The use of multi-angle polarization exploiting the synergy between in-situ and remote sensing measurements of aerosol and cloud particles

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The use of multi-angle polarization measurements at multiple wavelengths provides unique capabilities for the monitoring of the microphysical properties of aerosol and cloud particles. The measurement of a large number of angles spanning over a wide range of scattering geometries provide multiple independent variables that can be inverted for the detailed inference of aerosol amount (optical thickness), particle size distributions, particle shape parameters, real and imaginary refractive indices, single scattering albedo, etc., as well as for the retrieval of the microphysical and thermodynamic properties of clouds particles.
These techniques can be seamlessly applied to in-situ and to remote sensing measurements providing physically comparable results from both approaches, improving our knowledge from the aerosols that we brief at the nose level all the way to the vertical distribution of aerosol particles over the total atmospheric column. The fact that the same technique can be applied on satellite measurements and on locally sampled in situ data adds substantial value to the remote sensing dataset. The information acquired with these optical techniques can be enhanced with parallel in situ measurements including the particle's chemical composition and independent techniques for the measurement of particle size and shape, etc. In-situ measurements also allows for the aerodynamic separation of the particles in order to better emulate our respiratory system and to provide additional information for the interpretation of how the optically retrieved aerosol properties can be used on the assessment of the health effect of the remotely sensed particles.
The use of the same measurement approach and retrieval algorithm for in situ and for the remote sensing measurements substantially enhances the interpretation of the remote sensing data sets. In particular, the Generalized Retrieval of Aerosol and Surface Properties (GRASP) algorithm has been used to retrieve aerosol microphysical properties from remote sensing as well as from in situ aerosol measurements in the laboratory and in the field. Specific results to be discussed in this talk includes laboratory measurements with different aerosol types, results from past ground based and aircraft field campaigns, as well as remote sensing results from the HARP CubeSat satellite, from the polarimeter onboard the ADLER-2/GAPMAP satellite, and from the HARP2 sensor on the NASA PACE observatory. In situ results will be discussed from multiple versions of integrating nephelometers, from the Polarized Imaging Nephelometer, and from the newly developed IMAP instrument, all measuring the optical and microphysical properties of aerosols.

Preferred mode of presentation: Invited