

Wind Analysis for
Atlantic Marine Energy Test Site (AMETS A)

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Introduction

The purpose of this document is to provide a high level characterisation and understanding of the wind resource present at the AMETS A site off Belmullet, Co. Mayo. A central geographical location was chosen to represent the centre of the AMETS A site, 54.27673 N, 010.28526 W. A robust, simulated, 10 year dataset for this location was downloaded from <https://map.neweuropeanwindatlas.eu/about>.

Standard statistical processes have been utilised during the processing of all data in line with industry norms.

Site Location

The Atlantic Marine Energy test Site (AMETS) is located off Belmullet, Co. Mayo, on the west coast of Ireland.



Data Quality/ Recovery

Data was downloaded from the 4D simulated mesoscale model for wind speed and wind direction from the New European Wind Atlas. The data and further information on this model can be found at <https://map.neweuropeanwindatlas.eu/about>.

Data was downloaded for five discrete heights above sea level, 50m,75m,100m, 150m, 200m and 250m. The period of record for this analysis is from 01/01/2008 to 31/12/2018. A summary of the data downloaded can be seen in table 1 below.

Wind Speed (m/s)
Wind Direction (degrees from)
Turbulent Kinetic Energy (m^2/s^2)
Wind Power Density (W m/s)
Air Temperature (° C)

Table 1. Downloaded Variables for each height.

A visual QC examination of the dataset was conducted. Where there was no data for either wind direction or speed at a given time, that data point (time) for all variables was removed before any statistical analysis was carried out. This resulted in a relatively small amount of data being lost with the data recovery percentage for the period of record (POR) wind speed and direction being 99%. For the turbulent kinetic energy (TKE) and wind power density (WPD) data sets there is no data from 2014. This resulted in a data recovery percentage of 90% for those variables.

Results

A high level statistical analysis was carried out on the downloaded data. This analysis was carried out using Panoply to process netCDF files, Microsoft Excel and Python provided the tools used in any statistical or graphical processes that were required.

Summary tables for Wind Speed, Turbulent Kinetic Energy, Wind Power Density and Temperature can be seen in the following section with probability density graphs and wind roses provided for each specific height in the section thereafter.

Summary Tables

Table 2. Summary Table of Mean Wind Speed between 01/01/2008- 31/12/2018

Monthly Mean wind speed over POR	Mean Wind Speed (m/s)						
	Height	50m	75m	100m	150m	200m	250m
POR:01/01/2008 - 31/12/2018							
January		12.34	12.68	12.94	13.3	13.59	13.83
February		11.24	11.55	11.79	12.14	12.41	12.64
March		10.47	10.77	11	11.34	11.6	11.8
April		9.13	9.39	9.6	9.9	10.12	10.28
May		9.32	9.62	9.84	10.16	10.37	10.54
June		8.04	8.27	8.44	8.66	8.81	8.91
July		7.9	8.11	8.27	8.48	8.64	8.76
August		8.86	9.06	9.21	9.45	9.63	9.78
September		9.77	10.03	10.23	10.52	10.75	10.94
October		10.67	10.94	11.15	11.47	11.74	11.96
November		11.44	11.68	11.86	12.13	12.36	12.56
December		12.66	12.98	13.24	13.61	13.91	14.17
Average annual Wind Speed		10.15333	10.42333	10.63083	10.93	11.16083	11.3475

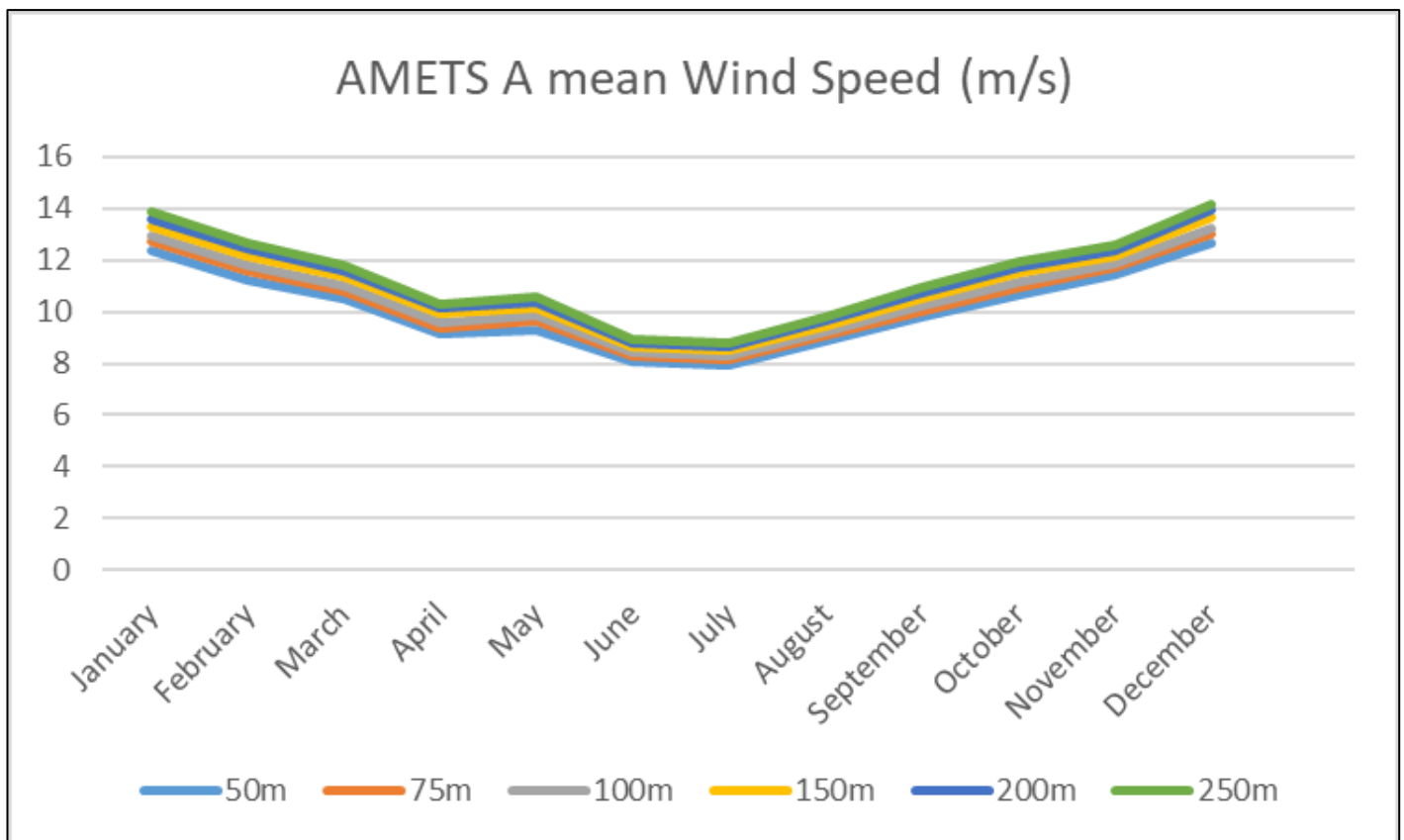


Figure 1. Mean Wind Speed Summary Graph

Table 3. Summary table of mean Wind Power Density between 01/01/2008 – 31/12/2018*
(2014 is excluded from this data set)

