LONG TERM SITE
WIND DATA ANNUAL REPORT

Mt. Tom

July 1, 2012 – June 30, 2013

Prepared for

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NOTICE AND ACKNOWLEDGEMENTS

This report was prepared by the Wind Energy Center (WEC) at the University of Massachusetts, Amherst in the course of performing work sponsored by the Renewable Energy Trust (RET), as administered by the Massachusetts Clean Energy Center (MassCEC). The opinions expressed in this report do not necessarily reflect those of MTC or the Commonwealth of Massachusetts, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it.

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EXECUTIVE SUMMARY

All the work presented in this Wind Data Report including installation and decommissioning of the meteorological tower and instrumentation, and the data analysis and reporting was performed by the Wind Energy Center (WEC) at the University of Massachusetts, Amherst.

This wind measurement station is installed on the FAA tower and on the University of Massachusetts wind turbine at Mt. Tom in Holyoke, MA. Installed in December of 1999, the station is in continuous operation to this day. Currently there are three anemometers at each of two heights, 24.4 m (80.0 ft) and 36.6 m (120.1 ft).

During the period covered by this report, July, 2012 – June, 2013, the mean recorded wind speed at 36.6m was 6.14 m/s (13.73 mph*) and the prevailing wind direction was from the West-Northwest. The average turbulence intensity measured at wind speeds near 10 m/s at 36.6 m was 0.15. The gross data recovery percentage (the actual percentage of expected data received) was 100% and the net data recovery percentage (the percentage of expected data which passed all of the quality assurance tests) was 98.1%.

Additional information about interpreting the data presented in this report can be found in the Fact Sheet, "Interpreting Your Wind Resource Data," produced by the WEC and the Massachusetts Technology Collaborative (MTC). This document is found through the WEC website:

http://www.umass.edu/windenergy/publications/published/communityWindFactSheets/RERL_Fact_Sheet_6_Wind_resource_interpretation.pdf

* 1 m/s = 2.237 mph.

SECTION 1 - Station Location

The Mt. Tom site is located at an existing FAA tower on top of Mt. Tom in Holyoke, MA. Some trees are located in the vicinity, as is an ESI-80 wind turbine. The location of the tower base is at 42° 14’ 59.2” N, 72° 38’ 42.2” W (NAD 27). The FAA tower of located at the east side of a high, West-facing ridge, at the top of the old Mt. Tom Ski slopes.

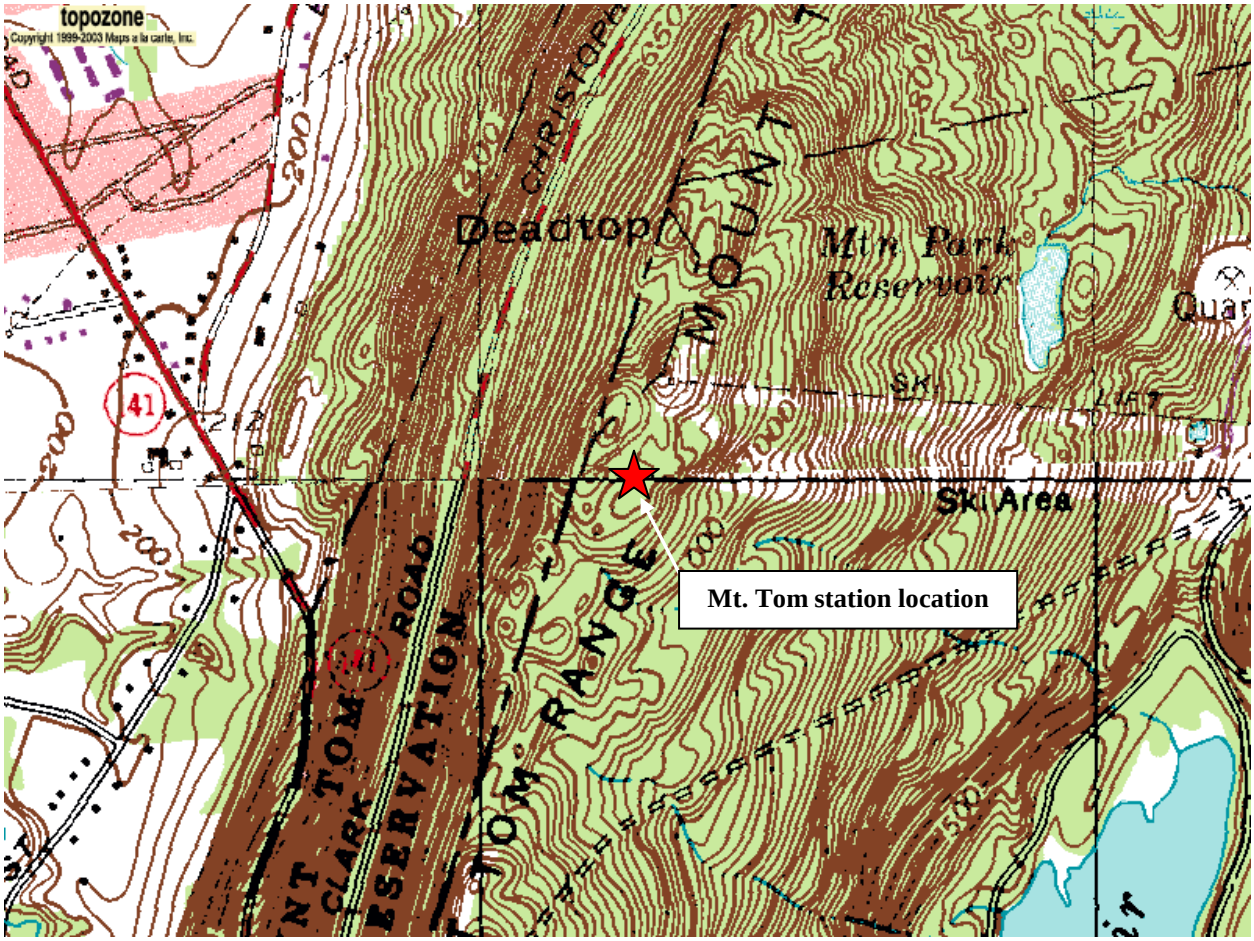

Figure 1 – Station location of Mt. Tom.

www.topozone.com

SECTION 2 - Instrumentation and Equipment

The wind monitoring equipment is mounted on two towers, the first, a 160 ft lattice FAA tower and the second, a 80 ft lattice wind turbine tower. The wind monitoring equipment is as follows:

- 1 Symphonie Logger within an electrical enclosure box
- 6 - #40c Anemometers, three anemometers are located at both 24.4 m (80.0 ft) and 36.6 m (120.1 ft).
- 2 - #200P Wind direction vanes. They are located at both 24.4 m (80.0 ft) and 36.6 m (120.0 ft).
- Shielded sensor wire and a junction box at the base of the FAA tower

SECTION 3- Data Summary

A summary of the wind speeds and wind directions measured during the reporting period is included in Table 1. Table 1 includes the mean wind speeds measured at each measurement height, the maximum instantaneous wind speed measured at each measurement height and the prevailing wind direction measured at each measurement height. These values are provided for each month of the reporting period and for the whole reporting period.

