Veðurstofa Íslands
Report

Flosi Hrafn Sigurðsson
Hreinn Hjartarson
Torfi Karl Antonsson
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Wind Observations at Eyri and Leirur in Reyðarfjörður

VÍ-G99015-TA03
Reykjavík
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Contents

1. Introduction

Following a contract with the **Invest in Iceland Agency - Energy Marketing**, the Icelandic Meteorological Office established late in June 1993 automatic wind observation stations at Eyri and Leirur in Reyðarfjörður. The stations were to be operated for one year from 1 July 1993 with a possible prolongation of the observing period.

The observed data were to be be delivered on computer diskettes for calculation of dispersion of air pollution from proposed industrial plants in the Reyðarfjörður area. The data from Leirur have been used for this purpose.

In the following report the observed wind conditions at Eyri and Leirur are described. For Eyri the 12 month period July 1993-June 1994 has been selected for presentation, but for Leirur the 24 month period October 1993-September 1995.

2. Observation Sites and Instrumentation

Eyri is located on the southern side of Reyðarfjörður directly opposite point Hólmanes. The anemometer was placed on top of a wooden pole, shortly east of Eyrará (65° 00.3´ N, 13° 59.3´ W, height of ground 11 m above mean sea level). The type of the anemometer was Young, Model 5103, and it's height above the ground was 10.7 m. A datalogger CR10 from Campbell Scientific, Inc., was used for receiving and storing data at the observation site. Figure 1 shows an eastwards view over Reyðarfjörður. Eyri is marked with a filled white circle. Figures 2 and 3 show the anemometer at Eyri.

The wind observations started at Eyri on 24 June 1993 and terminated on 27 September 1994. Mean values for every 10 minutes were observed for wind direction and wind velocity, and the highest wind gust during the 10 minutes was recorded.

The average monthly data availability from July 1993 to September 1994 was 81.1%, variable from 44.2 to 100 %.

The station Leirur was located on the flatland Sléttunes, also called Kollaleirunes (65° 01.7´ N, 14° 15.5´ W, height of ground a.m.s.l. 9 m). Two Gill UVW anemometers from R.M. Young Company were used for wind observations. The instruments were installed on a 38 m high mast, at 11.0 m and 35.5 m above the ground. The Gill UVW anemometer consists of three orthogonal propellers, two of them measuring horizontal components of the wind, and one measuring upwards or downwards

movement of the air. The propellers are at slightly different height and the anemometer height has been taken as the height of the middle one. The horizontal components were used for computing the wind direction and the wind velocity. A personal computer was used for receiving and storing the observed data at Leirur. Figures 4 and 5 show the anenometers and anemometer mast at Leirur. Fig. 6 shows a view westwards over Sléttunes and the inner part of Reyðarförður, and Fig. 7 shows where the anemometer mast was located .

At Leirur the observations started on 25 June 1993 and were terminated on 31 March 1995 at the 36 m level but on 23 October 1995 at the 11 m level.

The data availability was very variable. In the period July 1993 to December 1994 the average was 82.0 % at the 36 m level, and monthly means variable from 0 to 100 %. At the 11 m level the average in the period July 1933 to September 1995 was 91.4%, and monthly means variable from 16.3 to 100 %.

A map of the Reyðarfjörður area is presented in Fig. 8. The location of Eyri and Leirur is indicated on the map as well as that of three other stations, Kollaleira and Sómastaðagerði in Reyðarfjörður and Mjóeyri in Eskifjörður, where wind observations have also been made. To emphasize the wind's very strong dependence on topography, wind roses are shown for all five locations. The wind roses are all valid for the whole year but of necessity for different periods. The wind roses for Eyri and Leirur are the ones found in Annex 1 and 8 of this report. The wind rose for Kollaleira is for the years 1983-1998. The wind roses for Sómastaðagerði and Mjóeyri are based on observations in the periods October 1981 - September 1984 and October 1982 - September 1984, respectively.

Fig. 1 View towards east over Reyðarfjörður. Eyri is marked by a filled white circle on the southern side of the fjord. Photo: Mats Wibe Lund, 1998.

Fig. 2. The anemometer at Eyri, viewed towards south. Photo: Hreinn Hjartarson, 1993.

Fig. 3. The anemometer at Eyri, viewed towards north. Photo: Hreinn Hjartarson, 1993.

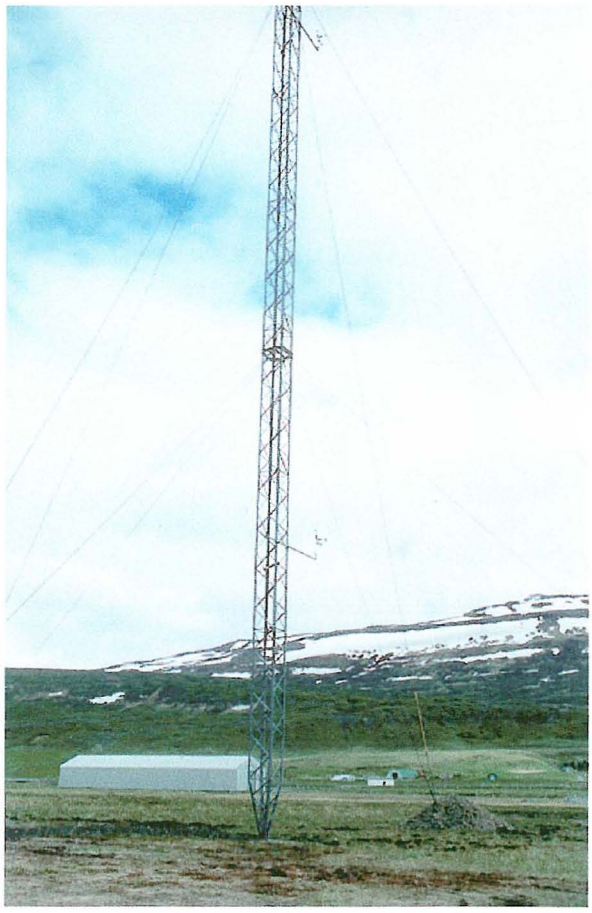


Fig. 4 The anemometermast at the observing station Leirur on Sléttunes. Photo: Elvar Ástráðsson, 1993.

Fig. 5. The lower of the two Gill UVW anemometers at Leirur. Photo: Hreinn Hjartarson, 1993.

Fig. 6. View towards Sléttunes. The river is Sléttuá.
Photo: Þórður Arason, 1999.

Fig 7. The anemometermast was located where the man is standing.
The farm Slétta is seen to the right.
Photo: Elvar Ástráðsson, 1999.

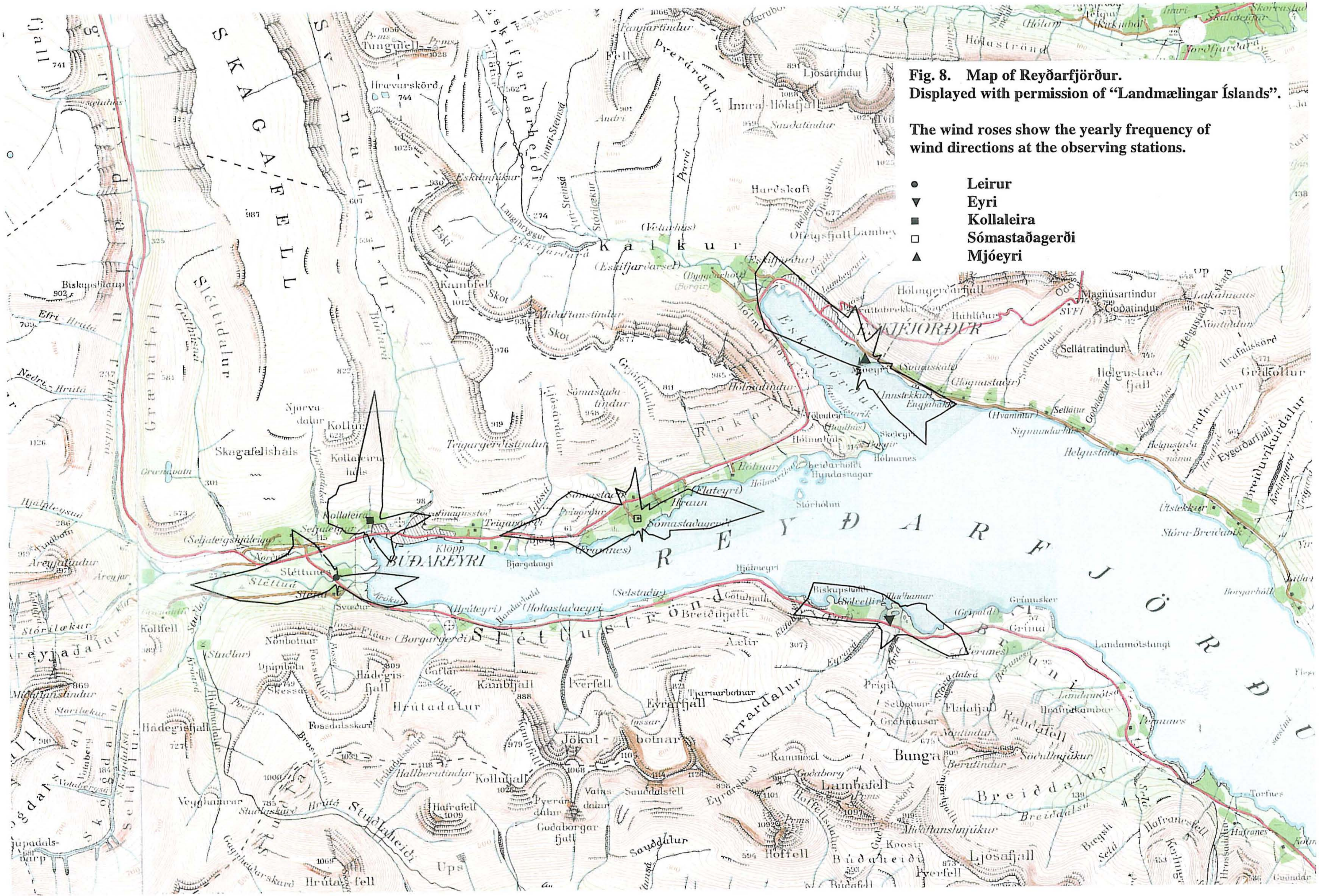


Fig. 8. Map of Reyðarfjörður.
Displayed with permission of "Landmælingar Íslands".

The wind roses show the yearly frequency of wind directions at the observing stations.

- ● Leirur
- ▼ Eyri
- ■ Kollaleira
- □ Sómastaðagerði
- ▲ Mjóeyri

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.

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

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, mm.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	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 observations at Eyri and Leirur in Reyðarfjörður are the subject of this report and will be dealt with in the following chapters. Wind observations at Kollaleira in the

years 1983-1998 have been presented in a separate report: Flosi Hrafn Sigurðsson et al.: Vindmælingar að Kollaleiru, Veðurstofa Íslands, Greinargerð VÍ-G99009-TA02, June 1999 (Ref. 1). Wind, weather and stability observations in the Reyðarfjörður area are also dealt with in a separate report: Flosi Hrafn Sigurðsson and Hreinn Hjartarson: Veðurathuganir á Reyðarfjarðarsvæðinu, Veðurstofa Íslands, 1986 (Ref. 2). 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 the air temperature in the Reyðarfjörður Area frequently is higher than the sea surface temperature, resulting in stable air and temperature inversions. Ground based inversions are accordingly relatively frequent.

4. Results of Wind Observations at Eyri

Results of wind observations at Eyri are presented for the 12 month period July 1993-June 1994.

4.1 Frequency of Wind Directions at Eyri

The frequency of wind directions at Eyri in the 12 month period July 1993 - June 1994 is presented in Annexes 1-3. Annex 1 showes the results for the whole year, Annex 2 for autumn and winter, the months October-March; and Annex 3 for spring and summer, the months April-September. There is little difference between the three wind roses. They all show the strong channelling effect of the fjord and the surrounding mountains. Most common are westerly winds, 270-290°, blowing along the mountains on the south side of inner Reyðarfjörður. The second most common wind direction is east-southeasterly, 110-130°, governed by the mountains on both sides of outer Reyðarfjörður. Although much less frequent, the wind direction 210° may also be mentioned, representing winds blowing from Eyrardalur and Eyrarskarð.

For the summer months, July - August 1993 and June - August 1994, a wind rose for the night hours 00-06 GMT is presented in Annex 4 and for the afternoon hours 12-18 GMT in Annex 5.

Weather and winds are very variable in Iceland. As a reminder of this, Annexes 6 and 7 show wind roses for the months February and March 1994. Southeasterly winds were prevailing in February but westerly winds in March. For calculations of pollution distribution this indicates that they should not **only** be limited to average conditions for whole seasons or the year. It seems necessary also to pay attention to shorter periods of unfavourable conditions, lasting for several consecutive days or even weeks. This is particularly important in Reyðarfjörður where ground based inversions are relatively frequent and where high mountains surround the fjord.

4.2 Wind Velocity at Eyri

The average monthly wind velocity at Eyri in the period July 1993 - June 1994 is presented in Table 5.

Table 5. Mean monthly wind velocity at Eyri, July 1993 - June 1994, m/s.

Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Year
6.2	4.3	2.9	4.4	6.8	6.6	6.4	4.8	5.7	5.1	3.9	3.2	5.0

The average wind velocity for the 12 month period was 5.0 m/s. Generally the wind velocity in Reyðarfjörður is higher during the winter and lower during the summer. In this case the mean for July has been exceptionally high and the mean for September unusually low.

The highest 10 minute wind velocity recorded was 23.1 m/s in easterly wind direction on 21 December 1993.

The frequency of the 10 minute mean wind velocity for selected intervals is shown in Table 6.

Table 6. Frequency of wind velocity for selected intervals
Eyri, July 1993 - June 1994, %.