Monthly Mean Wind Power Density over POR	Mean Wind Power Density (W m/s)						
	Height	50m	75m	100m	150m	200m	250m
POR:01/01/2008 - 31/12/2018 *2014 Not represented*							
January		1860.84	2040.43	2187.42	2415.69	2602.34	2771.65
February		1389.22	1528.19	1644.14	1827.09	1978	2112
March		1201.9	1315.97	1410.5	1560	1683.31	1792.36
April		806.63	888.92	958.54	1072.08	1166.17	1249.21
May		807.54	894.69	967.18	1079.31	1167.24	1239.7
June		572.54	630.59	678.69	753.32	811.88	859.1
July		527.35	577.36	619.42	685.89	739.55	784.36
August		642.81	699.62	746.88	821.95	884.47	939.64
September		1014.39	1113.79	1197.25	1331.58	1445.02	1547.04
October		1231.51	1348.37	1446.69	1608	1747.72	1875.15
November		1434.47	1546.92	1636.72	1779.82	1901.77	2017.06
December		1945.81	2128.73	2278.82	2515.77	2714.89	2899.9
Average annual WPD		1115.27	1221.74	1309.94	1449.87	1565.95	1669.73

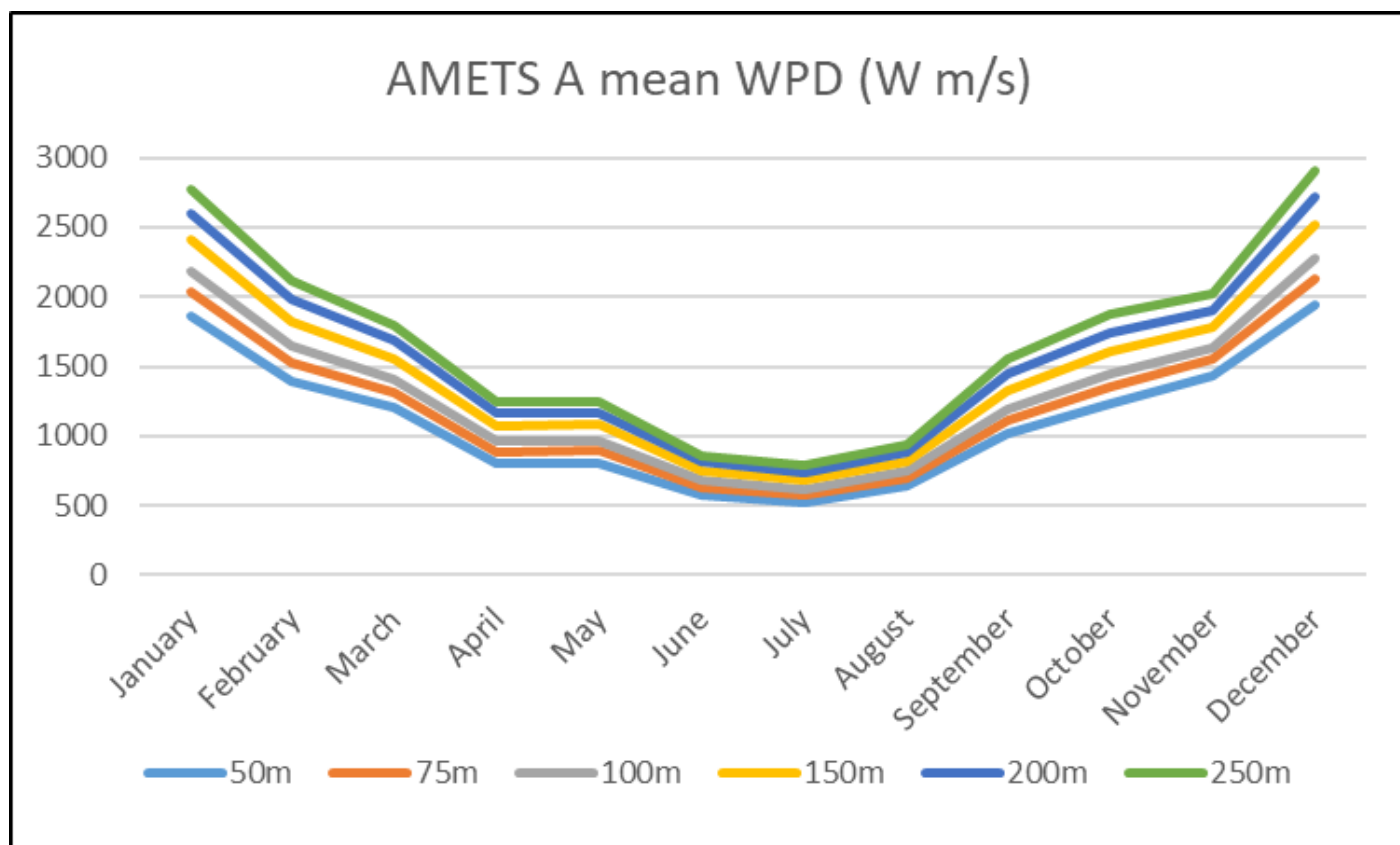


Figure 2. Mean Wind Power Density Summary Graph

Table 4. Summary table of Mean Turbulent Kinetic Energy between 01/01/2008 - 31/12/2018* (2014 is excluded from this data set.)

Monthly Mean TKE over por	Mean Turbulent Kinetic Energy (m^2/s^2)						
	Height	50m	75m	100m	150m	200m	250m
POR:01/01/2008-31/12/2018 *2014 Not represented*							
January		1.15	1.12	1.1	1.07	1.05	1.03
February		0.89	0.87	0.85	0.83	0.81	0.79
March		0.79	0.77	0.76	0.74	0.72	0.7
April		0.56	0.54	0.53	0.52	0.5	0.49
May		0.5	0.48	0.47	0.45	0.43	0.42
June		0.39	0.38	0.37	0.35	0.34	0.33
July		0.39	0.38	0.37	0.36	0.34	0.33
August		0.47	0.46	0.45	0.43	0.42	0.4
September		0.67	0.66	0.64	0.62	0.6	0.58
October		0.82	0.8	0.79	0.77	0.75	0.73
November		1.08	1.07	1.06	1.05	1.04	1.03
December		1.21	1.19	1.18	1.15	1.13	1.11
Average Annual TKE		0.743333	0.726667	0.714167	0.695	0.6775	0.661667

