The Urban Heat Island Behavior of a Large Northern Latitude Metropolitan Area

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Introduction

Urban heat islands occur when urban and suburban areas experience elevated temperatures relative to their rural surroundings because of differences in vegetation cover, buildings and other development, and infrastructure. Most cities in the United States are warming at twice the rate of the surrounding rural areas and the planet as a whole. Temperatures in the urban center can be 2-10°C higher during the daytime and as much as 17°C at night. Urban warming is responsible for excessive energy consumption, heat-related health effects, an increase in urban pollution, degradation of urban ecosystems, and changes in the local meteorology. Many cities are experimenting with strategies to reduce urban warming. A number of mitigation strategies involve manipulating the surface energy budget to either reduce the amount of solar radiation absorbed at the surface or offset absorbed energy through latent cooling. Options include using building materials with different properties of reflectivity and emissivity, increasing the reflectivity of parking lots, covering roofs with vegetation, and increasing the amount of vegetation overall through tree planting or increasing green space.

Methods

Since summer 2011 we have deployed 175 temperature sensors across the TCMA. The relatively insensitive HOBO temperature sensors (L3US-004, Pro V2 Temp) from Onset Inc. are located at 2 m height above vegetated surfaces within private residences and city parks. Air temperature is logged every 15 minutes.

Results

The TCMA urban heat island is usually strongest during summer when large temperature gradients arise between the snow-covered rural areas and snow-free urban areas; however, because of the minimal snow-cover during winter 2012, the TCMA urban heat island was strongest in July. The panel plots below show the relatively homogeneous temperature pattern across the TCMA in January, and a strong urban heat island signature in July. All four plots highlight the relative warmth of the downtown areas of Minneapolis and Saint Paul, as well as an extended warm region in the southwest suburbs along the Mississippi River.

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Future Work

By spring 2013 we will complete deployment of ~225 sensors around the TCMA. We will continue our observations of the surface energy budget over the built environment (white roofs, green roofs, and traditional roofs) in order to improve numerical modeling of urban environments.

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