Table 1. Wind Speed and Direction Data Summary

	Month	TI at 10 m/s [-]	NDR [%]	Mean Wind Shear Coefficient Between 36.6 and 24.4 meters []	NDR [%]
36.6 m	12-Jul	0.1274	99.98	0.4022	99.98%
	12-Aug	0.1194	100	0.3705	100%
	12-Sep	0.1555	100	0.4030	100%
	12-Oct	0.1507	99.98	0.4133	99.98%
	12-Nov	0.1469	100	0.397	100%
	12-Dec	0.1557	99.91	0.4751	99.73%
	13-Jan	0.1383	99.87	0.4092	99.73%
	13-Feb	0.1708	99.73	0.4547	99.68
	13-Mar	0.1597	99.98	0.4360	99.98%
	13-Apr	0.1695	99.93	0.3698	99.88%
	13-May	0.1386	99.98	0.4142	99.98%
	13-Jun	0.1436	99.95	0.4299	99.95%
	FY 2013	0.148	99.94	0.4146	97.57%
24.4 m	12-Jul	0.1764	99.98%		
	12-Aug	0.1569	100.00%		
	12-Sep	0.1807	100.00%		
	12-Oct	0.2102	99.98%		
	12-Nov	0.1978	100.00%		
	12-Dec	0.2091	99.73%		
	13-Jan	0.1898	99.73%		
	13-Feb	0.2178	99.68%		
	13-Mar	0.187	100.00%		
	13-Apr	0.2195	99.88%		
	13-May	0.2122	99.98%		
	13-Jun	0.1875	99.98%		
	FY 2013	0.195	99.91%		

Wind data statistics in the table are reported when more than 90% of the data during the reporting period that are valid. In cases when a large amount of data is missing, the percent of the available data that are used to determine the data statistics is noted. No measurement of wind speed or direction can be perfectly accurate. Wind speed measurement errors occur due to anemometer manufacturing variability, anemometer calibration errors, the response of anemometers to turbulence and vertical air flow and

due to air flows caused by the anemometer mounting system. Every effort is made to reduce the sources of these errors. Nevertheless, the values reported in this report have an expected uncertainty of about ± 2% or ± 0.2 m/s, whichever is greater. Wind direction measurement errors occur due to sensor measurement uncertainty, tower effects, boom alignment measurement errors and twisting of pipe sections during the raising of a pipe tower. Efforts are also made to reduce these errors, but the reported wind directions are estimated to have an uncertainty of +/- 5 degrees.

A summary of the turbulence intensity and mean wind shear measured at each measurement height during the reporting period is included in Table 2. These values are provided for each month of the reporting period and for the whole reporting period. Turbulence Intensity is calculated by dividing the standard deviation of the wind speed by the mean wind speed and is a measure of the gustiness of a wind resource. Lower turbulence results in lower mechanical loads on a wind turbine. Turbulence intensity varies with wind speed. The average turbulence intensity presented in Table 2 is the mean turbulence intensity when the wind speed at each measurement height is between 10 and 11 m/s.

Shear coefficients provide a measure of the change in wind speed with height. When data at multiple heights are available, shear coefficients, α, have been determined. They can be used in the following formula to estimate the average wind speed, $U(z)$, at height z, when the average wind speed, $U(z_r)$, at height z_r is known:

$$U(z)=U(z_r)\left(\frac{z}{z_r}\right)^{\alpha}$$

The change in wind speed with height is a very complicated relationship related to atmospheric conditions, wind speed, wind direction, time of day and time of year. This formula will not always provide the correct answer at any given site. Nevertheless the calculated shear coefficient, based on measurements at two heights, can be used to characterize the degree of increase in wind speed with height at a site.

The mean wind shear coefficient that is provided here is calculated based on the mean wind speeds in Table 1, where z_{high} and z_{low} are the heights of the higher and lower mean wind speeds used in the calculation and $U(z_{low})$ and $U(z_{high})$ are the mean wind speeds at the two heights.

$$\alpha = \log\left(\frac{U(z_{high})}{U(z_{low})}\right) \Big/ \log\left(\frac{z_{high}}{z_{low}}\right)$$

Table 2. Shear and Turbulence Intensity Data Summary

Table 3. Seasonal Average Wind Shear

	Mean Wind Shear Coefficient Between 36.6 and 24.4 meters [-]	NDR [%]
Jul - Sep 2012	0.3927	99.9%
Oct - Dec 2012	0.4267	99.9%
Jan - Mar 2013	0.4326	99.8%
Apr - Jun 2013	0.4027	99.9%

Table 4. Day and Night Time Wind Shear Averages

	Mean Wind Shear Coefficient Between 36.6 and 24.4 meters [-]
Day (6am-6pm)	0.4921
Night (6pm – 6am)	0.3971

Table 5. Average Directional Wind Shear

Direction Sector [deg]	Mean Wind Shear Coefficient Between 36.6 and 24.4 meters [-]
0	0.44966
22.5	0.369927
45	0.447535
67.5	0.72385
90	0.317941
112.5	0.043749
135	0.196426
157.5	0.264663
180	0.350072
202.5	0.377937
225	0.480799
247.5	0.474956
270	0.568541
292.5	0.4469
315	0.437298
337.5	0.711288

SECTION 4- Graphs

This report contains several types of wind data graphs. Unless otherwise noted, each graph represents data from 1 quarter (3 months). Each quarterly graph corresponds to a quarter of fiscal year 2013: Quarter 1 (July 2012-September 2012), Quarter 2 (October 2012 to December 2012), Quarter 3 (January 2013 – March 2013), or Quarter 4 (April 2013 – June 2013) The following graphs are included:

- Time Series – 10-minute average wind speeds are plotted against time.
- Wind Speed Distribution – A histogram plot giving the percentage of time that the wind is at a given wind speed.
- Monthly Average – A plot of the monthly average wind speed over the three-month period. This graph shows the trends in the wind speed over the year.
- Diurnal – A plot of the average wind speed for each hour of the day.
- Turbulence Intensity – A plot of turbulence intensity as a function of wind speed. turbulence intensity is calculated as the standard deviation of the wind speed divided by the wind speed and is a measure of the gustiness of a wind resource. Lower turbulence results in lower mechanical loads on a wind turbine.
- Wind Rose – A plot, by compass direction showing the percentage of time that the wind comes from a given direction and the average wind speed in that direction.
- Annual Average Wind Speeds – shows the average wind speed for the last several fiscal years

With regard to the Mt. Tom site, the following observations are noted.

- Time Series – The peak wind speeds for the year occurred in January 2013
- Wind Speed Distribution – Q3 experienced the highest wind speeds
- Monthly Average – The winter months show higher average wind speeds than the summer months.
- Diurnal – Wind Speeds at this site tend to be lowest in the morning
- Turbulence Intensity – In each quarter turbulence intensities for high wind speeds generally stay below 0.2

- Wind Rose – The wind rose shape varies significantly from quarter to quarter, but the North and West directions typically see the highest mean wind speed in any season.

- Annual Average Wind Speeds – The mean wind speed in FY 2013, 6.14 m/s, is slightly above the long-term average at the site, 5.97 m/s.

Data for the wind speed histograms, quarterly and diurnal average plots, and wind roses are included in 0.

