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KLAIPEDA Project

FINAL DATA REPORT

(20/07/2022 00:00 – 19/07/2023 23:50)

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Date	12/09/2023	Date	12/09/2023

REVISIONS		
Revision	**Modification causes**	**Date**
01	Document creation	08/08/2023
02	Vertical wind speed plots added (E01 and E06) and tilt correction of LIDAR wind speed measurement (E06)	12/09/2023

INDEX

FIGURES AND TABLES LIST

INTRODUCTION

1.1. Objective

The main objective of this document is to present the 12 months data availability based on the statistics for the observation period of measurement, as well as a basic statistic and graphs of the main meteocean measurement collected by the FLS200 systems in 12 months of campaign.

2. INSTALLATION SITE

2.1. Deployment location

The EOLOS FLS200 units have been installed at the following KLAIPEDA Project coordinates:

FLS200 UNIT	LAT:	LONG:
N-FLS: E01	55° 57.417'N	20° 25.917'E
S-FLS: E06	55° 53.467'N	20° 31.567'E

Figure 1. Location of EOLOS FLS200 units.

2.2. Drift radius

EOLOS FLS200 E01 has a maximum drift radius of 171 meters from its installation coordinates and EOLOS FLS200 E06 has a maximum drift radius of 169 meters from its installation coordinates.

3. EOLOS FLS200 CONFIGURATION

3.1. LIDAR

The EOLOS FLS200 units have been configured to measure the wind at the following heights:

Floating LIDAR Measurement heights	
Level	**Configured LIDAR height + offset (m)**
11	278+2 = 280 *
10	248+2 =250 *
9	218+2 = 220 *
8	198+2 = 200 *
7	173+2 = 175
6	148+2 = 150
5	123+2 = 125
4	98+2 = 100
3	48+2 = 50
2	38+2 = 40 (ZX reference height)
1	10+2 = 12

Table 1. Floating LIDAR measurement heights.

* Data at this height provided for information only but not contributing to availability guarantee. Since LIDAR manufacturer states "only heights ≤ 200m are recommended as they have been validated against a calibrated mast" (ZP300 Operations & Maintenance Manual_v3.7, page 49).

All heights will be measured above mean sea level (MSL).

LIDAR measurement heights configured apply a window height above sea level of 2 m as ZX-LIDARs allows only integer values, i.e: if a measurement is due to be performed at 40 m, the LIDAR measurement configuration is set to 38 m. Distance between the LIDAR measuring lens and the sea surface level is 1.6 m, and measurement is performed at 39.6m instead of originally targeted to 40 m. Hence, in postprocessing, an extra offset of 0.4 m is added as a constant.

3.2. Meteo

The EOLOS FLS200 units are designed to measure the surface wind at 3.1 m heigh

3.3. ADCP

The EOLOS FLS200 units have been configured to measure the current at the following depths:

Current Sensors Measurement depths		
Level	**N-FLS: E01 Configured ADCP depths + offset (m)**	**S-FLS: E06 Configured ADCP depths + offset (m)**
1	3.5 + 0.8 = 4.3	3.7 + 0.8 = 4.5
2	4.8 + 0.8 = 5.6	5.2 + 0.8 = 6
3	6.1 + 0.8 = 6.9	6.7 + 0.8 = 7.5
4	7.4 + 0.8 = 8.2	8.2 + 0.8 = 9
5	8.7 + 0.8 = 9.5	9.7 + 0.8 = 10.5
6	10 + 0.8 = 10.8	11.2 + 0.8 = 12
7	11.3 + 0.8 = 12.1	12.7 + 0.8 = 13.5
8	12.6 + 0.8 = 13.4	14.2 + 0.8 = 15
9	13.9 + 0.8 = 14.7	15.7 + 0.8 = 16.5
10	15.2 + 0.8 = 16	17.2 + 0.8 = 18
11	16.5 + 0.8 = 17.3	18.7 + 0.8 = 19.5
12	17.8 + 0.8 = 18.6	20.2 + 0.8 = 21
13	19.1 + 0.8 = 19.9	21.7 + 0.8 = 22.5
14	20.4 + 0.8 = 21.2	23.2 + 0.8 = 24
15	21.7 + 0.8 = 22.5	24.7 + 0.8 = 25.5
16	23 + 0.8 = 23.8	26.2 + 0.8 = 27
17	24.3 + 0.8 = 25.1	27.7 + 0.8 = 28.5
18	25.6 + 0.8 = 26.4	29.2 + 0.8 = 30
19	26.9 + 0.8 = 27.7	30.7 + 0.8 = 31.5
20	28.2 + 0.8 = 29	32.2 + 0.8 = 33
21	29.5 + 0.8 = 30.3	33.7 + 0.8 = 34.5
22	30.8 + 0.8 = 31.6	35.2 + 0.8 = 36

Table 2. ADCP measurement depths.

NOTE: All depths are referenced to mean sea level (MSL). The offset of 0.8 meters is the distance between the current sensor measuring transducer and the sea surface level in both units. Blanking distance configured is 2.2 m in both units, and cell size configured is 1.3 m in FLS200-E01 and 1.5 m in FLS200-E06.

4. AVAILABILITY

4.1. Definitions

4.1.1. LIDAR availability

The definitions from the Offshore Wind Accelerator Roadmap for the Commercial Acceptance of the Floating Lidar (OWA) [1] will be taken into consideration for assessing system data availability that will be included in the warranty.

- **Monthly System Availability – 1 Month Average**
  The LIDAR system is ready to function according to specifications and to deliver data, taking into account all time stamped data entries in the output data files including flagged data (e.g. by 9998 or 9999s) for the given month. The Monthly Overall System Availability is the number of those time stamped data entries relative to the maximum possible number of (here 10 minute) data entries including periods of corrective maintenance (not including period of preventive maintenance) (regarded as 100%) within the respective month.

- **Overall System Availability – Campaign Average**
  The LIDAR system is ready to function according to specifications and to deliver data, taking into account all time stamped data entries in the output data files including flagged data (e.g. by 9998 or 9999s) for the pre-defined total campaign length. The Overall System Availability is the number of those time stamped data entries relative to the maximum possible number of (here 10 minute) data entries including periods of corrective maintenance (not including period of preventive maintenance) (regarded as 100%) within the pre-defined total campaign period.

The Availability of the LIDAR wind data for the considered period will be based on the **arithmetic mean of the data availability of:**

- Horizontal Wind Speed at 150 meters
- Wind Direction at 150 meters

Flag definition:

- NaN: Not a Number, measurement value not available as sensor was affected by system down-time at the time of the measurement.

- 9999, extracted from ZXLidars user guide: High quality wind speed measurement is not possible. This is often caused by very low wind speed, or due to partial obscuration of the ZX 300 window, or significant interference with the laser beam at the specified height.

- 9998, extracted from ZXLidars user guide: The ZX 300 automatically detects atmospheric conditions which adversely affect lidar wind speed measurements. For example, in thick fog the beam from a lidar device may not be able to reach the measurement height. Also, in certain cases when affected by significant precipitation, the ZX 300 will also reject the vertical component of the wind speed, and only vertical wind speeds are affected by rain.

4.1.2. Current sensor availability

- **Monthly System Availability – 1 Month Average**
  The current sensor is ready to function according to specifications and to deliver data, taking into account all time stamped data entries in the output data files including flagged data (e.g. by 999) for the given month. The Monthly Overall System Availability is the number of those time stamped data entries relative to the maximum possible number of (here 30 minute) data entries including periods of corrective maintenance (not including period of preventive maintenance) (regarded as 100%) within the respective month.

- **Overall System Availability – Campaign Average**
  The current sensor is ready to function according to specifications and to deliver data, taking into account all time stamped data entries in the output data files including flagged data (e.g. by 999) for the pre-defined total campaign length. The Overall System Availability is the number of those time stamped data entries relative to the maximum possible number of (here 30 minute) data entries including periods of corrective maintenance (not including period of preventive maintenance) (regarded as 100%) within the pre-defined total campaign period.

The availability of the current data for the considered period will be based on the **arithmetic mean of the data availability of:**

- Current speed at surface
- Current direction at surface

Flag definition:

  - NaN: Not a Number, measurement value not available as sensor was affected by system down-time at the time of the measurement.

  - 999: invalid values returned by the system or detected at the postprocessing.

4.1.3. Wave sensor availability

- **Monthly System Availability – 1 Month Average**
  The wave sensor is ready to function according to specifications and to deliver data, taking into account all time stamped data entries in the output data files including flagged data (e.g. by 999) for the given month. The Monthly Overall System Availability is the number of those time stamped data entries relative to the maximum possible number of (here 30 minute) data entries including periods of corrective maintenance (not including period of preventive maintenance) (regarded as 100%) within the respective month.

- **Overall System Availability – Campaign Average**
  The wave sensor is ready to function according to specifications and to deliver data, taking into account all time stamped data entries in the output data files including flagged data (e.g. by 999) for the pre-defined total campaign length. The Overall System Availability is the number of those time stamped data entries relative to the maximum possible number of (here 30 minute) data entries including periods of corrective maintenance (not including period of preventive maintenance) (regarded as 100%) within the pre-defined total campaign period.

The availability of the wave data for the considered period will be based on the **arithmetic mean of the data availability of**

- Significant wave height
- Peak period

Flag definition:

- NaN: Not a Number, measurement value not available as sensor was affected by system down-time at the time of the measurement.
- 999: invalid values returned by the system or detected at the postprocessing.

4.1.4. Data filtering: LIDAR

LIDAR wind data will be filtered and considered not suitable only for statistics and plots presented in this document according to the following criteria:

- Data recorded when the buoy does not lay in the normal tolerance radius (maximum drift radius + 20 meters) of its agreed measurement position (as defined in section 2.2 above).
- Any invalid values returned by the system, e.g. those values marked as 9999, 9998 or NaN, or specifically marked as invalid by any other mean shall be excluded.
- Out of range wind speed (V>50m/s or V<0m/s) and direction values (Dir<0º or Dir>360º).

4.1.5. Data filtering: metocean

Metocean data will be filtered and considered not suitable only for statistics and plots presented in this document according to the criteria presented in the following table:

EOLOS FLS200 - Data quality control				
Sensor	**Variable name**	**Variable definition**	**Units**	**Data quality control checks Max and Min values**
Lidar	LIDARXXm_Z10_HorizWS	Lidar mean horizontal wind speed at XXm	m/s	*
	LIDARXXm_Z10_WD	Lidar mean wind direction at XXm	deg	*
Meteo	METEO_Sm_avg	Meteo wind speed mean	m/s	0-50 m/s
	METEO_Dir_bear	Meteo wind direction mean	deg	0-360 deg
	METEO_S3x_max	Meteo wind gust 3 sec	m/s	0-80 m/s
	METEO_Dir_bear3	Meteo wind gust 3 sec direction	deg	0-360 deg
	METEO_Pa_avg	Meteo air pressure	hPa	800 - 1100 hPa
	METEO_Ta_avg	Meteo air temperature	ºC	(-52)-60ºC
	METEO_Ua_avg	Meteo relative air humidity	%	0-100%
Current sensor	ADCP_vc_XX	Current velocity at XX m depth	m/s	0-2.5 m/s
	ADCP_dc_XX	Current direction at XX m depth	deg	0-360 deg
	ADCPtemp	Surface water temperature	ºC	(-4) - 40 ºC
	alti_ADCPlevelA_Avg	Distance between seabed and surface	m	30.5-40.5 m E01 36-46 m E06
Wave	wave_Hs	Significant wave height , zero crossing	m	0-25 m
	wave_Hmax	Maximum wave height , zero crossing	m	0-25 m
	wave_Tp	Peak period, spectral	s	1.6-30 s
	wave_Tz	Mean spectral period (TM02), spectral	s	1.6-30 s
	wave_DirAvg	Average wave direction,spectral	deg	0-360 deg
* Data quality control check according to section 4.1.4.				

Table 3. Data quality control checks of the main variables provided by the FLS200 system.

5. DATA AND RESULTS

5.1. DATA

5.1.1. Period of measurement campaign

The measuring campaign starts officially on:

20/07/2022 00:00 UTC *

This document presents the availability calculations, statistics and graphs for the following period:

- Start: 20/07/2022 00:00 UTC *
- End: 19/07/2023 23:50 UTC *

*DD/MM/YYYY HH:MM UTC

5.1.2. Data files

This subsection lists the data files that are the basis for this monthly report.

- E01:
  - EOLOS_20220720_0000_20230719_2350_10min.dat
  - EOLOS_20220720_0000_20230719_2350_30min.dat

- E06:
  - EOLOS_20220720_0000_20230719_2350_10min_ Corrected.dat
  - EOLOS_20220720_0000_20230719_2350_30min.da

5.2. RESULTS

5.2.1. Position results

The figures below show the E01 and E06 locations during the observation period and the installation location.

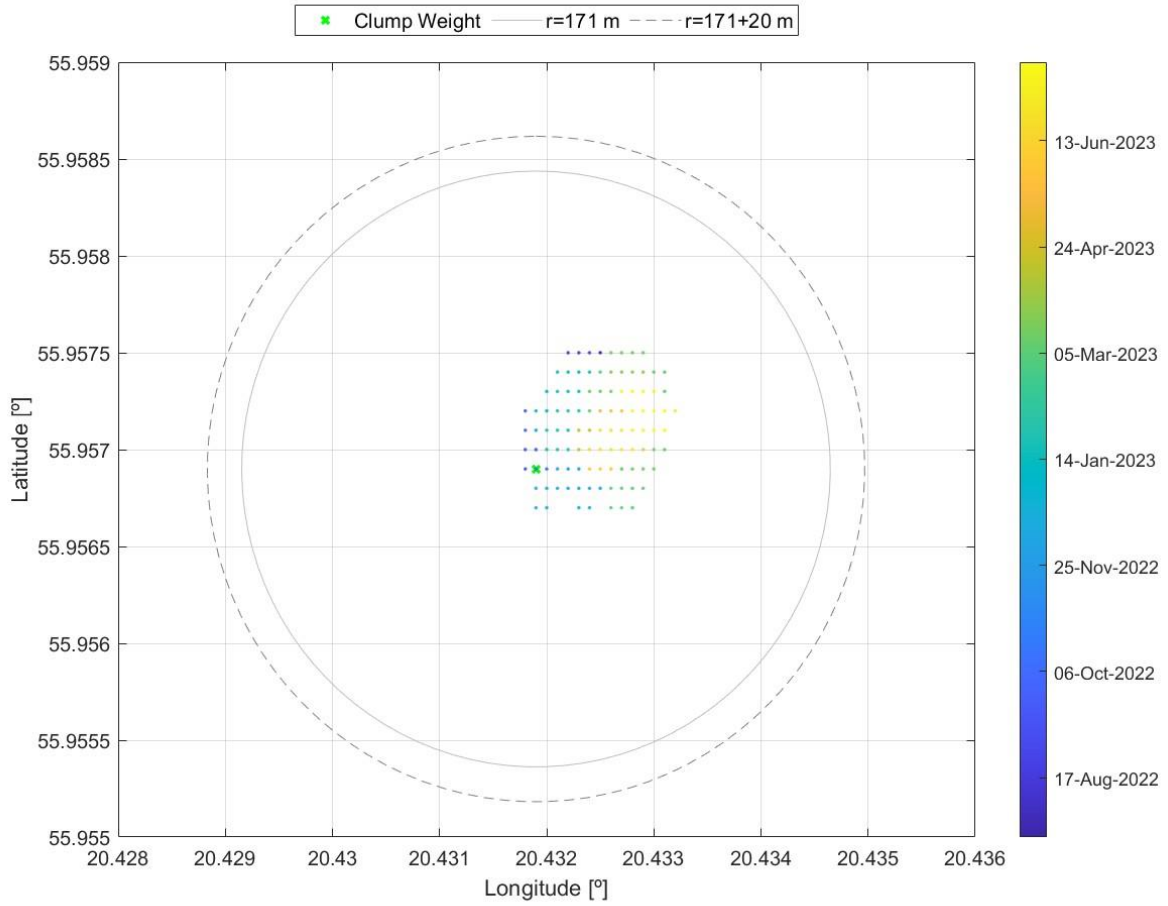


Figure 2. E01: FLS200 locations during the observation period.

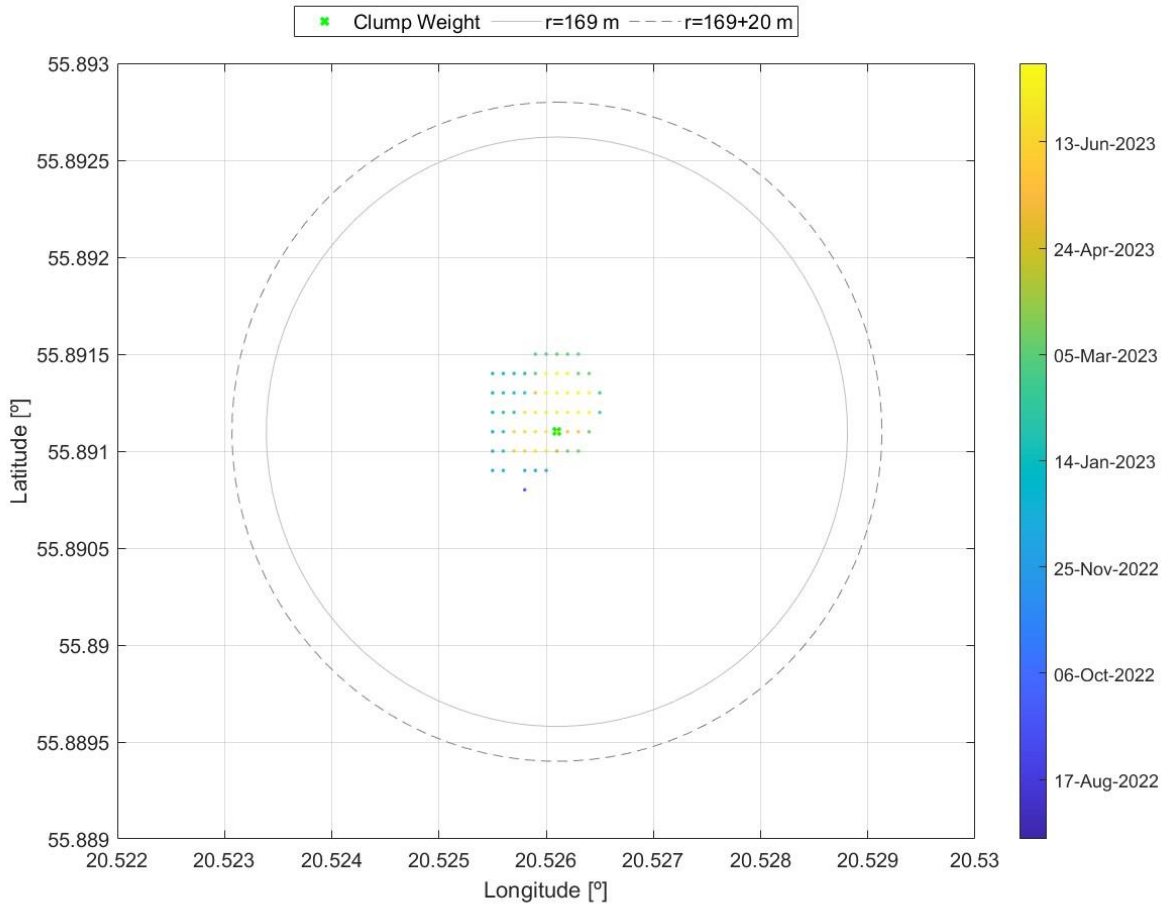


Figure 3. E06: FLS200 locations during the observation period.

5.2.2. Data availability calculations: full campaign period.

Tables below show a detailed calculation of system availability for the main variables of wind and other parameters of air and seawater for the 12 months of campaign.

eolos FLOATING LIDAR SOLUTIONS

Lidar Horizontal Wind Speed System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Height	Possible Data	Valid Data	Availablility (%)
12 m	52512	51971	98.97
40 m	52512	51971	98.97
50 m	52512	51971	98.97
100 m	52512	51971	98.97
125 m	52512	51971	98.97
150 m	52512	51971	98.97
175 m	52512	51971	98.97
200 m	52512	51971	98.97
220 m	52512	51971	98.97
250 m	52512	51971	98.97
280 m	52512	51971	98.97

Lidar Wind direction System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Height	Possible Data	Valid Data	Availability (%)
12 m	52512	49246	93.78
40 m	52512	49246	93.78
50 m	52512	49246	93.78
100 m	52512	49247	93.78
125 m	52512	49247	93.78
150 m	52512	49248	93.78
175 m	52512	49249	93.79
200 m	52512	49251	93.79
220 m	52512	49255	93.80
250 m	52512	49256	93.80
280 m	52512	49263	93.81

Meteo System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Parameter	Possible Data	Valid Data	Recovery (%)
Wind speed	52512	52331	99.66
Wind direction	52512	52181	99.37
Air temperature	52512	52331	99.66
Atm pressure	52512	52331	99.66

ADCP System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Parameter	Possible Data	Valid Data	Recovery (%)
Water Temperature	17504	17445	99.66
Surface current speed (4.3 m)	17504	17445	99.66
Surface current direction (4.3 m)	17504	17445	99.66

Wave System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Parameter	Possible Data	Valid Data	Recovery (%)
Hs	17504	17468	99.79
Tp	17504	17468	99.79
Dir	17504	17468	99.79

Table 4. E01: detailed calculation of data availability for the main variables.

Lidar Horizontal Wind Speed System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Height	Possible Data	Valid Data	Availability (%)
12 m	52500	52463	99.93
40 m	52500	52464	99.93
50 m	52500	52463	99.93
100 m	52500	52463	99.93
125 m	52500	52463	99.93
150 m	52500	52463	99.93
175 m	52500	52464	99.93
200 m	52500	52464	99.93
220 m	52500	52464	99.93
250 m	52500	52464	99.93
280 m	52500	52465	99.93

Lidar Wind direction System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Height	Possible Data	Valid Data	Availability (%)
12 m	52500	52463	99.93
40 m	52500	52464	99.93
50 m	52500	52463	99.93
100 m	52500	52463	99.93
125 m	52500	52463	99.93
150 m	52500	52463	99.93
175 m	52500	52464	99.93
200 m	52500	52464	99.93
220 m	52500	52464	99.93
250 m	52500	52464	99.93
280 m	52500	52465	99.93

Meteo System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Parameter	Possible Data	Valid Data	Recovery (%)
Wind speed	52500	52500	100.00
Wind direction	52500	52500	100.00
Air temperature	52500	52500	100.00
Atm pressure	52500	52500	100.00

ADCP System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Parameter	Possible Data	Valid Data	Recovery (%)
Water Temperature	17500	17455	99.74
Surface current speed (4.3 m)	17500	17455	99.74
Surface current direction (4.3 m)	17500	17455	99.74

Wave System Availability 20/07/2022 00:00 - 19/07/2023 23:50			
Parameter	Possible Data	Valid Data	Recovery (%)
Hs	17500	17500	100.00
Tp	17500	17500	100.00
Dir	17500	17500	100.00

Table 5. E06: detailed calculation of data availability for the main variables

5.2.3. LIDAR results

Tables below present a basic statistic of wind speeds measurements for all heights measured by the FLS200 systems for the observation period.

LIDAR horizontal wind speed (m/s)											
Month	Heights (m)										
Jul 2022 -Jul 2023	12	40	50	100	125	150	175	200	220	250	280
Mean	7.27	8.16	8.37	8.96	9.14	9.29	9.40	9.50	9.58	9.67	9.69
Max	19.63	22.11	22.37	26.81	27.96	28.63	29.38	34.01	33.83	34.88	35.31
Min	0.43	0.46	0.49	0.42	0.36	0.42	0.43	0.38	0.44	0.47	0.49
Std	3.34	3.72	3.81	4.19	4.35	4.50	4.62	4.72	4.80	4.89	4.96

Table 6. E01: basic statistic of horizontal wind speed for all heights measured by the FLS200 system.

LIDAR horizontal wind speed (m/s)											
Month	Heights (m)										
Jul 2022 -Jul 2023	12	40	50	100	125	150	175	200	220	250	280
Mean	7.16	8.01	8.22	8.81	8.99	9.13	9.27	9.36	9.44	9.54	9.57
Max	19.32	21.77	22.72	26.62	28.53	29.60	30.69	32.66	33.00	33.32	34.93
Min	0.53	0.44	0.46	0.38	0.39	0.34	0.39	0.37	0.35	0.43	0.40
Std	3.27	3.63	3.73	4.13	4.30	4.44	4.57	4.67	4.75	4.84	4.90

Table 7. E06: basic statistic of horizontal wind speed for all heights measured by the FLS200 system

Figure 4 and Figure 5 present the time series of the horizontal wind speed for all heights measured by the FLS200 systems for the observation period.

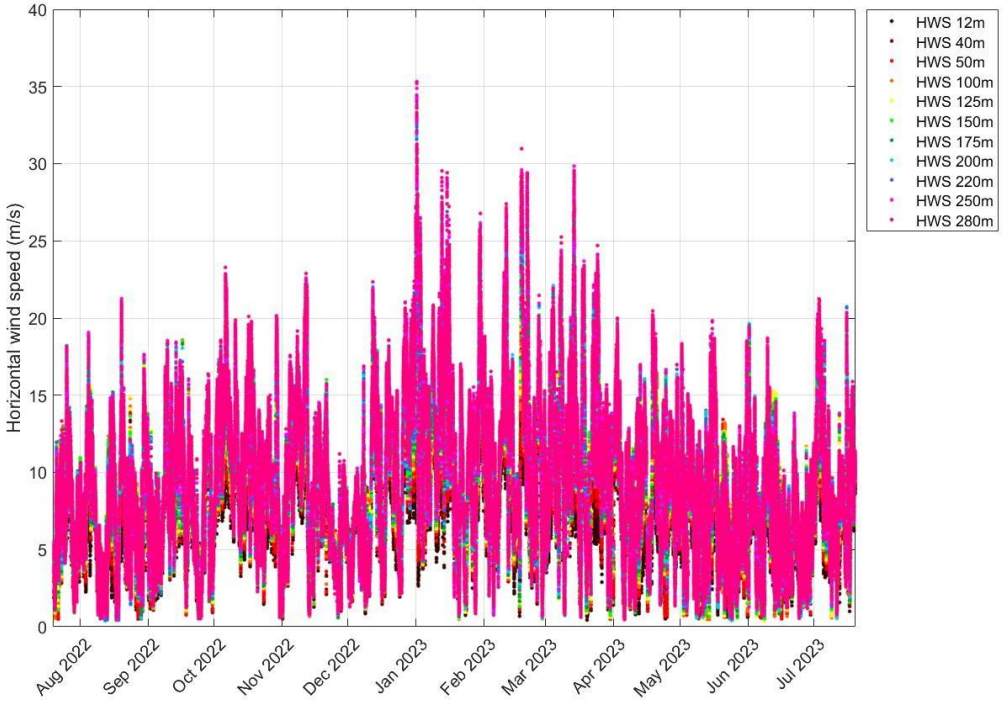


Figure 4. E01: time series of wind speed (DD/MM/YYYY).

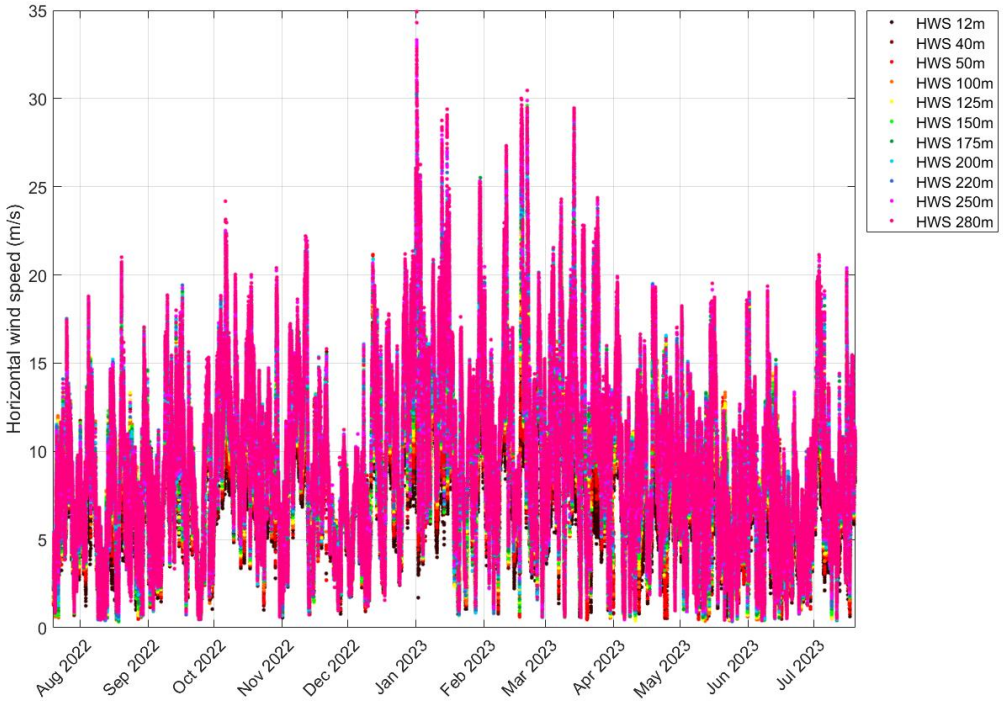


Figure 5. E06: time series of wind speed (DD/MM/YYYY

Figures below show the time series of wind direction for all heights measured by the FLS200 systems.

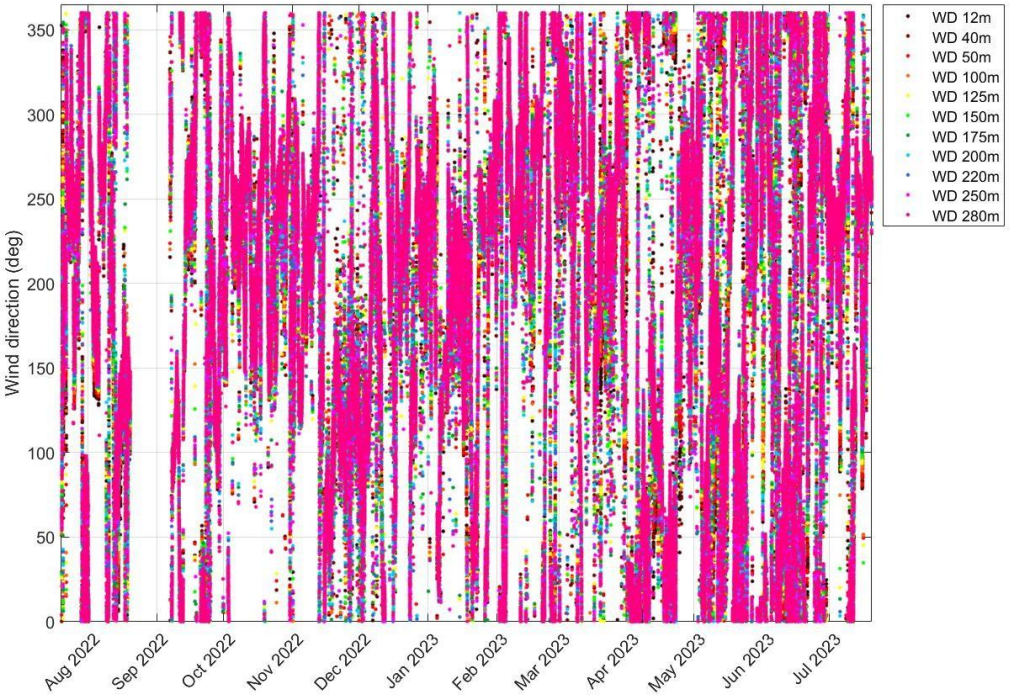


Figure 6. E01: time series of wind direction (DD/MM/YYYY).

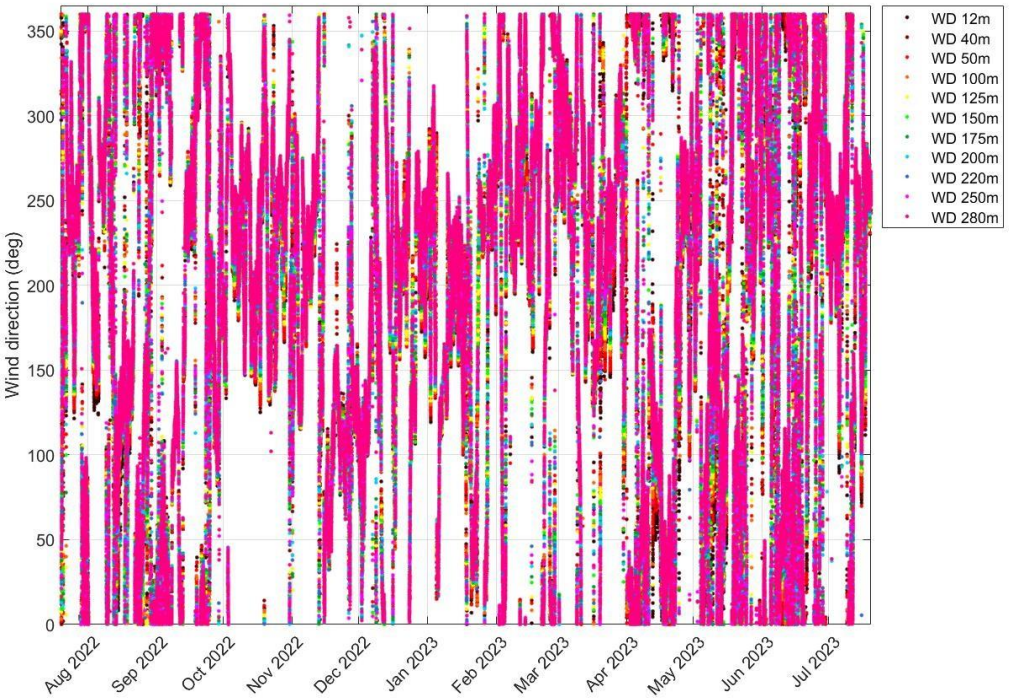


Figure 7. E06: time series of wind direction (DD/MM/YYYY).

Figures below show the time series of vertical wind speed for all heights measured by the FLS200 systems.

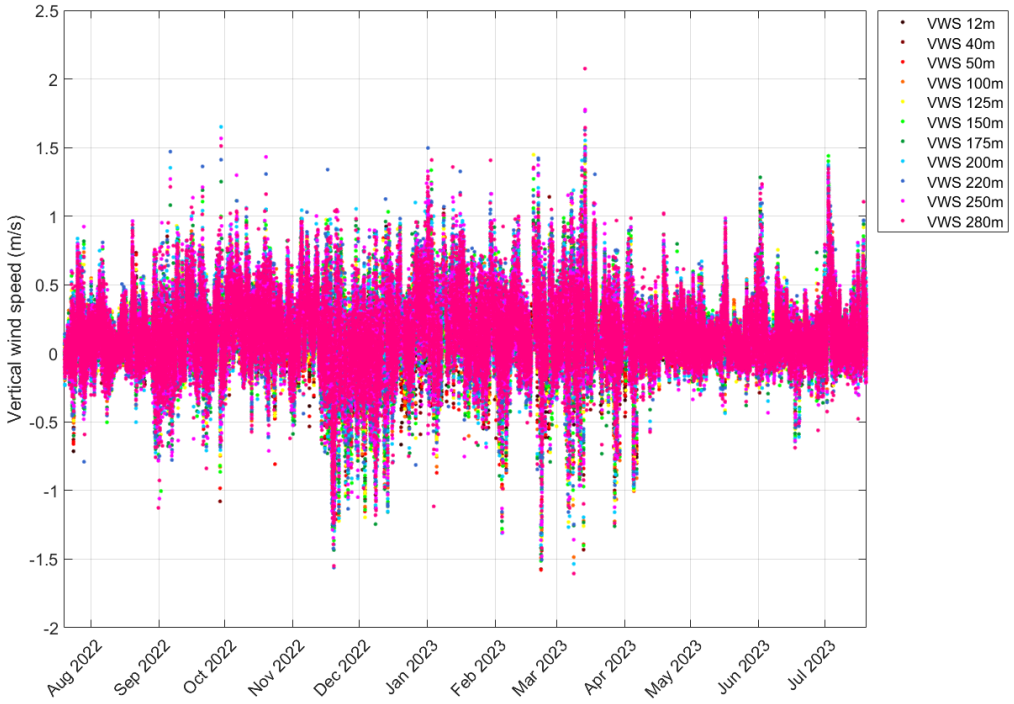


Figure 8. E01: time series of vertical wind speed (DD/MM/YYYY).

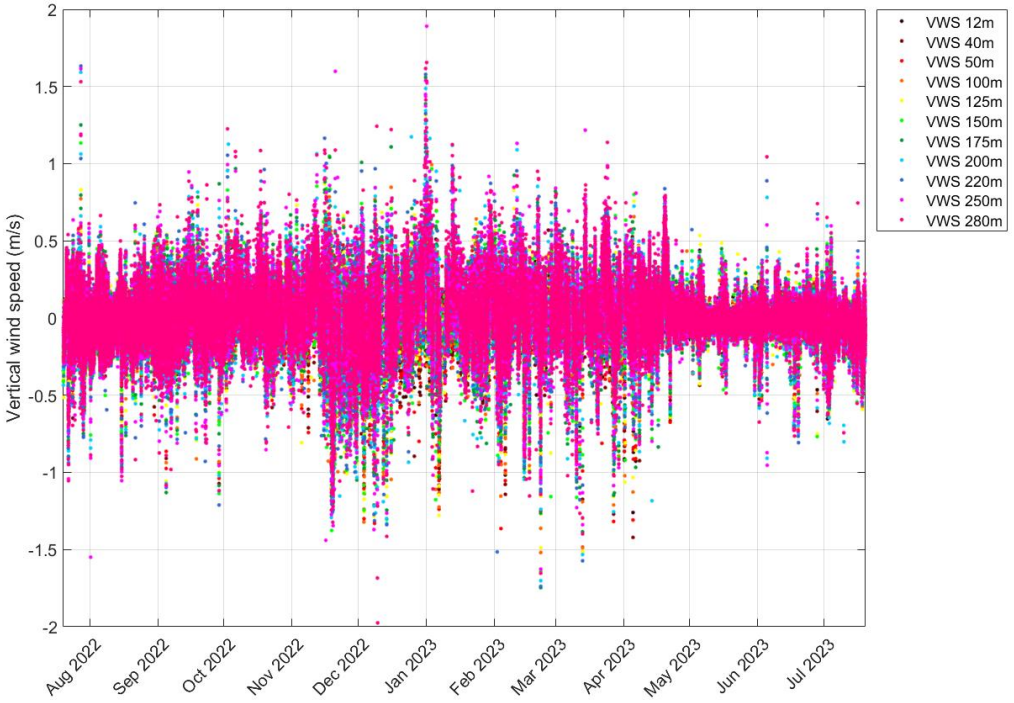


Figure 9. E06: time series of vertical wind speed (DD/MM/YYYY).

