EVALUATING THE WIND DATA FROM THE AUTOMATED SURFACE OBSERVING SYSTEM IN OAK RIDGE, TENNESSEE - IS KOQT THE CALMEST SITE IN THE US?

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1. INTRODUCTION

If one looks at a weather map, the winds from the Automated Surface Observing System (ASOS) at Oak Ridge, TN (KOQT) are often shown as calm. For a dispersion meteorologist, hazardous material spill responder, or an incident commander, calms present many problems and concerns. Which way is a plume actually going to travel, how will calms impact the regional wind field, who should take shelter or evacuate, and where should the incident command center be located? This study was conducted to determine the number of times KOQT reports the wind as calm or variable. The overall goal is to understand how often this site is calm or variable through the year and what implications this has for dispersion modeling on the Oak Ridge Reservation.

2. BACKGROUND

As shown in Figure 1, Oak Ridge is located in the Great Valley of Eastern Tennessee between the Cumberland Plateau to the west and the Great Smoky Mountains to the southeast. Figure 2 shows annual average wind speeds at 80m for the United States and east Tennessee and indicates that the central Appalachian region has some of the slowest wind speeds in the eastern United States.

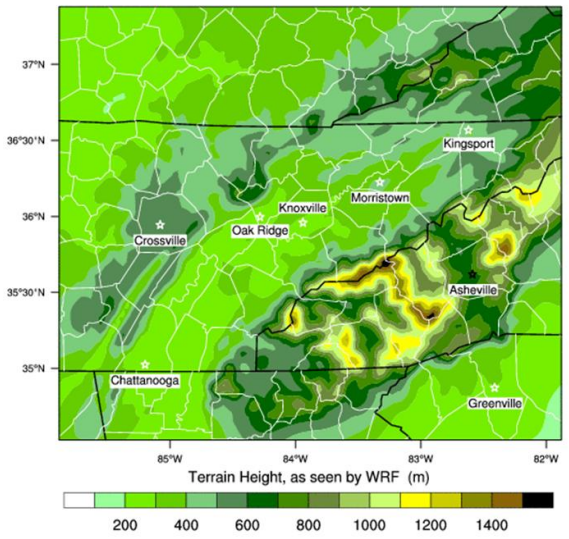

Figure 1. The Great Valley of Eastern Tennessee.(Courtesy of NOAA-ATDD).

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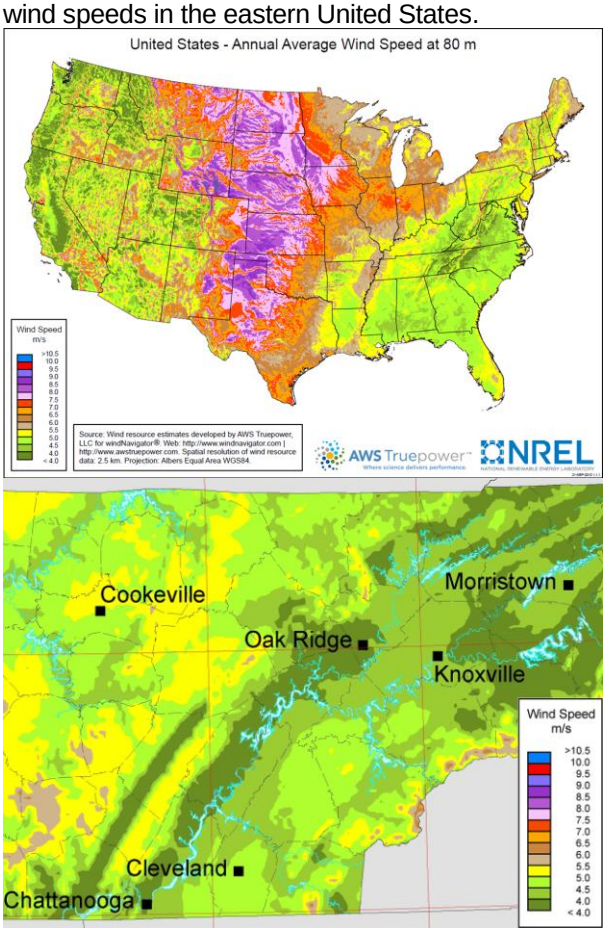

Figure 2. Average Annual Wind Speed at 80m for the Untied States and east Tennessee. (Courtesy of AWS Truepower).

