Establishing Climatological Validation of Aerosol Impact at Barrow: ‘Ground Truth’ vs. Satellite Measurements

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Recently, the 10th Anniversary Celebration for the Clouds and the Earth's Radiant Energy System (CERES) satellite mission was held at NASA. "The CERES data represent an entirely new generation of climate data accuracy and integration, both of which are critical to accurately predict future climate change." (B. Wielicki, Nov 27, 2007). Portions of the analyses of the CERES data are dependent upon data obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS), including aerosol optical depth and surface albedo; both instruments are aboard the polar orbiting Aqua and Terra satellites. Due to the differences in pixel size, ~25km vs. >1km, respectively, the matching of these analyses can be difficult, particularly over land. Additionally, the impact of aerosols upon climate change is not totally settled; aerosols in the atmosphere affect the earth's radiation budget in complicated ways, depending on their physical and optical characteristics and how they interact with solar and terrestrial radiation, as well as any indirect effects. The Barrow Observatory, located in a typically pristine background aerosol environment, provides the opportunity to assess the temporal impact of incursions of Eurasia dust and boreal smokes over an even smaller footprint, ~200 m, with decadal resolution. The comprehensive measuring systems in place near Barrow (NOAA ESRL and DOE ARM) present a unique opportunity to characterize the smoke and dust aerosols, both physically and optically. It is just these details that ultimately will provide critical ‘ground truth’ for the broader satellite-based climate change conclusions. Two Barrow events, each of approximately 3 days duration, of both dust and smoke, were captured by the full suite of NOAA and DOE surface instruments, such that the aerosol optical and physical properties could be established. Tying these events to overpasses of both CERES and MODIS, using an established radiative transfer (RT) code (MODTRAN™5), permitted a quasi-direct comparison, constrained primarily by the complex spatial footprints of each technique. Closure studies first replicated the surface measurements, and then reproduced the trends seen in the satellite data, including Direct Aerosol Radiative Forcing (DARF), outgoing shortwave radiation (OSR), Top-of-Atmosphere (TOA) albedo and net flux, all of which agree to within ~10% for both cases. Error analyses for both OSR and DARF show that the 10% differences arise primarily from the breadth of surface albedo variation and the determination of aerosol type.

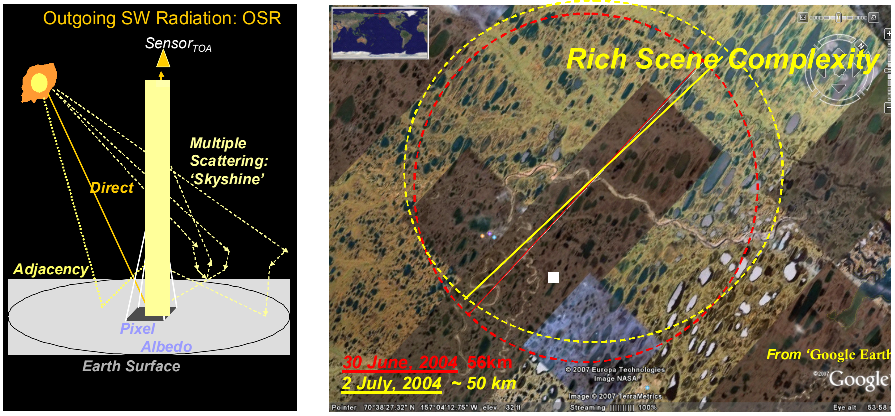

Figure 1. **(a)** The ‘soda straw’ pixel element for a radiative transfer code, including solar scattering and adjacency effects. The breadth of the range for adjacency is of order 1 km. **(b)** The larger red and yellow circles represent two overlapping CERES pixels over tundra. The albedo complexity is represented only by 1 value, after cloud clearing. The small white box depicts the MODIS pixel size, but the collection time is of order 1 week.