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## Wind and stability observations in the Húsavík area October 2003 - September 2004

Report prepared for Fjárfestingarstofan - orkusvið

# Wind and Stability Observations in the Húsavík Area, October 2003 - September 2004

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## 1. Introduction

In accordance with a contract between the Invest in Iceland Agency – Energy Marketing and the Icelandic Meteorological Office three automatic weather stations were established in the Húsavík area on 13 September 2002. The stations were to be operated to the end of September 2003. The purpose was to provide meteorological data for dispersion calculations for a possible industrial plant in the Húsavík area. An extension of the contract to continue the measurements until end of September 2004 was signed in 2004. This report is describing the results for the period October 2003 – September 2004 and is a continuation of the report from last year, see ref. 2.

Stations for observing wind direction, wind velocity and temperature were to be located at Bakkahöfði north of Húsavík and at Gvendarbás south of Húsavík. The third station should only measure temperature at Skjólbrekka, a ridge extending northwest from Húsavíkurfjall, at approx. 195 meter height above mean sea level.

The Icelandic Meteorological Office also operates an automatic weather station on the outskirts of Húsavík town.

Data from all the above mentioned stations are reported in the present report. Some information on climate, avalanches, earthquakes and sea ice can be found in the report: Húsavík. Náttúrufar og minjar [Ref 3] (in Icelandic).

## 2. Observation Sites and Instrumentation

The observation sites in the Húsavík area are shown by red filled circles on the map in Fig. 1. The former observation site Héðinshöfði (see Ref. 1) is shown by a blue filled circle on the map.

For air temperature observations a platinum resistance thermometer Logan 100PRT with a 6-plate Gill radiation shield is used at all the stations. At Bakkahöfði, Gvendarbás and Húsavík a Wind Monitor-MA 05106-5, Marine Model, from R.M. Young is in use for observations of wind direction and wind velocity.

At all 4 stations a Measurement and Control Module CR10X from Campbell Scientific, Inc. is used for collecting, storing and transmitting data to the Meteorological Office in Reykjavík. The data are registered every 10 min. The stations Bakkahöfði, Gvendarbás and Húsavíkurfjall are powered by a solar-panel and the data are transmitted over a GSM communication module. At Húsavík the station is powered from the electricity mains and the data are transmitted over a public telephone line.

At the time of installation no corrections were found necessary for the Logan thermometers used in this report. During a test on 12 September 2003 this was still found to be the case at Bakkahöfði, Gvendarbás and Húsavíkurfjall. For all 4 stations the thermometer corrections are believed to be less than  $\pm 0.1^\circ\text{C}$ .



Fig. 1. The automatic stations in the Húsavík area are shown by red filled circles. From north to south Bakkahöfði, Húsavíkurfjall, Húsavík and Gvendarbás. Former station Héðinshöfði is indicated by a blue filled circle. ©Landmælingar Íslands, leyfi L04030011.

## **Bakkahöfði**

The location of the station is 66° 04.6' N, 17° 21.7' W, elevation 15 m a.m.s.l. Height of anemometer above ground is 10.0 m. and of thermometer 2.1 m. A Vaisala temperature and relative humidity sensor HMP45A is also installed at 2.1 m above the ground, but is not used in this report.

## **Gvendarbás**

The location of the station is 66° 01.4' N, 17° 22.8' W, station elevation 16 m a.m.s.l. Height of anemometer above ground is 10.0 m and of thermometer 2.1 m.

## **Húsavíkurfjall**

The station is located on top of Skjólbrekka a ridge extending northwest from the mountain Húsavíkurfjall. Station location is 66° 03.2' N, 17° 19.2' W, elevation 194 m. The only instrument in use is the platinum resistance thermometer at 2.0 m above ground.

## **Húsavík**

The Húsavík station location is 66° 02.5' N, 17° 19.7' W, elevation 28 m a.m.s.l. The height of the anemometer is 10.4 m above ground and of the thermometer 2.0 m. The station is also provided with a Vaisala HMP45A temperature and humidity sensor, and a Vaisala PTB101B barometer is installed at 29.8 m above mean sea level, but these instruments are not used in this report.

# **3. Wind Observations in the Húsavík Area**

## **3.1 Data acquisition**

For Bakkahöfði only 2 out of 52704 wind observations were missing. The received observations are of good quality.

For Gvendarbás all wind observations were received but for the period May – August the wind speed measurement was faulty (giving far too low wind speed) and henceforth to high percentage of calm weather. The faulty anemometer was replaced 1. September 2004. Windroses, figures and tables including direction data for the summer months from Gvendarbás should therefore be interpreted with care, but they are presented here.

For the Húsavík station 4 observations are missing and the received observations are of good quality.

## **3.2 Frequency of Wind Directions**

The percentage frequency of the wind directions at Bakkahöfði is presented in Table 1 for each of the months October 2003 - September 2004 as well as in the form of wind roses in Annexes 1-3. Mean frequencies for the whole 12 month period, for the 6

month autumn and winter period, October-March, for the 6 month spring and summer period, April-September, and for the high summer period, June-August, are presented in Annex 4. Night and day values for the high summer period are shown in Annex 5. The percentage frequency of the wind directions at Gvendarbás is similarly presented in Table 2 and Annexes 6-10, and for Húsavík in Table 3 and Annexes 11- 15. Calm is in Tables 1-3 and elsewhere in this report defined as a 10-minute average wind speed below or equal to 0.2 m/s. Bold letters in the tables indicate the highest value for each month.

Table 1. Percentage frequency of wind directions at Bakkahöfði, October 2003 - September 2004

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Year
<b>N</b>	<b>360</b>	2.5	3.5	5.2	4.0	2.0	1.5	6.3	<b>9.6</b>	<b>11.1</b>	<b>11.6</b>	<b>7.5</b>	2.4	5.6
	<b>10</b>	2.1	2.2	5.9	4.8	2.0	2.3	6.3	7.6	9.1	8.0	4.7	3.8	4.9
	<b>20</b>	2.7	1.9	3.8	3.7	2.6	1.8	5.9	4.7	6.3	6.6	4.4	5.0	4.1
	<b>30</b>	2.2	2.4	2.8	2.8	2.3	2.1	5.3	2.8	5.8	4.3	4.6	4.7	3.5
	<b>40</b>	3.7	2.3	3.4	4.1	2.1	3.1	3.6	1.3	5.0	2.6	3.7	2.2	3.1
	<b>50</b>	2.6	1.5	3.4	2.6	1.4	1.7	2.7	1.3	4.8	3.4	3.7	3.1	2.7
	<b>60</b>	1.1	0.8	1.8	1.5	1.2	1.1	3.0	0.8	2.6	1.9	2.4	2.8	1.8
	<b>70</b>	1.6	0.7	1.3	1.0	0.3	1.4	1.7	0.6	1.5	1.1	1.2	1.6	1.2
	<b>80</b>	1.1	0.6	0.7	0.9	0.4	1.1	1.5	0.7	0.7	1.2	1.0	1.6	1.0
<b>E</b>	<b>90</b>	1.1	0.9	0.9	1.3	0.5	1.2	1.3	0.7	0.7	1.3	1.1	1.8	1.1
	<b>100</b>	1.3	1.1	1.2	1.5	0.5	0.9	1.4	1.0	0.7	0.8	0.9	0.6	1.0
	<b>110</b>	1.2	1.0	0.9	1.2	0.5	0.9	0.7	1.7	1.0	0.8	1.3	0.9	1.0
	<b>120</b>	1.5	1.0	1.0	1.5	0.9	1.0	0.6	2.3	1.4	1.0	0.9	1.7	1.2
	<b>130</b>	1.3	2.1	1.1	1.4	1.7	2.3	0.9	2.2	2.2	1.1	1.3	2.3	1.7
	<b>140</b>	1.0	1.8	1.7	1.6	1.1	3.3	1.9	1.8	3.3	2.7	0.7	1.2	1.8
	<b>150</b>	1.4	2.4	2.2	1.7	2.0	3.7	3.5	1.7	1.6	1.6	2.0	2.8	2.2
	<b>160</b>	4.1	7.2	6.9	7.1	9.0	8.4	<b>7.5</b>	2.3	2.3	3.0	4.8	7.6	5.8
	<b>170</b>	12.9	<b>12.5</b>	<b>12.3</b>	<b>11.8</b>	<b>16.5</b>	<b>11.8</b>	6.4	3.4	3.3	4.7	6.6	<b>8.9</b>	<b>9.2</b>
<b>S</b>	<b>180</b>	<b>16.1</b>	<b>12.5</b>	11.0	9.6	14.5	9.6	4.8	3.8	4.5	5.1	6.1	8.8	8.8
	<b>190</b>	11.4	11.8	8.1	7.2	8.6	6.3	2.7	3.2	3.6	4.4	6.1	5.6	6.6
	<b>200</b>	6.2	8.1	4.5	3.7	5.0	5.6	2.3	3.2	2.7	3.4	4.5	4.1	4.4
	<b>210</b>	2.6	3.1	1.9	1.6	2.5	3.2	1.3	2.3	1.9	2.2	2.7	2.4	2.3
	<b>220</b>	1.3	0.8	1.6	0.8	1.2	1.4	0.6	1.5	1.0	1.0	1.4	1.0	1.1
	<b>230</b>	0.5	0.4	0.4	0.6	0.7	1.0	0.4	1.1	0.9	0.6	1.3	0.6	0.7
	<b>240</b>	0.3	0.3	0.6	0.6	1.0	2.3	0.4	0.7	0.5	0.5	0.8	0.4	0.7
	<b>250</b>	0.4	0.3	0.5	0.4	1.4	2.5	0.3	0.6	0.4	0.4	0.4	0.6	0.7
	<b>260</b>	0.1	0.2	0.2	0.3	0.7	1.2	0.4	0.6	0.5	0.4	0.5	0.5	0.4
<b>W</b>	<b>270</b>	0.2	0.2	0.2	0.5	0.4	0.4	0.3	0.9	0.3	0.2	0.6	0.3	0.4
	<b>280</b>	0.3	0.2	0.3	0.5	0.7	0.4	0.4	0.6	0.4	0.2	0.5	0.7	0.4
	<b>290</b>	0.3	0.7	0.6	0.5	1.3	1.1	0.4	1.6	0.4	0.4	0.4	1.5	0.8
	<b>300</b>	0.5	0.7	0.7	0.9	0.8	1.8	1.7	2.8	0.5	1.8	0.7	3.4	1.4
	<b>310</b>	0.9	1.1	0.8	1.2	1.1	3.0	5.9	3.5	2.0	2.6	2.3	4.6	2.4
	<b>320</b>	2.8	1.6	1.2	1.6	1.8	4.5	4.1	5.3	2.4	3.2	2.9	3.0	2.9
	<b>330</b>	4.5	2.3	1.9	3.3	2.3	2.1	3.1	7.7	3.0	3.6	3.7	2.7	3.4
	<b>340</b>	3.2	5.0	3.6	6.8	3.8	1.7	3.6	5.9	4.2	4.1	3.9	2.1	4.0
	<b>350</b>	2.2	4.3	5.1	4.7	5.0	1.7	5.7	6.3	6.1	6.5	6.7	1.8	4.7
<b>Calm:</b>		0.7	0.4	0.3	0.6	0.3	0.5	1.2	2.0	1.3	1.5	1.6	0.9	1.0

As seen in Tables 1-3 and the wind roses in Annexes 1-15 the frequency of the wind directions are variable from month to month, from winter to summer, from night to day during the summer, and to some extent from station to station.

For the year as a whole southerly winds are most common at Bakkahöfði, south-southeasterly winds at Gvendarbás and southeasterly winds at Húsavík station. This difference between the stations is largely explained by the contours of the land.

During the winter half of the year as well as during summer nights, winds blowing from the colder land towards the warmer sea are dominating. Southerly winds have then the highest frequency at Bakkahöfði, south-southeasterly winds at Gvendarbás and southeasterly winds at Húsavík.

During daytime in summer the land is usually warmer than the sea and northerly sea breeze is then dominating at Bakkahöfði and Gvendarbás while winds between northwest and north are most common at Húsavík.

Table 2. Percentage frequency of wind directions at Gvendarbás,  
October 2003 - September 2004

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Year
<b>N</b>	<b>360</b>	2.8	4.0	5.5	4.7	2.5	1.9	7.1	9.4	13.3	13.4	9.0	3.8	6.5
	<b>10</b>	1.7	2.7	4.1	4.1	1.8	2.4	7.8	6.9	6.9	5.8	6.0	5.5	4.6
	<b>20</b>	1.9	1.9	4.3	4.5	2.9	2.1	7.0	4.2	4.7	3.5	3.2	5.4	3.8
	<b>30</b>	1.8	2.3	3.7	1.9	1.8	1.4	3.9	1.9	2.3	1.3	2.0	1.9	2.2
	<b>40</b>	2.7	1.4	3.2	2.6	1.1	1.9	1.8	0.7	1.3	0.9	1.1	1.3	1.7
	<b>50</b>	1.9	0.7	2.2	2.7	1.1	0.8	1.1	0.5	1.2	0.6	0.8	0.8	1.2
	<b>60</b>	1.6	0.6	1.7	1.6	0.5	0.4	1.1	0.3	1.2	0.4	1.1	0.9	1.0
	<b>70</b>	0.8	0.4	0.7	1.3	0.3	0.4	1.1	0.4	1.1	0.1	0.7	1.5	0.7
	<b>80</b>	0.8	0.6	0.4	1.1	0.3	0.6	1.1	0.6	1.3	0.5	0.6	1.8	0.8
<b>E</b>	<b>90</b>	0.7	0.6	0.7	0.7	0.3	0.8	1.0	0.6	0.9	0.2	0.5	1.9	0.7
	<b>100</b>	0.8	0.4	0.3	1.0	0.6	1.1	1.4	0.7	0.6	0.4	0.4	2.0	0.8
	<b>110</b>	1.2	0.7	0.8	1.0	1.0	1.1	1.2	2.3	1.3	0.5	0.4	1.3	1.1
	<b>120</b>	1.7	1.9	1.0	1.3	1.5	2.1	1.0	3.6	1.6	1.2	0.5	2.8	1.7
	<b>130</b>	2.1	2.0	2.1	1.4	1.6	4.5	2.3	2.9	2.6	1.7	1.4	2.5	2.3
	<b>140</b>	5.6	5.6	5.6	5.3	4.4	6.2	3.1	2.7	4.1	2.5	3.5	4.3	4.4
	<b>150</b>	12.9	15.7	11.4	12.3	15.3	10.2	7.2	3.5	3.9	3.3	5.2	8.9	9.1
	<b>160</b>	11.8	12.5	11.9	10.3	14.3	11.4	7.1	2.5	3.1	3.4	5.3	7.8	8.4
	<b>170</b>	8.5	9.0	7.3	8.3	9.4	8.2	4.5	2.6	3.1	2.9	4.6	6.9	6.2
<b>S</b>	<b>180</b>	7.4	7.1	5.4	5.7	5.8	6.2	2.9	2.1	2.8	2.8	3.5	4.7	4.7
	<b>190</b>	6.0	5.2	4.8	3.2	5.2	5.5	3.1	1.7	2.3	3.6	3.9	4.4	4.1
	<b>200</b>	3.2	3.8	2.9	1.8	3.8	3.7	1.5	1.2	1.5	2.3	2.6	3.1	2.6
	<b>210</b>	1.9	2.3	1.9	0.9	2.6	2.4	1.6	1.5	1.3	1.3	1.9	2.2	1.8
	<b>220</b>	1.9	1.1	1.4	0.9	2.2	1.4	0.7	1.0	1.1	0.7	1.0	1.4	1.2
	<b>230</b>	0.7	0.5	1.0	0.3	0.8	1.1	0.7	0.9	0.9	0.3	0.6	0.6	0.7
	<b>240</b>	0.5	0.4	0.4	0.4	0.6	0.9	0.5	0.5	0.3	0.1	0.4	0.3	0.4
	<b>250</b>	0.7	0.3	0.2	0.2	0.3	1.0	0.6	0.7	0.4	0.0	0.1	0.3	0.4
	<b>260</b>	0.5	0.3	0.4	0.3	0.7	1.0	0.2	0.4	0.4	0.2	0.2	0.3	0.4
<b>W</b>	<b>270</b>	0.5	0.2	0.3	0.6	0.5	1.4	0.4	0.5	0.5	0.1	0.2	0.5	0.5
	<b>280</b>	0.3	0.2	0.7	0.5	0.6	0.9	0.3	0.8	0.6	0.1	0.4	0.5	0.5
	<b>290</b>	0.2	0.2	0.5	0.5	0.7	0.5	0.5	0.9	0.8	0.3	0.2	0.5	0.5
	<b>300</b>	0.3	0.8	0.6	0.7	0.8	0.2	0.9	1.6	0.9	0.2	0.4	0.6	0.7
	<b>310</b>	0.6	1.3	0.8	1.0	1.0	1.3	1.0	2.6	1.2	0.4	0.8	1.9	1.2
	<b>320</b>	1.4	0.9	1.4	1.4	1.6	4.4	3.8	4.9	2.0	1.6	1.5	5.3	2.5
	<b>330</b>	3.9	2.0	1.3	2.3	1.8	5.0	6.1	8.4	3.1	3.8	2.5	3.8	3.7
	<b>340</b>	4.5	4.1	2.8	6.0	4.0	2.9	5.0	9.1	5.3	5.2	4.3	2.7	4.7
	<b>350</b>	2.9	5.4	5.4	5.8	5.8	2.4	7.4	8.9	10.7	10.5	7.6	3.1	6.3
<b>Calm:</b>		1.4	1.0	1.1	1.5	0.4	0.5	1.8	5.9	9.5	23.7	21.6	2.6	6.0



Table 3. Percentage frequency of wind directions at Húsavík,  
October 2003 - September 2004

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Year
<b>N</b>	<b>360</b>	2.1	4.0	4.1	4.2	1.6	1.5	4.4	5.8	3.8	5.6	3.5	2.3	3.6
	<b>10</b>	2.0	2.7	3.6	4.0	2.6	1.5	4.5	3.7	4.3	4.7	3.0	2.9	3.3
	<b>20</b>	1.2	1.9	2.8	4.2	1.6	1.4	4.2	3.1	5.4	3.3	2.7	2.7	2.9
	<b>30</b>	1.7	2.3	2.9	3.3	1.0	1.8	3.0	2.0	2.4	1.5	1.8	1.5	2.1
	<b>40</b>	1.3	1.4	3.0	0.6	0.4	1.1	1.9	1.0	1.7	0.9	1.1	1.0	1.3
	<b>50</b>	1.2	0.7	1.5	0.9	0.1	0.7	1.7	0.7	1.2	0.5	1.3	0.7	0.9
	<b>60</b>	0.8	0.6	0.8	0.4	0.2	0.4	0.6	0.2	1.1	0.4	0.4	0.7	0.6
	<b>70</b>	1.0	0.4	0.3	0.4	0.3	0.5	0.8	0.5	1.3	0.5	0.8	0.7	0.6
	<b>80</b>	1.0	0.6	0.9	0.7	0.5	0.8	1.5	0.8	1.1	0.7	1.0	0.4	0.8
<b>E</b>	<b>90</b>	1.4	0.6	0.9	0.7	1.3	0.8	1.0	0.6	1.3	0.9	1.1	0.9	1.0
	<b>100</b>	3.4	0.4	2.8	2.4	2.1	2.1	1.9	1.7	1.7	1.7	2.1	3.1	2.1
	<b>110</b>	11.9	0.7	8.2	8.2	8.2	5.2	3.9	4.7	3.3	3.4	4.0	6.8	5.7
	<b>120</b>	11.8	1.9	8.8	9.2	11.2	7.8	7.5	8.3	5.9	5.1	6.7	10.5	7.9
	<b>130</b>	10.4	2.0	10.4	10.0	13.1	15.3	12.1	8.0	8.6	9.6	9.3	13.1	10.1
	<b>140</b>	10.2	5.6	10.0	9.6	12.3	15.8	7.1	6.2	8.8	7.5	12.1	9.5	9.6
	<b>150</b>	6.6	15.7	6.1	6.7	8.2	6.7	3.4	2.4	3.6	3.0	3.6	4.6	5.9
	<b>160</b>	3.3	12.5	5.0	2.6	5.4	3.4	1.7	1.6	1.9	2.0	2.2	3.1	3.7
	<b>170</b>	2.5	9.0	2.7	1.1	3.5	2.4	1.2	0.9	1.1	2.0	1.9	1.7	2.5
<b>S</b>	<b>180</b>	1.5	7.1	1.5	0.6	1.8	1.9	0.8	0.8	1.0	1.9	1.1	0.9	1.7
	<b>190</b>	1.1	5.2	1.1	0.6	1.3	1.6	0.7	0.4	0.6	1.1	1.3	0.8	1.3
	<b>200</b>	0.9	3.8	0.8	0.3	0.6	1.3	0.8	0.4	0.8	1.0	0.8	0.7	1.0
	<b>210</b>	0.7	2.3	0.6	0.3	0.5	0.8	0.5	0.6	0.6	0.7	0.6	0.7	0.7
	<b>220</b>	0.6	1.1	0.6	0.2	0.6	0.8	0.6	0.4	0.4	0.6	0.6	0.6	0.6
	<b>230</b>	0.4	0.5	0.5	0.2	0.4	0.3	0.3	0.6	0.7	0.5	0.6	0.6	0.4
	<b>240</b>	0.7	0.4	0.3	0.2	0.3	0.4	0.5	0.6	0.6	0.5	0.5	0.6	0.5
	<b>250</b>	0.4	0.3	0.3	0.1	0.1	0.3	0.5	0.5	0.7	0.6	1.2	0.7	0.5
	<b>260</b>	0.2	0.3	0.3	0.3	0.1	0.5	0.7	0.8	1.1	0.9	1.4	0.9	0.6
<b>W</b>	<b>270</b>	0.3	0.2	0.3	0.3	0.3	1.0	0.7	1.3	1.6	1.0	2.3	0.9	0.9
	<b>280</b>	0.3	0.2	0.2	0.3	0.4	1.3	0.6	1.5	1.0	1.4	2.1	0.9	0.9
	<b>290</b>	0.4	0.2	0.2	0.6	0.6	1.5	0.7	1.6	1.4	1.4	2.2	0.9	1.0
	<b>300</b>	0.5	0.8	0.6	1.1	1.0	1.3	0.8	2.0	1.6	1.2	2.7	1.6	1.3
	<b>310</b>	0.4	1.3	1.1	1.6	1.3	2.0	1.5	3.2	2.3	1.9	2.6	3.3	1.9
	<b>320</b>	4.0	0.9	1.9	2.6	2.7	5.5	6.9	7.9	4.4	5.2	3.8	6.0	4.3
	<b>330</b>	5.4	2.0	2.3	6.0	4.5	4.8	5.9	10.2	5.3	6.9	4.9	5.0	5.3
	<b>340</b>	3.4	4.1	4.5	6.8	5.7	2.7	7.0	6.3	9.0	9.8	5.3	3.1	5.6
	<b>350</b>	2.8	5.4	6.1	5.2	3.3	1.5	6.4	6.5	6.9	7.1	4.4	4.1	5.0
<b>Calm:</b>		2.2	1.0	1.7	3.4	0.7	1.5	1.9	2.2	1.6	2.9	2.8	1.3	1.9

Annual variation of the percentage frequency of six selected wind directions is presented for Bakkahöfði in Fig. 2, for Gvendarbás in Fig. 3, and for Húsavík in Fig. 4, and similarly diurnal variation during the high summer months, June-August, is presented in Fig. 5, Fig. 6 and Fig. 7.

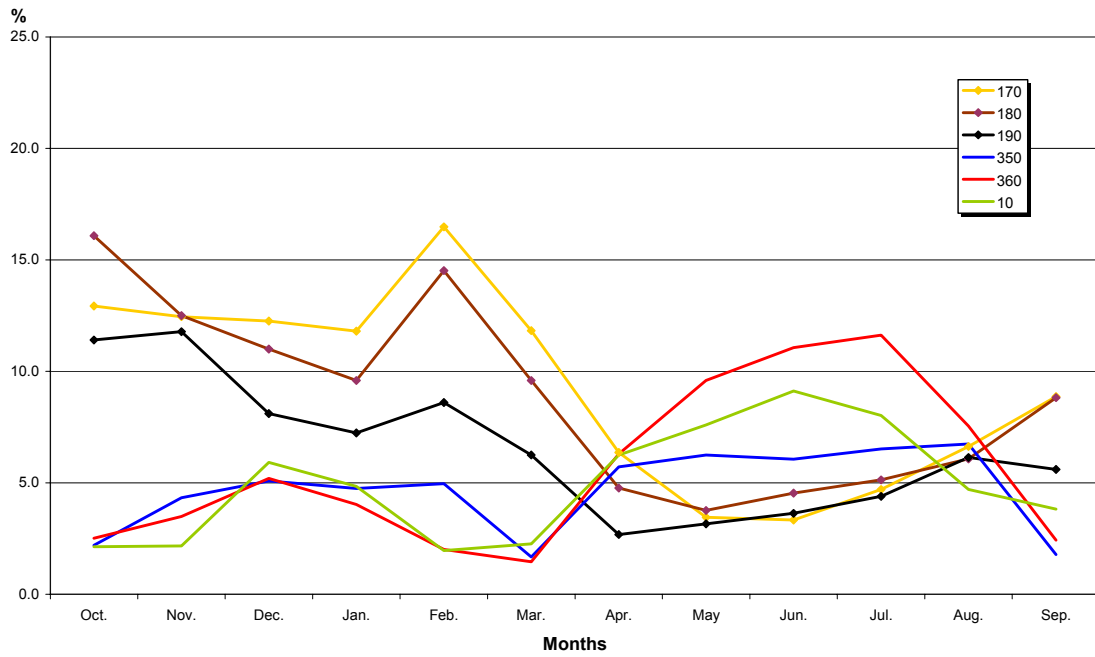


Fig. 2. Annual variation of percentage frequency of six selected wind directions, Bakkahöfði, October 2003 – September 2004.

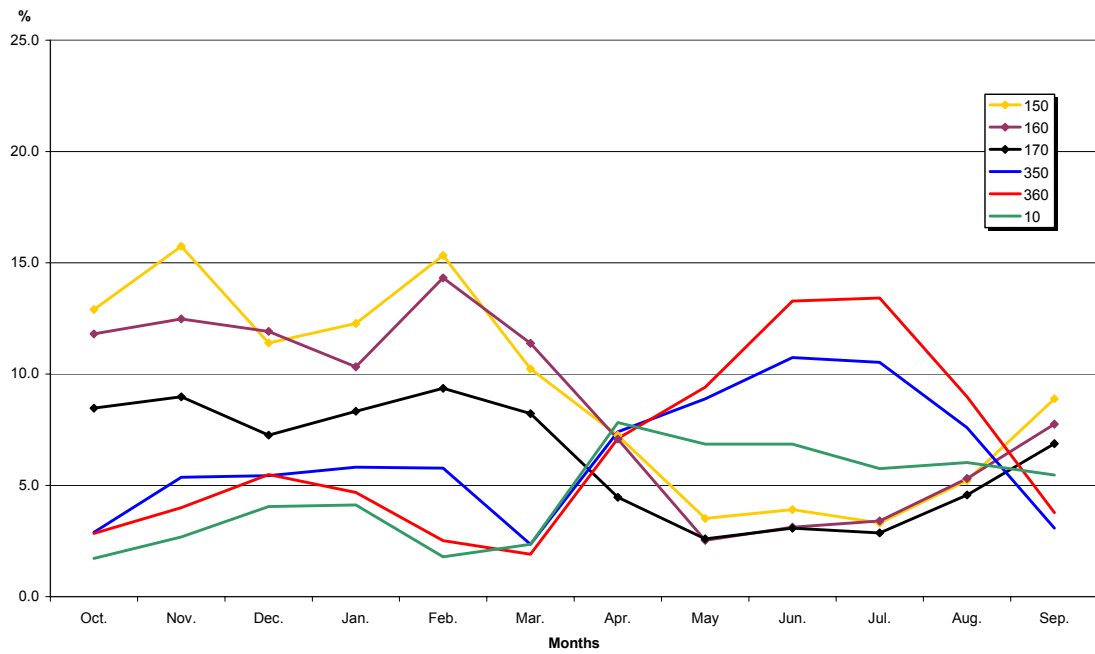


Fig.3. Annual variation of percentage frequency of six selected wind directions, Gvendarbás, October 2003 – September 2004.

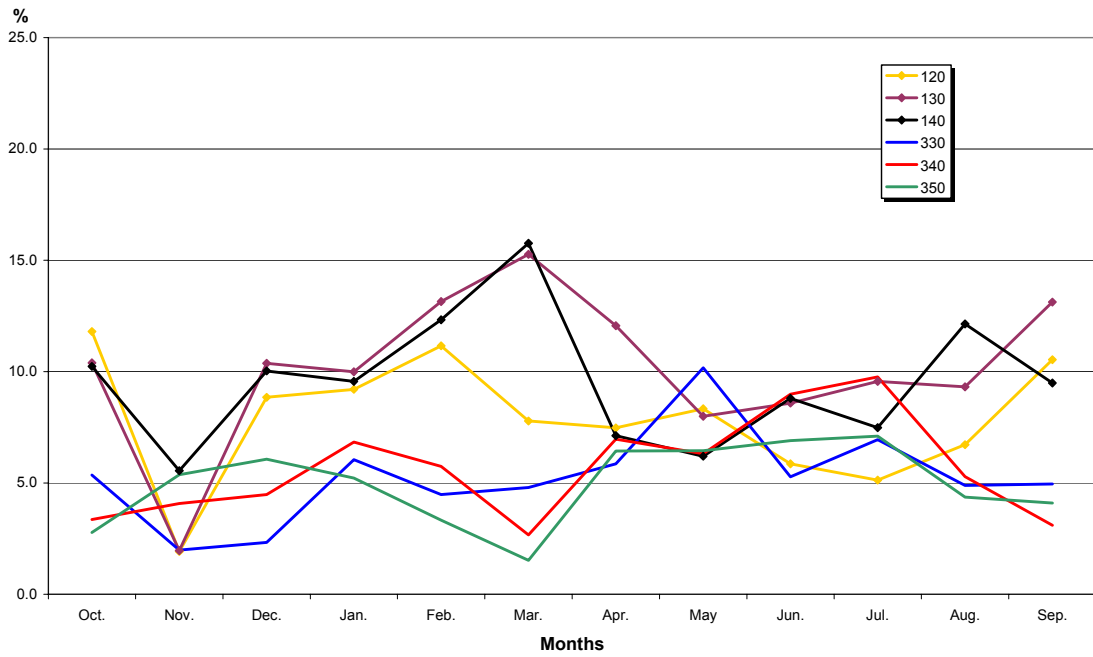


Fig. 4. Annual variation of percentage frequency of six selected wind directions, Húsavík, October 2003 – September 2004.

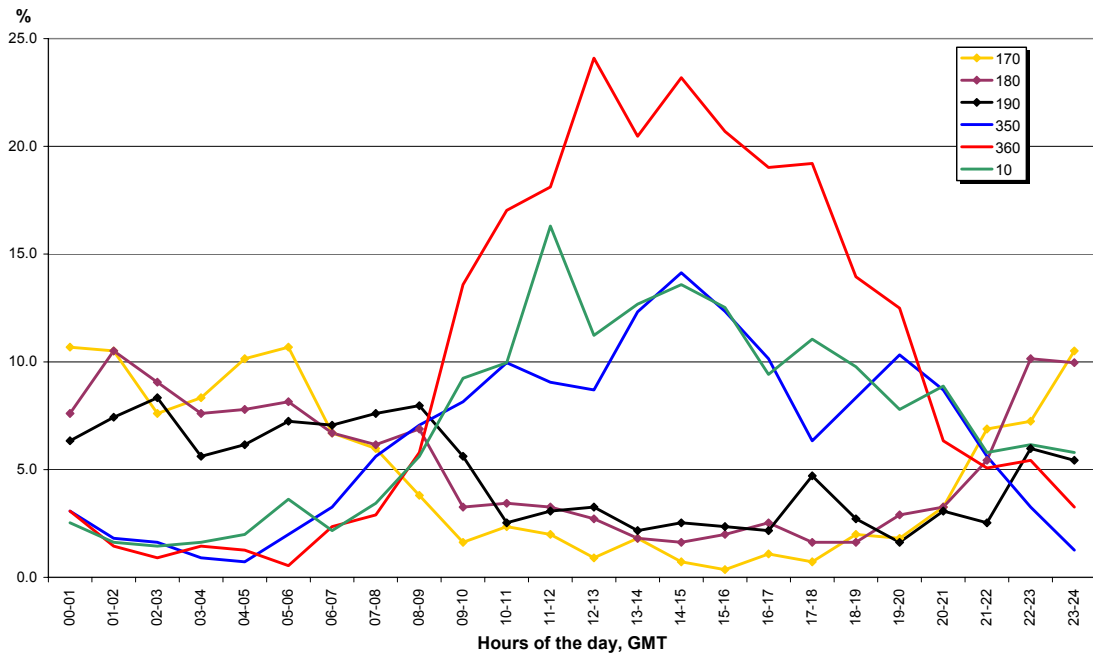


Fig. 5. Diurnal variation of percentage frequency of six selected wind directions, Bakkahöfði, June-August 2004.

