# In Situ Checks of Sonic Anemometer Temperature Calibration

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## Abstract

The temperature calibration of the Gill Instruments WindMaster Pro sonic anemometer used in the SGP ACRF ECOR systems is a curve, but is approximated as a linear fit for field use. The linear fit is only applied to the calculation of sensible heat flux and not to the reported temperature, and results in an underestimate of sensible heat flux during cold ambient temperatures and an overestimate during hot ambient temperatures. In situ calibrations performed using five years of ARM SGP ACRF data reveal how poorly the temperature is measured by the ECOR using the linear fit. Linear and non-linear in situ calibrations were determined for each sonic anemometer. In several cases, the linear calibration slopes presently being used in-field need to be changed (see Table 1). The non-linear slopes will be used in the ECOR VAP to convert the measured temperature to ambient temperature.

## Analysis Method

SGP SMOS, MET, EBBR and ECOR data for five years (2005-2009) were obtained from the ARM Data Archive. MATLAB programs were developed to perform the in situ sonic temperature calibrations. Plots of sonic temperature versus in situ temperature were constructed for each sonic anemometer and for each SGP Extended Facility at which they were used. Linear and non-linear (2nd and 3rd order) temperature regressions were determined for each sonic anemometer, using data that included 1) all wind directions and 2) wind directions of good fetch; little difference was seen between the two. In a few cases, insufficient data was available from a wide enough range of temperatures to produce a reasonable fit to the data. Examples of the linear and non-linear regressions fitted to the data plots are seen to the right in Figures 1 and 2.

## Results

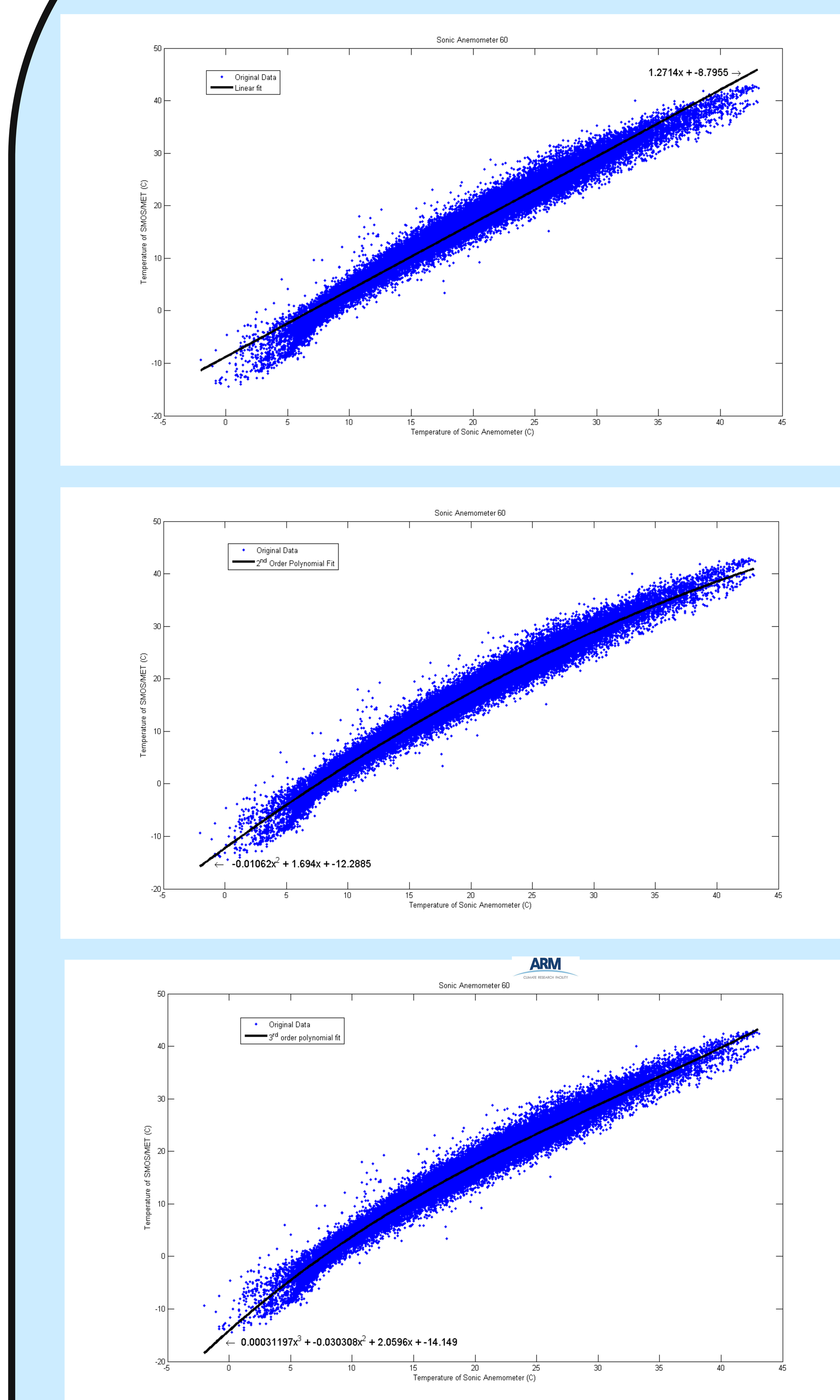

Figure 1. Linear, 2nd order, and 3rd order fits for sonic SN 60 (low temperatures not included).

