Validation of CERES-MODIS Cloud Retrievals Using the Azores Data

Research Highlight

Marine boundary layer (MBL) cloud properties derived for the National Aeronautics and Space Administration (NASA) Clouds and the Earth's Radiant Energy System (CERES) Project using Terra and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) data are compared with observations taken at the ARM Mobile Facility at the Azores (AMF-Azores) site from June 2009 through December 2010. Cloud properties derived from ARM ground-based observations were averaged over a 1-hour interval centered at the satellite overpass time, while the CERES-MODIS (CM) results were averaged within a 30 km × 30 km grid box centered over the Azores site.

A total of 63 daytime and 92 nighttime single-layered overcast MBL cloud cases were selected from 19 months of ARM radar-lidar and satellite observations. The CM cloud-top/base heights (Htop/Hbase) were determined from cloud-top/base temperatures (Ttop/Tbase) using a regional boundary-layer lapse rate method. For daytime comparisons, the CM-derived Htop (Hbase), on average, is 0.063 km (0.068 km) higher (lower) than its ARM radar-lidar observed counterpart, and the CM-derived Ttop and Tbase are 0.9 K less and 2.5 K greater than the surface values with high correlations (R2=0.82 and 0.84, respectively). In general, the cloud-top comparisons agree better than cloud-base comparisons because the CM cloud-base temperatures and heights are secondary products determined from cloud-top temperatures and heights. No significant day-night difference was found in the analyses.

The comparisons of MBL cloud microphysical properties reveal that, when averaged over a 30 km x 30 km area, the CM-retrieved cloud-droplet effective radius (re) at 3.7 μm is 1.3 μm larger than that from the ARM retrievals (12.8 μm). While the CM-retrieved cloud liquid water path (LWP) is 13.5 gm^{-2} less than its ARM counterpart (114.2 gm^{-2}) due to its small optical depth (9.6 vs. 13.7). The differences are reduced by 50 percent when the CM averages are computed only using the MODIS pixel nearest the AMF site. Using effective radius retrieved at 2.1-μm channel to calculate LWP can reduce the difference between the CM and ARM microwave radiometer retrievals from -13.7 to 2.1 gm^{-2}. The 10 percent differences between the ARM and CERES-MODIS LWP and re retrievals are within the uncertainties of the ARM LWP (~20 gm^{-2}) and re (~10 percent) retrievals. However, the 30 percent difference in optical depth is significant. Possible reasons contributed to this discrepancy increased sensitivities in optical depth from both surface retrievals when # ~ 10 and topography. The # differences vary with wind direction and are consistent with the island orography. Much better agreement in # is obtained when using only those data taken when the wind is from the northeast, where topographical effects on the sampled clouds are minimal.

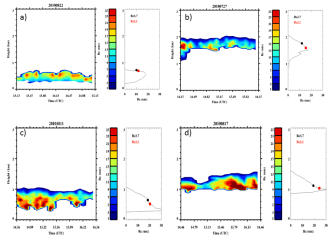

Figure 1. The ARM radar-MWR derived re profiles (Dong et al. 2014b) plotted for 2 h centered on the satellite overpass. The ARM retrievals represent a pencil beam of a grid box of 30 km × 30 km CERES-MODIS (CM) retrievals at 2.1 μm, re (2.1), and 3.7 μm, re (3.7). The right column represents the 1-hour averaged ARM re profiles with matched re (3.7) and re (2.1) retrievals (regardless of CERES-MODIS retrieved Heff).

Reference(s)

Xi B, P Minnis, and S Sun-Mack. 2014. "Comparison of marine boundary layer cloud properties from CERES-MODIS edition 4 and DOE ARM AMF measurements at the Azores." Journal of Geophysical Research – Atmospheres, 119, doi:10.1002/2014JD021813.

Contributors

Xiquan Dong, *University of North Dakota*

Working Group(s)

Cloud Life Cycle