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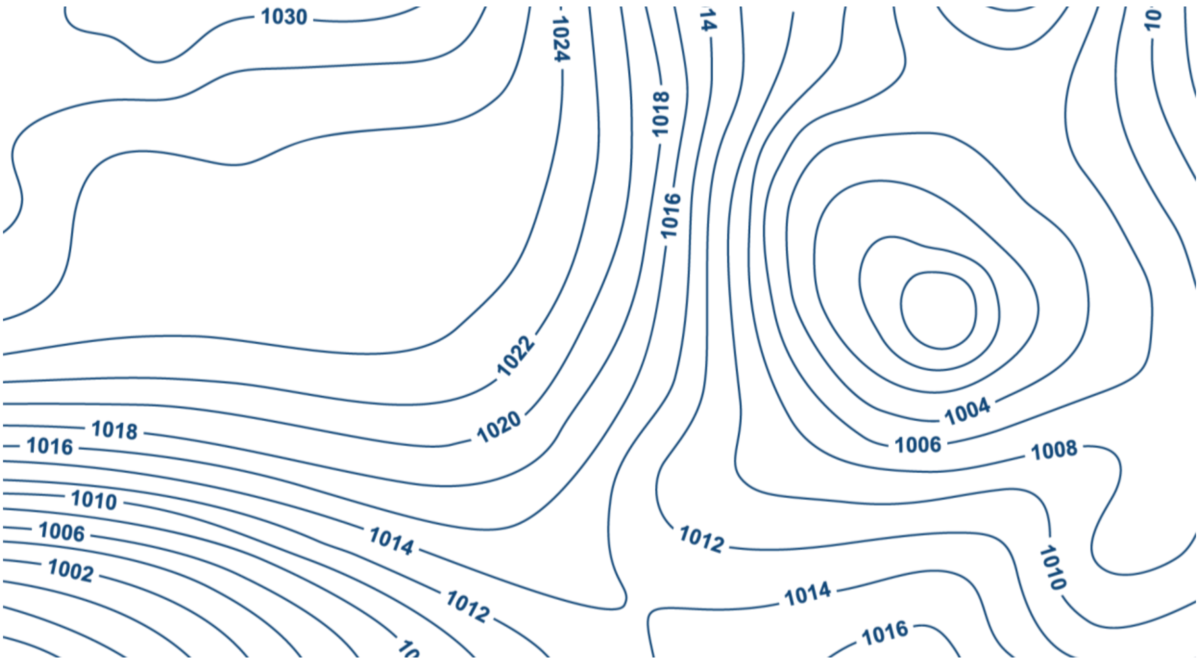
Alviðruhamrar - Meteorological conditions

Guðrún Nína Petersen



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Abstract

This report is written for EP Power Minerals ehf. that is planning activities in in Southeast-Iceland. The meteorological conditions in Mýrdalssandur and Alviðruhamrar in Southeast-Iceland are analysed using observations from two automatic long-term weather stations and reanalysis data from the CARRA reanalysis project. The emphasis is on the wind conditions. The climate of the region is mild and wet. There are three main wind directions, northerly, easterly and southwesterly. Winds from the north are in general dry and winds form the east wet. However, depending on the general weather conditions winds from the southwest can be either dry or wet. The region is in general a windy region. Extreme value analysis shows that wind speed exceeding 26 m/s is expected annually and 30 m/s every 50 years. Based on neutral stability profile, wind speed at 30 m a.g.l. is 17% higher than at 10 m a.g.l. In a warming climate precipitation is expected to increase as well as extreme precipitation although cool periods can still be expected. There is uncertainty in expected sea level change due to uncertainty in the melting of the ice caps of Iceland and ice sheets of Greenland and Antartica. Uplift counteracts decreasing the relative sea-level rise.

Key words: Mýrdalssandur, Alviðruhamrar, weather, climate, temperature, wind, extreme value analysis, precipitation, observations, reanalysis, CARRA.

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1 Introduction

This report is written for EP Power Minerals Iceland ehf. on the meteorological conditions in the region Mýrdalssandur east of Hafursey, with emphasis on Alviðruhamrar where the company is planning a wharf. The plan is to construct a conveyor belt for shipping sand from a sand mine just east and southeast of Hafursey to a stockyard, about 2.5 km from the coast at Alviðruhamrar, and another conveyor belt from the stockyard that ships the sand to the wharf, 2 km from the coast, and into ships. Early in 2025 EP Power Minerals Iceland ehf. set up two weather stations in the region, one close to the sand mine site, named Háaalda, and a second one close to the proposed stockyard, named Langabót. The weather stations are operated by Vista ehf.

The region in question is in SE-Iceland, about 30 km east of Vík í Mýrdal, see figure 1. Hafursey, 512 m a.s.l., is about 18 km northwest of Alviðruhamrar. About 16 km to the west of Alviðruhamrar there is another mountain Hjörleifshöfði, 175 m a.s.l. The region is characterised by barren sand and Icelandic braided river planes (Náttúrustofnun, 2025), with the exception of lupine fields surrounding the main road over Mýrdalssandur. Some areas are also covered with e.g. dune grass. The soil is therefore rather coarse and has little moisture capacity, i.e. the ground moisture is determined by ground water level and precipitation.

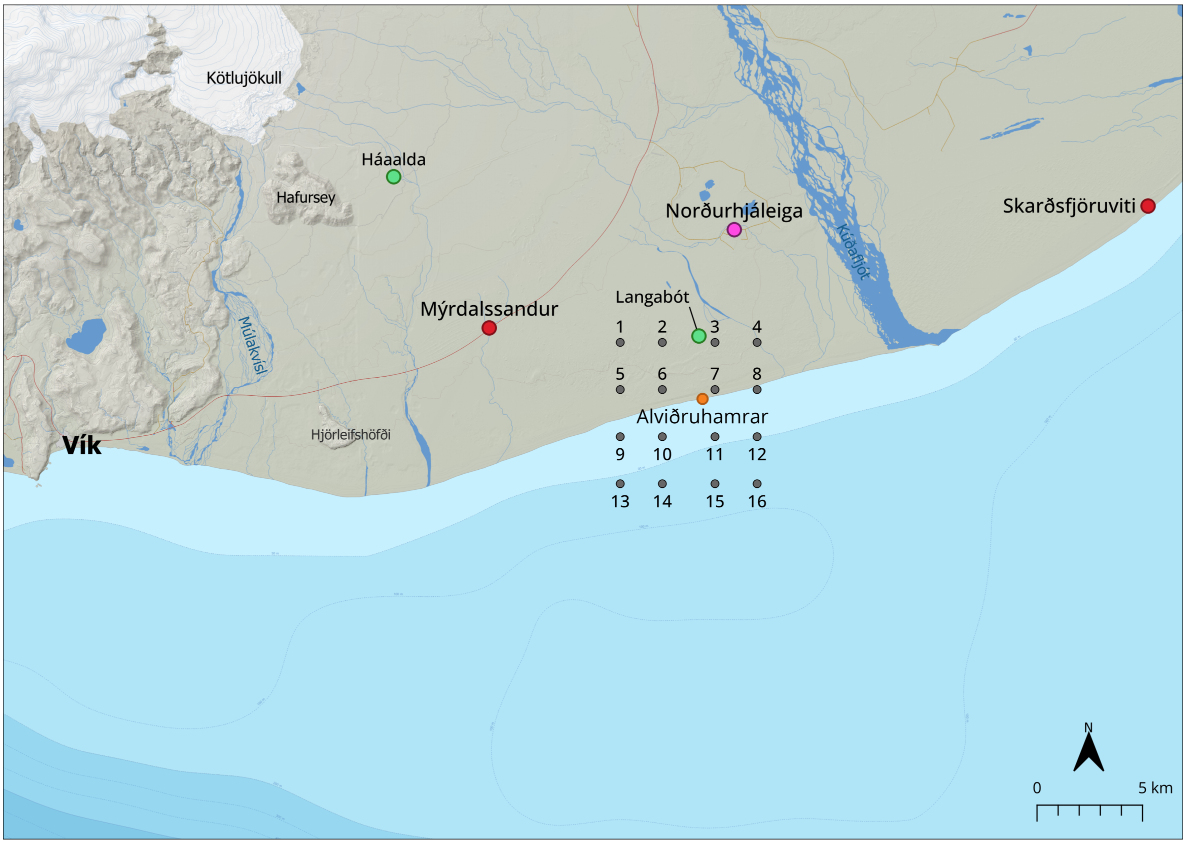

Figure 1. A map of Mýrdalssandur region with markings for Alviðruhamrar (orange), the long-term automatic weather stations (red), the manned station Norðurhjáleiga (1986–2007, magenta), the CARRA grid points (grey) as well as the locations of the two weather stations set up by EP Power Minerals Iceland ehf. (green).

