Geophysical Research Abstracts
Vol. 20, EGU2018-9549, 2018
EGU General Assembly 2018

Can green roofs reduce urban heat stress in vulnerable urban communities? A coupled atmospheric, energy and social modeling approach

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Urban areas provide organized, engineered, sociological and economical infrastructure designed to provide a high quality of life, but the implementation and management of urban infrastructure have been a continued challenge. Increasing urbanization, warming climate, as well as anthropogenic heat emissions that accompany urban development generates “stress”. This rapidly increasing ‘urban stress’ affects the sustainability of cities, making populations more vulnerable to extreme hazards, such as heat. Cities are beginning to extensively use green roofs as a potential urban heat mitigation strategy. This study explores the potential of green roofs to reduce summertime temperatures in the most vulnerable neighborhoods of the Chicago metropolitan area by combining social vulnerability indices (a function of exposure, sensitivity and adaptive capacity), energy consumption, and temperatures from a mesoscale model. Numerical simulations using the urbanized version the Advanced Research Weather Research and Forecasting (WRF) model were performed to measure rooftop temperatures, a representative variable for exposure in this study. The WRF simulations were dynamically coupled with a green roof algorithm as a part of urban parameterization within WRF. Specifically, the study examines how roof surface temperature and electrical energy consumption with changing green roof mitigation strategy would they help reduce exposure to heat stress for vulnerable urban communities. This study shows an example of applied research that can directly benefit urban communities and be used by urban planners to evaluate mitigation strategies.