Figures below present the wind speed frequency distributions at all heights for the observation period.

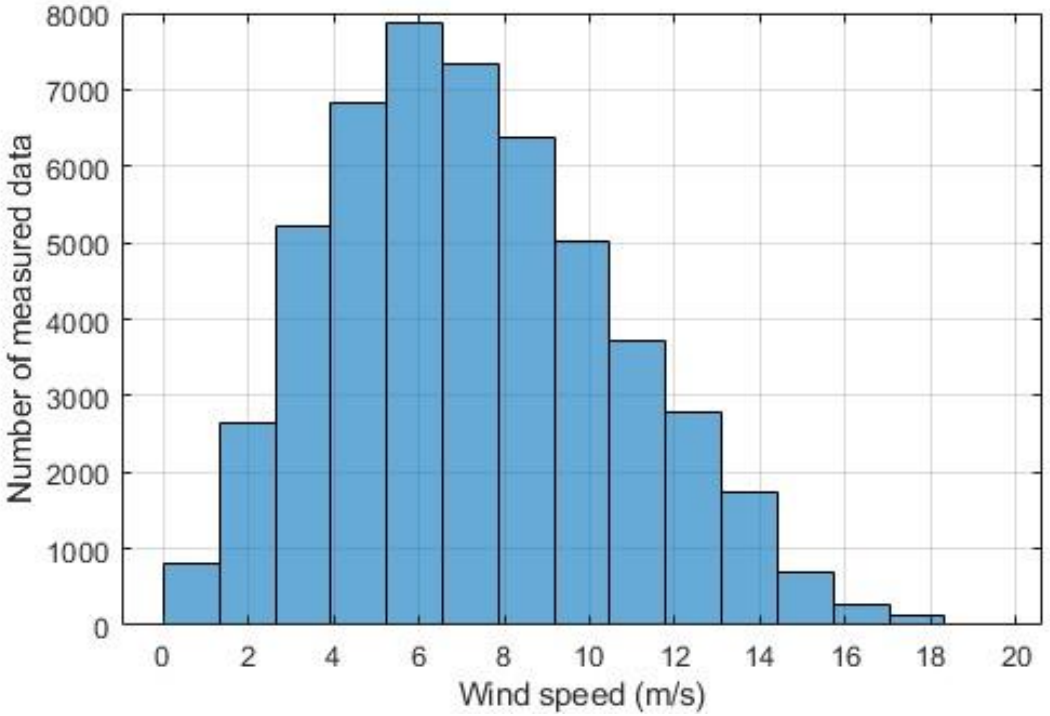


Figure 10. E01: horizontal wind speed frequency distribution at 12 m.

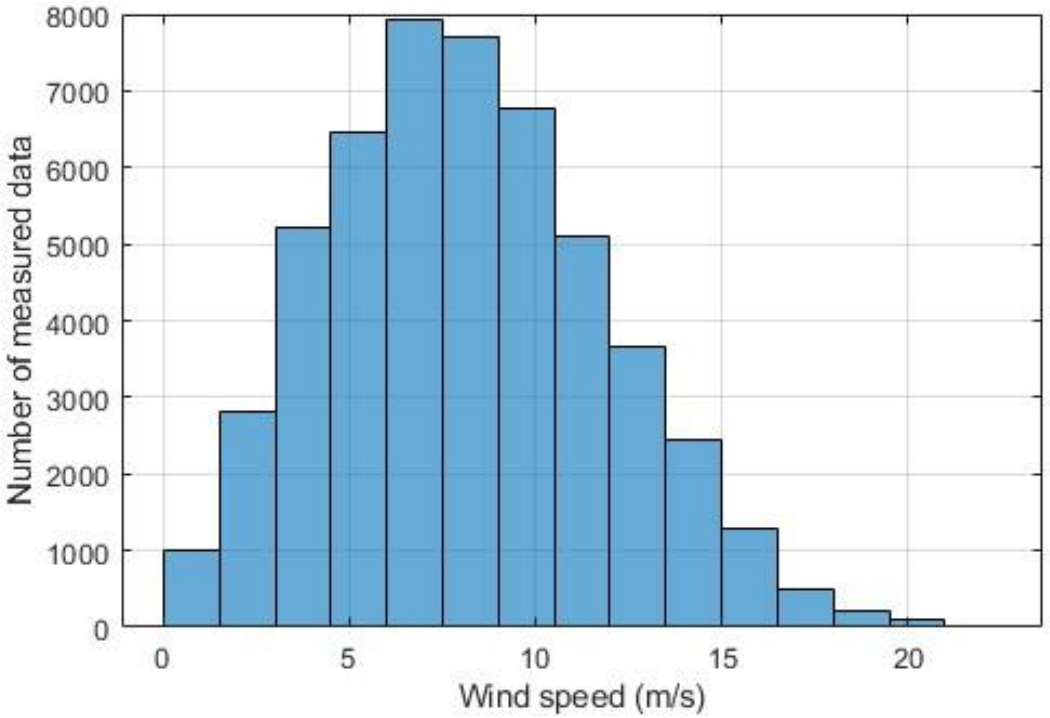


Figure 11. E01: horizontal wind speed frequency distribution at 40 m.

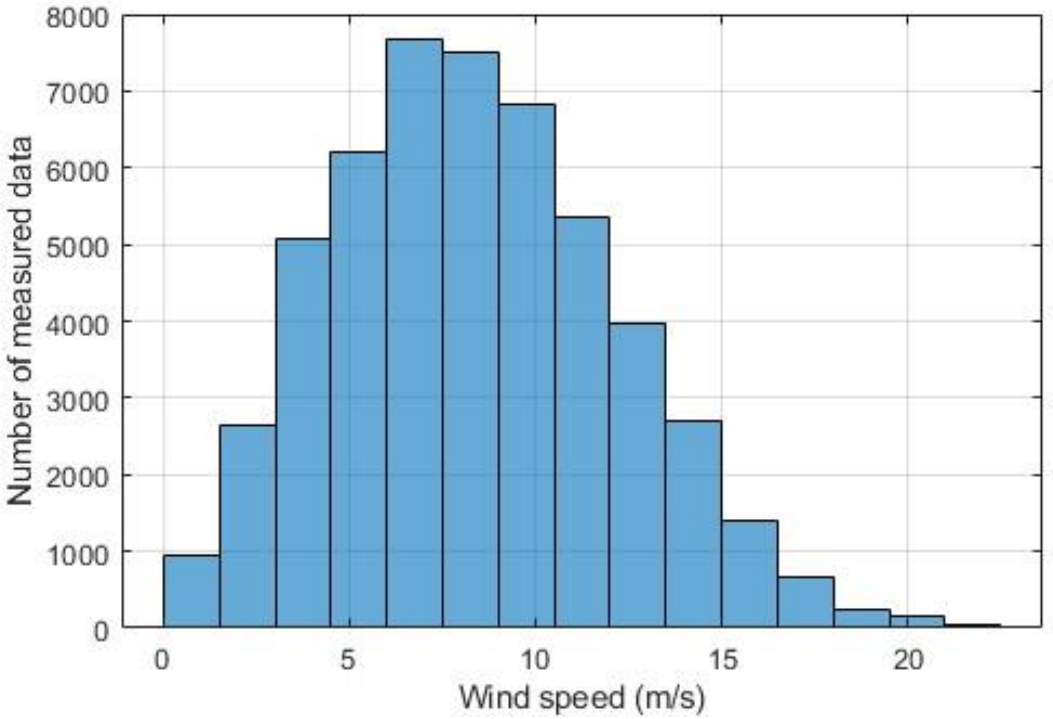


Figure 12. E01: horizontal wind speed frequency distribution at 50 m.

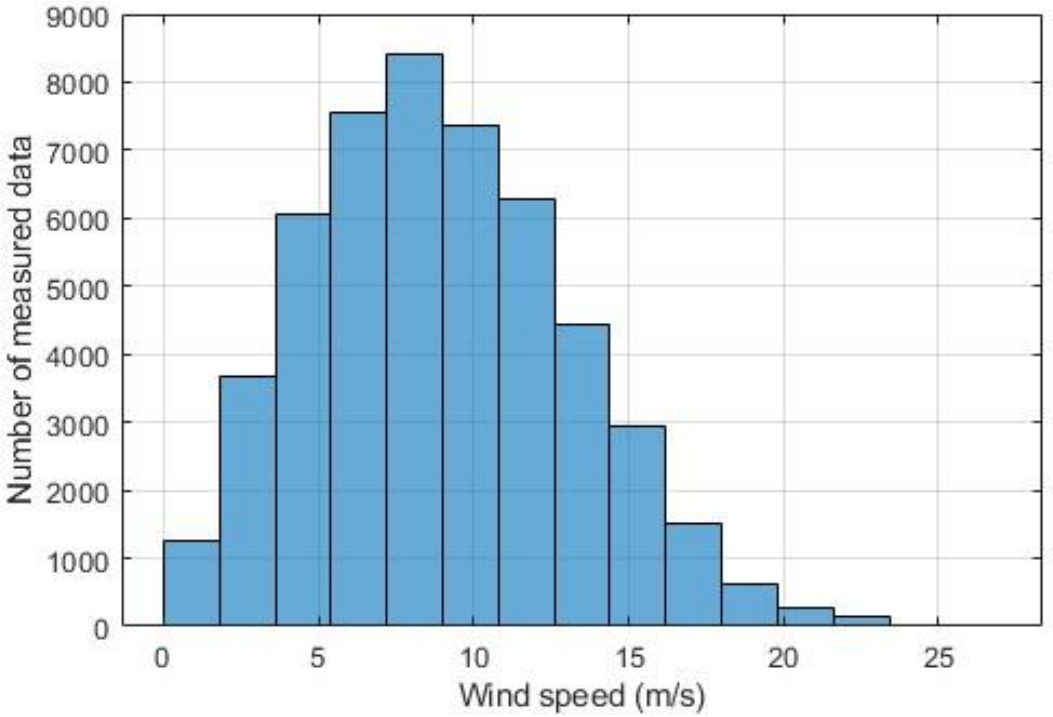


Figure 13. E01: horizontal wind speed frequency distribution at 100 m.

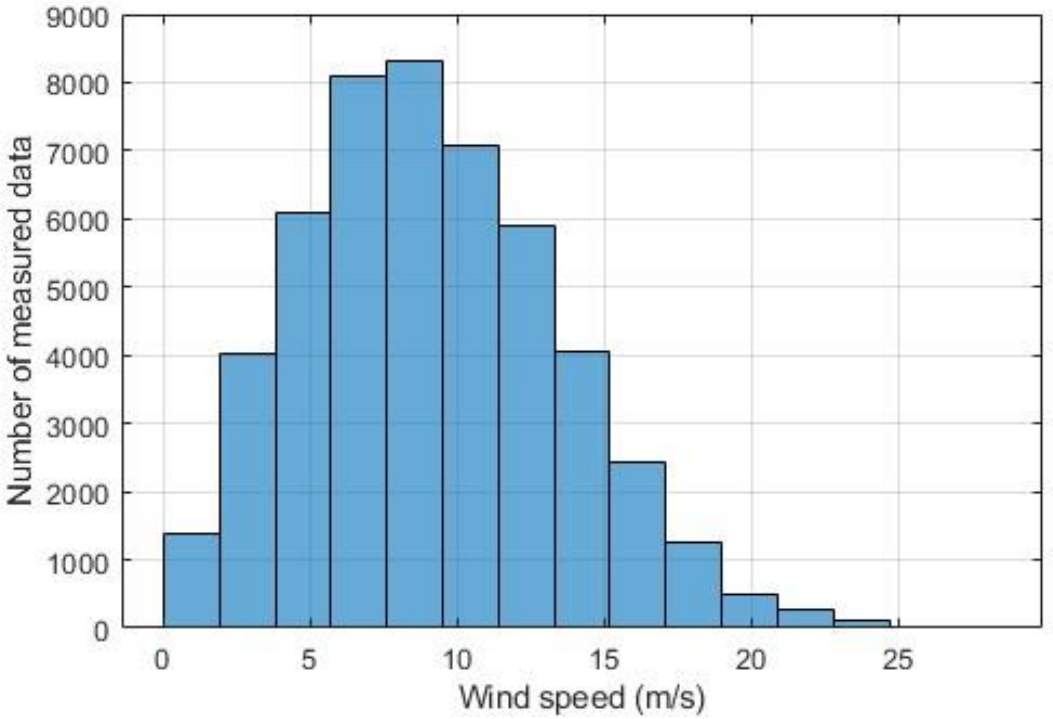


Figure 14. E01: horizontal wind speed frequency distribution at 125 m.

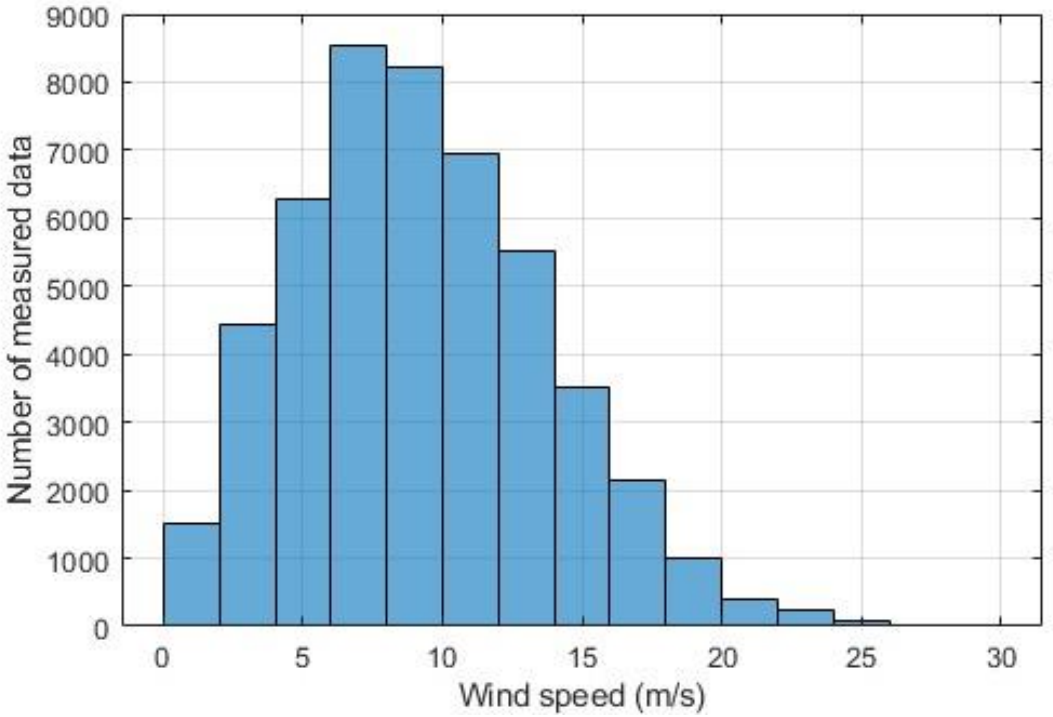


Figure 15. E01: horizontal wind speed frequency distribution at 150 m

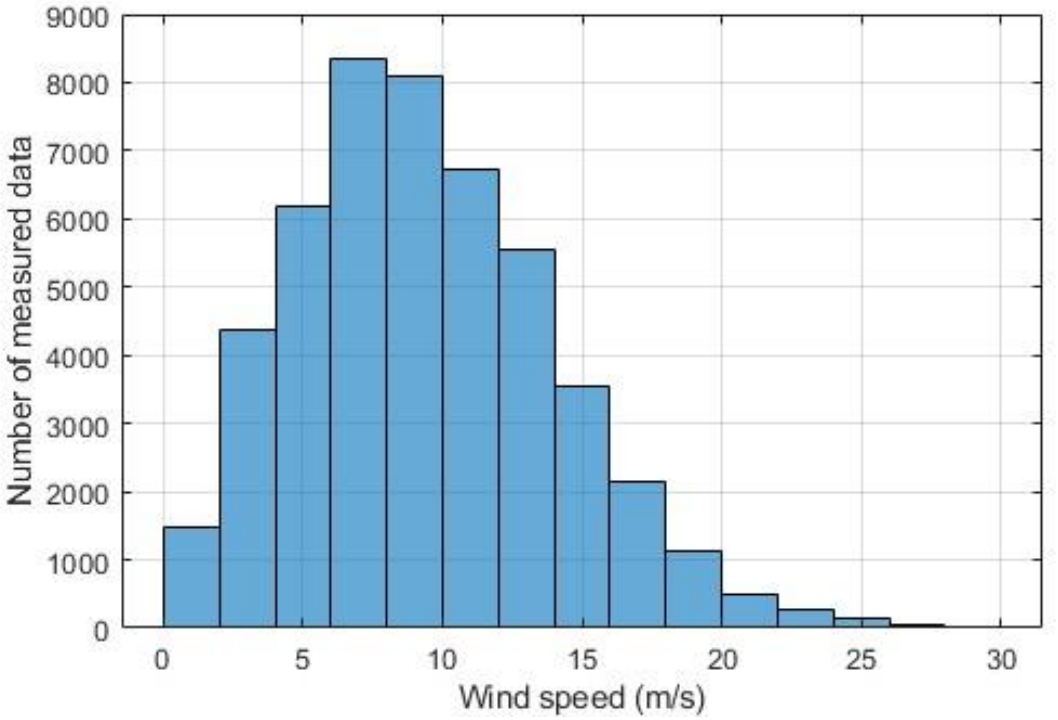


Figure 16. E01: horizontal wind speed frequency distribution at 175 m.

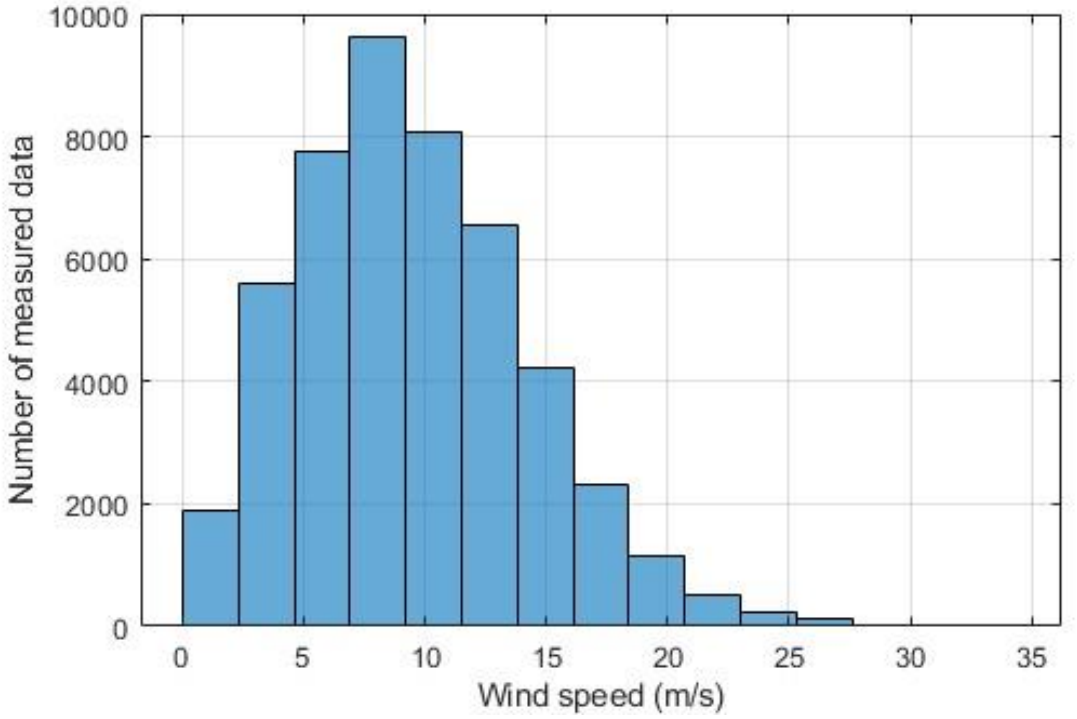


Figure 17. E01: horizontal wind speed frequency distribution at 200 m

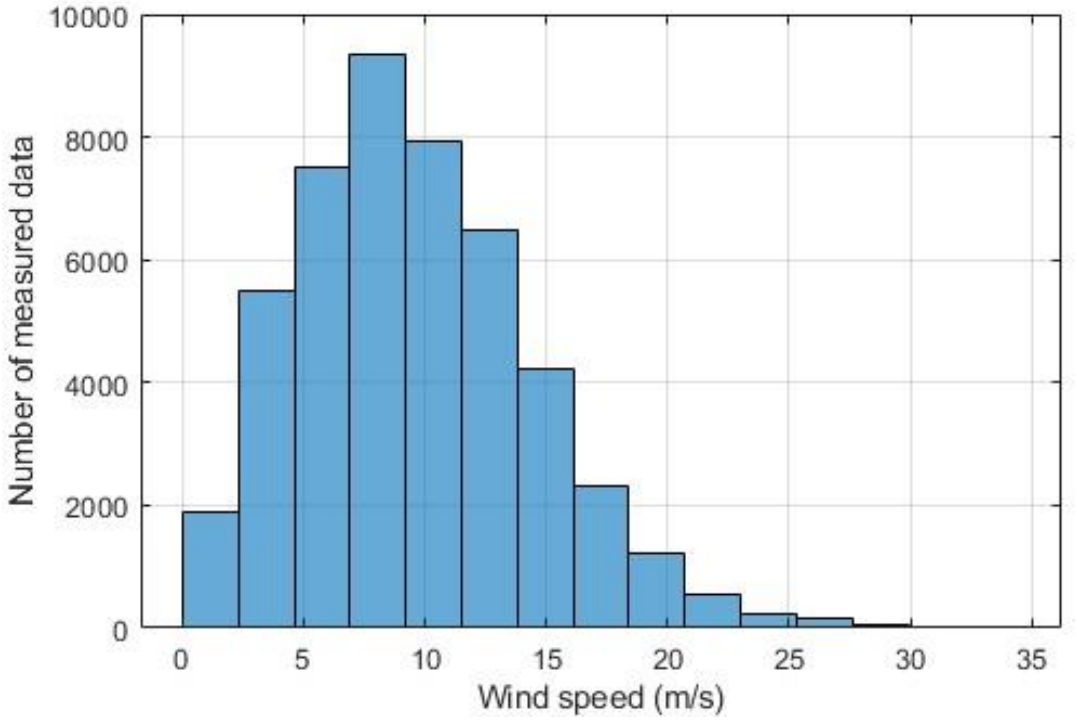


Figure 18. E01: horizontal wind speed frequency distribution at 220 m.

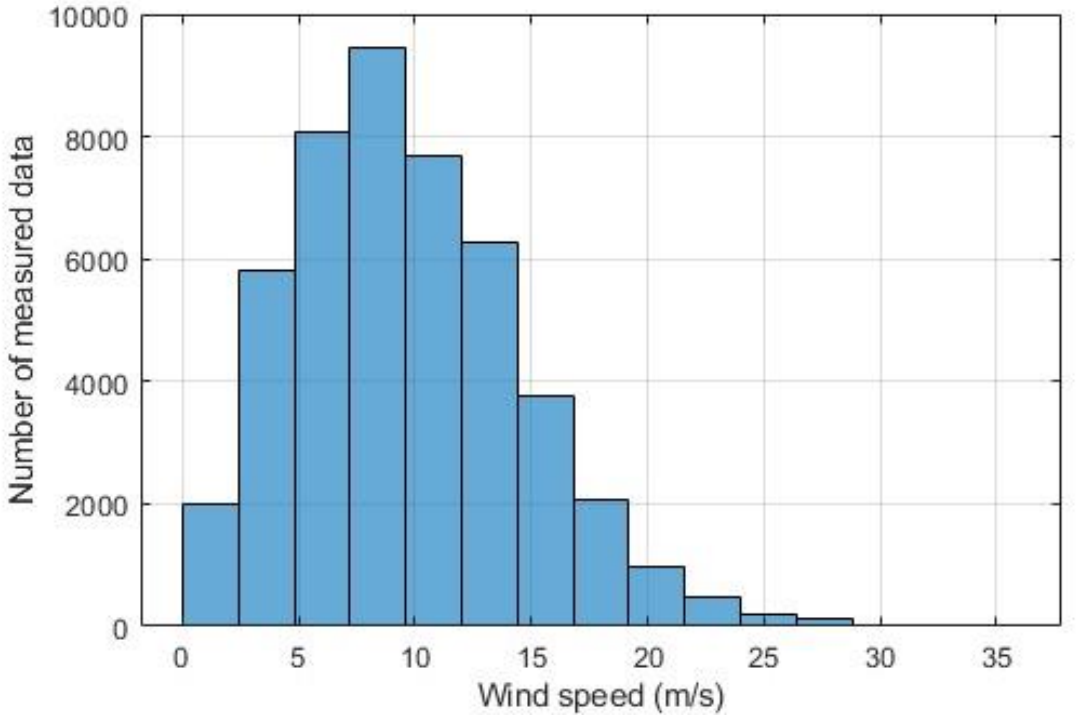


Figure 19. E01: horizontal wind speed frequency distribution at 250 m

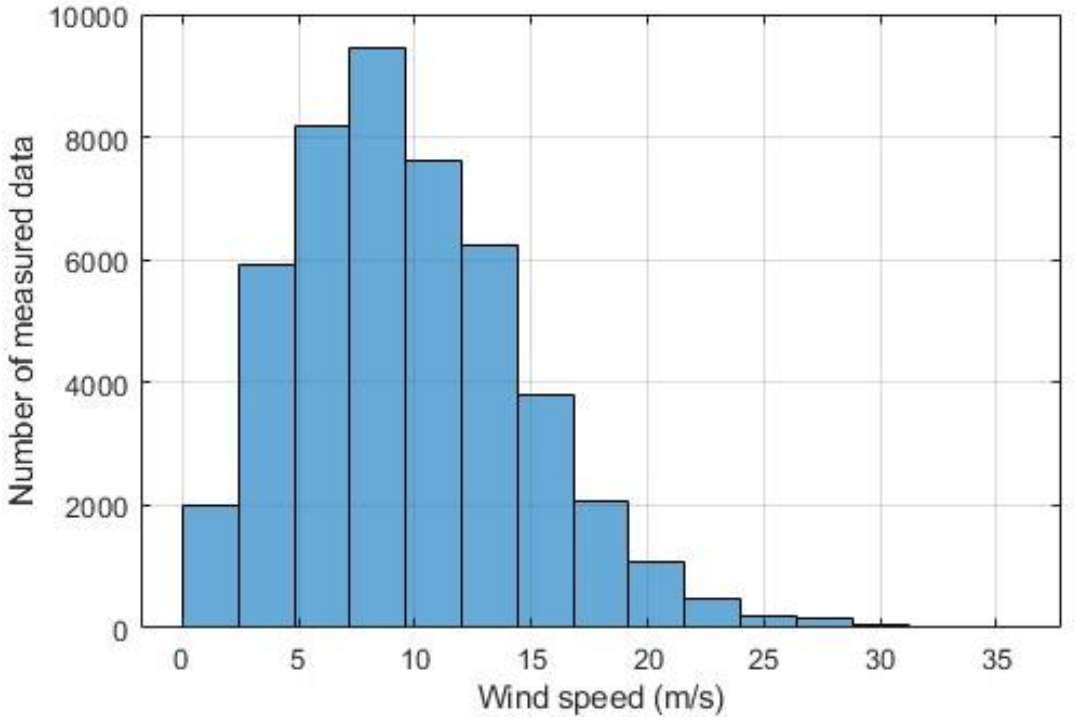


Figure 20. E01: horizontal wind speed frequency distribution at 280 m.

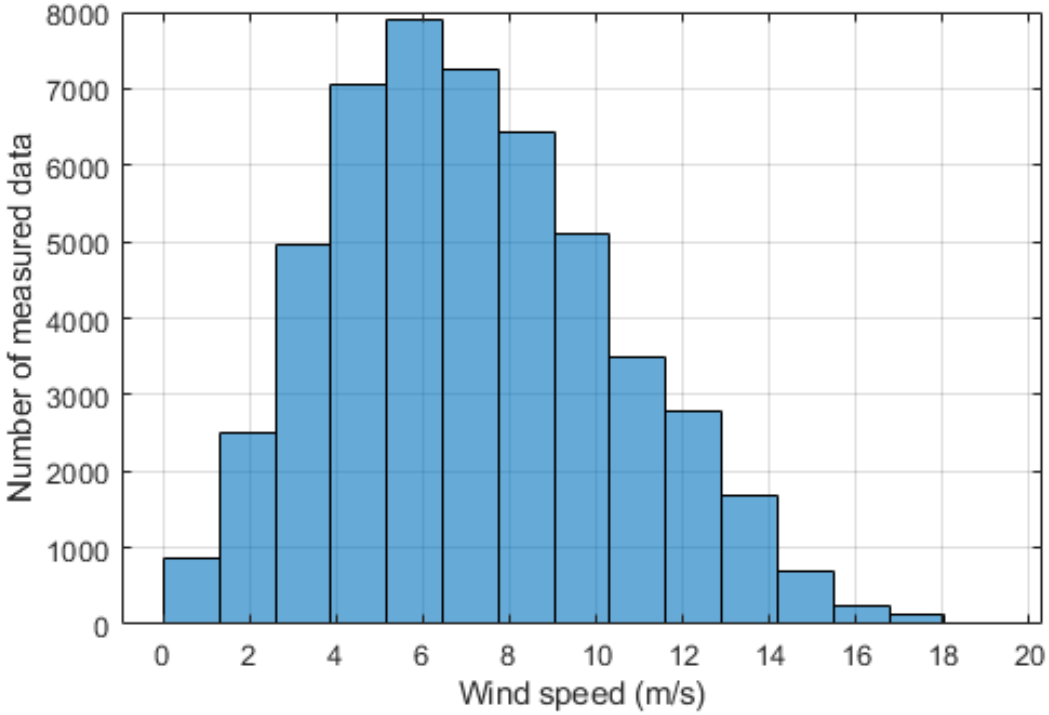


Figure 21. E06: horizontal wind speed frequency distribution at 12 m.

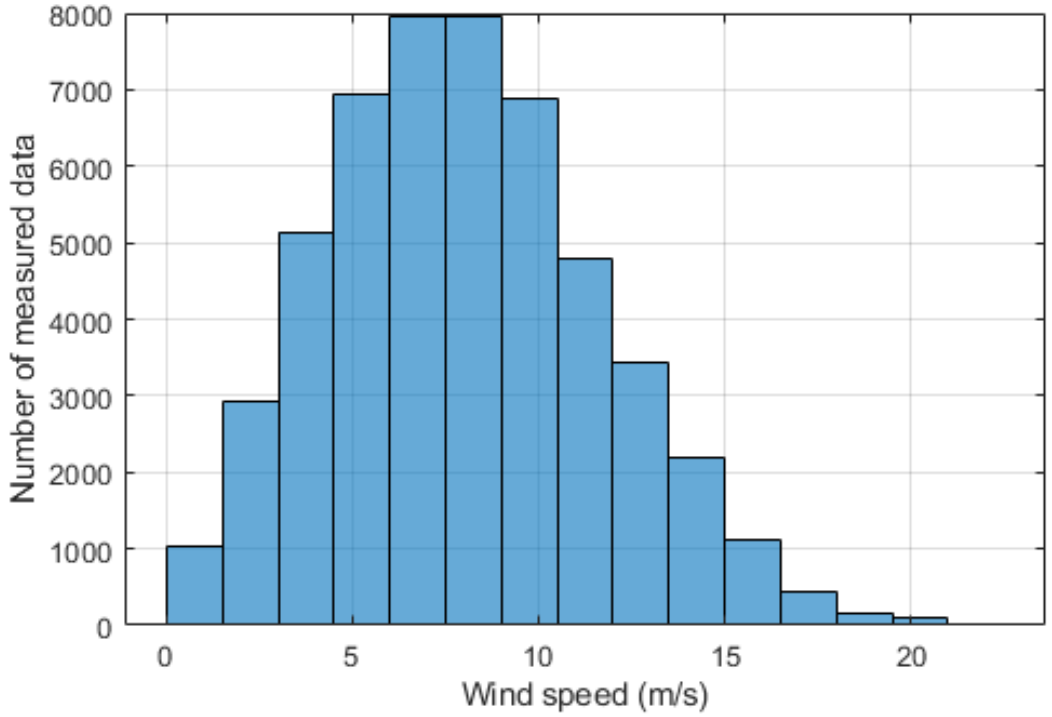


Figure 22. E06: horizontal wind speed frequency distribution at 40 m.

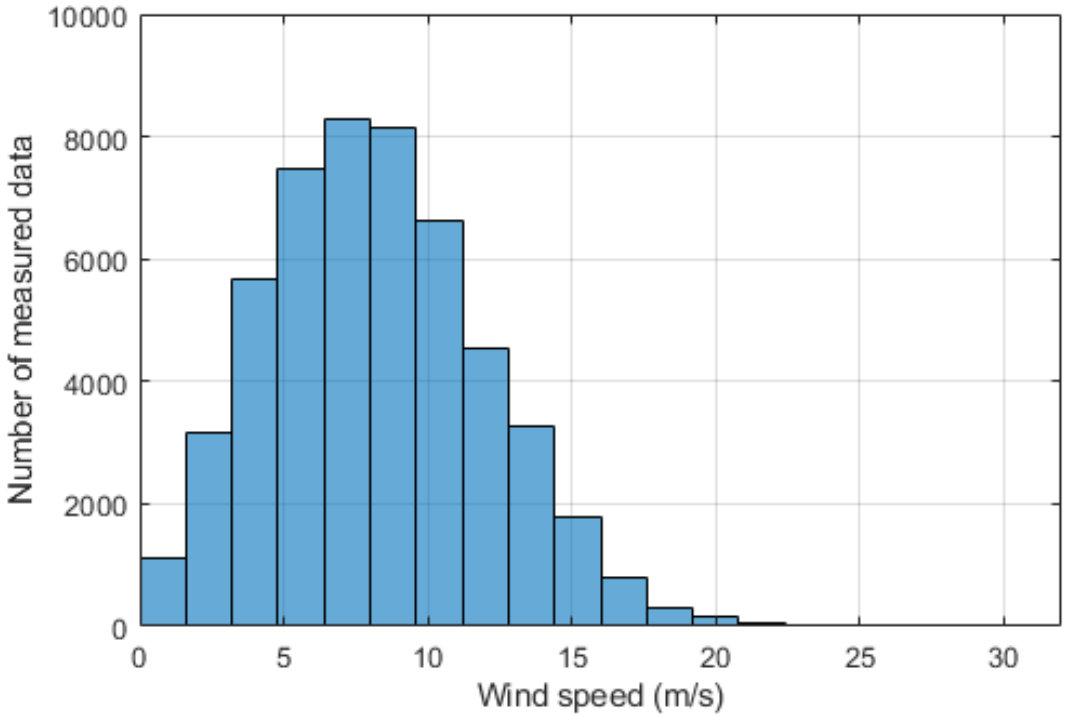


Figure 23. E06: horizontal wind speed frequency distribution at 50 m

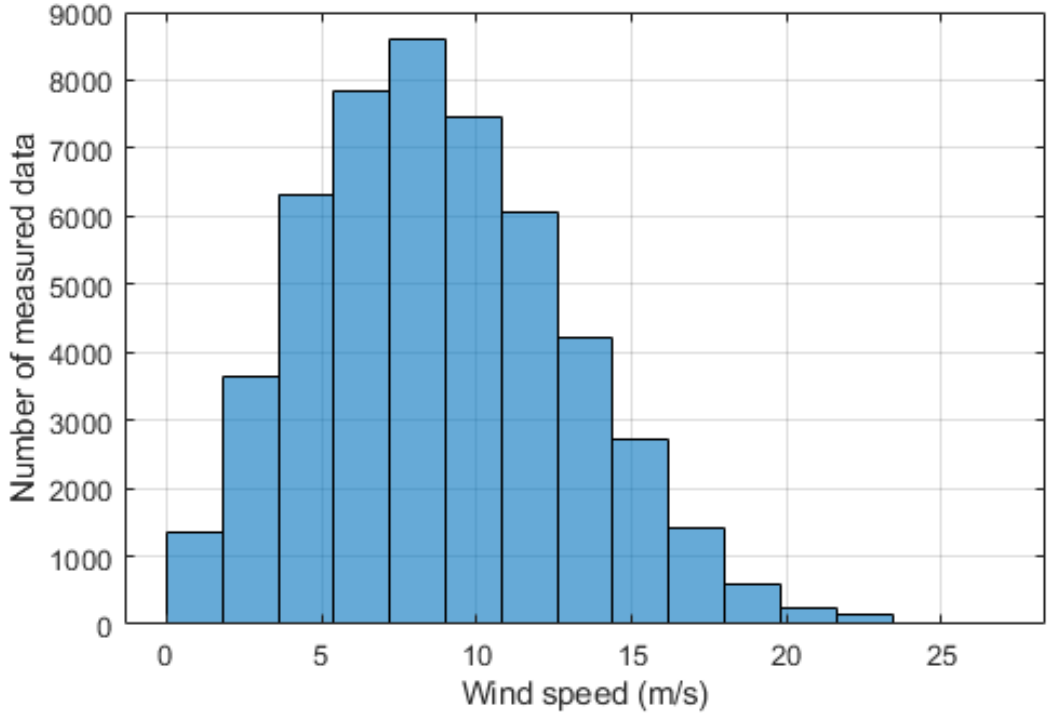


Figure 24. E06: horizontal wind speed frequency distribution at 100 m.

