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High spatial resolution Land Surface Temperature estimation over urban areas with uncertainty indices

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Land Surface Temperature (LST) is a key variable for studying land surface processes and interactions with the atmosphere and it is listed in the Earth System Data Records (ESDRs) identified by international organizations like Global Climate Observing System. It is a valuable source of information for a range of topics in earth sciences and essential for urban climatology studies. Detailed, frequent and accurate LST mapping may support various urban applications, like the monitoring of urban heat island. Currently, no spaceborne instruments provide frequent thermal imagery at high spatial resolution, thus there is a need for synergistic algorithms that combine different kinds of data for LST retrieval. Moreover, knowing the confidence level of any satellite-derived product is highly important to the users, especially when referred to the urban environment, which is extremely heterogenic.
The developed method employs spatial-spectral unmixing techniques for improving the spatial resolution of thermal measurements, combines spectral library information for emissivity estimation and applies a split-window algorithm to estimate LST with an uncertainty estimation inserted in the final product. A synergistic algorithm that utilizes the spatial information provided by visible and near-infrared measurements with more frequent low resolution thermal measurements provides excellent means for high spatial resolution LST estimation. Given the low spatial resolution of thermal infrared sensors, the measured radiation is a combination of radiances of different surface types. High spatial resolution information is used to quantify the different surface types in each pixel and then the measured radiance of each pixel is decomposed. The several difficulties in retrieving LST from space measurements, mainly related to the temperature-emissivity coupling and the atmospheric contribution to the thermal measurements, and the measurements themselves, introduce uncertainties in the final product, which are quantified here.