Media Resource: Summary of Fall et al, 2011

Background Information

The Surface Stations Project was started in June 2007 as an unfunded volunteer program set up by Anthony Watts of Intelliweather in cooperation with Dr. Roger Pielke, Sr., at the University of Colorado. Over 650 volunteers nationwide obtained quality-controlled surveys for 82.5% (1007 out of 1221) of the U.S. Historical Climatology Network (USHCN) stations. This National Oceanic and Atmospheric Administration (NOAA) network,, is a specially chosen subset of the larger volunteer operated Cooperative Observer Program (COOP) and is used as part of the construction of the national and global average surface temperature trends. Most volunteer observers interviewed had no idea their stations were part of a special USHCN network, and received no instructions for extra care or due diligence. No official notice was ever given that we could find.

The stations in the USHCN network were not designed for the purpose of measuring climate trends over time. During the past decade, NOAA has established such a trend detection network, the Climate Reference Network (CRN). In the course of designing the CRN, they adopted siting criteria in 2002 to determine which sites were suitable for the new CRN stations: http://www1.ncdc.noaa.gov/pub/data/uscrn/documentation/program/X030FullDocumentD0.pdf Siting categories range from CRN 1 (best) to CRN 5 (most vulnerable to contamination by nearby heat sources and sinks and other local effects).

The goals of our paper were to (1) determine to what extent the existing USHCN stations satisfied the CRN siting criteria, and (2) determine to what extent poor USHCN siting affects temperature trend estimates in the United States.

Survey Results

The vast majority of weather station sites surveyed are CRN 3 or CRN 4, which are considered undesirable for climate trend monitoring.

- Only 80 sites out of 1007 are CRN 1 (best) or CRN 2 (acceptable)
- 61 sites are CRN 5 (worst)

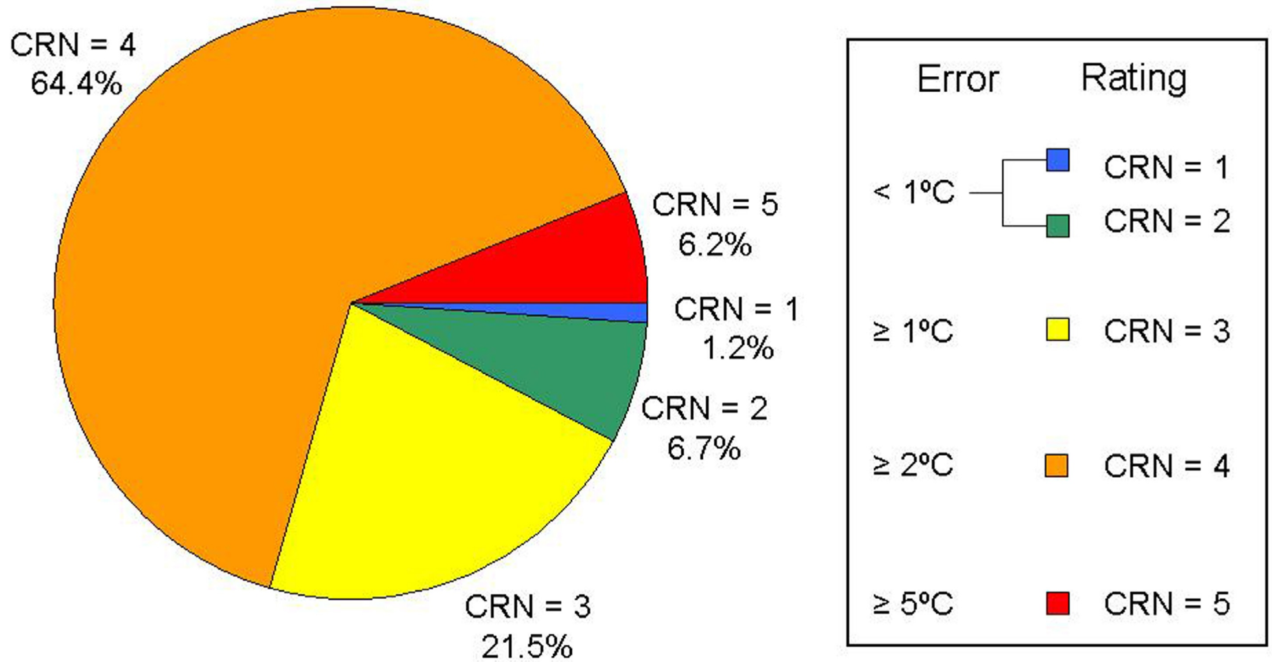

Figure caption : Surveyed USHCN surface stations. The site quality ratings assigned by the Surface Stations Project are based on criteria utilized in site selection for the Climate Reference Network (CRN). Temperature errors represent the estimated daily uncertainty due to siting [*Leroy,* 1999; *NOAA/NESDIS Climate Reference Network*, 2002].

