

Characterization of Fine Particles Emitted by the Inland and Maritime Shipping

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Abstract : The increase of global commerce and tourism makes the shipping sector an important contributor of atmospheric pollution. Both, airborne particles and gaseous pollutants have negative impact on health and climate. This is especially the case in port cities, due to the proximity of the exposed population to the shipping emissions in addition to other multiple sources of pollution linked to the surrounding urban activity. The objective of this study is to determine the concentrations of fine particles (immission), specifically PM_{2.5}, PM₁, PM_{0.3}, BC and sulphates, in a context where maritime passenger traffic plays an important role (port area of Bordeaux centre). The methodology is based on high temporal resolution measurements of pollutants, correlated with meteorological and ship movements data. Particles and gaseous pollutants from seven maritime passenger ships were sampled and analysed during the docking, manoeuvring and berthing phases. The particle mass measurements were supplemented by measurements of the number concentration of ultrafine particles (<300 nm diameter). The different measurement points were chosen by taking into account the local meteorological conditions and by pre-modelling the dispersion of the smoke plumes. The results of the measurement campaign carried out during the summer of 2021 in the port of Bordeaux show that the detection of concentrations of particles emitted by ships proved to be punctual and stealthy. Punctual peaks of ultrafine particle concentration in number (P#/m³) and BC (ng/m³) were measured during the docking phases of the ships, but the concentrations returned to their background level within minutes. However, it appears that the influence of the docking phases does not significantly affect the air quality of Bordeaux centre in terms of mass concentration. Additionally, no clear differences in PM_{2.5} concentrations between the periods with and without ships at berth were observed. The urban background pollution seems to be mainly dominated by exhaust and non-exhaust road traffic emissions. However, temporal high-resolution measurements suggest a probable emission of gaseous precursors responsible for the formation of secondary aerosols related to the ship activities. This was evidenced by the high values of the PM₁/BC and PN/BC ratios, tracers of non-primary particle formation, during periods of ship berthing vs. periods without ships at berth. The research findings from this study provide robust support for port area air quality assessment and source apportionment.

Keywords : characterization, fine particulate matter, harbour air quality, shipping impacts

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