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Resolving cirrus optical depth biases between active (CALIOP) and passive (MODIS,IIR) using IR retrievals

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The successful launch of CALIPSO and CloudSat in June 2006 has provided for the first time global, vertically resolved observations of both clouds and aerosols. These active sensors provide nearly coincident observations with the MODIS and AIRS on the Aqua platform. The combination of the active and passive cloud observations has provided a truly new capability to better understand the composition and distribution of clouds and aerosols. A recent IR radiative closure analysis using co-located single layer cirrus retrievals from MODIS and CALIOP has found a bias between the two (MODIS larger than CALIOP by a significant amount). As part of this effort we developed and implemented an IR cirrus OT retrieval designed to be a reference for to compare the CALIOP and MODIS retrievals. Recent reprocessing of selected MODIS data at the SSEC atmospheric PEATE has enabled generation of retrievals with a modified version of Collection 5 ice cloud Look Up Tables (LUTs) that eliminate a forward scattering numerical artifact and reduce the retrieved optical thickness. The main questions that where investigated in this effort was to:

1) Investigate uncertainties in the single scatter calculations used as part of the MODIS retrieval of cloud optical depth and effective radius.
2) Investigate biases in the CALIOP retrieval of cirrus optical depth resulting from an incorrect multiple scattering correction and/or lidar ratio used as part of the retrieval process.

A preliminary comparison between these retrievals finds significant systematic differences for single layer thin ice clouds (visible optical depth < 3) as presented in figure 1. Explanations for these differences are many, ranging from algorithm implementation to differences resulting from the physical assumption built into the MODIS and CALIOP optical thickness (OT) retrieval methods. A factor of two difference in cirrus OT has a significant impact on the characterization of the net cloud forcing for both the solar and IR, especially at low optical thickness (OT<1). To investigate the MODIS we developed an IR retrieval cirrus optical depth retrieval using the MODIS IR channels (8.5 – 11 um) channels. The advantage of the IR is that it has limited sensitivity to scattering and as a [U+FFFC]result is insensitive to the single scatter properties used in the MODIS visible retrievals. The IR retrieval was processed on a limited subset of the month of August 2006 with results presented in figure 1 and 2. The comparison of the MODIS OP retrievals to the IR is presented in figure 1. Based on this comparison we find that the MODIS retrievals are biased high, but with bias smaller then when compared to the CALIOP retrievals (Figure 2a). This result suggests that the MODIS single scatter properties are not representative of the true characteristics of cirrus. Research is on going in determining more appropriate properties that will provide better radiative consistency with the IR retrievals and CALIOP.