Masters Defense

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AN URBAN ENERGY BALANCE FOR THE PHOENIX, ARIZONA, METROPOLITAN AREA

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Abstract

The focus of this study is on urban heat island (UHI), which is the long term trend observed in the metropolitan Phoenix, Arizona region and other cities in which both the daytime and nighttime temperatures have been consistently increasing. The pressures of rapid urbanization, including the worsening of the urban heat island (UHI) effect, are causing city leaders and other policymakers to consider how to best allocate resources and develop policies to improve their urban environment. An analytical tool is developed to predict the relative effects of various policy measures, such as increasing the average albedo of a city through highly-reflective pavement coatings, or encouraging the adoption of “green” roofs to improve latent heat transfer. This tool is based on a fundamental “lumped” thermal model of the metropolitan area, where transient energy inputs and outputs are considered to generate a single temperature that is characteristic of the entire metropolitan area. Actual electricity, natural gas, vehicular traffic, and solar radiation data are utilized to predict how the temperature changes on an hourly basis. Of the measures evaluated, decreasing the quantity of paved surfaces to reduce daytime temperatures, and increasing the prevalence of green roofs to reduce nighttime temperatures, are the most effective means to alleviate UHI. As part of UHI mitigation and the need to change the built environment by introducing replacement materials that would further accelerate bringing down the temperatures experienced by our cities, extensive experimental research was carried out to obtain thermal conductivity values for various paving materials.