Wind Speed Time Series

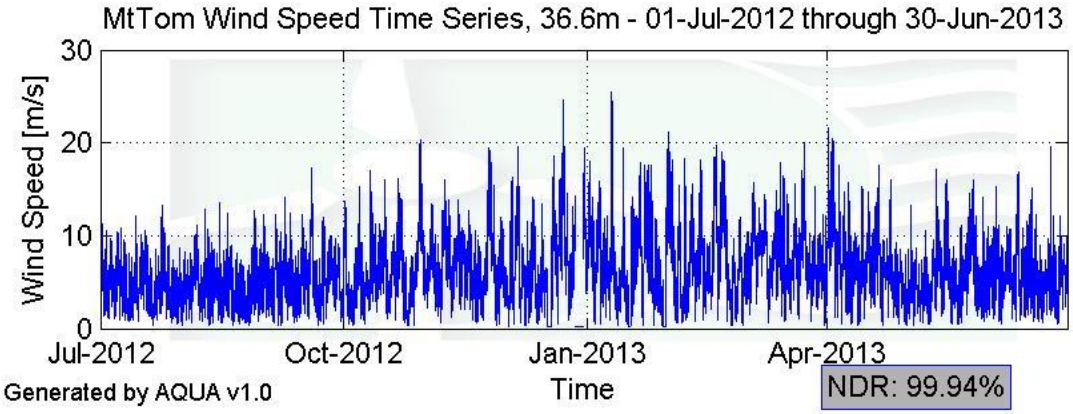

Figure 2 – Wind Speed Time Series

Wind Speed Distributions

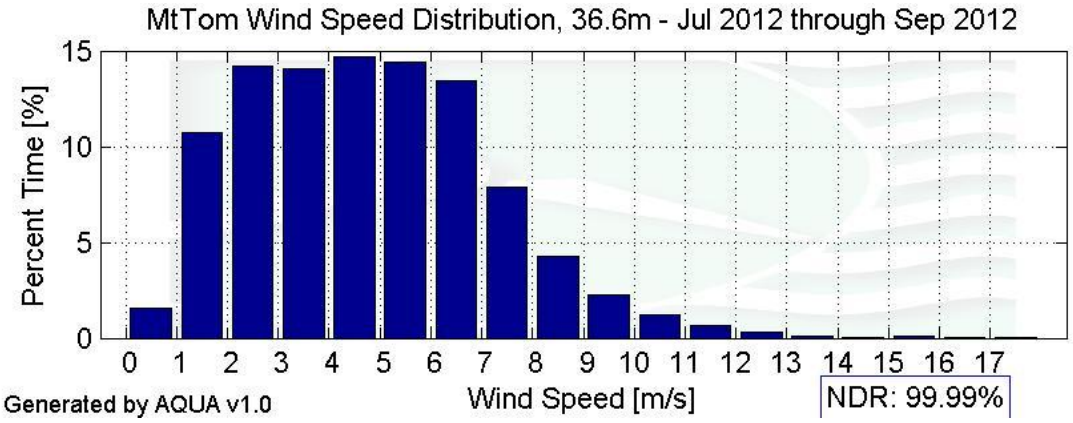

Figure 3a – Wind Speed Distribution Jul 2012 – Sep 2012

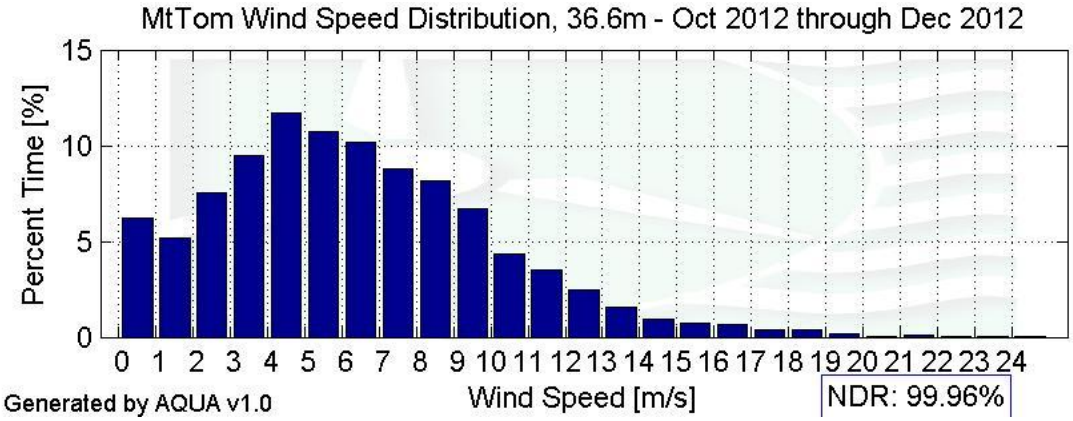

Figure 4b – Wind Speed Distribution Oct 2012 – Dec 2012

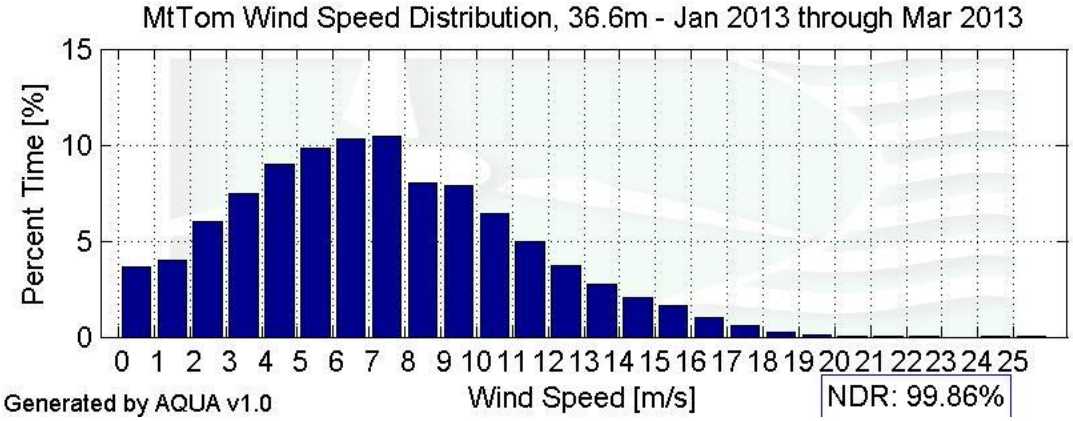

Figure 4c – Wind Speed Distribution Jan 2013 – Mar 2013

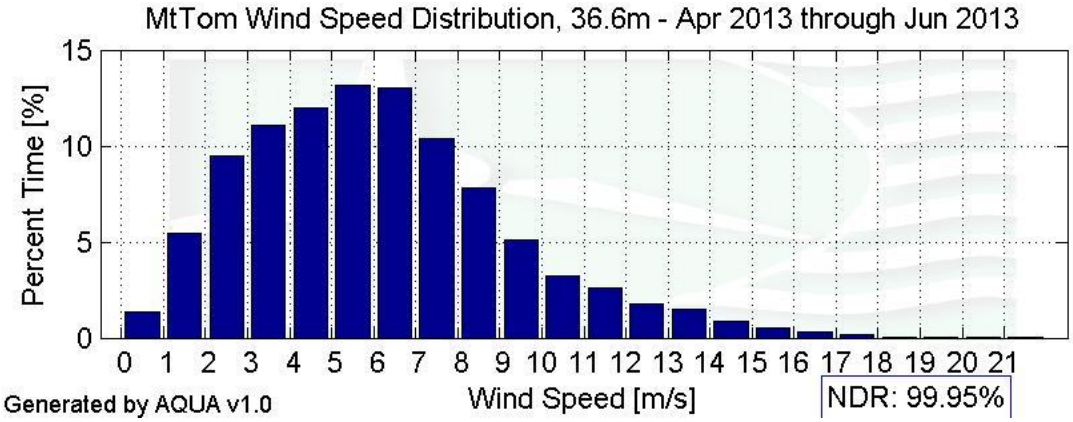

Figure 4d – Wind Speed Distribution Apr 2013 – Jun 2013

Monthly Average Wind Speeds

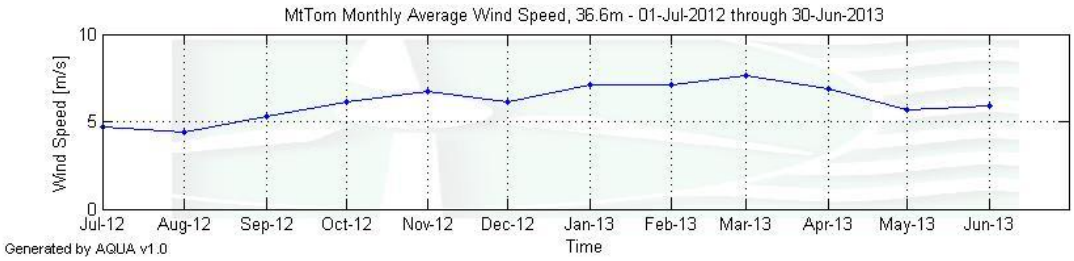

Figure 4 – Monthly Average Wind Speed

Diurnal Average Wind Speeds

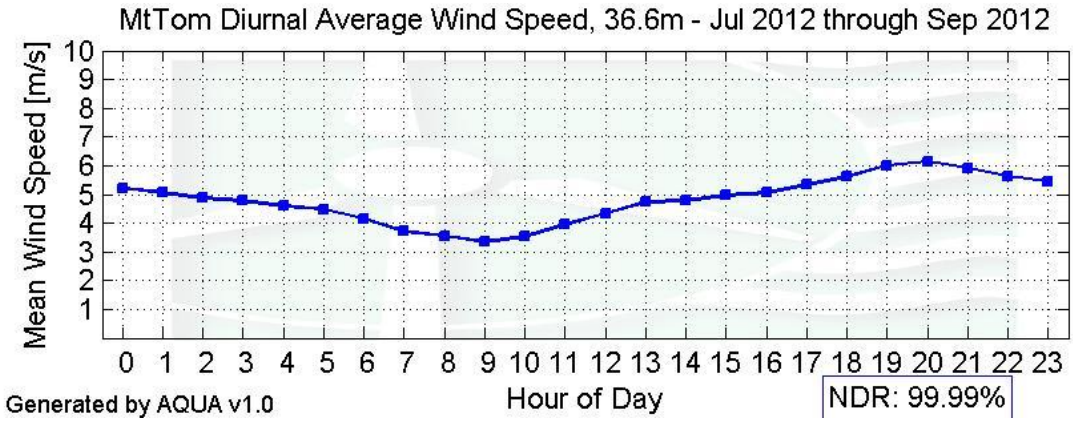

Figure 5a – Diurnal Average Wind Speeds Jul 2012 – Sep 2012

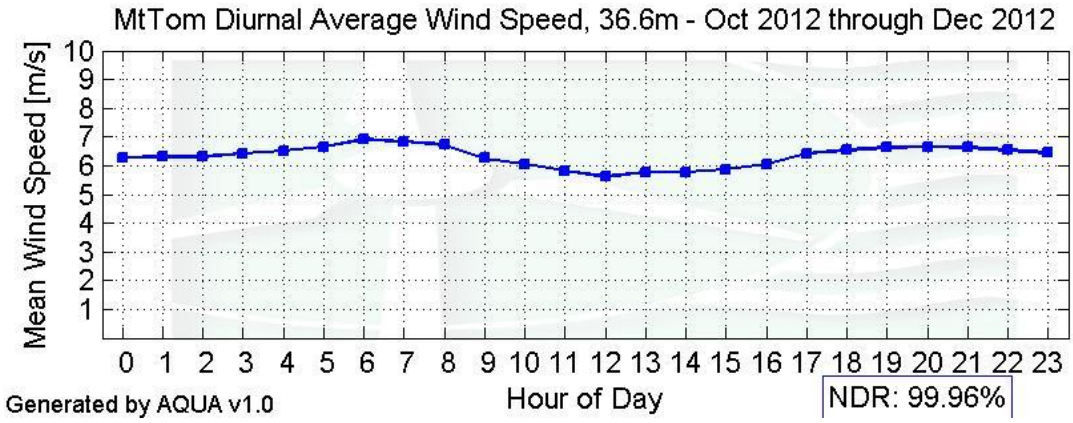

Figure 6b – Diurnal Average Wind Speeds Oct 2012 – Dec 2012

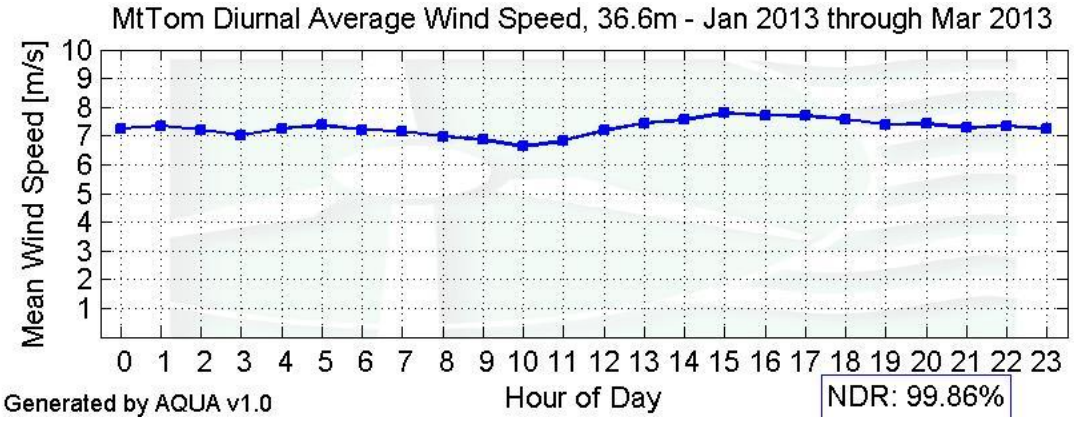

Figure 6c – Diurnal Average Wind Speeds Jan 2013 – Mar 2013

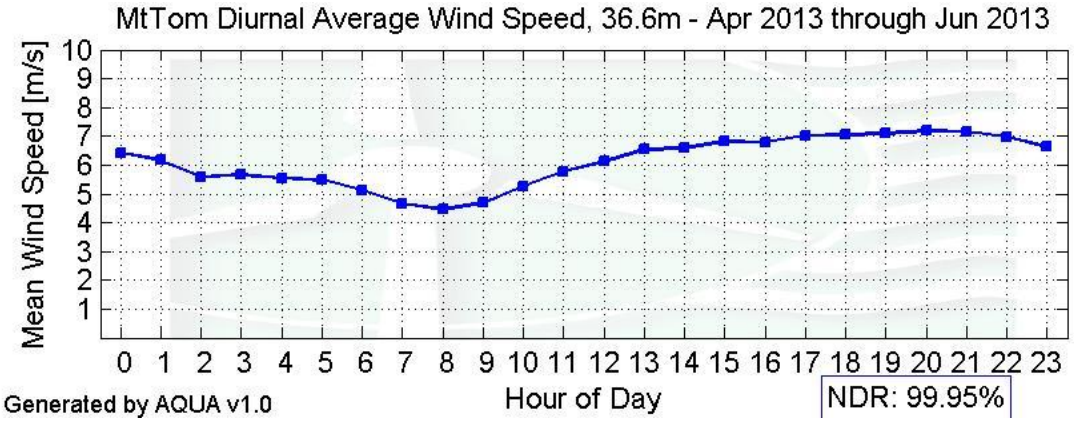

Figure 6d – Diurnal Average Wind Speeds Apr 2013 – Jun 2013

Turbulence Intensities

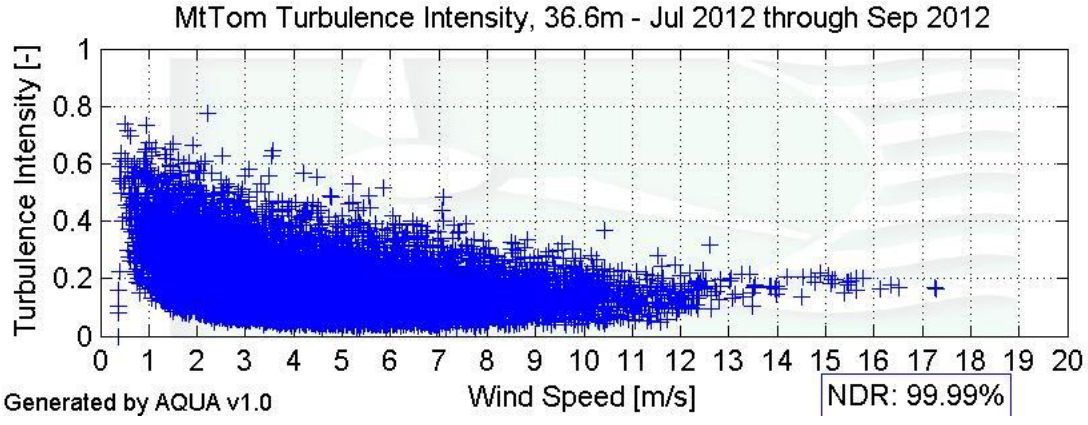

Figure 6a – Turbulence Intensity Jul 2012 – Sep 2012

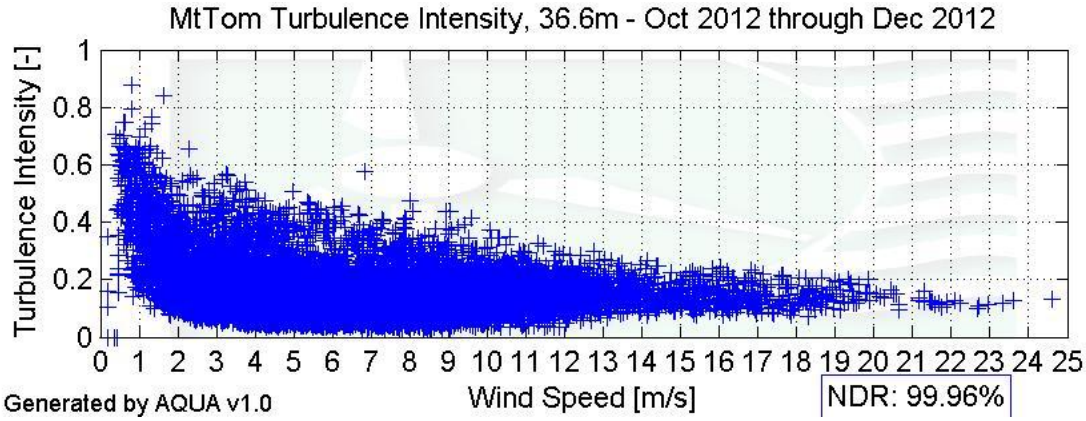

Figure 7b – Turbulence Intensity Oct 2012 – Dec 2012

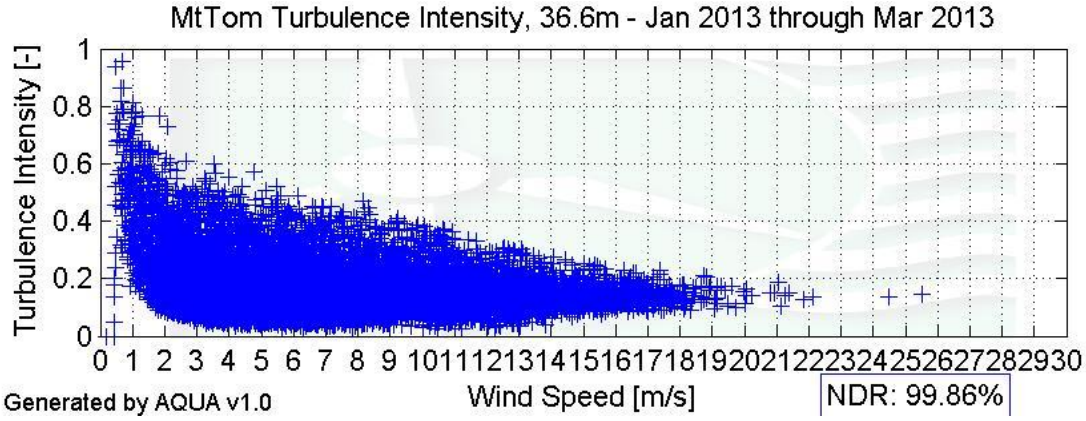

Figure 7c – Turbulence Intensity Jan 2013 – Mar 2013

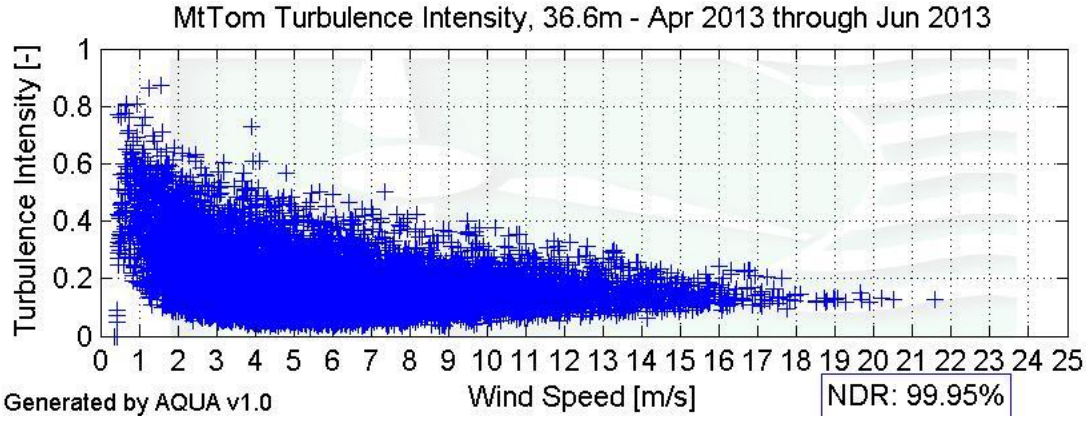

Figure 7d – Turbulence Intensity Apr 2013 – Jun 2013