The Icelandic Meteorological Office (IMO) does not have any weather statons in the region but the Icelandic Road and Coastal Administration (IRCA) operates two automatic weather stations, Mýrdalssandur (mysan) by the main road and Skarðsfjöruviti (skafj) at the coast. Here we analyse measurements from these two stations as well as meteorological data from a reanalysis project, Copernicus Arctic Regional Reanalysis (CARRA, Schyberg et al., 2020) at grid points surrounding Alviðruhamrar. At the time of the writing of this report the time series from the two weather stations set up by EP Power Minerals Iceland ehf. only spanned a few months and were thus not included in the analysis. The emphasis of this analysis is on wind, escpecially high winds, as knowledge of the wind climate is essential for the operation of the wharf.

2 Data

The data analysed are meteorological measurements at two long-term automatic weather stations as well as meteorological data from the CARRA project.

2.1 Meteorological measurements

The two weather stations are operated by IRCA. Details on location and start of operation of measurements can be found in table 1 and the locations on a map in figure 1. Mýrdalssandur (mysan) is a road weather station located just north of the main road, about 150 m east of the bridge over Dýralækur, inside a narrow lupine scarf surrounding the road. The wind sensor is located at about 6 m a.g.l. while the temperature and humidity sensor is at 2 m a.g.l. Skarðsfjöruviti (skafj) is on the other hand a coastal station, located at a light house 230 m from the coast in a location with very sparse vegetation. The light house is a lattice tower with a small housing at the top. The wind sensor is at 10 m a.g.l. and temperature and humidity at 2 m a.g.l. Note that the wind sensor is elevated compared to Mýrdalssandur. The same definition is used at both stations; wind speed is 10 minutes average wind and wind gust is the maximum 1 second wind speed over the same period.

For this report hourly data was retrieved. This means that wind speed is the 10 minutes average wind speed during the last 10 minutes of the hour while maximum wind speed and wind gust are the highest 10 minutes average wind speed and the highest 1 second wind speed during the last hour, respectively.

Data is available from 1994 and 1995 for Skarðsfjöruviti and Mýrdalssandur, respectively, and was retrieved until the end of 2024. In general the time series are continuous, with data availability at 94% or more for most variables, see table 2. The exception is relative humidity where more data are missing, especially for Skarðsfjöruviti.

2.2 CARRA data

Copernicus Arctic Regional Reanalysis (CARRA, Yang et al., 2020) project provides high-resolution data on atmospheric composition, focusing specifically on providing reanalysis of regional air quality, weather and climate parameters. It is designed to support decision-making processes in regions affected by pollution, climate change and atmospheric phenomena. Currently CARRA provides the most recent reanalysis of weather in Iceland, covering the period September 1990 up to present, updated regularily. The horizontal grid

Table 1. The weather stations: Information on name and IMO identification number as well as location and year of start of operation for the two stations used in the report.

Stations	IMO No.	Short name	Location (lat, lon)	Altitude	Start
Mýrdalssandur	36156	mysan	63.53075°N 18.88395°W	35 m a.s.l.	1995
Skarðsfjöruviti	6176	skafj	63.51787°N 17.97852°W	6 m a.s.l.	1994

Table 2. Measurement data availability (%), for the whole time series, until end of 2024.

Stations	Wind speed	Maximum wind speed	Wind gust	Wind direction	Temperature	Relative humidity
Mýrdalssandur	100.0	99.9	98.9	100.0	99.7	94.7
Skarðsfjöruviti	99.8	93.9	99.8	98.5	99.1	81.0

resolution is 2.5 km, the number of hybrid atmospheric vertical levels is 65 and time resolution is 3 hours. While wind data can be retrieved from analysis, precipitation is only available in forecasts. The data is available in Copernicus Climate Change Data Store (C3S). For easier access to the data IMO has downloaded the analysis data for the most used single level variables for Iceland, such as wind speed and wind direction at 10 m a.g.l., temperature and relative humidity at 2 m a.g.l. and precipitation as 3 hour forecasts. Table 3 contains the most important information on CARRA for this report. For this project data was retrieved from 16 grid points surrounding Alviðruhamrar, see figure 1. The area extends from south to north: 63.40°N to 63.46°N, and from east to west: 18.35°W to 18.48°W. The planned wharf, 2 km from the coast, would be close to grid point 11 which is about 1.8 km from the coast. The time period retrieved is 1 September 1990–31 December 2024, which was the maximum lenght of CARRA timeseries at the time of retrieval, spanning roughly 34 years.

3 Results

All analyses were performed using R Statistical Software (v4.4.1; R Core Team, 2024).

3.1 Climate overview from meteorological measurements

Figure 2 shows the monthly mean temperature for both weather stations. The southeast coast of Iceland experiences in general mild climate, with the lowest monthly mean temperature in January and highest in July. In general, Skarðfjöruviti being just a few meters from the coast is slightly warmer for all months although the 25–75 percentile boxes overlap for most calendar months. Mýrdalssandur station is likely to be more influenced by cool northeasterly winds which Skarðsfjöruviti is sheltered from. The spring to summer warming takes place from March/April to July while the autumn cooling occurs from

Table 3. *CARRA: Information on the set up and data retrieved for this project.*

Numerical weather prediction model	HARMONIE-AROME Cy40h1
Horizontal resolution	2.5 km
Output frequency	3 hours
Time coverage	1 September 1990–31 December 2024
Number of grid point retrieved	16
Area covered, south to north	[63.40, 63.46]°N
Area covered, east to west	[18.35, 18.48]°W
Variables applied in the report	Wind speed at 10 m a.g.l. (m/s)
	Wind direction at 10 m a.g.l. (°)
	Precipitation (mm/3-hour)

August until December. The highest median values are in July while the highest monthly mean values (whiskers and outliers) occured in August at both stations. The lowest median values are in December as well as the lowest monthly mean values. Lowest and highest temperatures measured at the stations for each calendar month are shown in table 4. The extremes were in both cases measured at Mýrdalssandur, the highest and lowest temperature being 25.5°C (18 July 2003) and -20.1°C (01 January 2023), respectively.

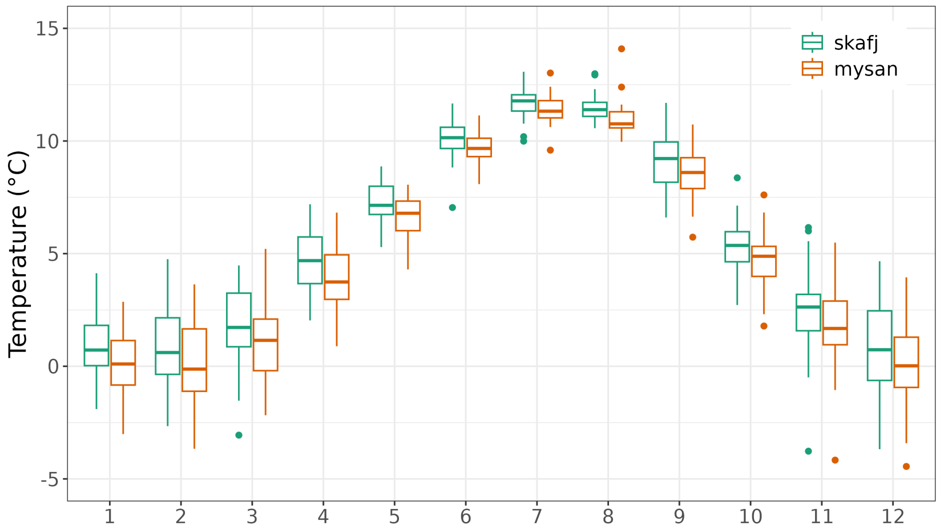

Figure 2. Monthly mean temperature (°C) for Skarðsfjöruviti and Mýrdalssandur, based on the whole time series. The figure shows boxplots where the box encompasses 50% of the values, 25th to 75th percentiles, with the median value shown as a horizontal line. The whiskers extend to the largest/smallest value no further than 1.5 inter-quartile range from the box with values beyond that plotted individually.

Table 4. Highest and lowest temperature (°C) measured at Skarðsfjöruviti and Mýrdalssandur in each calendar month as well as the dates of occurence. In the cases when the value was reached more than once, the most recent date is shown. The absolute maxima and minima are written in bold.

