Multi-annual variability of summertime atmospheric and surface urban heat island in Kraków, Poland

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The urban heat island (UHI) effect is primarily related to the atmosphere, but may also refer to the surfaces. The atmospheric UHI (AUHI), determined using air temperature (Tair), and the surface UHI (SUHI), assessed using land surface temperature (LST), are distinguished. There is undoubtedly a relationship between SUHI and AUHI due to the modulation of Tair by LST. On hot days in the summer months, the SUHI/AUHI effect may increase the heat load, which is dangerous to the health and comfort of people staying in the city. Detailed characteristics of the spatial distribution of Tair and LST in urban areas are required to identify the parts of the city with the highest heat load. Spatially continuous Tair data, enabling better characterizing AUHI, can be obtained by modelling. Satellite thermal data (LST) can be used as input to the Tair spatial distribution model. Satellite data with 1 km spatial resolution, due to availability several times a day, are most useful in characterizing SUHI diurnal variability and the relationship of LST with Tair. The detailed knowledge of LST and Tair correlation should be helpful in the development of the Tair estimation algorithm based on the LST values. Better recognition of the relationship between LST and Tair, and thus improving the quality of modelling the spatial distribution of Tair in urban area, can possibly be achieved through downscaling of LST data to higher spatial resolution. In the study the method of LST downscaling from 1 km to 100 m was developed, using LST derived from AVHRR, Landsat, ASTER and ECOSTRESS data. The LST-Tair correlation in the diurnal course was examined and the influence of LST downsampling on the correlation was assessed. A Tair regression model was developed based on LST, depending on local climate zone (LCZ). LST and Tair maps for Kraków and its vicinities were prepared, and on the basis of them the intensities of AUHI and SUHI in the multi-year period (2010-2019) in the summer months (June, July, August) were determined, separately for day and night.