

Wavelength-dependent optical properties of dust aerosols revealed by inhomogeneous super-spheroid models

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Dust aerosols typically consist of inhomogeneous mineral aggregates, yet traditional optical simulations often rely on homogeneous approximations that may misrepresent their scattering and absorption characteristics. Here, we present a new inhomogeneous dust particle model that accounts for the internal mineral composition of individual dust grains, enabling accurate simulation of multi-wavelength lidar observations, including depolarization ratios and lidar ratios. In this model, each dust particle is represented as an aggregate of multiple minerals, partitioned across a super-spheroid framework where each segment corresponds to a specific mineral component, with relative sizes proportional to their abundance. Comparisons with a homogeneous model demonstrate that neglecting inhomogeneity leads to overestimation of particle absorption and misinterpretation of lidar wavelength-dependence. Our results show that particle inhomogeneity is the key factor explaining the observed spectral variability in lidar measurements. This model provides a robust framework for interpreting multi-wavelength lidar observations and improves our understanding of dust optical properties in the atmosphere.

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