

## Results of a monitoring campaign from a cruise ship in the Western Mediterranean

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Keywords: Mediterranean Sea, PM2.5, ships cruise, MSA.

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In order to fill in the gap of observation in the Mediterranean basin and to obtain more information about sources of air pollutants and atmospheric dynamical and chemical mechanisms, the Joint Research Centre of the European Commission (JRC, EC) has started a long-term monitoring program over the Mediterranean Sea in collaboration with the cruise line Costa Crociere. In this framework, in a joint experiment with the Department of Physics of the University of Genoa, an intensive PM2.5 sampling campaign was organized in summer 2011, on a cruise ship following a regular route in the Western Mediterranean with continuous measurements of BC, NO<sub>x</sub>, CO, SO<sub>2</sub> and O<sub>3</sub> by the monitoring station, placed in a cabin of the top deck of the ship.

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

From July 18 to 25, August 15 to 22, and September 12 to 19, 2011, PM samples were collected on Quartz and Teflon filters (47mm diameter, flow rate 2.3 m<sup>3</sup>/h) using in parallel two Sven Leckel Ingenieurburo sequential samplers, placed on the top of the cabin where the monitoring station itself was located. The samplers were switched on after the departure from each harbor and stopped before the arrival in the next port. Each leg was then divided in periods of about 5 hours with one filter for each sampler collected per period, thus resulting in a variable number of filters per leg and in a total of about 100 filters for all the sampling campaigns during summer 2011. Information about meteorological parameters (wind speed and direction, temperature, humidity) was available with 10 min intervals from the meteorological station of the ship, together with information about the ship position, speed and sailing direction.

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 Tandem accelerator of the LABEC laboratory of INFN in Florence.

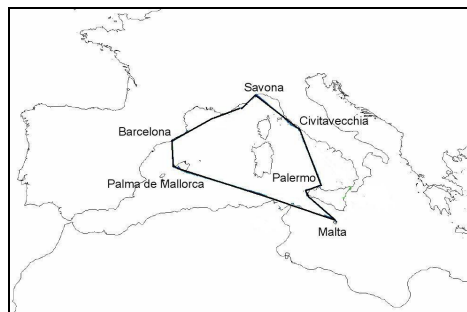


Figure 1. Route of the ship during the sampling campaigns in the summer 2011.

Positive Matrix Factorization, PMF (Paatero et al, 1994), was used to identify and characterize the major PM2.5 sources along the ship route. 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. The biogenic contribution to sulphate concentration along the route was estimated from the measurement of the MSA (methanesulfonic acid) concentrations.

This work has been partially supported by INFN (NUMEN project) and by Costa Crociere.

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