Wind and Stability Observations

at Sómastaðagerði in Reyðarfjörður

May 1998-April 1999

Contents

1. Introduction

Following a contract between the **Invest in Iceland Agency - Energy Marketing** and the **Icelandic Meteorological Office** anemometers and thermometers were installed in a 38 m high mast which had been erected at Sómastaðagerði in Reyðarfjörður. The purpose was to obtain information on winds and stability at Sómastaðagerði for model calculations of pollution dispersion from a proposed industrial plant.

The observations were to start on 1 May 1998 and terminate one year later on 1 May 1999 with the possibility of an extension of the observation period. It has now been decided to extend the observations to 1 May 2000. The present report covers the first year of observations.

Wind observations have previously been made at Sómastaðagerði although at a slightly different place. This was during the period 3 October 1981-24 April 1985. Wind direction and mean hourly values of wind speed were observed at 2 m above the ground with a mechanical Woelfle-Lambrecht 1482 wind recorder. A Lambrecht 1467 G anemometer was installed on a wooden pole, at 10 m above the ground and connected to a Lambrecht 1487 recorder for observing wind gusts. A report in Icelandic on these and other wind, weather and stability observations in the Reyðarfjörður area is available: Flosi Hrafn Sigurðsson and Hreinn Hjartarson: Veðurathuganir á Reyðarfjarðarsvæðinu. Veðurstofa Íslands, Reykjavík 1986. (Ref. 2).

Further information on wind conditions in the Reyðarfjörður area can be found in two other reports from Veðurstofa Íslands (Ref. 1 and 3).

2. Observation Site and Instrumentation

Sómastaðagerði is situated on the northern side of Reyðarfjörður. The old farm houses, near which observations were made during the period 1981-1985, have now been removed. The anemometer mast is located somewhat further from the fiord on a low gravel platform (65° 02.0’ N, 14° 06.7’ W, height of the platform 32 m a.m.s.l.).

Two Gill UVW anemometers from R.M. Young Company were used for wind observations at 10.8 and 36.6 m above the platform. In addition Wind Monitor-MA 05106, Marine Model, from R.M. Young was installed at a height of 10.3 m above the platform.

Platinum electrical resistance thermometers Logan 100PRT were used for air temperature observations at 3.0, 10.5 and 36.5 m height above the platform. For protection 6-plate Gill radiation shields were used. A Vaisala temperature and relative humidity sensor HMP-35D was furthermore installed at 3.0 m height, with a 12-plate Gill radiation shield.

A Measurement and Control Module CR10X from Campbell Scientific, Inc. was used for collecting the observation data. Data transfer was by phone to a computer at the Meteorological Office in Reykjavík.

The location of Sómastaðagerði is shown in Fig.1. Fig.2 shows the mast viewed in a southerly direction. The houses at Sómastaðagerði were near the wooden doublemast to the left. Figures 3-5 show the instruments attached to the mast.

A map of the Reyðarfjörður area is presented in Fig. 6. The locations of the present and previous observation places at Sómastaðagerði as well as that of three other observation stations in Reyðarfjörður and one in Eskifjörður are indicated on the map. To emphasize the wind direction's very strong dependence on topography, wind roses are shown for all six locations. The wind roses are all valid for the whole year but of necessity for different periods. At Sómastaðagerði the wind rose with broken lines is from Annex 13 of this report, valid for May 1998-April 1999. The wind rose with solid lines is based on observations at Sómastaðagerði in the period October 1981-September 1984. The wind roses for Eyri and Leirur are, respectively, for the periods July 1993-June 1994 and October 1993-September 1995. At Kollaleira the wind rose is for the years 1983-1998 and at Mjóeyri in Eskifjörður for the period October 1982-September 1984.

3. General Climatological Information.

For general climatological information in the Reyðarfjörður area temperature and precipitation data for the weather station Kollaleira (65° 02´ N, 14° 14´ W) are presented in Tables 1-4.

In Table 1 the average air temperature and the highest and lowest monthly means for the years 1977-1998 are presented.

Table 1. Air temperature at Kollaleira 1977-1998, °C.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean temp.	**-0.8**	**-0.5**	**-0.3**	**1.6**	**4.9**	**8.1**	**9.8**	**9.5**	**6.8**	**3.4**	**1.0**	**-0.1**	**3.6**
Highest mean	**3.1**	**2.2**	**2.5**	**4.1**	**7.8**	**10.5**	**12.0**	**11.2**	**10.8**	**5.4**	**5.5**	**2.0**	**4.8**
Lowest mean	**-5.1**	**-2.4**	**-4.9**	**-1.6**	**0.1**	**6.8**	**7.9**	**7.6**	**4.4**	**0.3**	**-2.5**	**-2.6**	**1.9**

As seen in Table 1 the winters are mild in Reyðarfjörður but the summers are relatively cool.

Tables 2 and 3 present information on maximum and minimum temperatures observed at Kollaleira.

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

Fig. 3. Thermometer and hygrometer at 3.0 m above the ground.
Photo: Flosi Hrafn Sigurðsson, 1999.

Fig. 4. Gill UVW anemometer and thermometer near the top of the mast. Photo: Flosi Hrafn Sigurðsson, 1999.

Fig. 5. Anemometers and thermometer at 10.3 – 10.8 m above the ground. Photo: Flosi Hrafn Sigurðsson, 1999.

Table 2. Maximum temperature at Kollaleira 1977-1998, °C.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean max. temp.	**2.1**	**2.5**	**2.8**	**4.7**	**8.3**	**11.7**	**13.1**	**12.8**	**9.8**	**6.2**	**3.8**	**2.7**	**6.7**
Highest mean	**7.3**	**5.2**	**6.1**	**7.6**	**12.3**	**15.1**	**15.4**	**16.0**	**14.3**	**10.1**	**8.2**	**4.8**	**8.1**
Lowest mean	**-1.9**	**-0.2**	**-2.0**	**1.2**	**2.4**	**9.6**	**10.7**	**10.5**	**7.1**	**2.3**	**0.0**	**-0.5**	**4.8**
Highest obs.max.	**16.8**	**12.8**	**14.6**	**17.6**	**23.0**	**27.1**	**28.9**	**26.0**	**23.5**	**20.9**	**13.6**	**15.6**	**28.9**

Table 3. Minimum temperature at Kollaleira 1977-1998, °C.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Mean min. temp.	**-3.9**	**-3.2**	**-3.1**	**-1.2**	**1.8**	**4.9**	**6.8**	**6.6**	**4.0**	**0.8**	**-1.8**	**-3.0**	**0.7**
Highest mean	**-0.5**	**-0.2**	**-0.4**	**-3.1**	**-1.2**	**7.2**	**9.2**	**8.0**	**7.9**	**2.5**	**2.1**	**-0.5**	**1.9**
Lowest mean	**-7.9**	**-5.5**	**-8.1**	**-4.4**	**-2.3**	**3.4**	**5.1**	**4.8**	**1.7**	**-2.3**	**-4.9**	**-5.7**	**-0.8**
Lowest obs. min.	**-17.1**	**-14.9**	**-17.1**	**-11.7**	**-7.6**	**-2.9**	**-0.2**	**0.6**	**-4.5**	**-8.7**	**-11.6**	**-15.1**	**-17.1**

As seen in Tables 1-3 January is on average the coldest and July the warmest month at Kollaleira. Information on precipitation at Kollaleira is given in Table 4.

Table 4. Precipitation amount at Kollaleira 1977-1998, mm.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean precipitation	**157**	**130**	**121**	**78**	**46**	**52**	**55**	**81**	**113**	**156**	**161**	**155**	**1306**
Highest sum	**289**	**290**	**263**	**188**	**101**	**186**	**125**	**197**	**249**	**333**	**548**	**312**	**1805**
Lowest sum	**33**	**36**	**18**	**14**	**5**	**8**	**18**	**19**	**35**	**28**	**35**	**34**	**856**
Max. 24 h value	**87**	**86**	**69**	**59**	**36**	**76**	**96**	**71**	**77**	**95**	**146**	**115**	**146**

Wind, temperature and stability observations at Sómastaðagerði are the subject of this report and will be dealt with in the following chapters. For earlier observations in the Reyðarfjörður area see Ref. 1 in English and Ref. 2 and 3 in Icelandic. The strong channelling influence of the terrain on the winds is evident from these reports.

Finally the influence of the East Iceland Sea Current should be mentioned, bringing cold sea water southwards along the East Coast of Iceland. During summer, spring and fall the air temperature in the Reyðafjörður area frequently is higher than the sea surface temperature, resulting in stable air and temperature inversions. During winter cold air streams downwards from valleys and mountains and seeks the lowest levels. Temperature inversions are accordingly relatively frequent in the lowland.

4. Results of Wind Observations

Results of wind observations at Sómastaðagerði are here presented for the period May 1998-April 1999 and, if not otherwise stated, based on observations with a R.M. Young Anemometer, Marine Model, at 10.3 m above the ground.

4.1 Frequency of Wind Directions

The frequency of the wind directions for each month in the period May 1998-April 1999 are shown in Table 5 and as wind roses in the upper part of Annexes 1-12. A wind rose for the whole 12 month period is presented in Annex 13, for fall and winter

in Annex 14 and for spring and summer in Annex 15. For high summer, the months June-August, a wind rose for the night hours 00-06 GMT is shown in Annex 16 and for the day hours 12-18 GMT in Annex 17. The term calm is here used when the wind speed is below 0.05 m/s.

Table 5. Frequency of wind directions at Sómastaðagerði May 1998-April 1999, %.

	Dir.	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
N	360	3,2	1,4	5,4	2,9	1,5	1,1	0,9	1,1	2,8	1,1	2,8	1,9	2,2
	10	1,5	1,0	1,6	1,8	1,1	1,3	0,8	1,0	1,2	0,7	1,5	1,4	1,2
	20	1,0	0,9	0,8	1,5	1,0	1,4	0,7	0,9	0,9	0,4	0,9	1,1	1,0
	30	0,9	1,1	0,7	1,0	1,0	1,3	0,9	1,3	1,6	1,0	0,8	1,5	1,1
	40	1,4	1,6	0,9	1,0	1,6	2,5	1,3	1,7	2,4	1,1	1,6	2,1	1,6
	50	2,4	2,3	1,6	2,1	3,0	3,9	2,6	3,1	3,9	2,2	3,2	2,9	2,8
	60	3,3	2,9	1,7	3,4	6,5	5,6	5,8	9,3	5,2	2,5	6,0	4,5	4,7
	70	4,0	3,8	1,6	3,5	9,9	8,2	9,0	19,0	6,6	2,1	6,8	3,8	6,5
	80	3,9	2,6	1,8	2,5	10,3	13,2	11,9	12,7	5,6	2,3	6,4	4,0	6,5
E	90	3,5	2,3	2,0	2,1	8,8	8,8	8,1	6,9	4,2	1,7	4,4	3,9	4,7
	100	3,0	1,1	1,5	1,3	4,8	4,2	3,9	2,8	3,5	1,5	1,7	2,5	2,7
	110	1,6	0,5	1,5	1,7	2,3	3,0	1,8	1,7	3,7	1,7	1,6	2,2	1,9
	120	2,5	0,2	1,1	1,5	2,0	2,9	1,3	1,0	4,1	1,6	1,6	2,1	1,8
	130	1,4	0,3	0,5	1,1	2,0	2,0	0,6	0,7	1,7	1,2	1,1	1,5	1,2
	140	0,6	0,2	0,3	0,7	1,0	1,2	0,6	0,3	0,4	0,5	0,7	1,0	0,6
	150	0,5	0,2	0,1	0,8	1,0	0,5	0,4	0,3	0,3	0,5	0,6	0,5	0,5
	160	0,2	0,2	0,1	0,5	0,6	0,1	0,2	0,4	0,3	0,5	0,5	0,5	0,3
	170	0,4	0,3	0,2	0,3	0,7	0,2	0,3	0,2	0,3	0,3	0,4	0,6	0,4
S	180	0,2	0,6	0,2	0,4	0,7	0,3	0,3	0,3	0,3	0,6	0,4	0,7	0,4
	190	0,3	0,5	0,1	0,5	0,9	0,1	0,2	0,3	0,4	0,7	0,4	0,6	0,4
	200	0,3	0,6	0,4	0,5	1,5	0,3	0,4	0,4	0,7	0,6	0,5	0,6	0,6
	210	0,6	0,7	0,2	1,0	1,2	0,6	0,3	0,4	0,7	0,5	0,7	0,7	0,6
	220	1,1	1,0	0,4	1,6	1,9	1,3	0,5	0,8	0,9	0,4	0,9	0,8	1,0
	230	1,9	1,6	1,4	4,0	2,1	2,0	1,4	1,0	1,7	1,6	1,6	1,1	1,8
	240	3,8	2,7	3,5	6,5	3,2	2,6	3,8	2,8	4,1	2,8	3,8	2,2	3,5
	250	5,5	4,4	5,9	8,3	3,8	3,9	5,4	3,4	7,5	5,1	4,7	4,4	5,2
	260	7,1	6,0	8,9	8,7	4,7	7,1	6,2	3,5	7,0	8,8	7,2	7,3	6,9
W	270	10,3	9,8	15,6	7,4	3,8	5,2	5,7	4,5	5,3	11,3	9,2	11,6	8,3
	280	8,3	15,9	10,8	7,7	3,9	4,6	6,5	4,8	4,1	15,3	9,1	10,3	8,4
	290	5,1	11,7	8,6	6,7	2,6	2,4	6,6	3,8	3,1	14,2	5,8	6,7	6,4
	300	4,1	7,2	5,4	2,9	1,8	1,2	2,5	1,6	3,0	5,7	3,5	3,9	3,5
	310	3,0	4,3	3,9	2,7	1,7	1,3	1,8	1,3	3,1	3,2	2,2	3,3	2,6
	320	2,3	3,4	2,6	1,8	1,1	0,8	1,4	1,0	3,2	1,8	2,0	2,0	1,9
	330	2,5	2,8	2,1	2,3	1,5	1,0	0,9	0,6	1,9	1,3	1,4	1,6	1,6
	340	3,0	1,9	1,9	2,5	1,5	1,0	1,0	0,7	1,4	0,9	1,4	1,4	1,6
	350	4,1	1,9	4,0	2,6	1,3	1,0	0,8	0,8	2,0	1,3	2,2	2,8	2,1

The strong influence of the topography is evident. A great majority of all winds are either blowing outwards or inwards along the fiord and its mountain sides. For the year as a whole, westerly winds are the most common, 42.2 % of all winds coming from the 70° sector, 235° to 305°. On the second place are easterly and east-northeasterly winds, 22.4 % of the winds coming from the 40° sector, 55° to 95°.

There is a strong annual variation in the frequency of easterly and westerly winds. This is shown in Fig. 7 for three easterly wind directions: 70°, 80° and 90°, and in Fig. 8 for three westerly wind directions 270°, 280° and 290°. As the observation period is only 12 months and due to the great variability of weather in Iceland, values for one or more of the months may not be representative.

During summer there is also a strong diurnal variation in the frequency of the wind directions. For the months June-August this is shown in Annex 16 for the night hours 00-06 GMT and in Annex 17 for the afternoon hours 12-18 GMT. The high afternoon frequency of the east and east-northeasterly sea breeze is particularly noteworthy. The duration of the sea breeze is of course variable from day to day, but in the summer it usually starts before 10 GMT and last until after 21 GMT. The diurnal variation is in Fig. 9 shown for four selected wind directions in June-August.

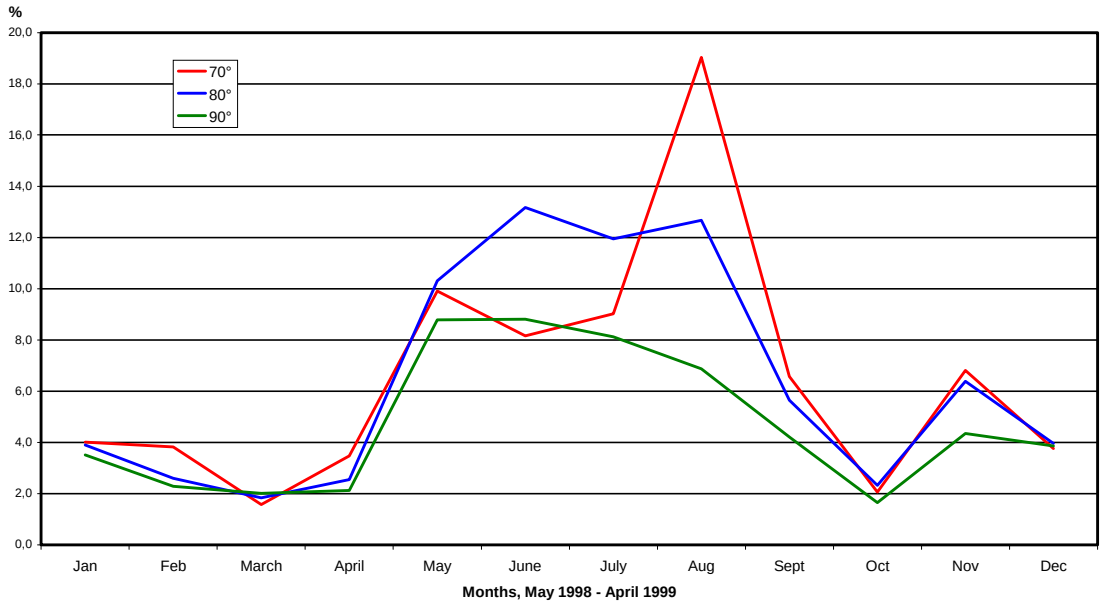


Fig. 7. Annual variation of the frequency of three easterly wind directions at Sómastaðagerði, May 1998-April 1999, %

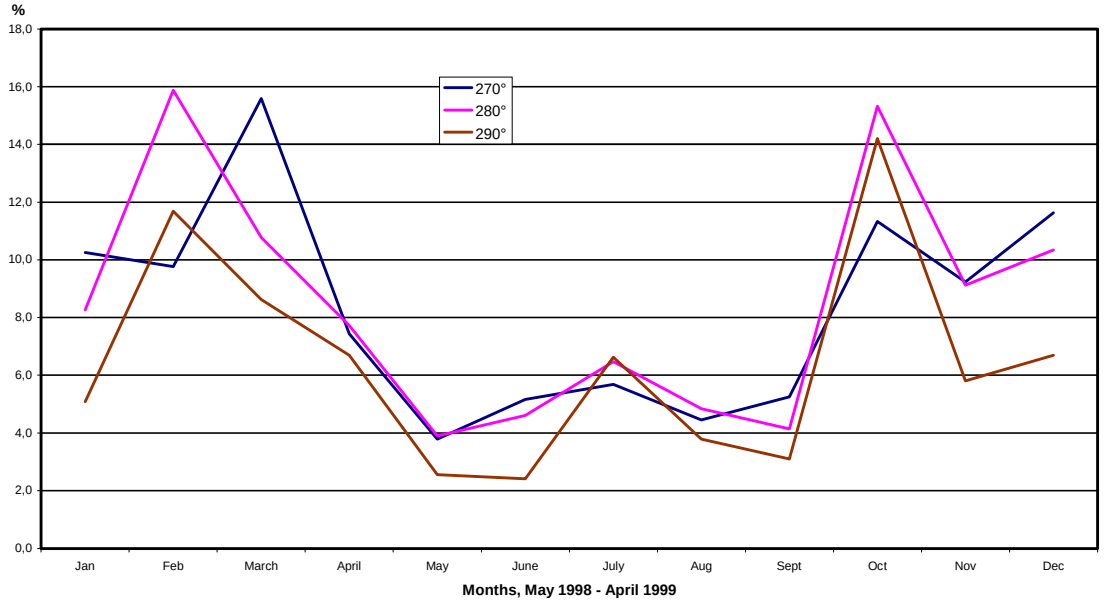


Fig. 8. Annual variation of the frequency of three westerly wind directions, Sómastaðagerði, May 1998-April 1999, %

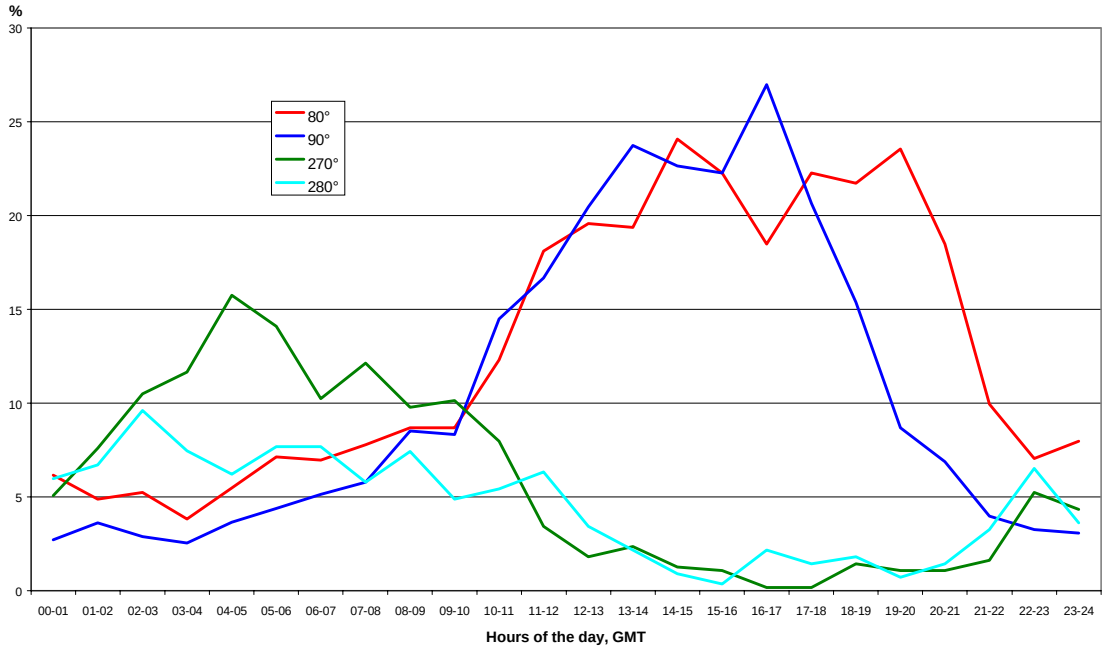


Fig. 9. Diurnal variation of frequency for selected wind directions, Sómastaðagerði, June-August 1998.

4.2 Wind Velocity

The average monthly 10 minute wind velocity at 10.3 m height at Sómastaðagerði during the 12 months period May 1998-April 1999 is presented in Table 6.

Table 6. Average monthly wind velocity at Sómastaðagerði, May 1998-April 1999, m/s.

May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	Year
3.6	3.6	4.4	3.7	3.9	6.3	5.1	5.3	4.8	6.8	5.8	3.9	4.8

The average for the year is 4.8 m/s with monthly means variable from 3.6 m/s to 6.3 m/s. Due to the short period of observation the annual variation is somewhat irregular.

The frequency of the 10 minute wind velocity for selected velocity intervals is shown in Table 7.

Table 7. Frequency of wind velocity for selected intervals, Sómastaðagerði, May 1998-April 1999, %.

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	12,2	15,3	11,2	10,5	8,1	57,2	34,0	7,6	1,1		
Feb	8,0	10,8	8,4	5,6	6,1	38,9	36,5	18,6	5,4	0,6	
Mar	8,0	10,8	12,2	9,5	7,6	48,1	35,6	13,8	2,2	0,3	0,1
Apr	19,6	19,3	14,6	8,8	6,7	69,0	23,7	6,4	0,9	0,0	
May	14,4	15,7	14,9	12,9	13,3	71,2	27,0	1,8			
Jun	13,7	13,9	14,1	16,5	14,1	72,3	27,0	0,7			
Jul	14,4	16,7	13,9	11,8	8,6	65,5	26,0	7,0	1,4	0,1	
Aug	19,7	14,2	12,0	10,1	11,3	67,4	30,3	2,2	0,1		
Sep	11,8	15,6	15,3	13,0	10,6	66,3	31,6	2,1			
Oct	9,5	11,0	10,5	7,8	6,5	45,4	32,9	15,7	6,0	0,1	
Nov	10,6	11,9	10,0	10,6	10,0	53,2	36,3	8,4	2,2		
Dec	8,7	12,5	10,0	9,2	8,1	48,5	41,7	9,6	0,2		
Year	12,6	14,0	12,3	10,5	9,3	58,7	31,9	7,8	1,6	0,1	0,0

The high frequency of low wind velocities is similar to that earlier found at Eyri and Leirur in Reyðarfjörður (Ref. 1). As seen from the table 26.6 % of observations were below 2.0 m/s, 58.7 % below 5.0 m/s, and 90.6 % were lower than 10.0 m/s.

The highest 10 minute wind velocity observed during the 12 month observation period was 26.9 m/s on 18 March 1999, wind direction 295°. The highest wind gust, 42.9 m/s was recorded on the same day and during the same interval between 15:20 and 15:30 GMT. This gives a gust factor of 1.60. During the years 1982-1984 wind observations were also made at 10 m above the ground at Sómastaðagerði. The highest 10 minute velocity then observed was 30.9 m/s and the highest gust 49.4 m/s, this also giving a gust factor of 1.60. It has been estimated that wind gusts will on average exceed 56 m/s once every 50 years at Sómastaðagerði.

The average wind velocity for each wind direction is presented in Table 8 as well as in the histograms on the lower part of Annexes 1-17.

Table 8. Average wind velocity for each wind direction,
Sómastaðagerði, May 1998-April 1999, m/s.

