

Interactive comment on “Environmental impacts of shipping in 2030 with a particular focus on the Arctic region” by S. B. Dalsøren et al.

Anonymous Referee #1

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The paper seems to be a straightforward application of previously documented models covering an important and 'hot' topic, the impact of increased shipping emissions in the Arctic region. I think the manuscript is fine in general, but quite a few clarifications and improvements (including better Figures) are needed before acceptance for ACP.

* There have been previous studies looking at the impact of these increased shipping emissions. The authors need to be very explicit in explaining why another paper is needed, and what is new.

* On the same theme, this paper presents a number of results for changes in ozone, NO₂, etc., but only one coarse-resolution model is used. The authors need to discuss how this model's results sit in the context of other studies done with other CTMs (Granier, Eyring, etc). For example, on P26649 we read that Granier et al. found factors

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of 2-3 changes in ozone, much larger than those found in this study. Why?

* The issue of non-linearity in modelling emissions from ship-plumes has been known and studied for a long time (e.g. Song et al., 2003, Kasibhatla et al., 2000). This is an important issue, but here is only brought up in 2 sentences in this study. I suspect this issue is a significant source of uncertainty in the calculations presented here, and it deserves a proper discussion.

* I missed a Tabulation of the non-Arctic emissions used in this study. This could well be an extension of Table 1. In any case, Table 1 should make it clear that the numbers come from Corbett et al.

* OC is discussed without mention of secondary compounds. I assume the authors are modelling only a primary inert OC compound? If so, what are the implications of this assumption for the RF calculations?

* Why are the HIGH and MFR SO₄ direct so similar for summertime in Fig. 11? Table 1 suggest different emissions.

* In many places (e.g. starting on L16 of the Introduction, or the second paragraph of the conclusions section), the authors resort to qualitative terms, with changes being large, significant, etc.,but with the reader being given no clue as to this means). If a change is mentioned, quantify it. This vagueness gives a careless impression and makes it hard for the reader.

* Figures:

In general, the quality of the Figures is quite poor - the maps are hard to read as they are so small, captions are not self-explanatory, and fonts in some Figures also need improvement. In more detail:

Type: The focus is on the Arctic, but the maps make this nearly impossible to see in any detail. Polar stereographic maps would be much better, as done in Odemark et al. 2012. For the few occasions where the S. Hemisphere is mentioned, it would be

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enough to just use text or Supplementary material.

Quality: The fonts and colourbars used need improving, e.g the numbers run into each other in Fig. 1a, and the text in Fig. 6 is tiny, being far inferior to that used for Fig. 7.

Captions:

- Many of the captions say the same thing, but for different pollutants. It is then clearer to say, "as Fig. XXX, for YYY".

- Use (a), (b), ... etc, instead of the wordy and less-clear upper-left, upper-right.

- Figs 1-4. What does at the surface mean? True surface concentrations are zero for depositing pollutants.

- Figs 6-11. The terminology is very unclear. What is RF 2004-2030? I assume the authors mean changes in radiative forcing between 2004 to 2030. What is "BC in air RF 2004-2030"? This phrasing makes little sense.

* Where is the 4th sub-figure in Fig. 5? Be consistent with the other Figures

* Throughout, please check tenses and English usage in general.

Other comments

P 26648, Abstract

L3. "A set of models" sounds as though an ensemble of CTMs is being used. Re-phrase.

L16-17. Do you mean changes in RF? Also, be explicit if you mean global or regional values.

L18. contracts "with"

L21-22. This sentence is difficult to understand - clarify.

P26649, L2-3. These references are getting old, and recent years have seen more and

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more interesting trends - find a recent reference.

P26651, L24-25. Tenses: Large emission increase*s* *are* found

P26653,

L7-8. Explain why no changes were made in land-based emissions between 2004 and 2030, this is not obvious to the reader.

L18-21. The issue of comparison to measurements is swept over here. OsloCTM2 is said to be as good as other models, but how good/bad is that for ozone and NO₂?

P26655, L27-29. The phrase about critical levels seems odd unrelated to the comment about 3-6% increase. Clarify. Also, I am not sure that Hjellbrekke is the best reference for such a discussion. (Torseth et al., ACP, 2012 is a better reference for the EMEP data anyway, but that too has little to say about critical levels.)

P26661, L10-11. Forming *the* basis. Also, it is better to say the Dalsoren et al and Corbett et al datasets than just the "two" datasets.

P26662

L11. Changes (or lack of) in sea-ice are mentioned, but many other meteorological factors will change as a result of global warming. This needs to be discussed.

L18-24. This section needs some references.

References

Kasibhatla, P., Levy, H., Moxim, W., et al., Do emissions from ships have a significant impact on concentrations of nitrogen oxides in the marine boundary layer? *Geophys. Res. Lett.*, 27, 2229-2232, 2000

Song, C., Chen, G., Hanna, S., Crawford, J. & Davis, D. Dispersion and chemical evolution of ship plumes in the marine boundary layer: Investigation of O₃/NO_y/HO_x chemistry *J. Geophys. Res.*, 108, 2003

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