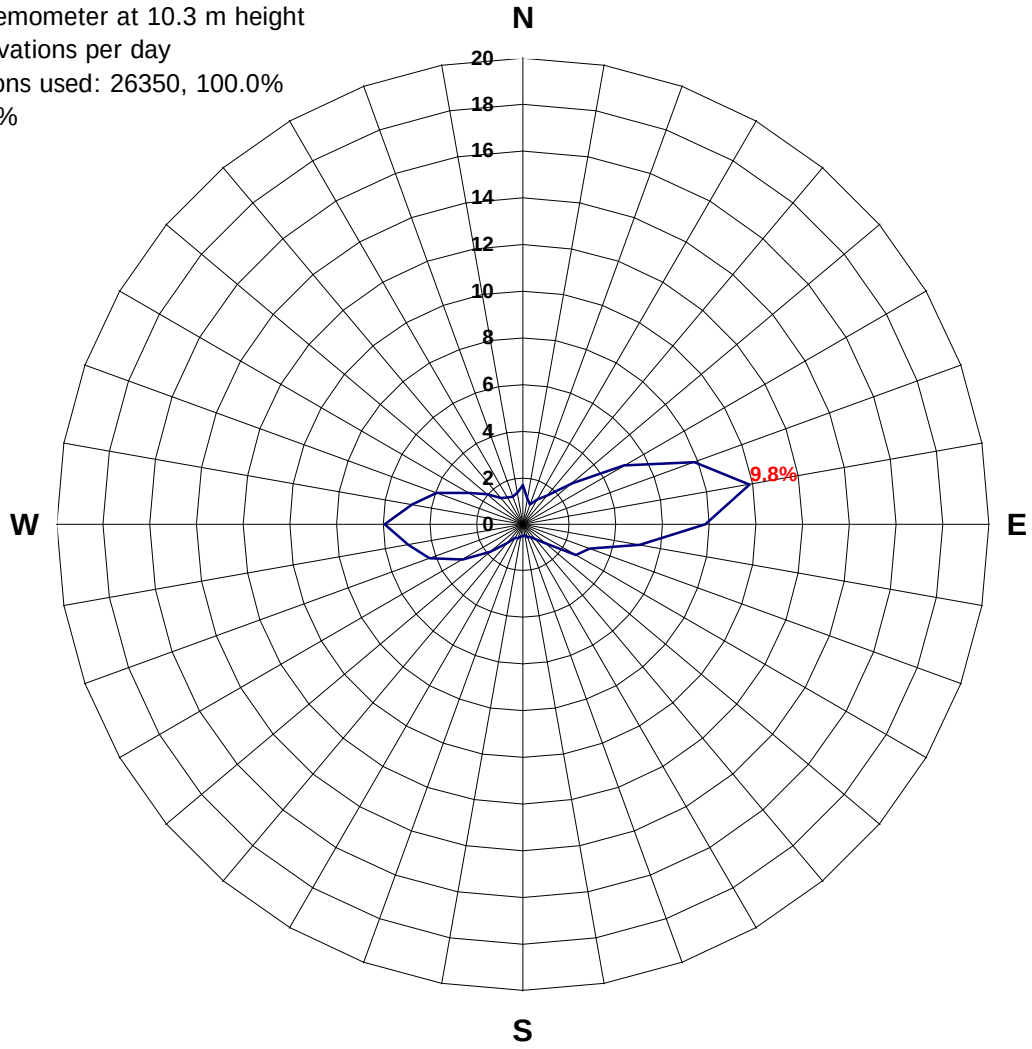


Average Wind Velocity for Wind Directions, m/s

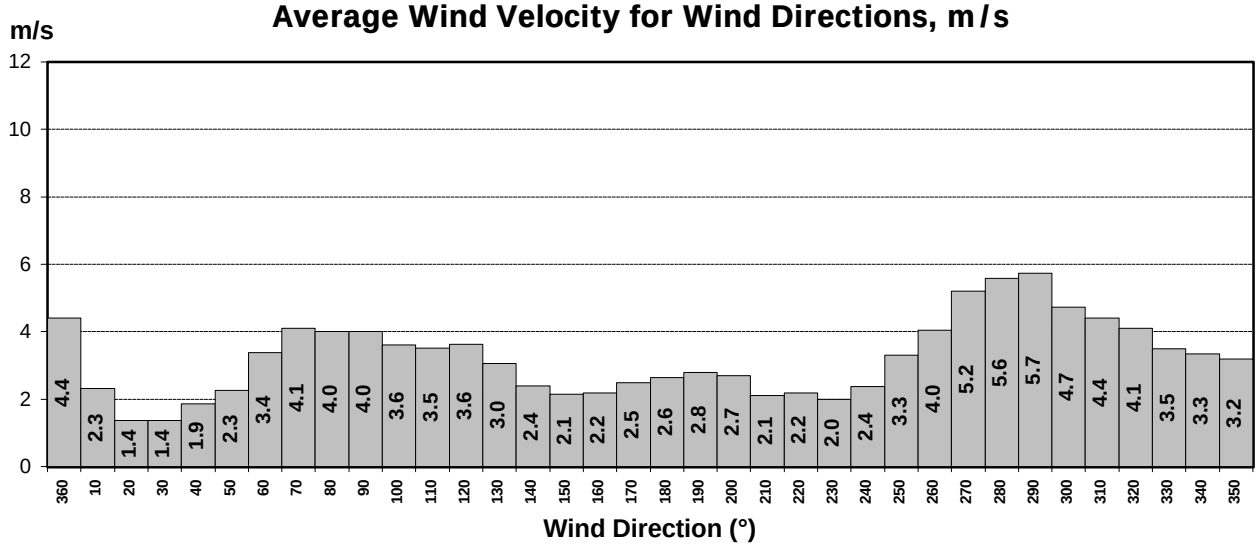


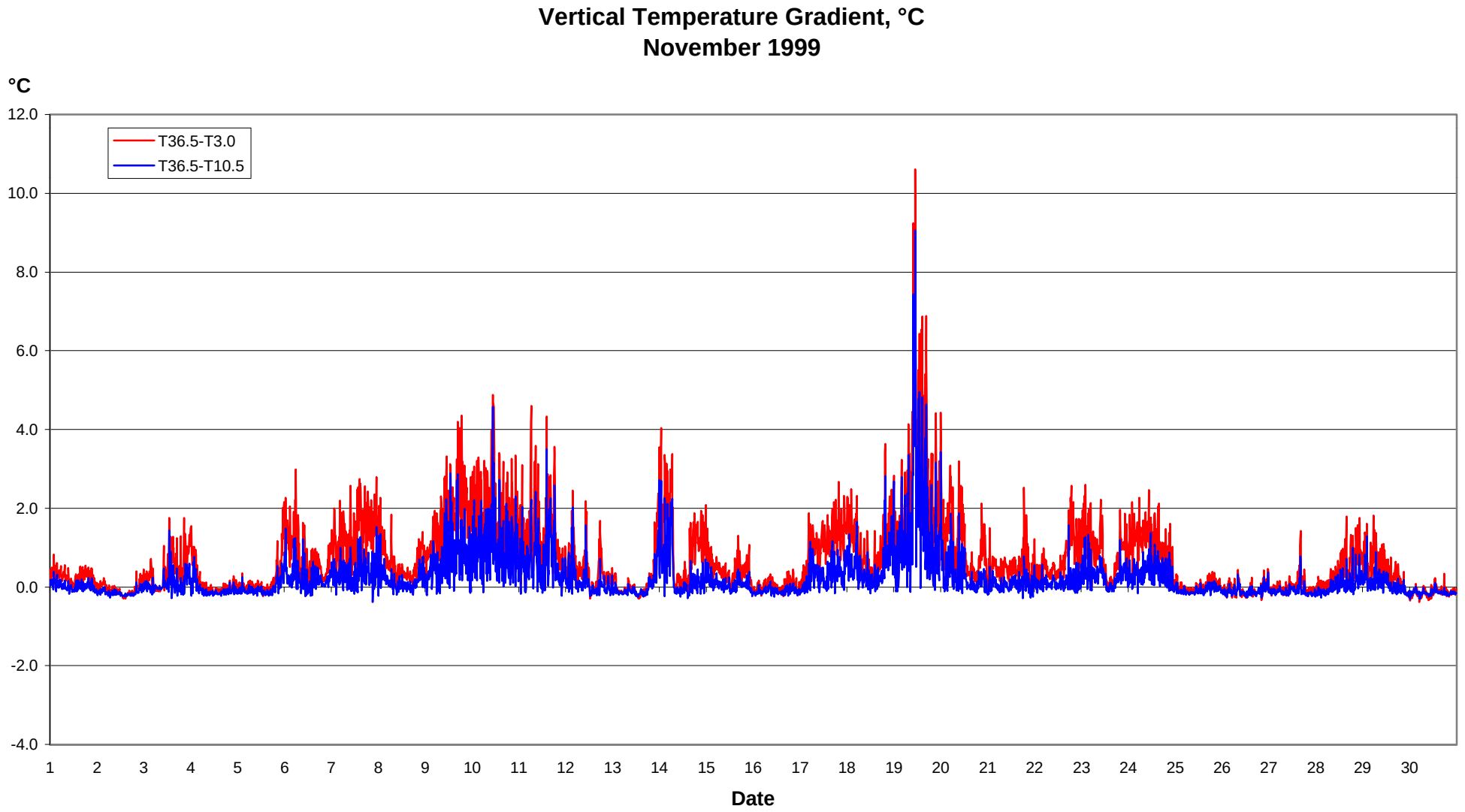
Frequency of Wind Directions, %
Spring and Summer, May - September 1999 and April 2000

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 26350, 100.0%