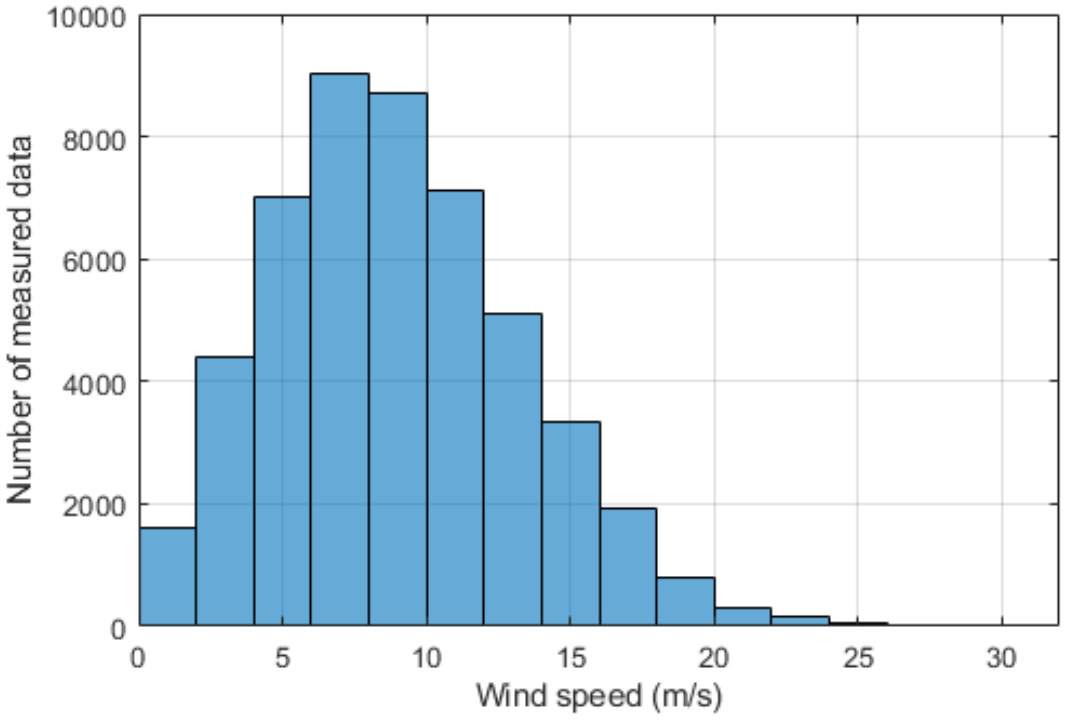


Figure 25. E06: horizontal wind speed frequency distribution at 125 m.

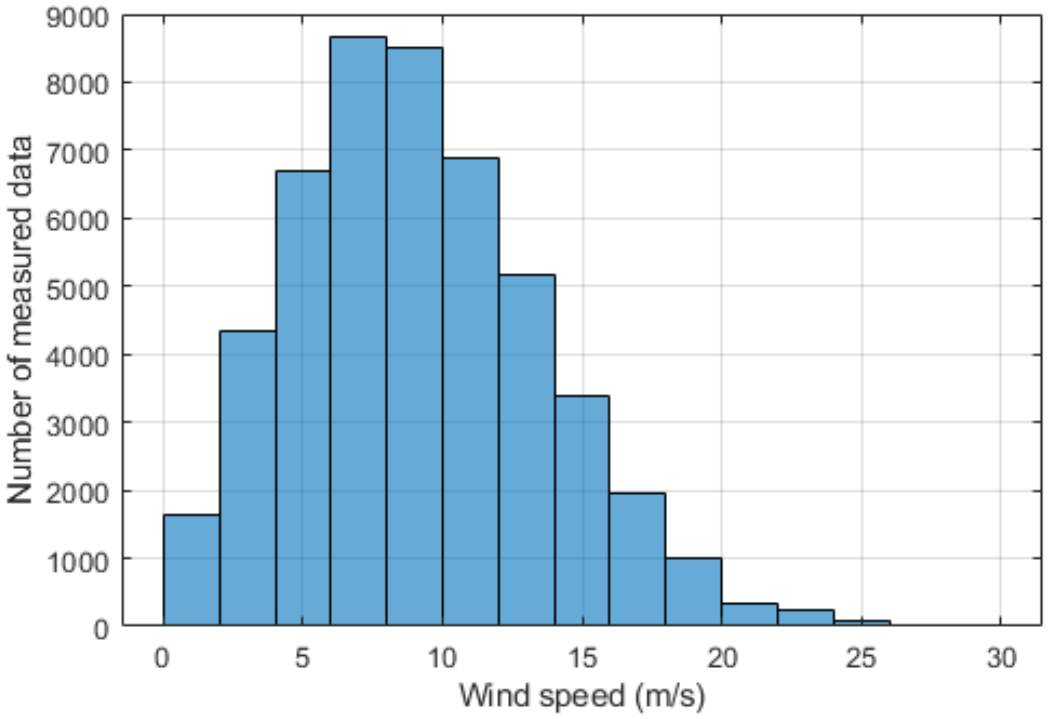


Figure 26. E06: horizontal wind speed frequency distribution at 150

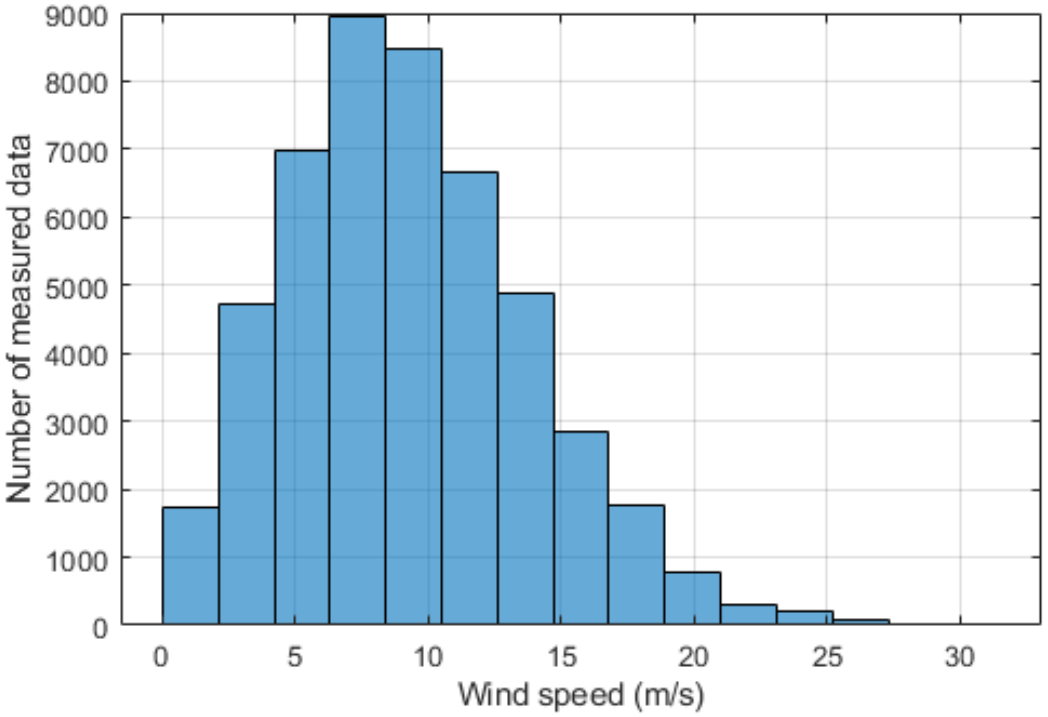


Figure 27. E06: horizontal wind speed frequency distribution at 175 m.

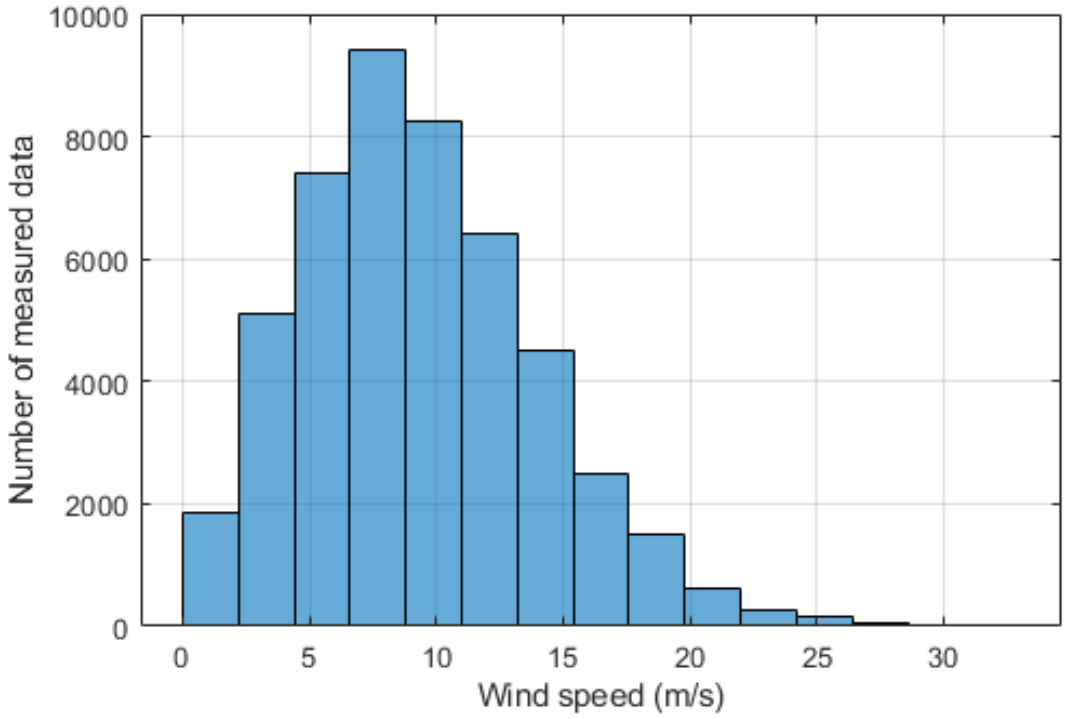


Figure 28. E06: horizontal wind speed frequency distribution at 200 m.

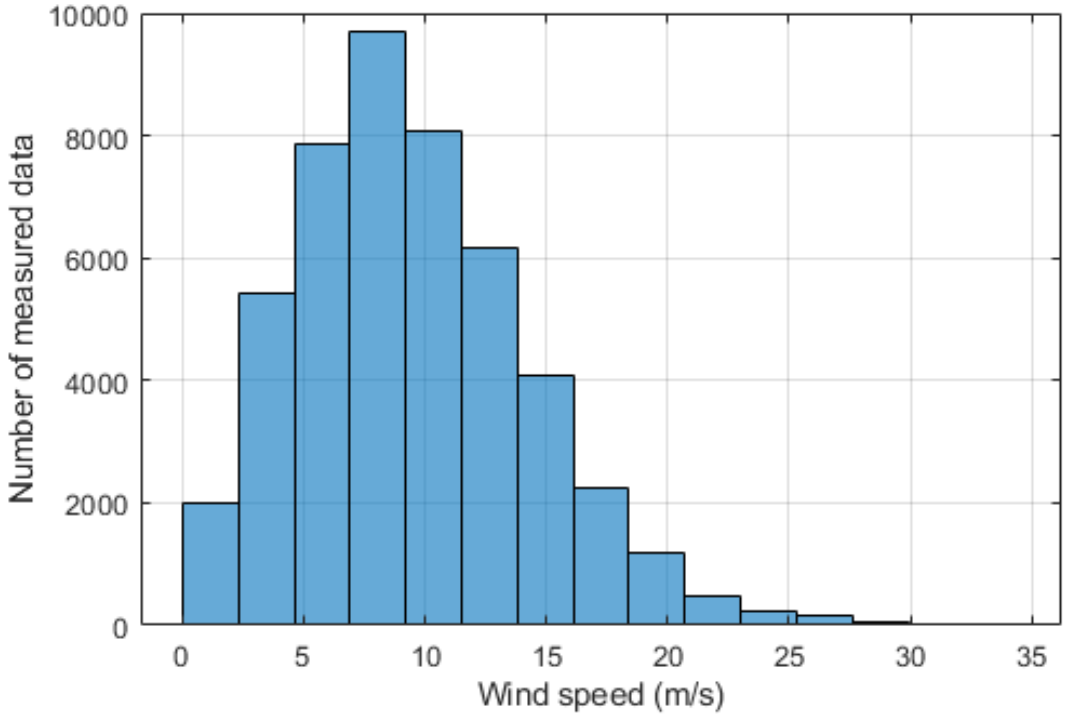


Figure 29. E06: horizontal wind speed frequency distribution at 220 m

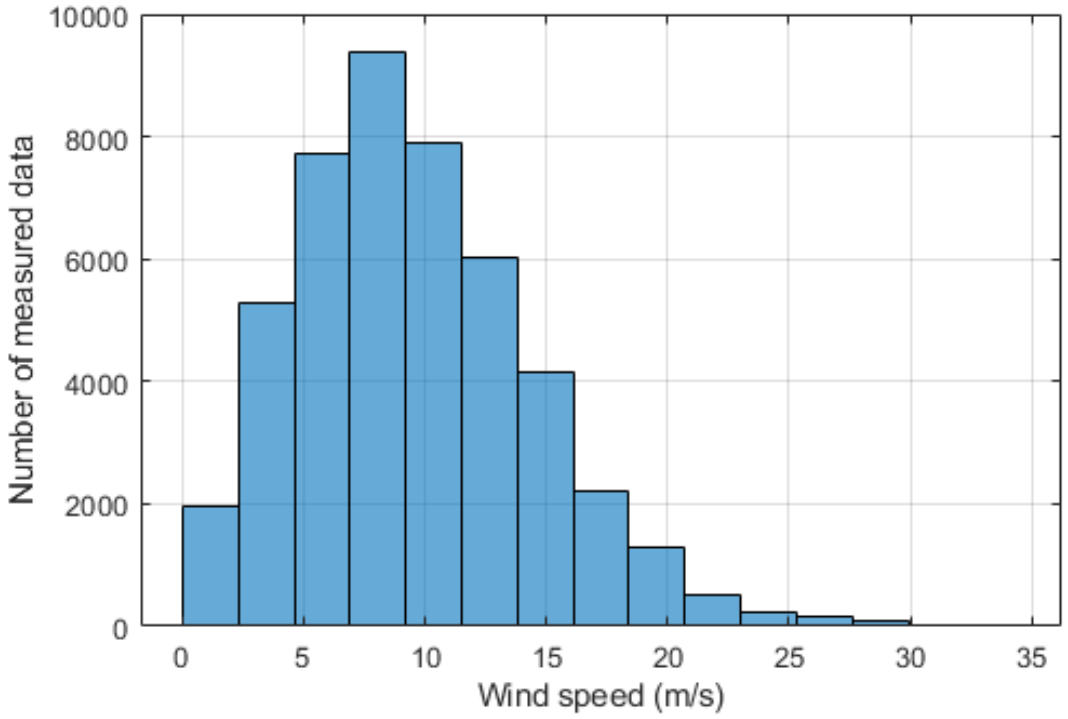


Figure 30. E06: horizontal wind speed frequency distribution at 250 m.

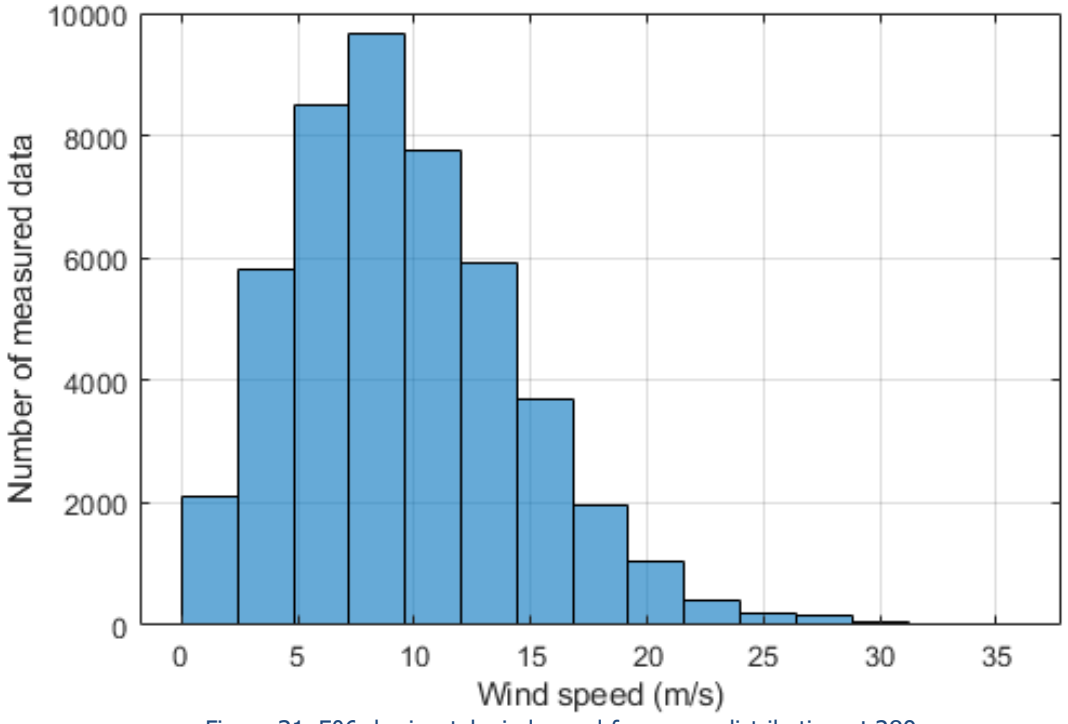


Figure 31. E06: horizontal wind speed frequency distribution at 280 m.

Figures below present the vertical wind speed frequency distributions at all heights for the observation period.

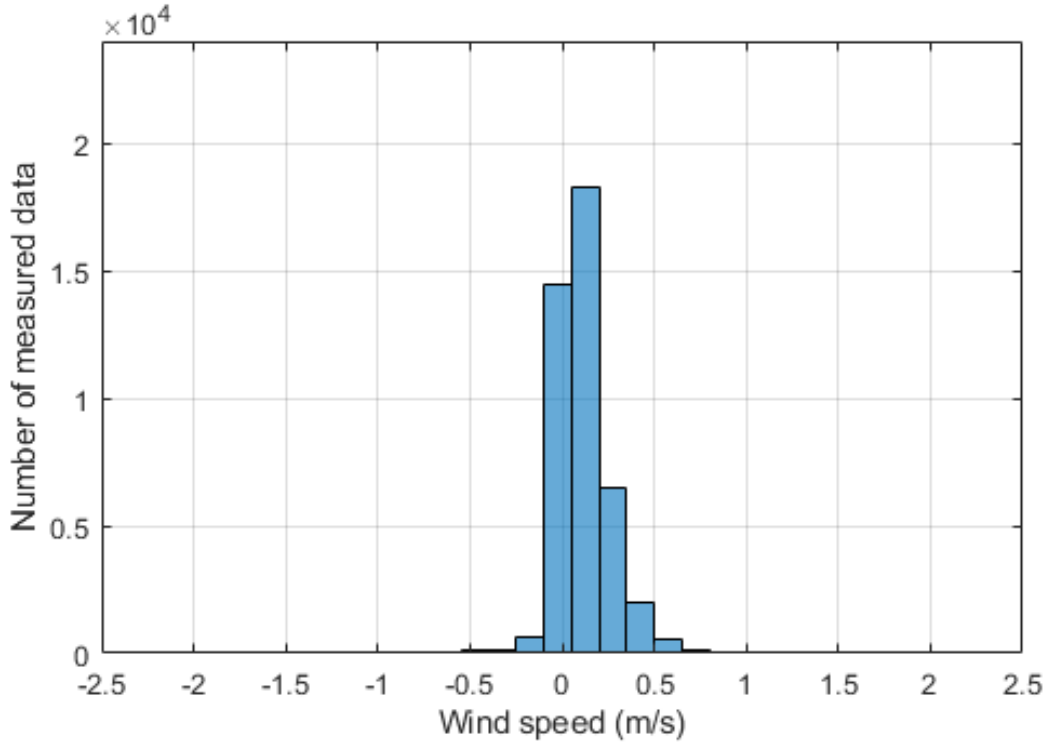


Figure 32. E01: vertical wind speed frequency distribution at 12 m.

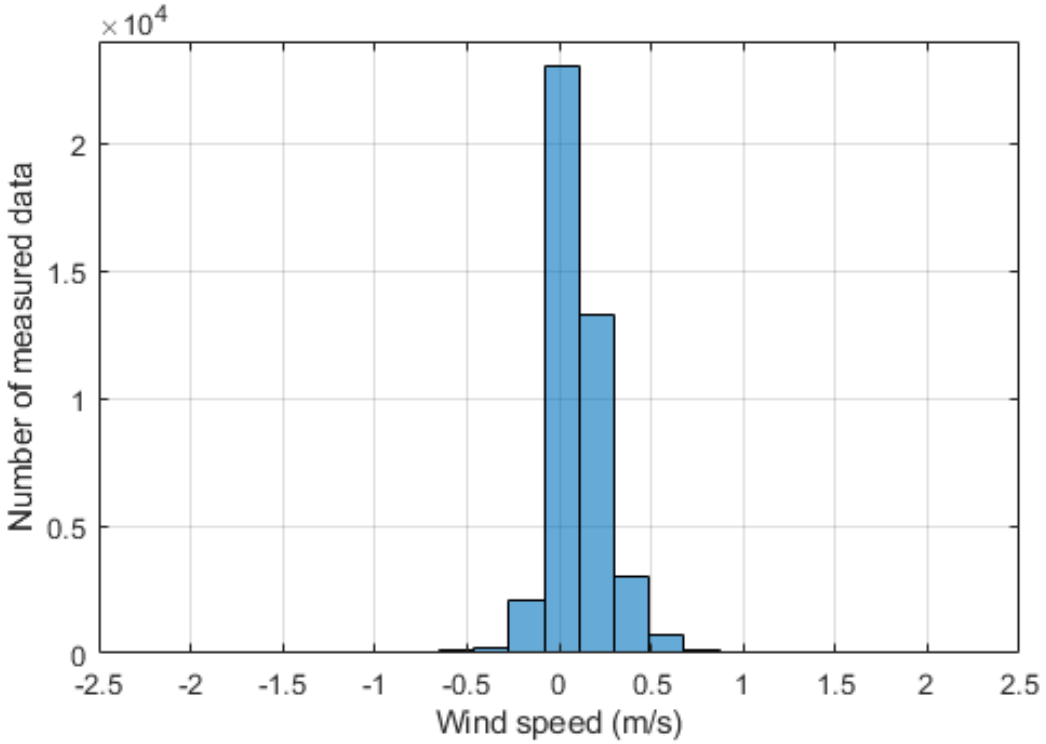


Figure 33. E01: vertical wind speed frequency distribution at 40 m.

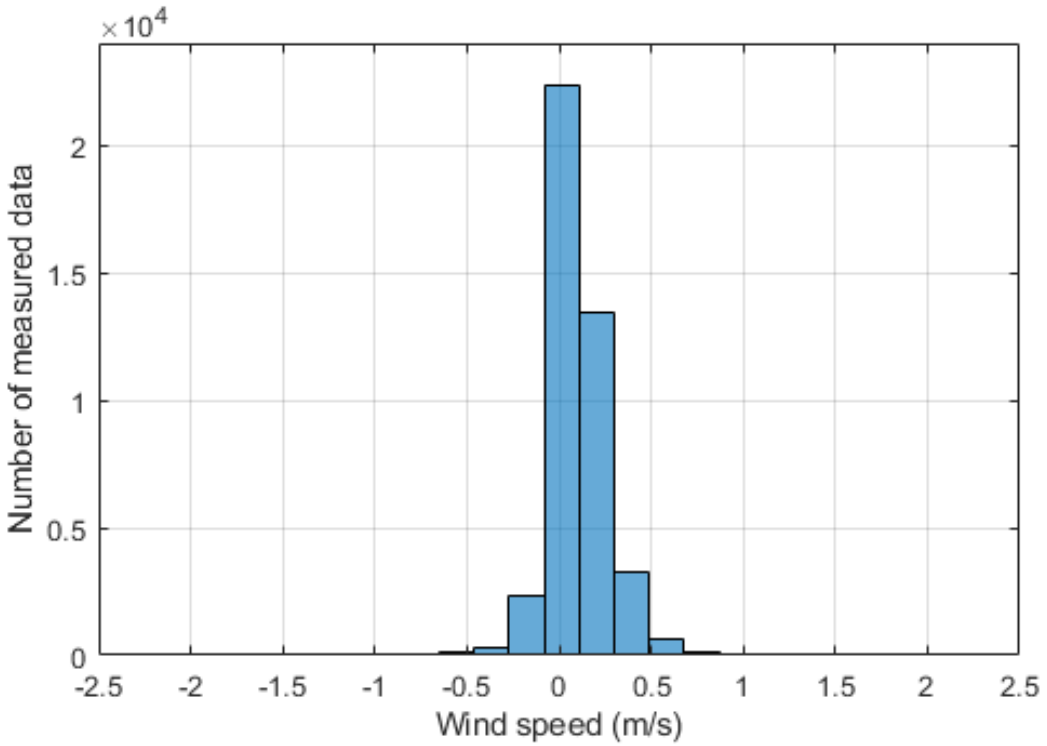


Figure 34. E01: vertical wind speed frequency distribution at 50 m.

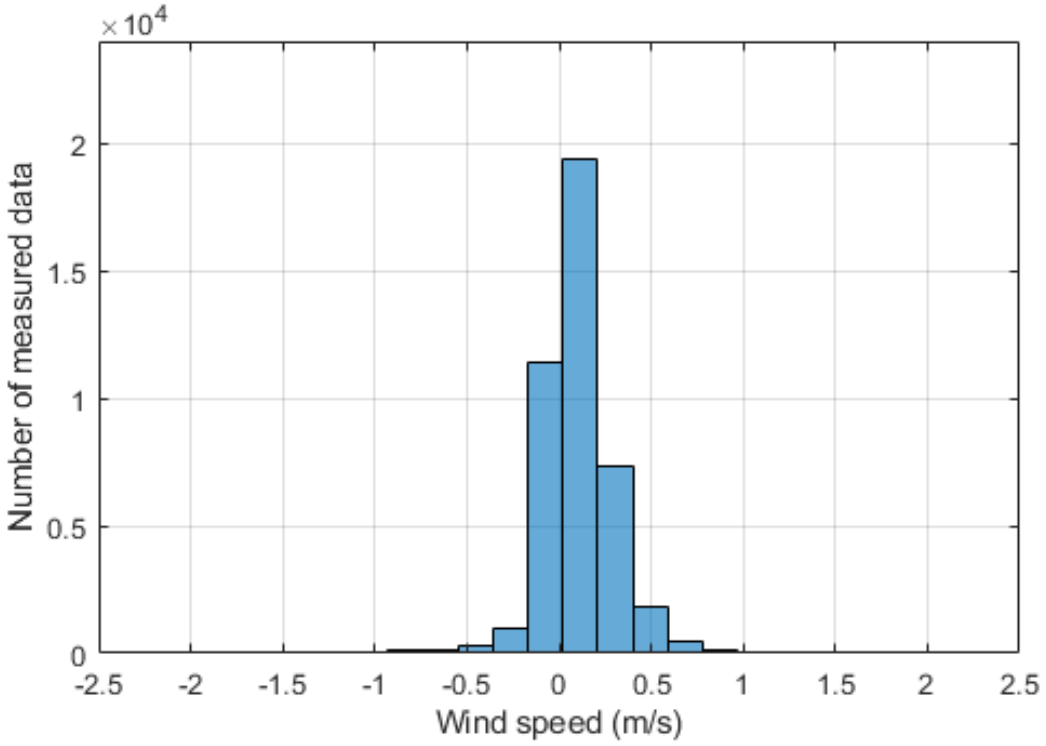


Figure 35. E01: vertical wind speed frequency distribution at 100 m.

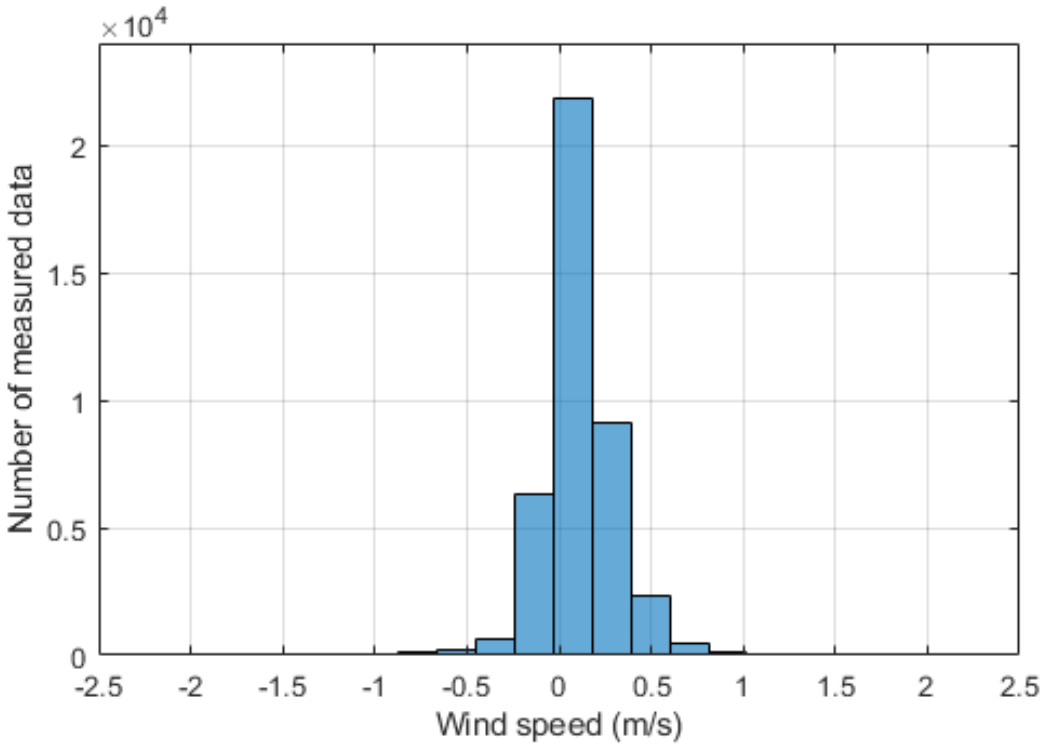


Figure 36. E01: vertical wind speed frequency distribution at 125 m.

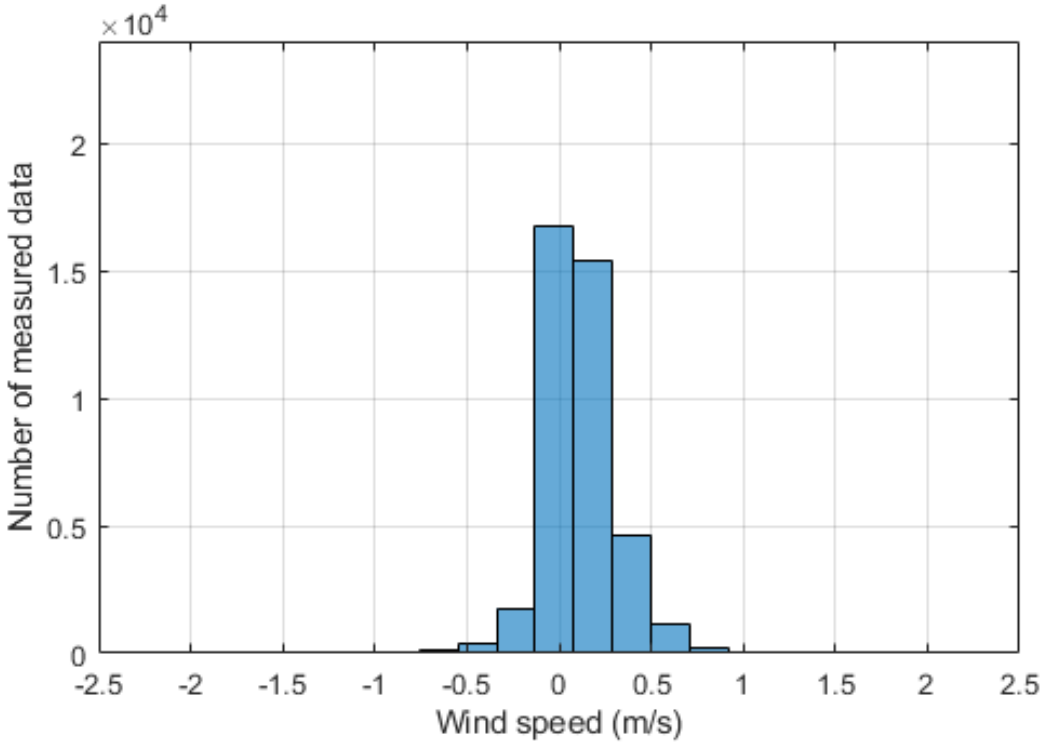


Figure 37. E01: vertical wind speed frequency distribution at 150 m.

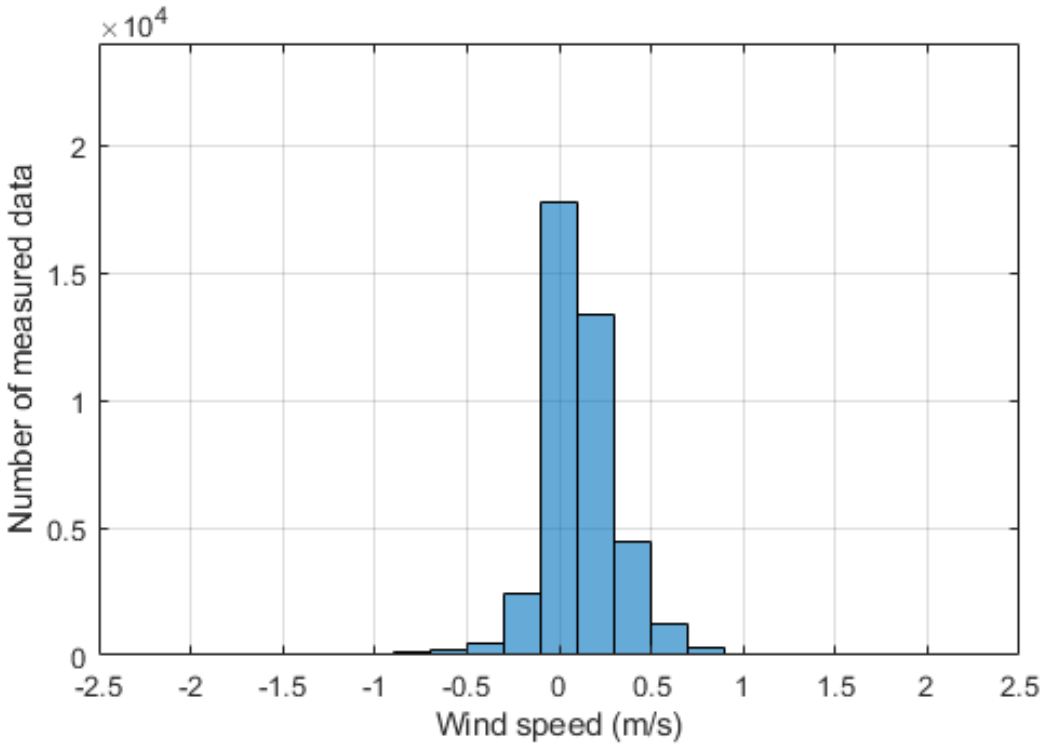


Figure 38. E01: vertical wind speed frequency distribution at 175 m.

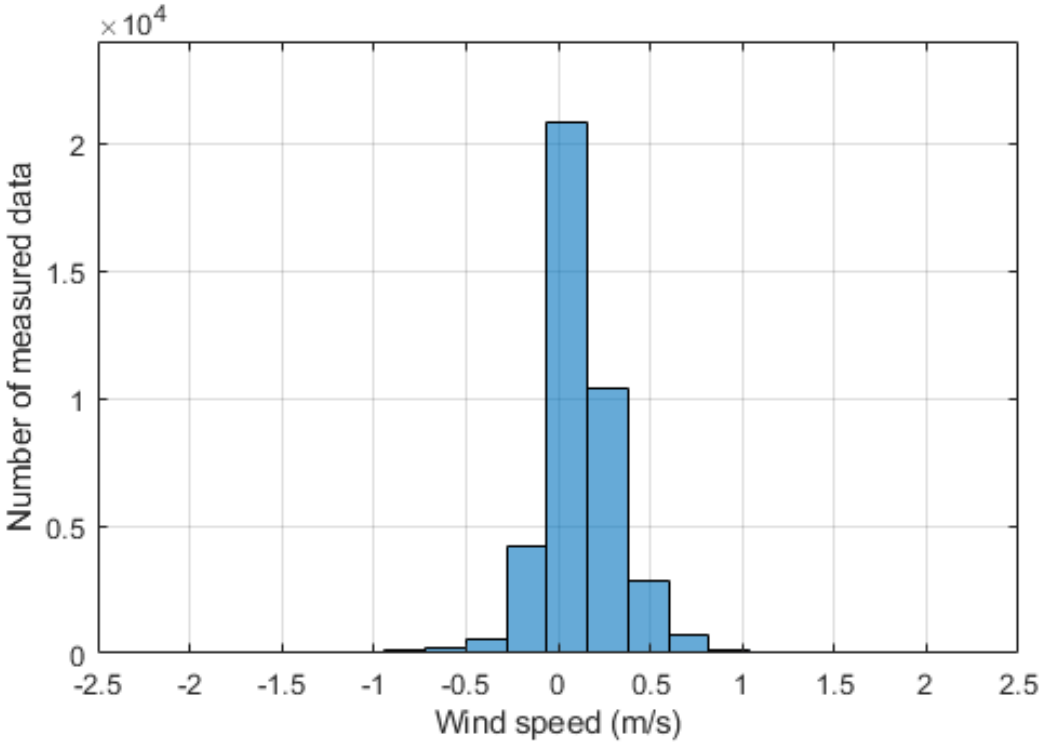


Figure 39. E01: vertical wind speed frequency distribution at 200 m.

