Triton Performance Study – Weatherflow

Triton 548

August 20, 2013

1. Introduction

The remote commissioning process includes an evaluation of the quality of Triton data coming from a new or moved unit. The purpose of this Triton installation is to establish:

- ✓ **Operational Check (*1 to 4 week operational check of Triton's performance)***
- ❑ Correlation Study *(4 to 16 week study to correlate Triton data with met tower)*
- ❑ Data Capture *(Ongoing site characterization and information gathering)*

If SWI believes that the data quality can be improved by refining the system configuration it will remotely make the changes and re-check the data in regard to:

- o Data capture levels
- o Specific site anomalies (fixed echo, etc.)
- o High quality (Q factor) data

The time interval covered in this report is a 20-day period from July 26 to August 15.

Site Characteristics

Triton 548 was installed on July 25, 2013 near the Estate Bovoni, St. Thomas. This unit is located in rolling vegetated hills near the ocean. There is a 78m tall hill 100m to the east and an ocean cliff 10m to the south.

Aerial View

Northern View

Eastern View

Southern View

Western View

2. Triton Performance

Operational Data

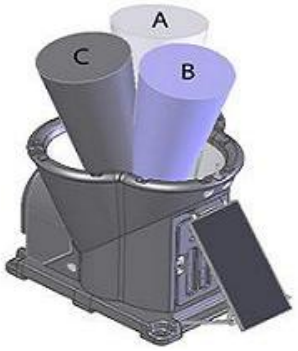
The gross data recovery, defined as the percent of operational 'up-time', was found to be 99.97% during the time interval. The Triton never lost power and almost every 10-minute data chunk was collected.

All internal sensors are showing valid readings: Ambient Temp, Internal Temp, Mirror Temp, Barometric Pressure and Relative Humidity. The tilt sensor confirms that the Triton was appropriately leveled during installation, with an (X,Y) tilt of (0.7°, 0.1°). The tilt is within the acceptable range. The installation crew noted that the true azimuth of the Triton is pointed to true north (for the northern hemisphere).

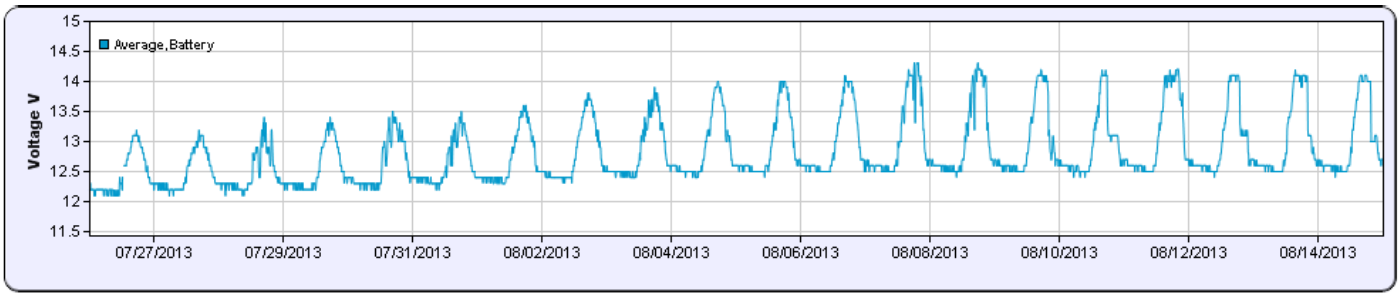
Triton 548

Latest 10-minute data: 8/20/2013 17:50:00 UTC

Triton Serial Number:	00548	**Triton Firmware History:**	Jul 24, 2013 - Rev 2.0
Operational Status:	Running		
Barometric Pressure:	1008.3 mBar	**Relative Humidity:**	80 %
True Azimuth:	0 °	**Speaker Volume:**	0 %
Tilt X (around Y axis):	0.7 °	**Battery Volts:**	14.3 V
Tilt Y (around X axis):	0.1 °		
		Modem Power:	0.9 W
Ambient Temperature:	29.8 °C	**CPU Power:**	2.4 W
Internal Temperature:	37.9 °C	**Core Power:**	2.7 W
Mirror Temperature:	40.7 °C	**PWM Power:**	1.5 W



The batteries are being charged by the solar charging system consistently every morning and remain charged throughout the night, never going below 12.2 Volts. The batteries and solar charging system are connected correctly and operating as expected.



