Weather data collected at Welsh sand dune sites

Report No: 713

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Crynodeb Gweithredol

Mae'r ddogfen hon yn crynhoi'r data tywydd a gasglwyd rhwng 2017 a 2023 mewn pedwar safle twyni tywod sy'n Warchodfeydd Natur Cenedlaethol o amgylch Arfordir Cymru. Casglwyd y data i helpu i lywio'r gwaith o reoli'r systemau o dwyni tywod ac i ddeall yn well ddatblygiad ymyriadau i roi tywod ar symud.

Y pedwar safle oedd Niwbwrch, Morfa Harlech, Whiteford a Merthyr Mawr. Yn Niwbwrch, lleolwyd yr orsaf dywydd ar bentir i'r gorllewin o'r system o dwyni; ar y safleoedd eraill, lleolwyd y gorsafoedd o fewn y systemau o dwyni eu hunain. Dim ond cyflymder a chyfeiriad y gwynt a fesurodd yr orsaf dywydd yn Niwbwrch. Ar y safleoedd eraill mesurwyd paramedrau pellach, sef tymheredd, lleithder, gwasgedd a glawiad.

Roedd amodau'r tywydd yn debyg ar draws yr holl safleoedd. Mae cyflymder y gwynt yn amrywio rywfaint yn ôl y tymor, gyda gwyntoedd cryfach yn y gaeaf, ond mae gwyntoedd cryfion bob adeg o'r flwyddyn. Mae'r diagramau rhosyn ar gyfer gwynt hefyd yn dangos rhywfaint o amrywio yn ôl y tymor o ran cyfeiriad y gwynt: ar bob safle, mae cyfran uwch o'r gwyntoedd yn mynd tua chyfeiriad y tir neu gyda'r draethlin yn yr haf, a chyfran uwch o'r gwyntoedd yn mynd tua chyfeiriad y môr yn y gwanwyn. Mae llai o amrywio yn ôl y tymor yn y data ar lawiad. Ar bob safle, yn achos tymheredd y mae'r amrywio yn ôl tymor ar ei fwyaf clir.

Rhagwelir y bydd y setiau data o fudd at wahanol agweddau ar waith rheoli ac ymchwil twyni tywod. Mae manylion am sut i gael gafael ar y data i'w gweld yn Atodiad B: Data Archive Appendix.

Executive summary

This document summarises the weather data collected between 2017 - 2023 at four sand dune National Nature Reserves around the Welsh Coast. The data was collected to help inform management of the dune systems and to better understand the development of sand mobilisation interventions.

The four sites were Newborough, Morfa Harlech, Whiteford and Merthy Mawr. At Newborough, the weather station was situated on a promotory to the west of the dune system; at the other sites, the stations were placed within the dune systems themselves. The weather station at Newborough only measured wind speed and direction, at the other sites further parameters were available, namely temperature, humidity, pressure and rainfall.

Weather conditions were similar between all sites. There is some seasonality in the wind speeds with stronger winds in winter, but strong winds occur at all times of year. The wind roses also show some seasonal variation in wind direction: all sites have a greater proportion of onshore / cross-shore directed winds in summer and a greater proportion of offshore directed winds in spring. There is less clear seasonality in the rainfall data. Temperature shows the clearest seasonality at all sites.

It is envisaged that the datasets will be of benefit for various aspects of sand dune management and research. Details of how to obtain the data can be found in Appendix B: Data Archive Appendix.

Introduction

Sand is transported into and around dune systems through Aoelian (wind-driven) transport. This relies on wind of sufficient velocity and sand that is dry enough to be picked up by the wind; in other words, days with wind and not rain. Tidal exposure, which controls dry beach width, is also important at coastal sand dunes but tidal data was not collected as part of this study. Likewise, dune vegetation and morphology will control patterns of sand erosion and deposition, but are not covered in this report.

Weather data were collected at four sand dune National Nature Reserves (Figure 1) to help understand the mobility of Welsh sand dunes and to support the sand dune rejuvenation works conducted by the Sands of Life project (Sands of LIFE Website) and the Dynamic Dunescapes project (Dynamic Dunescapes Website).

The four sites were Newborough, Morfa Harlech, Whiteford and Merthy Mawr (Figure 1), locations of the stations are given in Table 1. The sites are internationally important due to the rare plants and animals that exist in these areas. Sand dunes can also be important as a form of natural coastal defence. At Newborough, the weather station was installed on Llandwyn Island, approximately 2.5km west of the dune system (Figure 2). At the other sites, weather stations were installed within the dune systems (Figure 2).

Table 1: Co-ordinates (Latitude and Longitude) of the measurement locations for the four sites.

Site	**Latitude (°)**	**Longitude (°)**
Newborough	53.136004	-4.4135866
Morfa Harlech	52.85877	-4.11792
Whiteford	51.642502	-4.2459965
Merthyr Mawr	51.475585	-3.643644

Figure 1: A map of Wales showing the location of the four sites where weather stations were installed. © Crown copyright and database rights 2023 Ordnance Survey AC0000849444. Copyright © ESRI (UK) Limited [2023].

Figure 2: Maps showing the locations of the weather stations at the different sites: a) Newborough; b) Morfa Harlech; c) Whiteford; d) Merthyr Mawr.

Two different types of weather station were used. At Newborough, a Skye instruments MiniMet weather station was installed. This system measured wind speed and direction. Skyview Vantage Pro 2 weather stations with Weather Link data loggers were installed at Merthyr Mawr, Whiteford and Harlech. As well as wind speed and direction, these instruments measured wind gust, air temperature, relative humidity, rainfall and barometric pressure.

Data were collected at all sites between 2017 and February 2023. However, there were periods of time when instruments at a site malfunctioned or were serviced, with a loss of

data coverage. The periods where wind data are available for each site are detailed in Table 2. Data collection is ongoing for Newborough, but the last analysed data was 04/01/2023. For access to the data, see Appendix B.

Table 2: Periods of wind data availability for each site.

Site	**Data availability**
Newborough	30/01/2018 – 13/10/2018; 19/10/2018 - 31/07/2020; 17/11/2021 – 13/12/2021; 27/12/2021 – 04/01/2023. 04/01/2023 – present
Morfa Harlech	21/02/2017 – 03/11/2017; 15/11/2017 – 01/12/2017; 18/12/2017 – 04/10/2018; 15/11/2018 – 17/01/2019; 13/02/2019 – 20/02/2023.
Whiteford	22/02/2017 – 12/03/2018; 14/03/2018 – 23/09/2018; 09/10/2018 – 21/10/2018; 19/11/2018 – 20/04/2020; 22/04/2020 – 12/02/2022; 14/02/2022 – 19/02/2023.
Merthyr Mawr	21/02/2017 – 14/04/2017; 16/04/2017 – 29/04/2017; 01/05/2017 – 20/09/2017; 22/09/2017 – 28/11/2017; 20/02/2018 – 26/08/2019; 28/08/2019 – 10/04/2020; 29/06/2020 – 01/09/2021; 03/09/2021 – 29/09/2021; 01/10/2021 – 20/01/2022; 22/01/2022 – 21/10/2022.

Results

Data for each site are presented on a site-by-site basis in the following sections. Timeseries are shown for both the raw data and a fortnightly rolling average (to characterise seasonal variability); parameters displayed depend on instrument type and are detailed below for each location. For every site, wind roses are presented for the entire dataset and for each season; spring (March, April, May), summer (June, July, August), autumn (September, October, November) and winter (December, January, February). Monthly averages and standard deviation in monthly values are also displayed for the same parameters as the timeseries.

Newborough

Figures 3 and 4 show the timeseries of wind speed and wind direction respectively for Newborough. The mean wind speed is 4.9 ms^{-1} and mean wind direction is 178°. The large data gap means that it is hard to draw too much from the timeseries; some seasonality can be noted, with higher winds in winter but high winds can occur at any time of year.

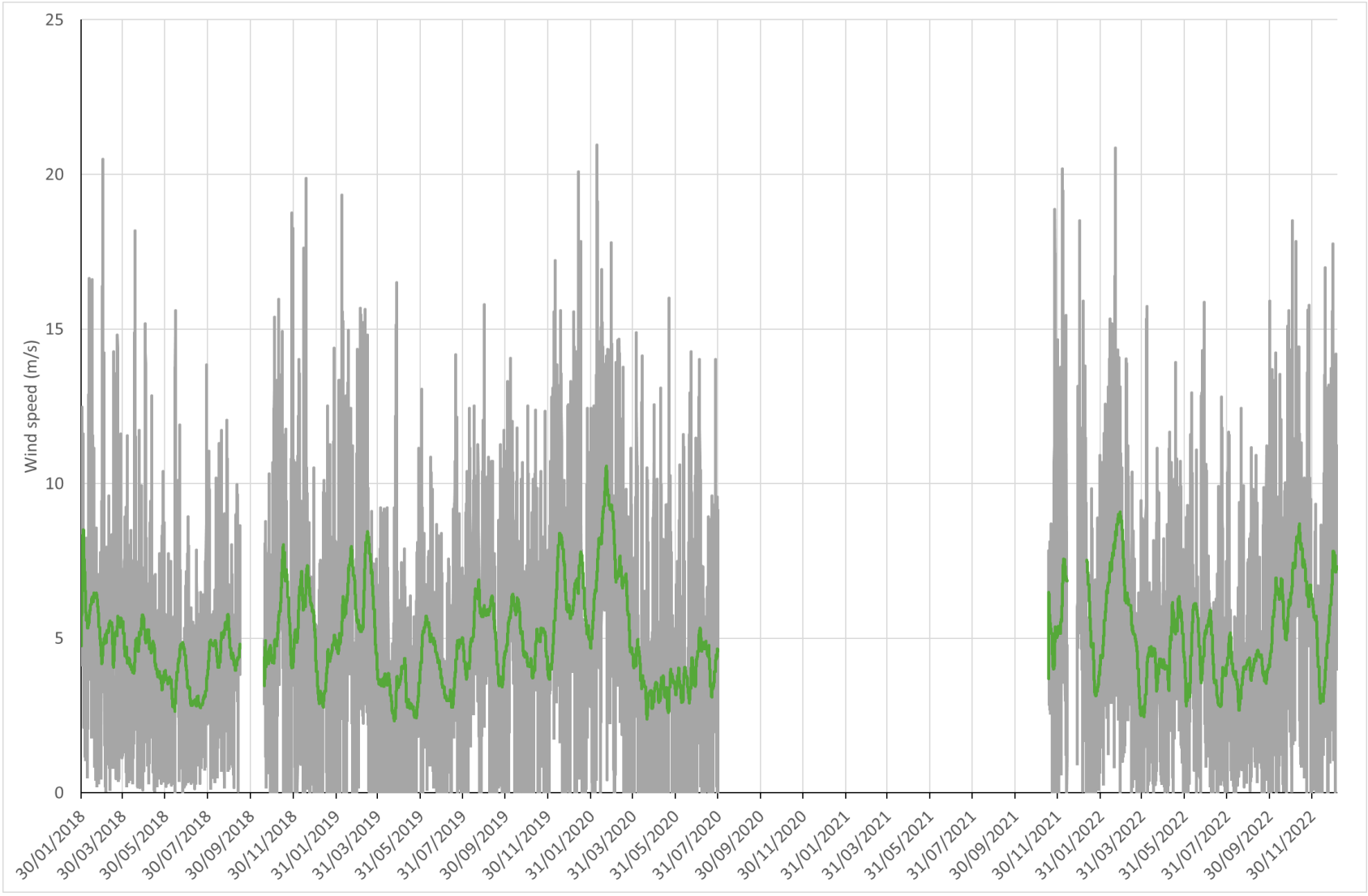

Figure 3: A timeseries of 10-minute mean wind speed for Newborough; raw data is show as grey line and 14 day rolling average shown as a green line.

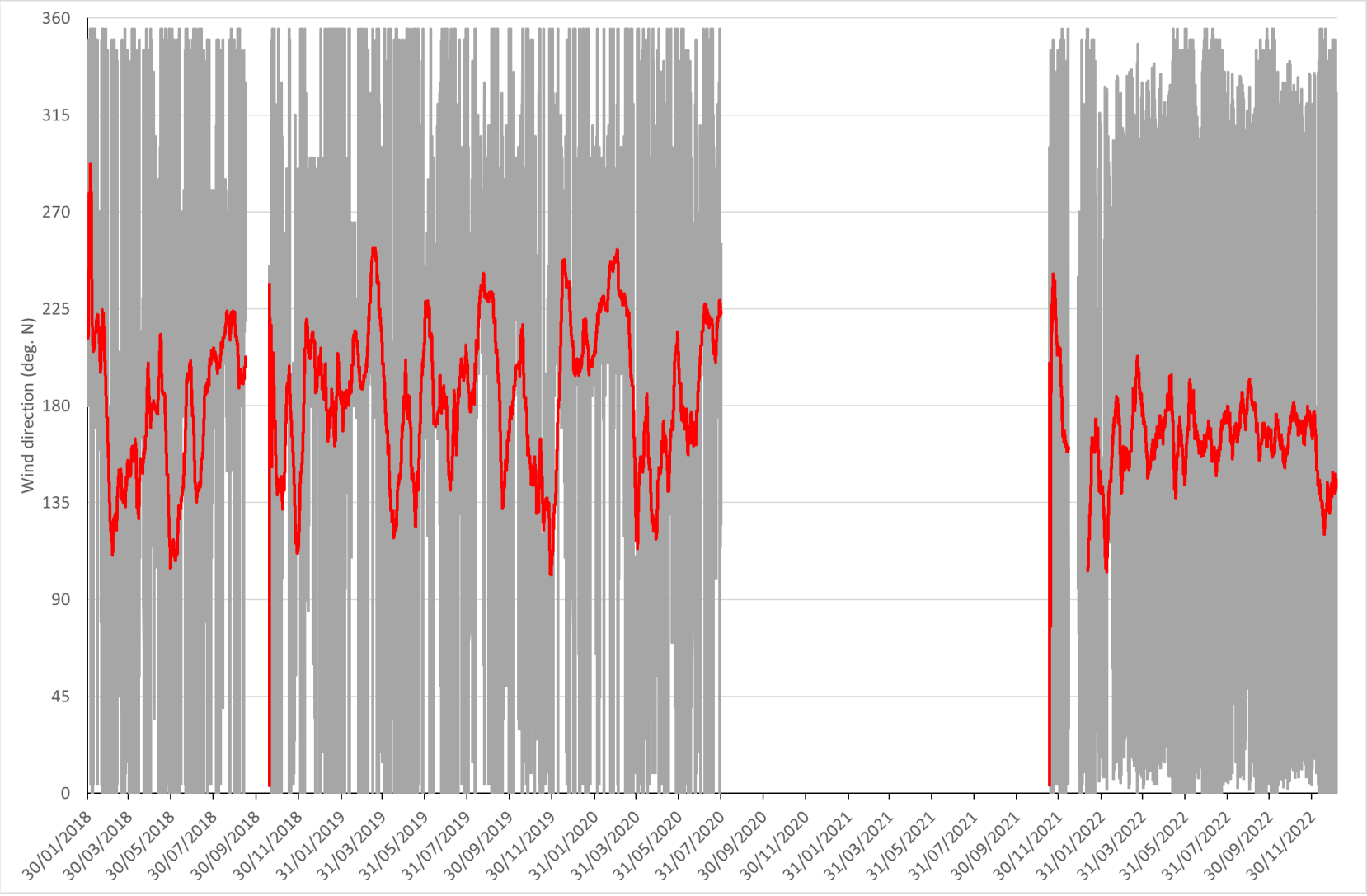

Figure 4: A timeseries of wind direction at Newborough, the data is displayed as raw data (grey line) and a rolling average over 14 days (red line).

Figure 5 shows a wind rose for all Newborough data and Figure 6 shows the wind rose broken down into seasons, with seasons of all years amalgamated. Overall, winds are predominantly from the south through to west-north-west, with strongest winds from the south to south-west (Figure 5). Some seasonal variation can be observed in the wind roses (Figure 6): in spring, a greater proportion of winds are incident from the north-east and east; in summer, winds are directly onshore (south west) more often; and, in winter a greater proportion of winds have higher velocities (dark blue band in Figure 6). Figure 7 shows the wind speed monthly averages and standard deviations for Newborough. There is seasonality in wind speeds, with higher monthly average speeds occurring in winter (maximum in February). However, the large standard deviations show that wind speeds are variable with both high and low speeds occurring at any time of year, as was also observed in the time series plot (Figure 3).