	Skarðsfjöruviti		Mýrdalssandur	
	T_{min} (Date) (°C)	T_{max} (Date) (°C)	T_{min} (Date) (°C)	T_{max} (Date) (°C)
Jan	-17.8 (2010-01-05)	10.6 (2003-01-10)	**-20.1** (2023-01-01)	11.0 (2025-01-12)
Feb	-16.0 (2004-02-02)	10.7 (2005-02-21)	-18.6 (2008-02-02)	10.6 (2004-02-19)
March	**-18.4** (2001-03-01)	13.7 (2006-03-18)	-16.2 (2006-03-22)	13.9 (2006-03-18)
April	-12.9 (1997-04-03)	15.3 (2012-04-06)	-12.2 (2012-04-03)	15.4 (2022-04-30)
May	-7.8 (2013-05-02)	19.8 (2012-05-27)	-6.7 (2003-05-01)	21.8 (2022-05-29)
June	0.0 (2019-06-03)	**25.3** (2019-06-12)	-1.5 (2019-06-03)	23.6 (2019-06-12)
July	2.5 (2009-07-24)	25.0 (2021-07-20)	1.8 (2004-07-28)	**25.5** (2003-07-18)
Aug	1.1 (2004-08-21)	23.7 (2021-08-14)	-0.3 (2018-08-30)	25.4 (2003-08-25)
Sept	-5.5 (2003-09-23)	20.6 (1996-09-11)	-3.4 (2005-09-24)	20.5 (1996-09-11)
Oct	-8.2 (2002-10-28)	13.9 (2001-10-01)	-9.6 (2008-10-03)	14.3 (2001-10-02)
Nov	-17.1 (1999-11-28)	11.1 (2003-11-07)	-14.8 (1996-11-04)	11.8 (2003-11-07)
Dec	-17.2 (1994-12-27)	11.0 (2001-12-31)	-16.0 (2022-12-28)	10.7 (1995-12-02)

The wind climate, for each calendar month, is shown in figure 3. The mean wind speed is highest in February and lowest in July. Note that the median value is often quite low inside the box, indicating that that a few extremely windy months result in the extention of the upper limit of the box (the 75 percentile). Also, it is windier at Skarðsfjöruviti than in Mýrdalssandur, with the impact of the autumn storms in September–November being more pronounced. However, the year-to-year variation is also larger at Skarðsfjöruviti for most months, indicated with the larger boxes. The monthly maximum wind speed and wind gust show a similar picture. The month with the highest wind speeds and wind gusts is in general February. However at Skarðsfjöruviti the highest maximum wind speed and gust were measured on 12 December 2015 (30.4 m/s and 45.0 m/s, respectively) but for Mýrdalssandur on 9 January 2012 (30.3 m/s) and 2 February 1999 (40.2 m/s), respectively, see table 5.

The crane used for transporting the sand from the coast and into ships in the wharf is estimated to be at 33 m a.s.l., in the highest position (Helgason, H., personal communication 27 May 2025). The increase in wind speed with height is dependent on atmospheric stability. Assuming neutral conditions the wind speed at 30 m a.g.l. is estimated to be 17% higher than at 10 m a.g.l.[1]

A wind rose shows the frequency of different wind direction. Figure 4 shows wind roses

[1] The wind profile law relationship is $U/U_r = \left(\frac{z}{z_r}\right)^{\alpha}$ where U is the wind speed at height z and U_r at reference height z_r. α is an empirical coefficient that is $\frac{1}{7}$ for neutral stable conditions.

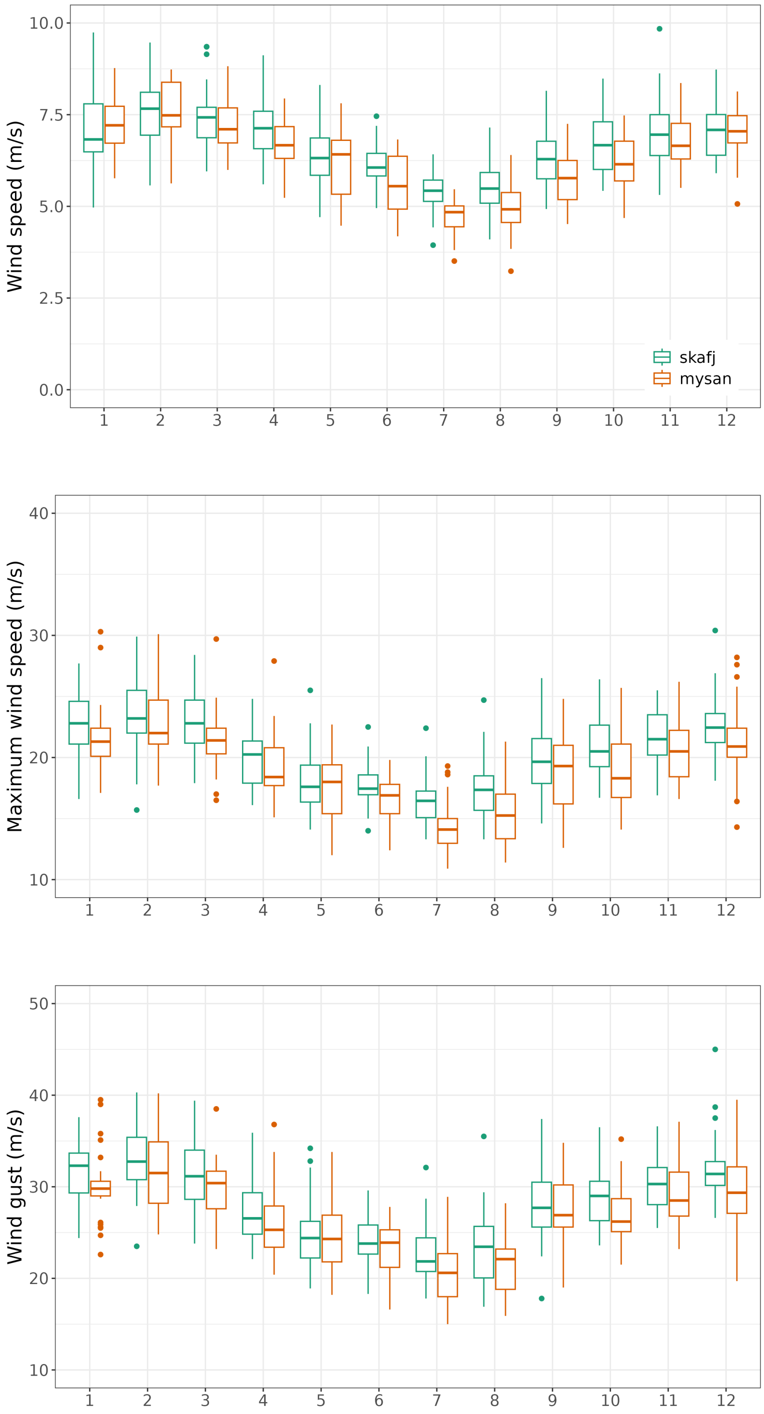

Figure 3. Monthly mean windspeed (m/s, top), maximum wind speed (m/s, centre) and maximum wind gust (m/s, bottom) for Skarðsfjöruviti (skafj) and Mýrdalssandur (mysan), based on the whole time series. The figure shows boxplots where the box encompasses 50% of the values, 25th to 75th percentiles, with the median value shown as a horizontal line. The whiskers extend to the largest/smallest value no further than 1.5 inter-quartile range from the box with values beyond that plotted individually.

Table 5. Highest maximum wind speed (m/s) and wind gust (m/s) measured at Skarðsfjöruviti and Mýrdalssandur in each calendar month as well as the dates of occurence, from the whole timeseries. The absolute maxima are written in bold.

	Skarðsfjöruviti		Mýrdalssandur	
	Wind speed (Date) (m/s)	Wind gust (Date) (m/s)	Wind speed (Date) (m/s)	Wind gust (Date) (m/s)
Jan	27.7 (2005-01-04)	37.6 (2005-01-04)	**30.3** (2012-01-09)	39.5 (2005-01-04)
Feb	29.9 (2020-02-14)	40.3 (2020-02-14)	30.1 (1999-02-02)	**40.2** (1999-02-02)
March	28.4 (2019-03-12)	39.4 (2019-03-12)	29.7 (2019-03-11)	38.5 (2019-03-11)
April	24.8 (2020-04-04)	35.9 (2020-04-04)	27.9 (2000-04-14)	36.8 (2000-04-14)
May	25.5 (2008-05-09)	34.2 (2008-05-09)	22.7 (2023-05-24)	33.8 (2023-05-23)
June	22.5 (2021-06-13)	29.6 (2017-06-01)	19.5 (1996-06-01)	27.8 (2017-06-01)
July	22.4 (2010-07-01)	32.1 (2010-07-01)	19.3 (2010-07-01)	28.9 (2022-07-07)
Aug	24.7 (2008-08-29)	35.5 (2008-08-29)	21.3 (2014-08-16)	28.2 (2014-08-16)
Sept	26.5 (2004-09-16)	37.4 (2004-09-16)	24.8 (2013-09-16)	34.8 (2021-09-21)
Oct	26.4 (2014-10-31)	36.5 (2014-10-31)	25.7 (1996-10-08)	35.2 (1996-10-08)
Nov	26.4 (2014-10-31)	36.5 (2014-10-31)	26.2 (2012-11-02)	37.1 (2012-11-02)
Dec	**30.4** (2015-12-07)	**45.0** (2015-12-07)	28.2 (2015-12-07)	39.5 (2015-12-07)

based on all wind speed as well as only wind speed exceeding 15 m/s, i.e. showing only the windiest wind directions. At Skarðsfjöruviti there is one dominant wind direction, easterly to east-northeasterly, along the coast. The second most frequent wind direction is southwesterly. The windy wind rose shows that wind speeds exceeding 15 m/s occurs mainly in easterly to east-northeasterly wind direction. Mýrdalssandur has a more complicated wind pattern with northerlies being most frequent followed by southwesterlies and then northeasterlies. The northerly winds are from the Icelandic highlands while the northeasterlies are from the western part of Vatnajökull glacier. The southwesterlies are coming in from the sea. Looking at the high wind situations, northeasterlies are the most frequent with the northerlies as the second most frequent windy wind direction.

