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Effects of urban impervious surfaces on land surface temperatures: Spatial scale dependence, temporal variations, and bioclimatic modulation

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Quantifying the relationship between urban impervious surfaces (UIS) and land surface temperatures (LST) is important for understanding and mitigating the environmental impacts of urban heat islands in human-dominated landscapes. The main goal of this study was to examine how the UIS-LST relationship changes with spatial scales, seasonal and diurnal variations, and bioclimatic context in mainland China. We took a hierarchical approach that explicitly considered three spatial scales: the ecoregion, urban cluster, and urban core. Remote sensing data and regression methods were used. Our results showed that, in general, UIS and LST were positively correlated in summer and winter nighttime, but negatively in winter daytime. The strength of correlation increased from broad to fine scales. For example, the mean R2 for winter nights was 3 times higher at the urban core scale than at the ecoregion scale. The relationship showed large seasonal and diurnal variations: generally stronger in summer than in winter and stronger in nighttime than in daytime. At the urban core scale, for instance, the mean R2 was 2.2 times higher in summer daytime than in winter daytime, and 3.1 times higher in winter nighttime than in winter daytime. Vegetation and climate modified the relationship during summer daytime on the ecoregion scale. In conclusion, UIS has substantial influences on LST, and these effects vary greatly with spatial scales, diurnal/seasonal cycles, and bioclimatic context. Our study reveals several trends on the scale multiplicity, temporal variations, and context dependence of the UIS-LST relationship, which deserve further examination. Importantly, high mean R2 values with large variations on the local urban scale suggest that a great potential exists for mitigating urban heat island effects via urban landscape planning.