KOQT is not your typical ASOS site. It is one of the few ASOS sites in the country that is not affiliated with an airport or runway. As shown in Figure 3, KQOT is located in the city of Oak Ridge on the south side of Laboratory Road, between the buildings of Roane State Community College and the DOE buildings for the Oak Ridge Operations Headquarters. The locations of other meteorological sites near KOQT are presented in Figure 4. A picture of the KOQT ASOS is shown in Figure 5.

As with most everything in Oak Ridge, KOQT had its beginnings with the Manhattan

Project. Some history about this site was found on the internet:

Today, while driving to go somewhere else, I drove by the KOQT and there were two NWS tech's from Morristown doing service on the site. I stopped and talked with them and they think the ASOS has been at that site for at least fifteen years. It was there before it was an ASOS, i.e., before ASOS existed. I shared with them that the reason for locating the ASOS there was that during the 1950's the Army and the Atomic Energy Commission realized they could use helicopters to ferry VIOP's from Oak Ridge to McGhee Tyson. They cut down the trees on the site and moved the then-current NWS station from in front of the old Cheyenne Hall office building to that location. I remember the white louvered shelter box and the red lights on the top of telephone poles to prevent the pilots from running into poles at night. When helicopters became old news, and after the Pellissippi Parkway was completed, the helicopter pad was seldom used, but the station was maintained. I don't know, but it seems logical that the NWS and FAA would want to use the same site because of their existing utilities and a long history of readings from that site.

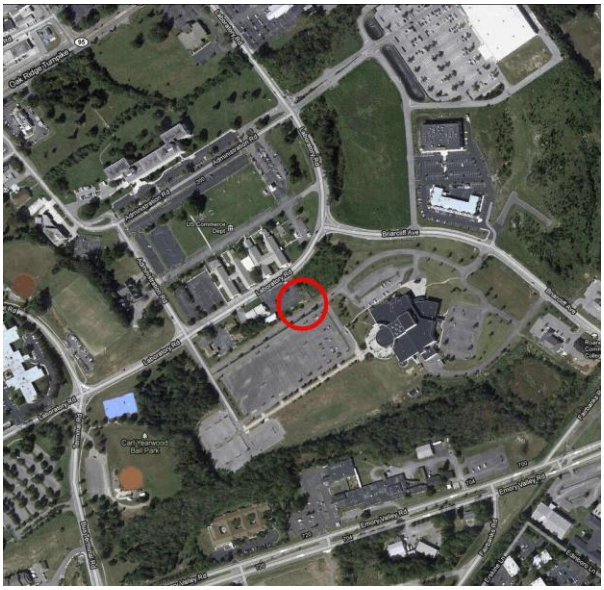

Figure 3. The location of KOQT in the city of Oak Ridge.

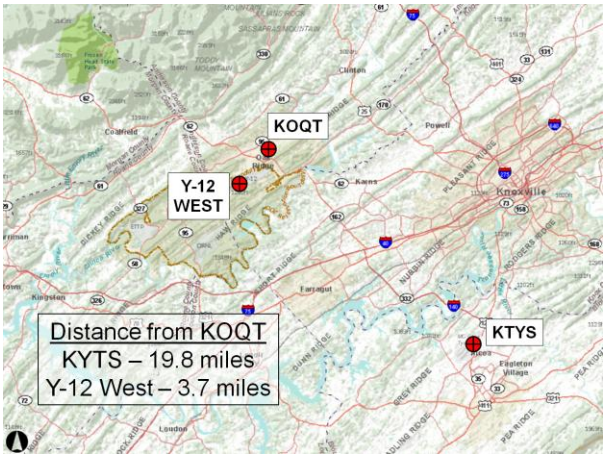

Figure 4. The location of other meteorological sites near KOQT.

Figure 5. The Oak Ridge ASOS site (KOQT).

