Using a machine learning approach for estimating monthly air temperature in Taiwan

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Accurate and high temporal resolution air temperature (Ta) measurements can be obtained from the ground weather stations. However, the weather stations have limited spatial coverage because of their sparse distribution. In contrast, satellite data with the advantage of high spatial coverage can provide us with land surface temperature (LST) observations, which have a strong relationship with Ta, to assist the improvement of Ta estimate. Taiwan constitutes a highly complex topography with different climatic conditions and even poses more challenges for estimating air temperature. In this work, we applied a machine learning (ML) approach, namely Support Vector Machine (SVM), to estimate 1-km resolution monthly Ta across Taiwan for the year 2020. The ML approach incorporates LST from Moderate Resolution Imaging Spectroradiometer (MODIS), air temperature observations from Taiwan Central Weather Bureau (CWB) (368 stations), remote sensing data derivative indices (Normalized Difference Latent Heat Index (NDLI), Normalized Difference Vegetation Index (NDVI), and albedo), and geographical data (elevation, longitude, latitude, and proximity to the sea). We employed out-of-sample five-fold cross-validation and used the coefficient of determination (R^2), root-mean-square of errors (RMSEs), and mean absolute errors (MAEs) as measures to evaluate the performance of the ML model. Excellent five-fold cross-validated performance of the model was found, with R^2 of 0.966, RMSE of 1.03˚C, and MAE of 0.78˚C. The results indicate that Ta can be accurately estimated using a ML prediction model, even in Taiwan with a complex topography and weather patterns. Thus, the resulting 1-km resolution monthly Ta can serve as valuable input for the environmental health risk assessment.

Keywords:Machine Learning, Air Temperature, Normalized Difference Latent Heat Index, Land Surface Temperature, MODIS