ELS-XV-2015 Abstracts
ELS-XV-2015-38
Electromagnetic & Light Scattering XV 2015, Leipzig

Light depolarization by an ensemble of complex-shaped particles in air : laboratory experiment at exact backscattering angle

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As underlined by the latest IPCC report [1], one of the main uncertainties affecting the Earth's climate is due to the complexity of atmospheric aerosols, which present potentially complex morphologies, as for sea-salt and desert dust particles. In this contribution, the depolarization of a laser electromagnetic radiation by such complex-shaped particles is evaluated at exact backscattering angle ($180.0 \pm 0.2^\circ$), one the main directions sensitive to the particles size and the particles shape, also of prime importance for remote sensing applications.

Our laboratory experiment set-up operates in the far-field single scattering approximation and covers the exact backscattering angle with accuracy within a small field of view, while minimizing any stray light [2]. Using scattering matrix formalism [3], we developed an accurate methodology to retrieve, from the scattering matrix elements, the depolarization d = 1 – F22/F11 of light by an ensemble of complex-shaped particles in air.

Hence, after calibrating our set-up on spherical water droplets (in agreement with Mie theory), we evaluated the depolarization of light by salt particles as a function of their relative humidity. We then treated the case of complex-shaped desert particles, using ATD-particles as a proxy. Interestingly, at exact backscattering angle, the retrieved depolarization is compatible with T-matrix numerical simulation, computed from the particles size distribution measured at our laboratory. This work may hence open new insights by potentially discussing on the validity of numerical simulations, for the first at exact backscattering angle on atmospheric aerosols.

References

[1] IPCC, Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press, (2013).

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[3] IPCC Mishchenko M.I., Travis L.D., and Lacis A.A., Scattering, Absorption and Emission of Light by Small Particles (Cambridge University Press, NASA, 2002).