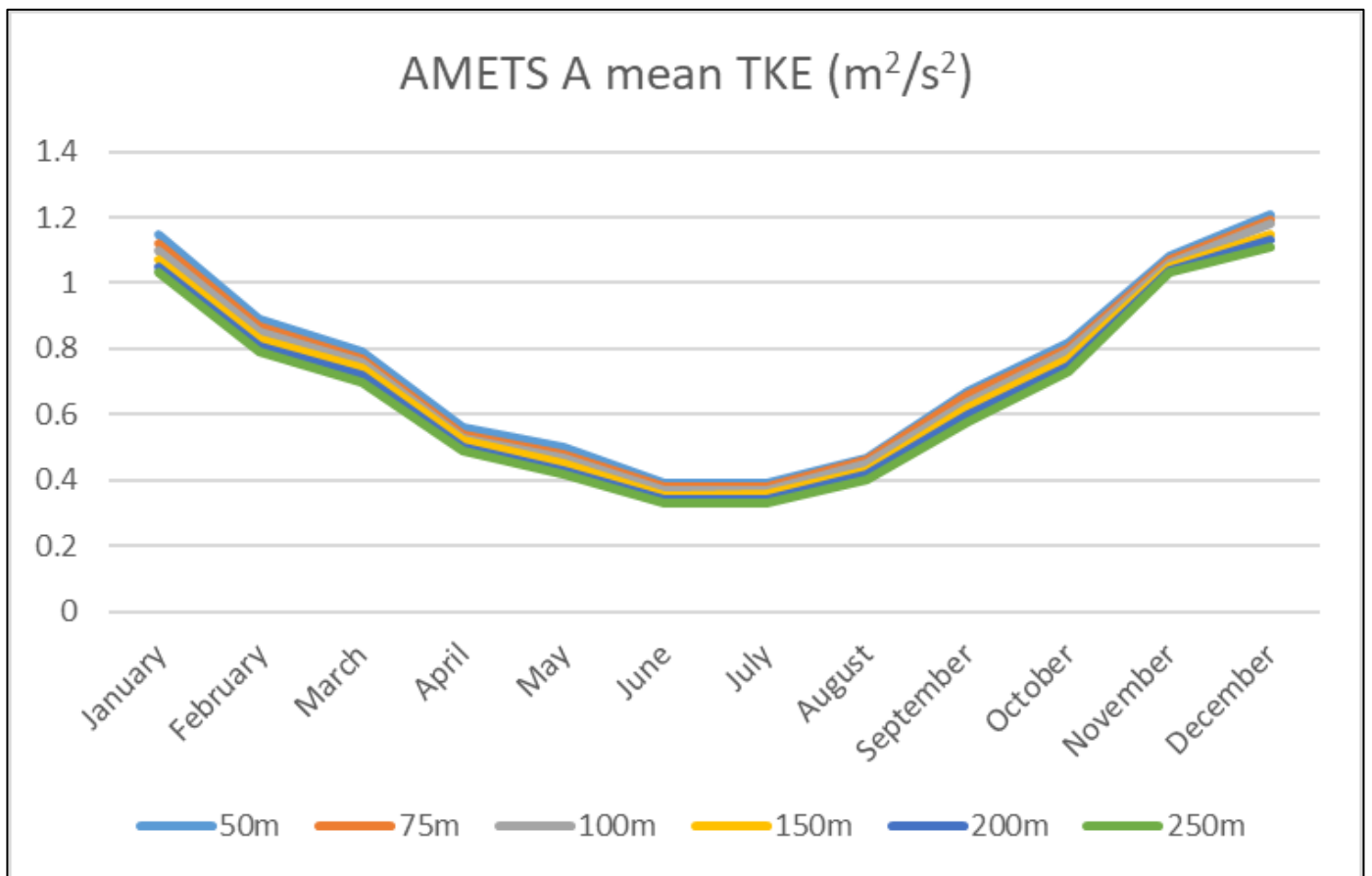


Figure 3. Mean Turbulent Kinetic Energy Summary Graph

Table 5. Summary Table of Mean Air Temperature between 01/01/2008 – 31/12/2018

Monthly Mean Air Temp for POR	Mean Air Temperature (° C)						
	Height	50m	75m	100m	150m	200m	250m
POR:01/01/2008-31/12/2018 *2014 Not represented*							
January		7.91	7.68	7.45	7.01	6.58	6.15
February		7.4	7.18	6.96	6.52	6.1	5.69
March		7.57	7.36	7.16	6.75	6.35	5.95
April		8.43	8.23	8.03	7.64	7.26	6.88
May		10.45	10.29	10.12	9.79	9.45	9.11
June		12.31	12.15	11.98	11.65	11.31	10.97
July		13.71	13.5	13.3	12.92	12.55	12.18
August		14.05	13.83	13.6	13.17	12.75	12.34
September		13.22	13	12.79	12.36	11.95	11.54
October		11.76	11.53	11.31	10.87	10.46	10.06
November		9.73	9.49	9.25	8.79	8.34	7.9
December		8.51	8.28	8.05	7.6	7.16	6.75
Average Annual Temp		10.42083	10.21	10	9.589167	9.188333	8.793333

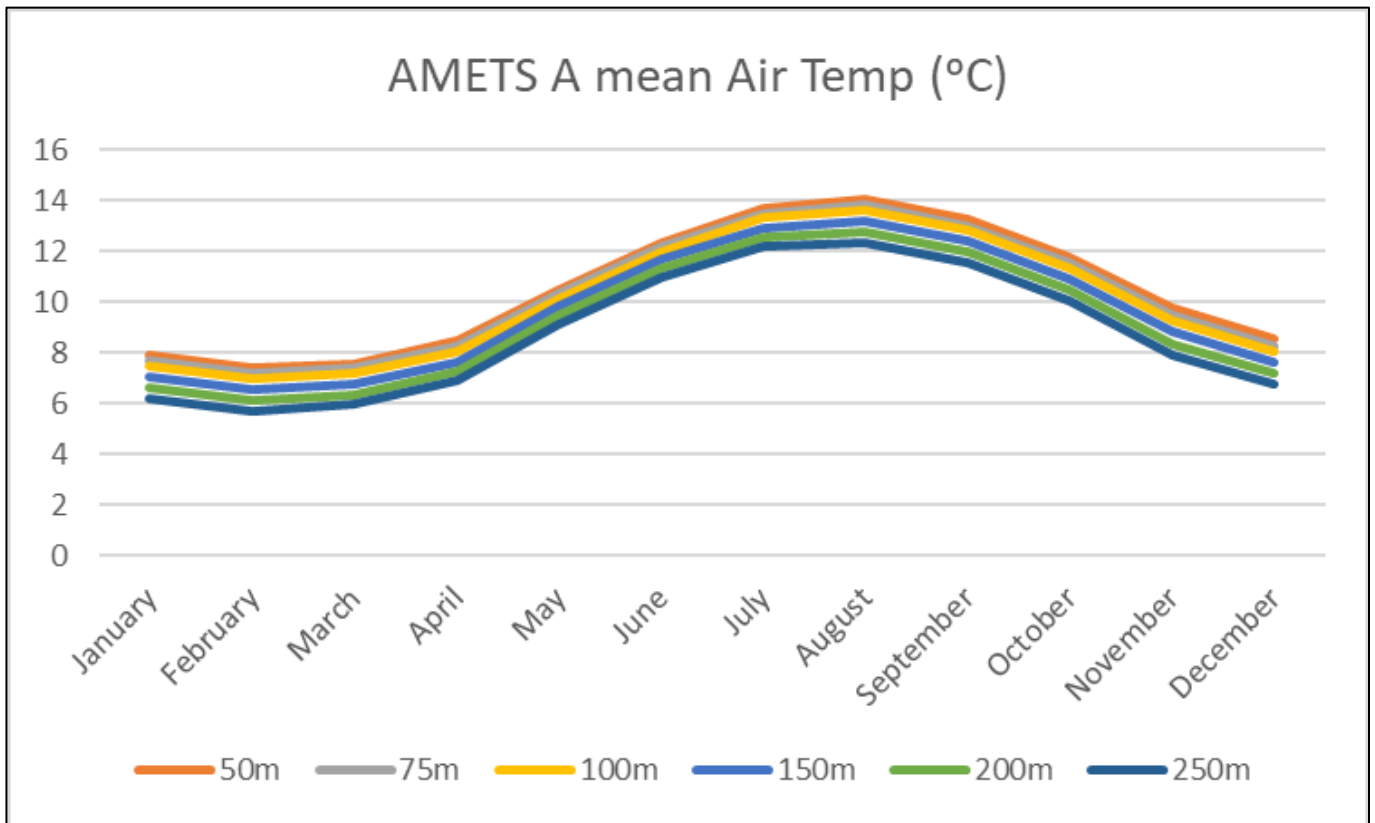


Figure 4. Mean Air Temperature Summary Graph

Height Specific Results

Analysis was carried out on the wind speed data sets for each height using excel to provide probability density graphs of wind speed and associated Weibull function parameters. A best fit approach was taken in determining the represented Weibull k and α values. A summary table of these values is provided below.

Table 6. Summary Table of Weibull k and α parameters.

Height	50m	75m	100m	150m	200m	250m
Weibull K	2.35	2.4	2.4	2.3	2.2	2.2
Weibull α	11.5 m/s	12 m/s	12.4 m/s	12.6 m/s	12.6 m/s	13.1 m/s

Wind roses were produced using python to show the predominant direction and magnitude of the wind at each specific height.

