11-2012

Lake Michigan Wind Assessment Project Data Summary and Analysis: November 2012

Lake Michigan Offshore Wind Assessment Project

Lake Michigan Wind Assessment Project

Data Summary and Analysis

November 2012

This report summarizes the data collected by the Laser Wind Sensor (LWS) #8 with collection information as follows.

Location: Lake Michigan – Mid-lake Plateau (4320.5105N 8707.1962W)

Date: November 1 through November 30, 2012 (UTC)

Cup Anemometer: 3 meters mounted on the buoy

Range Gates 1-6: 75, 90, 105, 125, 150, 175 meters

Observations: 10-minute averages, transmitted via satellite at the rate of one 10-minute average per hour

Number of Observations: 30 days at 24 observations per day = 720 observations

Missing Observations:

Start		End		
Date	**Time**	**Date**	**Time**	**Number Missing**
1-Nov	0:10	8-Nov	14:10	183
29-Nov	17:10	30-Nov	23:10	31

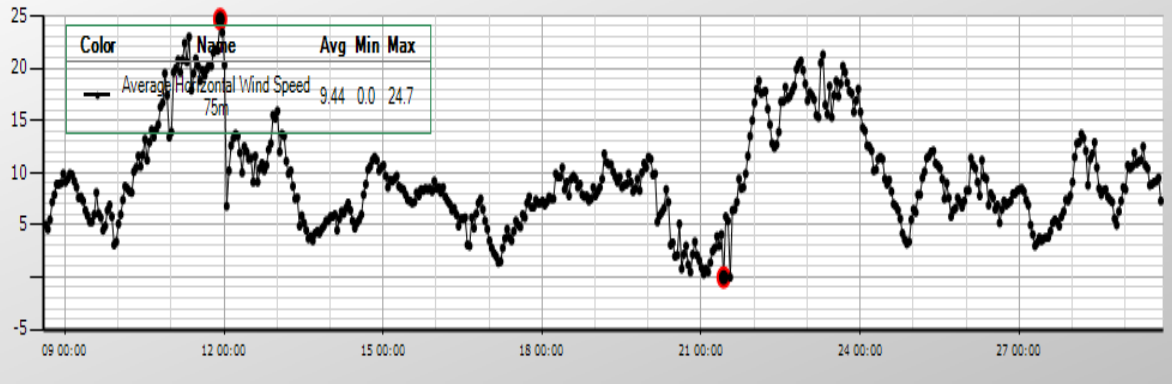
Good Observations: 506 (70.2%)

Notes:

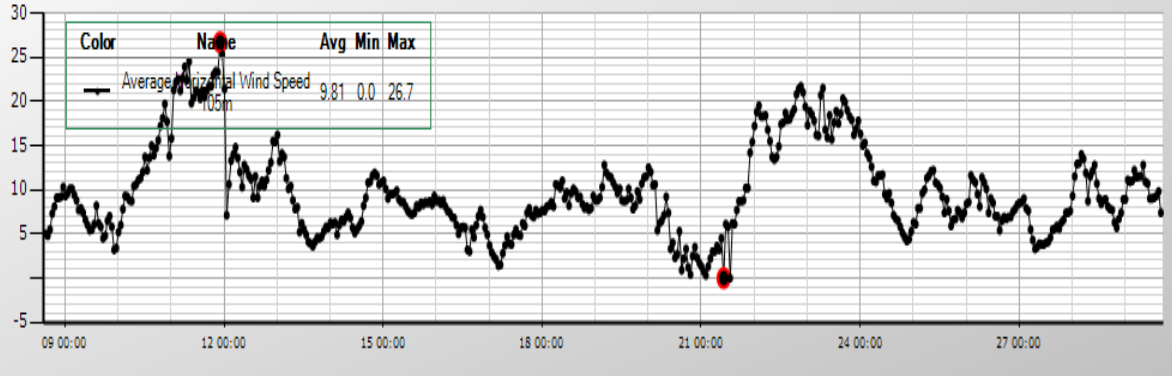
- Data for Range Gates 2 and 6 are available and stored on the buoy, but not transmitted (by choice) in the real-time 10 minute average data.
- Range Gate 6 (175 meters) is a test range gate to observe the performance of the sensor at the extreme operating height limit for this configuration. Thus, performance degradation was expected.
- All high resolution 1 second data for all wind speeds is stored onboard the buoy and can be used for further detailed post processing as required.

Graphs for wind speed for ranges gates 1, 3, 4, and 5 as well as the cup anemometer follow. Graphs of the horizontal wind direction at the cup anemometer and range gate 1 are included as well.