3. ASOS WIND MEASUREMENTS

ASOS sites are equipped to measure the temperature, dew point, wind speed and direction, precipitation, cloud cover and heights, visibility, and barometric pressure. These data are recorded in standard METAR format as discussed in the Federal Meteorological Handbook No. 1 - (FCM-H1-2005). The wind speed and direction are determined by averaging these data over a 2-minute period. Calm is defined as a condition when no motion of the air is detected. However, due to wind sensor starting thresholds, rounding, and administrative limits, the wind speed is actually reported as calm (00 knots, 00 direction) if the average wind speed is less than 2.5 knots (or 2.88 mph). A variable wind is reported (VRB) when the wind direction varies by 60 degrees or more during the 2-minute evaluation period. ASOS data are updated hourly and at times when significant weather changes are observed.

4. KOQT WIND DATA

LEVEL 3 METAR data for KOQT for January 2005 through February 2011 was obtained from the National Climatic Data Center. Level 3 data has been processed through an extensive quality control system including removal or correction of suspect values. Using the hourly METAR data, monthly percentages of calm and variable winds were calculated for each month over the 74-month period. To provide an annual average, overall monthly averages were also calculated. Figure 6 shows the monthly percentage of calm and variable winds over the 74-month period. Figure 7 shows the monthly average of calm and variable wind averaged over the period. These figures show that KOQT wind direction is unavailable about 67% of the time on an annual basis with September having the highest (80%) and March the lowest (52%) making this site one of the calmest in the country.

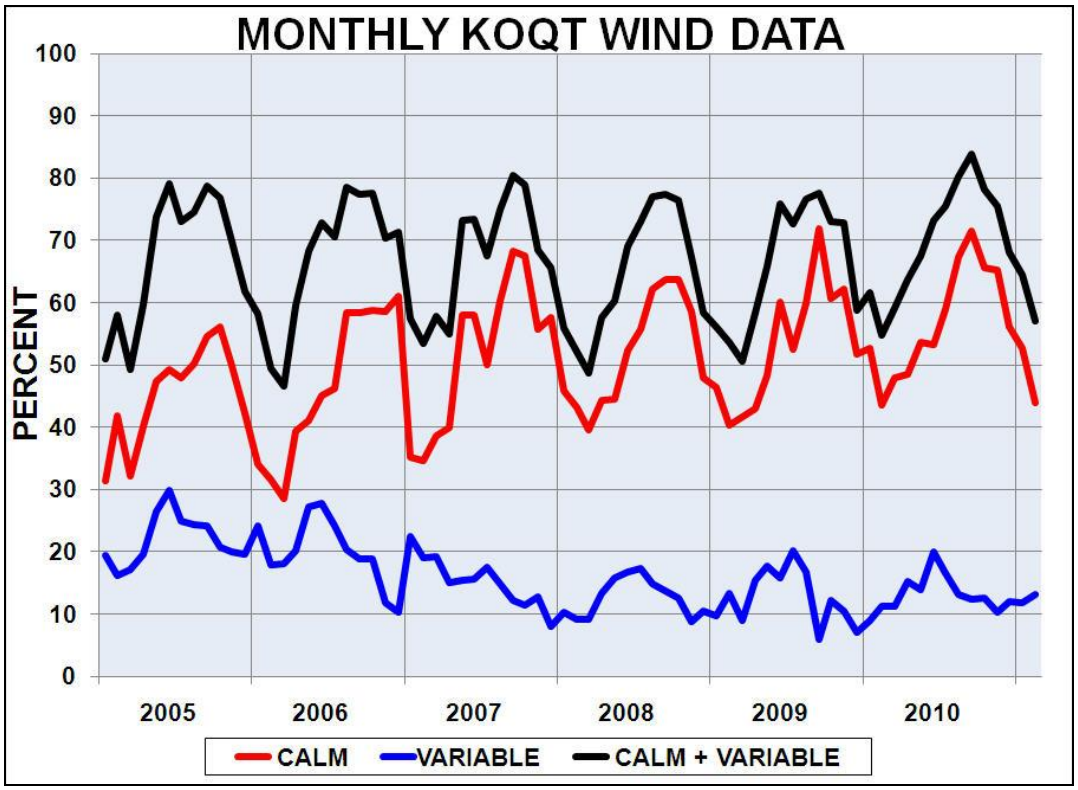

Figure 6. Monthly percentage of calm, variable winds, and calm+variable winds for KOQT over the 74 month period.

