Geophysical Research Abstracts
Vol. 20, EGU2018-1756, 2018
EGU General Assembly 2018

High spatio-temporal resolution thermal investigation of urban heat wave and heat island interactions for effective urban adaptation planning

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Research on links between urbanization and urban heat islands (UHI), their effects, and mitigation strategies have gained significant impetus over the past decade due to a warming planet and overall increase in the number of city dwellers during the 21st century. For example, it is projected that nearly 66% of the world's population will live in cities by 2050. The negative effects of urbanization and related UHI's are dangerous and widespread. Some of these include changes in vegetation phenology/response due to urban expansion, increased risk of vector-borne diseases, increases in the intensity and frequency of heat waves (and related heat stress/mortality), increased energy demands and economic cost, poor air quality, and changes in regional climate. The urban landscape represents a complex heterogeneous surface that strongly influences the development of the UHI and cannot be adequately characterized using traditional structural and optical based remote sensing classification techniques (i.e. land use/cover types) since they do not relate to the physical functioning of the surface energy budget. Including thermal infrared (TIR) derived land surface temperature (LST) information provides the critical missing element for quantifying the effect of urbanization on the UHI and helping understand UHI and heat wave interactions. However, current moderate resolution TIR data from Landsat/ASTER (~100m) are unable to resolve fine-scale urban features (<50m), compounded by infrequent observations of at most 16 days in clear skies, making it impossible to effectively model the daily energy balance cycle and provide heat mitigation strategies. As part of a NASA Land Cover Land Use Change (LCLUC) study, we will demonstrate a method for combining a sharpened Landsat 8 LST product with hourly GOES-16 LST and daily MODIS LST data from a new product available in Collection 6 (MxD21) that accounts for changes in emissivity across the urban landscape. The result will be an hourly LST at 30m spatial resolution optimized for the urban environment. The urban LST product will be used to investigate and better understand heat wave and UHI interactions in four US megacities; Los Angeles, Chicago, Phoenix, and Washington DC. The product will further be incorporated into a human-comfort model as a science tool to output energy fluxes that can be used to create Urban Heat Stress Index (UHSI) vulnerability maps. These data will be integrated and correlated with land cover maps and urban demographic information such as income, education, age, ethnicity from SEDAC. Los Angeles will be used as a case study to test and demonstrate application of methods, which will then be extended to three other US megacities. The UHSI vulnerability maps will be produced in near real time to provide data that would help local officials such as the LA county sustainability office to develop effective adaptation and mitigation strategies, issue heat warnings, and help identify communities most vulnerable to the effects of extreme heat events.