Columnar aerosol properties seen at the Antarctic Troll station (72.0S, 2.3E) since 2007

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Background: In early 2007, the Troll Atmospheric Station in Antarctica (72°01′S, 2°32′E, 1309 m a.s.l.) was put into operation. The site is located in the transition zone between the coastal zone and the inland ice plateau (see Figure 1). The Troll Atmospheric Station (see Figure 2) is about 200 m east of the main building, upwind of the predominant wind direction.

Figure 1: *The location of the Troll station on Dronning Muad Land, Antarctica (Map courtesy of Norwegian Polar Insitute).*

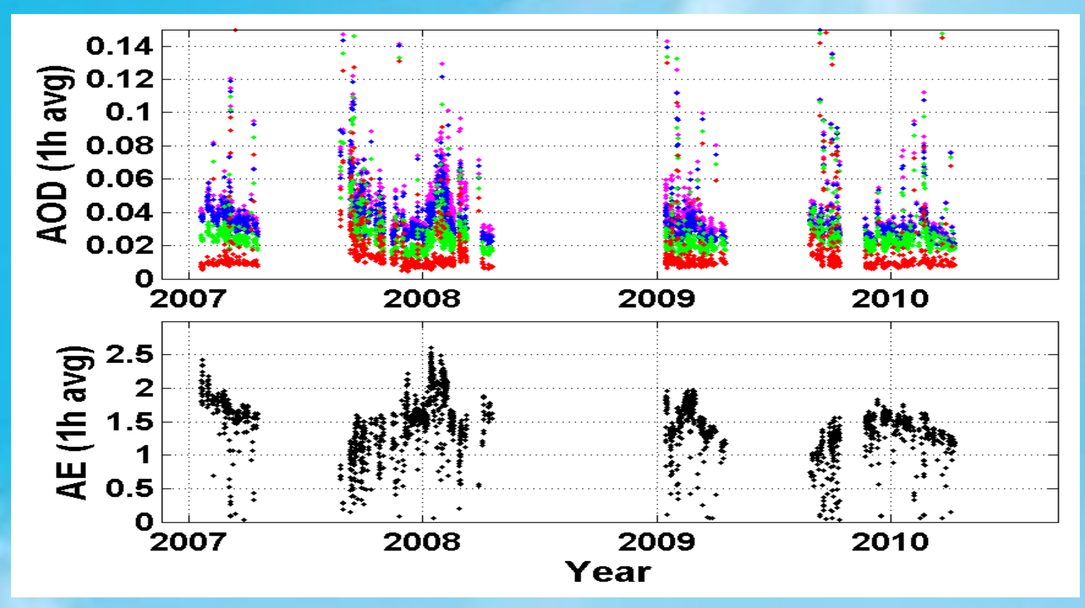
Figure 2: *The container with the atmospheric measurements*

Table 1 Instrument and parameter overview of Troll Atmospheric Station.

Instrument	Parameter observed
TSI-3563 Integrating Nephelometer (TSI, Shoreview, MN, USA)	Light scattering and absorption by aerosols → single scattering albedo
Differential Mobility Particle Sizer (DMPS), including a Differential Mobility Analyzer (Hauke, Gmunden, Austria)	Aerosol size distribution
Soot absorption photometer (custom-built)	Aerosol light absorption
EK Sequential Air Sampler (Norwegian Institute of Air Research, Kjeller, Norway)	Collection of gases and aerosols: European Monitoring and Evaluation Programme (EMEP) main components
Precision Filter Radiometer (PMOD/WRC, Davos, Switzerland)	Aerosol optical density (AOD)
Sky View PSV-100H (Prede, Tokyo, Japan)	All-sky images
NILU-UV (Norwegian Institute of Air Research, Kjeller, Norway)	UV irradiance at four wavelengths, PAR → total ozone, effective surface reflectance
2537A Mercury Vapour Analyzer (Tekran Instruments Corporation, Knoxville, TN, USA)	Gaseous elementary mercury (GEM)
400E UV Absorption Ozone Analyzer (Teledyne Instruments, City of Industry, CA, USA)	In-situ ozone concentration
AL5002 Very Fast Carbon Monoxide Monitor (Aero-Laser GmbH, Garmisch-Partenkirchen, Germany)	In-situ CO mixing ratio (ppbV)
DHA80 High Volume Sampler (Digitel, Hegnau, Switzerland)	Air samples for analysis of POPs/PAHs
Flask sampling	Analysis of NMHCs, CFCs concentration
WXT510 Weather Transmitter (Vaisala, Vantaa, Finland)	Standard meteorological parameters (temperature, pressure, wind strength and direction, relative humidity, precipitation)