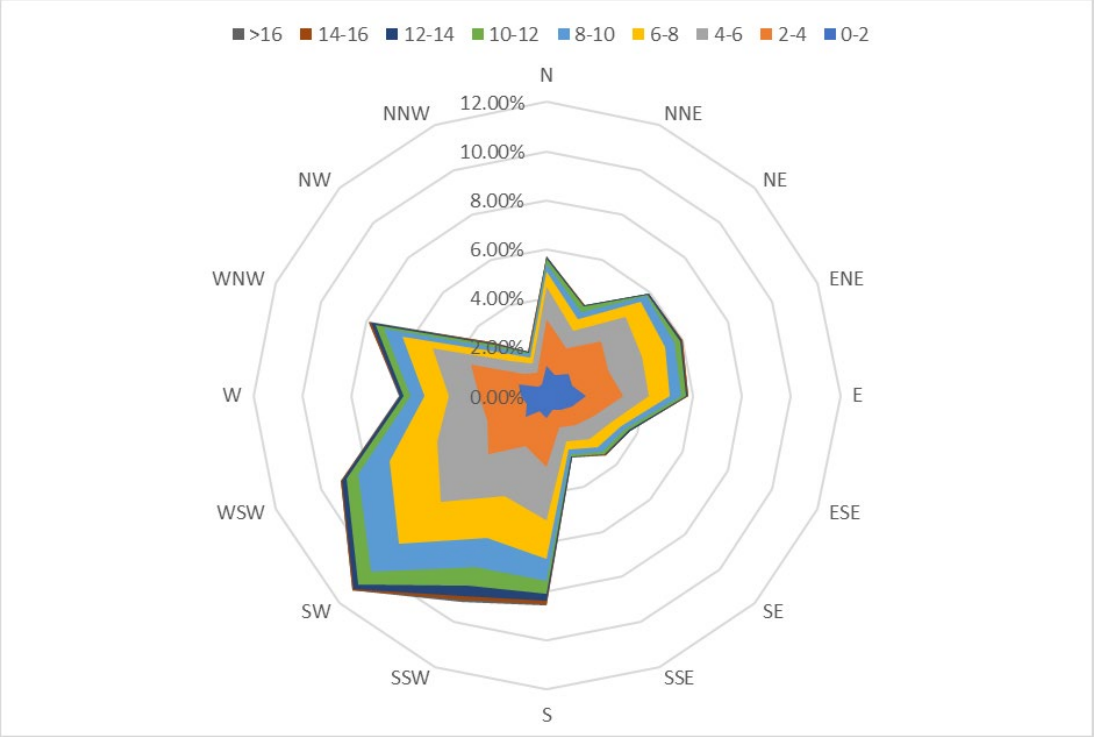

Figure 5: A wind rose (m/s) for the Newborough data from all years and seasons. Wind speed is indicated by colour shading, direction by the compass points and percentage proportion of occurence on the radial axis.

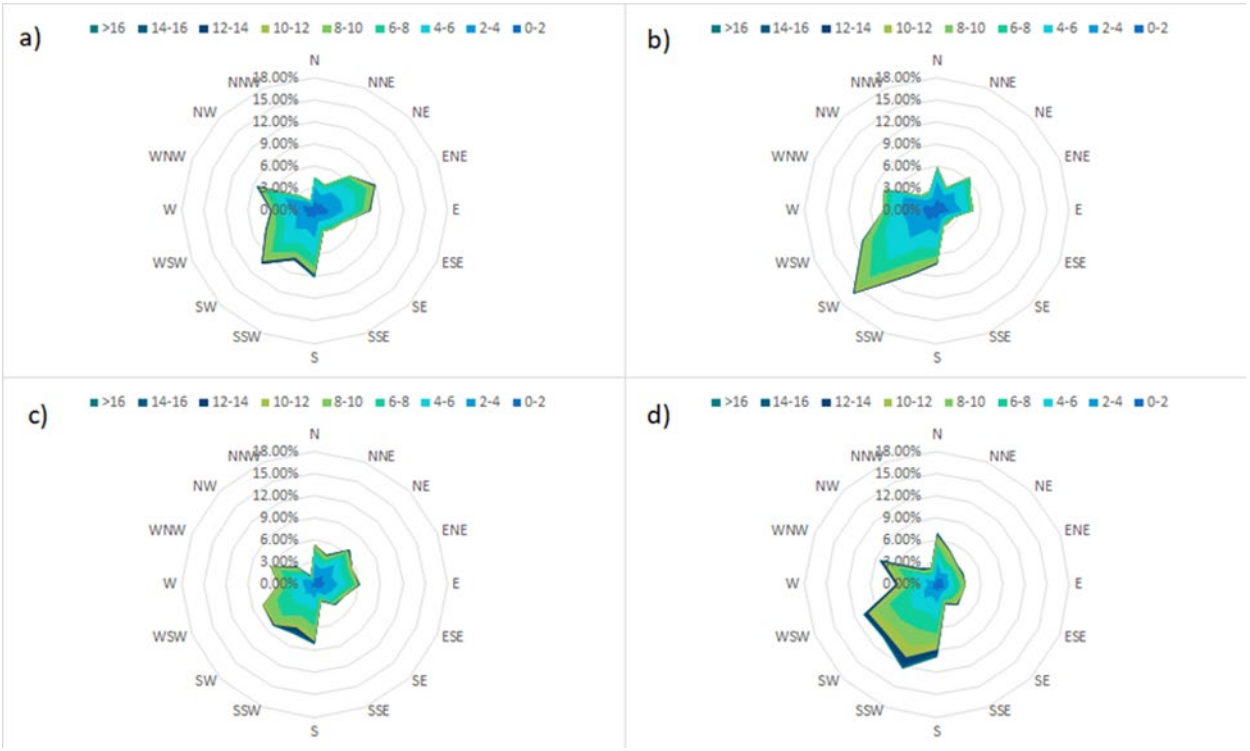

Figure 6: A wind rose from Newborough separated into seasons: a) Spring (March – May); b) Summer (June – August); c) Autumn (September – November); d) Winter (December – February).

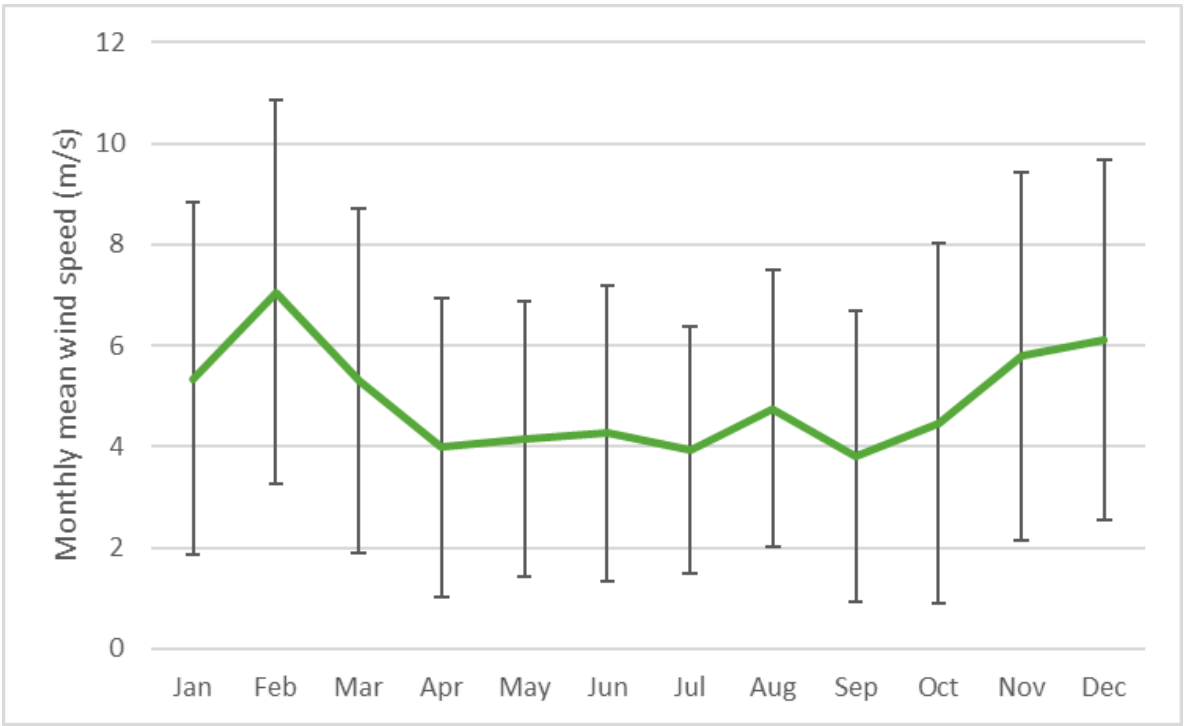

Figure 7: Monthly averages (green line) and standard deviations (vertical bars) in wind speed (m/s) for Newborough. Averages are calculated over all years where data is available.

Morfa Harlech

Table 3 presents mean values for key parameters and Figures 8-11 display timeseries of wind speed, wind gust, temperature and daily rainfall quantity, displayed as both raw data and fortnightly rolling averages. Temperature (Figure 10) is the only variable that shows clear seasonality in the time series. There is some seasonality in the wind speed (Figures 8 and 9) and rainfall (Figure 11) but it is less obvious and the large standard deviations indicate that higher values can occur at any time of the year.

Table 3: Mean values for the measured parameters at Morfa Harlech.

Parameter	**Mean value**
10 minute mean wind speed	4.0 m/s
Maximum wind gust over 10 minutes	6.8 m/s
Wind direction	189 deg.
Temperature	11.3 deg. C
Daily rainfall amount	2.6 mm
Rainfall rate	4.5 mm/hr

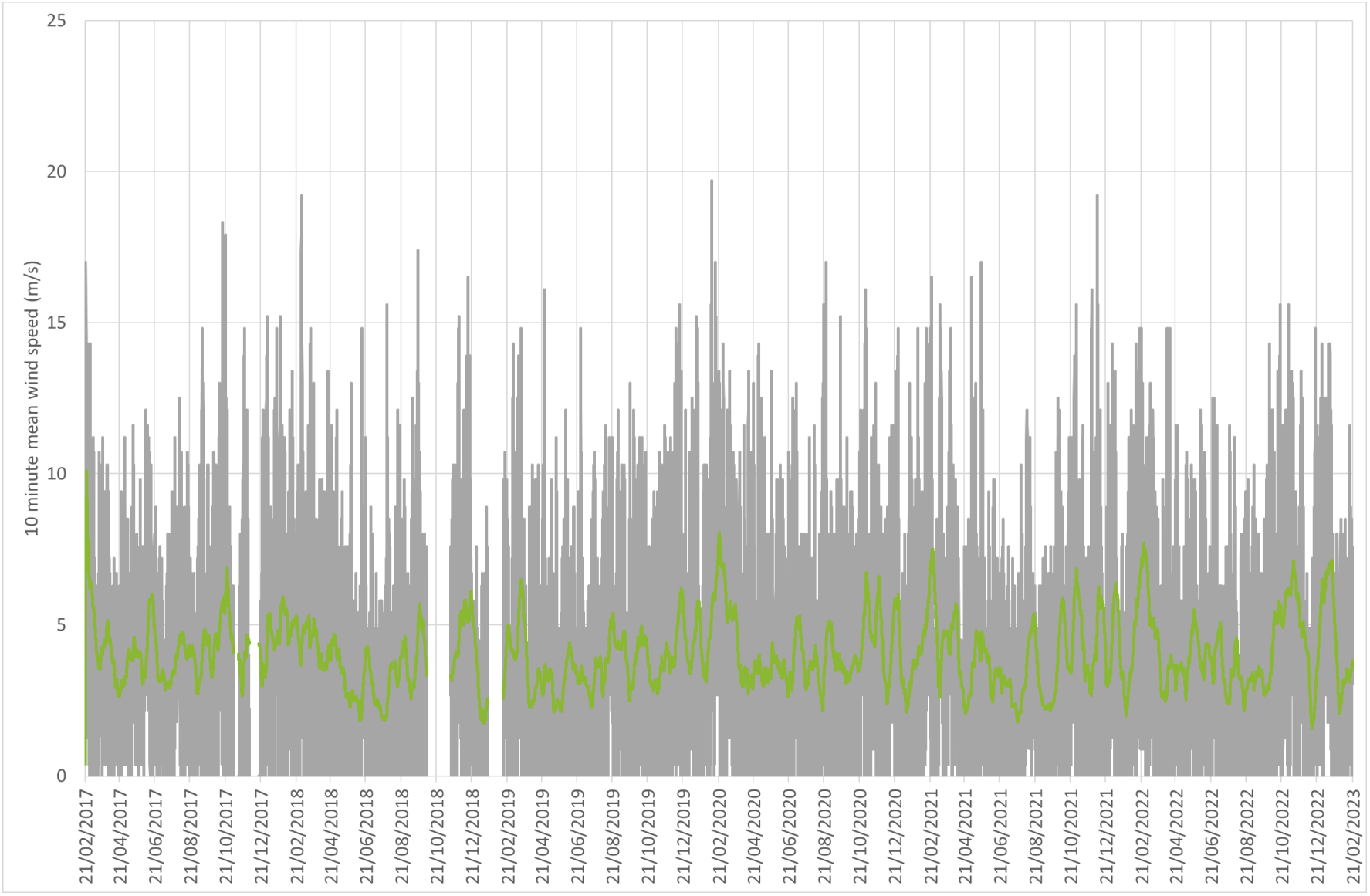

Figure 8: A timeseries of 10-minute mean wind speed, displayed as a raw data (grey line) and a 14 day rolling average (green line).

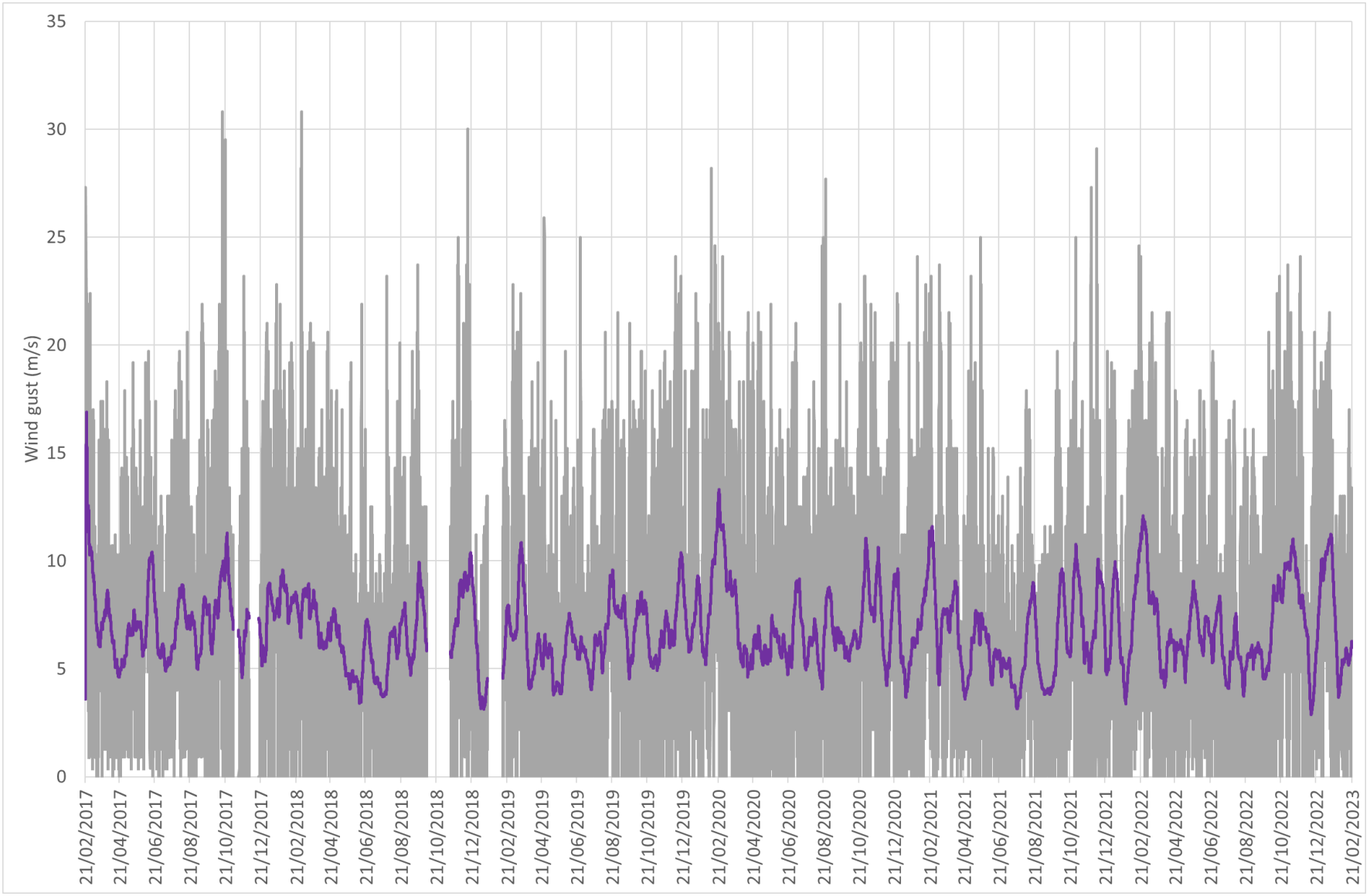

Figure 9: Timeseries from Morfa Harlech of maximum wind gust over a 10 minute period, displayed as raw data (grey line) and 14-day rolling average (purple line).

