The Influence of Soil Moisture and Tree Evapotranspiration on an Urban Microclimate

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Project Abstract:

A highly uncertain part of predicting microclimate in urban environments involves natural ecosystem components, i.e., soils and plants, which vary with degree of urbanization. Richer Americans enjoy more greenery in their environments than lower-income communities, while neighborhoods with a majority of people of color have lower tree canopy compared to majority white communities. Further, people of color are more likely than whites to experience the urban heat island effect. The goal of this project is to understand how temperature and relative humidity in urban environments are affected by the activities of plant evapotranspiration and soil moisture. We hypothesize that soil moisture, the extent of impervious surfaces, and tree canopy will influence local microclimate; specifically, low soil moisture, high percentages of impervious surfaces, and low extent of tree canopy will cause more intense heating in the summer and more intense cooling in the winter. Additionally, high relative humidity can exacerbate the heat index and make people feel less comfortable. We are choosing a single site for a coupled model-experiment investigation by implementing a representativeness analysis over the eastern U.S. Initial factors under consideration are % canopy, impervious surfaces, soil moisture, albedo, summer precipitation, temperature, and relative humidity. This investigation will inform site choice by identifying a site that is broadly representative of other medium and large cities in the eastern U.S. Then, using the geospatial information from the analysis coupled with social data such as population density, race, and income, we will choose paired sites with contrasts in tree canopy, imperviousness, and social factors. Instrumentation will include small weather stations to track temperature, relative humidity, solar radiation; tree sapflow sensors; and sensors for soil moisture, conductivity, and temperature as a function of depth. The data will be used to determine relations between urban microclimate (temperature and relative humidity) and natural components (soil moisture and tree evapotranspiration) as a function of diurnal and seasonal changes, and to potentially relate the results to socio-economic factors. This research can be used to assess the utility of models in simulating soil moisture and evapotranspiration, taking into consideration governing urban microclimates over days and seasons.