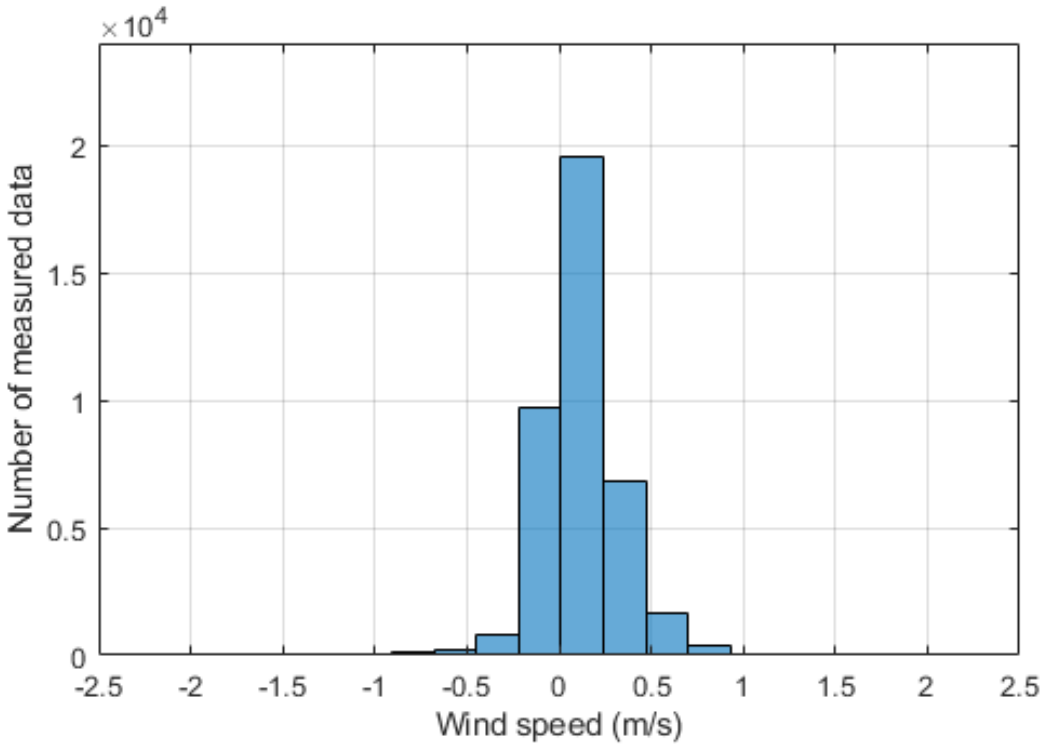


Figure 40. E01: vertical wind speed frequency distribution at 220 m.

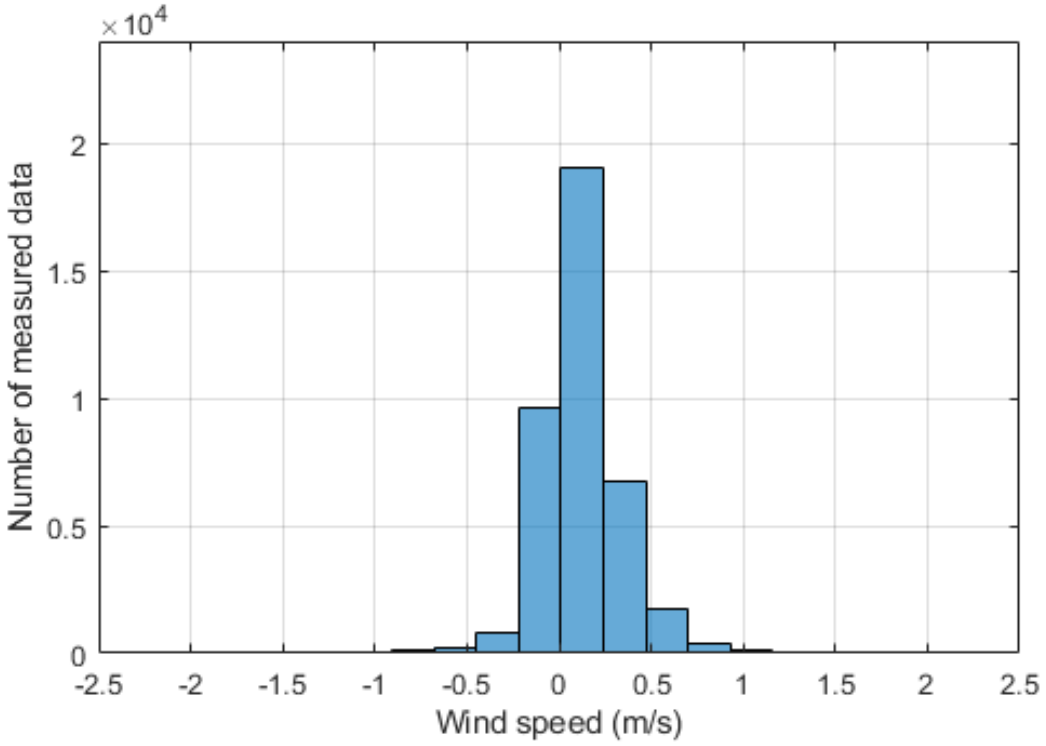


Figure 41. E01: vertical wind speed frequency distribution at 250 m.

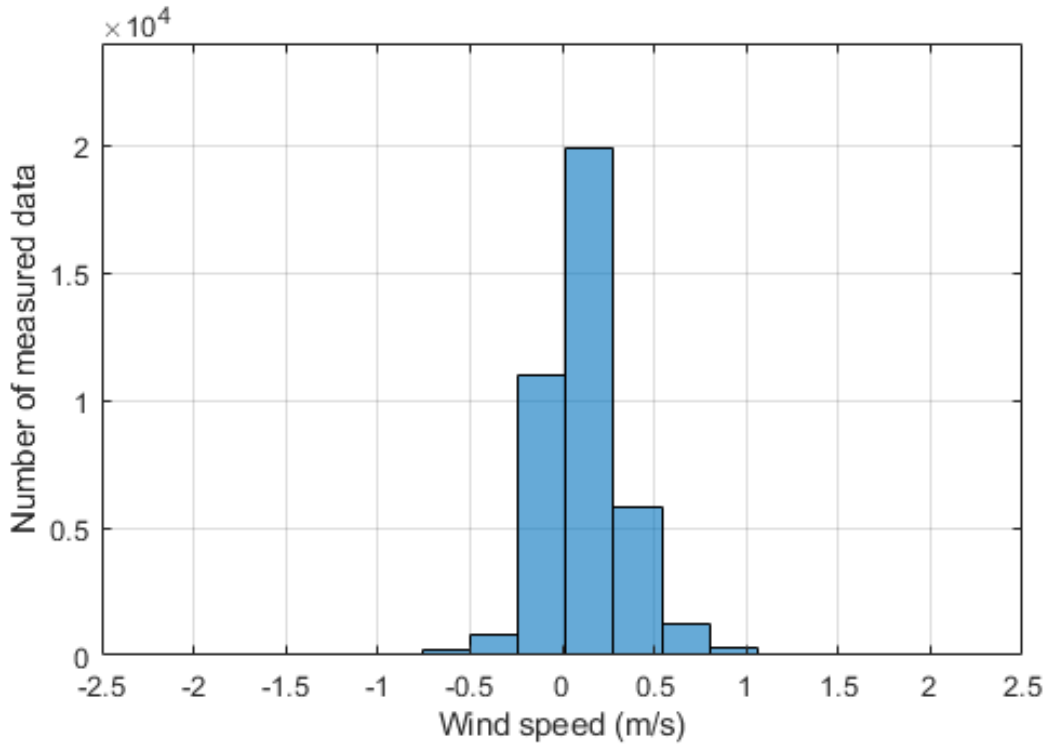


Figure 42. E01: vertical wind speed frequency distribution at 280 m.

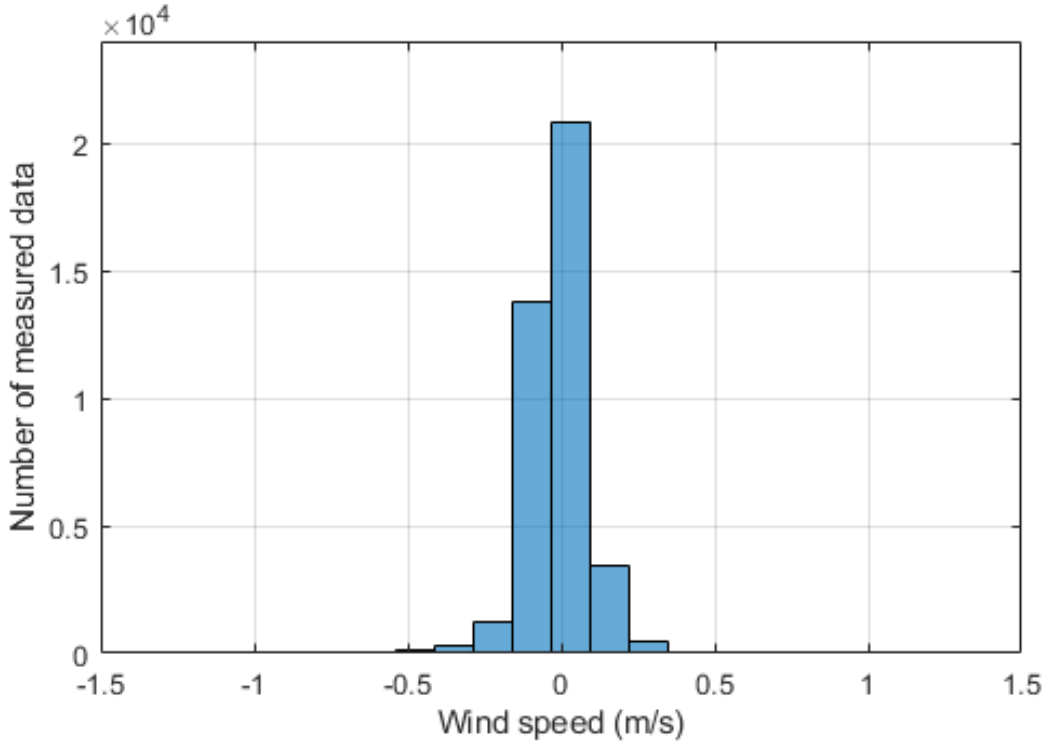


Figure 43. E06: vertical wind speed frequency distribution at 12 m.

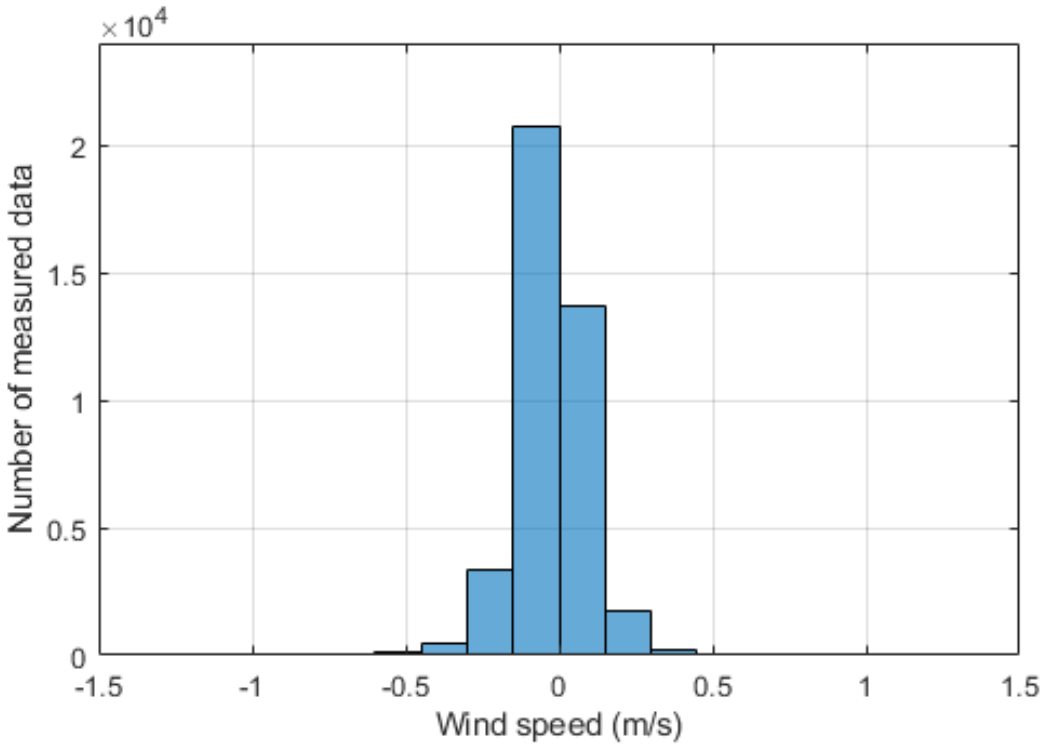


Figure 44. E06: vertical wind speed frequency distribution at 40 m.

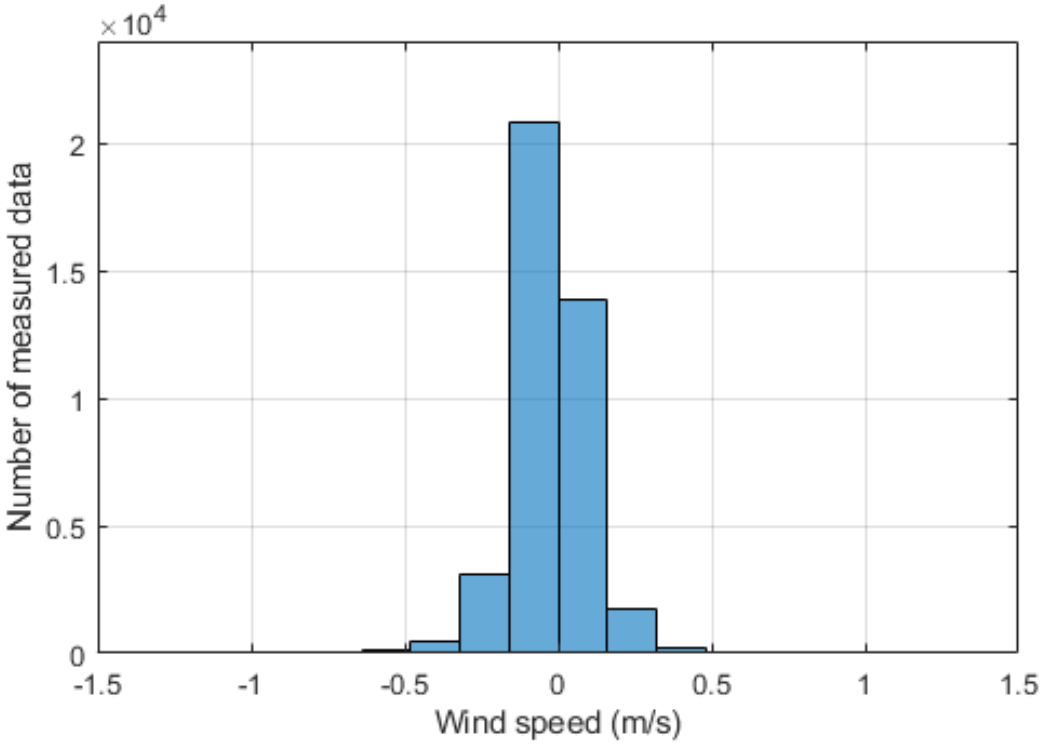


Figure 45. E06: vertical wind speed frequency distribution at 50 m.

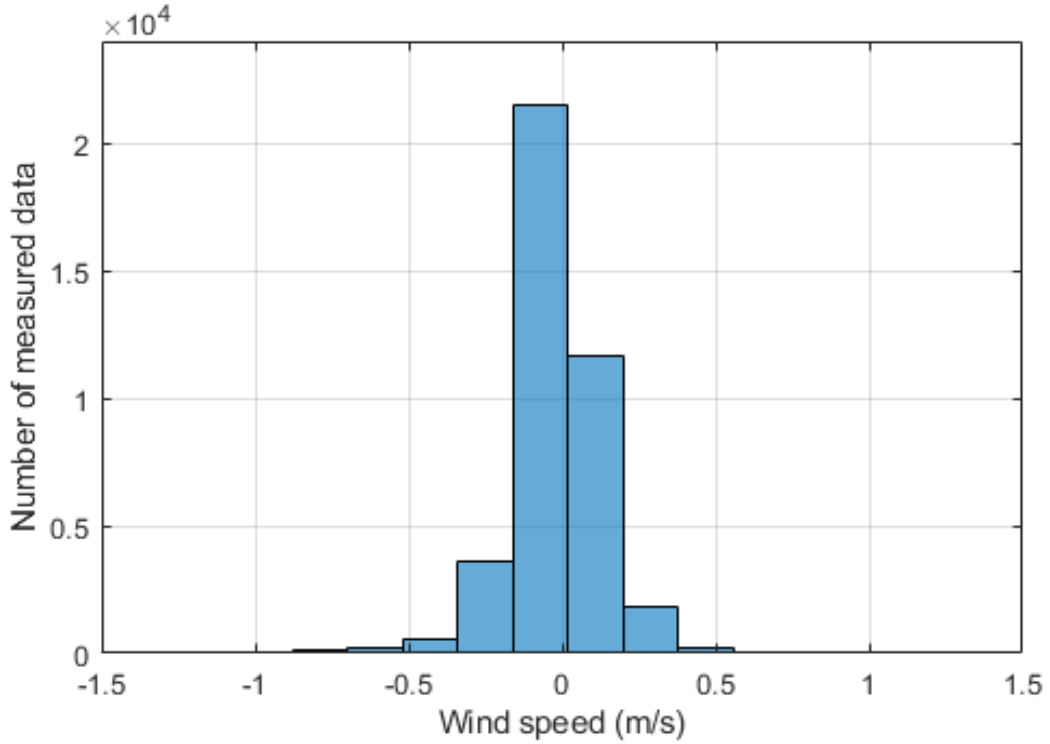


Figure 46. E06: vertical wind speed frequency distribution at 100 m.

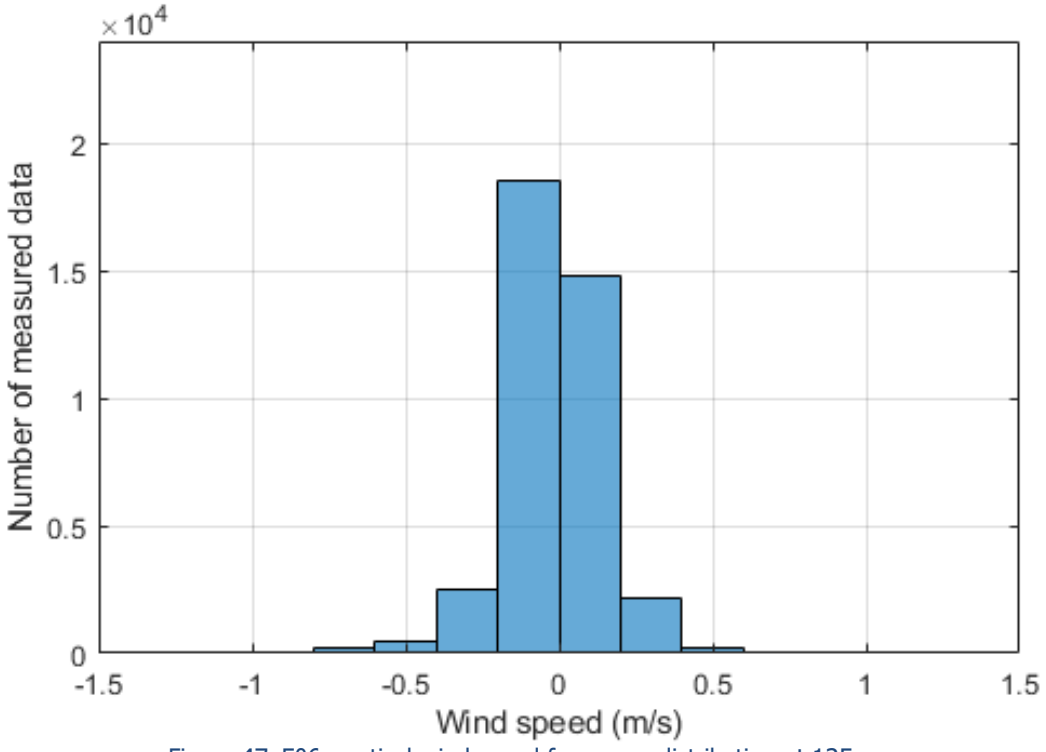


Figure 47. E06: vertical wind speed frequency distribution at 125 m.

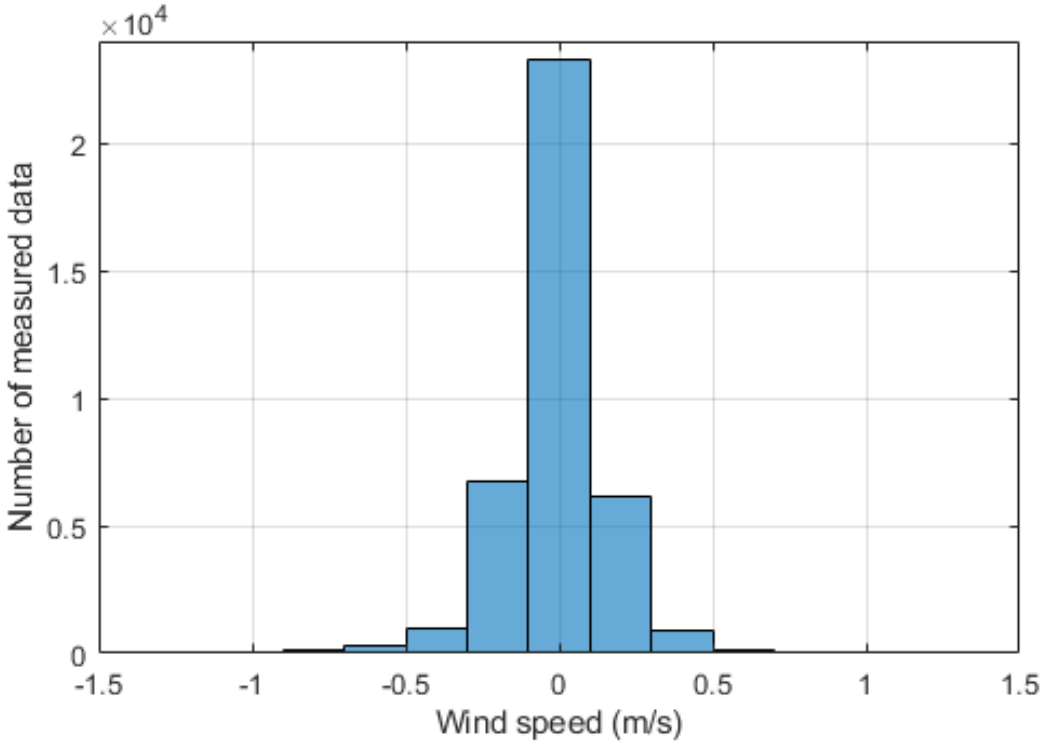


Figure 48. E06: vertical wind speed frequency distribution at 150 m.

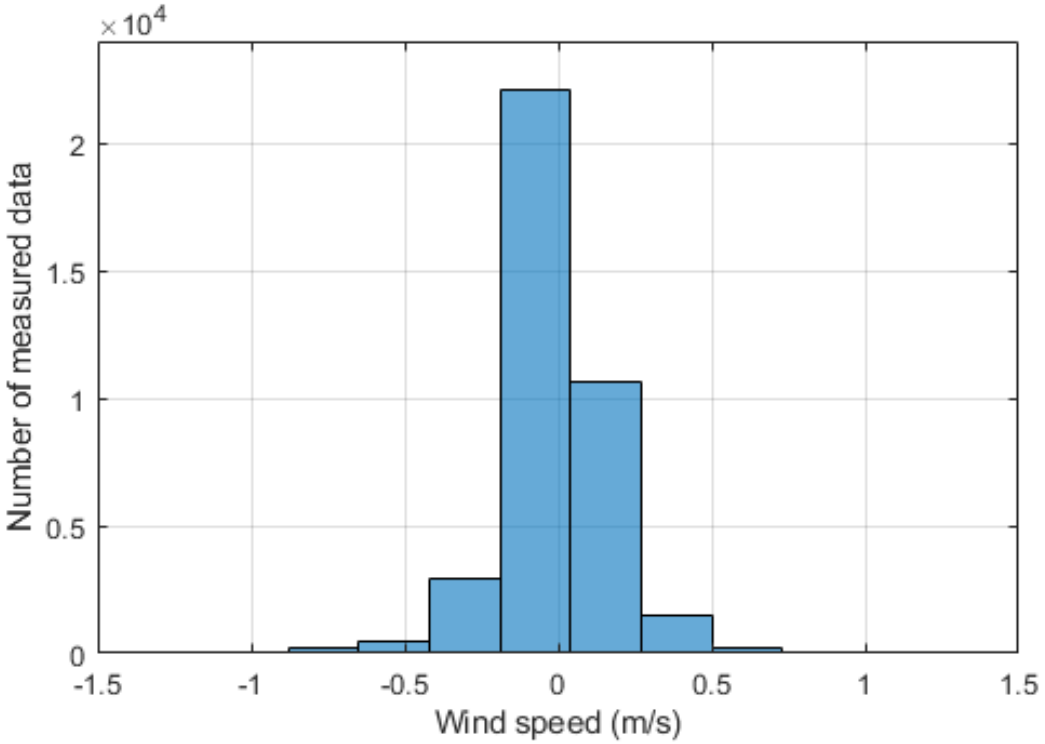


Figure 49. E06: vertical wind speed frequency distribution at 175 m.

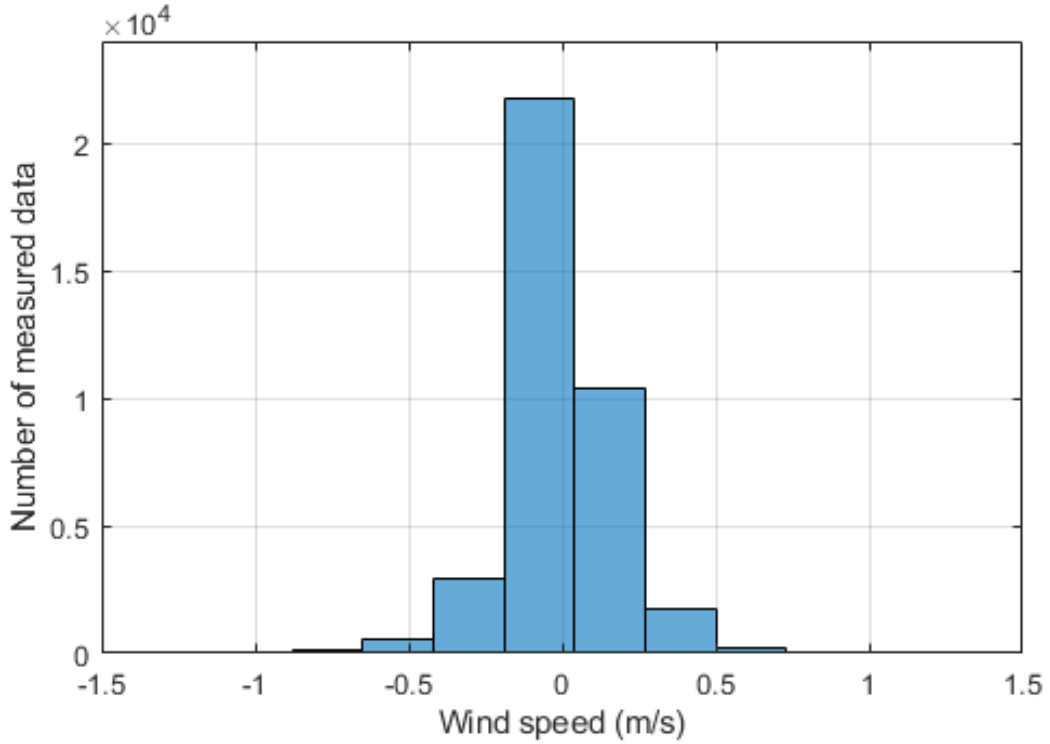


Figure 50. E06: vertical wind speed frequency distribution at 200 m.

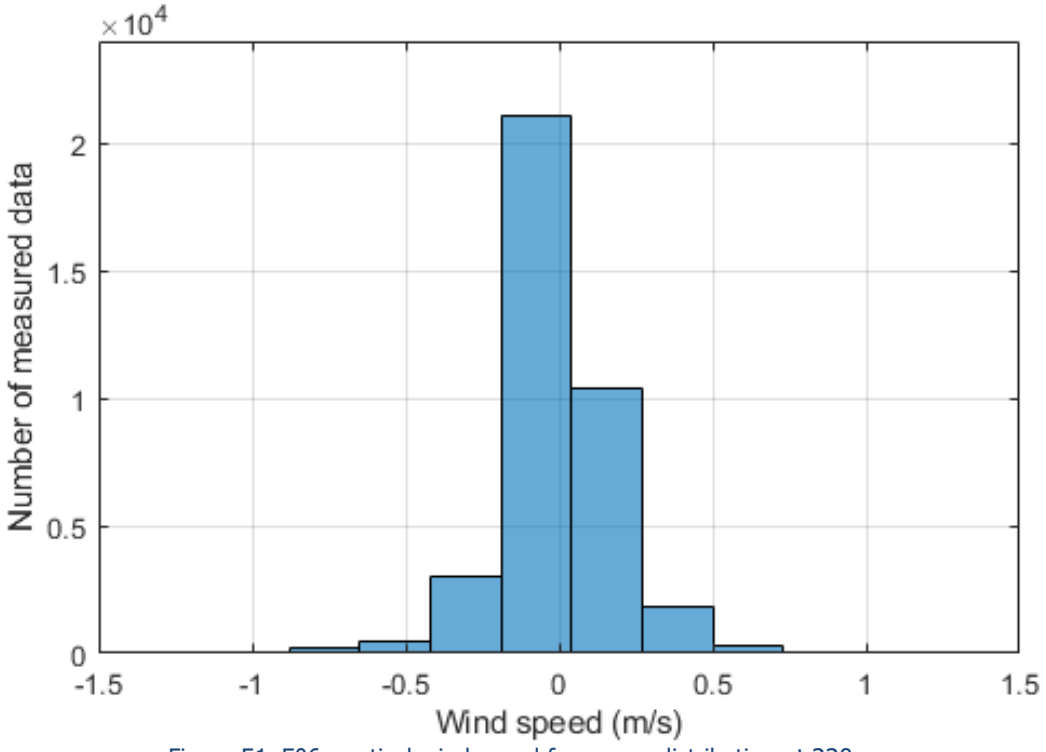


Figure 51. E06: vertical wind speed frequency distribution at 220 m.

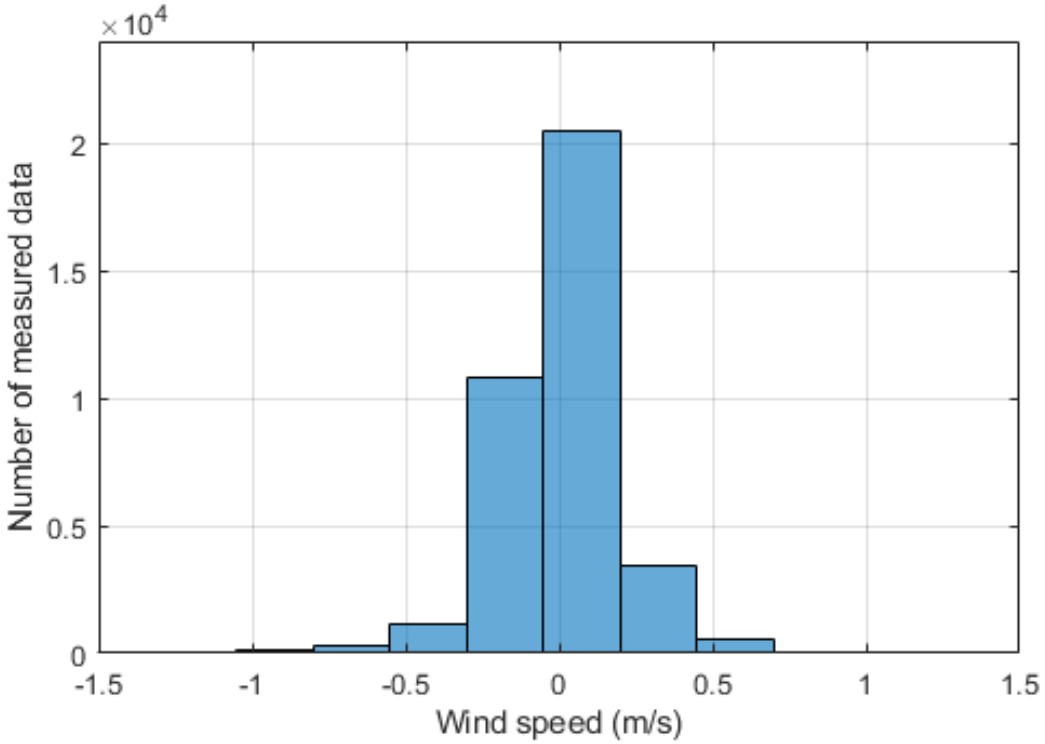


Figure 52. E06: vertical wind speed frequency distribution at 250 m.

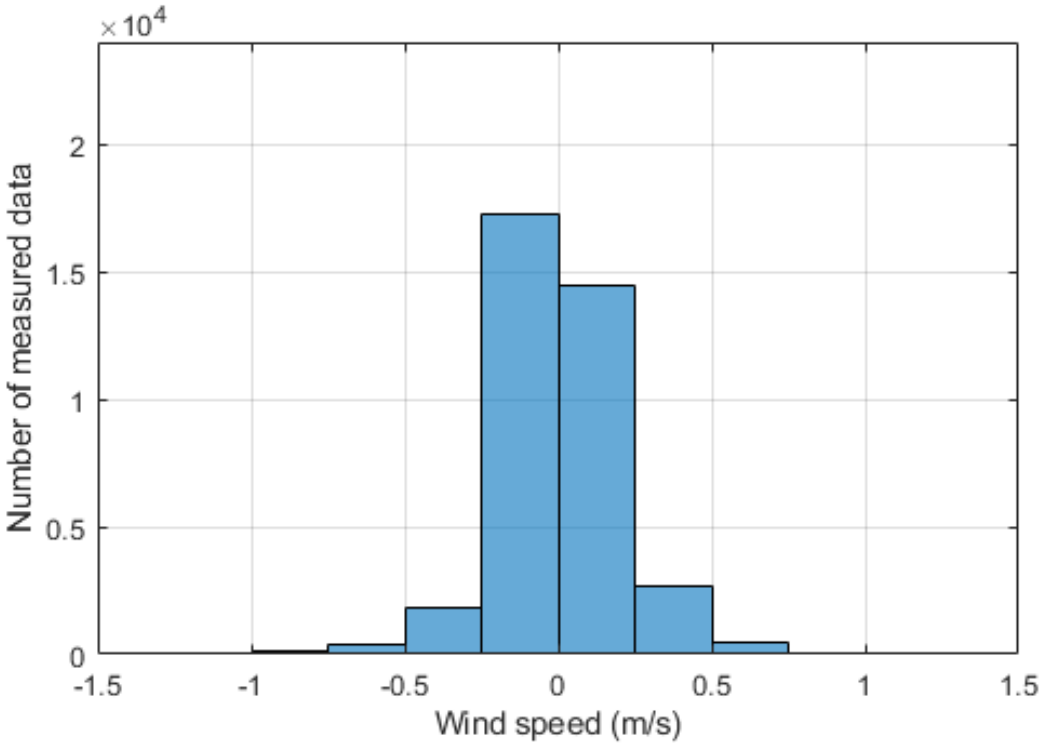


Figure 53. E06: vertical wind speed frequency distribution at 280 m.

Figures below show the wind roses at all heights for the observation period.

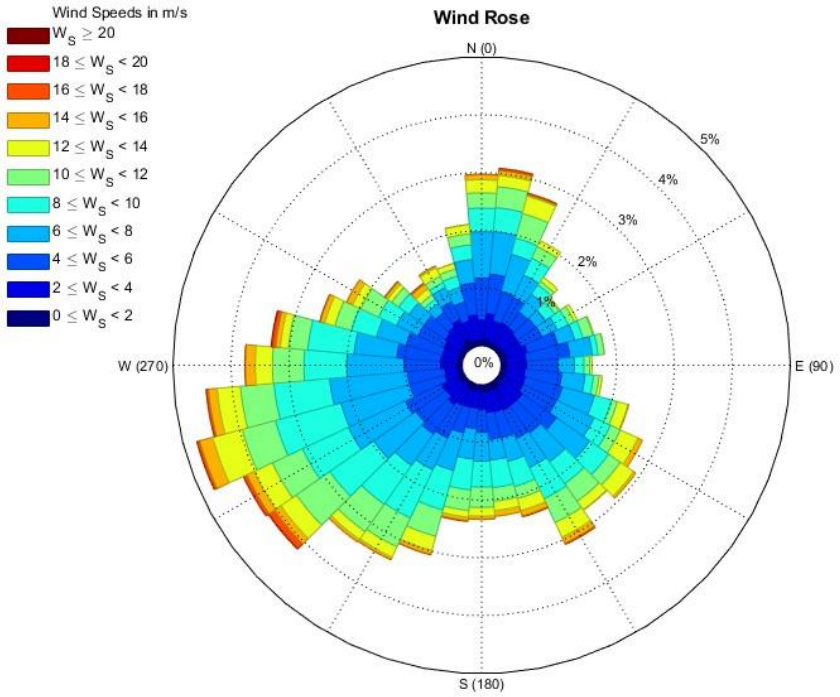


Figure 54. E01: wind rose at 12 m.

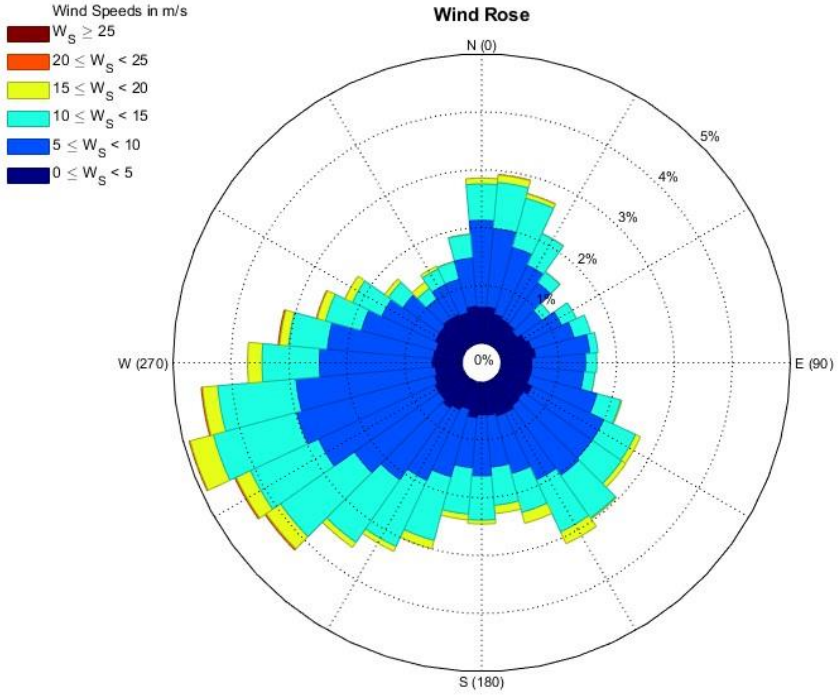


Figure 55. E01: wind rose at 40 m.

