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# Day-to-day temperature variability for four urban areas in China

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ABSTRACT

A relatively new urban heat island metric, based on day to day (DTD) temperature variability, was used to assess the urban heat island signal for four pairs of climate stations in China. A measure of climate similarity, G, the ratio of DTD to standard deviation, was introduced to assess the pairs of locations. For three of the pairs, the DTD variability of the maximum temperature minus the DTD variability of the minimum temperature (ΔDTD) was both positive and greater for the urban area with the higher population. For the only true urban/rural pair (Urumqi/Tikanlik) the difference was striking with the rural location having a negative value of ΔDTD, consistent with a similar analysis done in North America. The only pair that did not have a greater ΔDTD for the location of greater population was Lanzhou/Hezuo. This departure was likely the result of substantially different climates, as the G ratio attested, for the two locations in spite of their relative close proximity.



## 1. Introduction

Day to day (DTD) temperature variability has been used as a metric to assess temperature variability (Gough, 2008), to assess geographical variation in climate (Tam and Gough, 2012), and as an alternative metric for quantifying the urban heat island (UHI) (Tam et al., 2015). In Tam et al. (2015) urban areas in North America were examined. They found that the subtle difference between daytime DTD and nighttime DTD, which they called ΔDTD, was a strong indicator of urbanization with positive values for urban landscapes and negative values for rural landscapes. In this work, we turn to urbanized areas in China by examining

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four urban areas, with pairs of climate stations of varying urban intensity in each area, for a total of eight locations.

The urban heat island is an anthropogenic phenomenon resulting from the distinct surface modification caused by human settlement in urban areas. The UHI signature may be up to 10 °C warmer, although there is considerable variation due to local environments and atmospheric conditions (Morris et al., 2001; Scheitlin and Dixon, 2010). The extent of the built environment, population size and density, and anthropogenic activity of an urban area determine the magnitude and nature of the resulting temperature variation (Oke, 1978). The UHI has the strongest signal at night and in the winter months. However, the magnitude of the UHI differs among urban areas due to variation in local geographical features and climate type. The underlying causes of the UHI include the reduction of evaporation and evapotranspiration due to impermeable surfaces and reduced vegetation, lower albedo reflectivity (Jin et al., 2005), daytime heating of urban surfaces, the generation of heat from local infrastructure, and excess heat trapped by urban air pollution (Oke, 1978). These factors affect the radiative balance. In typical urban environments, more incoming solar energy partitions into surface heating and less into evaporation (latent heat), thus increasing heat storage and surface temperature. In addition, the urban infrastructure creates a complex geometry that traps energy and alters airflow, increasing the energy available to heat the urban surface (Oke, 1978). Surface heating in rural areas is reduced by the greater availability of water surfaces, resulting in greater partitioning of available energy into latent heat (Taha, 1997). For the daily minimum temperature which typically occurs at night, condensation (fog formation, latent heat release) and inertial heat release (from the surface substrate) play an important role in compensating for the radiative heat loss at night, thus producing the most consistent urban heat island signature, warmer night time temperatures in urban areas compared to surrounding rural areas.

Temperature variability is typically assessed using standard deviation (SD), based on a departure from the mean for a given period. However, in Karl et al. (1995), the DTD temperature variability framework was first introduced, in which the comparator temperature is not the mean but rather the previous day. This provides a measure of how temperature variation is experienced. Gough (2008) applied this DTD variability to two cities in Canada (Toronto and Calgary). The G ratio (=DTD/SD) was introduced in Gough (2008) for the first time indicating that climates could be classified theoretically into three types: random, orderly and oscillatory.

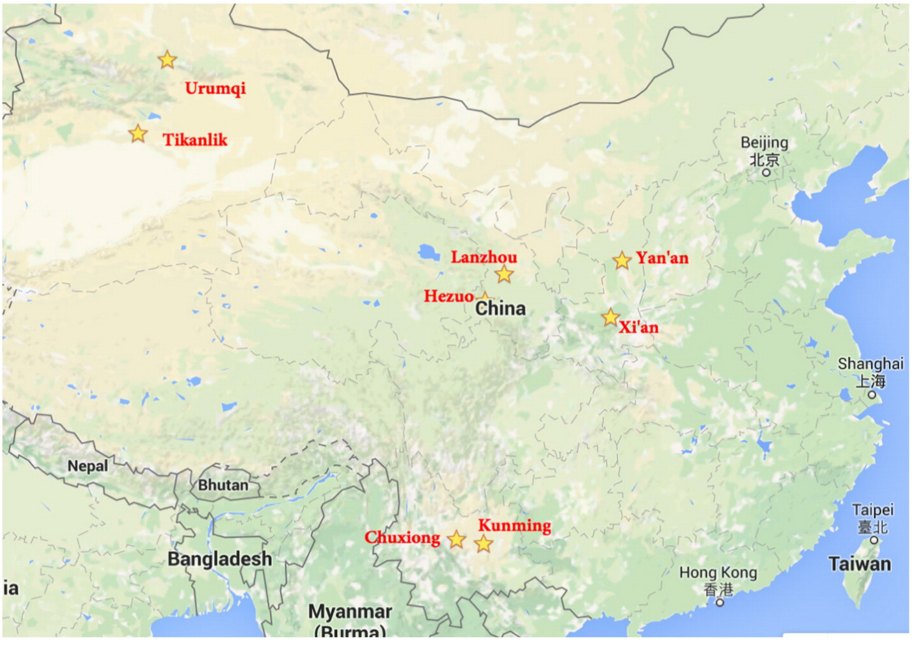


**Fig. 1.** Map of climate stations, highlighted in red. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)