Calm: 3.4%



Average Wind Velocity for Wind Directions, m/s




Vertical Temperature Gradient, °C
November 1999
°C
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
T36.5-T3.0
T36.5-T10.5
1
2
3
4
5
6
7
8
9
10
11
12
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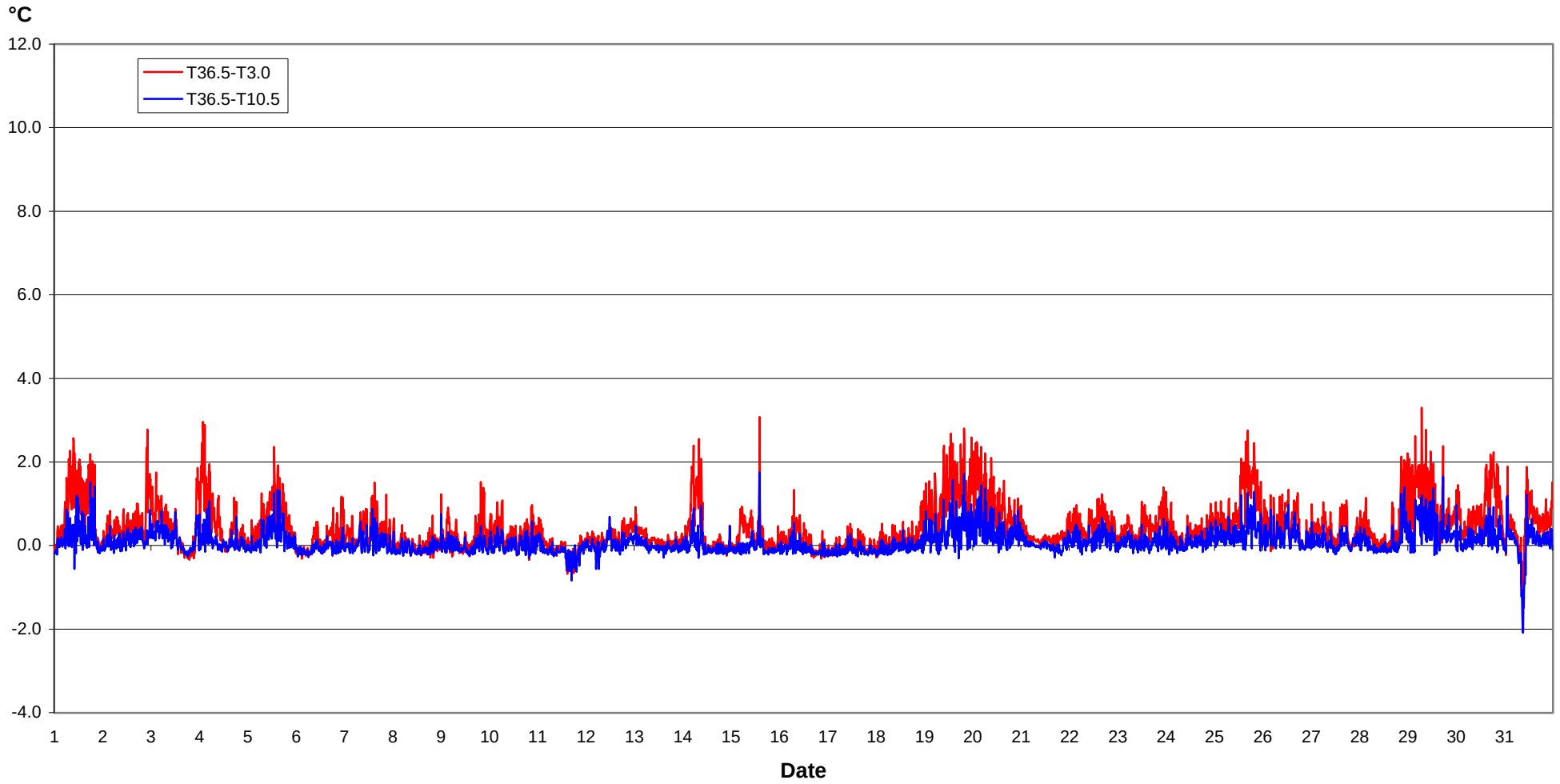
Date