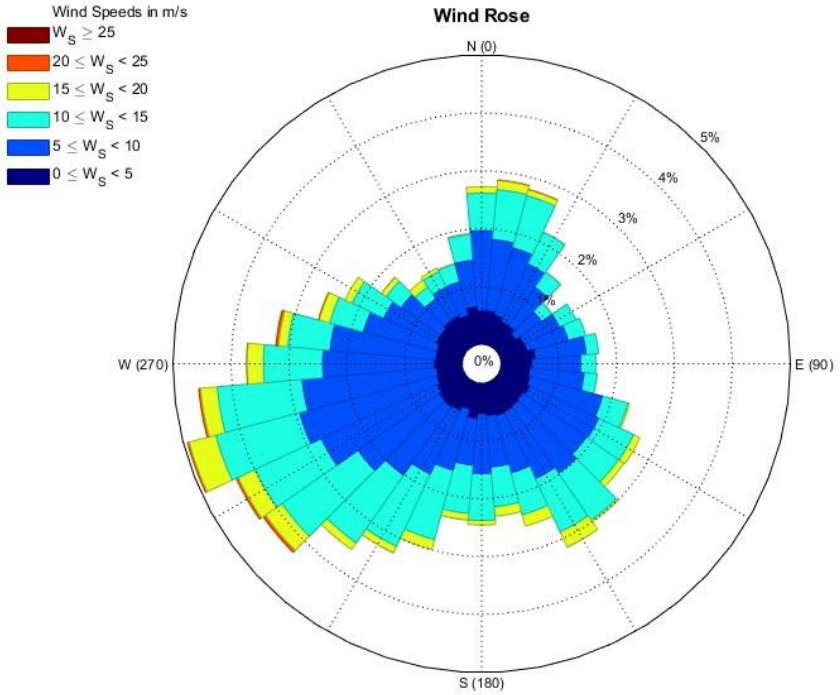


Figure 56. E01: wind rose at 50 m.

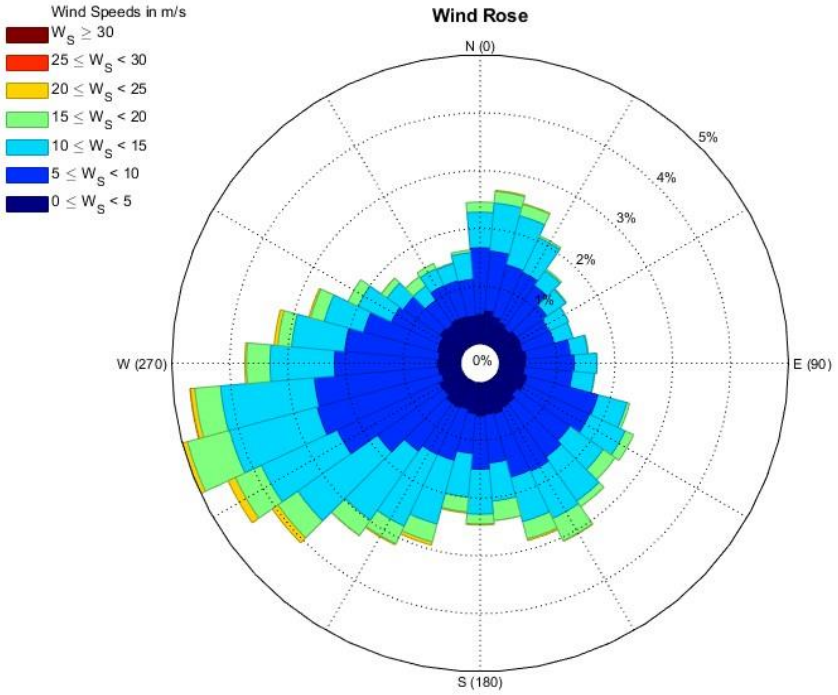


Figure 57. E01: wind rose at 100 m.

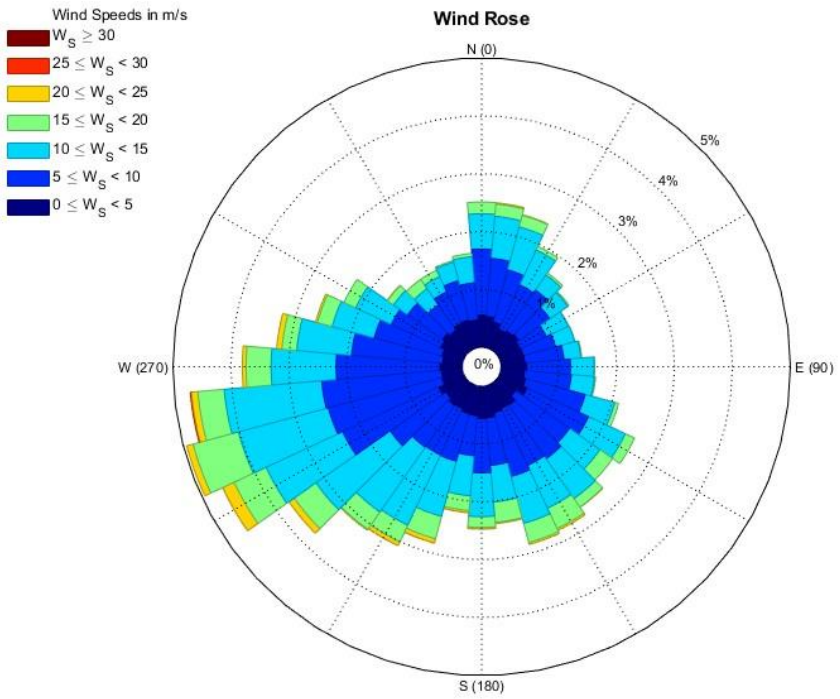


Figure 58. E01: wind rose at 125 m.

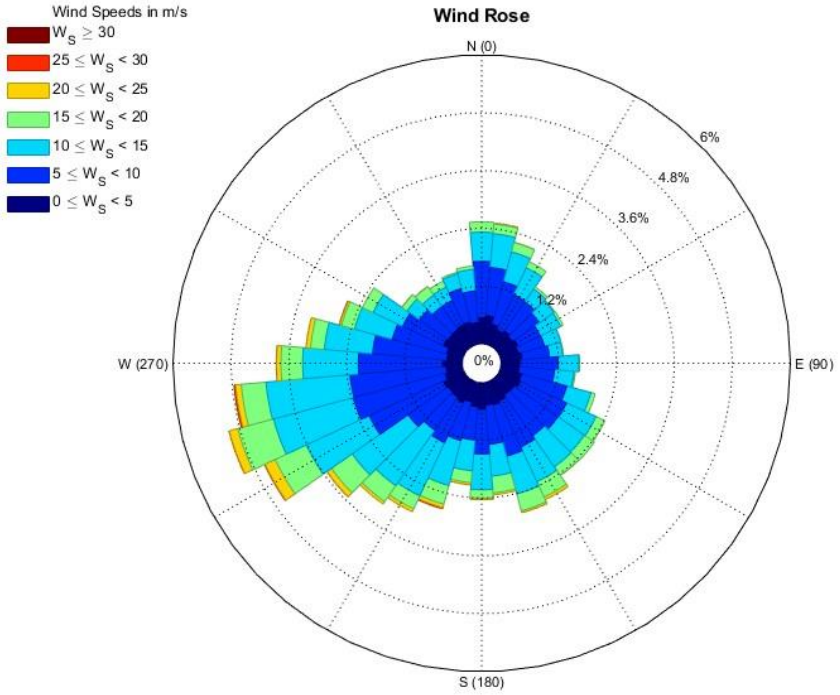


Figure 59. E01: wind rose at 150 m.

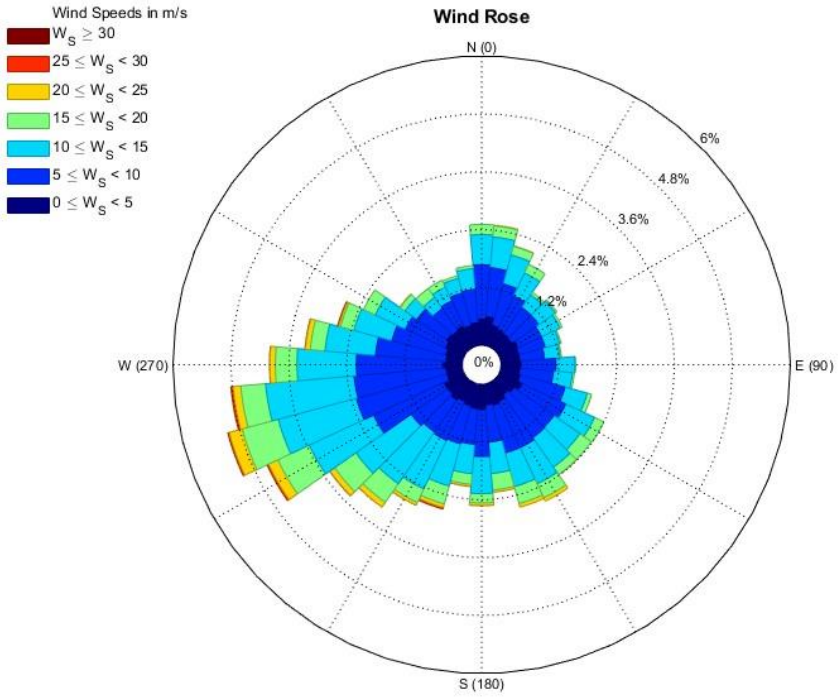


Figure 60. E01: wind rose at 175 m.

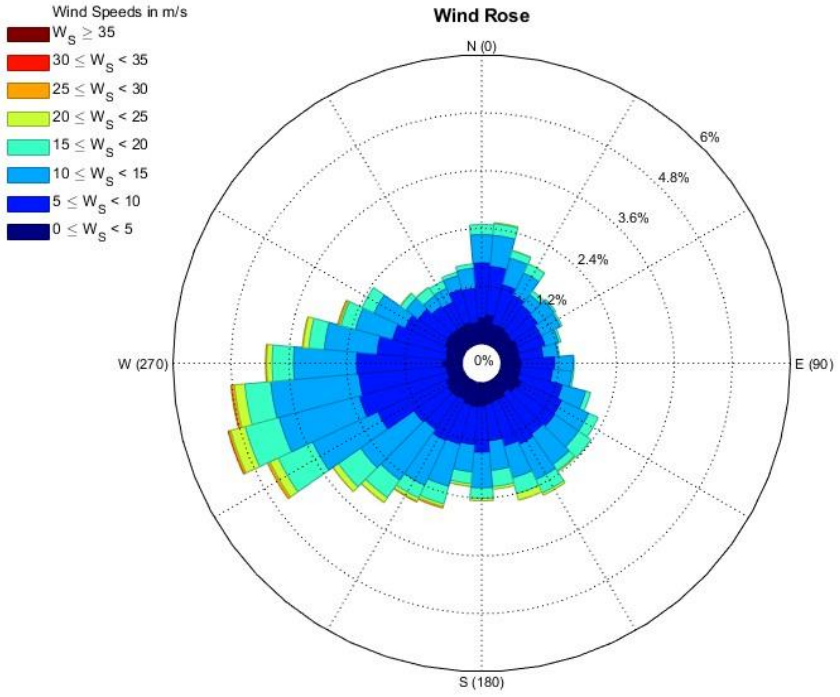


Figure 61. E01: wind rose at 200 m.

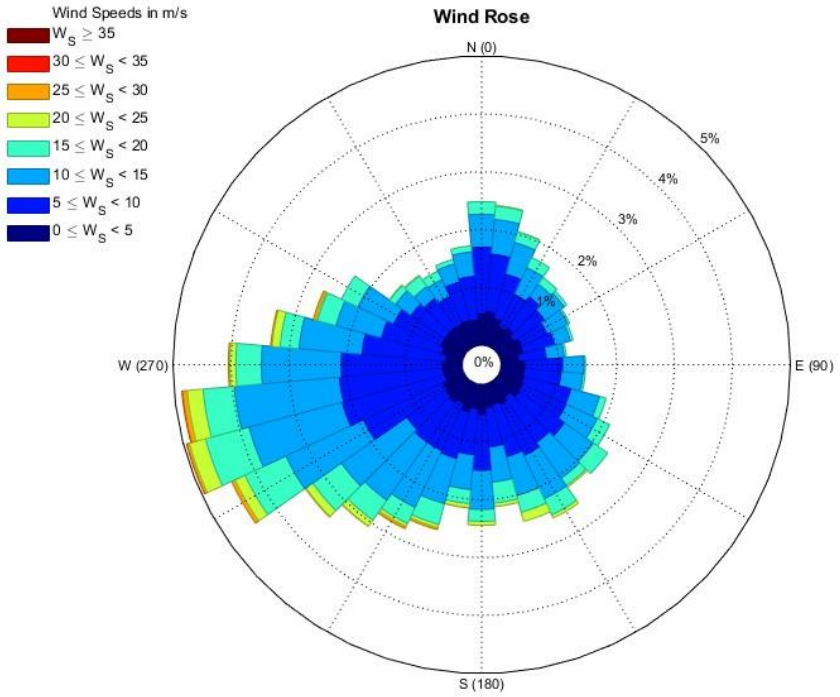


Figure 62. E01: wind rose at 220 m.

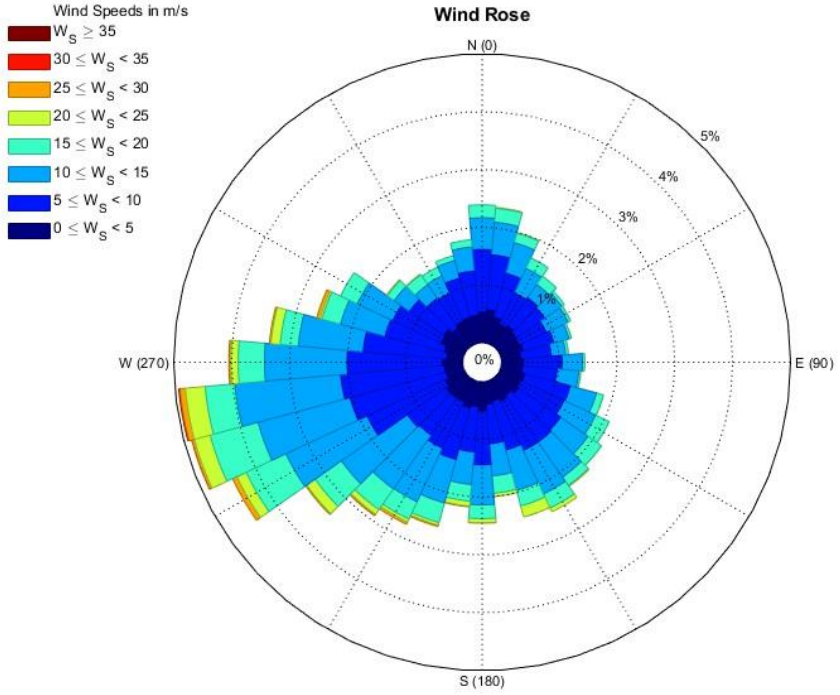


Figure 63. E01: wind rose at 250 m.

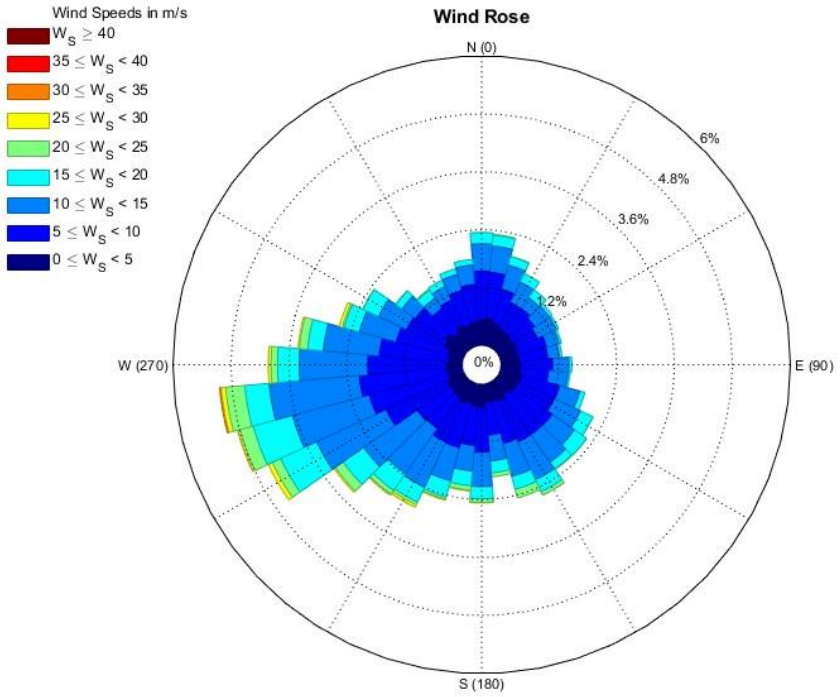


Figure 64. E01: wind rose at 280 m.

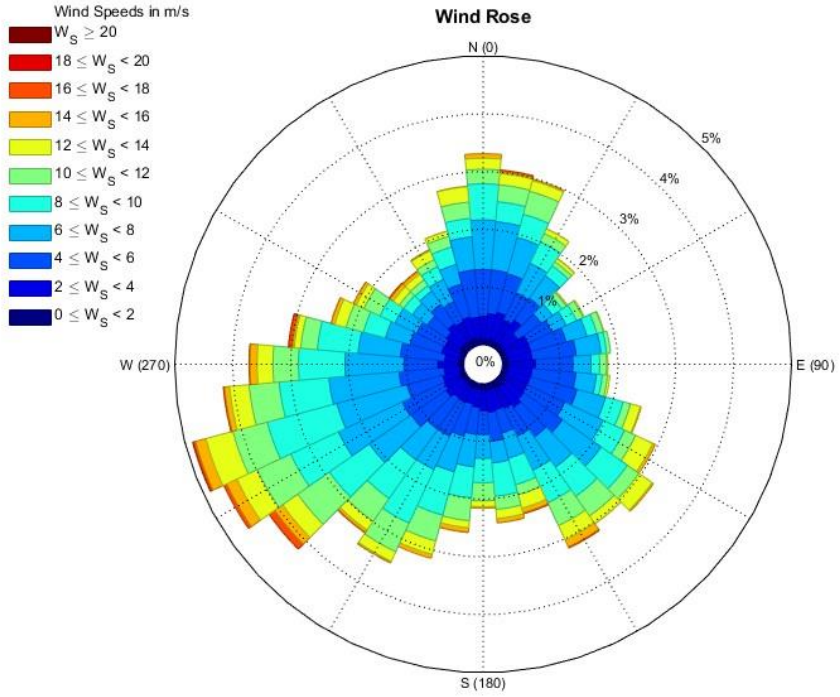


Figure 65. E06: wind rose at 12 m.

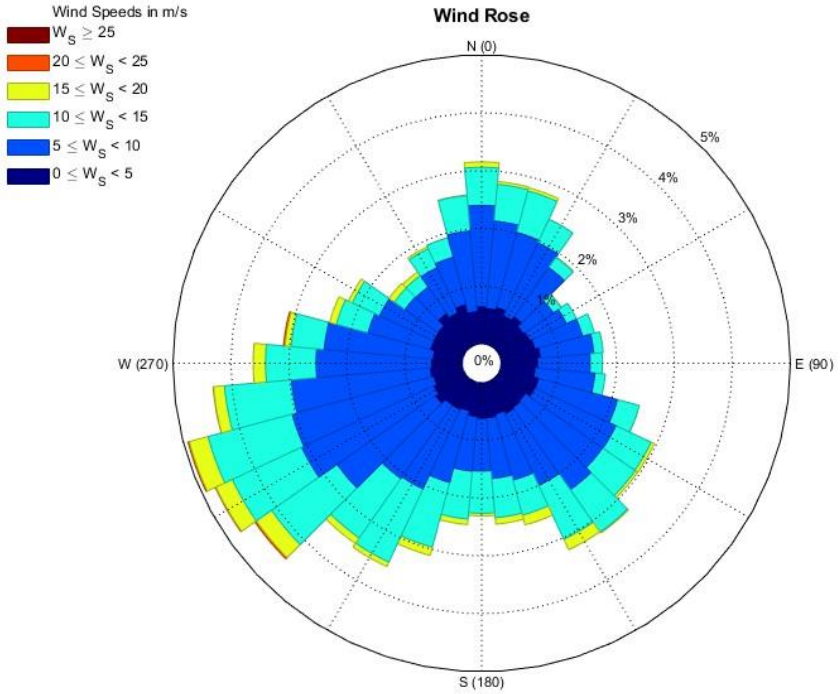


Figure 66. E06: wind rose at 40 m.

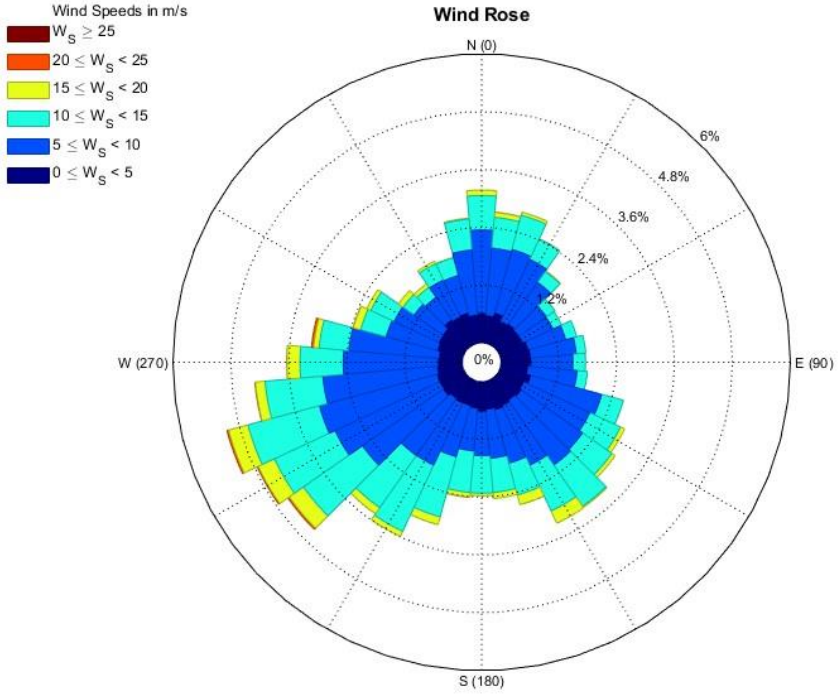


Figure 67. E06: wind rose at 50 m.

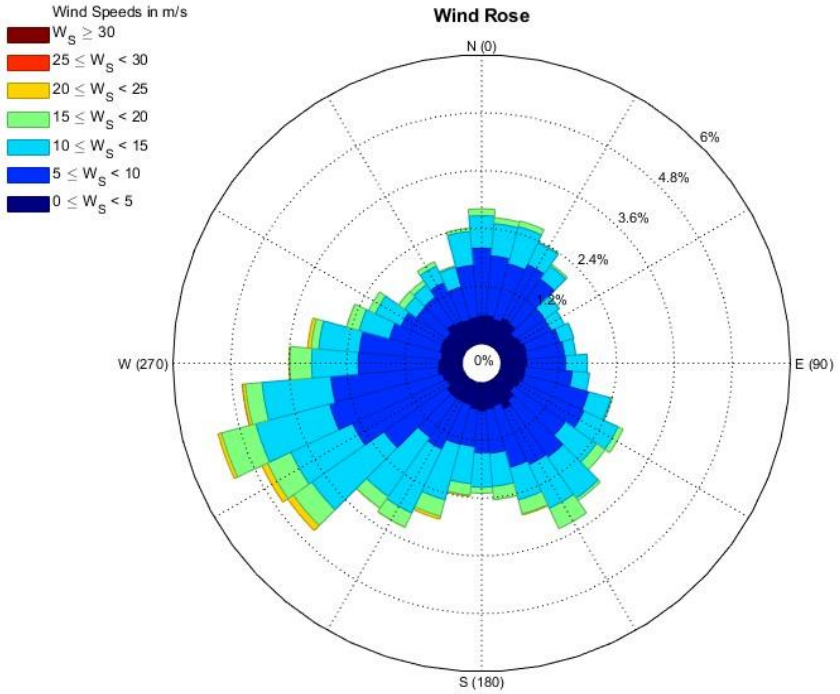


Figure 68. E06: wind rose at 100 m.

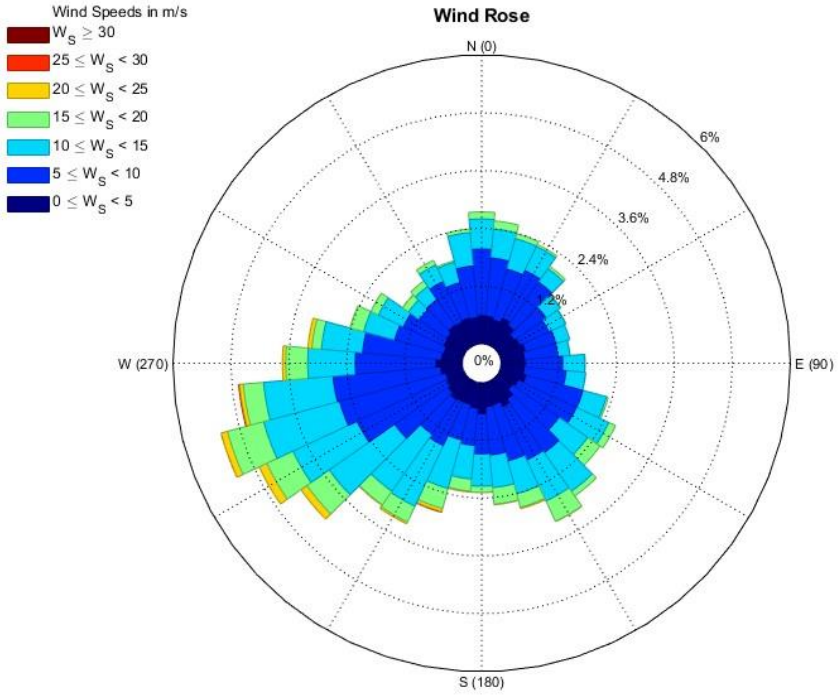


Figure 69. E06: wind rose at 125 m.

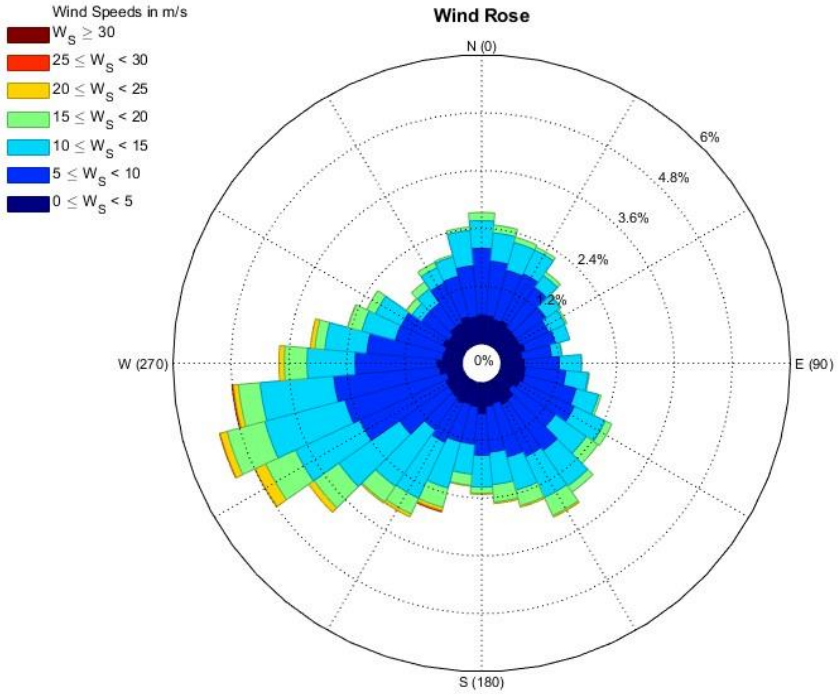


Figure 70. E06: wind rose at 150 m.

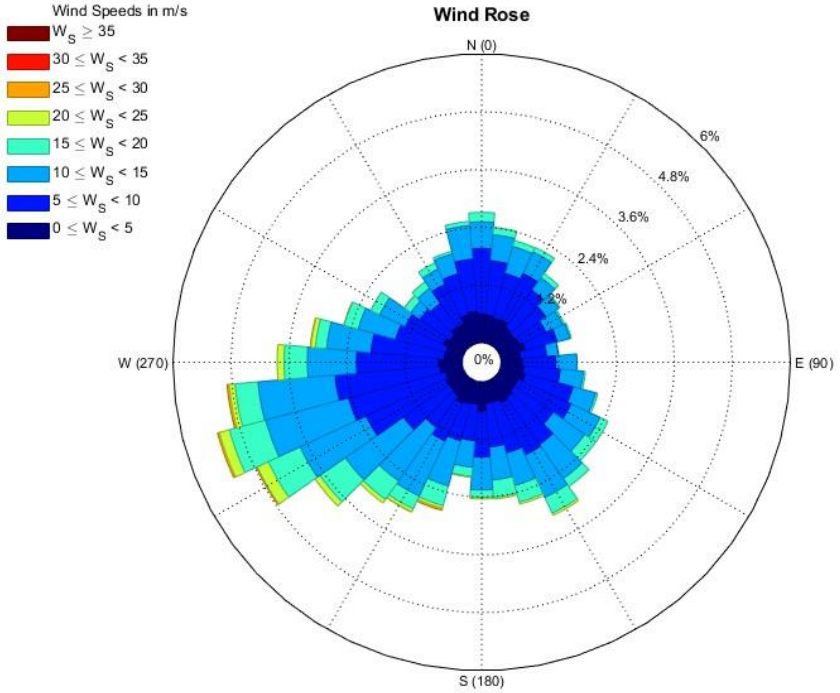


Figure 71. E06: wind rose at 175 m

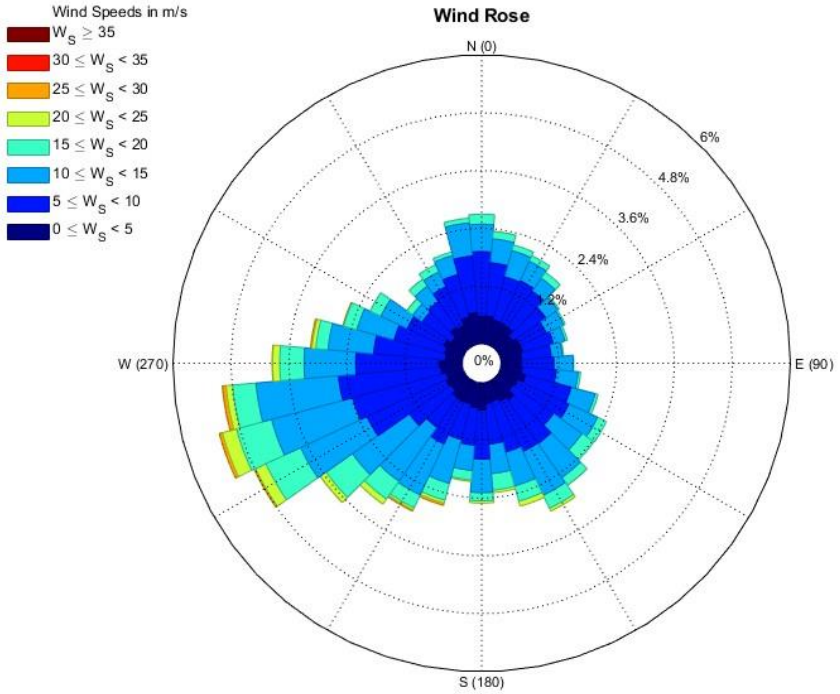


Figure 72. E06: wind rose at 200 m.

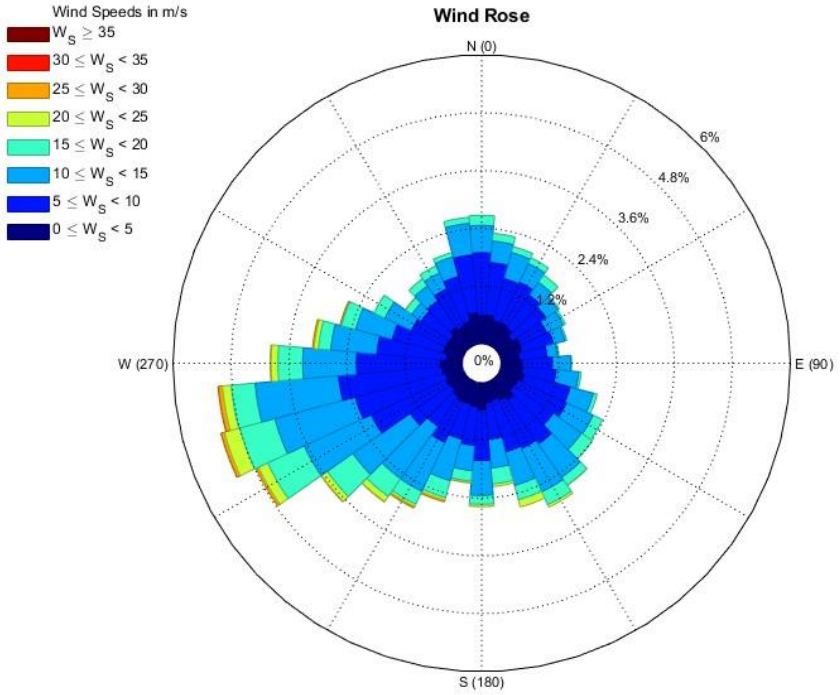


Figure 73. E06: wind rose at 220 m.

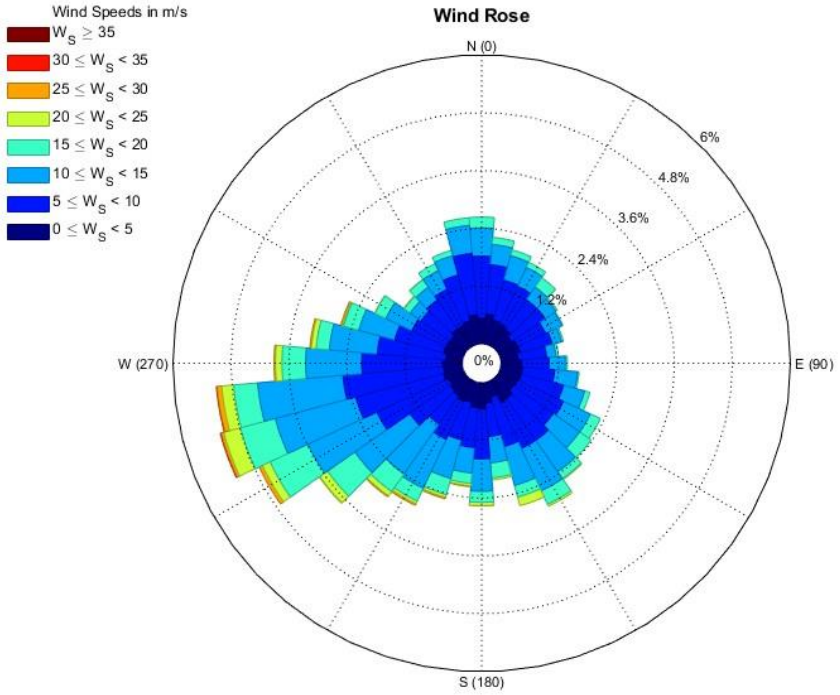


Figure 74. E06: wind rose at 250 m.

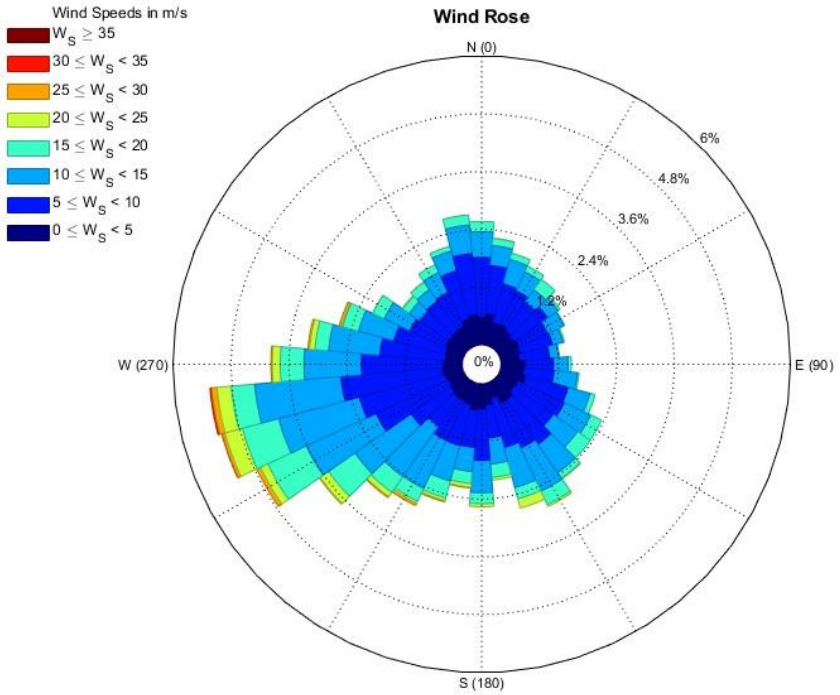


Figure 75. E06: wind rose at 280 m.

5.2.4. Meteo results

Tables below present a basic statistic of the main meteorological variables measured by the FLS200 systems for the observation period.