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	3.5	10.0	9.2	7.8	8.1	38.6	49.1	9.1	3.2		
Feb	13.1	18.0	11.8	9.0	7.5	59.5	31.8	7.4	1.3	0.0	
Mar	8.4	14.9	10.3	7.9	6.6	48.2	39.2	10.5	2.1		
Apr	6.8	19.7	12.0	6.7	5.2	50.4	46.1	3.5			
May	14.5	20.1	12.1	8.6	8.1	63.4	36.0	0.6			
Jun	16.9	22.3	15.7	13.6	9.9	78.4	20.9	0.7	0.0		
Jul	9.8	10.8	9.8	6.5	6.0	42.9	41.2	15.2	0.6		
Aug	17.2	21.5	11.5	8.0	5.5	63.7	29.2	6.7	0.5		
Sep	26.2	25.4	9.8	8.7	9.0	79.1	20.2	0.7			
Oct	10.4	22.8	14.0	6.7	6.7	60.5	36.3	2.6	0.5		
Nov	2.5	8.2	7.9	10.6	10.2	39.5	43.2	12.3	4.9	0.1	
Dec	6.0	9.3	7.9	7.3	8.2	38.7	45.3	12.1	3.7	0.1	
Year	11.2	16.9	11.0	8.5	7.6	55.1	36.5	6.9	1.5	0.0	

The high frequency of low wind speeds is noteworthy, 28.1 % of the 10 minute means being lower than 2.0 m/s, 55.1 % lower than 5.0 m/s and 91.6 % below 10.0 m/s.

The distribution of wind velocity at Eyri is shown in Figure 9.

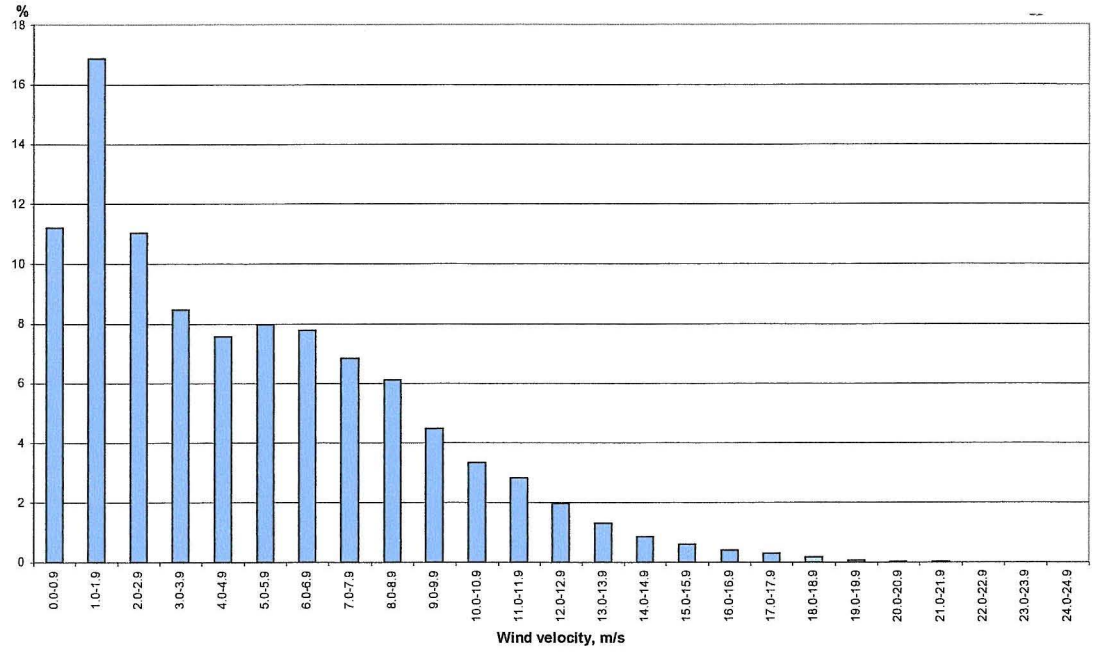


Fig. 9. Wind velocity distribution, 10 minute means, Eyri, July 1993 - June 1994, %.

The average wind velocity of each wind direction at Eyri is presented in the histograms on the lower part of Annexes 1-7. For the months of January and July the mean wind velocity of the different wind directions is also presented in Fig. 10.

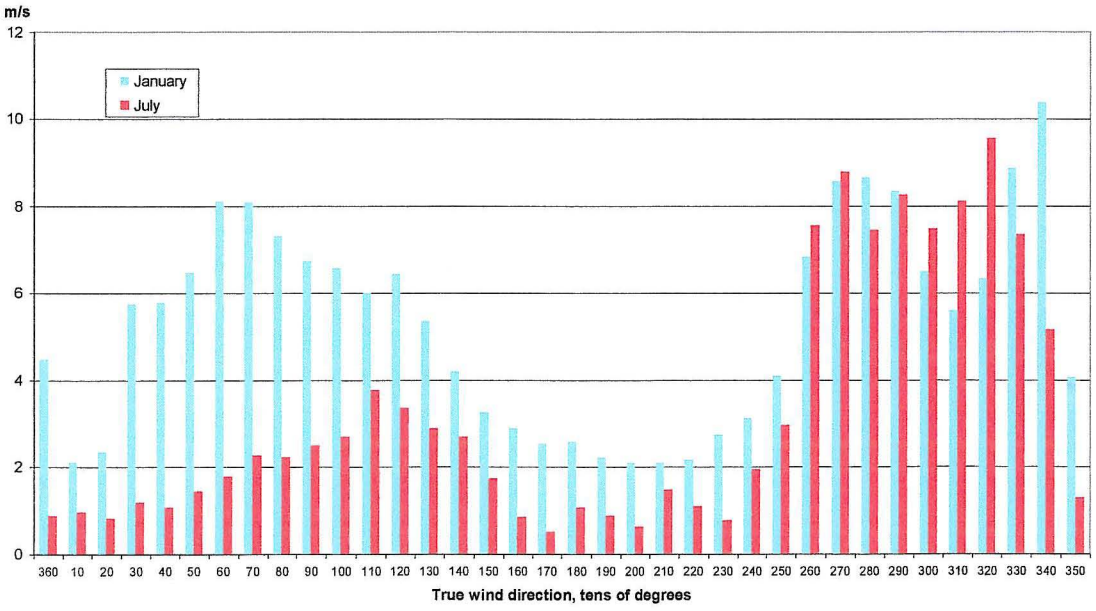


Fig. 10. Average wind velocity at Eyri according to wind direction in July 1993 and January 1994, m/s.

4.3 Highest Gusts

The highest wind gust (approx. 3 second value) recorded at Eyri was 46.5 m/s. This occurred between 08:00 and 08:10 on 27 November 1993. The wind direction was

east-southeasterly and the mean wind velocity for the 10 minute interval was 18.5 m/s. The second highest gust 43.8 m/s was recorded on 18 November 1993 between 04:50 and 05:00. The wind direction was the same as before and the 10 minute mean wind speed only 12.8 m/s. Gusts exceeding 35 m/s were recorded 27 times. Of these, 25 were observed in east-southeasterly wind direction (108°-133°) but two (40.0 and 39.4 m/s) in southerly winds (180°-182°).

5. Results of Wind Observations at Leirur

Results of wind observations at 11 meters above the ground at Leirur are here presented for the 24 month period October 1993-September 1995. Wind observations were also made at 35.5 meters above the ground at Leirur. The observations began on 25 June 1993 and ended at the 11 m level on 23 October 1995 but on 31 March 1995 at the 36 m level.

5.1 Frequency of Wind Directions at Leirur

The frequency of the wind directions at Leirur is presented by wind roses in Annexes 8-12. Annex 8 is valid for the whole year; Annex 9 for autumn and winter, the months October-March; and Annex 10 for spring and summer, the months April-September. Annexes 11 and 12 are valid for the summer months June-August, the former for the night hours 00-06 GMT but the latter for the afternoon hours 12-18 GMT.

The highest frequency have winds from true west, 270°, and generally speaking westerly and northwesterly winds are common, blowing out to the fjord from 250-330°. Easterly winds, blowing inland from 80-130°, are also common, especially during the afternoon in summer. Northerly and southerly winds are rare at Leirur. This is very different at the nearby weather station Kollaleira where northerly winds from the valley Svínadalur are very common during the winter, spring and autumn, as well as during the night in summer (Flosi Hrafn Sigurðsson et al., 1999, Ref. 1).

There is a very strong diurnal variation in the winds at Leirur during the summer as evident from Annexes 11 and 12, wind from 270° being by far the most common at night, but wind from 110° during the afternoon.

5.2 Wind Velocity at Leirur

The average monthly wind velocity at 11 m above the ground at Leirur during the 24 month period October 1993-September 1995 is presented in Table 7.

Table 7. Mean monthly wind velocity, Leirur, October 1993-September 1995, m/s

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
4.0	4.8	5.7	5.9	6.0	5.6	5.0	4.0	4.5	4.0	3.3	4.2	4.8

As seen in the table the average wind velocity for the two years was 4.8 m/s. For the 12 month period July 1993-June 1994 it was, however, 4.7 m/s, 0.3 m/s lower than the average velocity at Eyri for that period.

The highest 10 minute wind velocity observed at the 11 m level was 24.3 m/s. This was in a west-southwesterly wind direction, between 14:00 and 14:10 on 12 March 1995.

The frequency of wind velocity (10 minute means) for selected intervals is presented in Table 8

Table 8. Frequency of wind velocity for selected intervals
Leirur, October 1993-September 1995, %.

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	8.8	11.6	10.0	9.0	8.7	48.1	37.6	11.5	2.5	0.3	
Feb	6.3	8.1	6.6	8.1	11.3	40.5	50.2	8.3	1.0		
Mar	8.7	13.1	9.9	8.4	10.4	50.4	38.3	9.0	2.1	0.2	
Apr	10.3	12.4	10.4	8.6	10.2	51.9	42.1	5.1	0.9		
May	13.3	13.9	12.9	11.9	12.4	64.4	34.3	1.3			
Jun	12.1	13.3	10.9	11.9	13.1	61.3	35.7	3.0			
Jul	17.7	14.6	10.7	9.6	9.2	61.8	35.8	2.4			
Aug	19.0	18.1	13.7	12.1	11.2	74.1	25.2	0.7			
Sep	14.1	14.7	11.7	12.0	11.4	64.0	32.6	3.2	0.2		
Oct	16.3	17.9	11.6	10.2	10.6	66.5	30.1	3.2	0.2		
Nov	12.7	14.5	10.2	10.1	9.8	57.3	36.2	5.7	0.8		
Dec	9.0	10.5	8.7	9.1	9.2	46.5	43.0	8.2	2.2	0.1	
Year	13.5	14.1	10.7	10.0	10.5	58.7	35.7	4.7	0.8	0.0	

The high frequency of low wind velocities is similar to that found at Eyri. At Leirur 27.6 % of the observations were below 2.0 m/s, 58.7 % were lower than 5.0 m/s and 94.4 % lower than 10.0 m/s.

The wind velocity distribution at Leirur is also presented in Fig. 11. The velocity values are 10 minute means at 11 m above the ground.

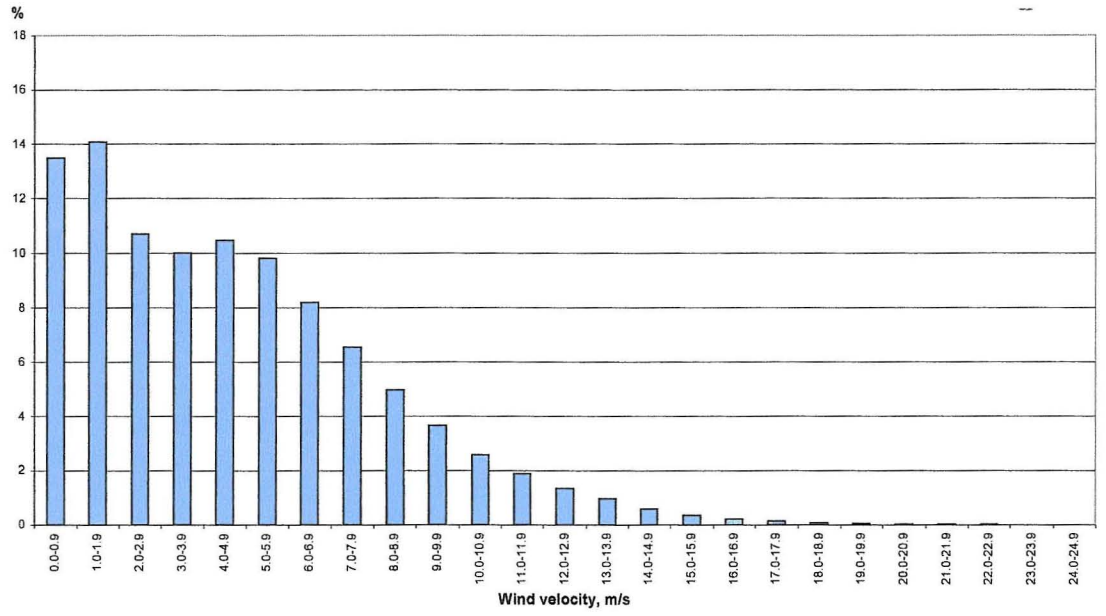


Fig. 11. Wind velocity distribution, Leirur, October 1993 - September 1995, %.

The average wind velocity observed in each wind direction at Leirur is presented in histograms in the lower part of Annexes 8-12.

Finally, to emphasize the annual variation, the average wind velocity of each wind direction at Leirur in January and July, 1994-1995, is presented in Fig. 12.

