PM10 source apportionment based on PMF and chemical tracers during different cruises in Western Mediterranean

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In the Western Mediterranean Basin, frequently exposed to high levels of air pollutants, an important source of pollution which influence the emission, is the intensive ship traffic.

The Joint Research Centre of the European Commission (JRC, EC) has started a long-term monitoring program along different years over the Mediterranean Sea based on observations from a cruise ship following a regular route in the Western Mediterranean, in collaboration with the Department of Physics of University of Genoa. In this framework, an intensive PM10 sampling campaign was organized in the summer of 2011, in order to fill in the gap of data recovered (in term of PM speciation) during the previous campaigns (Schembari et al., 2014) and to get a better and complete description of PM sources.

During this campaign the route of the ship was Civitavecchia-Savona-Barcelona-Palma de Mallorca-Malta (Valletta)-Palermo-Civitavecchia (see Figure 1).

The PM samples were collected on Quartz and Teflon filters (47mm diameter, flow rate 2.3 m^3/h) using in parallel two Sven Leckel Ingenieurburo sequential samplers, placed on the top of the cabin where the monitoring and meteorological station was located.

Samples were analyzed with different techniques: Energy Dispersive X-Ray Fluorescence at the Department of Physics of Genoa (Ariola et al, 2006); Ion Chromatography (Chow and Watson, 1999) at Department of Chemistry of University of Milan; Thermo-optical analysis (Birch and Cary, 1996) at the JRC laboratory. Ion Beam Analysis measurements of the Teflon filters sampled during the week of September 2011, using simultaneously PIXE, EBS and PESA techniques (Chiari, 2005), were performed at the 3 MV Tandetron accelerator of the LABEC laboratory of INFN in Florence.

The data were used to identify and characterize the main PM10 sources along the ship route, with a focus on ship emissions, through apportionment Positive Matrix Factorization receptor modelling, PMF (Paatero et al, 1994).

Particular attention was given to the evidence of emissions from heavy fuel oil combustion by ships, known to be an important source of secondary sulphate aerosol. Five sources of aerosol were resolved by the PMF analysis with a new database. The analysis allows distinguishing between secondary and primary particle mass resulting from ship emissions: V and Ni were found to be suitable tracers of heavy fuel oil combustion source during the campaign. The source having the largest impact on PM10 was identified as Sulphate source by PMF. The correlations between Sulphate and V and Ni showed the influence of ship emissions on sulphate in marine air masses.

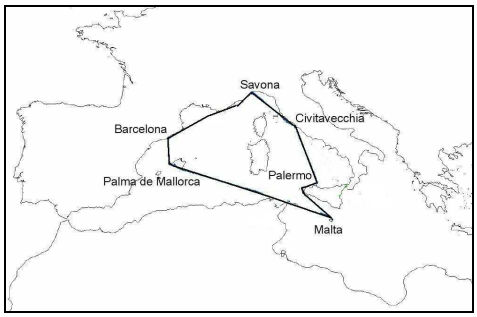

Figure 1. Route of the ship during the sampling campaigns in summer 2011.

Source apportionment using chemical marker compounds and a comparison between chemical composition during the different sampling campaigns in Western Mediterranean, was also performed.

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