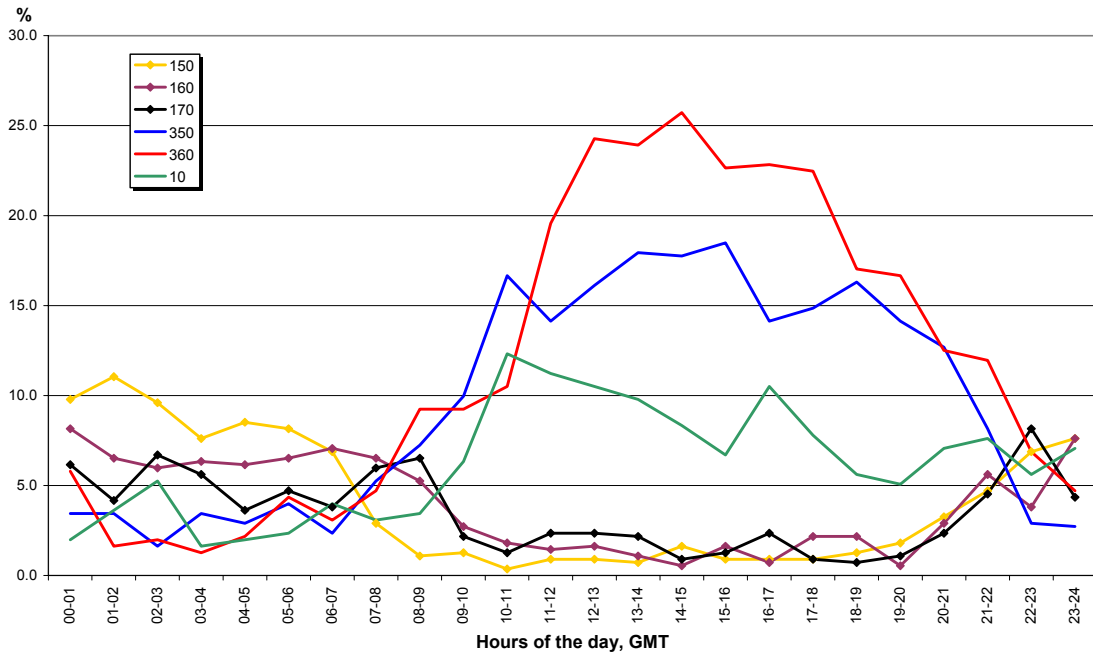


Fig. 6. Diurnal variation of percentage frequency of six selected wind directions, Gvendarbás, June-August 2004.

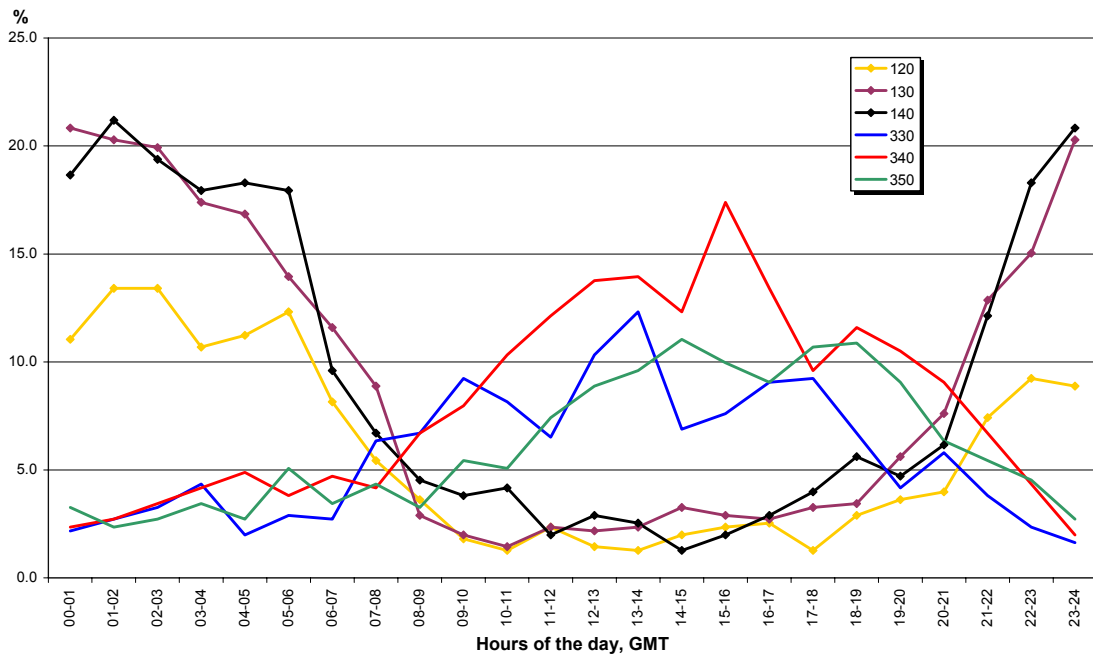


Fig. 7. Diurnal variation of percentage frequency of six selected wind directions, Húsavík, June-August 2004.

### 3.3 Wind Velocity

The average 10-minute wind velocity at Bakkahöfði, Gvendarbás and Húsavík for each month and for the twelve-month period October 2003 - September 2004 is listed in Table 4. Data for Gvendarbás are missing for the months May –August.

Table 4. Monthly average wind velocity at Bakkahöfði, Gvendarbás and Húsavík, October 2003 – September 2004

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Year
Bakkahöfði	6.9	6.6	7.5	8.0	9.2	7.7	6.3	5.7	4.5	4.7	3.8	6.0	6.4
Gvendarbás	6.4	6.2	7.2	7.8	8.9	7.5	6.2					5.8	
Húsavík	4.4	6.2	5.2	5.7	6.5	5.9	4.8	4.4	3.5	3.5	2.9	4.2	4.8

Percentage frequency of 10-minute wind velocity for selected velocity intervals is presented for Bakkahöfði in Table 5, for Gvendarbás in Table 6 and for Húsavík in Table 7.

Table 5. Percentage frequency of 10-minute wind velocity for selected velocity intervals at Bakkahöfði, Október 2003 – September 2004

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
Oct	3.7	7.5	8.3	9.1	12.0	40.6	37.3	16.5	5.4	0.3	
Nov	4.7	9.1	9.3	9.0	7.5	39.6	41.8	15.0	3.2	0.4	
Dec	2.9	6.3	6.3	5.5	7.2	28.2	44.3	24.2	3.2	0.1	
Jan	3.2	8.7	9.8	6.8	5.6	34.1	35.8	17.7	8.6	3.8	
Feb	1.3	2.9	2.4	3.4	5.0	15.0	45.5	28.4	10.3	0.8	
Mar	2.9	5.4	6.1	7.1	8.1	29.7	40.4	24.8	4.0	1.0	
Apr	5.4	9.1	8.4	7.7	6.9	37.4	47.3	13.5	1.9		
May	8.2	14.3	10.6	7.7	7.1	47.9	34.6	15.2	2.3		
Jun	4.9	12.4	13.5	15.5	12.7	59.0	38.7	2.2			
Jul	6.7	13.2	11.2	15.6	12.4	59.0	34.6	5.9	0.4		
Aug	7.4	18.2	19.6	14.5	11.2	70.9	27.0	2.1			
Sep	5.6	9.7	8.8	8.3	8.6	41.0	44.3	13.6	0.9	0.1	
Year	4.8	9.8	9.6	9.2	8.7	42.0	39.2	14.9	3.3	0.5	

Table 6. Percentage frequency of 10-minute wind velocity for selected velocity intervals at Gvendarbás, Október 2003 – September 2004

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
Oct	5.1	7.4	10.2	10.1	10.3	43.1	39.3	11.6	5.9		
Nov	5.4	9.8	9.8	10.5	8.8	44.3	36.4	17.2	2.2		
Dec	3.9	5.6	5.9	5.3	7.3	28.0	49.6	19.9	2.5		
Jan	5.7	7.6	8.2	7.3	5.8	34.6	34.7	20.5	9.1	1.1	
Feb	1.4	3.1	2.9	3.0	3.6	14.1	48.0	31.5	5.7	0.7	
Mar	3.3	5.0	5.1	6.3	8.8	28.5	43.4	25.4	2.7		
Apr	6.6	9.1	7.9	7.4	7.9	38.8	45.9	13.7	1.6		
May											
Jun											
Jul											
Aug											
Sep	6.9	8.4	8.9	8.4	10.3	42.9	44.2	11.5	1.4		
Year											

Table 7. Percentage frequency of 10-minute wind velocity for selected velocity intervals at Húsavík, Október 2003 – September 2004

m/s	0.0-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9	19.0-19.9	20.0-20.9	21.0-21.9	22.0-22.9	23.0-23.9	24.0-24.9	>25.0	
<b>Oct</b>	10.1	12.8	11.8	12.8	12.8	60.3	34.1	5.6	0.0																		
<b>Nov</b>	5.4	9.8	9.8	10.5	8.8	44.3	36.4	17.2	2.2																		
<b>Dec</b>	5.6	6.9	7.9	11.1	14.1	45.6	49.9	4.0	0.5																		
<b>Jan</b>	9.8	9.3	9.1	7.5	6.6	42.4	45.7	11.1	0.7																		
<b>Feb</b>	3.3	3.9	4.3	6.9	9.9	28.2	59.6	11.9	0.2																		
<b>Mar</b>	5.6	6.7	9.6	9.7	9.6	41.1	45.8	12.7	0.4																		
<b>Apr</b>	8.1	9.1	10.7	12.4	13.0	53.1	43.1	3.8																			
<b>May</b>	10.7	14.2	10.9	12.2	12.7	60.7	35.3	4.0																			
<b>Jun</b>	10.6	16.2	16.6	16.9	14.8	75.1	23.8	1.1																			
<b>Jul</b>	11.3	13.8	17.9	19.3	14.6	76.9	22.0	1.1																			
<b>Aug</b>	14.2	22.5	22.0	16.8	11.7	87.1	11.6	1.3																			
<b>Sep</b>	8.1	11.9	11.7	16.2	18.5	66.5	31.5	1.6	0.5																		
<b>Year</b>	8.6	11.5	11.9	12.7	12.2	56.9	36.5	6.2	0.4																		

As evident from Table 4 the average wind velocity is considerably lower at the relatively sheltered Húsavík than at Gvendarbás and Bakkahöfði. This is also evident from Tables 5-7 which show that 56.9 % of the velocity observations at Húsavík during the period October 2003 - September 2004 were below 5.0 m/s, while corresponding figure was 42.0 % for Bakkahöfði.

The average wind velocity for each wind direction at Bakkahöfði is shown in Fig. 8 for the whole year, for the winter half of the year and for the summer half; and similarly in Fig. 10 for Húsavík. For Gvendarbás only average wind speed for the winter half is shown in Fig. 9.

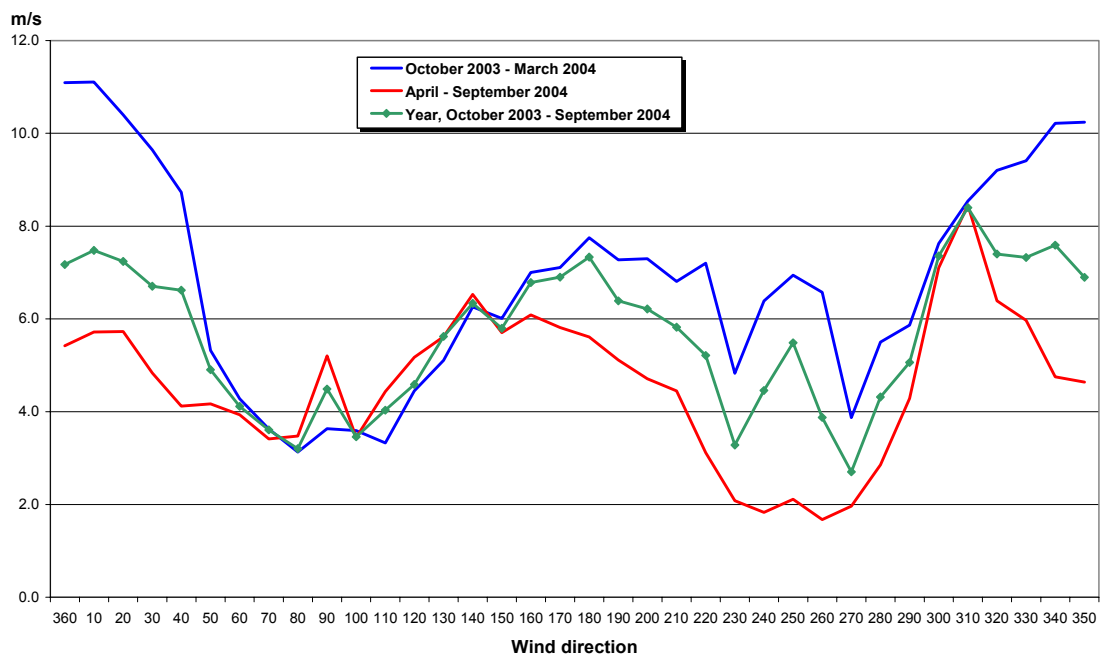


Fig. 8. Average wind velocity for each wind direction at Bakkahöfði during the winter half of the year, the summer half and the whole year.

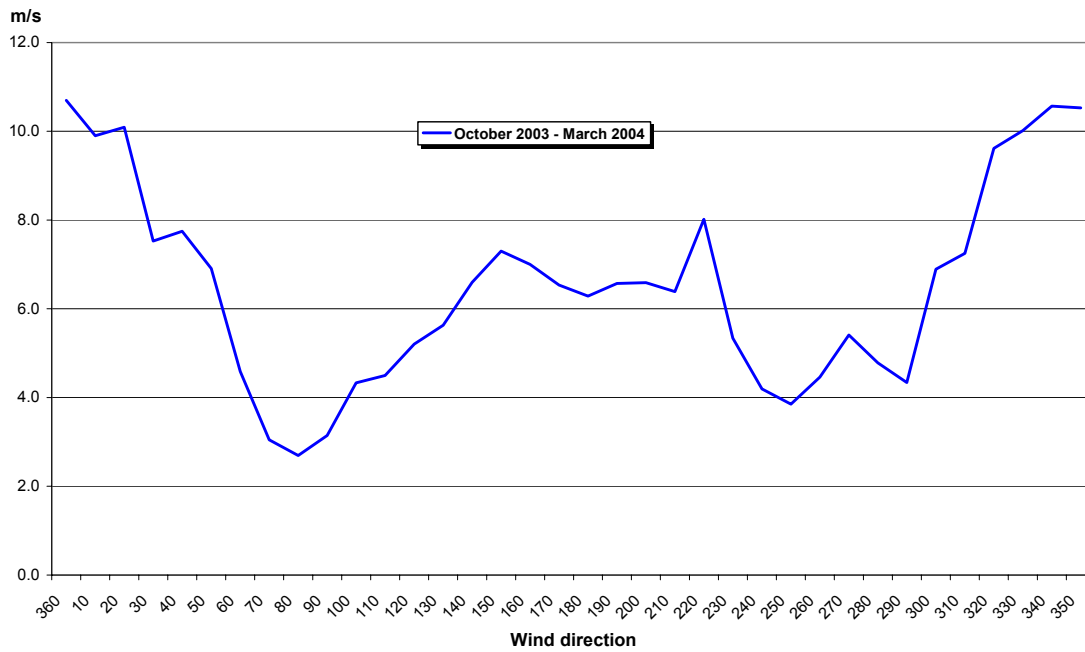


Fig. 9. Average wind velocity for each wind direction at Gvendarbás during the winter half of the year.

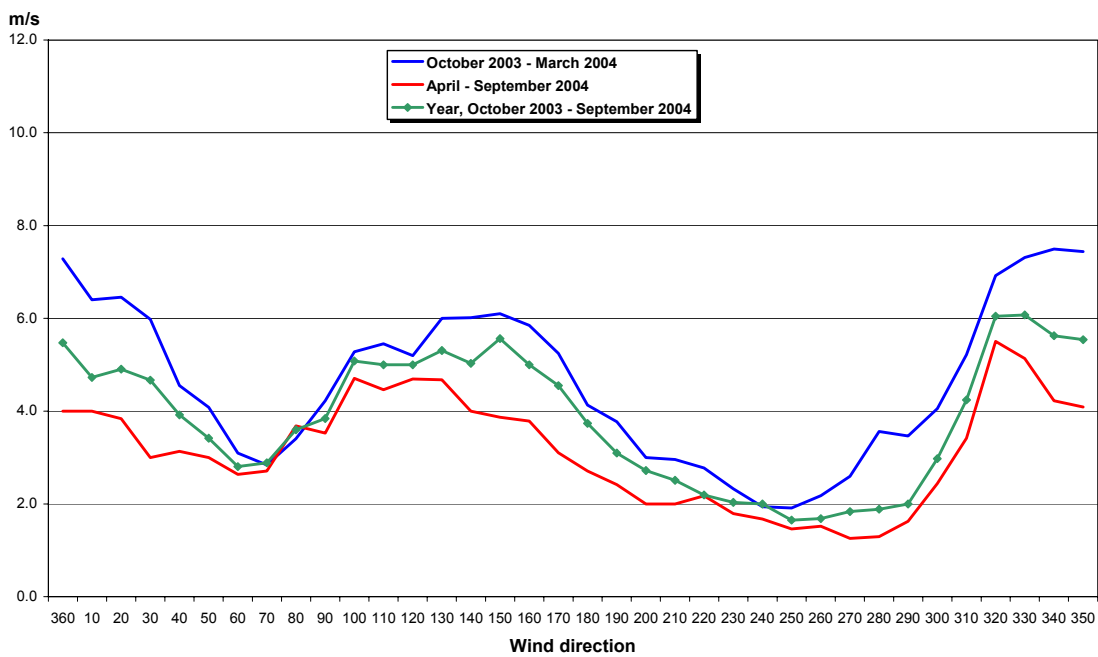


Fig. 10. Average wind velocity for each wind direction at Húsavík during the winter half of the year, the summer half and the whole year.

The distribution of 10-minute wind velocity in February and August 2004 is presented for Bakkahöfði in Fig. 11 and for Húsavík in Fig. 13. For Gvendarbás in Fig. 12 we use September instead of August.

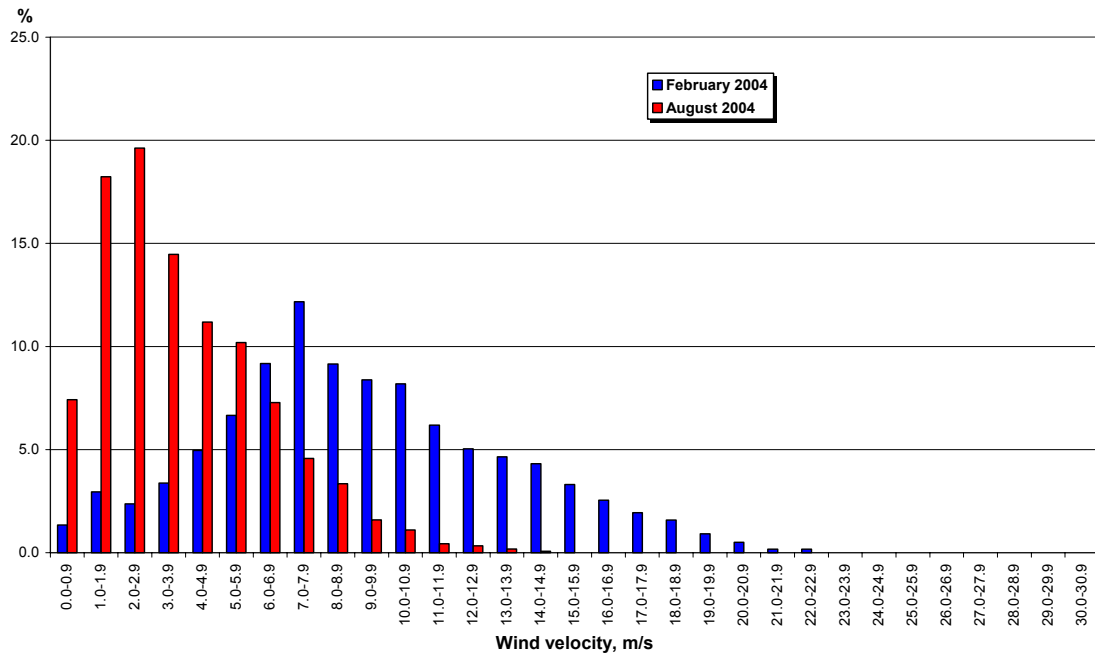


Fig. 11. Distribution of 10-minute wind velocity in February and August 2004 at Bakkahöfði.

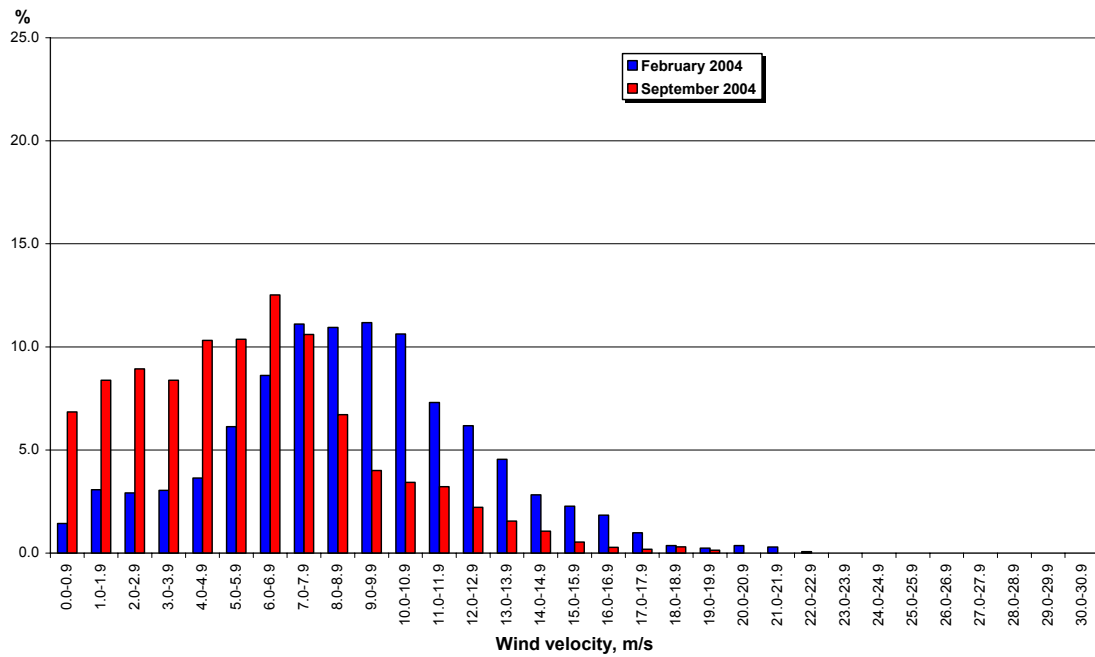


Fig. 12. Distribution of 10-minute wind velocity in February and September 2004 at Gvendarbás.



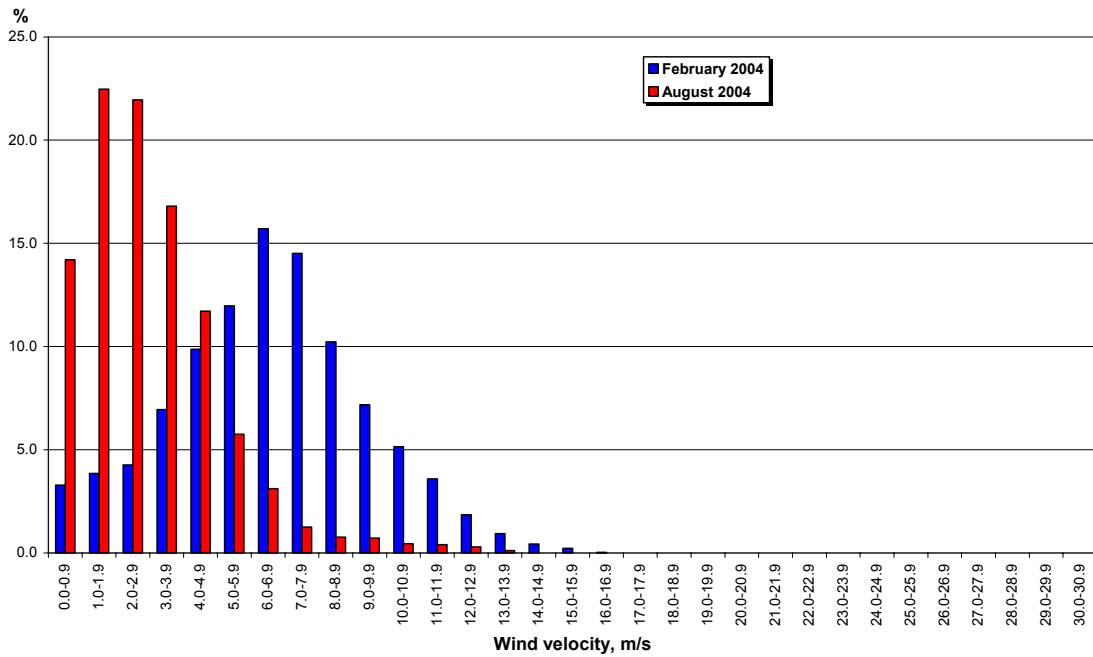


Fig. 13. Distribution of 10-minute wind velocity in February and August 2004 at Húsavík.

The diurnal variation of the 10-minute wind velocity is considerable during the summer half of the year. In Fig. 14 this is shown for the high summer months, June-August 2004, at Bakkahöfði and Húsavík.

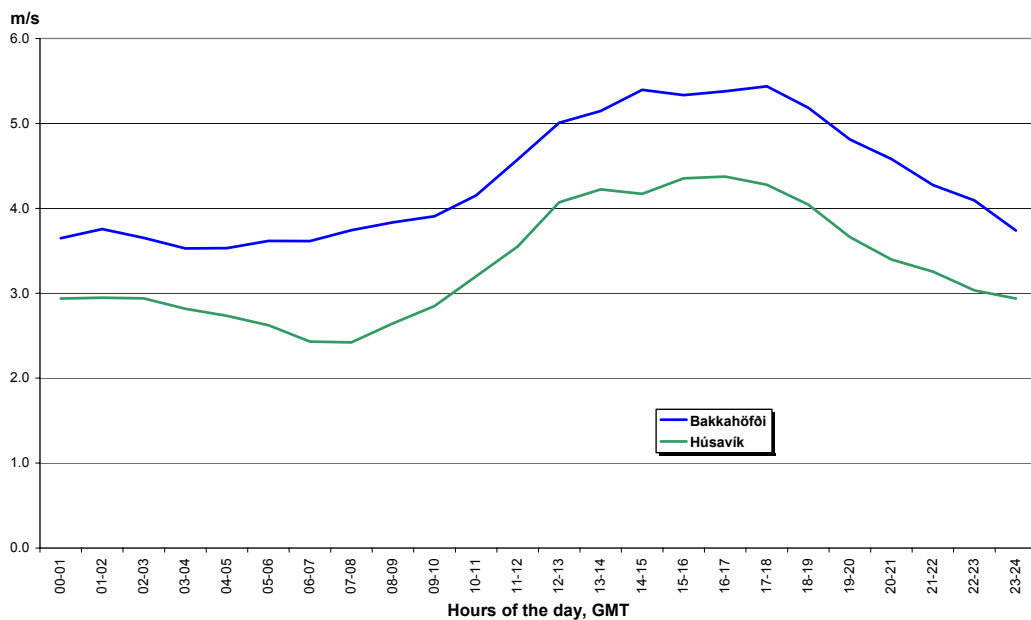


Fig. 14. Mean diurnal variation of 10-minute wind velocity at Bakkahöfði and Húsavík during the high summer months June- August 2004.

The highest 10-minute wind velocity observed at Bakkahöfði during the twelve month period October 2003 – September 2004 was 25.4 m/s, observed on 7 March 2004 (direction 193°). The highest gust 31.7 m/s (direction 018°) was observed on 13 January 2004. Highest 10-minute wind velocity and gust at Gvendarbás, 23.0 m/s and 29.6 m/s respectively, also observed in northerly wind (direction 021°) on 13 January 2004.

At Húsavík the highest observed 10-minute wind was on 7 November 2003, 18.7 m/s (direction 162°) and the highest gust 31.9 m/s on 14 January 2004 (direction 025°).

#### 4. Air Temperature Observations in the Húsavík Area

The monthly mean temperature at the 4 observation stations is presented in Table 8 for the period October 2003 - September 2004. For the stations Gvendarbás, Bakkahöfði and Húsavík the same observations are missing as for the wind measurements (see chapter 3.1) For Húsavíkurfjall ca. 1200 observations are missing, 2.3% in February and March 2004 and 1 day in the summer half. The sea has a warming influence during the winter but cooling during the summer. This influence is greatest at Bakkahöfði and smallest at the Húsavík station. Accordingly Bakkahöfði has higher monthly mean temperatures than the other stations during the winter half of the year, the months October-March, but Húsavík usually during the summer, especially for the high summer months, June-August.

Table 8. Monthly mean temperature, October 2003 – September 2004, °C.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Year
Bakkahöfði	4.4	2.5	-0.2	-0.8	1.0	3.5	3.6	5.1	8.8	11.1	11.5	8.7	4.9
Gvendarbás	3.9	1.6	-0.9	-1.6	0.4	3.4	3.6	5.2	8.9	11.2	11.4	8.5	4.6
Húsavík	3.9	1.6	-1.2	-1.8	0.2	3.1	3.4	5.3	9.2	11.5	11.7	8.4	4.6
Húsavíkurfjall	3.2	1.5	-1.9	-2.3	-1.3	1.9	2.4	4.1	8.1	10.5	11.5	7.8	3.9

The diurnal temperature variation is considerable during the summer half of the year, especially on clear days. In Fig 15 the mean diurnal variation is shown for the high summer months, June-August 2004.

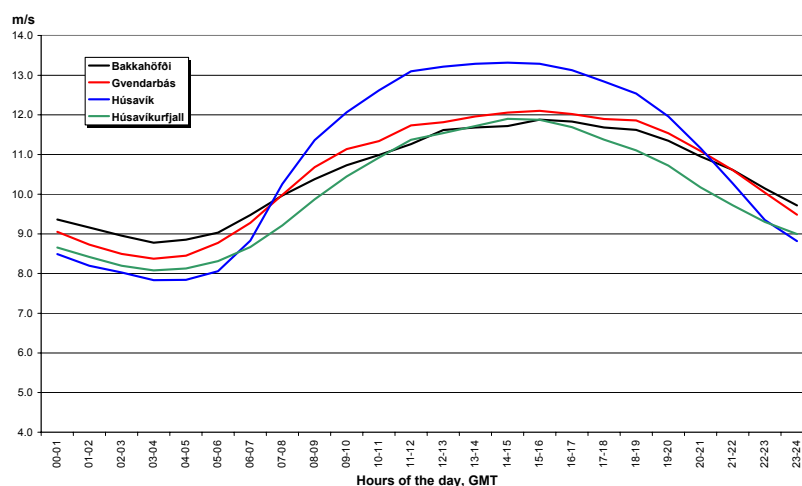


Fig. 15. Diurnal temperature variation in the Húsavík area during June-August 2004.

## 5. Stability Observations in the Húsavík Area

The vertical temperature gradient between the stations Húsavíkurfjall and Bakkahöfði (height difference 179 m) is presented hour for hour and month for month in Annexes 16-21, between Húsavíkurfjall and Gvendarbás (height difference 178 m) in Annexes 22-27 and between Húsavíkurfjall og Húsavík (height difference 166 m) in Annexes 28-33.

The vertical temperature gradient is here expressed in degrees Celcius per 100 meters. It is a measure of the stability of the air. As seen in the graphs in Annexes 16-33 temperature inversions, i.e. higher temperature at Húsavíkurfjall than at the other stations, occur rather frequently, indicating moderate or strong stability of the lowest air layers. As seen from figures 16 and 17 and table 9 the neutral conditions are most frequent. During both summer- and wintertime the frequency of stable conditions is considerable.

Table 9. Stability classification (%) for winter and summer half  
October 2003 – September 2004.

### October 2003 - March 2004

		Húsavíkurfjall - Gvendarbás	Húsavíkurfjall - Bakkahöfði	Húsavíkurfjall - Húsavík
<= -2.0	very unstable	0.6	0.8	0.2
-1.9 - -1.0	unstable	31.2	40.3	18.4
-0.9 - -0.0	neutral	39.4	47.7	53.9
0.1 - 1.0	stable	22.4	9.1	21.1
>= 1.1	very stable	6.4	2.2	6.5

### April - September 2004

		Húsavíkurfjall - Gvendarbás	Húsavíkurfjall - Bakkahöfði	Húsavíkurfjall - Húsavík
<= -2.0	very unstable	0.1	0.1	0.3
-1.9 - -1.0	unstable	23.1	19.2	26.5
-0.9 - -0.0	neutral	55.1	60.8	56.6
0.1 - 1.0	stable	15.7	14.6	10.2
>= 1.1	very stable	6.0	5.3	6.4

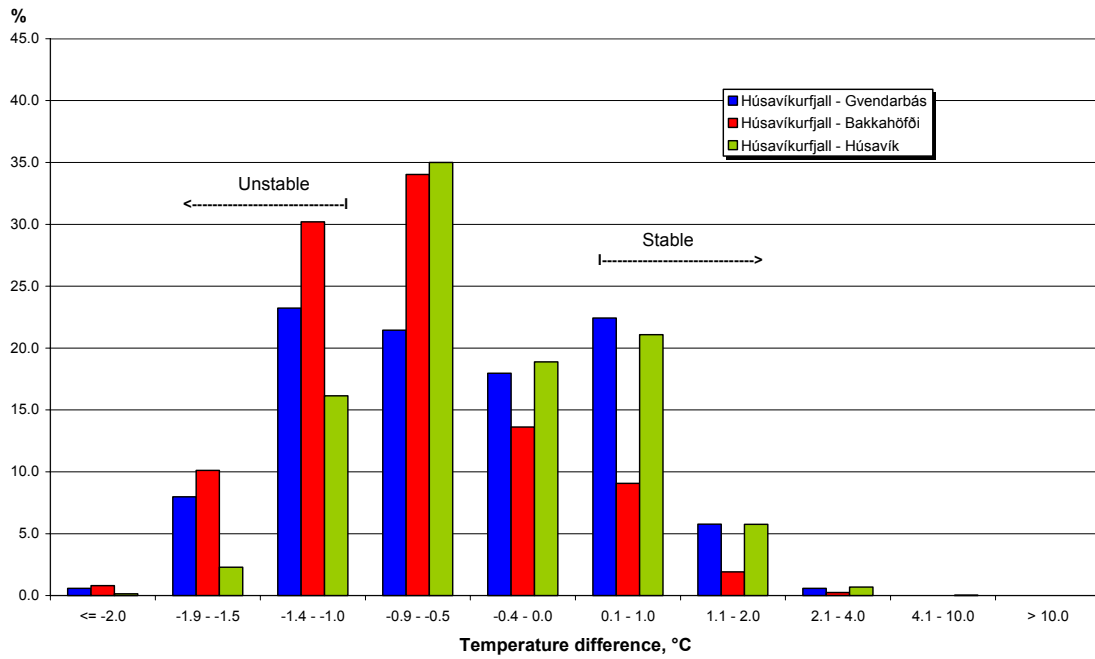


Fig. 16. Percentage frequency of the stability for selected temperature gradient intervals. For Húsavíkurfjall – Bakkahöfði, Gvendarbás and Húsavík, respectively. October 2003 - March 2004.

