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Analysis of the impacts of station exposure on the U.S. Historical Climatology Network temperatures and temperature trends

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[1] The recently concluded Surface Stations Project surveyed 82.5% of the U.S. Historical Climatology Network (USHCN) stations and provided a classification based on exposure conditions of each surveyed station, using a rating system employed by the National Oceanic and Atmospheric Administration to develop the U.S. Climate Reference Network. The unique opportunity offered by this completed survey permits an examination of the relationship between USHCN station siting characteristics and temperature trends at national and regional scales and on differences between USHCN temperatures and North American Regional Reanalysis (NARR) temperatures. This initial study examines temperature differences among different levels of siting quality without controlling for other factors such as instrument type. Temperature trend estimates vary according to site classification, with poor siting leading to an overestimate of minimum temperature trends and an underestimate of maximum temperature trends, resulting in particular in a substantial difference in estimates of the diurnal temperature range trends. The opposite-signed differences of maximum and minimum temperature trends are similar in magnitude, so that the overall mean temperature trends are nearly identical across site classifications. Homogeneity adjustments tend to reduce trend differences, but statistically significant differences remain for all but average temperature trends. Comparison of observed temperatures with NARR shows that the most poorly sited stations are warmer compared to NARR than are other stations, and a major portion of this bias is associated with the siting classification rather than the geographical distribution of stations. According to the best-sited stations, the diurnal temperature range in the lower 48 states has no century-scale trend.

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1. Introduction

[2] As attested by a number of studies, near-surface temperature records are often affected by time-varying biases. Among the causes of such biases are station moves or relocations, changes in instrumentation, changes in observation practices, and evolution of the environment surrounding the station such as land use/cover change [e.g., *Baker*, 1975; *Karl and Williams*, 1987; *Karl et al.*, 1988, 1989; *Davey and Pielke*, 2005; *Mahmood et al.*, 2006, 2010; *Pielke et al.*, 2007a, 2007b; *Yilmaz et al.*, 2008; *Christy et al.*, 2009]. Maximum and minimum temperatures are generally affected in different ways. Such inhomogeneities induce artificial trends or discontinuities in long-term temperature time series and can result in erroneous characterization of climate variability [*Peterson et al.*, 1998; *Thorne et al.*, 2005]. Even if stations are initially placed at pristine locations, the surrounding region can develop over decades and alter the footprint of these measurements.

[3] To address such problems, climatologists have developed various methods for detecting discontinuities in time series, characterizing and/or removing various nonclimatic biases that affect temperature records in order to obtain homogeneous data and create reliable long-term time series [e.g., *Karl et al.*, 1986; *Karl and Williams*, 1987; *Quayle et al.*, 1991; *Peterson and Easterling*, 1994; *Imhoff et al.*, 1997; *Peterson et al.*, 1998; *Hansen et al.*, 2001; *Vose et al.*, 2003; *Menne and Williams*, 2005; *Mitchell and Jones*,

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