These graphs and wind roses are presented in the following section.

50m Height

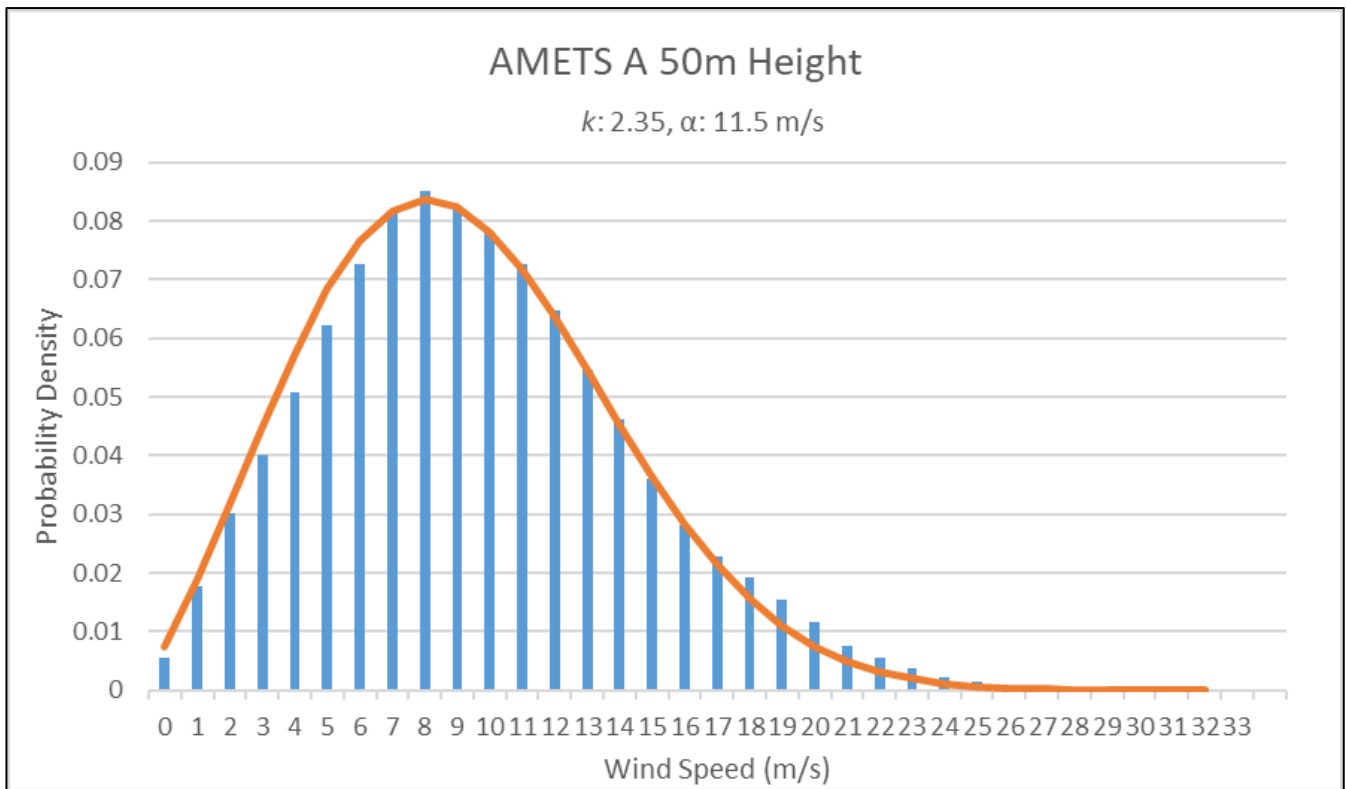


Figure 5. Probability Density Graph for 50m height with Weibull Function in Orange

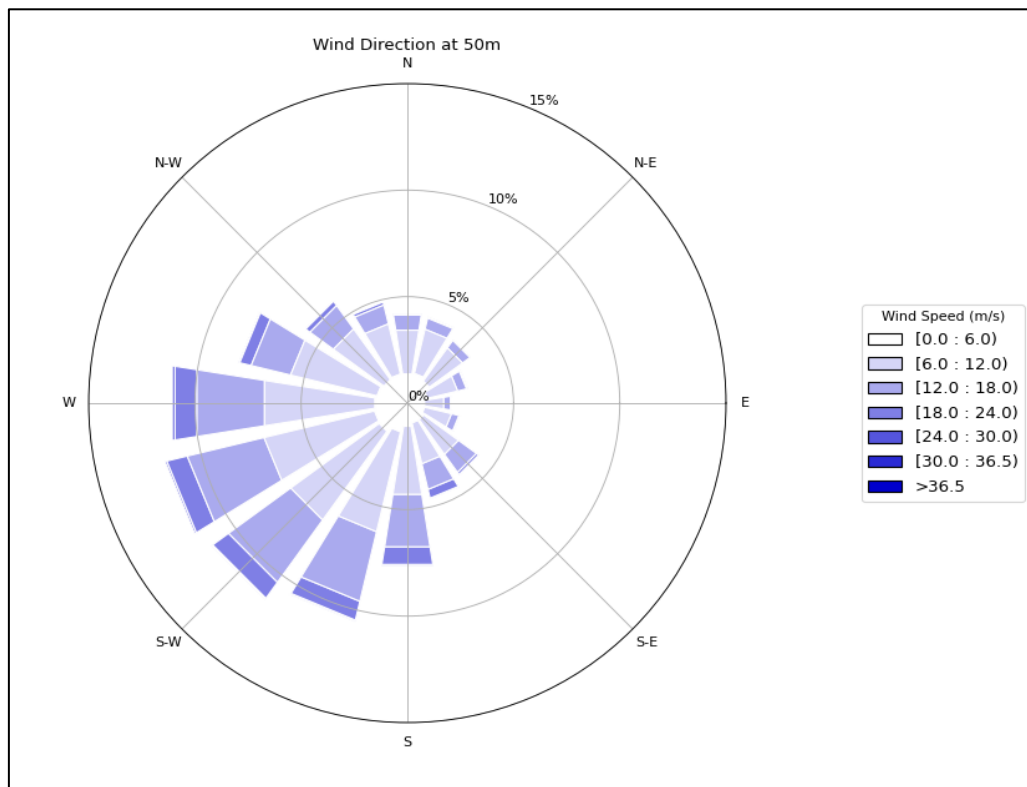


Figure 6. Wind rose showing measured wind direction and wind speed at 50m over the POR

