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Lidar ratio calculations from in situ aerosol optical, microphysical and chemical measurements: observations at puy de Dôme, France and analysis with CALIOP.

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The ratio between lidar extinction and backscatter coefficients, also known as lidar ratio (LR), is an important parameter in atmospheric aerosol studies. LR is an intensive property which depends on the particle size distribution, shape, refractive index and relative humidity (Evans, 1988).

We have recently published (Eswaran *et al*, 2023) a method to determine the 532 nm LR using in situ measurements performed at the puy de Dôme (PUY) station, central France, located at about 1465 m altitude (Baray *et al*, 2020). This method uses a Mie code with the measured aerosols size distribution and refractive index determined from aerosols optical measurements as inputs. The LR values obtained (LR_{PUY}) have been compared to LR calculated also with a Mie code but with refractive index determined from the measured aerosol chemical composition (LR_{CHEM}). A good correlation is observed for the period 2015-2016 with an agreement which increases to 99% after a significant imaginary part refractive index reduction, corresponding to much less carbonated particles than initially estimated (Figure 1).

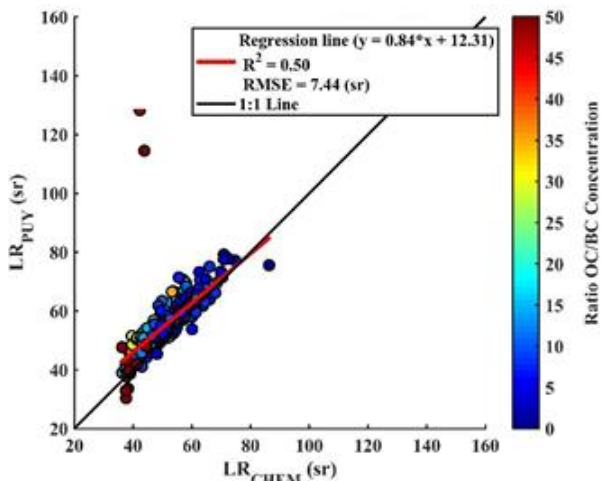


Figure 1. Comparison between the LR_{PUY} and LR_{CHEM} products.

By looking the 1443 hourly mean LR_{PUY} calculated in 2015-2016, more than 50% are within the 60-80 sr range under ambient atmospheric conditions. A

statistical comparison with the CALIOP spatial lidar retrieval (Kim *et al*, 2018) gives a good agreement at the location of PUY between retrieved values (mean of 62 sr) with a negligible bias and a dispersion indicative of a similar variability of LR (about 14 sr).

The influence of air mass history on the LR has also been studied using backward trajectory analysis (Figure 2). LR are around 40-60 sr for air masses coming from oceanic sectors and around 60-80 sr for air masses coming from continental sectors. Statistical comparisons with CALIOP typing and LR retrievals show a good agreement for continental, smoke and polluted dust aerosols types. For dusty and mainly clean marine aerosols, the differences observed between both suggest that air masses coming from the Atlantic Ocean sector at altitudes lower than 2.5 km, have experienced mixing with continental air masses during their travel increasing their LR before reaching the PUY station.

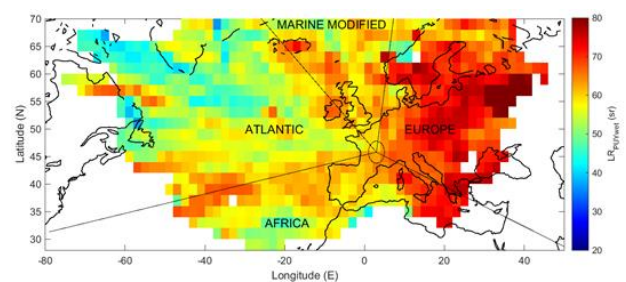


Figure 2. Mean advected LR_{PUY} in $2^\circ \times 2^\circ$ grid cells

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Baray, J.-L. *et al* (2020) *Atmos. Meas. Tech.* 13 (6), 3413-3445.

Eswaran, K. *et al* (2023) *Atmos. Res.* 296, 107043.

Evans, B.T.N. (1988) *Appl. Opt.* 27 (15), 3299.

Kim *et al* (2018) *Atmos. Meas. Tech.* 11, 6107-6135.