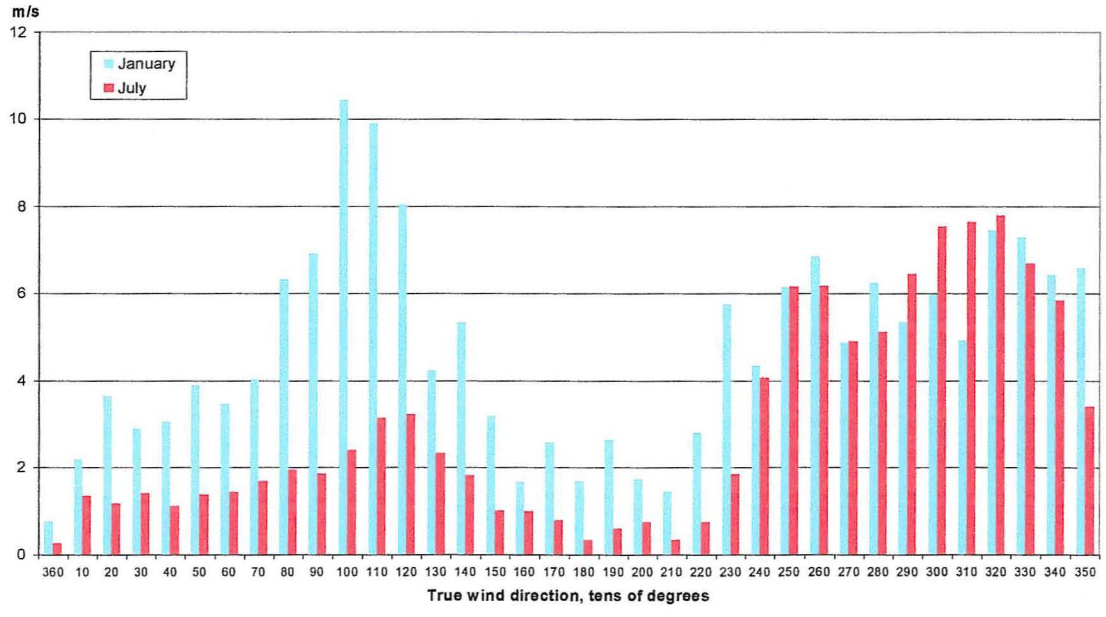


Fig 12. Average wind velocity according to wind direction
Leirur, January and July, 1994-1995, m/s.

5.3 Variation of Wind Velocity with Height

A study has been made of the variation of wind velocity from 11.0 m to 35.5 m for the first 6 months of observation, July - December 1993, with exception of the second half of October. The Gill anemometer is a delicate instrument and the best results were obviously obtained during the first months of the operation. During February-April 1994 there was a serious breakdown at the higher level and there were also problems in January - March 1995 as well as during some shorter periods.

During the selected 6 months the wind velocity at the higher level was on average 14.3 % higher than at the lower level, see Annex 13.

The variation with height 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.

The average value of α during the selected period was 0.11 which is low compared to values found in Reykjavík during the years 1986-1996 (between 0.18 and 0.15, decreasing with increasing wind velocity). (Þórður Arason, 1998. Ref. 3)

6. Remarks

From this and earlier reports (Ref. 1 and 2) it is evident that low wind velocities are very frequent in the Reyðarfjörður area. It is also evident that the mountain sides and the general topography strongly modify the wind directions. During summer it is furthermore evident (Ref. 2) that ground based or low level inversions are quite frequent due to the cold East Iceland Sea Current. During the daytime an easterly sea breeze is commonly blowing inwards over Reyðarfjörður and further into the side and end valleys. During the nights the wind turns and blows down the valleys and out over the fjord. Some of the air may accordingly be circulating back and forth inside the Reyðarfjörður area.

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 several days or even weeks. This could prove important for determing the size of proposed industrial plants in Reyðarfjörður.

7. References

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

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

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

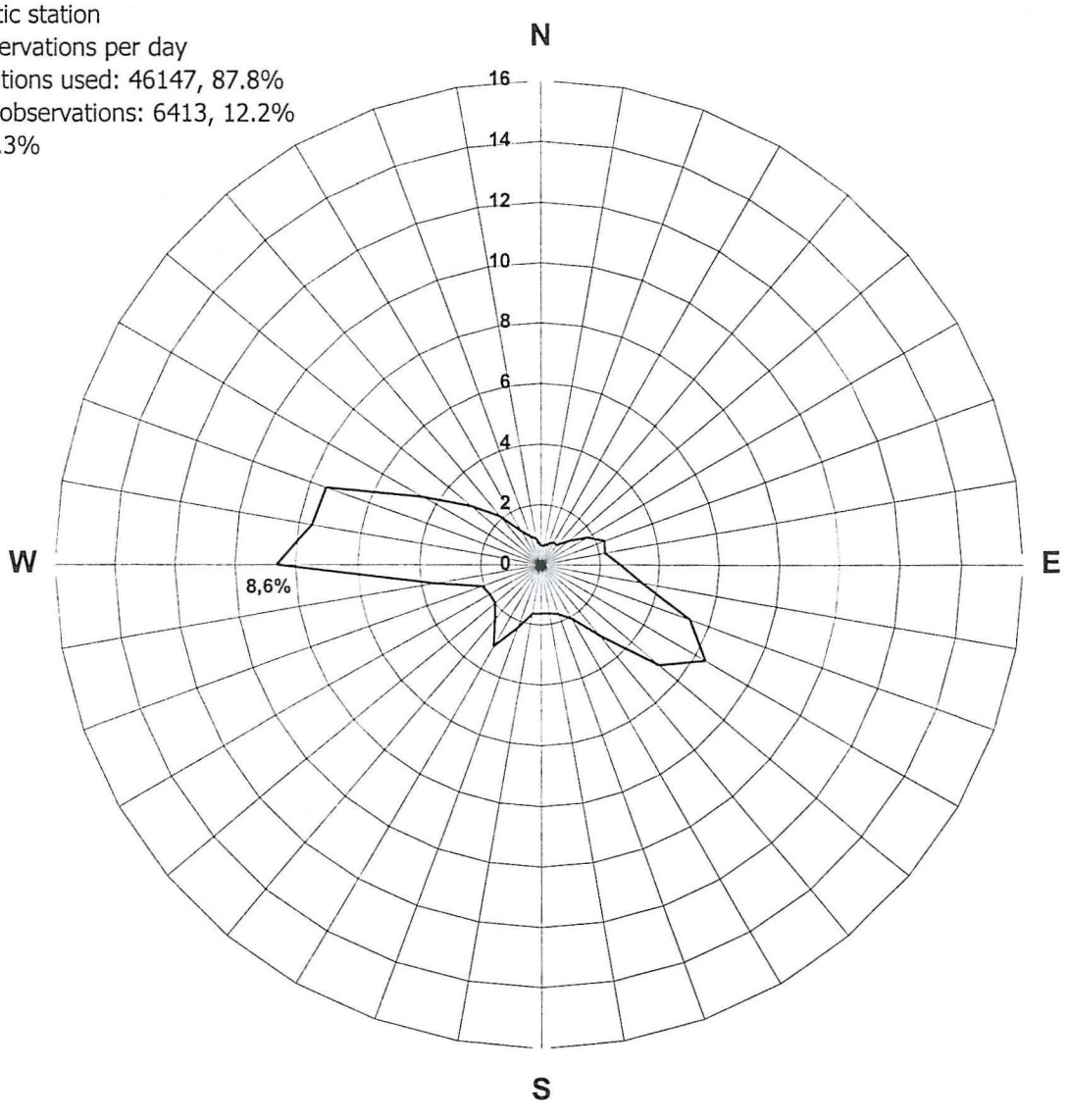
Annexes 1 - 13

Eyri

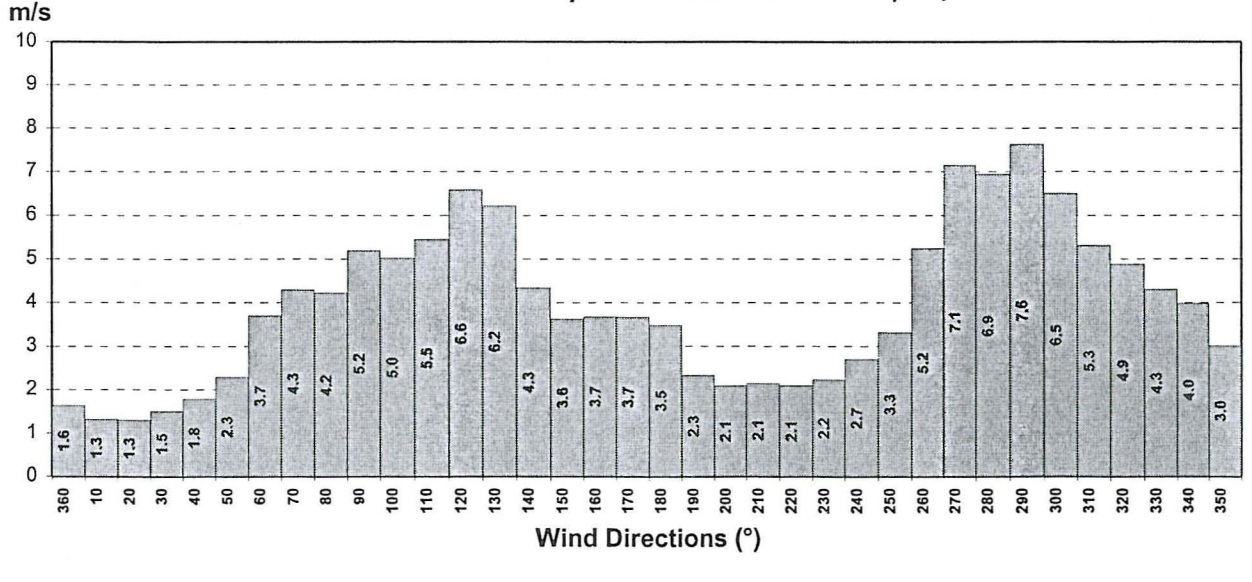
Frequency of Wind Directions (%)

Year, July 1993 - June 1994

Automatic station
144 observations per day
Observations used: 46147, 87.8%
Missing observations: 6413, 12.2%
Calm: 0.3%



Mean Wind Velocity for Wind Directions, m/s



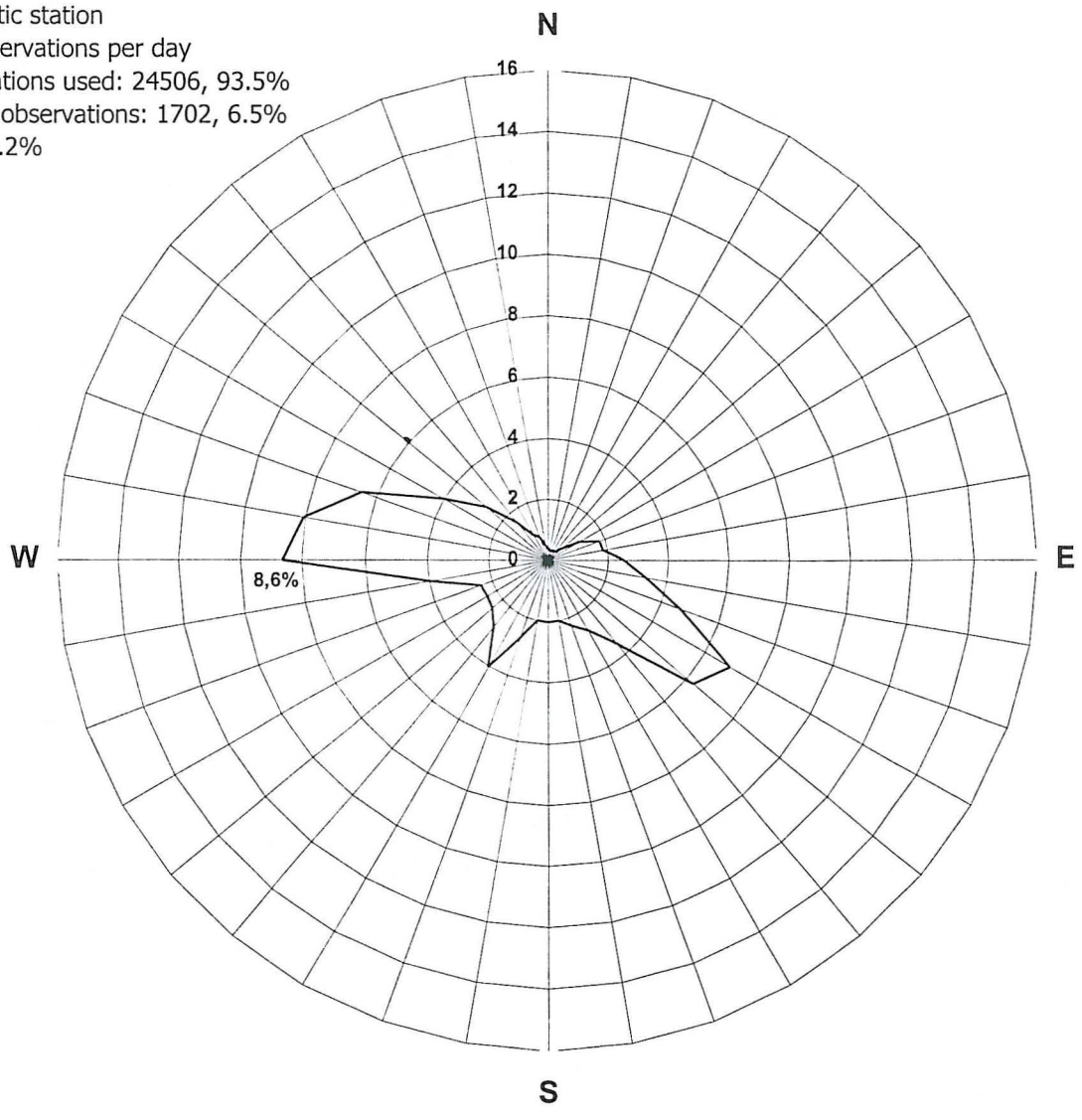
Annex 1

Eyri

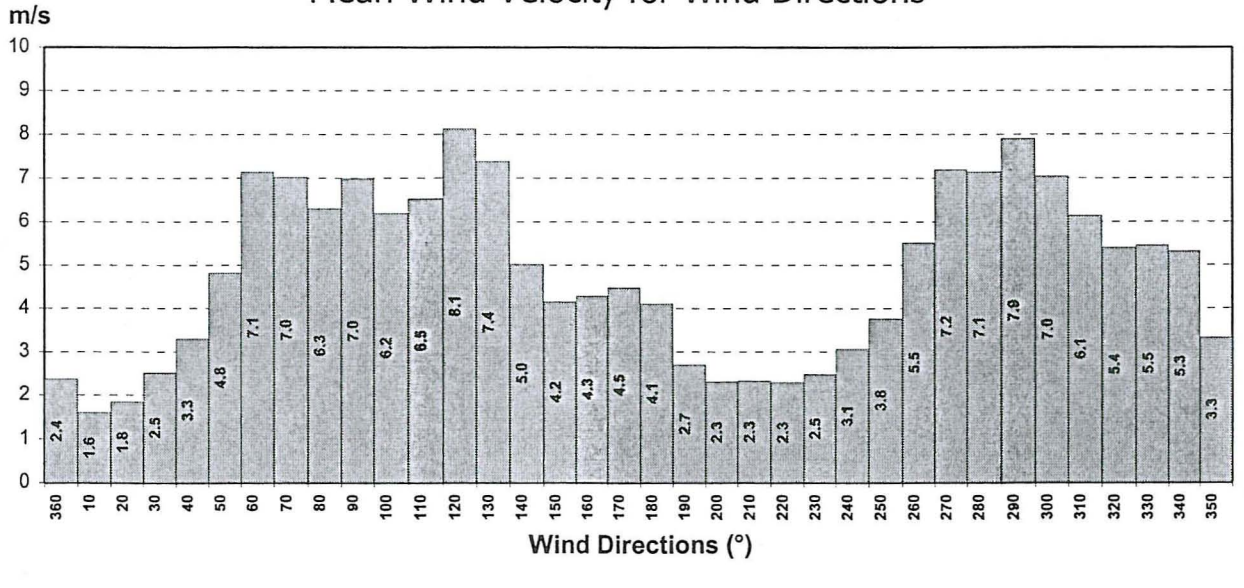
Frequency of Wind Directions (%)