Direction		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
N	360	5,8	4,9	8,3	6,6	2,0	2,0	4,2	0,7	5,7	3,1	5,8	4,3	5,5
	10	2,5	1,2	2,2	2,9	1,8	2,3	3,2	0,7	2,7	2,0	2,8	1,5	2,2
	20	1,5	1,3	1,6	1,7	1,2	1,5	1,8	0,8	1,5	1,8	1,7	2,0	1,5
	30	1,7	2,0	1,9	1,7	1,2	1,5	1,2	0,8	1,6	1,3	1,9	2,1	1,5
	40	2,6	2,5	1,9	1,3	1,9	1,9	1,3	1,5	1,9	1,9	2,2	2,5	2,0
	50	5,4	3,0	2,5	2,3	2,6	2,0	1,6	2,8	2,2	2,6	3,7	4,0	2,9
	60	7,3	4,9	2,9	3,0	3,4	2,6	2,2	4,6	2,8	3,3	4,6	5,4	3,9
	70	6,8	5,9	3,6	3,5	4,2	3,2	2,8	5,2	3,9	3,8	6,2	6,5	4,6
	80	7,4	6,0	5,2	3,5	4,0	4,0	3,1	4,2	3,7	3,6	9,7	7,6	4,7
E	90	7,2	7,2	7,0	2,9	3,6	4,0	2,7	3,3	3,9	3,0	8,9	8,4	4,7
	100	7,0	5,9	6,0	2,8	3,3	3,2	2,1	2,3	4,4	3,4	7,4	6,0	4,2
	110	6,3	1,9	5,0	3,1	3,0	2,9	1,4	1,7	4,3	4,3	6,5	5,9	3,9
	120	5,8	3,5	4,7	2,6	2,8	3,1	1,4	1,8	4,6	4,7	5,8	6,2	4,2
	130	6,0	2,1	3,0	2,8	3,6	3,3	1,2	1,0	3,9	4,7	5,3	5,5	3,9
	140	4,9	3,0	2,6	2,9	3,2	3,0	1,1	0,7	2,0	3,4	4,1	4,7	3,2
	150	3,0	3,2	1,2	2,4	3,0	2,1	0,9	0,8	1,3	3,0	3,1	3,7	2,6
	160	3,4	3,1	2,3	1,9	2,2	2,0	1,5	0,7	1,2	3,9	4,4	3,9	2,7
	170	2,0	4,3	1,3	0,9	3,7	1,7	1,3	1,2	1,2	4,1	3,4	3,2	2,6
S	180	1,4	3,5	2,4	1,2	3,8	1,5	1,2	1,1	1,4	3,8	4,0	4,0	2,8
	190	2,1	4,3	2,5	1,5	4,3	1,6	1,0	1,4	1,6	3,9	3,5	5,3	3,2
	200	1,6	3,7	2,0	1,1	3,8	1,2	1,4	0,9	1,4	2,9	2,4	4,8	2,6
	210	2,7	4,0	2,2	1,7	3,2	2,4	2,1	1,4	2,3	1,9	1,8	3,8	2,5
	220	2,0	2,8	2,2	1,9	2,9	2,2	2,0	1,2	1,8	2,7	2,3	2,7	2,2
	230	2,7	2,7	3,2	2,3	3,3	2,2	3,3	1,6	2,1	1,6	2,3	2,4	2,5
	240	2,6	3,1	3,3	2,3	3,0	3,1	4,0	2,2	3,5	1,8	3,0	2,5	2,9
	250	3,1	4,2	3,5	2,5	4,4	5,4	6,4	2,8	5,2	3,9	4,1	3,5	4,1
	260	3,8	6,1	5,6	3,9	4,4	6,5	7,3	4,3	5,9	5,5	4,5	6,1	5,3
W	270	5,4	8,6	7,0	5,2	4,7	5,5	7,0	4,6	4,9	6,6	5,7	6,3	6,2
	280	5,3	10,1	6,3	6,4	4,9	5,1	9,4	5,9	4,0	8,8	5,8	6,2	7,1
	290	4,8	8,6	7,5	6,6	5,1	4,9	10,2	6,8	3,8	11,2	4,7	5,8	7,6
	300	3,8	6,9	7,8	5,5	4,4	3,3	6,6	4,4	3,7	8,7	4,3	4,8	5,9
	310	3,5	7,6	7,8	5,5	3,9	3,0	5,0	4,1	4,0	7,9	4,1	4,3	5,5
	320	3,8	7,6	6,6	5,3	2,8	2,6	3,7	2,6	4,4	5,6	4,0	5,0	4,9
	330	3,0	7,8	4,6	5,6	3,5	2,5	5,1	2,9	3,8	3,5	2,9	4,0	4,4
	340	4,2	5,5	5,2	4,3	3,6	2,7	3,6	1,5	3,7	3,8	2,5	3,4	3,9
	350	5,8	6,7	6,8	4,7	3,4	2,7	4,4	0,7	5,6	4,0	4,1	4,6	5,0

The highest averages are for west-northwesterly winds (290° an 280°).

The distribution of 10 minute wind velocity is presented in Fig. 10.

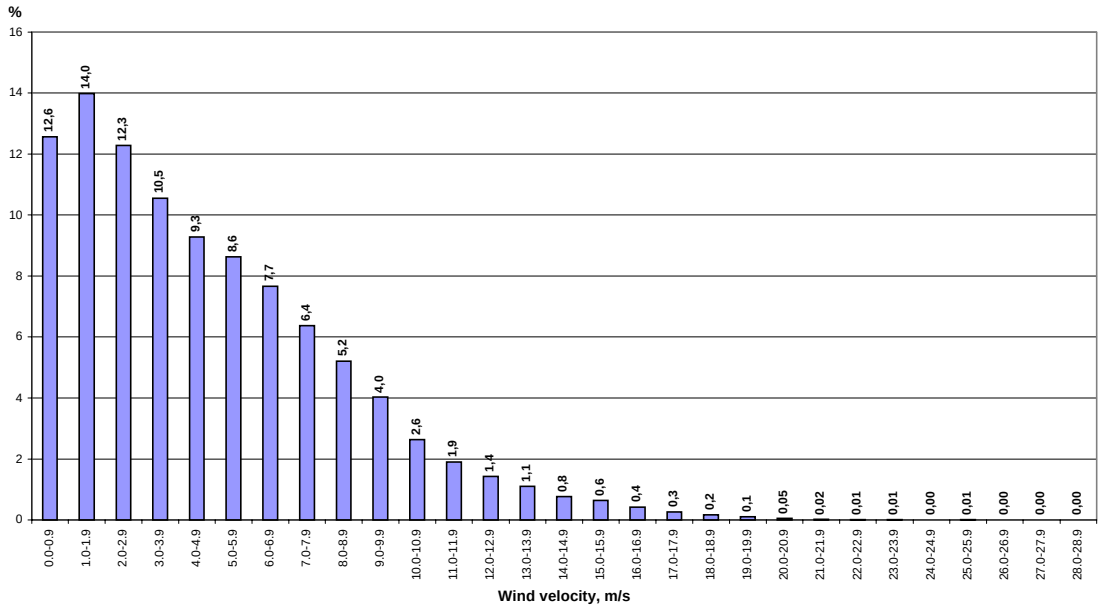


Fig. 10. Wind velocity distribution, 10 minute means, May 1998-April 1999, %.

Diurnal variation of wind velocity is considerable during the summertime. For the months May- August, this is shown in Fig. 11. The graphs are somewhat irregular due to the short period of observation.

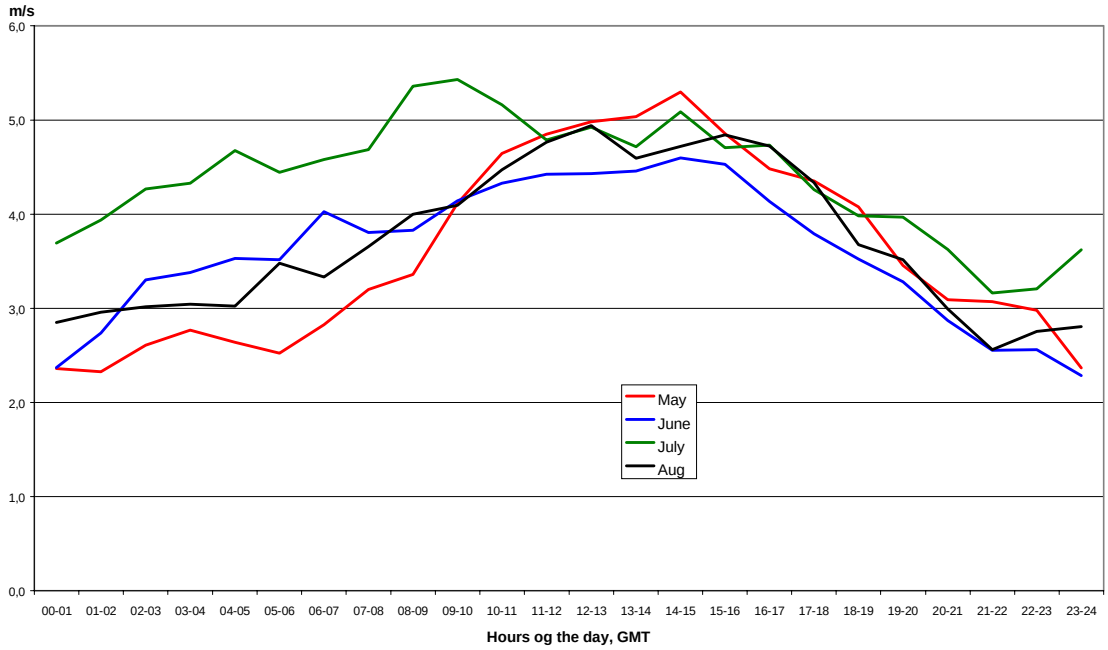


Fig. 11. Diurnal variation of wind velocity,
Sómastaðagerði, May-August 1998, m/s.

4.3 Variation of Wind Velocity with Height

The Gill UVW anemometers at 10.8 m and 36.6 m above the ground have been used to study the variation of 10 minute wind velocity with height at Sómastaðagerði. This variation is often described with the equation:

$$V_2/V_1 = (H_2/H_1)^{\alpha}$$

where V_2 and V_1 are wind velocities at the heights H_2 and H_1, respectively, and α is an exponent.

At Sómastaðagerði it turned out that α was quite variable according to wind direction. For easterly wind directions (90°±30°) a mean value for α was 0.14 but for westerly wind directions (270°±30°) a mean value for α was only 0.08. In both cases observations with wind speed below 5 m/s were excluded. The former value is slightly lower than was found at the Meteorological Office in Reykjavík during the years 1986-1996 (α between 0.18 and 0.15, decreasing with increasing wind velocity) (Þórður Arason, 1998. Ref. 4). At the observation station Leirur on Sléttunes in Reyðarfjörður a mean value for α was found to be 0.11 (Ref. 1).

5. Results of Temperature and Stability Observations

Electrical platinum resistance thermometers were used at 3.0 m, 10.5 m and 36.5 m above the ground for observations of air temperature and stability. Data from the two Gill UVK anemometers at 10.8 m and 36.6 m above the ground have been delivered for model analysis of stability and pollution dispersion at NILU.

5.1 Air Temperature at 3.0 m Height

Mean monthly air temperature at 3.0 m height at Sómastaðagerði is presented for the period May 1998-April 1999 in Table 9. For comparison the corresponding means for Kollaleira at 2.0 m above the ground are included as well as the averages for Kollaleira for the years 1977-1998.

Table 9. Mean monthly air temperature, Sómastaðagerði and Kollaleira, May 1998-April 1999,°C.

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Year
Sómastaðagerði	5.7	6.1	8.3	9.0	6.7	2.6	1.7	1.2	-0.4	-1.2	-1.8	0.7	3.2
Kollaleira	6.5	6.8	8.6	9.8	6.7	2.4	1.8	1.1	-0.7	-1.6	-1.9	0.7	3.3
Kollaleira 1977-1998	4.9	8.1	9.8	9.5	6.8	3.4	1.0	-0.1	-0.8	-0.5	-0.3	1.6	3.6

A comparison between the mean monthly air temperature at 3.0 m, 10.5 m and 36.5 m above the ground is presented in Table 10.

Table 10. Mean monthly air temperature at 3.0 m, 10.5 m and 36.5 m height, Sómastaðagerði, May 1998-April 1999, °C.

Sómastaðagerði	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	Year
Height 3.0 m	5.74	6.11	8.26	8.95	6.68	2.64	1.68	1.19	-0.40	-1.19	-1.77	-0.71	3.24
Height 10.5 m	5.71	6.00	8.23	9.07	6.93	2.93	2.13	1.68	0.07	-0.78	-1.44	1.01	3.49
Height 36.5 m	5.61	5.79	8.16	9.04	6.96	2.93	2.25	1.79	0.17	-0.70	-1.44	1.06	3.49

During fall and winter the monthly means are higher at 10.5 m than at 3.0 m, and the means at 36.5 m are equal or slightly higher than those at 10.5 m. This underlines the stability of the ground layer during fall and winter.

5.2 Vertical Temperature Gradient

The temperature difference between 36.5 m and 3.0 m on the one hand and 36.5 m and 10.5 m on the other hand are presented for each month in Annexes 18 to 29, based on 10 minute means, 144 sets of observations per day. The data for the first day of the month start where 1 is marked on the x-axis of the diagrams, the data for the second day where 2 is marked etc. During the months October-March the ground based layer seems to be more or less stable practically all the time. It is of course regrettable that the observation mast was not higher, but earlier observations in Eskifjörður in the years 1982-1985 show that ground based inversions often reach a considerable height, i.e. 90 m or even 260 m or more above sea level.

During the summer months there is a marked diurnal variation in the stability. This is clearly seen in Annexes 18-21 but can perhaps best be seen in Annexes 30 to 35 which for each month show the mean diurnal variation of the temperature difference between the observation levels. On average the air layer between 3.0 m and 36.5 m is stable from approx. 21 GMT in the evening to approx. 07 GMT in the morning but neutral or unstable during the day. This is apparently in contradiction with what was found in Eskifjörður 1982-1985 where the frequency of stable air between 3 m and 92 m, between 3 m and 260, m and between 92 m and 260 m was in the summer found to be highest around 12 to 15 GMT. Possibly this can partly be due to a hillside effect in the Eskifjörður observations. This could also indicate that the presently observed instability frequently is limited to a relatively thin ground based layer with a stable layer above.

5.3 Periods with Stable Air Conditions and Low Wind Velocities

As seen from Annexes 18 to 29 periods of very stable air at the ground often occur at Sómastaðagerði, especially during the fall and winter. Sometimes the stable conditions prevail for many days or even weeks. Often the wind velocity is low, at least for considerable parts of these periods. Frequently the wind direction is westerly but sometimes interspersed with easterly or other wind directions. As examples of such periods we mention 11-17 November and 5-12 December 1998.

During the former period the mean wind velocity was 3.1 m/s. All wind directions occurred during the period, as frequently happens during fluctuating winds of low velocity. Westerly winds, between 245° and 295°, were blowing 41.8 % of the time, and east-northeasterly wind, between 45° and 95°, were observed 22.6 % of the time.

During the second period in December the mean wind velocity was higher, 3.9 m/s, and winds also occurred from all wind directions. From the sector between 35° and 125° the wind was blowing 38.5% of the time, and 31.2% from the equally large sector between 235° and 325°.

6. Remarks

From this and earlier reports (Ref. 1, 2 and 3) it is evident that low wind velocities are very frequent at Sómastaðagerði and in the Reyðarfjörður area. The high mountains surrounding the fiord steer and modify the wind and limit to some extent ventilation.

Furthermore, it is evident that ground based temperature inversions are very frequent during the winter and during the nights in summer. During daytime in summer an easterly sea breeze is usually blowing, and although the lowest air layer over land then frequently is neutral or unstable, as seen from the observations at Sómastaðagerði, higher temperature inversions may often be suspected, as indicated by earlier observations in Eskifjörður.

In the Reyðarfjörður area the winds are usually either blowing inwards or outwards along the fiord. On the positive side, the common and frequently stable westerly winds will blow polluted air towards the sea. During summer the winds, however, usually turn in the morning and become easterly. Accordingly there seems to be some possibility of recirculation of polluted air.

In view of this, it seems advisable not to limit studies of pollution dispersion to whole seasons or the whole year, but also to study shorter periods of unfavourable dispersion conditions, lasting for days or even weeks. This could prove to be of importance for determining the size of proposed industrial plants in Reyðarfjörður and the requirements for control and cleaning systems.

7. References

1. Flosi Hrafn Sigurðsson, Hreinn Hjartarsson, 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.

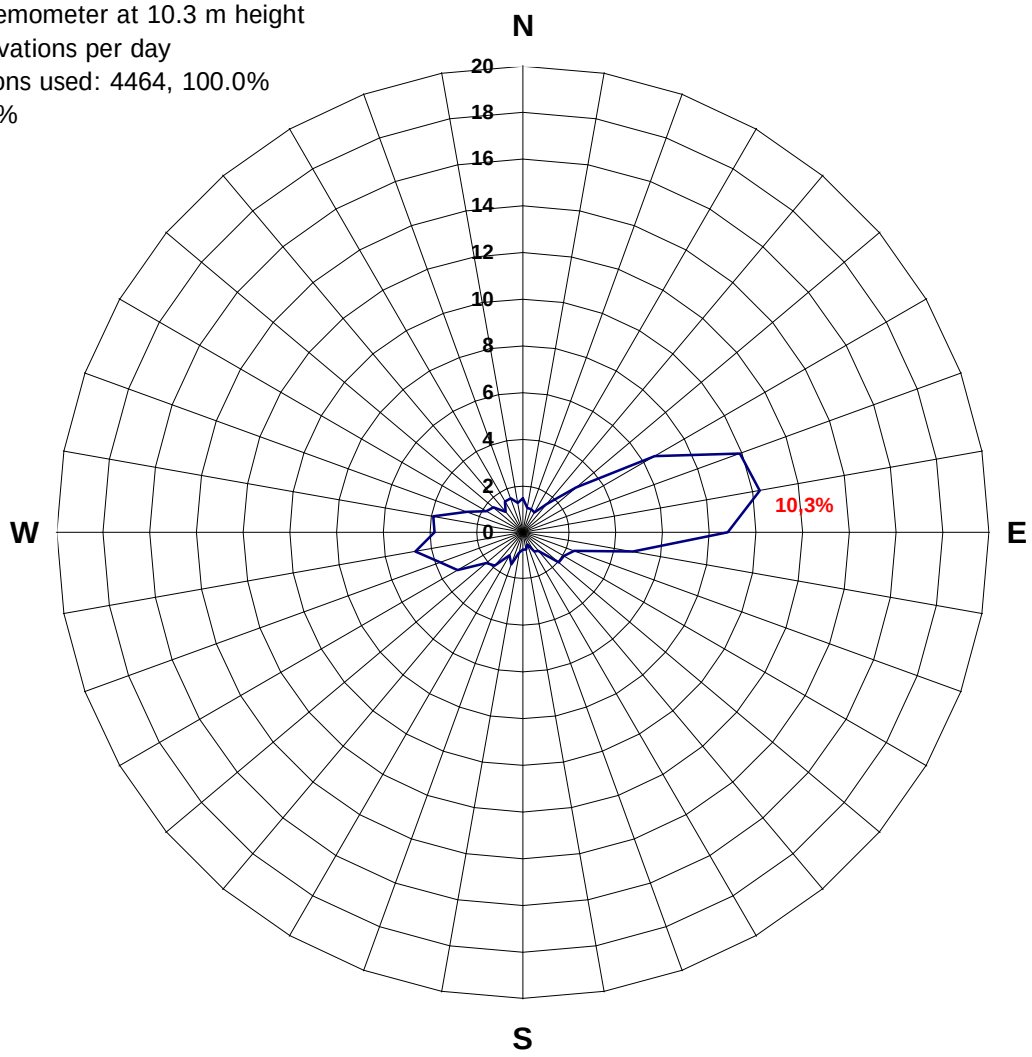
2. Flosi Hrafn Sigurðsson and Hreinn Hjartarson: Veðurathuganir á Reyðarfjarðarsvæðinu (Weather Observations in the Reyðarfjörður Area). Veðurstofa Íslands, Reykjavík 1986. 116 p. (In Icelandic).

3. 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).

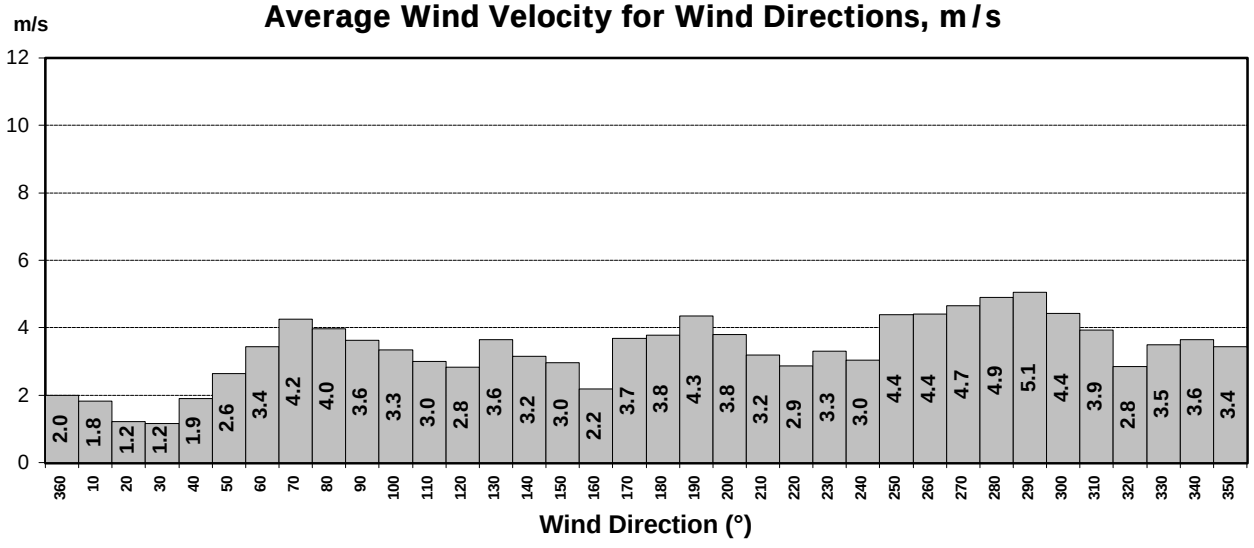
4. Þórður Arason: Mat á vindi á fyrirhuguðum brúm í Reykjavík (Estimated Wind Velocity at Bridges planned in Reykjavík). Veðurstofa Íslands, Greinargerð VÍ-G98017-TA01, Reykjavík, March 1998. 30 p. (In Icelandic).

Frequency of Wind Directions, %
May 1998

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 1.8%

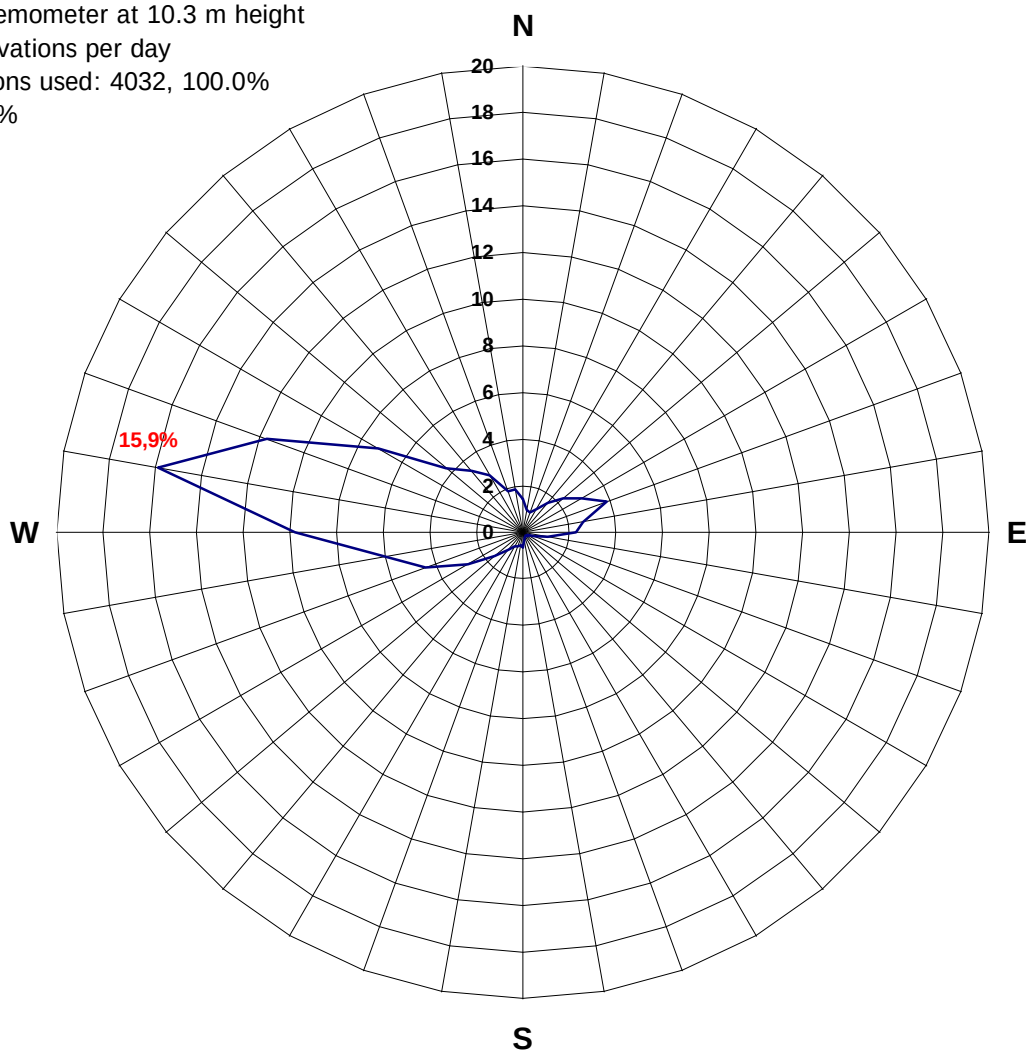


Average Wind Velocity for Wind Directions, m/s

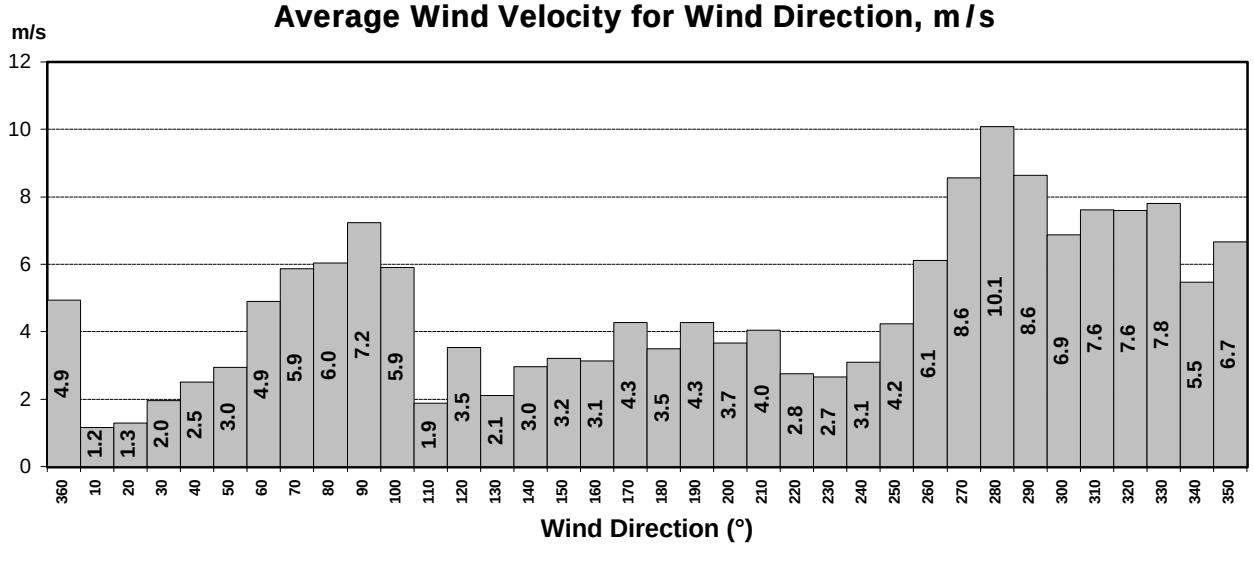


Frequency of Wind Directions, %
February 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4032, 100.0%
Calm: 0.1%