Percent of Valid Data vs. Height

Table 1 and Figure 1 below show the percent of valid data acquired at this site during the specified time period. Valid data is defined as a ten-minute average with a quality greater than 90%. The Percent of Valid Data is within an acceptable range throughout the studied interval.

Table 1: Percent of Valid Data

Height	% of Valid Data
40	97.50%
50	96.98%
60	97.08%
80	97.39%
100	95.00%
120	88.36%
140	75.58%
160	56.20%
180	35.81%
200	21.47%

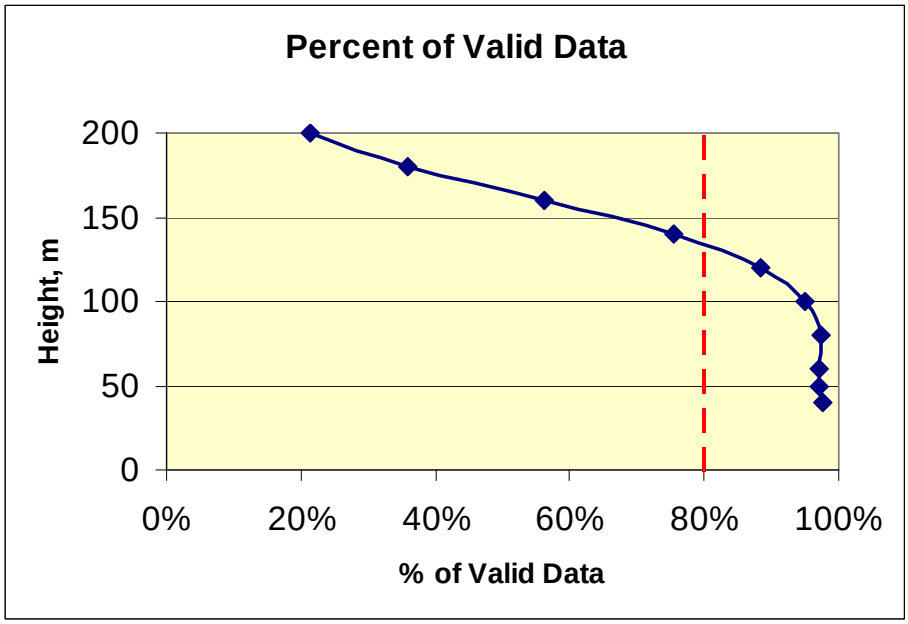


Figure 1: Percent of Valid Data vs Height

Figure 2: Wind Speed, Wind Direction and Vertical Wind Speed Over the Selected Time Period, Filtered at Q > 90 %

Average Signal-to-Noise Ratio (SNR), Signal and Noise vs. Height

Figure 3 and Table 2 below show the average SNR as a function of height. Signal is defined as the amount of acoustic energy that was backscattered due to atmospheric reflectivity (i.e. reflections proportional to wind speed). Noise is defined as all sources of noise that entered the signal and is not attributed to atmospheric reflections. In the plot below, SNR is plotted vs. the height in each beam. This Triton exceeds Second Wind's performance standard of a SNR of 9 or greater up to at least 120m. The SNR is actually over 9 up to 160 m.

Table 2: Average SNRs

Height	Average SNR A	Average SNR B	Average SNR C
40	17.55	17.10	17.70
50	17.55	16.92	17.72
60	17.28	16.43	17.38
80	16.04	15.10	16.08
100	14.43	13.55	14.44
120	12.67	11.88	12.72
140	11.07	10.39	11.10
160	9.69	9.14	9.69
180	8.57	8.12	8.54
200	7.72	7.36	7.67