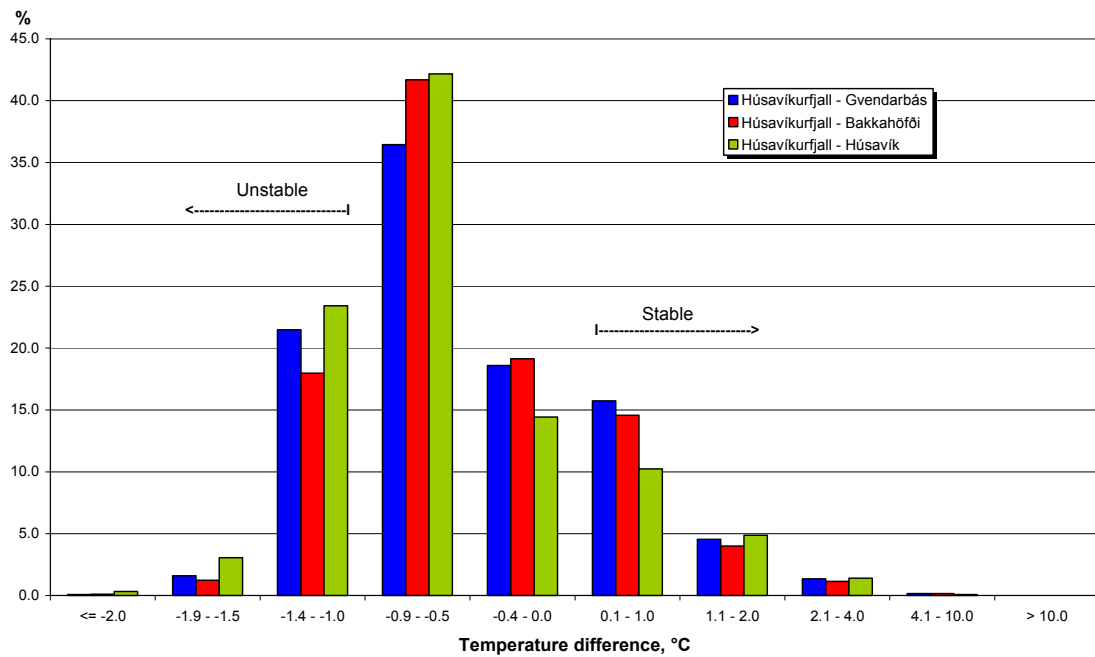


Fig. 17. Percentage frequency of the stability for selected temperature gradient intervals. For Húsavíkurfjall – Bakkahöfði, Gvendarbás and Húsavík, respectively. April – September 2004.

## 6. Remarks

The main purpose of the observations described in this report, is to provide a basis on which dispersion calculations can be based for an eventual industrial plant, possibly located at Héðinsvík north of Bakkahöfði or at Gvendarbás south of Húsavík. All data from the observation network are stored in the computerized data base of the Icelandic Meteorological Office and can be obtained as needed for dispersion calculations. The results of this year wind measurements is very similar to the results of the year before, but the average temperature is ca. 1°C lower for this period than the year before for all stations, see Ref. 2.

## 7. Stutt yfirlit á íslensku (Brief summary in Icelandic)

Samkvæmt samningi við Fjárfestingarstofuna-orkusvið setti Veðurstofan þann 13. september 2002 upp þrjár sjálfvirkar veðurstöðvar í næsta nágrenni við Húsavík: á Bakkahöfða, við Gvendarbás og í 194 m hæð yfir sjó efst á Skjólbrekku. Skyldu stöðvar þessar, sem í skýrslunni kallast Bakkahöfði, Gvendarbás og Húsavíkurfjall, reknar til loka september 2003 en mælingar voru framlengdar um eitt ár – til loka september 2004. Gera skyldi skýrslu um helstu niðurstöður mælinganna og þá einnig stuðst við mælingar á sjálfvirkri veðurstöð Veðurstofunnar á Húsavík. Á Skjólbrekku er aðeins mældur lofthiti, en á hinum stöðvunum einnig vindátt og vindhraði. Gerð er grein fyrir þessu, staðsetningu stöðvanna og tækjabúnaði í 1. og 2. kafla skýrslunnar.

Í þriðja kafla og viðaukum 1-15 er fjallað ítarlega um niðurstöður vindáttar- og vindhraðamælinga á sjálfvirkri veðurstöðvunum Bakkahöfða, Gvendarbási og Húsavík á 12 mánaða tímabilinu október 2003 - september 2004.

Í fjórða kafla er fjallað um niðurstöður hitamælinga á veðurstöðvunum, og í fimmta kafla um lóðréttan hitastigul milli stöðvarinnar á Skjólbrekku og hinna veðurstöðvanna. Hitastigullinn segir til um stöðugleika loftsins sem ásamt vindinum hefur afgerandi áhrif á dreifingu mengunarefna. Viðaukar 16-21 sýna hitastigulinn, og þar með stöðugleikann, dag fyrir dag og mánuð fyrir mánuð miðað við mælingar á Skjólbrekku og Bakkahöfða, en hæðarmunur stöðvanna er 179 metrar. Viðaukar 22- 27 sýna á sama hátt hitastigul milli Skjólbrekku og Gvendarbáss, en hæðarmunur er 178 m. Loks sýna viðaukar 28-33 hitastigul milli Skjólbrekku og stöðvarinnar í jaðri Húsavíkur, en hæðarmunur er 166 m.

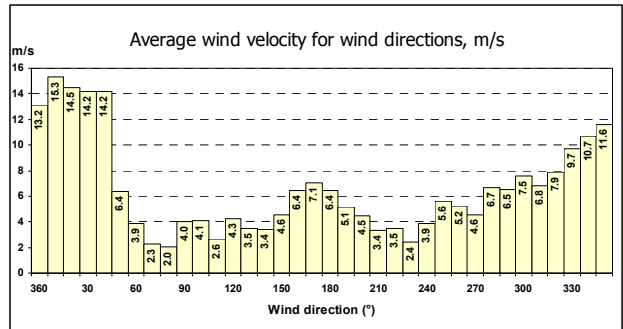
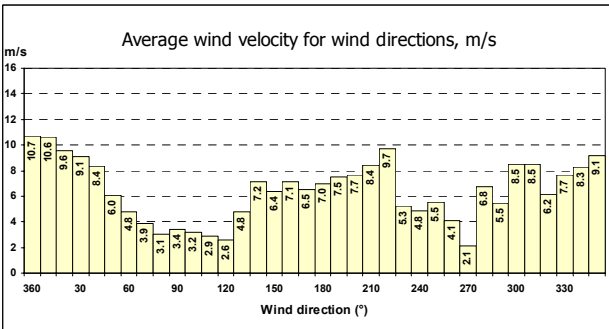
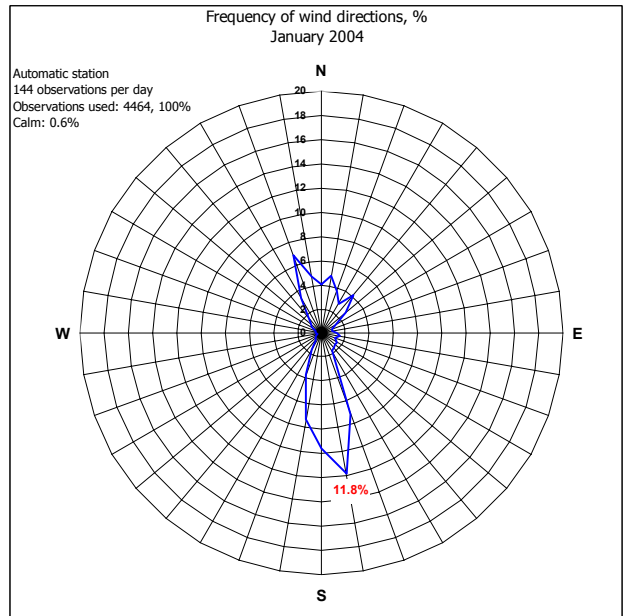
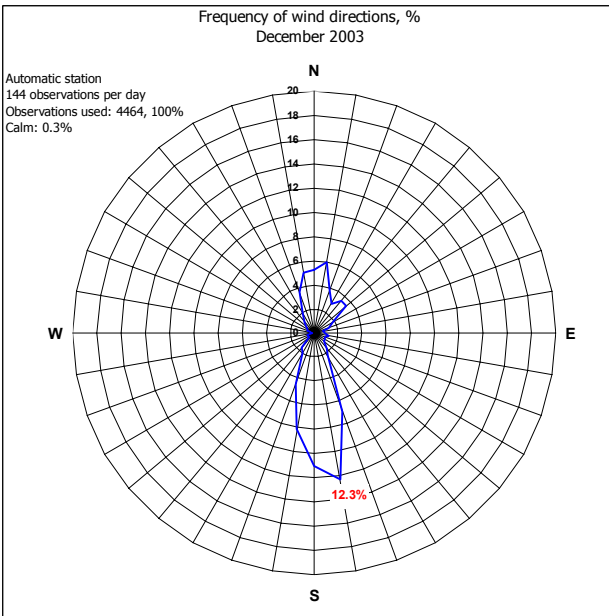
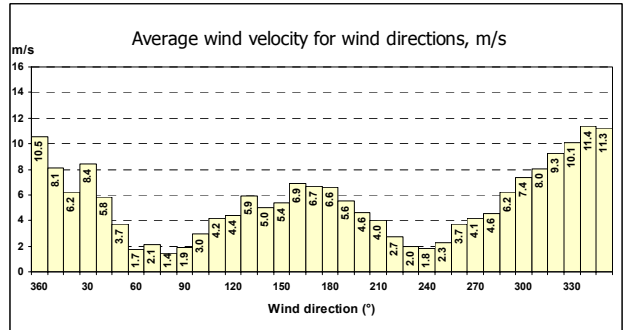
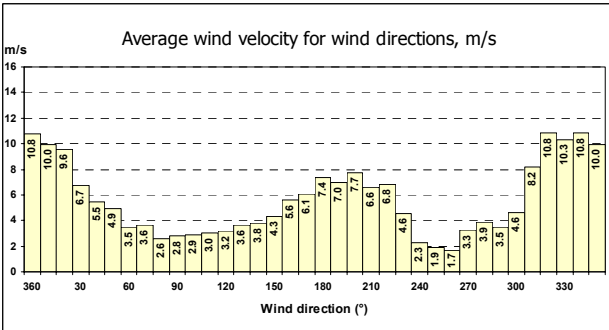
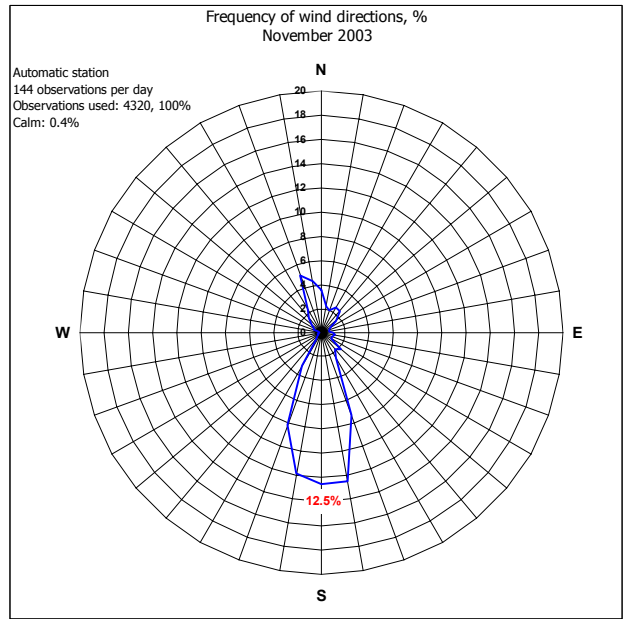
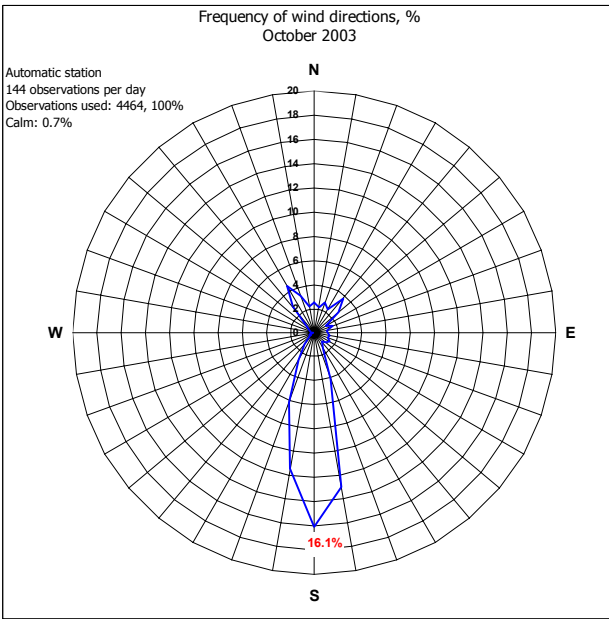
Í sjötta kafla er greint frá tilgangi mælinganna sem er að afla gagna sem á má byggja útreikninga á dreifingu mengunarefna frá stóriðjufyrirtæki sem staðsett kynni að verða á Húsavíkursvæðinu, væntanlega í námunda við Bakkahöfða eða Gvendarbás. Jafnframt er sagt frá því að öll gögnin séu geymd í tölvuvæddum gagnabanka Veðurstofunnar og þar tiltæk þegar og ef gera þarf dreifingarútreikninga.

## 8. References

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3. Þóroddur F. Þóroddsson, Helgi Hallgrímsson, Þórir Haraldsson, Ólafur K. Nielsen og Jóhannes Björnsson: Húsavík. Náttúrufar og minjar. (A report on nature and historical remains in the neighbourhood of Húsavík). A report prepared for Staðarvalsnefnd um iðnrekstur by Náttúrugripasafnið á Akureyri. Iðnaðar-ráðuneytið, Reykjavík 1984, 167 p. (in Icelandic).

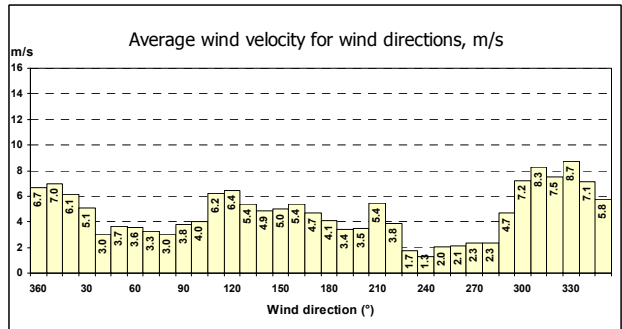
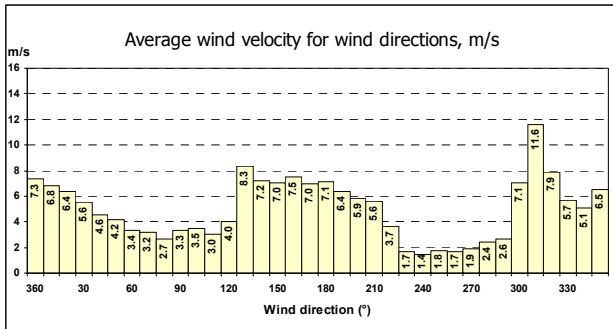
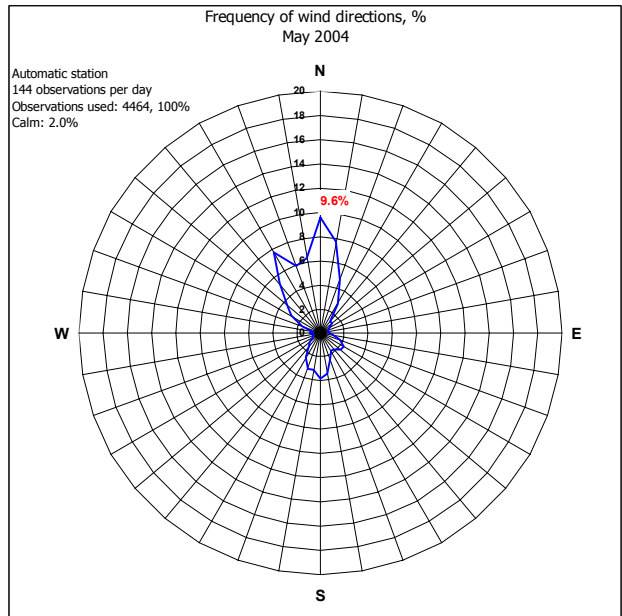
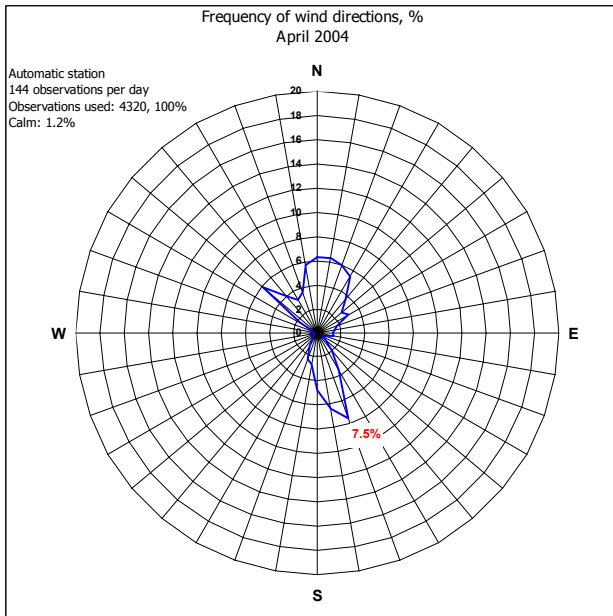
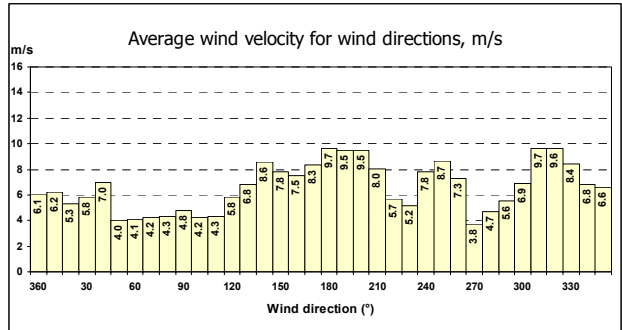
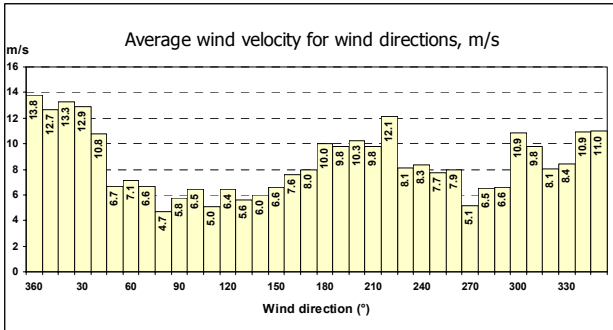
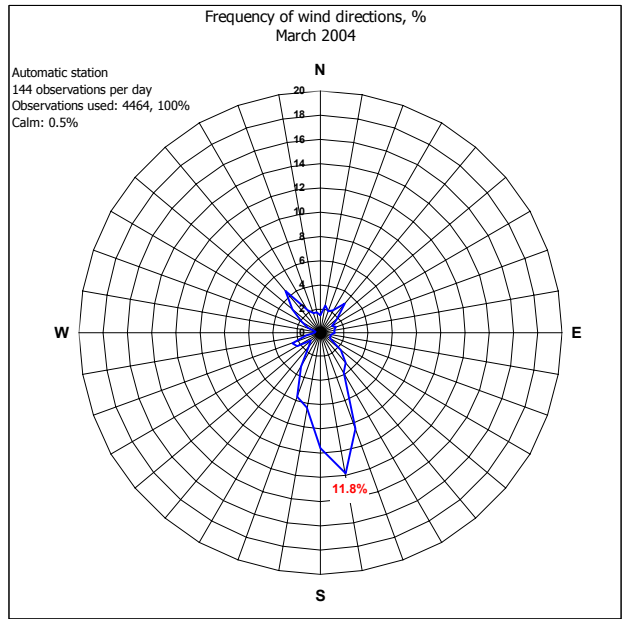
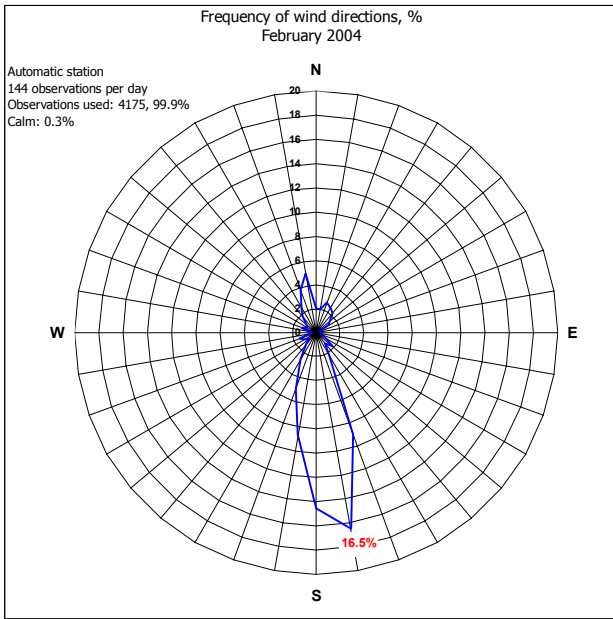
## **Annexes 1 - 33**

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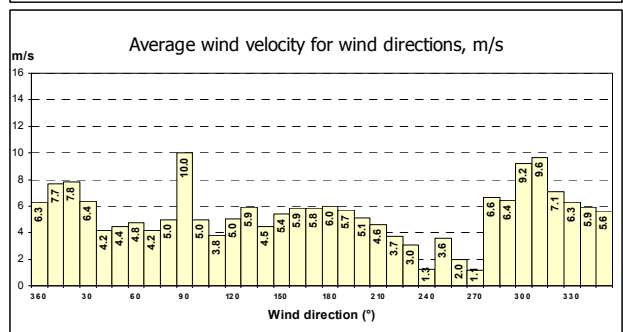
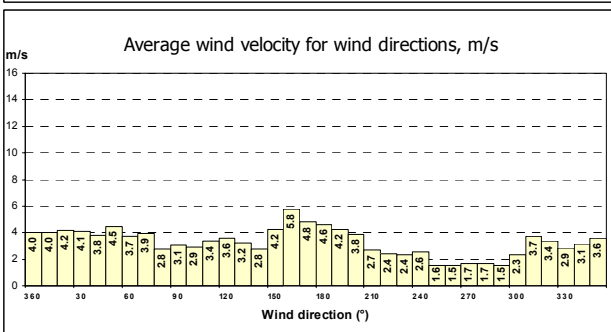
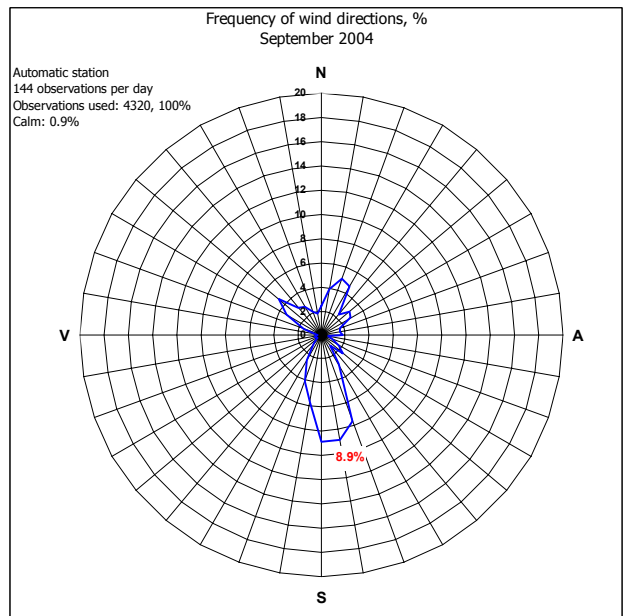
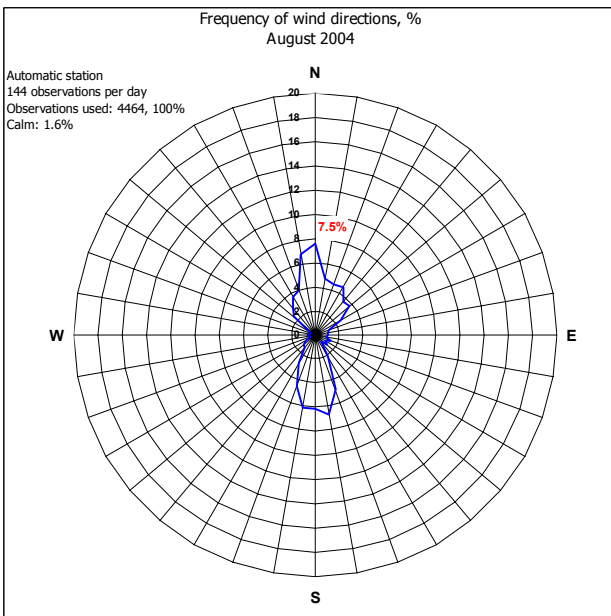
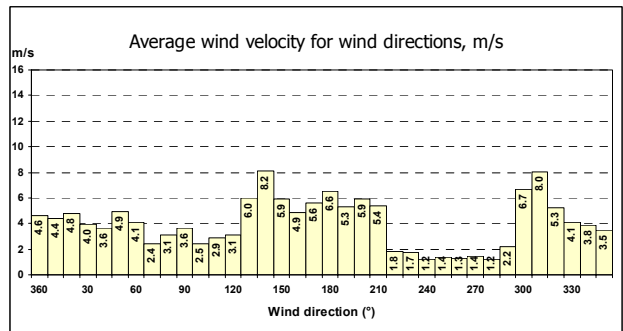
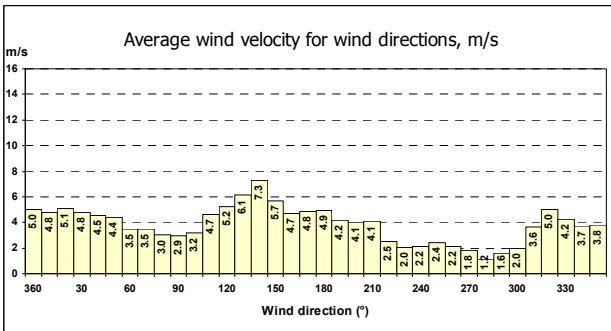
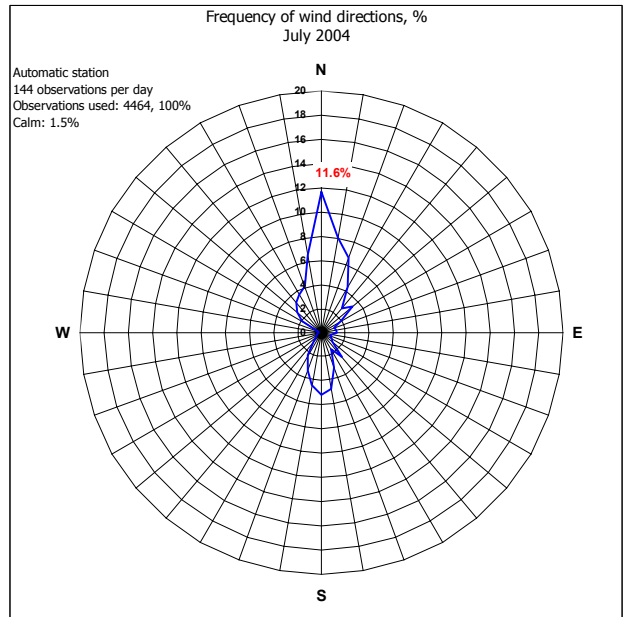
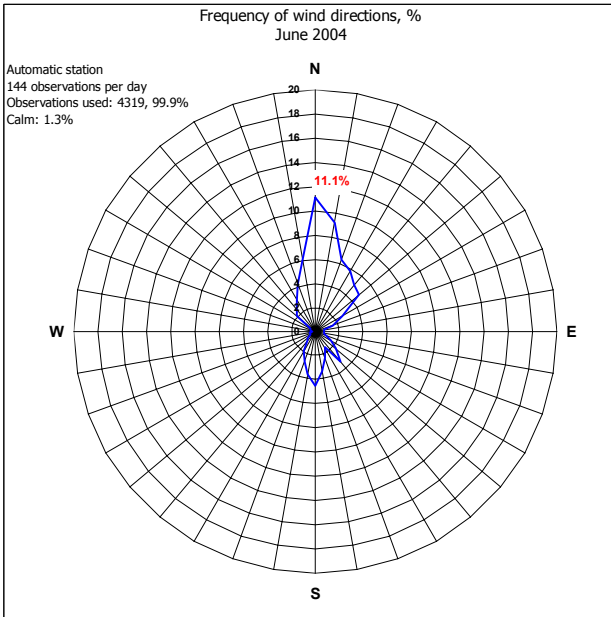