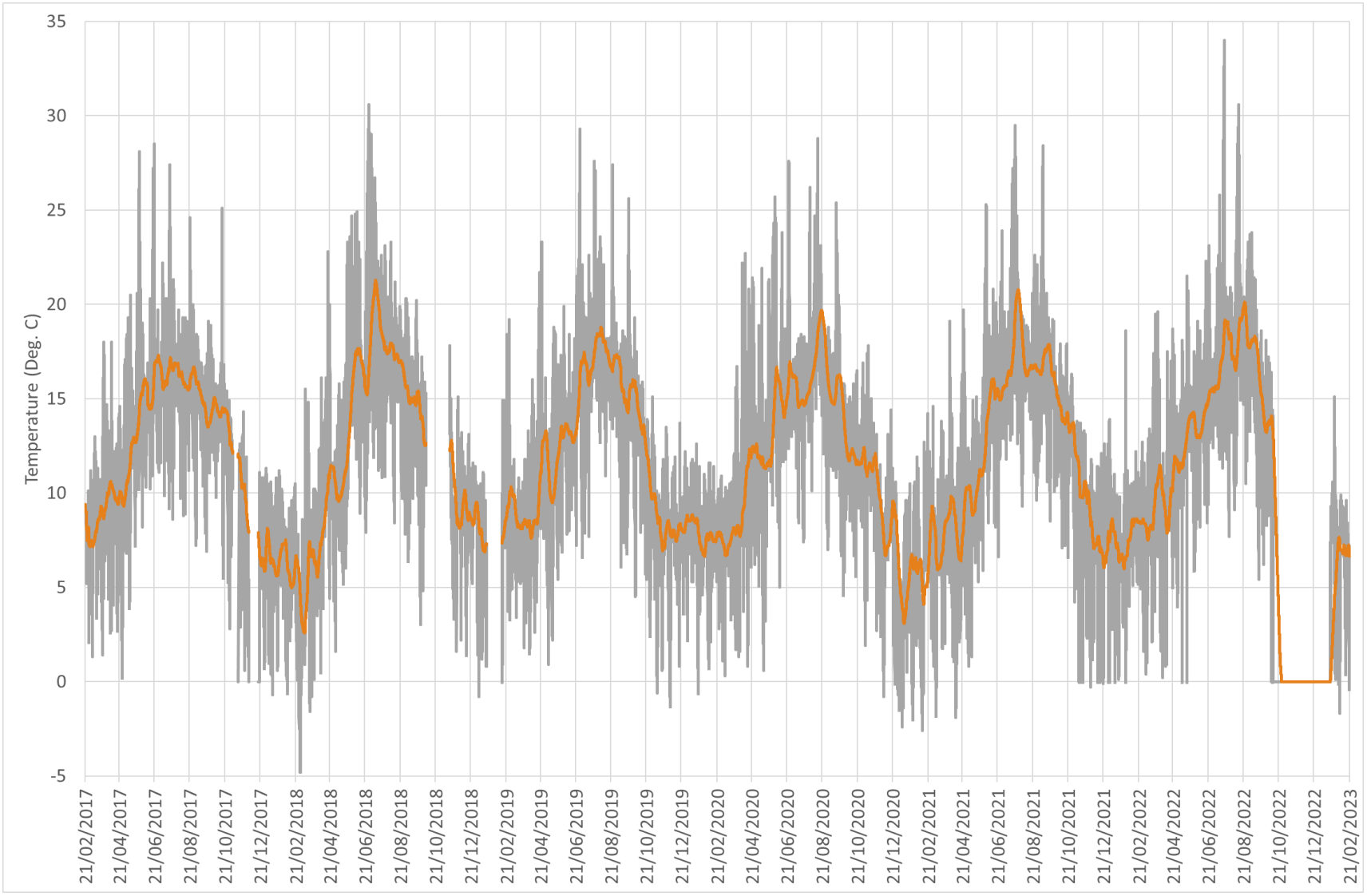

Figure 10: A timeseries of temperature (°C) at Morfa Harlech, displayed as a raw data (grey line) and 14-day rolling average (orange line)

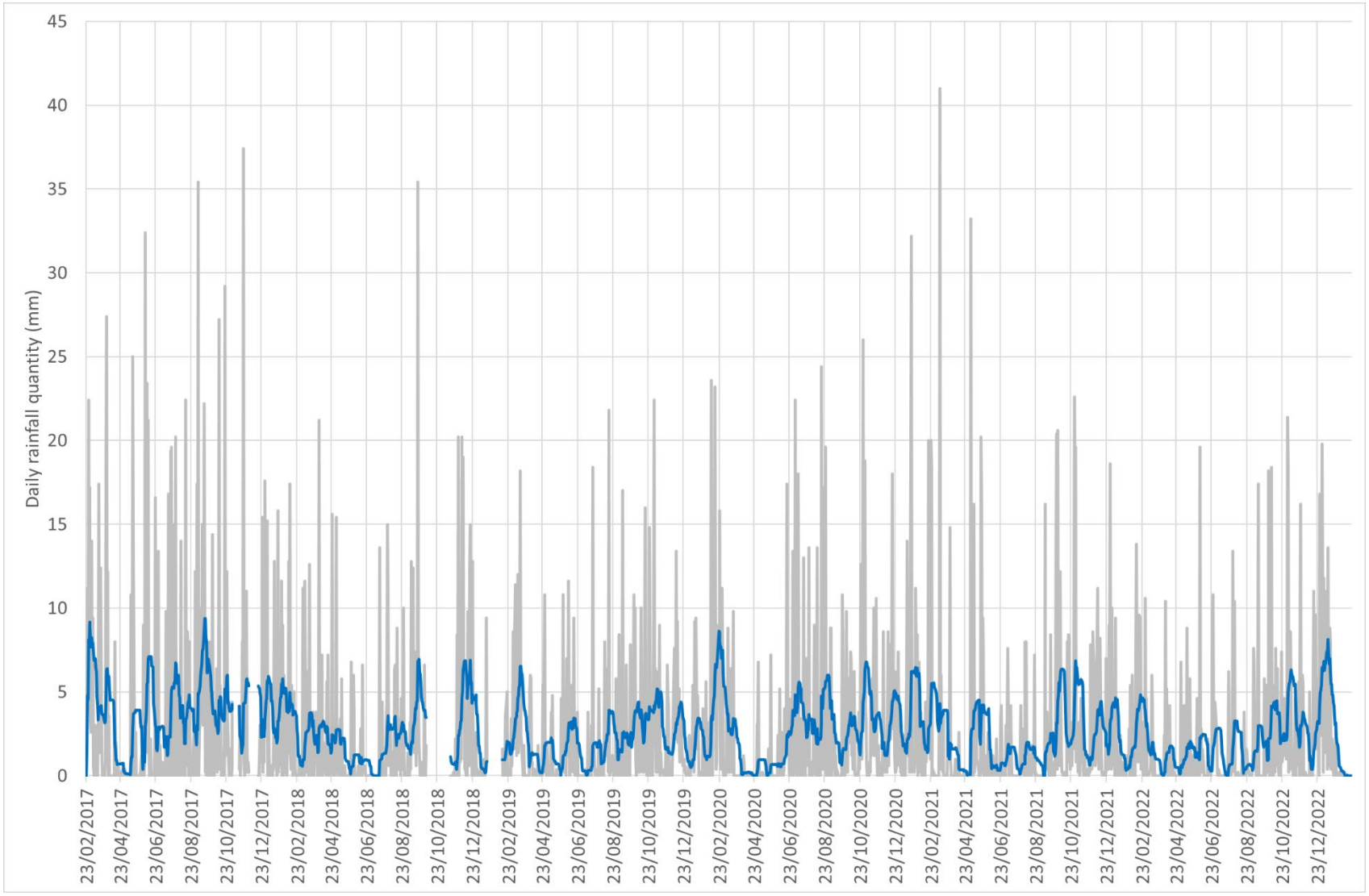

Figure 11: A timeseries of daily rainfall quantities (mm) from Morfa Harlech, displayed as raw data (grey line) and 14-day rolling average (blue line)

Wind roses are displayed for the whole dataset (Figure 12) and split into seasons (Figure 13). It is believed that the ‘spikiness’ in the wind rose is due to topographic steering of the wind by the dune system. The majority of the wind, and the strongest wind comes from the south. Summer and autumn roses (Figure 13b & c) look similar to the overall rose (Figure 12). In spring, there is a greater proportion of wind from the north east, whereas in winter a greater proportion comes from the south to south-south-east.

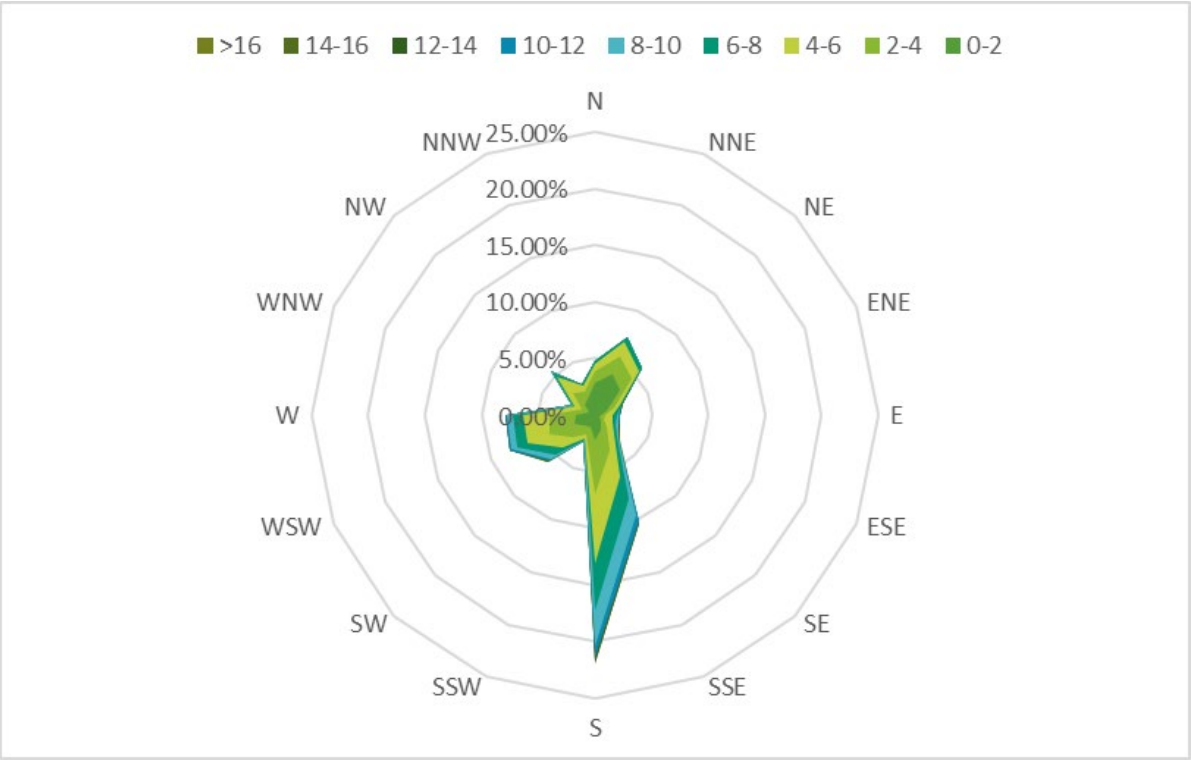

Figure 12: A wind rose from the Morfa Harlech data, using all available data.

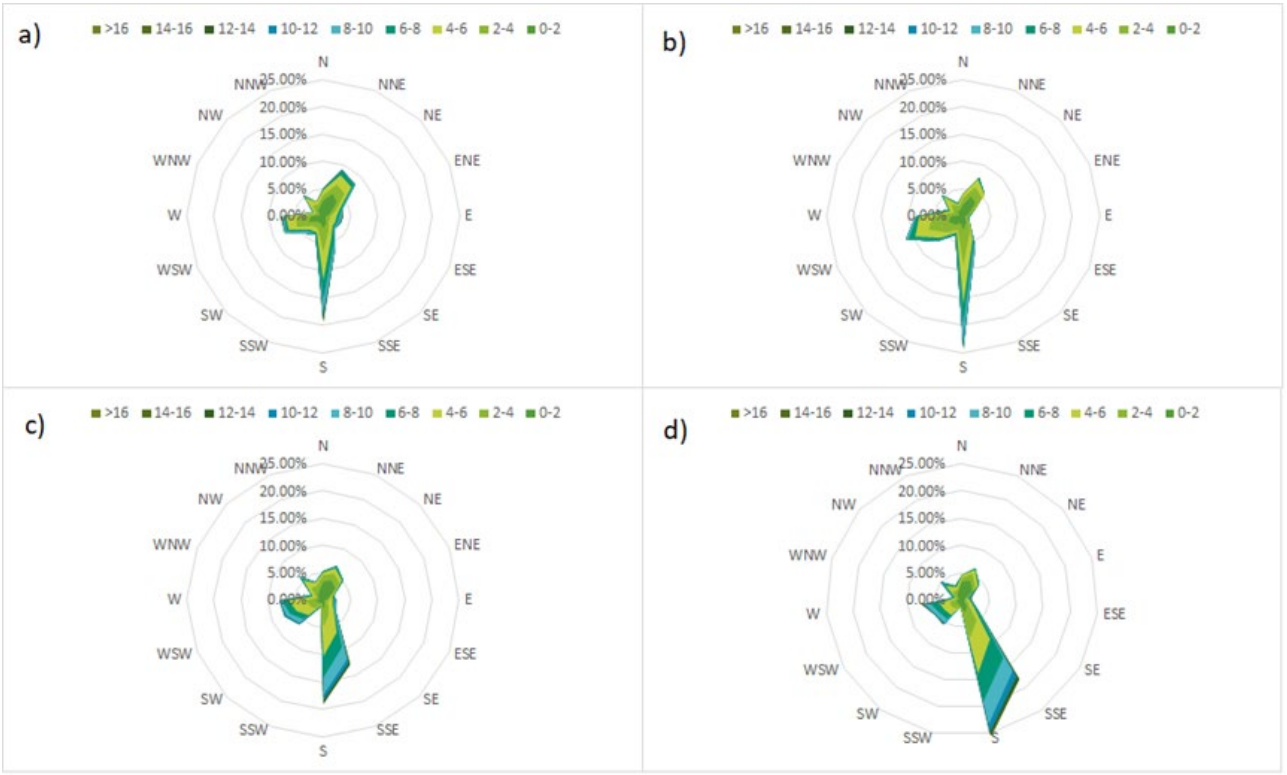

Figure 13: A wind rose for Morfa Harlech separated into seasons: a) Spring (March – May); b) Summer (June – August); c) Autumn (September – November); d) Winter (December – February).

Figures 14 – 17 give monthly averages and standard deviations of daily parameters for key variables at Morfa Harlech to further consider seasonality.The 10 minute mean wind speed (Figure 14) and wind gust (Figure 15) have very similar monthly distributions. While there is seasonality in both parameters, the standard deviation in each parameter is much greater than the difference in mean value between months; indicating that strong winds can occur at any time of year. As noted in the timeseries plots, temperature is the only variabile with obvious seasonality (Figure 16). Daily rainfall (Figure 17) totals show even less seasonality than the wind speeds.

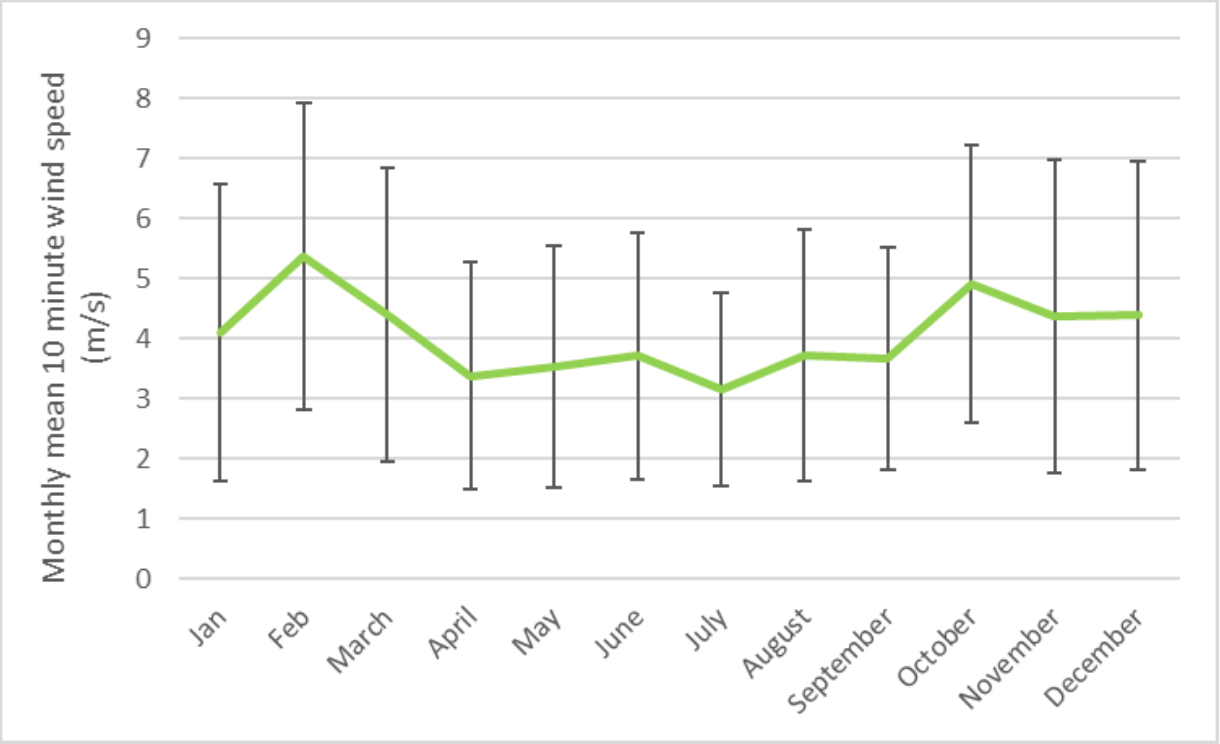

Figure 14: Monthly average (green line) and standard deviation (vertical bars) of 10-minute mean wind speeds at Morfa Harlech.

