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Title: Detecting Multilayered Clouds Using MODIS Data

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Detecting overlapping cloud cases accurately is very important for improving the quality of the cloud products, since most satellite-based cloud remote sensing techniques assume a 1-layer cloud system for the retrieval. Many satellite observations of clouds are affected by radiation from more than one cloud layer. Cloud overlap can cause errors in the retrieval of many cloud properties. Application of retrieval algorithms that account for more than one layer in a pixel first requires identification of those radiances affected by multilayered clouds. Multilayered clouds often yield retrieved cloud properties that represent some value between those for the two separate layers. For example, the contamination of the 3.7-μm radiance due to the presence of ice crystals tends to raise the value of effective water droplet radius derived from 3.7-μm data because water droplets have a greater albedo than ice crystals of the same size. Conversely, the derived ice crystal effective diameter will be smaller in overlapped conditions than for a single-layered cirrus. Such effects provide a basis for detecting multilayered clouds. This work describes the methods currently used by CERES for multilayer classification and an initial evaluation of their accuracy. The technique is basically a combination of cloud properties check, stated above, and a cascade of threshold tests utilizing the the brightness temperature differences (BTD) between the 11-12, 11-6.7, 11-4.05, 11-8.5, 11-13.6 and 11-3.7 μm for different cloud phase and optical depth respectively. Thresholds are established empirically from a variety of

sources. The CERES Multilayer Algorithm is examined using Aqua and Terra MODIS data. The performance of the algorithm is validated with coincident cloud physics lidar (CPL) data obtained from an aircraft platform and from active sensor data taken at the ARM surface sites. The initial comparisons are very encouraging.