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Interactive comment on “Air quality and radiative impacts of Arctic shipping emissions in the summertime in northern Norway: from the local to the regional scale” by L. Marelle et al.

Anonymous Referee #1

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General Comments:

This study investigates the impacts of shipping emissions in northern Norway on local air quality and short-wave radiative effects. The study combines measurements and modeling tools in several ways: Airborne measurements from the 2012 ACCESS campaign are combined with FLEXPART-WRF to generate ship-specific emissions of NO_x and SO₂, which are then used to evaluate the STEAM2 shipping emissions inventory for the same ships. Next STEAM2 is used in WRF-Chem to quantify the impact of shipping on local levels of atmospheric pollutants and radiation, and model results are compared with ACCESS measurements. The topic of the paper is suitable for ACP

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and of importance in light of the expected increase in shipping activity in the Arctic in the coming years. The paper is quite comprehensive, but well structured and written. A few clarifications (see specific comments) are needed, and once these are addressed the paper should be accepted.

Specific Comments:

- 1) P 18411, L2: suggest noting that the combination of reduced SO₂ and the expected continued increase in CO₂ is important.
- 2) P 18411, L 3: Is this really expected? For instance, the future projections of shipping emission in the Second IMO GHG study do not show sustained reductions in shipping SO₂ and NO_x emissions towards 2050. Suggest rephrasing.
- 3) P 18411, L 20: This is a bit imprecise and should be rephrased. The results is not purely an effect of reduced SO₂ emissions, but also of the fact that SO₂(SO₄) gives a stronger cooling effect for the southern routes.
- 4) P 18416, L 6: how important is the quality of STEAM2 CO₂ emissions for this method and has the quality previously been evaluated?
- 5) P 18417, L 20: VOC speciation both for shipping and anthropogenic emissions?
- 6) P 18420, L 13: is this consistent with lines 4-5 above which says that ship emissions are injected using the plume model for CTRL and CNTR3?
- 7) P 18421, L 14: looking at Fig. 3 the agreement seems to be a bit poorer for Costa Deliziosa (panels C and D), which might be worth noting if really the case.
- 8) P 18422, Eq. 1: how is the SO₂ background derived? If derived from model output, has the general model performance been evaluated?
- 9) P 18426, L 12: is there a reference that could be used for the current growth?
- 10) Section 5.1 suggests that because the CTRL simulation performs well on average,

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the STEAM2 is able to represent the average emissions from ships. Given the significant differences for individual ships shown in Section 4, how confident are the authors that this is indeed valid in a more general context?

11) Section 5.1, first paragraph: is there evidence that a 3km x 3km resolution is sufficiently small to capture subgrid plume processes? And is the difference between the two resolutions used here sufficient to actually capture relevant non-linearities?

12) A more general comment is that it is not entirely clear from the start what the scale of “local” versus “regional” is. For instance, in the Section 5.1 “local” essentially means ship plumes. I think that could be better reflected in the title of this section.

13) The title of section 5.1 should also better reflect the focus on model evaluation in order to separate it more clearly from section 5.2.

14) P 18427, L 22: has Falcon 20 been mentioned before? Suggest mentioning in Section 2.

15) P18428, L13: could you provide the absolute value (ppbv) for comparison with the results previously found for global models described below?

16) Fig. 6: Could corresponding results for SO₂ be presented?

17) P 18429, L 3: could this overestimation also be caused modeling issues, e.g., chemistry?

18) P 18432: it would be interesting to compare the ozone changes on a per unit emission basis to examine the sensitivity. Is this possible with the available data?

19) P 18433, L5: what is the average lifetime of BC in WRF-Chem?

20) Section 5.2.2: It would be good if this section could be expanded to include some further comments about how the modeled overestimation of PM_{2.5} (P 18430) influences the estimate of radiative effect, the role of black carbon (incl. BC in snow) and placing the results of this study in the context of the large uncertainty ranges previously

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found for the indirect aerosol effect of shipping.

21) P 18436, L 21: did these studies include calculations of the CO₂ impact?

Technical Corrections:

1) P 18420, L4-5: clumsy, consider rephrasing

2) P 18420, L 25: “First”, is there a “second” in this paragraph

3) P 18428, L 3: NO should be NO_x?

4) P 18433, L23: “Averaged over the surface of the Earth”; strange wording, consider rephrasing

5) P 18436, L 23: missing period between “challenging” and “Our”?

6) Figure 3: is y-axis label on top right panel correct? Please check.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 18407, 2015.

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