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Retrieval of dust particle refractive index from scattering data using ellipsoid ensembles

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Retrieval of aerosol microphysical properties, such as dust particle refractive index, from remote sensing data is a key problem. Even when full scattering matrix data is available, the problem is challenging to solve due to the large number of possible particle property combinations, and the non-linear response of scattering data to changes in these properties.

One approach is to perform a mathematical fit of a pre-defined shape class, such as ellipsoids, varying the free parameter, and evaluating the goodness of the fit for each free parameter value. It is known that a shape ensemble of ellipsoids can replicate dust particle scattering data with good accuracy, but it is less known if the good match guarantees that the microphysical properties used in the ensemble correspond to those of the real particle. Essentially, it is unclear if a small fit residue guarantees that the parameter is retrieved accurately.

In this work, we test how accurate the refractive index retrieval with shape ensembles of ellipsoids is by using computational scattering data. Using the computational data allows us to know with certainty what is the true refractive index of the particle in question, and thus to quantify the retrieval accuracy. We test multiple realistic dust-like particle shapes that have been inverted from real dust particles by using electron microscopy stereogrammetry.