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Interactive comment on "**An improved parameterisation of ozone dry deposition to the ocean and its impact in a global climate-chemistry model**" *by* **Ashok K. Luhar et al.**

Anonymous Referee #2

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Overview:

This paper reports the implementation of 2 additional schemes for ozone deposition over oceans into a global chemistry-climate model (the Australian Community Climate and Earth-System Simulator). Model outputs using the original and the 2 additional schemes are compared to recent observations of ozone deposition fluxes and velocities over sea water made during a number of ship cruises. Finally, the impact of the different ozone deposition schemes on atmospheric ozone concentrations is investigated.

Deposition of ozone to the Earth's surface is an important component of the tropospheric O_3 budget. The analysis of the HTAP multi-model outputs reported in the cited

paper by Hardacre et al. is indicative of the uncertainty in deposition to both the land and ocean surfaces. The larger surface area of the oceans more than compensates for the smaller ozone deposition velocities to ocean surfaces compared to land, especially vegetation, surfaces. As also shown in Hardacre et al., the deposition to the ocean has the largest uncertainty.

The two additional schemes (denoted 'one-layer' and 'two-layer') both improve the model performance against observations. The 'two-layer' scheme gives the best realisation of the observed deposition velocity and its dependence on sea surface temperature and wind speed (for the assumptions made and parameters used).

The paper addresses a neglected but important topic and covers a relevant subject for this journal. Overall, the paper reads well and should be published, after addressing the specific and technical comments below. These are mostly minor or suggestions to improve clarity.

Specific Comments:
Deposition Schemes: The 'one-layer' scheme is effectively that developed by Fairall et al. (2007). The 'two-layer' scheme includes a surface microlayer layer and some pragmatic choices are made to make it computationally tractable. The description of the schemes includes a significant number of equations, which for the one-layer scheme repeat to some extent those given in Fairall et al. (2007). As a suggestion, the authors may wish to consider moving these to an appendix or supplement to aid clarity.

Iodide fields: Based on earlier experimental studies, the O_3 deposition process includes *inter alia* a reaction of O_3 with iodide (I^-) in the surface layers of the ocean (page 7, line15). Initially, I could not see the relevance of the subsequent chemistry (equations 6 to 10 on page 8), except perhaps to indicate that the iodide is effectively regenerated (or how I_2 is formed). Are these equations needed?

The cited paper by Ganzeveld et al. (2009) used sea-water nitrate as a proxy to derive global iodide fields. In this study, sea-surface temperatures are used (after Sherwen et al.). Later in the paper (page 18, line 9 and Figure 11), a qualitative comparison is made with the modelled O_3 deposition velocity maps in Ganzeveld et al. (2009). There were latitudinal differences in the position of the maxima. One can arguably see the same mid-latitude Atlantic feature that Ganzeveld et al. reported (for July 2006). Allowing for the other differences mentioned (page 18, line 15), it would have been interesting to see a simulation using an iodide field based on nitrate.

Nudging and monthly-averaged fields: The model is nudged to ERA-Interim reanalyses of wind and temperature. Thus, synoptic variability is similar to that observed, improving the comparison with observations of atmospheric trace constituents.

Monthly-averaged concentration fields are used in the analysis reported here. To those more familiar with land-based deposition, the use of monthly-averaged fields would not seem realistic, given the strong diurnal variations in O_3 concentrations and in the stomatal uptake over vegetation-cover surfaces. It might be worth contrasting this with the behaviour over oceans where the diurnal variations are expected to be smaller (presumably), which justifies the use of monthly-averaged fields. What about coastal regions, which are more influenced by the land???

The UKCA atmospheric chemistry module used in ACCESS has a branch, which includes an aircraft/satellite emulator, allowing the model to be sampled at the time and location of an aircraft or satellite sounding (http://www.ukca.ac.uk/wiki/index.php/ Flight_track_emulator_to_compare_to_campaign_data). It could easily be used for ship-based measurements. The model could then be sampled at the actual time of the observation.

Performance of standard model configuration: The modelled O_3 concentrations and budgets are underpredicted. While this does not detract from the present work, it

would be good to understand the source of this bias. The cited paper by Woodhouse et al. does not really provide further details as to whether this is a result of emissions, initialisation, spin-up, etc ...

Code availability Are these model developments available in an accessible code repository? If so, the authors could provide access details as I am sure that other groups would be interested in using this approach.

Technical comments:

It was hard to compare Figures 5a and 6, especially on the screen. As a suggestion, I wonder if these could be combined into a single plot or made into a single figure on the same page to make the comparison easier.

The colour scale used in the panels of Figures 9 and also of Figure 11 differ. While the colour scales used aid the comparison of the spatial patterns, it makes comparison of the the absolute magnitudes harder. It might be better if a common scale could be adopted, with sufficient dynamic range and discretisation.

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