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Light depolarization by an ensemble of complex-shaped particles in air: lidar remote sensing field applications.

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As underlined by the latest IPCC report [1], atmospheric aerosols, such as desert dust, sea-salt, or soot particles, which present a wide range of sizes and shapes, are one of the main uncertainties affecting the Earth's climate. In this context, lidar remote sensing is essential: it provides range-resolved vertical profiles of aerosols backscattering under real atmospheric conditions of temperature and relative humidity. In this contribution, the spectral and polarization properties of the light backscattered by atmospheric aerosols are remotely analyzed. Three new methodologies are hence proposed [2-4] to address part of the complexity of atmospheric aerosols, by taking benefit from the sensitivity and accuracy achieved on our home-built UV-VIS polarization lidar detector [5].

In the first methodology [2], we applied Mishchenko's T-matrix numerical code [6] to address the backscattering and depolarization properties of an ensemble of sea-salt, then desert dust particles. We developed an algorithm, based on coupling these numerical simulations with our UV-VIS polarization lidar backscattering measurements, allowing to partition up to three-component external mixtures (water-soluble, sea-salt and dust particles) into their specific backscattering coefficients [2].

The second methodology [3] relies on the sensitivity and accuracy achieved on the retrieved lidar particles depolarization ratio (from 0.4 % molecular depolarization up to 40 %). By applying Mie theory, we identified the optical requirements for observing new particles formation events in the atmosphere: as published in OSA Spotlight in 2014 [3], in the presence of non-spherical desert dust particles, such nucleation events can be remotely observed with our UV-polarization lidar, the UV-wavelength acting as a size filter, while the polarization acts as a shape discriminator between spherical and non-spherical particles.

The third proposed methodology [4] is relative to the remote detection of the carbon aerosol, which efficiently absorbs light. We report an experiment based on coupling lidar remote sensing with Laser-Induced-Incandescence (LII), which allows, in agreement with Planck's law, to retrieve the vertical profile of very low thermal radiation emitted by light-absorbing particles in an urban atmosphere over several hundred meters altitude. Accordingly, we set the LII-lidar formalism and equation and addressed the main features of LII-lidar in the atmosphere by numerically simulating the LII-lidar signal [4].

References

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