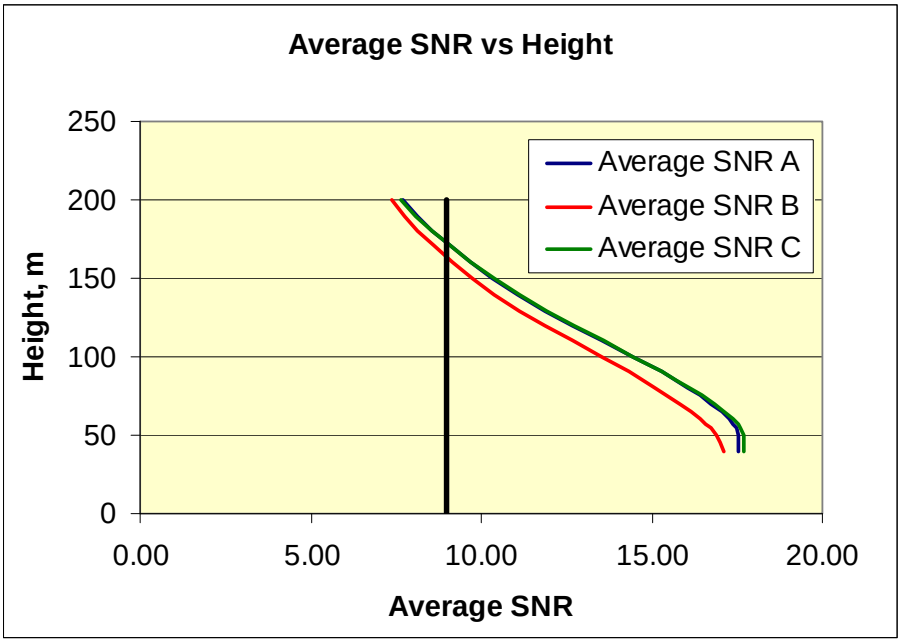


Figure 3: Average SNR vs Height

Wind Speed Scatterplots from 40 m to 120 m

The graphs below represent the correlation of consecutive altitudes up to 120m. The following four plots compare the wind speeds measured from 40 to 120 m. Figure 4 illustrates the measured wind speeds at 40 m compared to those measured at 60 m. Figure 5 shows a comparison between 60 and 80 m. The wind speeds at 80 m are plotted against the 100 m wind speeds in Figure 6. And finally, Figure 7 shows the 100 m wind speeds compared to the 120 m wind speeds. There are no noticeable echoes seen in the scatterplots, meaning the echo rejection is suppressing all the echoes present.