Given that the observations span almosts 30 years with few data gaps it is possible to make an extreme value analysis (EVA) and estimate return values for different return periods, i.e. the statistical likelihood of wind speed exceeding certain thresholds. The method used here is the same as described in Petersen (2015), using daily maximum values of wind speed and wind gusts and the Peak over threshold method (POT), applying the R package POT (Ribatet and Dutang, 2022). Before applying the method, the data is filtered to include only the values exceeding the 0.9 percentile, i.e. only 10% highest values. To make sure the selected values are approximately independent, a 5-day separation is required between the seleced values. Detailed description of EVA and the peak over threshold method can be found in e.g. Coles (2001). Figures 5 and 6 show the results based on data from Skarðsfjöruviti and Mýrdalssandur for daily maximum wind speed and wind gust, respectively. For maximum wind speed, every year wind speed of 25–26 m/s can be

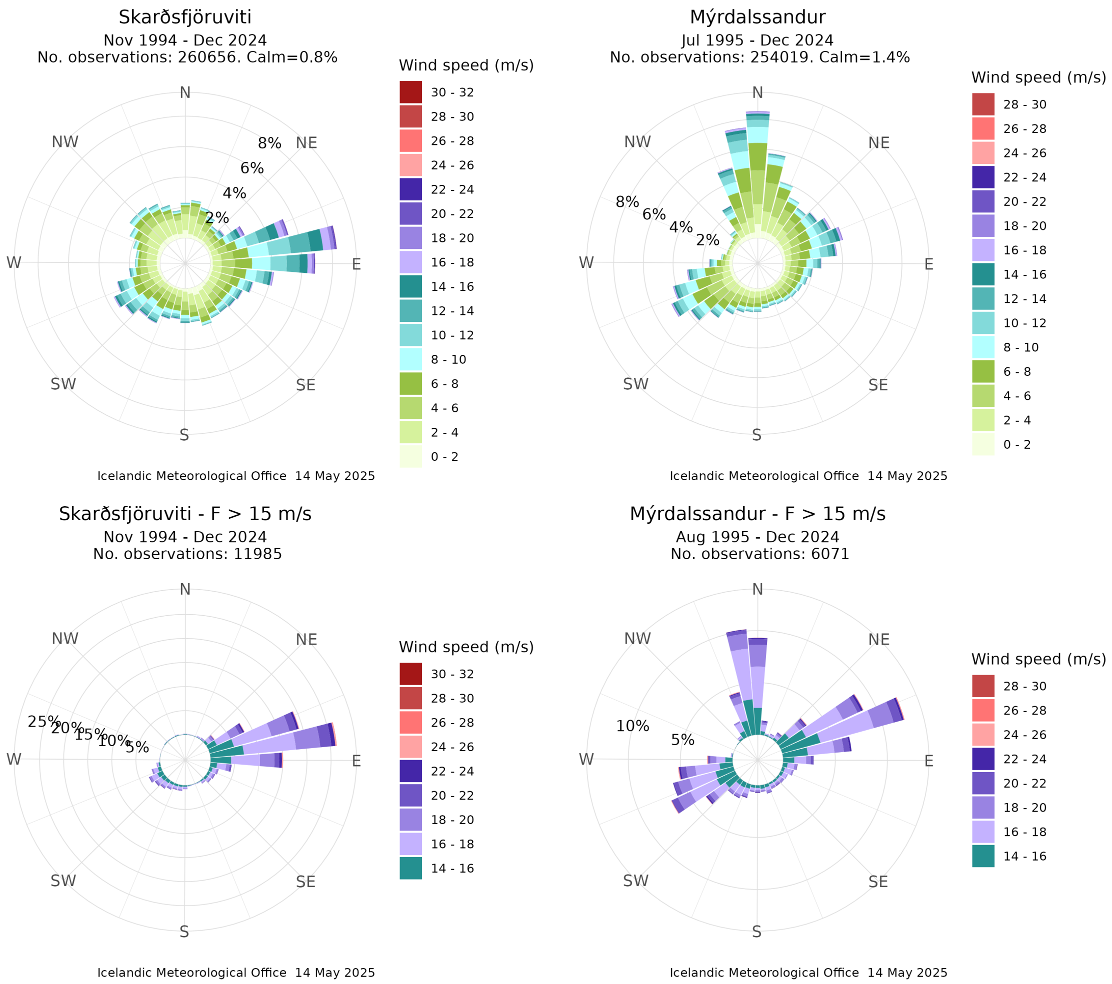

Figure 4. Wind roses showing the wind directional frequency at Skarðsfjöruviti (left) and Mýrdalssandur (right) for all wind speed (top) and only wind speed exceeding 15 m/s (bottom). The colours indicate wind speed. Based on hourly data.

expected to occur, i.e. the return level of wind speed with return period of 1 year, with the values slightly higher at Skarðsfjöruviti than at Mýrdalssandur. The 50 year return level is around 30 m/s. EVA based on hourly wind speed at Mýrdalssandur, i.e. on wind speed on the hour, results in 1 year return level of about 24 m/s and 50 year return level of 28 m/s, i.e. slightly lower values. The return levels of wind gust for the same periods are considerably higher or around 35 m/s and 39-43 m/s for 1 year and 50 year return period, respectively, see figure 6. Skarðsfjöruviti has considerably higher return levels for wind gust than Mýrdalssandur, but the model (the solid line) diverges further from the observations (circles) for wind speed between 33 and 40 m/s. Thus, the model may be overestimating the return levels.

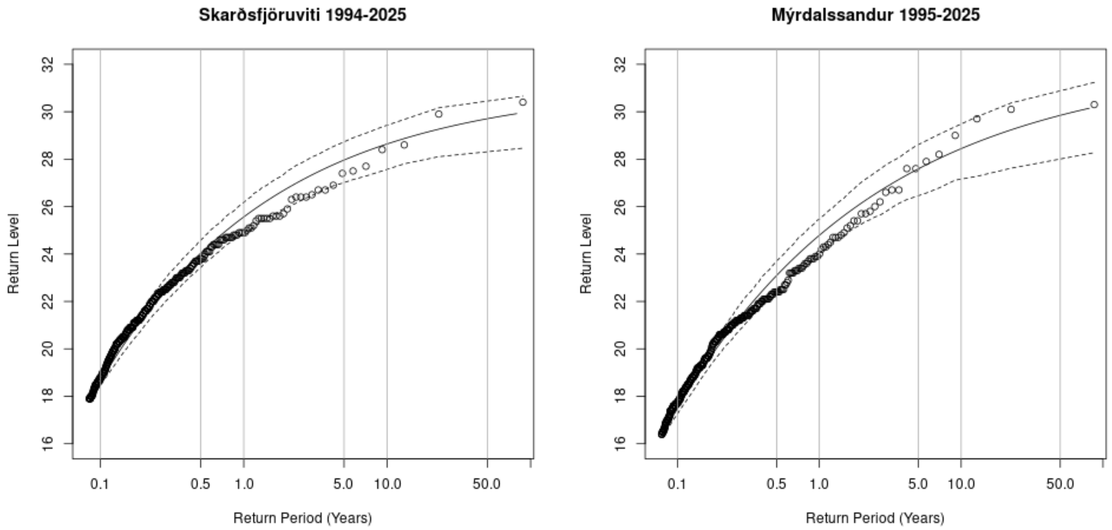

Figure 5. Return level of daily maximum wind speed (m/s) for different return periods for Skarðsfjöruviti (left) and Mýrdalssandur (right). The observed values are shown as circles and the extreme value model as a solid line with 95% confidence interval as dashed lines. Based on the peak over the threshold method.