75m Height

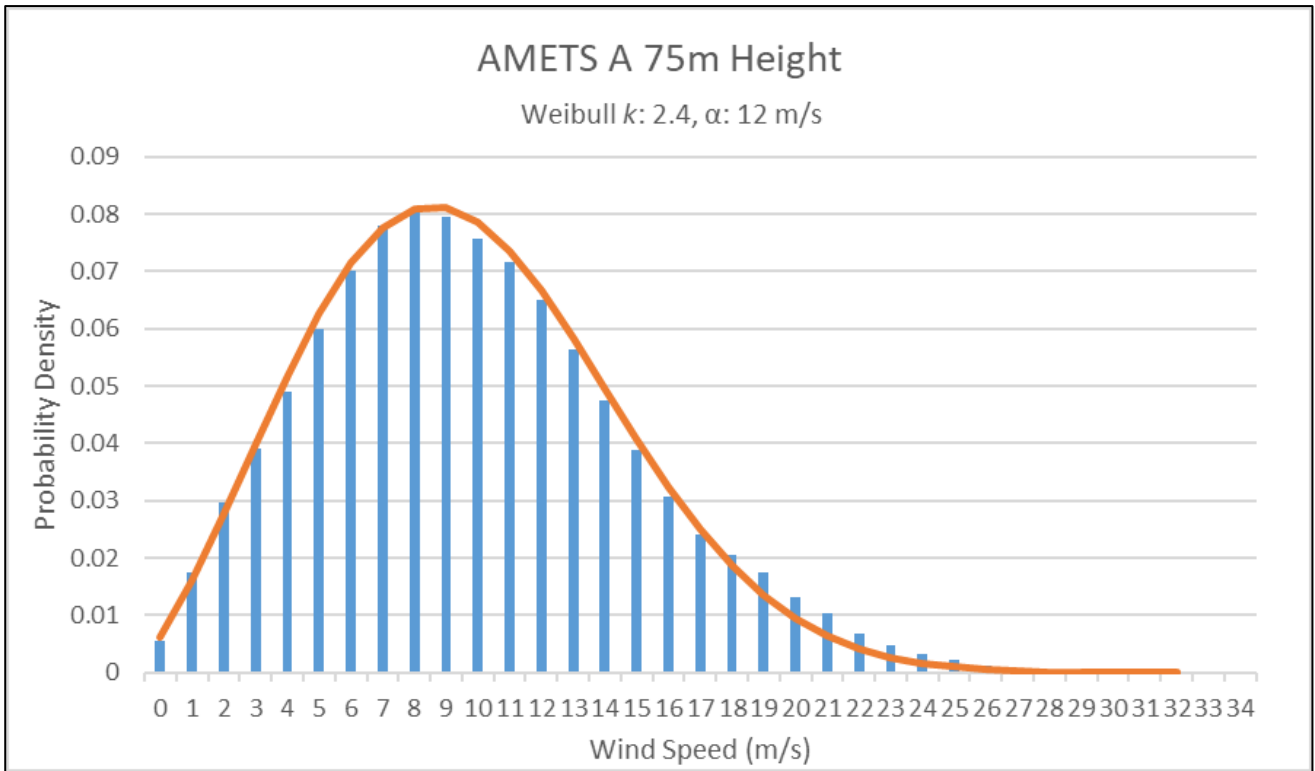


Figure 7. Probability Density Graph for 75m height with Weibull Function in Orange

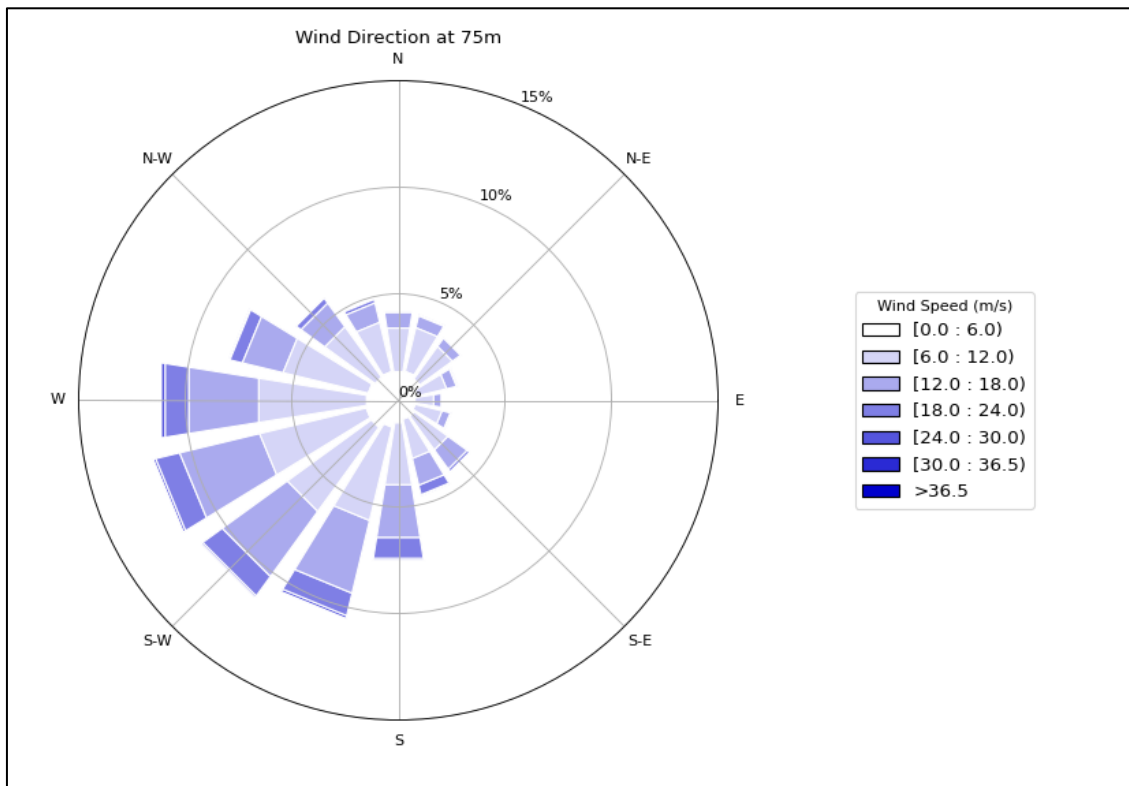


Figure 8. Wind rose showing measured wind direction and wind speed at 75m over the POR

100m Height

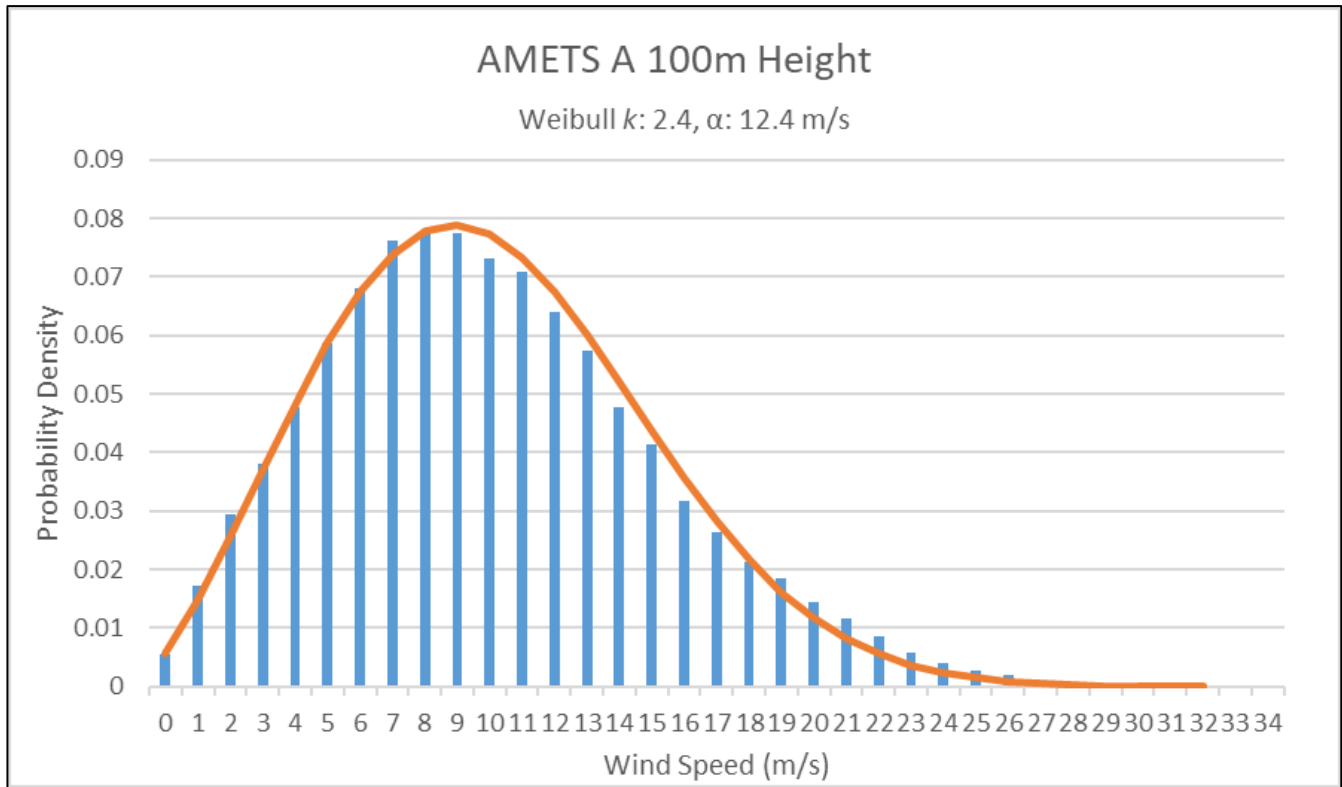


Figure 9. Probability Density Graph for 100m height with Weibull Function in Orange