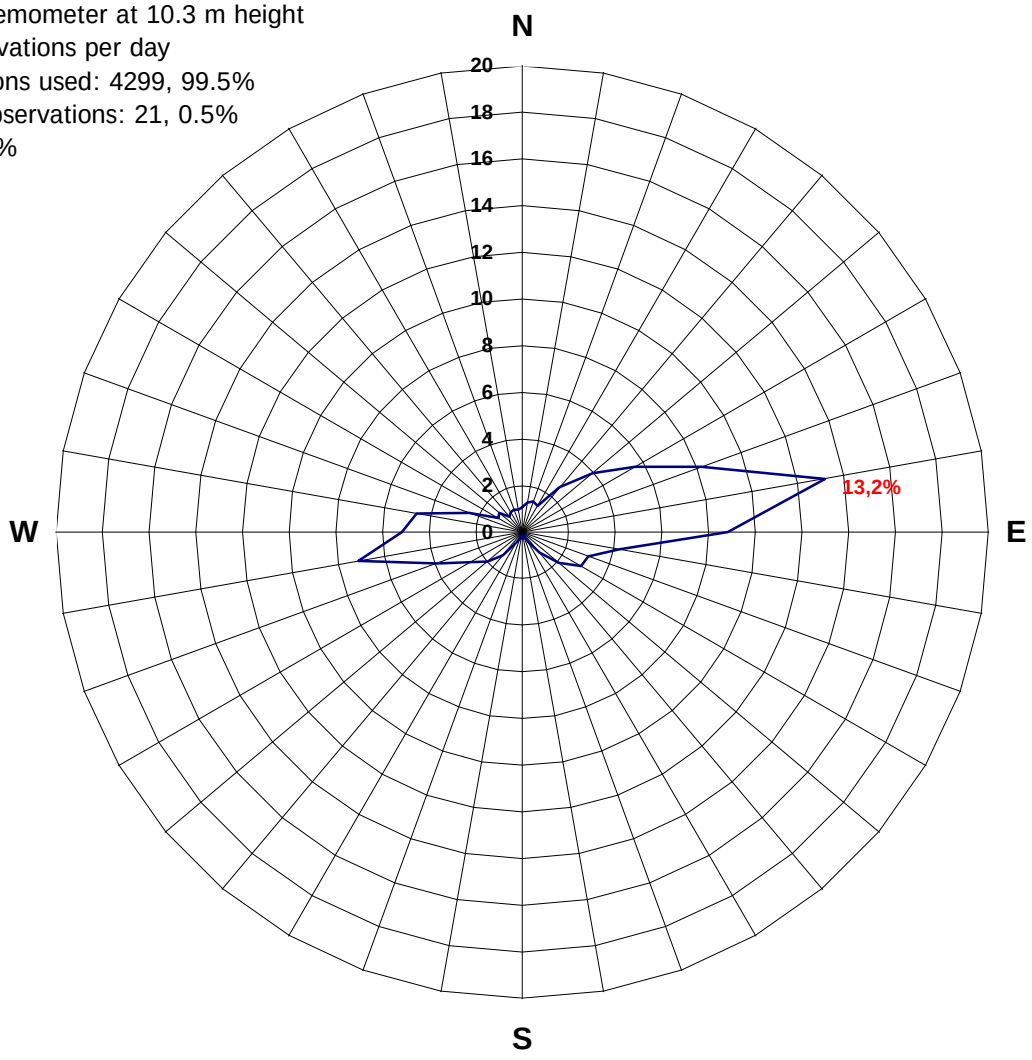


Average Wind Velocity for Wind Direction, m/s

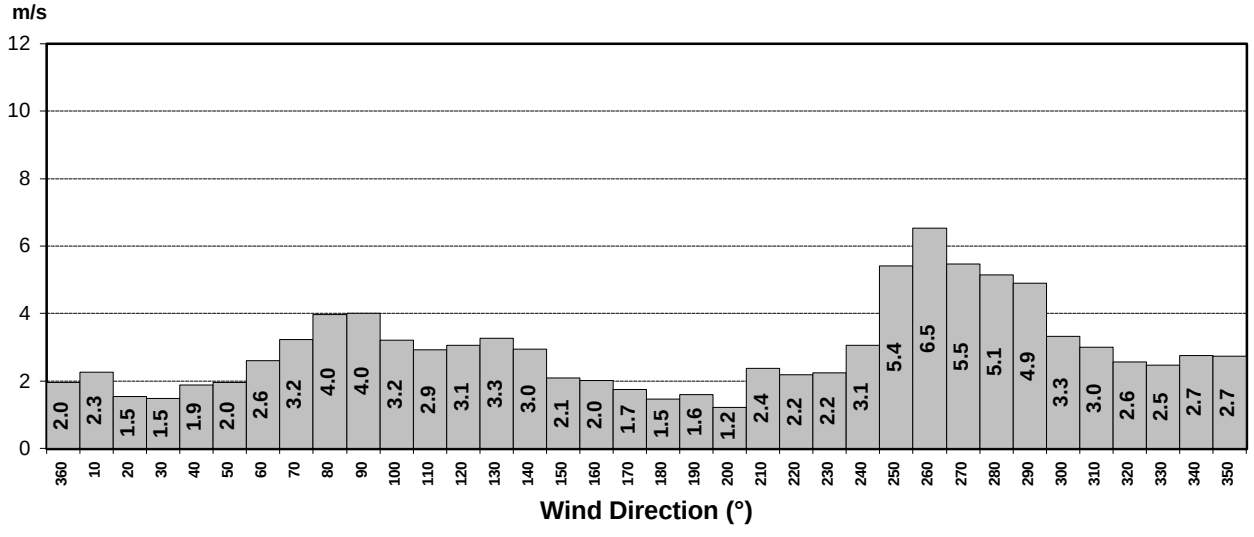


Frequency of Wind Directions, %
June 1998

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4299, 99.5%
Missing observations: 21, 0.5%
Calm: 2.0%