Autumn and Winter, October 1993 - March 1994

Automatic station
144 observations per day
Observations used: 24506, 93.5%
Missing observations: 1702, 6.5%
Calm: 0.2%



Mean Wind Velocity for Wind Directions



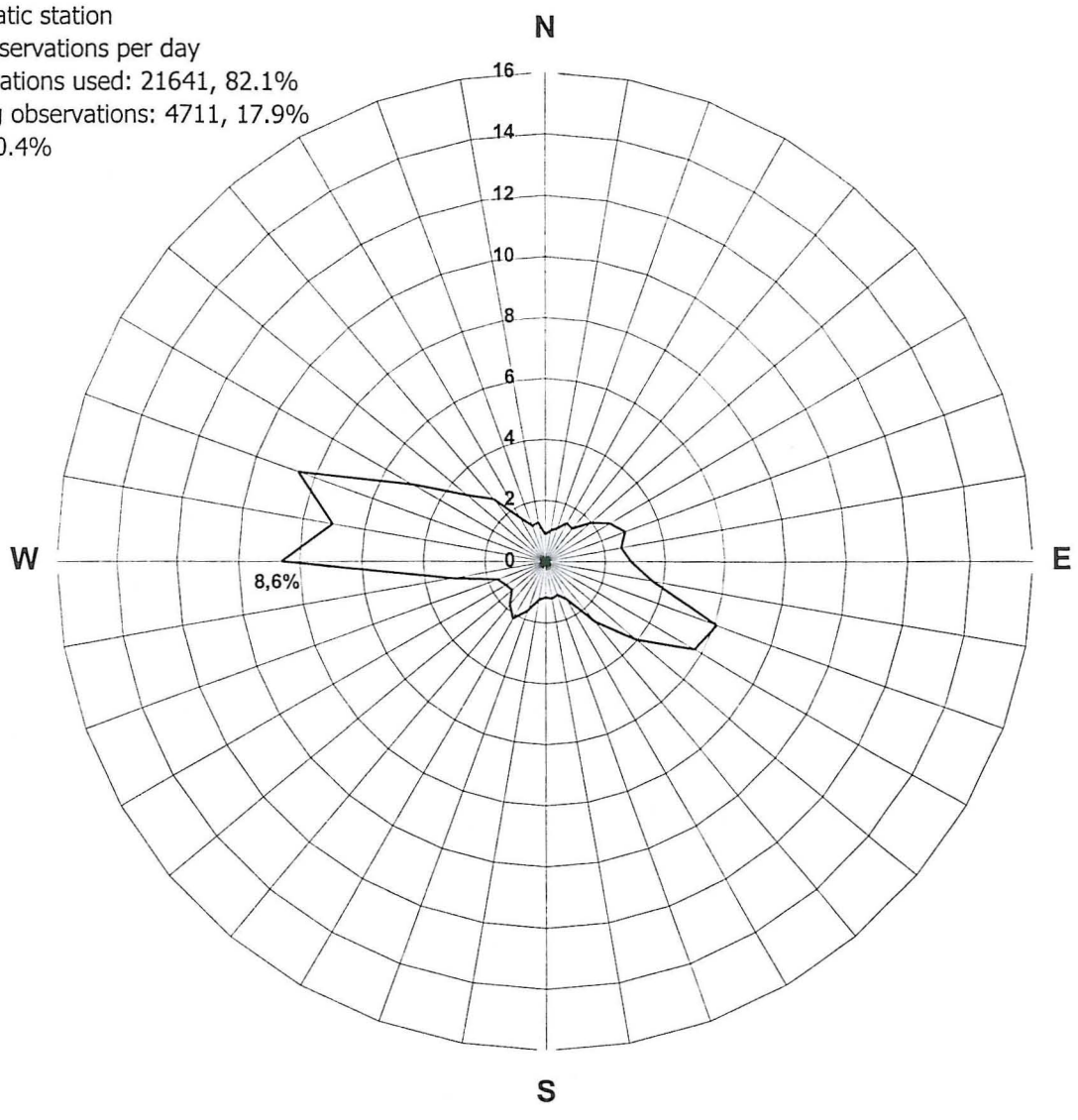
Annex 2

Eyri

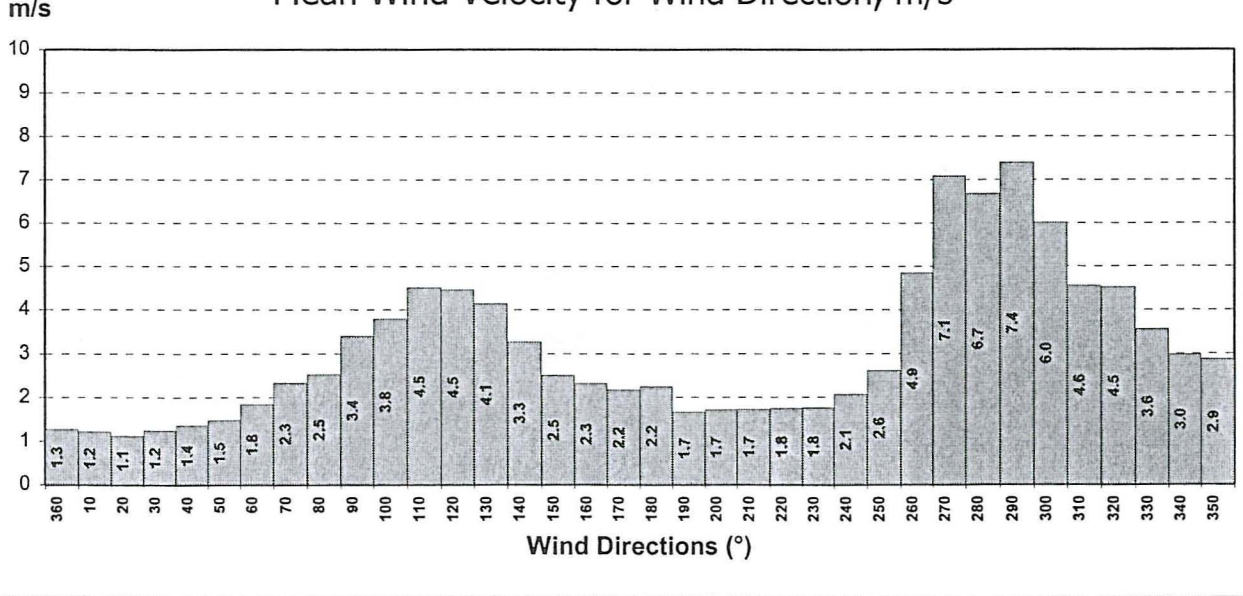
Frequency of Wind Directions (%)

Spring and Summer, July - September 1993 and April - June 1994

Automatic station
144 observations per day
Observations used: 21641, 82.1%
Missing observations: 4711, 17.9%
Calm: 0.4%



Mean Wind Velocity for Wind Direction, m/s



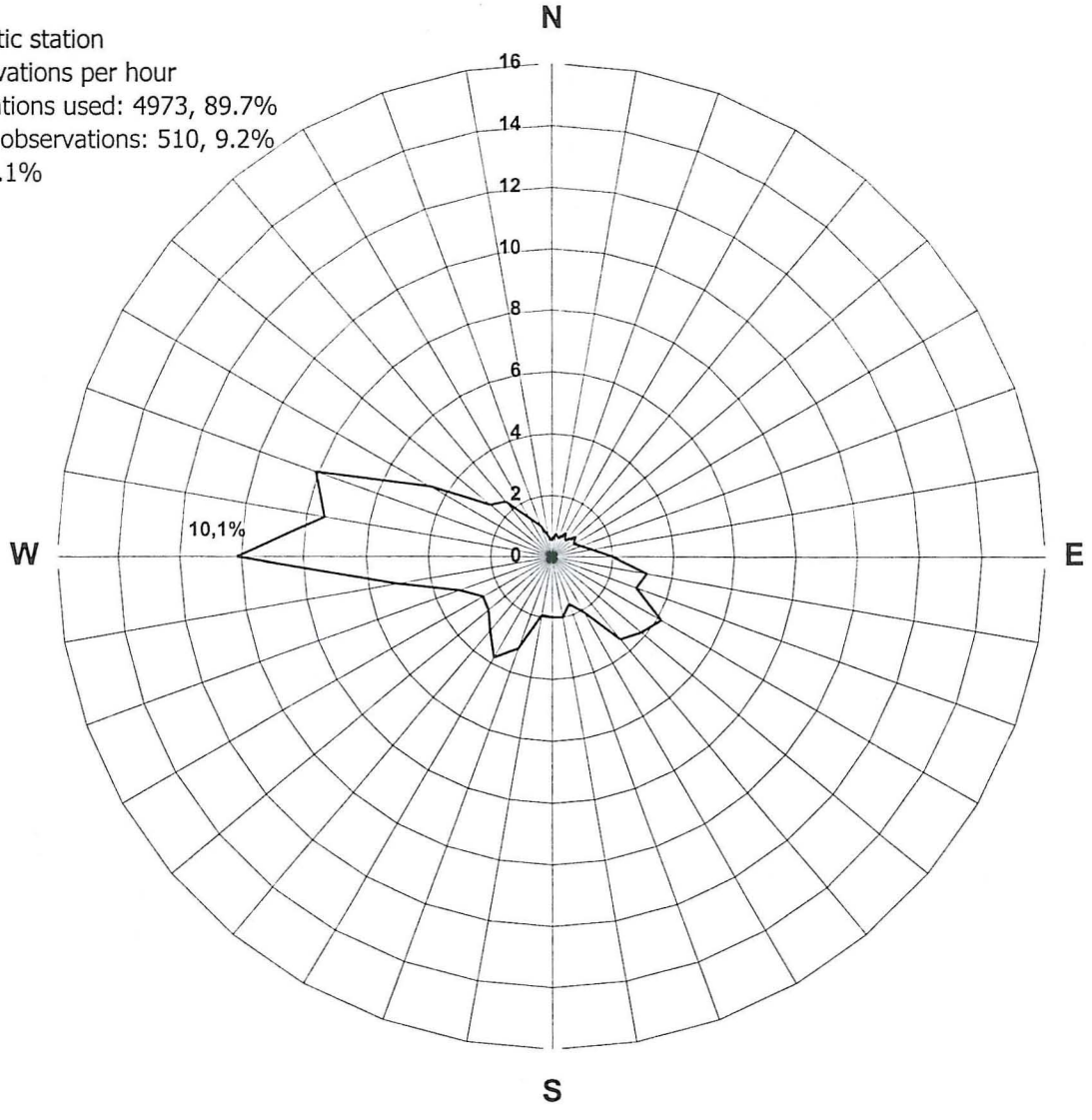
Annex 3

Eyri

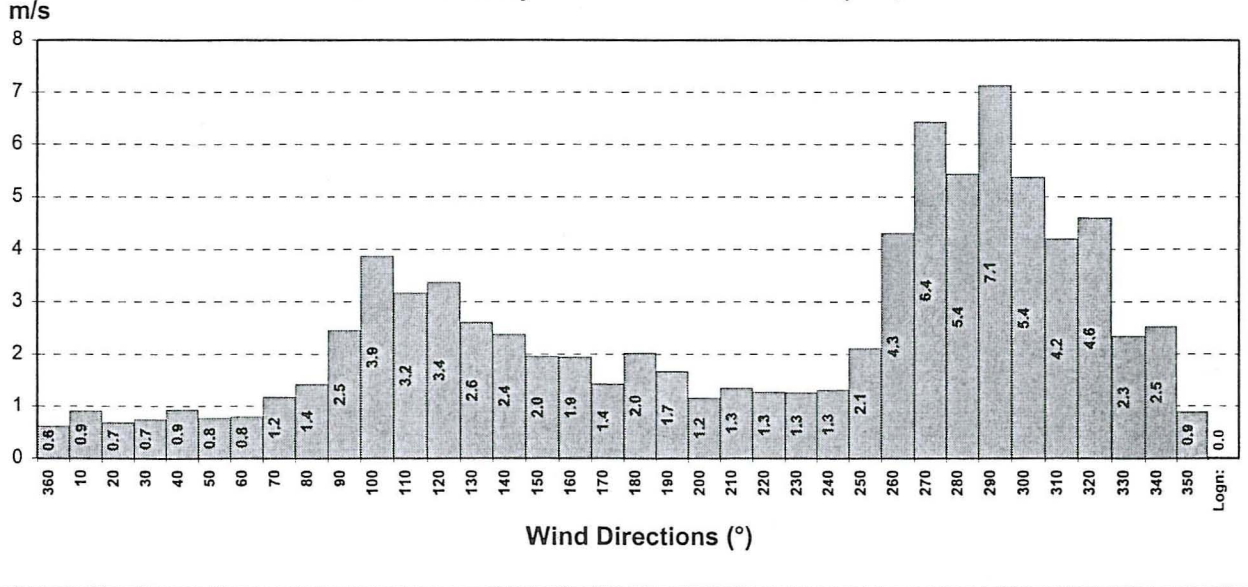
Frequency of Wind Directions (%)