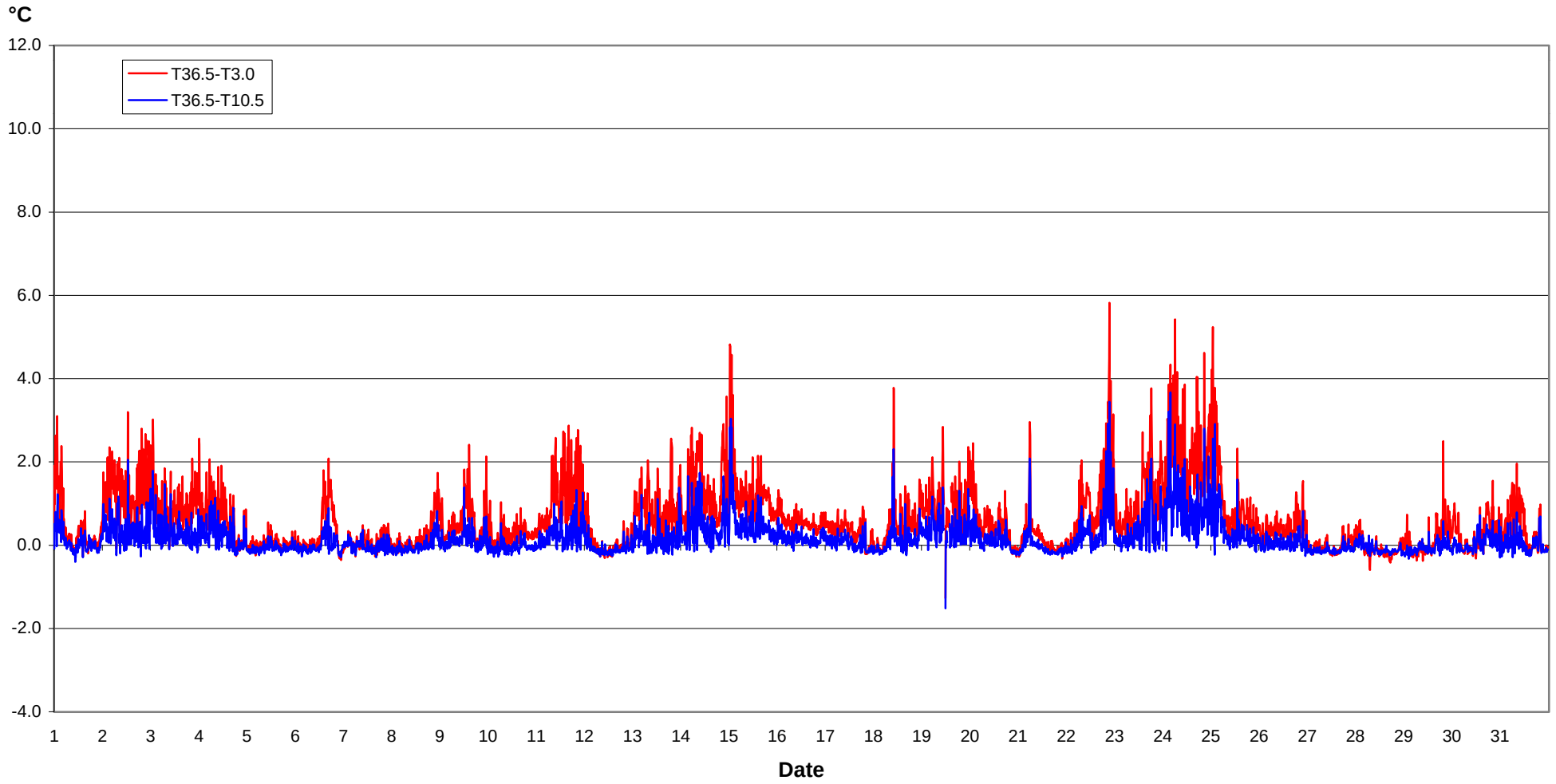
Annex 10

Vertical Temperature Gradient, °C
December 1999



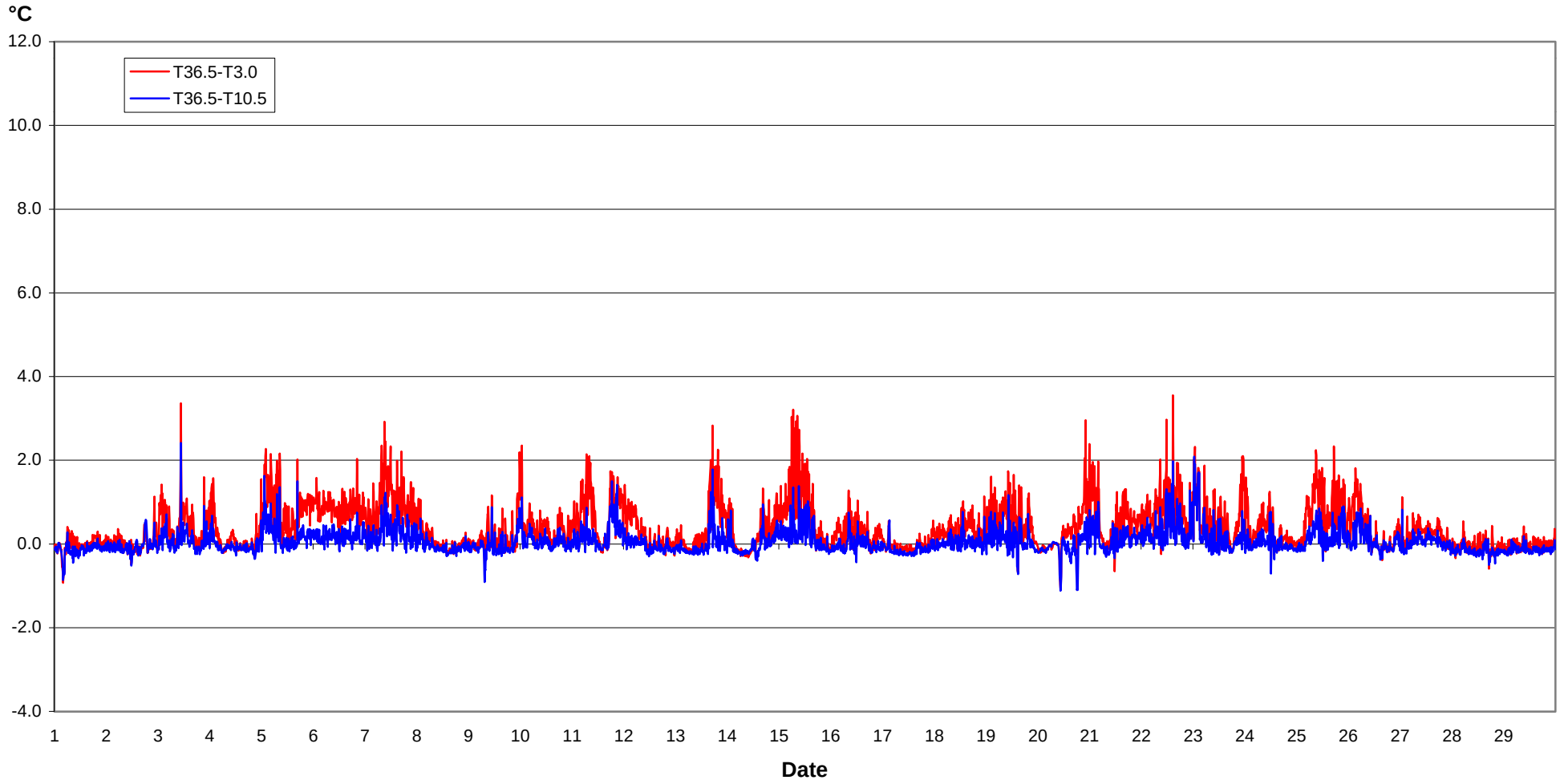
Annex 11

Vertical Temperature Gradient, °C
January 2000



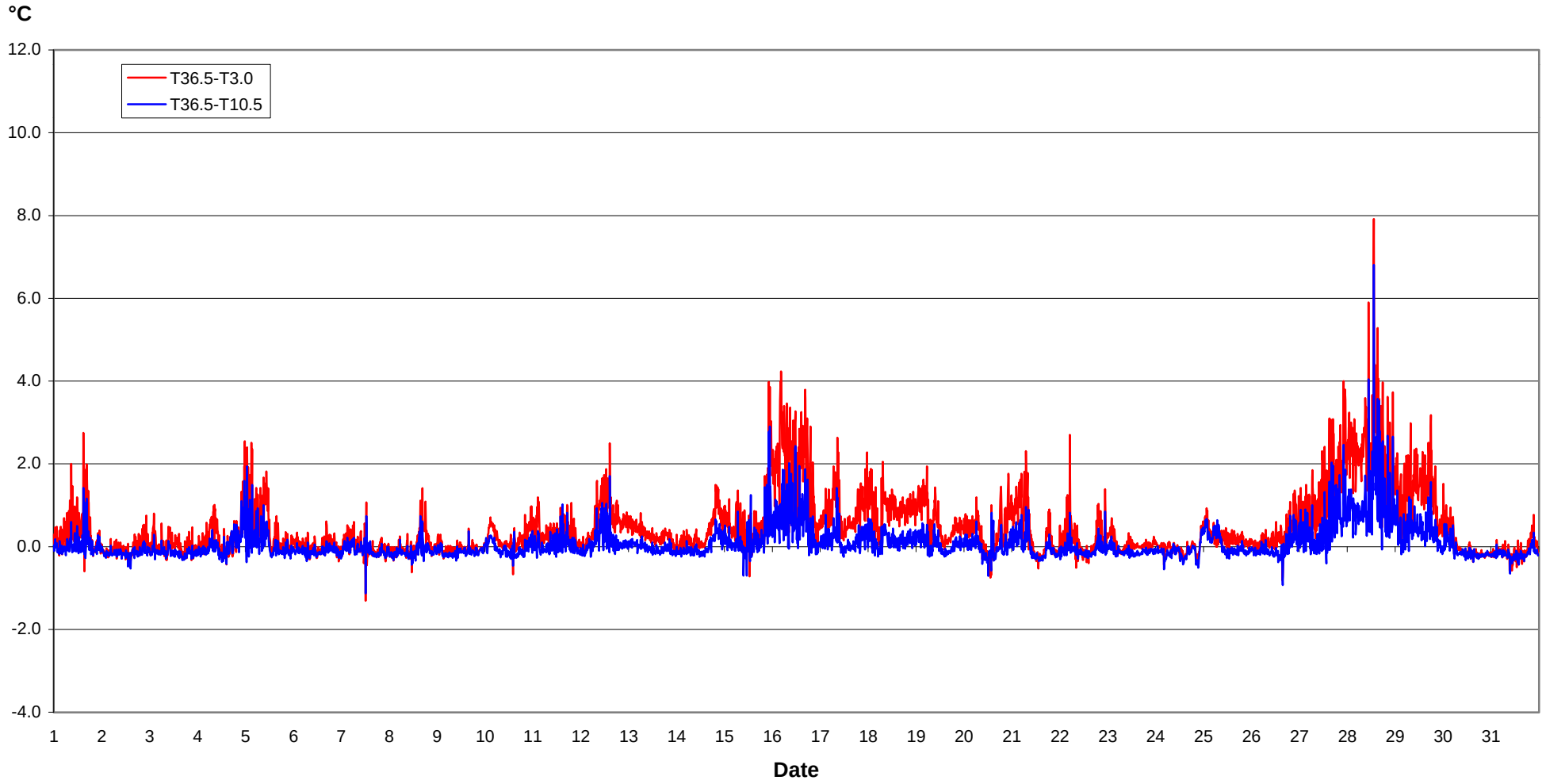
Annex 12

Vertical Temperature Gradient, °C
February 2000