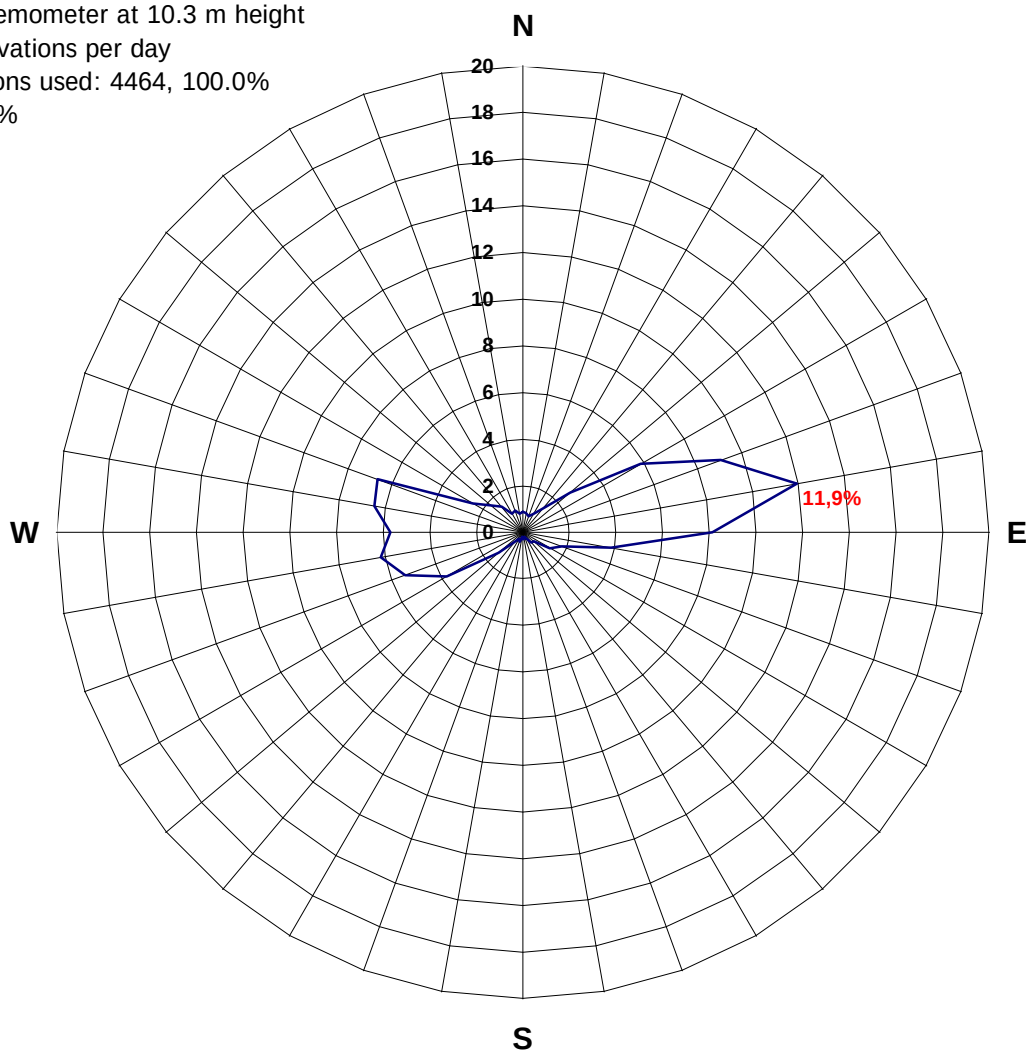


Average Wind Velocity for Wind Directions, m/s

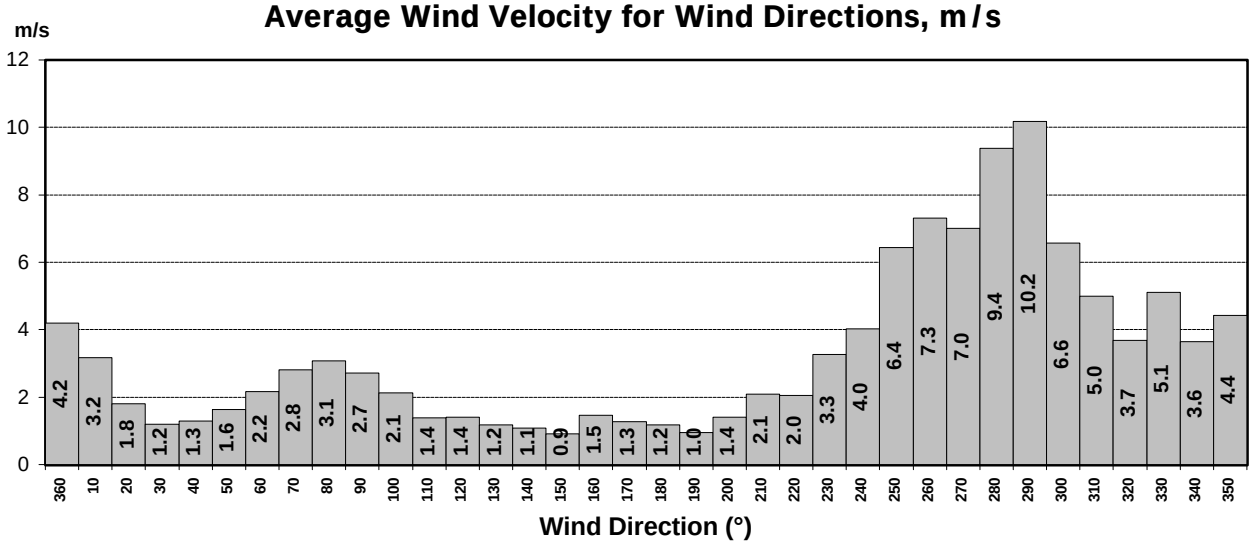


Frequency of Wind Directions, %
July 1998

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 3.2%

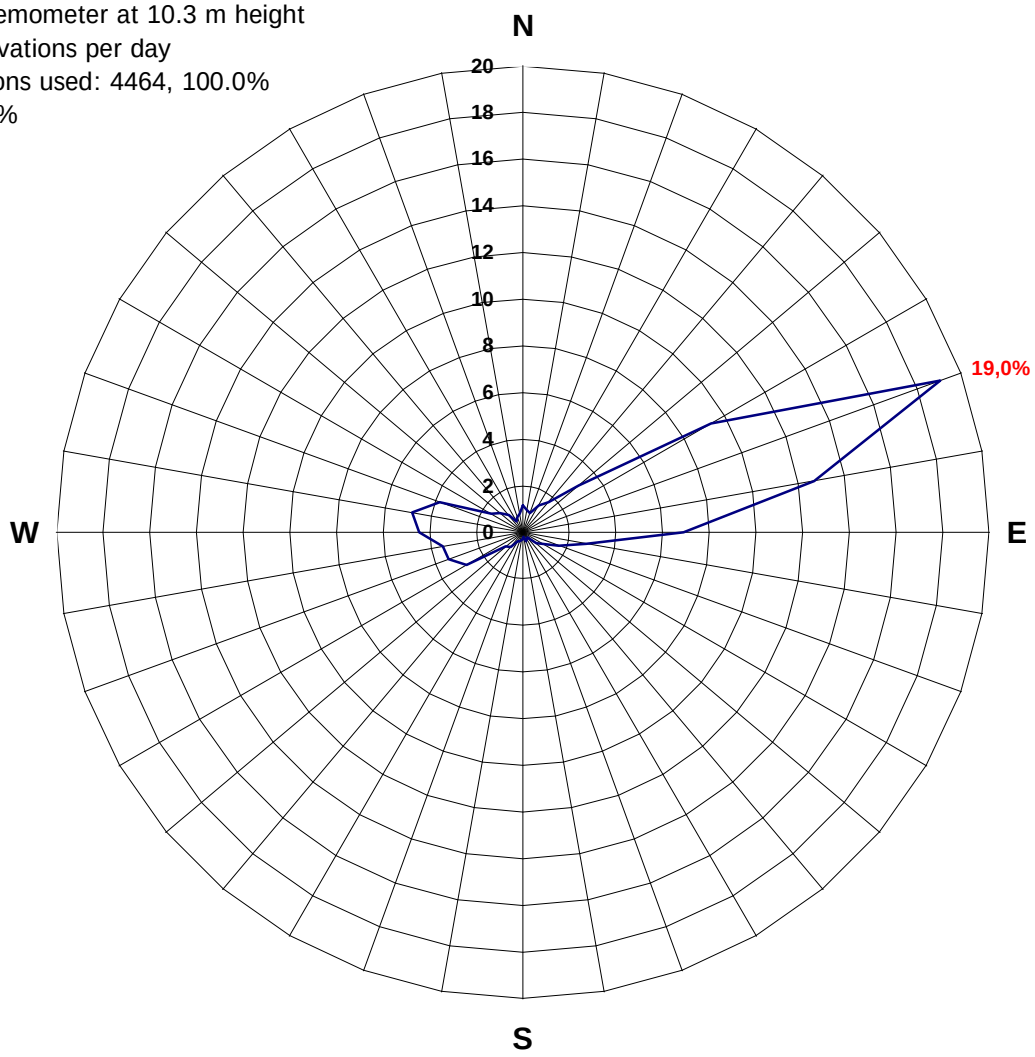


Average Wind Velocity for Wind Directions, m/s

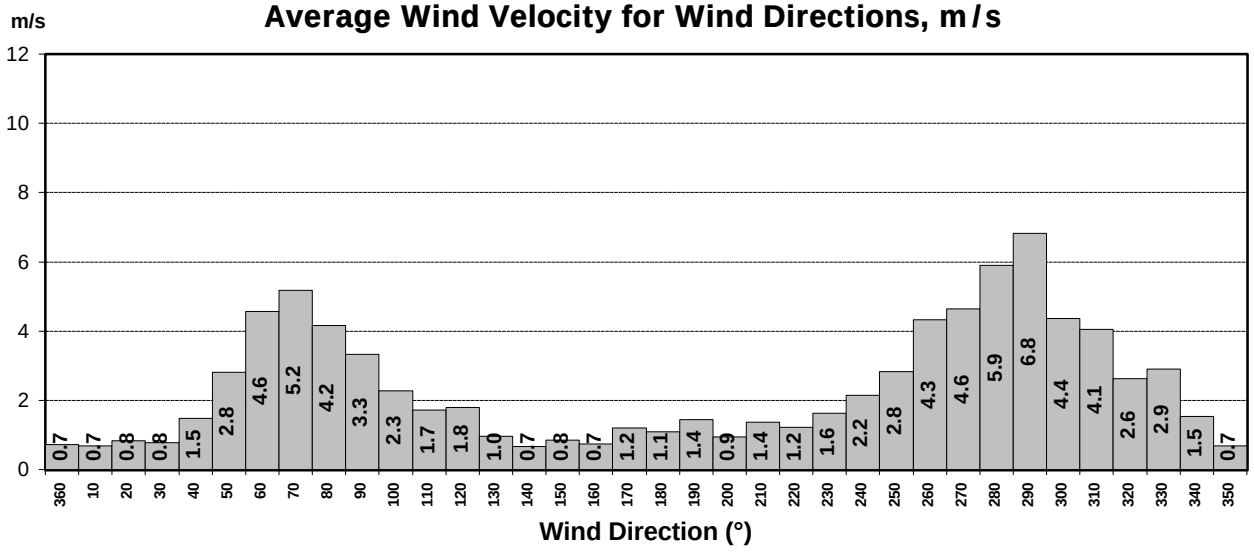


Frequency of Wind Directions, %
August 1998

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 3.7%

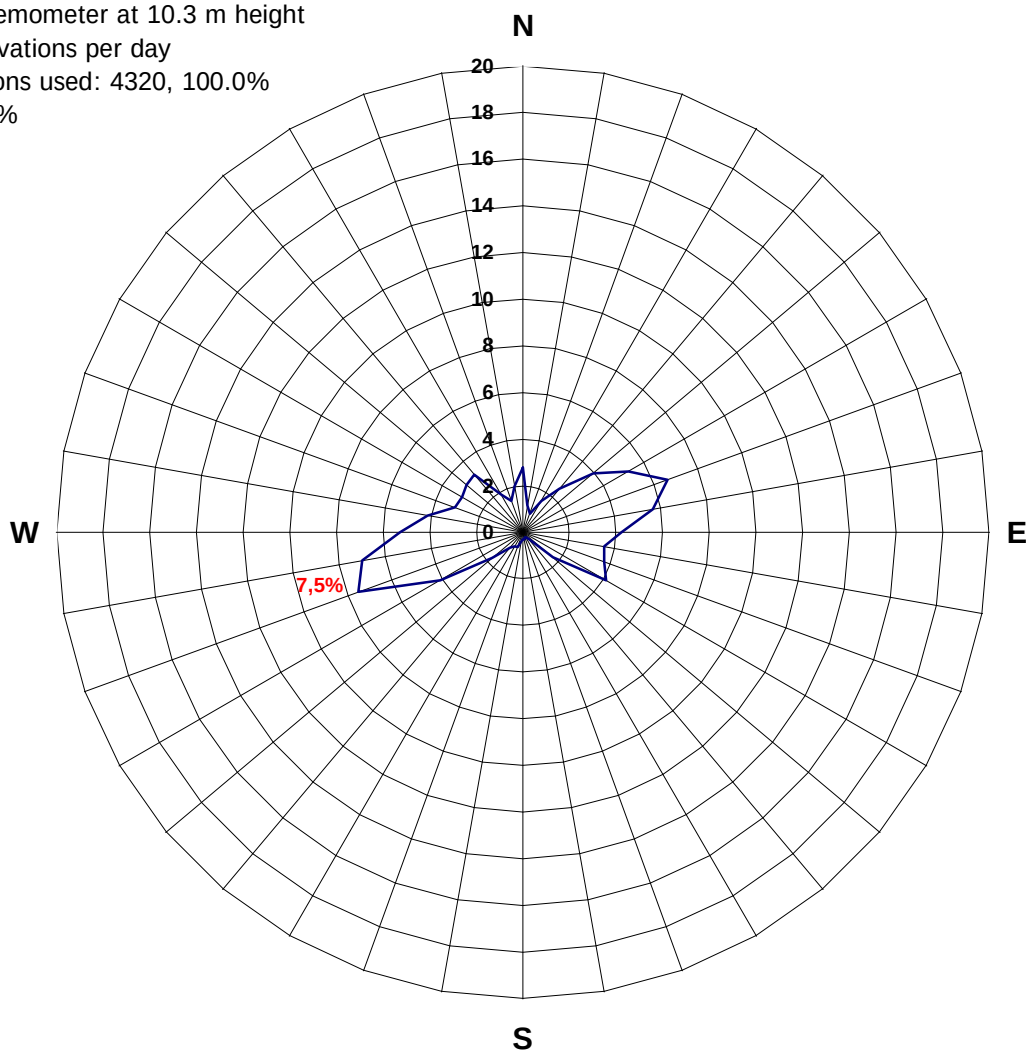


Average Wind Velocity for Wind Directions, m/s

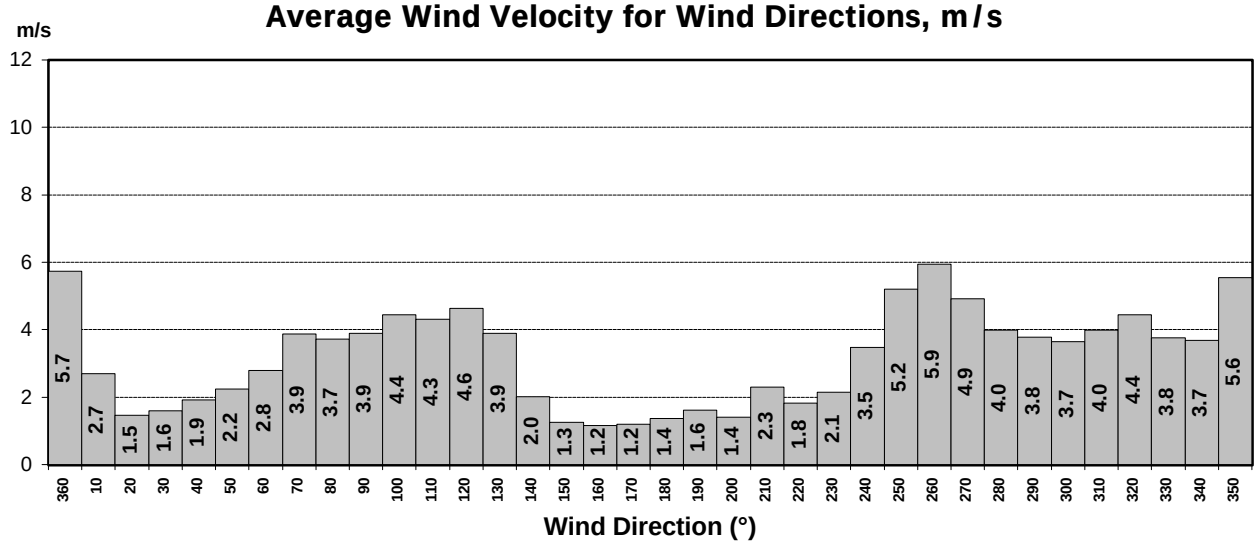


Frequency of Wind Directions, %
September 1998

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4320, 100.0%
Calm: 0.9%

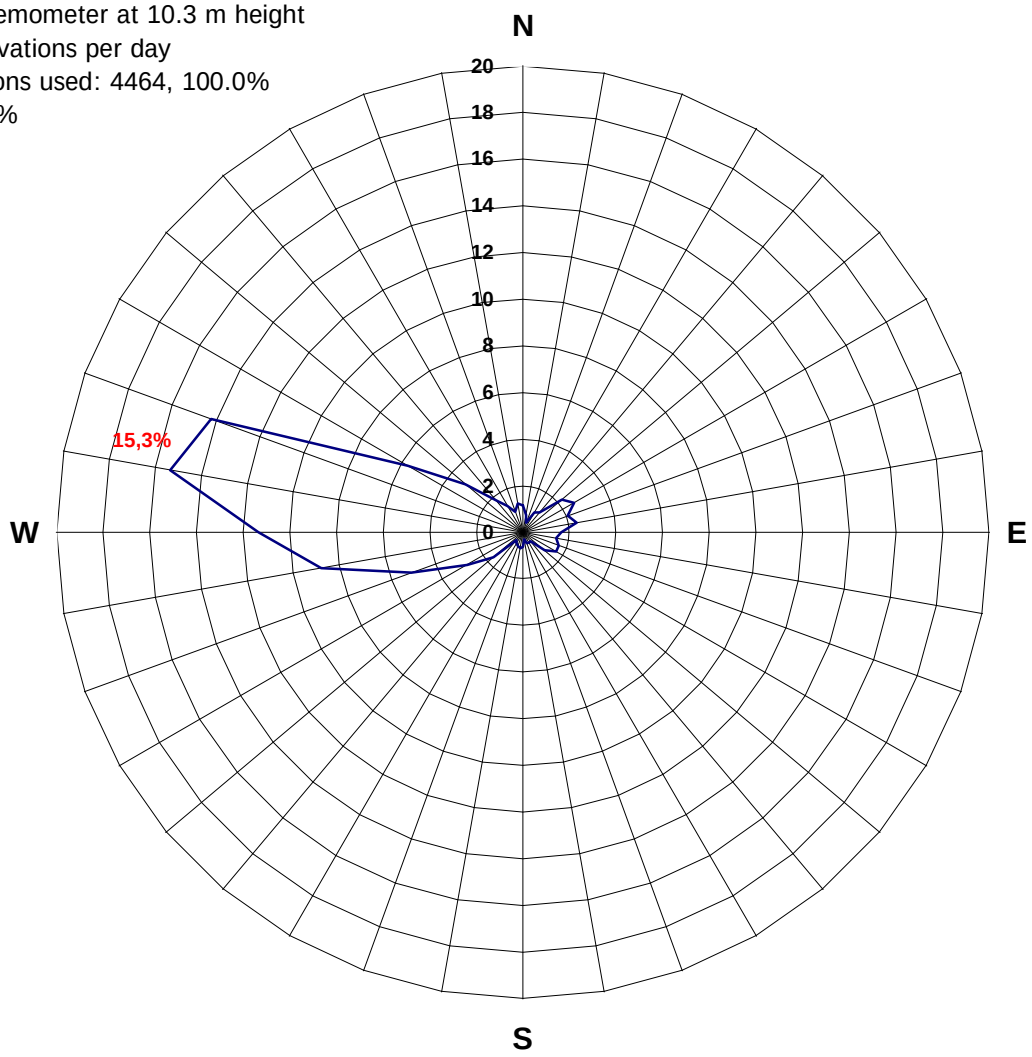


Average Wind Velocity for Wind Directions, m/s

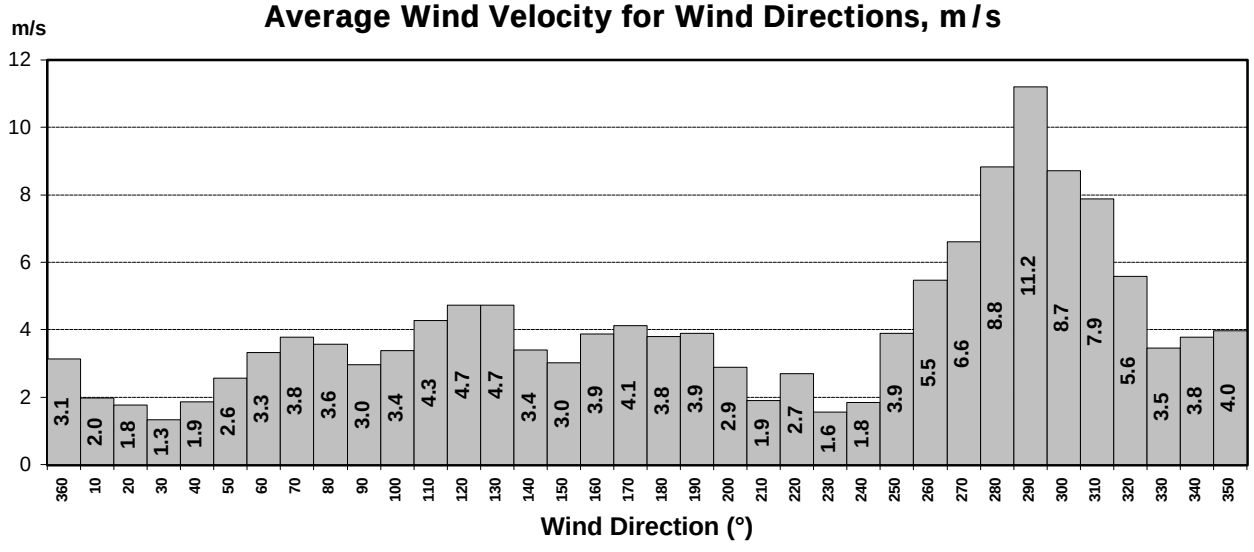


Frequency of Wind Directions, %
October 1998

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 0.9%

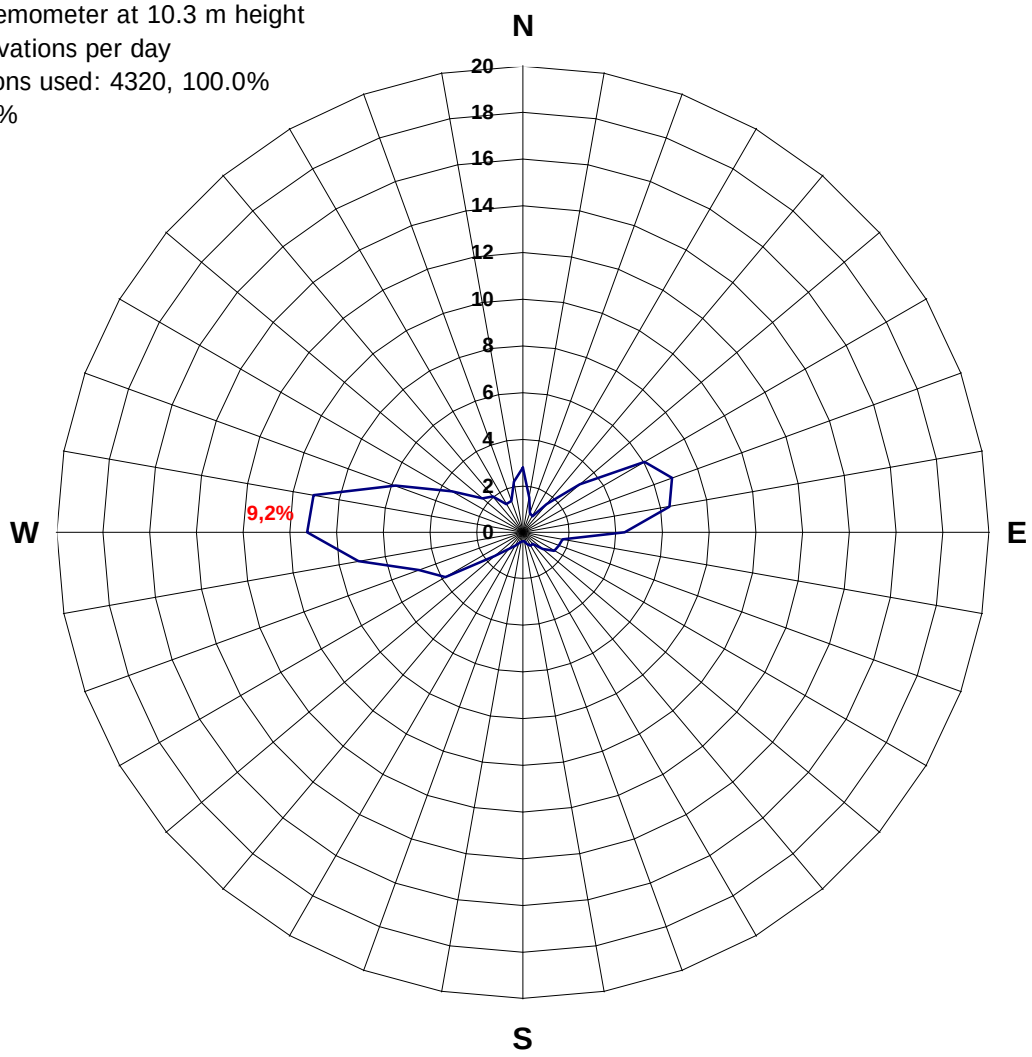


Average Wind Velocity for Wind Directions, m/s

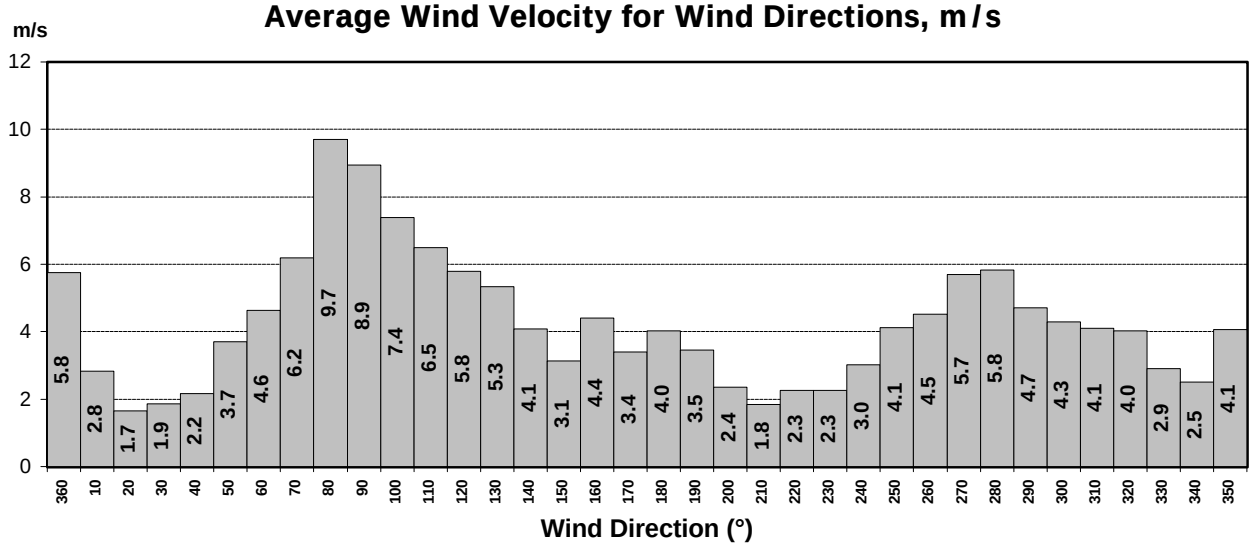


Frequency of Wind Directions, %
November 1998

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4320, 100.0%
Calm: 0.3%

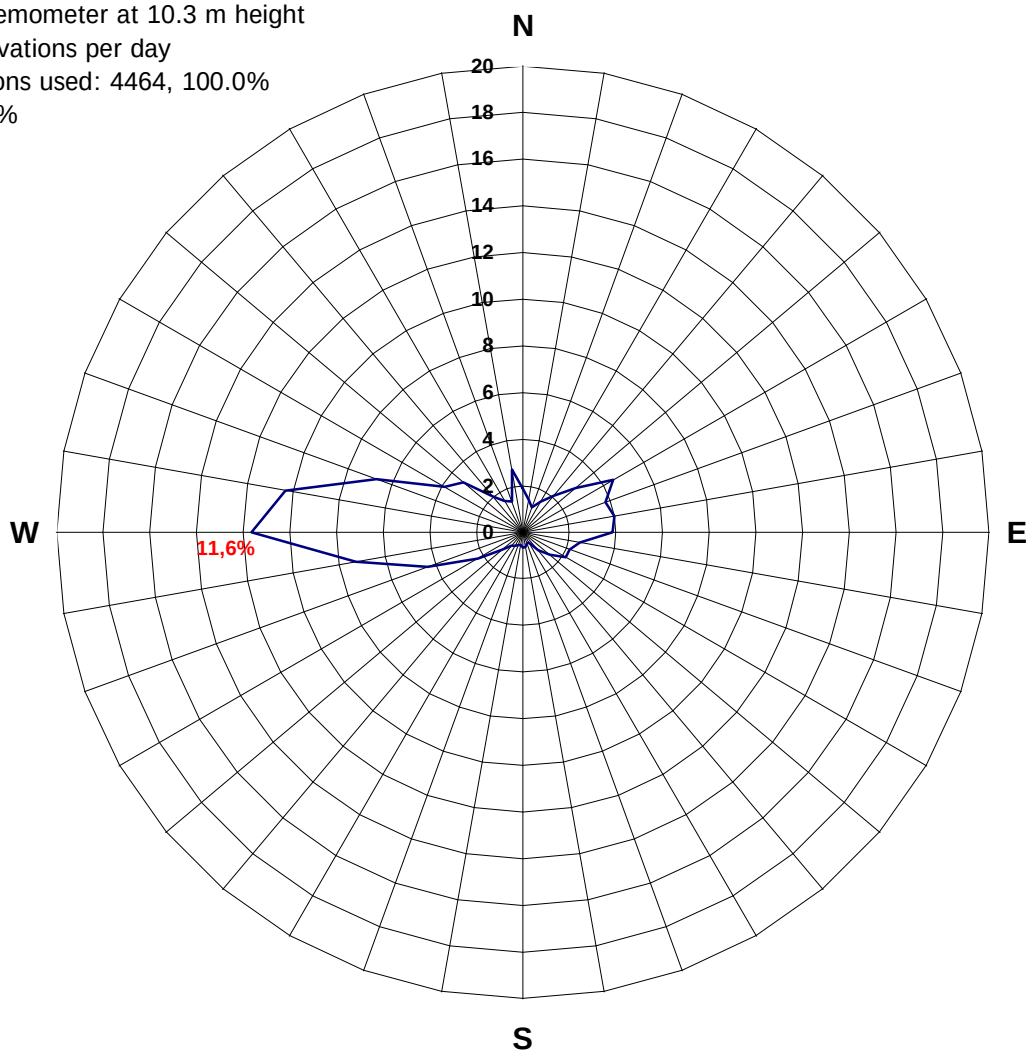


Average Wind Velocity for Wind Directions, m/s

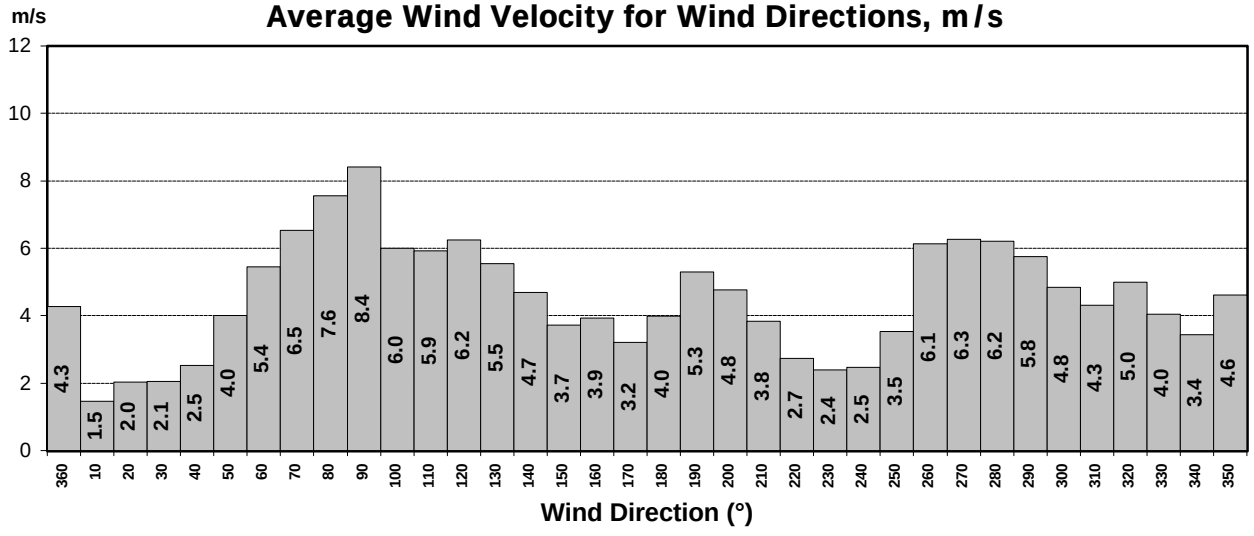


Frequency of Wind Directions, %
December 1998

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 0.3%

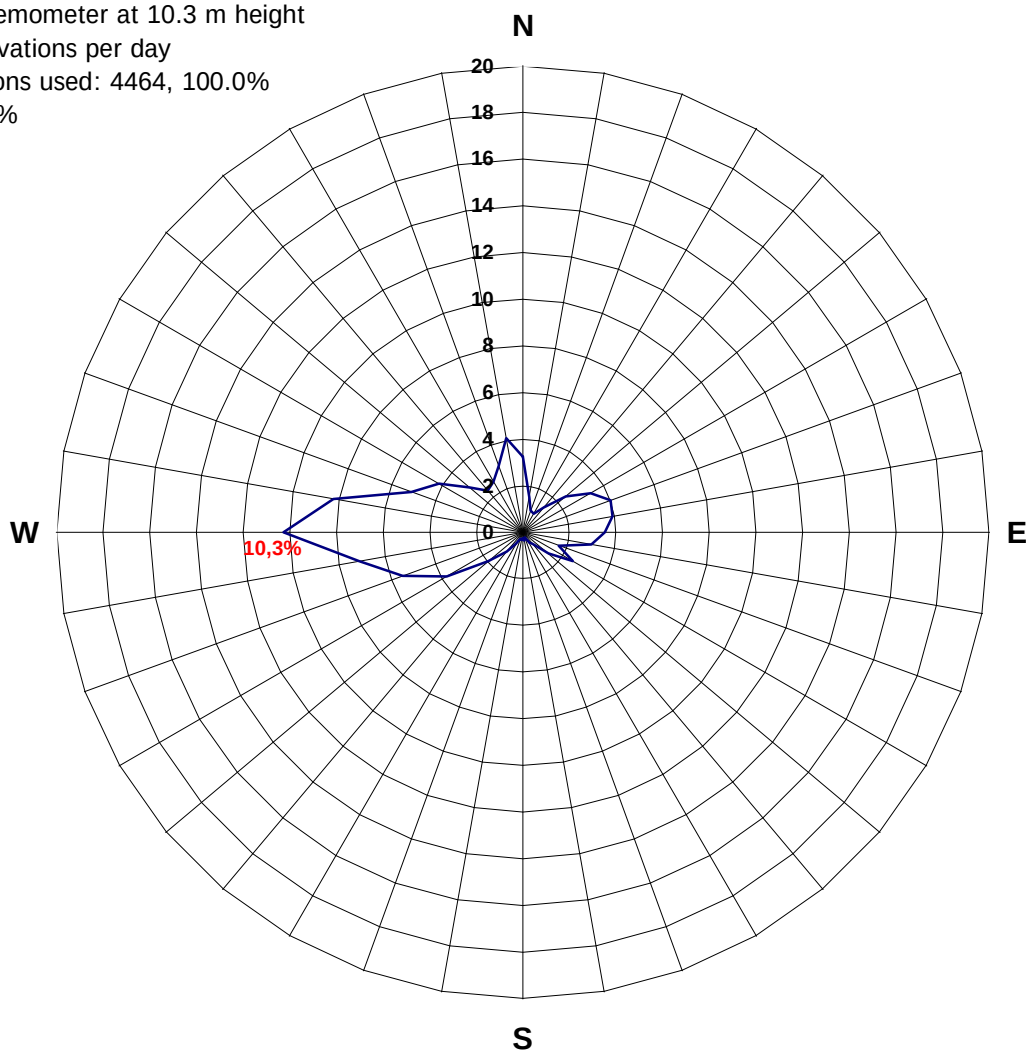


Average Wind Velocity for Wind Directions, m/s

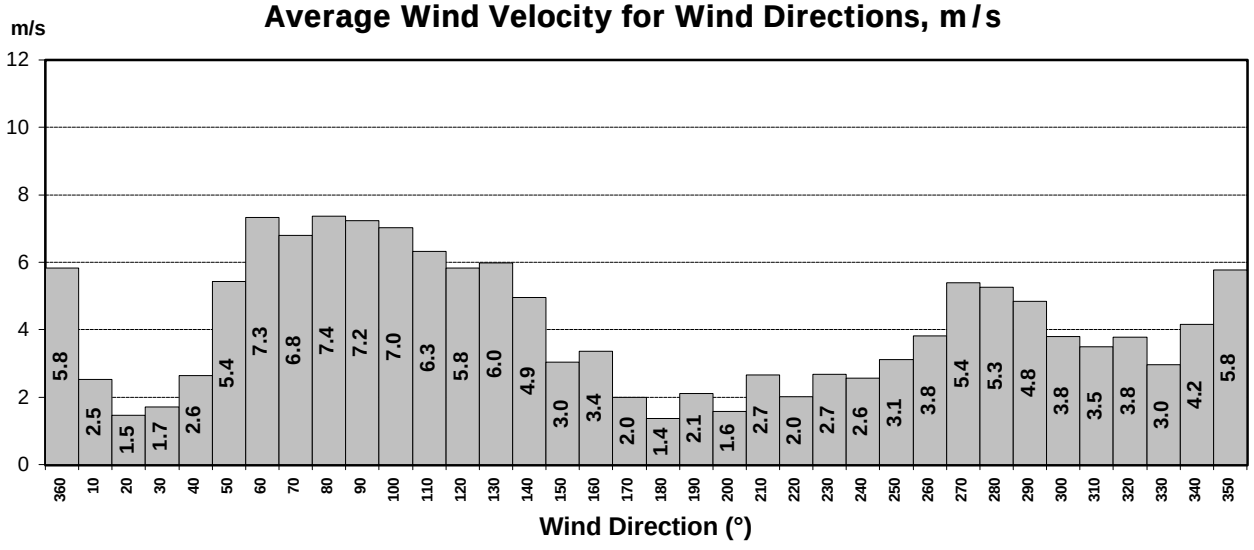


Frequency of Wind Directions, %
January 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 0.9%

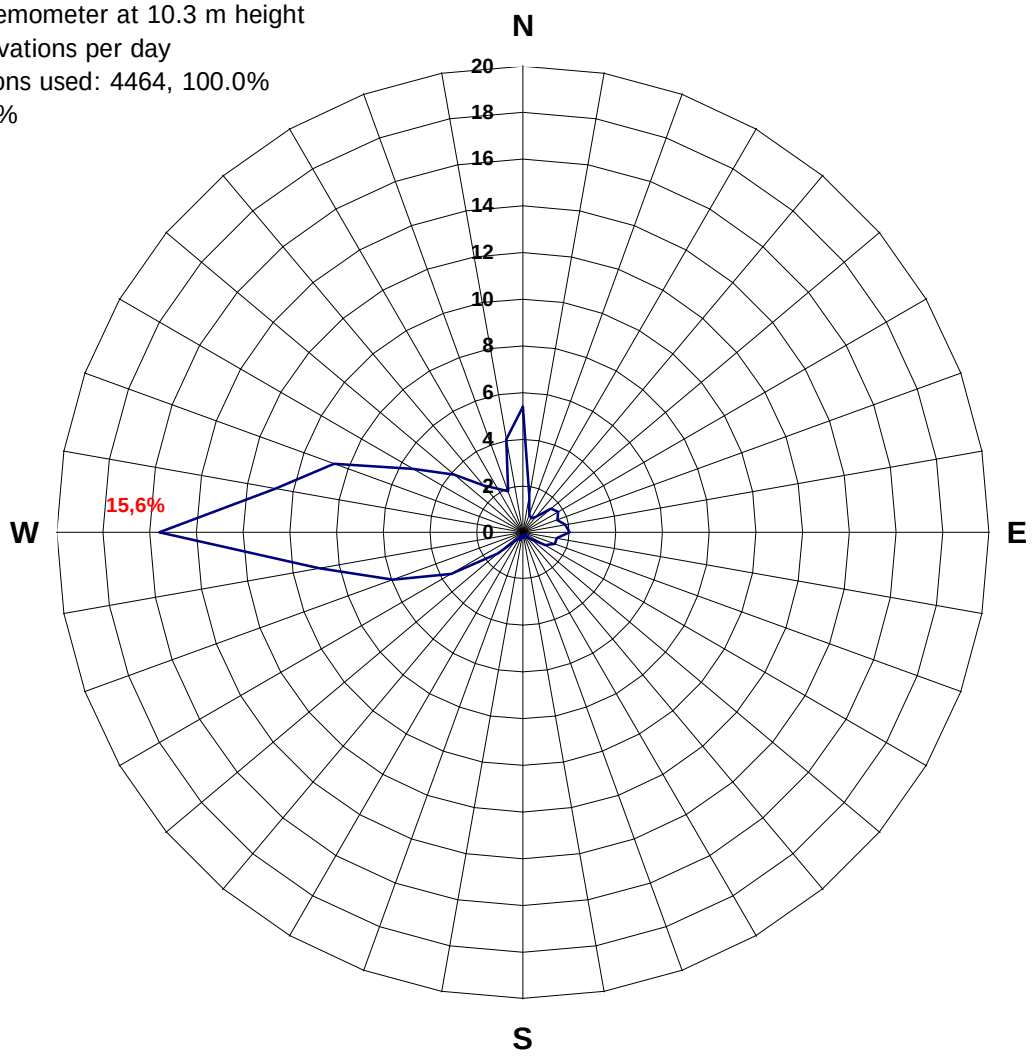


Average Wind Velocity for Wind Directions, m/s

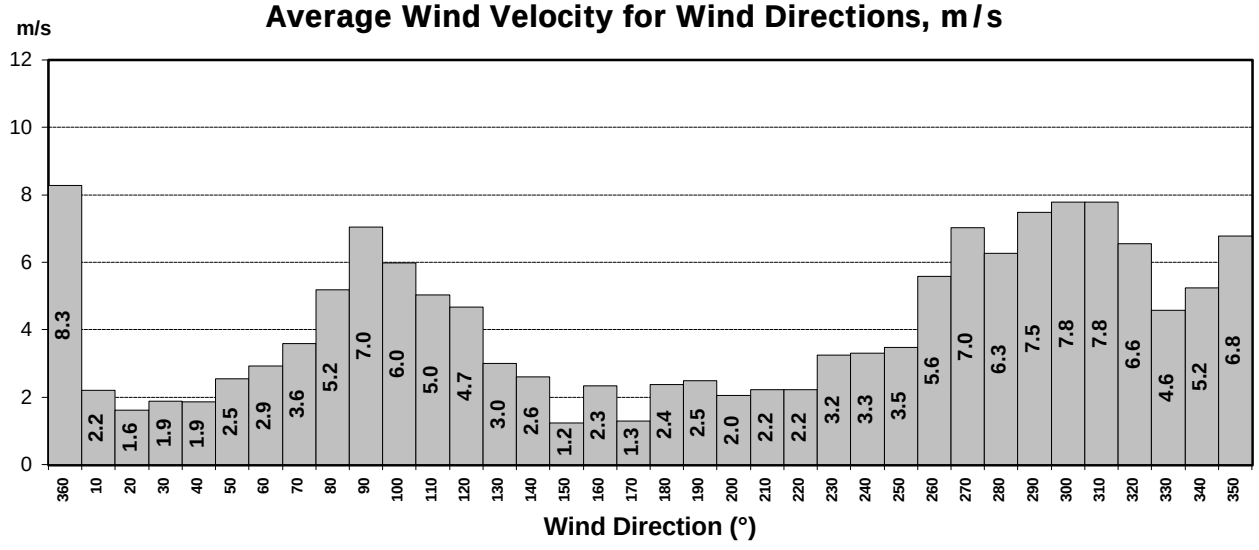


Frequency of Wind Directions, %
March 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4464, 100.0%
Calm: 0.6%