If the surface of the sand is moist it is more difficult for wind to suspend the sand. Unfortunately, precipitation is not measured at these stations. However, relative humidity is measured and can be used as a proxy, i.e. if relative humidity is high it is likely that the surface is moist. Figure 7 shows the frequency of wind directions and the relative humidity for wind speed exceeding 10 m/s, i.e. for winds that are potentially strong enough to be able to suspend sand. The figure shows that the northwesterly and northerly winds at Mýrdalssandur are relative dry, with only a small portion being 80% humid or more. The few cases of northwesterlies above 10 m/s recorded at Skarðsfjöruviti are also dry. In general, the other main wind directions, northeasterly to easterly and southwesterly are more humid. However, looking at the rose for Mýrdalssandur there are indications of more frequent drier conditions in southwesterlies wind than those with an easterly component. This might be due to southwesterly winds often being associated with unstable atmospheric conditions resulting in rain or snow showers while winds from the east are more often associated with cyclones and weather fronts, i.e. with rain or snow.

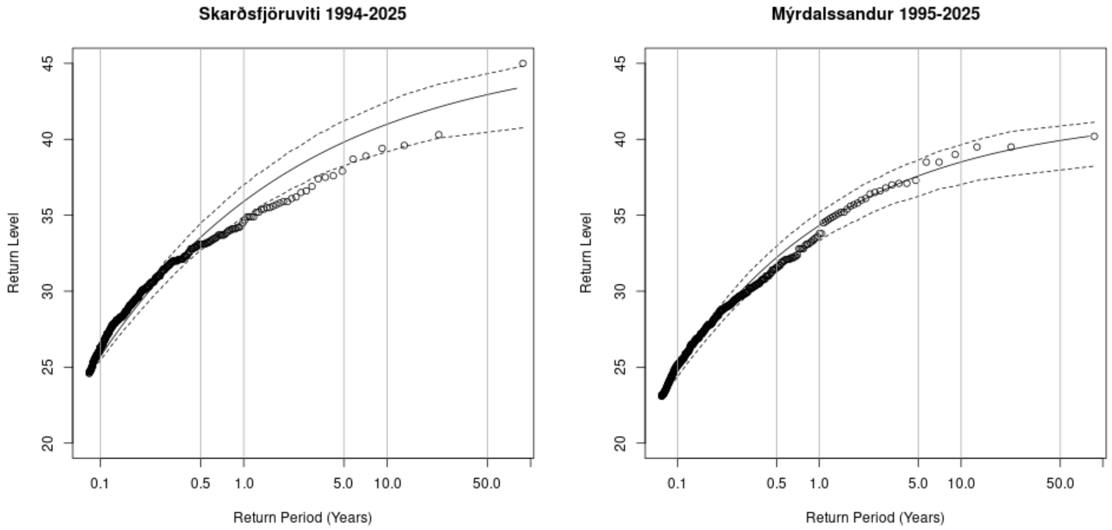

Figure 6. Return level of daily maximum wind gust (m/s) for different return periods for Skarðsfjöruviti (left) and Mýrdalssandur (right). The observed values are shown as circles and the extreme value model as a solid line with 95% confidence interval as dashed lines. Based on the peak over the threshold method.

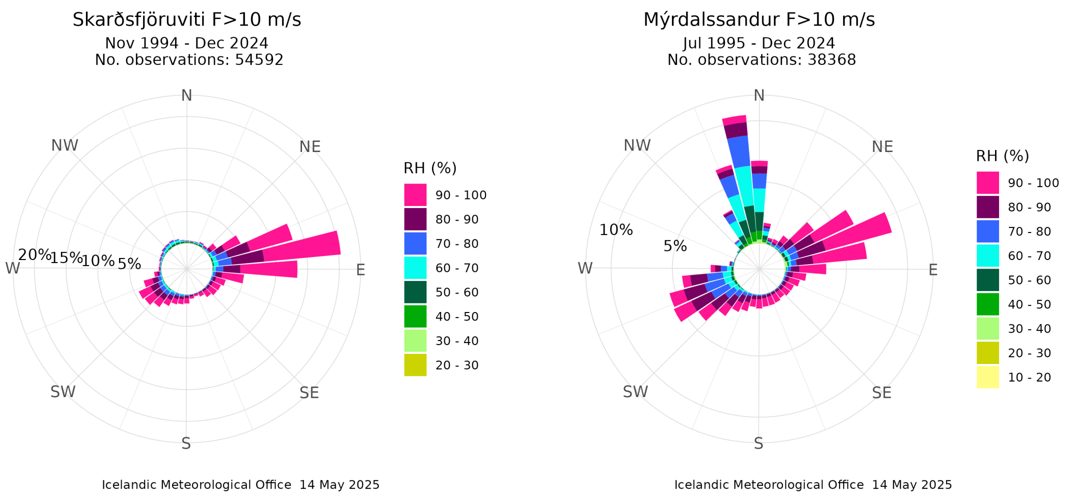

Figure 7. Frequency roses for Skarðsfjöruviti and Mýrdalssandur, showing the relative humidity levels for different wind direction. Data is shown for wind speed exceeding 10 m/s, based on hourly data.

Figure 8 shows four weather charts that can be said to represent the four windy weather regimes at Skarðsfjöruviti and Mýrdalssandur. The top left chart shows a cyclone south of Iceland, moving northward and bringing strong easterly winds towards the southern coast (showing up as east-northeasterlies at Mýrdalssandur). Associated with the cyclone is a warm weather front that results in considerable precipitation in South- and Southeast-Iceland. In the bottom left chart a high pressure system is dominating over the Irminger Sea resulting in strong northerly winds over Iceland. While there is precipitation in North-Iceland the air has dried up before reaching the southern part. The charts on the right side show two different regimes both resulting in strong southwesterly winds in the region of interest. Firstly, in the top chart a cyclone is moving north over West-Iceland and through Denmark Strait. The cold weather front associated with the cyclone moves into South-Iceland bringing precipitation. Secondly, in the bottom chart a cyclone to the north of Iceland as well as a high pressure over Greenland are dominating the weather situation. Westerly and southwesterly winds moving over the Irminger Sea towards Iceland bring unstable humid air resulting in rain og snow showers over the western part of the country. In the southeast of Iceland, this weather regime may bring some precipitation but then mainly intermittent and much less than from a weather front. In this case no precipitation fell in the southeast.

As northerly winds are in general dry at Mýrdalssandur it is of interest to assess the frequency of northerly winds that may suspend materials. Figure 9 shows, for each calendar month and for wind speed exceeding 10 m/s, the frequency of northerly winds, i.e. in the sector 310–360°. The figure shows that northerly winds have the lowest frequency during the summer months, June–August, and highest in the autumn and early winter, October–December.

3.2 Weather information from CARRA data

As shown in figure 1 the CARRA data was retrieved for 16 grid point surrounding Alviðruhamrar and extending out into the sea to cover the location of the planned wharf. Here we look at results from four grid points:

gp1: Grid point 1 is the grid point closest to the weather station Mýrdalssandur. It is therefore used to assess how the CARRA wind data compares to the observations.

gp3: Grid point 3 is the grid point that is closest to the location of the proposed stockyard by Alviðruhamrar, see location of weather station Langabót in figure 1. It is therefore the grid point that gives the best information regarding conditions on land by the coast.

gp11: Grid point 11 is about 1.8 km off the coast. It is thus slightly closer to the coast than the end of the proposed wharf which is planned at 2 km distance from the coast.

gp15: Grid point 15 is roughly 4 km away from the coast. It is used to assess how the wind climate changes with distance from the coast.

