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Urban heat island by means of city clusters: a statistical assessment of size influence and seasonality

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In the last decades, influence factors of the Urban Heat Island (UHI) effect have been intensively investigated and further broadened through a variety of studies around the world. Briefly, compared to non-built surroundings, built-up areas of cities differ considerably in albedo, thermal capacity, roughness, etc. which can significantly modify the surface energy budget and make downtown areas of cities hotter than their vicinities.

Most previous studies were built upon a limited number of cities, and suffered from inconsistency and instability with regard to the urban-rural definition, which hinders the inter-comparison between results. To overcome this limitation in the number of considered cities, we perform a systematic study of all cities in Europe to assess the Surface Urban Heat Island (SUHI) intensity by means of land surface temperature data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor. After defining cities as spatial clusters of urban land cover based on CORINE data, we determine a boundary around the urban cluster of approximately equal area to the cluster area. SUHI intensity is thus defined as the difference between the mean temperature in the cluster and that of the surroundings. We investigate the relationships of the SUHI intensity, respectively with the cluster size and with the temperature of the surroundings.

Our results show that in Europe, the SUHI intensity in summer has a strong correlation with the cluster size, which can be well fitted by an empirical sigmoid model. Furthermore, we find a pronounced seasonality of the SUHI intensity for individual clusters in the form of hysteresis-like curves. Characterizing the shape by means of Fourier series approximation and consequential work of clustering, we identify apparent regional patterns which suggest a climatological basis for the heterogeneity of UHI.