High Summer, July - August 1993 and June - August 1994, Night Hours 00-06 GMT

Automatic station
6 observations per hour
Observations used: 4973, 89.7%
Missing observations: 510, 9.2%
Calm: 1.1%



Mean Velocity for Wind Directions, m/s



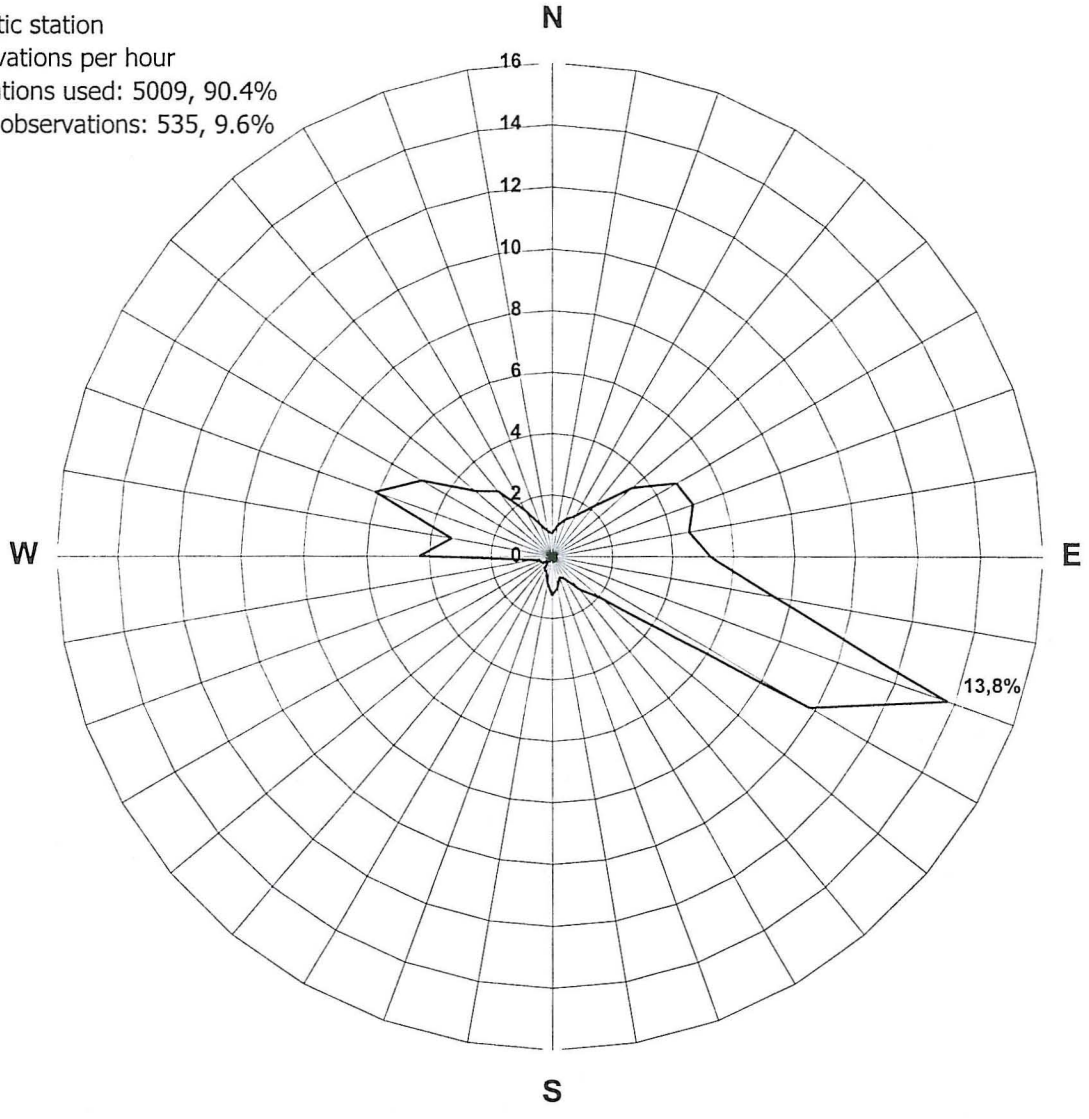
Annex 4

Eyri

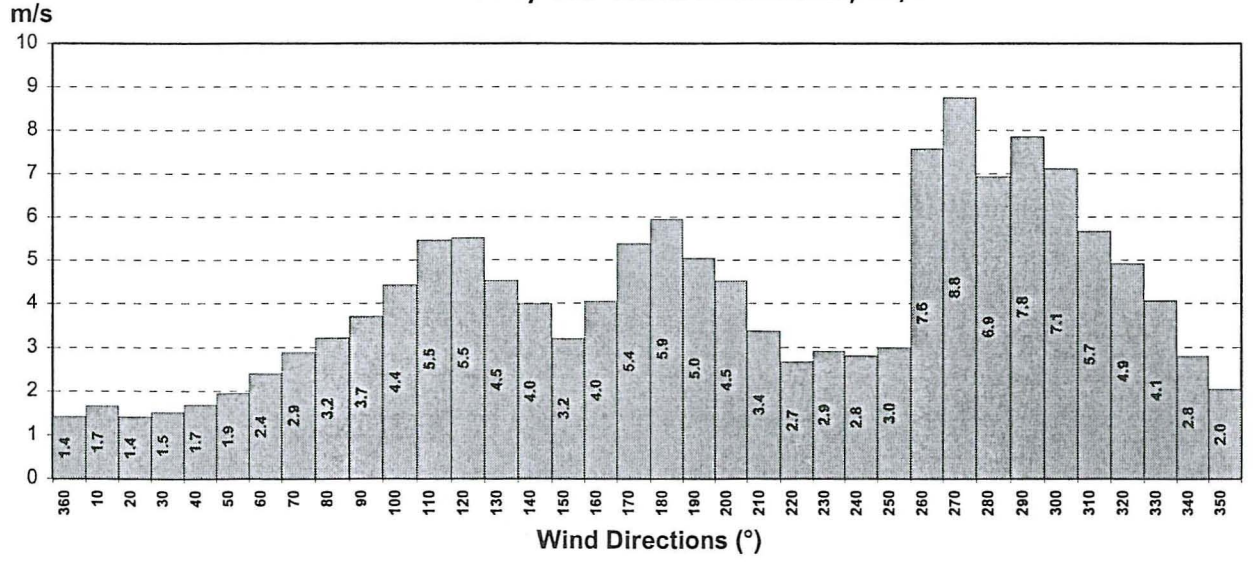
Frequency of Wind Directions (%)

High Summer, July - August 1993 and June - August 1994, Day Hours 12-18 GMT

Automatic station
6 observations per hour
Observations used: 5009, 90.4%
Missing observations: 535, 9.6%



Mean Velocity for Wind Directions, m/s

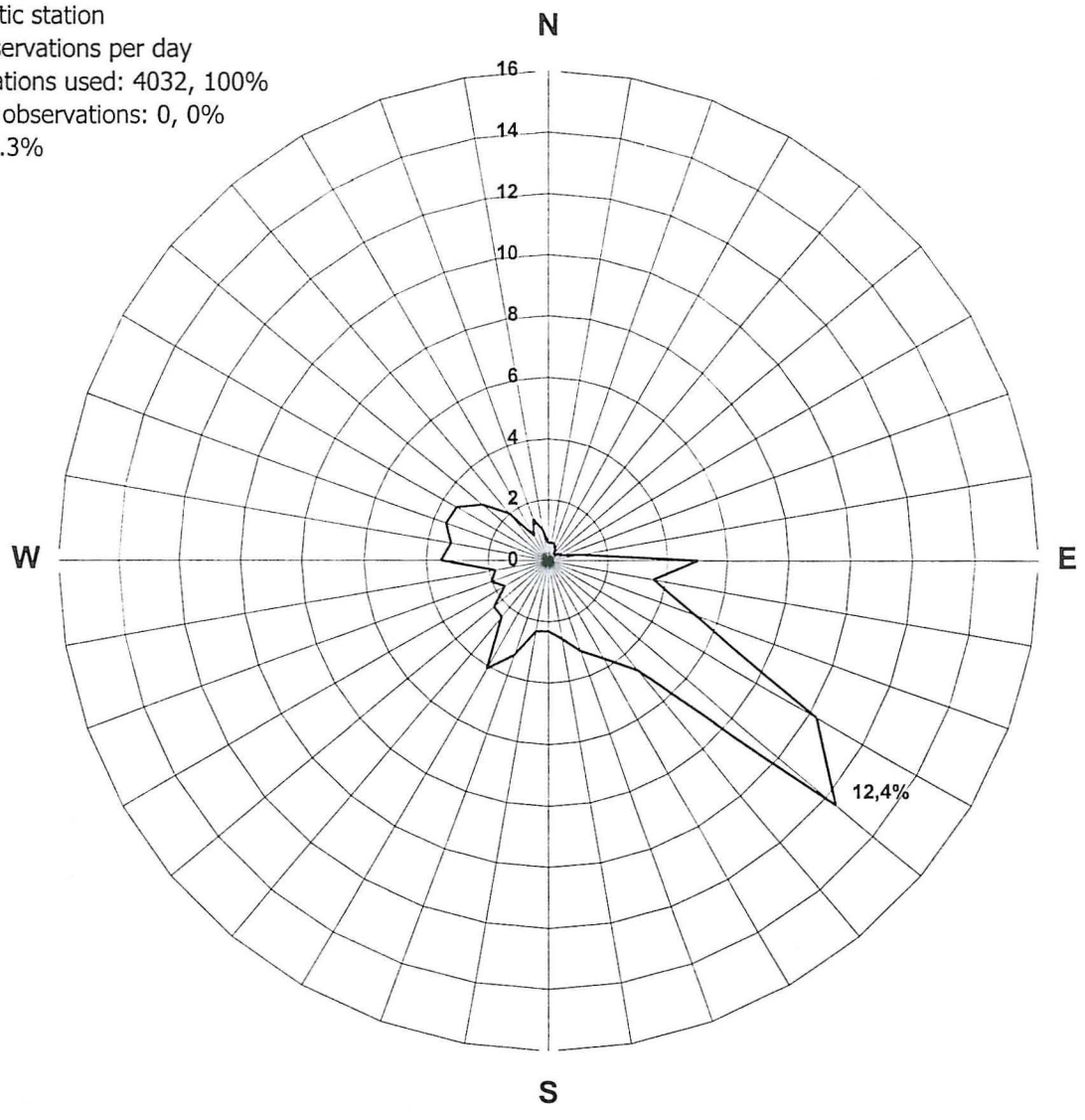


Annex 5

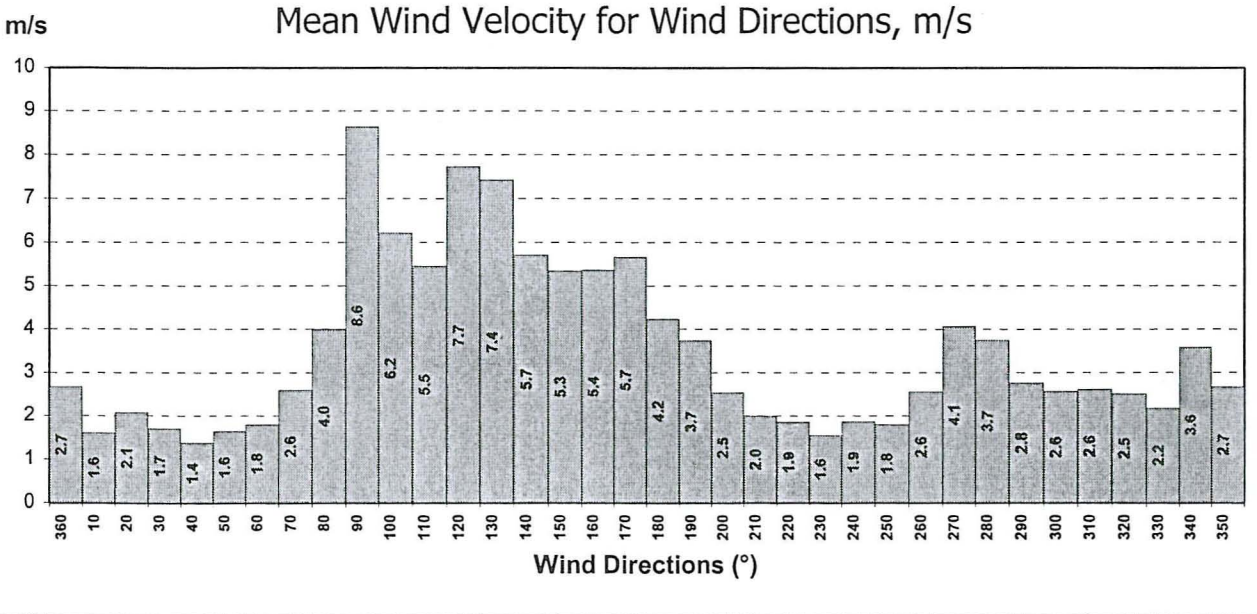
Eyri

Frequency of Wind Directions (%)
February 1994

Automatic station
144 observations per day
Observations used: 4032, 100%
Missing observations: 0, 0%
Calm: 0.3%



