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Quantifying topoclimatic driving forces of near surface temperature variations in heterogeneous environments

Lars Gerlitz, Benjamin Bechtel, Langkamp Thomas, and Böhner Jürgen
Institute of Geography, University of Hamburg, Germany (lars.gerlitz@uni-hamburg.de)

Local temperature observations are considerably influenced by microscale topographic and surface characteristics and hence often not sufficiently represented by large scale atmospheric models. This is particularly valid for heterogeneous environments such as urban or mountain areas. Although the physical processes which lead to spatial variations of temperatures are evident, their physically based quantification remains complicated and computationally intensive. Further the damand of detailed input data is rising with the model complexity. Thus less complex statistical and GIS based approaches often lead to comparable results.

Presuming that near surface temperatures can be interpreted as combination of both, large scale atmospheric processes and a terrain induced local modification, a regression tree based approach is presented, which enables the identification of predominant influencing factors for the local scale temperature distribution. Therefore temperature anomalies (derived from in situ observations) are statistically linked with large scale atmospheric and local topographic parameters. The regression tree based model identifies the most relevant predictors for the local scale temperature distribution and quantifies typical temperature anomalies as a function of synoptic variables and surface characteristics. The model can be subsequently used to generate temperature fields with high spatial resolution.

A regression tree model was exemplarily applied to investigate the spatial heterogeneity of temperatures and their driving forces in a highly structured area in the central Himalayas. Large scale atmospheric parameters and local terrain characteristics were used as potential predictors. For the high mountain region the occurrence and magnitude of topoclimatic effects, such as solar insolation variations or terrain induced circulation systems, could be linked to specific synoptic situations and topographic characteristics. The model was subsequently used to refine large scale atmospheric modeling results, supporting the requirements of climate impact studies. Currently, the approach is transferred to analyze the influence of surface characteristics and varying large scale weather conditions on the magnitude and intra urban pattern of the urban heat island in the city of Hamburg, Germany.