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Towards Improved Next-Generation Angular Distribution Models for Top-of-Atmosphere Radiative Flux Estimation from the CERES Instruments

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The Clouds and the Earth's Radiant Energy System (CERES) instrument provides highly accurate top-of-atmosphere (TOA) shortwave, longwave, and window radiance measurements. To estimate TOA fluxes from measured radiances, we must account for the angular distribution of the radiance field. The angular distribution is a strong function of the physical and optical properties of the scene (i.e. surface type, vegetation index, aerosol type/loading, cloud fraction, cloud optical depth, cloud phase), as well as the solar-viewing geometry. To facilitate the construction of the angular distribution model (ADM), the CERES instrument was designed to rotate in azimuth as it scans in elevation, therefore it acquires data over a wide range of viewing zenith and azimuth angles. Furthermore, the CERES instrument and the Moderate Resolution Imaging Spectrometer (MODIS) are on the same spacecraft. Aerosol and cloud retrievals based upon MODIS spectral measurements provide critical information to define CERES scene types. The global CERES radiances together with the aerosol and cloud properties retrieved from MODIS, and the meteorological information from reanalysis are used to construct the scene type dependent CERES shortwave and longwave ADMs. In this presentation, we detail the ongoing efforts to improve the existing CERES shortwave and longwave ADMs for different scene types. For example, over clear ocean scenes, the new CERES shortwave ADMs explicitly account for aerosol optical depth and aerosol type, in addition to wind speed. Over clear land/desert and fresh snow, the new shortwave ADMs are inferred from the RossThick-LiSparse surface bidirectional reflectance distribution function for each 1 by 1 degree region and each calendar month. To account for the different vegetation characteristics and aerosol optical depth within each 1 by 1 degree region, the three parameters of the RossThick-LiSparse model are derived for different normalized differential vegetation index and solar zenith angle ranges. For longwave angular distribution models over clear scenes, we increase the surface temperature bins used in ADM development. These improvements in ADMs are expected to reduce the TOA flux uncertainties by 20%. The anticipated instantaneous TOA flux errors are estimated to be less than 8 Wm-2 in the shortwave and less than 2.5 Wm-2 in the longwave.