

# Vertical profiles and seasonal variation of aerosol particles in the PBL upon Ny Ålesund (Svalbard Islands): electron microscopy vs geochemical records

B. Moroni<sup>1</sup>, S. Becagli<sup>2</sup>, E. Bolzacchini<sup>3</sup>, M. Busetto<sup>4</sup>, L. Ferrero<sup>3</sup>, D. Frosini<sup>2</sup>, C. Lanconelli<sup>4</sup>, A. Lupi<sup>4</sup>, M. Mazzola<sup>4</sup>, R. Traversi<sup>2</sup>, R. Udisti<sup>2</sup>, V. Vitale<sup>4</sup> and D. Cappelletti<sup>1</sup>

<sup>1</sup>DICA and Centro di Eccellenza SMAArt, University of Perugia, Perugia, 06123, Italy

<sup>2</sup>Department of Chemistry, University of Florence, Sesto Fiorentino, 50019, Italy

<sup>3</sup>POLARIS research centre, DISAT, University of Milano-Bicocca, Piazza della Scienza 1, Milano, 20126, Italy

<sup>4</sup>Institute of Atmospheric Science and Climate, Via Gobetti 1010, Bologna, 40129, Italy

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Presenting author email: b.moroni@tiscali.it

Studies on the nature, properties and seasonal variability of aerosols in the polar regions are a critical point in the definition of the sources, atmospheric reactions and transport processes on these regions. They are, on turn, main aspects in the assessment of the direct climate forcing due to polar aerosols on the regional and global scales for climate changes modelling (IPCC 2007).

In order to achieve these goals, two sampling/measurement campaigns were performed during spring/summer 2011 and 2012 in the framework of the PRIN (Progetti di Rilevante Interesse Nazionale) 2009 "ARCTICA" project. Size-segregated particle samplings were carried out at the Gruevbadet observatory, about 1 km South-West the Ny Alesund village (Svalbard Islands) both at ground level (about 50 m a.s.l.) and along vertical profiles (up to ~ 1,000 m a.g.l.). In this latter case a tethered balloon was employed. Particles were collected on polycarbonate filters using a four-stage DEKATI sampler (cut-off diameters  $D_p$ : < 1  $\mu\text{m}$ , 1-2.5  $\mu\text{m}$ , 2.5-10  $\mu\text{m}$  and > 10  $\mu\text{m}$ ) at ground level, and a two-stage miniaturized Sioutas SKC cascade impactor (cut-off diameters  $D_p$ : < 1  $\mu\text{m}$  and > 1  $\mu\text{m}$ ) in the balloon samplings. Individual particle size, morphology and chemical composition were investigated by scanning electron microscopy coupled with energy dispersive microanalysis (SEM-EDS). The elemental atomic ratios were calculated and then compared with those of pure minerals and phases to obtain distinct particle classes.

Silicates (quartz, feldspars, micas, pyroxenes, amphiboles, clay minerals), carbonates (calcite, dolomite), metal particles (Fe, Ti, mixed Fe-Cr-Ni, Cu oxides), sulfate (gypsum, alkali-sulfates) and chloride (halite and sylvite) salts are the main particle groups in the samples. Except for Cu metal oxides, they are all from soil (silicates, carbonates, Fe, Ti and mixed metal particles) and from sea spray (sulfate, chloride) natural sources. In particular, compositional data of evaporites suggest the co-precipitation in cold conditions.

Seasonal trends of the type, size and relative abundance of the mineral phases along the vertical profiles are evidenced. In spring, in particular, < 1  $\mu\text{m}$  fine grained chloride salts are the main aerosol component at ground level in the case of north wind circulation (clear sky, medium to dry conditions), while 1  $\mu\text{m}$  <  $D_p$  < 2.5  $\mu\text{m}$  fine grained silicates are the prevailing phase component at some height (~ 250 m a.s.l.) in the PBL for south wind circulation (cloudy, wet conditions). An abrupt decrease of the total amount of

airborne particles is observed in summer, along with a significant increase of marine particles larger than 1  $\mu\text{m}$  at every altitude in the PBL. Remarkable differences in the mineral chemistry of silicates are also observed in the transition from spring to summer. In particular, the general enrichment of feldspars, chain-like silicates (various pyroxene and amphibole types) and Ti oxide (titanite) suggest a local provenance from granitoid source rocks widely outcropping in the western margin of the Svalbard archipelago, that is in good accordance with seasonal deglaciation in the area. In the meanwhile the general decrease of carbonates and sheet-like silicates follows the decrease of long range transport phenomena from Siberia. This is likely due to the northerly position of the Arctic front in this season (Law and Stohl, 2007) which prevents long range atmospheric circulation from Europe and Russia leading to almost local patterns of aerosol deposition, along with local deglaciation.

Results of OPC measurements, bulk chemical analyses and back trajectory calculations confirm this typical seasonal trend. The REE patterns, in particular, reveal a change of the Eu anomaly from negative to positive values, along with a general enrichment of HREEs in the summer season. This is in good accordance with the higher amount of intermediate-acidic chain silicates (*e.g.*, hornblende) in the aerosols during summer. Detailed examination and comparison with the mineralogical associations and parageneses of the surrounding basement regions will provide further evidence to these studies.

In conclusion, SEM methods revealed distinct distributions of number, size and geochemical properties of different particles classes in the aerosols. They reflect distinct behaviours and spatial/temporal evolution of the constituent particles, along with the common occurrence of dust inputs from regional to long range sources. All these features have to be taken into account when approaching the modelling of atmospheric processes in a such complex environment.

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IPCC 2007 - Intergovernmental Panel on Climate Change 2007 Report.

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