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Spatial Gap-filling of GK-2A/AMI AOD products for Estimation of Particulate Matter using Machine Learning

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Extended Abstract

Particulate Matter (PM) directly or indirectly affects climate change by changing the radiative forcing of sunlight. This is known to be harmful to the human body and affects industrial activities. In order to prevent damage to the health environment, society, and economy as a whole due to the increase in PM concentration, it is important to secure regional accurate PM concentration calculation and monitoring technology for it. However, the current PM observation network consisting of ground and point observation shows many limitations in time and space. As an alternative to this, studies that obtain PM concentration using satellite observation are actively underway [1]. As the optical characteristics of PM can be measured and the polar orbit and geostationary satellites, which are environmental satellite payloads, become more diverse, it will be more promising. Nevertheless, there is a problem here, too. The optical sensor-based Aerosol Optical Depth (AOD) images have missing parts due to clouds, etc., which make it difficult to analyze the PM variation. Therefore, this study aims to spatial gap-filling of the GK-2A (Geostationary Korea Multi-purpose Satellite 2A)/AMI (Advanced Meteorological Imager) AOD images using the meteorological data and random forest model.

The spatial area of study is the Korean Peninsula, where long-distance transportation PM from neighboring Asian countries such as China, Mongolia, and Russia occurs at high concentrations every year. The experiment was conducted on 8 timeslots between 00 UTC and 07 UTC during daytime among GK-2A/AMI AOD data in 2021. AMI hourly AOD data with an annual null pixel ratio of 50.57% based on the land of the Korean peninsula. For meteorological data, LDAPS (Local Data Assimilation and Prediction System) which is a numerical weather prediction model by KMA (Korea Meteorological Administration) was used. The input variables for the RF model are air temperature, (u-/v-) wind speed, boundary layer height, latent heat flux, relative humidity, (high/medium/low) cloud cover, short wave flux, surface pressure, and dew point temperature. Because the spatial and temporal resolution differs depending on the source of the dataset, all data were resampled to 0.02° and hourly. Finally, the reference data of the model are pixels having an AOD reliability of "good confidence". The modeling data was divided into the training set and the test set. The training set used all data for training and evaluation, performing 5-fold cross-validation(cv) to avoid bias and overfitting. The target accuracy of the test set is higher than that of MBE (Mean Bias Error) from 0.1 to 0.2 and RMSE (Root Mean Square Error) from 0.25 to 0.30 which are the target accuracy ranges for the GK-2A AOD product. In addition, it will provide a full coverage hourly AMI AOD prediction map. Most previous studies have difficulty tracking diurnal variation only in gap-filling of the polar satellite AOD product, but this study is highly utilized in subsequent studies such as PM estimation using geostationary satellites with high-time resolution. Also, the same methodology can be applied to GEMS (Geostationary Environment Monitoring Spectrometer) and GOCI2 (Geostationary Ocean Color Imager) of GK-2B (Geostationary Korea Multi-purpose Satellite 2B).

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