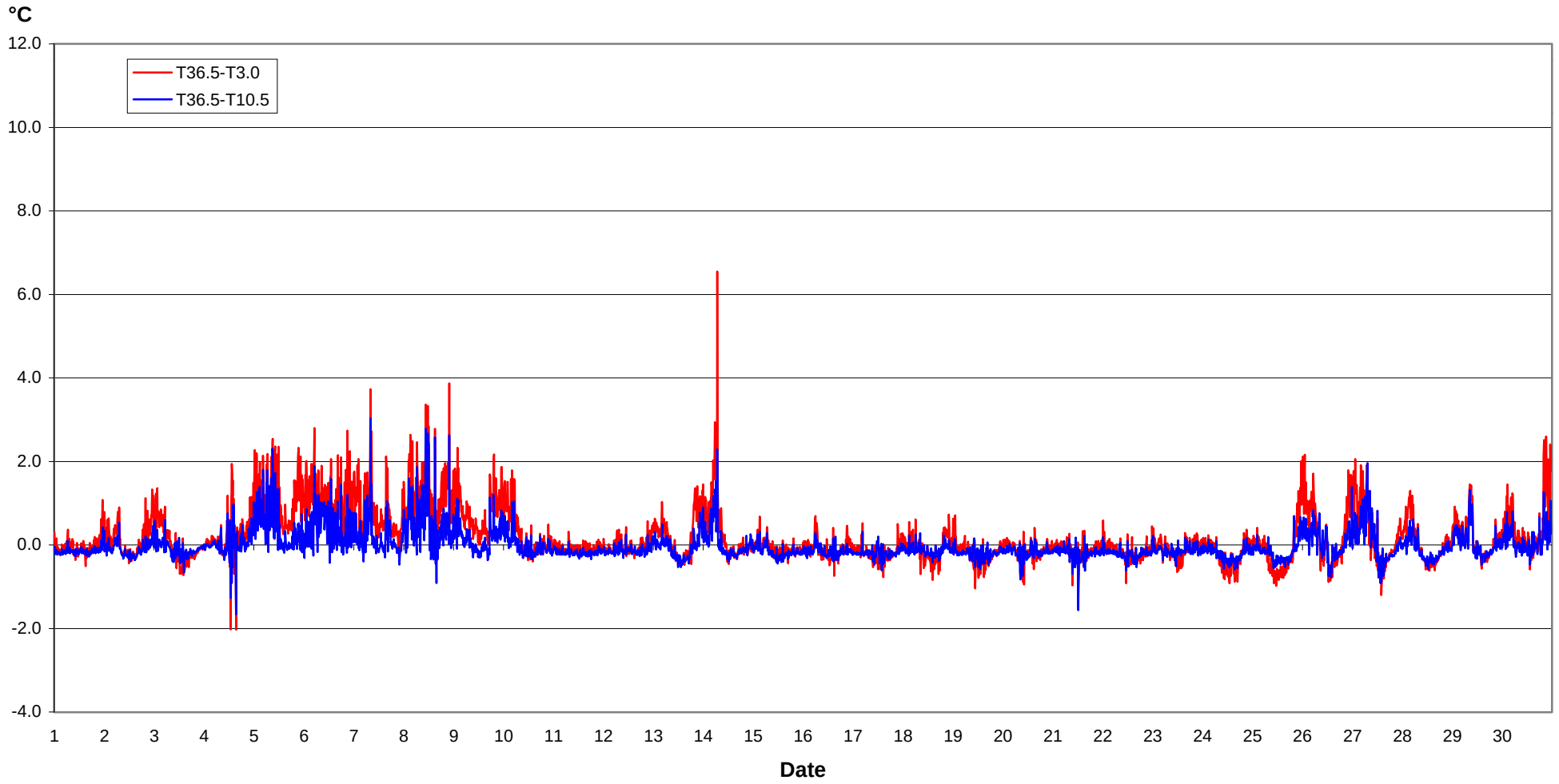
Annex 13

Vertical Temperature Gradient, °C
March 2000



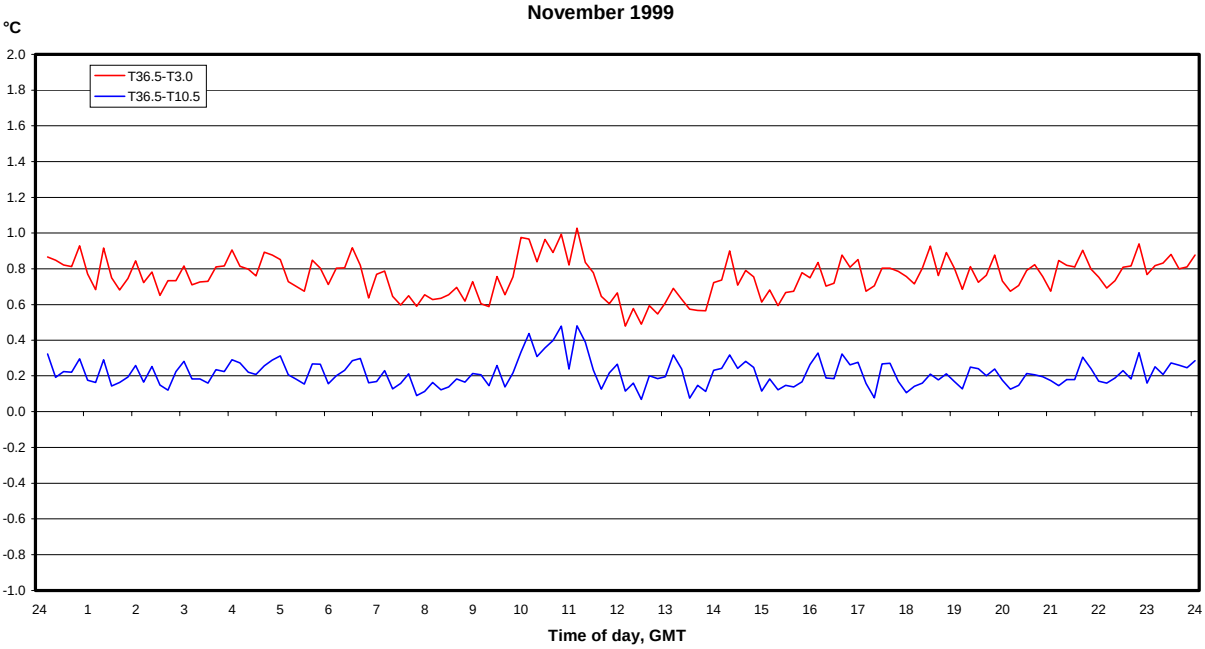
Annex 14

Vertical Temperature Gradient, °C
April 2000

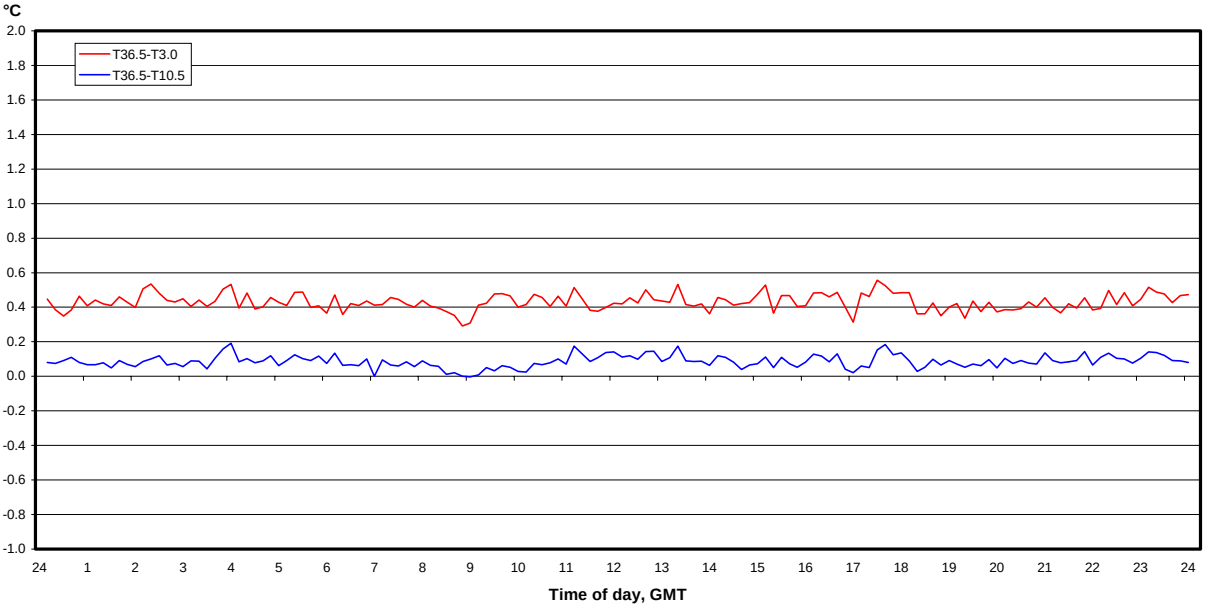


Annex 15

Sómastaðagerði
Average Vertical Temperature Gradient, °C