Figures 10 and 11 show comparisons of the CARRA wind speed at gp1 and the observations at Mýrdalssandur. The first figure shows the frequency distribution of the wind

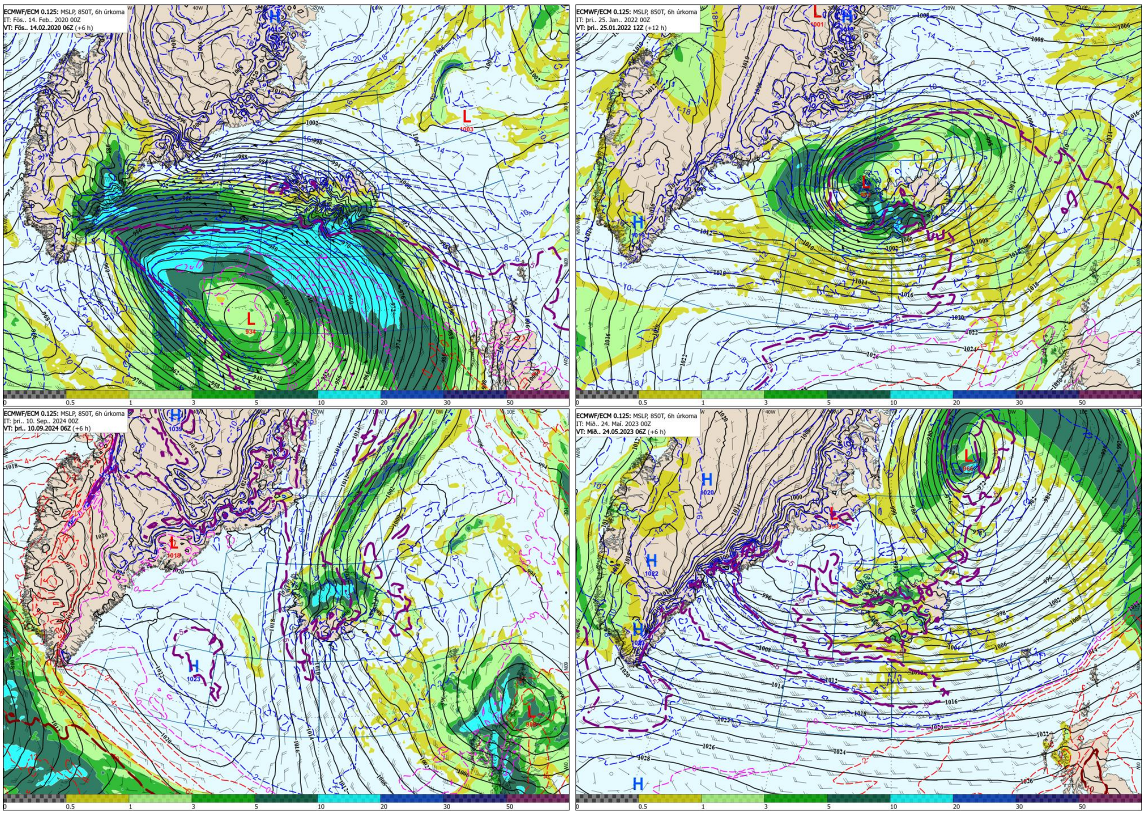

Figure 8. Weather charts representing typical high wind weather regimes at the southeast coast. Top left: Easterly winds on 14 February 2020 at 06 UTC. Bottom left: Northerly winds on 10 September 2024 at 6 UTC. Top right: Southwesterly winds on 25 January 2022 at 12 UTC. Bottom right: Southwesterly winds on 24 May 2023 at 6 UTC. The charts show mean sea level pressure (hPa, solid lines), 6-hour precipitation (mm, shaded) and temperature (°C, dashed lines). The charts show short forecasts from the ECMWF (European Centre for Medium Range Forecasts) HRES (high resolution) forecasting model.

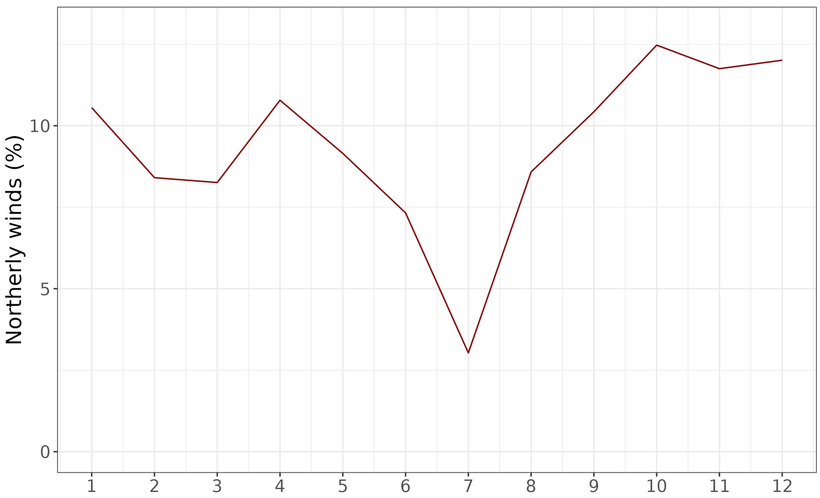

Figure 9. For each calendar month, for wind speed exceeding 10 m/s the proportion of northerly winds (310–360°) at Mýrdalssandur.

speeds. Here 3-hourly wind speeds from gp1 are compared to hourly wind observations at Mýrdalssandur. The distributions have tha same shape, with wind speeds in the interval 4–8 m/s being the most frequent. CARRA gp1 has a slightly higher freqencies for wind speeds exceeding 8 m/s, i.e. a sligthly thicker right tail. This is to be expected as the wind speed should be higher closer to the coast. The second figure shows a scatter plot of the CARRA wind speed against observations at Mýrdalssandur; here both data set have a time resolution of 3 hours. There is a scatter around the linear regression line but it narrows for higher wind speeds. A scatter is to be expected between observations and model data as the model is not able to accurately describe the small scale landscape. Small differences in timing of a weather between the two can also play a role. The regression line is very close to the 1:1 line, deviating more as wind speed increases with the wind speed at CARRA gp1 exceeding the observed wind speed. The comparison thus does not give indications that the CARRA wind field has significant bias or errors that would skew these results.

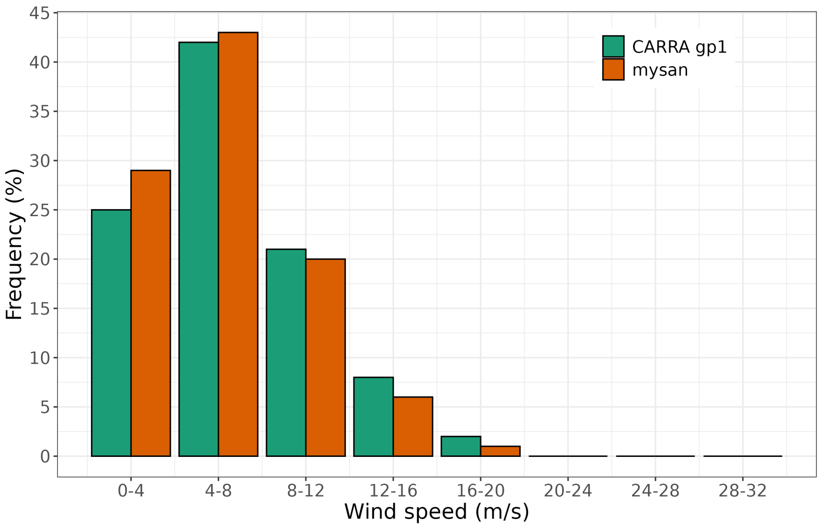

Figure 10. The wind speed frequency (%) at CARRA gp1 and Mýrdalssandur. The CARRA data have 3 hour time resolution but Mýrdalssandur 1 hour.

The wind roses for the CARRA grid points are shown in figure 12. There are many similarities between the wind rose for Mýrdalssandur, see figure 4, and the CARRA wind roses as well as some obvious differences. Firstly, looking at the wind roses for Mýrdalssandur and CARRA gp1, both have three main wind direction but they are all diverged slightly to the right at gp1 compared to Mýrdalssandur. This means that the westerly and easterly component at gp1, and the other CARRA grid points, are more lined with the coastline than at Mýrdalssandur, that is further inland. In both wind roses the northerly winds are the most frequent, and least windy, while at gp1 the coastal winds have a larger proportion than at Mýrdalssandur. In both cases there is hardly any winds from the northwest and southeasterly to southerly winds are also not common. Comparing the CARRA wind roses it is evident, as one would have expected, that as one moves from the inland grid points towards the sea there is a slight increase in easterly wind frequency as well as the wind speed. The windiest direction is the easterly coastal wind, similarly as at Skarðsfjöruviti.

