The New Angular & Spectral Kernel Model for BRDF and Albedo Retrieval

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Abstract

Surface albedo, the hemispheric reflectivity integrated over the entire solar spectrum, is one of the fundamental components for determining the Earth's climate and surface energy balance. Albedo may be derived from atmospherically corrected, cloud-cleared multi-angular reflectance observations through the inversion of a bidirectional reflectance function (BRDF) model and angular integration. This paper proposes a new angular & spectral kernel based BRDF model (ASK model) and outlines an algorithm suitable for broadband albedo retrieval by using the new model.

The ASK model express BRDF as a linear combination of kernels, which are known functions, weighted by coefficients which are model parameters retrieved from remote sensing data. A significant difference from previous works is that the kernels are expressed as functions of not only sun/view geometry but also wavelength, which gives advantages to the new model. Firstly, with spectral information adding into kernels, the model inversion process can make use of multi-angular and multi-spectral information together. Compared with original kernel-driven BRDF model using only multi-angular information to do inversion, our new model will give much more reliable inversion results especially when the angular data is limited. Secondly, with the merit that the kernel coefficients are independent from waveband, broadband albedo can be directly derived from kernel integrals defined as integration of kernel functions both at angular and wavelength dimension. So, the new algorithm avoids the step of narrowband to broadband conversion which is in the traditional process of albedo computation. Furthermore, by putting the wave-dependent variables into the kernels, the new kernel coefficients are independent form wavelength and of specific biophysical significant as well. This will provide us the potential possibility to relate kernel coefficients directly to the

canopy structure specialty or surface characteristic.

In this study, analysis and validation of ASK model is carried out in two different scales. In the fine resolution scale, a field measured multi-angular reflectance dataset including 6 cover types forms the basic validation. Results show that in spite of the different land cover types, the retrieved kernel coefficients are generally reasonable and retrieved albedo is reliable. Additionally, a sensitivity index is defined to compare the component spectrums' impact and sensitivity to the new model. Results show that nearly all numbers are smaller than 10%, indicating stability with respect to noise amplification in deriving the respective quality.

In the coarse resolution scale, the algorithm for albedo retrieval is demonstrated on PROB-CHRIS and EOS-MODIS observations acquired over YK experimental site during Heihe experiment campaign. The CHRIS data are of 5 observation angles acquired in June 4th, 2008, and MODIS multi-angle dataset is 16-day composite from May 27th, 2008 to June 12th, 2008. Albedo retrieve from CHRIS and MODIS data are validated with in-situ observations taken by pyranometers. CHRIS data are of comparatively high resolution and help to upscale the ground based validation to much larger scale data acquire from MODIS. The results show that ASK model is adaptive to mixed pixels, and thus the albedo retrieval algorithm is adaptive to regional or global application. In addition, broadband albedo retrieved from our algorithm is compared with that from AMBRALS algorithm as in MODIS standard albedo products. The algorithm using ASK model outperforms AMBRALS algorithm especially when there are less angular samples in the data.

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