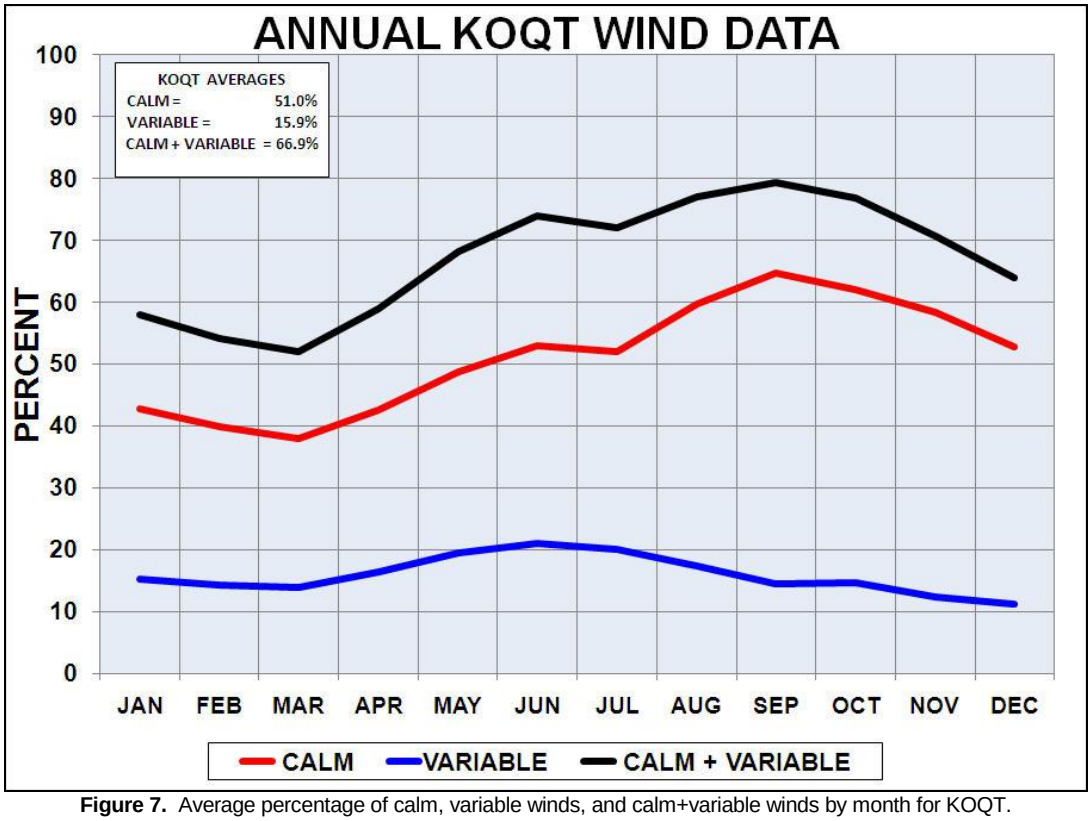

Figure 7. Average percentage of calm, variable winds, and calm+variable winds by month for KOQT.

5. DATA COMPARISONS

LEVEL 3 METAR data for Knoxville - McGhee Tyson Airport (KTYS) for January 2005 through February 2011 was obtained from the National Climatic Data Center and similarly analyzed like the KOQT data. KTYS is located 19.8 miles southeast of KOQT. Figure 8 shows the monthly average of calm and variable wind averaged over the period for both KTYS and KOQT. This figure shows that KTYS wind direction is unavailable about 29% of the time on an annual basis with September having the highest (37%) and March the lowest (21%) thus KOQT is about twice as calm as KTYS.

