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# Satellite and airborne aerosol remote sensing in the presence of clouds

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Our ability to assess aerosol effects on climate using remote sensing data depends on the discrimination between cloudy and cloud-free viewing elements. Aerosol microphysical and related radiative properties have been shown to vary rapidly in the immediate vicinity of clouds, a circumstance that further complicates the distinction of cloudy from cloud-free pixels and the assessment of direct and indirect aerosol effects on climate. In this paper we will discuss the utility of simultaneous airborne and satellite aerosol remote sensing and each method's caveats in the presence of clouds. In a few select case studies, we will show how MODIS aerosol retrievals vary as a function of distance from clouds and we will discuss which of the variations found in the MODIS aerosol data can be verified using airborne remote sensing observations. In a case study of aerosol measurements near cloud edges within a dissipating stratiform cloud deck near the California coast in March 2004, we find that the MODIS-derived visible AOD agrees well with the sunphotometer-derived measurements, but that the SWIR (1240-2130nm) AOD increases near cloud edges are of the order of 0.03 and as such three times as large as the sunphotometer-derived values. The implications for the recently discussed "bluing" of aerosols near cloud edges, i.e., a preferential apparent increase in the visible reflectances of clear-sky pixels due to 3-D radiative transfer effects in the vicinity of clouds, are discussed.
From a compilation of MODIS validation studies using airborne sunphotometer measurements in a large number of field campaigns we show that the agreement between sunphotometer and MODIS derived aerosol properties varies only slightly with the satellite-derived cloud fraction. We show further how the comparison of MODIS AOD to AOD derived from the CALIPSO backscatter lidar shows a significant dependence on cloud fraction, suggesting that the current version CALIPSO and MODIS data sets can only be usefully combined under severely cloud-free conditions. Finally, we show initial comparisons of a newly developed experimental 3x3km2 MODIS aerosol retrieval to airborne sunphotometer observations, again with an emphasis on observations near clouds.