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Are Passive Remote Sensed Clouds Comparable with Active Sensed Clouds?

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Passive satellite observations, such as CERES-MODIS and GOES, can provide global and regional coverage of clouds. For reliable application of satellite datasets in understanding cloud processes and evaluate climate models, it is important to estimate the errors in the derived cloud properties. In this study, we have used the collocated DOE ARM ground-based and CloudSat/CALIPSO active radar-lidar observed clouds as "cloud-truth" data sets in the validation of the NASA CERES Science Team derived MODIS and GOES cloud products over the DOE ARM NSA and SGP sites. Based on a total of 4-yr ARM, CERES-MODIS, and CloudSat/CALIPSO (CC) data over the ARM NSA site, and 10-yr ARM and GOES data over the ARM SGP site, we are attempting to answer the following three scientific questions:
1) How do passive satellite-retrieved cloud heights compare with active satellite/surface radar-lidar observations?
2) Do passively remote sensed Cloud Fractions (CFs) agree with actively remote sensed CFs?
3) How can point observations (ground-based radar-lidar) be compared with satellite results?

Studies (Dong et al. 2008, Xi et al. 2010, Giannecchini et al. 2012) have shown that most MODIS and GOES-derived cloud effective heights are close to ARM-derived cloud-top heights for optically thick clouds, and are near or below the cloud physical center for optically thin clouds. However, there are large differences in cloud-top height comparisons between DOE ARM and CloudSat/CALIPSO over the ARM NSA site from May to October. The maximum difference occurs in September with CC=7.3 km and ARM=3.3 km, which results from CC limitations in detecting clouds below 1 km and ARM radar-lidar limitations in measuring optically thin upper-level clouds. For CF comparisons over the NSA site, the CERES-MODIS CFs agree well with ARM and CC results during warm moths (May-Oct), but are significantly lower during cold months. We therefore conclude that the passive CERES-MODIS retrieved CFs agree well with those from CC and ARM during warm months, but significantly underestimate CFs under the high albedo and cold temperature surface conditions during polar night. The CC derived CF is 6% lower than ARM, primarily due to CC measurement limitations to clouds below 1 km.

Finally, we analyzed one decade of radar[U+2010]lidar and GOES data at the ARM SGP site and found that there is excellent agreement in the long[U+2010]term mean CFs derived from the surface and GOES data, and the CF is independent of temporal resolution and spatial scales for grid boxes of size 0.5° to 2.5°. When computed over a 0.5 h (4 h) period, cloud frequency of occurrence (FREQ) and amount when present (AWP) derived from the point surface data agree very well with the same quantities determined from GOES for a 0.5° (2.5°) region centered on the DOE ARM SGP site.