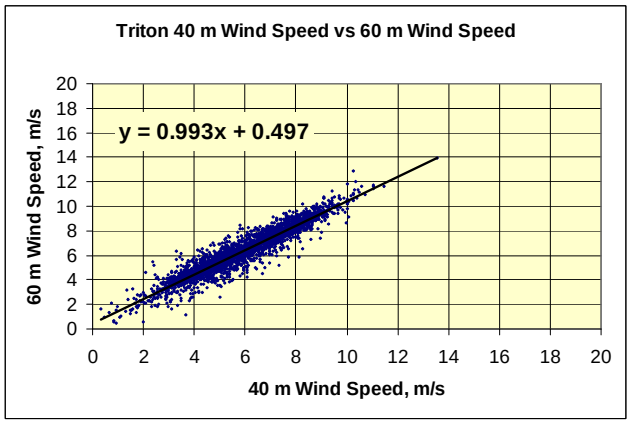


Figure 4: Triton 40 m vs 60 m

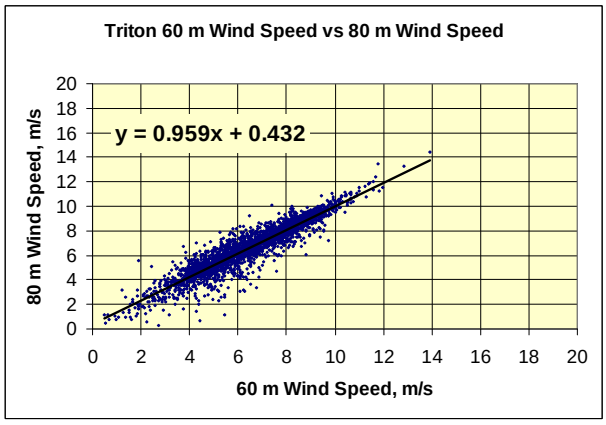


Figure 5: Triton 60 m vs 80 m

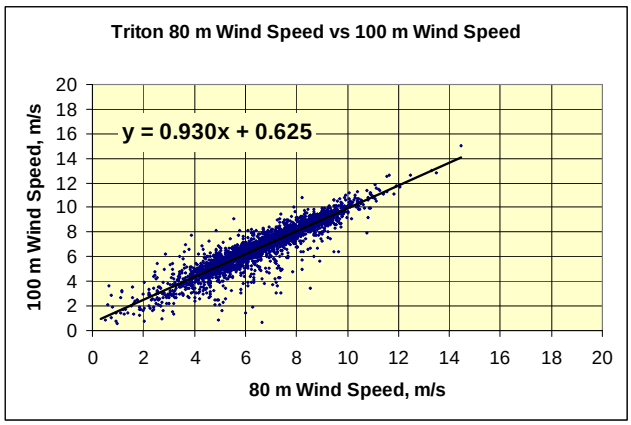


Figure 6: Triton 80 m vs 100 m

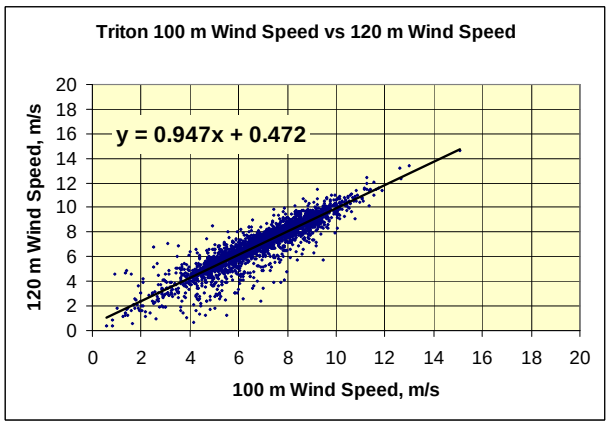


Figure 7: Triton 100 m vs 120 m

3. Triton Data Analysis

Wind Speed Distribution at 80m

Figure 8, below, is a histogram depicting the frequency of different wind speeds at 80m. The best-fit Weibull Probability Density Function revealed the following factors:

Weibull Parameters:
Shape factor, k = 3.7293
Scale factor, c = 7.2211

The shape factor, k, indicates a widely spread wind speed distribution. The scale factor, c, has a direct relationship with the mean wind speed.

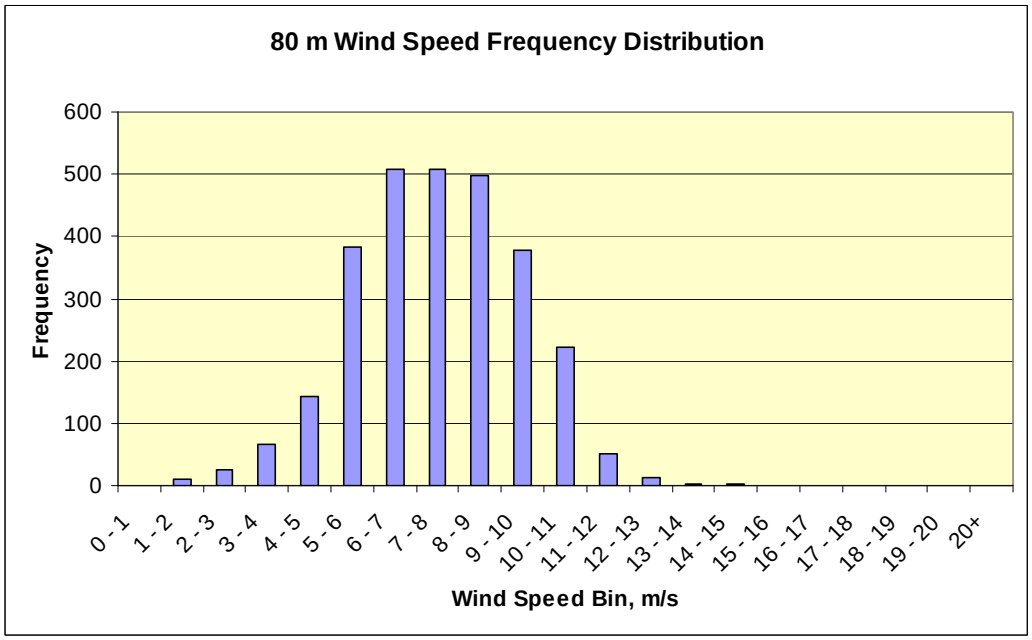


Figure 8: Wind Speed Histogram at 80m

Wind Direction

Figure 9 is a wind rose that depicts the prevailing wind direction at this site over the specified period at 80m. The distribution indicates that the wind is primarily coming out of the east-northeast.

