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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The global impact of the transport sectors on atmospheric aerosol in 2030 – Part 1: Land transport and shipping" *by* M. Righi et al.

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We thank the reviewer for her/his constructive comments and suggestions. Please find detailed answers in the following (*italic: reviewer's comments*, roman: author's reply).

The impact of this study could also be increased if it was made clear what the new and original contribution is. The authors make several references are made to existing work (which is good), but I am left wondering what the new results are.
The existing literature focuses on the overall effect of aerosol in the RCPs, but a study

dealing with the individual emission sources under these scenarios was lacking. As mentioned in the Introduction, the transport sectors are of particular interest in this context, due to their comparatively large growth rates and the different regional impacts (as found in Righi et al., 2013; see manuscript for detailed reference). Furthermore, the RCPs show very different projections for short-lived and long-lived species (and resulting climate effect), which motivated a more thorough analysis of the individual sectors.

1. The study is based on present-day meteorology. I understand the reason for doing this, i.e. to focus on the impact of changes in emissions. However, the conclusions about in increasing nitrate concentrations might not hold if the temperatures increase in a future climate. Please point out this caveat in the text. Is it possible to roughly estimate if the nitrate will indeed stay in the particle phase given the expected increases in temperature?
This a good point. We added the following caveat in the conclusions: "We recall that our assumption of year 2000 climate conditions for 2030 is a possible source of uncertainty. Aerosol composition and life cycle might experience significant changes due to changed climate conditions (see, e.g., Megaritis et al., 2013; Pozzer et al., 2014) and their specific implications for particle-induced climate effects of transport emissions shall be the subject of future investigations."
The impact of increased temperature on nitrate was analysed by Megaritis et al. (2013). Using a regional model, they found significant decreases in nitrate concentrations following an increase in temperature of 2.5 and 5 K. However, their study focused on the continental Europe, and the situation could be different over the oceans, where background ammonium concentrations are much lower. We would need a dedicated model experiment to answer this question for the specific shipping case.

2. p. 22991, line 1: Is there any aging process included for hydrophobic black carbon and hydrophopic POM? Please clarify.

Yes. Conversion of hydrophobic into hydrophilic BC and POM is parameterized with an exponential decay using a 24h e-folding time. This has been added to in the second paragraph of Sec. 2.

3. Figure 3: The result for RCP6.0 over Africa look very different from the other RCPs. Why is this?
The BC emissions in this region are mostly caused by biomass burning and domestic fires. For RCP6.0, both sectors show very little changes in emission between 2000 and 2030 in this region.

4. p.22997, line 18-22: Why does this opposite behavior occur?
See reply to the next comment.

5. p. 22998, line 8-13: Can you explain why these difference between southern and eastern Asia occur?
Unfortunately, the literature on the RCP scenarios concerning the projection of short-lived species is limited and their behavior is often not obvious and hard to interpret. As mentioned in Sect. 3, the RCPs assume a correlation between income (GDP) and stringency of air pollution policies. This is the main way to interpret the short-lived emissions projections in these scenarios. Specifically for the two examples raised by the reviewer, they could be explained by the income (GDP) projection in the given region/scenario. As pointed out by van Vuuren et al. (2011), the short-lived species emissions also depend on the specific climate policy adopted in each region/scenario.

6. p. 23003, line 4-6: Regarding the shipping impact on number concentration: Nucleation can occur in ship plumes, which would increase the number concentration. Do you account for this?

Yes, nucleation is simulated by the model, according to Vehkamäki et al. (2002), although sub-grid processes at the plume scale cannot be resolved. Details on the representation of nucleation in the model can be gained from Lauer et al. (2005, 2007) cited in our manuscript.

7. p. 23004, line 1: This is only a suggestion for future work: Would it be possible to employ the emulator technique by Lee et al. to address this question of uncertainty? (Lee, L. A., et al. "Emulation of a complex global aerosol model to quantify sensitivity to uncertain parameters." Atmospheric Chemistry and Physics 11.23 (2011): 12253-12273.)
Number emissions are calculated from mass emissions assuming some set of lognormal parameters (median diameter and sigma, see R13 for details). Similar parameters are analyzed in Lee et al. (2011), therefore it should be possible to apply the same method here as well. Thanks for the suggestion, which could be indeed the subject of a future study.

8. Figure 11: I am surprised that the different RCPs give so similar results for the RF due to land transport. Can you please explain this?
The bulk of the RF impact from transport is due to cloud effects, therefore is controlled by changes in particle number concentration in the activation size range (which roughly corresponds to our accumulation mode). As shown in Fig. 6, the relative change in accumulation particle number burden is quite similar among the scenarios, which explains the small differences in 2030 RF shown Fig. 11. A corresponding statement has been added to the second paragraph of Sec. 5.

1. Notation for the "D" quantities in equations 2, 3, 4: Given that the r.h.s of these equations has an index for the RCP scenario, the l.h.s. should have one, too.
Fixed. Thanks for spotting.

2. Notation for aerosol nitrate, ammonium and sulfate: Should be NO−, NH+, SO2−
We prefer to stay with the current notation, for consistency with the companion paper (R13).

3. p. 22987, line 11: should read "affect" (plural)
4. p. 22987, line 18: "microphysical"
5. p. 22992, line 21: novelty "aspects" (plural)
6. p. 22999, line 25: should read "These"
All fixed. Thanks for correcting the text.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 22985, 2014.