A Comparative Study of Combined Lidar-Polarimeter Aerosol Retrievals using Spheroidal and Hexahedral Particle Shape Models with Data from the ORACLES Field Campaigns

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Understanding aerosol optical properties is important for improving our understanding of their radiative forcing and impact on climate. 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 morphologies. However, it is recognized that resolving polarization features, particularly the degree of linear polarization (DoLP), can yield higher sensitivity to aerosol morphology and other microphysical properties compared to total intensity alone. The aim of this study is to identify the scattering properties that are most susceptible to changes in morphology assumptions using the Generalized Retrieval of Aerosol and Surface Properties (GRASP) 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 designed to represent dust and volcanic ash particles. TAMUdust2020 was used to create a modified GRASP kernel, permitting forward radiative transfer calculations and aerosol property retrievals under the assumption of hexahedral particles. The new kernels were used to simulate total and polarimetric radiances corresponding for a typical polarimeter observation of a scene containing hexahedral particles. Inverting these simulated observations using the default spheroid/spherical kernels of GRASP induced bias in retrieved volume concentration, single scattering albedo and real refractive index. To gain a better understanding of these different shape models' impact under real world conditions, we performed combined lidar-polarimeter retrievals on dust scenes observed by Research Scanning Polarimeter (RSP) and The Second generation High Spectral Resolution Lidar (HSRL- 2) instruments during ORACLES field campaigns.

We explored different retrieval approaches by conducting independent RSP and HSRL-2 retrievals and a single-step joint retrieval. We will compare the microphysical properties from different retrieval methods for both spheroids and hexahedral particle morphology and present our findings on which combinations of particle morphology and retrieval method can best represent the natural dust aerosols. This will give us insights to be able to conduct 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.

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