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RETRIEVAL OF SURFACE DIRECTIONAL REFLECTANCE AND HEMISPHERICAL ALBEDO USING MULTI-ANGLE MEASUREMENTS

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Knowledge of the directional reflectance properties of natural surfaces such as soils and vegetation canopies is essential for classification studies and surface model inversion. Atmospheric correction schemes, using various levels of approximation, are described to retrieve surface directional reflectance and hemispherical albedos from multi-angle radiance measurements. Three particular observing scenarios are considered: 1) space-based observations with MISR (Multi-angle Imaging Spectroradiometer) on the EOS-AM space platform to be launched in 1998, 2) airborne observations with ASAS (Advanced Solid-State Array Spectrometer) , and 3) ground level observations with PARABOLA (Portable Apparatus for Rapid Acquisition of Bidirectional Observations of the Land and Atmosphere) . In each of these scenarios it is assumed that the optical properties of the atmosphere are known well enough to adequately model the radiative effects in the retrieval process. The retrieval schemes are tested on simulated data using realistic surface bidirectional reflectance distribution functions (BRDFs) and atmospheric models incorporating aerosols. The BRDF cases include 11 different types, ranging from soil to forest canopies and exhibiting a variety of angular shapes and albedos. Two aerosol opacities were considered, 0.1 and 0.5.

The retrieval algorithms tested in this study included a rigorous version, which solved for the directional reflectance by means of an iterative technique, and a much faster version, which employed simplifying approximations and resulted in an explicit expression for the directional reflectance. These two algorithm versions were tested and compared for a number of different sun-viewing geometries associated with the MISR, ASAS and PARABOLA observing scenarios . The sun zenith angles considered were 26°, 46° and 64°.

The PARABOLA data sets at a given solar zenith angle are composed of radiance measurements uniformly spaced over the hemisphere (15° increments in viewing zenith angle from 0° to 75°, and 45° increments in viewing azimuth angle referenced from the principal plane) . The retrieval results for a given BRDF case were found to be more accurate when multiple (different sun zenith angle) data sets were analyzed simultaneously using the rigorous algorithm instead of analyzing each sun angle set individually, using either the rigorous or fast algorithm. In addition it is shown that the downward radiance field, also measured by PARABOLA, is sensitive to the aerosol properties and provides constraints on the aerosol model used in the retrieval.

Both the ASAS and MISR data sets at a given sun angle are composed of radiance measurements made at only two particular viewing azimuth angles separated by 180° and a number of symmetrically directed viewing zenith angles. This observation scenario is

characteristic of an instrument which looks both backward and forward along the direction of flight. For the ASAS data sets the viewing zenith angles typically ranged from 0° to ±45° in increments of 15°. Data sets with an extended viewing angle range out to ±60° were also studied. Retrieval tests in which multiple (different sun zenith angle and azimuth angle) data sets were simultaneously analyzed produced more accurate results than the same sun angle sets analyzed individually. Comparison of results between the typical and the extended angle data sets showed that the extended angle sets also produced more accurate retrievals. Application of the fast algorithm showed only a modest degradation in retrieval quality when compared to the rigorous version.

The data sets for MISR had viewing zenith angles positioned at 0°, ±26.1°, ±46.1°, ±60.0° and ±70.5°. Because MISR will be in a sun-synchronous orbit, observations of a given target are usually limited to a single sun zenith angle measurement. Good results were obtained with both the fast and rigorous versions of the retrieval algorithm. Sensitivity of the atmospherically corrected directional reflectance and associated hemispherical albedos to aerosol properties was also studied.