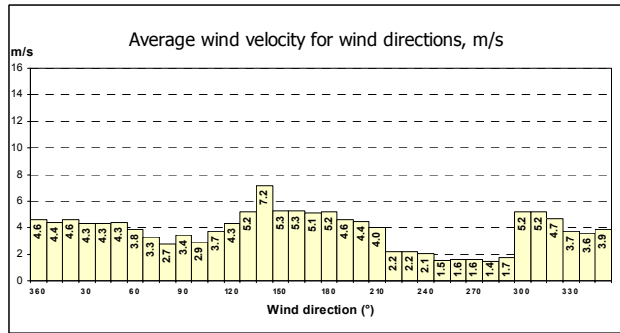
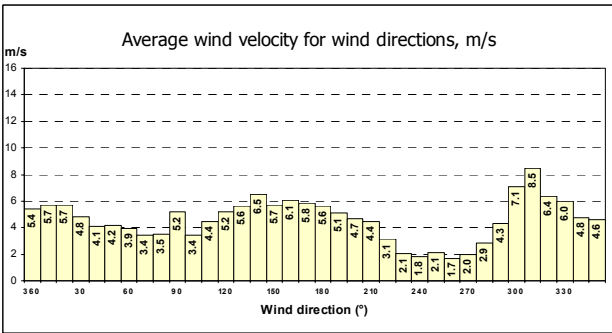
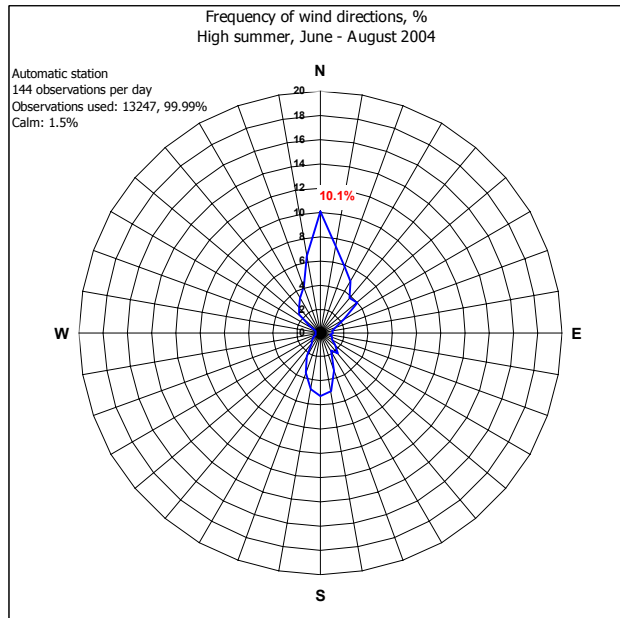
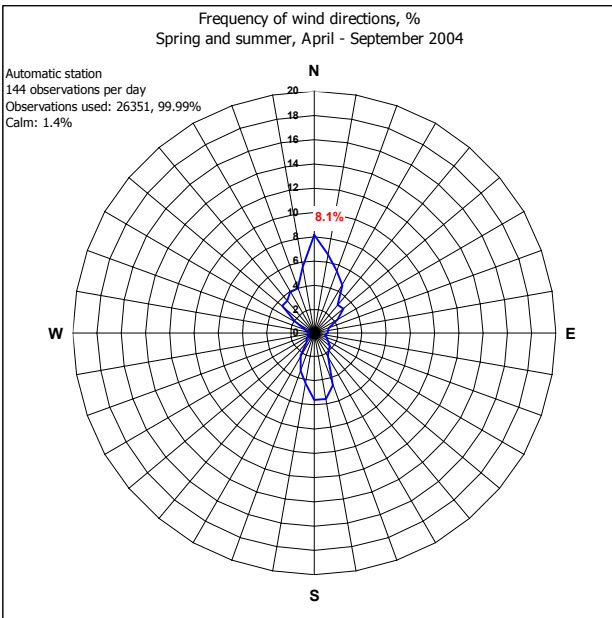
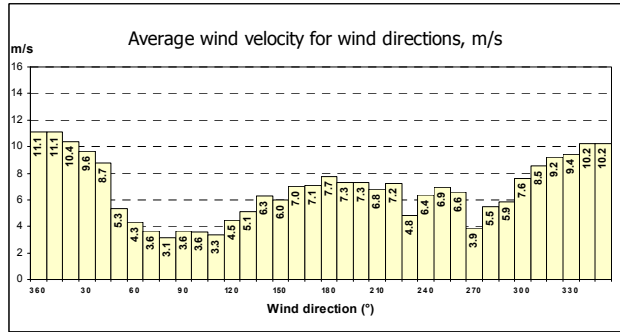
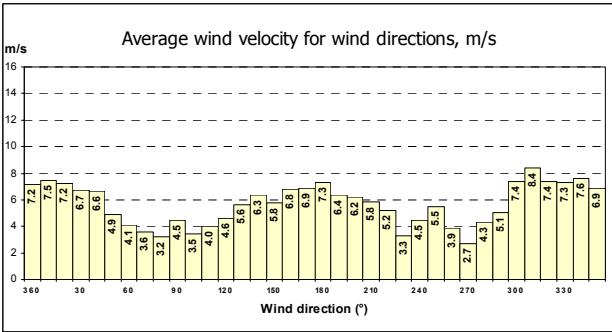
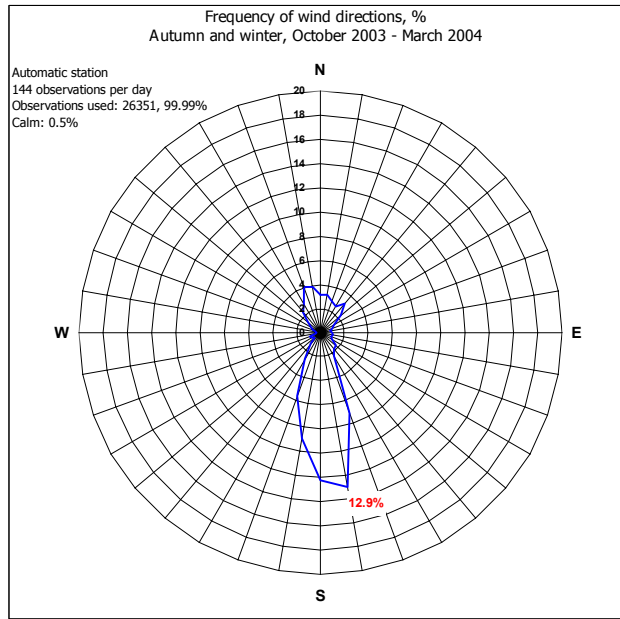
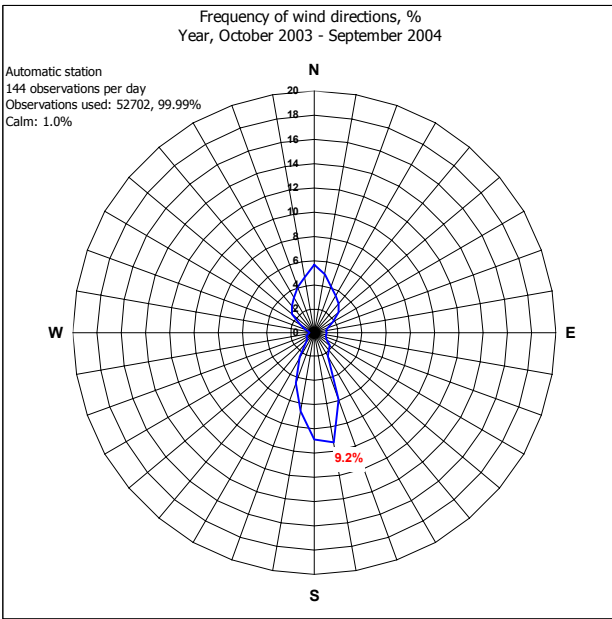
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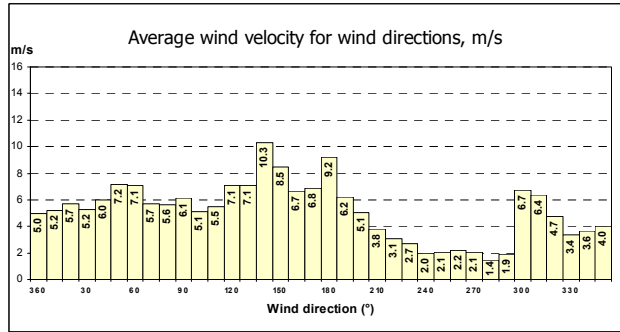
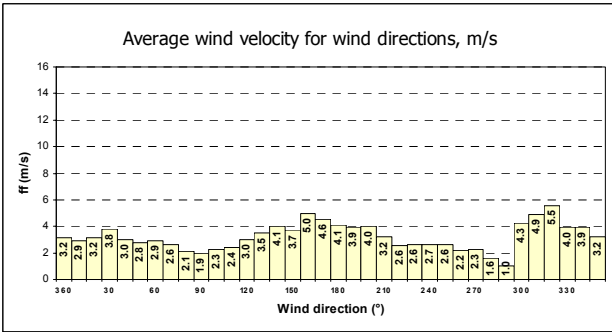
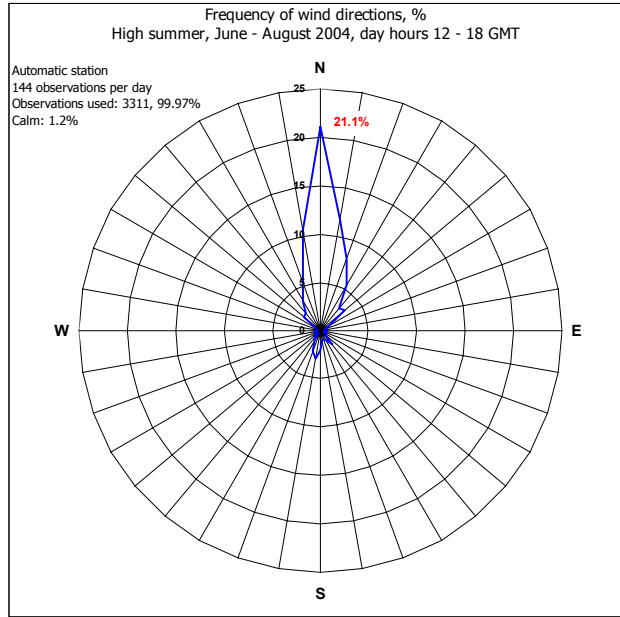
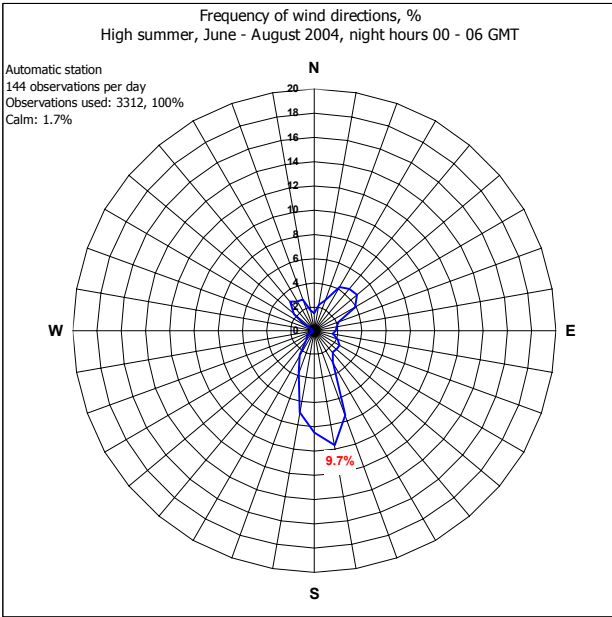
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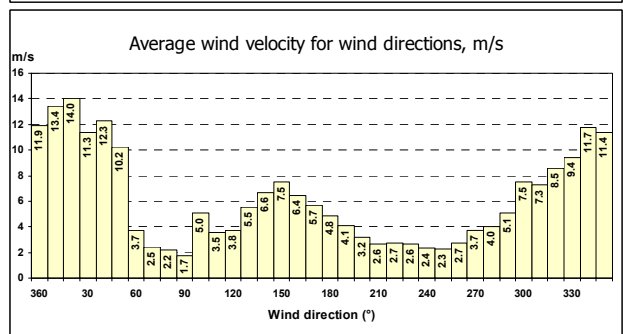
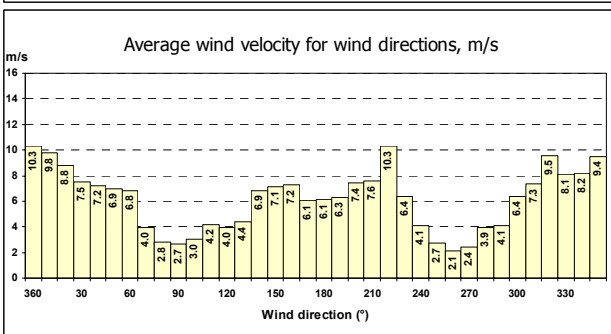
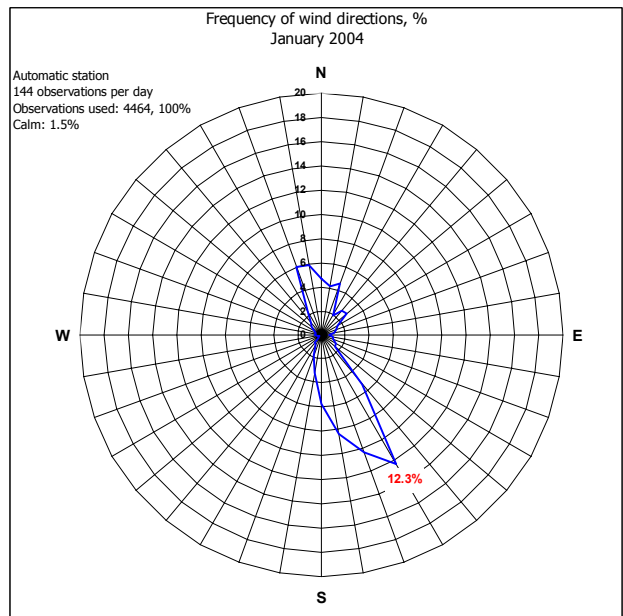
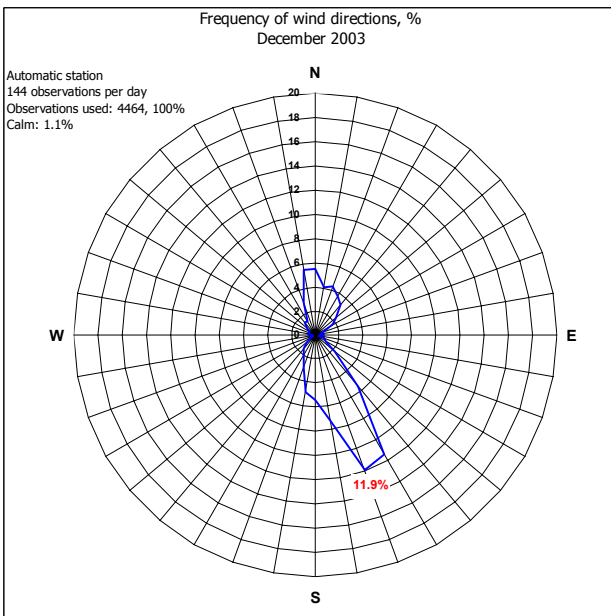
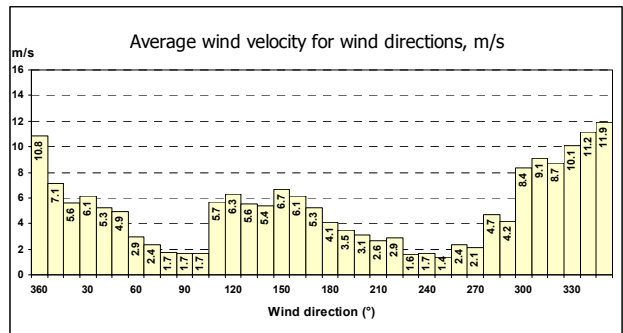
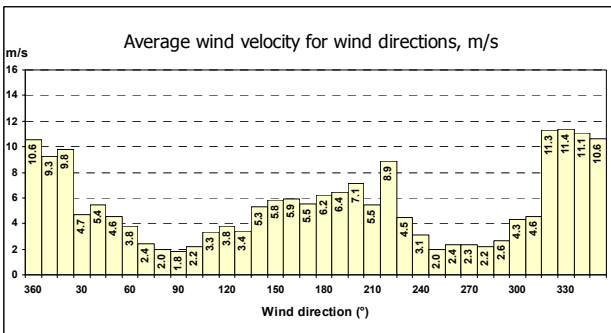
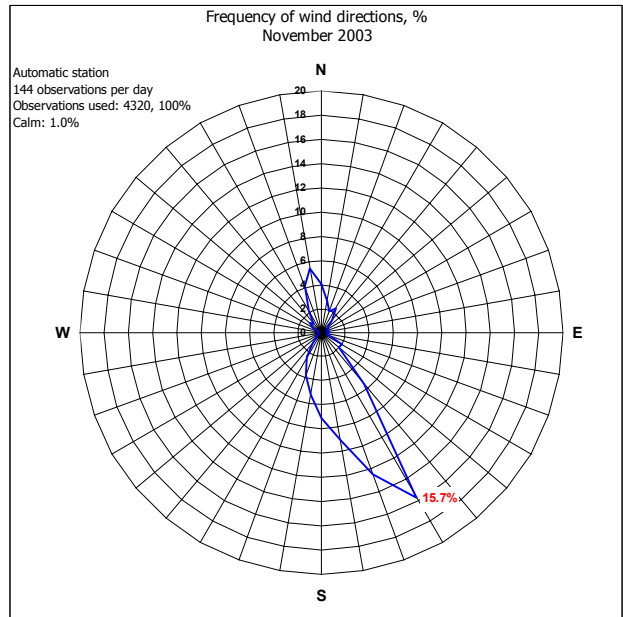
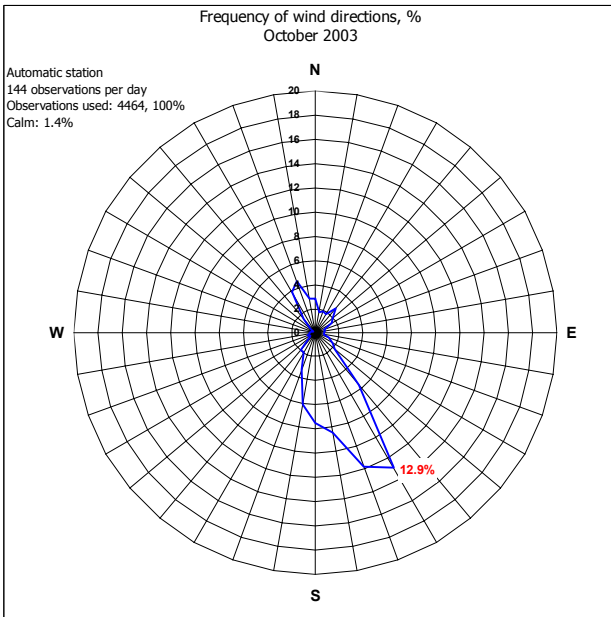
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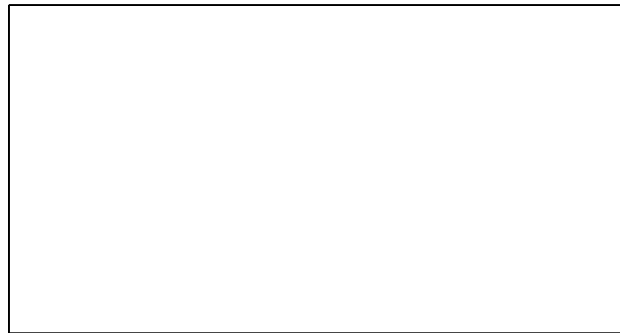
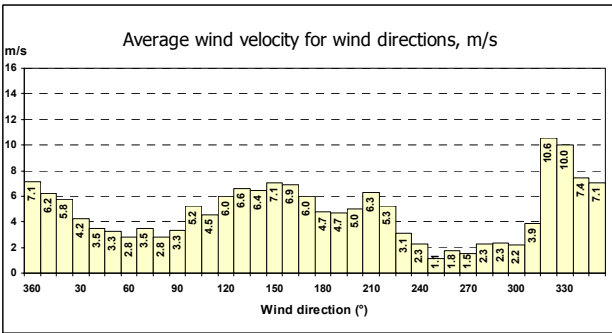
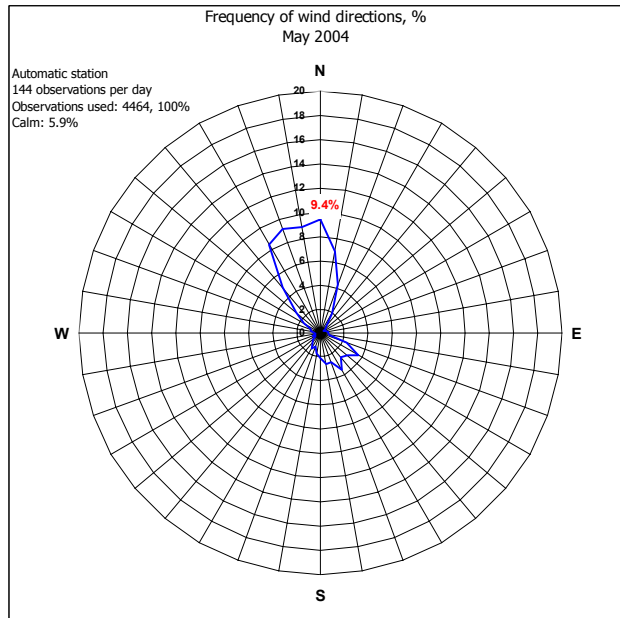
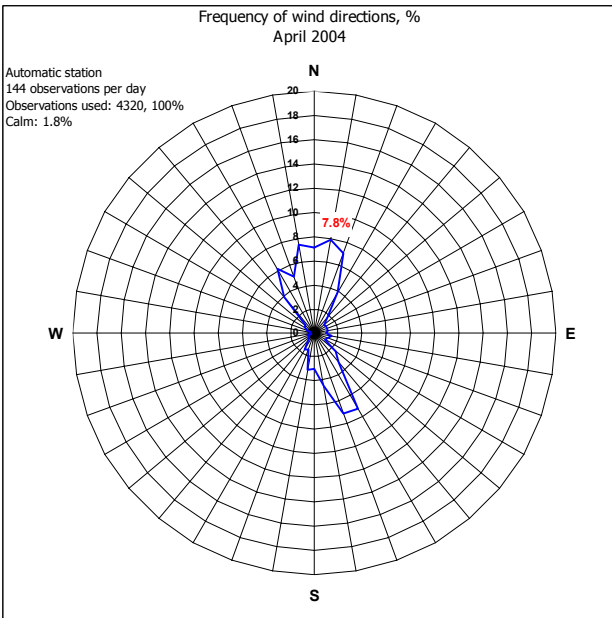
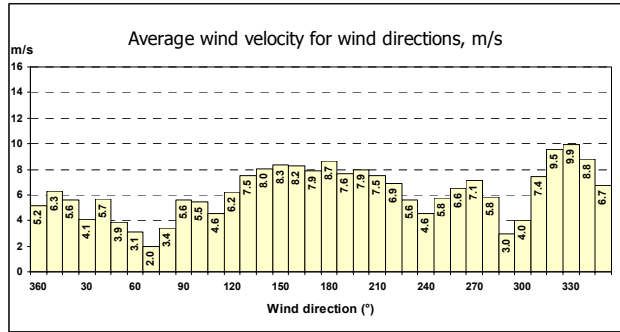
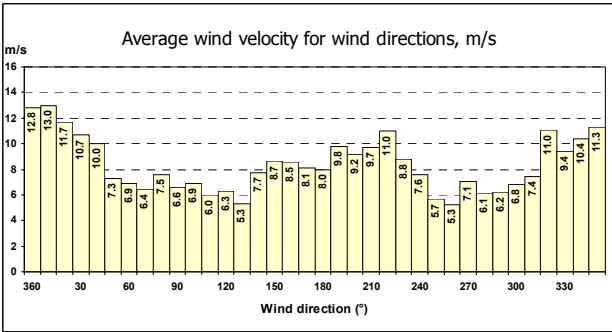
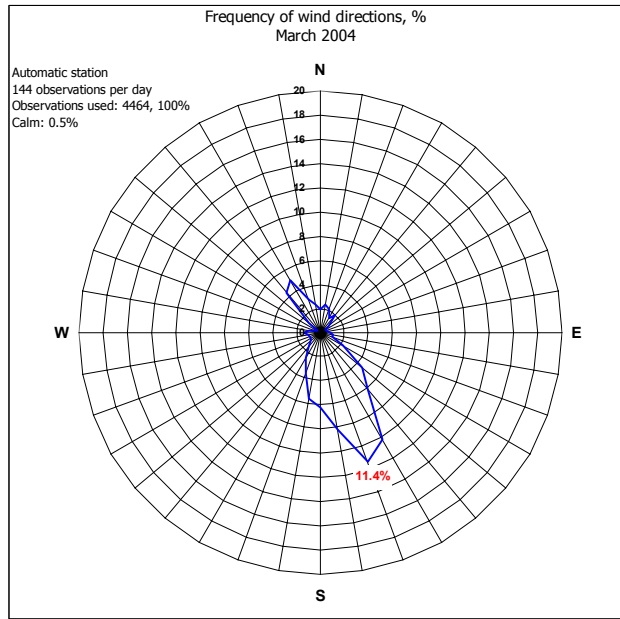
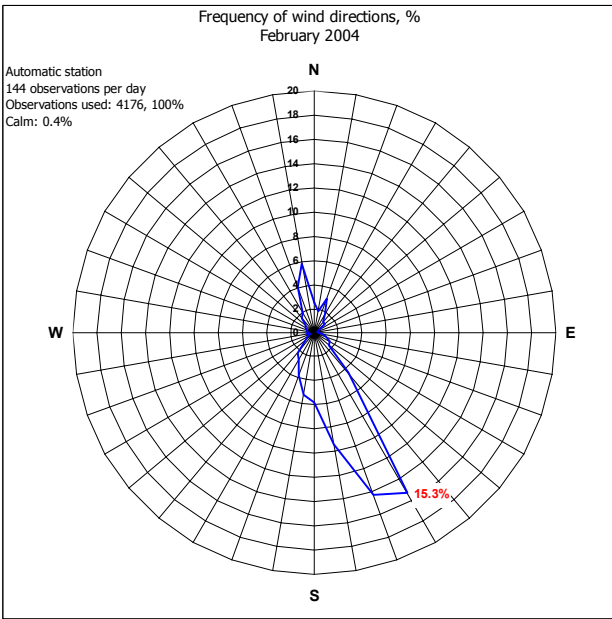
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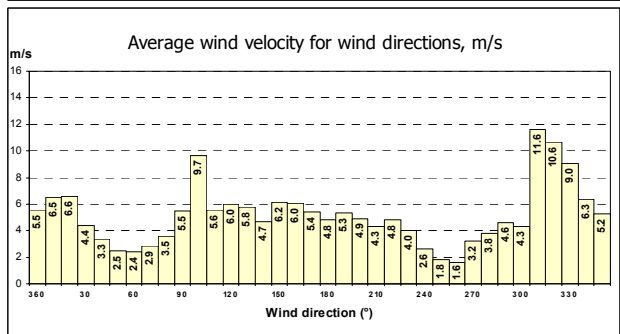
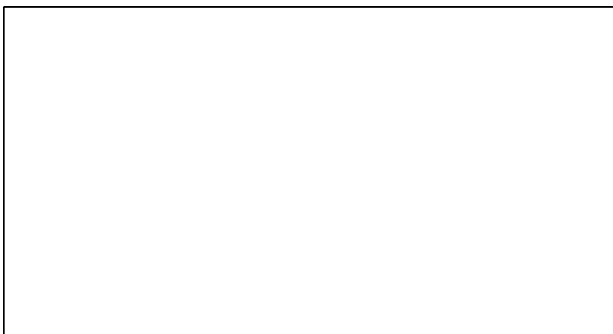
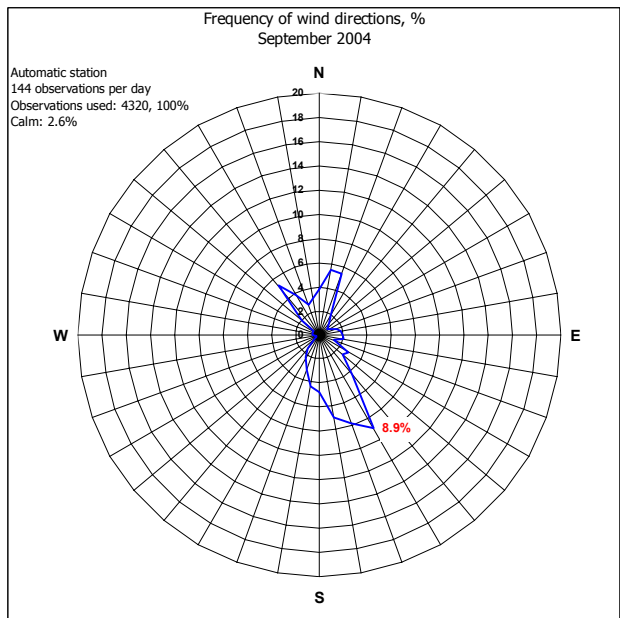
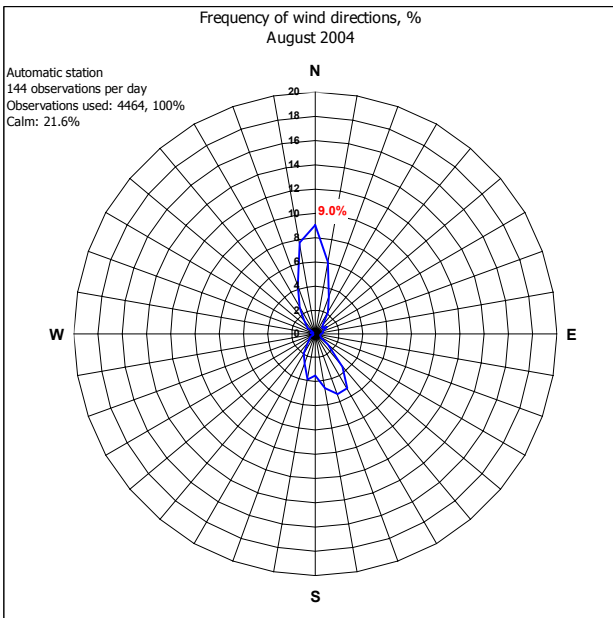
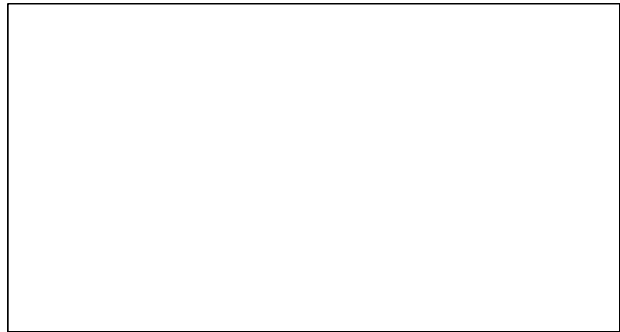
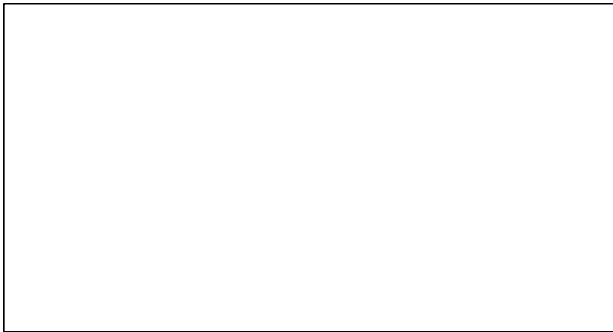
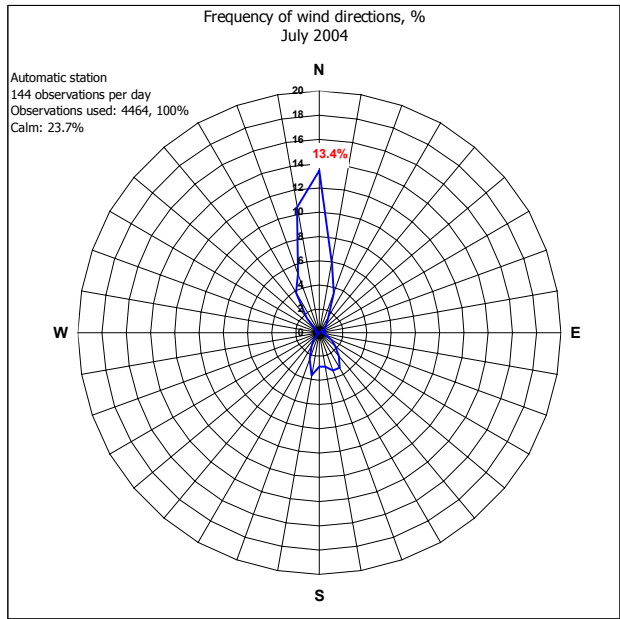
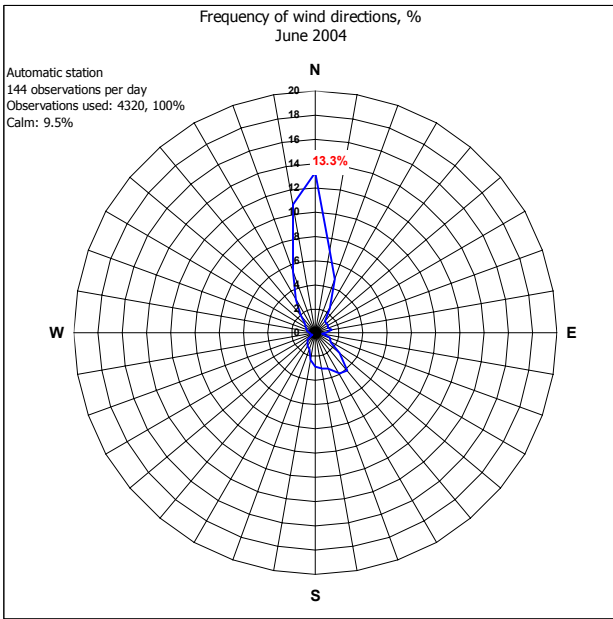
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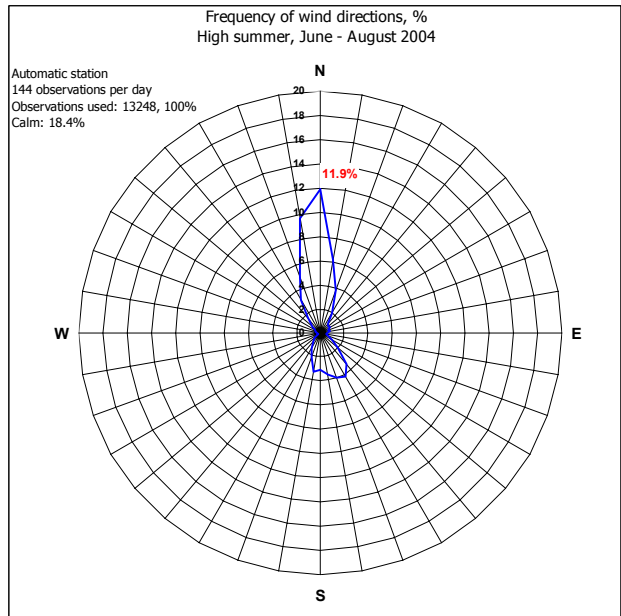
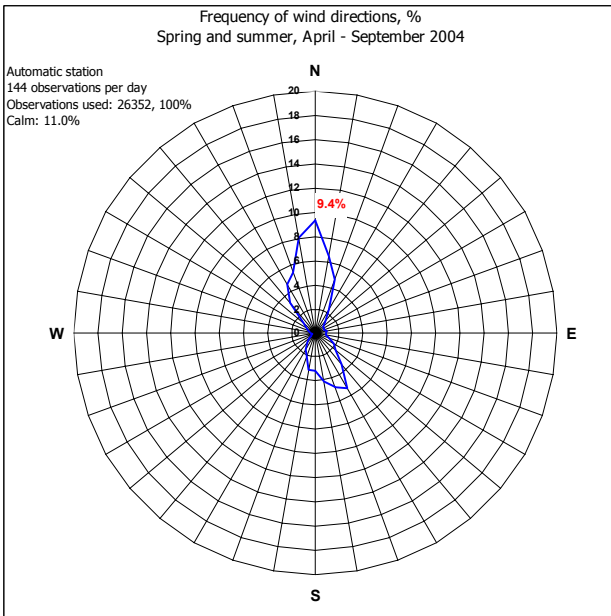
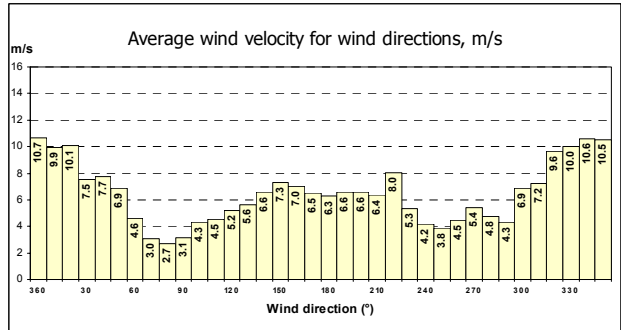
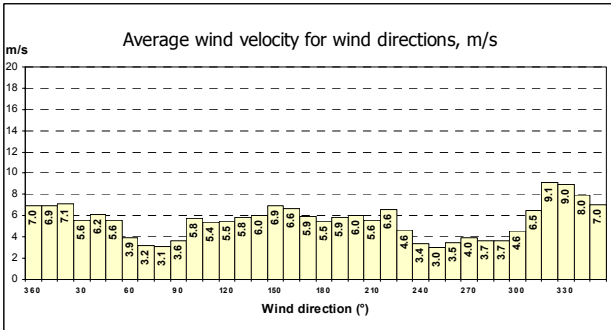
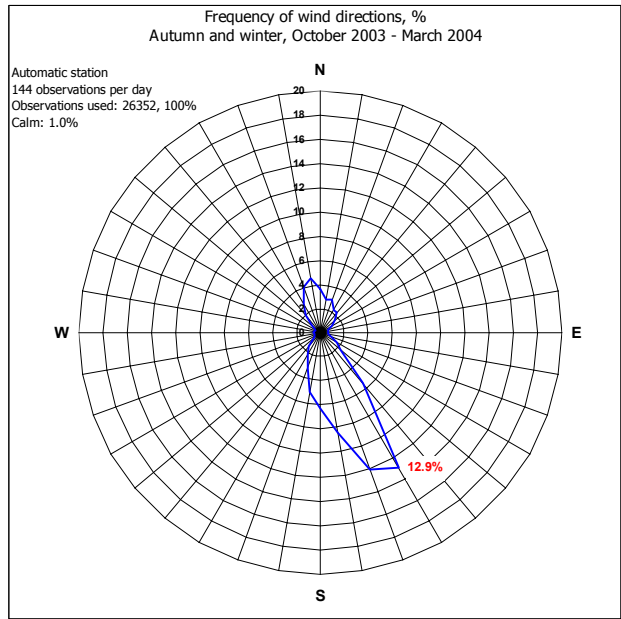
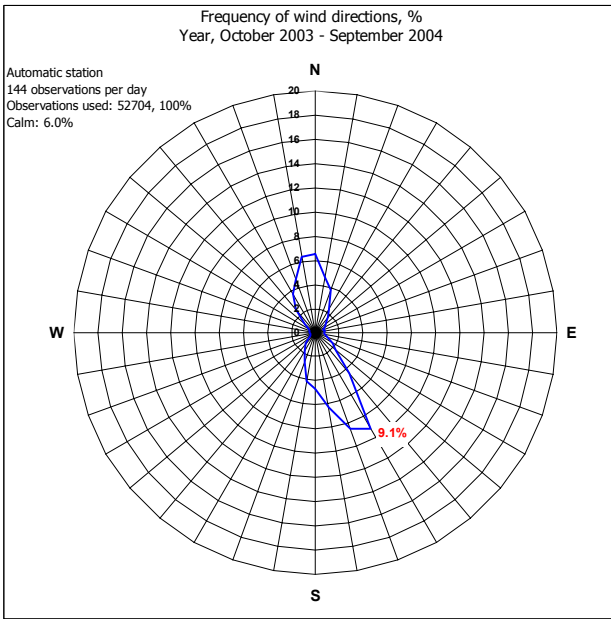
# Gvendarbás