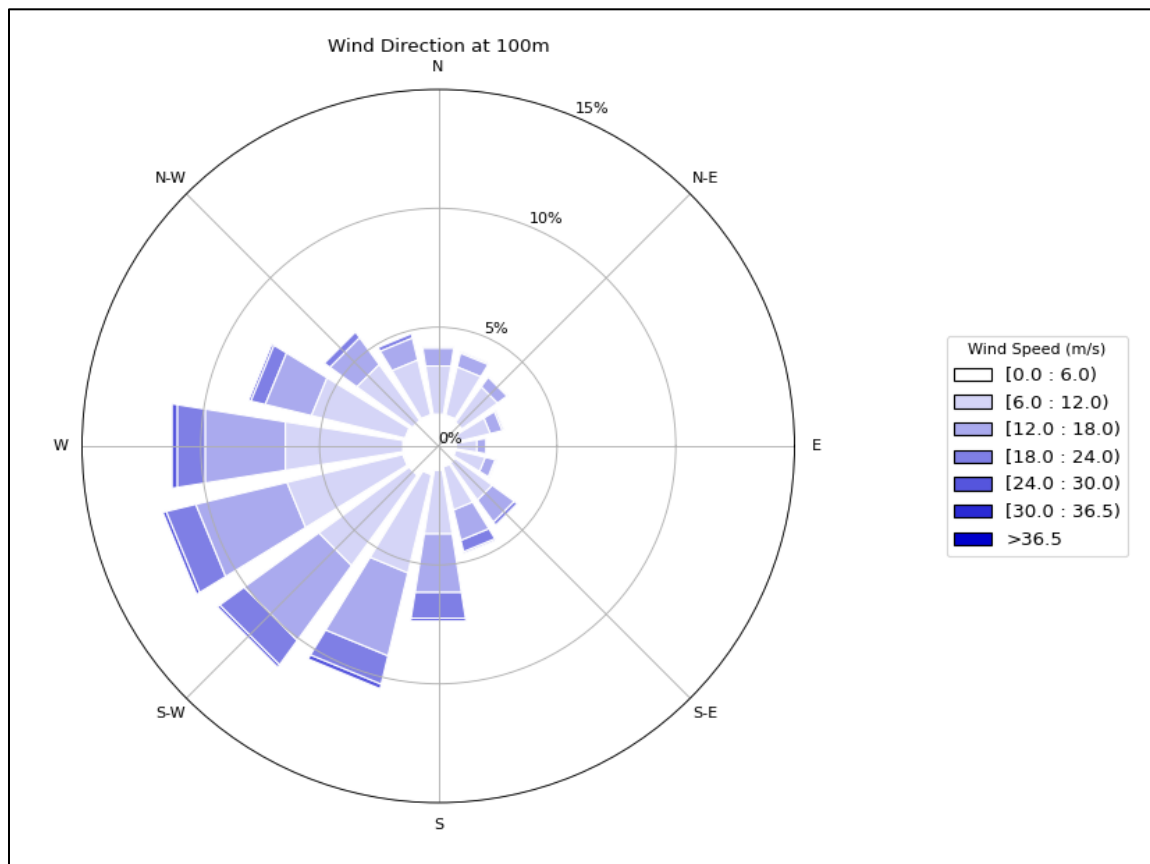


Figure 10. Wind rose showing measured wind direction and wind speed at 100m over the POR

150m Height

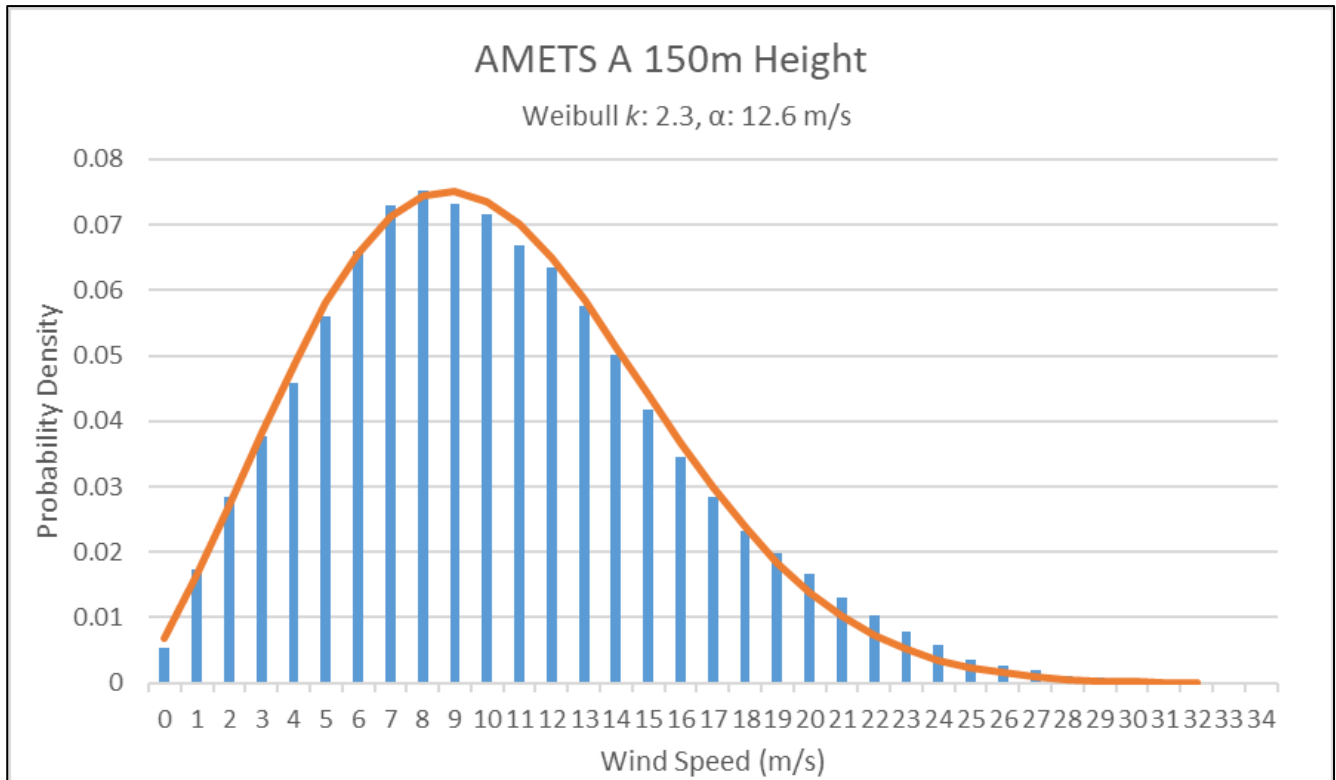


Figure 11. Probability Density Graph for 150m height with Weibull Function in Orange

