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Intercomparison of Ceilometer aerosol profiling versus Raman lidar including pollution events and transported biomass burning aerosols across the United Kingdom

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Raman lidars are often used to gain quantitative aerosol profile information in the atmosphere including the atmospheric boundary layer. While ceilometers are less powerful and show some technological disadvantages compared to lidars, their lower cost and low maintenance needs may be useful to fill geographical and temporal gaps between advanced lidar stations.

The Met Office operates a ground based operational network of nine dual-polarisation Raman lidars and co-located sun photometers (column integrated information), as well as more than 40 ceilometers across the United Kingdom. In this study we present a comparison between attenuated backscatter profiles, extinction profiles and mass concentration retrieved from the Raman lidars as well as selected ceilometer stations. The AERONET data from the sun photometers are used as an additional input parameter in the retrieval, and for validating the integrated extinction profiles. Aerosol optical properties from the Raman lidars are calculated from glued analogue and photon-counting signals using a data analysis package developed at the Met Office. A-Profiles, which is a python library dedicated to the analysis of atmospheric profilers, is used for the Ceilometer data. The calibration constant of the ceilometer in particular, is shown to impact the quality of the retrieval and will be investigated in detail. The Raman LR111-300s lidars (manufacturer: Raymetrics) emit at 355 nm and have polar and cross-polar depolarisation detection channels at 355 nm and a N2 Raman detection channel at 387 nm. The Ceilometer network consists of a mix of Vaisala CL31 and CL61 operating at 910.5nm, as well as Lufft CHM15K with an emitting wavelength at 1064nm. The CL31 and CHM15K ceilometers are part of the E-PROFILE network. In this study, we focus on several pollution events in the boundary layer, as well as aerosol transported from the Canadian wild fires in September 2020. The aerosol information at different wavelengths is used to inform the origin and type of the aerosols in conjunction with satellite images and dispersion model outputs using the Met Office Numerical Atmospheric-dispersion Modelling Environment (NAME).

Ceilometers show a good potential for aerosol profiling, especially in synergy with lidars and sun photometers. The higher spatial resolution of the ceilometer network in conjunction with the

better sensitivity and accuracy of the lidar, improves the knowledge of the vertical aerosol distributions and transport in near real time. This is needed to complement in situ surface measurements especially for monitoring air pollution and related health impacts.