# Gvendarbás

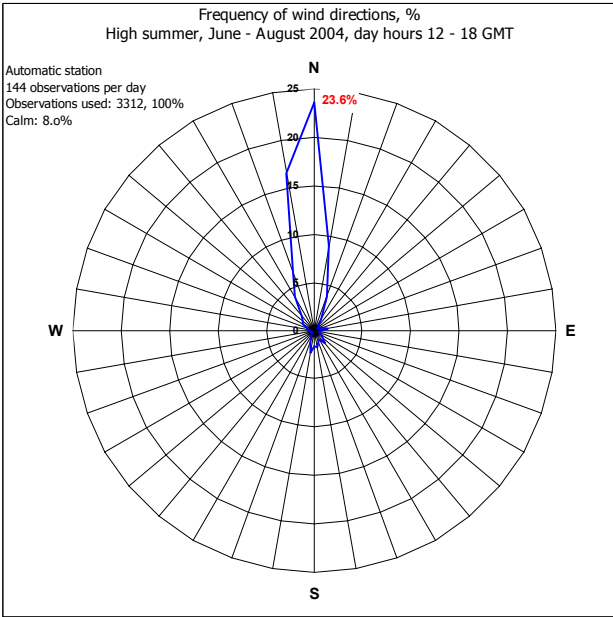
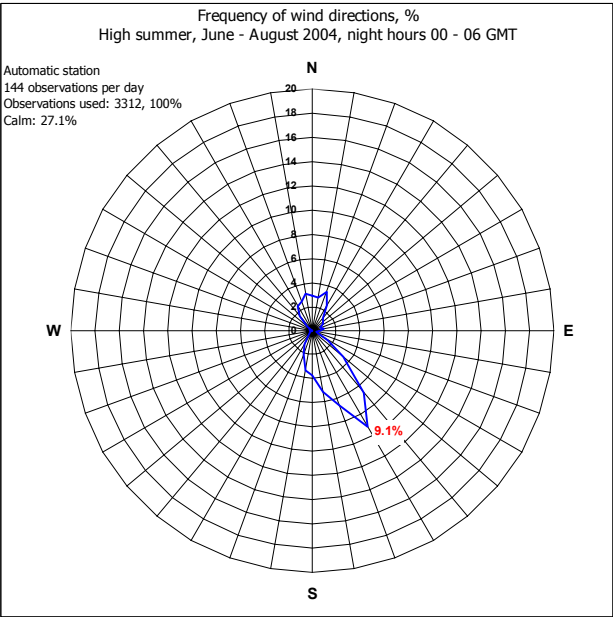


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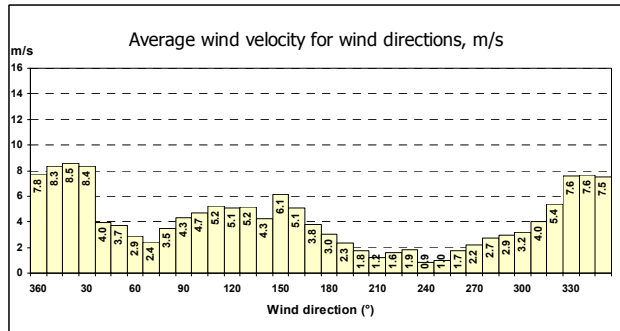
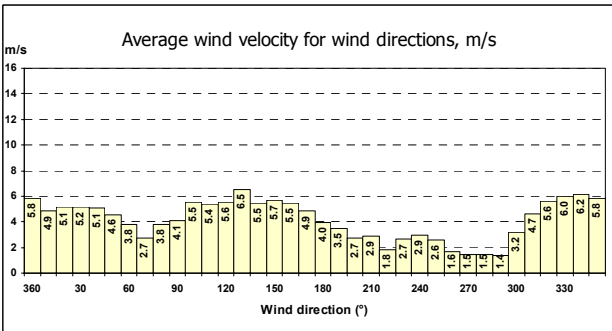
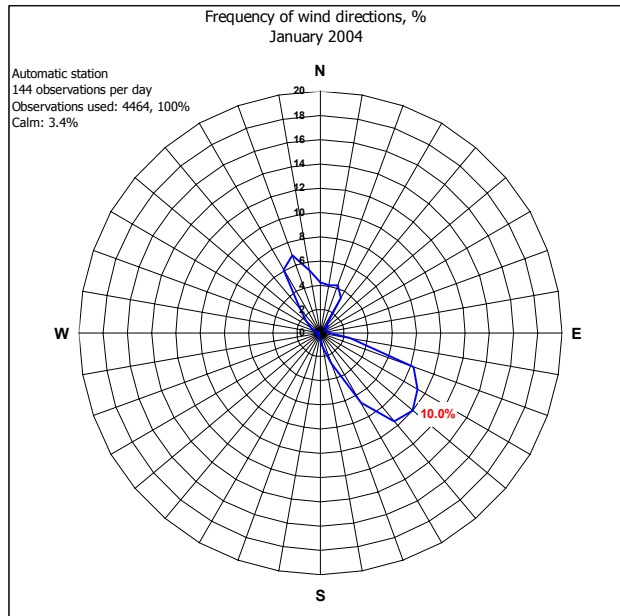
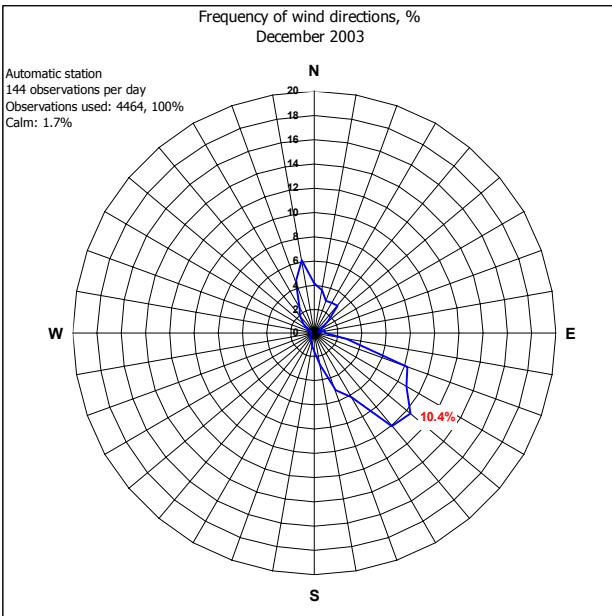
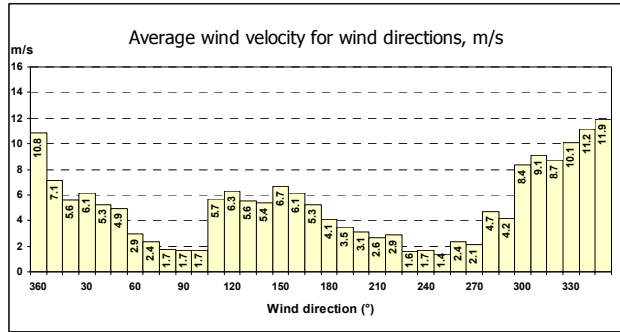
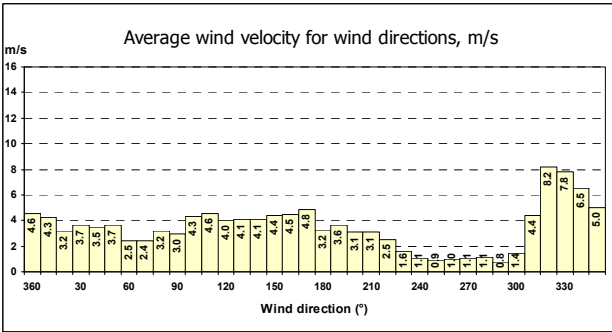
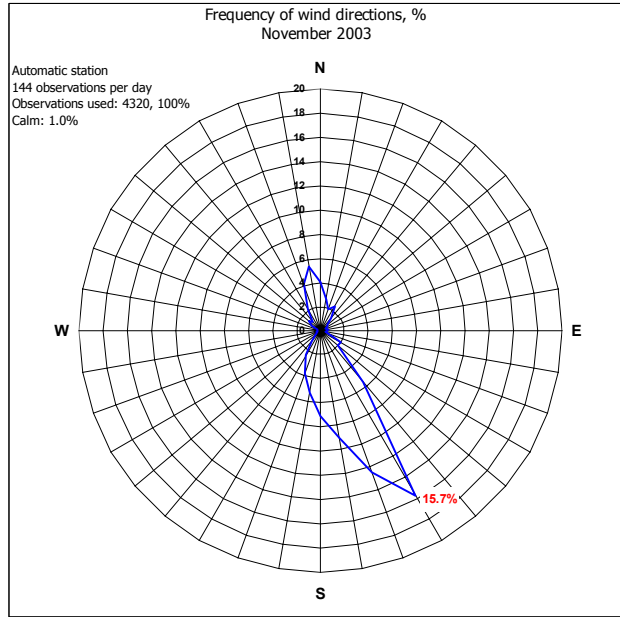
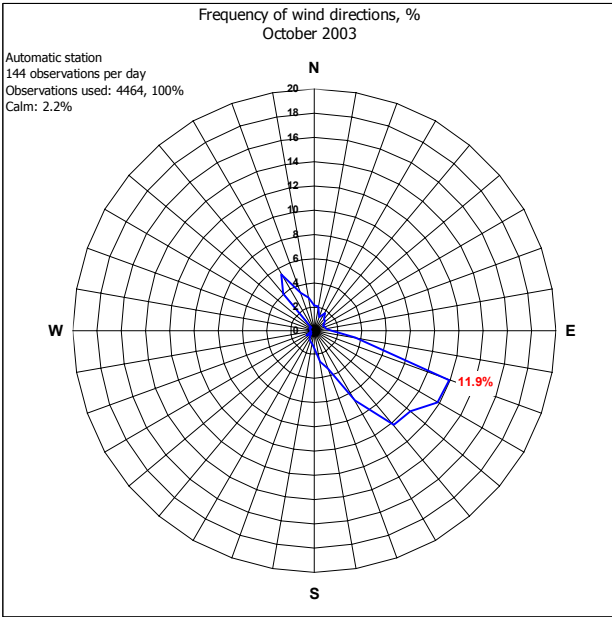




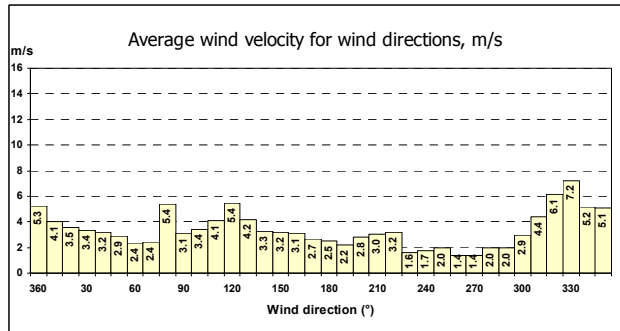
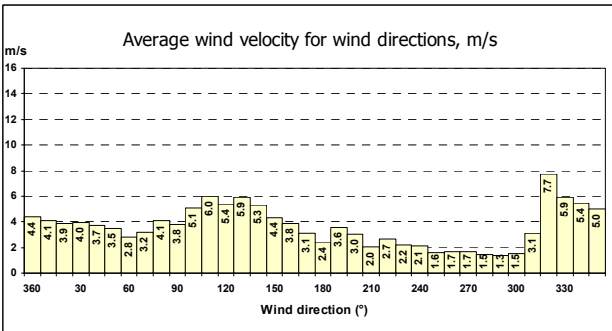
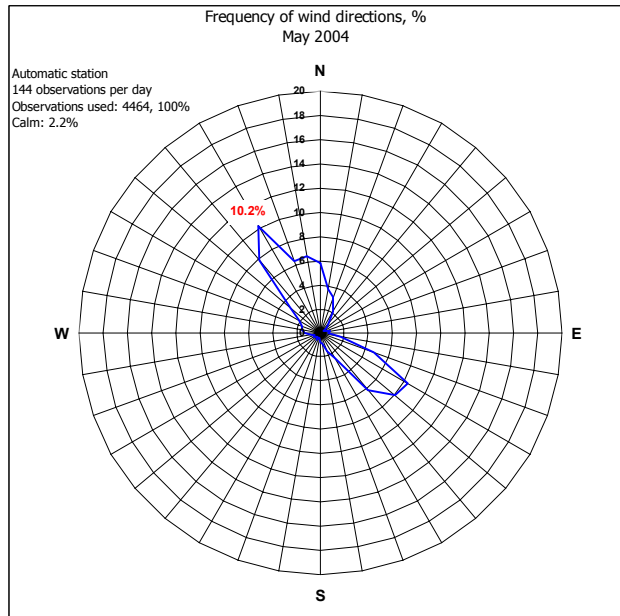
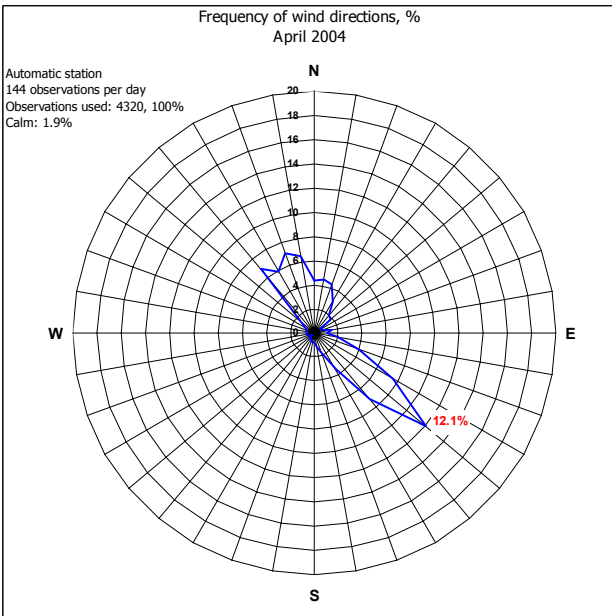
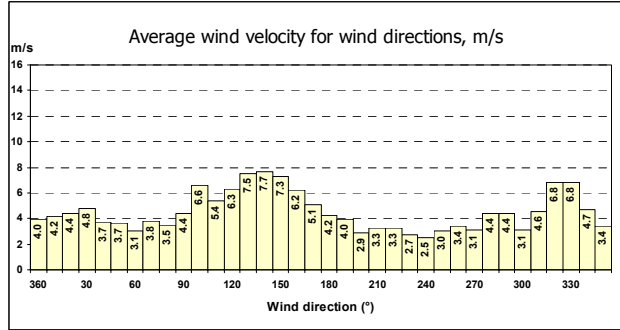
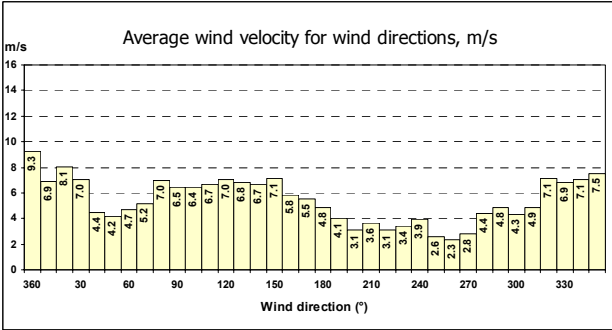
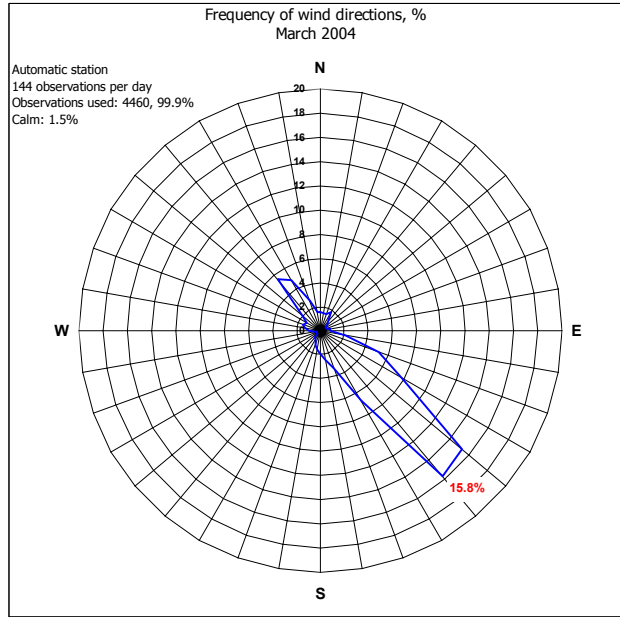
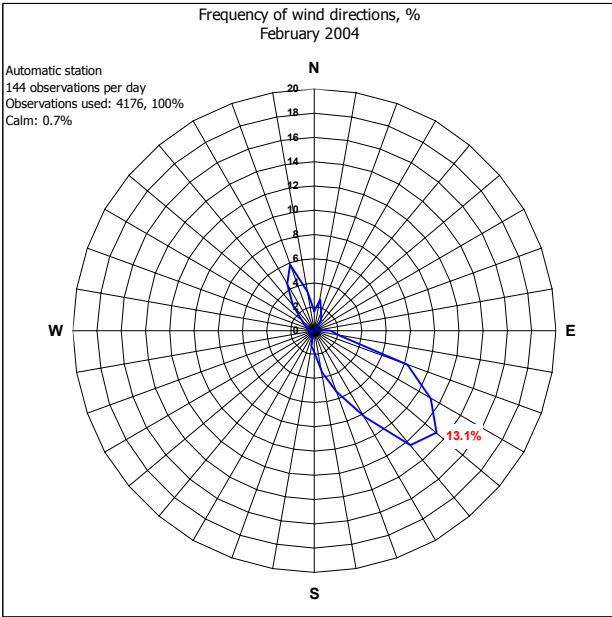
# Gvendarbás



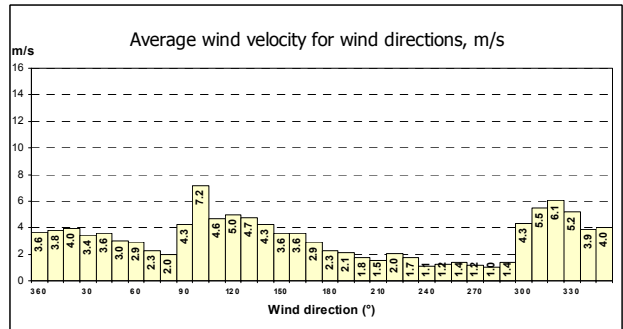
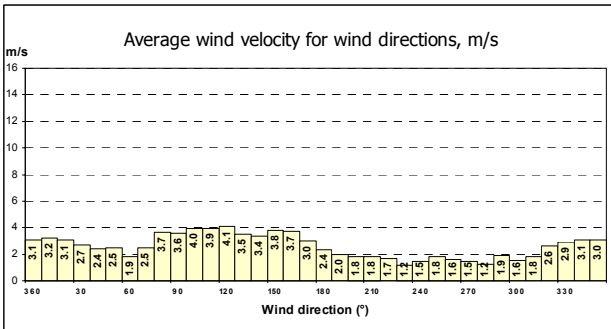
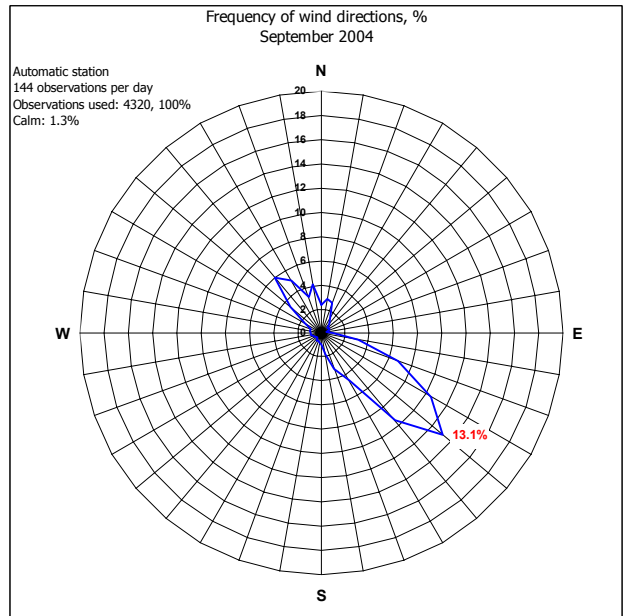
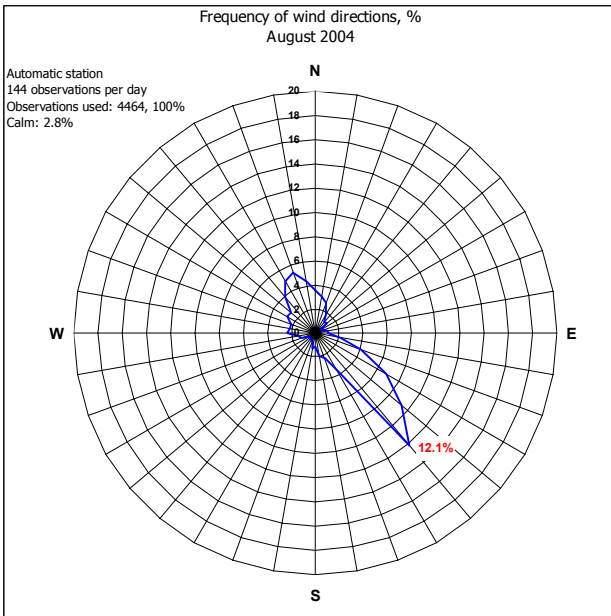
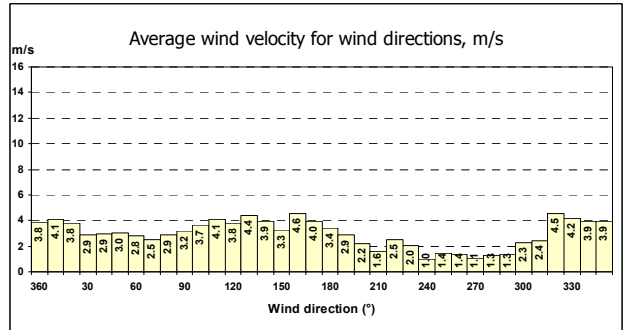
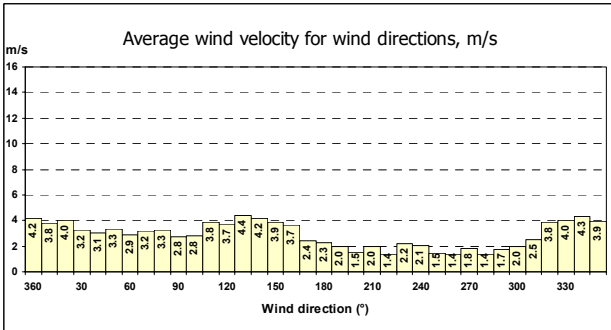
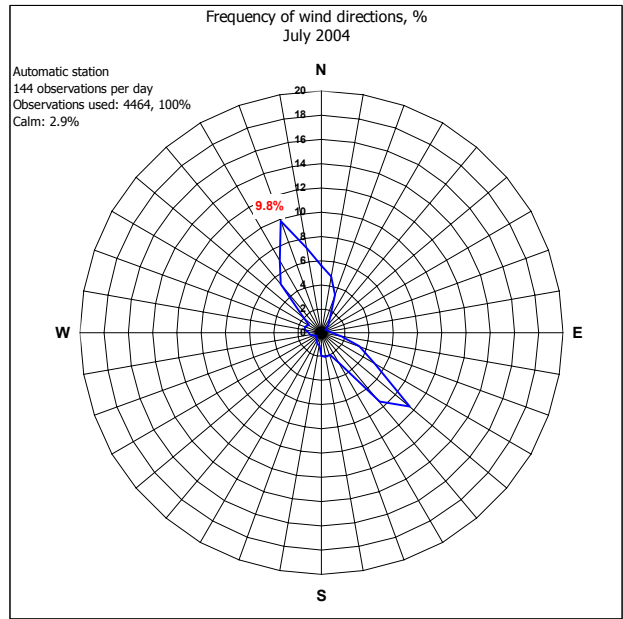
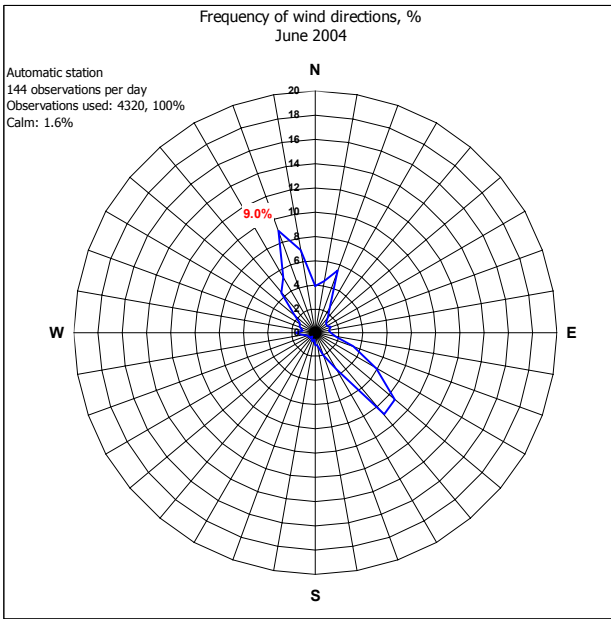
# Húsavík



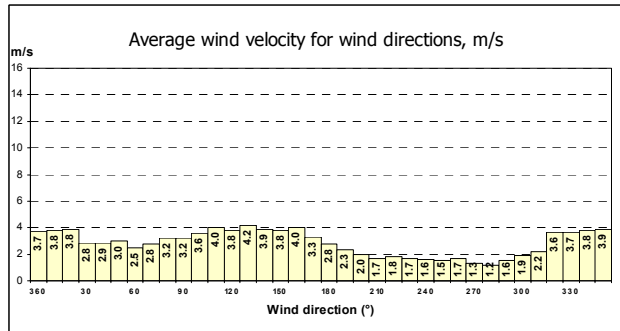
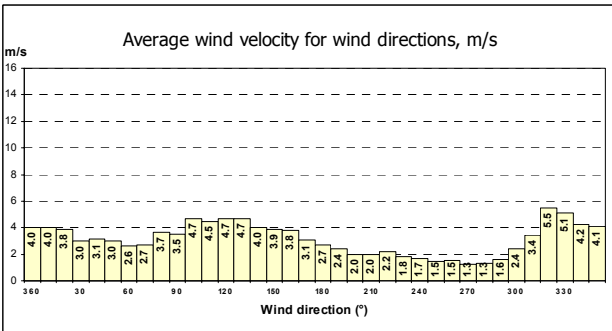
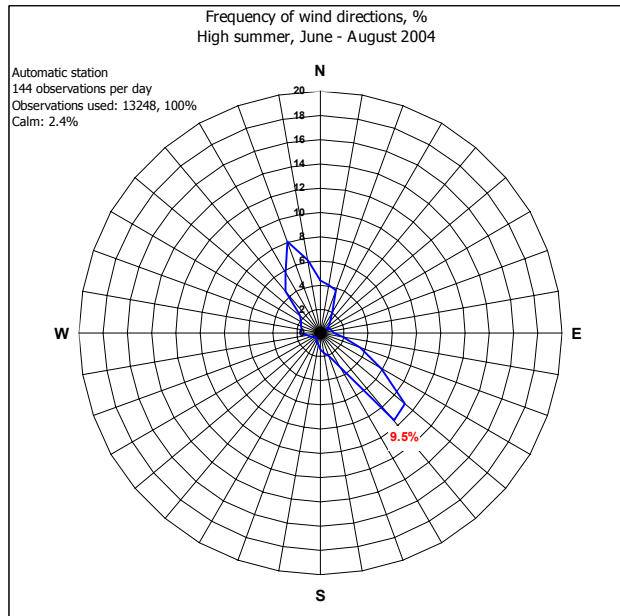
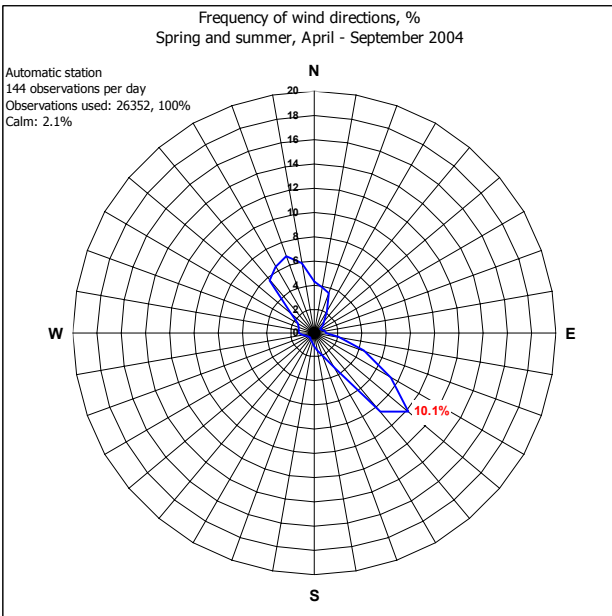
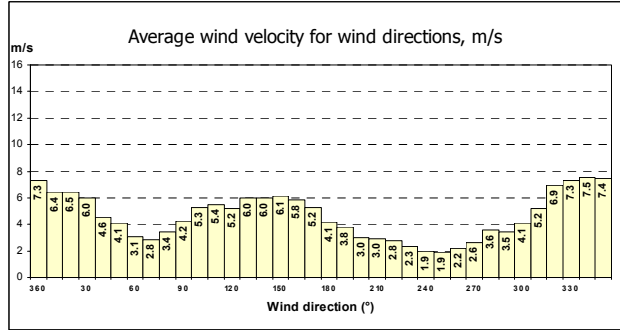
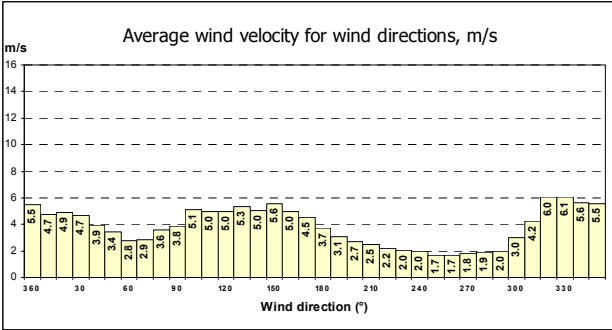
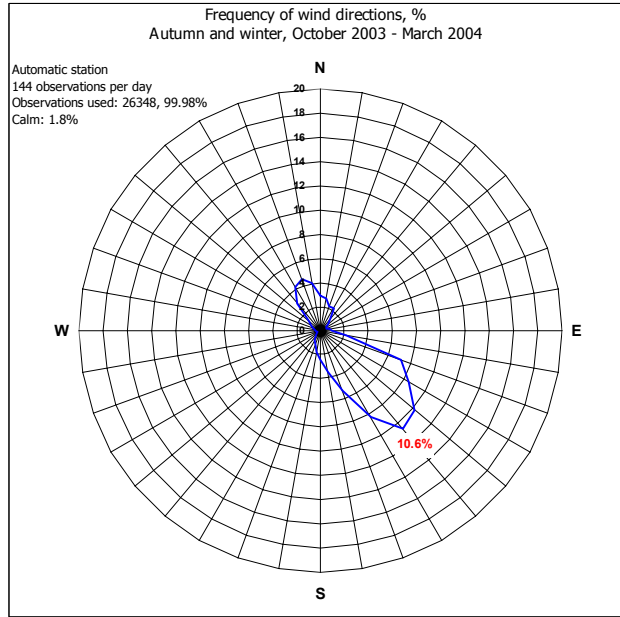
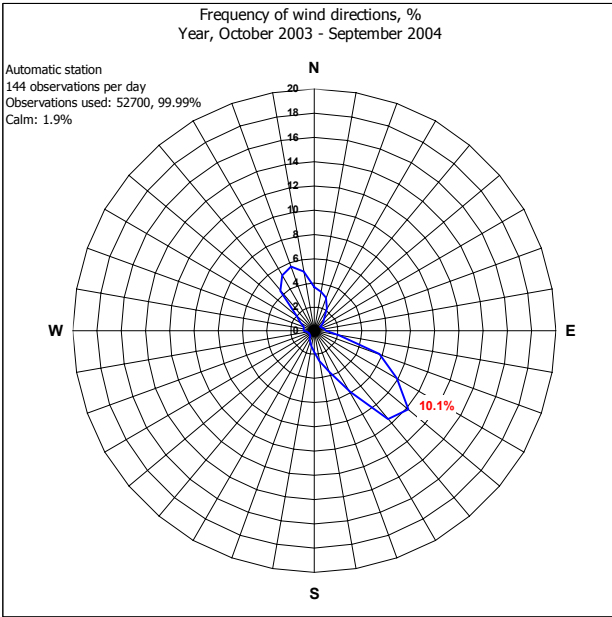
# Húsavík



