# Spatial Variability of MODIS and MISR Derived Atmospheric Data Products

Spatial variability of aerosol optical depth on scales of a few hundred meters is crucial for understanding the spatial separation of cloudy and cloud-free pixels in satellite remote sensing and for assessing the feasibility of comparing modeled and observed aerosol data at different spatial scales. The work under this grant is aimed at the combined analysis of suborbital and EOS satellite measurements of aerosol optical depth and columnar water vapor collected during recent field experiments. In particular, we proposed to investigate the spatial variability in MODIS- and MISR-derived data products using suborbital sensors and to assess how well this variability is captured by satellite sensors and their data products. The stated goals of our study are (i) to determine the spatial variability of aerosol optical depth in the vicinity of clouds and assess how well current EOS satellite sensors capture or suppress such variability within their processing algorithms, (ii) to determine what fraction of the direct aerosol radiative forcing of climate may be undetected because the aerosol optical depth in the vicinity of clouds is erroneously filtered out or masked as cloud by current EOS sensor retrievals, (iii) to compare the spatial variability in aerosol optical depth and columnar water vapor in different geographical regions, thereby assessing the performance of current EOS sensor algorithms under a variety of regional and climatic conditions.

The major accomplishments in the first two years of this project include the completion of the analysis of the EVE (Extended-MODIS-λ Validation Experiment) data set, the publication of a GRL-manuscript dealing with MODIS near-IR aerosol products and their spatial variability, and the extension of our spatial variability analysis to the MODIS L1B-reflectance product (see Figure 2). EVE is an airborne field campaign conducted out of Monterey, CA in spring of 2004. The primary purpose of the EVE experiment http: //geo.arc.nasa.gov/sgg/EVE-website/) was to validate the over-ocean MODIS aerosol optical depth (AOD) measurements at 1.6 and 2.1µm aboard the Terra and Aqua platforms using the 14-channel NASA Ames Airborne Tracking Sunphotometer, AATS-14.

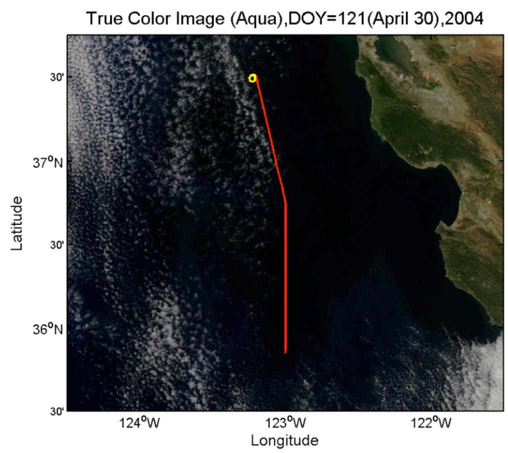


*Figure1: Flight track of EVE flight CIR06 (red), April 30, 2004, superimposed on MODIS-Aqua true color image.*

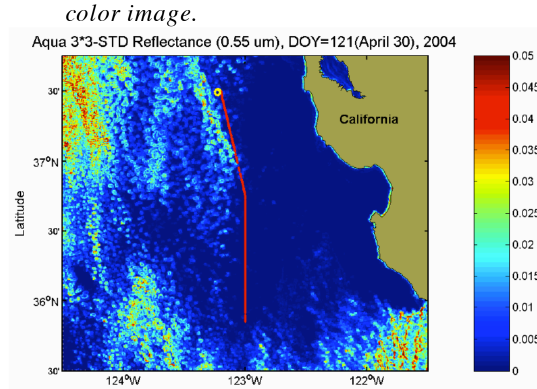


*Figure 2: Standard deviation of groups of 3-by-3 MODIS L1B reflectance at 553nm.*

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In EVE, a total of 35 and 49 coincident over-ocean suborbital measurements at the nominal level-2 retrieval scale of 10 km x 10 km were collected for Terra and Aqua, respectively. For MODIS-Terra about 80% of the AOD retrievals were within the estimated uncertainty; this was true for both the visible (here defined to include 466 – 855 nm) and near-IR (here defined to include 1243 – 2119 nm) retrievals.

For MODIS-Aqua about 45% of the AOD retrievals were within; the fraction of near-IR retrievals that fell within this uncertainty range was about 27%. We found an rms difference of 0.71 between the sunphotometer and MODIS-Aqua estimates of the visible (553-855 nm) Ångstrom exponent, while the MODIS-Terra visible Ångstrom exponents showed an rms difference of only 0.29 when compared to AATS. The cause of the differences in performance between MODIS-Terra and MODIS-Aqua could be instrument calibration and needs to be explored further.

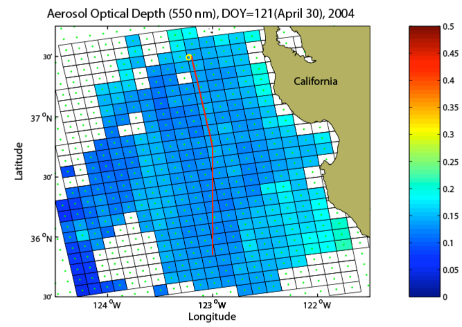


*Figure 3: MODIS Level 2 aerosol optical depth retrieval for this day.*

The spatial variability of AOD between retrieval boxes as derived by MODIS was generally larger than that indicated by the sunphotometer measurements. Spatial variability in MODIS-derived Ångstrom exponents between retrieval boxes was considerably larger than that indicated by the sunphotometer measurements. These results are summarized by *Redemann et al*., 2006.

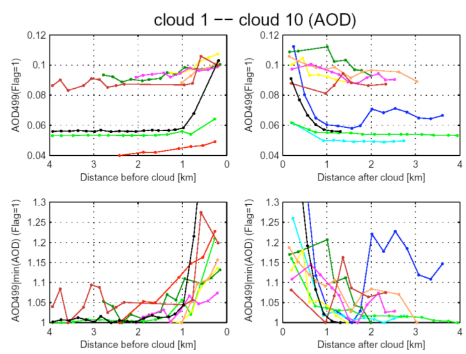


*Figure 4: Suborbital AOD observations near 10 clouds in EVE, 2004.*

In our recent efforts we have focused on studying the aerosol-cloud boundary using combined suborbital and satellite observations. In a preliminary study of AOD data near cloud edges collected in the EVE field we found that in 75% of the cases there was an increase of 5-25% in AOD in the closest 2 km near the clouds. Concurrently, the MODIS-observed mid-visible reflectances in the vicinity of the suborbital cloud observations also show an increase with decreasing distance to cloud edge. Possible causes include 3-D radiative effects, but also the increased variability in the aerosol fields near clouds as indicated by the suborbital observations.

Redemann, J., Q. Zhang, B. Schmid, P. B. Russell, J. M. Livingston, H. Jonsson, and L. A. Remer (2006), Assessment of MODIS-derived visible and near-IR aerosol optical properties and their spatial variability in the presence of mineral dust, *Geophys. Res. Lett*., 33, L18814, doi:10.1029/2006GL026626.

**Points of Contact:**
Jens Redemann
Project Principal Investigator
650-604-5933, jredemann@mail.arc.nasa.gov
http://geo.arc.nasa.gov/sgg/AATS-website