BEST Data Quality Problems

Gary Wescom – November, 2011

(November 7, 2011 update – providing BEST site plot ID info)

While doing a cursory look at the Berkeley Earth Surface Temperature (BEST) October preliminary data release, I noticed some problems. I was quite surprised to see very obvious errors in their data.txt file. They are the kind of things that should never have made it into public view, let alone presented as an example of the work done in the BEST project.

The data presented is smoothed to remove seasonal variations. That, by itself, does not present a problem other than any work based upon that smoothed data must trust its accuracy. Verification against the original raw data to create the smoothed data set is not possible.

Harmonic Distortion

Unfortunately, the BEST project smoothing algorithm introduces a four month period low level (+/- 1.6 degree C) ringing in the smoothed data. A four month ringing period is, of course, the third harmonic of the twelve month annual seasonal cycle. While ringing in a filter made up with analog resonant circuits is easy to imagine, it is not common for folks to realize digital implementation of filters can exhibit the same problem. In fact, many digital filter algorithms are simply mathematical representations of analog filter designs. This concept should have been familiar to the BEST project statisticians.

The third harmonic ringing showed up in a previous comparison between US Historical Climate Network raw data with the BEST data. That was covered in a previous document:

http://climate.n0gw.net/BEST_data_for_Lebanon_Missouri.pdf

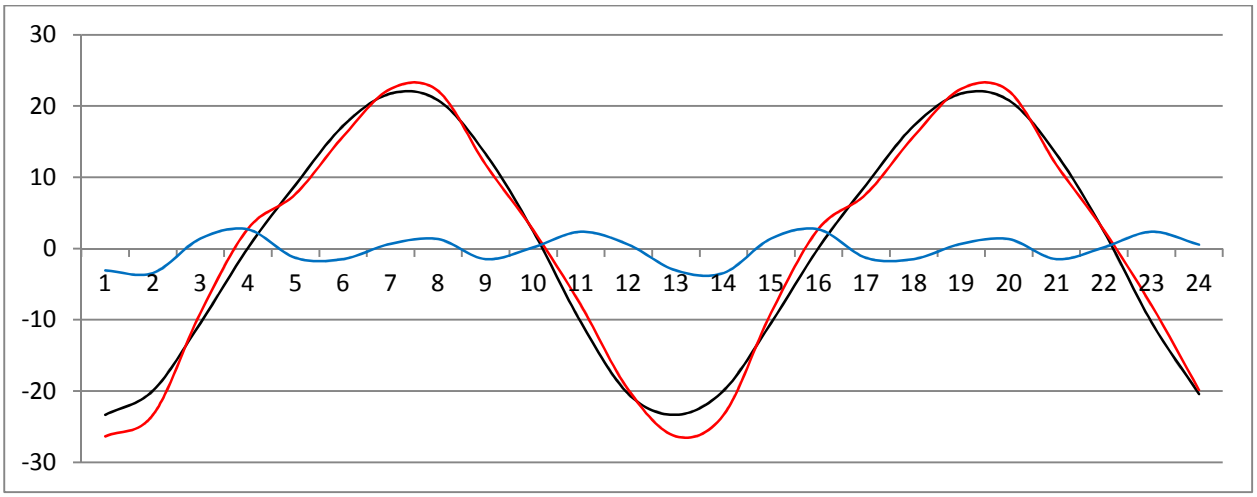

Fig 1: Seasonal offsets leb2w: USHCN (black), BEST (red), and difference between them (blue)

Figure 1 above shows a smoothed plot of the monthly seasonal normalizing values in Fahrenheit (from USHCN data), showing 24 months to better display the December/January break. The black plot is of the actual seasonal anomalies, which you will notice is a close approximation of a sine wave, as one might expect for 37 degrees north latitude. The red plot is a back calculation of the BEST calculated anomalies. The blue line is the difference between the two. Notice that there are three humps for each year in the blue line. That is the third harmonic of the twelve month annual season cycle.