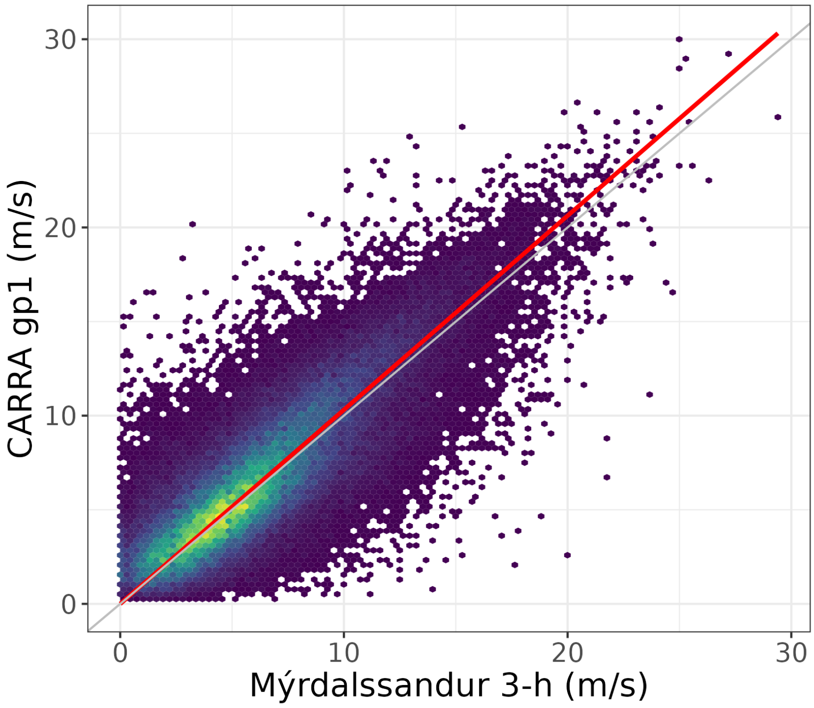

Figure 11. A scatter plot of the wind speed (m/s) at CARRA gp1 and Mýrdalssandur, in both cases with 3 hour time resolution. The red line shows the linear regression line and the grey line is the 1:1 line.

There is not a great difference between gp11 and gp15, indicating not a big change in the wind climate in this area a few kilometers from the coast.

The extreme value analysis peak over threshold was also applied to the CARRA data in gp3 and gp11, in the same manner as for the observations, see figure 13. Note though that the maximum values are here the maximum of the 3-hourly wind speed, as CARRA does not contain information on the maximum wind speed. The return levels at gp11 are slightly higher than at gp3, as the wind speed is in general higher. The return value for a return period of 1 year, i.e. an event that could statistically occur every year, is 25–26 m/s and for 50 year 29–30 m/s. These values can be compared to the ones calculated for Mýrdalssandur and Skarðsfjöruviti, see figure 5. They are slightly higher than the values based on daily maximum wind speed at Mýrdalssandur. Given the difference of about 1 m/s between calculation based on daily maximum hourly wind speed and daily maximum wind speed at Mýrdalssandur, one would expect the values at the coast also to be about 1 m/s higher for maximum wind speed (that is not available in CARRA).

The monthly mean precipitation is shown in figure 14. The values are averaged over all 16 grid points, shown in figure 1. The figure shows that April–June are significantly drier than the rest of the year. During the autumn and winter there is more precipitation but the year-to-year variation is considerable. Especially, the year-to-year variation is large in October and March, depending on the occurency and depth of autumn and spring lows.

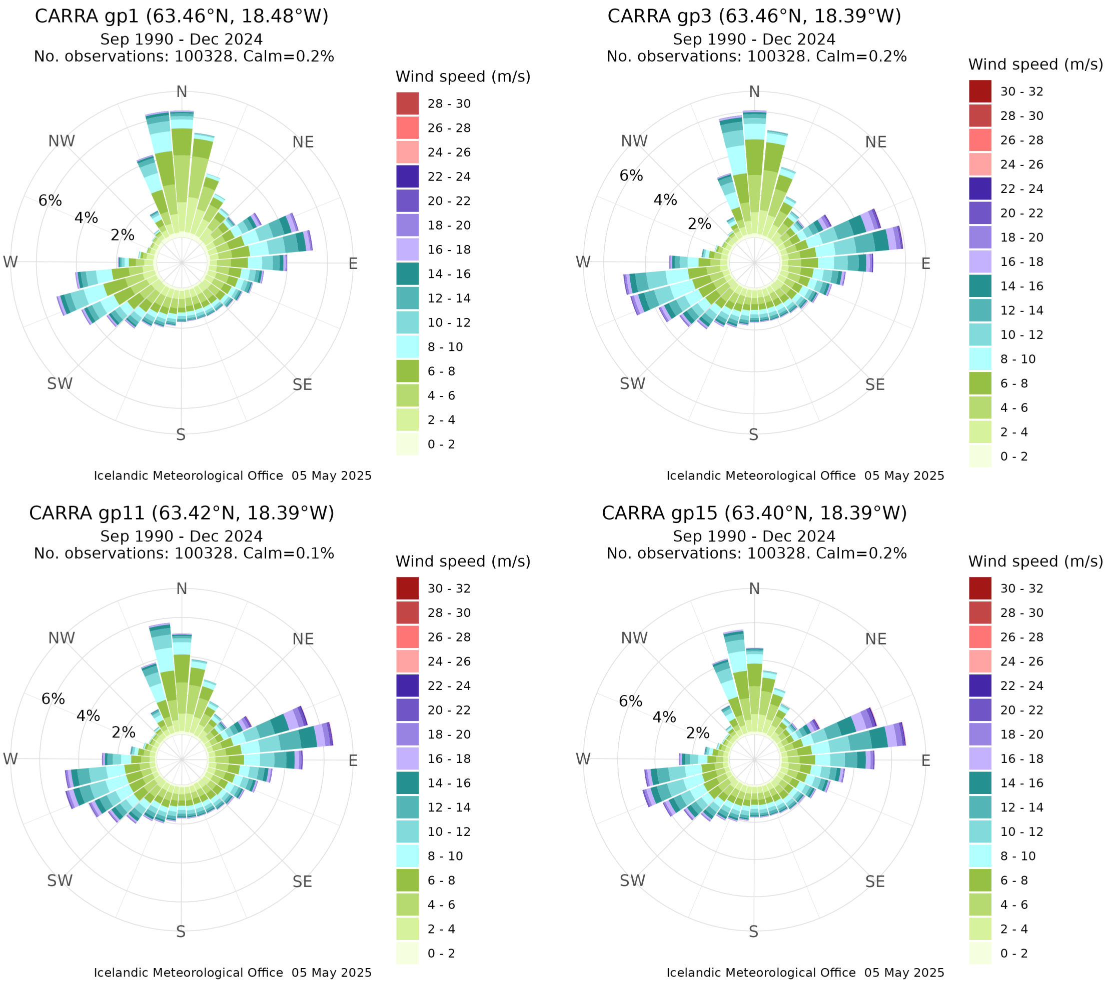

Figure 12. Wind roses in CARRA gp1, gp3, gp11 and gp15, see figure 1 for locations. The colours indicate wind speed. Based on 3-hourly data.

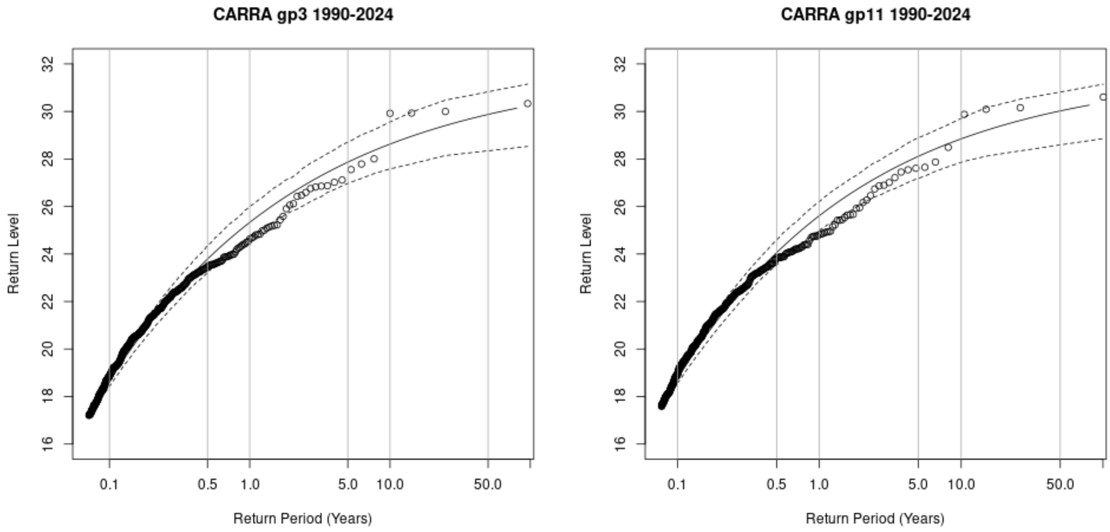

Figure 13. Return levels of daily maximum wind speed for different return periods for CARRA gp3 (left) and gp11 (right). The CARRA values are shown as circles and the extreme value model as a solid line with 95% confidence interval as dashed lines. Based on the peak over the threshold method.

