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Ship contribution to the PM10 in central Mediterranean

Silvia Becagli (1), Fabrizio Anello (2), Carlo Bommarito (2), Federico Cassola (3,4), Giulia Calzolai (5), Tatiana Di Iorio (6), Alcide di Sarra (6), José-Luis Gómez-Amo (7), Franco Lucarelli (5), Daniela Meloni (6), Francesco Monteleone (2), Silvia Nava (5), Giandomenico Pace (6), Mirko Severi (1), Damiano Sferlazzo (8), and Rita Traversi (1)

(1) University of Florence, of Chemistry, Sesto F.no, Italy (silvia.becagli@unifi.it), (2) ENEA, Laboratory for Observations and Analyses of Earth and Climate, 90141 Palermo, Italy, (3) Department of Physics & INFN, University of Genoa, 16146 Genoa, Italy, (4) ARPAL-Unità Operativa CFMI-PC, 16129 Genova, Italy, (5) Department of Physics, University of Florence & INFN-Firenze, Sesto F.no, 50019 Florence, Italy, (6) ENEA, Laboratory for Observations and Analyses of Earth and Climate, 00123 Rome, Italy, (7) Department of Earth Physics and Thermodynamics, University of Valencia, Valencia, Spain, (8) ENEA, Laboratory for Observations and Analyses of Earth and Climate, 92010 Lampedusa, Italy

In this work we investigate the impact of the ship emissions to PM10 in the central Mediterranean. The main objective of the study is to unambiguously identify the tracers of ship emissions in the sampled aerosol. Particulate matter with aerodynamic diameters lower than 10 um, (PM10) was collected during summer 2013 at two sites located north (Capo Granitola) and south (Lampedusa Island; 35.52°N, 12.63°E), respectively, of the main Mediterranean shipping route in the Strait of Sicily.
The PM10 samples were collected with 12 h time resolutions at both sites. Selected metals, main anions, cations and elemental and organic carbon were determined.
The evolution of soluble V and Ni concentrations (typical markers of heavy fuel oil combustion) was related to meteorology and ship traffic intensity in the Strait of Sicily, using a high-resolution regional model for calculation of back trajectories.
Elevated concentration of V and Ni at Capo Granitola and Lampedusa are found to correspond with air masses from the Strait of Sicily and coincidences between trajectories and positions of large ships; the vertical structure of the planetary boundary layer also appears to play a role, with high V values associated with strong inversions and a stable boundary layer. The V concentration was generally lower at Lampedusa than at Capo Granitola, where it reached a peak value of 40 ng/m3.
Concentrations of La and Ce were used to identify possible contributions from refineries, whose emissions are also characterized by elevated V and Ni amounts; refinery emissions are expected to display high La/Ce and La/V ratios due to the use of La in the fluid catalytic converter systems. In general, low La/Ce and La/V ratios were observed in the PM samples.
The combination of the analyses based on chemical markers, air mass trajectories, and ship routes allows us to unambiguously identify the large role of the ship source in the Strait of Sicily.
Based on the sampled aerosols, ratios of the main aerosol species arising from ship emission with respect to V were estimated with the aim of deriving a lower limit for the total ship contribution to PM10. The estimated minimum ship emission contributions to PM10 were 2.0 ug/m3 at Lampedusa and 3.0 ug/m3 at Capo Granitola, corresponding with 11 and 8.6% of PM10, respectively.
Lampedusa is a small island in the southern sector of the central Mediterranean, relatively far from the main Mediterranean shipping route; thus, results at Lampedusa may be taken as representative of the impact of ships on the aerosol properties in a wide open sea area in the central Mediterranean during summer.