Table 1: *Overview of instruments and parameter observed in 2010.*

Measurements and Results: The full list of the atmospheric measurement program is given in Table 1. Aerosol optical depth (AOD) and the Ångström coefficient are derived from the measurements with. a Precision-Filter-Radiometer (PFR) measures direct solar radiation at four different wavelengths (862 nm, 500 nm, 412 nm and 368 nm). The observations are shown in Figure 3. The median average values based on 2049 1-hourly averaged data are: 0.034 ± 0.025, 0.030 ± 0.024, 0.022 ± 0.024, and 0.009 ± 0.024 for AOD and 1.51 ± 0.40 for the Ångström coefficient. The observations made are in-between typical values for coastal and Antarctic Plateau sites reported by Tomasi et al. (2007), consistent with values expected for typical Antarctic conditions, reflecting the 'in-between' location of the site. Small particles (α >1.5) dominate in 53% of the measurements, in 15% larger particles (α < 1.1) are dominating.



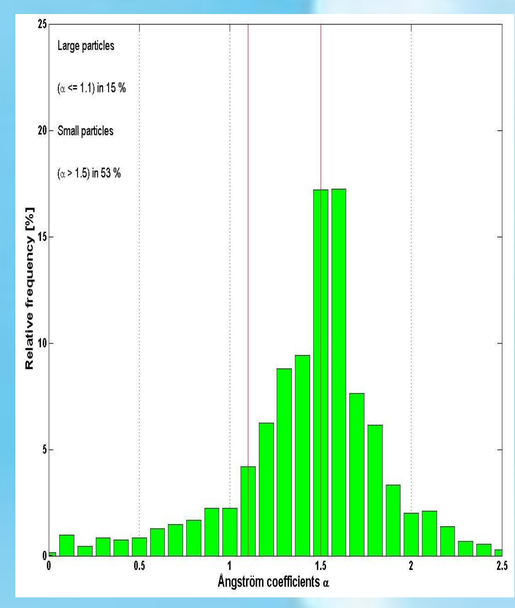
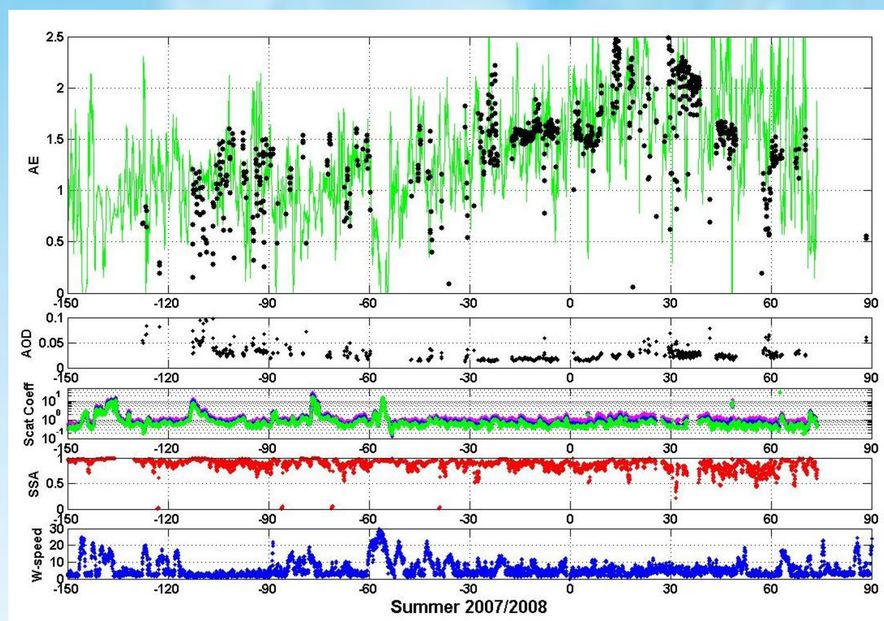


Figure 3: Left: Overview of AOD, Ångström coefficient observations from 2007to April 2010**. Right**: Frequency distribution of the Ångström coefficient at 500 nm.



