Geophysical Research Abstracts
Vol. 17, EGU2015-15292-2, 2015
EGU General Assembly 2015

Statistical modeling of urban air temperature distributions under different synoptic conditions

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Within urban areas air temperature may vary distinctly between different locations. These intra-urban air temperature variations partly reach magnitudes that are relevant with respect to human thermal comfort. Therefore and furthermore taking into account potential interrelations with other health related environmental factors (e.g. air quality) it is important to estimate spatial patterns of intra-urban air temperature distributions that may be incorporated into urban planning processes.
In this contribution we present an approach to estimate spatial temperature distributions in the urban area of Augsburg (Germany) by means of statistical modeling.
At 36 locations in the urban area of Augsburg air temperatures are measured with high temporal resolution (4 min.) since December 2012. These 36 locations represent different typical urban land use characteristics in terms of varying percentage coverages of different land cover categories (e.g. impervious, built-up, vegetated). Percentage coverages of these land cover categories have been extracted from different sources (Open Street Map, European Urban Atlas, Urban Morphological Zones) for regular grids of varying size (50, 100, 200 meter horizonal resolution) for the urban area of Augsburg.
It is well known from numerous studies that land use characteristics have a distinct influence on air temperature and as well other climatic variables at a certain location. Therefore air temperatures at the 36 locations are modeled utilizing land use characteristics (percentage coverages of land cover categories) as predictor variables in Stepwise Multiple Regression models and in Random Forest based model approaches. After model evaluation via cross-validation appropriate statistical models are applied to gridded land use data to derive spatial urban air temperature distributions. Varying models are tested and applied for different seasons and times of the day and also for different synoptic conditions (e.g. clear and calm situations, cloudy and windy situations).
Based on hourly air temperature data from our measurements in the urban area of Augsburg distinct temperature differences between locations with different urban land use characteristics are revealed. Under clear and calm weather conditions differences between mean hourly air temperatures reach values around 8°C. Whereas during cloudy and windy weather maximum differences in mean hourly air temperatures do not exceed 5°C. Differences appear usually slightly more pronounced in summer than in winter. First results from the application of statistical modeling approaches reveal promising skill of the models in terms of explained variances reaching up to 60% in leave-one-out cross-validation experiments.
The contribution depicts the methodology of our approach and presents and discusses first results.