Table 3: Wind Direction Distribution

Direction	Count	% Data
N	10	0.4%
NNE	29	1.0%
NE	308	11.0%
ENE	1256	44.8%
E	966	34.4%
ESE	140	5.0%
SE	47	1.7%
SSE	30	1.1%
S	6	0.2%
SSW	2	0.1%
SW	5	0.2%
WSW	0	0.0%
W	3	0.1%
WNW	1	0.0%
NW	1	0.0%
NNW	2	0.1%

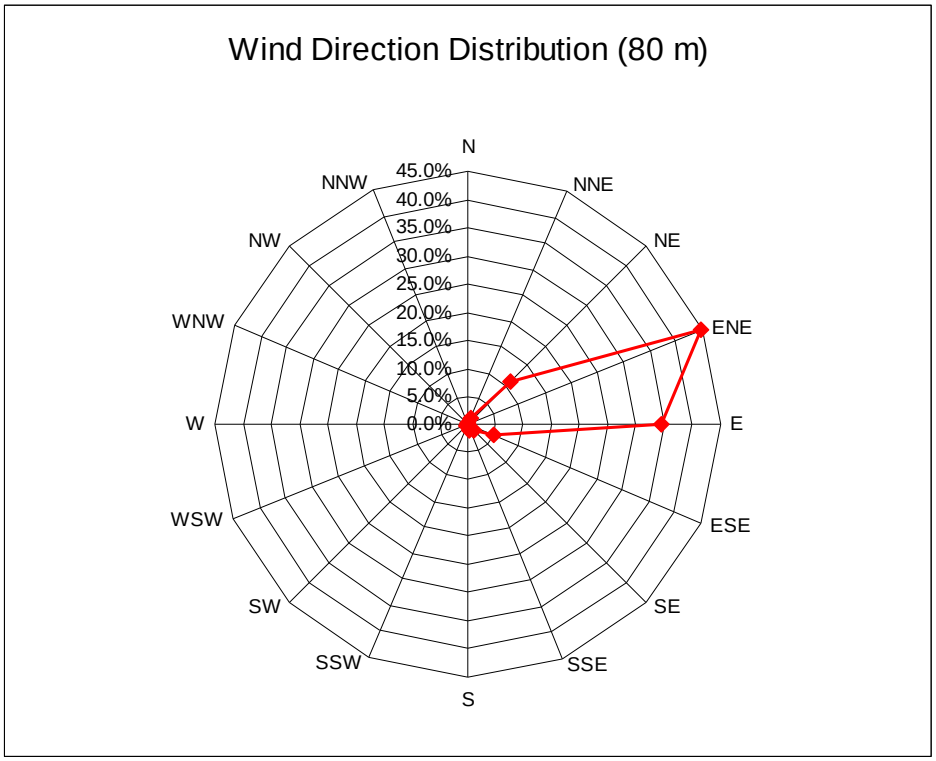


Figure 9: Wind Direction Distribution

Average Wind Speed Profile

Table 4 and Figure 10 below show the average wind speeds measured from 40 to 120 m. Shown in Figure 10 are the average wind speeds measured when valid data was recorded from 40 to 120 m and the best-fit power law profile. The power law shear exponent (alpha) is a measurement of the wind shear at this site over the specified time frame. A higher value indicates the presence of more extreme shear at the site.

Table 4: Average Wind Speed Profile

Height	Average Wind Speed, m/s	# of 10-min Averages
40	5.86	2569
50	6.16	2556
60	6.33	2560
80	6.53	2576
100	6.74	2564
120	6.90	2503