How the plot in figure 1 was developed was described in the "BEST data for Lebanon Missour.pdf" paper mentioned above. However, the presence of the third harmonic ringing is likely of little concern to long term trend development. The contribution of the harmonic values averages very close to zero over the full year.

What is important about the third harmonic is not is magnitude but rather its presence at all. This is an indication that the processing algorithms are introducing phase and amplitude distortion into the BEST temperature record.

Temperature Errors

A more serious problem is found in the temperature data. I had noticed some unusual temperature blips in the BEST data for Lebanon, Missouri. A plot of that data showed temperatures remained within a narrow band of roughly +/- 5 C. However, there were several individual monthly values that were 15 to 30 degrees off from the main plot. As an example, July 1914 is listed in the BEST data as -12.1 C. The raw USHCN value for that month is 80.1 F (26.7 C).

Upon scanning best.txt for this specific problem, I discovered that it is common. Some examples follow:

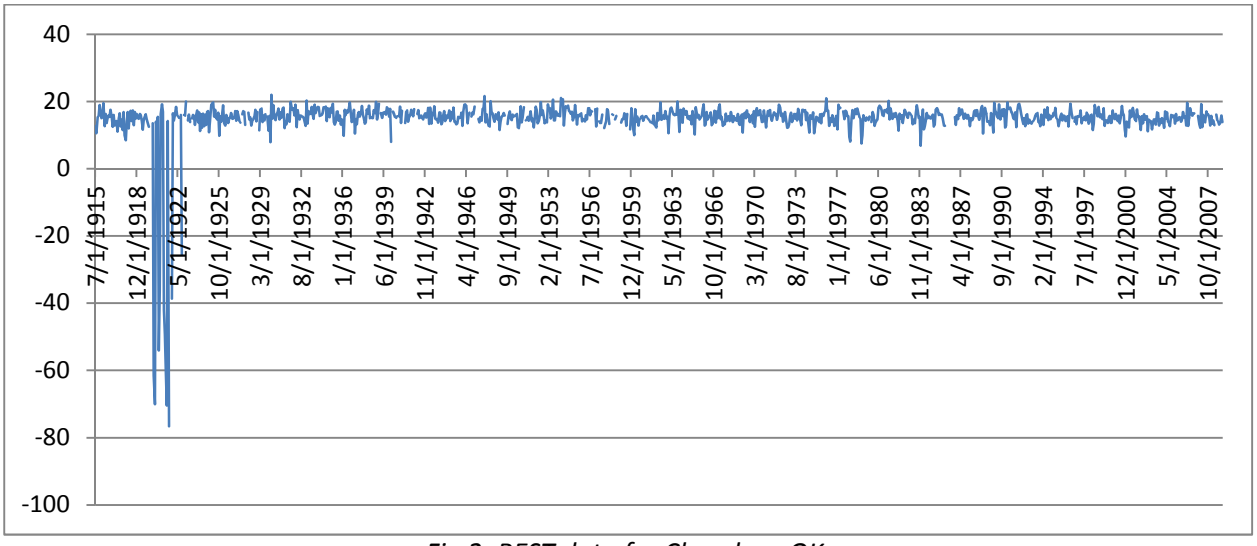

Fig 2: BEST data for Cherokee, OK
(BEST site ID 149255)

Cherokee, Oklahoma, did not actually experience Antarctic winter temperatures during the early twentieth century.