Wind Roses

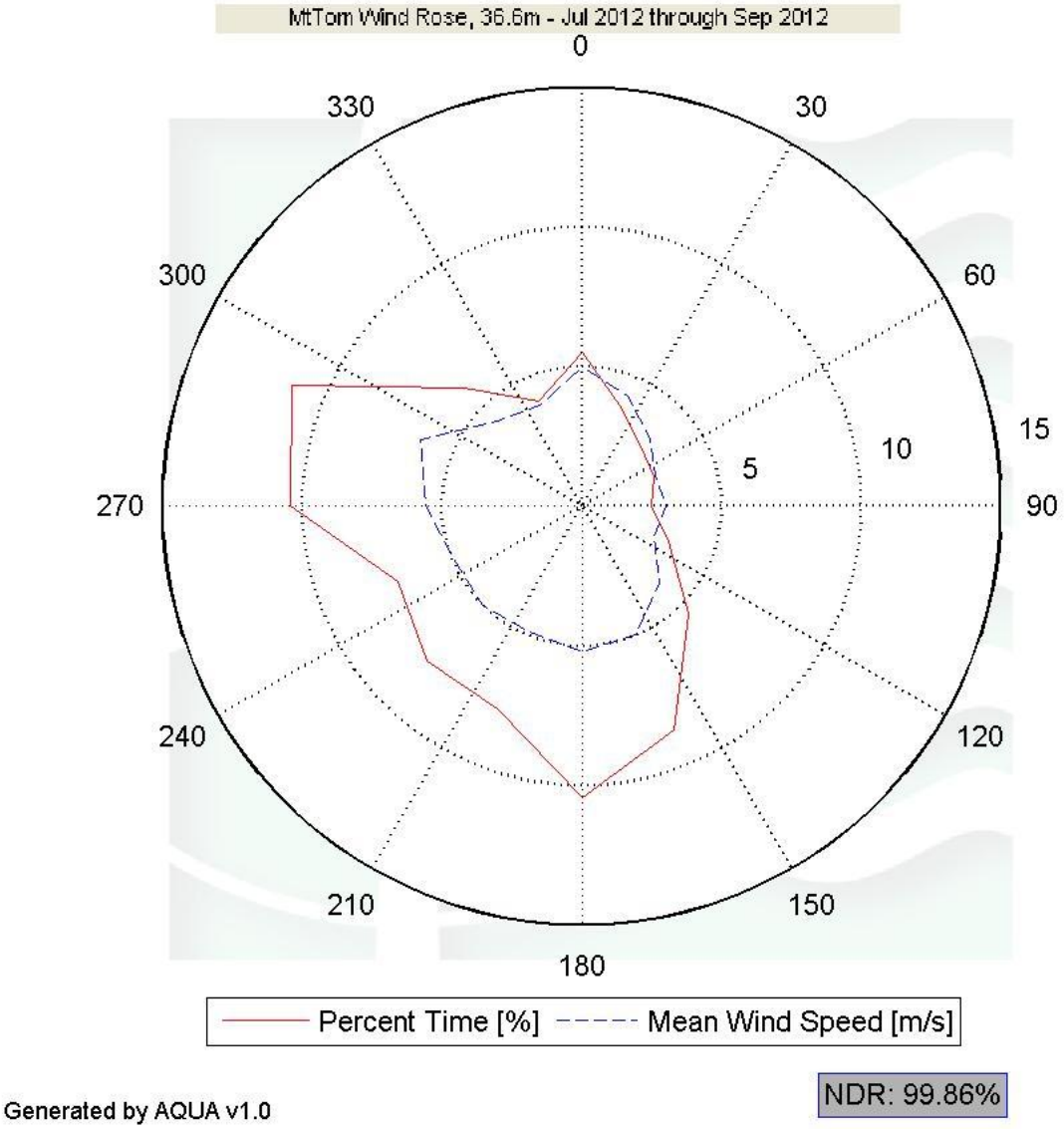

Figure 7a – Wind Rose Jul 2012 – Sep 2012

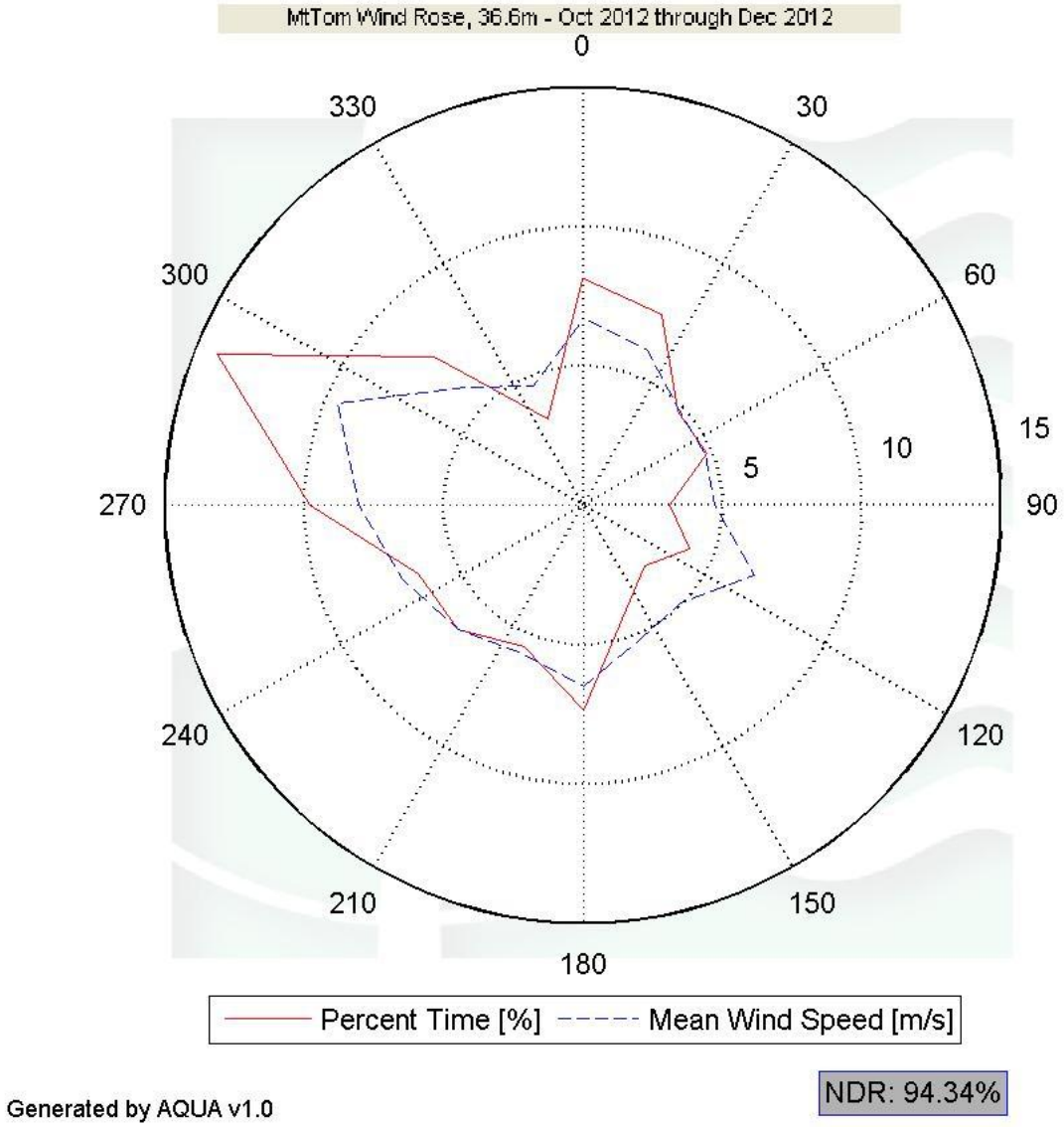

Figure 8b – Wind Rose Oct 2012 – Dec 2012

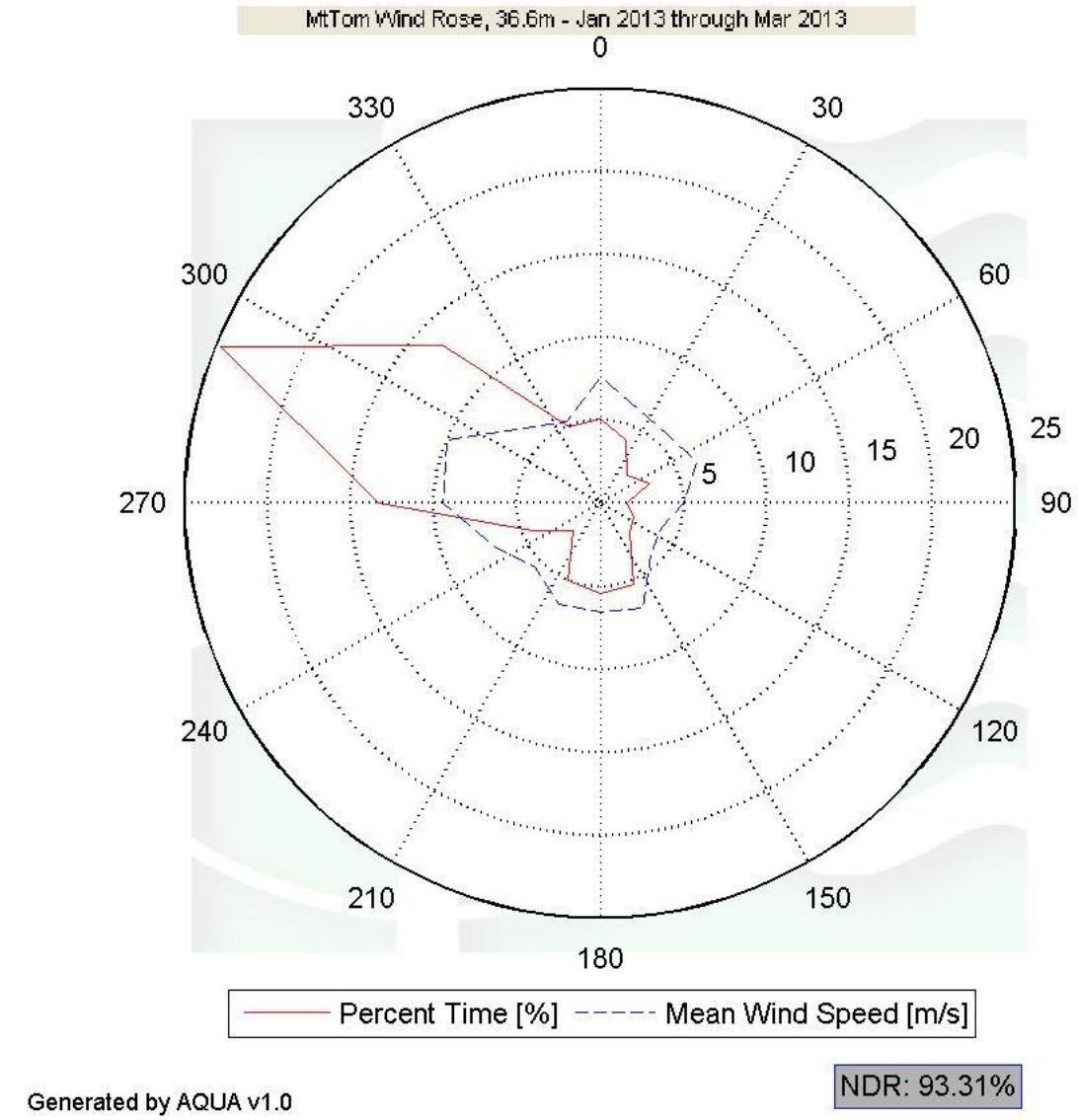

Figure 8c – Wind Rose Jan 2013 – Mar 2013

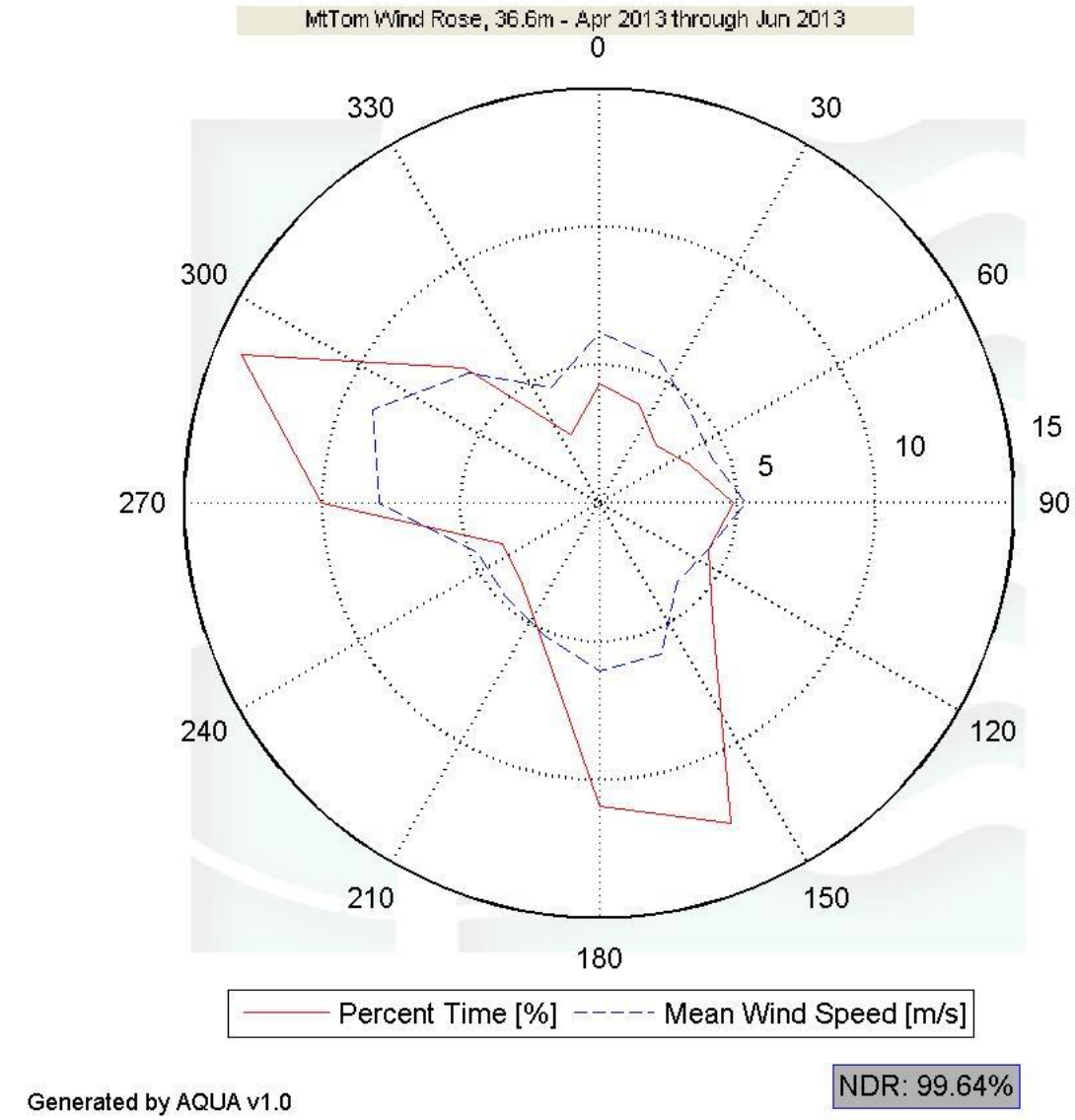

Figure 8d – Wind Rose Apr 2013 – Jun 2013

Annual Average Wind Speeds

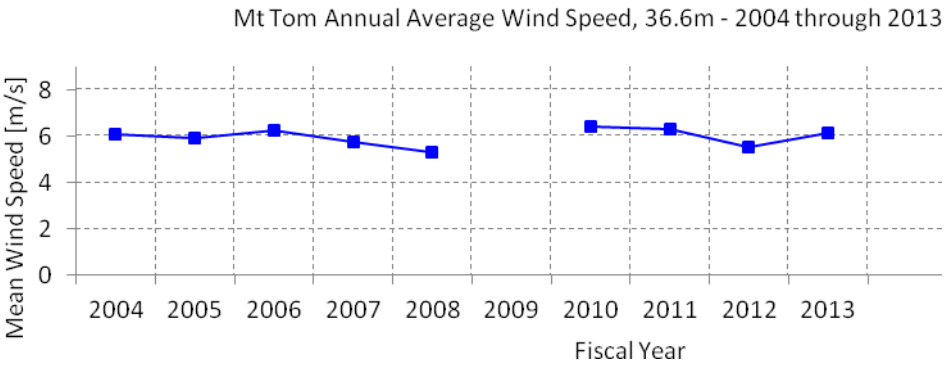

Figure 8 – Annual Average Wind Speed 1999 – 2013

SECTION 5 - Significant Meteorological Events

No meteorological events significant enough to affect monthly averages occurred during this reporting period.

SECTION 6 - Data Collection and Maintenance

When the sensors on Mt. Tom were replaced, the two Riso anemometers were replaced with class1 40c anemometers, because the Riso anemometers insufficiently durable.

SECTION 7 - Data Recovery and Validation

All raw wind data are subjected to a series of tests and filters to weed out data that are faulty or corrupted. Definitions of these quality assurance (QA) controls are given below under Test Definitions and Sensor Statistics. These control filters were designed to automate the quality control process and used many of the previous hand-worked data sets made at UMass to affect a suitable emulation. The gross percentage of data recovered (ratio of the number of raw data points received to data points expected) and net percentage (ratio of raw data points which passed all QA control tests to data points expected) are shown below.

