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Estimation of maximum and minimum air temperatures in urban areas using MODIS satellite data

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Urban air temperature is highly related to the various urban issues such as urban heat island effect, air pollutions, and human mortality. Especially, the urban maximum and minimum air temperatures are important variables in populated areas as they are directly related to fatal disasters such as heat waves and tropical nights strike. Due to the complex landscape of a typical city, urban air temperature has spatial heterogeneity. Therefore, it is difficult to estimate the spatial distribution of air temperature within a city simply based on in situ measurements at sparsely located stations. Satellite data can be a good alternative as they provide land surface temperature (LST) over vast areas. In recent years, some studies estimated air temperature at a specific time using satellite-derived LST time series data. However, since daily maximum and minimum temperatures do not occur at any particular time, it is more challenging to estimate them from satellite-derived LST. In this study, Moderate Resolution Imaging Spectroradiometer (MODIS) LST time series data were used to estimate daily maximum and minimum temperatures of two major cities with different climate characteristics, Seoul in South Korea and Los Angeles in the United States. Elevation, aspect, latitude, longitude, impervious area, solar radiation and normalized difference vegetation index (NDVI) were used as ancillary data. Random forest, a widely used machine learning approach, was used to estimate daily maximum and minimum temperatures in this study. The results through 10-folds cross-validation showed Root Mean Square Errors (RMSE) of 1.2 and 1.7°C and correlation coefficients of 0.83 and 0.92 for estimating the daily maximum temperatures of Seoul and Los Angeles and RMSE of 1.2 and 1.3°C and correlation coefficients of both 0.87 for estimating the daily minimum temperatures of two cities, Seoul and Los Angeles.