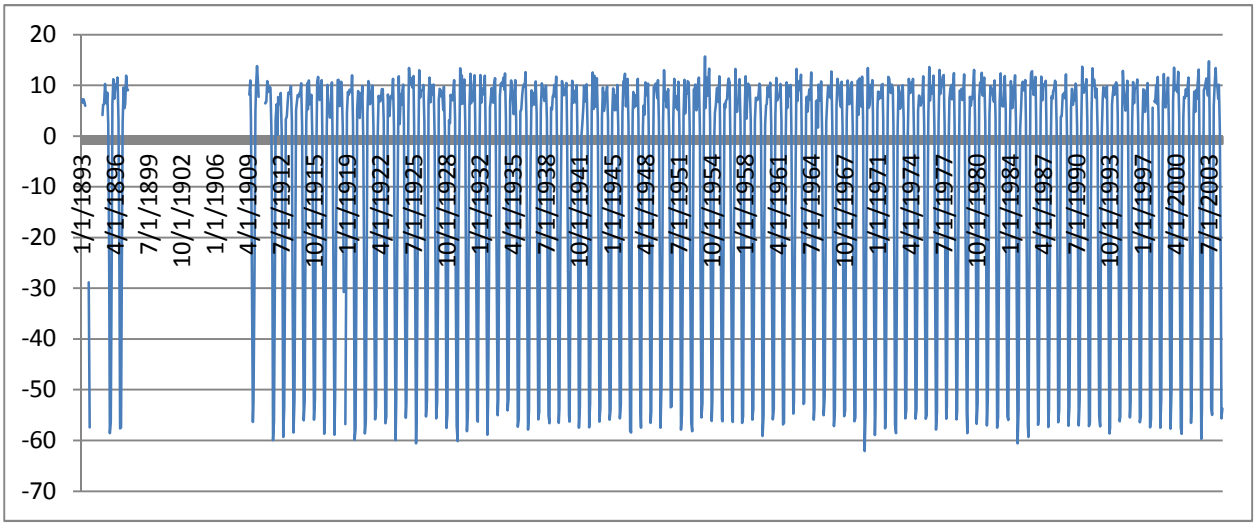

Fig 3: Longmone 2 ESE, Boulder, CO

(BEST site ID 138546)

This Boulder, Colorado, station shows an interesting pattern. Those negative spikes occur September, October part of the year. Colorado fall temperatures usually a bit milder that the plot above might suggest.

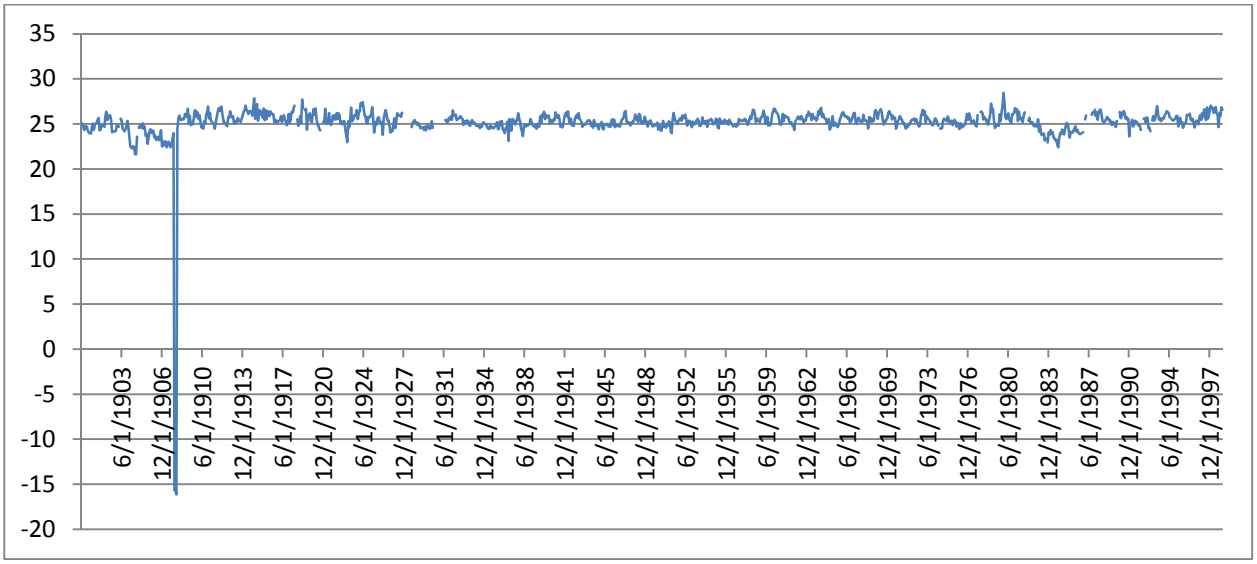

Fig 4: ARECIBO 3 ESE, Arecibo, PR

(BEST site ID 126893)

Figure 4 from Puerto Rico shows 3 cold winter months in 1908.