Gross Data Recovered [%]	100.0
Net Data Recovered [%]	99.8

Test Definitions

All raw data were subjected to a series of validation tests, as described below. The sensors tested and the parameters specific to each sensor are given in the Sensor Performance Report which is included in APPENDIX A. Data which were flagged as invalid were not included in the statistics presented in this report.

MinMax Test: All sensors are expected to report data values within a range specified by the sensor and logger manufacturers. If a value falls outside this range, it is flagged as invalid. A data value from the sensor listed in Test Field 1 (TF1) is flagged if it is less than Factor 1 (F1) or greater than Factor 2. This test has been applied to the following sensors (as applicable): wind speed, wind speed standard deviation, wind direction, temperature, and solar insolation.

$$F1 > TF1 > F2$$

MinMaxT Test: This is a MinMax test for wind direction standard deviation with different ranges applied for high and low wind speeds. A wind direction standard deviation data value (TF1) is flagged either if it is less than Factor 1, if the wind speed (TF2) is less than Factor 4 and the wind direction standard deviation is greater than Factor 2, or if the wind speed is greater than or equal to Factor 4 and the wind direction standard deviation is greater than Factor 3.

$$(TF1 < F1)$$
$$\text{or } (TF2 < F4 \text{ and } TF1 > F2)$$
