Appendix B

Triton Performance Study

Triton Performance Study – Meridian Associates

Triton 329

November 4, 2010

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:

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

The time interval covered in this report is a 10-day period from October 29 to November 8.

Site Characteristics

Triton 329 was installed on October 28, 2010 near the town of Swampscott, Massachusetts. This unit is located in the middle of a baseball diamond. There is a tree line and several light towers surrounding the unit. Some of these towers are only 40 m away.

Aerial View

Topographic View

Northern View

Eastern View

Southern View

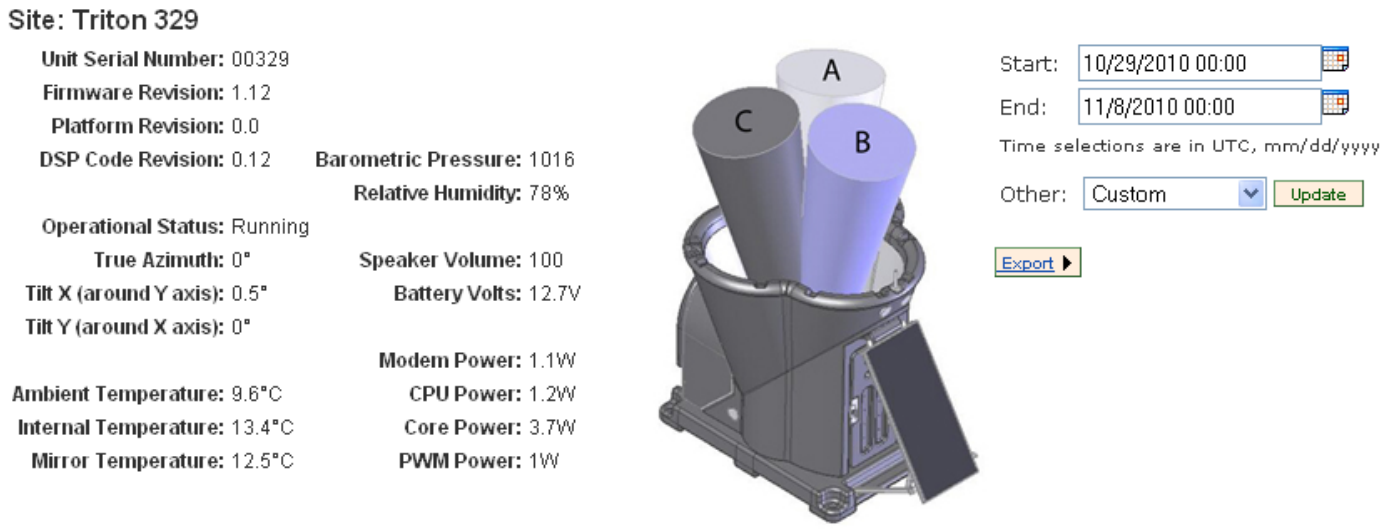
Western View

2. Triton Performance

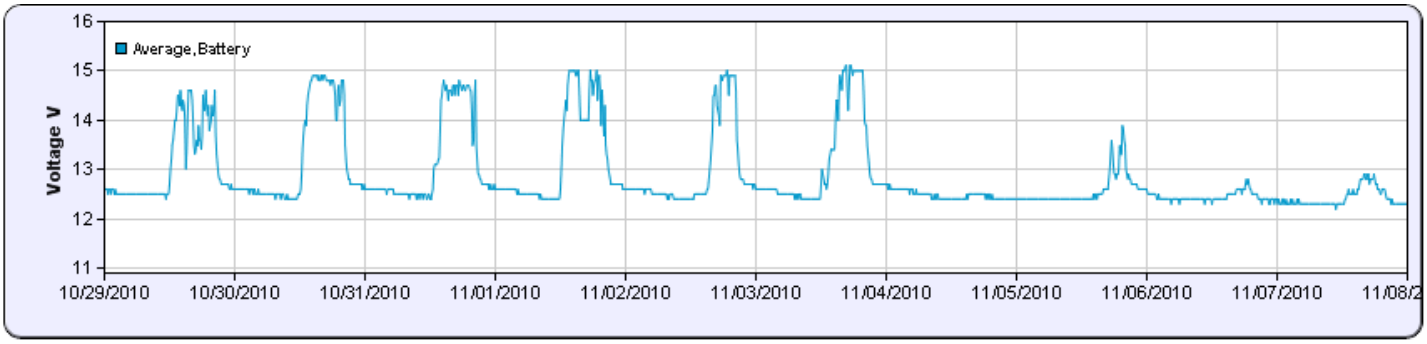
Operational Data

The gross data recovery, defined as the percent of operational 'up-time', was found to be 100% during the time interval. The Triton never lost power and 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 (.5°, 0°). The tilt is within the acceptable range.