METEO					
Month	Variables				
Jul 2022 -Jul 2023	Wind speed (m/s)	Wind gust 3 sec (m/s)	Air temperature (ºC)	Atm pressure (hPa)	Air humidity (%)
Mean	6.65	8.43	9.56	1014.97	83.35
Max	18.18	24.40	25.43	1041.35	100.00
Min	0.14	0.23	-6.56	980.43	40.97
Std	3.16	3.98	6.70	10.15	10.56

Table 8. E01: basic statistic of the main meteorological variables measured by the FLS200 system.

METEO					
Month	Variables				
Jul 2022 -Jul 2023	Wind speed (m/s)	Wind gust 3 sec (m/s)	Air temperature (ºC)	Atm pressure (hPa)	Air humidity (%)
Mean	6.52	8.17	9.58	1015.04	82.81
Max	16.71	23.37	25.50	1041.52	100.00
Min	0.19	0.37	-6.79	981.30	38.42
Std	3.03	3.80	6.74	10.12	10.76

Table 9. E06: basic statistic of the main meteorological variables measured by the FLS200 syst

Figures below display the time series of wind speeds measured by the meteorological stations for the observation period.

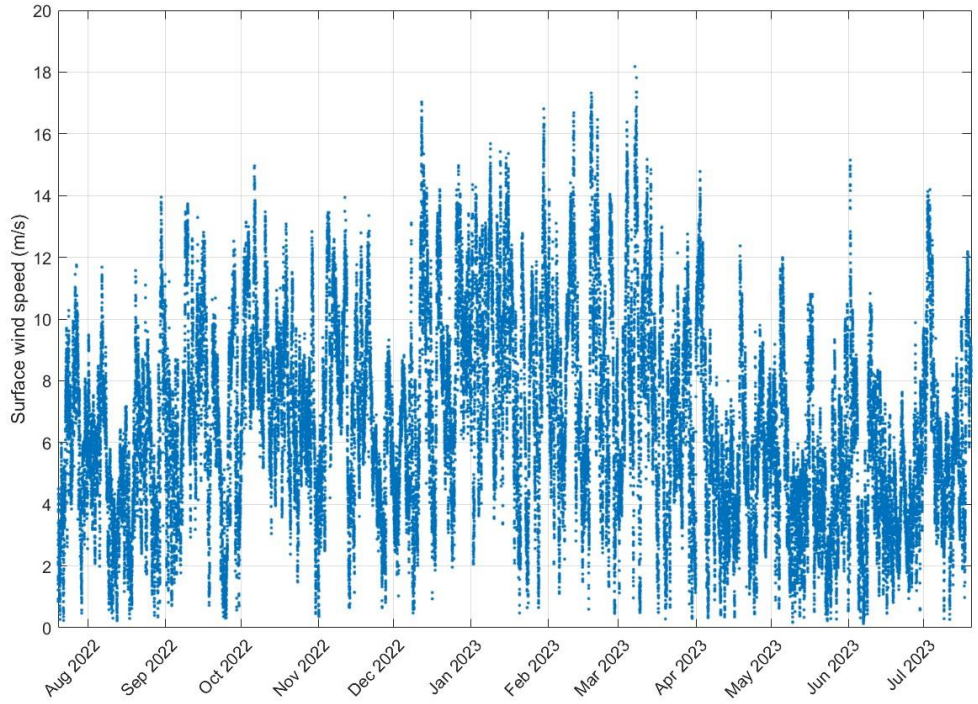
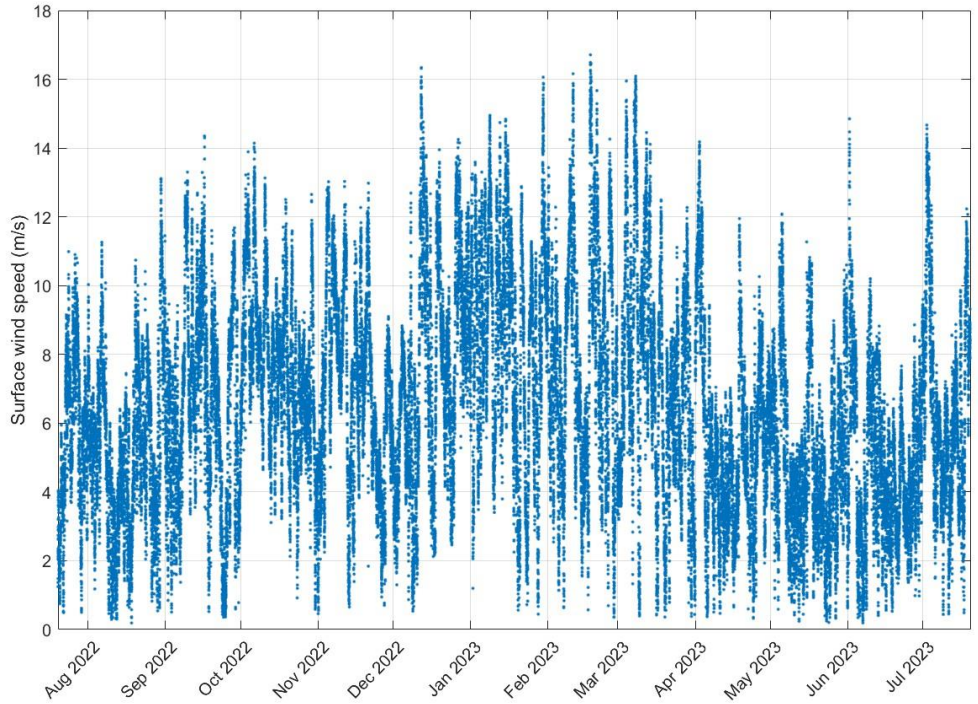


Figure 76. E01: time series of wind speed (DD/MM/YYYY).



Figures below display the time series of wind direction measured by the meteorological stations for the observation period.

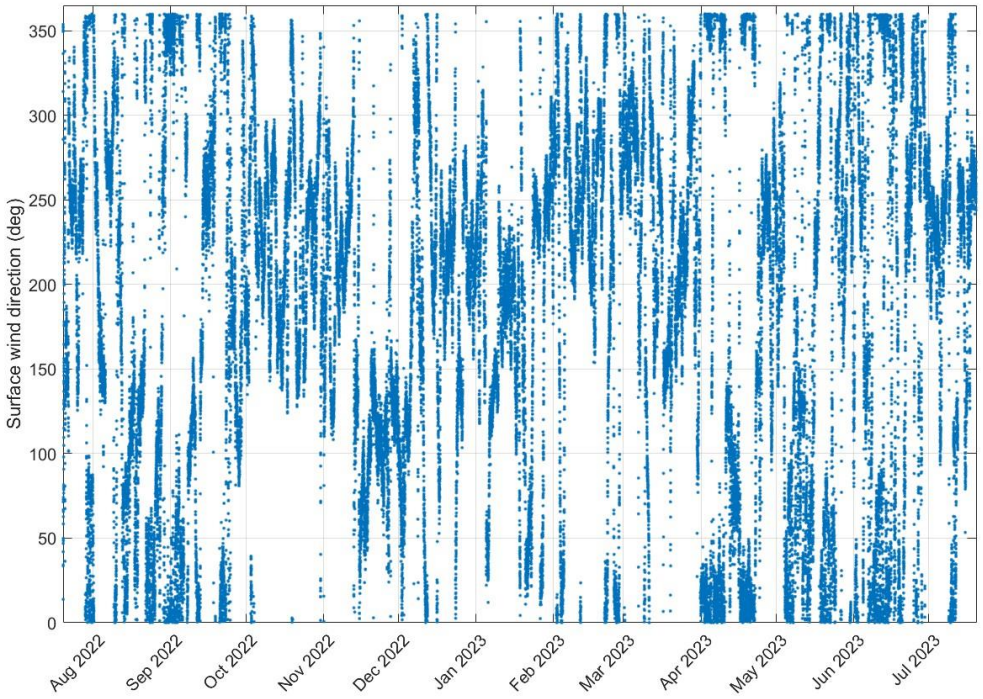


Figure 78. E01: time series of wind direction (DD/MM/YYYY).

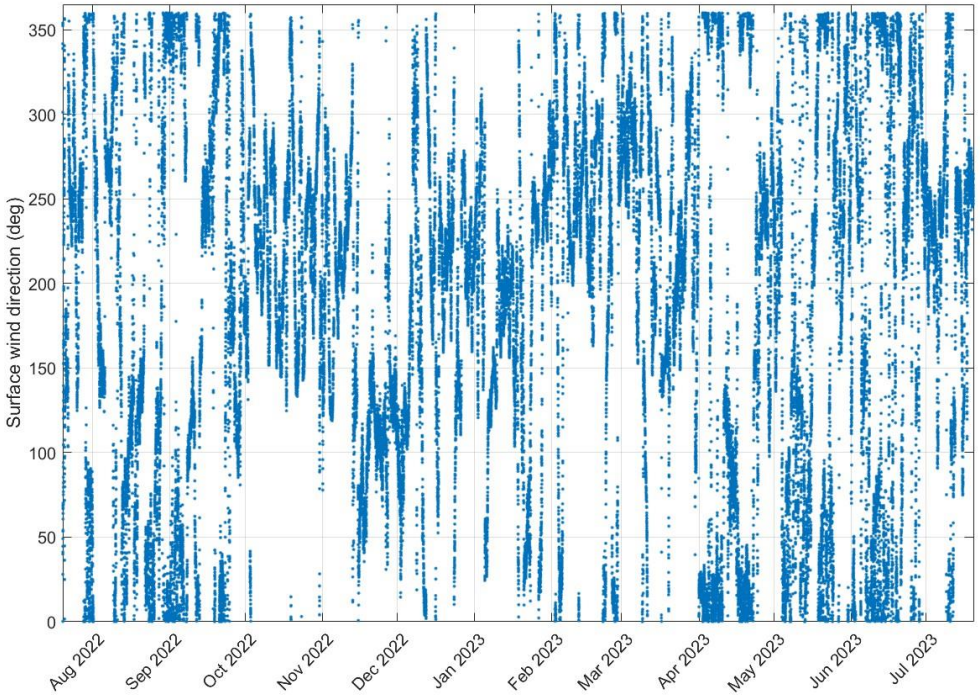


Figure 79. E06: time series of wind direction (DD/MM/YYYY).

Figures below present the time series of wind gust 3 seconds measured by the meteorological stations for the observation period.

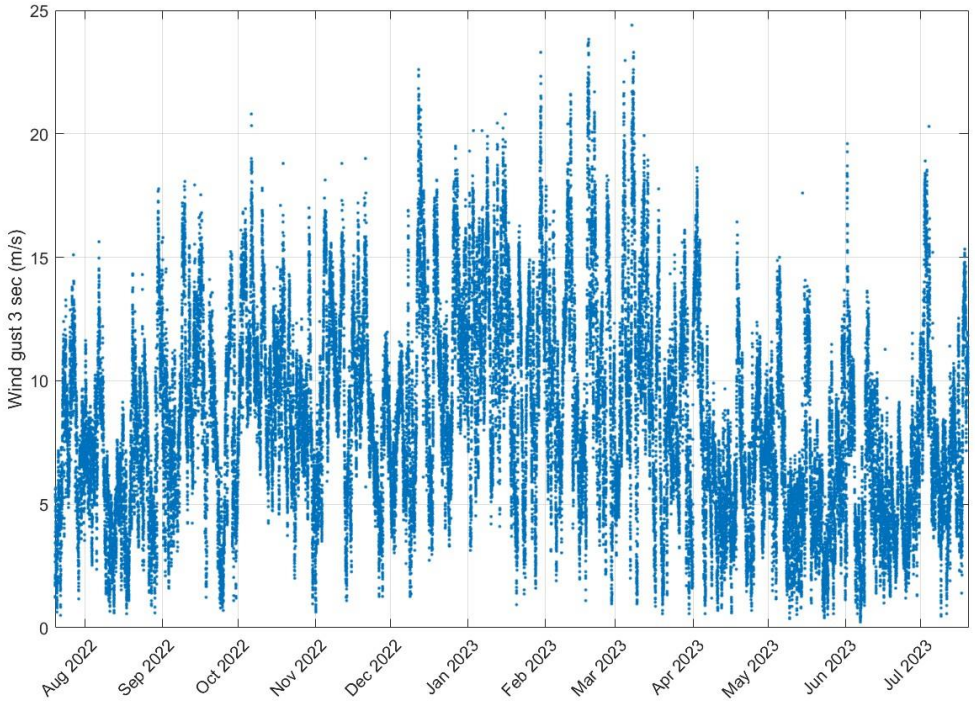


Figure 80. E01: time series of wind gust 3 seconds (DD/MM/YYY).

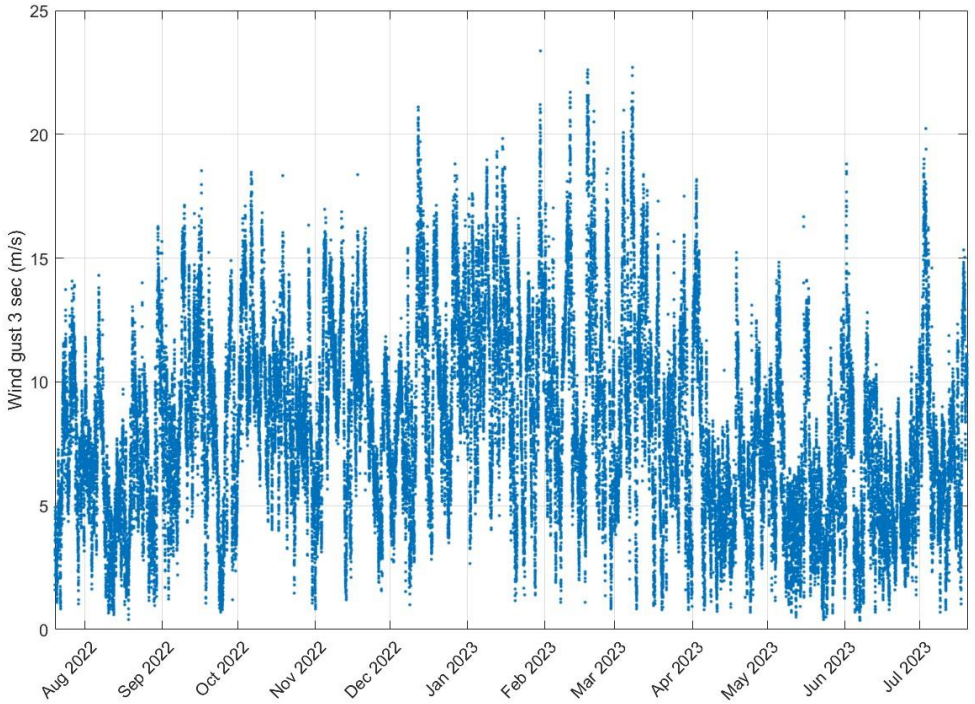


Figure 81. E06: time series of wind gust 3 seconds (DD/MM/YYY).

Figures below show the time series of the air temperature measured by the meteorological stations for the observation period.

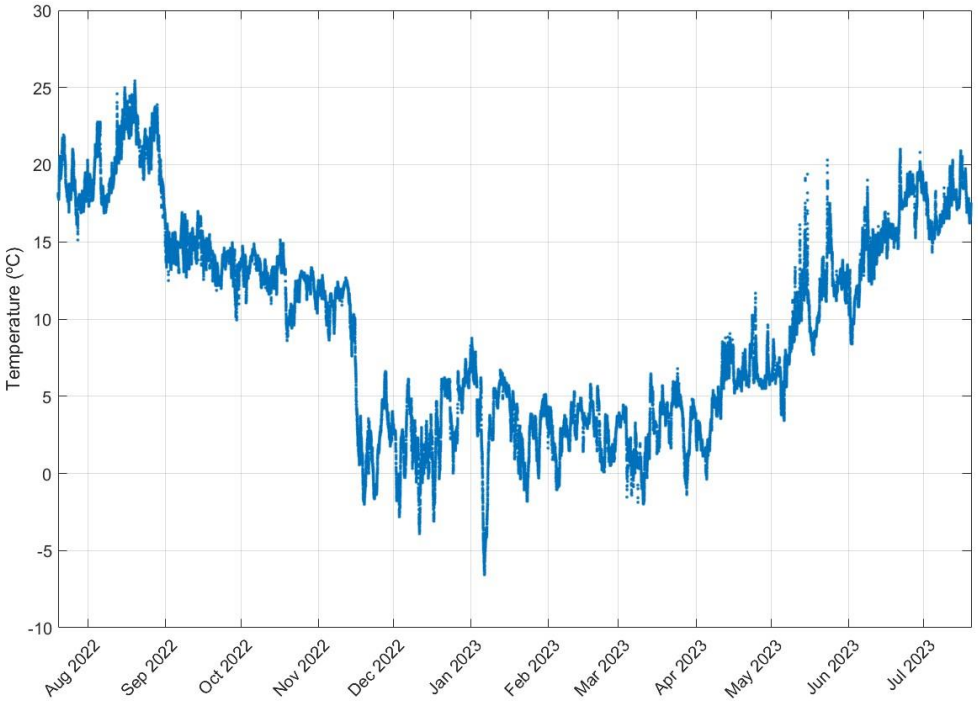


Figure 82. E01: time series of temperature (DD/MM/YYYY).

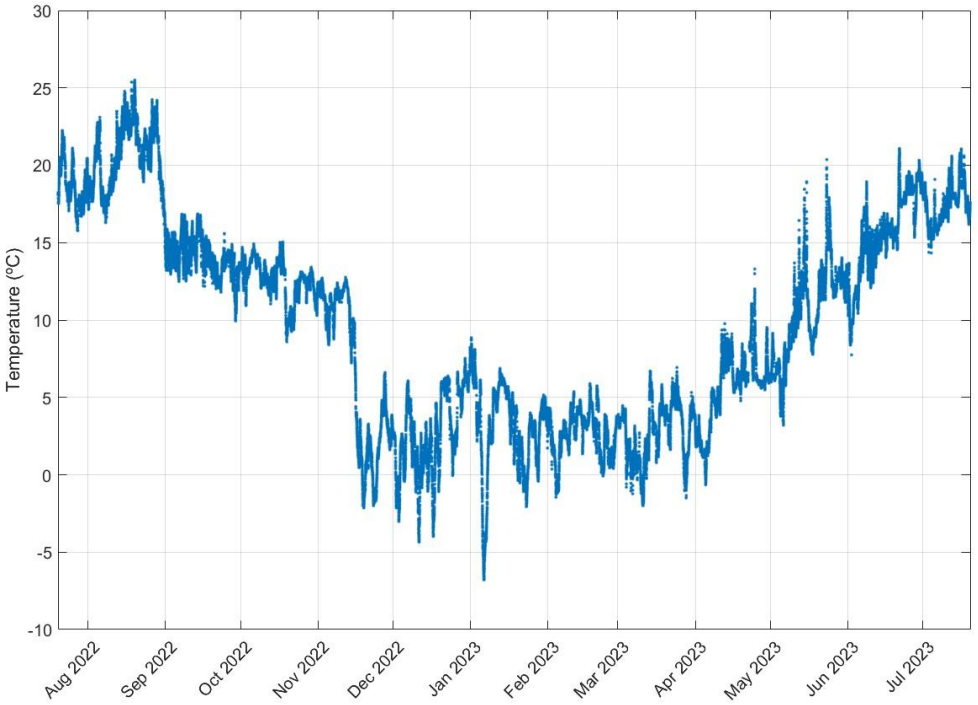


Figure 83. E06: time series of temperature (DD/MM/YYYY).

Figures below show the time series of atmospheric pressure measured by the meteorological stations for the observation period.

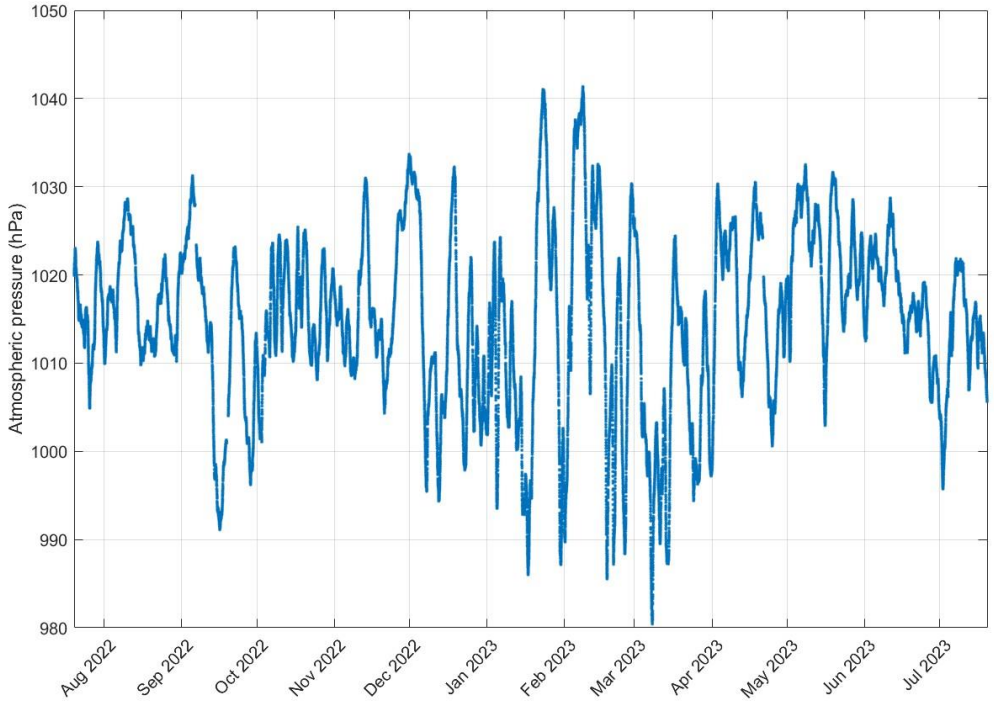


Figure 84. E01: time series of atmospheric pressure (DD/MM/YYYY).

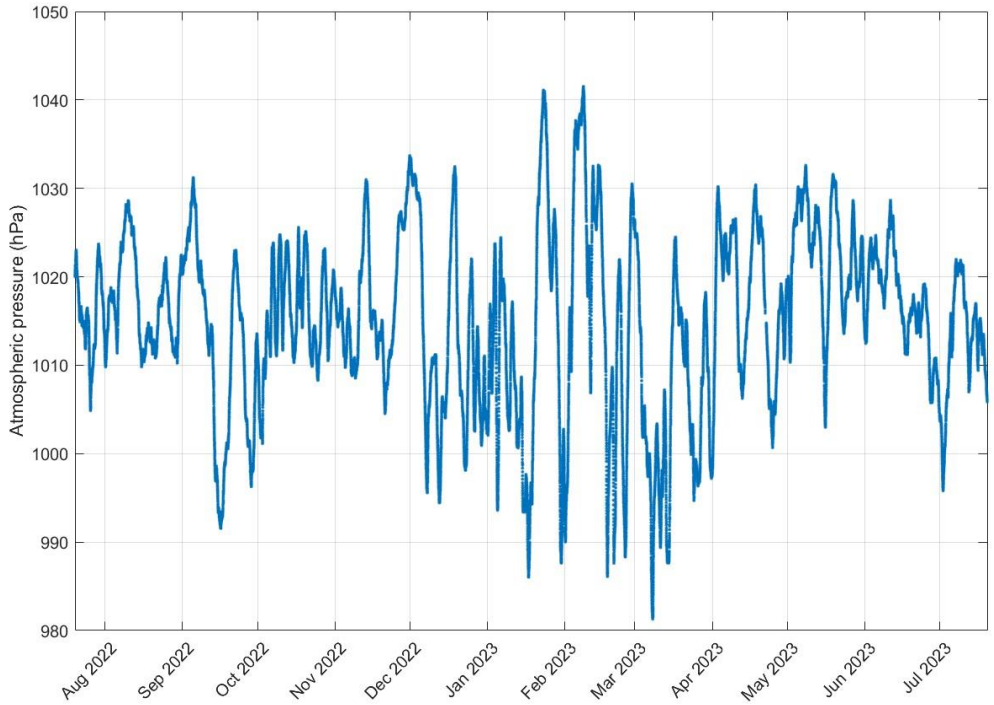


Figure 85. E06: time series of atmospheric pressure (DD/MM/YYYY).

Figures below show the time series of relative air humidity measured by the meteorological stations for the observation period.

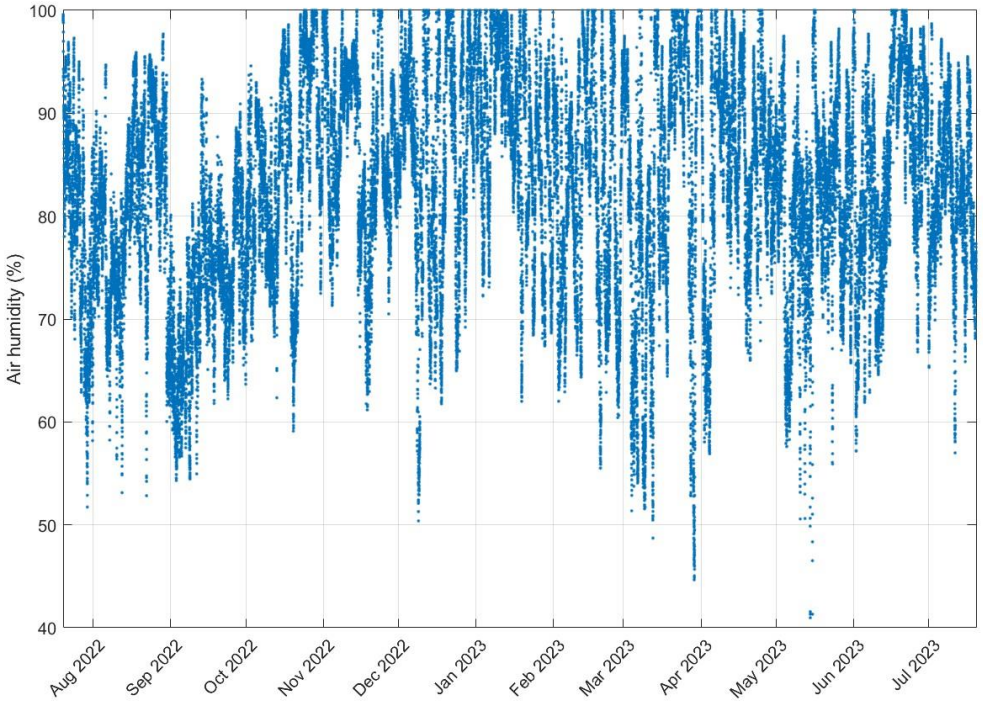


Figure 86. E01: time series of relative air humidity (DD/MM/YYYY).

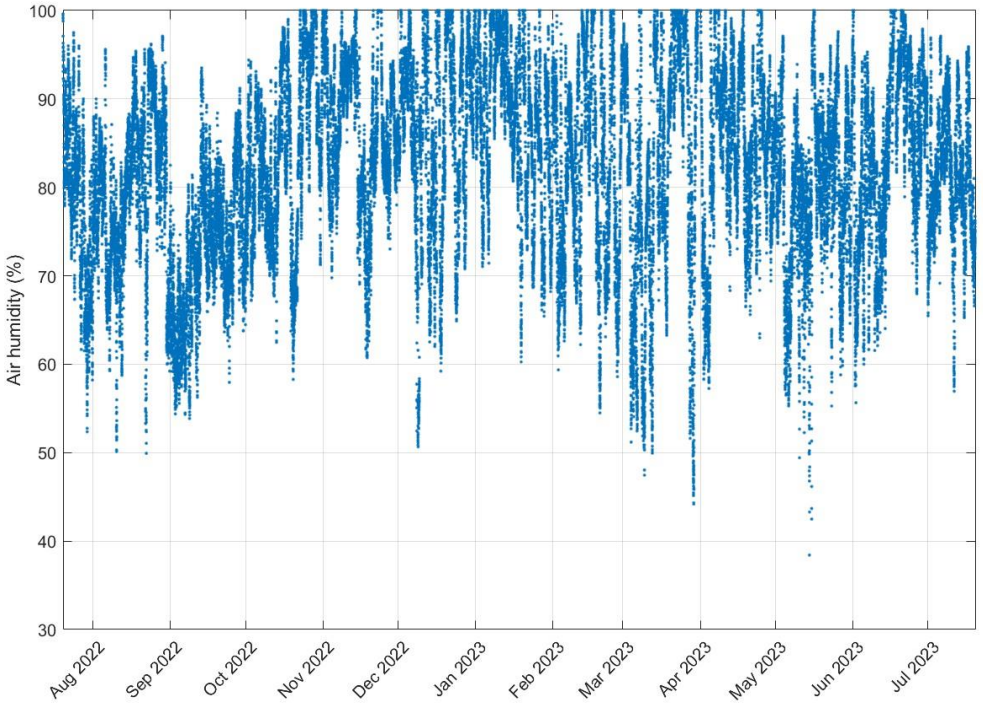


Figure 87. E06: time series of relative air humidity (DD/MM/YYYY).

Figures below show the wind roses at surface for the observation period.

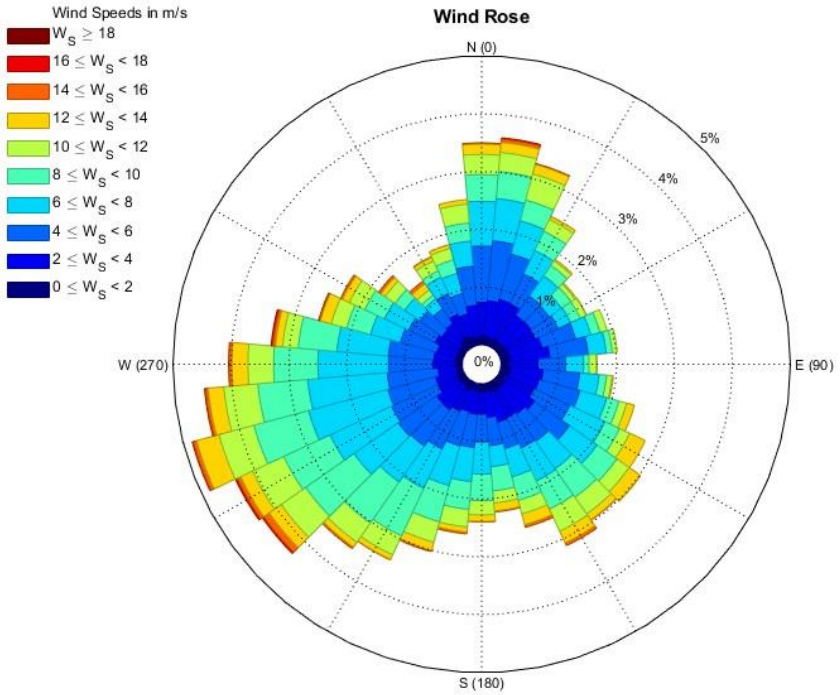


Figure 88. E01: wind rose at surface.

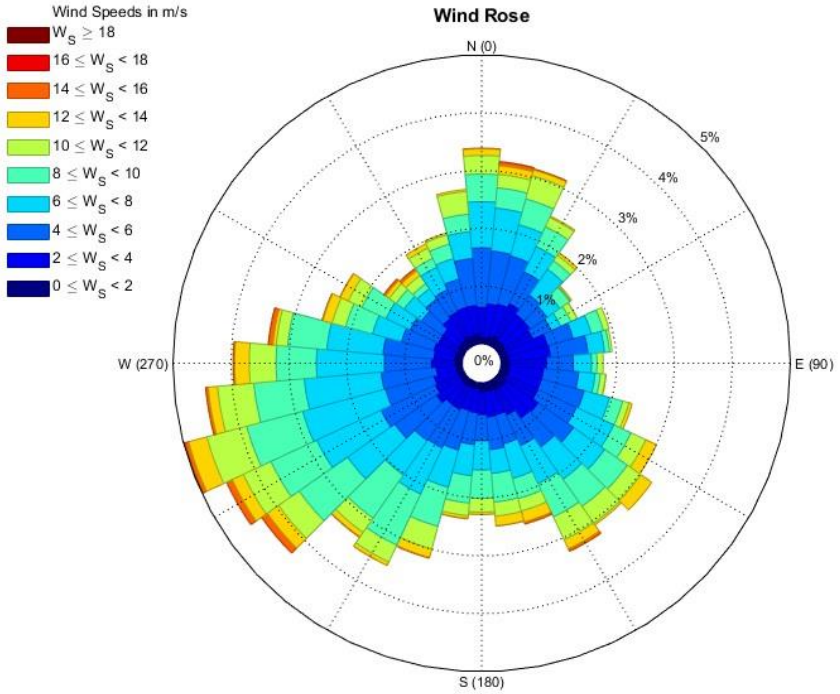


Figure 89. E06: wind rose at surface.

Figures below present the wind gust 3 seconds roses at surface for the observation period.

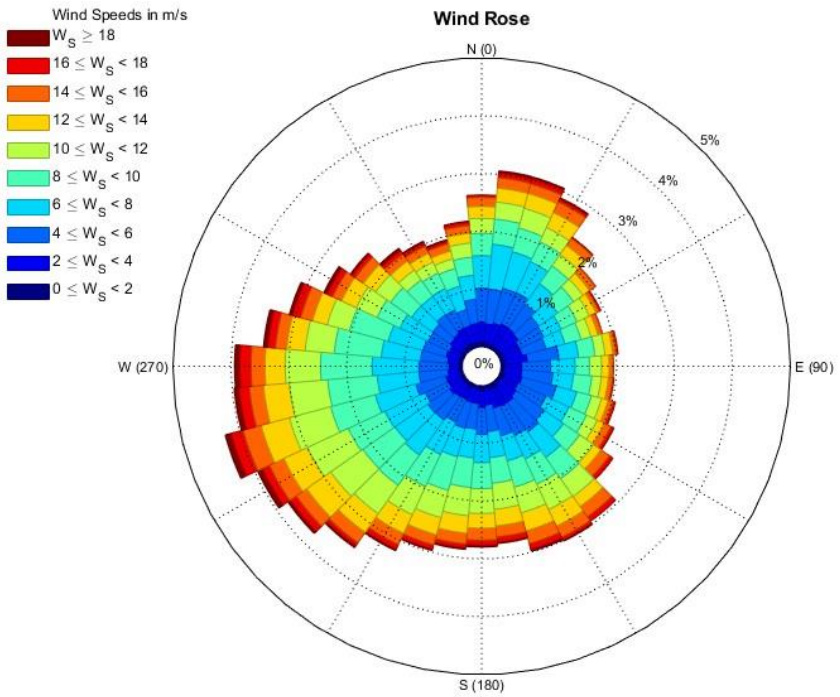


Figure 90. E01: wind gust 3 seconds rose at surface.

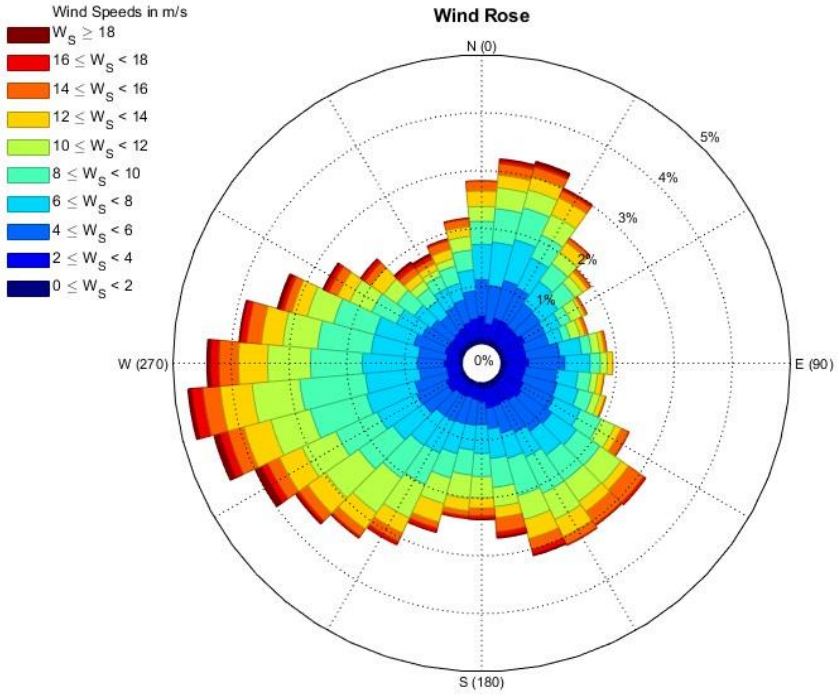


Figure 91. E06: wind gust 3 seconds rose at surface.

5.2.5. Current results

Tables below show a basic statistic of the main variables of the current sensors installed in the FLS200 systems for the observation period.

ADCP					
Month	Variables				
Jul 2022 -Jul 2023	Sea surface temp (ºC)	Current speed at surface (4.3 m) (m/s)	Current speed at mid-column (17.3 m) (m/s)	Current speed seabed (31.6 m) (m/s)	Distance seabed-surface (m)
Mean	10.91	0.07	0.07	0.07	36.33
Max	23.88	0.35	0.37	0.37	37.07
Min	2.62	0.00	0.00	0.00	30.55
Std	6.14	0.04	0.05	0.04	0.28

Table 10. E01: basic statistic of the main variables measured by the current sensor installed in the FLS200 system.

ADCP					
Month	Variables				
Jul 2022 -Jul 2023	Sea surface temp (ºC)	Current speed at surface (4.5 m) (m/s)	Current speed at mid-column (19.5 m) (m/s)	Current speed seabed (36.0 m) (m/s)	Distance seabed-surface (m)
Mean	11.01	0.06	0.08	0.14	39.33
Max	24.10	0.35	1.40	1.56	40.49
Min	2.80	0.00	0.00	0.00	35.62
Std	6.19	0.04	0.07	0.13	1.09

Table 11. E06: basic statistic of the main variables measured by the current sensor installed in the FLS200 system

Figures below present the time series of surface water temperature.

