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Comparison of different statistical modelling approaches for deriving spatial air temperature patterns in an urban environment

Annette Straub (1), Christoph Beck (1), Susanne Breitner (2), Josef Cyrys (2), Uta Geruschkat (2), Jucundus Jacobeit (1), Benjamin Kühlbach (1), Thomas Kusch (2,3), Katja Richter (2), Alexandra Schneider (2), Robin Umminger (1), and Kathrin Wolf (2)

(1) University of Augsburg, Institut für Geographie, Physische Geographie und Quantitative Methoden, Augsburg, Germany (christoph.beck@geo.uni-augsburg.de), (2) Institute of Epidemiology II, Helmholtz Zentrum München, German Research Center for Environmental Health, Neuherberg, Germany, (3) Environment Science Center, University of Augsburg, Augsburg, Germany

Frequently spatial variations of air temperature of considerable magnitude occur within urban areas. They correspond to varying land use/land cover characteristics and vary with season, time of day and synoptic conditions. These temperature differences have an impact on human health and comfort directly by inducing thermal stress as well as indirectly by means of affecting air quality. Therefore, knowledge of the spatial patterns of air temperature in cities and the factors causing them is of great importance, e.g. for urban planners. A multitude of studies have shown statistical modelling to be a suitable tool for generating spatial air temperature patterns. This contribution presents a comparison of different statistical modelling approaches for deriving spatial air temperature patterns in the urban environment of Augsburg, Southern Germany.
In Augsburg there exists a measurement network for air temperature and humidity currently comprising 48 stations in the city and its rural surroundings (corporately operated by the Institute of Epidemiology II, Helmholtz Zentrum München, German Research Center for Environmental Health and the Institute of Geography, University of Augsburg). Using different datasets for land surface characteristics (Open Street Map, Urban Atlas) area percentages of different types of land cover were calculated for quadratic buffer zones of different size (25, 50, 100, 250, 500 m) around the stations as well for source regions of advective air flow and used as predictors together with additional variables such as sky view factor, ground level and distance from the city centre. Multiple Linear Regression and Random Forest models for different situations taking into account season, time of day and weather condition were applied utilizing selected subsets of these predictors in order to model spatial distributions of mean hourly and daily air temperature deviations from a rural reference station. Furthermore, the different model setups were evaluated and the relative importance of individual predictors was examined via averaging over orderings (for MLR) and permutation importance (for RF) respectively.
The results indicate that MLR is superior to RF with mean squared skill scores reaching up to 0.85 and R^2 in leave-one-out cross validation up to 65% for individual situations and setups. The best performing models are obtained for situations with low to medium wind velocities before sunrise and after sunset. Important predictor variables for these situations are percentage of built-up area, sky view factor, and distance from the city centre.