The batteries are being charged by the solar charging system consistently every morning and remain charged throughout the night, never going below 12.4 Volts. There were four days of low solar insolation due to rain. 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, however, there is an echo present at the 40 m, and slight echoes possible at 50 m and 60 m levels.

Table 1: Percent of Valid Data

Height	% of Valid Data
40	69.72%
50	95.35%
60	96.39%
80	97.08%
100	95.56%
120	83.40%
140	59.10%
160	38.06%
180	22.57%
200	10.56%

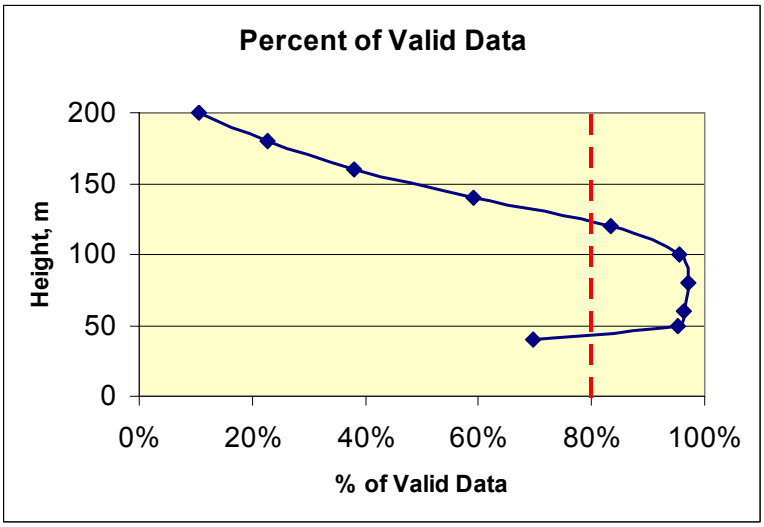


Figure 1: Percent of Valid Data vs Height

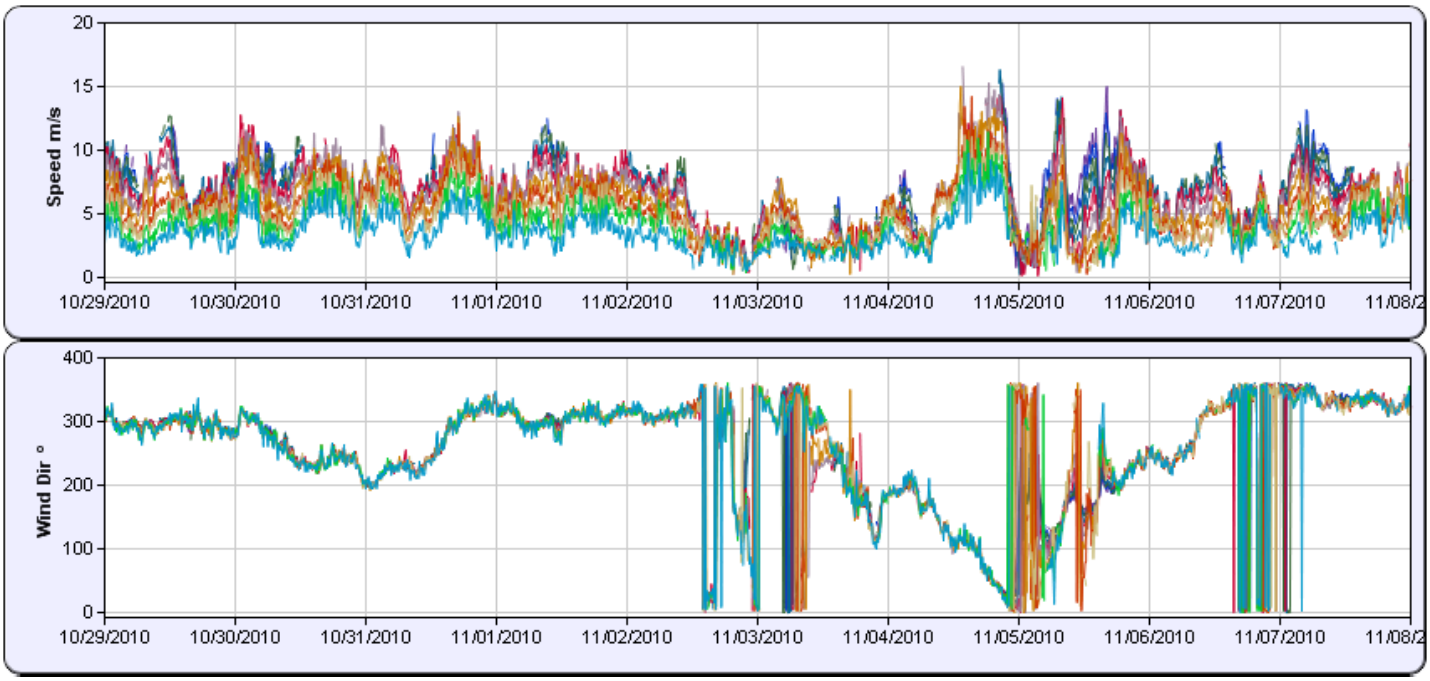


