Temporal trends in the atmospheric concentration of selected metals in the PM10 aerosol collected in March-September 2010 at Ny-Ålesund (Svalbard Islands)

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The study of the size-distribution and chemical composition of the atmospheric particulate is a topic of ever-increasing interest for the scientific community, since the aerosol was found to have a remarkable effect on both the health of living organisms and, at a larger scale, on the ongoing climate changes.

The Arctic regions, owing to their distinctive environmental properties, are showing to be the first areas affected by the present climatic variations. In this scenario, the study of the chemical composition of atmospheric particulate matter in the polar areas is important to understand the feedback processes between the climate forcing and the environmental responses. For this aim, it is important to know the areas of origin of the atmospheric particulate present in the Arctic regions and the processes that caused its formation.

In this study, the concentrations of main and trace metals in the PM_{10} collected at Ny-Ålesund (Svalbard Islands) during the spring and summer 2010 campaign was determined. From the results obtained it can be concluded that both local and continental sources influence the composition of the Arctic atmospheric particulate matter. Indeed, Svalbard Islands are affected by aerosols coming from the continental areas of North America, North Europe and Asia by long range transport processes, especially occurring in early spring. This seasonal pattern is evident in the PM10 temporal profiles of the majority of the chemical components of the atmospheric particulate, that show higher atmospheric concentrations in March-April.

In the PM_{10} samples collected during the 2010 campaign at Ny Alesund, Na, K, Ca, Al, Zn and Fe are the metals showing the highest concentrations (at ng/m^3 level), while the other elements are present at lower concentrations (few pg/m^3). The enrichment factors, calculated considering Fe as crustal reference, are higher than 100 for Zn, Mo, As, Cd, Hg, Pb and Na, pointing out their different origin (anthropic and sea spray sources). The chemometric investigation on the experimental results shows an evident separation between spring and summer Arctic PM_{10} samples. Principal Component Analysis evidences a strong correlation among Al, Mn, Ti and Fe, as expected for metals mainly coming from crustal sources (both from local inputs and long-range transport). A correlation among As, Cu, Hg, K, Na and Pb is evident. As, Cu, Hg and Pb could be attributed to long range transport of pollutants from anthropized areas in North America and Northern Europe. The correlation with Na and K, markers of sea spray aerosol, could be attributed to common transport processes over large seawater regions. Another PCA factor includes Cr, Ni and V. This factor could be related to emissions from fossil fuel, coal and heavy oil combustion processes.

Among the trace elements, Rare Earth Elements (REEs) deserve a particular relevance because their concentrations, or better their concentration ratios, can be used as fingerprints of continental sources of dust. The rare earth elements have the typical saw-toothed trend with lanthanides having even atomic number in greater amount than those having odd atomic number and a decreasing trend from La to Lu.

PM10 samples show a strong seasonal pattern. All the REEs show very low concentrations in March-April, while their atmospheric load significantly increases in late spring-summer (Figure 1).

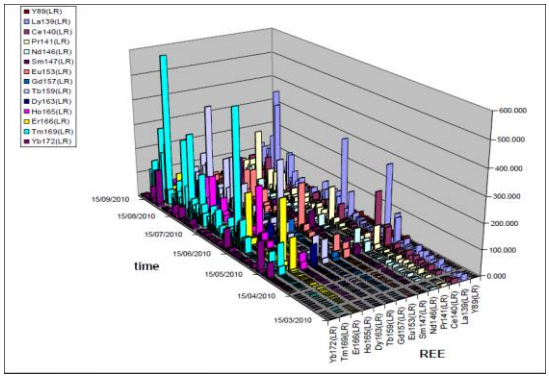

Figure 1. Temporal profile of REEs in NyA PM10.

This evidence could be explained by the higher contribution of local source, more intense after snow melting, with respect to the long-range transport inputs. The different sources can be shown by the temporal trend of the ratio between light-REEs (LREEs: from La to Sm) and heavy-REEs (HREEs: from Eu to Yb). In early spring, the LRREs/HREEs ratio is very high (up to 14 in the late April). Such ratio is much lower (around a background value of 3) in the remaining period, with two exceptions: in early July and in late August. An increasing trend is shown in the fall samples. High LRREs/HREEs ratios should be related to long range transport of dust, more frequent in early spring and occasionally occurring in other periods, while low LRREs/HREEs ratios could attributed to local sources.

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