$$\text{or } (TF2 \geq F4 \text{ and } TF1 > F3)$$

Icing Test: An icing event occurs when ice collects on a sensor and degrades its performance. Icing events are characterized by the simultaneous measurements of near-zero standard deviation of wind direction, non-zero wind speed, and near- or below-freezing temperatures. Wind speed, wind speed standard deviation, wind direction, and wind direction standard deviation data values are flagged if the wind direction standard deviation (CF1) is less than or equal to Factor 1 (F1), the wind speed (TF1) is greater than Factor 2 (F2), and the temperature (CF2) is less than Factor 3 (F3). To exit an icing event, the wind direction standard deviation must be greater than Factor 4.

$$CF1 \leq F1 \text{ and } TF1 > F2 \text{ and } CF2 < F3$$

CompareSensors Test: Where primary and redundant sensors are used, it is possible to determine when one of the sensors is not performing properly. For anemometers, poor performance is characterized by low data values. Therefore, if one sensor of the pair reports values significantly below the other, the low values are flagged. At low wind speeds (Test Fields 1 and 2 less than or equal to Factor 3) wind speed data are flagged if the absolute difference between the two wind speeds is greater than Factor 1. At high wind speeds (Test Fields 1 or 2 greater than Factor 3) wind speed data are flagged if the absolute value of the ratio of the two wind speeds is greater is greater than Factor 2.

