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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Constraints on ship NO_x emissions in Europe using GEOS-Chem and OMI satellite NO_2 observations" *by* G. C. M. Vinken et al.

Anonymous Referee #1

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Vinken et al. provide emission estimates constrained by OMI observations for European ship tracks. The paper is well written and in principle suitable for publication on ACP. However, I am not convinced of the correctness of the applied methodology (Eq. 4). As this is the key equation for the constrained emissions, the authors should check it carefully and provide the detailed mathematical justification for this equation, and clearly point out what assumptions have to be made.

Comments:

Abstract: The abstract is quite long, and I recommend to shorten it. However, I miss a

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sentence on the idea how the constrained emissions are derived.

P19352 L4: Why was the time period restricted to only two years, where OMI provides a much longer time period?

P29352 L21: Please reword. The satellite "observation" is not affected by a model, but the derived vertical column is.

P19355 L18: I miss a clear definition of the investigated areas. I propose to put a figure here, similar to Fig. 6a, where the current knowlegde on shipping routes is reflected, and the investigated regions are marked by a box. In addition, the region boundaries should be added to table 2.

Section 2.1: I haven't fully understood the concept of the combined CTM/plume model: In Vinken et al., 2011, a box model is used to study individual ship plumes. But how are these results merged into the CTM? Is each individual ship represented by a ship plume? Or, as I assume, are the results from the plume model scaled into the CTM? How is this scaling done, by number of ships or by average emissions? How could this effect your study?

P19358 L8/L15: It took some time until I understood this paragraph. Please avoid switching the order of what is higher/lower compared to what.

P19359 L16: "dominates ... over oceans": Please comment on this with respect to this study: It might be different over ship tracks!

P19360 L13: How sensitive are the results on clouds? Information on this can be gained by varying the cloud radiance fraction threshold.

P19361 L12: Why should lower emissions result in higher AMFs? Please explain!

Section 2.4: How is the selection done in detail? Are there some thresholds applied, or was it done by visual inspection only?

P19362 L2: Fig. 3 shows a map of OMI NO2, in which some ship tracks can be

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recognized or guessed. In my print out, the mediterranean ship track is much better visible in Fig. 6b than in Fig. 5c. Why? Please optimize Fig. 5.

Section 3.2: How is beta calculated? Is it the spatio-temporal mean (complete box, complete month/season) for Delta N and N?

Equation 4:

I can not comprehend this equation:

- If there is some kind of iterative approach, the terms N_OMI-N_GC should be different in the both brackets.

- I do not understand why there is just a second additive term multiplied by gamma: gamma affects N_OMI, so I would expect to have it as factor at N_OMI, not the whole term!?

- Please provide the maths leading to Eq. 4: A change of emissions causes a specific change of N_GC, and, due to gamma, also of N_OMI. I tried to write down delta E as function of N_OMI and N_GC, using Eqs. 1 and 2, but found it to be not trivial to relate this to (N_OMI-N_GC)/N_GC, as in Eq. 4. So please justify Eq. 4 in detail and show how this equation follows from Eqs. 1 and 2, and clearly state what assumptions have to be made.

Section 3.5/Fig. 9: I am surprised and also worried by the strong change in OMI compared to Fig. 7. As I am not convinced by the correctness of Eq. 4, I suspect that something might have went wrong here. What would happen if a further iteration would be applied? Would this further decrease the OMI columns in the Mediterranean?

I would also like to ask for more information on what's going on here; so please provide figures/tables on the GEOSchem profiles and AMFs for the shiptracks for initial and constrained emissions (e.g. as supplementary material).

I am also missing some discussion on why beta and gamma are that different for the

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different ship tracks.

Table 2: Please add a column on the a-priori input emissions (the combined EMEP/AMVER emissions used in GEOSchem).

Figs. 6/8: Please indicate the areas defined as ship track as boxes in all maps for orientation.

Fig. 7: Add the a-priori emissions, as in Fig. 9.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 19351, 2013.