Aerosol physical and optical characteristics, including equivalent black carbon at Ny-Ålesund (Svalbard)

Vito Vitale, Angelo Lupi and Stefania Gilardoni,
Institute of Polar Science - National Research Council of Italy (CNR-ISP)

vito.vitale@cnr.it

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WP1: Ground-based component for SLCFs

T1.1: Integration of observations provided by research infrastructures and networks

D1.1.2: Dataset on selected species (ground-based measurements). particle number, black carbon, optical parameters

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The purpose of this activity is to investigate the different modal behavior of physical (size distribution) and optical features of aerosol particles in Ny-Ålesund (Svalbard Islands, 78°55'N, 11°56'E) at the ground level at the Gruvebadet Observatory located at the foot of the Zeppelin mountain. Acquired data can be compared with co-located chemical composition information arising from size-segregated samples to provide a better picture of the long-range transport processes in the Arctic regions as well as allow investigating the nucleation processes. Ny-Ålesund is the only site in the Arctic, where routine physical, optical and chemical measurements are carried out at two different height. This offers an opportunity to elucidate vertical variability of formation processes and aerosol stratification in the Arctic boundary layer along the whole year. At the Gruvebadet Lab, the aerosol particle size distribution is measured in the fine size range from 10 to 470 nm with a TSI SMPS 3034, and in the coarse size range with a TSI APS 3321. Since 2017, the measurements are performed year-round, while previously these were typically carried out from beginning of spring until beginning of fall. At the same time, measurements of optical characteristics are performed with using radiance research instruments. Scattering and absorption coefficients are measured at 1 and 3 wavelengths, respectively. Obtained data are analyzed and corrected for instrumental errors following standard procedures usually adopted for these instruments.

Optical techniques can be used to infer black carbon concentration. Such techniques allow a quantification of the equivalent black carbon (eBC), namely the amount of strongly light absorbing

carbon, with optical properties similar to those of soot, that would lead to the same absorption signal (Andreae & Gelencser, 2006). The eBC mass concentration is derived by multiplying the measured light absorption coefficient by an appropriate mass absorption cross-section. At Gruvebadet, both the light absorption and eBC concentrations have been monitored since June 2010, and mainly during spring and summer months. Time-series of daily-averaged eBC concentrations is shown in Figure 1 (with information on data coverage). Before 2017, in winter and autumn, the data coverage was often lower than 50%. Since 2018 it has been improved as a consequence of year-round opening of the Italian Arctic station "Dirigibile Italia". Short episodes characterized by high eBC concentration, are likely due to the influence of local emission sources at Ny-Ålesund village and harbour.

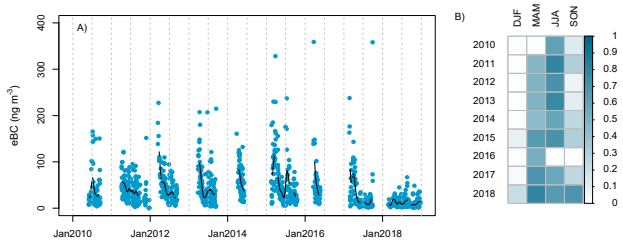

Figure 1 - *Time series of daily average eBC concentration (MAC 7.2 m2 g-1) from PSAP measurements at Gruvebadet (panel A); the black line indicates the seasonal trend from the application of a Kolmogorov-Zurbenko filter. On the right, the seasonal data coverage of eBC measurements (panel B).*

References

Bond, T. C., Anderson, T. L., and Campbell, D. (1999): Calibration and Intercomparison of Filter-Based Measurements of Visible Light Absorption by Aerosols, Aerosol Sci. Tech., 30, 582-600, https://doi.org/10.1080/027868299304435

Virkkula, A (2010): Correction of the Calibration of the 3-wavelength Particle Soot Absorption Photometer (3λ PSAP), Aerosol Sci. Tech., 44, 706-712, https://doi.org/10.1080/02786826.2010.482110

Zanatta, M., Laj, P., Gysel, M., Baltensperger, U., Vratolis, S., Eleftheriadis, K., Kondo, Y., Dubuisson, P., Winiarek, V., Kazadzis, S., Tunved, P., and Jacobi, H.-W. (2018): Effects of mixing state on optical and radiative properties of black carbon in the European Arctic, Atmos. Chem. Phys., 18, 14037-14057, https://doi.org/10.5194/acp-18-14037-2018

Andreae M. O. and A. Gelencsier (2006): Black carbon or brown carbon? the nature of light-absorbing carbonaceous aerosols. Atmos. Chem. Phys., 6(10):3131{3148, 07 2006.