Mean Wind Velocity for Wind Directions, m/s



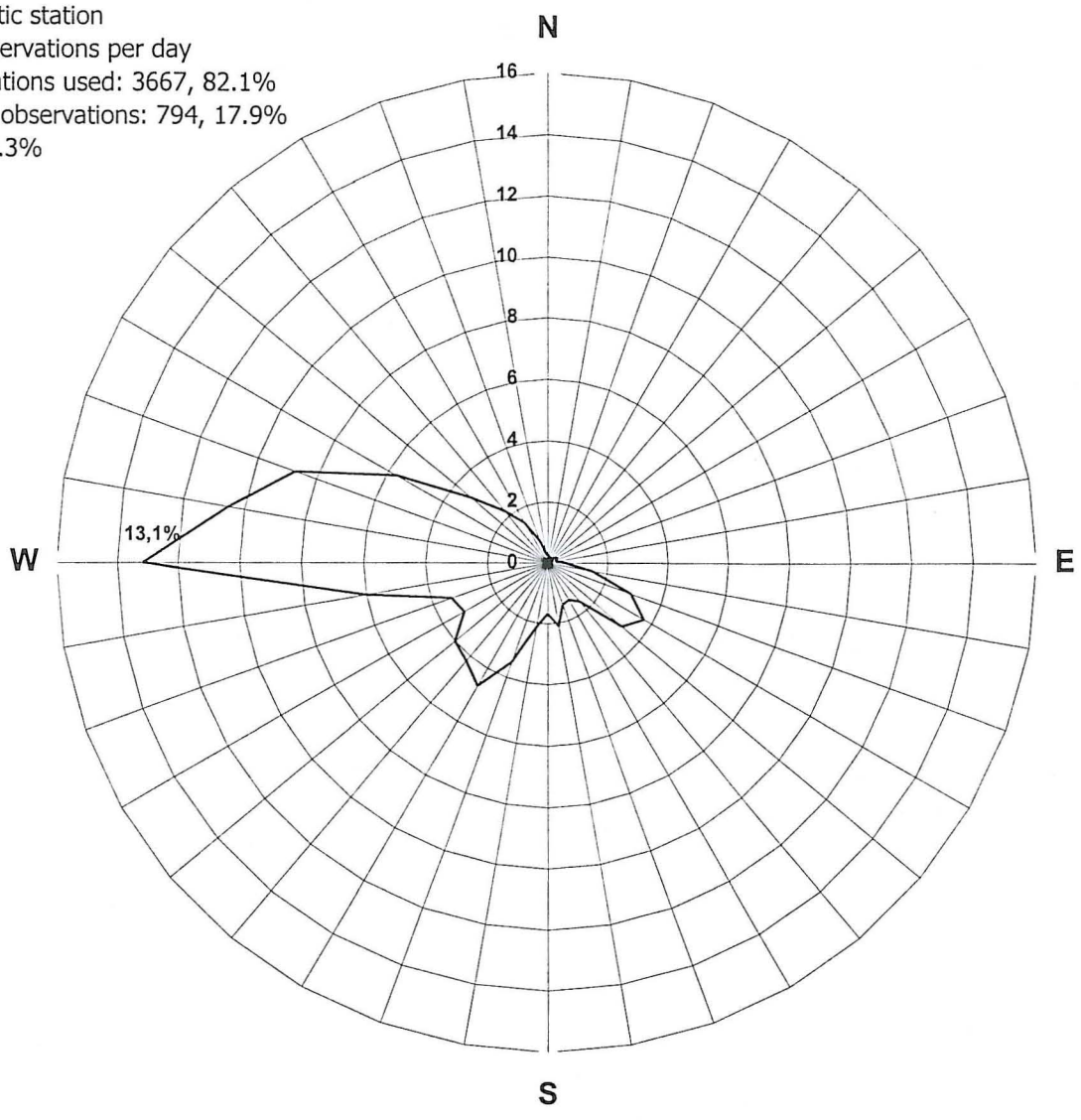
Annex 6

Eyri

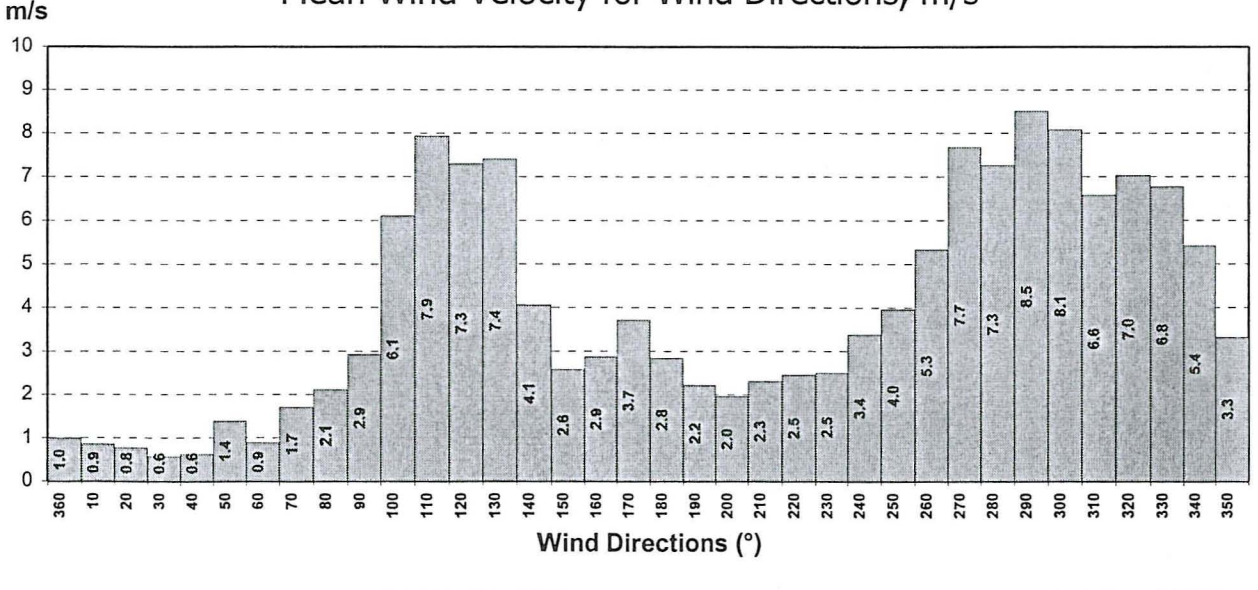
Frequency of Wind Directions (%)

March 1994

Automatic station
144 observations per day
Observations used: 3667, 82.1%
Missing observations: 794, 17.9%
Calm: 0.3%



Mean Wind Velocity for Wind Directions, m/s



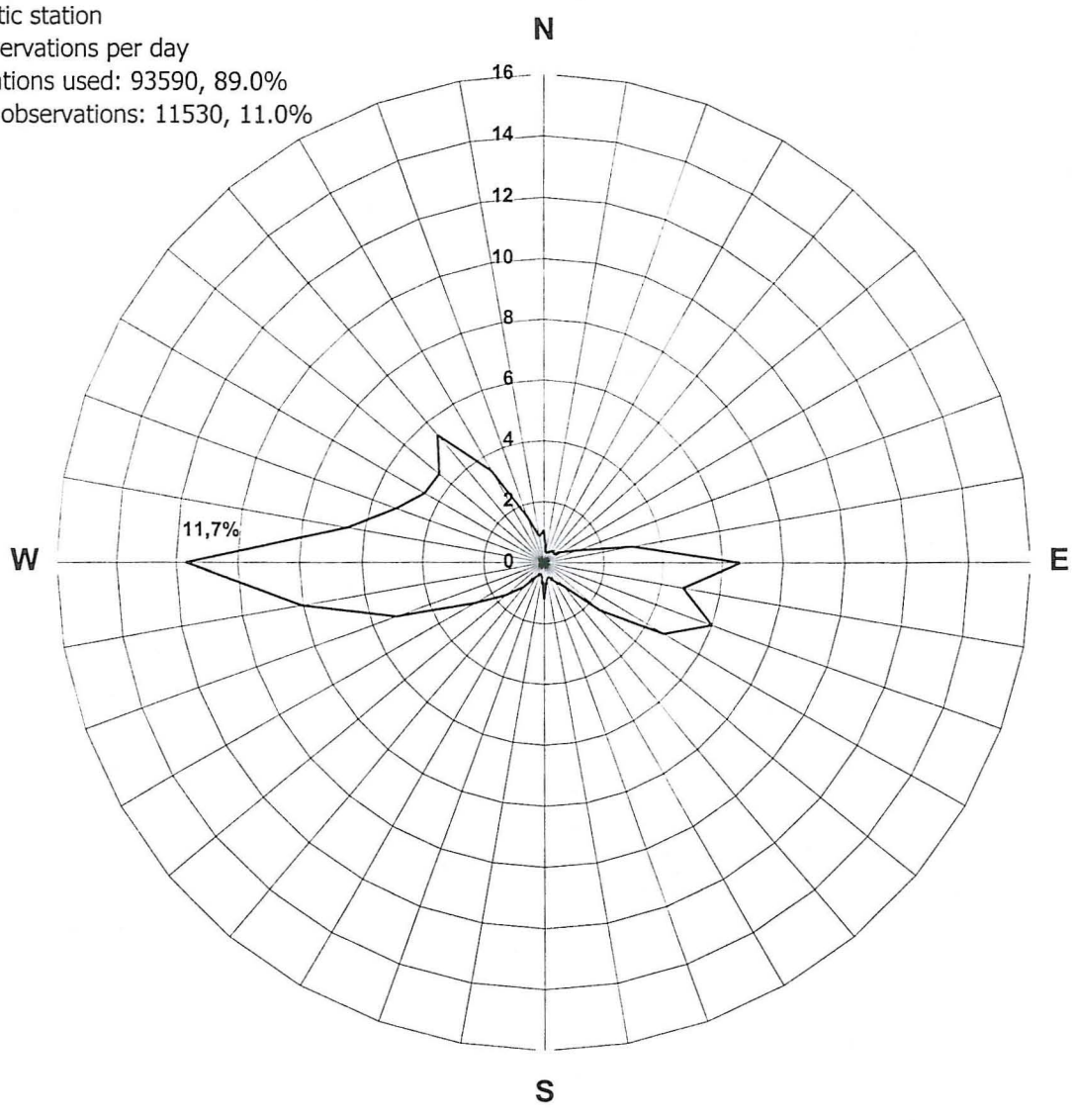
Annex 7

Leirur

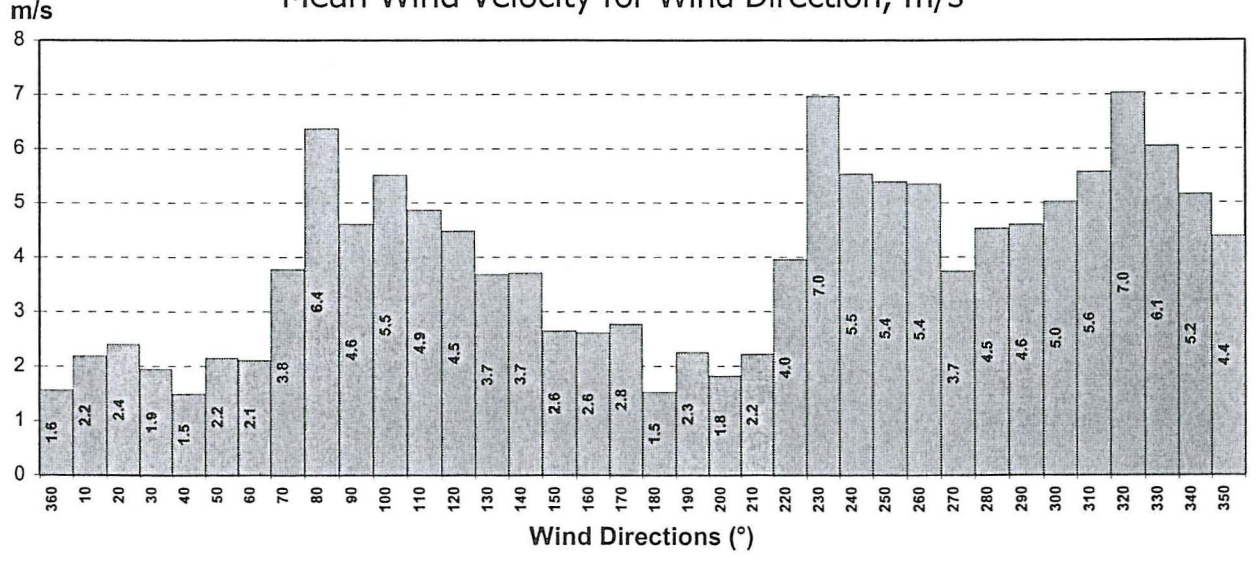
Frequency of Wind Directions (%)

Year, October 1993 - September 1995

Automatic station
144 observations per day
Observations used: 93590, 89.0%
Missing observations: 11530, 11.0%



