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Optical single particle sizing of desert dust aerosol: Quantification of the effect of random orientation and application to A-LIFE data

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Optical particle counters count the number of particles but they often have the additional capability to measure the size of individual particles. Particle size is inverted from the measured intensity of the laser light scattered by each particle into the detector of the instrument. The inversion is based on the pre-calculated scattering intensity as function of size.

For spherical particles, if the refractive index is known, the intensity as function of size can be easily calculated with the Mie theory. In case of desert dust, particles are nonspherical and the scattering signal not only depends on size but also on particle shape and the orientation of the particle during the scattering event. This introduces a variability of the signal for fixed particle size leading to a reduction of the precision of the inversion.

In this contribution, we first quantify for a few typical instruments the signal variability for fixed particle sizes. This is achieved by optical modeling and it is assumed that each particle has a random orientation when it flies through the laser beam. As the next step, the effect of this variability on retrieved size distributions is estimated theoretically. As the final step, we invert desert dust data collected on board a research aircraft during the A-LIFE campaign which was performed in April 2017 around Cyprus. We compare size distributions obtained considering and neglecting the orientation effect.