Intercomparison of Sonic vs. Mechanical Anemometers – Burden’s Creek

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Outline

• What’s the Criteria
• The Prop – Vane system
• The Sonics
• Comparisons
• Summary
Criteria

• EPA – OAQPS updated the EPA QA Handbook Volume IV
  – Draft in 2006
  – Final in 2008

• Chapter 2, Section 2.7, discusses auditing, prop/vane, cup/vane and sonic anemometers

• Section 2.7.4.2 discusses the Collocated Transfer System (CTS) Method for sonics
Strategy

• Recommended procedure
  • Collocate a cup/vane or prop/vane system
  • Locate them as close to the system as you can
  • Calibrate the mechanical system using motor and compass
  • Operate the two systems side by side
  • Recommend 72 hours
In this Corner: The Prop and Vane

RM Young Wind Monitor

Model 05103

Range: 0 – 100 m/s

Accuracy: +/- 0.3 m/s and +/- 1°

Threshold: prop: 1.0 m/s and vane 1.1 m/s
In this Corner: Sonic System #1

RM Young Ultrasonic

Model 81000

Range: 0 – 40 m/s

Accuracy: +/- 1% (WS) +/- 2° (WD)

Threshold: prop: 0.01 m/s
In this Corner: Sonic System #2

Vaisala

Model WXT 520

Range: 0 – 60 m/s

Accuracy: +/- 0.3 m/s/+- 3°

Threshold: 0.3 m/s
## The Criteria

Table 2-2 Proposed Audit Criteria for the Sonic Systems*

<table>
<thead>
<tr>
<th>Wind Variable</th>
<th>Average Difference</th>
<th>Standard Deviation of the Differences</th>
<th>Qualifications</th>
</tr>
</thead>
</table>
| Speed         | ±0.25 ms\(^{-1}\) <5ms\(^{-1}\)  
or ±5%  
or <2.5ms\(^{-1}\) above 5ms\(^{-1}\) | 0.2 ms\(^{-1}\) | Wind speeds greater than 1 ms\(^{-1}\) |
| Direction     | ±5°                  | 2°                                    | Wind speeds greater than 1 ms\(^{-1}\) |

*As proposed by Lockhart*¹
# The Results are In!

## Wind Direction Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>RY Sonic vs. Vais Sonic</th>
<th>RY V vs. RY Sonic</th>
<th>RY Vane vs. Vais Sonic</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>-3.8875</td>
<td>0.3868</td>
<td>-4.0277</td>
<td>5 degrees</td>
</tr>
<tr>
<td>Count</td>
<td>1355</td>
<td>1355</td>
<td>1355</td>
<td>NA</td>
</tr>
<tr>
<td>ST Dev</td>
<td>3.5312</td>
<td>2.1305</td>
<td>10.3253</td>
<td>2 degrees</td>
</tr>
<tr>
<td>Slope</td>
<td>0.9476</td>
<td>0.9693</td>
<td>0.9583</td>
<td>1.05 +/- 5 deg</td>
</tr>
<tr>
<td>Intercept</td>
<td>7.6096</td>
<td>4.4306</td>
<td>8.4779</td>
<td>5 degrees</td>
</tr>
<tr>
<td>Correlation</td>
<td>0.9679</td>
<td>0.9723</td>
<td>0.9411</td>
<td>&gt; 0.95</td>
</tr>
</tbody>
</table>
**The Results are In!**

**Wind Speed Results**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Prop vs. RMY sonic</th>
<th>Prop vs. Vais Sonic</th>
<th>RMY sonic Vs. Vais</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>-0.0575</td>
<td>0.4176</td>
<td>-0.4754</td>
<td>0.25 m/s*</td>
</tr>
<tr>
<td>count</td>
<td>1355</td>
<td>1355</td>
<td>1355</td>
<td>NA</td>
</tr>
<tr>
<td>STD</td>
<td>0.1047</td>
<td>0.3000</td>
<td>0.2912</td>
<td>0.2 m/s</td>
</tr>
<tr>
<td>Slope</td>
<td>0.9457</td>
<td>0.9096</td>
<td>0.9365</td>
<td>1.05 +/- 0.5 m/s</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.0442</td>
<td>0.5486</td>
<td>0.5700</td>
<td>0.5 m/s</td>
</tr>
<tr>
<td>Correlation</td>
<td>0.9747</td>
<td>0.8945</td>
<td>0.8936</td>
<td>&gt; 0.95</td>
</tr>
</tbody>
</table>

* Criteria for less than 5 /s, which represents all but one data point
Cause and Effect

• What could be some of the factors affecting these differences?
  – Shorter time duration may be a key to the difference in how the data are stored then calculated
  – Less than ideal siting, more turbulence than what is ideal
  – Robertson and Katz, and Baxter et. al. found that the criteria by Lockhart may be too stringent.
Summary

A comparison was made of two sonic and prop/vane anemometer
Using the Audit Criteria in the EPA Volume IV, section 2.7.4.2

• We did not meet the audit criteria
• However, we were close
• Other studies, (Baxter, et. al) also found these to be difficult to meet
• Other linear regression data also found some interesting results