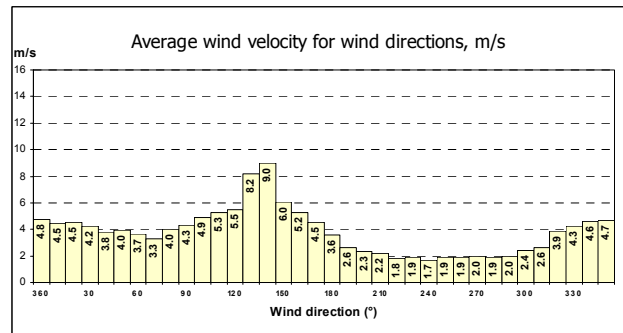
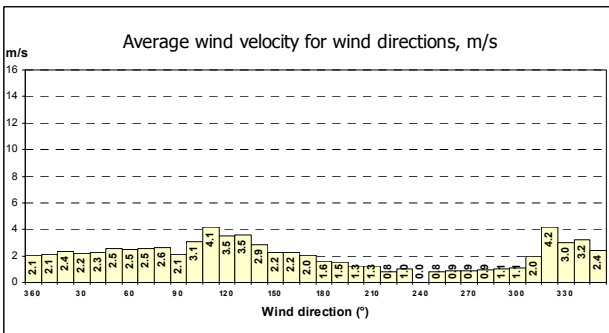
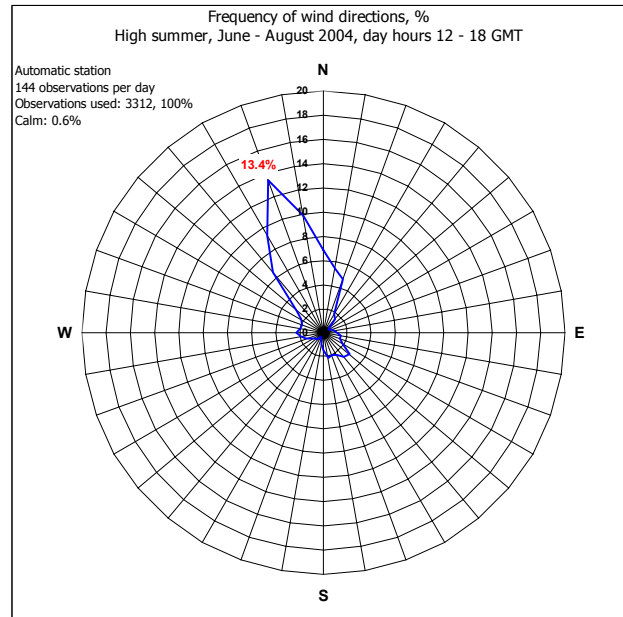
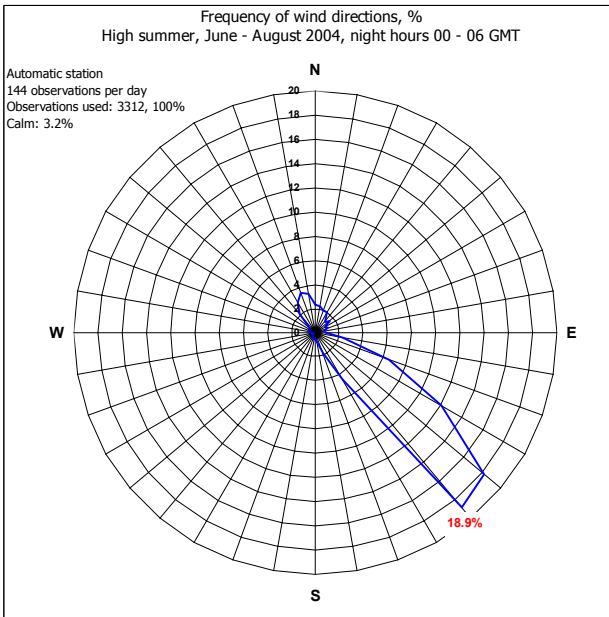
# Húsavík



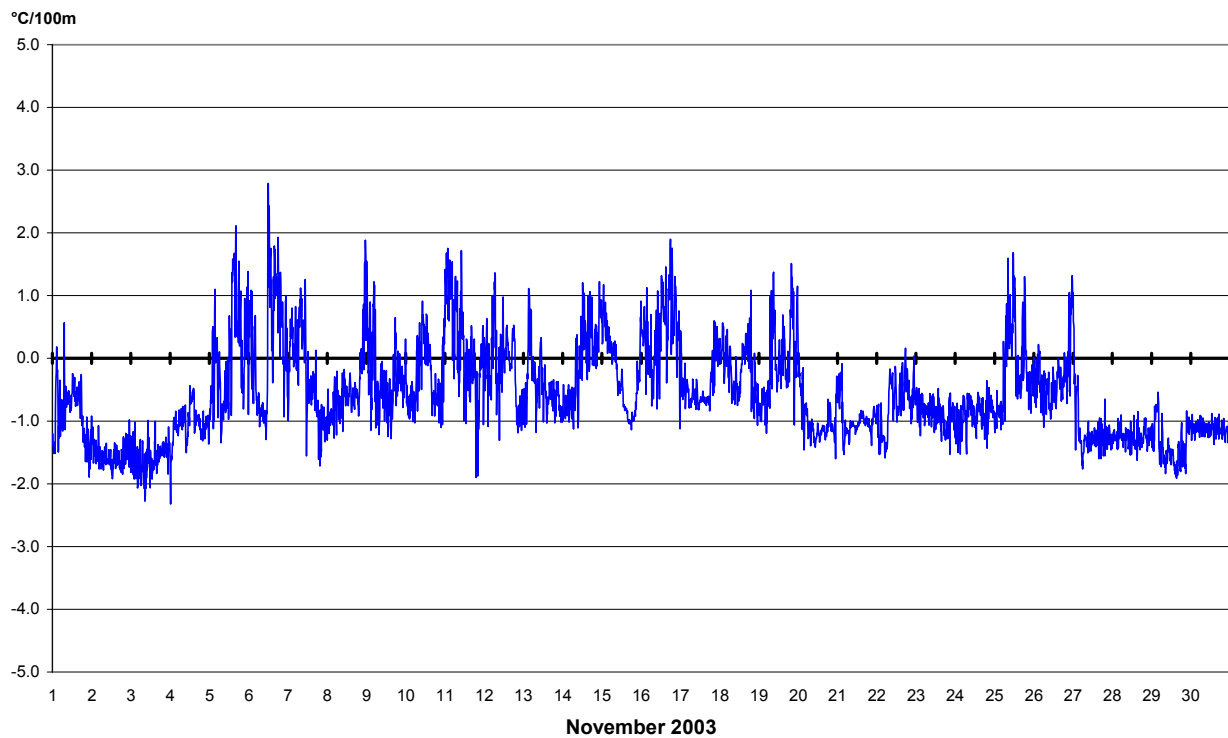
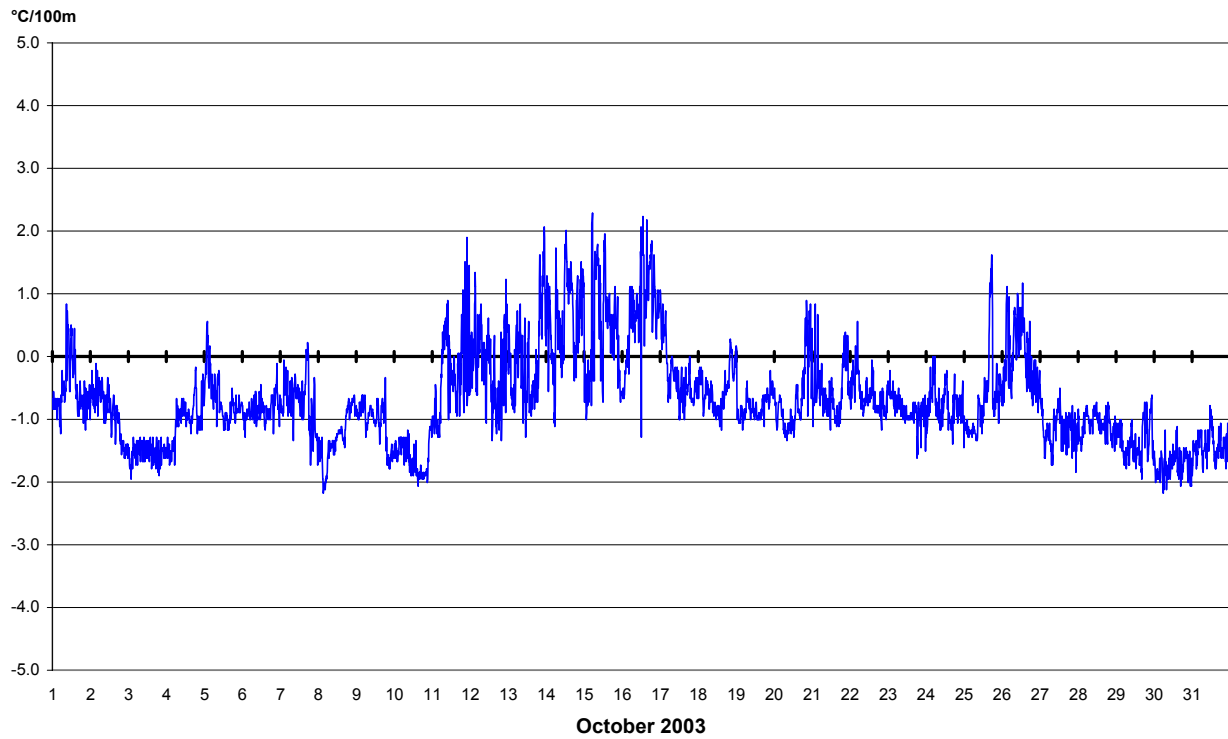
# Húsavík



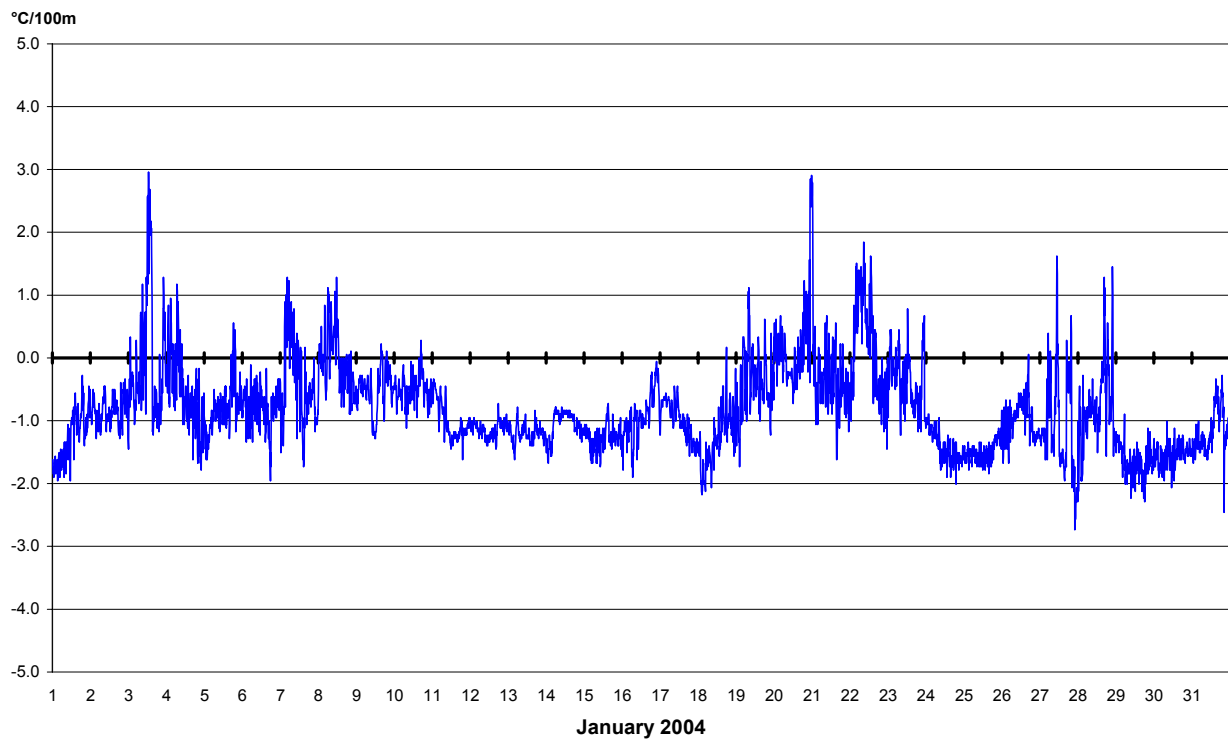
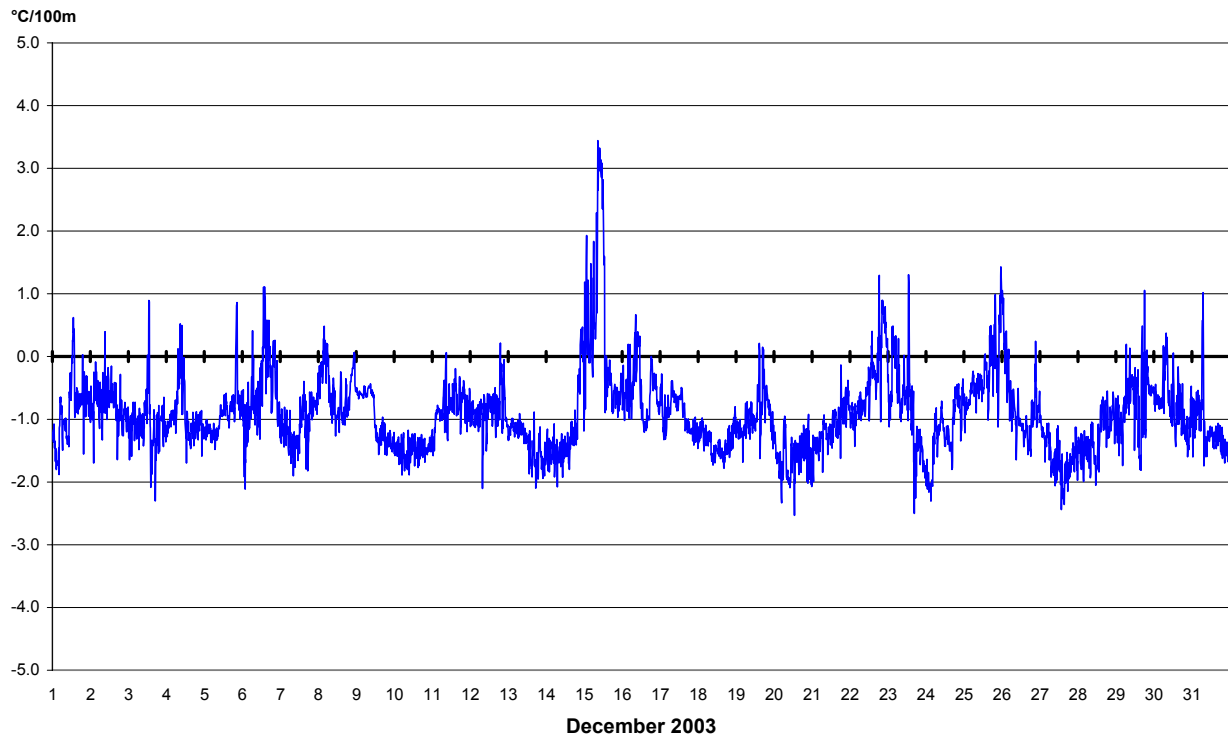
# Húsavík



# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Bakkahöfði (height difference 179 m)

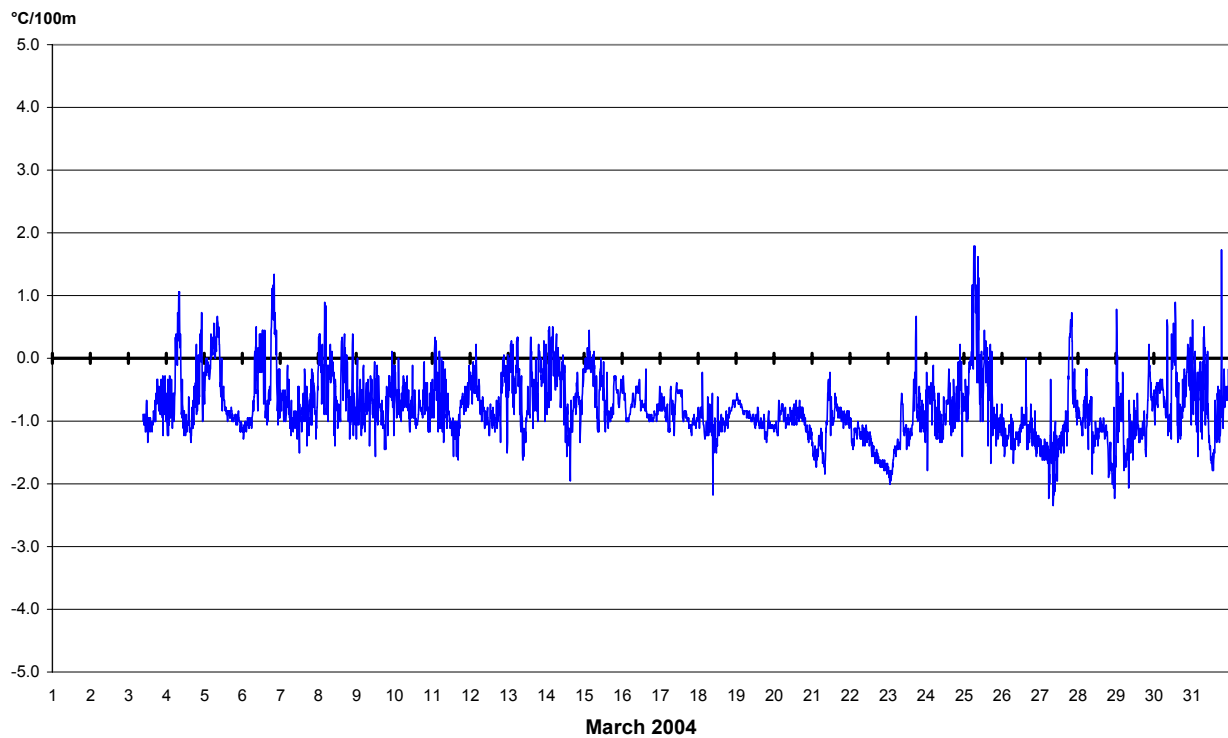
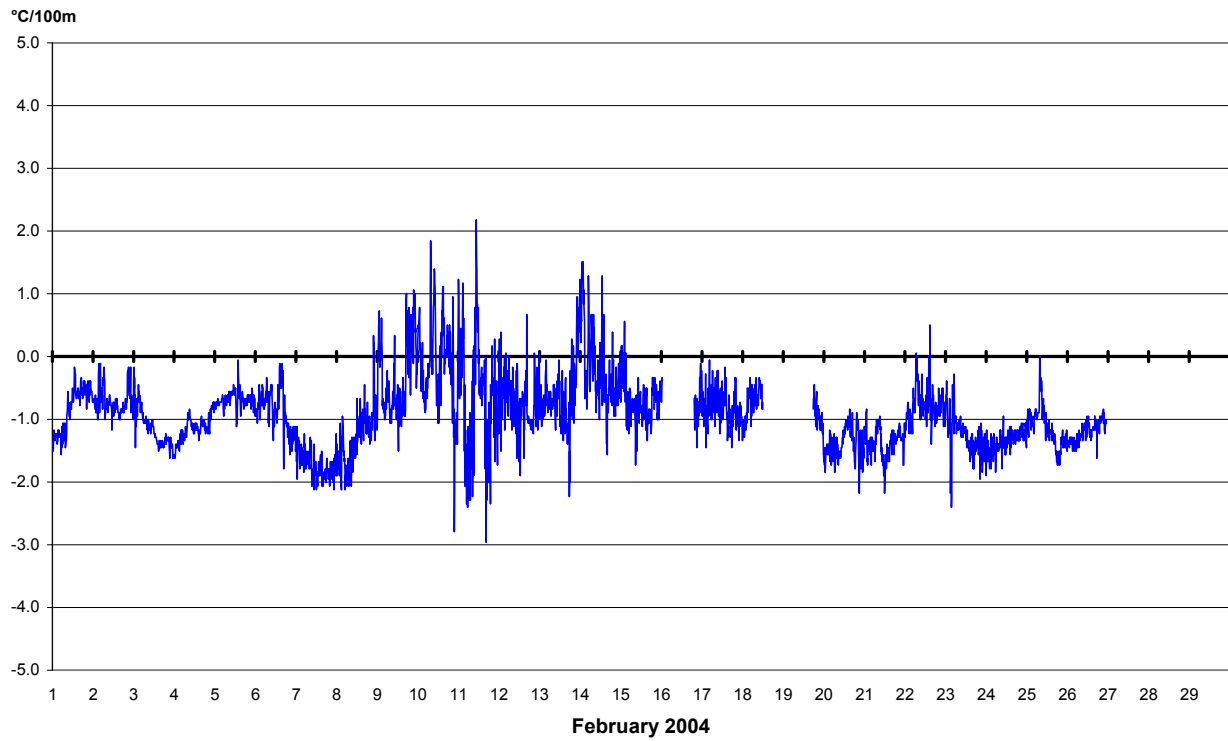


# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Bakkahöfði (height difference 179 m)

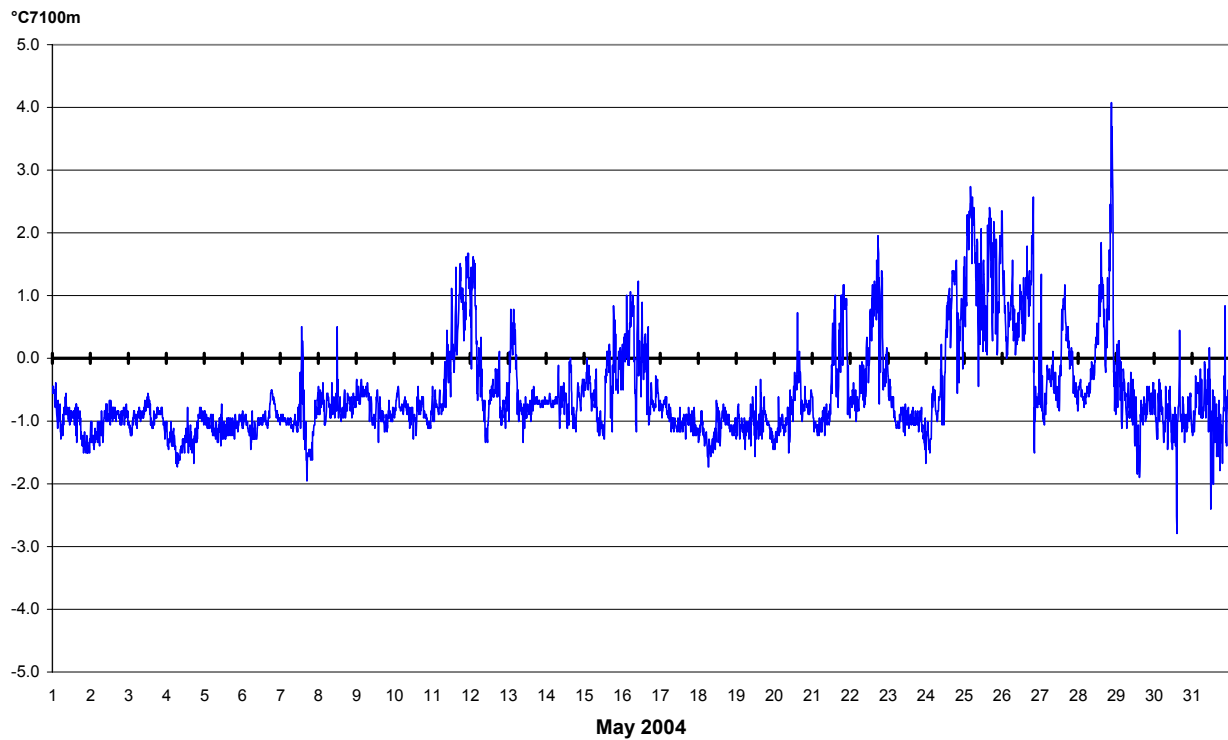
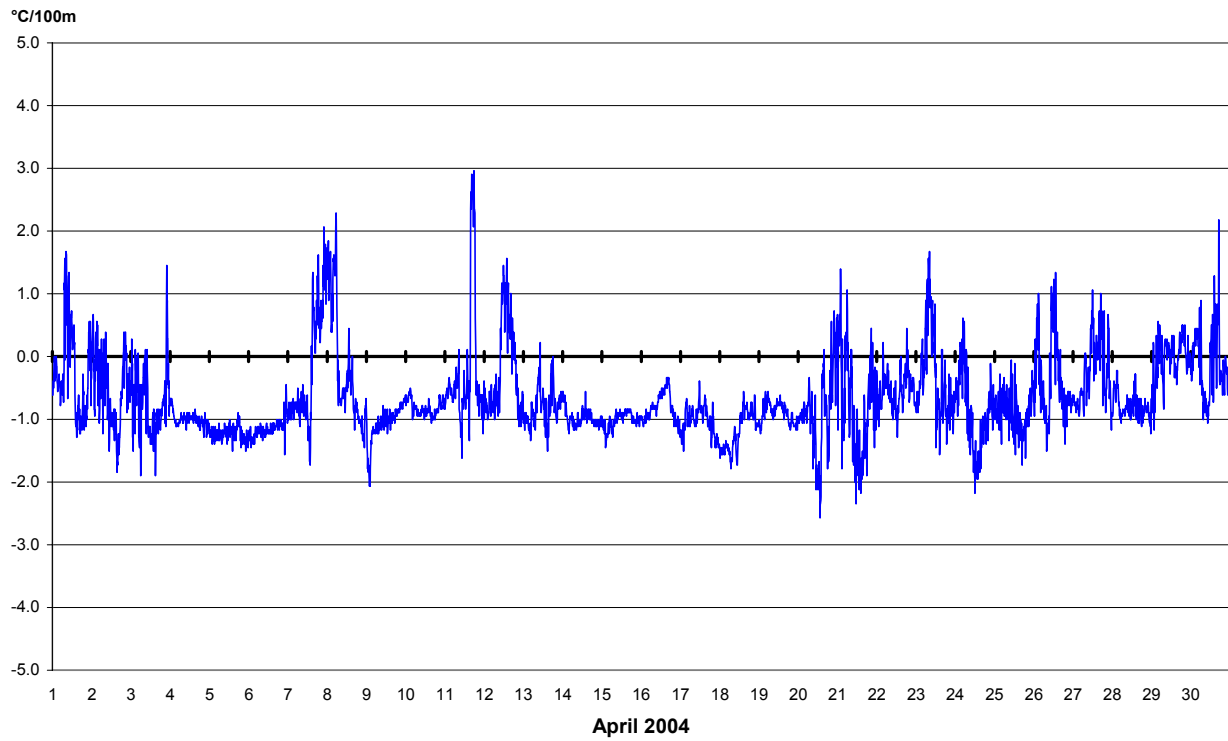




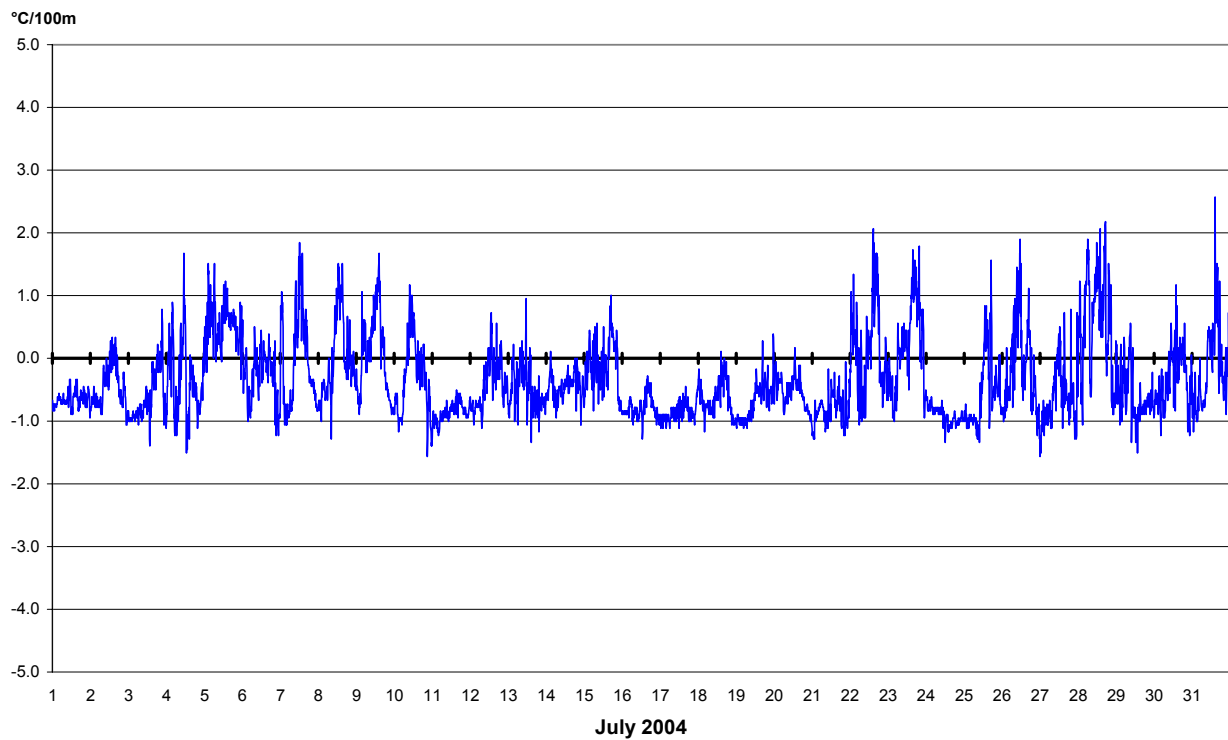
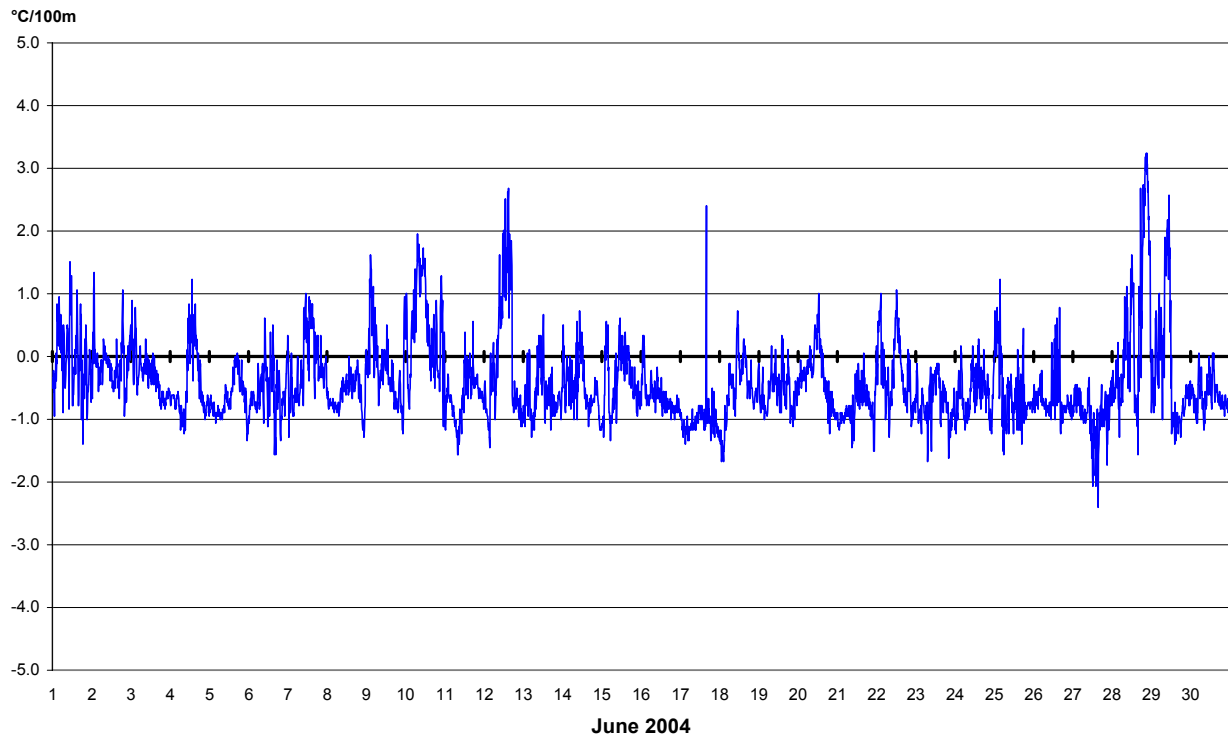
# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Bakkahöfði (height difference 179 m)



