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Microphysical aerosol parameters of spheroidal particles via regularized inversion of lidar data

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One of the main topics in understanding the aerosol impact on climate requires the investigation of the spatial and temporal variability of microphysical properties of particles, e.g., the complex refractive index, the effective radius, the volume and surface-area concentration, and the single-scattering albedo. Remote sensing is a technique used to monitor aerosols in global coverage and fill in the observational gap. This research topic involves using multi-wavelength Raman lidar systems to extract the microphysical properties of aerosol particles, along with depolarization signals to account for the non-sphericity of the latter. Given, the optical parameters (measured by a lidar), the kernel functions, which summarize the size, shape and composition of particles, we solve for the size distribution of the particles modeled by a Fredholm integral system and further calculate the refractive index. This model works well for spherical particles (e.g. smoke); the kernel functions are derived from relatively simplified formulas (Mie scattering theory) and research has led to successful retrievals for particles which at least resemble a spherical geometry (small depolarization ratio).
Obviously, more complicated atmospheric structures (e.g dust) require employment of non-spherical kernels and/or more complicated models which are investigated in this paper. The new model is now a two-dimensional one including the aspect ratio of spheroidal particles. The spheroidal kernel functions are able to be calculated via T-Matrix; a technique used for computing electromagnetic scattering by single, homogeneous, arbitrarily shaped particles. In order to speed up the process and massively perform simulation tests, we created a software interface using different regularization methods and parameter choice rules. The following methods have been used: Truncated singular value decomposition and Pade iteration with the discrepancy principle, and Tikhonov regularization with the L-curve-method as well as the generalized cross validation method. Data can be read directly from netcdf-files of the EARLINET data base. First promising results will be shown.