Mean Wind Velocity for Wind Direction, m/s

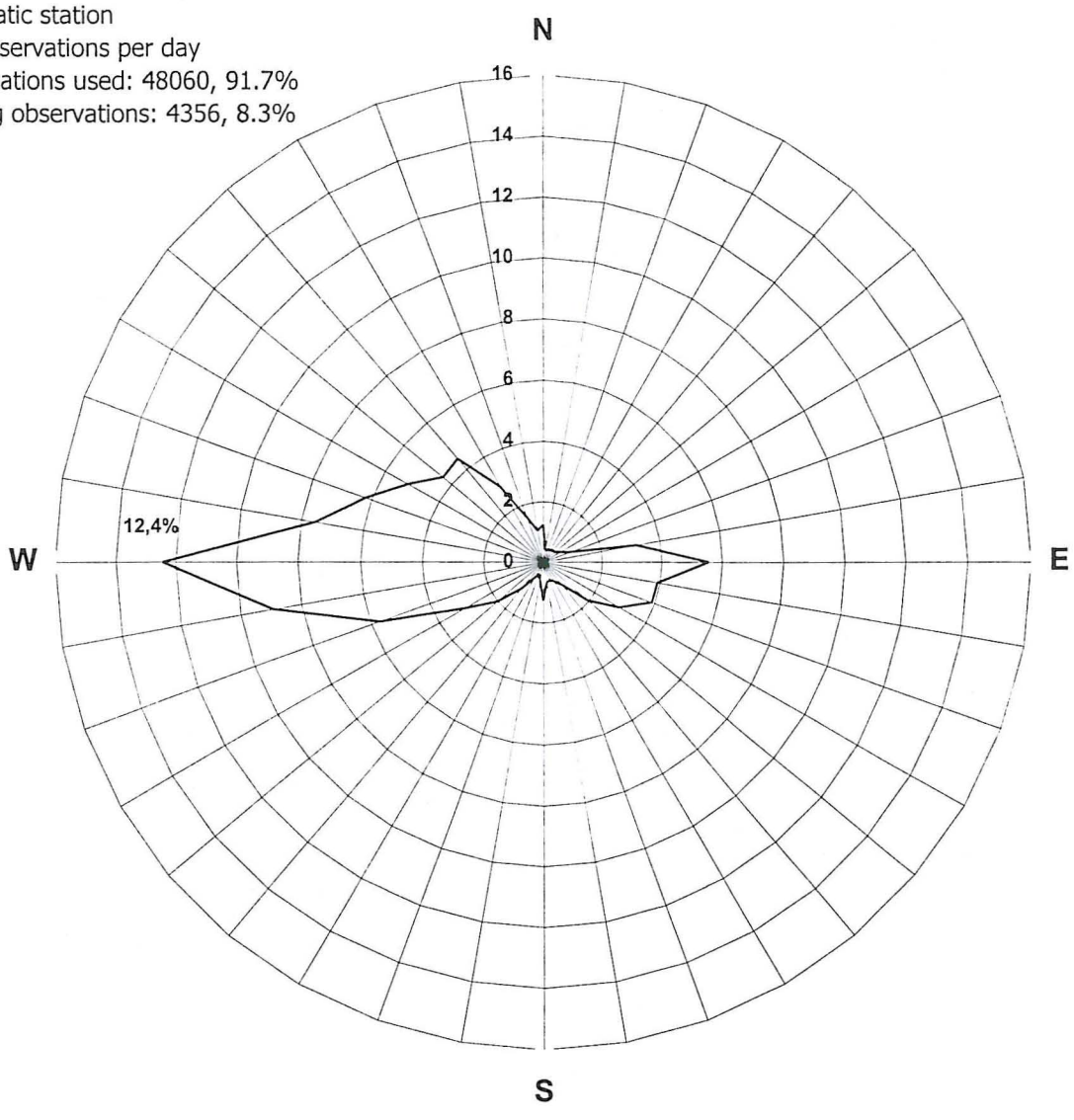


Annex 8

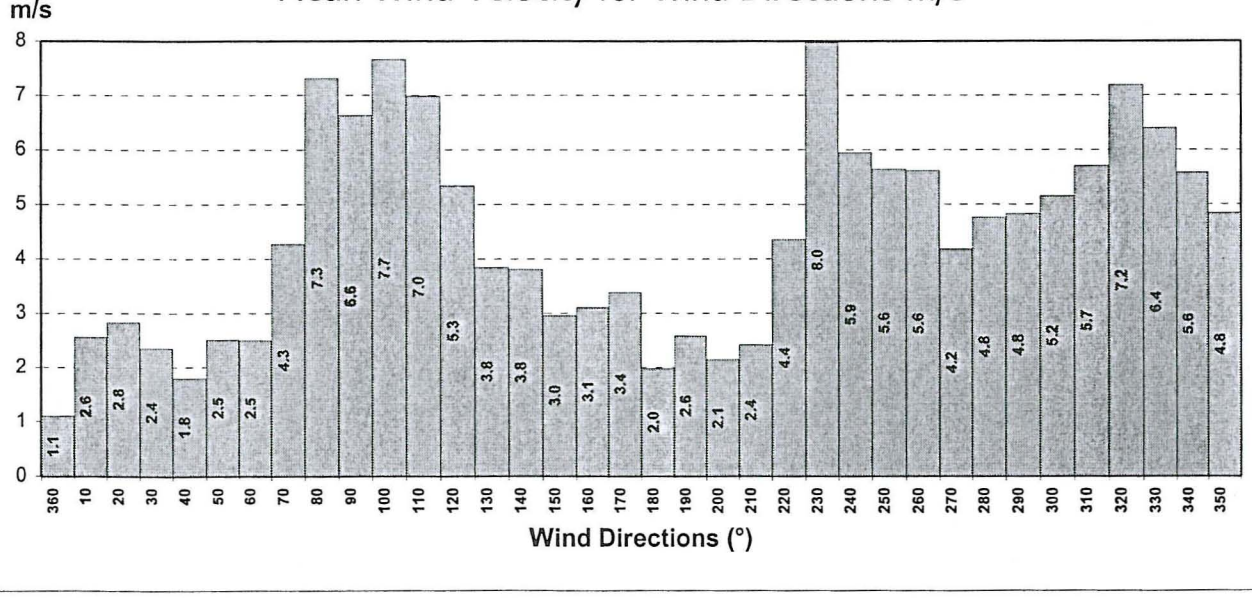
Frequency of Wind Directions (%)

Autumn and Winter, October - March, 1993-1994 and 1994-1995

Automatic station
144 observations per day
Observations used: 48060, 91.7%
Missing observations: 4356, 8.3%



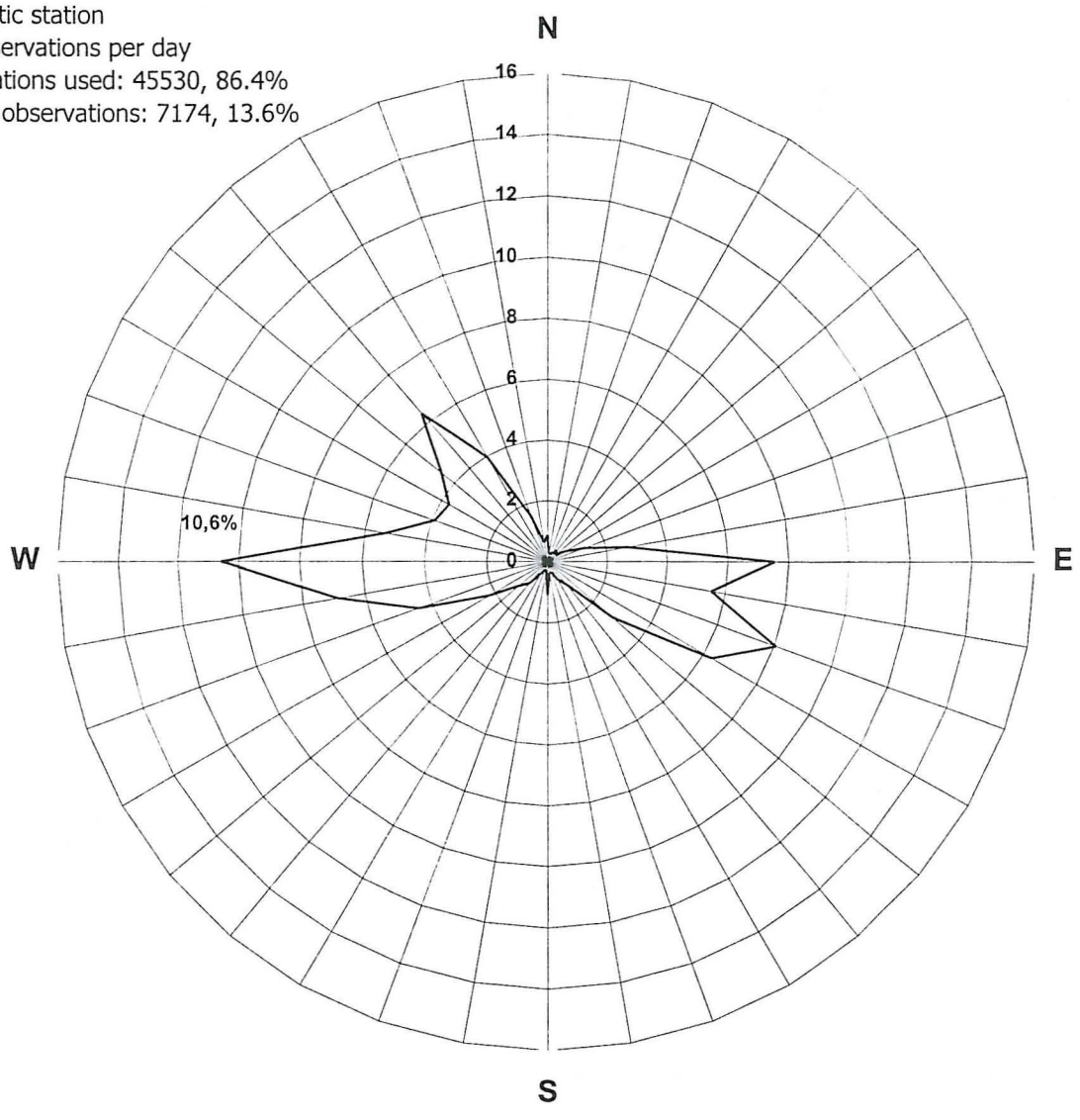
Mean Wind Velocity for Wind Directions m/s



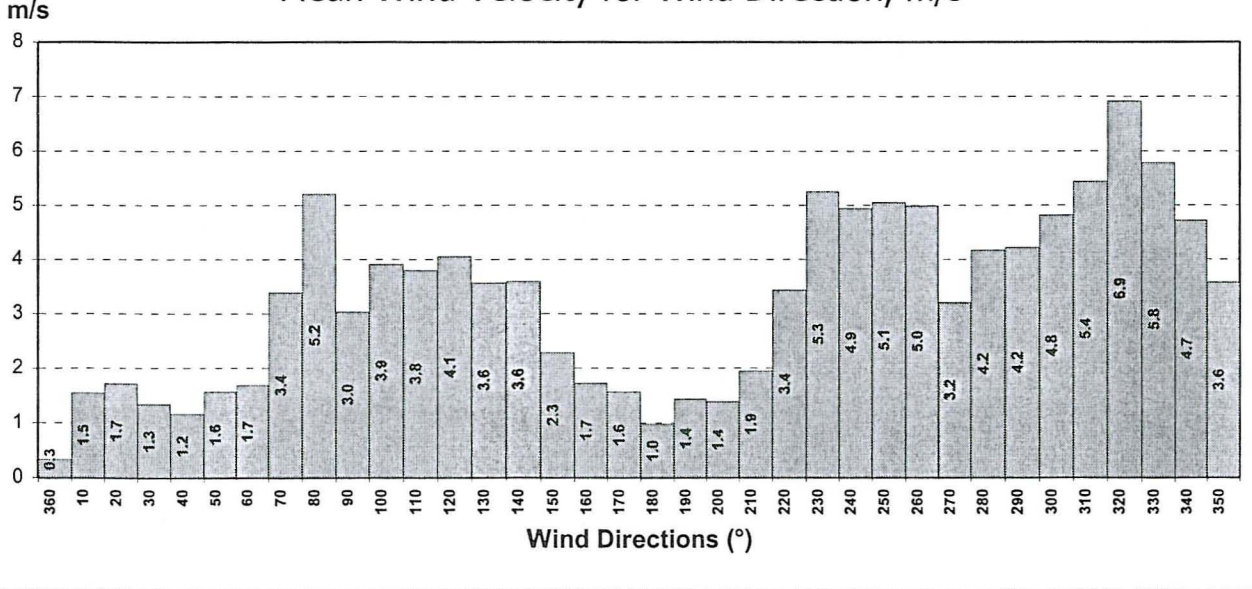
Frequency of Wind Directions (%)

Spring and summer, April - September, 1994 and 1995

Automatic station
144 observations per day
Observations used: 45530, 86.4%
Missing observations: 7174, 13.6%