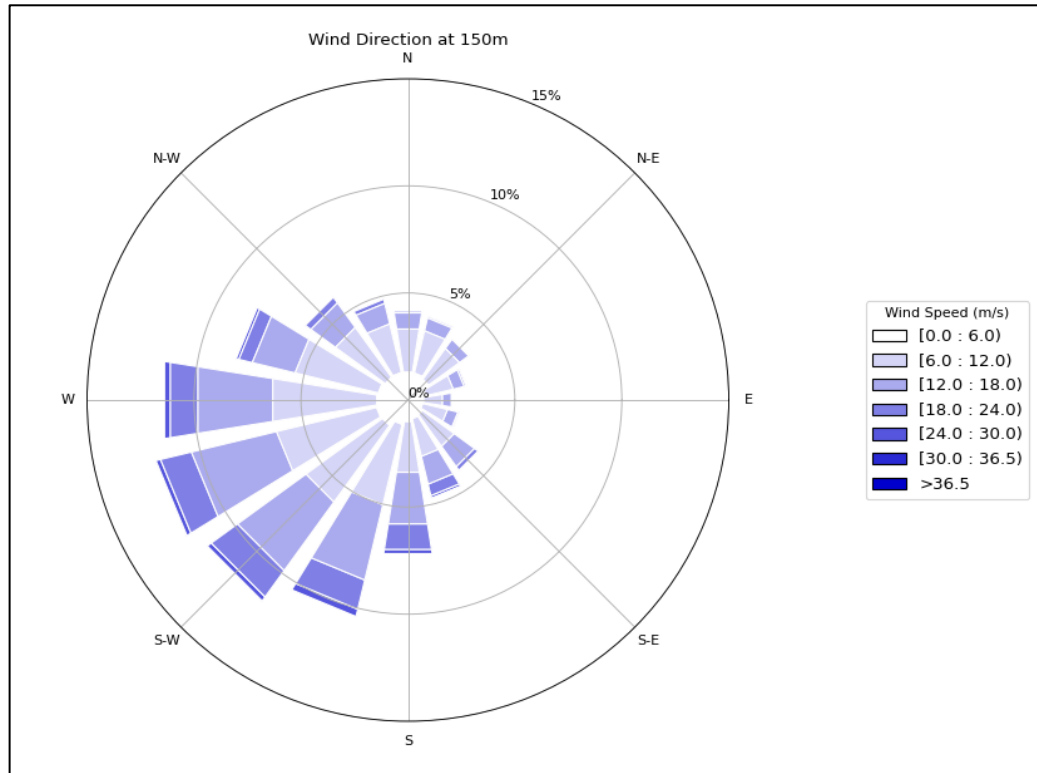


Figure 12. Wind rose showing measured wind direction and wind speed at 150m over the POR

200m Height

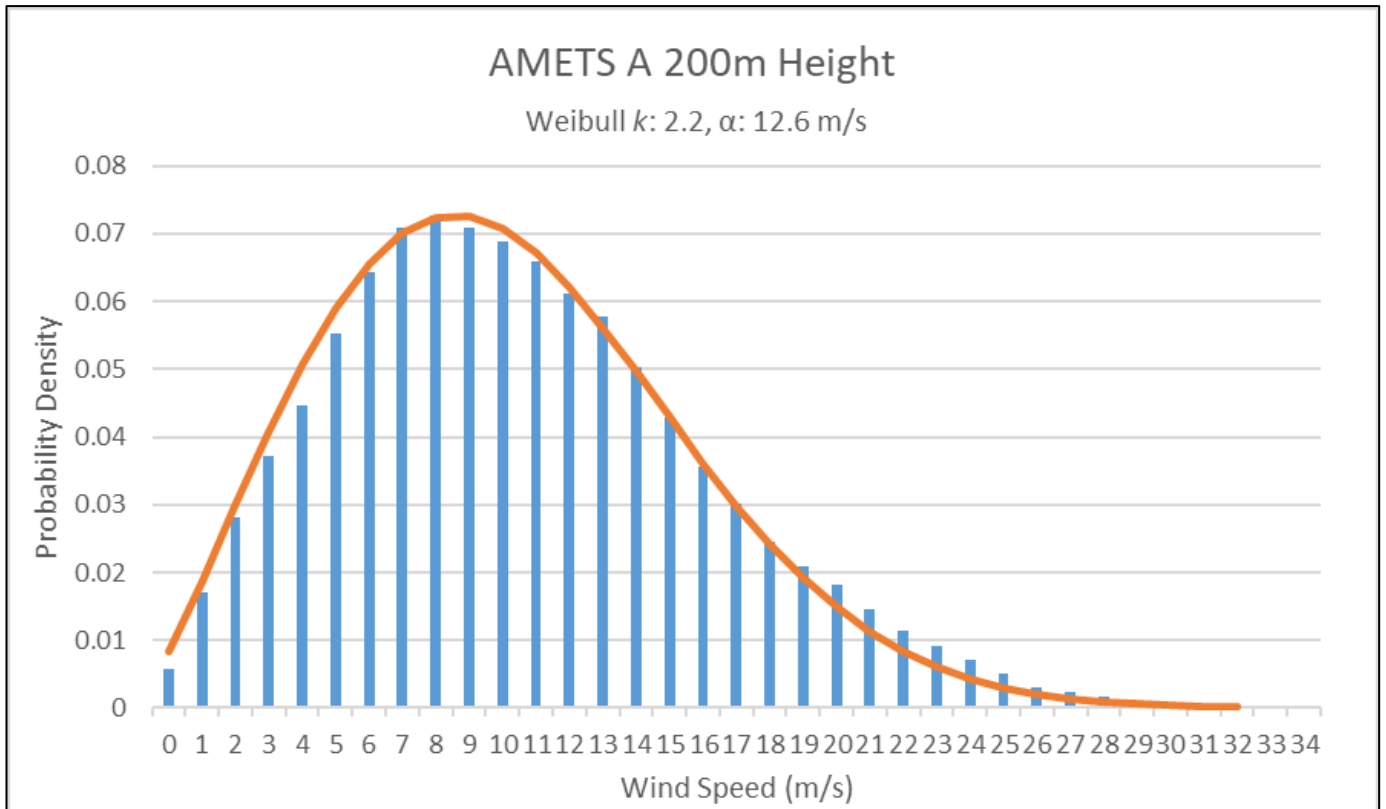


Figure 13. Probability Density Graph for 200m height with Weibull Function in Orange