Wind data from the West tower at the Y-12 National Security Complex for 2007-2010 was also used for comparison. This site is located 3.7 miles to the southwest of KOQT. However, to fully compare this data to the data from ASOS sites where wind sensor starting thresholds, rounding, and administrative limits greatly determine calms, wind speeds equal to or below 2.9 miles per hour from this site were defined as calm. Using this definition, Figure 9 shows the monthly average of calm for the Y-12 West Tower overlaid with the KOQT data. This figure shows that the Y-12 West Tower is nearly as calm as KOQT thus making the Y-12 National Security Complex one of the calmest areas in the country.

6. DISPERSION MODELING IMPLICATIONS

Dispersion modeling in areas with low annual average wind speeds, such as the Oak Ridge Reservation, can be quite challenging. Although not an exhaustive list, the dispersion modeler working in a low wind speed environment should be aware of the following:

- Since downwind concentrations are inversely proportional to wind speed, use caution when interpreting the model's prediction under very low wind speeds. Gaussian models tend to perform poorly with gross over predictions.
- Know what the lowest wind speed your dispersion model will allow. Some models will automatically assign calms to sensor thresholds or other values.
- Know the starting threshold(s) of the anemometer(s) from the site(s) you wish to use and determine if there are rounding or other administrative limits imposed on the data.
- Heed low wind speed warning messages produced by your model.
- Depending of the model used, follow guidance on how to assign wind speeds during calm conditions.
- In more complex models, understand how calms (zero speed) are handled in the local wind field. Some models may ignore this data altogether or substitute other data.
- Have some knowledge of the maintenance and calibration performed on the wind sensor that is used for your model input. Lack of wind sensor maintenance can lead to erroneous data or tend to indicate more calms due to worn sensor bearings.
- Have some knowledge of the topography and nearby structures where the site is located. Some sites may be located without attention to siting standards.
- Perform a study to determine the number of calms on a monthly basis that occur at the site of interest.

7. SUMMARY

This paper documents that KOQT and the Y-12 National Security Complex are located in one of the calmest areas of the United States. Dispersion modelers in other areas of the country can conduct a similar analysis to understand how often calms are observed on a monthly basis.

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http://www.windpoweringamerica.gov/pdfs/wind_maps/tn_80m.pdf

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http://cdo.ncdc.noaa.gov/qclcd/QCLCD

