Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-413-RC1, 2021

Geoscientific Model Development Discussions
Open Access
EGU

Interactive comment on "EC-Earth3-AerChem, a global climate model with interactive aerosols and atmospheric chemistry participating in CMIP6" *by* Twan van Noije et al.

Anonymous Referee #1

Received and published: 15 February 2021

1 General

The paper "EC-Earth3-AerChem, a global climate model with interactive aerosols and atmospheric chemistry participating in CMIP6" presents the configuration of the EC-Earth3 climate model used for the AerChemMIP CMIP6 simulations. This configuration adds interactive tropospheric aerosols and tropospheric chemistry to the standard configuration. A thorough description of the aerosol scheme is given followed by an analysis of a few diagnostics, mainly the surface air temperature, from some CMIP6 simulations. As a general comment, I would like to emphasize that the whole paper is very clearly written, and the reader goes through numerous details easily, in a very

Printer-friendly version

Discussion paper

fluent way. This a far from being an obvious exercise, congratulations to the authors for that.

This being said, I would like to distinguish two parts in my review.

Firstly, my comments concern the descriptions of the model, and more specifically those of the aerosol characteristics and their interactions with the rest of the climate model. The CMIP6 version builds upon previous versions, in particular that described in van Noije et al. 2014, and the new features are presented here with very precise and specialized details. This is of great interest to those analyzing outputs of this scheme and evenmore to the whole aerosol modelling community. The number of new features in the CMIP6 version is truly impressive. I only have a few suggestions and or questions that I list below in the following section.

Secondly, I would like to indicate that the results shown are not so convincing and would benefit from additional analyses. Results concerning global surface air temperatures in the CMIP6 historical simulation are shown from 4 realisations, three of which show quite large interdecadal variability, one shows quite a substantial cooling during most of the 20th century, and none shows a warming trend comparable to that of observations at the end of the period.

The authors note this "spurious interdecadal variability" and indicate that it has been seen in other EC-Earth3 configurations described in Doscher et al. GMDD, 2021. They point that the instability is related to the use of NEMO3.6 ocean model and ORCA1 grid. This explanation do not seem fully appropriate as for instance the CMIP6 CNRM climate models (CNRM-CM6-1 and CNRM-ESM2-1), that share the same ocean model and a comparable ocean grid, show evolutions of the global surface temperature consistent with observations throughout the 20th century.

Later on, the authors indicate that "The cooling of the Northern Hemisphere simulated in the 1950s and 1960s may also be caused or enhanced by aerosol effects... Simulations that provide more information on the role of aerosols and their effective radiative

Printer-friendly version

Discussion paper

forcing contributions are in production".

I would strongly urge the authors to present further analyses on these issues, especially concerning the role of the aerosols. Furthermore, such a large spread in the historical simulations raises doubts on evolutions of the other simulations shown. Therefore, analysis of additional members of both the historical simulation, but also the hist-piNTCF simulation, and the scenario simulations ssp370 and ssp370-lowNTCF would be of benefit to the paper. The authors indicate that such additional members are under production.

Finally, the impact of the complex aerosol scheme should be better highlighted. Either this impact is important or not, positive or not, in the model behaviour, but this should be made clear in the paper.

2 Comments/questions

- in addition to information of Table 1, it would be of value to add a table with extinction, single- scattering albedo and asymmetry factors, at 550 nm and 80% humidity for instance
- it is not so clear to me how you deal with stratospheric ozone:

  line 61 you indicate that there is a difference between EC-Earth3 and EC-Earth3-AerChem in "lower-stratospheric ozone": why is that?

  and line 383: how do you deal with differences in the tropopause between your model and the CMIP6 ozone data?
- line 215: please indicate how the wet deposition of aerosol is performed, from convective precipitation and from stratiform precipitation, considering 3D precipitation fields from IFS or...?

- line 338: could you detail why you use fixed values of CDNC here?
- line 423: it would be interesting to have a Table summarizing emitted quantities
- line 502: I could not find in Dentener et al. 2005 recommendation for emission of SO4. Please provide further details
- line 544: you use a fixed number of layers, independently of the tropopause height?
- line 552: have you done any testing for 3h exchange of fields?
- line 608: please indicate names of such regions you observed such a discrepancy in particle number concentration
- line 620: it is more common to nudge winds. Do you have a reference for such a configuration?
- line 780: a usual climatology covers a 30-year period. Why did you restrict it to a 20-year period?
- line 784: biases over Antarctica seem to be larger than 6K, please specify the maximun biaises
- Table 6: could you add fields transferred from IFS to TM5?
- how do you deal with aerosol transport (large-scale and small-scale ones)?
- last paragraph of the paper: "Meanwhile a number of developments ...": more complexity is not always the way forward for a climate model. What about going to an on-line description of the aerosols and chemistry, making use of recent developments in the IFS in the MACC and CAMS projects? not to mention the numerical advantages, this would also allow better coherence between EC-Earth and EC-EarthAerChem. Please elaborate on that in the concluding remarks.

3 Minor remarks

- line 48: I suggest: "Other EC-Earth CMIP6..."
- line 65: "as follows:"
- line 80: It is "perturbing" for a meteorologist, or for me at least, to refer to IFS here, outside the Numerical Weather Prediction context, and knowing that a number of adaptations have been made to the original IFS. Please indicate more clearly that you call "IFS" the atmospheric component of EC-Earth-AerChem although it difers from the original IFS cy36r4.
- line 97: what is the reference for the stratospheric aerosol radiative properties?
- line 106: from the release 3.6
- line 126: "specific release" instead of "specifically release"?
- line 128: what vertical domain is covered?
- line 149: please specify what "of these particles" refer to
- line 246: no clear whether the three aerosol optical properties are computed on-line at each time step of the radiation scheme (or the aerosol scheme) or whether the calculation of aerosol optical properties has been made just once and look up tables are used. Please clarify.
- line 281: please indicate: 'Thus, the LW absorption in EC-EarthAerChem..."
- line 314: please indicate units
- line 347: please indicate units

- line 390: please clarify what you mean by "calculated from the CMIP6 input data," what are these CMIP6 data?
- line 392: can you explain why this vertical domain was chosen?
- line 444: towards what is the global dust emission tuned?
- line 633: in the SW ERFaci you mean?
- line 707: what are these several reference values?
- line 718: please indicate the offset
- Figure 2 legend: Times series of the global (a) ....and (b)
- Figure 6 legend: please indicate which statistical test has been used
- Figure 7 and 8: more distinct than orange, brown and red colors would help

---

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-413, 2020.

Printer-friendly version

Discussion paper