Examination of the "Southeastern Warming Hole" of the United States

The UN's Intergovernmental Panel on Climate Change (IPCC) notes that although the average global temperature is increasing, some areas have seen little temperature change, and some actually are becoming somewhat cooler.[1]

I recently became aware of a climatological phenomenon known as the "southeastern warming hole" (WH), an area of the United States that reportedly has experienced temperature decreases—rather than increases—for the past 50 to 100 years. According to the National Phenology Network[2]:

> Over the past century, the Southeast [US] has experienced . . . a general cooling trend until 1980 when temperatures began to increase. . . . [This is the] so-called "warming hole" (an area centered across the southeastern U.S. where warming is happening at a slower rate than elsewhere in the U.S.). . . .

Several scientists have studied the WH and offer varied hypotheses to explain its existence. Although it is beyond the scope of this paper to analyze those, some references of interest are Meehl, et al. (2012)[3]; Kumar, et al. (2013)[4]; Leibensperger, et al. (2012)[5]; and Kunkel, et al (2006).[6] Figure 1[7], from research done by Harvard University, shows one study's extent of the WH.

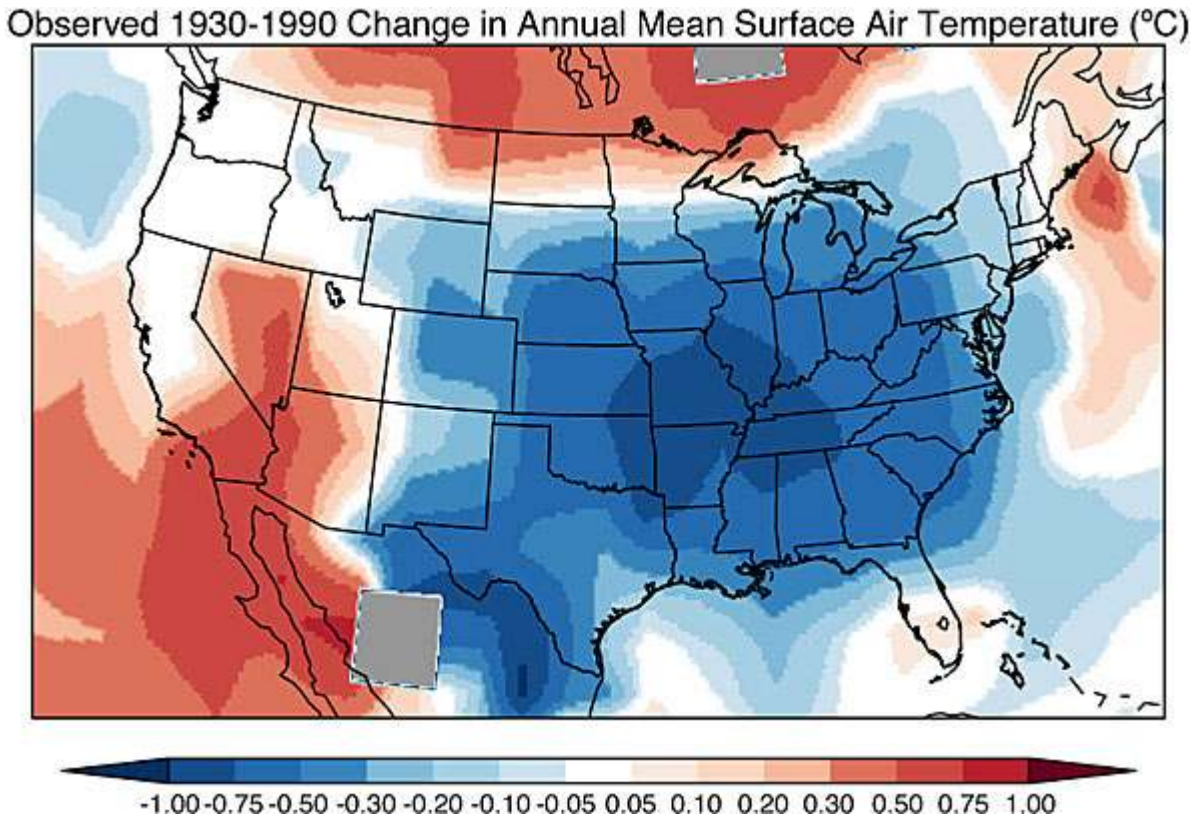

Figure 1. Observed change in surface air temperature in the US between 1930 and 1990. Original source NASA GISS.