Figure 2: Wind Speed and Wind Direction Over the Selected Time Period, Filtered at Q > 90 %

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 above 9 all the way up to 140 m. There is a noticeable echo in the C beam of this triton as seen in the significantly decreased SNR at 40 m.

Table 2: Average SNRs

40	15.50	15.74	11.60
50	15.84	16.08	15.83
60	15.77	15.79	15.46
80	15.44	15.28	15.44
100	13.93	13.70	13.85
120	11.78	11.57	11.67
140	9.71	9.55	9.54
160	7.93	7.77	7.76
180	6.50	6.41	6.41
200	5.51	5.46	5.47

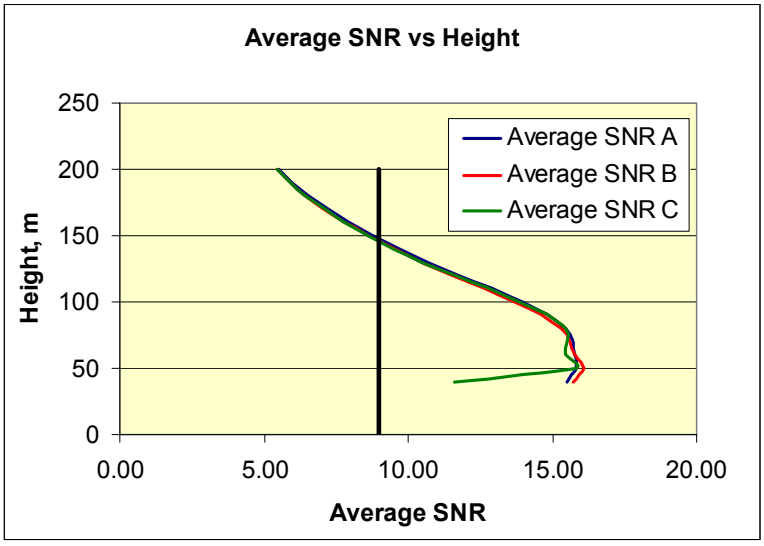


Figure 3: Average SNR vs Height

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.