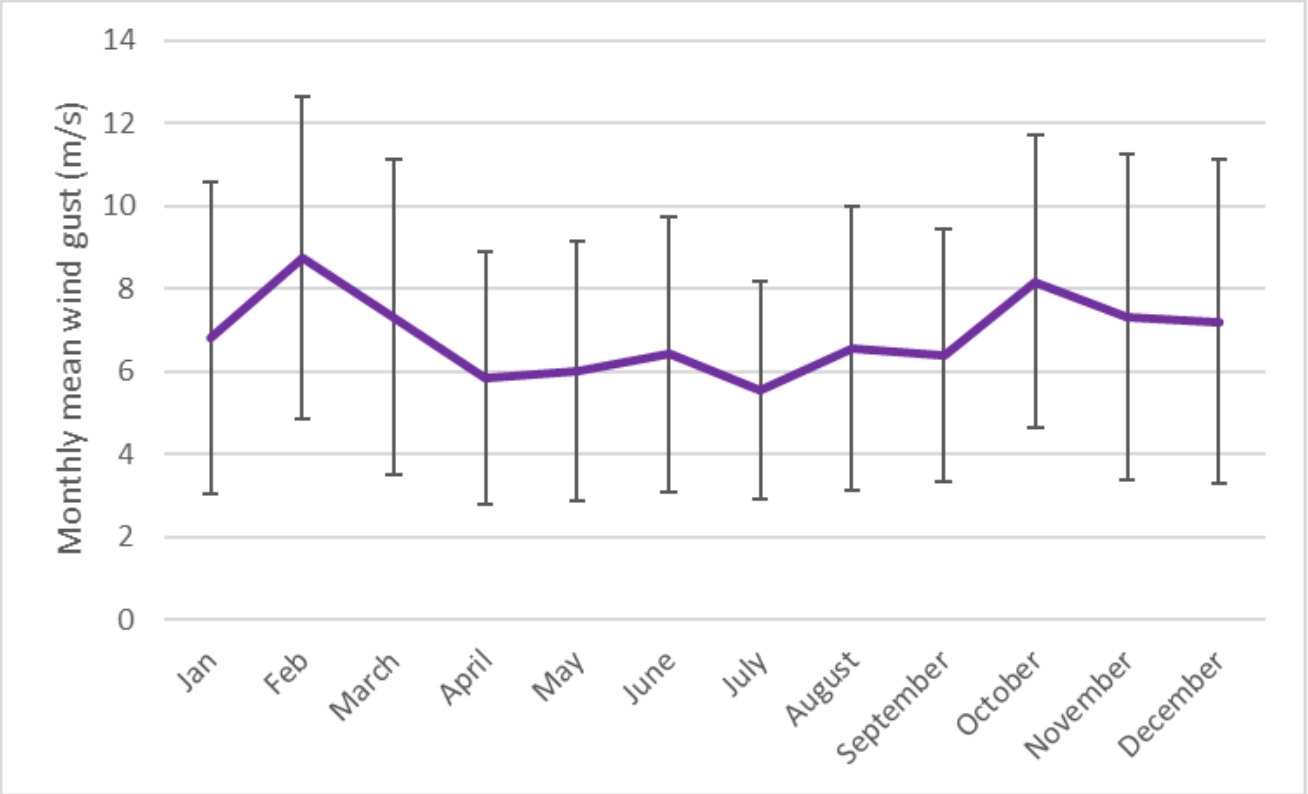

Figure 15: Monthly averages of maximum 10 minute wind gust (purple line) and standard deviation in mean gust (vertical bars), for Morfa Harlech.

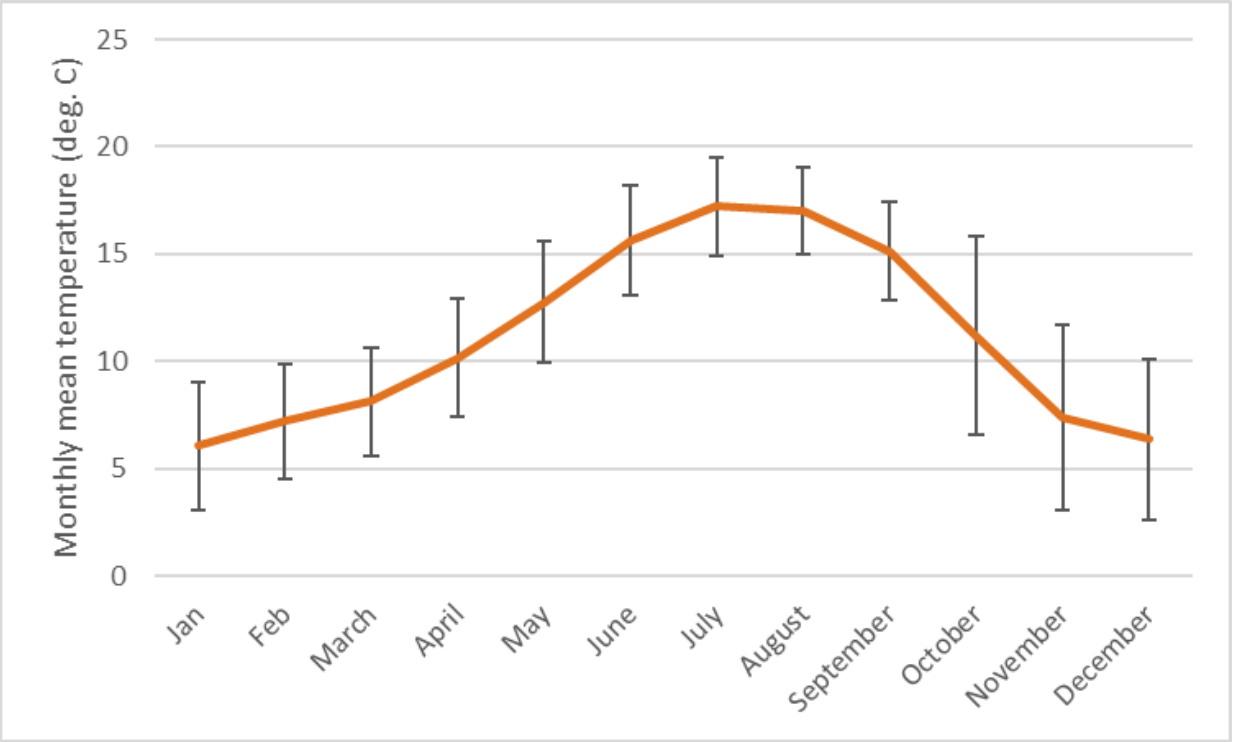

Figure 16: Monthly mean temperature (orange line) and standard deviation in daily mean temperature (vertical bars) for Morfa Harlech.

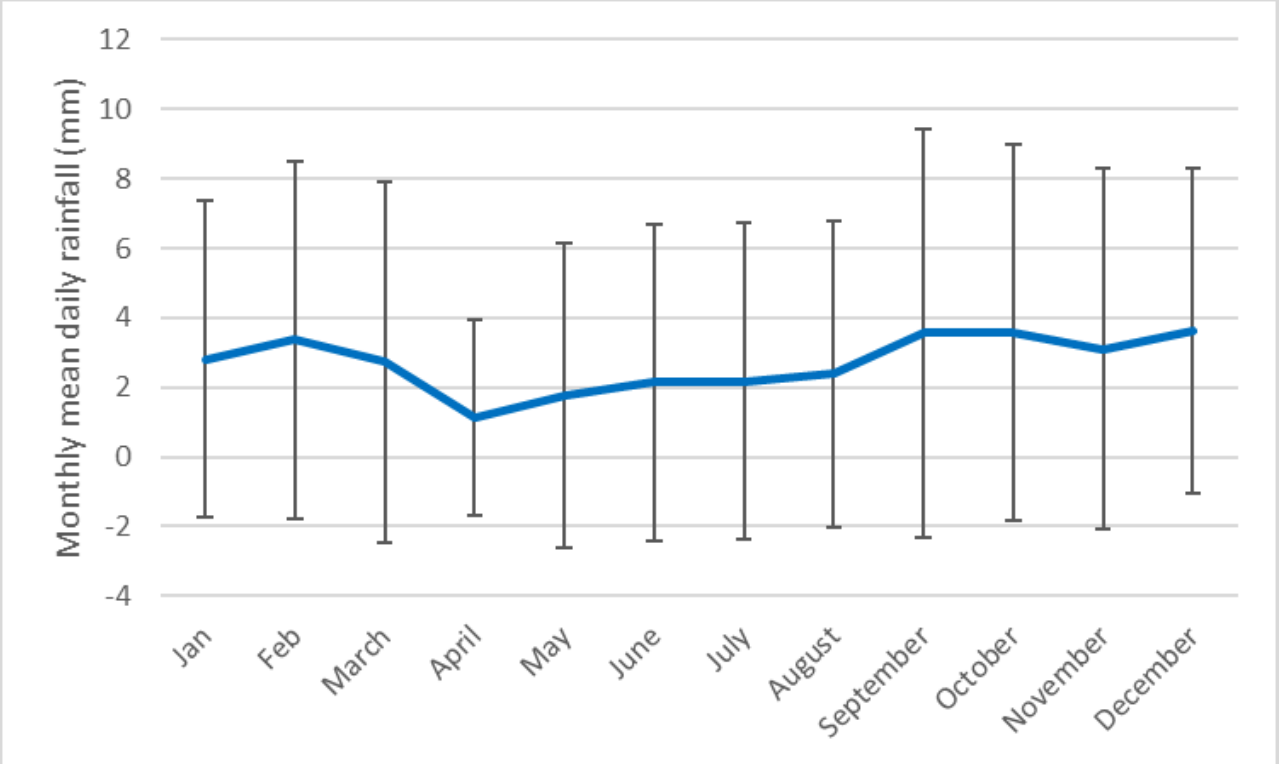

Figure 17: Monthly mean daily rainfall (blue line) and standard deviation in daily total rainfall (vertical bars) for Morfa Harlech.

Whiteford

Figures 18-21 show timeseries of wind speed, wind gust, temperature and daily rainfall. Table 4 gives mean values of measured parameters. As for the other sites, there is limited seasonality evident in the 10-minute mean wind speed data (Figure 18). The wind gust data (Figure 19), shows a similar pattern to the 10-minute wind speed but with higher values. Similar to the other sites, much clearer seasonality can be seen in the temperature record; however, the temperature sensor seems to malfunction in the summer of 2022, with suspicious readings after that (Figure 20). Therefore, temperature was not analysed beyond 28/08/2022.The most noticeable part of the rainfall timeseries (Figure 21) is the lack of rain in spring and summer 2018. However, while the data has been left in the record, caution is recommended for this period: gauges on the other sites show rainfall during this time.

Table 4: Mean values of key parameters over the whole dataset for Whiteford.

Parameter	**Mean value**
10 minute mean wind speed	3.9 m/s
Maximum wind gust over 10 minutes	6.7 m/s
Wind direction	209 deg.
Temperature	12.3 deg. C
Daily rainfall amount	1.9 mm
Rainfall rate	1.4 mm/hr

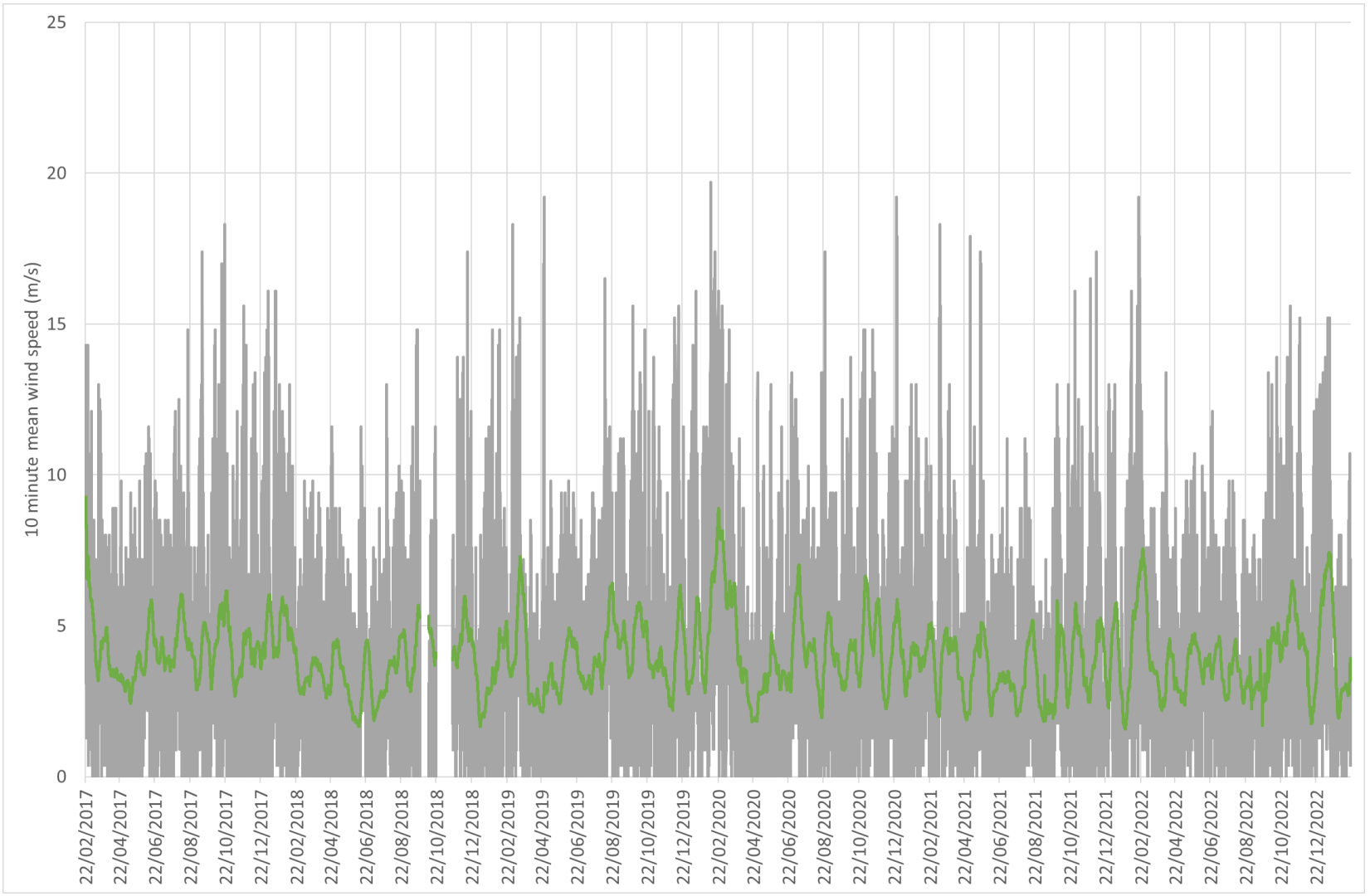

Figure 18: A timeseries of mean 10-minute wind speed at Whiteford, displayed as raw data (grey line) and 14 day rolling average (green line).