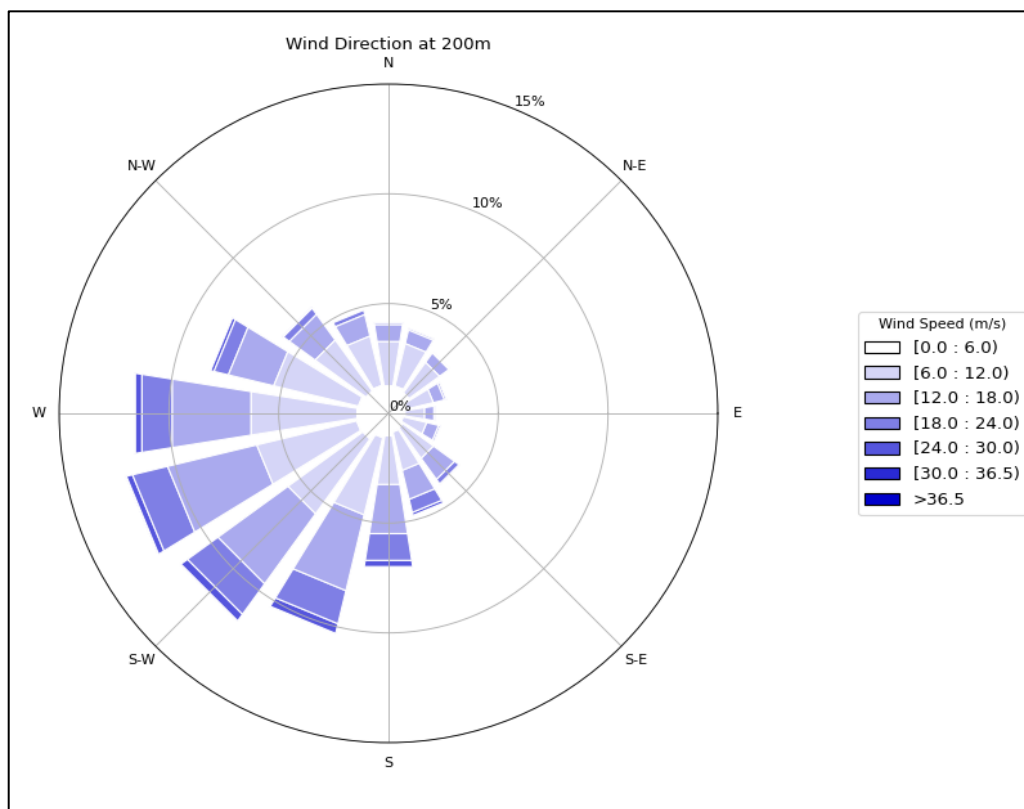


Figure 14. Wind rose showing measured wind direction and wind speed at 200m over the POR

250m Height

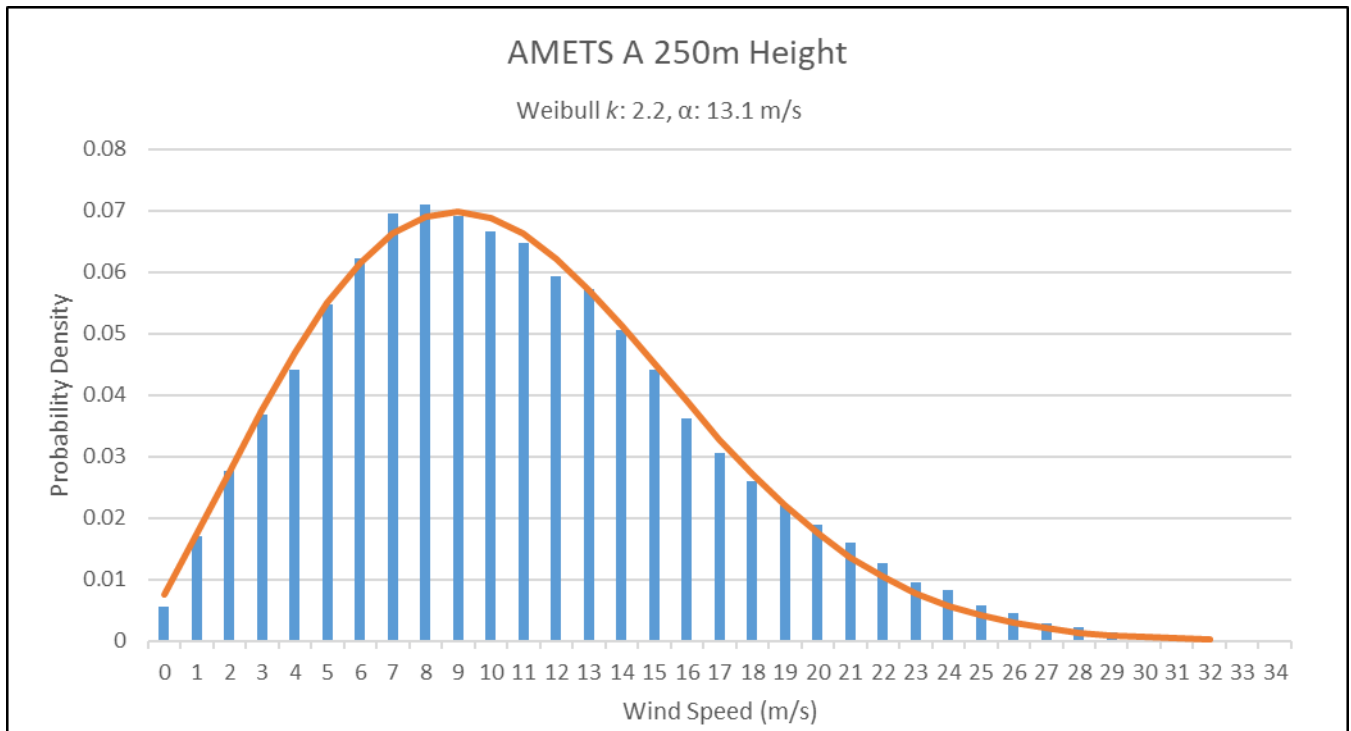


Figure 15. Probability Density Graph for 250m height with Weibull Function in Orange

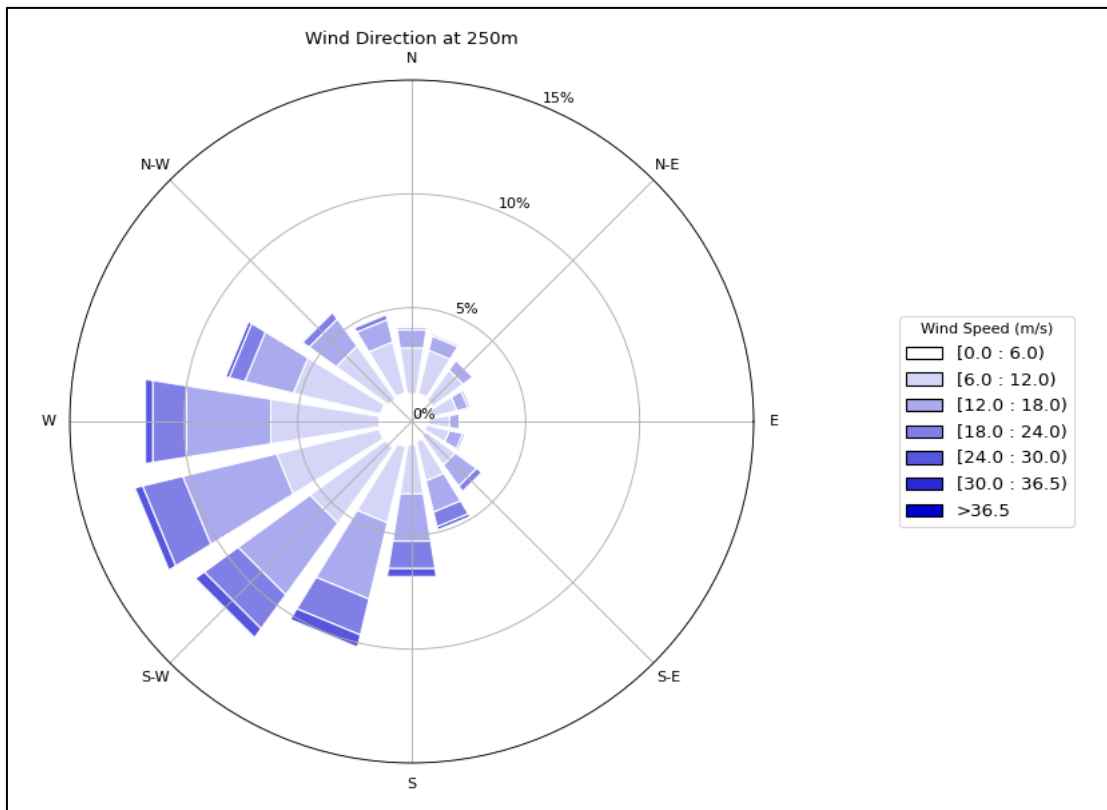


Figure 16. Wind rose showing measured wind direction and wind speed at 250m over the POR