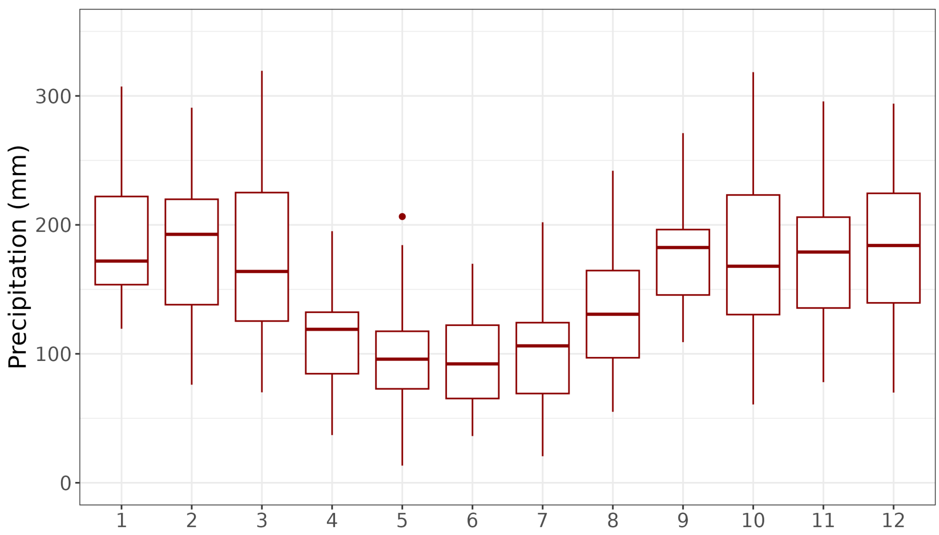

Figure 14. Monthly mean precipitation (mm) from CARRA, averaged over all 16 grid points. The figure shows boxplots where the box encompasses 50% of the values, 25th to 75th percentiles, with the median value shown as a horizontal line. The whiskers extend to the largest/smallest value no further than 1.5 inter-quartile range from the box with values beyond that plotted individually.

A precipitation frequency rose for CARRA gp3, close to the planned stockyard, gives similar results as the humidity frequency rose for Mýrdalssandur (figure 15 compared to figure 7), i.e. the easterly wind direction is the one that brings in the most precipitation. The second dominating precipitation wind direction is southwesterly.

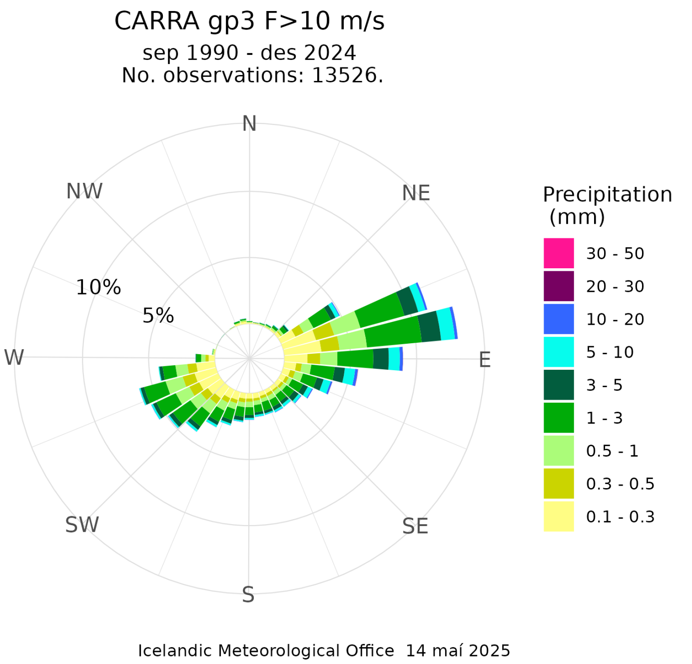

Figure 15. A frequency rose for CARRA gp3 showing the precipitation (mm/3-hour) for different wind directions. Data is shown for 3 hourly wind speed exceeding 10 m/s.

3.3 Other weather and climate information

Thunderstorms are not common in Iceland, and actually more common in the wintertime than during summer. In general, the frequency of thunderstorm is considered to be that low that it is seldom for infrastructure in Iceland to have lighting protection systems. Due to the low frequency it is not possible to state if the frequency has been increasing, decreasing or remaining constant during the last decades (Arason, Þ., personal communication 13 May 2025).

Although the region is one of the mildest in Iceland, being close to the sea and at low elevation, sometimes the weather situation may bring snow to the region that can cover the ground for a few weeks. Snow observations from a manned station, Norðurhjáleiga in Álftaver (observational period 1986–2007), show that e.g. late winter 1989 the ground was snow covered for almost two months with maximum snow depth of 35 cm and the snow depth record of 70 cm is from 12 November 1999, when the ground was covered for about a month. In years with much snow accumulation, in a region of in general mild climate, this may result in snow melt floodings when thawing sets in. In addition, thawing conditions are usually due to cyclones bringing warm and humid air towards Iceland from the south and thus resulting in precipitation which will enlargen the floodings. Such flooding have been known to increase the volume of rivers fast under the right conditions.

Climate change has resulted in intermittent warming in Iceland, with alternating cooler and warmer periods (Björnsson et al., 2018). This means that even though the climate is warming cold intervals can still be expected. Although future climate change scenarios do not have strong precipitation change signal, there are indications that precipitation will increase by more than 1% for each degree Celsius of warming (Björnsson et al., 2023). The increase is expected to be seen mostly during autumn months. Extreme precipitation (100 year daily maximum) could increase by 5-15% from present values, but more for regions with high annual precipitation such as Southeast-Iceland. It is expected that return periods of what is currently considered to by 100 year precipitation will shorten when extreme precipitation increases.

The expected sea-level change is a combination of changes in elevation, oceanic thermal expension and melting of the ice caps in Iceland and the ice sheets in Greenland and Antarctica. Central-Iceland and the southeast coast are experiencing uplift. In Vík, just east of the Mýrdalssandur region, the uplift has been about 5.3 mm/year during the period 1996–2022 (Table 2.9 in Björnsson et al., 2023). There is uncertainty in the rise of sea level due to melting of the big ice sheets and thermal expension. The mean relative sea-level change at the end of the century at Vík varies from -20 cm to 54 cm, for medium to high range climate change scenarios (Table 2.11 in Björnsson et al., 2023).

4 Conclusion and remarks

This report is written for EP Power Minerals Iceland efh. due to planning of shipping sand from a sand mine close to Hafursey south to the coast and then into ships at a wharf 2 km from the coast. Here the meteorological conditions in the region Mýrdalssandur are investigated using observations from two long-term automatic weather stations and reanalysis data from the reanalysis project CARRA. There is an agreement between the two types of data regarding e.g. wind speed and the most frequent wind directions as well as which wind directions bring most precipitation into the region. The main emphasis of the analysis is on wind speed, as it may be the most limiting weather parameter for the planned activities.

The climate of the region is in general mild and wet, because of the location at the southern coast of Iceland, open to cyclones moving in from the south bringing moist and warm air to Iceland. In northerly winds the air is cooler but also drier as most of the precipitation then falls in North-Iceland.

There are three main wind directions in the region, northerly, easterly and southwesterly. The northerlies are in general dry winds and the easterly often bring considerable precipitation into the region. The southwesterlies can bring precipitation but can also be rather dry, depending on the general weather conditions. Winds from the north or southwest are therefore most likely to suspend sand. This should be considered when planning potential sheltering for the sand stockyard close to the coast.

Weather measurements from the two stations set up by EP Power Minerals Iceland ehf. were not used in this report as the time series only span a few months. However, they will give additional information on the variability of weather in the area, in particular wind.

Langabót, located close to the planned stockyard, will give further guidance on what kind of sheltering is needed at the stockyard while Háalda, will give information on the wind climate at the sand mine compared to closer to the coast and the planned wharf. At a later stage, these measurements should be compared to the long-term measurements and possibly also CARRA data. That would put these relatively short time series into a longer context as well as highlight potentially weather conditions not found at the location of the long-term weather stations.

The extreme value analysis of both observations and CARRA data show that the region is a windy region, with wind speed expected to exceed 26 m/s annually and 30 m/s every 50 years. Winds exceeding 20 m/s can be found from autumn and into spring, e.g. from September to April, with highest values expected in December to March. However, high wind speeds have been measured at the coast in all calendar months. Based on neutral stability wind profile, wind speed at 30 m a.g.l. is estimated to be 17% higher than at 10 m a.g.l.

Although the area is in general snow light, due to the mild climate, there have been events with much snowfall. In such cases there can be significant water floods when thawing sets in. Such events can still be expected in a warming climate. Thunderstorms are rare in Iceland and currently it is not possible to predict any changes in the frequency. In a warming climate extreme precipitation is expected to increase as well as annual precipitation. There is uncertainty in the relative sea-level change in the region but uplift in the region counteracts sea-level change due to thermal expansion and melting of ice caps and ice sheets.

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