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Comment on acp-2022-275

Anonymous Referee #2

Referee comment on "Radiative impact of improved global parameterisations of oceanic dry deposition of ozone and lightning-generated NO_x" by Ashok K. Luhar et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-275-RC2, 2022

Review for 'Radiative impact of improved global parameterizations of oceanic dry deposition of ozone and lightening-generated NOx'

Reviewer Summary: This manuscript uses the ACCESS-UKCA chemistry climate model to investigate the radiative impact of changes to the oceanic dry deposition parameterisation and the lightening NOx (LNOx) parameterisation. The authors find that there is small impact on radiation from the changes to the oceanic dry deposition parameterisation which is attributed to higher tropospheric ozone concentrations. The authors found that the changes to the LNOx parameterization had a relatively large impact on radiation, predominantly in the longwave and over tropical latitudes. These changes were attributed to increased ozone and OH in the upper troposphere, combined with a shorter CH4 lifetime due to the higher oxidant levels.

I have some general and technical comments (please see below) which should be addressed prior to publication.

General comments:

- The manuscript is reasonably clear and well laid out. The manuscript extends the evaluation of a new LNOx parameterization described in Luhar et al. (2021) (as well as the revised oceanic dry deposition parameterization described in Luhar et al., 2018). However, with the evaluation of the new LNOx parameterization split across two publications I found it necessary to read this manuscript in parallel with Luhar et al. (2021) to fully understand how the new parameterization impacts NOx, ozone and OH in the atmosphere, and might therefore be expected to impact radiation. It would be helpful to include a short 'scene setting' paragraph highlighting the main findings from Luhar et al. (2021), with respect to where and by how much the atmospheric composition changed when the new LNOx parameterization was implemented. In my

opinion this would be best placed in either the introduction or at the start of Section 3.

- It would be useful to have a paragraph summarizing how the changes in LNOx impact ozone, CH4 and therefore radiation (Net TOA, downward LW, downward SW, surface LW and SW). The changes in radiation shown in Figures 1-4 and Table 1 are described in Section 3.2 and later in that section are attributed to changes in ozone (e.g. in Section 3.2, p. 15, L4-6 '*In terms of the differences from the base run, dry deposition has little effect, but increased LNOx increases the downward flux from ~ 40°N to 40°S presumably due to increased emission of LW by O3 produced by the LNOx.'*). It would be helpful to include a paragraph, possibly in the Conclusions, to summarize the impacts of the changes to the LNOx parameterization on atmospheric composition and how this drives changes in the radiation.
- Are the changes in radiation reported for clear sky or all sky? In Section 3.2, p.15, L7-17 the authors state that downward SW radiative flux at the surface is impacted by clouds through reflection and scattering of solar radiation, but when the new LNOx parameterization is used the increase in downward SW flux from ~20N-60S is attributed to increased ozone. Reporting changes in both the clear-sky and all sky would help to isolate the impact of changes in ozone on the downward SW.
- In Section 3.2 the authors find that the spatial distribution of LNOx changes the magnitude of the impact on the radiation. How does the spatial distribution of the radiation change between Runs C and D? Why does the spatial distribution impact radiation differently in Runs C and D?
- It would be helpful for the reader if the units on the figures (generally W m^{-2}) were consistent with those used throughout the text, where both W m^{-2} and W m^{-2} are used. Although the exception here would be the right-hand axis in Figures 1 and 2 where the absolute radiative flux is shown for the base run.

Technical comments (by manuscript section):

Section 2.4

L10: Please revise the sentence to make it a bit easier to follow.

=> ''…the other runs were calculated were indexed as follows on xaxis in relevant plots…'

L20-25: Could the authors please add a sentence to explain that Run D is to check the impact of the spatial distribution of the lightning flashes. While this does become clear, it is not immediately apparent as the reader reads through the manuscript.

Section 3

Hopefully Table 1 will appear before Figures 1 and 2 in the typeset manuscript!

Section 3.1

L19-26: It would be useful if these abbreviations could be tabulated, ideally within the main body of the text, although an appendix could also be useful.

L4-12: I would also suggest that the radiative fluxes for the observed and modelled values (both from ACCESS-UKCA and the CMIP5 ensemble) be tabulated so that the reader can clearly see where the differences and similarities are.

Section 3.2

L11-13: This statement should be expanded on given that nitrate aerosol forms from both nitrate and ammonium precursors. While the new LNOx parameterisation increases nitrate in the upper troposphere, ammonium forms from ammonia emission near the surface. The additional nitrate from the new scheme is therefore unlikely to drive any significant increase in nitrate aerosol. However, given the recent availability of a nitrate scheme in UKCA, this should be tested in the future.

L16: Please correct this sentence.

=> 'The contrast in radiation changes over land the ocean is not as stark as that over the tropical and nontropical regions, except for the no-LNOx case.'

L28: Could the authors please restate what the ozone ERF is? i.e. '…is 18% of the anthropogenic O3 radiative forcing of 0.47 ± 0.23 W m^{-2}

Figure 4: Pleased include units on the colour bars.

Section 3.4

L20: '… LNOx parameterisation…' -> '…**the** LNOx parameterisation…'

Conclusions

L3: representation -> represented

L17: '…with ramifications on Earth's radiation budget.' -> '…with ramifications **for the** Earth's radiation budget.'

L11-12: The authors report uncertainty ranges of 241 mW m-2 and 218 mW m-2 – should this be ±241 mW m^{-2} and ±218 mW m^{-2}.