

Geosci. Model Dev. Discuss., referee comment RC4
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Comment on gmd-2021-49

Anonymous Referee #4

Referee comment on "Description and evaluation of a secondary organic aerosol and new particle formation scheme within TM5-MP v1.2" by Tommi Bergman et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-49-RC4>, 2021

The authors describe and evaluate a new secondary organic aerosol (SOA) scheme implemented in the TM5-MPv1.1 chemical transport model used in EC-Earth3-AerChem. This version of the EC-Earth model has been used to contribute to the AerChemMIP element of CMIP6 so this paper provides useful documentation and insight into the behaviour of this model version. The paper is within scope of GMD and I recommend publication if the following minor issues are addressed:

General points:

Throughout, the reader would benefit from some more clarity or consistency as to how the two schemes are referred. The terms "NEWSOA" and "OLDSOA" could be introduced earlier to help the reader keep track of which parts of the model description relate to which results. For example, referring to the "TM5 aerosol distribution" (as in the Fig 9 caption); it is not clear whether this is TM5 with the SOA developments included or not.

Similarly, it would be clearer throughout to refer to the model performance being improved or degraded relative to observations rather than increased or decreased, as there are a lot of numerical values that increase and decrease.

Minor / specific points:

Line 10-11: Reword to clarify which value (modelled or observed) is lower than which.

Line 17-18: Reword to clarify what the retrievals or observations are of (AOD?)

Line 34: correct "vegetation"

Line 150: this section could be clarified to confirm whether the split of the 15% and 5% yields into ELVOCs and SVOCs (I.e., 1% ELVOC and 14% SVOC for the monoterpene + OH reaction) is also based on Jokinen *et al.*, (2015) - if not how were those values determined? If the total values and the split values are from Jokinen *et al.*, (2015) then this citation should be added to the Table 1 caption.

Line 164: can you clarify in this section whether the equilibrium partitioning approach is reversible or irreversible?

Line 175-176: this implies that ELVOCs cannot condense onto particles in the nucleation mode but could you add a note to confirm? If so, does that leave a gap - i.e., ELVOCs can grow particles up to 5 nm diameter, but not beyond?

Line 191-192: In Riccobono *et al.*, (2014), *BioOxOrg* represented the product of oxidation of monoterpenes by OH specifically so this description could be clarified slightly to explain that you are including a wider set of products (by using ELVOCs).

Line 218+: Add a note here to clarify whether / if all the other emission sources are identical between your simulations (i.e., the only difference is OLDSOA -> NEWSOA).

Line 250: should "overpresented" be "overrepresented"?

Line 358: stray "fig" here

Line 360+: it would be useful to restate in this section (and the Figure 8 caption) where these stations are, even just by reference to Table S3.

Line 361: correct "increas"

Line 368-369: can you specify at which two stations the particle number concentration decreased in NEWSOA relative to OLDSOA? This may aid with the subsequent explanation.

Line 479: I couldn't find a Fig. S13

Line 490+: this description, in terms of the differences between the MODIS and AATSR comparisons, doesn't seem to align with Figure 13 – can you check that this is the correct Figure? (this may relate to below comment about Figure 13 caption/legend)

Line 507+: would it be more informative to show the seasonal cycle for each hemisphere separately?

Page 41, Figure 13: the caption suggests that this is the difference between NEWSOA and two different observations rather than NEWSOA - OLDSOA as the legend indicates, can you correct the caption / legend?