Joint retrieval of aerosol optical depth and surface reflectance over land using geostationary satellite data

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The Advanced Himawari Imager (AHI) aboard Himawari-8 geostationary satellite provides high-frequent observations with big coverage, multiple spectral channels, and high spatial and spectral resolution. With these characteristics, the AHI data have significant advantages to monitor the air quality and estimate the aerosol properties. In this study, AHI data were used to develop an algorithm for the joint retrieval of aerosol optical depth (AOD) over land and land surface bidirectional reflectance. Instead of constructing a Look-Up-Table (LUT) and pre-estimating the surface reflectance to retrieve the AOD, the atmosphere properties and surface bidirectional reflectance were retrieved simultaneously using an optimal estimate method. The algorithm uses an Earth-atmosphere model, which couples the atmospheric radiative transfer model and surface bidirectional reflectance factor (BRF) model. Utilizing the character that the surface reflectance properties are much more stable than atmosphere aerosol, our retrieval is based on the two basic assumptions: the surface bidirectional reflective properties is invariant during a short time window while aerosol properties (e.g. AOD, AE) change. Optimal estimate method is employed to calculate the AOD and surface BRF. Detailed analysis and validation about the retrieval results were conducted using ground-based measurements (AErosol RObotic NETwork (AERONET) sites) and satellite product (MODIS C6 aerosol product). The validation of the AOD with AERONET measurements shows a high correlation coefficient: R2=0.81, RMSE=0.13, and about 80% AOD retrieval results within the Expected error (EE) of (0.20*$AOD_{AERONET}$ ±0.05). The retrieved AOD were also compared with MODIS Collection 6 AODs and it shows high consistency. All comparison and validation demonstrated that the algorithm has the ability to estimate hourly aerosol optical depth with high accuracy over land.