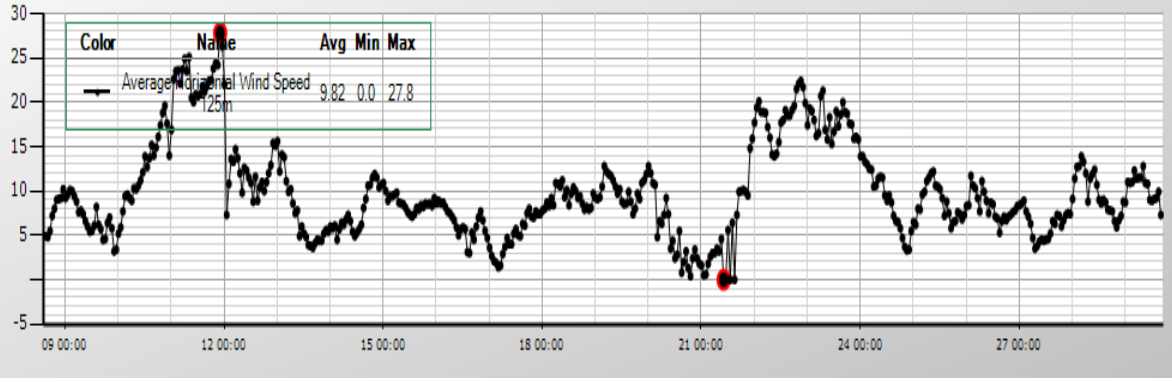
GVSU Primary
Iridium Combined Message
Average Horizontal Wind Speed 75m



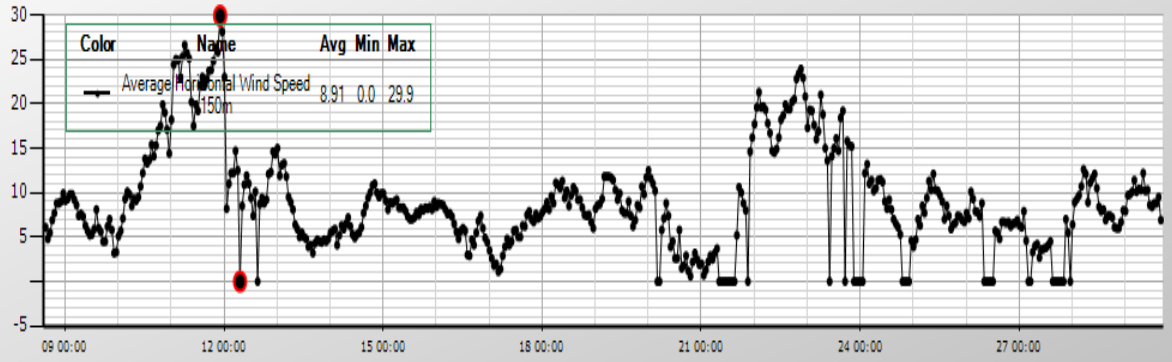
GVSU Primary
Iridium Combined Message
Average Horizontal Wind Speed 105m



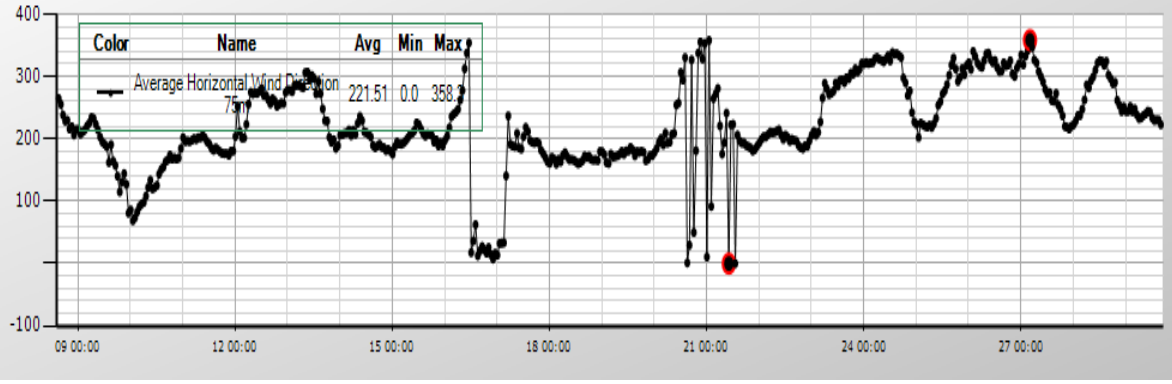
GVSU Primary
Iridium Combined Message
Average Horizontal Wind Speed 125m