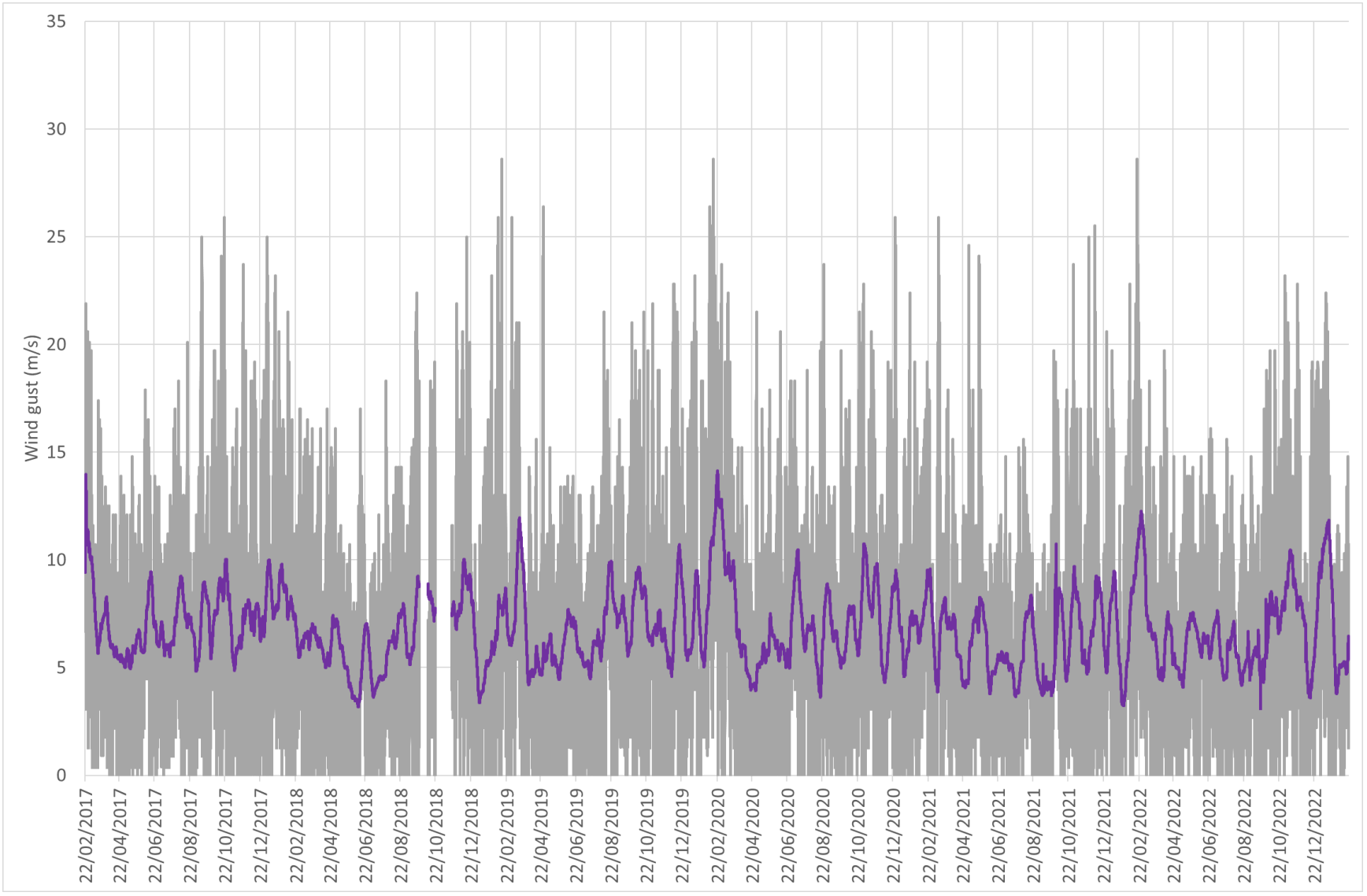

Figure 19: A timeseries of wind gust at Whiteford, displayed as both raw data (grey line) and 14 day rolling average (purple line).

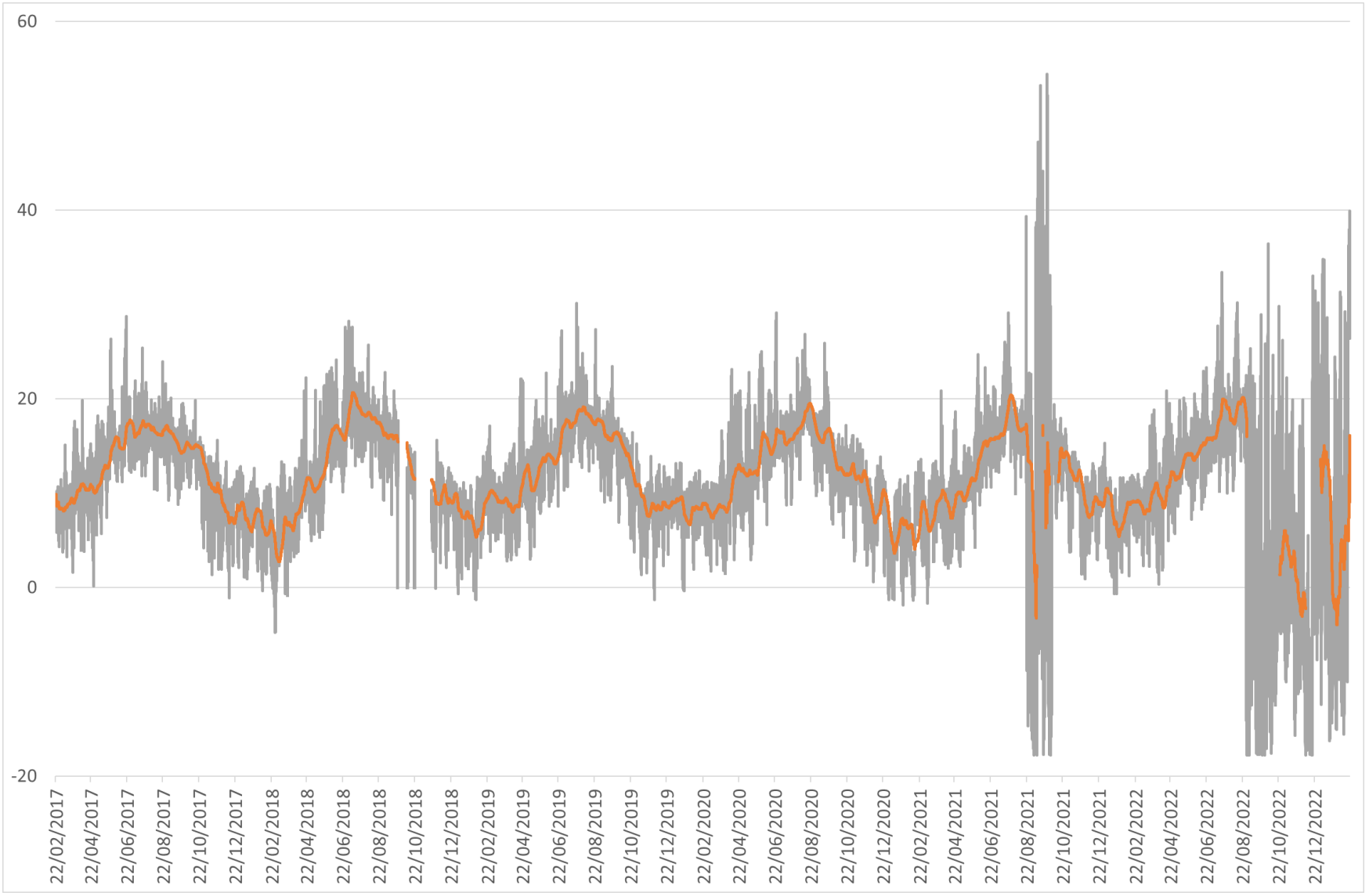

Figure 20: Temperature at Whiteford, displayed as raw data (grey line) and 14 day rolling average (orange line). The sensor malfunctioned after 08/2021.

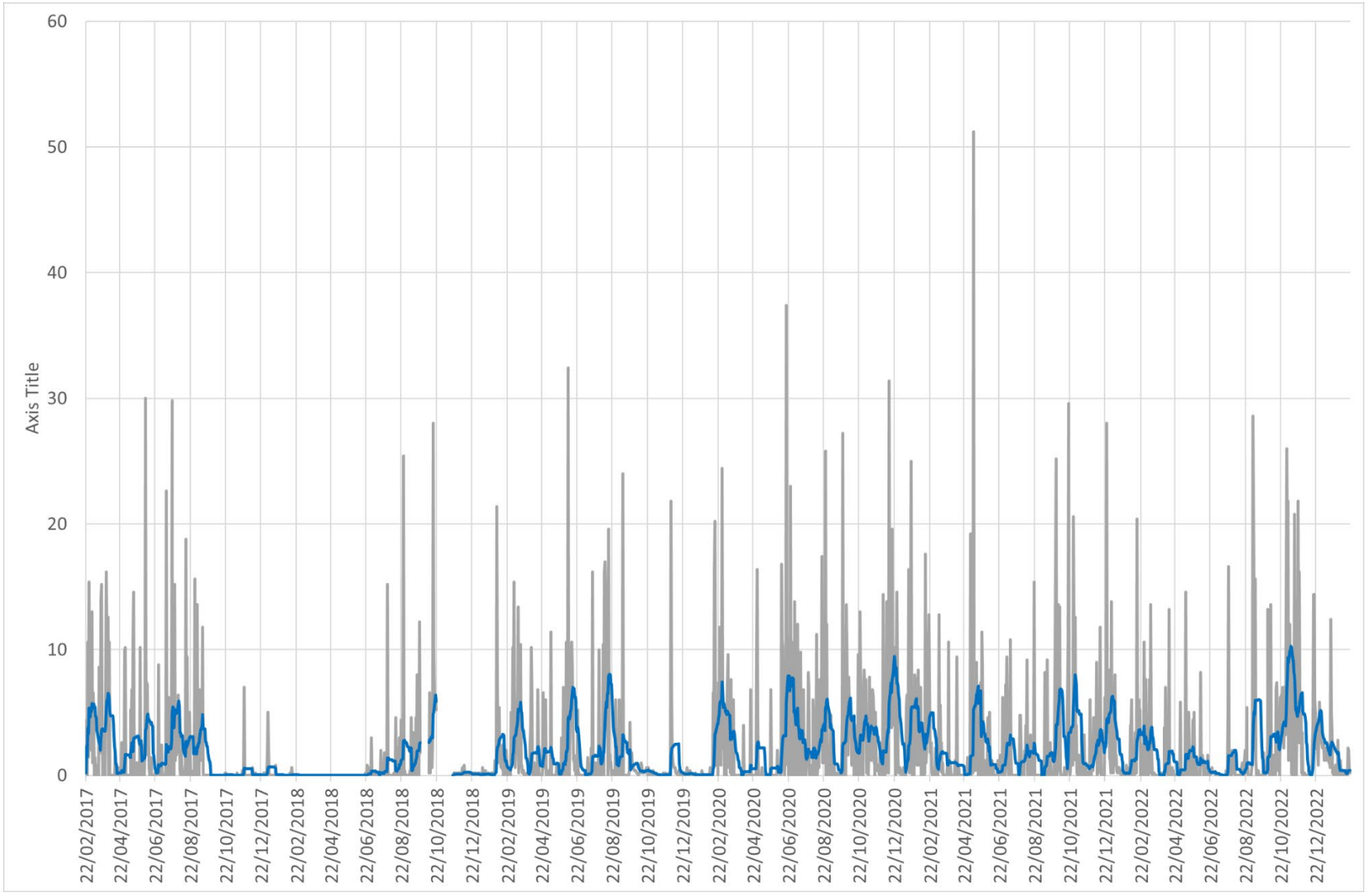

Figure 21: Daily rainfall amount (mm) at Whiteford, displayed as both raw data (grey line) and a 14 day rolling average (blue line).

The wind rose for the whole dataset (Figure 22) shows that the dominant direction and the direction that the strongest winds come from is the west-south-west to south-west. The small proportion attributed to a westerly direction is likely to be due to topographic steering (Figure 22). Similar to the other sites, seasonal variation can be seen in the wind roses (Figure 23). In Spring (Figure 23a), a larger proportion of the wind comes from the south-east compared to the overall rose. In summer (Figure 23b), a greater proportion of winds come from the WSW, although this is largely due to less winds coming from the SW rather than changes to the wider rose. In autumn (Figure 23c), wind direction is slightly more variable and in winter (Figure 23d) wind distribution is similar to the overall rose (Figure 22). For all seasons, similar to the overall wind rose, strongest winds are from the WSW to SW.

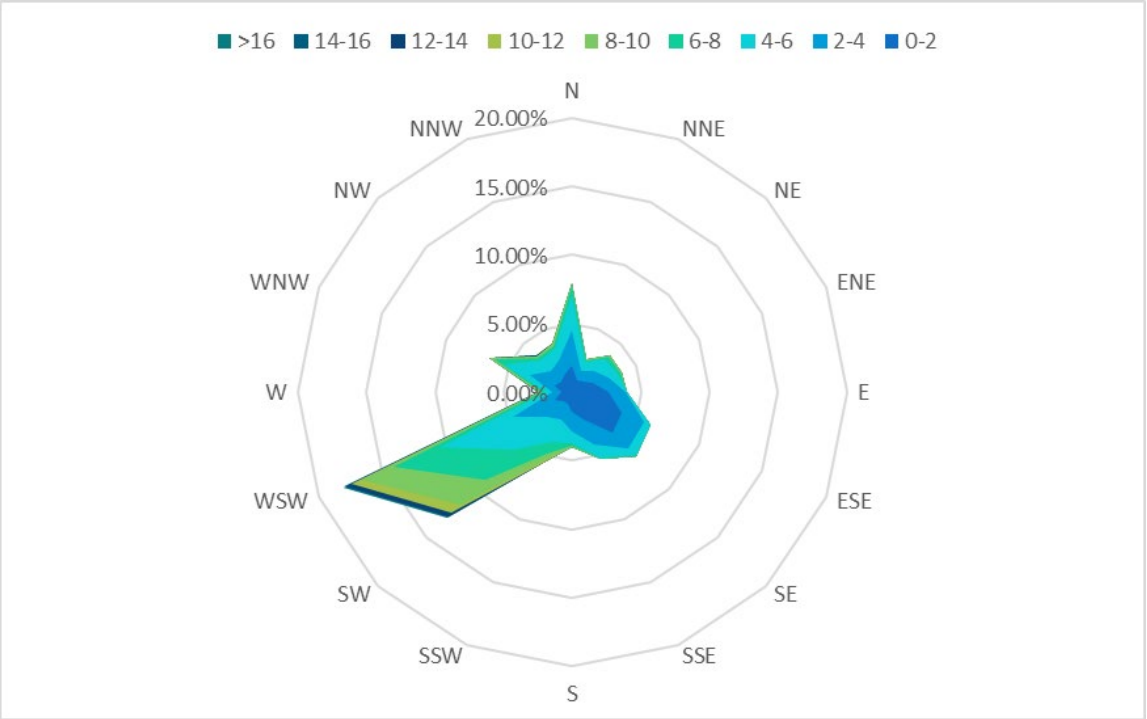

Figure 22: A wind rose for the entire Whiteford record.

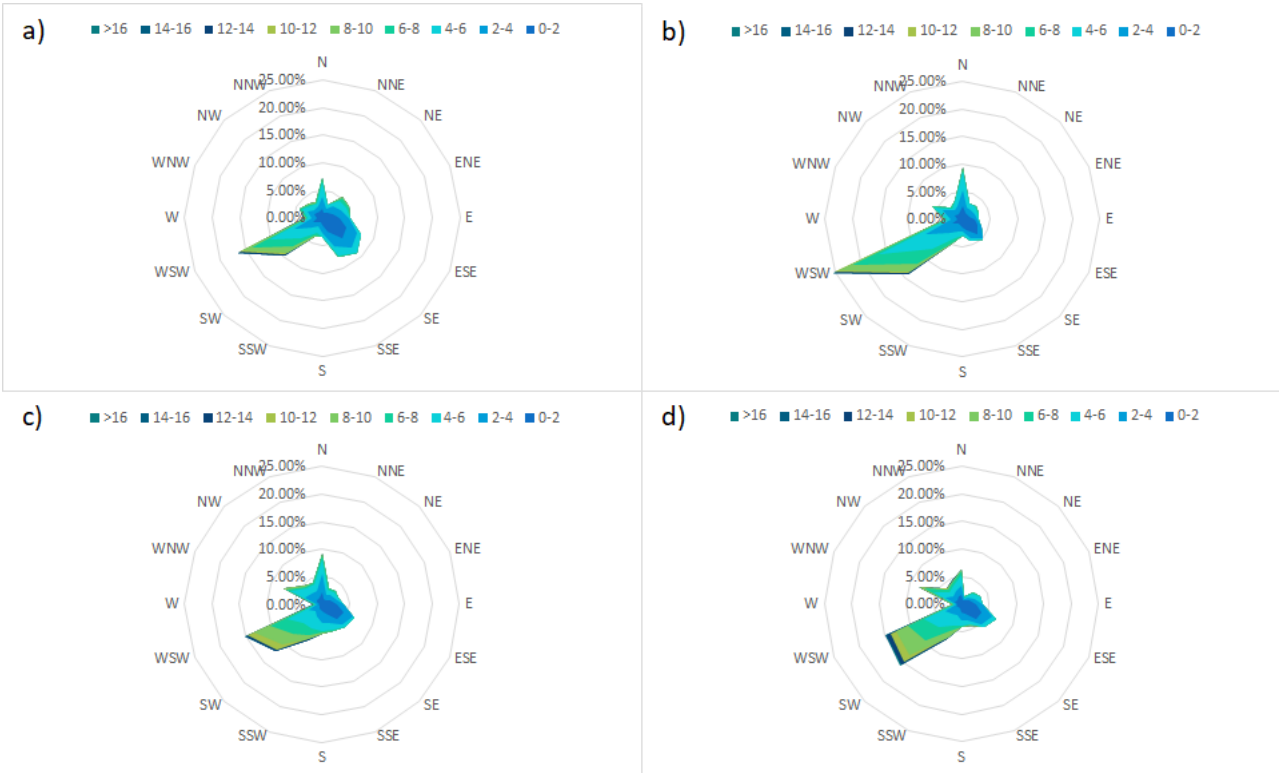

Figure 23: A wind rose for Whiteford separated into seasons: a) Spring (March – May); b) Summer (June – August); c) Autumn (September – November); d) Winter (December – February).

Figures 24 – 27 give the monthly averages and standard deviations of daily mean 10-minute wind speed, daily mean wind gust, daily mean temperature and daily rainfall amount. These corroborate the timeseries and are similar to the other sites.

