DEVELOPMENT OF A MODIS SEA ICE ALBEDO PRODUCT

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Surface albedo is a fundamental climate parameter as it governs the amount of solar energy available for absorption by the surface of the earth. In the polar regions, the high albedo of sea ice allows much less solar energy to be absorbed by the darker ocean. Open water absorbs between 85 and 95% of the incoming solar energy, whereas, only 30-50% is absorbed by sea ice. However, as the areal extent of Arctic sea ice continues to decrease during summer, the heat input into the ocean increases. The increased absorption of energy from the sun further warms the water column, delaying autumn freeze-up and slowing ice growth. The recent pattern of significantly lower Arctic sea ice extent is consistent with the ice-albedo feedback in the Arctic system that enhances the link between warming and reduced ice.

The lack of high quality and high spatial and temporal resolution observations of Arctic sea ice albedo is a critical observational gap. This work attempts to fill that gap by developing an algorithm to compute Arctic sea ice albedo spanning 2000 through the lifetime of the Terra and Aqua MODIS instruments, with applicability to future sensors, such as the NPOESS VIIRS instrument. The approach utilizes multiple sensors on the Terra and Aqua platforms (MODIS, MISR, and AMSR-E) to derive daily sea ice albedo and its variability. The work is an extension of the Direct Estimation Algorithm (DEA) of Liang et al. [2005] to include a multi-temporal/angular/sensor approach coupled with enhanced snow and ice radiative transfer modeling that accounts for non-sphericity of particles, snow and ice impurities, surface roughness, and snow and ice optical thicknesses. In order to be able to quantify and understand the rapid environmental changes taking place in the Arctic, it is essential that steps are taken now to fill observational gaps such as the gap in sea ice albedo. Although our region of study is currently limited to the Arctic, the methodology is designed so that it is easily adaptable to Antarctic sea ice conditions.

In this talk we outline our progress to date in deriving sea ice albedo from MODIS. One of the first tasks was to compile a spectral albedo library of *in situ* measured Hemispherical-Directional Reflectance Factors (HDRF) and spectral albedo that can be used for (1) determining which MODIS channels are useful in defining the underlying surface type (i.e. melt ponds, bare ice, snow-covered ice); (2) provide validation data for the MODIS albedo retrievals and (3) provide validation of how well the radiative transfer model is able to accurately simulate spectral albedo and HDRF for different ice types. Using this data base, various MODIS channels were found to be useful for distinguishing between melting and bare/snow-covered sea ice. Melt pond classification using the MODIS data was compared with high resolution spy satellite data to evaluate its accuracy. Secondly, we investigated using additional satellite sensors to improve surface type classification. For example, analysis shows that the age of the sea ice, derived from Lagrangian tracking of ice parcels using satellite passive microwave data [e.g. *Fowler et al.,* 2004], influences the surface albedo, with large differences in albedo observed for first-year and multiyear sea ice. MISR data was also investigated to help improve HDRF classification for different ice types. All these analysis help provide *a priori* information that can be used to select the appropriate angular regression model (ARM) derived from the radiative transfer model results and thus, provide an instantaneous retrieval of sea ice albedo. We note that AMSR-E data was found to not be particularly useful for snow depth retrievals. Thus, the lack of snow depth information remains an unresolved issue.

References

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