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Simultaneous Retrieval of Aerosol Optical Depth and Surface Reflectance over Land within Short Temporal Interval Using MSG Data

C. Li (1,4), Y. Xue (1,2,3), Y.J. Li (3,4), L.K. Yang (5,6), T.T. Hou (1,4)

(1) Center for Earth Observation and Digital Earth of Chinese Academy of Sciences, Beijing 100094, China (wslygr@163.com), (2) Faculty of Computing, London Metropolitan University, 166-220 Holloway Road, London N7 8DB, UK (yx9@hotmail.com), (3) State Key Laboratory of Remote Sensing Science, Jointly Sponsored by the Institute of Remote Sensing Applications of Chinese Academy of Sciences and Beijing Normal University, Institute of Remote Sensing Applications, Chinese Academy of Sciences, Beijing 100101, China (liyingjie2009@gmail.com), (4) Graduate University of the Chinese Academy of Sciences, Beijing 100049, China (houtt-09@163.com), (5) School of Geography, Beijing Normal University, Beijing 100875, China (yanglk2002@126.com), (6) School of Surveying and Land Information Engineering, Henan Polytechnic University, Jiaozuo 454003, China

Aerosols cause a major uncertainty in the research of climatology and global change, whereas satellite aerosol remote sensing over land still remains a big challenge. Due to their short time repeat cycle, geostationary satellites are capable of monitoring the temporal features of aerosols, while its limited number of visible bands is an obstacle. On the other hand, a main uncertainty in aerosol retrieval is the difficulty to separate the relatively weaker contribution of the atmosphere to the signal received by the satellite from the contribution of the Earth's surface.
In this paper, an analytical retrieval strategy is presented to solve the both problems above. For the lack of surface reflectance, we use the Ross-Li BRDF (Bidirectional Reflectance Distribution Function) model and assume that the surface reflective property changes mainly due to the change of illumination geometry in a short time interval while the kernals of Ross-Li model remain the same. For the limited visible band, we take advantage of the Aerosol Optical Depth (AOD) consistence within short distances, thus to reduce the number of unknown parameters. A parameterization of the atmospheric radiative transfer model is used which is proved to be proper to retrieve aerosol and surface parameters by sensitivity analysis. Taking the three kernels of kernel-driven BRDF model and AOD as unknown parameters and based on prior knowledge of aerosol types, a series of nonlinear equations can be established then. Both AOD and surface reflectance can be obtained by using a numerical method to solve these equations.
By applying this method, called LABITS-MSG (Land Aerosol and Bidirectional reflectance Inversion by Time Series technique for MSG), to data from the Spinning Enhanced Visible and Infrared Imager (SEVIRI) observations on board Meteosat Second Generation (MSG), we obtain regional maps of AOD and surface reflectance in July 11, 2010 within a temporal interval of as short as 1 hour, and a spatial resolution of 10 km. Preliminary validation results by comparing our retrieved AOD with Aerosol Robotic Network (AERONET) data show that the correlation coefficient R is about 0.81, the root-mean-square error (RMSE) is less than 0.1, and the uncertainty is found to be $\Delta\tau = \pm\, 0.05 \pm 0.20\tau$. Time serial comparison of MSG and AERONET AODs on Granada site also shows a good fitting. To conclude, this algorithm shows its potential to retrieve real-time AODs over land from geostationary satellites.