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Case studies of aerosol property retrievals over land and ocean using AirMSPI measurements

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The Airborne Multiangle SpectroPolarimetric Imager has been flying aboard the NASA ER-2 high altitude aircraft since October 2010. In step-and-stare operation mode, it makes 9 viewing-angle observations of a target area between $\pm 67°$. Its spectral channels are centered at 355, 380, 445, 470*, 555, 660*, and 865* nm, where the asterisk denotes polarimetric bands. To model AirMSPI observations of radiance and polarization over ocean and land during various field campaigns, a vector Markov chain radiative transfer model was developed and coupled with an adding/doubling method to simulate ocean-atmosphere and land-atmosphere systems. This model was used to build a look-up-table (LUT) with the 74 aerosol mixtures currently used in the Multi-angle Imaging SpectroRadiometer (MISR) operational aerosol retrieval algorithm. The retrieval approach is then divided into two-steps: aerosol and surface properties retrieved from the LUT method at all patches (patch size $\sim$0.25 km2) are used as a preliminary solution and then refined by (1) accounting for polarization measurements, and (2) running a multi-patch optimization algorithm which imposes smoothness constraints on the variations of aerosol and surface properties over neighboring patches and over subsequent views of the same patch.

Test retrievals were performed for AirMSPI flights over Southern California, Monterey Bay, and Fresno. For a relatively high aerosol optical depth (AOD) case ($\sim$0.28 at 550 nm), the retrieved aerosol concentration, size distribution, water-leaving radiance, and chlorophyll concentration over the ocean were compared to those reported by the USC SeaPRISM AERONET-OC site off the coast of Southern California on 6 February 2013. We evaluated the benefits of multi-angle and polarimetric observations by performing the retrievals using (a) all view angles and channels; (b) all view angles without polarization; (c) the nadir view angle only with both radiance and polarization; and (d) the nadir view angle without polarization. We found that removal of multi-angular or polarimetric information resulted in both increases in parameter uncertainty and systematic bias. Over land, the AOD, aerosol size distribution, and single scattering albedo over land were compared to the AERONET site at Fresno 06 January 2012 with favorable results.