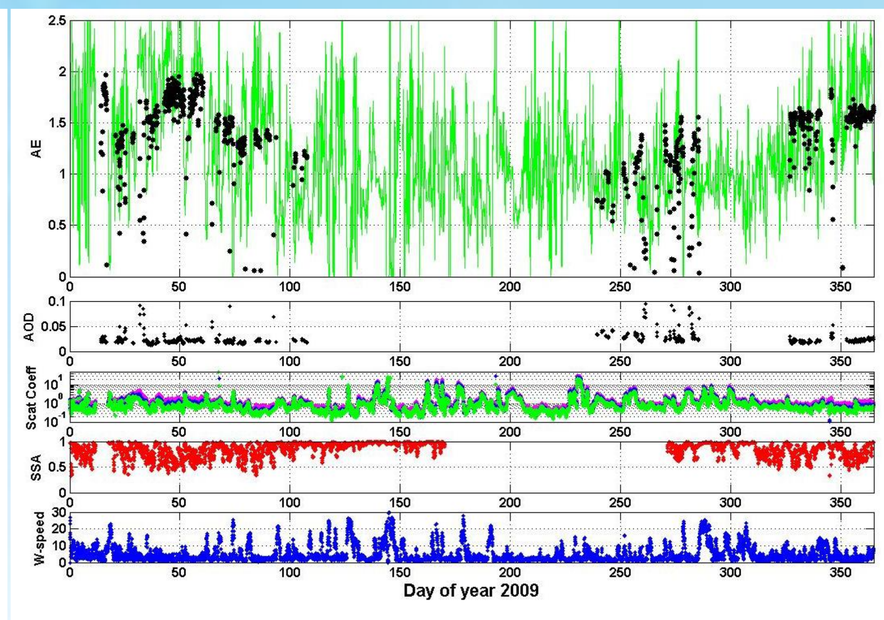


Figure 3: Upper panel *Ångström coefficient observations from sun-photometer (black) and* nephelometer (green) *for summer 2007/08 (left) and 2009 (right).* ***Panels 2-5*** *show AOD at 500 nm, particle scattering coefficients (Mm^{-1}) at 450,550 and 750 nm, single scattering albedo (in red) and wind speed [m/s](blue) .*

In parallel with the total column measurements, information on the spectral aerosol scattering coefficient was obtained by means of a TSI 3563 integrating nephelometer. Since absorption is in most cases negligible in the pristine Antarctic air (the particle absorption coefficient at one light wavelength is measured at the site by a custom built soot absorption photometer), the Ångström-exponent of the ground-level aerosol can be calculated independently. If only the boundary layer aerosol contributes significantly to the columnar AOD, the Ångström-exponent obtained from both instruments should agree within their …

… respective uncertainties, unless significant optical depth was caused by aerosol layers aloft. One has to keep in mind that the total column values are valid for ambient humidity while the in situ measurements represent the aerosol characteristics in the dry state.

Due to low aerosol load the observed scatter and uncertainty of the Ångström-exponent is relatively high. The absolute values and the annual cycle compare surprisingly well in most cases. The deviations in Antarctic spring, with lower total column AOD can be related to Polar Stratospheric Clouds or thin cirrus/ice. Further analysis is needed to estimate if one or more of these cases might be related to lofted layers of e.g. dust particles and to study the correlation between ground-based and column aerosol properties in dependence of air-mass history in more detail.

References: Tomasi, C., et al. (2007), Aerosols in polar regions: A historical overview based on optical depth and in situ observations, *J. Geophys. Res.*, 112, D16205, doi:10.1029/2007JD008432.

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