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Cryosphere surface albedo derivation with MODIS narrowband to CERES broadband conversion

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Clouds and the Earth's Radiant Energy System (CERES) instruments on NASA?s Earth Observing System (EOS) Terra and Aqua satellites measure broadband shortwave and longwave radiation reflected and emitted at the Top of the atmosphere (TOA). CERES synthesizes broadband observations with other EOS data streams. The CERES Surface and Atmospheric Radiation Budget (SARB) group matches observations with a radiative transfer code to determine fluxes at several levels; surface albedo is then inferred as the ratio of up and down surface fluxes. While validation of SARB with ground measurements at scores of sites has been impressive, we (and all other satellite efforts) are frankly weak over sea ice. The presentation describes how the next edition of CERES will improve the retrieval of cryosphere surface albedo. Surface albedo is one of the input parameters of numerous models such cloud-resolving model (CRM) simulation, general circulation models (GCMs) and transient climate change simulations. It was recently showed by Park and Wu (2010) that CRM simulation well represents the SW radiative budget during winter because the radiation calculation for the snow-covered period is improved by using prescribed evolving surface albedo. Qu and Hall (2007) analyzed snow albedo feedback (SAF) in several transient climate change models. They stated that high quality observations of albedo of snow-covered surfaces would be extremely useful in reducing SAF spread in the next generation of models. CERES measures radiance and infers flux by applying scene-dependent, empirically based angular distribution models (ADMs). CERES ADMs are obtained from the complex CERES rotating azimuth plane scan mode to establish BRDF on the scale of 30 km broadband footprints. While CERES has much coarser spatial resolution than MODIS, the CERES measurement-based BRDF provides a keen advantage in accuracy over complex surfaces. CERES SARB retrievals of surface albedo have to date been based on only those 30 km footprints that are completely clear; there are too few (~5%) such footprints over sea ice. The upcoming edition of CERES will include MODIS radiances in 7 SW bands which are point spread function weighted to a CERES footprint. MODIS radiances over the clear portion of the CERES footprint are averaged and kept as well. This enables us to convert MODIS narrowband radiance measurements into CERES broadband radiance; and allows us to retrieve surface albedo using CERES algorithm with a predicted radiance over the clear sky portion of the numerous partly cloudy footprints. MODIS to CERES radiance conversion algorithm is implemented in 2 major steps: 1) Observed footprint mean MODIS reflectance was fitted against CERES reflectance in a parameter space defined by surface type, solar zenith and scattering angle. 2) Continuous parameterizations over the 2-D angular space were determined for each surface type. Obtained parameterizations were tested over sea ice and permanent snow. It was shown that proposed conversion algorithm slightly underestimates CERES radiance in comparison with actual observations: ~0.6% over permanent snow and ~0.7% over sea ice. Clear-sky broadband shortwave fluxes were used to calculate broadband surface albedo using an atmospheric correction based on the Langley Fu-Liou model and bulk atmospheric properties.