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Integrating local urban climate modelling and mobile sensor data for personal exposure assessments in the context of urban heat island effect

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Deeper knowledge about urban climate conditions is getting more important in the context of climate change, urban population growth, urban compaction and continued surface sealing. Especially the urban heat island effect (UHI) is one of the most significant human induced alterations of Earth's surface climate. According to this the appearance frequency of heat waves in cities will increase with deep impacts on personal thermal comfort, human health and local residential quality of citizens. UHI can be very heterogenic within a city and research needs to focus more on the neighborhood scale perspective to get further insights about the heat burden of individuals.
However, up to now, few is known about local thermal environmental variances and personal exposure loads. To monitor these processes and the impact on individuals, improved monitoring approaches are crucial, complementing data recorded at conventional fixed stations. Therefore we emphasize the importance of micro-meteorological modelling and mobile measurements to shed new light on the nexus of urban human-climate interactions. Contributing to this research we jointly present the approaches of our two PhD-projects.
Firstly we illustrate on the basis of an example site, how local thermal conditions in an urban district can be simulated and predicted by a micro-meteorological model. Secondly we highlight the potentials of personal exposure measurements based on an evaluation of mobile micro-sensing devices (MSDs) and analyze and explain differences between model predictions and mobile records.
For the examination of local thermal conditions we calculated ENVI-met simulations within the "Bayerischer Bahnhof" quarter in Leipzig (Saxony, Germany; 51°20', 12°22'). To accomplish the maximum temperature contrasts within the diverse built-up structures we chose a hot summer day (25 Aug 2016) under autochthonous weather conditions. From these simulations we analyzed a UHI effect between the model core (urban area) and the surrounding nesting area (rural area).
Preparing for the outdoor application of mobile MSDs we tested their accuracy and performance between several MSDs and reliable sophisticated devices under laboratory conditions. We found that variations mainly depend on the device design and technology (e.g. active/passive ventilation). The standard deviation of the temperature records was quite stable over the whole range of values and the MSDs proved to be applicable for the purpose of our study.
In conclusion the benefit of integrating mobile data and micrometeorological predictions is manifold. Mobile data can be used for the investigation of personal exposure in the context of heat stress and for the verification and training of micrometeorological models. Otherwise, model predictions can identify local areas of special climate interest where additional mobile measurements would be beneficial to provide new information for mitigation and adaptation actions.