$$[\ TF1 \leq F3 \text{ and } TF2 \leq F3 \text{ and } abs(TF1 - TF2) > F1\ ]$$
$$\text{or } [\ (TF1 > F3 \text{ or } TF2 > F3) \text{ and } (abs(1 - TF1 / TF2) > F2 \text{ or } abs(1 - TF2 / TF1) > F2)\ ]$$

Sensor Statistics

A summary of the results of the data collection and filtering are given in the Sensor Performance Report which is included in APPENDIX A. The following categories of information, tabulated for each sensor, are included in that report.

Expected Data Points: the total number of sample intervals between the start and end dates (inclusive).

Actual Data Points: the total number of data points recorded between the start and end dates.

% Data Recovered: the ratio of actual and expected data points (this is the *gross data recovered percentage*).

Hours Out of Range: total number of hours for which data were flagged according to MinMax and MinMaxT tests. These tests flag data which fall outside of an expected range.

Hours of Icing: total number of hours for which data were flagged according to Icing tests. This test uses the standard deviation of wind direction, air temperature, and wind speed to determine when sensor icing has occurred.

Hours of Fault: total number of hours for which data were flagged according to CompareSensors tests. These tests compare two sensors (e.g. primary and redundant anemometers installed at the same height) and flag data points where one sensor differs significantly from the other.

