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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Model calculations of the effects of present and future emissions of air pollutants from shipping in the Baltic Sea and the North Sea" *by* J. E. Jonson et al.

Anonymous Referee #2

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General comments:

This study models the effect on air quality from shipping emissions in the Baltic Sea and North Sea. The effects are estimated both for recent years (2009 and 2011) and for 2030. These years are chosen to highlight the effect of key regulations affecting emissions making the study policy relevant and interesting for a broad audience. The methods used are adequate, the scientific findings are solid, and much of the paper is well written. However, I suggest that the Conclusion section should be rewritten. A solution could be to split it into a Conclusion section and a Discussion section. The manuscript is also sometimes a bit short on information and I suggest some more

discussion. See specific comments for more on these aspects.

Specific comments:

Page 21944, Line 19: “stricter control on sulphur emissions from 2010”. Hard to understand for the reader as the first paragraph of the abstract discussing regulations forgets to explain what happened to sulphur content (and emissions) in 2010. The abstract therefore discusses several air quality results without informing the reader about the premises. Please discuss the sulphur regimes before and after 2010 in the first paragraph.

Page 21944, Line 23-25: “At the same time, however, an increase in ship activity has resulted in higher emissions and subsequently air concentrations. . .”. Suggest to state that this is for other components (not sulphur) as sulphur is discussed in the previous line.

Page 21944, Line 27: Maybe state that the decrease in emission is for the total emissions from all sectors to assure that this is not misinterpreted as for shipping only.

Page 21946, Line 3: The major fraction of sulphur is emitted as SO2 and not PM (table 1). But it is only mentioned that fuel sulphur reduction affect emitted PM.

Page 21948, Section 2: How is chemistry in ship plumes treated in the model? Several recent studies have shown that NOx lifetime is significantly reduced in ship plumes and that this affects the calculated impacts of shipping on ozone and oxidation capacity. The model is run in quite high resolution which is good but information whether parameterization of plume processes is used is missing. If it is not accounted for the consequences for the results should be briefly discussed. This could for instance be done in a separate Discussion section at the end of the paper.

Page 21950, Line 19: “Emissions of organic and elemental carbon and ash also increase as they are assumed to be unaffected by the fuel type”. Is this really the case? Lack et al. (2009) for instance finds that organic carbon is dependent on fuel sulphur

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content.

Page 21951, Line 3-10: I miss a short discussion on the assumptions about how a NECA affect the emissions. To meet the stringent NOx regulations in Tier III the ships either have to use Selective Catalytic Reduction (SCR) with high costs or alternative fuels. The latter could induce changes in emissions of other components than NOx. How is this accounted for?

Page 21955, Line 17: “not affect”, rather strong statement, suggest changed to “have limited effect”

Page 21956, Line 22: Suggest clarifying that it is the effect of changes in all emission sectors that is discussed (not only shipping).

Page 21956-21957, Section 3.4: I miss figures and discussions on how ozone and SOMO35 is affected by the changes in ship emissions from 2009 to 2030. In 2009 you find that the NOx increase due to shipping results in titration of ozone in and around the major shipping lanes. What are are the results for ozone in 2030 with decreased background NOx levels and rather stable (baseline) or decreasing (NECA case) NOx emissions from shipping? Ozone response is highly non-linear dependent on background NOx levels. Would different background NOx in 2030 lead to a different sign of the ozone response?

As mentioned above the NOx-ozone chemistry is highly non-linear. Likewise, formation of nitrate aerosols is very dependent on background sulphur levels. This study uses only one scenario for non-shipping emissions and two for shipping (baseline and NECA). The results are discussed without mentioning alternative scenarios. Would chosing other scenarios for non-shipping sources have a large effect on the results, why/why not? I suggest some discussion on this in a separate Discussion section.

Page 21958, Line 3 : Acidification from sulphur deposition is mentioned here (in the Conclusions) for the first time. Earlier the paper only addresses the effect of sulphur on

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PM levels. I miss a discussion of the effect on sulphate deposition in the results section. I would have preferred to have it in. Alternatively, it should at least be mentioned in the beginning of the manuscript that this still is an important effect in certain regions but that you have chosen to focus on the effect of sulphur on PM and YOLL.

Page 21958, Section 4: In my view the Conclusions section should summarize the main findings of the study. This is done rather briefly and should be extended with more information. The findings could also be discussed in relation to the studied regulations with some policy relevant perspectives like did /will the regulations have the intended/optimal effect.

The last and longest part of the Conclusions section seems a bit misplaced. I suggest to move it to a Discussion section. It is interesting but seems to be repetition of discussions in the studies referred to. It would therefore be better to shorten it and point the interested reader to the references. Very much attention is given to fuel prices which is only one driver for change in emissions while other drivers (trade markets, policies, technology, alternative fuels, etc.) are not discussed.

Reference: Lack, D., Corbett, J., Onasch, T., Lerner, B., Massoli, P., Quinn, P., Bates, T., Covert, D., Coffman, D., Sierau, B., Herndon, S., Allan, J., Baynard, T., Lovejoy, E., Ravishankara, A., andWilliams, E.: Particulate emissions from commercial shipping: Chemical, physical, and optical properties, J. Geophys. Res.-Atmos., 114, 2156–2202, doi:10.1029/2008JD011300, 2009.

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