

Multi-year Arctic and Antarctic aerosol chemical characterization

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Long term measurements of aerosol chemical composition in polar region are particularly relevant to investigate potential climatic effects of atmospheric components arising from both natural and anthropogenic emissions. In order to improve our knowledge on the atmospheric load and chemical composition of polar aerosol, several measurements and sampling campaigns were carried out both in Antarctica and in the Arctic since 2005. The main results are here reported.

As regard as Antarctica, a continuous all-year-round sampling of size-segregated aerosol was carried from 2005 to 2013 at Dome C (East Antarctica; 75° 60' S, 123° 200' E, 3220 m a.s.l. and 1100 km away from the nearest coast). Aerosol was collected by PM10 and PM2.5 samplers and by multi-stage impactors (Dekati 4-stage impactor). Chemical analysis was carried out by Ion Chromatography (ions composition) and ICP-MS (trace metals). Sea spray showed a sharp seasonal pattern, with winter (Apr-Nov) concentrations about ten times larger than summer (Dec-Mar). Besides, in winter, sea spray particles are mainly sub micrometric, while the summer size-mode is around 1-2 μm . Meteorological analysis and air mass back trajectory reconstructions allowed the identification of two major air mass pathways: micrometric fractions for transport from the closer Indian-Pacific sector, and sub-micrometric particles for longer trajectories over the Antarctic Plateau.

The markers of oceanic biogenic emission (methanesulfonic acid – MSA, and non-sea-salt sulphate) exhibit a seasonal cycle with summer maxima (Nov-Mar). Their size distributions show two modes (0.4– 0.7 μm and 1.1–2.1 μm) in early summer and just one sub-micrometric mode in full summer. The two modes are related to different transport pathways. In early summer, air masses came primarily from the Indian Ocean and spent a long time over the continent. The transport of sulphur compounds is related to sea spray aerosols and the resulting condensation of H₂SO₄ and MSA over sea salt particles form sodium salts. Conversely, in mid-summer, a rapid transport of H₂SO₄ and MSA formed above the boundary layer over oceanic areas leads to higher concentrations of the acidic species in the fine fraction of aerosols reaching Dome C.

Non-sea-salt calcium was used as a continental dust marker. Besides the seasonal pattern, single dust inputs were observed. A large transport event of dust coming from Patagonia was studied with a combined and complementary use of satellite retrievals, transport model simulation and surface observations.

In the Arctic, a continuous all-year-round PM10 sampling campaign is ongoing since 2010 at Thule (North Greenland, 76.5°N, 68.8°W) and Ny Ålesund (Svalbard Islands, Norway; 78°56' N, 11°56'E; 50 m a.s.l.). Aerosol was collected by several systems (PM10 samplers, Dekati 4-stage impactor) and on different substrates (Teflon filters, quartz filters, polycarbonate membranes). Chemical analysis includes: ions composition, main and trace metals (including Rare Earth Elements - REEs, and Pb isotopic ratio) and Elemental/Organic Carbon fractions (by Sunset thermo-optical analysis).

Positive Matrix Factorization and back-trajectory cluster analysis were used in order to identify possible aerosol source areas and to evaluate reliable source apportionment.