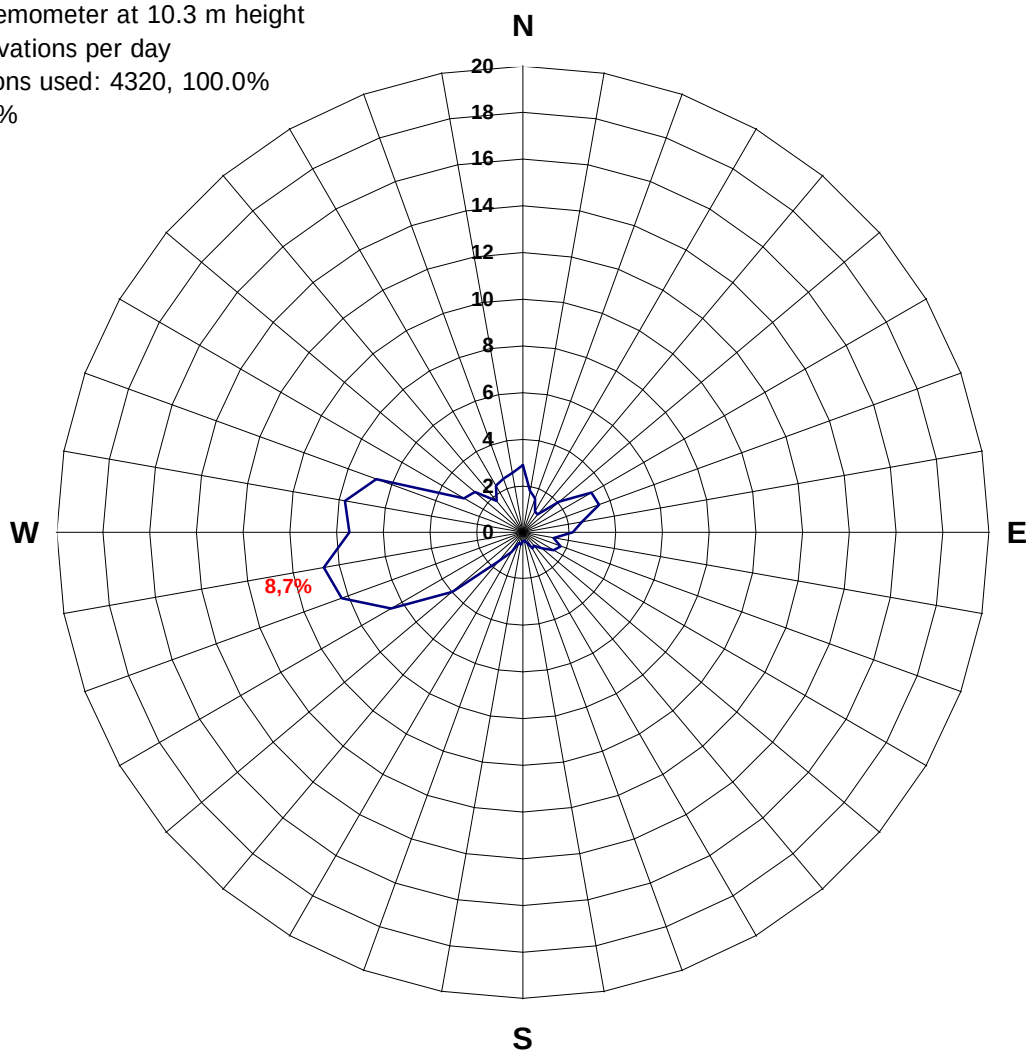


Average Wind Velocity for Wind Directions, m/s

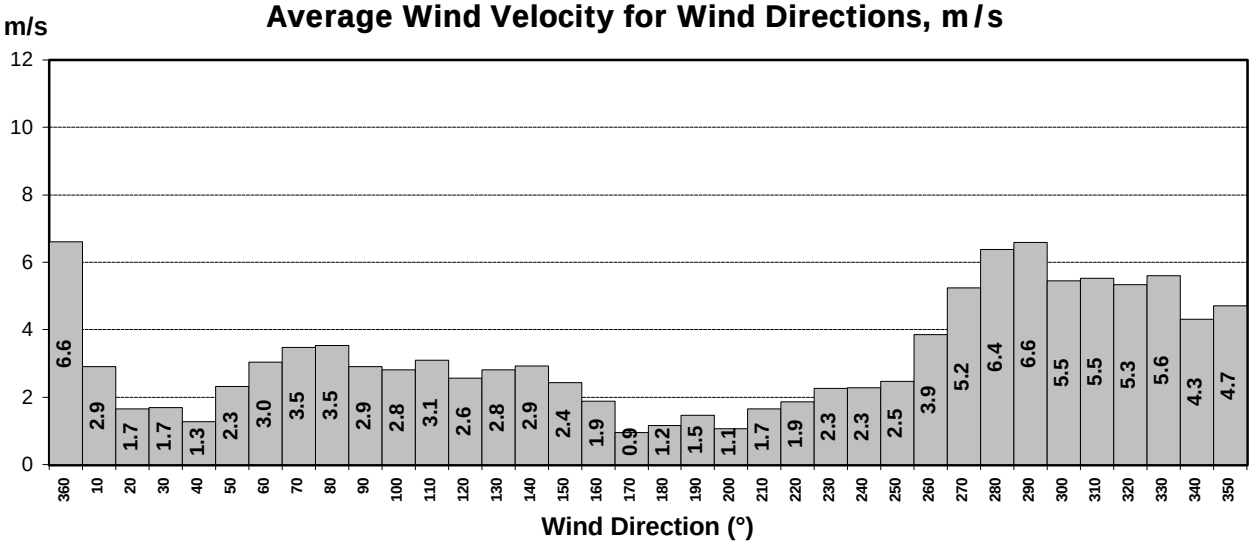


Frequency of Wind Directions, %
April 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 4320, 100.0%
Calm: 2.2%

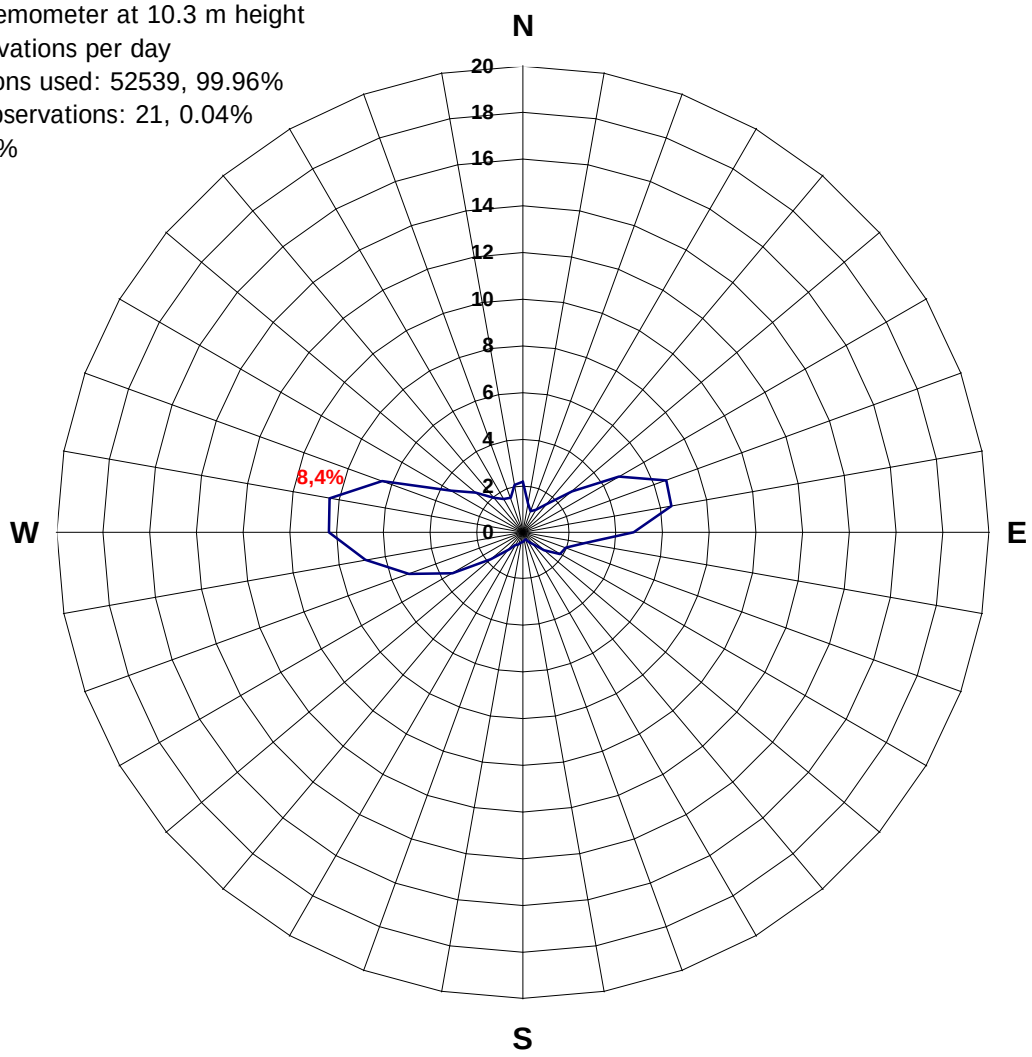


Average Wind Velocity for Wind Directions, m/s

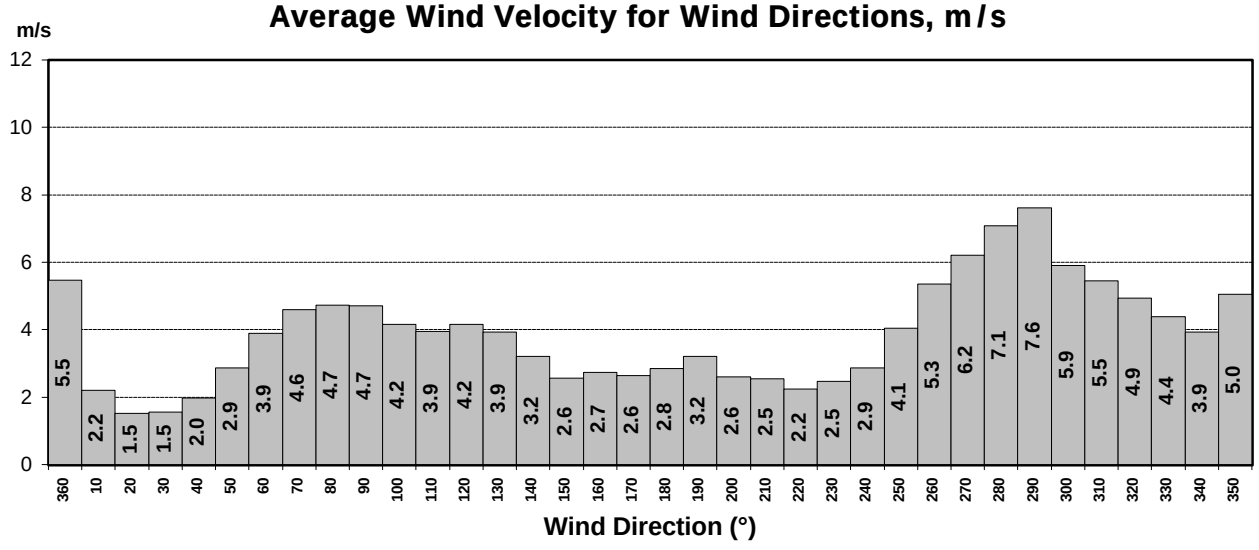


Frequency of Wind Directions, %
Year, May 1998 - April 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 52539, 99.96%
Missing observations: 21, 0.04%
Calm: 1.4%

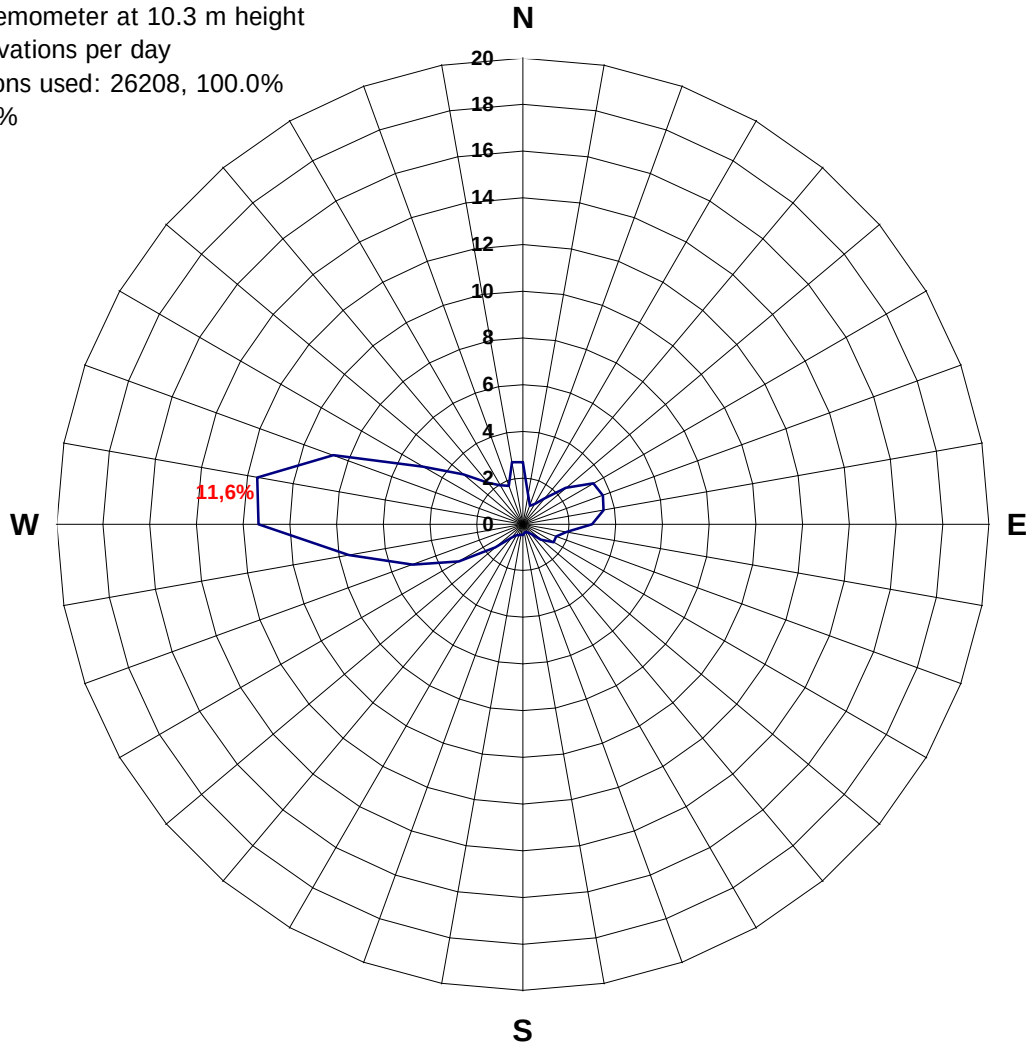


Average Wind Velocity for Wind Directions, m/s

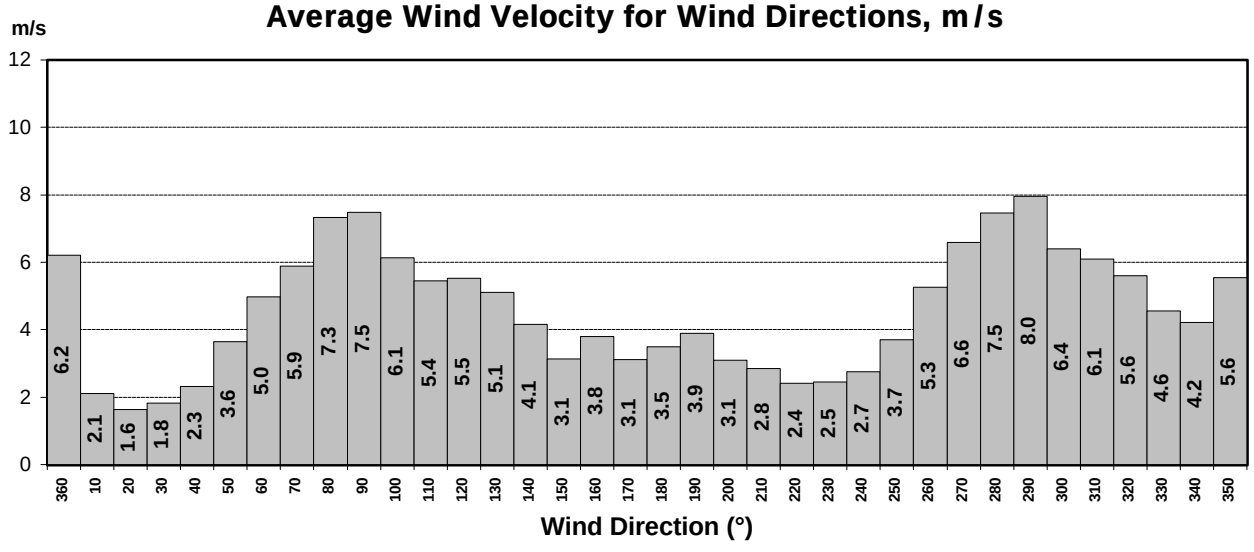


Frequency of Wind Directions, %
Autumn and Winter, October 1998 - March 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 26208, 100.0%
Calm: 1.4%

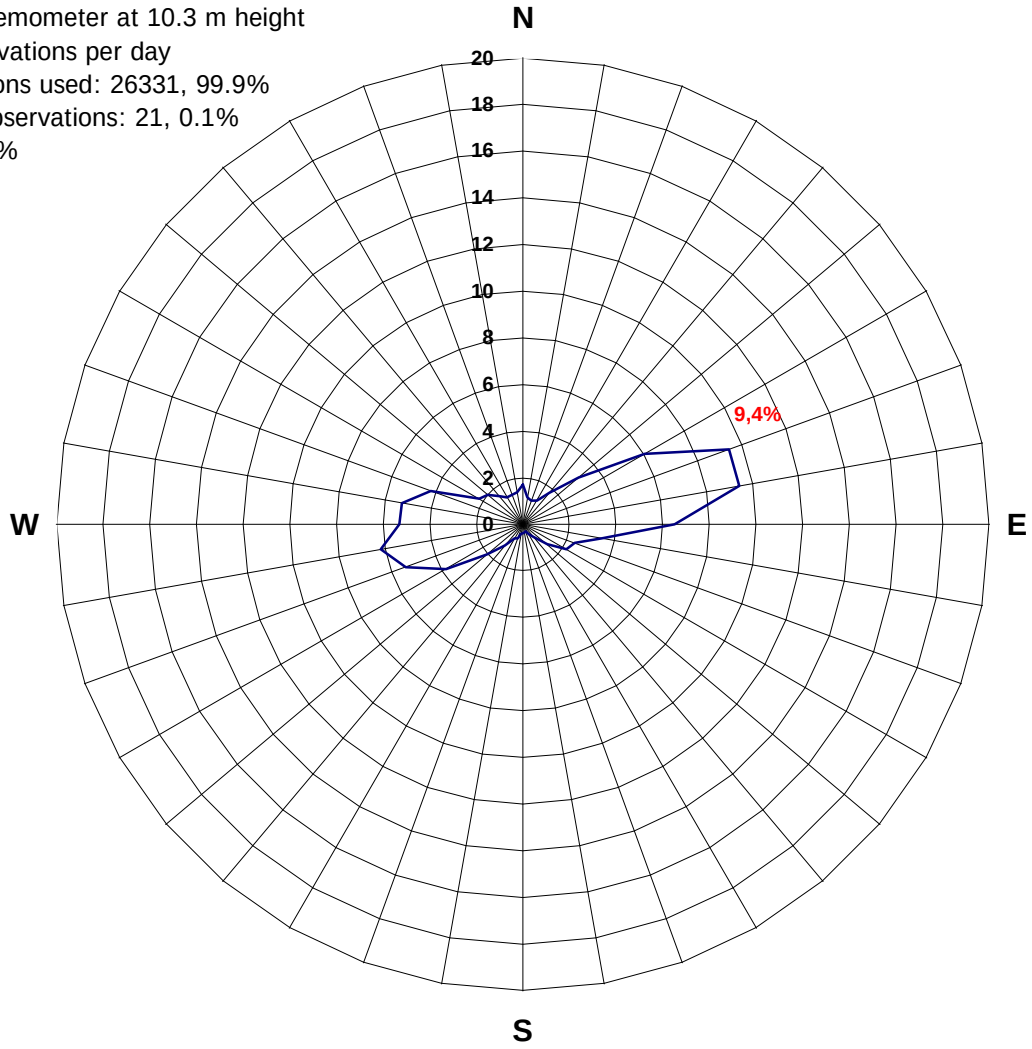


Average Wind Velocity for Wind Directions, m/s

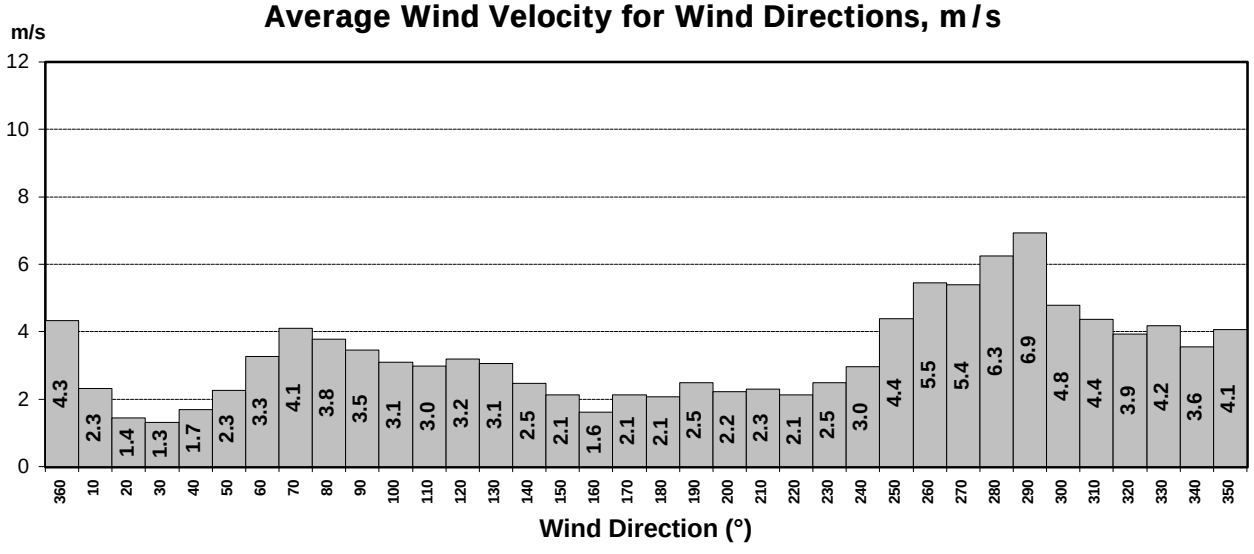


Frequency of Wind Directions, %
Spring and Summer, May - September 1998 and April 1999

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 26331, 99.9%
Missing observations: 21, 0.1%
Calm: 2.3%

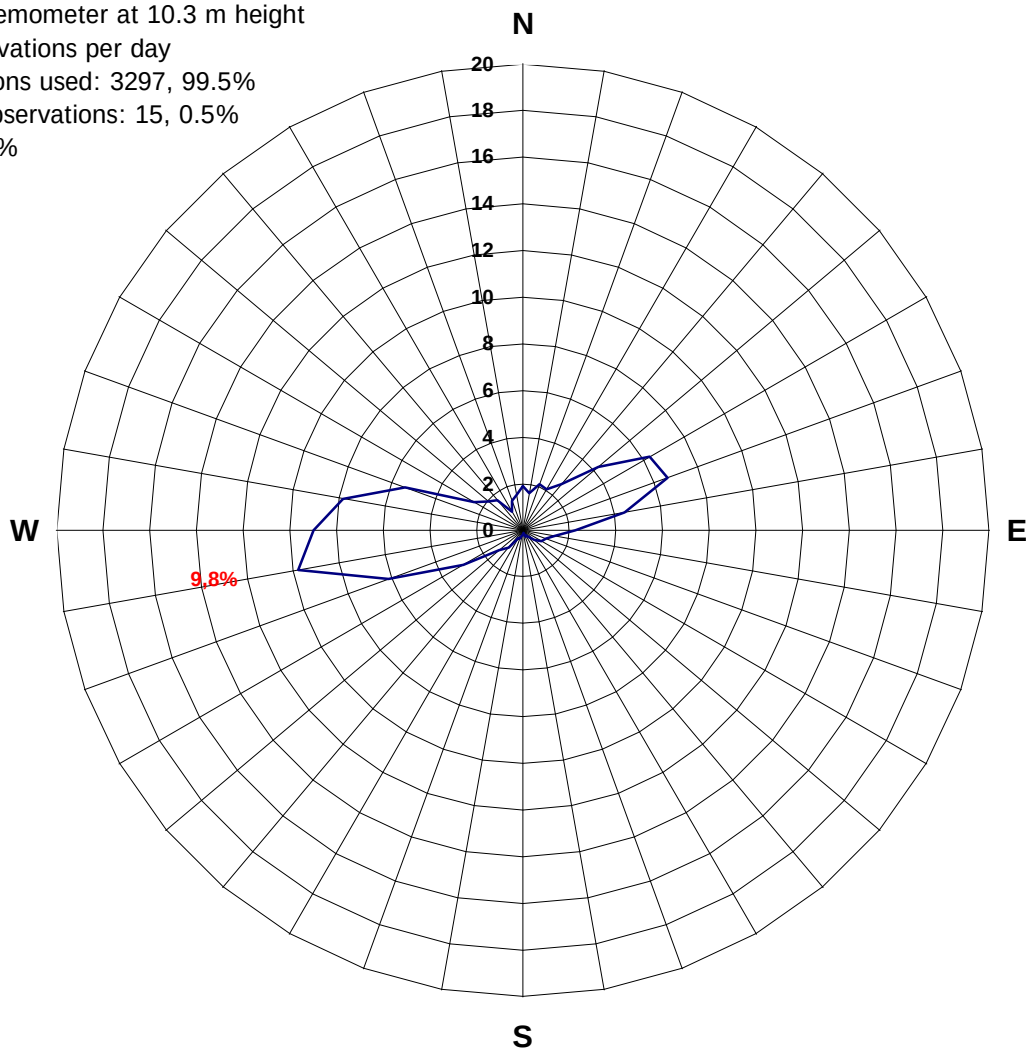


Average Wind Velocity for Wind Directions, m/s

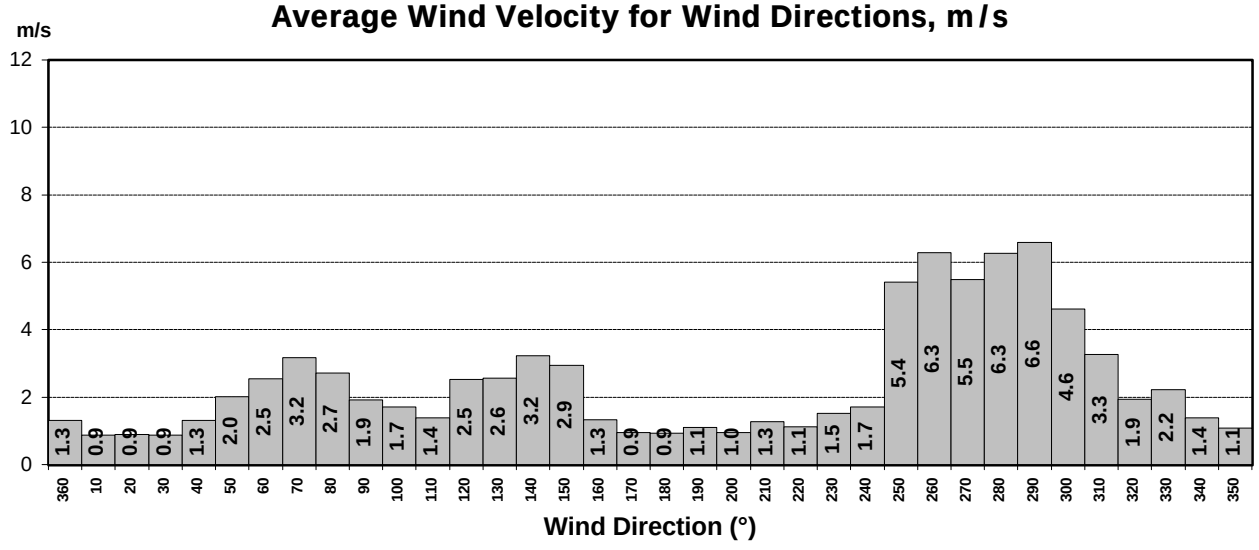


Frequency of Wind Directions, %
High Summer, June - August 1998, Night hours 00-06 GMT

Young Anemometer at 10.3 m height
144 observations per day
Observations used: 3297, 99.5%
Missing observations: 15, 0.5%
Calm: 6.6%

