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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of shipping emissions on air pollution in the Greater North Sea region – Part 2: Scenarios for 2030" *by* V. Matthias et al.

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Response to the comments of Reviewer 2

R: a) Page 11326, L23-24: I would be careful with the transport fuel efficiency statement. True, ship on average, is the most efficient mode of transport, but very large differences exist between various ship types. Large intercontinental container ships or oil tankers are drastically more efficient than RoPax ferries.

A: We modified the sentence accordingly.

R: b) Page 11327, L5-6 and L8-9: Repetition of 0.1% S fuel requirement. I would also say that the EU sulphur directive is relevant in this context.

A: We omitted the sentence in Line 8/9 and added references to the EU sulphur directive.

R: c) Page 11327, L15-24. Here the authors shed some light on the NO_x emission factors used in part 1, but it is not reported in part 1 at all. Also, IMO Marpol Annex VI Reg 13 Paragraph 7 sets the NO_x emission requirements for ships in ECAs and extends the Tier 1 limits to vessels built in 1990's. Was this considered in the current work?

A: The way the emission factors were derived from the GL test bed data and the emission functions themselves will be described in more detail in part 1 of these articles. It is not considered that some ships that were built in the 1990s already comply to Tier I limits. This is beacuse this rule applies only to ships with bigger engines ($>$ 5000 kW) and only if the technical specifications allow for such a retrofit. The latter information was not available to us. In addition, the largest part of the bigger ships that sail the North Sea were built after 2000. In a sensitivity run of the emission model we estimated the activities of ships with engines $>$ 5000 kW that were built in 1990s (in number of ship movements) to be 1% of all movements. We therefore think, that the effect of Marpol Annex VI Reg 13 Paragraph 7 on the NO_x emissions in the North Sea is small.

R: d) Page 11328, L22-23: Here a reference is made to part 1 of the combined manuscript, but the necessary details are not there unless the authors significantly improve the description of the emissions part of the manuscript.

A: The description of the emission factors has been significantly extended in Part 1.

R: e) Page 11329, L17: Fleet renewal rate. How is the 2.5% replacement of the fleet done? Do the oldest vessels go first or is this done with random sampling of ships

regardless of vessel age?

A: The oldest ships go first. This seems to be more reasonable than a random sampling, although it might be a bit too optimistic in terms of emissions reductions. Certainly, also newer ships will be put out of service and some older will still remain in service. However, we found it hard to put numbers to the fraction of old ships that might remain in service. We added a sentence that briefly explains this.

R: f) Page 11331: Scenarios for ECA LNG16 and ECA LNG21. I do not see emission factors for engines using LNG fuel (or specific consumption) reported anywhere in part1 or part2. These should be added, as well the discussion regarding methane slip from marine engines.

A: We added a paragraph on the construction of the LNG scenarios.

R: g) I agree with the statement made by Referee1 that land based emissions change, too. EMEP has made projections for 2030, which could be used for this purpose. The authors are actually quite optimistic with the reduction of land based emissions if they expect no growth between present date and 2030.

A: We added a brief discussion about the effects of changing land based emissions. See our answer to the comments of Referee 1. However, we disagree with the reviewer that keeping the land based emissions constant would be an optimistic scenario. In the RCP scenarios of the IPCC, OECD states expect a decrease in e.g. NO_x emissions from 2010 until 2030 of 30% or more, the same holds for Sulphur emissions (see http://tntcat.iiasa.ac.at/RcpDb/dsd?Action=htmlpage&page=compare , last accessed 18 August 2015). EU expects a decrease in SO_2 and NO_x even under current legislation, by more than 50% between 2005 and 2050 (see Amann (Ed), The final policy scenarios of the EU clean air policy package, TSAP report 11, February 2014 http://www.iiasa.ac.at/web/home/research/researchPrograms/
MitigationofAirPollutionandGreenhousegases/
TSAP_11-finalv1-1a.pdf, last accessed 18 August 2015)

R: h) Page 11335, L17-19: Conversion rates are not the only factors increasing the concentrations, because also ship activity is higher during summer than in winter.

A: We now explain this in more detail.

R: i) Page 11337, L18-21: This "All ships in Tier3 by 2030" is not a very realistic scenario. I understand it sets the game with Maximum Feasible Reduction and the reductions available through drastic measures, but I do not believe for a second that this would happen in reality.

A: We agree, but as you pointed out, this scenario sets the scene for what could be possible and what would be reality in e.g. 2050 when most ships would be replaced by new ones (and assuming that the total transported volume will not drastically increase further).

R: j) Page 11341, Chapter 4.2.5 "PM2.5": The discussion of PM2.5 feels weak because it is not reported in part1 or part2 how the emission factors for PM are impacted by fuel sulphur content.

A: The emission factors for PM are now reported and discussed in Part 1 of the two papers. We describe the changes applied in the scenarios in section 2.3.

R: k) Page 11354 and Page 11357, Figures 6 and 9: These figures are an excellent idea how to describe the impact of scenarios.

A: We agree.

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