Interpreting lidar Backscattering Ångström Exponents beyond a size indicator: dependence with size, shape and complex refractive index

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Atmospheric multi-wavelength lidar instruments remotely evaluate the backscattering Ångström exponent for particle backscattering BAEp, an exponent which is usually considered as a qualitative particle size indicator (Veselovskii et al., 2016; Haarig et al., 2018). Basically, the backscattering Ångström exponent describes the wavelength dependence of the particle backscattering coefficient β_p between wavelengths (λ_1, $\lambda_2 > \lambda_1$) since $BAE_p = -\,Ln(\beta_{p,2}/\ \beta_{p,1})/Ln(\lambda_2/\lambda_1)$. The backscattering Ångström exponent BAE_p hence basically depends not only on the particles size, but also on the particles shape and complex refractive index. The goal of the proposed oral presentation is to make available to the lidar community the results of a recently published paper in Optics Letters (Miffre et al., 2020), exhibiting the dependence of BAE_p with the particles size, shape and complex refractive index.

In this oral presentation, we hence introduce a new methodology taking benefit from light polarization to investigate the size, the shape and the complex refractive index dependence of BAE. Where previous interpretation of Ångström exponent was that of a particles size indicator, the use of light polarization makes it possible to investigate the Ångström exponent dependence on the particles shape by separately retrieving the backscattering Ångström exponent of the spherical (s) and non-spherical (ns) particles contained in an atmospheric particle mixture (p) = {s, ns}. The light polarization can be used to retrieve the backscattering Ångström exponent BAE_s and BAE_{ns} and we could establish the relationship between BAE_p, BAE_s and BAE_{ns}. Moreover, analytical solutions of the Maxwell's equations (Lorenz-Mie theory for s-particles, spheroidal model for ns-particles) can then be applied to investigate the dependence of the backscattering Ångström exponent on the particles size and complex refractive index for each assigned shape (i.e. spherical, non-spherical). Hence and as an output, the lidar-retrieved vertical profiles of backscattering Ångström exponents BAE_s and BAE_{ns} can be used by the lidar community to evaluate a range of involved particles sizes and complex refractive indices for both spherical and non-spherical particles. The oral presentation will detail this new methodology and present a concrete case study where the spectral dependence of the imaginary part of the complex refractive index is also taken into account. We believe our new methodology can be applied in complement to existing inversion algorithms to improve the accuracy of the retrieval by reducing the range of involved effective radii or / and complex refractive index to be considered for s and ns-particles.