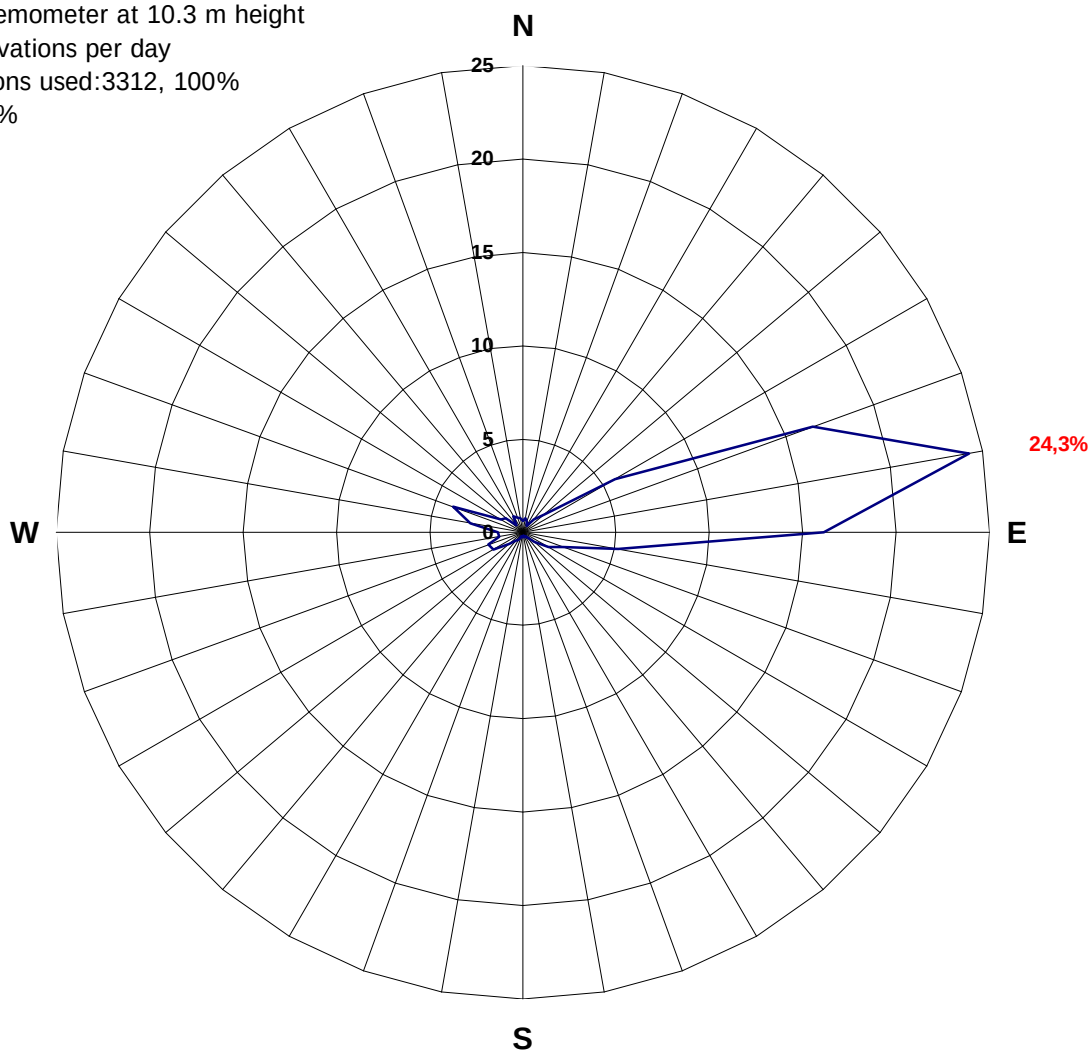


Average Wind Velocity for Wind Directions, m/s

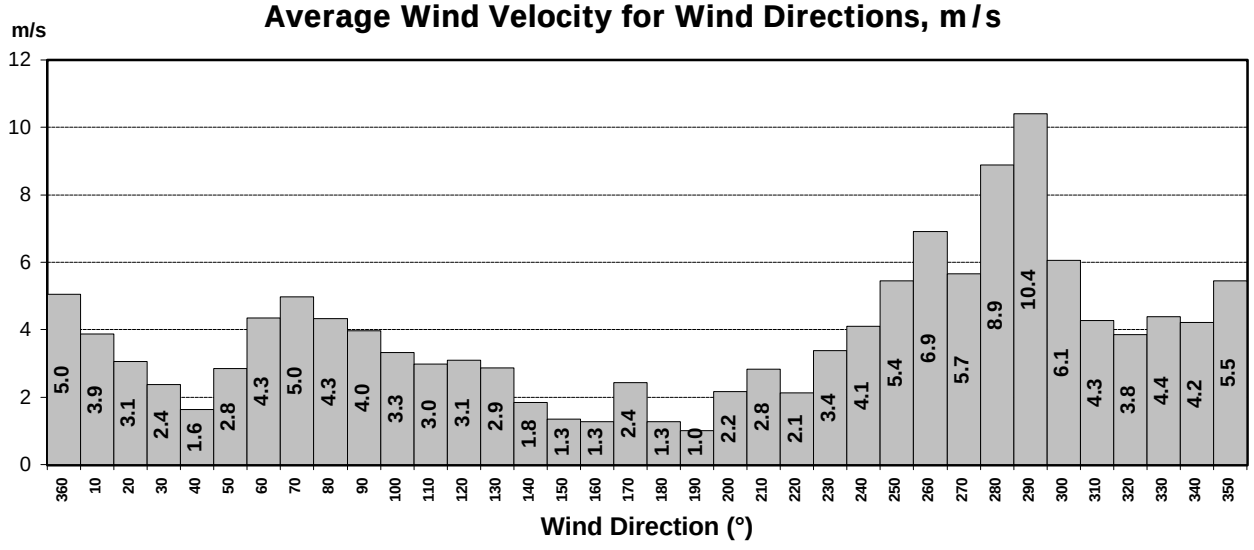


Frequency of Wind Directions, %
High Summer, June - August 1998, Day hours 12-18 GMT

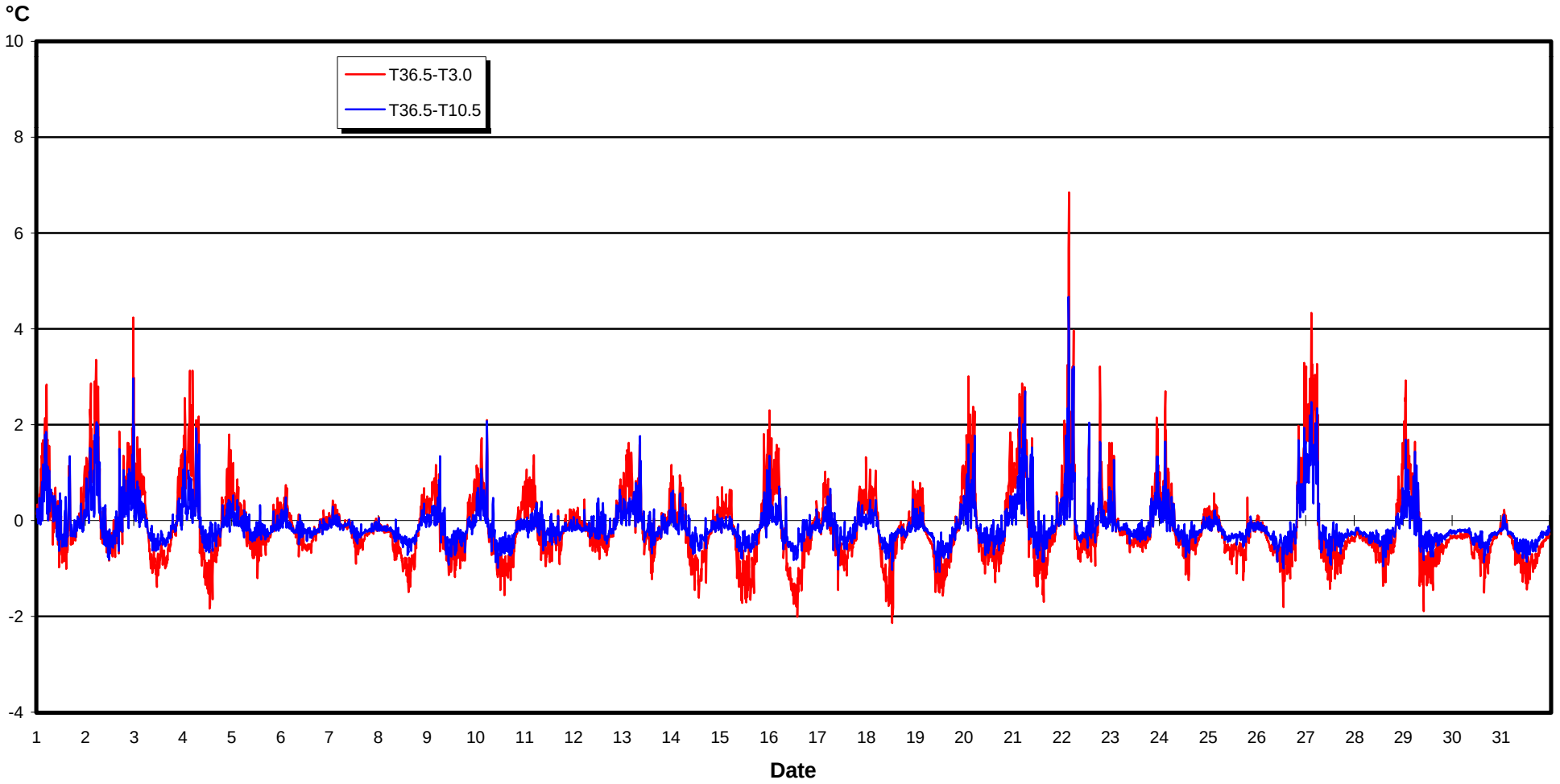
Young Anemometer at 10.3 m height
144 observations per day
Observations used:3312, 100%
Calm: 0.2%



