Physico-chemical characterization of Venice lagoon aerosol

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The Venice lagoon, located along the northern Adriatic coast, represents a unique ecosystem in contact with an important historical city and a large industrial area. The centre of Venice has influenced the lagoon for more than 1000 years, while the industrial district, located on the inner edge of the lagoon and linked with the rest of the lagoon through its navigable canals, became active only at the beginning of the last century.

The main anthropogenic activities having an important influence on air quality in the Venice area can be summarized as follows: oil refining, metallurgy (e.g. production of Al), chemical plants producing a range of plastic materials (e.g. vinyl and polyvinyl chloride), energy generation (coal and oil), urban waste incineration, and traffic emission (e.g. ferry-boats). At present there is no waste water treatment facility.

In order to evaluate the contribution of aerosol in the transport of pollutants in the Venice lagoon system, an experimental campaign was carried out at Mazzorbetto (May 2006), in the north-east part of the lagoon.

Aerosol samplings were performed by means of an inertial spectrometer (INSPEC), which allows the collection on a filter of particles separated according to their aerodynamic diameter (V. Prodi et al., 1979). The filters were analysed with PIXE to obtain the concentration of chemical elements in different size fractions. Crustal elements (Si, Fe) are present in higher percentages in the coarse fraction, while sulphur is present both in fine and coarse fraction.

By comparing the SO$_4^{2-}$ concentration in the PM2.5 fraction and the sulphur (S) concentration measured with PIXE in the same range, it can be deduced that in the fine fraction S is prevalently present as sulphate. In addition the PM2.5 aerosol fraction was sampled, and filters were weighted in order to obtain the atmospheric aerosol concentration. Subsequently they were analysed with an Ion Chromatograph to assess the main inorganic water soluble ions, and organic compounds, i.e. formic acetic, oxalic and pyruvic acids, and methane-sulfonic acid (MSA).

A strong correlation was observed between NH$_4^+$ and (SO$_4^{2-}$+ NO$_3^-$), indicating that the NH$_4^+$ ion is mostly in the form of sulphate and nitrate. The ratio between the sum of the concentration of NH$_4^+$, SO$_4^{2-}$, NO$_3^-$ (anthropogenic ions) and PM2.5 ranges from 50 to 95% in the considered filters. Fig.1 shows the measured concentrations of NH$_4^+$, SO$_4^{2-}$, and NO$_3^-$.

Diurnal and night sampling showed different ion concentrations, first of all for nitrate. By assuming Na as reference element for sea-salt aerosol, it can be inferred that the contribution of inorganic marine aerosol would be negligible. A contribution to non sea-salt sulphate (nss-SO$_4^{2-}$) might come from the oxidation of dimethylsulfide (DMS), which flows from sea-water to the atmosphere (Sciare et al., 2000; Querol et al., 2001).

PM2.5 was measured in real time also by optical counters (pDR 1200 and DustTrack 8520 TSI). The size distribution of the aerosol was obtained with an optical counter (Handheld 5016, Lighthouse), which classified particles in six channel: 0.5-1.0 µm, 1.0-3.0 µm, 3.0-5.0 µm, 5.0-10.0 µm, 10.0-25.0 µm, >25.0 µm.

Comparisons were made between elements and water-soluble ion concentrations measured in this campaign, and those deduced from samplings performed elsewhere. Meteorological parameters (temperature, relative humidity, wind speed and direction, back-trajectories of air masses, boundary layer height, etc) were considered in order to try to assess the sources of the pollutants.