Mean Wind Velocity for Wind Direction, m/s

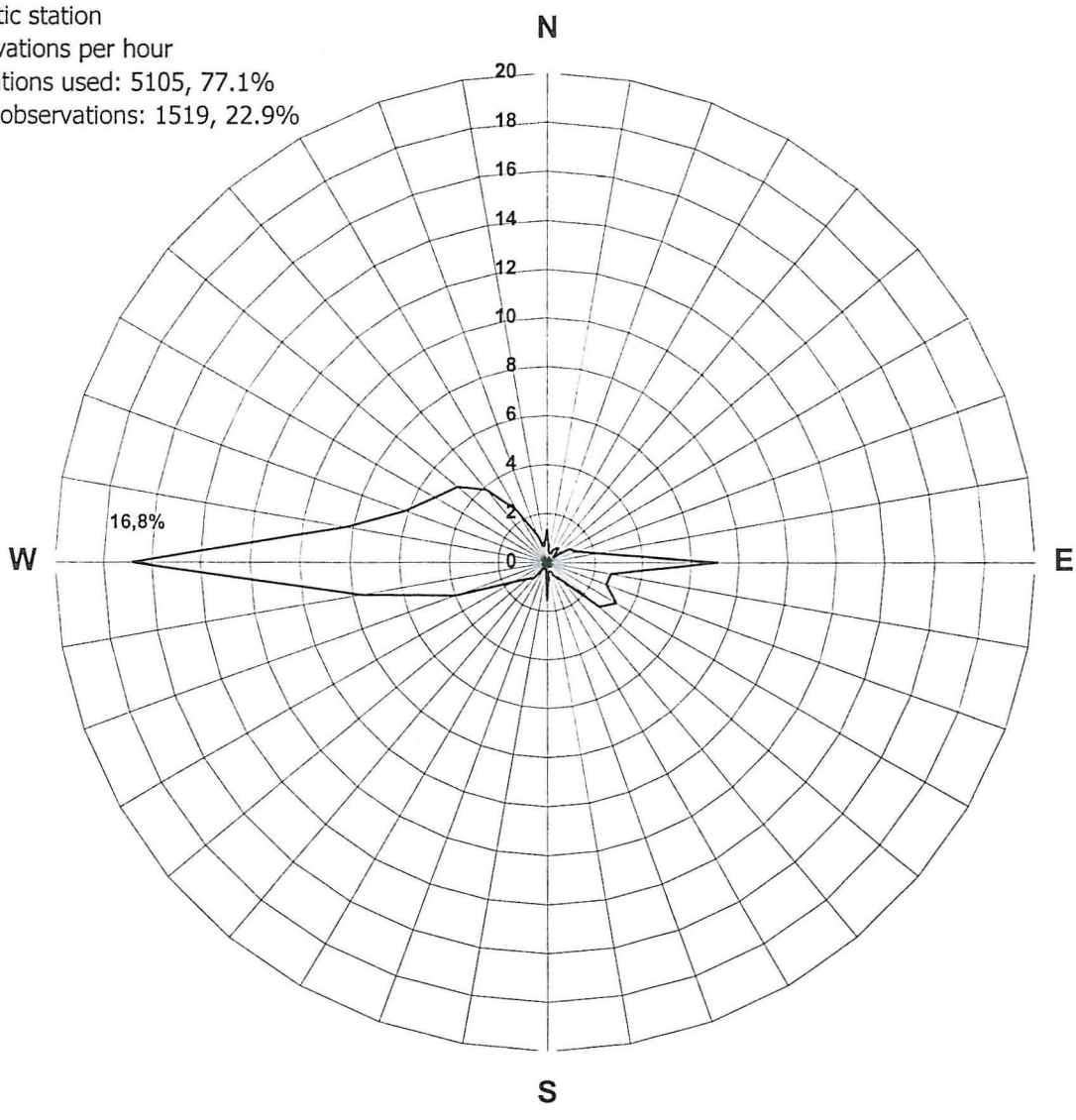


Leirur

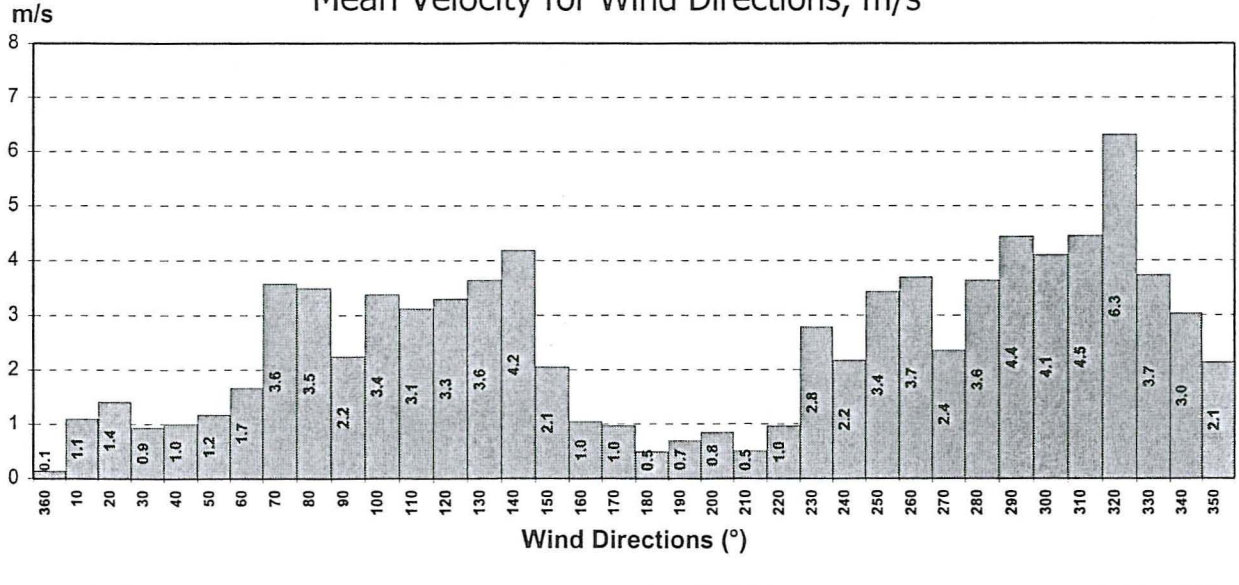
Frequency of Wind Directions (%)

High Summer, June - August 1994 and 1995, Night Hours 00-06 GMT

Automatic station
6 observations per hour
Observations used: 5105, 77.1%
Missing observations: 1519, 22.9%



Mean Velocity for Wind Directions, m/s



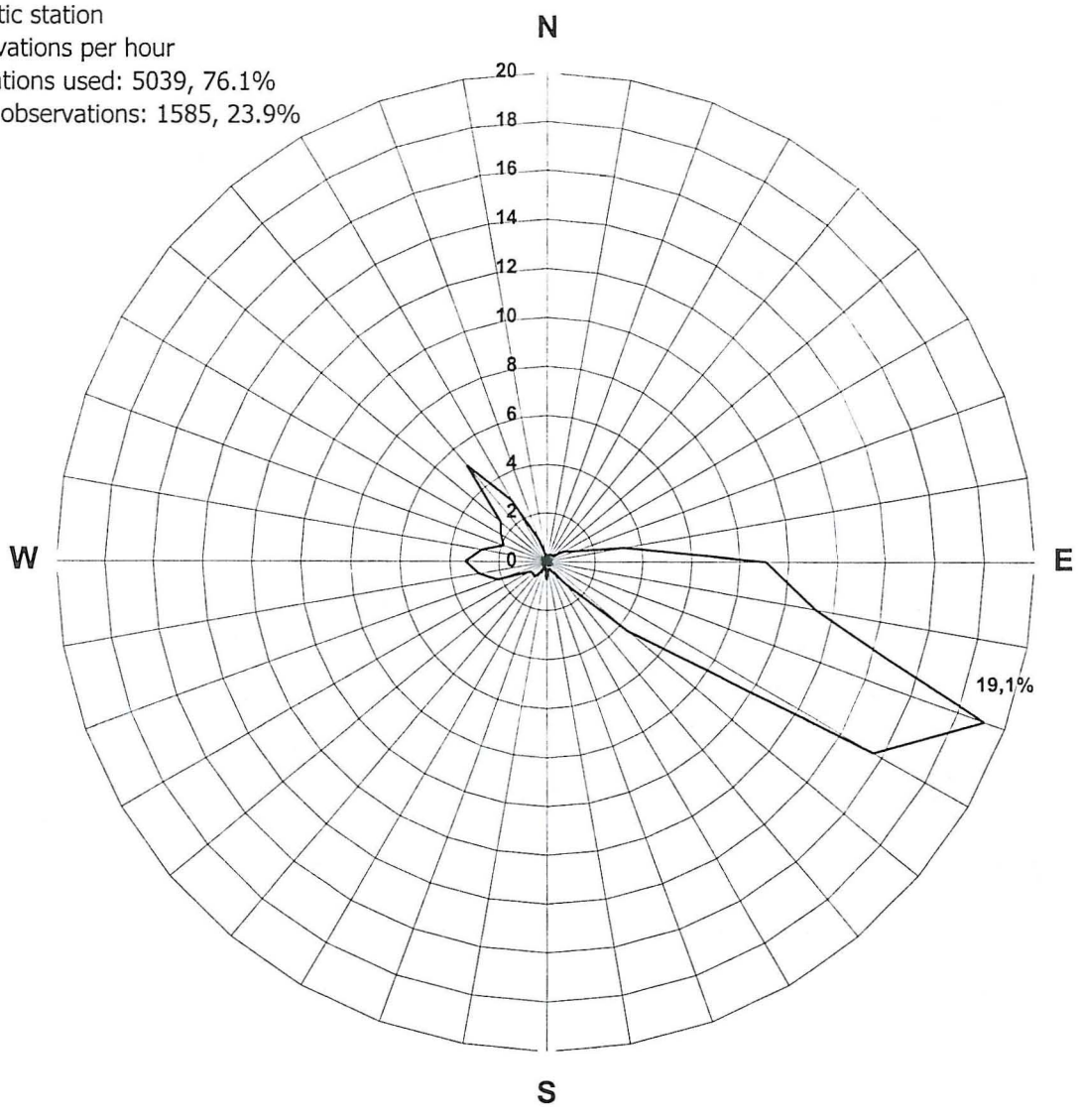
Annex 11

Leirur

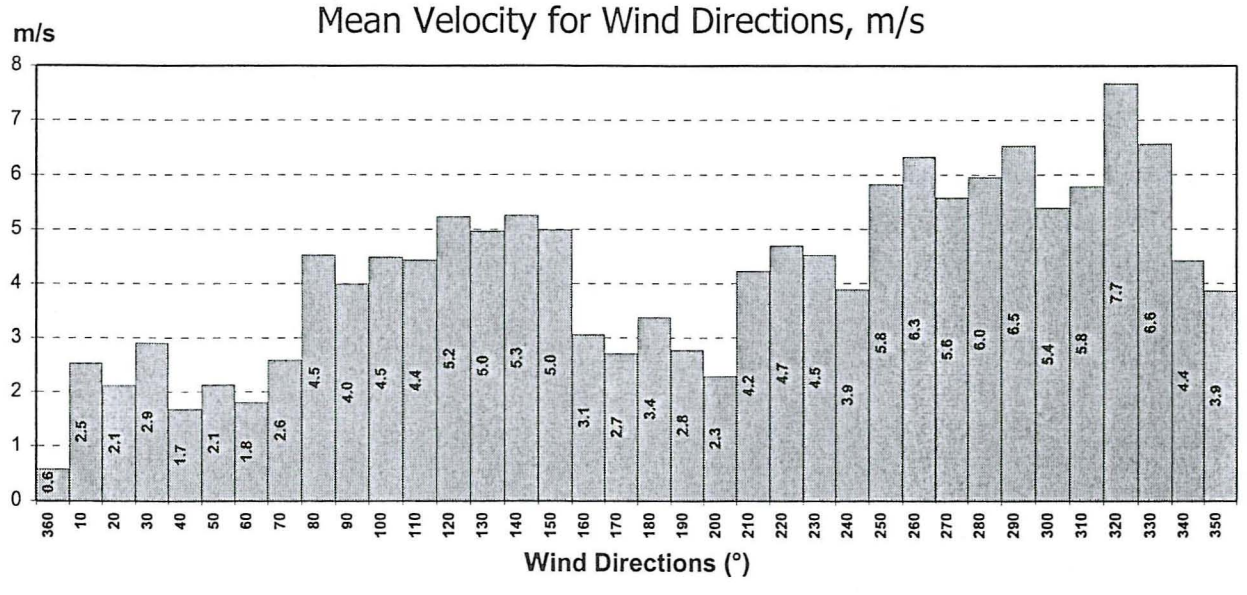
Frequency of Wind Directions (%)

High Summer, June - August 1994 and 1995, Day Hours 12-18 GMT

Automatic station
6 observations per hour
Observations used: 5039, 76.1%
Missing observations: 1585, 23.9%

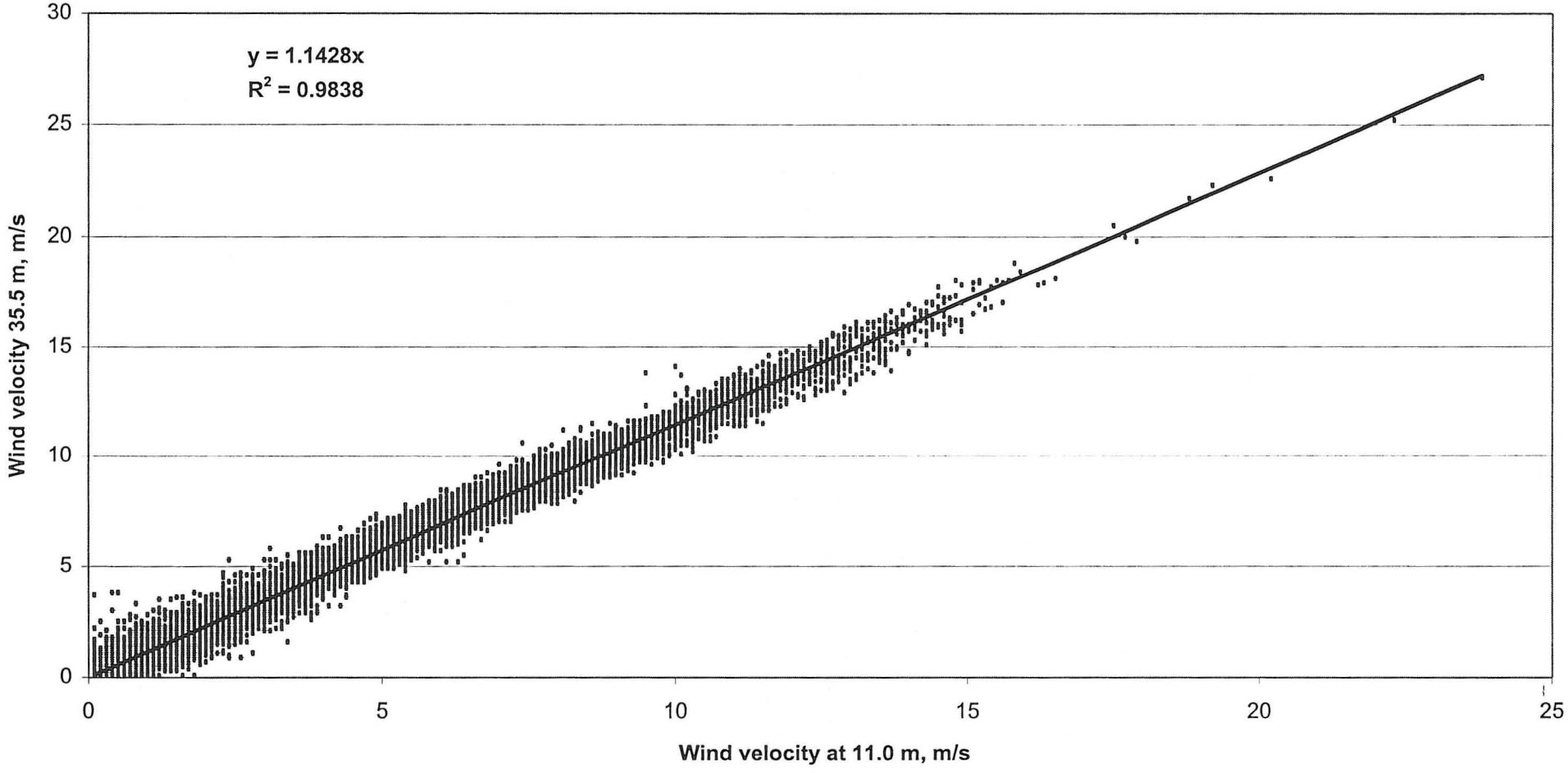


Mean Velocity for Wind Directions, m/s



Annex 12

Leirur
Comparison of Wind Velocity at 11.0 m and 35.5 m
July-December 1993



Annex 13