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Absorption of Solar Radiation by Clouds: Observations versus Models [1]

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This study used Earth Radiation Budget Experiment (ERBE) data available from the EOSDIS Langley DAAC to compare collocated satellite and surface measurements of short wave (SW) radiation and output from two atmospheric global circulation models (GCMs) to determine how accurately the models describe the SW cloud forcing in the atmosphere. In addition to assessing the accuracy of the models, the authors examined some proposed mechanisms to describe the absorption of SW radiation by clouds in the atmosphere.

To assess the SW cloud forcing, the investigators compared data for all clear sky cases and all cloudy sky cases to determine the SW absorption. The ground measurements determined by pyranometers provided the surface SW measurements. The satellite measurements provided the top of the atmosphere (TOA) values. The TOA and surface SW measurements were used to directly determine the cloud absorption of the SW radiation. The cloud absorption at the five sites was compared to the GCM output. The comparison indicated that there is more SW absorption by clouds than the models predict. The authors also used a rigorous analytical method which yielded the same conclusion.

An extension of the analysis from the five point measurements to the surrounding regions was carried out. This analysis resulted in the determination that the cloud forcing results were invariant with respect to geographic location on all spatial scales. The only exceptions to these results were regions with high surface albedos.

The results of the study demonstrate the present shortcoming in the current knowledge of cloud radiative processes. One explanation for the enhanced SW absorption by clouds is the cloud absorption changing due to aerosol effects.

The study does not support this explanation because the absorption does not exhibit the spatial nor temporal variability that the heterogeneous nature of tropospheric aerosols would dictate. The authors conclude that there is no obvious explanation for the enhanced SW absorption and this absorption should reduce the global mean SW surface absorption by 25 watts per square meter compared to climate models.

Reference(s)

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