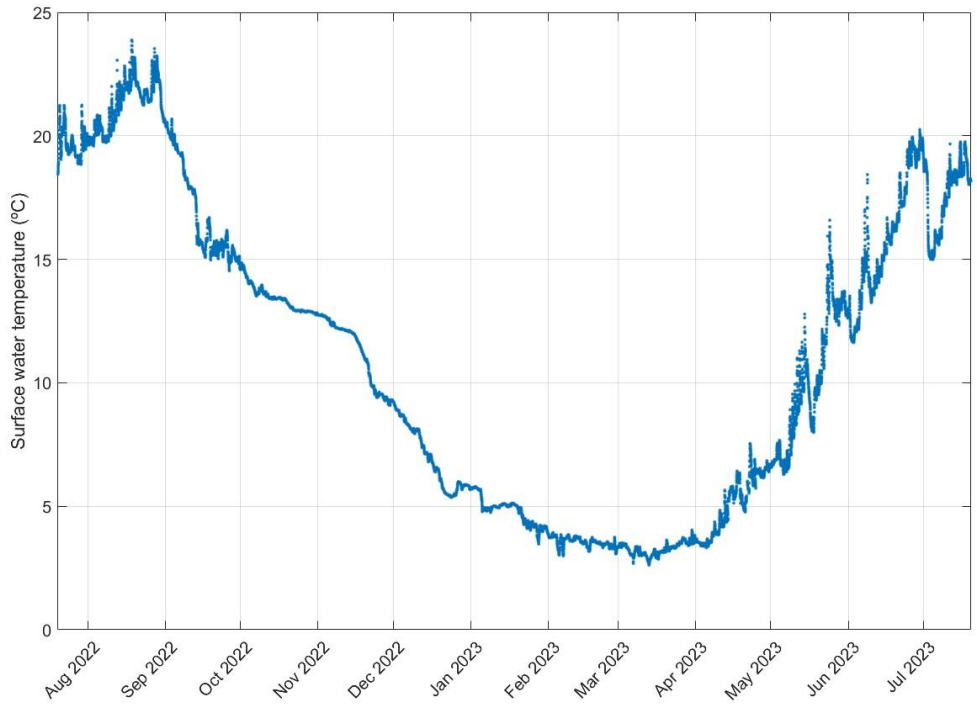


Figure 92. E01: time series of surface water temperature (DD/MM/YYYY).

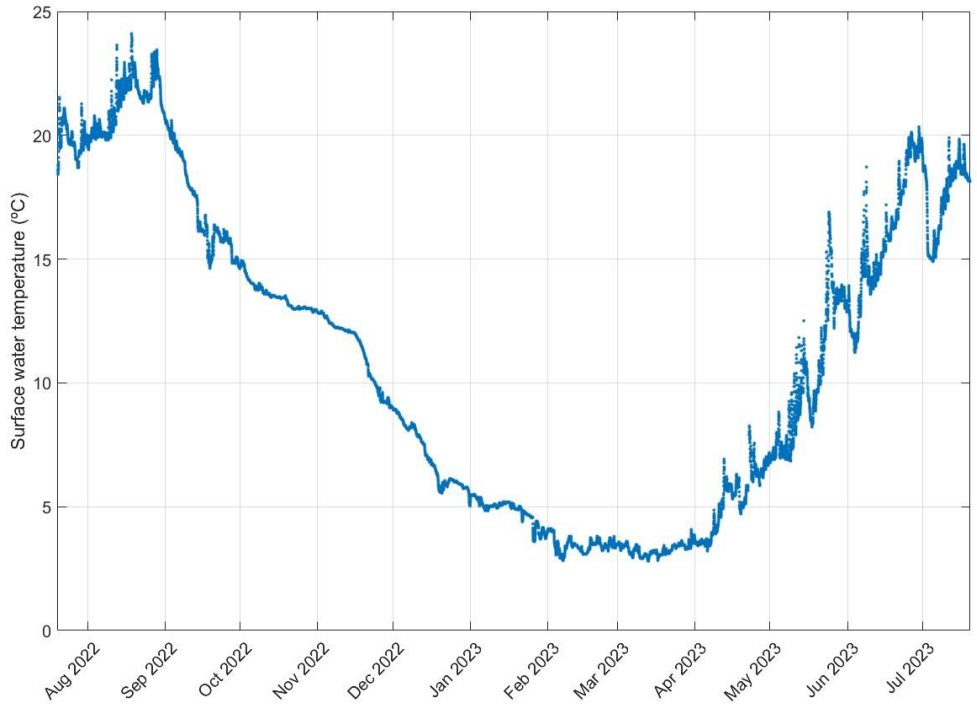


Figure 93. E06: time series of surface water temperature (DD/MM/YYYY)

Figures below show the time series of current speed at surface, mid-column, and near seabed measured by the current sensors for the observation period.

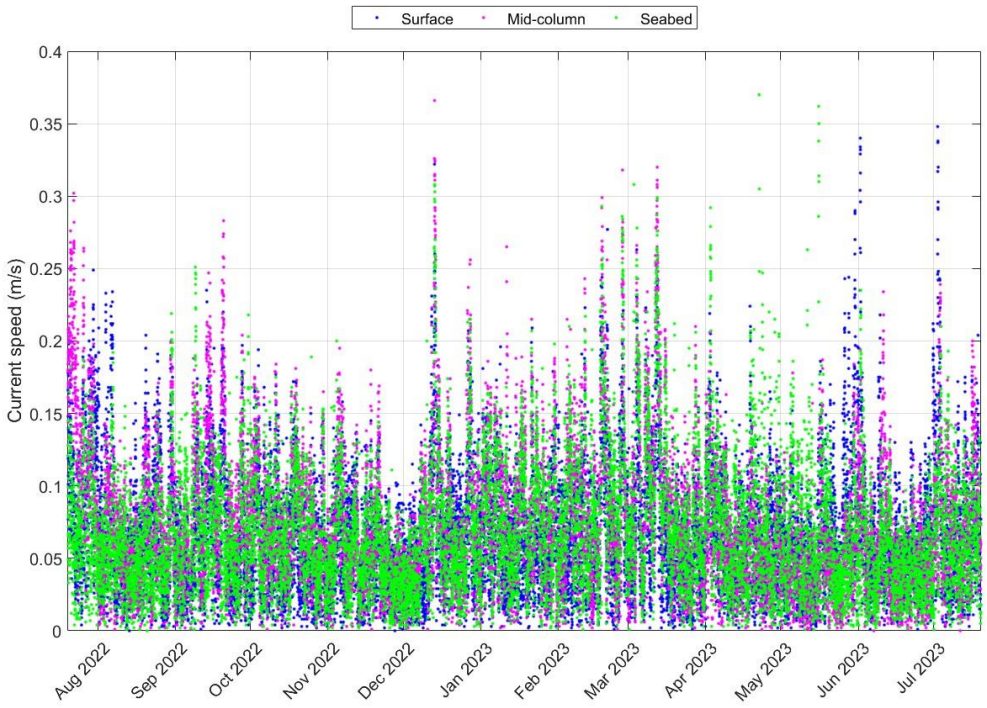


Figure 94. E01: time series of current speed at surface (4.3 m), mid-column (17.3 m) and near seabed (31.6 m) (DD/MM/YYYY)

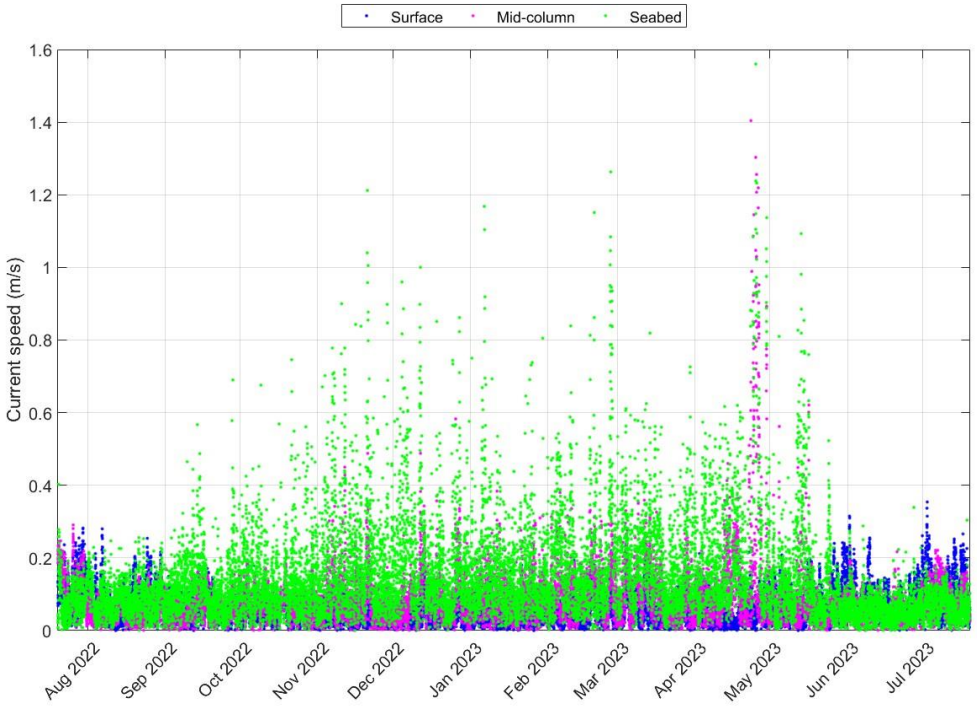


Figure 95. E06: time series of current speed at surface (4.5 m), mid-column (19.5 m) and near seabed (36.0 m) (DD/MM/YYYY)

Figures below show the time series of current direction at surface, mid-column and near seabed, measured by the current sensors for the observation period.

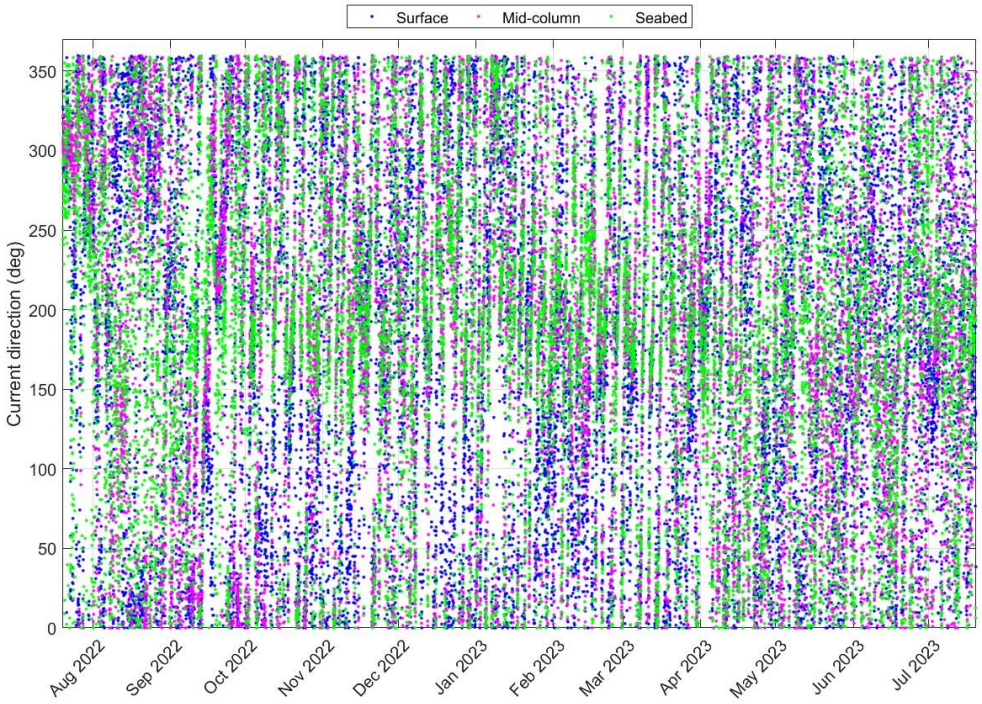


Figure 96. E01: time series of current direction at surface (4.3 m), mid-column (17.3 m) and near seabed (31.6 m) (DD/MM/YYYY).

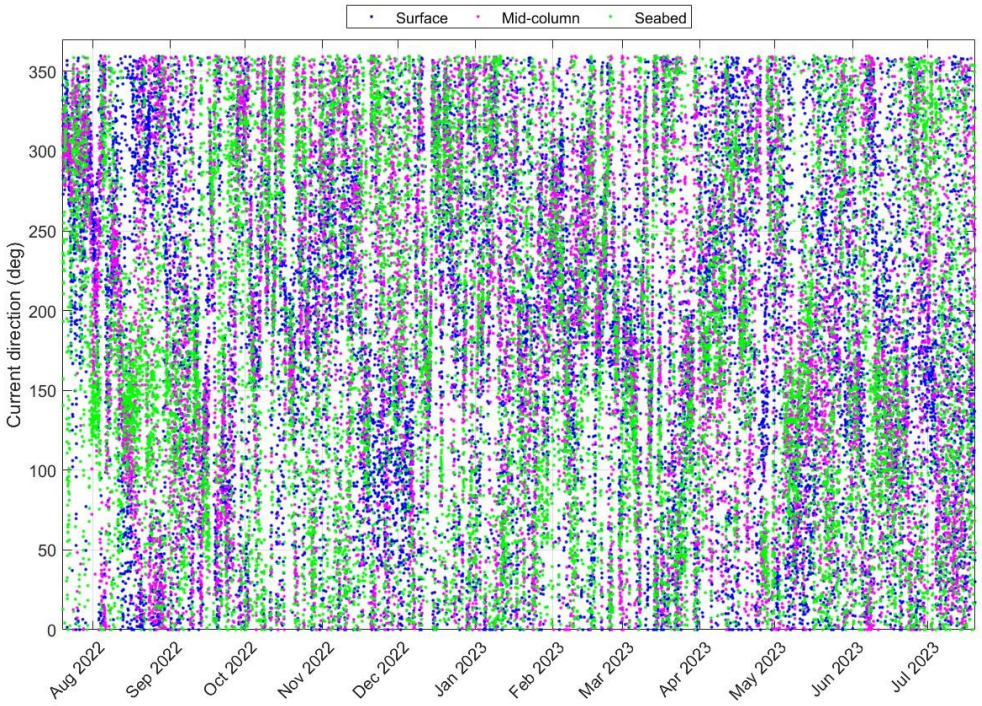


Figure 97. E06: time series of current direction at surface (4.5 m), mid-column (19.5 m) and near seabed (36.0 m) (DD/MM/YYYY).

Figures below present the current roses at surface measured by the current sensors for the observation period.

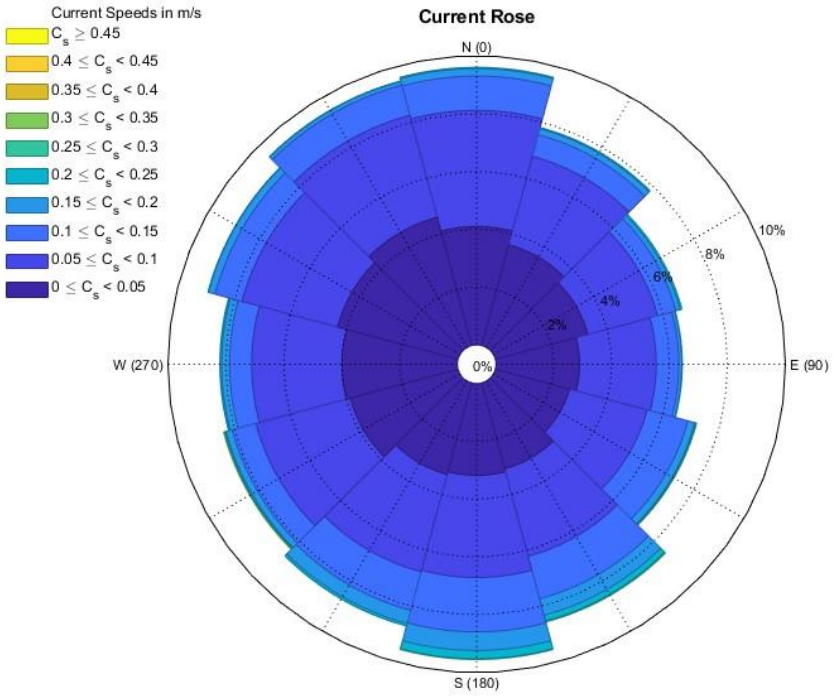


Figure 98. E01: current rose at surface (4.3 m).

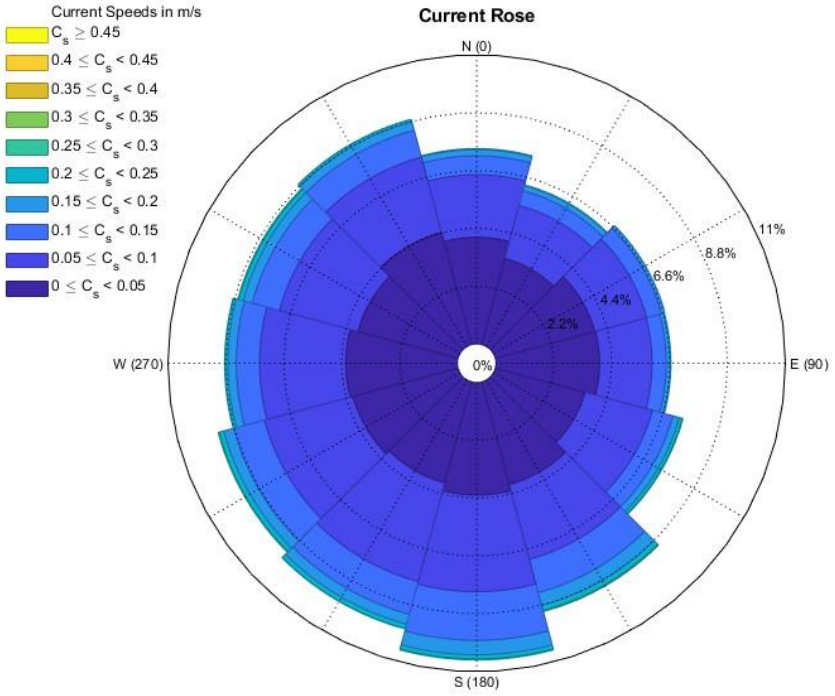


Figure 99. E06: current rose at surface (4.5 m).

Figures below display the current roses at mid-column measured by the current sensors for the observation period.

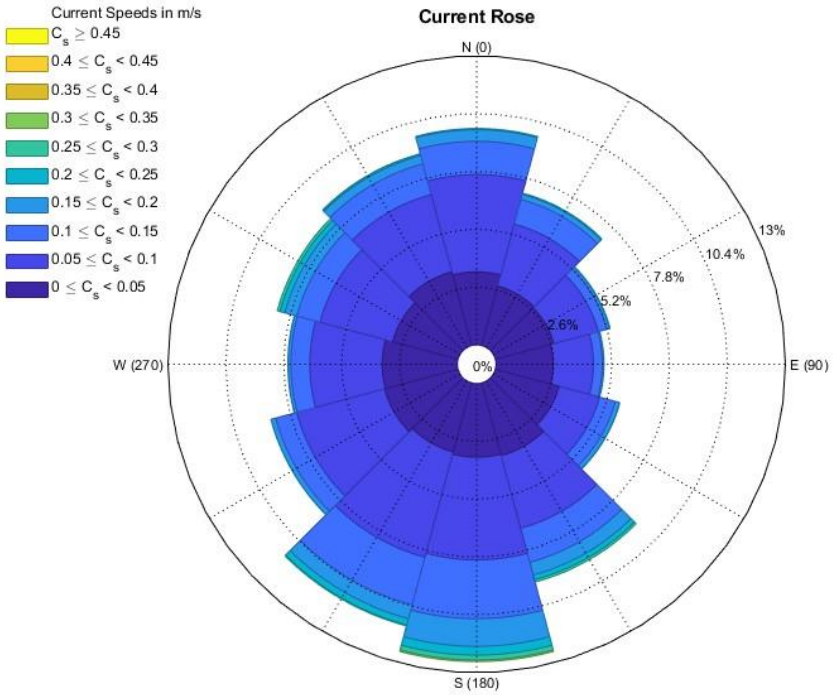


Figure 100. E01: current rose at mid-column (17.3 m).

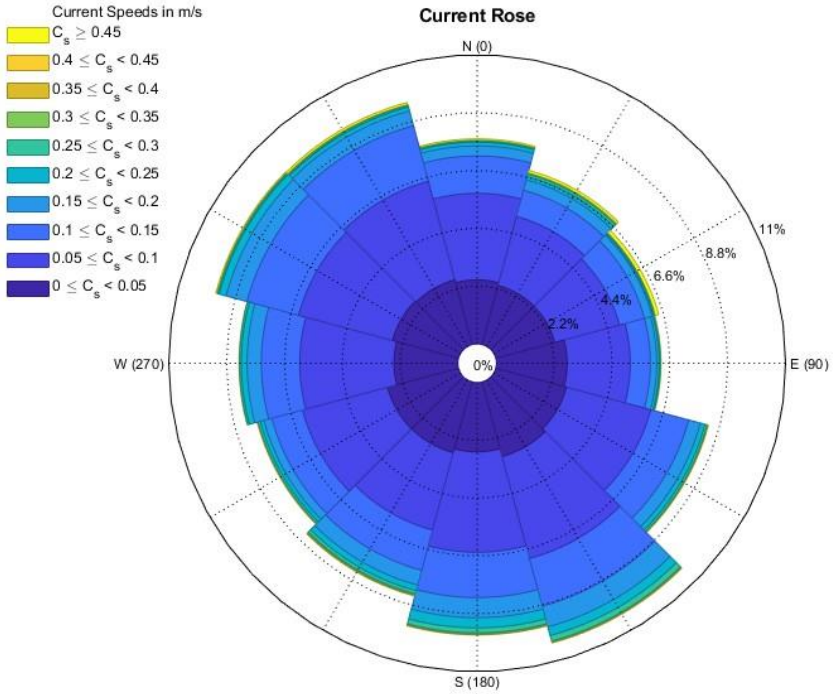


Figure 101. E06: current rose at mid-column (19.5 m).

Figures below present the current roses near seabed measured by the current sensors for the observation period.

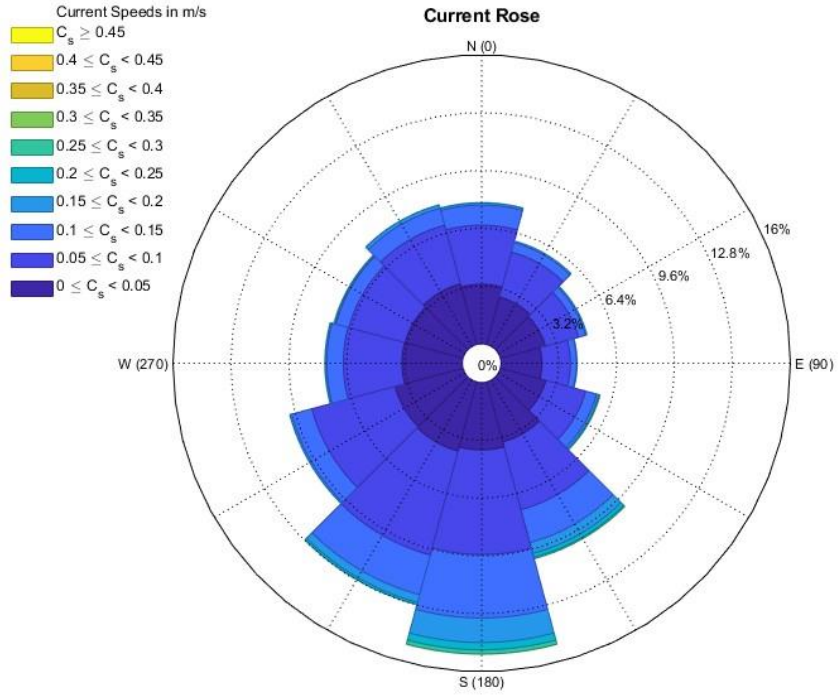


Figure 102. E01: current rose near seabed (31.6 m).

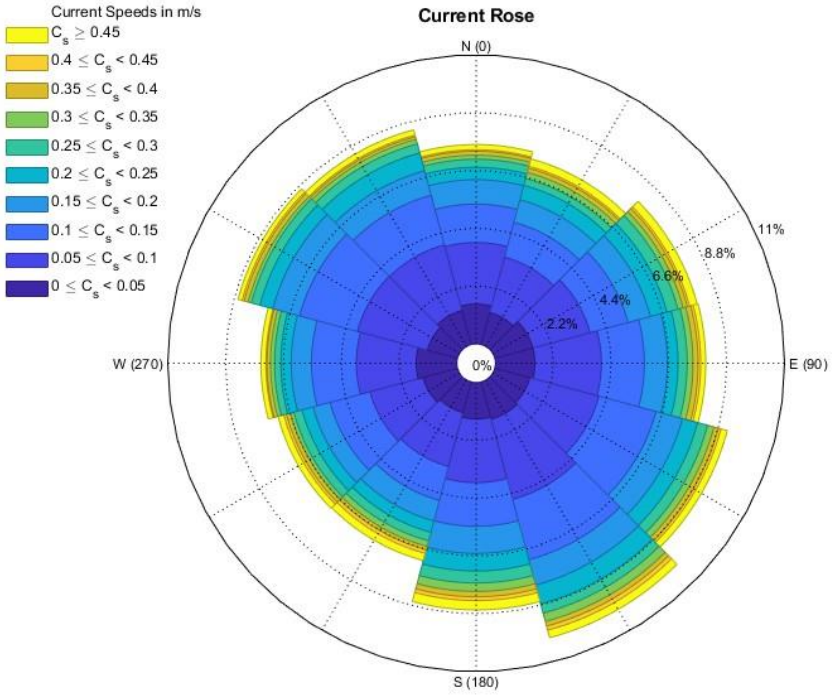


Figure 103. E06: current rose near seabed (36.0 m).

Figures below display the occurrence tables of current direction versus current speed at surface for the observation period.

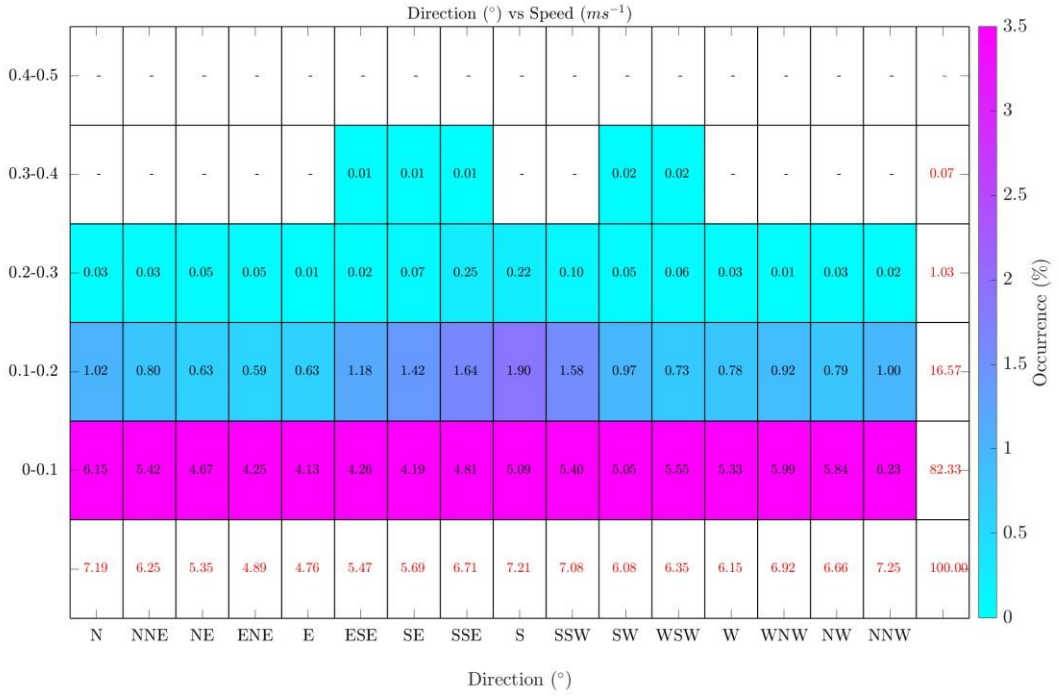


Figure 104. E01: surface (4.3 m) current direction vs current speed occurrences.

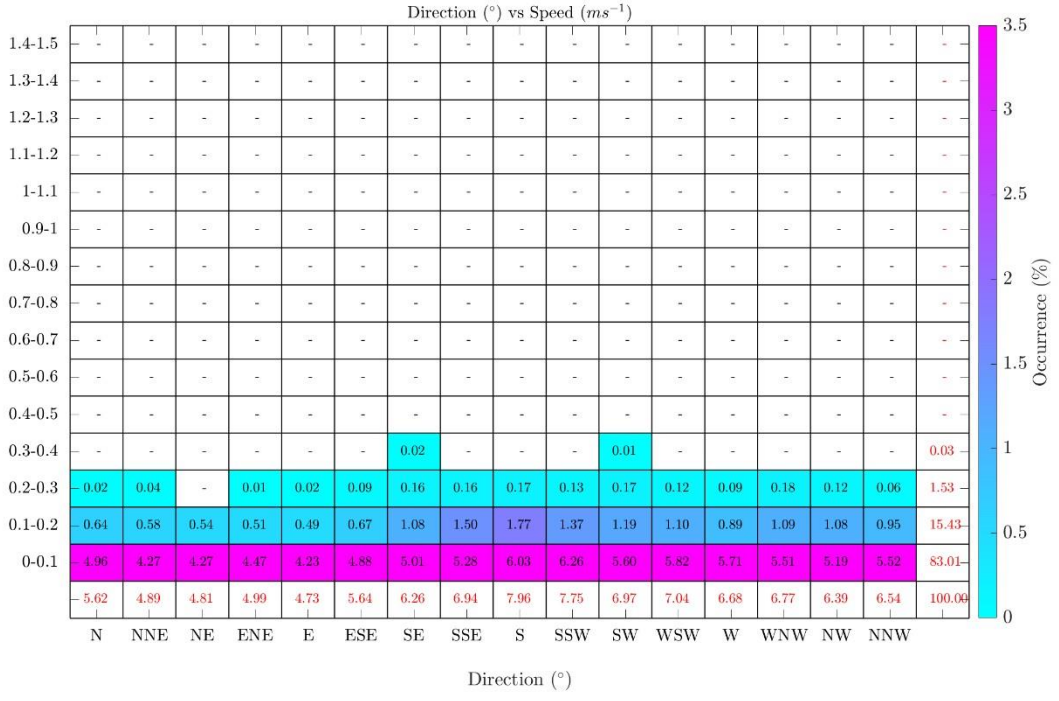


Figure 105. E06: surface (4.5 m) current direction vs current speed occurrences

Figures below present the occurrence tables of current direction versus current speed at mid-column for the observation period.

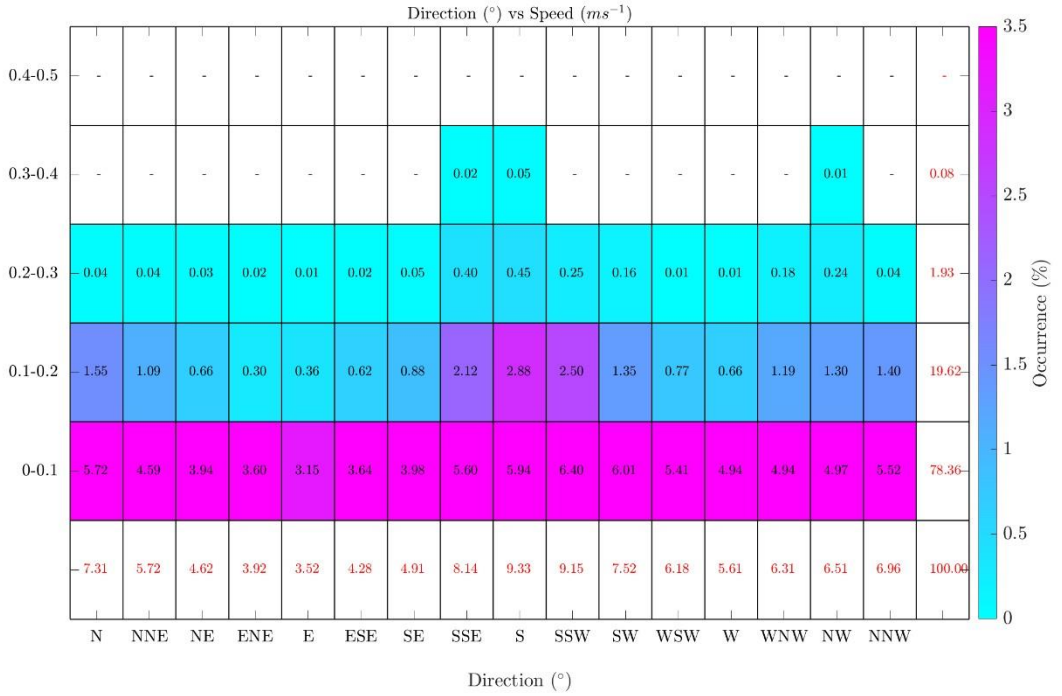


Figure 106. E01: mid-column (17.3 m) current direction vs current speed occurrences.

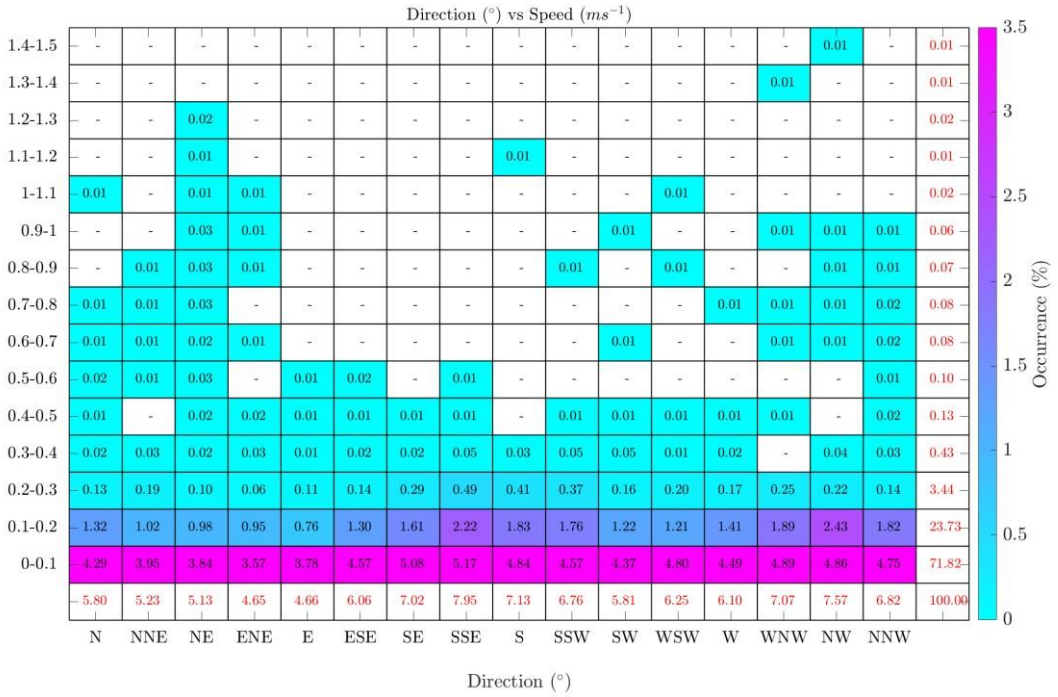


Figure 107 E06: mid-column (19.5 m) current direction vs current speed occurrences.

Figures below show the occurrence tables of current direction versus current speed near seabed for the observation period.

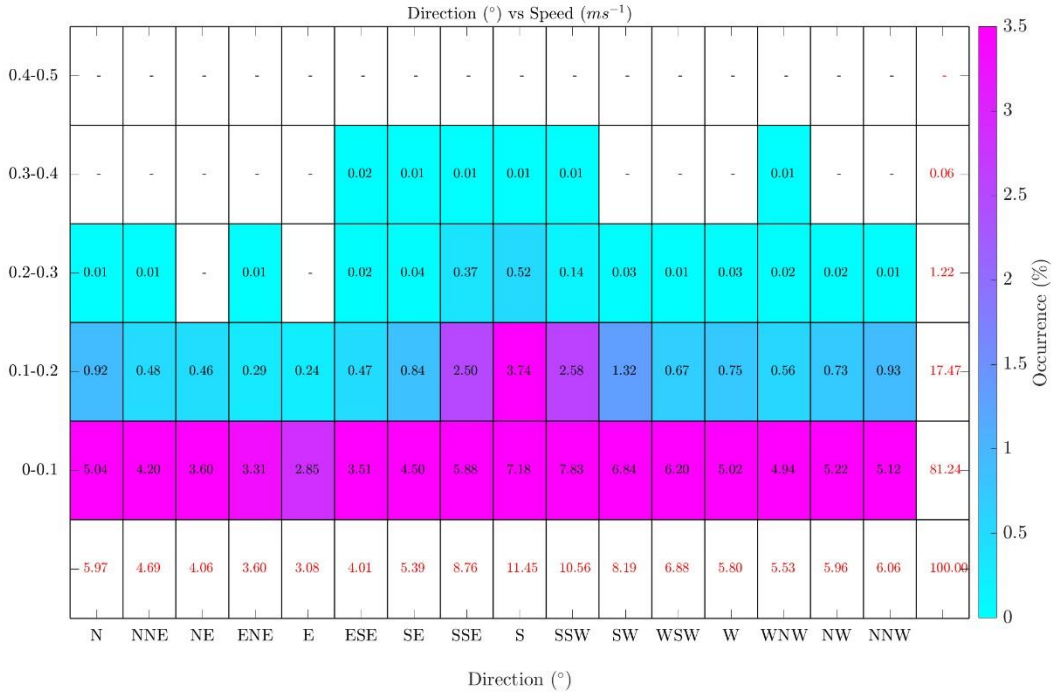


Figure 108. E01: seabed (31.6 m) current direction vs current speed occurrences.

