COMPENSATION OF ATMOSPHERIC AND DIRECTIONAL EFFECTS IN MODIS REFLECTANCE DATA

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Abstract

A variety of high-quality MODIS land products has been available to the global modeling and monitoring communities now for a full decade. The surface reflectance product (MOD09) serves as the underlying basis for the majority of these products (Vermote et al, 2002; Vermote and El Saleous, 2006). MOD09 provides a per pixel estimate of the surface spectral reflectance for each of the first seven MODIS bands equivalent to what would be measured at ground level as if there were no atmospheric scattering or absorption. It corrects for the effects of atmospheric gases, aerosols, and thin cirrus clouds. The surface reflectance is inverted with the help of a radiative transfer model 6SV (Kotchenova and Vermote, 2007; Kotchenova et al., 2006) using atmospheric inputs taken from NCEP (ozone, pressure) or directly derived the MODIS data (aerosol, water vapor).Aerosol optical thickness (AOT) is retrieved from MODIS data with the help of an internal aerosol inversion algorithm. Single scattering albedo, size distribution and refractive indices are the parameters of one of four pre-assigned aerosol models, which are also selected by the internal aerosol algorithm. The vertical profile is in most cases assumed to be exponential. AOT needs to be retrieved at the spatial resolution of 1 km due to its high spatial variability, while the other aerosol parameters can be retrieved at a coarser resolution with little loss of accuracy. Uncertainties on AOT retrievals depend on the atmospheric conditions although the goal is to retrieve AOT at 1km with an accuracy of 0.01. The product is accompanied by extensive quality information characterizing the cloudiness, the atmospheric state, and the compensation uncertainties.

High quality MODIS surface reflectances from both Terra and Aqua are then accumulated over a 16 day period to reconstruct the reflectance anisotropy of the surface with the use of a bidirectional reflectance distribution (BRDF) model (Lucht et al., 2000; Schaaf et al., 2002). A retrieval is accomplished if there are sufficient cloud-free surface reflectances to adequately sample the viewing hemisphere. The resulting product (MCD43) is provided operationally every 8 days at a 500m resolution (note that a variation of this algorithm has also been implemented for direct readout applications and with this implementation a multiday retrieval can be attempted each day in a rolling fashion). With the surface anisotropy characterized, intrinsic measures of surface albedo and view-angle corrected surface reflectances can be computed. Consistent nadir BRDF-adjusted reflectances (NBAR) quantities are used as the primary input for the operational MODIS land cover and vegetation phenology products. The albedo

measures represent directional and bihemispherical reflectances without atmospheric effects and thus must be recombined with instantaneous optical depth information to produce an actual (blue-sky) albedo such as would be measured at the surface by field sensors under ambient illumination. Extensive MODTRAN computations have been utilized to both specify this recombination and to compute the broadband quantities that are routinely used by biophysical models (Liang et al., 1999).

Both the MODIS surface reflectance products and the MODIS albedo and NBAR products have undergone extensive validation using field data from the Aerosol Robotic Network (AERONET) and Baseline Surface Radiation Network (BSRN). A review of the validation and an assessment of the currently available fifth reprocessing of these products will be provided.

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