Geophysical Research Abstracts, Vol. 9, 05841, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-05841

Using observations of deep convective systems to constrain atmospheric column absorption of solar radiation in the optically thick limit

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Atmospheric column absorption of solar radiation (Acol) is a fundamental part of the Earth's energy cycle but is an extremely difficult quantity to measure directly. To investigate Acol, we have collocated satellite-surface observations for the optically thick Deep Convective Systems (DCS) at the Department of Energy Atmosphere Radiation Measurement (ARM) Tropical Western Pacific (TWP) and Southern Great Plains (SGP) sites during the period March 2000-December 2004. The surface data were averaged over a 2-hour interval centered at the time of the satellite overpass, and the satellite data were averaged within a 1o x 1o area centered on the ARM sites. In the DCS, cloud particle size is important for top-of-atmosphere (TOA) albedo and Acol although the surface absorption is independent of cloud particle size. In this study, we find that the Acol in the tropics is ˜ 0.011 more than that in the middle latitudes. This difference, however, disappears, i.e., the Acol values at both regions converge to the same value (˜ 0.27 of the total incoming solar radiation) in the optically thick limit (τ > 50). Comparing the observations with the NASA Langley modified Fu_Liou 2-stream radiative transfer model, the difference between observed and model-calculated surface absorption, on average, is less than 0.01, but the model-calculated TOA albedo and Acol differ by 0.01 to 0.03, depending primarily on the cloud particle size observation used. The model versus observation discrepancies found are smaller than many previous studies and are just within the estimated error bounds. We did not find evidence for a large cloud absorption anomaly for the optically thick limit of extensive ice cloud layers. A more modest cloud absorption difference of 0.01 to 0.03 cannot yet be ruled out. The remaining uncertainty could be reduced with additional cases, and by reducing the current uncertainty in cloud

particle size.