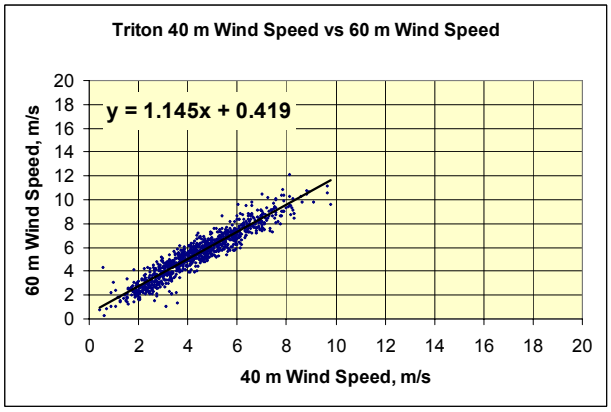


Figure 4: Triton 40 m vs 60 m

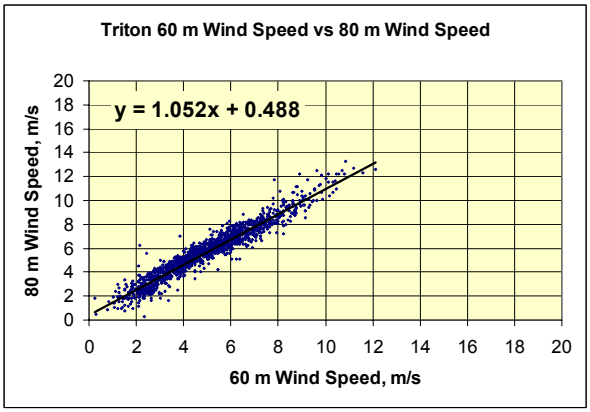


Figure 5: Triton 60 m vs 80 m

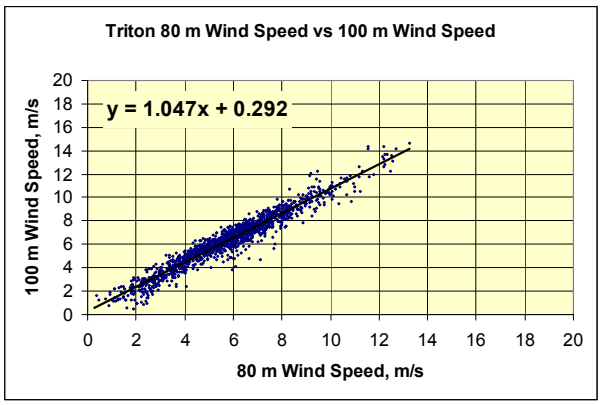


Figure 6: Triton 80 m vs 100 m

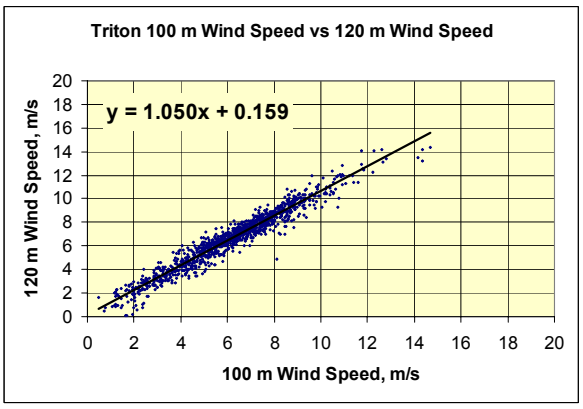


Figure 7: Triton 100 m vs 120 m

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 = 2.8086
Scale factor, c = 6.4631