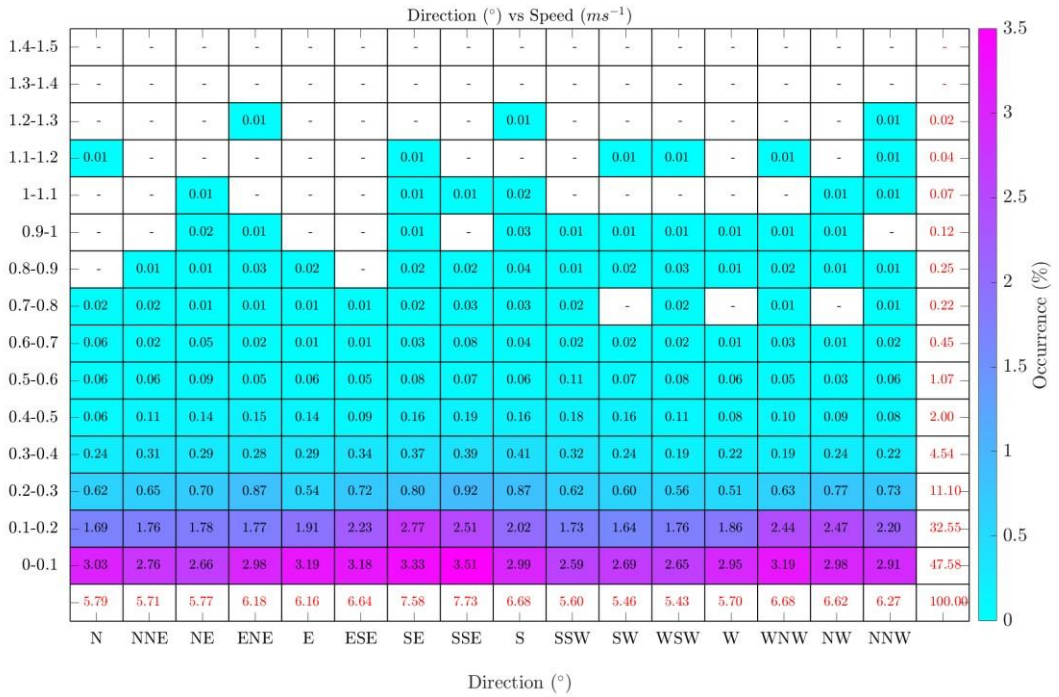


Figure 109. E06: seabed (36.0 m) current direction vs current speed occurrences.

5.2.6. Wave results

Tables below show a basic statistic of the main variables of the wave sensors installed in the FLS200 systems for the observation period.

WAVE				
Month	Variables			
Jul 2022 -Jul 2023	Hs (m)	Hmax (m)	Tp (sec)	Tz (sec)
Mean	1.03	1.70	5.29	4.13
Max	5.79	10.05	11.40	8.20
Min	0.05	0.08	2.10	2.40
Std	0.79	1.28	1.58	0.95

Table 12. E01: basic statistic of the main variables measured by the wave sensor installed in the FLS200 system.

WAVE				
Month	Variables			
Jul 2022 -Jul 2023	Hs (m)	Hmax (m)	Tp (sec)	Tz (sec)
Mean	1.04	1.72	5.16	4.03
Max	5.76	10.28	10.90	8.20
Min	0.05	0.07	1.70	2.20
Std	0.80	1.30	1.65	0.97

Table 13. E06: basic statistic of the main variables measured by the wave sensor installed in the FLS200 system.

Figures below present the time series of the significant wave height and maximum wave height measured by the wave sensors for the observation period.

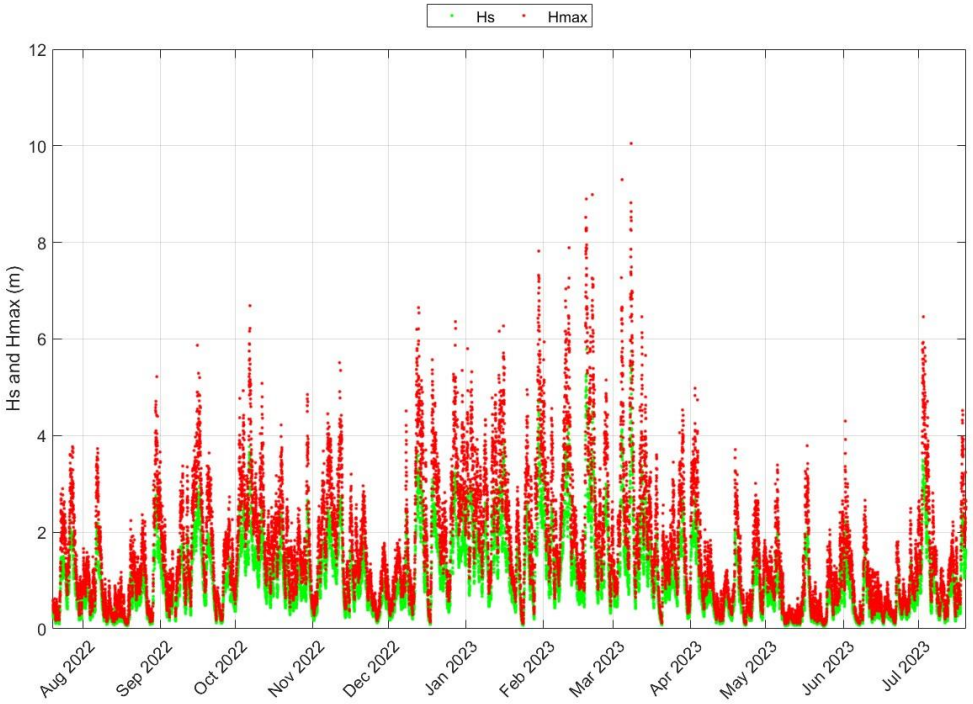


Figure 110. E01: time series of Hs and Hmax (DD/MM/YYYY).

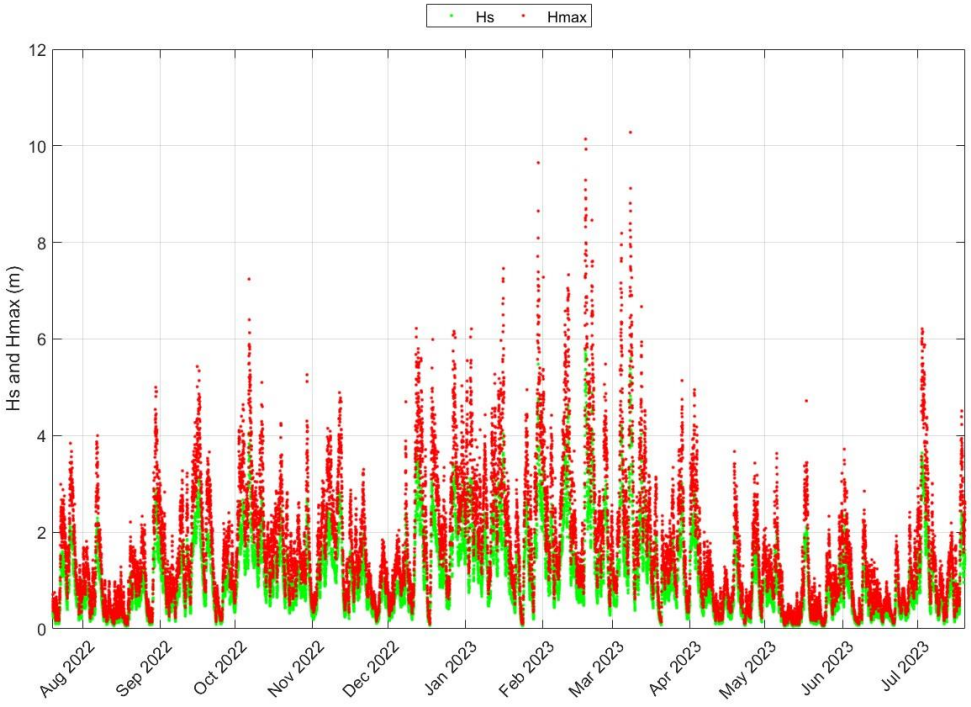


Figure 111. E06: time series of Hs and Hmax (DD/MM/YYYY).

Figures below display the time series of peak period and mean spectral period measured by the wave sensors for the observation period.

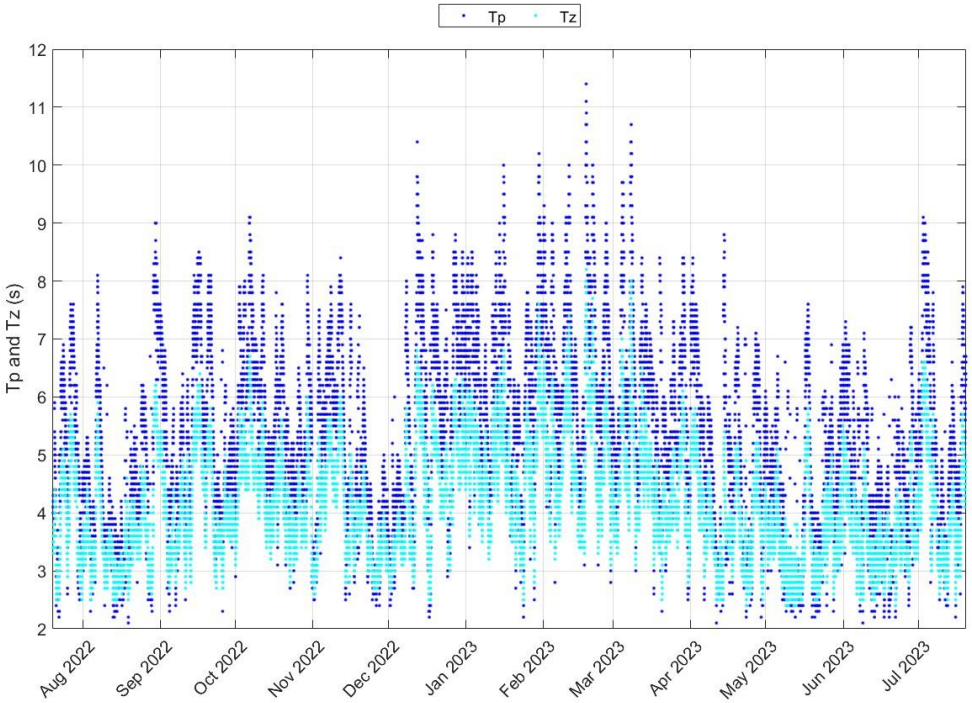


Figure 112. E01: time series of Tp and Tz (DD/MM/YYYY).

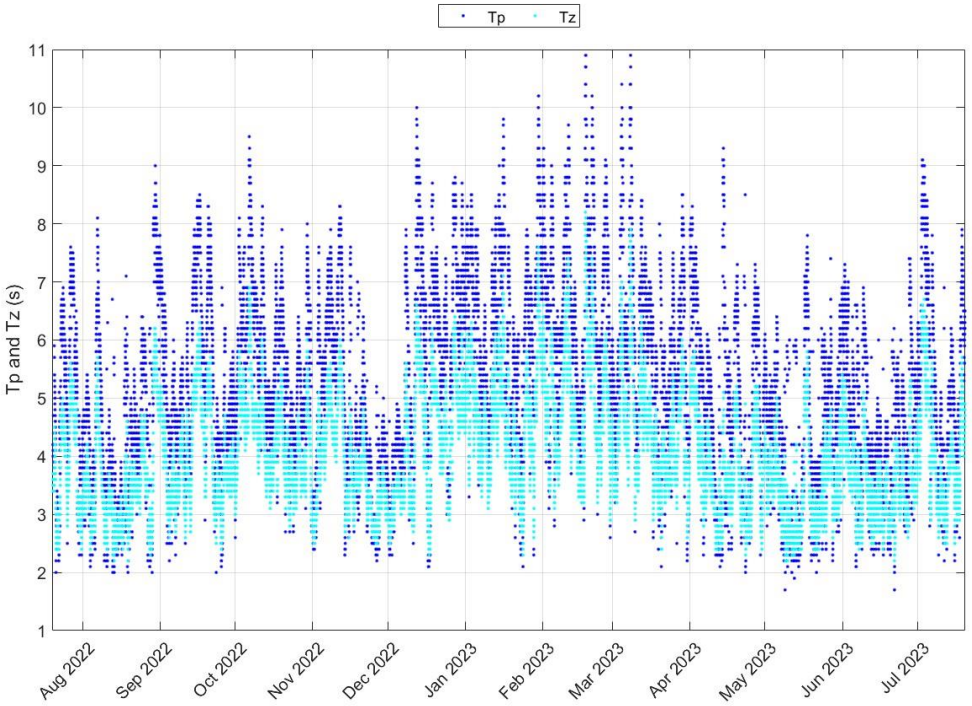


Figure 113. E06: time series of Tp and Tz (DD/MM/YYYY).

Figures below display the time series of average wave direction measured by the wave sensors for the observation period.

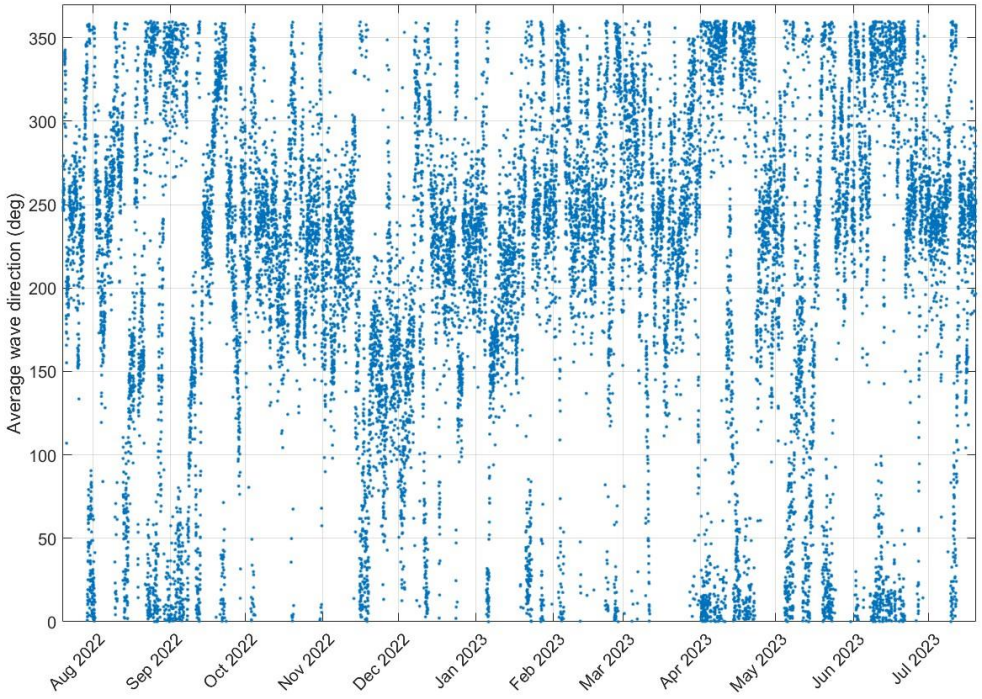


Figure 114. E01: time series of average wave direction (DD/MM/YYYY).

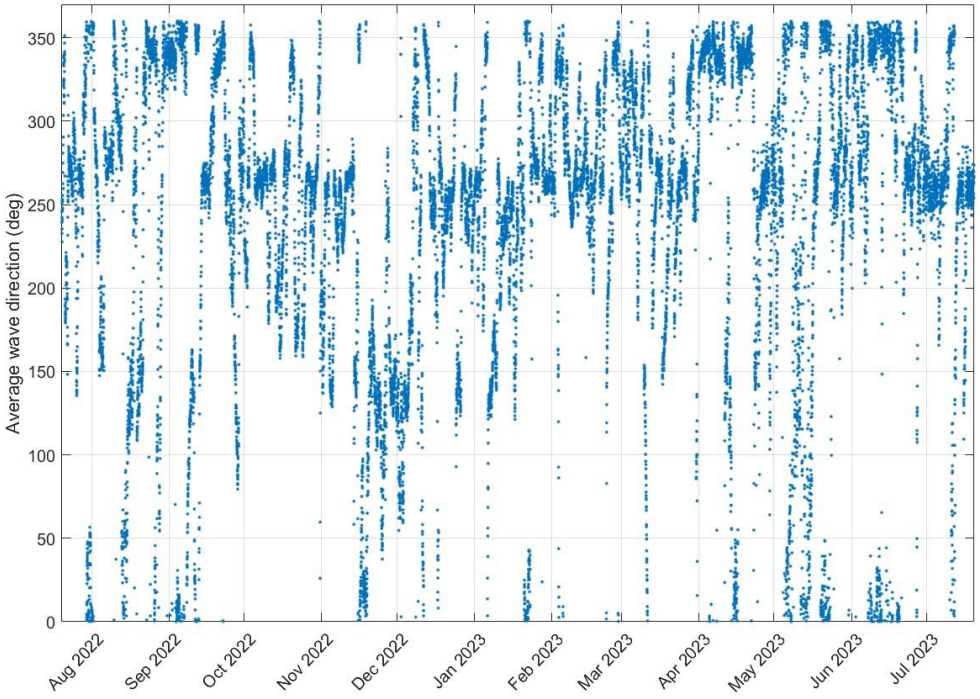


Figure 115. E06: time series of average wave direction (DD/MM/YYYY).

Figures below show the wave roses of significant wave height for the observation period.

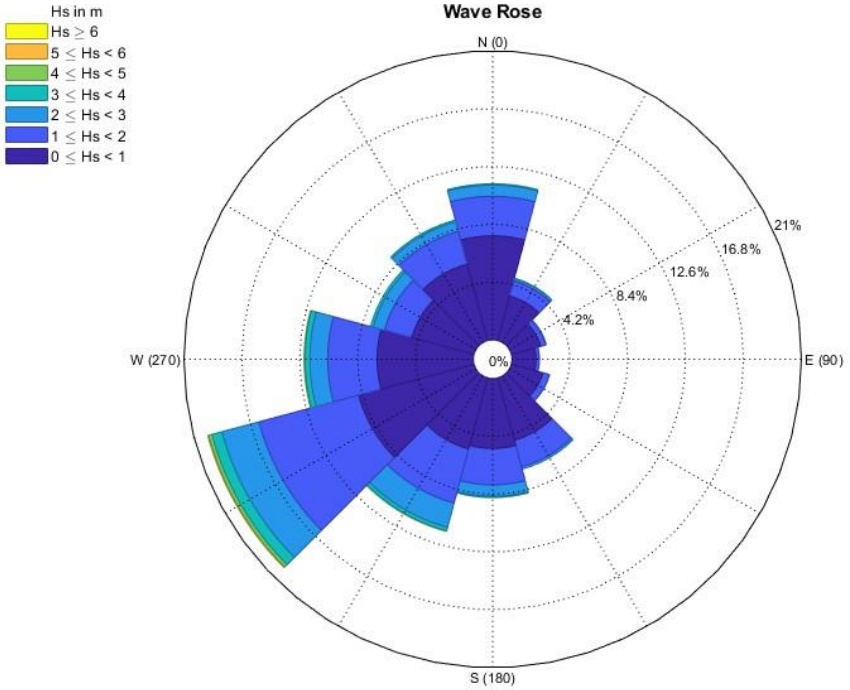


Figure 116. E01: wave rose Hs.

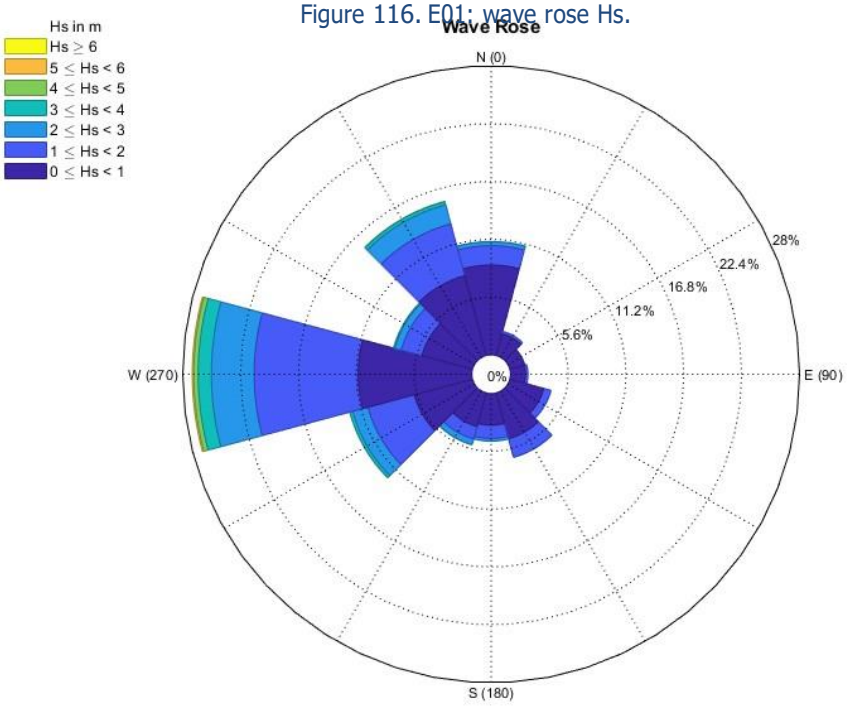


Figure 117. E06: wave rose Hs.

Figures below present the wave roses of peak period for the observation period.

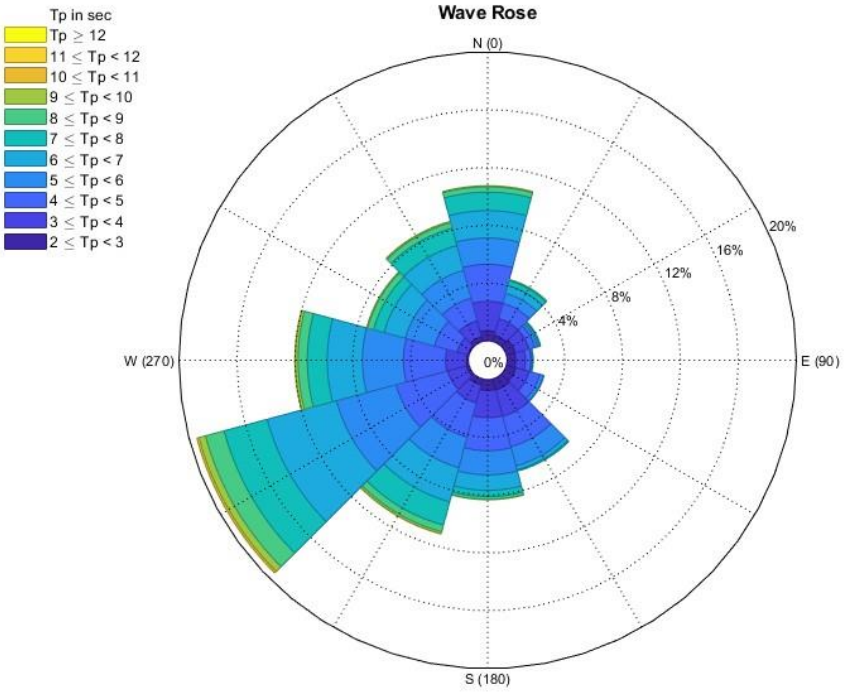


Figure 118. E01: wave rose Tp.

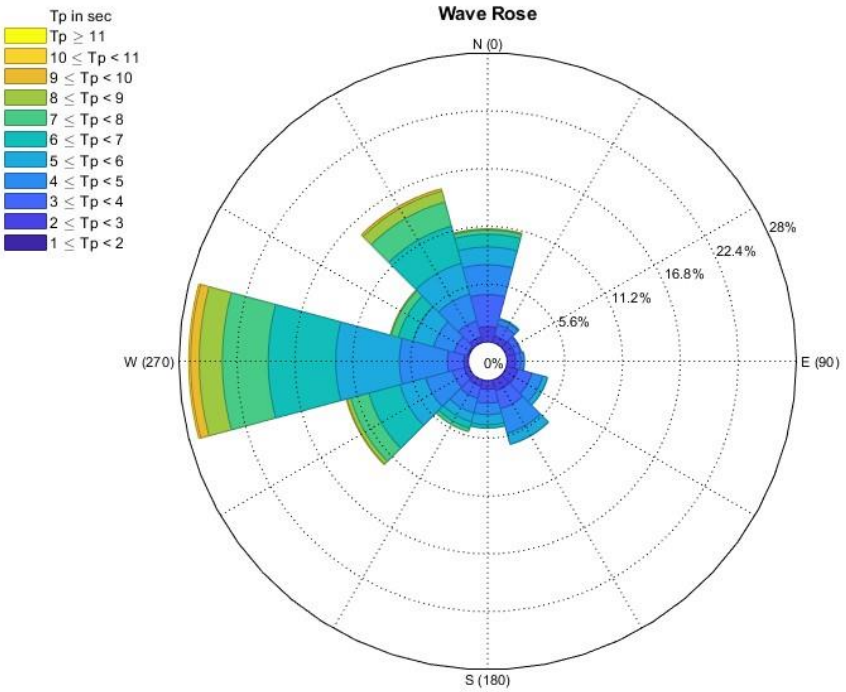


Figure 119. E06: wave rose Tp.

Figures below show the joint occurrence tables of average wave direction versus significant wave height and peak period versus significant wave height measured by the wave sensors for the observation period.

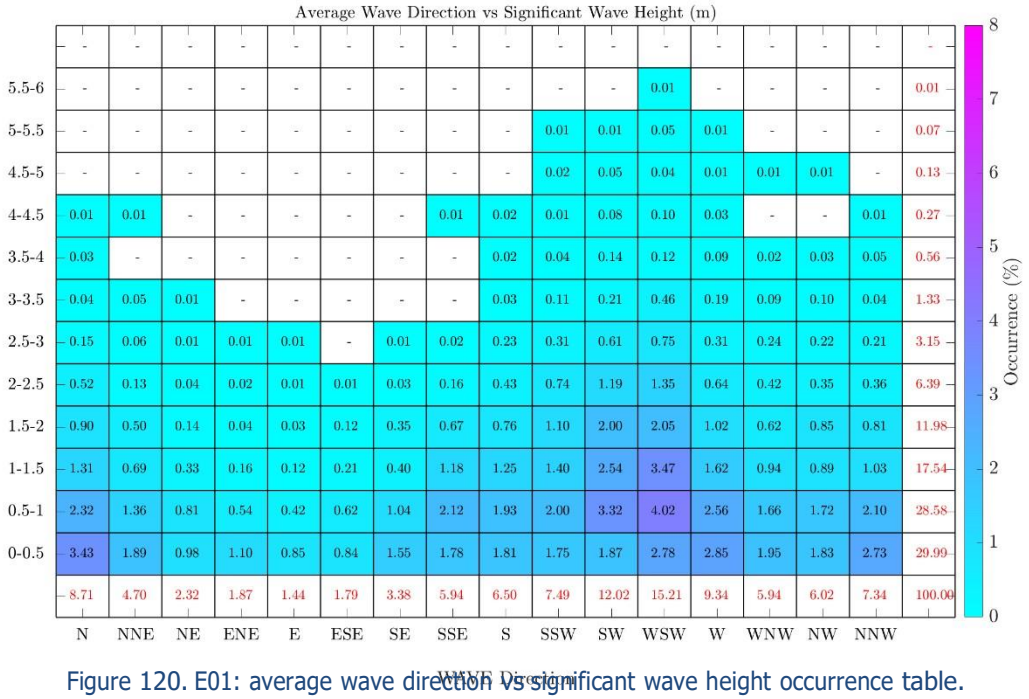


Figure 120. E01: average wave direction vs significant wave height occurrence table.

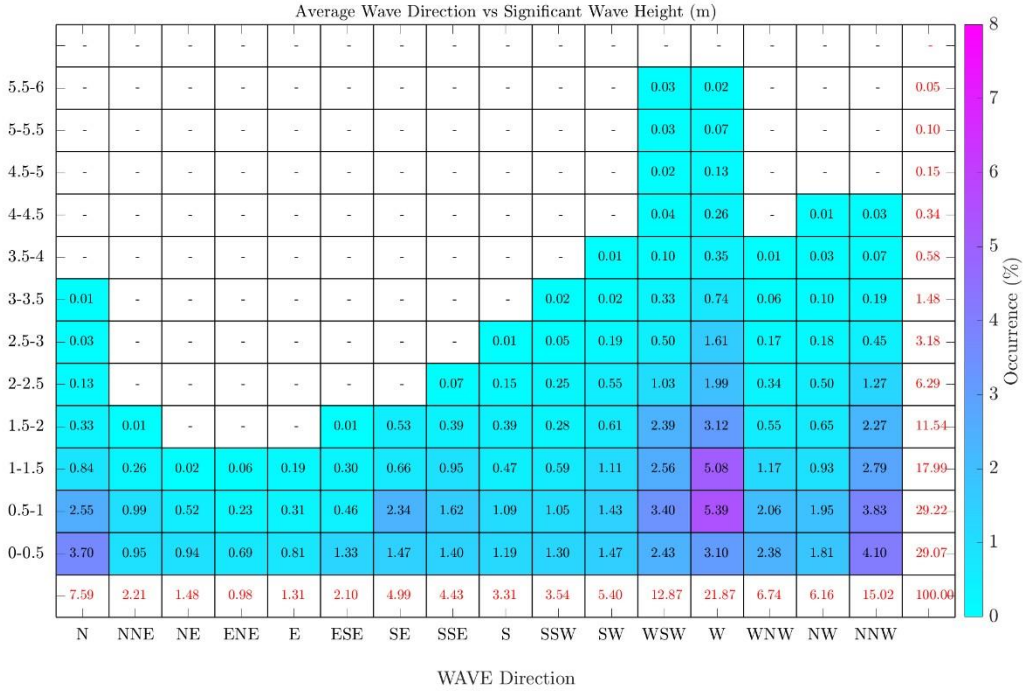


Figure 121. E06: average wave direction vs significant wave height occurrence table

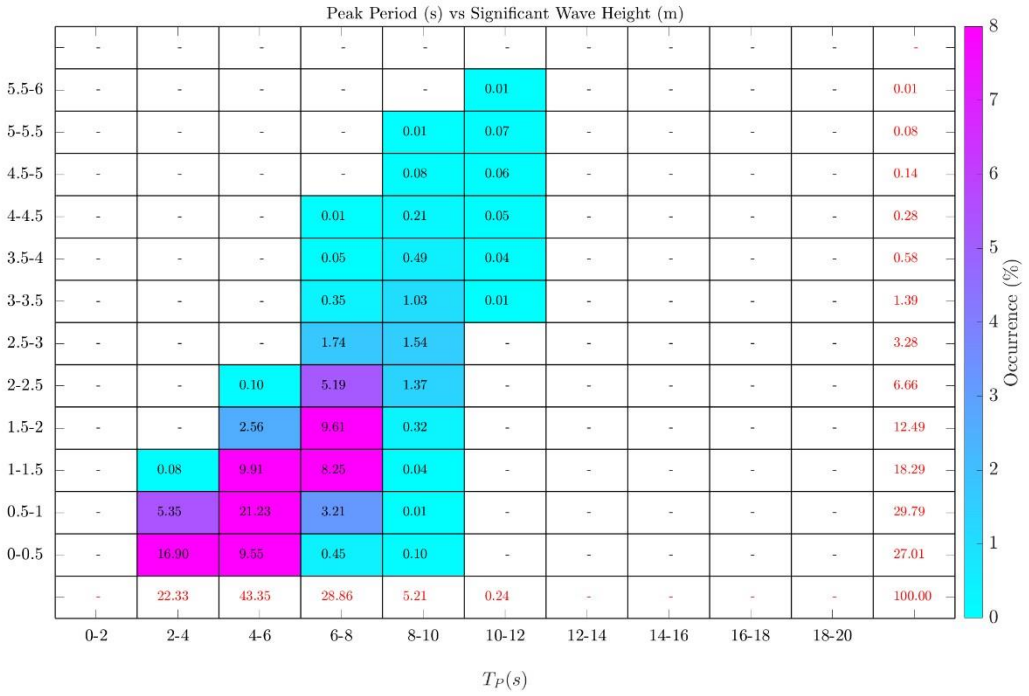


Figure 122. E01: peak period vs significant wave height occurrence table.

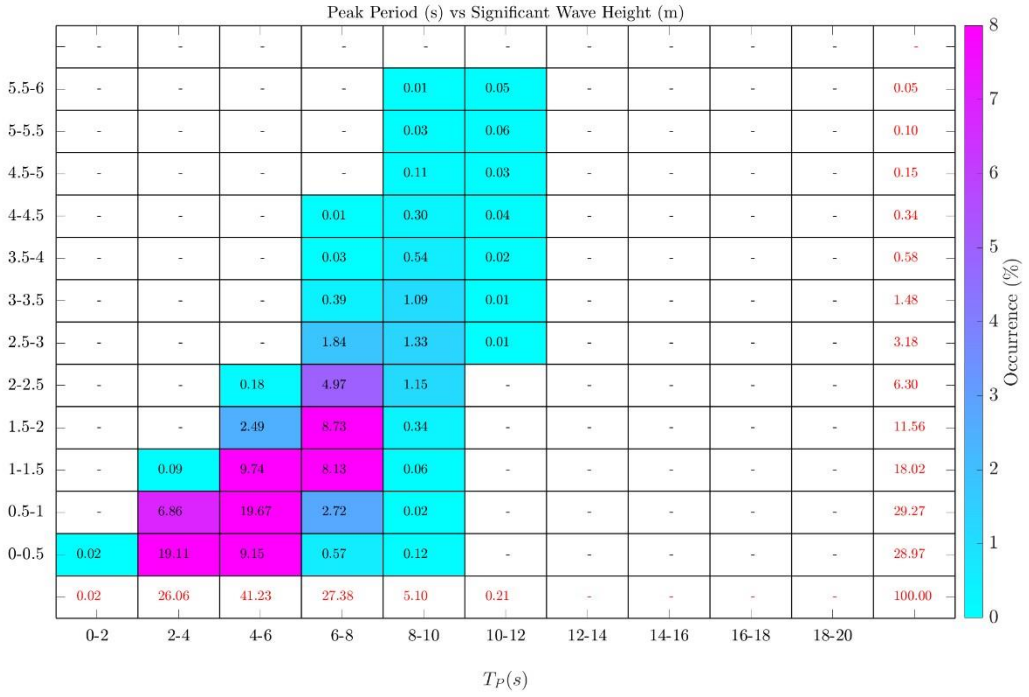


Figure 123. E06: peak period vs significant wave height occurrence table

6. SUMMARY: DATA-SENSOR

The data operation log will cover the performance of the EOLOS FLS200 units in reference to the data delivered to the client. In the case of EOLOS buoys face any issues related to the data provided to the client, it will be shortly described here.

6.1. E01 data-sensor: operation LOG

#	Sensor	Issue Description	Start Date	Resolution Date	Reference documentation
01	LIDAR	Dubious wind direction values	20/07/2022	06/09/2022	E01-KLA-INC001.v.02.pdf
02	LIDAR	Data gaps	20/07/2022	06/09/2022	E01-KLA-INC002.v.02.pdf
03	ADCP (Variable: distance between seabed and surface)	Inconsistent behaviour	20/07/2022	06/09/2022	E01-KLA-INC003.v.02.pdf
04	METEO (Variable: wind gust 3 sec direction) and WAVE (Variable: average wave direction)	Noisy data	20/07/2022	20/07/2023	E01-KLA-INC004.v.03.pdf
05	ALL SENSORS	Maintenance	06/09/2022	06/09/2022	EOL-KLA13-V01-OPS-Daily Progress Report - E01 Maintenance 06 Sep 22.pdf
06	ALL SENSORS	Data gaps	12/09/2022	22/05/2023	E01-KLA-INC006.v.02.pdf
07	ALL SENSORS	Data gap due to datalogger issue	18/09/2022	20/09/2022	E01-KLA-INC005.v.01.pdf
08	LIDAR	Data gaps due to power issue	03/12/2022	22/05/2023	E01-KLA-INC007.v.02.pdf
09	LIDAR (Variable: wind direction) and METEO (Variable: wind direction)	Noisy data	20/09/2022	20/07/2023	E01-KLA-INC004.v.03.pdf
10	LIDAR	Flags (9999)	03/12/2022	20/07/2023	E01-KLA-INC008.v.02.pdf
11	ADCP and WAVE	Code bug	20/07/2022	20/07/2023	E01-KLA-INC010.v.02.pdf
12	LIDAR and METEO (variables : wind direction)	Code bug	20/07/2022	20/07/2023	E01-KLA-INC011.v.02.pdf
12	LIDAR and WAVE	Data gap due to	02/02/2023	03/02/2026	E01-KLA-INC009.v.01.pdf

		communication issue			
13	ALL SENSORS	Maintenance	21/04/2023	21/04/2023	EOL-KLA30-V01-OPS-Daily Progress Report - E01 Maintenance 21 April 23. pdf

6.2. E06 data-sensor: operation LOG

#	Sensor	Issue Description	Start Date	Resolution Date	Reference documentation
01	ADCP (Variable: distance between seabed and surface)	Inconsistent behaviour	20/07/2022	18/10/2022	E06-KLA-INC001.v.02.pdf
02	AHRS	Pitch and roll anomalous behaviour	20/07/2022	22/04/2023	E06-KLA-INC002.v.03.pdf EOL-KLA38-V01-OPS-Static tilt correction of off-shore LiDAR wind speed measurements (E06). pdf
03	LIDAR and METEO	Wind direction corrected with mast compass	20/07/2022	20/07/2023	E06-KLA-INC003.v.02.pdf
04	ALL SENSORS	Data gap due to ADCP reconfiguration	17/10/2021	18/10/2021	E06-KLA-INC001.v.02.pdf
05	LIDAR	Flags (9999)	03/12/2022	20/07/2023	E06-KLA-INC004.v.02.pdf
06	ALL SENSORS	Data gap due to datalogger issue	22/12/2022	24/12/2022	E06-KLA-INC005.v.01.pdf
07	ADCP and WAVE	Code bug	20/07/2022	20/07/2023	E06-KLA-INC006.v.02.pdf
	LIDAR and METEO (variables: wind direction)	Code bug	20/07/2022	20/07/2023	E06-KLA-INC007.v.012.pdf
08	ALL SENSORS	Maintenance	22/04/2023	22/04/2023	EOL-KLA31-V01-OPS-Daily Progress Report - E06 Maintenance 22 April 23.pdf
09	SEVERAL SENSORS	Data gap	21/04/2023	22/04/2023	E06-KLA-INC010.v.01.pdf
10	LIDAR	Data gaps	24/04/2023	20/07/2023	E06-KLA-INC008.v.01.pdf E06-KLA-INC009.v.01.pdf

7. REFERENCES

[1]- "Offshore Wind Accelerator Roadmap for the commercial acceptance of floating LIDAR technology". V 2.0 - The Carbon Trust, October 2018.