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All-year-round aerosol chemical composition at Dome C, Antarctica

Roberto Udisti, Silvia Becagli, Daniele Frosini, Gaia Galli, Costanza Ghedini, Francesco Rugi, Mirko Severi, and Rita Traversi

University of Florence, Chemistry, Sesto Fiorentino, Italy (udisti@unifi.it)

Since 2005, continuous, all-year-round aerosol sampling was carried out at Dome C (Central East Antarctica, 3233 m a.s.l., about 1100 km far from the coastline), in the framework of "Station Concordia" project, an Italian PNRA – French IPEV joint program. Size-segregated aerosol samples were collected in summer and winter periods by using different low- and medium-volume systems, including pre-selected cut-off samplers (with PM10, PM2.5 and PM1 cut-off heads) and multi-stage (Andersen 8-stage and Dekati 4-stage) impactors. Sampling resolution and volumes ranged from 1 day to 1 month and from 2.3 to 12 m3/h, respectively.

Aerosol study at Dome C is expected improving our knowledge on present-day source intensity, transport efficiency and pathways (including stratosphere-troposphere interchanges) of particles reaching internal sites of Antarctica. Besides, more detailed information on atmosphere-snow interactions, including depositional and post-depositional processes, as well as the effect of sublimation/condensation processes on snow surface, will be used for improving the reconstruction of past atmosphere composition from ice core chemical stratigraphies (EPICA Dome C ice core).

Here we report major results from the chemical composition of the Antarctic background aerosol reaching Dome C, pointing out the seasonal pattern and the temporal trend of some ionic components used as tracers of sea spray, marine biogenic and crustal emissions.

Oxidised sulfur compounds are assumed to affect the climate system by influencing the Earth's radiative budget, both directly (solar light scattering) and indirectly (acting as cloud condensation nuclei). Among these compounds, methanesulphonic acid (MSA) and H2SO4 (arising from the atmospheric oxidation of phytoplanktonic dimethylsulphide - DMS), are considered the best tracers of marine productivity. Their use as reliable markers of oceanic biogenic emissions is hindered by poorly known mechanisms (temperature and photochemistry induced) controlling the MSA-H2SO4 ratio from DMS. Since, in summer, DMS in route toward central Antarctica is subjected to larger atmospheric concentrations of OH (and/or BrO) radical, lower temperatures and lower humidity, all conditions promoting the preferential H2SO4 formation, non-sea-salt sulphate is assumed to be the most reliable biogenic marker at Dome C.

A further insight from ice-core stratigraphies is concerning the sea salt sodium (ssNa) content in snow precipitation as a reliable marker of sea-ice extent, via frost-flower formation at the pack-ice seasonal growth. This interpretation faces with the classical view that consider higher sea-spray production as caused by an increase in zonal wind intensity. Sea spray originated from frost flowers can be distinguished from sea spray coming from bulk sea-water by the lower sulphate/sodium ratio (caused by mirabilite – Na2SO4 10H20 - precipitation occurring when sea-ice temperature falls below -8°C). High resolution aerosol measurement can allow to identify different sea-spray sources and quantify frost flowers contribution to the annual ssNa budget.

Finally, dust recorded in ice cores can be used as a valuable proxy for changes in hydrological cycles in the dust source areas and transport processes (pathways and scavenging). The geochemical characterization of dust in the present-day aerosol, compared with chemical composition of soils collected in South America and Australia, allows identifying the major dust source area (South America) and reconstructing pathways of atmospheric circulation. South America role in feeding dust aerosol at Dome C was supported also by comparing aerosol composition with satellite observations (dust plumes on the source sites) and back-trajectory analysis (air masses reaching Antarctica) during massive dust-storm events.