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

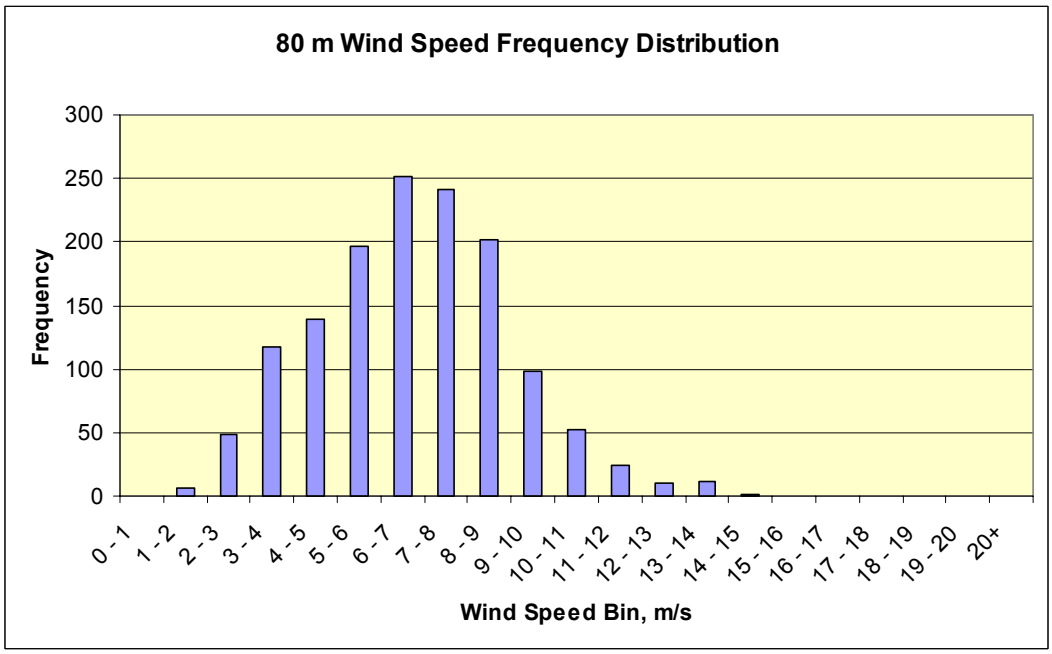


Figure 8: Wind Speed Histogram at 80m

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 northwest.

Table 3: Wind Direction Distribution

Direction	Count	% Data
N	93	6.6%
NNE	35	2.5%
NE	14	1.0%
ENE	13	0.9%
E	13	0.9%
ESE	29	2.1%
SE	37	2.6%
SSE	32	2.3%
S	45	3.2%
SSW	66	4.7%
SW	129	9.2%
WSW	134	9.6%
W	60	4.3%
WNW	226	16.2%
NW	314	22.4%
NNW	159	11.4%

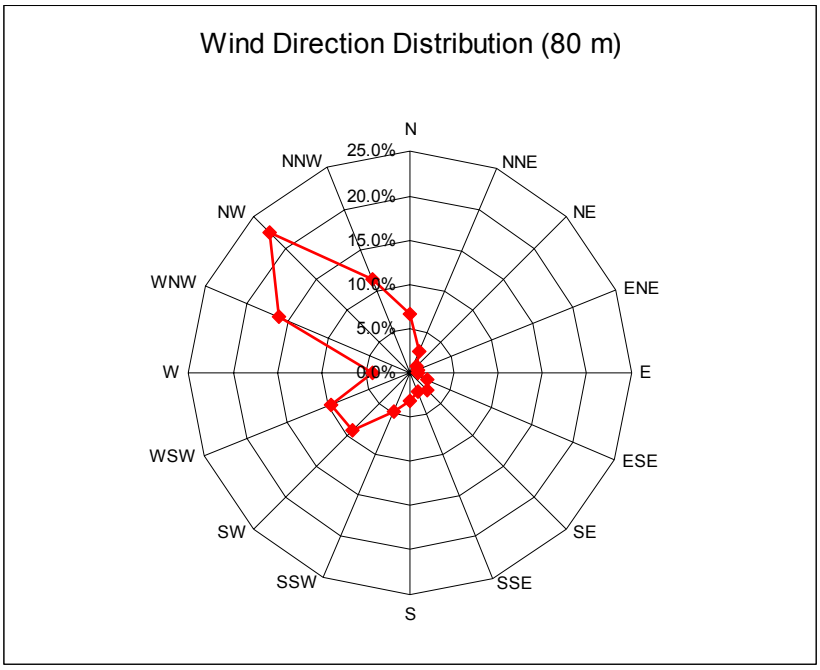


Figure 9: Wind Direction Distribution

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.

Table 4: Average Wind Speed Profile

Height	Average Wind Speed, m/s	# of 10-min Averages
40	4.20	745
50	4.88	748
60	5.28	750
80	6.10	751
100	6.68	749
120	7.15	749

