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Physical models vs semi-empirical models for surface reflectance treatment in application to problem of aerosol retrieval over land

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For the retrieval of atmospheric aerosol properties from satellite measurements, the atmospheric signal should be correctly separated from the surface signal. This represents one of the most important challenges in the development of algorithms for the retrieval of aerosol properties over land surfaces. Intrinsic reflectance properties of surfaces can be described by the Bidirectional Reflectance and Polarization Distribution Functions (BRDF and BPDF). At present time the semi-empirical models for BRDF and BPDF are used for retrievals of properties of aerosol over land. Because of lack of physical basis, the parameters of the semi-empirical BRDF models are not necessarily consistent with the parameters of the semi-empirical BPDF models. There are, therefore, uncertainties regarding the physical constraints, which can be imposed on the spectral and angular dependencies of BRDF and BPDF models. This may introduce uncertainties in aerosol properties retrievals. Moreover, the semi-empirical BRDF and BPDF models are unable to describe the surface total and polarized reflectance at all possible illumination and viewing geometries. This leads to angular dependence uncertainties in the BRDF and BPDF models that can manifest themselves at the top of the atmosphere and thereby contribute to uncertainties in the retrieved aerosol properties. To reduce the uncertainties caused by the semi-empirical BRDF and BPDF models, either a reliable algorithm for the separation of the atmospheric and surface signals or a more physically based models of the BRDF and BPDF are required. In such physically-based models, the BRDF and BPDF model parameters would be related to each other, and physical constraints would be imposed by the surface structure and composition. Here we discuss advantages and disadvantages of physical and semi-empirical models in application to the problem of aerosol properties retrieval over land.