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This study. I compared temperatures in the WH with temperatures throughout the US in general. I arbitrarily chose 55 sites (the "experimental" sites) from the "Climate Time Series Browser" database[8], selecting them to be relatively evenly dispersed geographically within the centermost portion of the WH—the central dark-blue area of Figure 1. The resulting dataset can be viewed at:
http://climatemodels.uchicago.edu/timeseries/#EzmBBhECBBCCBBGjFUDoJFBSElDFOCBCBCCCBBBGLeZFiCCGBBNMsDylMDaBDICLbBcW

For comparison (the "control" sites), I randomly chose 55 other sites from within the US, each of which was outside the experimental area. Again, I attempted to achieve a geographically even distribution of sites. That dataset can be seen at:
http://climatemodels.uchicago.edu/timeseries/#FcuBvFBdBhBcCaDBpBbBCoZDqFCWBBtYDeGJBeBeBhBcHBsMKZBrCoHBcCeTFfOEEaBnHBsBdLCfBuXBuUNYCl

Analysis. For each of those two datasets, I selected a "Time Range" of 1930 to 1990, which some of the previously mentioned WH studies have used. I validated that each site included sufficient data within this time period. I plotted the "Fit Only," normalized the data to the date range of 1900-1950, and used "Combine," thus representing the temperature change by a single line.

Results. The 1930-1990 temperature change for the WH's sites showed an anomaly of +0.350º C to -0.635º C, yielding a delta of -0.985º C. This is a temperature decrease of 0.164º C per decade.

The temperature change for sites from the entire United States for 1930-1990 was from +0.233º C to -0.043º C, yielding a delta of -0.276º C. This is a temperature decrease of 0.046º C per decade.

The fact that the WH's temperature delta was approximately 3.5 times that of the US's provides some verification of the existence of the WH. (For comparison, the United States Environmental Protection Agency states that during the 20th century, the Earth's average surface temperature has increased almost 0.83º C.[9])

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[1] Frequently Asked Question 3.1; How are Temperatures on Earth Changing?
http://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-3-1.html

[2] Observed Changes in Phenology Across the United States – Southeast
https://www.usanpn.org/files/shared/files/Changes_in_Phenology-SE.pdf

[3] Meehl, G. A., Arblaster, J. M., & Branstator, G. (2012). Mechanisms Contributing to the Warming Hole and the Consequent U.S. East–West Differential of Heat Extremes. *J. Climate, 25*, 6394–6408.
http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-11-00655.1?journalCode=clim

[4] Kumar, S., Kinter, J., Dirmeyer, P. A., Pan, Z., & Adams, J. (2013). Multidecadal Climate Variability and the "Warming Hole" in North America: Results from CMIP5 Twentieth- and Twenty-First-Century Climate Simulations. *J. Climate, 26*, 3511–3527.
http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00535.1

[5] Leibensperger, E. M., Mickley, L. J., Jacob, D. J., Chen, W.-T. Seinfeld, J. H., Nenes, A., . . . Rind, D. (2012). Climatic effects of 1950–2050 changes in US anthropogenic aerosols – Part 2: Climate response. *Atmos. Chem. Phys., 12*, 3349–3362. http://www.atmos-chem-phys.net/12/3349/2012/acp-12-3349-2012.pdf

[6] Kunkel, Kenneth E., Xin-Zhong Liang, Jinhong Zhu, Yiruo Lin, 2006: Can CGCMs Simulate the Twentieth-Century "Warming Hole" in the Central United States?. J. Climate, 19, 4137–4153. http://journals.ametsoc.org/doi/abs/10.1175/JCLI3848.1

[7] 'Warming hole' delayed climate change http://news.harvard.edu/gazette/story/2012/04/warming-hole-delayed-climate-change/

[8] University of Chicago. http://climatemodels.uchicago.edu/timeseries/

[9] Climate Change Science Overview http://www.epa.gov/climatechange/science/overview.html