November 1999

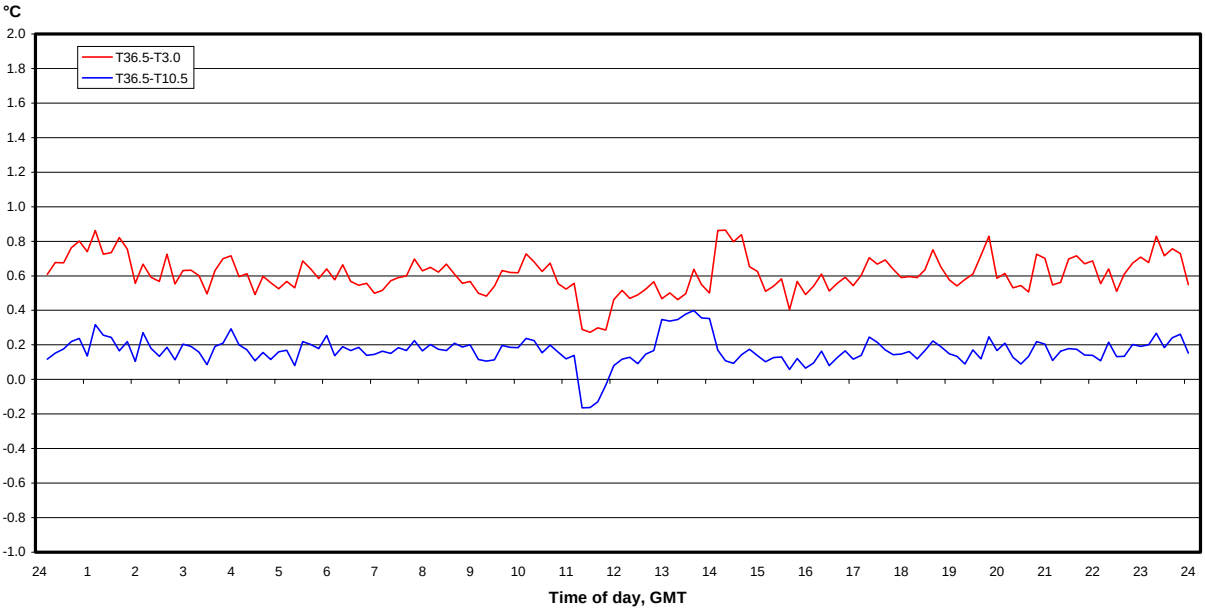


Sómastaðagerði
Average Vertical Temperature Gradient, °C
December 1999

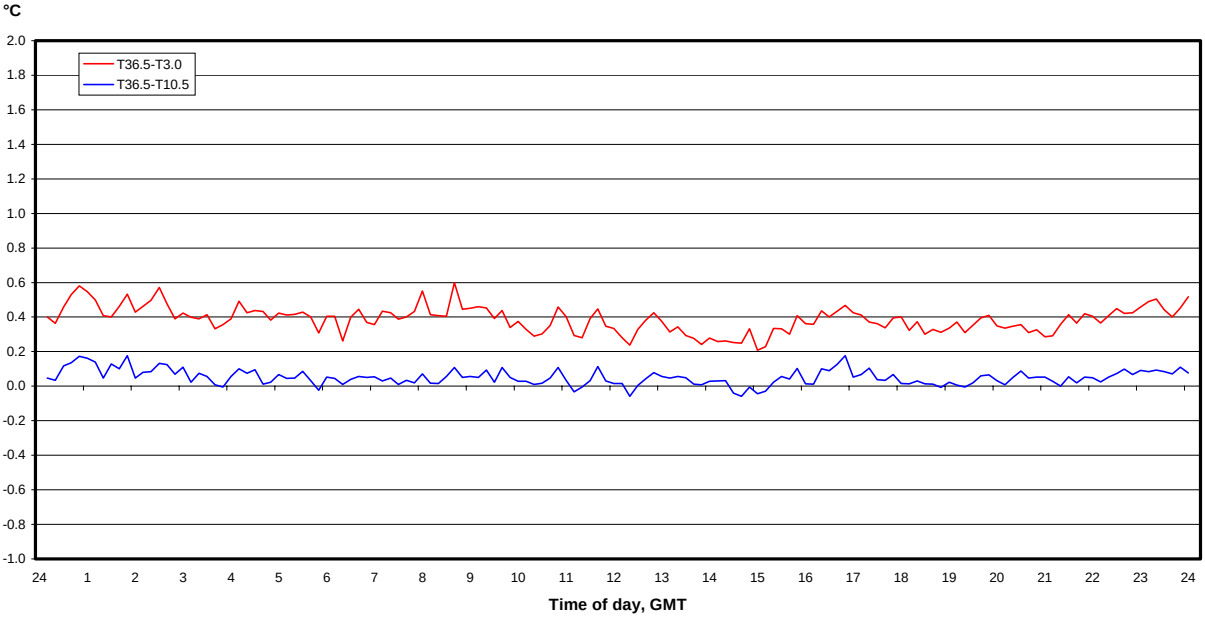


Annex 16

Sómastaðagerði
Average Vertical Temperature Gradient, °C
January 2000

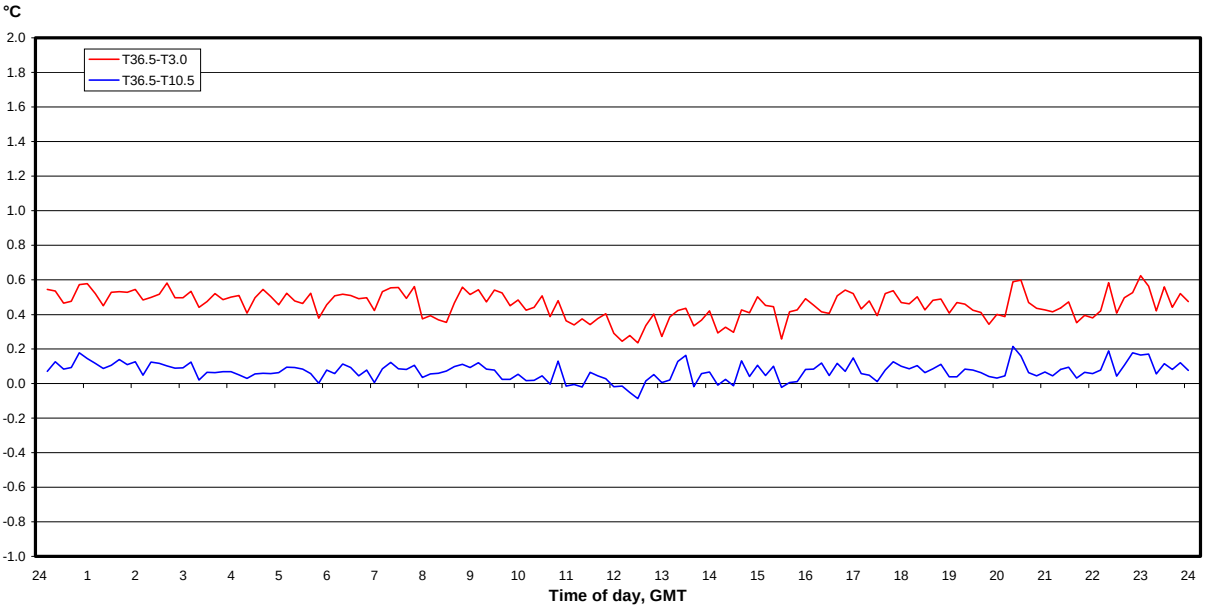


