

Interactive comment on “Measurements of air pollution emission factors for marine transportation” by B. Alföldy et al.

Anonymous Referee #2

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GENERAL REMARKS

The manuscript presents results from a measurement campaign at the port of Rotterdam which targeted the chemical composition of emissions from ships entering or leaving the port. Measurements were conducted from mobile labs which sampled advected exhaust plumes. Emission factors for SO₂, NO₂, NO_x, and PM were determined from the observed mixing ratios and/or mass concentrations by normalizing the observed values to the measured CO₂ mixing ratios. In total 340 ships were probed. Probability distribution functions are presented for the investigated species proving statistically significant data on respective emission factors. The potential for using SO₂ emission factor measurements for controlling the sulfur content of bunt fuel is discussed.

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Although the manuscript addresses an important topic of current atmospheric research, major revisions are requested before the manuscript is acceptable for publication. The major points to be addressed in the revision are discussed in the following. However, as a very general concern I question whether AMT is the best choice for publication. From my perspective, ACP would be more appropriate because the manuscript describes results from a well-established approach for measuring emission factors from mobile sources. Similar approaches have been widely used for the determination of emission factors of aircraft at airports (Herndon et al., 2004; Herndon et al., 2008). Contrariwise, the manuscript does not introduce a new methodology for measuring emission factors, which would make it more suitable for AMT.

SPECIFIC COMMENTS

1. The manuscript does not provide an adequate description of the measurement campaign. Key information on the dates, season, weather situation, relative humidity, prevailing wind directions as well as horizontal wind speed and average atmospheric residence times of investigated plumes are missing. The latter information however is crucial for the interpretation of aerosol number concentration data provided by a Condensation Particle Counter (CPC) which detects particles above 10 nm in diameter. Sulfate-containing particles show significant particle growth at high relative humidity which will shift particles above the lower detection size of the deployed CPC, simply by taking up water vapor from the humid atmosphere.
2. A schematic of the sampling set-up is missing. Applied instruments and methods are described in detail while no information is given on the equipment of the mobile labs, sampling height, identification of plumes etc.
3. Equation 2 should be checked for correctness. Shouldn't it read: $s[\%] = 32/64 \times \text{EFR} \times 10$? At least the equation was applied in this version in Section 3.1 for calculating SO₂ EF.
4. The section on particle emissions is not acceptable in the current form. The number

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emission factors determined in the proposed manner are not applicable as described. Particle growth during plume aging will have a significant impact on the determined number concentration as well as on the mass median diameter; see Lobo et al. (2007) as an example. The effect of water associated to sulfate molecules (hydrated sulfate) is neglected in the mass determination although water will make a substantial contribution to the total mass of emitted PM (Agrawal et al., 2008; Petzold et al., 2010). Additionally, the number emission factors determined here are only of limited use for determining the global particle emissions impact because engine operation conditions at port are totally different to operation conditions at cruise, whereas the effect of engine power on particle emissions was demonstrated in many of the referenced emission studies.

5. The use of English language should be checked carefully.

TYPOGRAPHIC ERRORS

1. Abstract, line 12: "... emission factors."
2. Page 8927, line 12: rephrase the sentence "... which adverse health effect on humans ..."
3. Page 8927, line 23: "have not been in the focus"
4. Page 8930, line 4: rephrase "...at the entrance of the channel is split into two [e.g. branches]"
5. Page 8932, line 8: Please state the mixing ratio of the calibration gas. An expression like the one used here ("reference gas of around ...") is not acceptable.
6. Page 8933, line 24/25. Rephrase the sentence "precision of the determinations for each analysis ...".

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