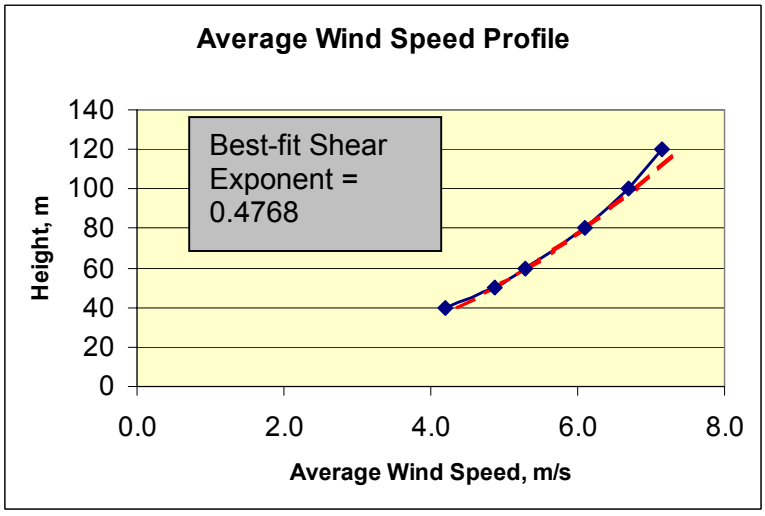


Figure 10: Average Wind Speed Profile

Inflow Angle

Figure 11 and Table 5 are a distribution of the angle of attack of vertical wind at 80m for the specified time.

Table 5: Inflow Angle Distribution

Direction	Vert. Speed	AOA
N	-0.08	-1.10
NNE	-0.10	-0.98
NE	-0.27	-2.48
ENE	-0.30	-1.46
E	-0.21	-1.36
ESE	-0.18	-1.29
SE	-0.02	-0.22
SSE	0.05	1.06
S	0.05	0.62
SSW	-0.04	-0.50
SW	-0.07	-0.58
WSW	-0.09	-1.09
W	-0.07	-0.50
WNW	-0.10	-0.94
NW	-0.10	-0.82
NNW	-0.07	-0.70

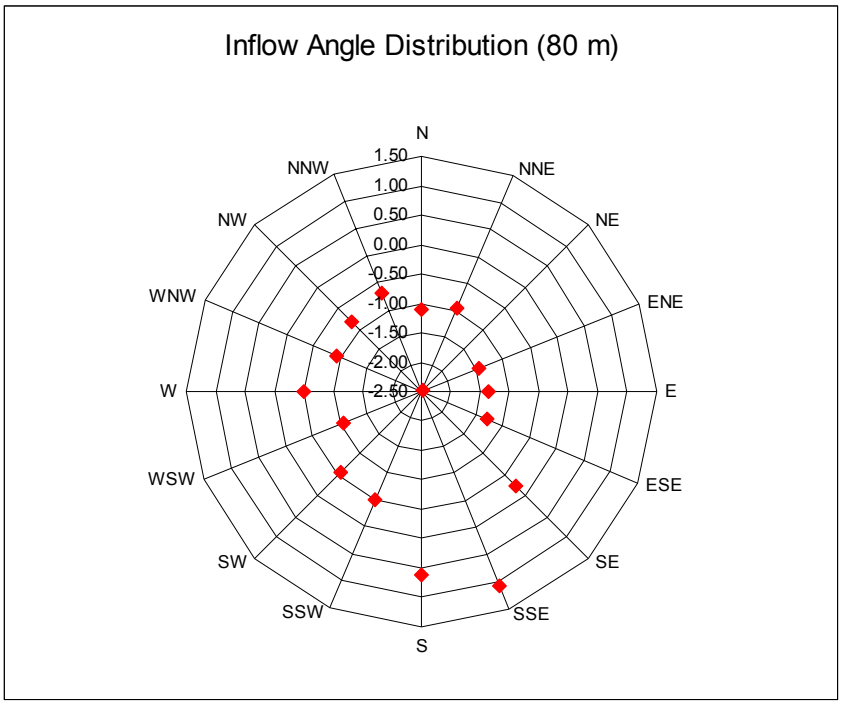


Figure 11: Inflow Angle Distribution at 80m

4. Conclusions and Recommendations

In summary, Triton 329 is operating well. The gross data recovery is near perfect, the SNR is high all the way up to 140 m, and the Percent of Valid Data is within an acceptable range throughout the studied period. While there is a very noticeable echo present at the site at 40 m, the echo rejection algorithm is suppressing that echo and the data is not affected by its presence. The physical installation of the Triton is adequate with the unit anchored in a level position with an azimuth to true north.