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Using crowdsourced data from citizen weather stations to analyse air temperature in 'local climate zones' in Berlin, Germany

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Provision of observational data with high spatial coverage over extended time periods still remains as one of the biggest challenges in urban climate research. Classical meteorological networks are seldomly designed to monitor atmospheric conditions in a broad variety of urban environments, though the heterogeneity of urban structures leads to distinct thermal characteristics on local scales, i.e. hundreds of metres to several kilometres. One approach to overcome the aforementioned challenges of observation networks is to use data from weather stations that are maintained by citizens. The private company 'netatmo' (www.netatmo.com) produces and distributes such citizen weather stations (CWS) around the world. The stations automatically send their data to the netatmo server, and the user decides if data are publicly shared. Shared data can freely be retrieved via an application programming interface.

We collected air temperature (T) data for the year 2015 for the city of Berlin, Germany, and surroundings with more than 1500 'netatmo' CWS in the study area. The entire data set was thoroughly quality checked, and filter techniques, involving data from a reference network, were developed to address different types of errors associated with CWS data. Additionally, the accuracy of 'netatmo' CWS was checked in a climate chamber and in a long-term field experiment.

Since the terms 'urban' and 'rural' are ambiguous in urban climate studies, Stewart and Oke (2012) developed the 'local climate zone' (LCZ) concept to enhance understanding and interpretation of air temperature differences in urban regions. LCZ classification for the study region was conducted using the 'WUDAPT' approach by Bechtel et al. (2015). The quality-checked CWS data were used to analyse T characteristics of LCZ classes in Berlin and surroundings. Specifically, we analysed how LCZ classes are represented by CWS in 2015, how T varies within each LCZ class ('intra-LCZ variability'), and if significant differences can be detected between LCZ classes ('inter-LCZ differences'). Results show that most 'built-up' LCZ classes in the study region are represented by CWS, while only few CWS are located in 'natural' LCZ classes (i.e. in inner-city parks or in rural areas). T as measured by CWS showed overall good agreement with data from a network of professional weather stations throughout the year, though for some LCZ classes mean monthly deviations were up to 1 K. Intra-LCZ variability of T was especially pronounced during night-time hours and during summer months. We found significant inter-LCZ differences in T mainly for dissimilar LCZ classes and during night-time. Our results indicate the suitability of CWS data for T monitoring of specific LCZ classes and the applicability of this data set for further scientific research.

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