Average Wind Velocity for Wind Directions, m/s

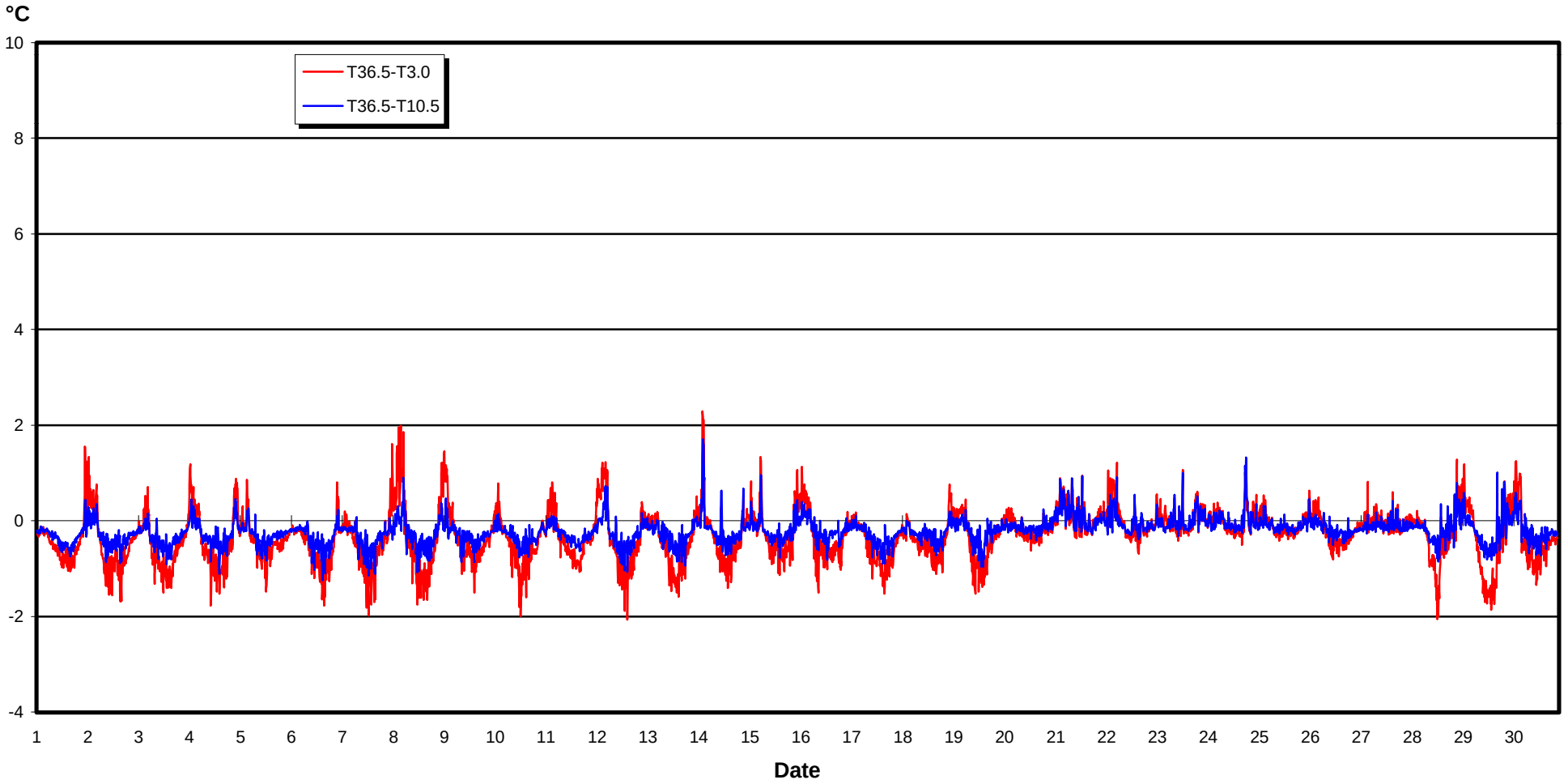


Vertical Temperature Gradient, °C
May 1998



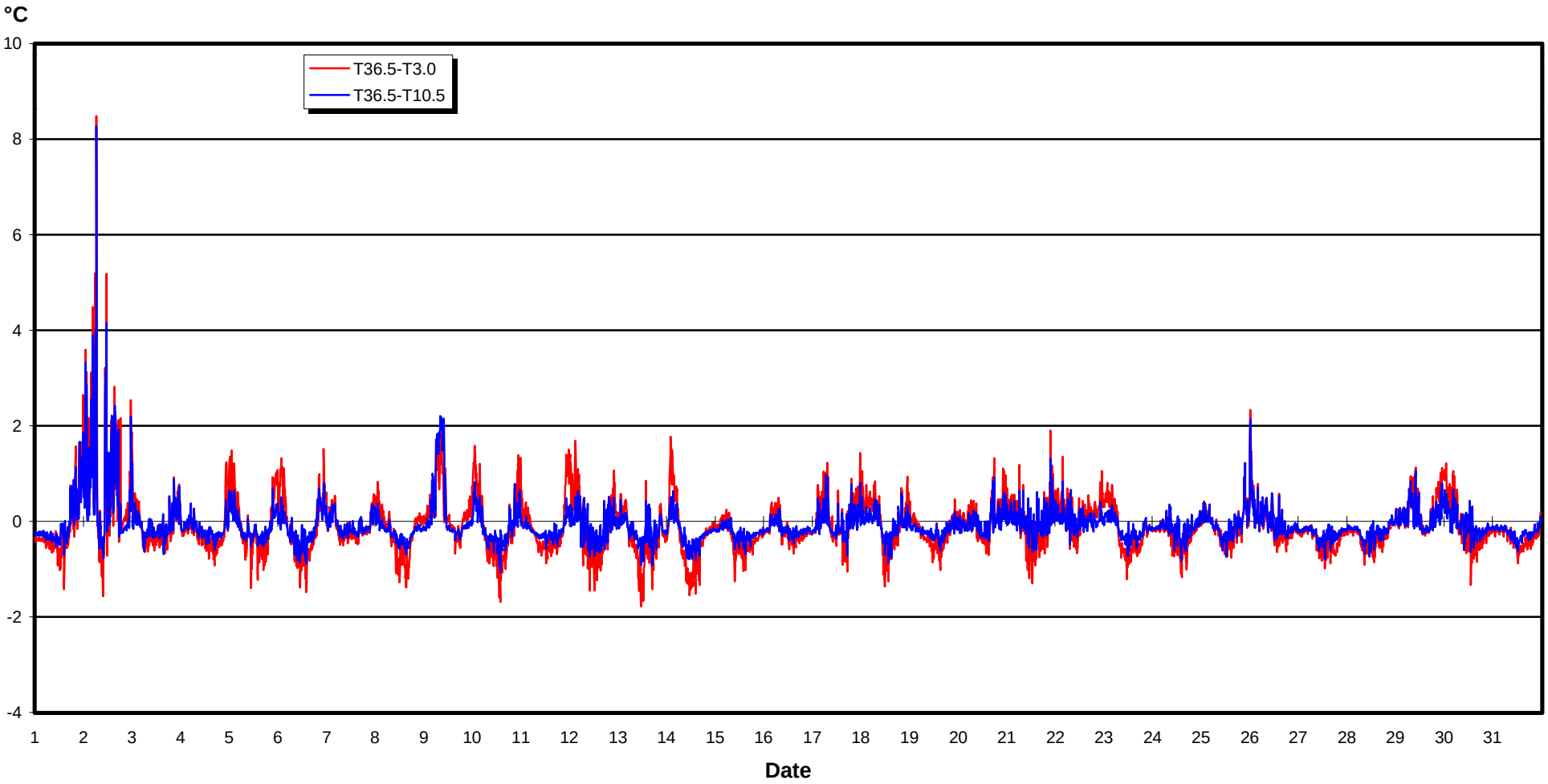
Annex 18

Vertical Temperature Gradient, °C
June 1998



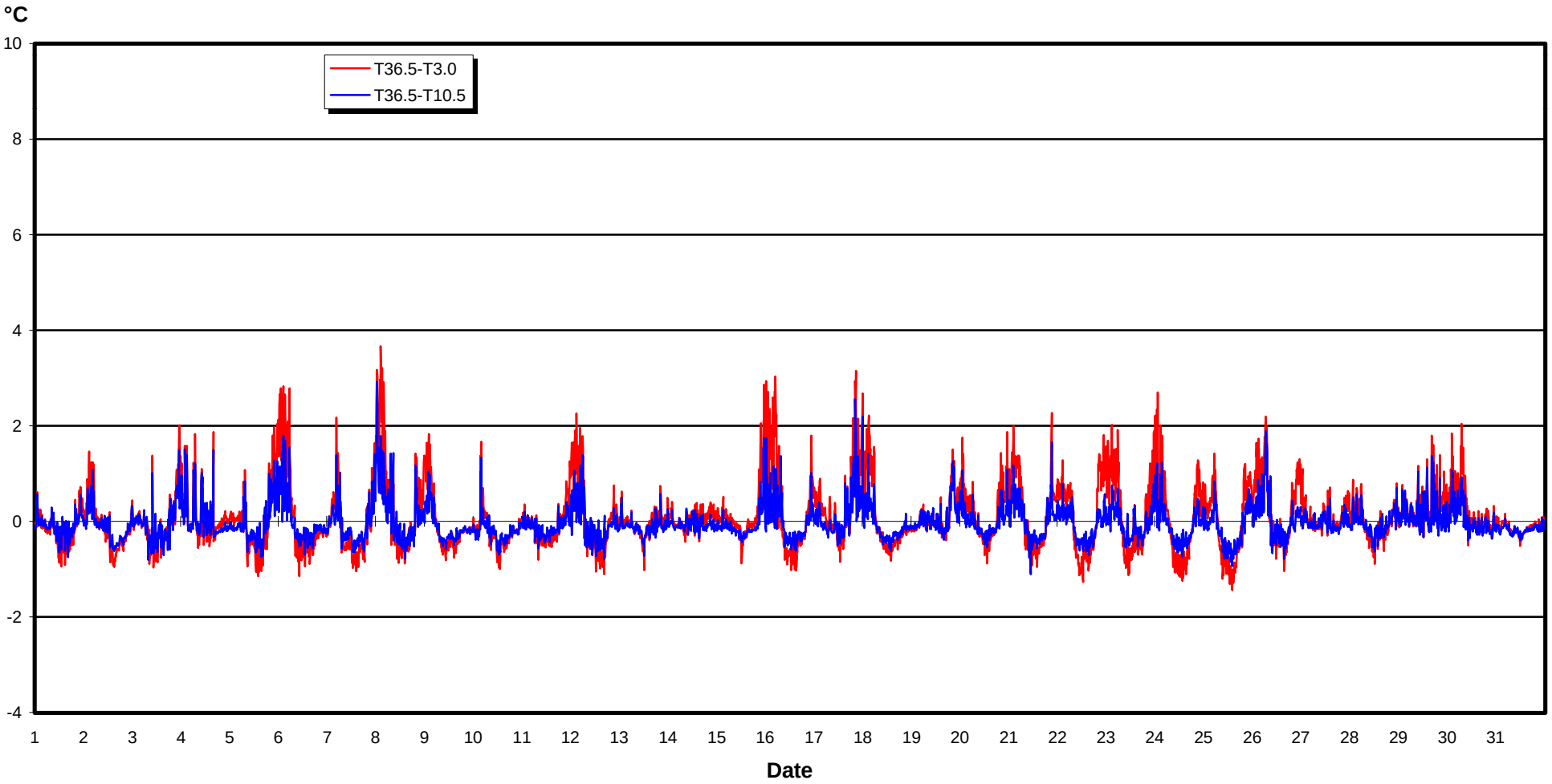
Annex 19

VerticalTemperature Gradient, °C
July 1998



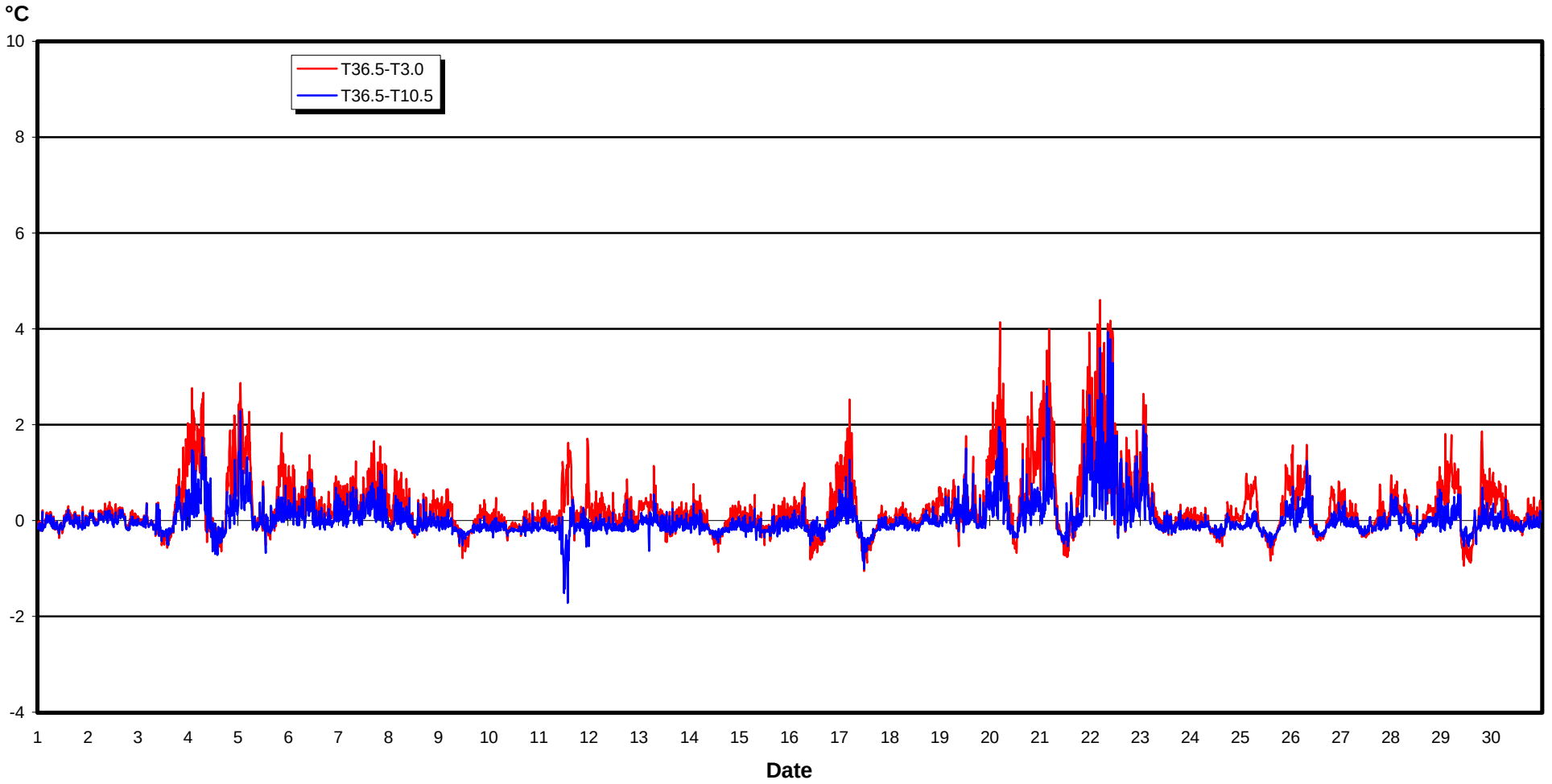
Annex 20

Vertical Temperature Gradient, °C
August 1998



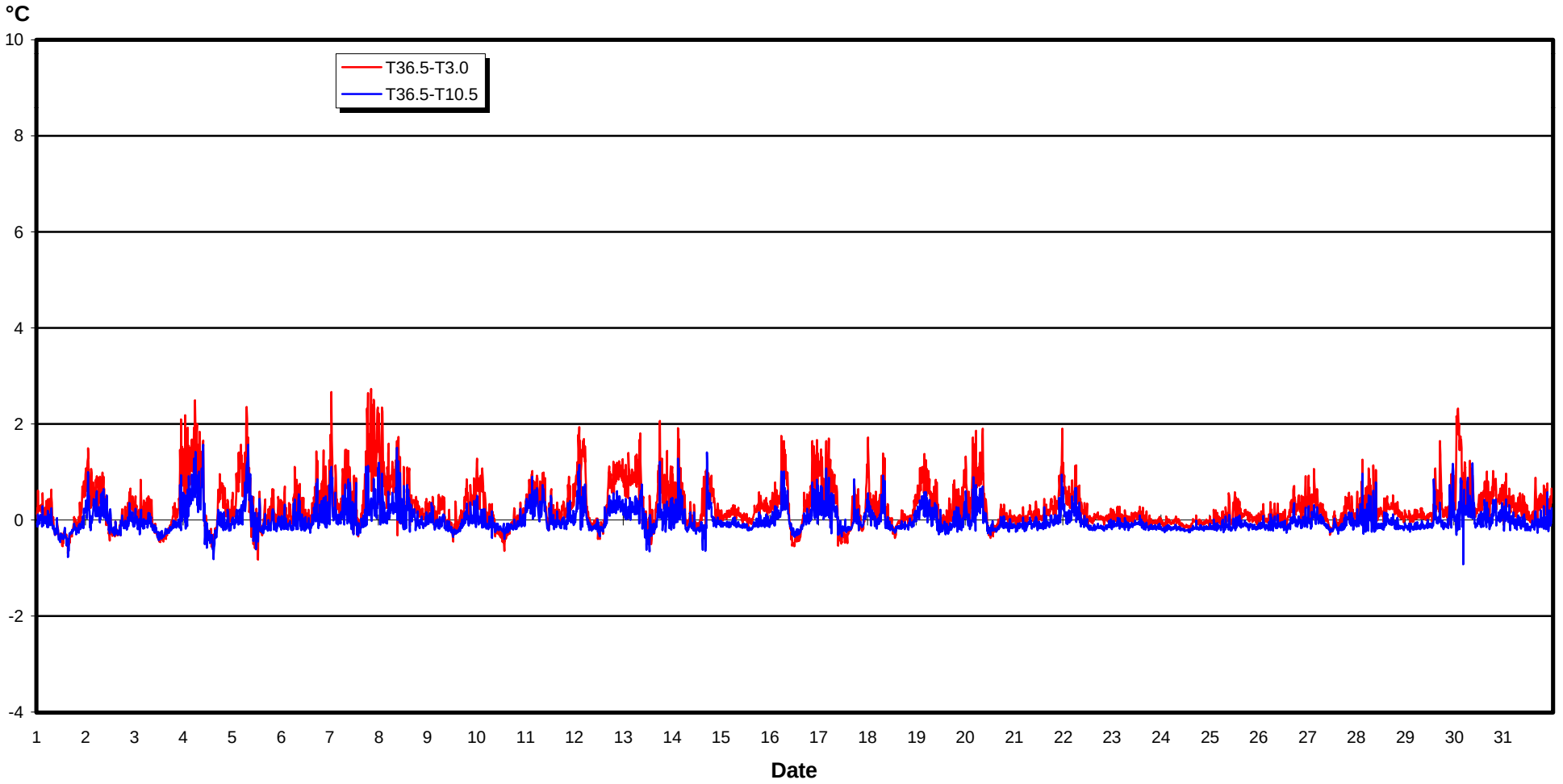
Annex 21

Vertical Temperature Gradient, °C
September 1998



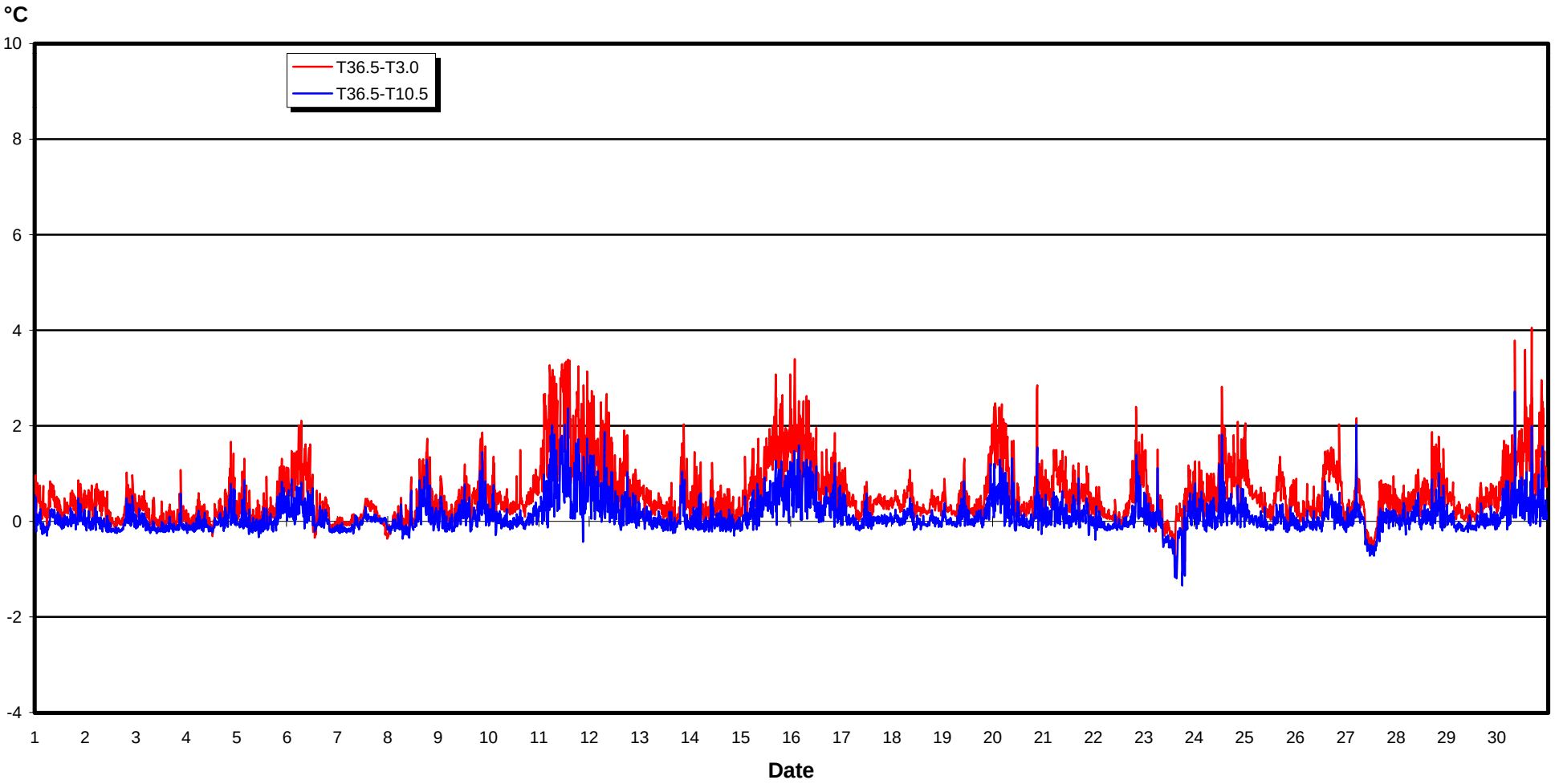
Annex 22

Vertical Temperature Gradient, °C
October 1998



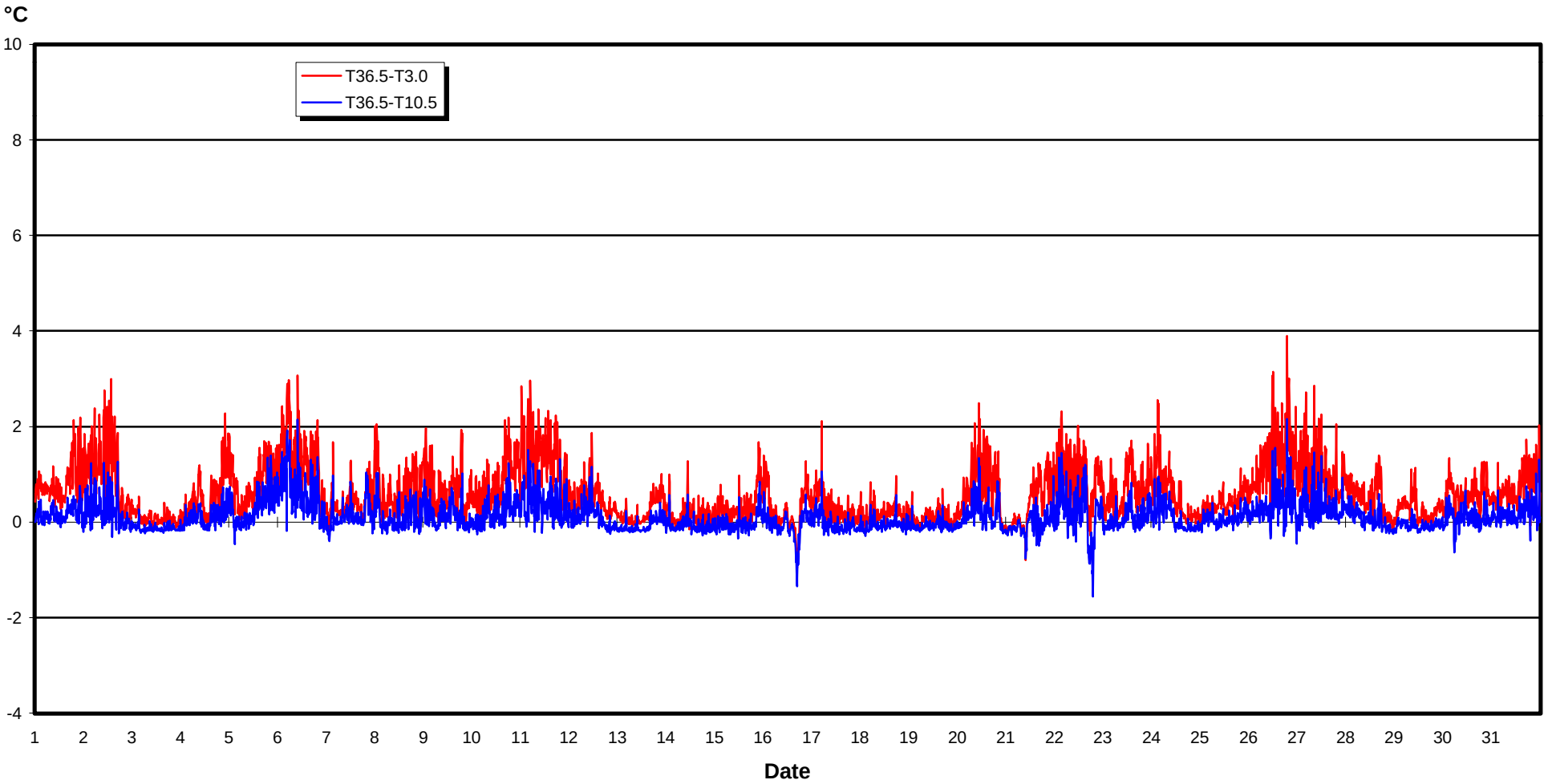
Annex 23

Vertical Temperature Gradient, °C
November 1998



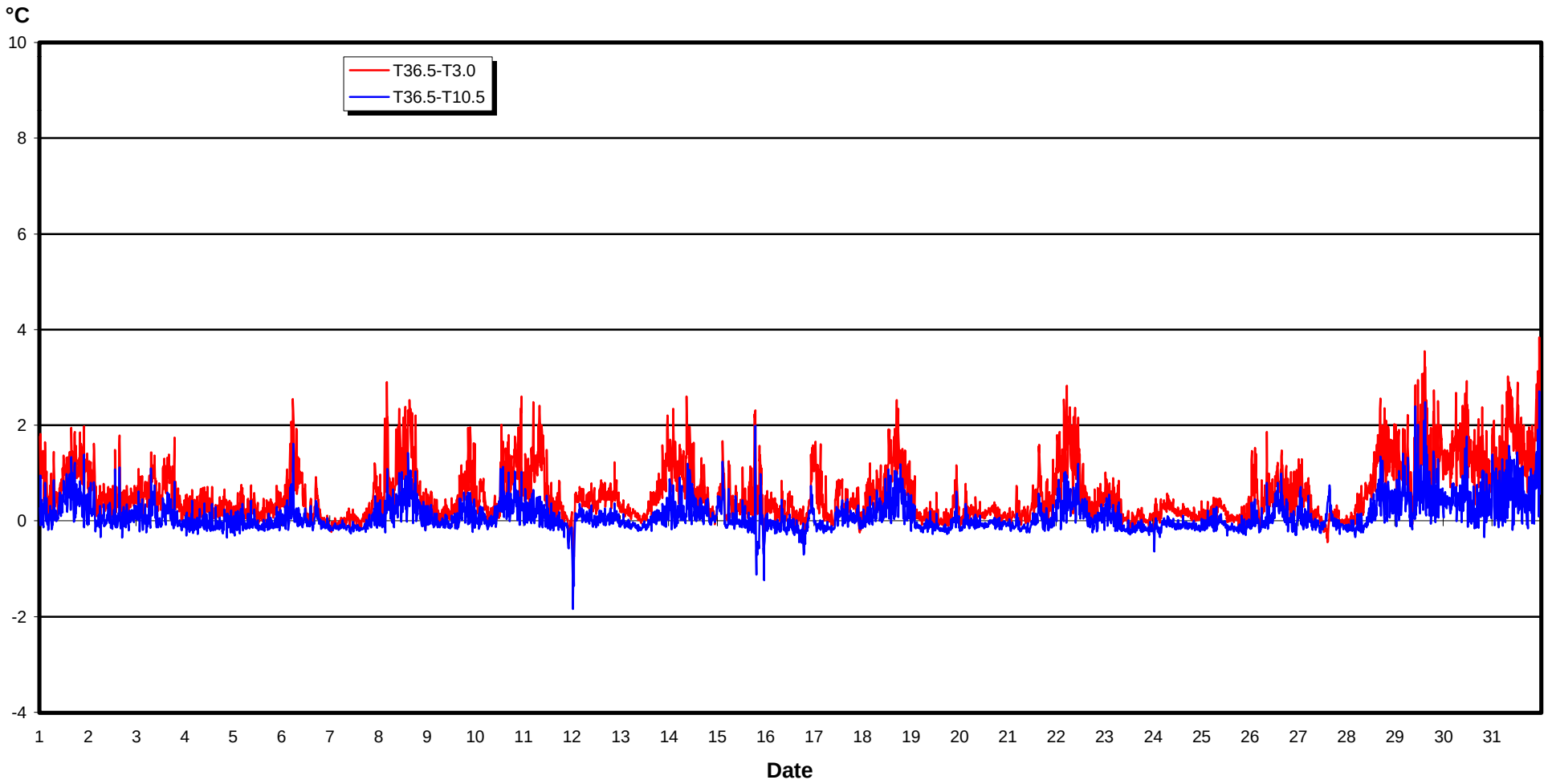
Annex 24

Vertical Temperature Gradient, °C
December 1998



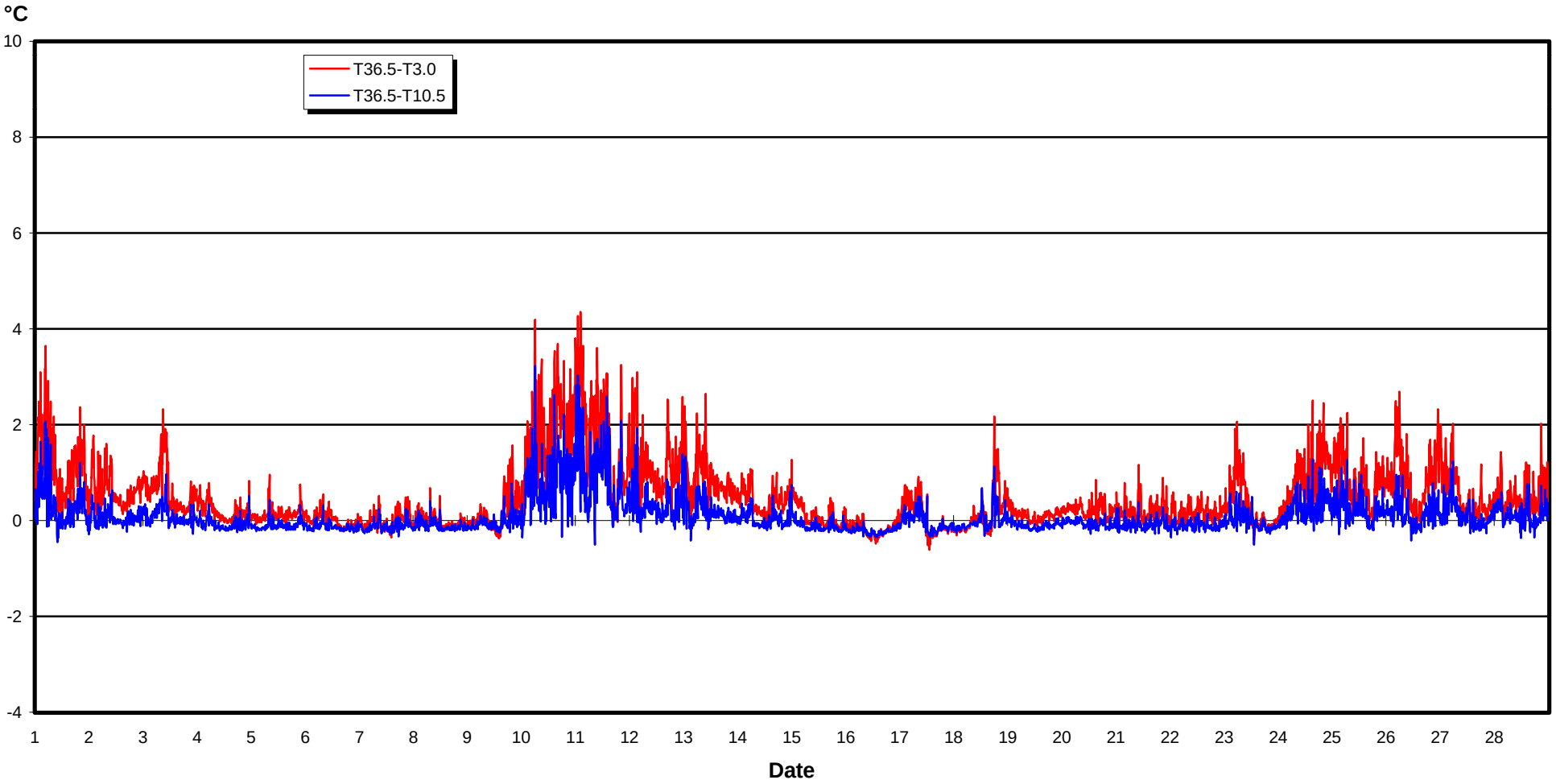
Annex 25

Vertical Temperature Gradient, °C
January 1999



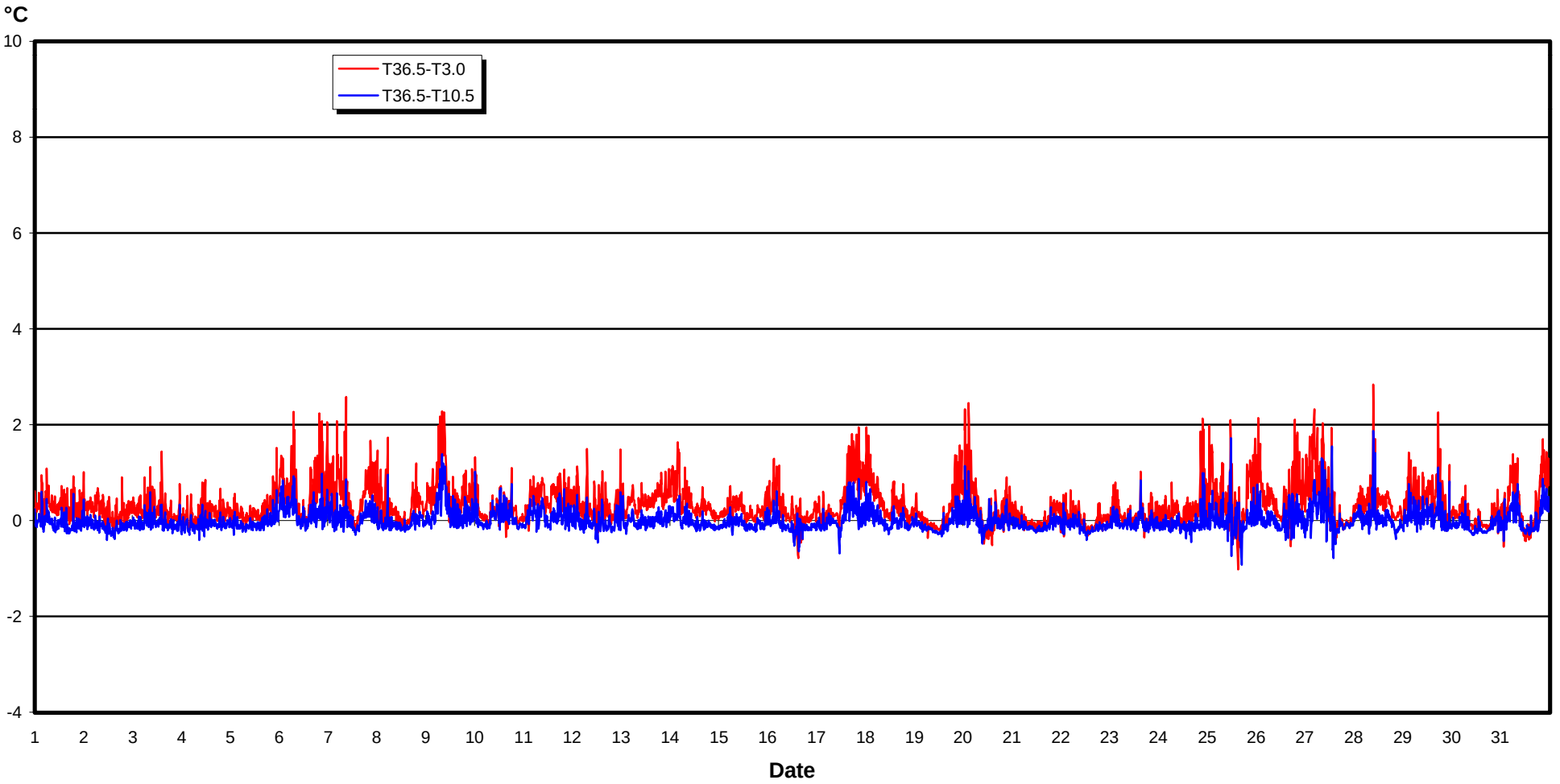
Annex 26

Vertical Temperature Gradient, °C
February 1999



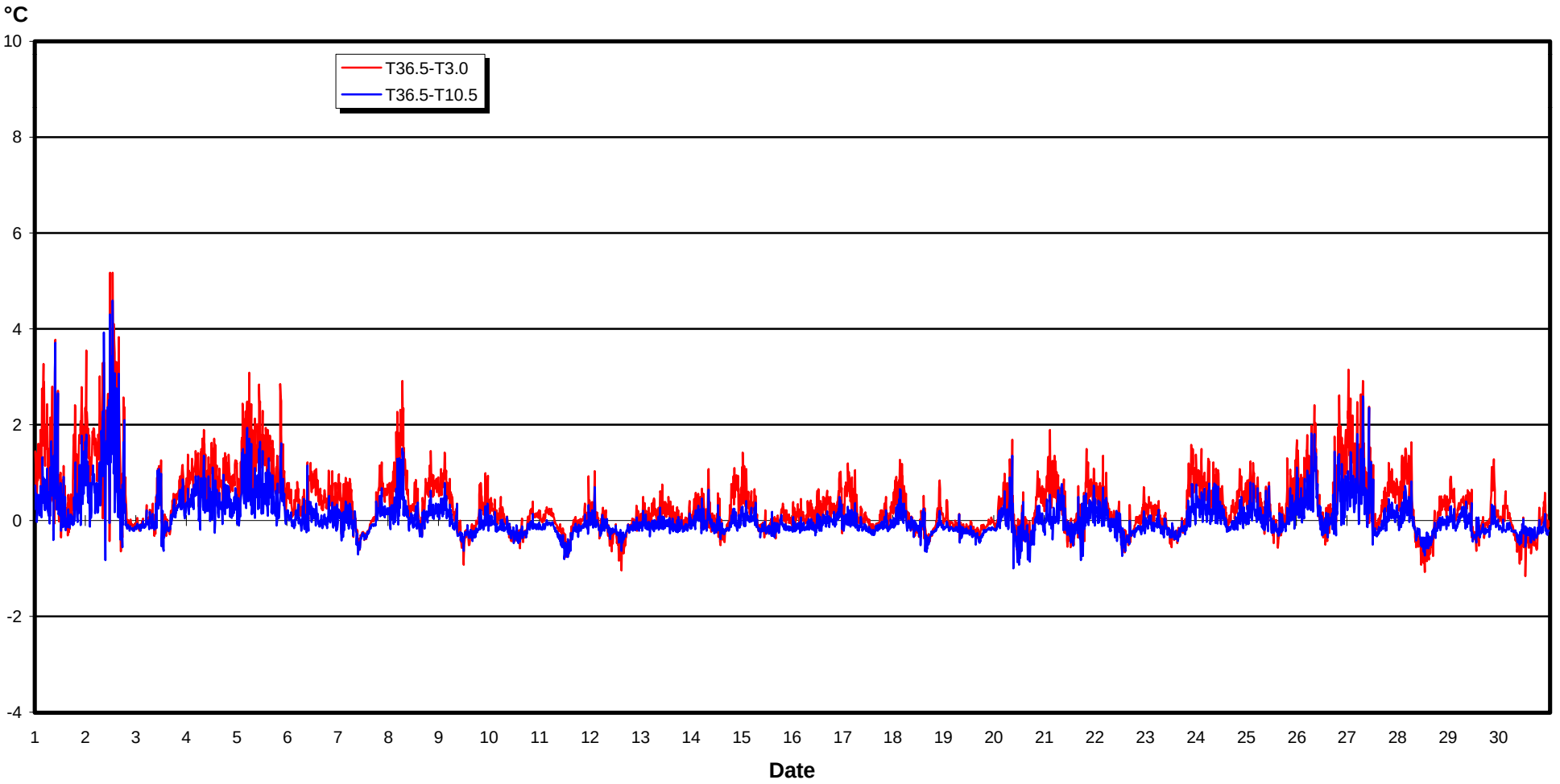
Annex 27

Vertical Temperature Gradient, °C
March 1999



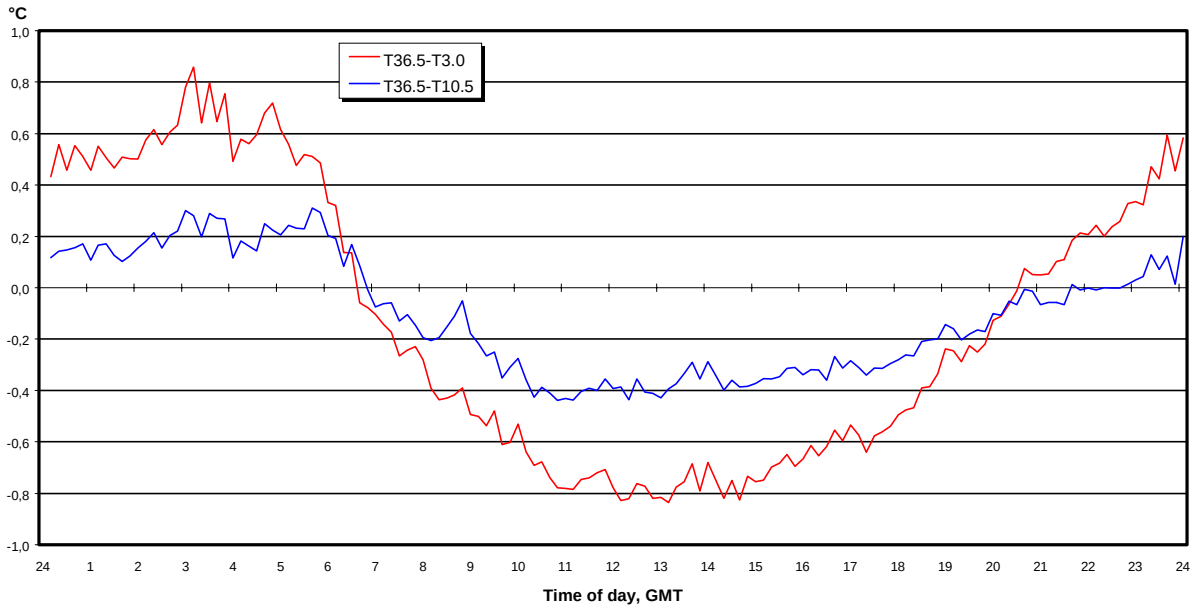
Annex 28

Vertical Temperature Gradient, °C
April 1999

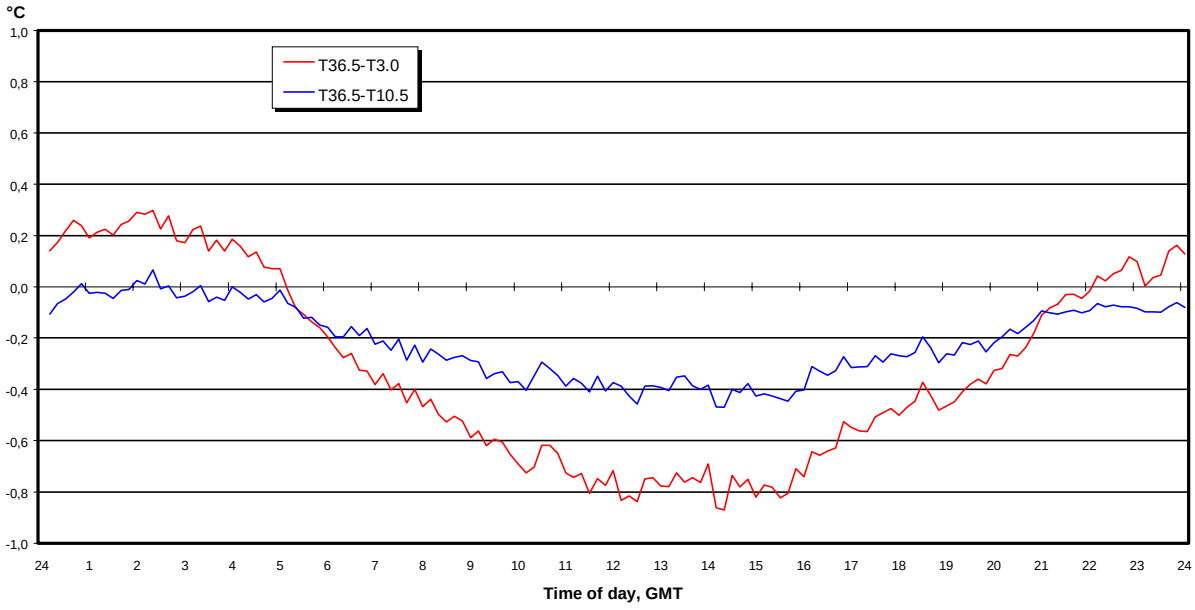


Annex 29