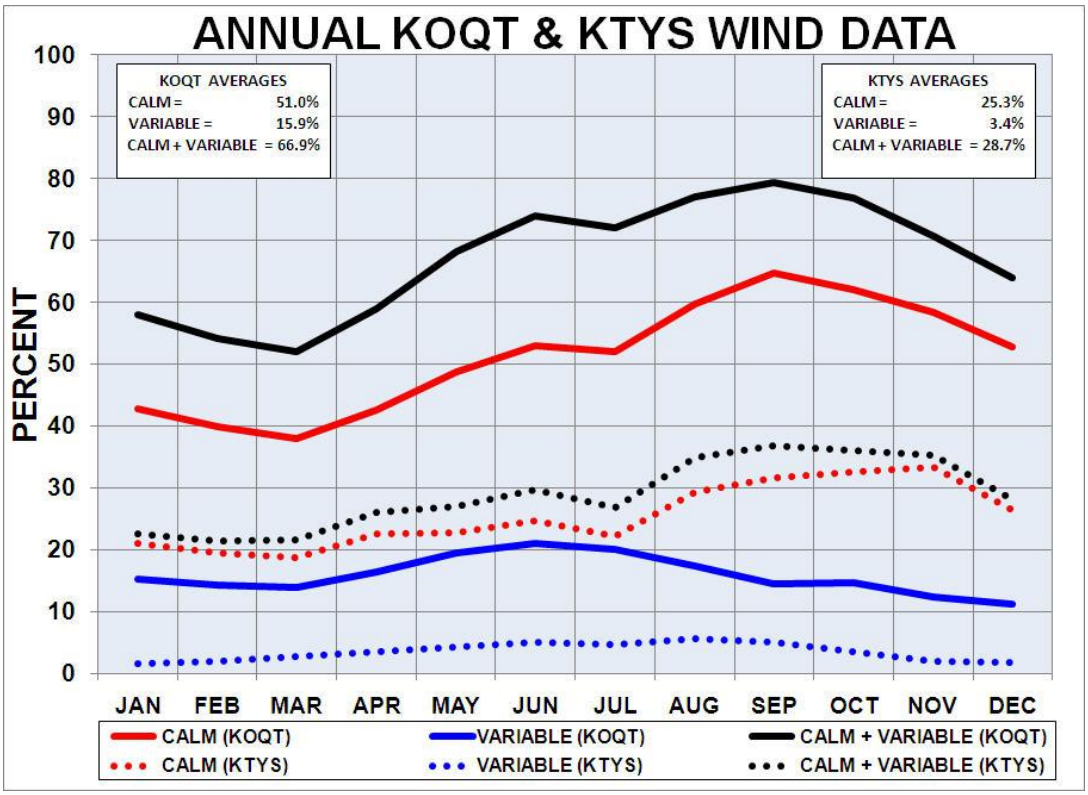

Figure 8. Average percentage of calm, variable winds, and calm+variable winds by month for KOQT (solid) and KTYS (dotted).

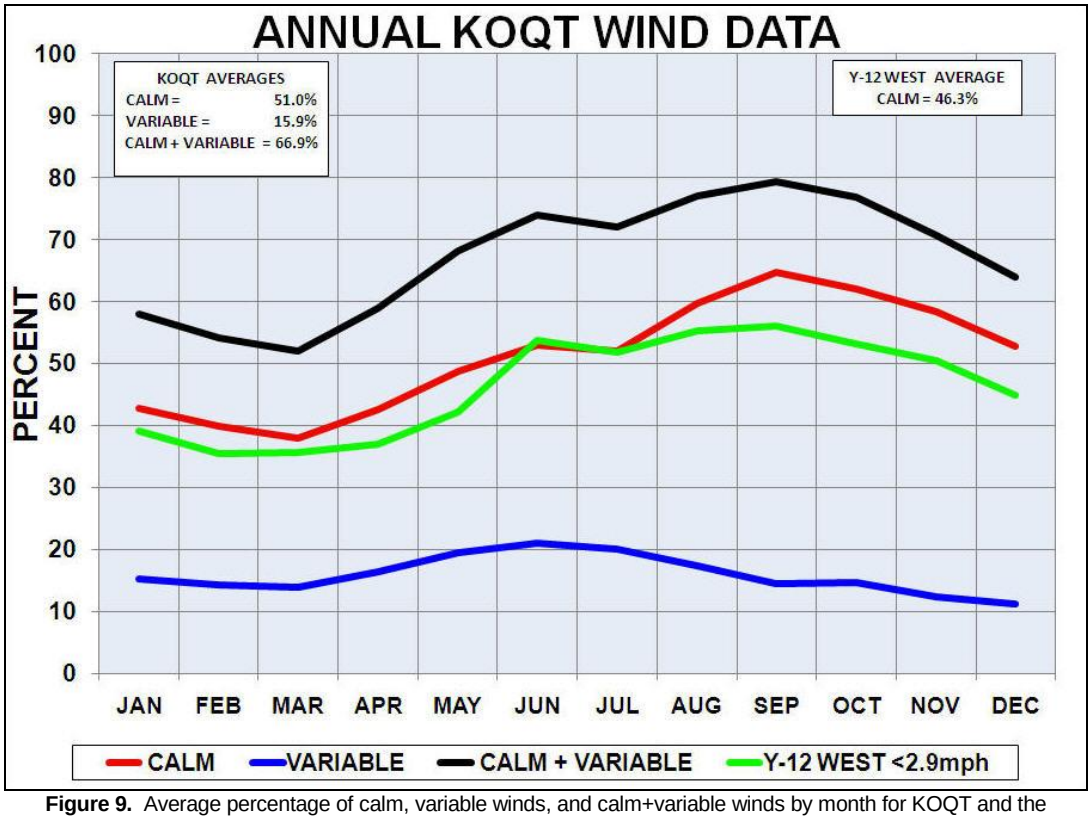

Figure 9. Average percentage of calm, variable winds, and calm+variable winds by month for KOQT and the percentage of calms (defined as wind speed less than 2.9 mph) from the West Tower at Y-12 (green)

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