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Impact of maritime transport on particulate matter concentrations and chemical compositions in four port-cities of the Adriatic/Ionian area: an overview of the results of POSEIDON project

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Pollutant emissions from ships and harbour activities constitute an important source of pollution of coastal areas with potential influences on the climate and the health of their inhabitants. A recent review (Viana et al., 2014) shows that these emissions could have an important impact on the Mediterranean and that there is a lack of data for the Eastern and South-Eastern part of this area. This work presents an analysis of the impact of ship emissions to atmospheric particle concentrations (PM) in four important port-cities (Patras Greece, Brindisi and Venice Italy, and Rijeka Croatia) of the Adriatic/Ionian area. The study was performed within the POSEIDON project (Pollution monitoring of ship emissions: an integrated approach for harbours of the Adriatic basin, funded within the MED Programme 2007-2013). The study uses an integrated approach using emission inventories, dispersion modelling and measurements taken at high temporal resolution (1 min) and low temporal resolution for chemical characterization of PM. The emission inventories of the four port-cities show that ships contribute between 11.7% and 31.0% of the total PM emissions being a source locally comparable with road traffic (ranging between 11.8% and 26.6%). The source apportionment using the receptor model PMF showed an oil combustion source (that includes ship emissions), characterized by V and Ni, in Brindisi, Venice and Rijeka with V/Ni ratio ranging between 1.4 and 4.2 indicating local differences in chemical profiles of the emissions. The V concentrations were used to evaluate the contributions of primary ship emissions to PM (Agrawal et al., 2009) that resulted between 1.3% and 2.8%. The contribution to secondary sulphate was 11% of PM2.5 in Brindisi (Cesari et al., 2014). The analysis of high-temporal resolution measurements taken near the harbour areas of Venice, Patras and Brindisi showed a contribution of ship emissions to PM2.5 varying between 3.5% and 7.4%. The relative contribution to particle number concentrations (PNC) was larger at all sites (between 6% and 26%). This demonstrates that ship particulate emissions include mainly small and ultrafine particles. The trend of the impact of passenger ships primary emissions to PM2.5 concentrations in Venice between 2007 and 2012 showed a decrease from 7% ($\pm$1%) to 3.5% ($\pm$1%) even if the gross tonnage of ship traffic increased in the same period by 47% (Contini et al., 2015). This was a consequence of the use of low-sulphur content fuels due to the application of local mitigation strategies and of the European Directive 2005/33/EC. The WRF-CAMx modeling system was applied over the Central and Eastern Mediterranean so as to identify the air quality impact of ship emissions. The zero-out modelling method was implemented involving model simulations performed while including and omitting the ship emissions. The results for both gaseous and particulate pollutant concentrations generally show a fairly good agreement with observations at the areas under study.

Agrawal et al., 2009. Environmental Science and Technology 43, 5398-5402.
Cesari et al., 2014. Science of the Total Environment 497-498, 392-400.
Contini et al., 2015. Atmospheric Environment 102, 183-190.
Viana et al., 2014. Atmospheric Environment 90, 96-105.