

A closure study between Raman lidar observations and model simulations of aerosol optical properties during the RITA 2021 campaign

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There is a growing interest in the conversion of the typical lidar products (backscatter and extinction coefficients, lidar and depolarization ratios) to other aerosol properties commonly used by, for instance, Air Quality Monitoring Networks (e.g., aerosol mass and number concentrations, PM₁₀ and PM_{2.5}) generally obtained by in-situ measurements. However, the relation between the physicochemical composition of aerosols and their light scattering properties is still not well understood, leading to large uncertainties in such conversions and preventing the usage of other ground-based instruments for the improvement of the lidar retrievals.

To increase our understanding in this area, a working group in the RITA (Ruisdael land-atmosphere interactions Intensive Trace-gas and Aerosol) measurement campaign, in the Netherlands, has engaged in an effort for a closure study between the aerosol optical properties retrieved from remote sensing observations (multi-wavelength Raman lidar and AERONET sunphotometer) and those derived from simulations based on a set of comprehensive aerosol in-situ measurements (SMPS, APS, nephelometer, ACSM and filter sampling). To that end, a model for the aerosol extinction, absorption, total and backscatter coefficients has been built based on the measured particle size distribution, relative humidity (RH), and mass concentration of the different chemical compositions, with profiles of RH being used to simulate the vertical profiles of lidar-relevant properties for direct comparison with the Raman lidar observations. In this work, we present the measurements and first results from this campaign.

A very good agreement between the modelling results and nephelometer observations at ground level was found, providing an important initial validation for the modelling of an extensive aerosol property. The simulated humidity-dependent vertical profiles were compared to a set of coincident day and nighttime aerosol optical profiles retrieved from the Raman lidar observation under different atmospheric conditions. Preliminary results for days with well developed and apparently well mixed boundary layer show some cases with relatively good agreement, but also cases with a significant underestimation in the backscatter and overestimation in the extinction and lidar-ratio by the simulated profiles compared to the observations. Based on sensitivities studies, it is still unclear whether a different aerosol composition at ground level or a wrong relative humidity information could be regarded as the main cause of the observed discrepancies. Also, errors in the lidar retrievals are being investigated. The number of suitable cases for lidar retrievals were significantly limited by the numerous occurrences of shallow boundary layer (no extinction retrievals) or by the impossibility for a far-end backscatter calibration due to cloud cover. The application of overlap corrections and its errors on the lidar retrievals are discussed.