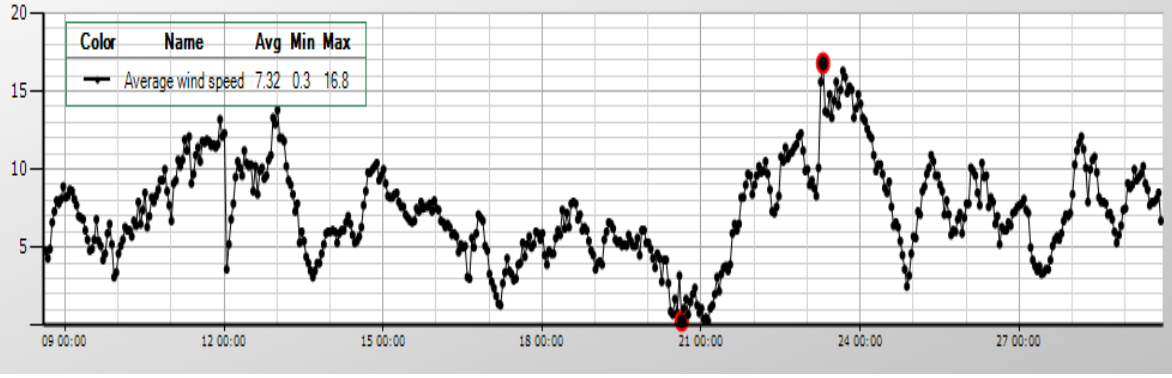
GVSU Primary
Iridium Combined Message
Average Horizontal Wind Speed 150m

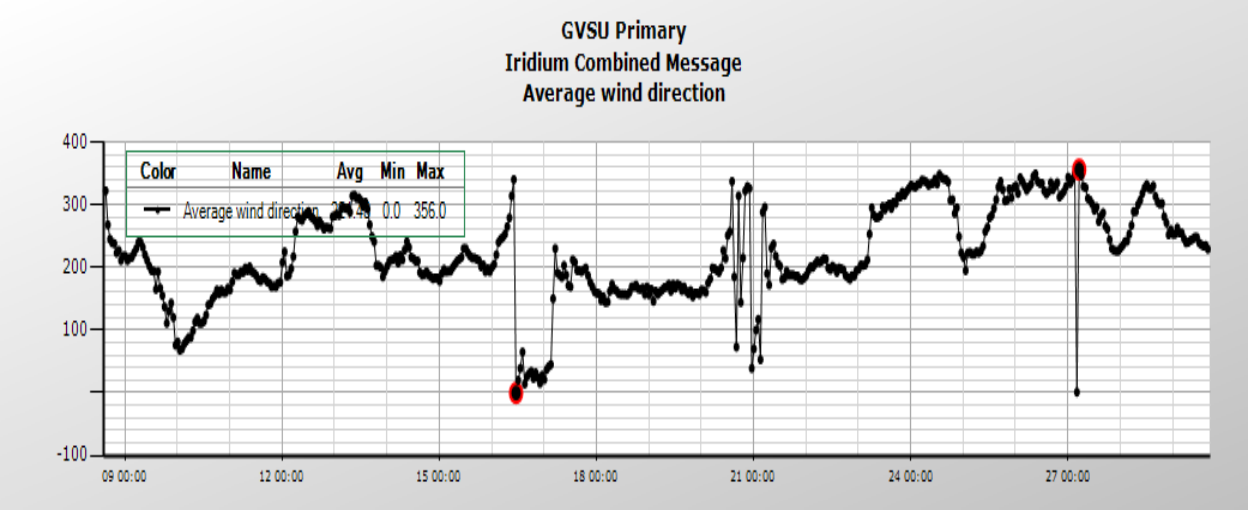


GVSU Primary
Iridium Combined Message
Average Horizontal Wind Direction 75m



GVSU Primary
Iridium Combined Message
Average wind speed




GVSU Primary
Iridium Combined Message
Average wind direction
Color
Name
Avg
Min
Max
Average wind direction
0.0
356.0
400
300
200
100
-100
09 00:00
12 00:00
15 00:00
18 00:00
21 00:00
24 00:00
27 00:00

Summary statistics for wind speed by range gate and for the cup anemometer are shown in the following tables. Good observations are 10-minute averages consisting of at least 300 one-second observations. There were 506 hours with one 10-minute average transmitted.

