Novel spectropolarimetric imaging instrumentation and algorithm concepts for aerosol remote sensing

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Building upon our successful development and application of the Multi-angle Imaging SpectroRadiometer (MISR) on NASA's Terra spacecraft to aerosol remote sensing [1], we are maturing technologies and algorithms for a next-generation global satellite imager, the Multiangle SpectroPolarimetric Imager (MSPI). MSPI extends MISR's multiangle visible and near-infrared observations to the ultraviolet (UV) and shortwave infrared (SWIR), and acquires highly accurate degree of linear polarization (DOLP) imagery in selected bands using a novel photoelastic modulator-based technique. Our first airborne prototype, AirMSPI [2], flies on NASA's high-altitude ER-2 aircraft, and includes 8 bands from 355-935 nm, with polarization channels at 470, 660, and 865 nm. A second prototype that includes SWIR bands, AirMSPI-2, is currently being built.

A coupled aerosol-surface retrieval algorithm to exploit MSPI capabilities is also under development. A vector Markov chain/adding radiative transfer model [3] is used to achieve high computational efficiency. The retrievals employ maximum likelihood inversion with constraints on the spectral variation in angular shapes of surface bidirectional reflectance, along with constraints on the spatial and temporal variability, respectively, of aerosol and surface properties. Multi-pixel methods, with the assumption of invariant [4] or smooth [5] changes of aerosol properties across neighboring pixels are incorporated. The use of a chemical transport model to further constrain particle properties, especially for application to studies of air quality impacts on human health, is also being explored.

In this paper, the benefits of UV and polarization channels for enhanced sensitivity to aerosol absorption and size distribution [2, 6] over land, ocean, and clouds, and the use of optimization methods in comparison to look-up table approaches, are illustrated using MISR and AirMSPI data.

[1] Diner *et al* (2005) *Rem. Sens. Environ.* **97**, 495-518 [2] Diner *et al* (2013) *Atmos. Meas. Tech.* **6**, 2007-2025 [3] Xu *et al* (2011) *Opt. Lett.* **36**, 2083-2085 [4] Martonchik *et al* (2002) *TGARS* **40**, 1520-1531 [5] Dubovik *et al* (2011) *Atmos. Meas. Tech.* **4**, 975-1018 [6] Kalashnikova *et al* (2011) *JQSRT* **112**, 2149-2163