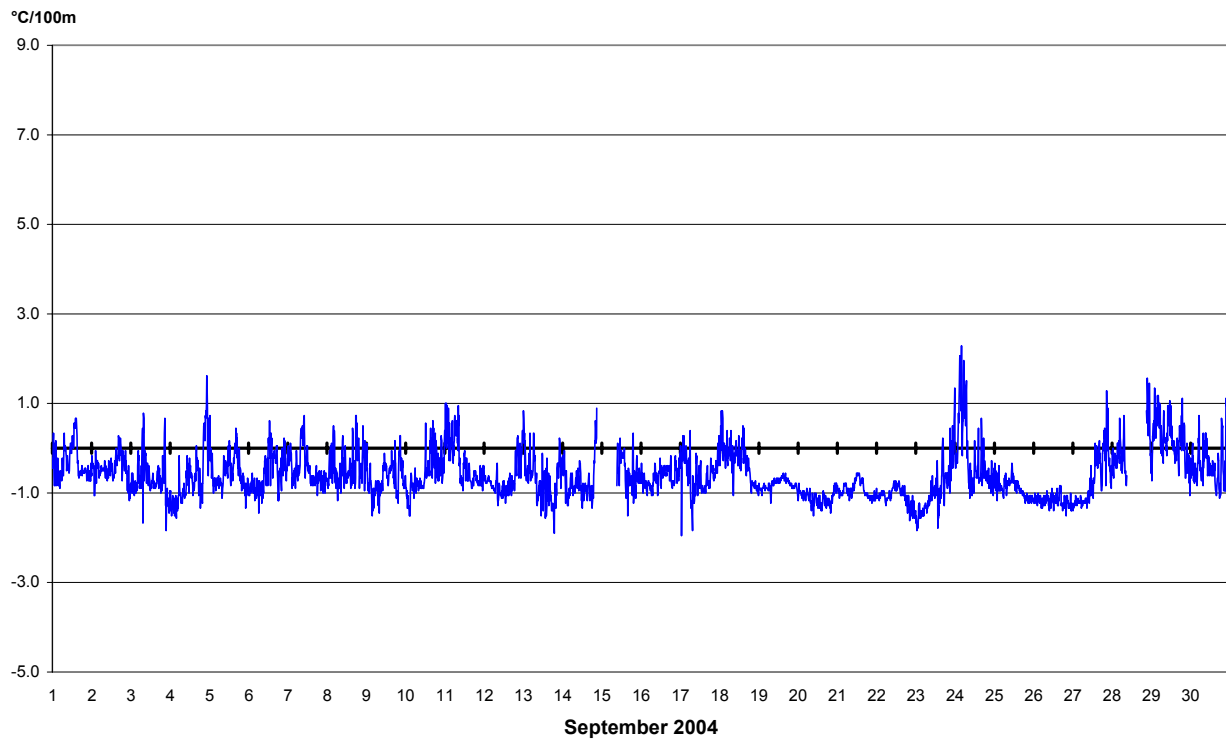
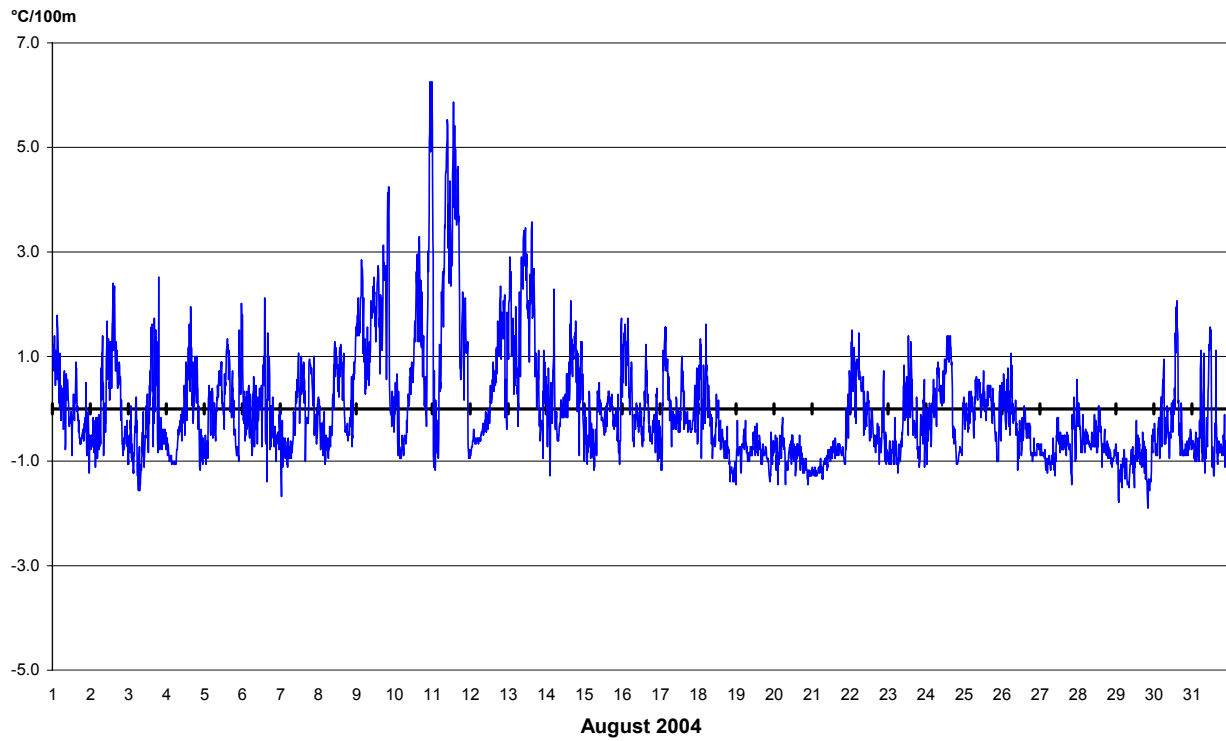
# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Bakkahöfði (height difference 179 m)



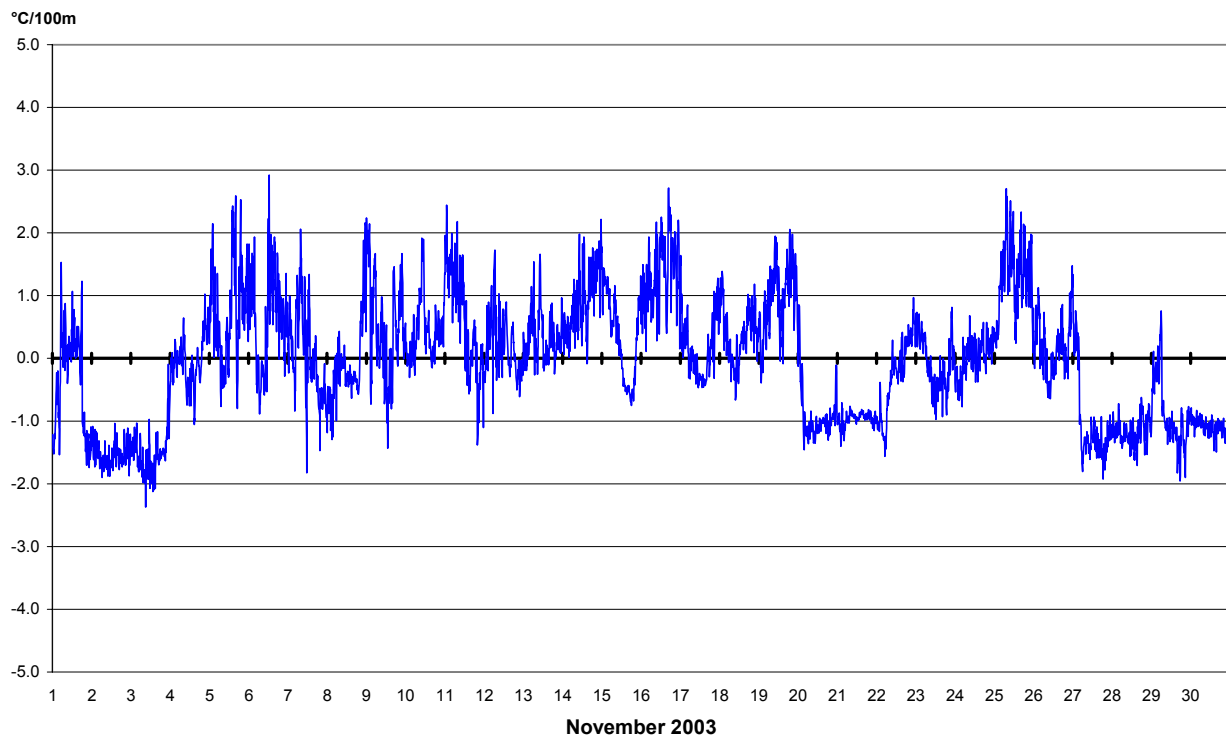
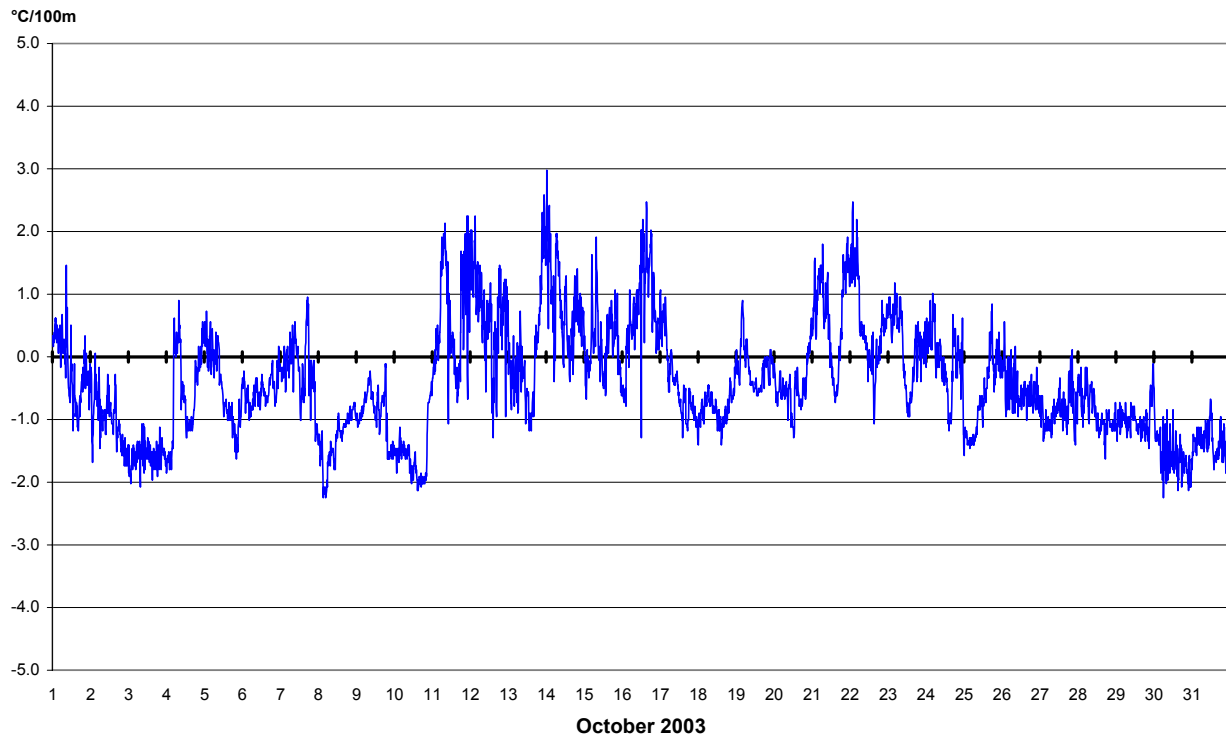
# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Bakkahöfði (height difference 179 m)



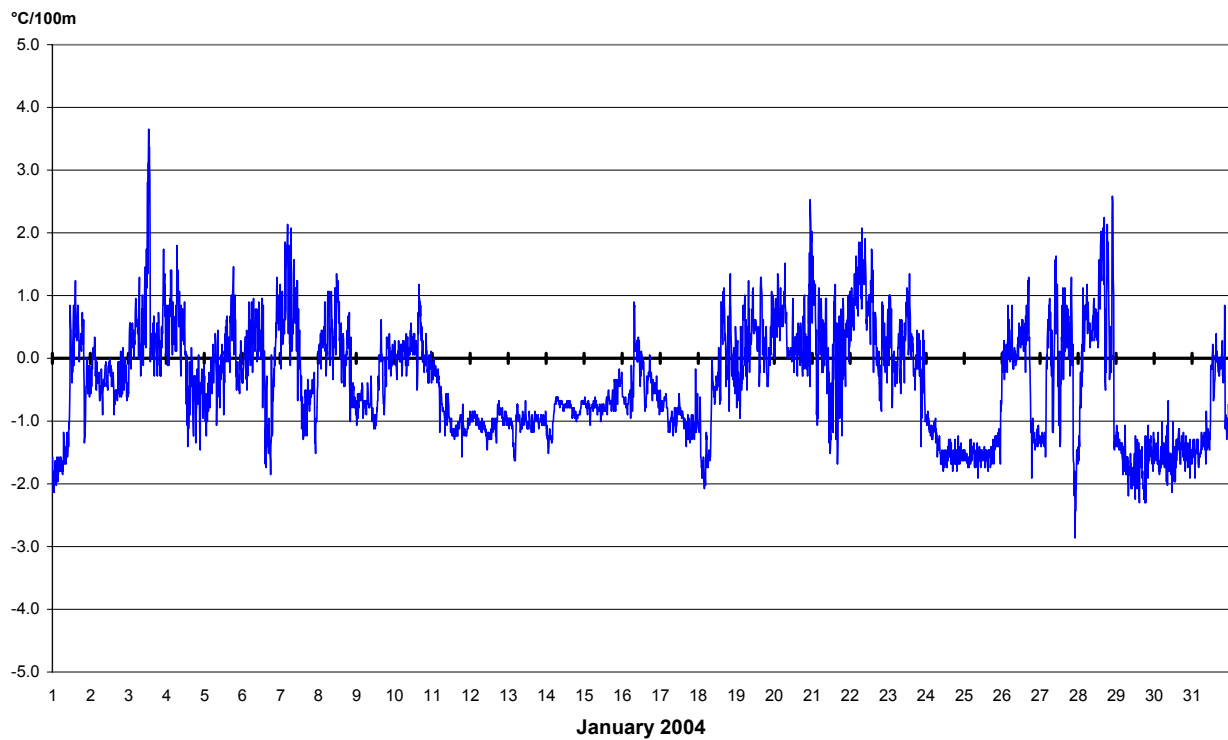
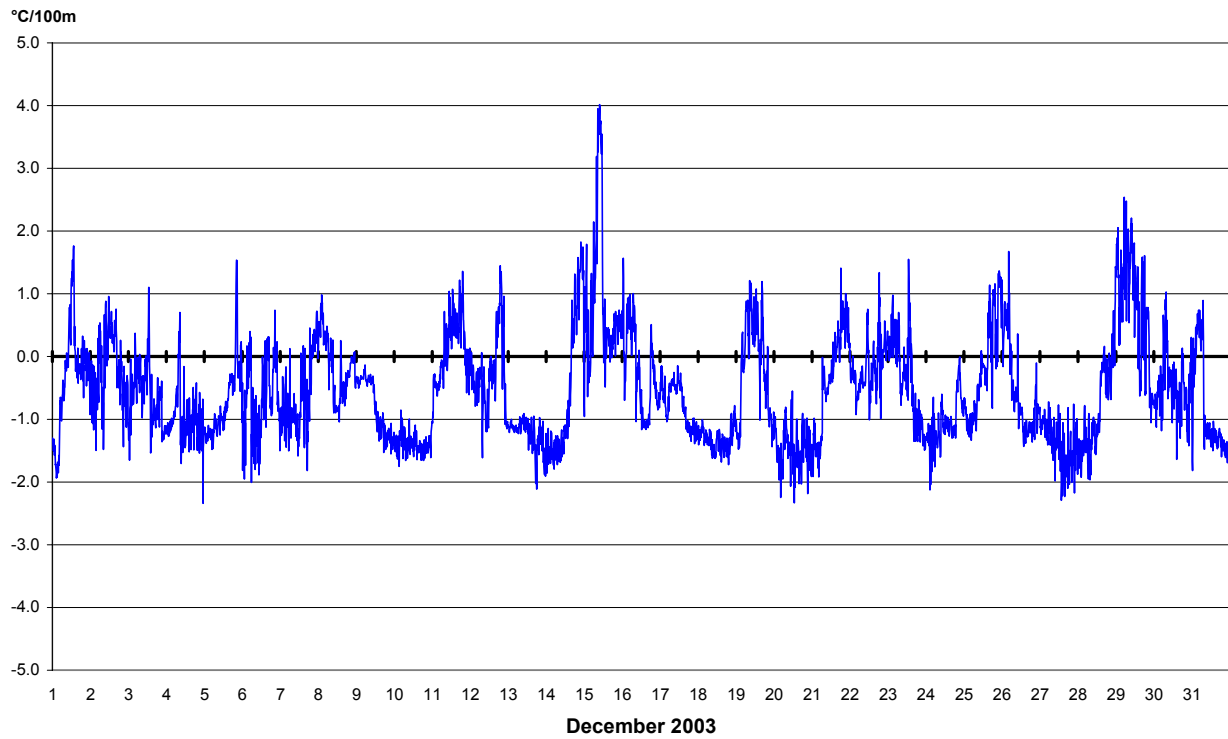
# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Bakkahöfði (height difference 179 m)



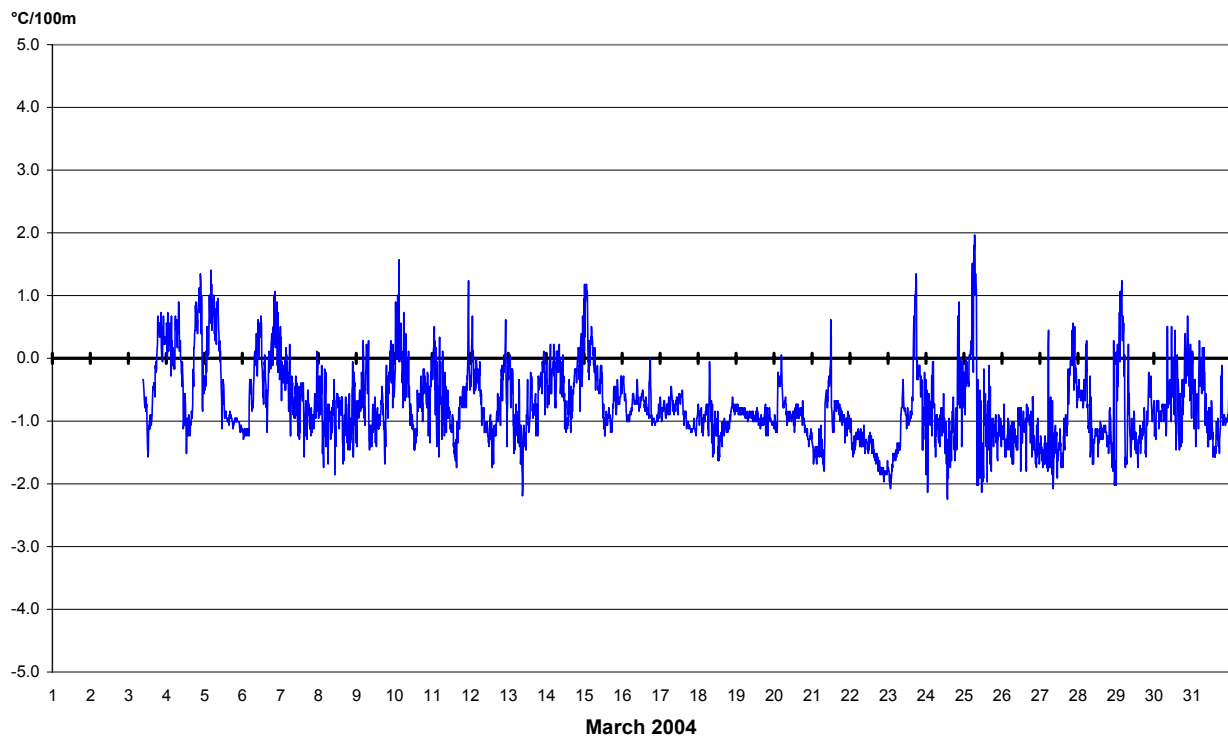
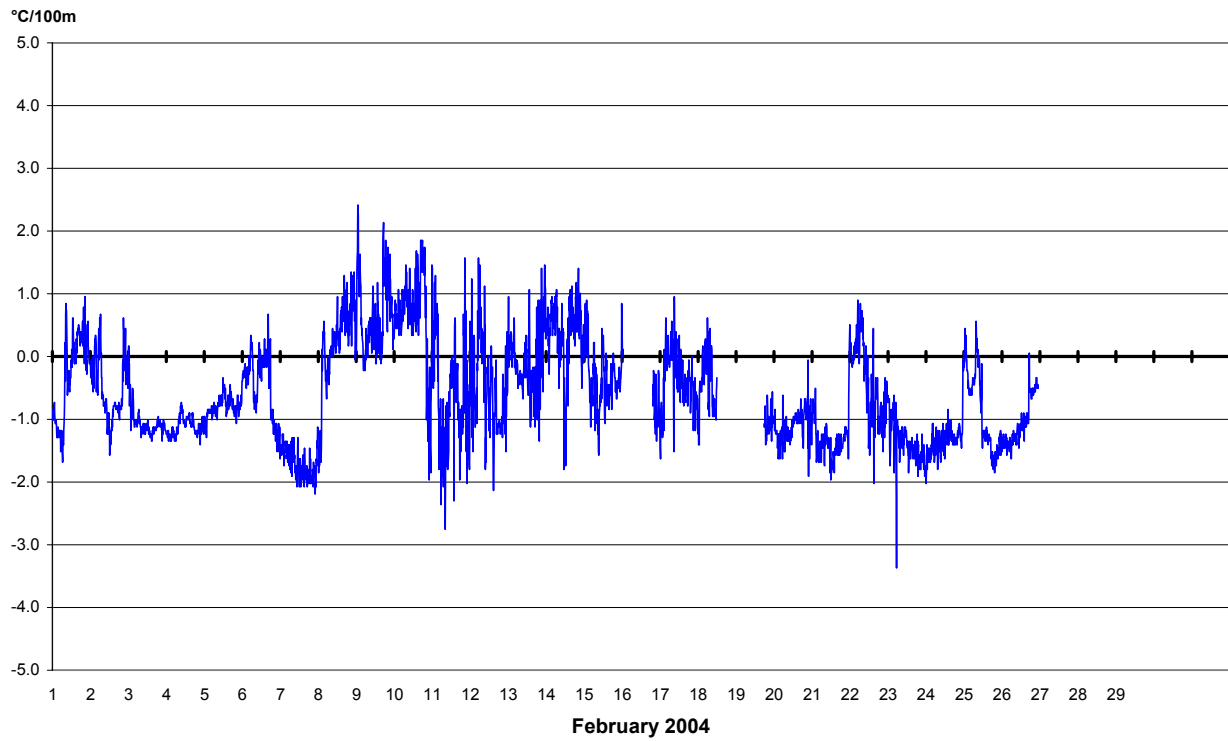
## Vertical temperature gradient, °C/100 m Húsavíkurfjall – Gvendarbás (height difference 178 m)



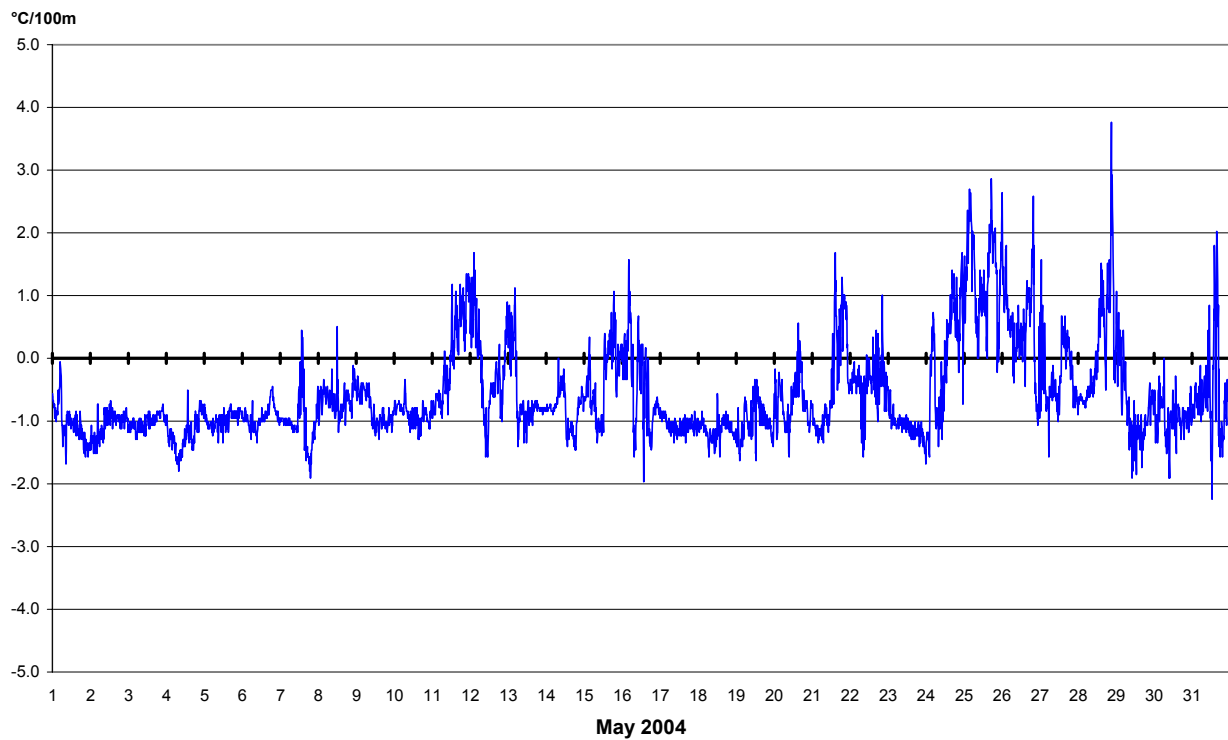
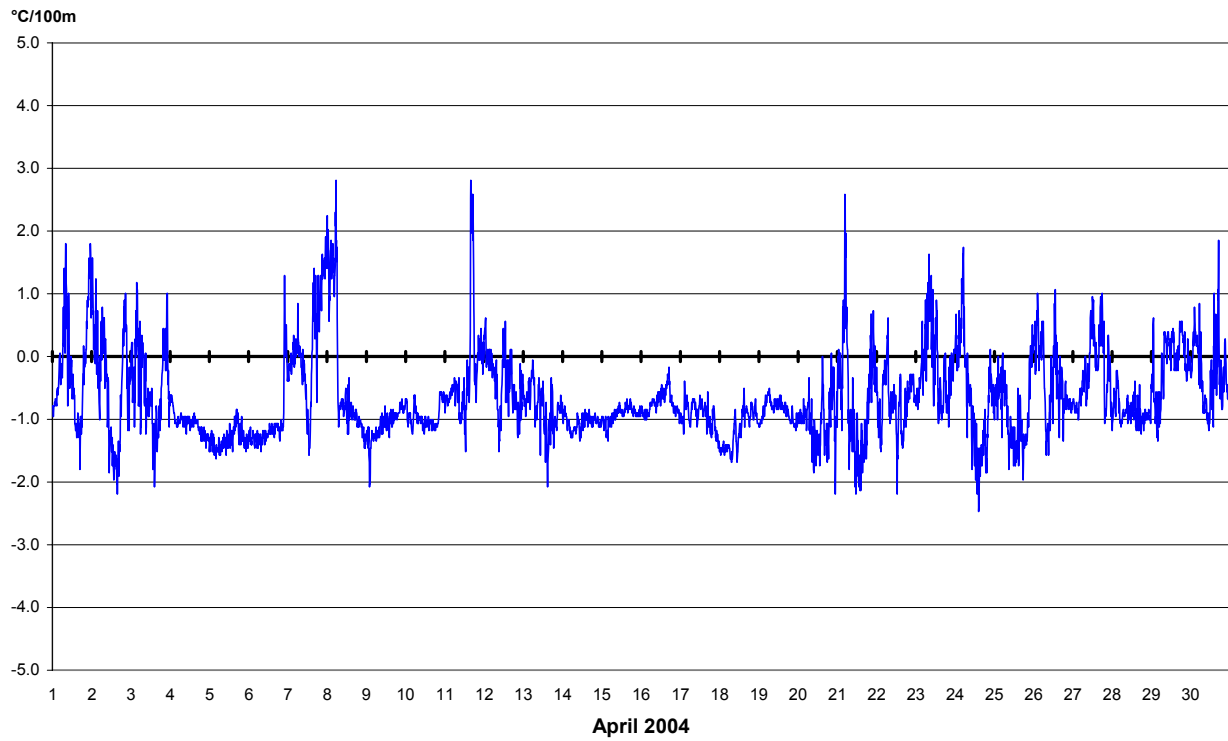
# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Gvendarbás (height difference 178 m)



# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Gvendarbás (height difference 178 m)

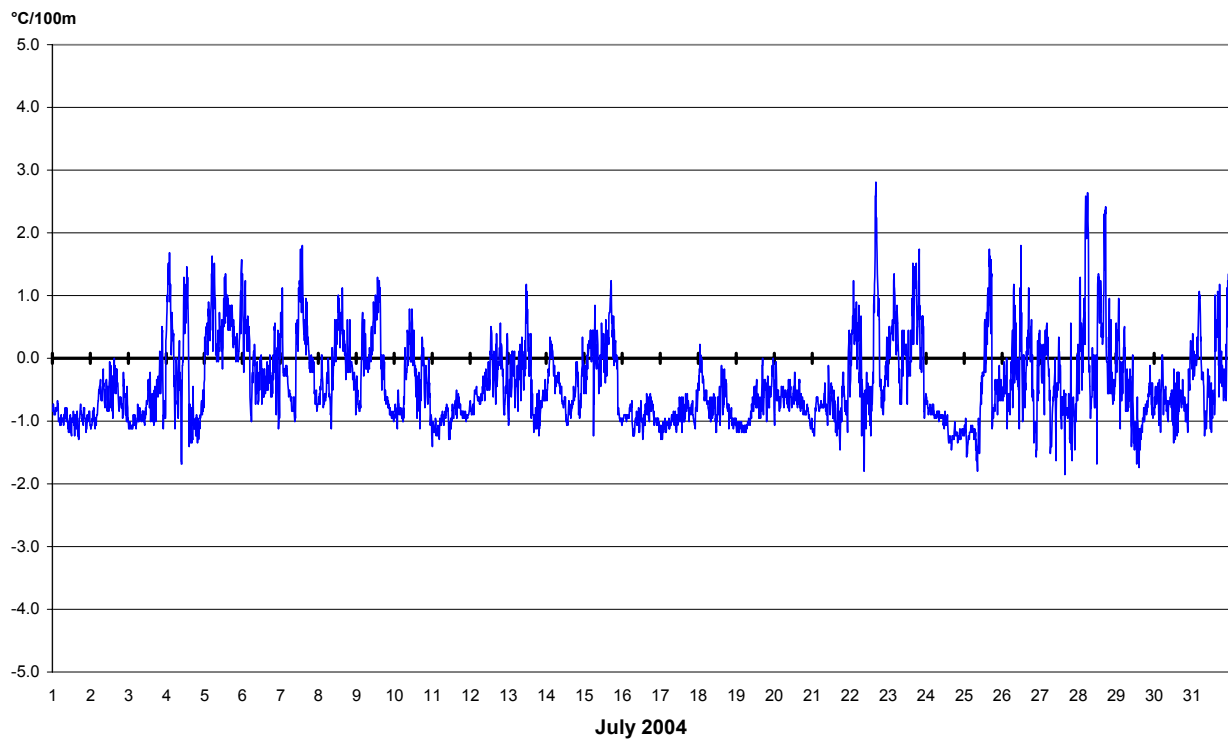
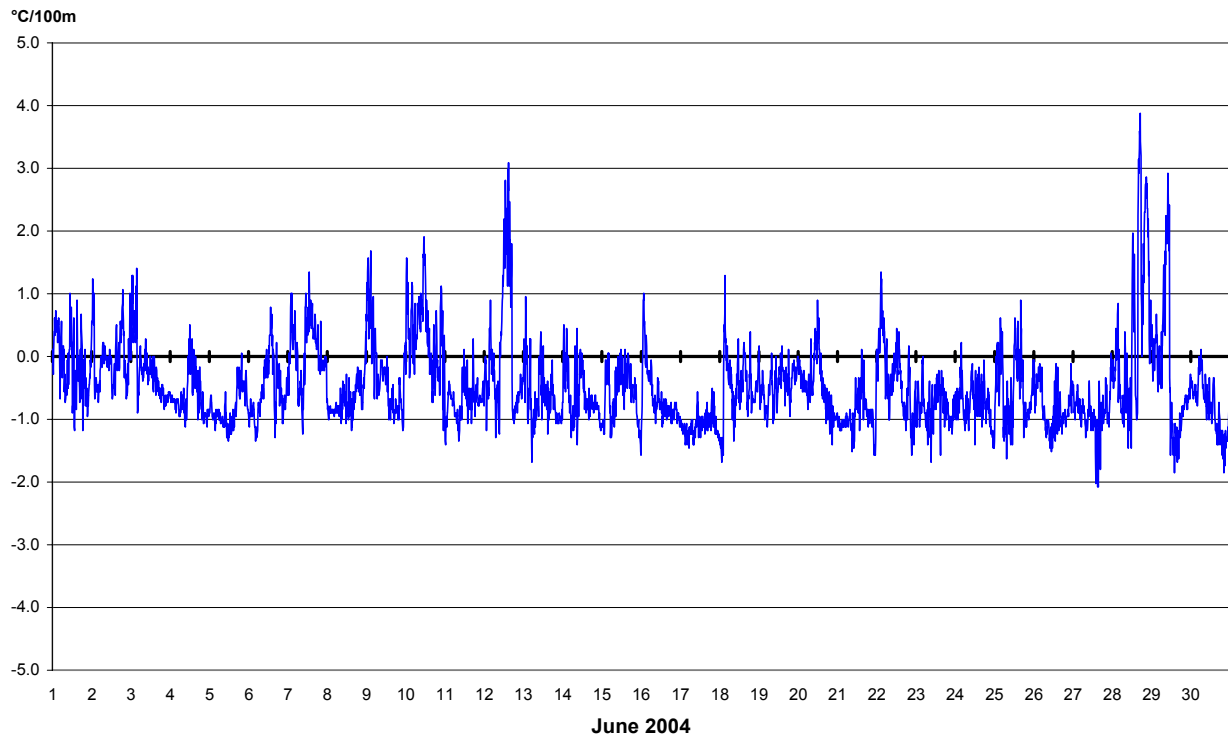


# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Gvendarbás (height difference 178 m)