% Data Good: the filter results are subtracted from the gross data recovery percentage to yield the *net data recovered percentage*.

APPENDIX A - Sensor Performance Report

Test Definitions

TestOrder	TestField1	TestField2	TestField3	CalcField1	CalcField2	CalcField3	TestType	Factor1	Factor2	Factor3	Factor4
1	Temp>T_val						MinMax	-30	60	0	0
2	AnemRMY17>WS_val						MinMax	0	90	0	0
3	AnemRMY17>WS_SD						MinMax	0	4	0	0
4	AnemRMY19>WS_val						MinMax	0	90	0	0
5	AnemRMY19>WS_SD						MinMax	0	4	0	0
6	Anem24W>WS_val						MinMax	0	90	0	0
7	Anem24W>WS_SD						MinMax	0	4	0	0
8	Anem24WSW>WS_val						MinMax	0	90	0	0
9	Anem24WSW>WS_SD						MinMax	0	4	0	0
10	Anem24R>WS_val						MinMax	0	90	0	0
11	Anem24R>WS_SD						MinMax	0	4	0	0
12	Vane24>WD_val						MinMax	0	359.9	0	0
13	Vane24>WD_SD						MinMax	0	100	0	0
14	Anem37W>WS_val						MinMax	0	90	0	0
15	Anem37W>WS_SD						MinMax	0	4	0	0
16	Anem37WSW>WS_val						MinMax	0	90	0	0
17	Anem37WSW>WS_SD						MinMax	0	4	0	0
18	Anem37R>WS_val						MinMax	0	90	0	0
19	Anem37R>WS_SD						MinMax	0	4	0	0
20	Vane37>WD_val						MinMax	0	359.9	0	0
21	Vane37>WD_SD						MinMax	0	100	0	0
22	Anem24W>WS_val	Anem24W>WS_SD	Vane24>WD_val	Vane24>WD_SD	Temp>T_val		Icing	0.5	1	2	4
23	Anem24WSW>WS_val	Anem24WSW>WS_SD	Vane24>WD_val	Vane24>WD_SD	Temp>T_val		Icing	0.5	1	2	4
24	Anem37W>WS_val	Anem37W>WS_SD	Vane37>WD_val	Vane37>WD_SD	Temp>T_val		Icing	0.5	1	2	4
25	Anem37WSW>WS_val	Anem37WSW>WS_SD	Vane37>WD_val	Vane37>WD_SD	Temp>T_val		Icing	0.5	1	2	4

Sensor Statistics

	Expected Data Points	Actual Data Points	% Data Recovered	Hours Out of Range	Hours of Icing	Hours of Fault	%Data Good
Temp	52560	52559	99.998	0	0	0	99.998
iPack	52560	52559	99.998	0	0	0	99.998
Anem24W	52560	52559	99.998	8.5	259.167	72.833	96.943
Anem24WSW	52560	52559	99.998	14.333	262.333	296	96.844
Anem24R	52560	52559	99.998	14.833	0	0	99.829
Vane24	52560	52559	99.998	10	263	0	96.882
Anem37W	52560	52559	99.998	7	241	87.5	97.171
Anem37WSW	52560	52559	99.998	6.667	264.333	478.667	96.906
Anem37R	52560	52559	99.998	11.167	0	0	99.871
Vane37	52560	52559	99.998	5.5	270.167	0	96.851
Total	525600	525590	99.998	78	1560	935	98.1293

APPENDIX B- Plot Data

Wind Speed Distribution Data

	Percent Time [%]			
Bin Center [m/s]	Q1	Q2	Q3	Q4
0.5	1.56	6.19	3.63	1.37
1.5	10.73	5.19	4.01	5.47
2.5	14.17	7.53	6	9.51
3.5	14.06	9.46	7.44	11.06
4.5	14.69	11.71	8.97	12.01
5.5	14.42	10.71	9.82	13.16
6.5	13.47	10.16	10.28	13
7.5	7.88	8.79	10.42	10.39
8.5	4.3	8.13	7.99	7.8
9.5	2.26	6.72	7.87	5.08
10.5	1.22	4.37	6.45	3.24
11.5	0.63	3.52	4.96	2.6
12.5	0.31	2.46	3.75	1.8
13.5	0.13	1.55	2.72	1.48
14.5	0.06	0.94	2.02	0.89
15.5	0.1	0.76	1.62	0.55
16.5	0.02	0.69	0.97	0.29
17.5	0.02	0.4	0.59	0.16
18.5	0	0.35	0.24	0.07
19.5	0	0.17	0.1	0.04
20.5	0	0.06	0.05	0.02
21.5	0	0.09	0.04	0.01
22.5	0	0.04	0.01	0
23.5	0	0.02	0	0
24.5	0	0.01	0.01	0
25.5	0	0.01	0.01	0

Monthly Average Wind Speed Data

Month	Wind Speed at 36.6 m [m/s]
12-Jul	4.685
12-Aug	4.392
12-Sep	5.336
12-Oct	6.158
12-Nov	6.747
12-Dec	6.119
13-Jan	7.092
13-Feb	7.112
13-Mar	7.632
13-Apr	6.86
13-May	5.643
13-Jun	5.873

Diurnal Average Wind Speed Data

Hour of Day	Q1 Mean Wind Speed [m/s]	Q2 Mean Wind Speed [m/s]	Q3 Mean Wind Speed [m/s]	Q4 Mean Wind Speed [m/s]
0	5.23	6.3	7.26	6.43
1	5.05	6.31	7.36	6.18
2	4.87	6.32	7.22	5.58
3	4.78	6.43	7.02	5.67
4	4.59	6.53	7.27	5.55
5	4.49	6.64	7.37	5.49
6	4.15	6.9	7.21	5.12
7	3.71	6.84	7.17	4.67
8	3.55	6.73	6.98	4.46
9	3.34	6.25	6.86	4.68
10	3.53	6.06	6.62	5.28
11	3.94	5.82	6.83	5.78
12	4.34	5.61	7.18	6.12
13	4.74	5.78	7.44	6.53
14	4.78	5.78	7.56	6.58
15	4.96	5.87	7.78	6.83
16	5.05	6.05	7.71	6.79
17	5.33	6.43	7.69	7.03
18	5.61	6.54	7.59	7.06
19	6	6.62	7.4	7.1
20	6.15	6.66	7.42	7.2
21	5.92	6.64	7.28	7.17
22	5.64	6.54	7.35	6.98
23	5.44	6.45	7.25	6.63

Wind Rose Data

	Q1		Q2		Q3		Q4	
Direction Sector [deg]	Percent Time [%]	Mean Wind Speed [m/s]	Percent Time [%]	Mean Wind Speed [m/s]	Percent Time [%]	Mean Wind Speed [m/s]	Percent Time [%]	Mean Wind Speed [m/s]
0	5.53	5.01	8.11	6.71	5.05	7.57	4.33	6.17
22.5	3.74	4.29	7.39	6.03	4.13	6.06	3.84	5.67
45	3	3.45	4.78	4.87	2.31	5.8	2.93	4.69
67.5	2.78	2.84	4.81	4.75	3.19	6.31	3.55	4.38
90	2.51	3.01	3.1	4.71	1.64	5.06	4.85	5.28
112.5	3.38	2.82	4.12	6.64	2.17	3.95	4.29	4.29
135	5.43	3.9	3.12	4.95	2.51	4.32	5.84	4.01
157.5	8.67	4.97	4.04	5.25	5.35	6.82	12.54	5.9
180	10.45	5.21	7.36	6.51	5.45	6.58	10.99	6.08
202.5	7.87	4.86	5.5	5.76	5.07	6.58	5.4	5.21
225	7.85	5.03	6.33	6.33	2.31	5.51	4	4.79
247.5	7.11	4.94	6.4	7.01	4.4	6.87	3.79	4.76
270	10.42	5.58	9.83	8.07	13.31	9.44	10.05	7.94
292.5	11.25	6.23	14.21	9.54	24.7	9.97	14.04	8.86
315	5.96	4.27	7.55	5.96	13.44	6.4	6.92	6.68
337.5	4.06	3.93	3.34	4.62	4.96	5.31	2.67	4.53

Annual Average Wind Speed Data

Fiscal Year	Wind Speed at 36.6 m [m/s]
2004	6.10
2005	5.92
2006	6.23
2007	5.75
2008	5.30
2009	-
2010	6.41
2011	6.33
2012	5.53
2013	6.14