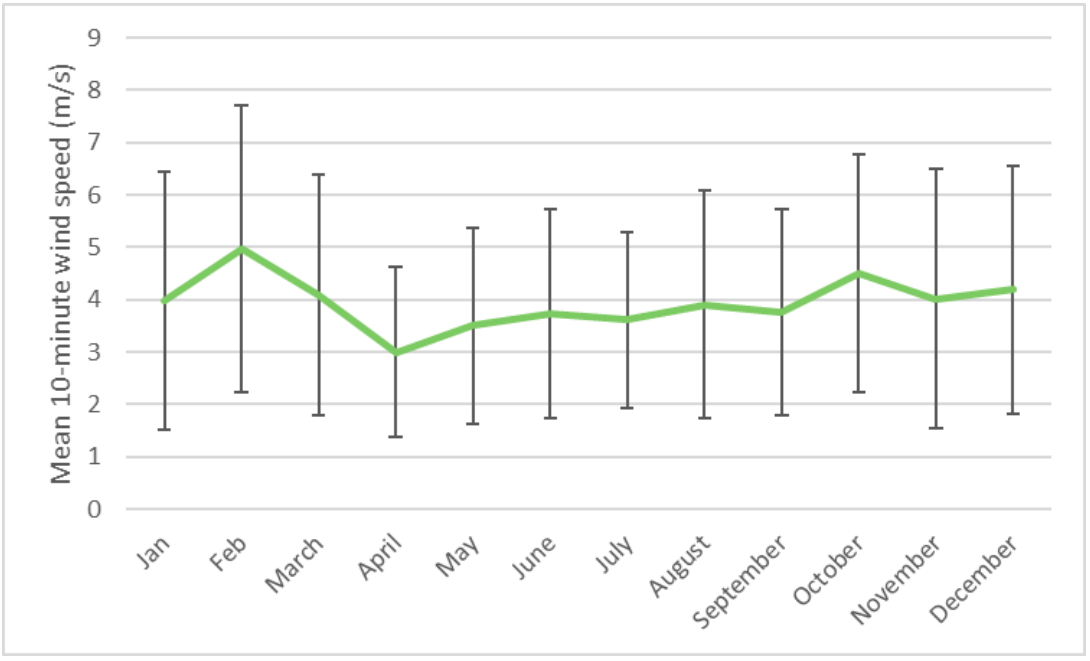

Figure 24: Monthly averages of 10 minute mean wind speed (green line) and standard deviation (vertical bars) at Whiteford.

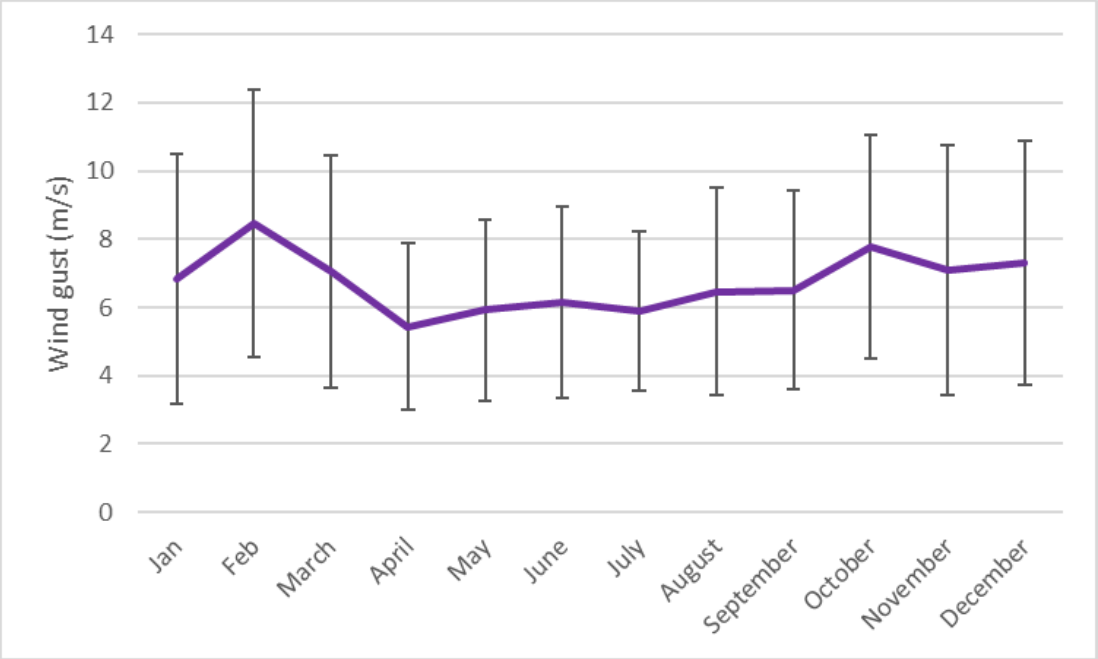

Figure 25: Monthly averages of wind gust (purple line) and standard deviation (vertical bars) at Whiteford.

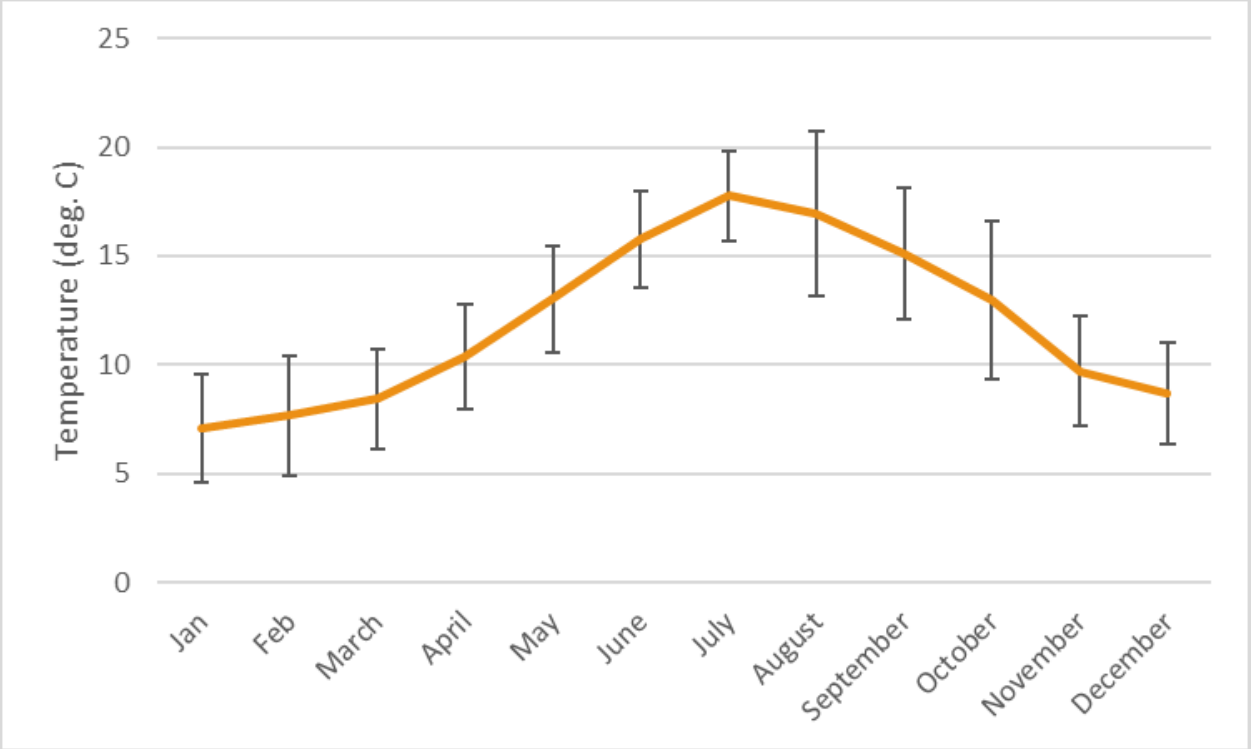

Figure 26: Monthly averages of daily mean temperature (orange line) and standard deviation (vertical bars) at Whiteford.

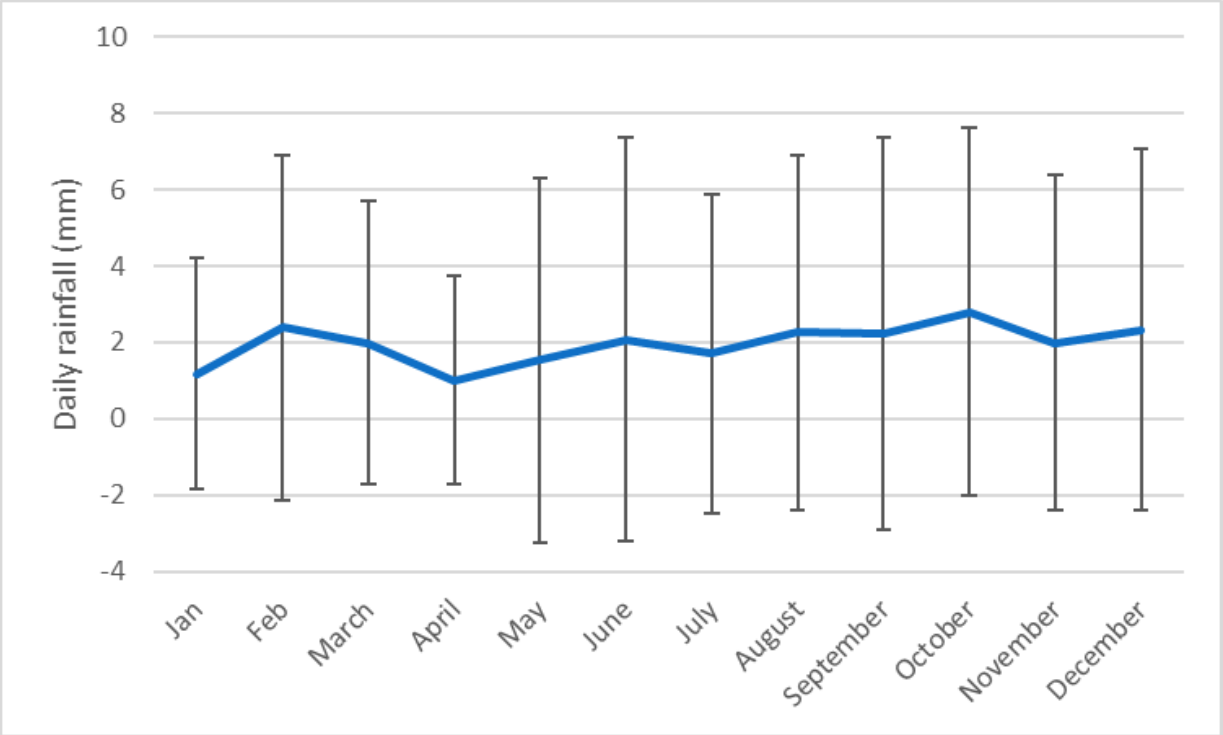

Figure 27: Monthly averages of daily rainfall quantity (blue line) and standard deviation (vertical bars) at Whiteford.

Merthyr Mawr

Figures 28 – 31 give timeseries of 10-minute mean wind speed, wind gust, daily mean temperature and daily rainfall. Mean values for various parameters are given in Table 5.There is a large datagap in 2020, as evident in the figures. As with the other sites, higher values are more common in winter, but clear seasonality is not that obvious. Also similar to the other sites is the clear seasonality in temperature (Figure 30), with level of variation between summer and winter also similar (approximately 10°C). Rainfall (Figure 31), is also similar to the other sites, with large quantities of rain possible throughout the year.

Table 5: Mean parameters over the entire record for Merthyr Mawr.

Parameter	**Mean value**
10-minute mean wind speed	4.1 m/s
Maximum wind gust over 10 minutes	6.5 m/s
Wind direction	194 deg.
Temperature	12.1 deg. C
Daily rainfall amount	2.4 mm
Rainfall rate	1.9 mm/hr

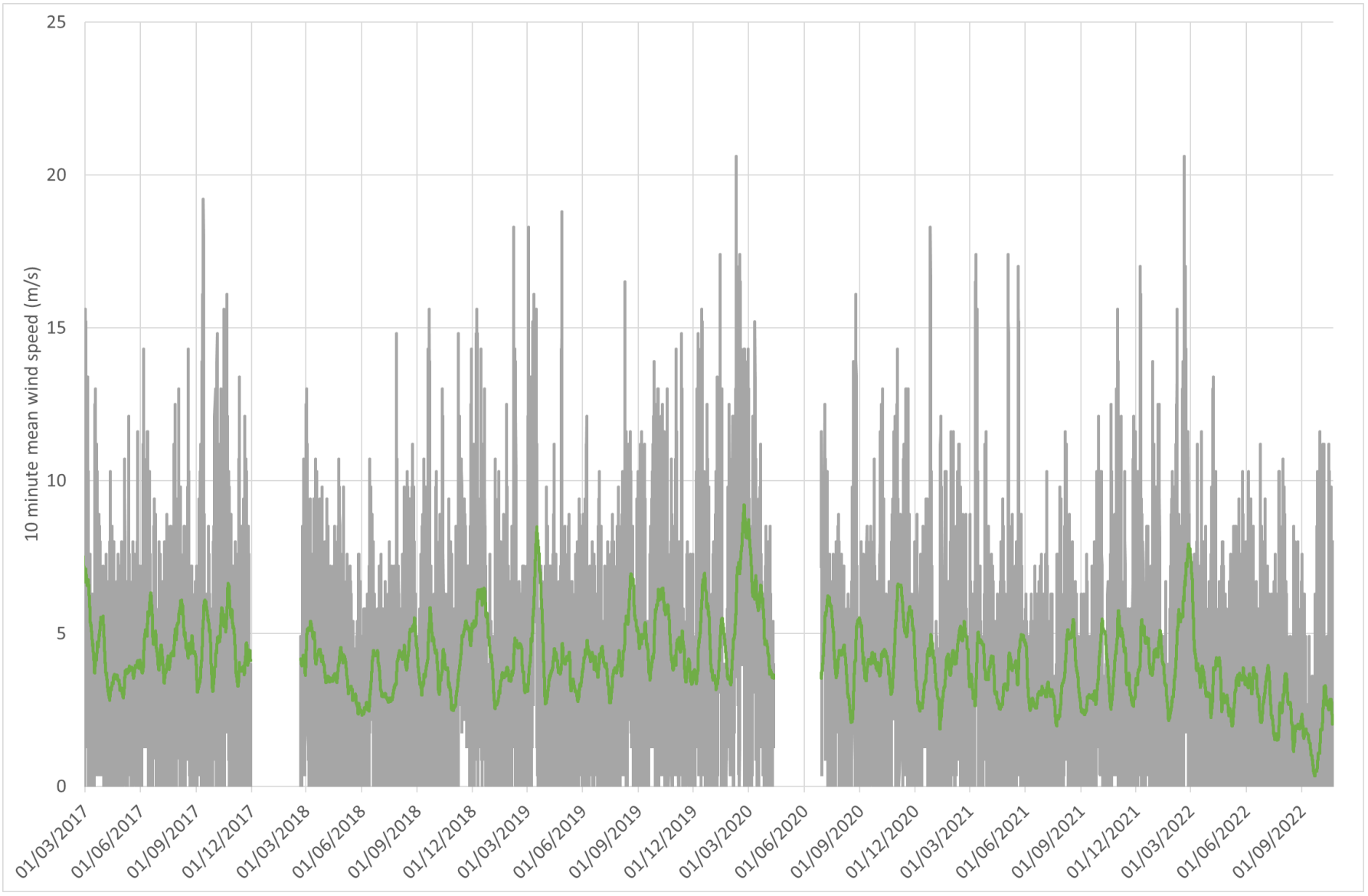

Figure 28: A timeseries of 10 minute mean wind speed from Merthy Mawr, displayed as the raw data (grey line) and the 14 day rolling average (green line).