Sómastaðagerði
Average Vertical Temperature Gradient, °C
February 2000

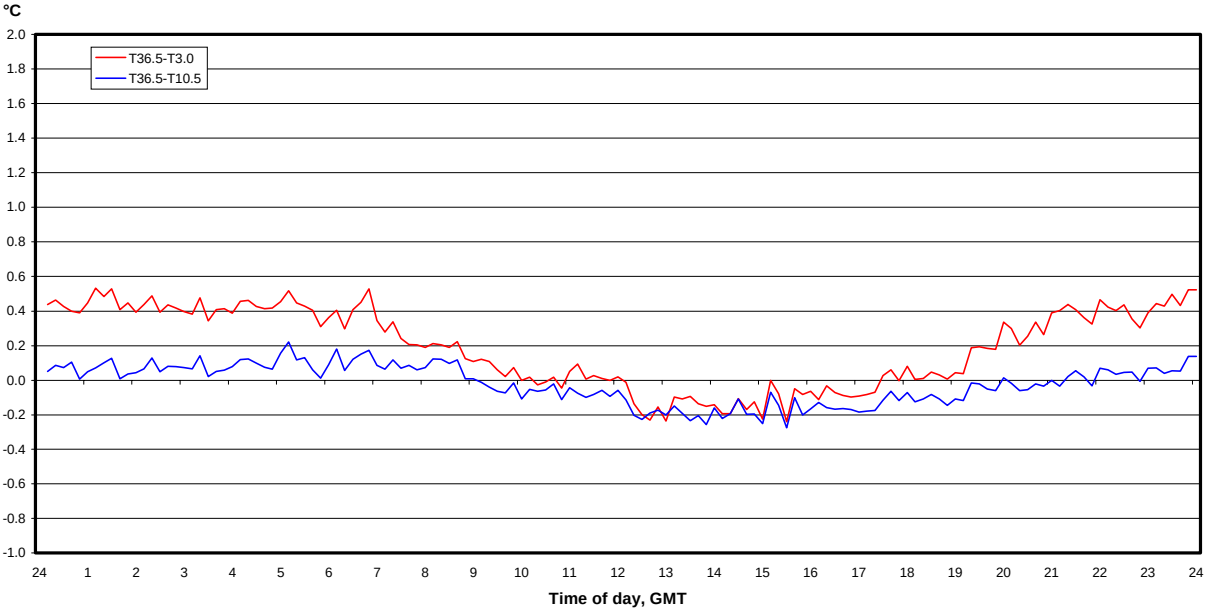


Annex 17

Sómastaðagerði
Average Vertical Temperature Gradient, °C
March 2000

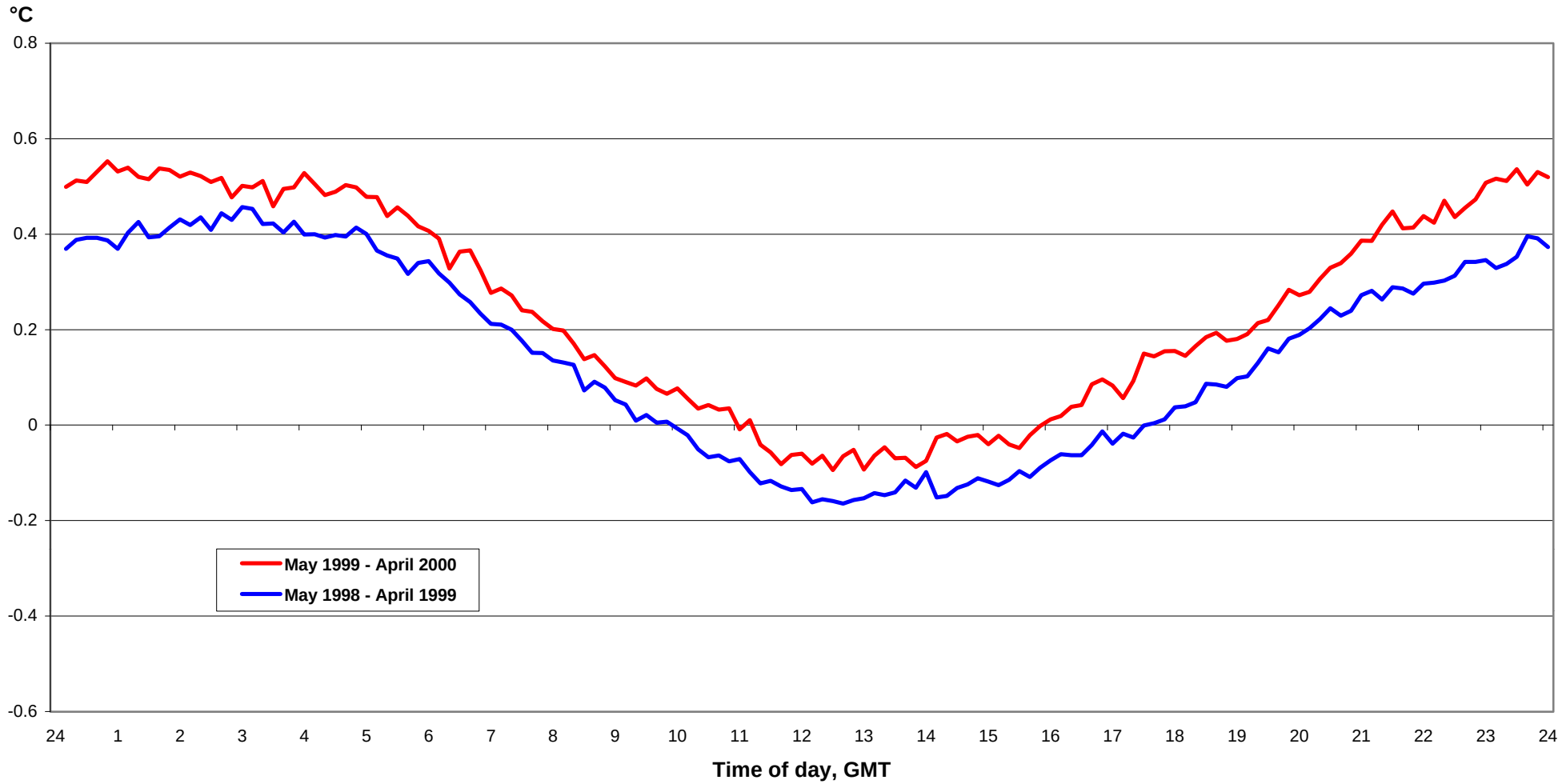


Sómastaðagerði
Average Vertical Temperature Gradient, °C
