

Line 16: "update to the representation of physical processes". I think it would be nice to replace this by something more specific, such as "updates, including updates of emissions and the addition of brown carbon."

This line has been updated to "The Goddard Chemistry Aerosol Radiation and Transport (GOCART) model, which controls the sources, sinks, and chemistry of aerosols within the Goddard Earth Observing System (GEOS), recently underwent a major refactoring and update, including a revision of the emissions datasets and the addition of brown carbon."

Line 21: "and underestimates aerosol extinction over northern hemisphere boreal forests, requiring further tuning of emissions." -> In case you mean boreal forests, please briefly mention boreal forests in the results section, e.g. in Sect. 4.2.1. In case you mean biomass burning regions, please change boreal forests to biomass burning regions. Only in case you mean boreal forests, I also recommend to rethink the "requiring further tuning of emissions". In this case, one idea might be to place "requiring further tuning of emissions" directly behind dusty regions in the previous line and perhaps to write "requiring further investigation" where it now says "requiring further tuning of emissions". Over boreal forests, not only emission tuning, but also missing SOA formation mechanisms might be an issue. Another option could be to replace "requiring further tuning of emissions" by "requiring further investigation and tuning of emissions". If you are going to change boreal forests to biomass burning regions, "requiring further tuning of emissions" would seem fine to me.

The end of this sentence has been modified to state "requiring further investigation and tuning of emissions".

Line 121: please explain "replay"

The word "replay" has been removed and the sentence was updated to "Precursor gases for sulphate and nitrate are prescribed based on a prior GEOS simulation that was coupled to the GMI stratosphere-troposphere chemical mechanism and constrained by MERRA-2 meteorology (MERRA-2 GMI; Strode et al., 2019)."

In the author response to the reviews, the authors cite Levy et al. (2018) stating "users should not interpret global differences between Terra and Aqua aerosol products as representing a true diurnal signal." I recommend to mention something like this also in the manuscript, perhaps somewhere around Line 302.

"However, Levy et al. (2018) points out that differences due to satellite should not be used to indicate diurnal biases." has been added to the end of the paragraph.

Line 311: I think the increase of global mean AOD in GOCART-2G moving the GOCART-

2G global mean closer to the MODIS global mean may in part be due to a newly introduced AOD overestimate in the Saharan outflow in GOCART-2G (Fig. 4d)? Please discuss briefly.

Yes, agreed. The following sentence has been added, “However, this could have resulted from an overestimate in the outflow of Saharan dust that was introduced in GOCART-2G (Figure 4).”

Line 339: 4.2.4 -> 4.2.5

Fixed.

Lines 331 to 339 and Figure 7: I would have perhaps expected not only dust but also sulphate to display a more pronounced annual cycle over Europe. Based on this, it may seem that wet deposition in summer might be overestimated and long- and medium-range transport of sulfate (and dust) underestimated for some mid-latitude continental regions. Figure 17 shows a small annual cycle for sulphate over selected stations in Germany (only) at the surface. I think that uncertainties related to wet deposition could be mentioned and perhaps be explored in a future study.

The following sentence has been added “Uncertainty remains pertaining to the wet deposition of aerosols and how that may contribute to biases in the seasonal cycle of AOD of Europe, warranting future investigation.”

Lines 497 to 505: Given many other uncertainties, this seems very speculative. Das et al. investigate a single event. I do not think that their study alone provides sufficient evidence for this speculation here to be overly plausible.

An additional reference has been added that documented concerns with smoke transport to Europe in a GEOS simulation (<https://doi.org/10.5194/egusphere-2023-1945>).