To show that not all temperature blips are toward lower temperatures, this Kazakhstan station plot below shows a 140 degree C spike.

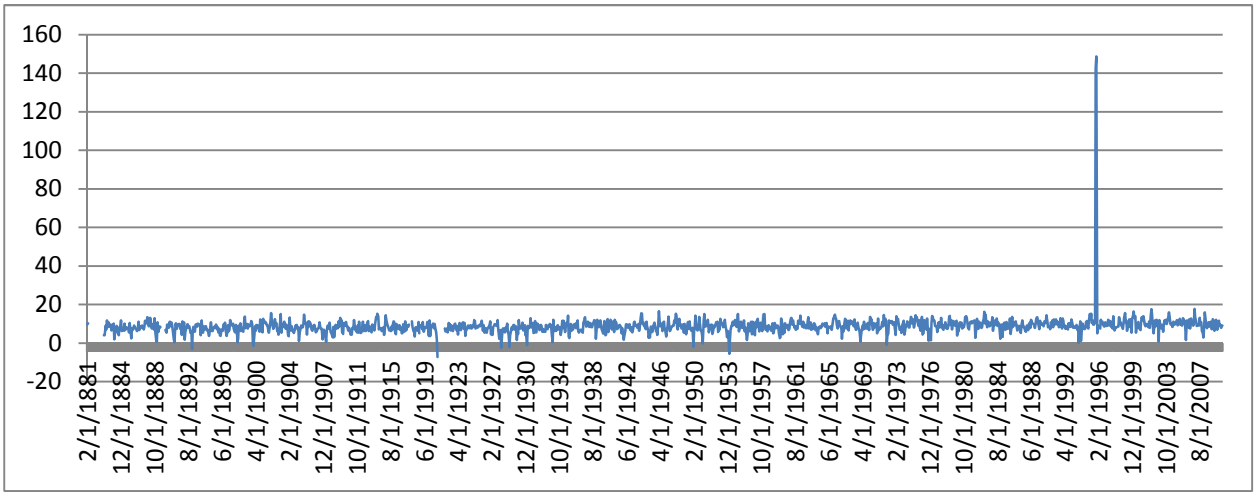

Fig 5: GUR'EV, AS, Balykshi, Kazakhstan (north of Caspian Sea)
(BEST site ID 124643)

The plots shown in figures 2 through 5 above are not unique. Of the 39028 sites listed in the data.txt file, arbitrarily counting only sites with 60 months of data or more, 34 had temperature blips of greater than +/- 50 degrees C, 215 greater than +/- 40 C, 592 greater than +/- 30 C, and 1404 greater than +/- 20 C. That is quite a large number of faulty temperature records, considering that this kind of error is something that is so easy to check for. A couple hours work is all it took to find these numbers.

In the engineering world, this kind of error is not acceptable. It is an indication of poor quality control. Statistical algorithms were run on the data without subsequent checks on the results. Coding errors obviously existed that would have been caught with just a cursory examination of a few site temperature plots. That the BEST team felt the quality of their work, though preliminary, was adequate for public display is disconcerting.

Conclusion

Does either the third harmonic problem or the temperature blips make any difference when using the data for overall trend analysis? Maybe it doesn't. Maybe it does. These problems do indicate that the fundamental quality of the data presented may not be adequate for the job. As the saying goes "Trust but Verify." This attempt at verification shows a problem.