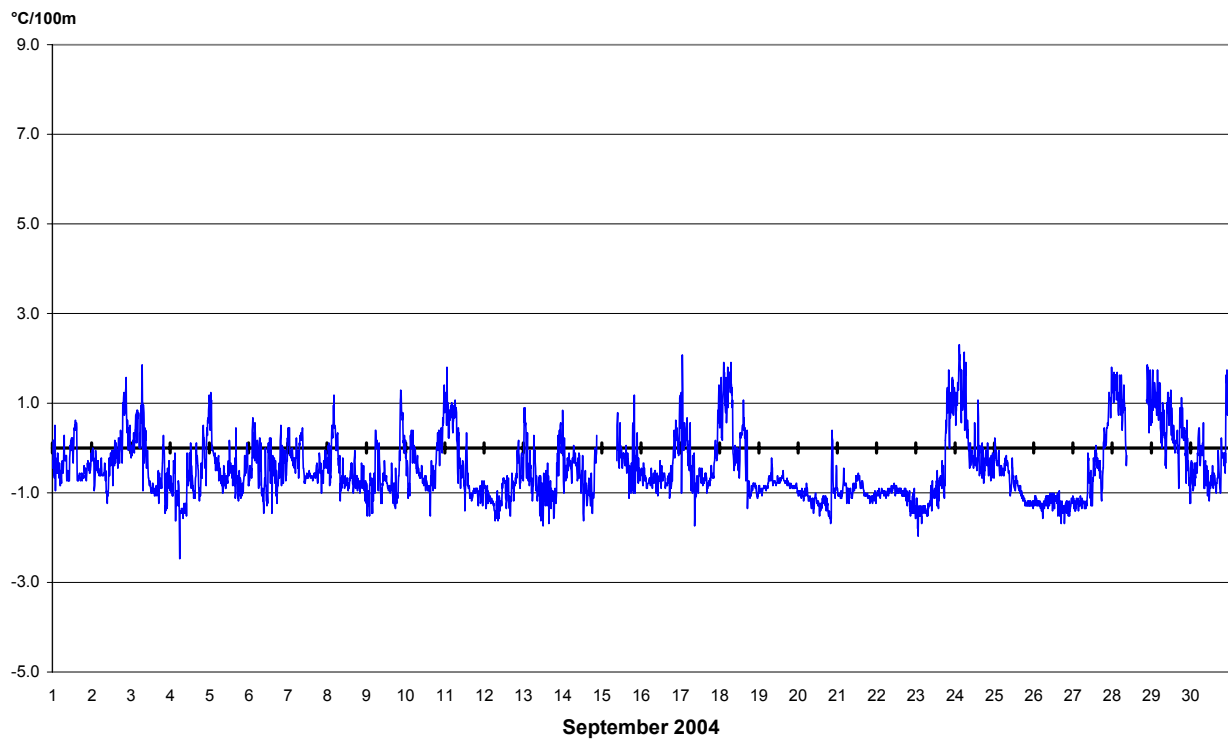
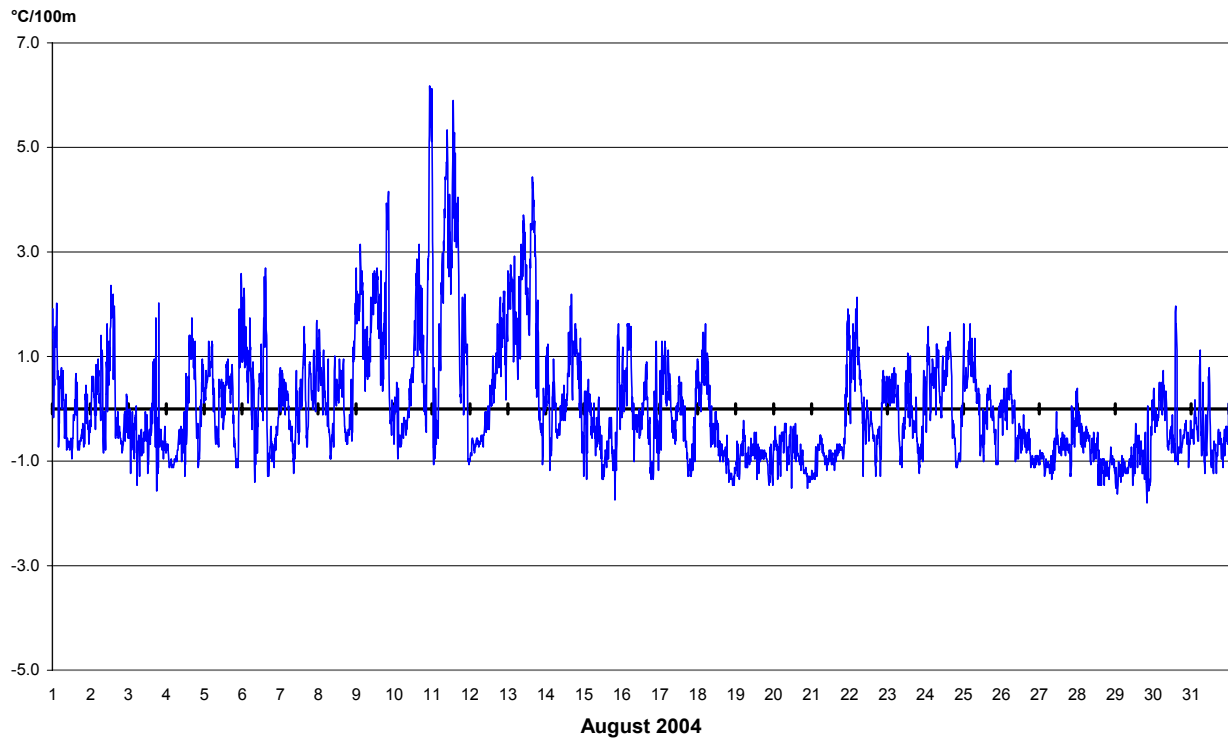




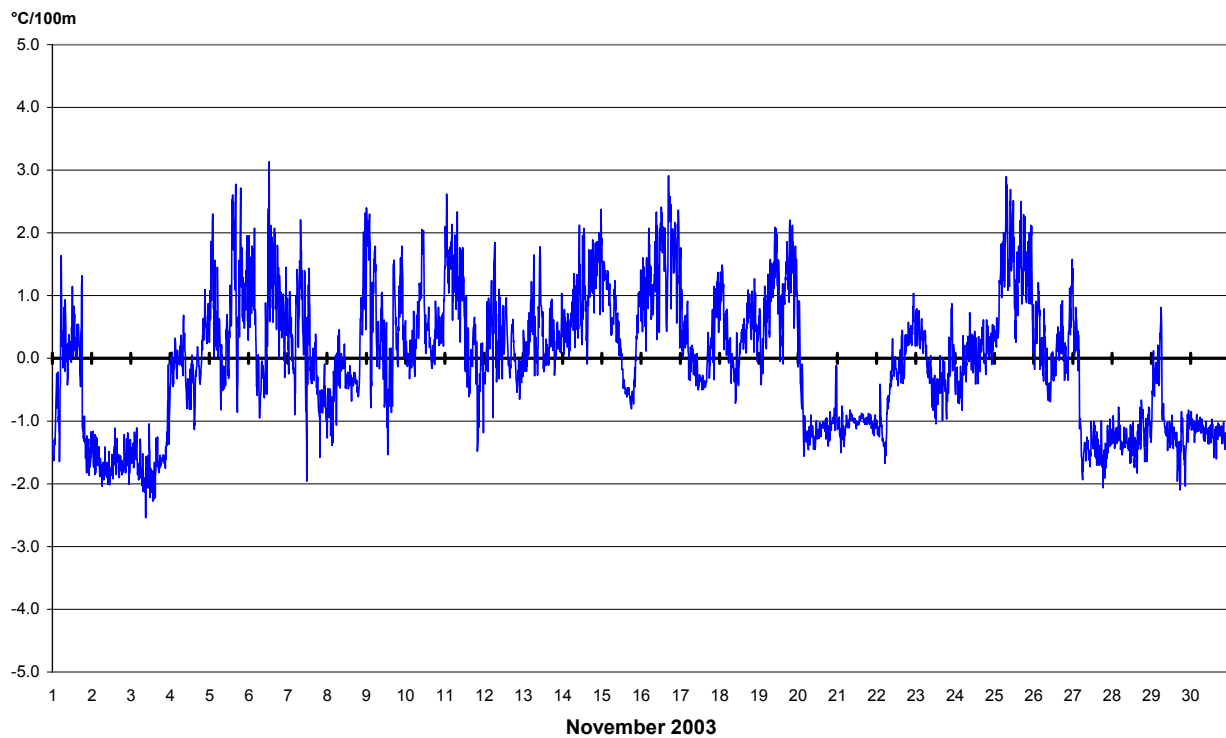
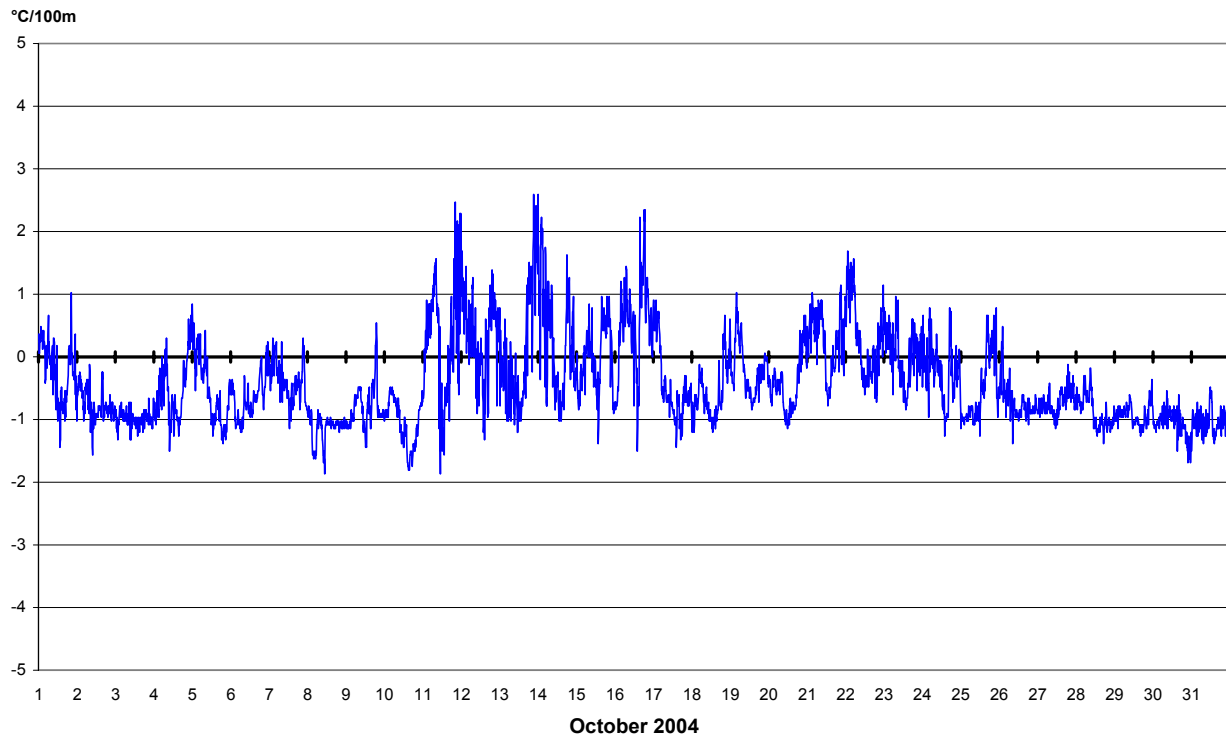
# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Gvendarbás (height difference 178 m)



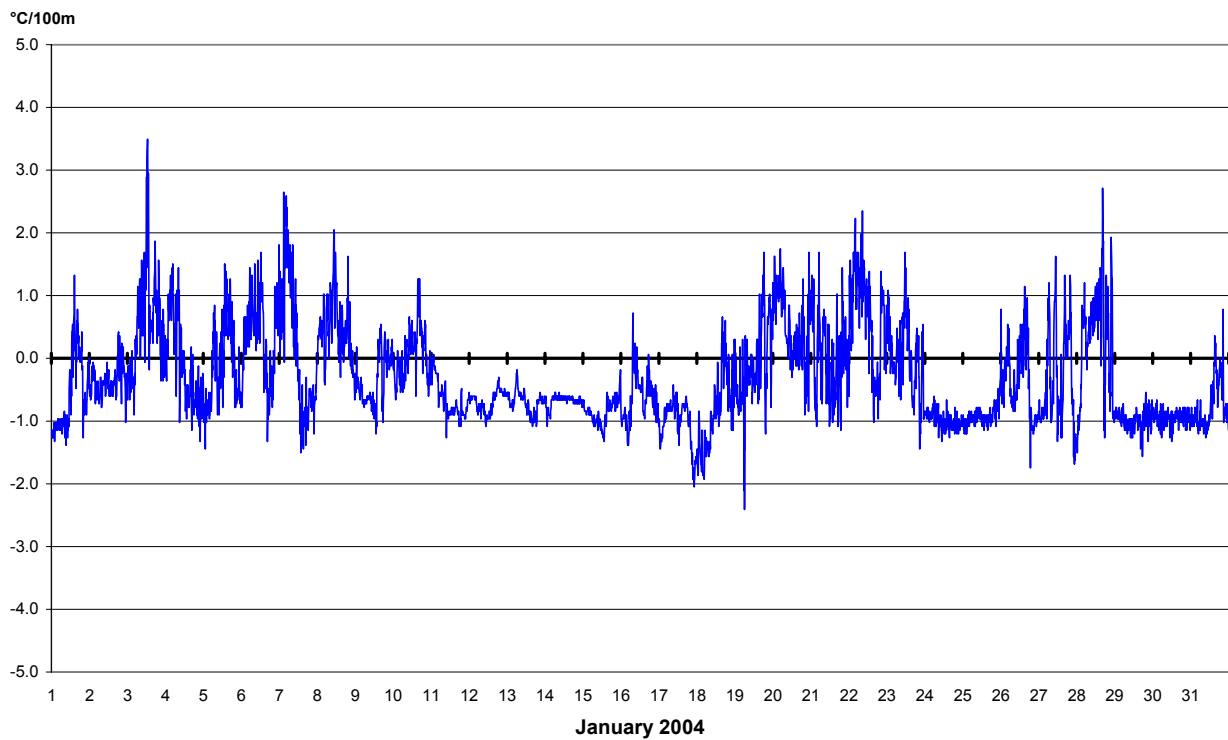
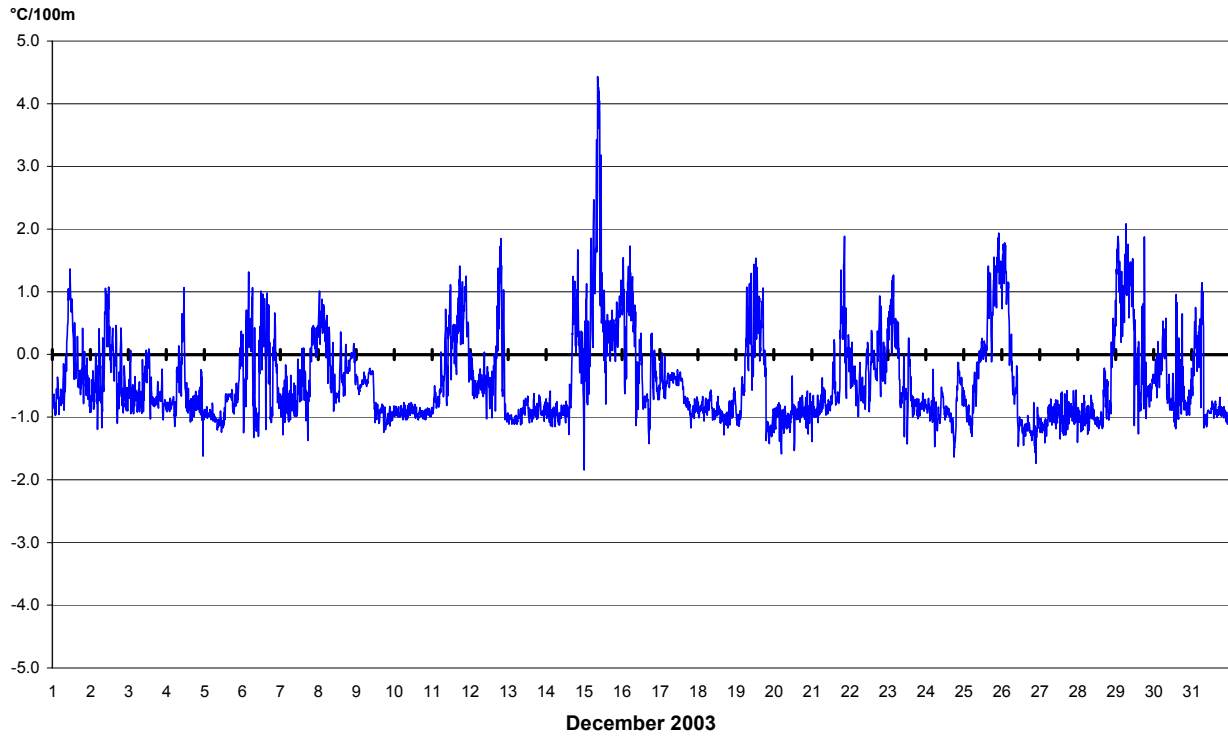
# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Gvendarbás (height difference 178 m)



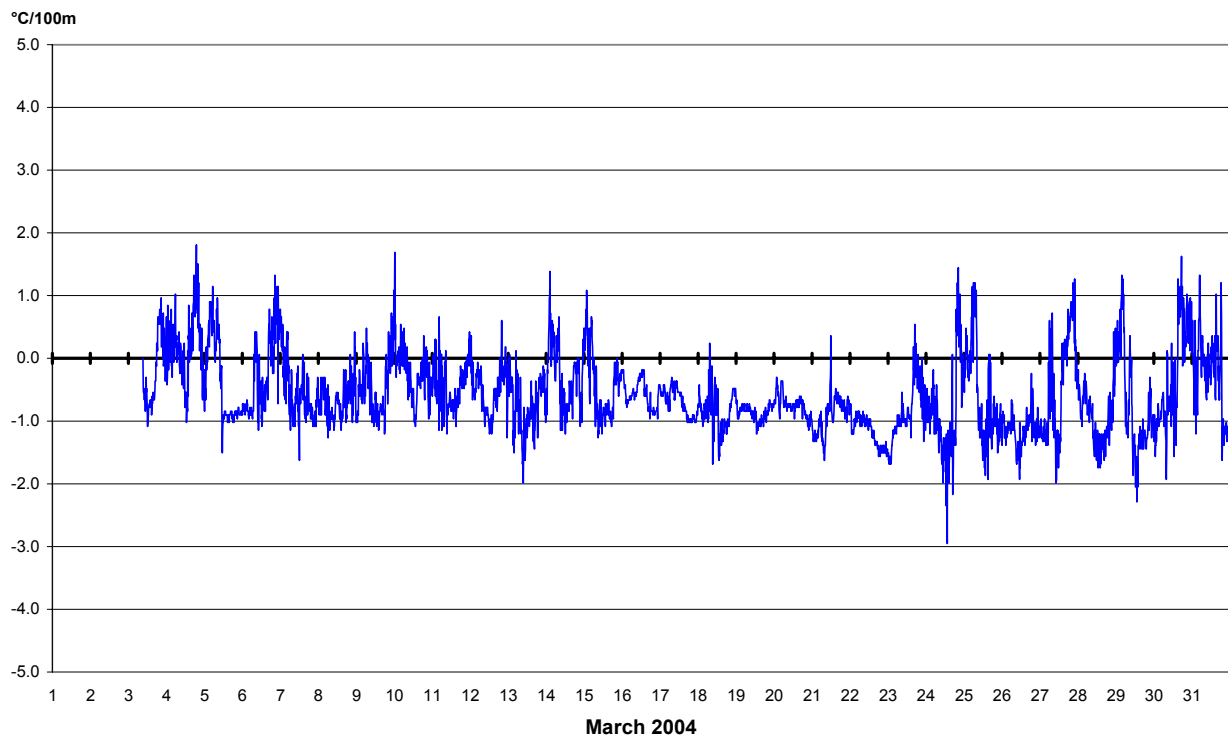
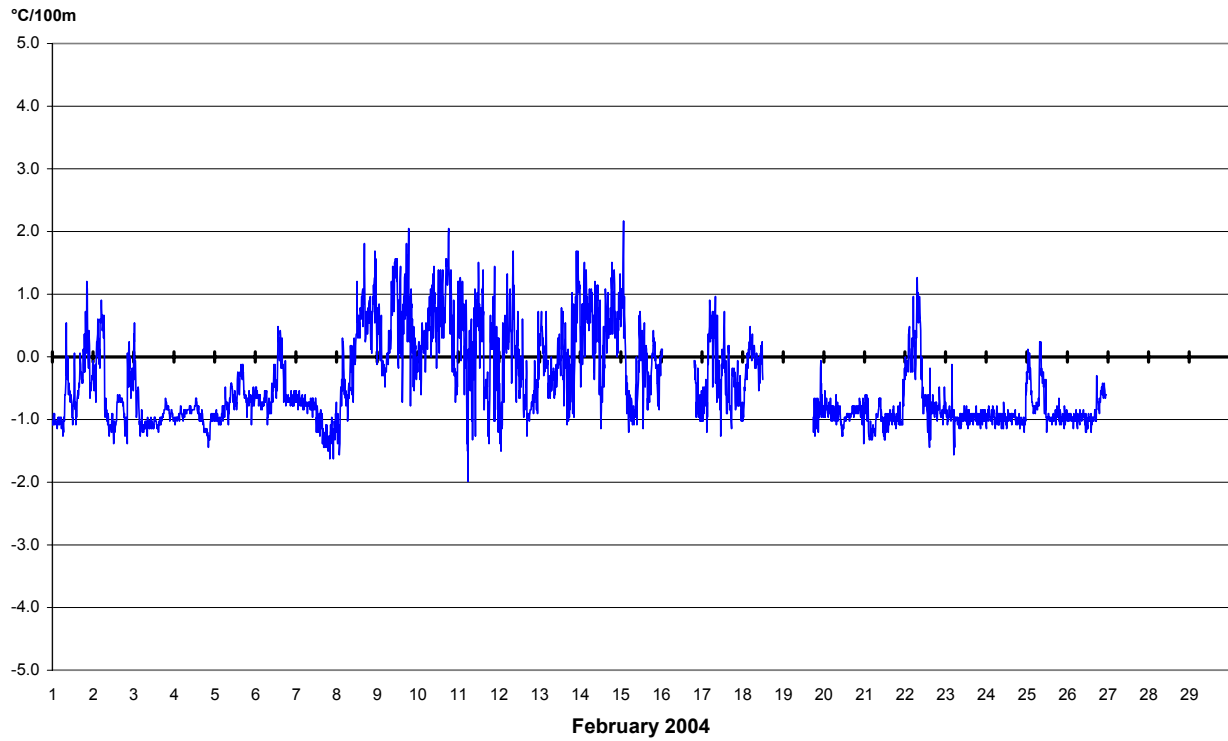
## Vertical temperature gradient, °C/100 m Húsavíkurfjall – Húsavík (height difference 166 m)



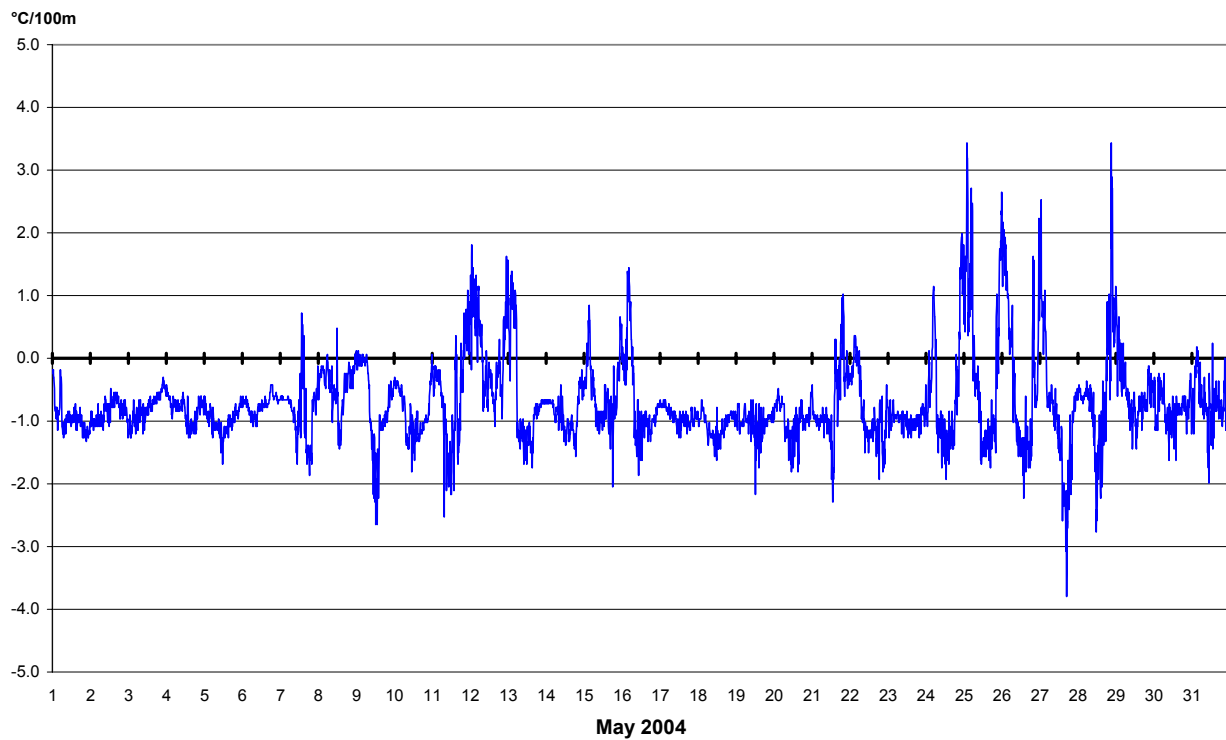
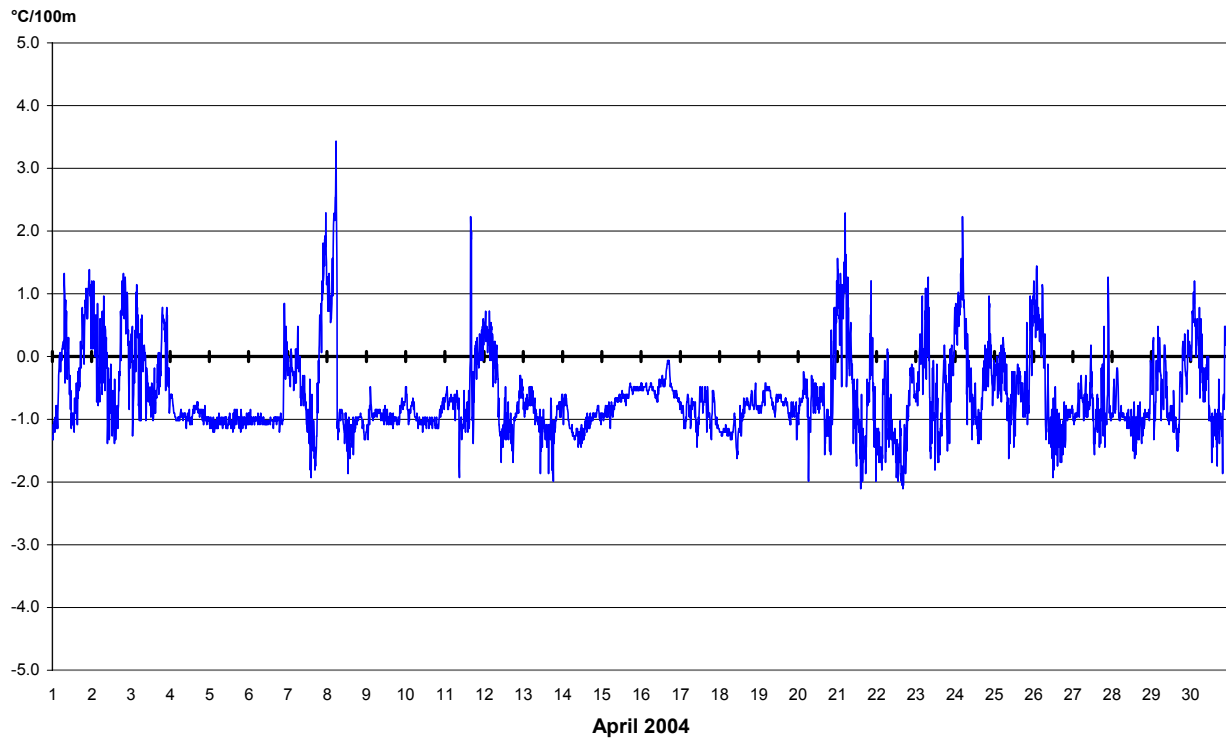
## Vertical temperature gradient, °C/100 m Húsavíkurfjall – Húsavík (height difference 166 m)



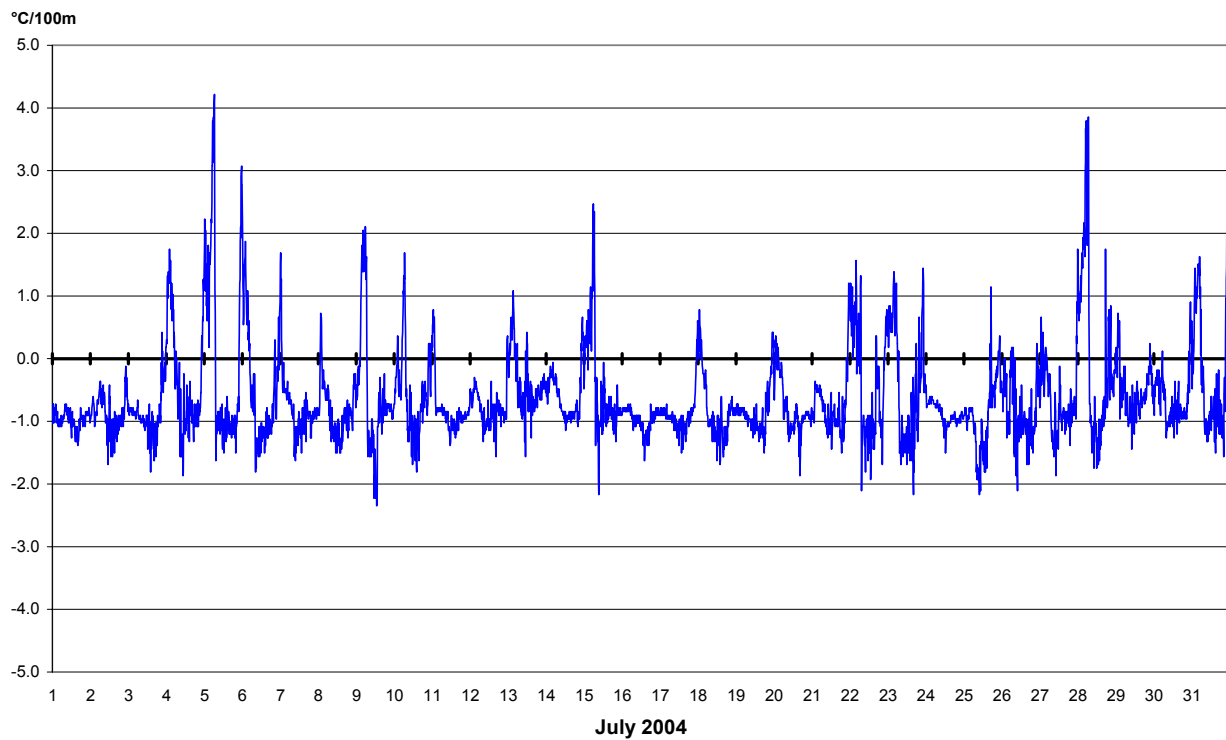
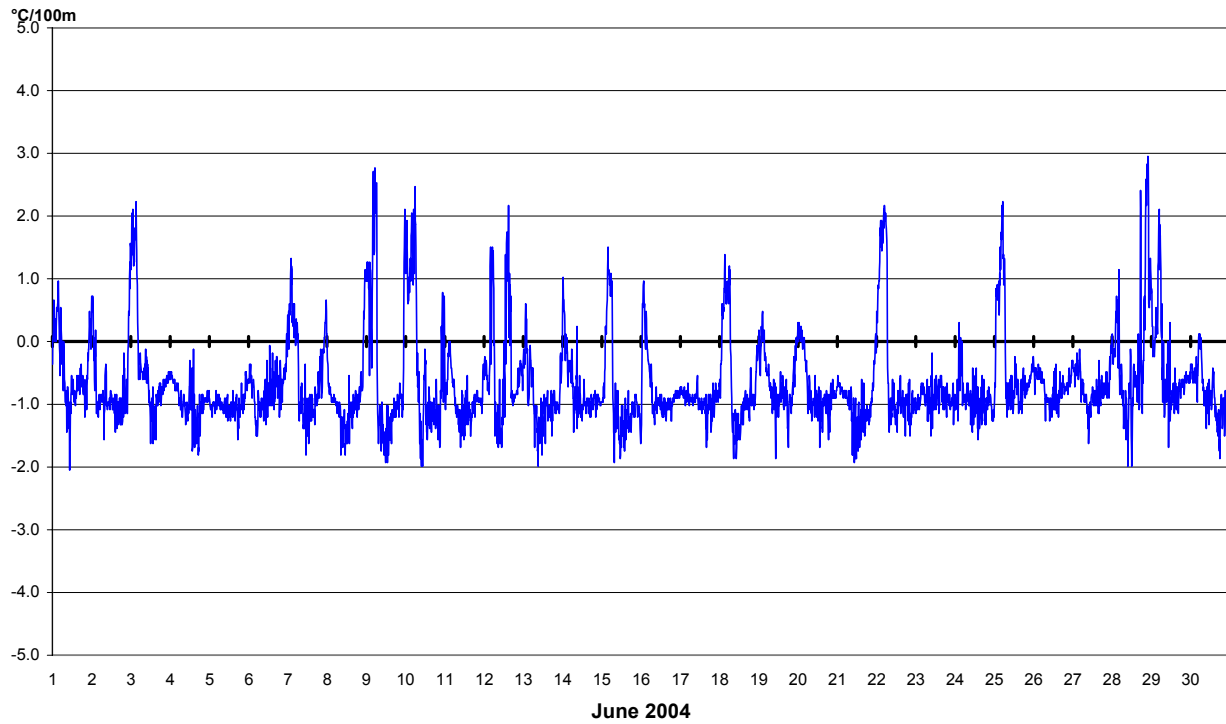
# Vertical temperature gradient, °C/100 m Húsavíkurfjall – Húsavík (height difference 166 m)



## Vertical temperature gradient, °C/100 m Húsavíkurfjall – Húsavík (height difference 166 m)



## Vertical temperature gradient, °C/100 m Húsavíkurfjall – Húsavík (height difference 166 m)



## Vertical temperature gradient, °C/100 m Húsavíkurfjall – Húsavík (height difference 166 m)