An example of a CRN 5 rated station is shown below:

Figure caption: USHCN station #028815 at the University of Arizona, Tucson. Note the placement in the parking lot. Photo by surfacestations.org volunteer Warren Meyer.

Trend Analysis Results

Temperature trend estimates do indeed vary according to site classification. Assuming trends from the better-sited stations (CRN 1 and CRN 2) are most accurate:

- Minimum temperature warming trends are overestimated at poorer sites
- Maximum temperature warming trends are underestimated at poorer sites
- Mean temperature trends are similar at poorer sites due to the contrasting biases of maximum and minimum trends
- The trend of the “diurnal temperature range” (the difference between maximum and minimum temperatures) is most strongly dependent on siting quality. For 1979-2008 for example, the magnitude of the linear trend in diurnal temperature range is over twice as large for CRN 1&2 (0.13ºC/decade) as for any of the other CRN classes. For the period 1895-2009, the adjusted CRN 1&2 diurnal temperature range trend is almost exactly zero, while the adjusted CRN 5 diurnal temperature range trend is about -0.5°C/century.

- *Vose and Menne*[2004, their Fig. 9] found that a 25-station national network of COOP stations, even if unadjusted and unstratified by siting quality, is sufficient to estimate 30-yr temperature trends to an accuracy of +/- 0.012°C/yr compared to the full COOP network. The statistically significant trend differences found here in the central and eastern United States for CRN 5 stations compared to CRN 1&2 stations, however, are as large (-0.013°C/yr for maximum temperatures, +0.011°C/yr for minimum temperatures) or larger (-0.023°C/yr for diurnal temperature range) than the uncertainty presented by Menne at al (2010).

Many more detailed results are found in the paper, including analyses for different periods, comparisons of raw and adjusted trends, and comparisons with an independent temperature data set.

References

Fall, S., A. Watts, J. Nielsen-Gammon, E. Jones, D. Niyogi, J. Christy, and R.A. Pielke Sr., 2011: Analysis of the impacts of station exposure on the U.S. Historical Climatology Network temperatures and temperature trends. J. Geophys. Res., in press. Copyright (2011) American Geophysical Union.

Menne, M. J., C. N. Williams Jr., and M. A. Palecki (2010), On the reliability of the U.S. surface temperature record, *J. Geophys. Res*., **115**, D11108, doi:10.1029/2009JD013094.

Vose R. S., and M. J. Menne (2004), A Method to Determine Station Density Requirements for 834 Climate Observing Networks. J. Climate, 17, 2961-2971.

<u>Questions and Answers</u>

Q: So is the United States getting warmer?

A: Yes. We looked at 30-year and 115-year trends, and all groups of stations showed warming trends over those periods.

Q: Has the warming rate been overestimated?

A: The minimum temperature rise appears to have been overestimated, but the maximum temperature rise appears to have been underestimated.

Q: Do the differing trend errors in maximum and minimum temperature matter?

A: They matter quite a bit. Wintertime minimum temperatures help determine plant hardiness, for example, and summertime minimum temperatures are very important for heat wave mortality. Some of us have concluded and published that maximum temperature trends are the best indicator of temperature changes in the rest of the atmosphere, since minimum temperature trends are much more a function of height near the ground and are of less value in diagnosing heat changes higher in the atmosphere.

Q: What about mean temperature trends?

A: In the United States the biases in maximum and minimum temperature trends are about the same size, so they cancel each other and the mean trends aren't much different from siting class to siting class. This finding needs to be assessed globally to see if this also true more generally.

However, even the best-sited stations may not be accurately measuring trends in temperature or, more generally, in trends in heat content of the air which includes the effect of water vapor trends. Also, most are at airports, are subject to encroaching urbanization, and use a different set of automated equipment. The corrections for station moves or other inhomogeneities use data from poorly-sited stations for determining adjustments to better-sited stations.

Q: What's next?

A: We also plan to look specifically at the effects of instrument changes and land use issues, among other things. The Surface Stations volunteers have provided us with a superb dataset, and we want to learn as much about station quality from it as we can.

Print quality graphs and photographs are available on request.