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Aerosol Optical Depth Retrieval from Landsat 8 OLI Images using SREM and SARA algorithms over complex surfaces

Bijoy Krishna Gayen
Vidyasagar University, Remote Sensing and GIS, Midnapore, India (rsrs_bgayen@mail.vidyasagar.ac.in)

The Aerosol Optical Depth (AOD) from several to tens of kilometres coarse resolution satellite images such as MODIS and VIIRS sensors is a standard geophysical product that has gained significant importance for atmospheric pollution and climate studies. In regional studies, coarser-resolution limits the application of these products. AOD retrieval is highly challenging due to subjected high complex surface characteristics and dynamics aerosol properties. Many methods have been developed based on the state-of-the-art radiative transfer (RT) model or the Look-Up-Table (LUT) approach, which is very time-consuming. Therefore, in this paper, we proposed the integration of two simplified algorithms for retrieving AOD from Landsat 8 Images; one is Simplified and Robust Surface Reflectance Estimation Method (SREM), and the second is Simplified Aerosol Retrieval Algorithm (SARA). SREM has been used for the estimation of LSR from top-of-atmospheric reflectance (TOA) with support of geolocation information, which is one of the key input in SARA for AOD retrievals from TOA. Both simplified algorithms are developed based on the RT equation without using a LUT approach, which makes them fast and robust in their inherent retrieval processes. The method is validated using Aerosol Robotic Network (AERONET) measurements over two distinct locations, Beijing (China) and Indo Gangetic Plain (IGP) (India, Bangladesh and Nepal foothills). For cross-evaluation of SREM LSR in AOD retrieval, available LSR products LaSRC (Landsat 8 Surface Reflectivity Code) have been taken as input to SARA. Also, the results of the SREM-SARA algorithm have been evaluated with a collection of 6 (C6) MODIS MOD04_3k products at 3 km spatial resolution. The performance of this algorithm is evaluated with four statistical metrics: correlation coefficient (R^2), root means square error (RMSE), mean absolute error (MAE) and expected error (EE). The 30 m AOD retrieved from the SREM-SARA algorithm showed high consistency with AERONET AOD measurements, with R^2 ~ 0.98, and that approximately 97.44% of the retrievals fall within the EE with a low RMSE of 0.072 and MAE of 0.037 over the Beijing area. However, in the IGP region, surface features distributed consist of various land covers with high reflective surfaces and complex aerosol type distribution; SREM-SARA-derived AOD showed relatively high agreement with AERONET measurements, with an R^2~ 0.90, RMSE~0.168, and MAE~0.141 compared to the LaSRC corrected LSR, where LaSRC-SARA showed R^2 ~ 0.61, RMSE~0.298, and MAE~0.250. Comparison of SREM-SARA retrieved AOD with MOD04_3k revealed that the retrieved AOD agree quite well with MODIS C6 products (spatial R^2<= 0.80). In terms of spatial coverage, the MODIS product has not as good as the SREM-SARA AOD. These results suggested the robustness of the combination of SREM-SARA and the potential for effective in retrieving AOD at the finer scale resolution that holds the impression of the localized

process in the atmospheric pollution and thereby lays out a way to study the atmosphere and climate interaction at the finer scale.