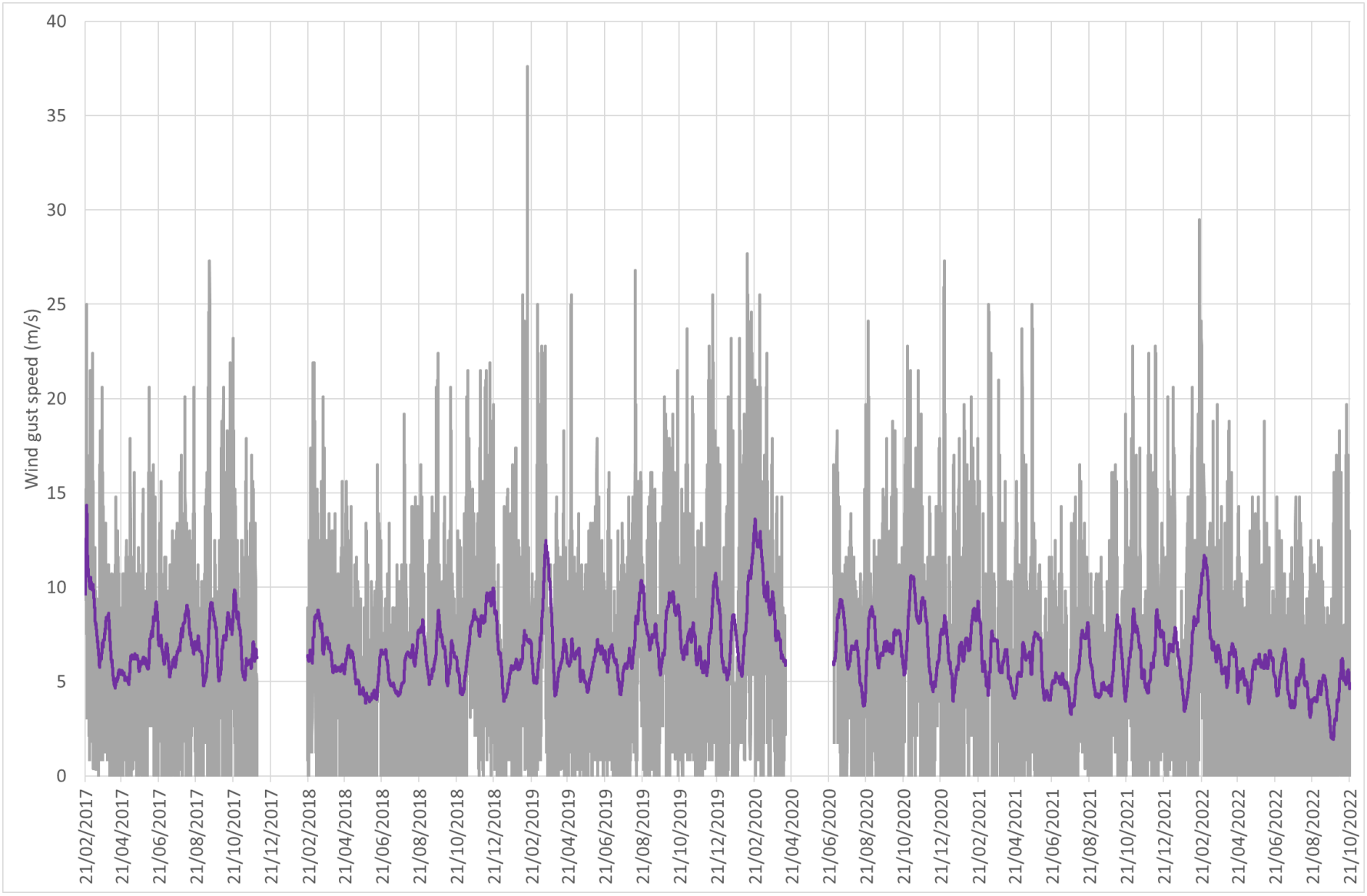

Figure 29: A timeseries of 10 minute maximum wind gust from Merthyr Mawr, displayed as the raw data (grey) and the 14 day rolling average (purple).

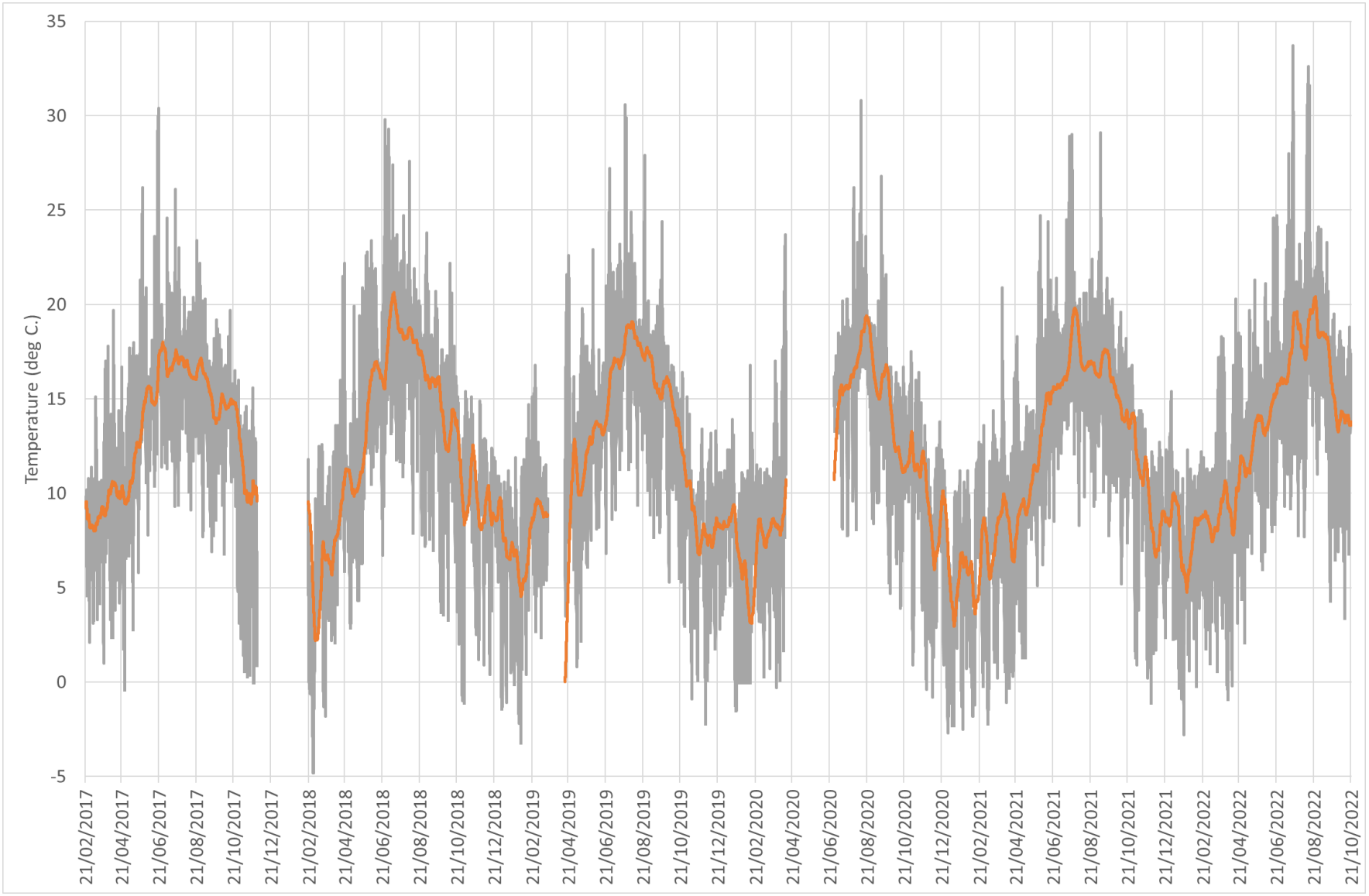

Figure 30: A timeseries of temperature from Merthyr Mawr, displayed as the raw data (grey) and the 14 day rolling average (orange).

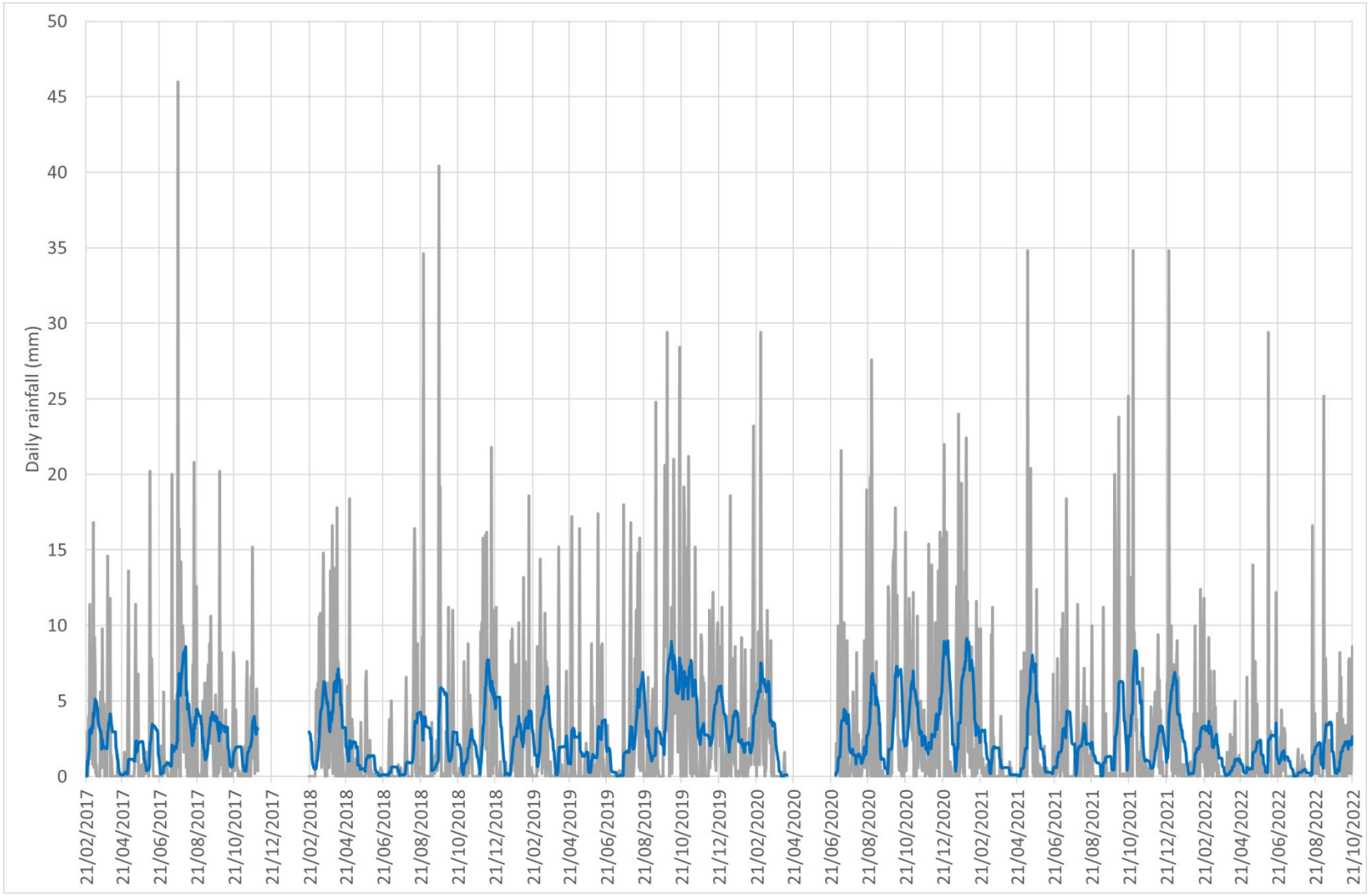

Figure 31: A timeseries of daily rainfall amount from Merthyr Mawr, displayed as the raw data (grey line) and the 14 day rolling average (blue).

Figure 32 shows a wind rose from all years, there is bidirectionality in the wind data, this is due to topographic steering of the winds by the dunes caused by the location of the station. This does mean that winds might vary elsewhere in the dune system, however most of the bare sand and excavated notches are orientated in the same direction as the dune trough that the station is in; therefore, winds can be considered representative of bare sand areas away from the more exposed foredune. Seasonal wind roses are shown in Figure 33; the roses are similar for all seasons. In spring there is a greater proportion of winds from the east compared to the other seasons. Winds are lower in the summer months. Autumn and winter are very similar and show a more even spread in directions between WSW – WNW, compared to spring and summer when winds are more concentrated from a W direction. To further consider seasonality in parameters, Figures 34 – 37 give monthly averages and standard deviations for key parameters. For the wind data, there is seasonality in the wind speeds, with stronger mean wind speeds (Figure 34) and wind gusts in winter (Figure 35), the standard deviation in these parameters shows that strong winds can occur at any time of year. As with other sites, wind direction isn't considered because due to the bidirectionality in the wind roses, averaging wind directions gives values from the south, which is actually an uncommon direction.

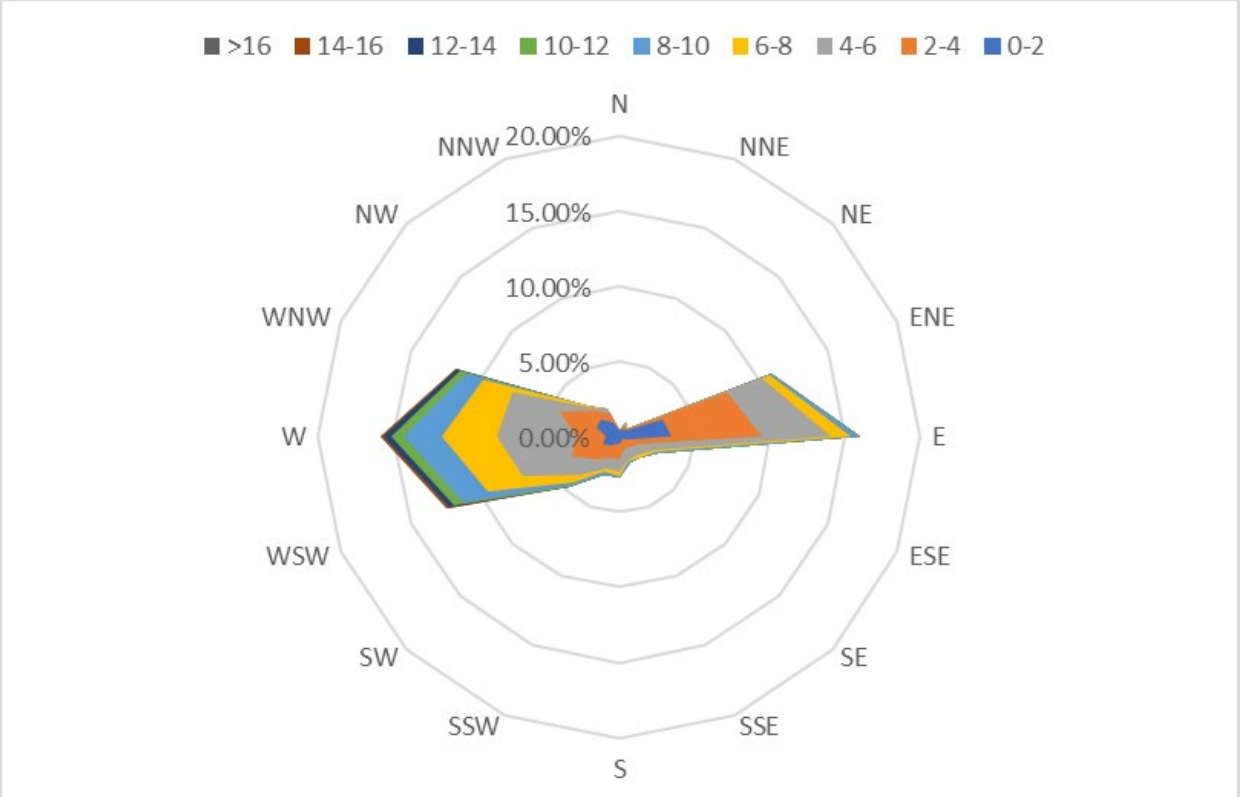

Figure 32: A wind rose for the entire Merthyr Mawr dataset.

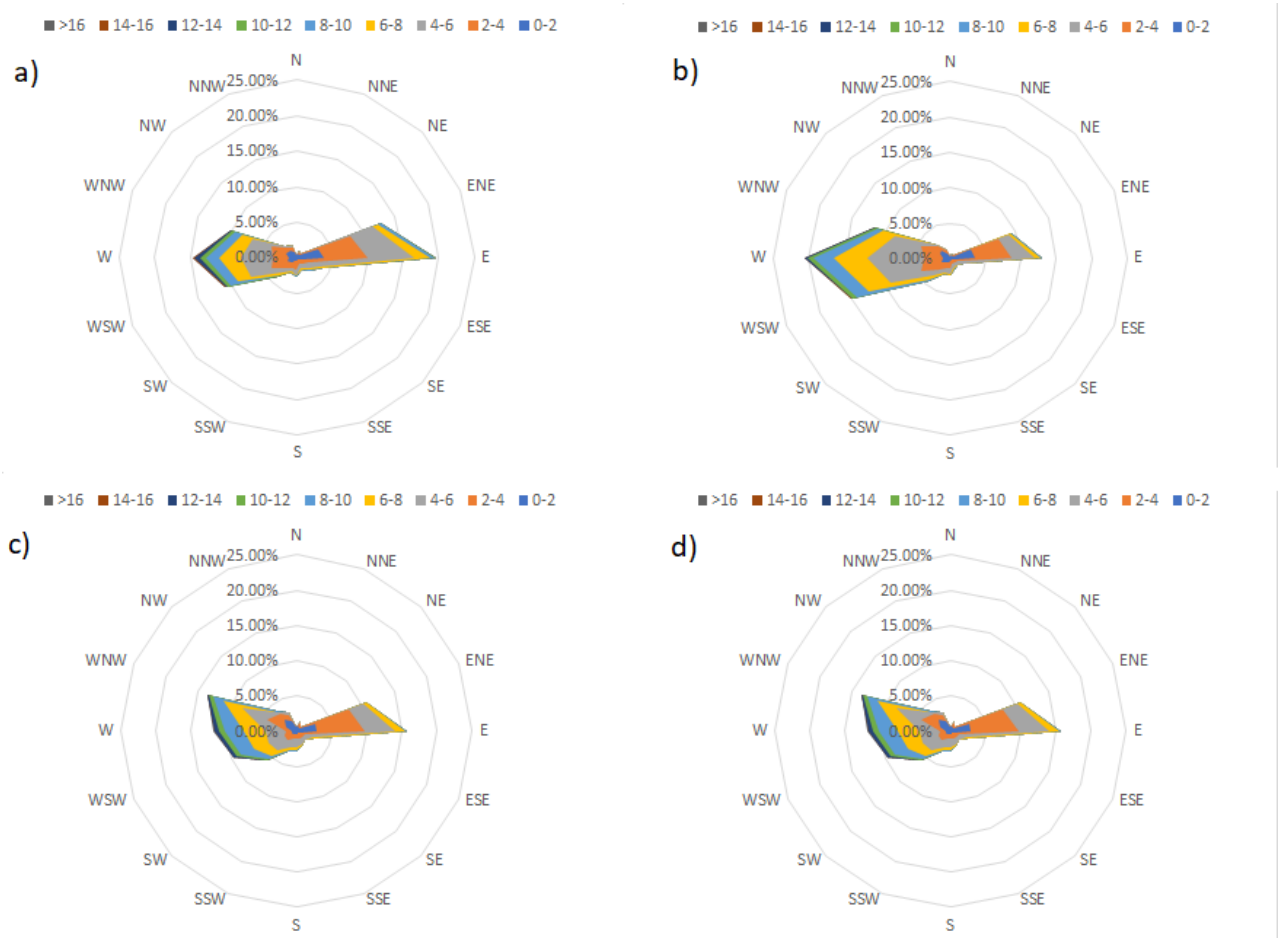

Figure 33: Seasonal wind roses from Merthyr Mawr for: a) Spring (March -May); b) Summer (June – August); c) Autumn (September – November); d) Winter (December – February).

