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A "direct" estimation of surface solar fluxes from satellite data

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Model simulations and measurements indicate a near-linear relationship between surface solar absorption and surface-atmosphere solar absorption (e.g., Ramanathan, 1986; Cess and Vulis, 1989, Schmetz, 1993). The existence of such a relationship has also been shown theoretically (Laszlo and Pinker, 1994), using the adding principle of radiative transfer (Chandrasekhar, 1960) for isotropic reflection. This direct relationship can be used to estimate the surface solar absorption when absorbed solar radiation at the top of atmosphere (TOA) is known and the composition of the atmosphere is well characterized. The technique has the advantage of avoiding the need for the potentially uncertain upward flux (due to errors/assumptions in surface albedo) when calculating the absorbed flux at the surface.

The method is implemented with MODIS radiance data and atmosphere product, as well as CERES TOA fluxes globally, and as a demonstration for the upcoming GOES-R satellite. Limitations of the technique are explored/characterized both theoretically and experimentally by comparing the retrievals, respectively, to calculated and ground-observed fluxes. The results suggest that solar radiation absorbed at the surface can be reliably estimated by this technique for clear skies. For cloudy skies the results indicate significant biases, especially for ice clouds. When cloud data from CERES are used the biases are reduced, suggesting that MODIS clouds and CERES albedos are perhaps less consistent than CERES clouds and CERES albedos. Application of the technique with radiances and products from the Visible Infrared Imager Radiometer Suite (VIIRS) onboard NASA's newest Earth-observing satellite, NPP is also discussed.