Seasonal physical and optical properties of atmospheric aerosol at Princess Elisabeth station, East Antarctica

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Aerosol optical and physical properties have been measured during recent austral summers and winters at the Belgian Antarctic research station Princess Elisabeth, inaugurated in February 2009. Princess Elisabeth station is situated around 180 km inland from the coast, north of the Sør Rondane Mountains in Dronning Maud Land, East Antarctica, on the Utsteinen ridge (71°57'S, 23°20'E, 1390 m asl; Pattyn *et al.*, 2010). The station is manned during austral summer. In winter, the station operates in automatic mode with remote control.

Measured aerosol properties comprise aerosol size distribution (laser aerosol spectrometer, LAS, TSI3340), total aerosol number (condensation particle counter, CPC, TSI3776), total aerosol mass concentration (TEOM-FDMS), mass concentration of light-absorbing aerosol and absorption coefficient (Magee 7-wavelength aethalometer) and total scattering coefficients (Ecotech 3-wavelength nephelometer).

All instruments were in simultaneous operation during summers 2011/12 and 2012/13 and are currently installed for continuous operation, including this austral winter. The aethalometer and TEOM-FDMS have been measuring since December 2010 and also during two winter months in 2011 and six in 2012. The LAS could measure during two winter months in 2012.

Besides these instruments for boundary layer aerosol characterisation, a 8-wavelength sunphotometer, (AErosol RObotic NETwork; aeronet.gsfc.nasa.gov; CIMEL CE318), provides aerosol information like aerosol optical depth (AOD) for the total atmospheric column during austral summer since February 2009.

Since February 2009, there are continuous data of an automatic weather station (Gorodetskaya *et al*., 2013) in order to interpret the meteorological conditions.

The aethalometer is operated at a nominal flow of 5.5 litre/min and an integration time of 60 min. The mean mass concentration of light-absorbing particles in winter 2011 was 6.0±4.7 ng/m^{-3} at 660/880 nm, and 10.5±5.6 ng/m^{-3} at 370/470 nm. The respective values for summer 2011/12 were 7.6±6.1 ng/m^{-3} and 11.6±6.8 ng/m^{-3}. The mean absorption coefficients, calculated using the instrument's cross sections, were 0.10±0.08 Mm^{-1} at 880 nm (soot particles absorb strongest at this wavelength) and 0.43±0.22 Mm^{-1} at 370 nm in winter 2011. The values for summer 2011/12 were 0.13±0.12 Mm^{-1}, and 0.49±0.28 Mm^{-1}, respectively. The mean absorption Angström exponent (370/470 to 660/880/950 nm) was 2.0±1.2 in winter 2011 and 1.8±1.2 in summer 2011/12. The differences between the wavelengths indicate that several absorbing aerosol types were present, as, e.g., pure soot has an absorption Angstrom exponent around 1. The single scattering albedo (SSA) could be derived from simultaneous aethalometer and nephelometer measurements in February 2012 (Table 1). The aethalometer data has been interpolated between wavelengths. SSA values showed high uncertainty, mainly due to low aerosol concentrations and the uncertainties of the absorption coefficient determination. SSA values around 0.9 would have been expected.

Table 1: Optical parameters February 2012:

λ	total scatter Mm^{-1}	absorption Mm^{-1}	single scatt. albedo (= sca/(sca+abs))
425nm	1.07±0.53	0.48±0.23	0.69±0.34
525nm	1.06±0.50	0.35±0.19	0.75±0.35
635nm	0.94±0.61	0.20±0.13	0.82±0.38

The CPC measures particles in the diameter range 3 to 3000 nm. Figure 1a shows data of February 2012. Simultaneous size distribution measurements revealed diurnal cycles in the size range 3–90 nm for 12 and 13 February 2012, indicative of locally formed aerosol.

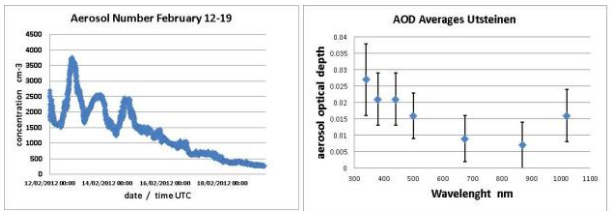

Figure. 1: a) CPC number concentration February 2012; b) total AOD averages February 2009 to February 2013

Figure 1b shows the average AOD values from the sunphotometer for all summer seasons. The average Angström exponent (440–880 nm) was 2.0±0.6, indicating a dominance of sub-micron particles.

We will present further seasonal aerosol properties from austral winters 2011/2012/2013 and respective summers.

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