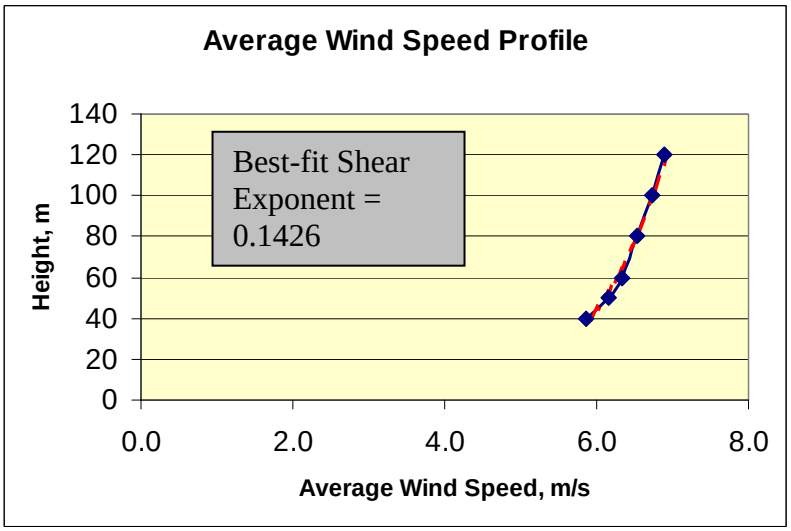


Figure 10: Average Wind Speed Profile

Inflow Angle

Figure 11 and Table 5 are a distribution of the angle of attack of vertical wind at 80m for the specified time. There is a slightly upward inflow angle at this site in the east-northeast direction

Table 5: Inflow Angle Distribution

Direction	Vert. Speed	AOA
N	-0.08	-3.45
NNE	0.29	4.82
NE	0.34	3.72
ENE	0.32	3.18
E	0.33	2.77
ESE	0.62	5.98
SE	0.37	4.77
SSE	0.53	7.88
S	0.61	10.43
SSW	0.41	
SW	0.10	8.00
WSW		
W	0.40	20.71
WNW	-1.22	
NW	1.30	
NNW	-0.26	-5.75

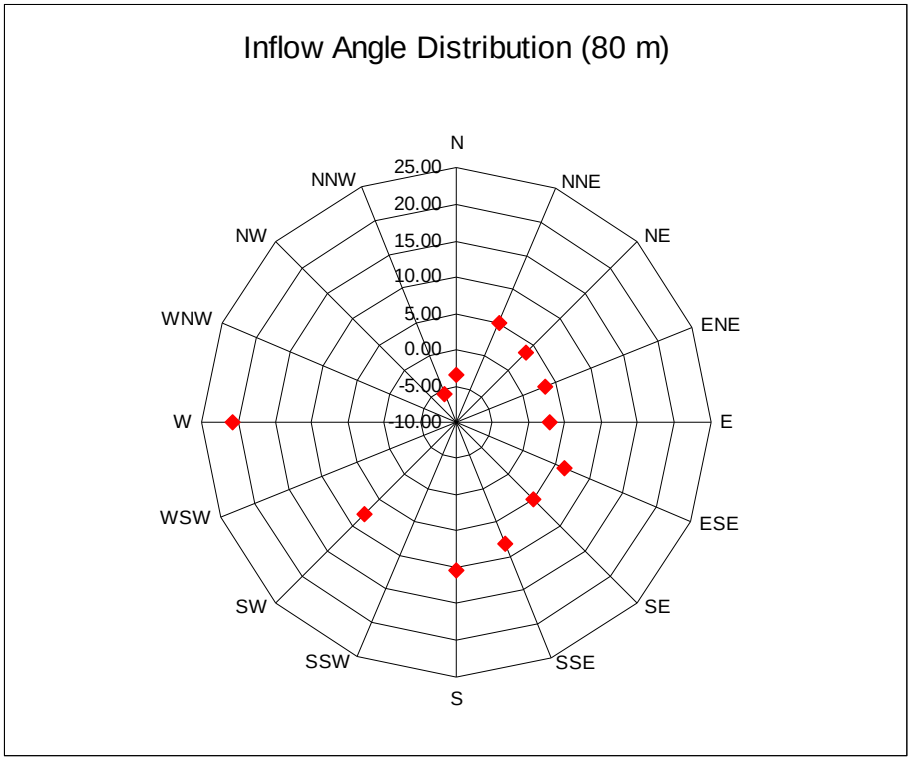


Figure 11: Inflow Angle Distribution at 80m

4. Conclusions and Recommendations

In summary, Triton 548 is operating well. The gross data recovery is near perfect, the SNR is high all the way up to 160m, the Percent of Valid Data is high, and the echo rejection algorithm is suppressing any echoes that may be present. The physical installation of the Triton is adequate with the unit anchored in a level position with an azimuth to true north.