Table 1: Wind Speed (meters per second) Statistics by Range Gate

Statistic	N001S007P006 Average Wind Speed Cup Anemometer	N001S009P083 Average Horizontal Wind Speed RG #1	N001S009P085 Average Horizontal Wind Speed RG #3	N001S009P086 Average Horizontal Wind Speed RG #4	N001S009P087 Average Horizontal Wind Speed RG #5
Good Observations	506	496	498	494	427
% of Total (506)	100.0%	98.0%	98.4%	97.6%	84.4%
Average	7.3	9.5	9.9	10.0	9.7
Standard Deviation	3.1	4.8	5.0	5.2	5.5
Minimum	0.3	0.3	0.3	0.4	0.6
1st quartile	5.3	6.4	6.5	6.6	6.2
Median	7.1	8.6	8.9	8.9	8.4
3rd quartile	9.5	11.5	11.9	11.9	11.3
Maximum	16.8	24.7	26.7	27.8	29.9
99% CI for Mean – Lower Bound	7.0	9.0	9.3	9.4	9.0
99% CI for Mean – Upper Bound	7.7	10.1	10.5	10.6	10.4

Table 2: Wind Speed (meters per second) Frequencies by Range Gate

Wind Speed Range	N001S007P006 Average Wind Speed Cup Anemometer	N001S009P083 Average Horizontal Wind Speed RG #1	N001S009P085 Average Horizontal Wind Speed RG #3	N001S009P086 Average Horizontal Wind Speed RG #4	N001S009P087 Average Horizontal Wind Speed RG #5
0-4	13.8%	9.7%	8.6%	8.5%	8.7%
4-8	48.8%	33.7%	31.3%	31.8%	35.8%
8-12	30.8%	34.1%	36.1%	35.8%	34.0%
12-16	6.1%	9.3%	9.6%	9.9%	7.0%
16-20	0.4%	9.3%	8.2%	7.9%	7.5%
20-24	0.0%	3.8%	5.4%	4.9%	4.2%
24-28	0.0%	0.2%	0.6%	1.2%	2.3%
28-32	0.0%	0.0%	0.0%	0.0%	0.5%

Table 3: Wind Direction Frequencies and Average Speed by Range Gate

Wind Direction Range (Degrees)	N001S009P089 Average Horizontal Wind Direction RG#1	N001S009P083 Average Horizontal Wind Speed RG#1
0 – 45 (NNE)	3.6%	4.2
45 – 90 (NE)	1.4%	5.0
90 – 135 (SE)	2.6%	8.4
135 – 180 (SSE)	14.5%	10.3
180 – 225 (SSW)	34.5%	10.8
225 – 270 (SW)	14.7%	8.6
270 – 315 (NW)	16.5%	9.8
315 – 360 (NNW)	12.1%	8.2

Notes for November:

1. The average wind speed for ranges gates 1, 3, 4, and 5 appears to be equivalent. However, the average wind speed for range gate 1 may be slightly less. The difference in the averages between range gate 1 and range gate 3 of 0.4m/sec is statistically significant ($\alpha = 0.01$).
2. The same pattern indicating equivalent wind speed at range gates 1, 3, 4, and 5 is seen in the other summary statistics, as well as the distribution of wind speeds.
3. The distribution of the wind speeds shows more values in the 4-8m/sec range and the 8-12m/sec range together for all range gates.
4. Ranges gates 1, 3, 4, and 5 have higher average wind speeds than the cup anemometer. The difference in the averages between the cup anemometer and range gate 4 of 2.6m/sec is statistically significant ($\alpha = 0.01$).
5. The most prevalent wind direction is 180 – 225 degrees (SSW). Almost 50% percent of the time, the wind direction is between 180 and 270 degrees (SSW to SW).
6. About one-third of the time, the wind direction is between 180 and 225 degrees (SSW) and the average wind speed in this direction appears to be higher than the overall average of 9.5m/sec for range gate 1.

Notes comparing October and November:

1. The average November wind speed seems less than the October wind speed. This is seen in all summary statistics.
2. In October and November, the variability of the wind seems to be about the same, as seen in the standard deviation.
3. In November, about two-thirds of the time the wind speed was between 4 and 12m/s. In October, slightly less than one-half of the time the wind speed was in this range.
4. Approximately 50% of the time in October the wind direction was between 135 and 270 degrees (SSE to SW). In November, about two-thirds of the wind came from this direction.
5. There appears to be a shift in wind direction to the South in November versus October. In October, about 50% of the time the wind direction was between 270 and 90 degrees (NW to NE). In November, about one-third of the wind came from this direction.