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Lidar remote sensing of atmospheric aerosols: investigation of involved particles sizes using Backscattering Ångström Exponents and application to the remote observation of new particle formation events

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This abstract is dedicated to dual-wavelength polarization lidars (2β+2δ) and related particles backscattering Ångström exponents BAE_p, as nowadays remotely evaluated by atmospheric multi-wavelength lidar instruments (Veselovskii et al., ACP, 2016). We here present two new lidar remote sensing developments applicable to every multi-wavelengths polarization lidars, as published in Miffre et al. (Rem. Sens. 2019, Opt. Lett. 2020).

As a first development, we investigate the size, shape and complex refractive index dependence of measured backscattering Ångström exponents (Miffre et al., Opt. Lett., 2020). If BAE_p is generally considered as a particles size indicator, it actually depends on the particles size, shape (Mehri et al., Atm. Res., 2018) and complex refractive index as β_p does. From a precise analysis of the polarization state of the backscattered radiation and of its wavelength dependence, in two components particle mixtures (p) = {s, ns} involving spherical (s) and nonspherical (ns)-particles, we could establish the relationship between BAE_p, BAE_s and BAE_{ns}. Then, by numerically simulating the two latter, we could discuss on the range of involved particle sizes and complex refractive indices.

The second development is related to the remote sensing observation of a new particle formation event with a dual-wavelength polarization lidar (Miffre et al. Rem. Sens. 2019). Where previous thoughts were that it is not feasible due to the small size of involved particles, we identified the requirements ensuring a (UV, VIS) polarization lidar to be sensitive to the subsequent particles growth following nucleation events promoted by nonspherical mineral dust particles. The presentation will explicit these optical requirements in terms of polarization and spectroscopy, as recently published in (Miffre et al., Rem. Sens., 2019).

The oral presentation will first present our dual-wavelength polarization lidar remote sensing instrument (2β+2δ), based on an unique laboratory Pi-polarimeter (Miffre et al., JQSRT, 2016). Special focus will be made on the (UV, VIS) calibration of the polarization lidar, as a decisive point for precise observations and interpretations. As an application case study, the oral presentation will then consider the lidar remote sensing observation of a nucleation event promoted by mineral dust. There, the involved particles sizes of freshly nucleated sulfuric acid particles and mineral dust

will be retrieved by considering the above backscattering Ångström exponents analysis. As expected, the retrieved involved particles sizes reveal the underlying physical-chemistry of the nucleation process promoted by mineral dust (Dupart et al., PNAS, 2012). We believe this work may then interest a wide community of scientists.

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