Estimation 1 km MODIS Land Surface Temperature under Cloudy Conditions for Humid Summer days

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Abstract: Land surface temperature (LST) is used as a key indicator for various climate issues by linking land surface energy with surface atmosphere. Moderate Resolution Imaging Spectroradiometers (MODIS) that measure LSTs with one-kilometer resolutions are widely used but have the limitation of not functioning under cloudy conditions. Especially in humid regions, clouds can cover a very wide area, and contaminated LSTs are therefore vast. In this study, MODIS Aqua daytime (1:30 p.m.) LST was estimated utilizing Advanced Microwave Scanning Radiometer 2 (AMSR2) brightness temperatures and air temperatures observed from weather stations in humid regions of South Korea, in the months of July and August from 2013 to 2018. The input variables were as follows: downscaled AMSR2 brightness temperatures from four frequencies (10, 18, 23 and 36 GHz) of dual polarization measurements (V and H); in-situ hourly air temperatures observed from weather stations of the Korea Meteorological Administration (KMA); the elevation, aspect, slope, elevation, and mean land surface temperature within the study period; and the ratio of impervious area. Ordinary Least Squares regression (OLS) and random forest (RF) machine learning were used to estimate the MODIS daytime Aqua LST (MYD21A1). The validation results showed a Root Mean Square Errors (RMSE) of 2.24 and 1.84° C, and correlation coefficients of 0.68 and 0.79, for estimating LST by OLS and RF, respectively. We found that the machine learning-based RF method could estimate LSTs better than linear models such as OLS. We further validated LST under cloud areas using in-situ LST data from weather stations. Despite the bias from in-situ and MODIS LST, the proposed method is practical for retrieving LST in cloudy conditions, and it appears to be a promising method to seamlessly reconstruct LST from satellite observations.

Keywords: Land surface temperature, Machine learning, Random forest, AMSR2, MODIS