The Contribution of Anthropogenic Energy Use to Urban Heat Island: Combining Energy Consumption Data with Satellite Observation of Land Surface Temperature

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Energy consumption, such as building energy use and traffic, is one of the key sources of anthropogenic heat flux in cities (\(Q_F\)), which influences the urban climate. Different methods have been proposed to quantify \(Q_F\), such as using the inventory data and satellite observations of the land surface temperature. In this study, we develop an analysis framework based on urban surface energy balance and inverse calculation of the expected change of thermodynamic state as a result of different sources of energy consumption. This framework enables us to link the energy consumption data with remotely sensed land surface temperature (LST). Thus, the contribution of different sources of anthropogenic energy consumption to the urban land surface temperature can be readily quantified. We apply this method to ECOSTRESS LST, traffic volume and building energy consumption for cities in the US. We show that the exhaust heat from traffic and building energy use contributes differently to the surface urban heat island effect: the contributions differ in cities with different background climates, urban morphologies and green area fractions. Overall, the combined model-observation framework demonstrates potential in quantifying the impact of two major anthropogenic heating sources on urban climate, in particular with increasingly available high-quality urban energy-use data and fine-resolution satellite observations.