| Sonic SN | Old Slope | Old Bias | New Slope | New Bias |
|---|---|---|---|---|
| 58 | 1.34 | -7.14 | 1.33 | -9.73 |
| 59 | 1.14 | -4.87 | 1.22 | -10.73 |
| 60 | 1.34 | -8.85 | 1.26 | -8.84 |
| 61 | 1.23 | -6.71 | 1.26 | -6.94 |
| 62 | 123 | -7.46 | 1.31 | -7.33 |
| 63 | 1.23 | -6.19 | 1.27 | -7.82 |
| 64 | 1.20 | -6.64 | 1.19 | -6.36 |
| 65 | 1.22 | -6.93 | 1.26 | -5.62 |
| 66 | 1.26 | -7.22 | 1.21 | -6.94 |
| 67 | 1.39 | -9.42 | 1.38 | -11.03 |
| 85 | 1.26 | -7.14 | 1.13 | -4.35 |
| 88 | 1.26 | -7.14 | 1.26 | -7.93 |
| 95 | 1.26 | -7.14 | 1.36 | -6.48 |
| 96 | 1.26 | -7.14 | 1.29 | -9.92 |

Table 1. Old and new slope and bias of the sonic anemometer linear regression fit for the 14 sonic anemometers at SGP.

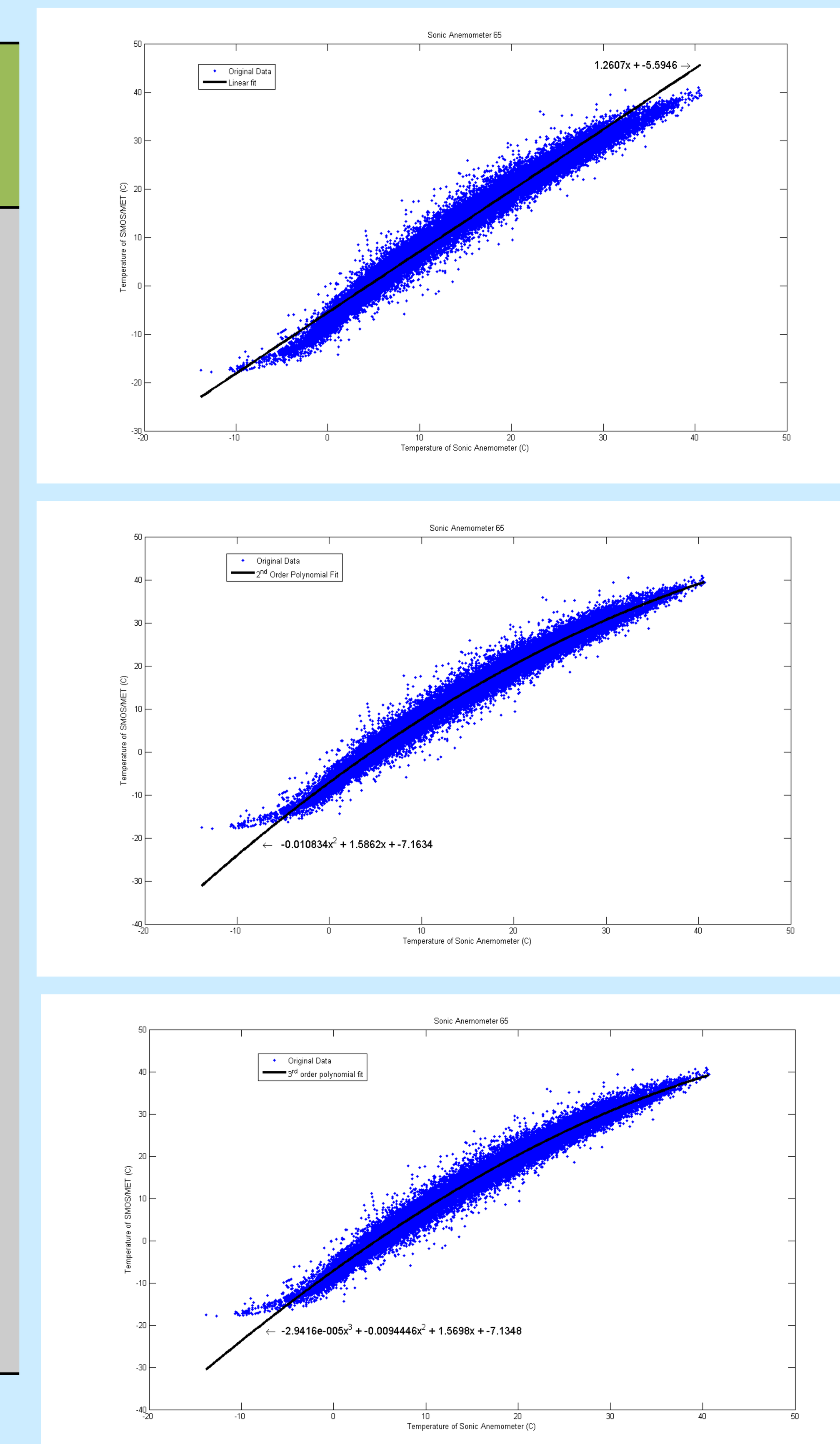

Figure 2. Linear, 2nd order, and 3rd order fits for sonic SN 65. Note tail (sensitivity loss) at low temperatures.

## Conclusions

**Small changes are generally seen in the slope and bias of the linear sonic temperature calibration fits, with several notable exceptions. A few of the exceptions can be attributed to a generic calibration being used for four sonic anemometers.**

**Use of the non-linear fits in the ECOR VAP will yield much more accurate sonic anemometer temperature measurements.**

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