Geophysical Research Abstracts
Vol. 13, EGU2011-8608, 2011
EGU General Assembly 2011

Hyperspectral at-sensor radiance for aerosol and surface reflectance retrievals

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The retrieval process of aerosol properties and surface reflectance from space data based on simulation of the outgoing reflected and scattered radiation in the Earth-Atmosphere system, are widely used [Kaufman et al., 1997; Vermote et al., 1997; Kotchenova et al., 2008; Kokhanovsky et al. 2010]. Concerning hyperspectral data, minimization algorithms solve the inverse problem retrieving the aerosol optical thickness [Guanter et al., 2007; Gao et al., 2009; Bassani et al., 2010] for a given aerosol model. The a priori assumption of the aerosol model could provide inaccurate simulation of the atmospheric radiative field which also relies on phase function of the aerosol. Furthermore, the physically-based atmospheric correction of the hyperspectral remote sensing data provides the surface reflectance starting from the at-sensor radiance [Guanter et al., 2007; Gao et al., 2009; Kotchenova et al. 2009; Bassani et al., 2010]. The data processing requirements are the knowledge of the atmospheric state during the data acquisition. The forward problem solution could be unrealistic surface reflectance if the atmospheric parameters are not available and a priori assumed.

This work presents synthetic at-sensor radiance generated for contiguous channels of a sensor with high spectral resolution inside the atmospheric window of the visible and near short-wave infrared spectral domain, that are hyperspectral data.

The sensitive analysis of the synthetic optical spaceborne and airborne measurements is performed with respect to the aerosol properties, namely the urban and continental aerosol model and the increasing of the aerosol optical thickness at 550 nm. The signal is generated for nadir viewing angle over three different surface with bright, vegetated and water reflectance.

The approach is based on the equation presented in [Vermote et al., 1997] assuming negligible the anisotropy of the considered surface reflectance (lambertian surface). The straightforward application of this equation uses the last generation of the Second Simulation of a Satellite Signal in the Solar Spectrum (6S) radiative transfer code [Vermote et al., 1997]. The 6S is an open-source code with a reasonable computational time and with an increasing of the accuracy of the radiative field simulation in the Earth-Atmosphere system with respect to the previous version of the code [Kotchenova et al., 2008]. Consequently, a significant improvement of the remote sensing results is derived [Vermote et al., 2009].

The results show that both the aerosol properties, optical thickness and model, are required to improve the accuracy of the results for retrieval process when hyperspectral data are available. From the synthetic data, an increasing of the aerosol optical thickness highlights the coupled retrieval of the properties, optical thickness and model, of the aerosol.

The hyperspectral data show the spectral behavior of the at-sensor radiance along the entire spectral domain under different atmospheric conditions, as was the case for viewing the three surface reflectance with urban model and high aerosol loading.

As a conclusion, this study reveals the potential of spaceborne hyperspectral data to provide more and better spectral information useful for optical atmospheric study. Currently, the imaging spectroscopy is a challenging task and new hyperspectral mission are intended to fill the gap of availability of hyperpsectral data.

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