

Referee review of Doscher et al: "The EC-Earth3 Earth System Model for the Climate Model Intercomparison Project 6"

General comments

This manuscript describes the EC-Earth3 modelling system and components as used for the CMIP6 experiments. It describes different configurations, model performance, tuning, reproducibility on different supercomputers, and some aspects of scientific performance.

The manuscript is very well written, logically arranged, and gives a good overview of what model components are used in different configurations and how the model performs compared to the CMIP5 equivalent. As well as describing the EC-Earth system, some aspects such as the reproducibility on different machines may be more generally applicable. As noted below, there are several places where a little more explanation could make some of this work more relevant to other models.

Specific comments

Line 83: Are google hits a good measure, since they will vary over time.

Line 124: I realise that you do this later, but maybe the references for the different model components should be here as well or instead of later?

Line 179: Do different configurations of the model have different E-P imbalances, and hence is this flux corrector changed? Also how do future projections work, might having this corrector affect how the future change in runoff is simulated?

L219: can you state which timestep is used in the final model (perhaps refer to the table)

L239: I think this sentence would be clearer if rewritten, e.g.: The goal was to maintain the same atmospheric tuning as much as possible, and only modify the ocean and sea-ice parameters...

L386: Do I understand that this is not a dynamic ice sheet (i.e. it cannot grow or shrink). It may be worth noting this just for clarity, or if I misunderstand then clarifying what the ice sheet can do.

L516: was the closure of Bechtold included in the model (it is implied but not said).

L516: for what reason was the Rayleigh friction included - the other changes have reasons why they were included.

L566: it might be useful to briefly mention what processes are missed by the MACv2-SP scheme, such as natural aerosol variability.

L1025: Can you say any more about the Southern Ocean warm bias? For a 1 degree model this seems quite large.

L1142. You note that the AMOC strength is close to observations, but why is there no mention of the northward heat transport, which is as or more important for the climate state. Some mention of how this compares to observations would be welcome.

L1196: You make no mention of the large range in power of the different ensemble members. For example, does the member with the strongest ENSO power have any other climatological differences, is such as range understandable?

L1213: Are there any hypotheses for the reason for the improvement in the ENSO-NAO that could inform other models?

Table 2: It is implied that the timestep in the ocean and atmosphere are the same, could this be stated explicitly.

Table 3: The variable “Sensitivity of non solar heat flux” may need more explanation.

Table 12: I’m not sure what is meant by “Mem.B. is the division between the theoretical memory of a memory and the real one”.

Table 13: I’m slightly concerned that the web links used in the table here will not be persistent years hence, references to the datasets themselves used may be better (or in addition).

Fig. 2c: I hope the quality of this will improve, the black dots are difficult to see.

Fig. 4: would be nice to have this split into land and ocean to better understand.

Fig. 6: The bias in pr might be more instructive than just the full field – as you have done for the other variables.

Fig. 10: In Fig. 10b have EC-Earth#19 on it?

Fig. 11: I assume the quality of this figure will improve in the final version.

Fig. 15: I confess I don’t find this figure very instructive as it is, as a rather bland mean with no orography shown, in z-space. I think it would be much more useful if you showed (either or both) of the overturning in density space, and/or some measure of where the variance between ensemble members occurs.

Fig. 17: big range

Technical corrections

Line 82: Need an open bracket (e.g. Koenigk

Line 219: testwise – is this a typo?

L241: I think sought may be better than searched.

L264: I think you mean “... interactive vegetation (using LPJ-GUESS)...”

L311: Repeat of the title of the next section

L455: typo “and. Is”

L1197: “impact on”

L1352: “though n”

Table 6: 4.2e-5 → 4.2E-5 for consistency.

Table 11: the formatting of the table is slightly off for each row.

Fig. 18 caption: Regression of Nino3.4 SST index onto...