

## ***Interactive comment on “Extension of an assessment model of ship traffic exhaust emissions for particulate matter and carbon monoxide” by J.-P. Jalkanen et al.***

**J.-P. Jalkanen et al.**

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Author response to anonymous referee comments on "Extension of an assessment model of ship traffic exhaust emissions for particulate matter and carbon monoxide" by Jalkanen et al., ACPD, 11, 22129-22172, 2011. Referee 2: General Comment: There is no question that constructing better emission models is an important task as uncertainties in the quantification of emissions in general and ship emissions in particular are a major problem for regional and global model simulations. The paper under review represents an important step in this direction by using a more "process oriented" approach. However, the problem that I see is that its main contribution (i.e.

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the presentation of the model) is not adequate. I agree with Referee 1 that in some instances too many details are given; but on the other hand important information is missing that would be necessary to make this work reproducible for other scientists, and I will give specific examples below. For this paper to be considered for publication, these problems need to be addressed.

Author response: A substantially more detailed description of the model has been added to Chapter 2.1 and mathematical formulation has now been included to clarify the steps necessary to understand the flow of information from vessel particulars and speed entries to engine power, fuel consumption and emissions. Although we have made our best effort to make the revised model description as reader-friendly and understandable as possible, it was not possible to explain each and every detail of the model in this article (and still keep the length of the article reasonable). In some cases, we have therefore made references to the original articles or reports, in which the complete details have been given.

Specific comment,1: The introduction would benefit from some streamlining. In particular the paragraph on page 22134, l. 3-22, contains too much detail. While it is important to (concisely) describe in the introduction what the advances of STEAM2 are over STEAM, many details of this paragraph should be moved to the model description. This paragraph might also be combined with the paragraph starting on p. 22131, l. 26, where STEAM is described. The sentences at the end of the introduction (p. 22124, l. 28-p. 22125, l.2) are also redundant, given the list of objectives above.

Author response: The introduction chapter has been revised and some paragraphs have been moved to model description (Chapter 2) section as suggested by the reviewer. The sentences at the end of introduction have been deleted. Specific comment,2: Model description: As mentioned in the "General comments" above, this needs to be reworked, so that it is clear how to get to the output quantities (emissions) from the input quantities in Figure 1. Author response: More detailed description of the model was added to Chapter 2.1.

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Specific comment, 2a: What is the temporal and spatial resolution that is typically achieved?

Author response: The system is limited by the accuracy of the GPS data. The model interpolates vessel routes between two known locations. With full update rate of AIS messages are sent out every two seconds at best. The model interpolates the location of every vessel with one second time interval. These issues are now explained in the introductory section of Chapter 2.

Specific comment, 2b: It is not clear where equation (1) enters.

Author response: Calculation of the Block coefficient is necessary for the application of the Hollenbach resistance evaluation, more specifically the determination of the residual resistance coefficient. Description of the power estimation of the model as well an explanation of the calculation procedure have been added to Chapter 2.1.

Specific comment, 2c: Is equation (2) always needed or only to infer the propeller rpm?

Author response: Propeller RPM is required to determine the quasi propulsive constant (QPC), which describes the efficiency of transmitting the engine power to water. Quasi propulsive constant varies between zero and unity and it includes losses from the propeller and power transmission. If propeller RPM cannot be obtained from technical details directly, it can be estimated if propeller diameter and installed engine power is known. If both propeller diameter and propeller RPM are not known, the model will estimate the propeller diameter using fraction of draught table (see Appendix A, Table A.1). More discussion explaining this was added to the manuscript.

Specific comment, 2d: How is power eventually calculated?

Author response: Propelling power is a product of total resistance and vessel speed. However, all engine power cannot be converted to propelling power because of losses occurring in transmission and the propeller itself. New set of equations was added to Chapter 2.1, which will explain the calculations in more detail.

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Specific comment, 2e: Equation (4): I assume that this should be "+" instead of "=".

Author response: The conversion of equations from the original document was incomplete. This was corrected.

Specific comment, 2f: Equation (5): I assume that this should be "=" instead of "-"?

Author response: The conversion of equations from the original document was incomplete. This was corrected.

Specific comment, 2g: Equation (6c): Is the variable "load" the same as "EL" in equations (4) and (5)?

Author response: Yes. All equations have been corrected for consistent notation.

Specific comment, 2h: How is EL eventually calculated?

Author response: Chapter 2.2.1 has been revised to include the description of engine load calculations. Basically, this involves the determination of minimum number of engines which are required to achieve the instantaneous engine power estimated from resistance calculations. This approach requires knowledge of the main engine setup of each vessel, at least number of engines and total installed main engine power are required.

Specific comments, 2i: Equation 9, what is delta\_t?

Author comment: Delta\_t indicates the time difference (in seconds) between consecutive AIS position reports. This is now explained in the text of Chapter 2.3.3.

Specific comments, 3: Example application in section 3.4: It would make the paper stronger if the claim on page 22150, l. 11-15, could be quantified. How different is the STEAM2 emission inventory really from other currently available inventories? Are there conditions (e.g. seasons) when these differences are particularly large/small?

Author response: Comparison to EMEP ship emission inventories was added. How-

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ever, the EMEP inventories do not include the temporal variation of emissions because only an annual total is reported. This would make in our view seasonal comparisons unfair for EMEP, since this information is not available in EMEP data set.

Specific comment, 4: Are there any other areas, in addition to the Baltic Sea, where AIS data is available?

Author response: A short summary of the availability of AIS data was added to the end of Chapter 3.4. All ships over 300 Gross Tons are required to carry this device globally, which, in principle, facilitates the construction of global ship emission inventories based on AIS data. However, the access to the AIS data can be obtained in several different ways depending on the scale: a) local scale, like port emission studies: A single AIS base station can be used to record ship movements in an area with a radius of 40-60 km. b) Regional scale: Usually an agreement with national maritime authorities is required to gain access to the data collected by national AIS networks. However, negotiations with several countries are required if regions like the Baltic Sea are to be studied. c) Global scale: Commercial operators of satellite-AIS constellations are currently the only available option. Access to satAIS data can be bought, but complete global coverage requires data from both terrestrial and satAIS networks because of strong ground level interference from certain regions. The Baltic Sea is an example of a problematic area regarding the satellite reception of AIS data. Both the high traffic density and ground level interference hinder the reception of AIS signals from Earth orbit necessitating the use of terrestrial AIS network.

Specific comment, 5: Figure 4: This figure would look clearer if it was not in 3D. I.e. use fuel sulphur content and engine load as axis and PM emission factor as contours.

Author response: This figure was replaced with a contour plot.

Specific comment, 6: Figure 11: If this is the original size of the figures, the labels on the color bar are not legible.

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Author comment: The text size has been increased

Specific comment, 7: Typo: p. 22136, l. 1: should read "model".

Author comment: This was corrected

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/11/C14629/2012/acpd-11-C14629-2012-supplement.pdf>

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 22129, 2011.

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