April 2000



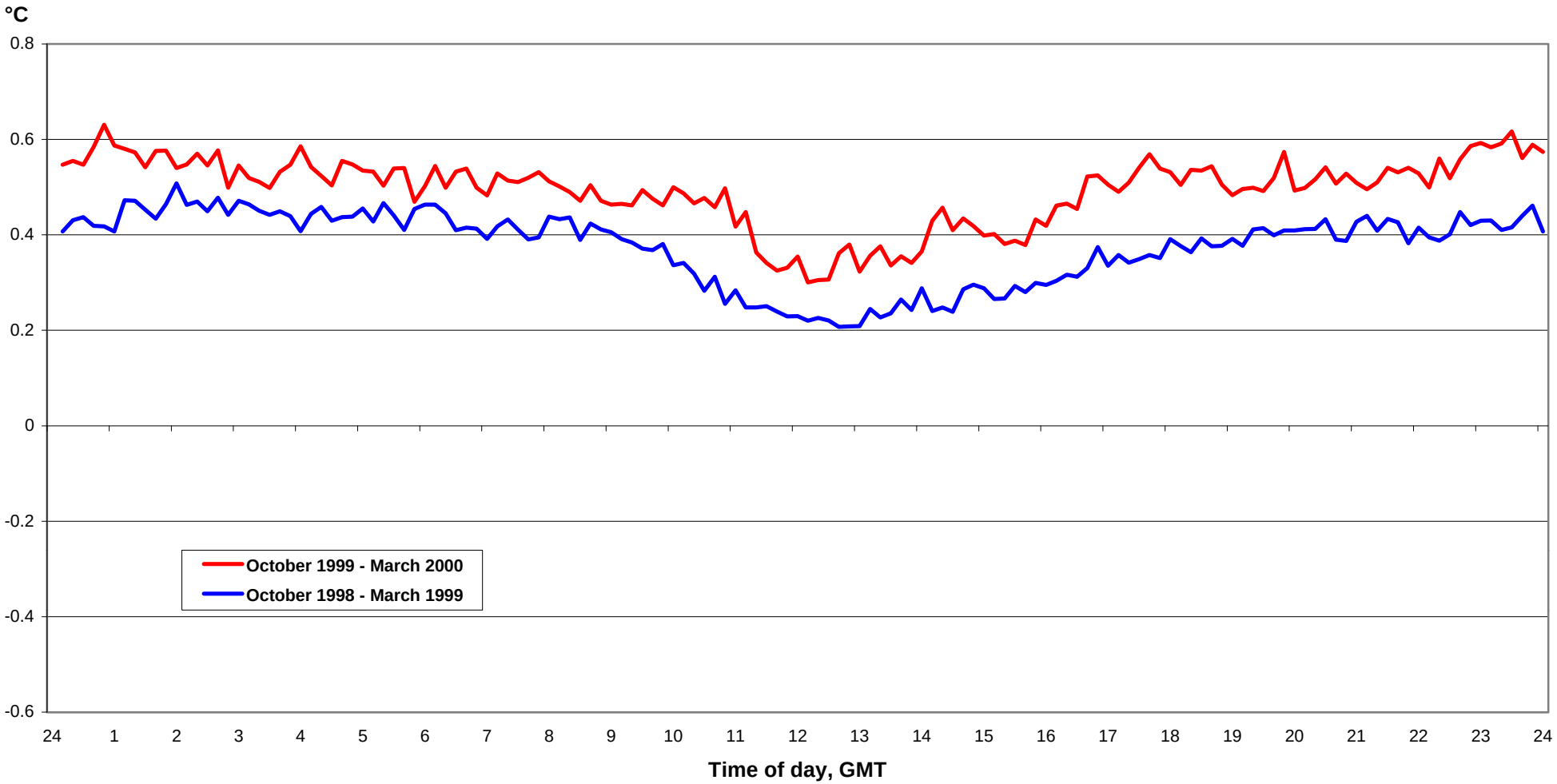
Annex 18

Average whole year diurnal variation of temperature difference 36.5 m - 3.0 m, °C
May 1998 - April 1999 and May 1999 - April 2000



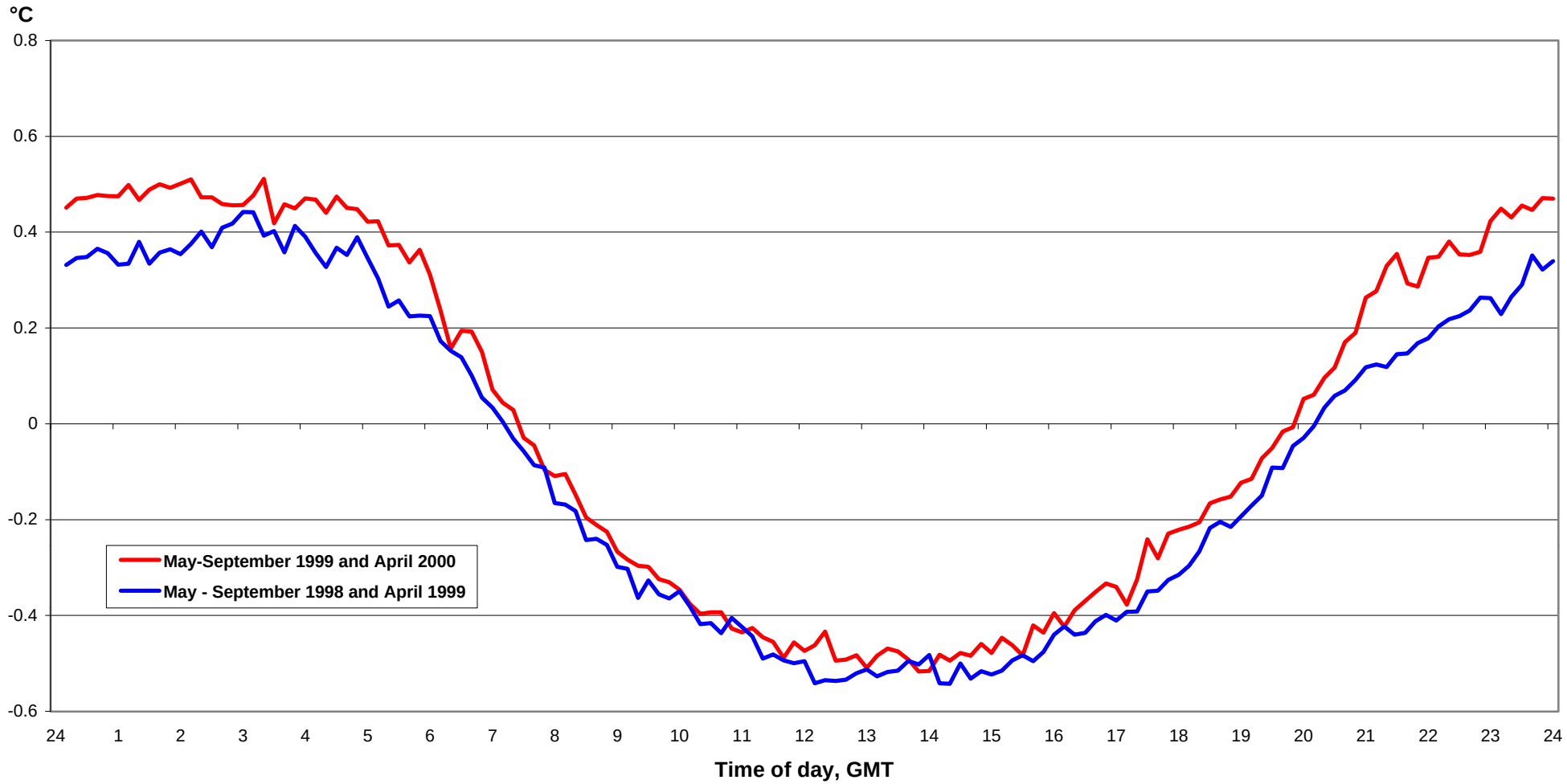
Annex 19

Average fall and winter diurnal variation of temperature difference 36.5 m - 3.0 m, °C
October 1998 - March 1999 and October 1999 - March 2000



Annex 20

Average spring and summer diurnal variation of temperature difference 36.5 m - 3.0 m, °C
May - September 1998 and April 1999, and May - September 1999 and April 2000



Annex 21