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Climatological overview of the urban heat island in main cities of Switzerland

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The significantly higher temperatures in city centres compared to rural areas have a negative effect on the health of the city population. Depending on the size of the city, the building density, the proportion of vegetation and ventilation, the urban heat island (UHI) effects can differ in magnitude. The goal of the study was to provide a climatological overview of the intensity of the UHI in five main Swiss cities with more than 130'000 inhabitants.
The UHI was studied by comparing data series of weather stations located in city centres with weather stations in the rural vicinity. The UHI is calculated as temperature difference between the urban and the rural station. The rural stations were selected from the network of the Federal Office of Meteorology and Climatology MeteoSwiss, while the urban stations were taken from various national, cantonal and university observational networks. Data series of a length of 6 to 26 years were analysed. Following the classification of Stewart and Oke (2012), the urban stations were classified as Local Climate Zones LCZ 5 (open midrise) or LCZ 2 (compact midrise) with paved grounds.
The UHI is present in all investigated cities during the whole year. Maxima are reached in summer, especially at night. Night temperatures in city centres are on average over 2 K higher in summer than in rural areas. In less densely built-up areas they are between 1 and 2 K higher. Nighttime city temperatures can be up to 6-7 K higher than in rural areas in the vicinity. During the warmest nights, the temperature in the city centres does not drop below 24-25 °C. The number of tropical nights in cities is significantly higher than in rural areas, while the number of hot days is only slightly higher. An exception to this are the monitoring stations in Basel, where the number of hot days is also significantly higher. They represent locations in the immediate vicinity of asphalt and buildings, which warm up strongly during the day. A comparison of the occurrence UHI with weather classes confirms, that the urban heat island is most pronounced during high-pressure periods, i.e. in windless, low-cloud and high-radiation weather conditions. For the Zurich stations, the diagnostic model from Theeuwes et al. (2017) was adapted to estimate the daily maximum heat island effect on the basis of weather data from the rural station, the vegetation fraction and the sky view factor in the city. The model revealed suitable results with mean absolute errors (MAE) of 0.75 to 1.53.
With climate change and the expected population growth in cities and agglomerations, the issue of heat stress in cities is becoming increasingly important. It is therefore important to collect measurement data on the characteristics and changes of the urban heat island and to model and project future changes the urban climate.