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Direct aerosol radiative forcing based on combined A-Train observations – challenges in deriving all-sky estimates

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We describe a technique for combining CALIOP aerosol backscatter, MODIS spectral AOD (aerosol optical depth), and OMI AAOD (absorption aerosol optical depth) measurements for the purpose of estimating full spectral sets of aerosol radiative properties, and ultimately for calculating the 3-D distribution of direct aerosol radiative forcing. We present results using one year of data collected in 2007 and show comparisons of the aerosol radiative property estimates to collocated AERONET retrievals. An apparent bias in the input aerosol absorption optical depth and a related bias in the input aerosol single scattering albedo (SSA) are removed after application of the multi-sensor aerosol retrieval. We surmise that the removal of the SSA bias from the input data is a consequence of requiring the multi-sensor retrievals to be consistent with all input data and that the multi-sensor retrievals may be better constrained than retrievals from individual A-Train sensors. Initial calculations of seasonal clear-sky aerosol radiative forcing based on our multi-sensor aerosol retrievals compare well with over-ocean and top of the atmosphere IPCC-2007 model-based results, and with more recent assessments in the "Climate Change Science Program Report: Atmospheric Aerosol Properties and Climate Impacts" (hereafter referred to as CCSP-2009).
We also discuss some of the challenges that exist in extending our clear-sky results to all-sky conditions. On the basis of comparisons to suborbital measurements, we present preliminary findings regarding the limitations of the MODIS and CALIOP retrievals in the presence of adjacent and underlying clouds, respectively. Strategies for meeting these challenges will be examined and uncertainties associated with such strategies will be discussed.