Geophysical Research Abstracts
Vol. 13, EGU2011-2134, 2011
EGU General Assembly 2011

Polar aerosol: insights from the size distribution and chemical composition of atmospheric particulate collected in the Arctic and Antarctica.

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The interactions among solar irradiance, concentration of atmospheric gases and aerosols, cloud coverage, sea ice, snow surface and albedo is still poorly known, preventing the development of reliable climate models on regional scale. Therefore, a deeper knowledge of atmospheric aerosols and clouds effects on the radiative balance in the Polar Regions can help in reducing the uncertainties on the actual contribution of aerosol forcing on climate change. Indeed, glacial areas are of great interest in climate change studies, due to their high sensitivity with respect to any other part of the planet. In recent years, increasing attention has been devoted to improve the knowledge of Earth's climate system through bi-polar projects joining Arctic and Antarctic data sets in order to achieve a global perspective.

We report here the most interesting results obtained by the comparison among aerosol physical characteristics (size-distribution, optical properties), chemical composition of size-segregated atmospheric particles, long range transport and PBL dynamics in three polar sites: Dome C (East Antarctica), Ny Alesund (Svalbard Islands, Norway) and Thule (North Greenland). In the same sites, up-welling and down-welling radiation measurements were also carried out, in order to understand the relationship between aerosols and climatic forcing.

Since 2005, continuous, all-year-round aerosol sampling was carried out at Dome C (Central East Antarctic Plateau, 75° 06' S, 123° 23' E, 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 (PM10, PM2.5 and PM1) and multi-stage impactors. Sampling resolution ranged from 1 day to 1 month. The chemical analysis of size-segregated aerosol and daily superficial snow samples, collected all year-round for more than 4 years, can contribute to increase our knowledge about the relevance of the Antarctic aerosol as forcing and/or feedback factor in climate changes and provide basic information on the main natural sources, tropospheric transformation processes and prevailing long-range transport pathways of the aerosol reaching Antarctica. In particular, insights on sources and transport processes of sulphur compounds, sea spray and dust aerosols along the whole annual cycle and during specific events, are here reported.

Ny Ålesund (78.6 ° N, 11.6 ° E), is a site where international cooperation ensures the study and monitoring of a large number of physical and chemical key-parameters of the Arctic ecosystem. In the March – September 2010, an intensive campaign for aerosol direct measurements and sampling was carried out by using several samplers equipped with different cut-off heads, operating at a temporal resolution ranging from 1 to 7 days. The study of the size distribution (about 26,000 spectra, each covering the 6 nm – 20 um range, 10-minute resolution) and of the chemical composition (elemental and organic carbon, ions and metals) of aerosol particles will allow understanding the relative contribution and timing of the aerosol multiple sources and transporting patterns affecting the Arctic.

In parallel with scientific activity in Ny Ålesund, a PM10 sampling campaign have been carried out at Thule (76.5° N 68.8° W), North Greenland. In the same site, measurements of optical properties and vertical distribution of atmospheric aerosol (by LIDAR) have been performed.

Synoptic-scale meteo analysis and back-trajectory reconstructions hallowed to describe atmospheric conditions favoring the origin and the transport of aerosol particles in the three sites, with particular attention to sea spray, biogenic, crustal and anthropic components. This wide data set will help to clarify the main atmospheric processes leading the aerosol to the Polar Regions and to improve our knowledge on the radiative effects of polar aerosols.

This work was supported by PNRA, Station Concordia Project and MIUR-PRIN 2007.