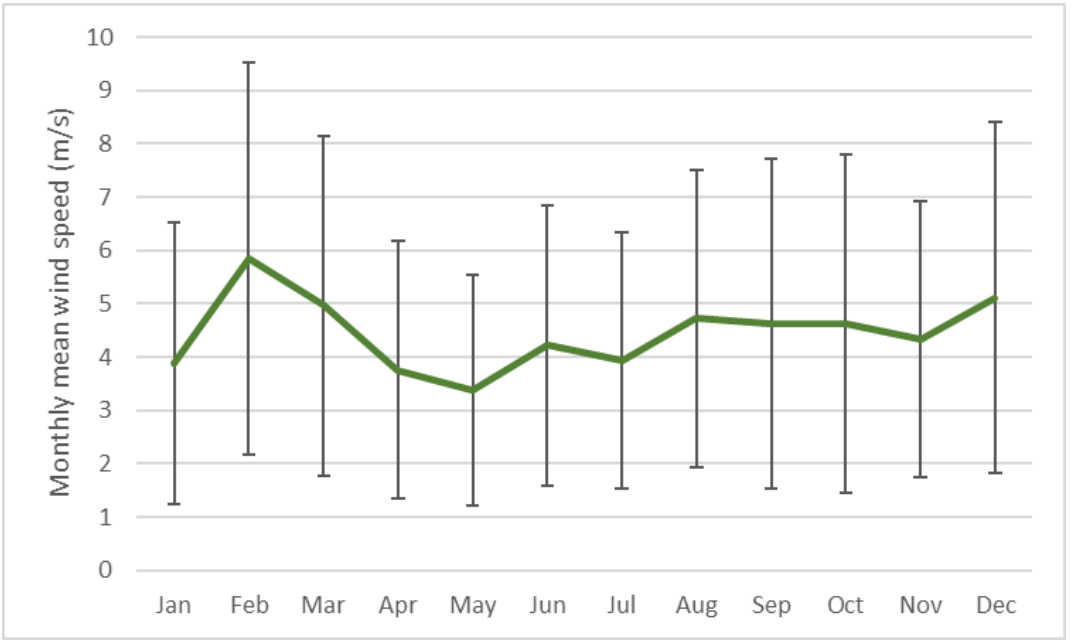

Figure 34: Monthly average 10-minute-mean wind speeds (green line) and monthly standard deviation in 10-minute-mean wind speeds (vertical bars) for Merthyr Mawr.

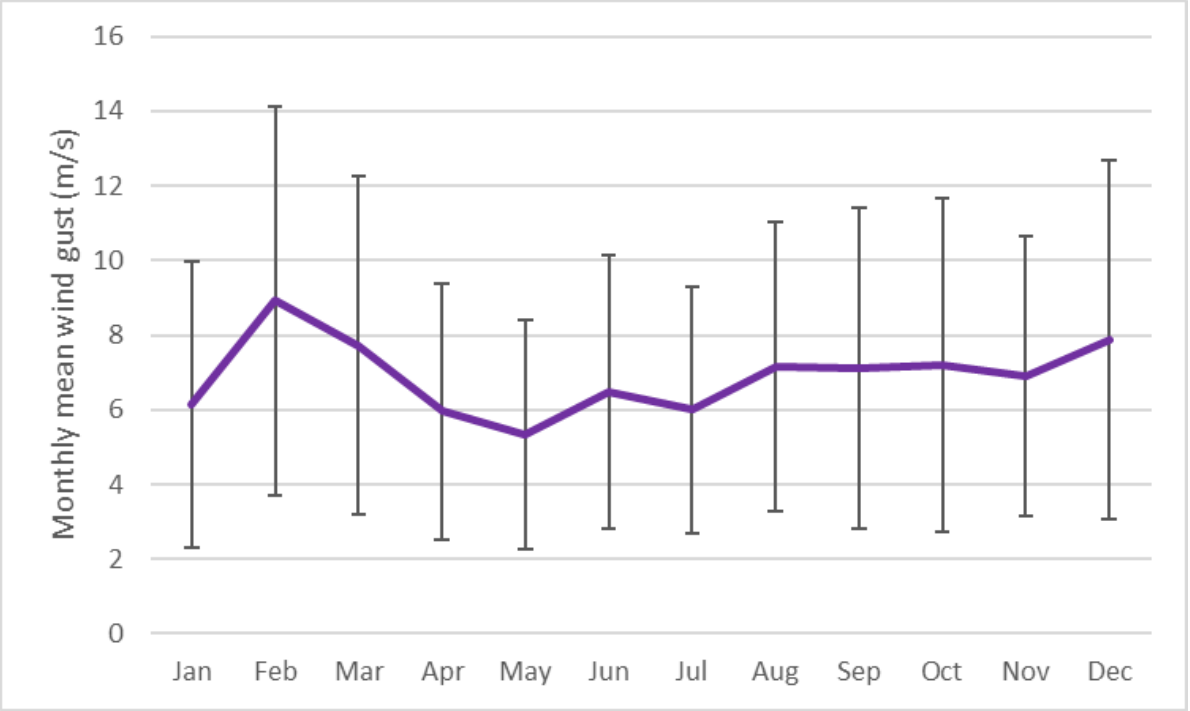

Figure 35: Monthly average wind gusts (purple line) and monthly standard deviation in wind gust (vertical bars) for Merthyr Mawr.

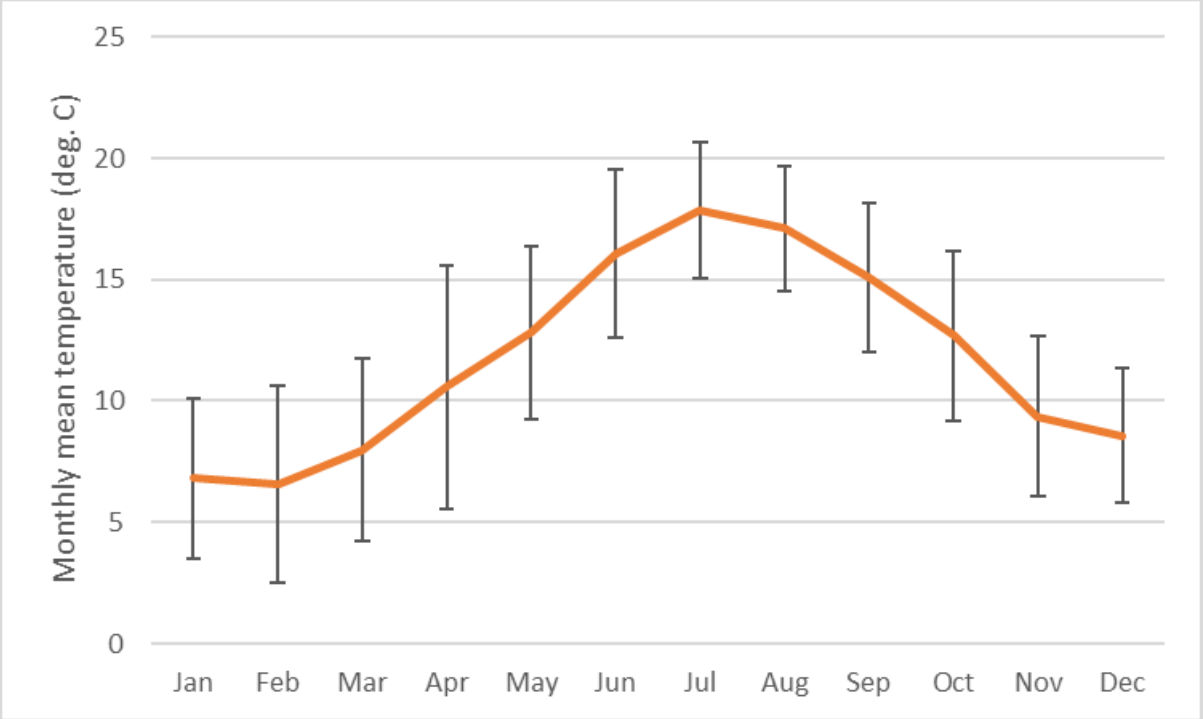

Figure 36: Monthly mean temperatures (orange line) and monthly standard deviation in temperature (vertical bars) for Merthyr Mawr.

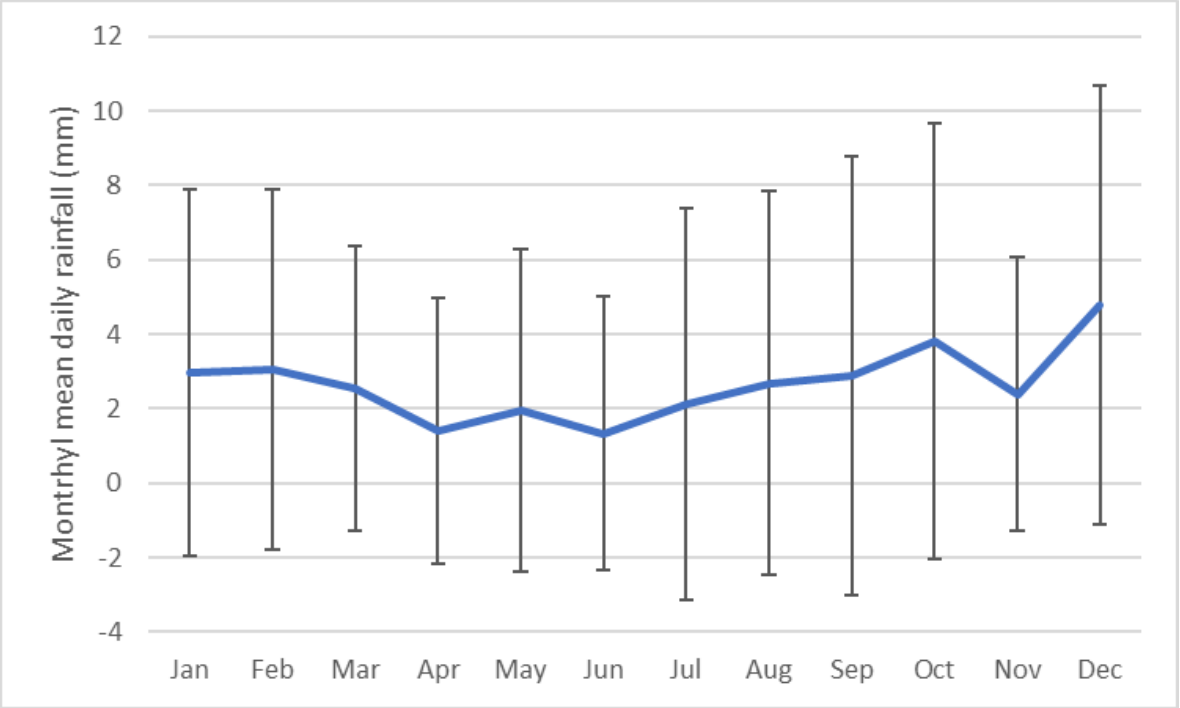

Figure 37: Monthly mean daily rainfall (blue line) and standard deviation in daily rainfall (vertical bars) for Merthyr Mawr.

Summary

This report presents data from four meteorological stations sited in Welsh sand dunes. Details of where to access the data can be found in Appendix B.

There are similarities in the records from all sites. Mean wind speeds at the three stations situated in the dune systems vary from 3.9 – 4.1 m/s, while at Newborough, where the station is more exposed, mean wind speed is 4.9 m/s. There is some seasonality in wind speed and wind gust for all sites, with stronger winds in winter. However, the fact that the values of monthly standard deviation are greater than the variation in monthly mean values indicate that the seasonality is not that strong, i.e., high winds can occur at any time of year. All sites show a greater proportion of onshore breezes in summer (June – August), possibly related to sea breezes. In spring, all sites show an increased proportion of wind in an offshore direction. The only parameter with a strong seasonal signal is the daily mean temperature. For the sites with rainfall data, mean rainfall varies between 1.9 mm/day (Whiteford, where rainfall records are questionable for a period) and 2.6mm/day. Rainfall shows less obvious seasonality than the wind data.

Appendices

Appendix A: Further details of data collection methodology and data pre-processing

Harlech, Merthyr Mawr and Whiteford

These datsets have all been collected using the same equipment (Skyview Vantage Pro 2 weather stations with Weather Link data loggers) and so the process has been the same for the three sites.

Data was downloaded intermittently from the Skyivew website, and cut and pasted into a spreadsheet of all data. Care was taken to ensure no duplication where time limits overlapped.

Day, month and year columns were added to the excel sheets; these are not included in the csv files for external distribution but can be added based on the datetime column.

Wind speed was recorded in miles per hour and so was convered to meters per second in Excel. Both values are given in the data files.

There are two columns for wind sector. The raw wind sector column defaults to a northerly direction if the wind is still, which could affect any analysis; therefore, a corrected column ('wsectorC') was created where the wind sector was set to 'STILL' if the wind speed was zero. This was achieved by inserting a new column and using the 'IF' function in Excel as follows. =IF(cell with windm/s in = 0, "STILL",original wind sector cell).

While the raw data included values for evapotranspiration; this is only an estimate and should not be used since solar radiation sensors were not used. It has been removed from the csv files.

Newborough

Newborough data has been collected by a different company (Skye Instruments), and therefore the data is laid out differently. The station only measured windspeed and direction. This data collection is ongoing.

Wind speed and direction are recorded in different tabs in the excel file, therefore, to facilitate analysis, these were merged into one tab using the following approach. Firstly, it was noticed that duplicates readings were sometimes recorded; therefore these were removed by filtering using the "collected_at" column. Secondly a column for wind direction was created in the wind speed tab and this populated using the VLOOKUP command.

Once all data was in one tab, several steps were needed to provide the same data as for the other three sites. A wind speed in miles per hour was created using the CONVERT function to convert from the recorded meters per second.

The wind direction column was corrected in order to match the data from the other provider. When the wind speed is zero for the other three sites, the wind direction is blank, therefore to do this, a new wind direction column was created and populated using:

=IF(wm/s=0,"",wdir)

There is no wind sector provided with the Newborough data so this was added based on the directional data. This was calculated using:

=CHOOSE(1+ABS(ROUND(F3/22.5,0)),"N","NNE","NE","ENE","E","ESE","SE","SSE","S","SSW","SW","WSW","W","WNW","NW","NNW","N")

Finally, similar to the other sites, another column called 'wsectorC' was created to have the directional sector as STILL for still wind conditions, using the same approact as the other three sites.

Wind roses

Wind roses were created using a pivot table and a filled radar plot. These plots were created on different sheets. The data was filtered by years and months to obtain the desired duration for the rose, then copied and 'paste values' used to replicate the 'datetime', 'wm/s', 'wsector', 'and wsectorC' columns in a new sheet.

Creating the pivot table

An new pivot table was created for each rose and 'wsectorC' put in the columns and values box click and 'windm/s' put in the rows box. The values were summarised as a count and the values shown as percentage of the grand total. The wind speed data was grouped into groups of 2 by right clicking on one of the wind speed values and selecting the 'group' option. In order to have the data in the correct orientation in the radar plot, the pivot table column headers were ordered from N clockwise through to NNW with STILL being the last column. Since there were few values over 16m/s, all data over 16m/s was summed into a >16 row. The final step prior to graph creation was to convert from percentages into cumulative percentages for each column. This was done in a copy of the original pivot table.

Creating the graph

A 'filled radar' plot was used to create the wind rose, this can be found under the 'radar' option in the insert graphs section of Excel. To get the graph to display correctly, the wind categories need to be ordered from highest to lowest. This can be achieved by right

clicking on the radar plot and clicking on ‘select data.’ Up and down arrows can then be used to re-order the categories.

Appendix B: Data Archive Appendix

Data outputs associated with this project are archived in datasets with URI 122205 (Newborough) and URI 123954 (Morfa Harlech, Whiteford and Merthy Mawr) on server–based storage at Natural Resources Wales.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] Excel and .csv files containing the raw data.

Metadata for this project is publicly accessible through Natural Resources Wales’ Library Catalogue https://libcat.naturalresources.wales (English Version) and https://catllyfr.cyfoethnaturiol.cymru (Welsh Version) by searching ‘Dataset Titles’. The metadata is held as record no [NRW to insert this number]

Further copies of this report are available from library@cyfoethnaturiolcymru.gov.uk