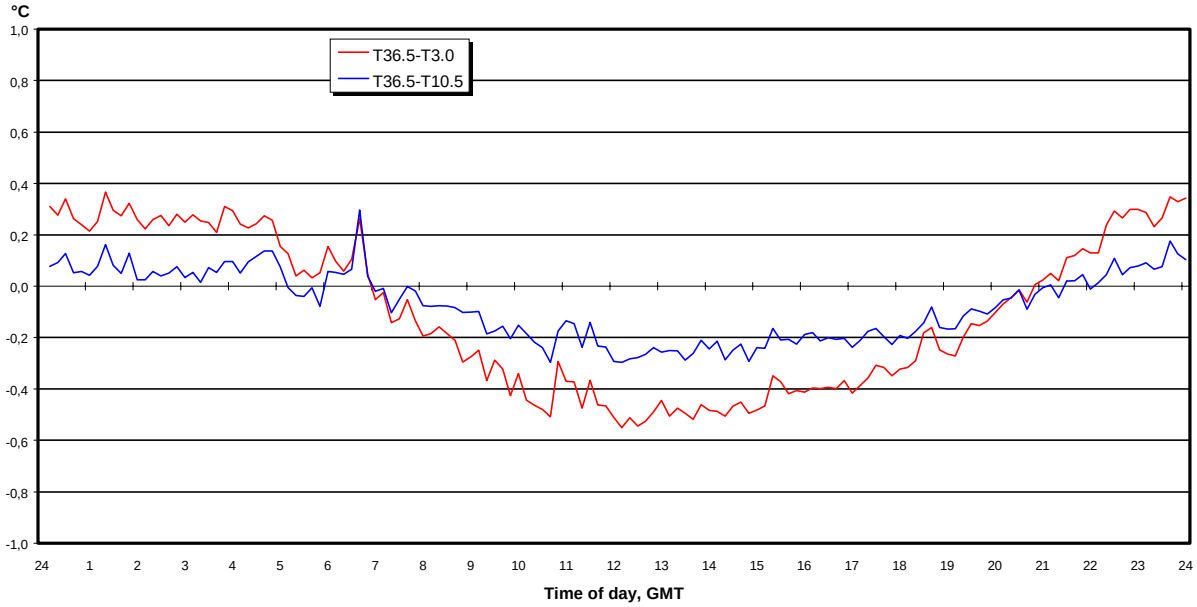
Sómastaðagerði
Average Vertical Temperature Gradient, °C
May 1998



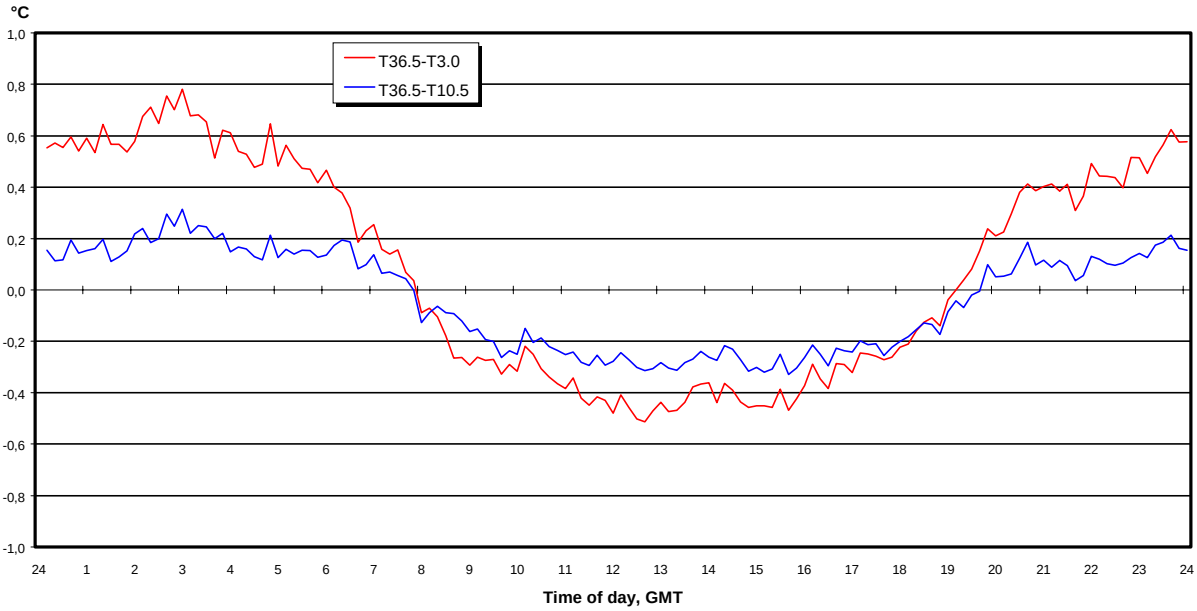
Sómastaðagerði
Average Vertical Temperature Gradient, °C
June 1998



Sómastaðagerði
Average Vertical Temperature Gradient, °C
July 1998

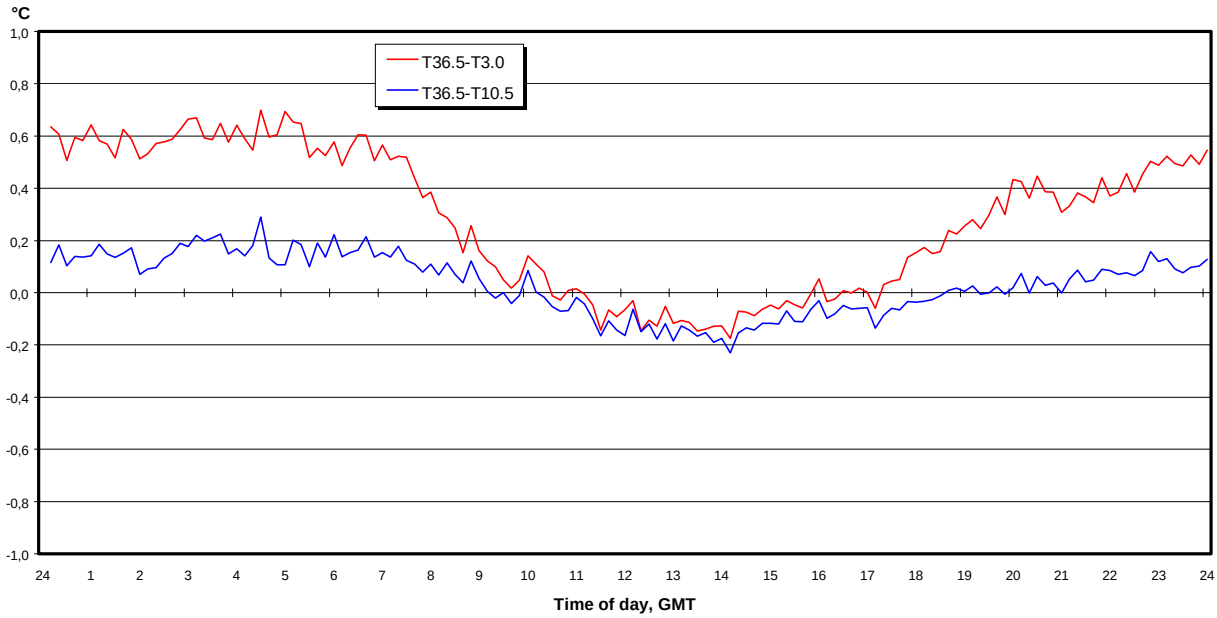


Sómastaðagerði
Average Vertical Temperature Gradient, °C
August 1998

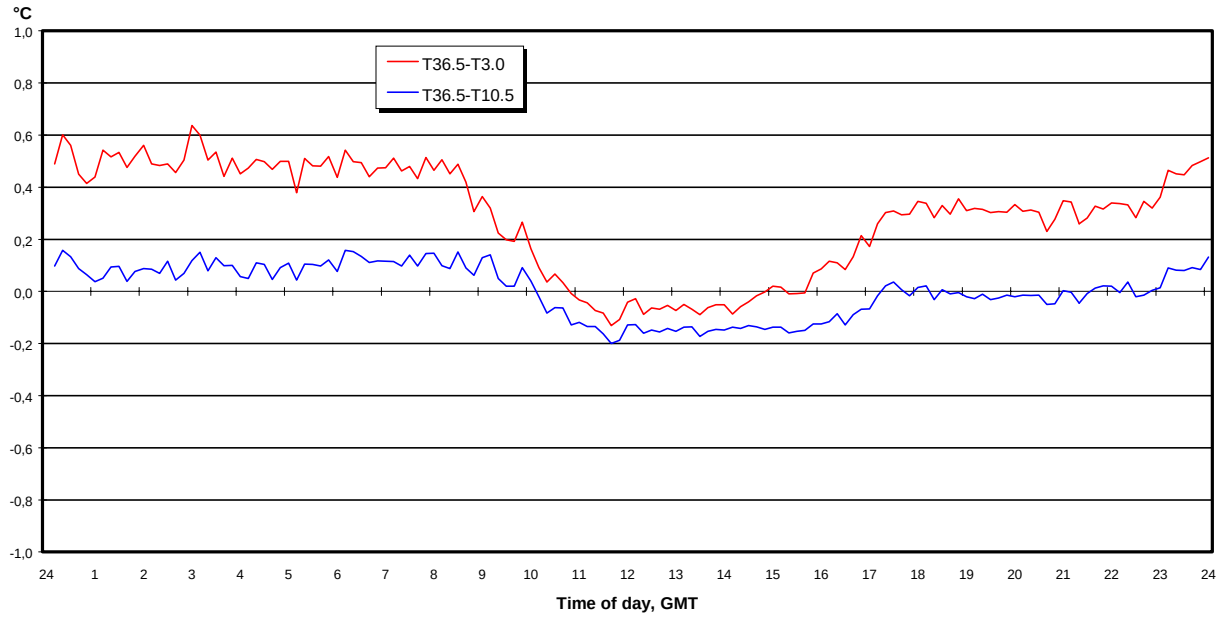


ANNEX 31

Sómastaðagerði
Average Vertical Temperature Gradient, °C
September 1998

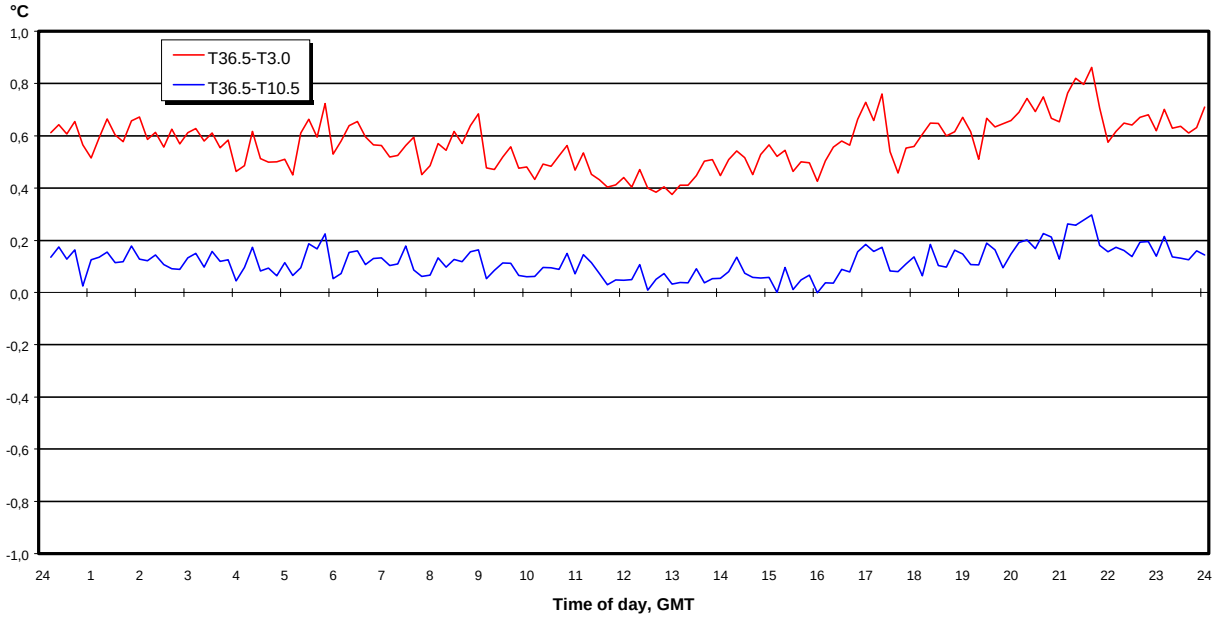


Sómastaðagerði
Average Vertical Temperature Gradient, °C
October 1998

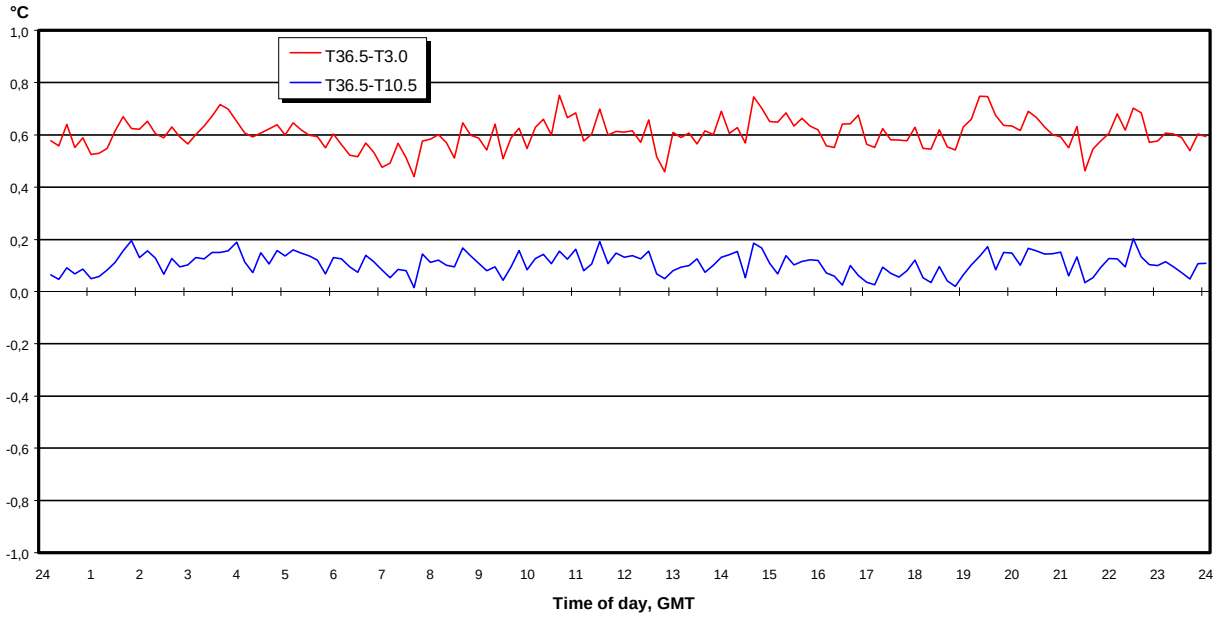


ANNEX 32

Sómastaðagerði
Average Vertical Temperature Gradient, °C
November 1998

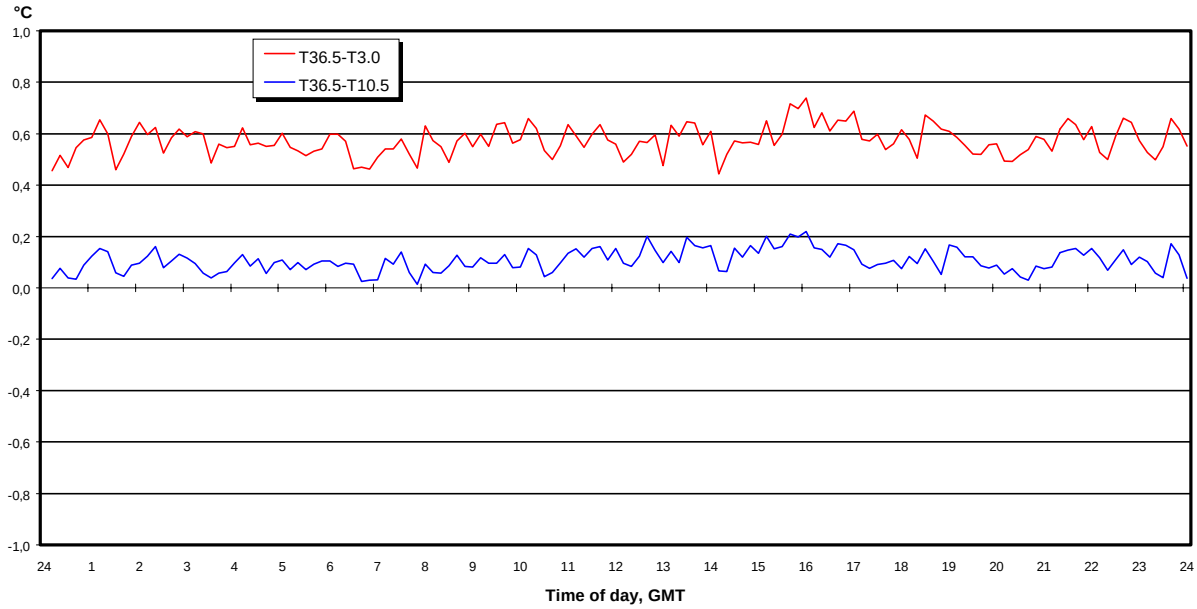


Sómastaðagerði
Average Vertical Temperature Gradient, °C
December 1998

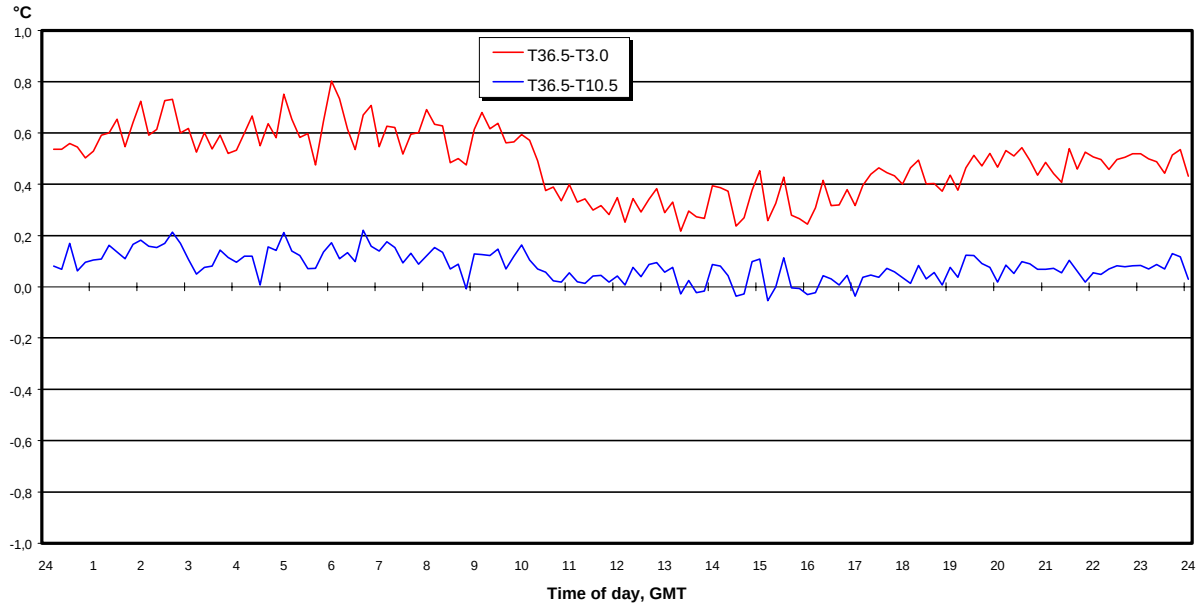


ANNEX 33

Sómastaðageröi
Average Vertical Temperature Gradient, °C
January 1999

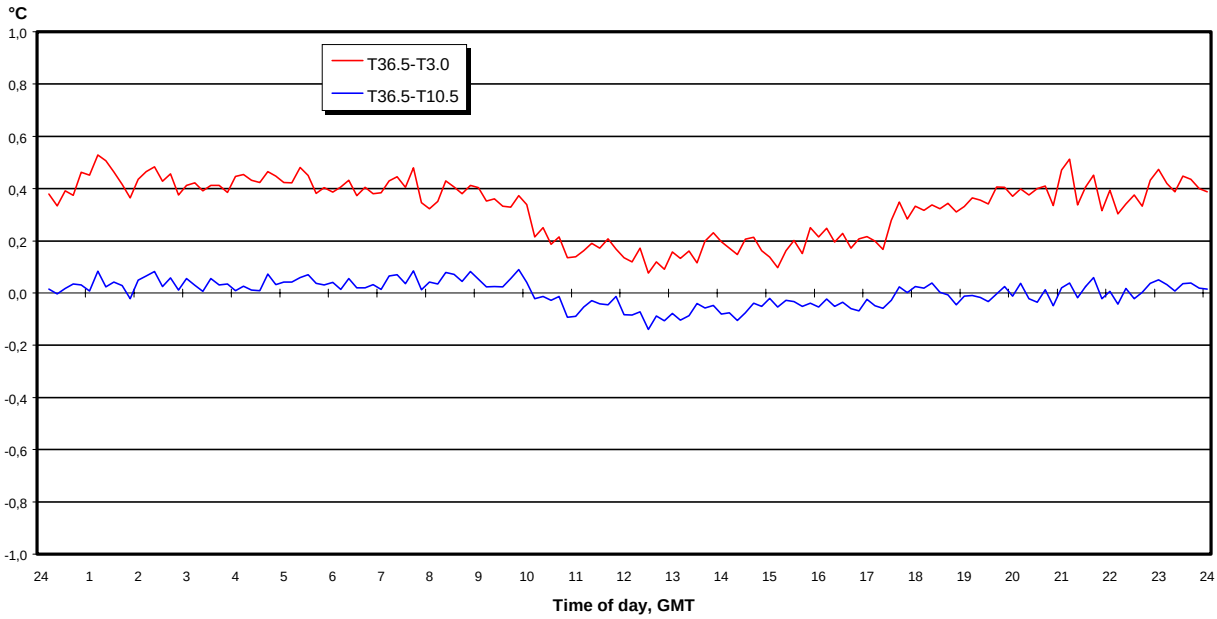


Sómastaðageröi
Average Vertical Temperature Gradient,°C
February 1999

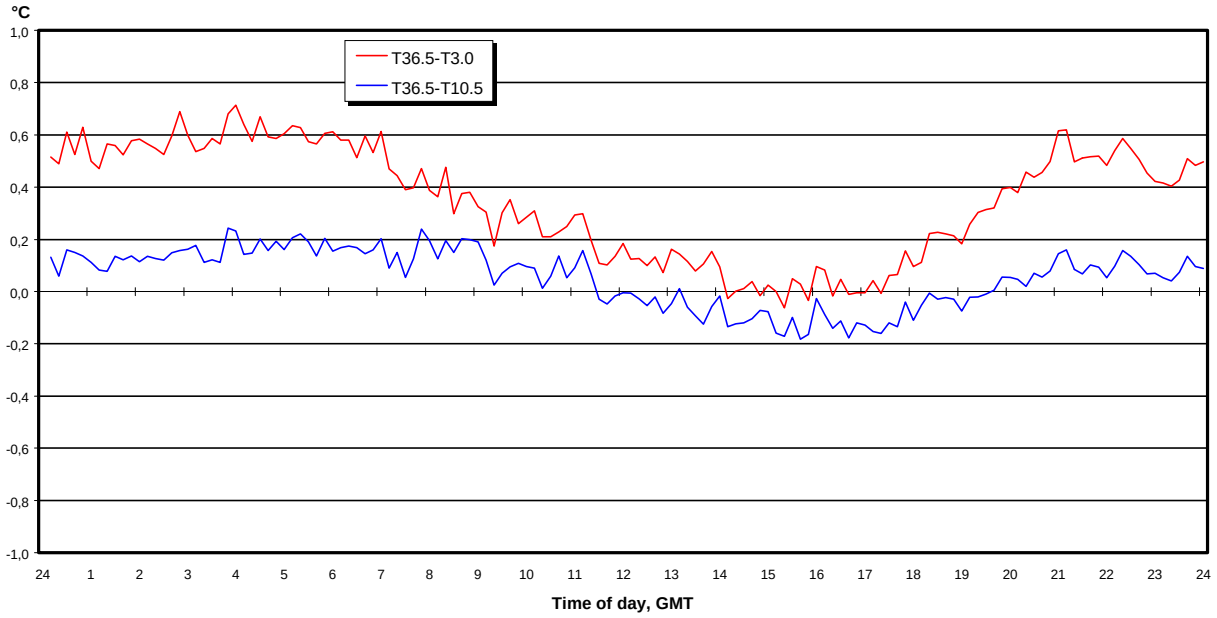


ANNEX 34

Sómastaðagerði
Average Vertical Temperature Gradient, °C
March 1999



Sómastaðagerði
Average Vertical Temperature Gradient, °C
April 1999



ANNEX 35