The Use of MODIS-N, MODIS-T and MISR for BRDF Studies Relative to the EOS/MODIS/Snow Investigation

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Introduction

Snow cover is a highly variable material in terms of its extent, thickness and reflectance. These parameters change as snow ages and metamorphoses, and are important to global energy balance because the thermal and reflective properties of snow influence its duration and the heat flux between the atmosphere and the ground. Snow reflectance is highly variable over large areas especially since it is influenced by ground cover. At present, satellite measurements can be used to measure reflectance at near-nadir viewing angles using the Landsat Thematic Mapper (TM) sensor on board Landsats 4 and 5. In the future, Moderate Resolution Imaging Spectrometer-Nadir (MODIS-N) sensors on board the Earth Observing System (EOS) will be capable of measuring snow reflectance globally.

The anisotropic reflectance properties of snow are more pronounced in the viewing direction toward the Sun, and at large solar zenith angles. Off-nadir measurements are generally more correlated with the hemispheric reflectance than are nadir measurements. Thus the ability to obtain directional measurements of snow is key to calculating hemispheric reflectance and estimating albedo of snow.

Comparison of MODIS-N, MISR and MODIS-T for Snow Reflectance Studies

MODIS-N will be capable of providing off-nadir viewing by virtue of having a wide field-of-view (FOV) (+/- 55 degrees in the cross-track direction). Thus some capability to measure the bidirectional reflectance distribution function (BRDF) will be available with MODIS-N alone. However, data will be acquired in only a single string across the subsatellite track. By contrast, MODIS-T (Tilt) with a wide (+/- 45 degrees) FOV and along-track pointing, would provide a more complete sample of the BRDF. The large number of channels (32) on MODIS-T would also permit a good sampling of the reflectance curve of snow.

The Multi-angle Imaging SpectroRadiometer (MISR) will provide multi-angle imaging of the Earth using 8 discrete cameras pointed at fixed angles viewing forward and aftward along the spacecraft ground track. Every point in a 200 km swath is imaged at 8 viewing angles during a 7 minute period, under nearly identical illumination and atmospheric conditions. Images will be acquired at nadir, 36.9, 53.1 and 66.4 degrees forward and 25.8, 45.6, 60.0 and 72.5

degrees aftward of nadir. MISR will have a +/- 14 degrees FOV. Each image will be obtained in 4 spectral bands centered at: 440, 550, 670 and 860 nm at a maximum resolution of 240 m. Thus MISR will permit BRDF measurements of snow to be acquired. Using the BRDF measurements, one can interpolate between angles to calculate hemispheric reflectance at a particular azimuth angle if sensor saturation is not a problem in the visible bands.

MISR, though likely to be useful for BRDF studies of snow, is percieved from the point-of-view of this investigation to be limited relative to MODIS-T due to its fixed fore/aft pointing angles and, more particularly, by the restricted cross-track FOV. It was envisioned in this investigation that MODIS-T would be employed in the targeted mode to acquire a more complete set of BRDF measurements over snow than is possible with MISR. By targeting snowcovered areas in northern latitudes over the interiors of continents, it would appear that MODIS-T could be operated successfully in this mode. Furthermore, the far fewer bands on the MISR, relative to MODIS-T, will be less than desired in an analysis of the BRDF of snow throughout the 400-900 nm part of the electromagnetic spectrum.

Conclusions

The objectives of this investigation clearly require a companion instrument to MODIS-N that is capable of obtaining a significant set of BRDF measurements over snow. These measurements are required in order that knowledge be obtained permitting MODIS-N bidirectional observations to be used for achieving improved and useful hemispheric reflectance estimates and, eventually, albedo estimates over snow fields on a global basis. MODIS-T with its capability to obtain, over time, a relatively complete set of observations of bidirectional radiances in the 400-800 nm spectral range was and is still viewed as the superior instrument for the purposes of this investigation. MISR, if the MODIS-T instrument is not available, will be necessary and accepatable in allowing progress to be made in understanding and quantifying the BRDF over snow. MISR will also permit improved conversion of MODIS-N bidirectional radiances to hemispheric reflectance and albedo estimates over snow providing that MISR sensors do not experience saturation in the visible bands over snow and ice targets.