MATC Major Research Instrumentation
Polar Climate and Weather Station
Temperature Case Studies

Theresa Cody, Dr. Matthew Lazzara and Lee Welhouse
Department of Physical Sciences
Madison Area Technical College

tacody@madisoncollege.edu
mlazzara@madisoncollege.edu
ljwelhouse@madisoncollege.edu
Material in this document may be copied without restraint for library, abstract service, educational, or personal research purposes.

This report may be cited as:

Cody, T. A., M.A. Lazzara, and L.J. Welhouse; 2019: MATC MRI AWS Temperature Case Studies. Department of Physical Sciences, School of Arts and Sciences, Madison Area Technical College. 9 pp. [Available upon request]

This report is available from:

The Department of Physical Sciences  
Madison Area Technical College  
1701 Wright Street, Madison, WI, 53704

Or on-line at:

https://madisoncollege.edu/antarctic-meteorology-project

This report is dedicated to my Aunt Mary who inspired me with scientific endeavors at the early age of three. She was instrumental in raising me with her nurturing love and guidance. She helped development a strong and determined spirit that I reply on often in life. She will be greatly missed.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>3</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>4</td>
</tr>
<tr>
<td>HYPOTHESIS</td>
<td>4</td>
</tr>
<tr>
<td>FEBRUARY 2018 CASE</td>
<td>4</td>
</tr>
<tr>
<td>MAY 2018 CASE</td>
<td>6</td>
</tr>
<tr>
<td>CONCLUSION</td>
<td>8</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>9</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>9</td>
</tr>
</tbody>
</table>
Introduction

In Antarctica at Williams Field, Madison College installed onto the UW-Madison automatic weather station (AWS) an additional temperature sensor to compare temperature reactions between the R.M. Young upper platinum resistance thermometer (PRT) and the Apogee ST-110 thermistor (referred to henceforth as thermistor) sensor through the different seasons. UW-Madison operates a network of AWS across the Antarctic, with Willie Field AWS as its test site (Lazzara et al., 2012). The additional thermistor was installed in February of 2018 and has been collecting data ever since. In this paper, we will be examining why there were differences between the PRT and the thermistor sensor.

Hypothesis

The working hypothesis is that the thermistor will perform better in low wind situations. In low wind situations, the thermistor will not be as warm as the PRT when the sun is up (austral summer and associated spring/fall time frames). This is due to the form factor of the specific instruments. The PRT has a larger form factor, and more wind is necessary to properly ventilate it in comparison to the smaller form factor of the thermistor.

February 2018 Case

This period, shown in figure 1, is the latter half of February 2018. Temperatures are decreasing overall, as the season shifts from Austral summer to fall. Throughout the period analyzed the overall agreement between the instruments is good. This agreement in sensors is both found in the pattern as well as the absolute values of the data. That being said, there are periods where the difference in temperature between the PRT and thermistor exceeds the specified accuracy of the instruments. The PRT sees higher peak temperatures throughout the month of February compared with the thermistor.
Figure 1. Sample temperature observations from the PRT (blue, UW) and thermistor (orange, MATC) from the latter half of February 2018. The trend of the observations shows the seasonal decrease from Austral summer to fall, with the PRT showing warmer observations at times.

As the temperatures are getting colder, the first significant difference between the PRT and thermistor is seen on the left side of the graph with a difference 1.9°C (Figure 2). We suspect the reason for this difference is due to the form factor of the PRT which is not “ventilating” or equilibrating the same rate as the more responsive thermistor (Blonquist and Bugbee, 2018). At lower wind speeds, the air doesn’t cycle through the radiation shield, air heats up inside, and both temperature sensors warm up. The PRT with a larger form factor observes a warmer temperature than the thermistor with a smaller form factor in this situation. Then both temperatures sensors balance to near-agreement at higher winds, as suspected. At these higher wind speeds, greater than 2.0 m/s, both shields naturally ventilate allowing more accurate measurement of air temperature. Winds increase a bit to high winds towards the middle of the sampled time period, but the temperatures remain in agreement. In other portions of this time period, low wind speeds...
are observed without large differences between the PRT and thermistor. These uninvestigated situations may be due to other factors (e.g. cloud cover, snowfall, low sun angle, sun behind topography, etc.).

Figure 2. Early in this sample time period, a significant difference between the PRT and thermistor is seen (PRT minus thermistor is shown). This occurs during a period of low wind speed (which implies limited natural ventilation).

May 2018 Case

The May 2018 sample observation period shows very high agreement in the observations as seen in figure 3. No significant differences are obviously seen between the PRT and the thermistor. However, as shown in figure 4, there are differences seen between the PRT and thermistor measurements. Two periods show large differences during very low to near calm wind speeds. There are differences where the PRT is colder than the thermistor. This is suspected to be due to the PRT larger form factor radiating away energy.
in a sunless environment. At Willie Field AWS, in May, there is no incoming sunshine. There are also periods where the PRT is warmer than the thermistor. The cause for this phenomenon is unclear. Other measurements available at the station (e.g. relative humidity, wind direction, lower-level temperature, etc.) do not provide additional evidence supporting any particular cause.

Figure 3. Temperature observations from both the PRT and thermistor for the month of May 2018 shows values that are very close to each other. In only a few instances does the PRT values depart from the thermistor measurements.
Figure 4. During two periods of light to calm winds in the first third and last third of the month come with large differences between the PRT and thermistor. Differences of a colder PRT than thermistor may be due to the form factor of the sensor in no-sunlight conditions. Situations with warmer PRT than thermistor are not well understood.

Conclusion

In conclusion, more testing should be done on the sensors to understand the behavior observed here. Some evidence show here supports the hypothesis that the thermistor does indeed perform better than the PRT in low wind, sunlight conditions. Wintertime, non-sun and low wind situations are less clear and will require additional investigation to determine the causes for the larger departures between the PRT and thermistor.
Acknowledgements

This material is based upon work supported by the National Science Foundation, Major Research Instrumentation, Directorate for Geosciences, Office of Polar Programs, under Grant PLR-1625904

References
