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A simulated comparison of Top of the Atmosphere (TOA) reflectance by choosing different ground-atmosphere interacting models in satellite aerosol optical depth retrieval

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

(1) School of Geography, Beijing Normal University, Beijing 100875, China (yanglk2002@126.com), (2) 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, Beijing 100101, China (liyingjie2009@gmail.com), (5) School of Surveying and Land Information Engineering, Henan Polytechnic University, Jiaozuo 454003, China, (3) Department of Computing, London Metropolitan University, London N7 8DB, UK (yx9@hotmail.com), (4) Center for Earth Observation and Digital Earth of Chinese Academy of Sciences, Beijing 100094, China (wslygr@163.com), (6) Graduate University of the Chinese Academy of Sciences, Beijing 100049, China

Atmospheric aerosol radiative forcing is widely recognized as the largest source of uncertainty among all sources of forcing to the Earth's climate system. To increase the understanding of aerosol climatic effect and decrease its uncertainties, long term global aerosol distribution obtained by satellite remote sensing is necessary. Aerosol retrieval over ocean could be accomplished relatively easily due to the low surface reflectance. Apart from the complex and spatio-temporal changeful aerosol optical properties, the retrieval of aerosol properties over land is more complicated due to a) the relatively strong contribution of the land surface reflectance to the radiation measured at the top of the atmosphere (TOA), b) the inhomogeneous distribution of surface types, and c) a variety of spectral bidirectional reflectance distribution functions (BRDF) in a satellite ground scene.

In most aerosol retrieval algorithms of the single satellite view, a simple Lambertian surface model was assumed, but the surface BRDF and the environment reflectance around the target are not fully considered. Even in some studies, surface BRDF was added in the retrieval model, but how the diffuse solar radiation interacts with directional surface is ignored. In this paper, we make simulations of the top of the atmospheric reflectance (or apparent reflectance) from the single satellite view using second simulation of a satellite signal in the solar spectrum-vector (6SV) radiative transfer code. Four ground-atmosphere interacting models which are homogeneous with Lambertian surface, homogeneous with directional reflectance, non homogeneous with uniform environment reflectance and non homogeneous with patchy structure environment reflectance, can be chosen in 6SV code. To compute the apparent reflectance value with various aerosol loadings, we should also define the geometrical conditions, specific aerosol properties, land type and directional characteristic in the radiative transfer code. Through comparing the results of apparent reflectance at top of the atmosphere with different ground-atmosphere interacting models, it can help us in analyzing how much uncertainty accompanies with these assumptions in satellite aerosol optical depth retrieval.