Verifying the 10:1 rule for anemometer placement

Jasmine Stanley
Mentored by Mr. Michael Padovani

Introduction

The purpose of this project was to test the validity of the 10:1 rule when measuring wind speed and direction from a tree line. The 10:1 rule stated that when measuring wind speed near an obstruction, the anemometer needed to be ten times the distance away from the obstruction than the obstruction was tall (Wind measurement). This project challenged the validity of this rule because ten times the height of the obstruction will not necessarily be enough to get a true reading of the wind speed. To achieve reliable results, the perpendicular component of the wind over the tree line was used with the tree height, which was found to be seventy-five feet. It was also assumed that the wind speed and direction were the same before the tree line as it was at the 14.5 H, or 14.5 times the height of the trees, position. The percentages were based on the 14.5 H position, even though previous research done by Abel, indicated that the anemometer needed to be further away to completely negate the wind (1997). However, this setup was not possible as we would be in the Chesapeake Bay at that point. The benefit of testing this rule was that meteorologists would know how far away the anemometer needed to be from the obstruction to get a true wind reading.

Materials & Methods

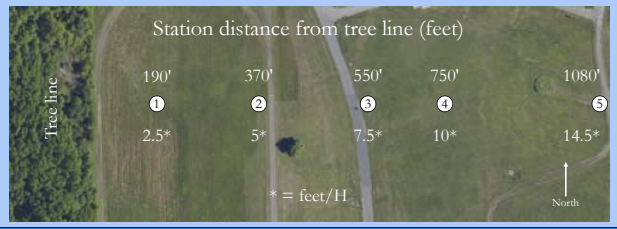
First the height of the tree line at Aberdeen Proving Ground (APG, site 1) and at a field in Churchville (corner of Routes 543 and 136, site 2) were determined. Then exact instrument locations were determined by finding different distances away from the tree line and picking the best ratios to collect data. For APG, the positions at 2.5, 5, 7.5, 10, and 14.5 times the height of the tree line (seventy-five feet) were targeted for data collection. As shown in figure 1, the tripod was then set-up at position 1 (2.5 H) and the anemometer box and solar panel were screwed on. The R. M. Young® anemometer blade was attached and readings were received from the station. The set-up process for positions 2 through 5 was repeated. As shown in table 1, each anemometer was at a set position for the duration of the project. The sustained and peak wind speed were then measured every minute from November 17, 2016 until April 5, 2017 and then compared. Sustained wind speed being the average wind speed per minute and peak wind speed being the maximum wind speed per minute.

Materials & Methods (cont.)

At the Churchville field, the positions at 2.5, 5, 7.5 and 10 times the height of the tree line (sixty-five feet) were located. The ground was then marked with a spray-painted "X". Once all positions were marked, working backward, the wind speed perpendicular to the tree line was measured, with the handheld anemometer at arm's length to get accurate readings. Data was collected for about a minute and a half at each position on one occasion before it was realized that the data there wouldn't be able to be used.

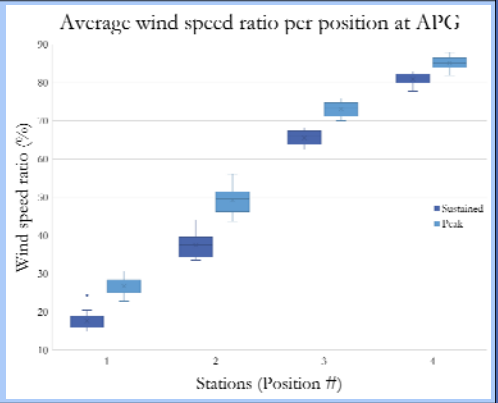
Figure 1 (right): Jasmine Stanley tightening the wind sensor onto the tripod at position 3. This was the total station equipment for each data collection position.

Table 1 (below): Labeled aerial view of APG site representing the distance from the tree line to all of the anemometer positions in feet rounded to the nearest whole foot. The Chesapeake Bay is a few hundred feet to the east. The calculation for distance was the horizontal ground distance away from the tree line divided by the height of the tree line (H = seventy-five feet).



Results

Graph 1 (right): The wind speed ratios relative to position 5 are graphed. Each data set for sustained and peak wind speed included 14 events, each one occurring at the same time. Refer to table 1 for the position locations. Position 4 had the maximum value between the four positions because it was the closest to positon 5.



Results (cont.)

The data collected from Churchville could not be used because there was no way to collect the data all at the same time without the proper equipment like what was used at APG. There was also no way to calculate which way the wind was coming from, which was a key factor in collecting data.

At APG, data showed that the 10:1 rule was not enough to get a true sustained or peak wind speed reading. As shown in table 1, positions 1-4 are about the same distance apart relative to each other. Position 5, however, was much farther away from the rest of the positions, which was why position 5 was used as the baseline value. Since it was assumed at the beginning that the wind speed and direction were the same before and after the tree line as it was at the 14.5 H position, all of the data was collected and calculated consistently. As shown in graph 1, position 4 (10.0 H position) was not at 100% of the true wind speed. It was also shown that the results were collected consistently because all of the boxes were relatively small, which indicated a low standard deviation.

Conclusion

The purpose of this project was to challenge the 10:1 rule that the anemometer needs to be 10 times the distance away from the obstruction than the obstruction was tall. After looking at the data and analyzing it, it was concluded that the 10:1 rule did not provide an accurate reading of the true wind speed. The 10:1 rule did not provide the true wind speed because at that distance from the tree line, there was still some interference from the trees causing the readings to be lower than the true readings. If more than 80% of the true wind speed was required, then further research could be conducted to find additional ratios between 10:1 and 14.5:1. These results would help meteorologists who were trying to find the best possible distance to measure wind speed off of a tree line.

References

Abel, N. (1997). *Design principles for farm forestry: A guide to assist farmers to decide where to place trees and farm plantations on farms.* Australia: Barton, A.C.T.

Wind measurement. (n.d.). Retrieved May 4, 2017 from the Cumulus Wiki: http://wiki.sanaysoft.com/a/Wind_measurement