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A Comparative Study of Aerosol Retrievals using Spheroidal and Hexahedral Kernels in Generalized Retrieval of Aerosol and Surface Properties (GRASP) Model with Research Scanning Polarimeter (RSP) and High Spectral Resolution Lidar (HSRL) Data from ORACLES Field Campaigns

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Understanding aerosol optical properties is important for improving our understanding of their impact on radiative forcing. Aerosols are diverse and inhomogeneous in nature, so they require continuous and global monitoring with high accuracy. The current approaches for aerosol retrievals are generally based on measurements of total radiometric intensity and assume spherical or spheroidal aerosol morphology. However, it is recognized that resolving polarization features, particularly the Degree of Linear Polarization (DoLP) of reflected radiation, can yield higher sensitivity to aerosol morphology and other microphysical properties compared to total intensity alone. This study aims to identify the scattering properties that are most susceptible to changes in particle morphology assumptions using the Generalized Retrieval of Aerosol and Surface Properties (GRASP) model coupled with several non-spherical optical property databases. The Texas A&M University Comprehensive Dust Scattering Database (TAMUdust2020) is based on an ensemble of 20 irregular hexahedral particles representing dust and volcanic ash particles. We use TAMUdust2020 to create a modified GRASP kernel permitting forward simulations and retrievals based on optics corresponding to hexahedral particles. We observe moderate bias in volume concentration, single scattering albedo and real refractive index retrieved from simulated radiances generated with hexahedral particle optics when the standard spheroid/spherical kernels are used in the GRASP retrieval's forward model. To compare particle shape model performance under real world conditions, we performed retrievals on dust scenes observed by RSP and HSRL instruments during the ORACLES field campaigns using both spheroidal and TAMUdust2020 single scattering kernels. We will evaluate geophysical variable retrievals within situ observations from both kernels and examine the ability of different particle morphologies to reproduce optics of natural dust aerosols. This will give us insights enabling more accurate aerosol retrievals on remote sensing measurements from future missions such as the Hyper Angular Rainbow Polarimeter (HARP2) aboard the upcoming Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission.

Keywords: retrieval algorithm, hexahedral aerosol, GRASP kernels