What We Hope to Learn About Global Mineral Dust Aerosols from EOS Multi-angle Imaging SpectroRadiometer (MISR)

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On global scales, just a few broad atmospheric aerosol compositional groups are commonly observed (e.g., *Shettle and Fenn*, 1979, and many others). Of these, "mineral dust" is the only group which both contains non-spherical particles, and typically has size distributions with enough large particles for particle shape to affect its visible-light-scattering properties.

The MISR instrument is scheduled for launch into a 10:30 AM sun-synchronous, polar orbit aboard the EOS Terra satellite in 1999. MISR will measure the upwelling visible radiance from Earth in 4 spectral bands centered at 446, 558, 672, and 866 nm, at each of 9 emission angles spread out in the forward and aft directions along the flight path at ±70.5°, ±60.0°, ±45.6°, ±26.1°, and nadir. Over a period of 7 minutes, as the spacecraft flies along, a 360 km wide swath of Earth will successively be viewed by each of the cameras, allowing MISR to sample a very large range of scattering angles; in mid latitudes, the instrument will observe scattering angles between about 60° and 160° (*Diner et al.*, 1998). Global coverage will be acquired about once in 9 days at the equator; the nominal mission lifetime is 6 years.

The distinction in single scattering phase function between natural distributions of spherical and randomly oriented, non-spherical particles, with a broad range of aspect ratios, shows up strongly for scattering angles ranging from about 90° to near 180° (*Mishchenko et al.*, 1997). For non-spherical particle distributions, single scattering phase functions tend to be much flatter in this region than for spherical particles. Since MISR samples the relevant range of scattering angles very well, we expect to be able to make critical distinctions between natural distributions of spherical and randomly oriented, non-spherical particles with MISR data (*Kahn et al.*, 1997).

We anticipate that the new multiangle, multispectral data from MISR will also contain other information about particle properties, a major step beyond current spacecraft remote sensing retrievals, which obtain aerosol optical depth based on entirely assumed particle microphysical properties. According to simulations over cloud-free, calm ocean, for pure particles with natural ranges of optical depth, particle size, and indices of refraction, MISR should retrieve column optical depth for all but the darkest particles, to an uncertainty of at most 0.05 or 20%, whichever is larger, even if the particle properties are poorly known. For one common particle type, soot, constraints on the optical depth over dark ocean are very poor. The simulated measurements also should allow us to separate two to four compositional groups based on indices of refraction, and to identify three to four distinct size groups between 0.1 and 2.0 microns characteristic radius at most latitudes (*Kahn et al.*, 1998). The technique is most sensitive to particle microphysical properties in the "accumulation mode" sizes, where particle scattering undergoes the transition from Rayleigh to large-particle regimes for the MISR wavelengths.

Based on these results, we expect to distinguish air masses containing different aerosol types, routinely and globally, with multiangle remote sensing data. Such data complements *in situ* and field data, which can provide details about aerosol size and composition locally that are needed to assess the radiative effects of aerosols quantitatively. Both field data and correlations in space and time with likely source and sink regions will also be helpful in developing a global picture of mineral dust aerosol budgets. Further work on the expected sensitivity of MISR to natural mixtures of pure particles, including climatologically likely mineral dust components, is currently underway.

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