

Geosci. Model Dev. Discuss., referee comment RC3
<https://doi.org/10.5194/gmd-2022-39-RC3>, 2022
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Reply on RC2 - regarding specific point 8

Declan Finney (Referee)

Referee comment on "Introducing new lightning schemes into the CHASER (MIROC) chemistry–climate model" by Yanfeng He et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-39-RC3>, 2022

I am largely in agreement with the reviewer's comments, except with regard to their specific point 8:

"One comment on the ICEFLUX as it displayed the downward trend of lightning flashes with rising temperature. Since the rising temperature would mean less ICE and less ICE FLUX, that would result in fewer lightning flashes. This probably suggests the intrinsic shortcomings for this scheme to simulate climate lightning trends."

I think whether there will be less cloud ice (in the column) in a future climate could be a more complex question than is implied in this statement, but that is not my main concern. I can go along with expecting less cloud ice at a given tropospheric pressure level due to warming (though there are possibly caveats even to that regarding e.g. aerosols).

My main issue, is implying that the use of cloud ice itself is an intrinsic shortcoming. If it's accepted that the non-inductive charging mechanism is an appropriate basis for a lightning parametrisation, then the implication is that in future if cloud ice (and cloud ice fluxes) reduce then electrical charging will reduce too. This provides a line of scientific reasoning to explain why lightning might reduce in future (whether we can reliably simulate the change in cloud ice in future is another matter).

The shortcoming/challenge of the ICEFLUX parametrisation is not its use of cloud ice, but its application of a pressure level. If seen as a challenge then one could take the approach of Finney et al. (2018) and adjust the pressure level in response to the changing climate. Or if seen as a shortcoming then I suggest the isotherm variation proposed by Roms (2019, <http://dx.doi.org/10.1029/2019GL085748>) is well worth exploring.

I recommend including a paragraph highlighting the above modelling considerations with regard to the ICEFLUX parametrisation and climate change simulations.