

Geosci. Model Dev. Discuss., referee comment RC4  
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## **Comment on gmd-2022-39**

Anonymous Referee #3

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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-RC4>, 2022

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## **Review of "Introducing new lightning schemes into the CHASER (MIROC) chemistry climate model" by Yangfeng He et al.**

### **General Comments**

This paper presents an interesting set of model experiments that tests different representations of lightning. Unfortunately it is rather unclearly written and many important details are missing, so I have struggled to fully assess its contents. Some of this lack of clarity and missing details are listed below in the Specific Comments section. For example, it is unclear what the un-nudged simulations represent, and it is hence difficult to interpret what is meant by the difference between the nudged and un-nudged runs (and these differences are large). Other aspects of the experiments are also not very clear – e.g., how is soil NO<sub>x</sub>, the other major natural NO<sub>x</sub> source, handled? Presumably it is somehow fixed. It is also unclear how the other major NO<sub>x</sub> emissions (anthropogenic and biomass burning) are prescribed in the experiments. Some of the units are incorrect or unclear. There is little detail about how the TROPOMI comparison is carried out, and I am unsure from what is written if averaging kernels have been applied correctly, to make this a valid evaluation. I appreciate this is mainly a paper that describes the lightning schemes and their differences, but it would be nice to include a bit more discussion on the interpretation of the differences, particularly as they appear to lead to very different trends in lightning. If all these points can be clarified in a revised version, then this paper may be acceptable for GMD, but in its current form it is not.

### **Specific Comments**

L8 most dominant -> dominant

L11-12 Sentence does not make sense

L19 Biases for what?

L27 Why does nudging make such a large impact on the trends? What do the un-nudged runs represent?

L27 Was the earlier study also 2001-2020 changes?

L30 reproducibility?

L35 Is there such a thing as unreactive NO?

L37 Finney et al (also I53)

L57 The schemes are not 'described above'

L57 I much prefer evaluated to "validated"

L66 CAPE – also clarify "CAPE x precipitation as a proxy"

L72 Contiguous?

L86 "This study" is ambiguous

L91 (etc) Capitalise Section references

L118 What about other natural NO<sub>x</sub> sources, e.g. soil?

L132 over land and ocean

L133 Check units

L135 Why was 440 hPa chosen?

L139 In the ECMWF scheme, why is no level specified for the frozen precipitation flux? Surely it varies hugely with vertical level?

L141 The units are a bit confusing (km, day); I suggest standardize on base SI units for all equations.

L142 Is alpha dimensionless?

L163-167 These alphas are not dimensionless and must have odd units that depend on the units used for CAPE.

L172  $z_0$  and  $z_{-25}$  already defined

L185 Definition of D is ambiguous (above 0C – do you mean positive temperatures or at altitudes greater than the 0C isotherm?)

L197 Capitalize Earth

L211 Clarify why you only use a subset of the ATom data.

L236 Table 2 could give more details of each experiment. E.g., are HTAP2 (2008) anthropogenic emissions used for all run years? Are the MACC GFAS biomass burning emissions annually varying? What is done with soil NO<sub>x</sub> emissions? Is nudging off equivalent to a free running climate?

L245 Why compare OTD data from 1996-2000 with simulations of 2007-2011? Are these

simulations with nudging on or off?

L353 Did you sample the model at TROPOMI overpass times, and then somehow produce the monthly mean values in Figure 9? Please clarify how you applied the averaging kernels to demonstrate that the model-satellite comparison is like-for-like.

L394 Clarify the plots in Figure 10 are all relative to CTH.

L422 Figure 11 I am unclear what the un-nudged runs represent. Do these runs somehow represent climate change over the 2001-2020 period, or are they completely unforced?