

Geosci. Model Dev. Discuss., referee comment RC1  
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## Comment on gmd-2021-312

Anonymous Referee #1

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Referee comment on "Description of historical and future projection simulations by the global coupled E3SMv1.0 model as used in CMIP6" by Xue Zheng et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-312-RC1>, 2021

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### **Review of "Description of historical and future projection simulations by the global coupled E3SMv1.0 model as used in CMIP6" by Zheng X. and co-authors.**

The study documents the experimental setup and main characteristics of the historical and scenario simulations generated with the Earth System Model E3SMv1.0. The simulations follow the CMIP6 protocol under historical and the SSP5-8.5 scenario. The authors describe the main changes in global surface temperature and precipitation, ocean state, and runoff by 2100. The study also compares full-forcing scenario simulations with greenhouse-gas-only simulations, which allows the authors to assess the influence of aerosols in the slight cooling trend in the late 20<sup>th</sup> century.

The paper is important to document the experimental setup. It is clearly written and structured. I only have minor suggestions to extend and, in my view, improve the quality of the analysis presented, before the paper can be accepted for publication.

i) All variables may be compared over the historical period: while global surface temperature and precipitation, in Figure 1, are shown since 1850, all the other time series (Figures 7, 11, 13) start in 2014. Extending these time series back until 1850 too will help assessment of the historical part as well.

ii) The paper will benefit if some other variables are also included to assess dynamical changes in the climate: for example, changes (maps) in winter vs. summer precipitation, atmospheric jets (via zonal wind at 250 hPa), storm tracks, ENSO variability (spectrum over reference periods), sea ice volume, or the spatial pattern of the AMOC (in addition to the time series).

iii) Whenever possible, I suggest including observed time series as a reference.

#### **Minor points:**

L7: You can give the value of the model's climate sensitivity here too.

L8: Can you elaborate on how changes in runoff respond to precipitation changes.

L9-11: I suggest talking first about all oceanic changes (mixed layer depth, AMOC) and

then about sea ice.

L11: Can you give the AMOC weak strength as a reference?.

L16: Certain regions: Which ones in particular?.

L33: Is it known why the climate sensitivity is so high in this model?.

L128: at the lower end: this is hard to see in the Figure because it is clipped at 0. I suggest extending the vertical axis.

L136: Is there a value for the correlation?.

L140-143: The temperature pattern can briefly be described too, as done for precipitation.

L143: I would also say the ITCZ seems to narrow over the central and earth Pacific while it seems to shift northward over the Indian and Atlantic (increasing their precipitation over their monsoon regions).

L154-157: Because it is directly related to the Tair temperature series, the description of Figure 4 can come before the description of the maps.

L157: I suggest a paragraph break before "Besides".

L161: It is not entirely clear why the mention of the Golaz et al. (2019) paper on SST anomalies is relevant here. Can you clarify it?.

L187: A substantial difference is not very precise. Can you give a value?.

L192: Give approximate periods when there is asymmetric cooling and warming.

L215: Can you give the mean values of the simulated and observed AMOC that are here compared?.

L234: contributes to.

L240: Runoff also decreases over the Amazon basin (assuming this is not included in Central America).

L245: The correlation coefficient between runoff and precipitation changes is needed.

L244: It is not clear what is meant by "the position of E3SMv1.0".

L253: Contribute to

L255: Please, clarify "high-level features"

L259: "In the absence of all other external forcing,"

L269: This warming slow down is hard to see. In Figure 1, the Tair trend (as the first derivative of the curve) in the full-forcing ensemble progressively increases until it matches the trend in the GHG-only runs by 2100. In Figure 2 the smaller polar amplification in the GHG-only runs compared to the full-forcing ones is because the mean temperature of the reference period is initially different. In Figures 5 and 15a any reduction in the warming rate is also difficult to see because the color scale saturates above 9K. And in Figure 15c, the difference in trend by 2100 are relatively small (0-0.5 K

in 30 year) and of different sign in the NH and SH, which compensate each other globally (so the similar trends in Fig. 1a). I would propose a simpler interpretation of these figures, with the full-forcing runs having the GHG-related warming delayed by the cooling effect of aerosols, which, once removed, leads to a transient faster warming in the first half of the 21<sup>st</sup> century.

L297: "increases more significantly" no statistical test has been included to prove this.

L303: "reducing deep convection" This is partially shown in the Figure 10.

L310: Changes in SST are not only necessary driven by ocean dynamics. There can be thermodynamic processes as well, for example, related to increases energy flux through the surface.

Section 3.2.3: I would propose extending the Kolmogorov-Smirnov test to the other variables compared between the full-forcing and GHG-only runs to highlight where anomalies are statistically significant. Also, I would add the information in Figure 16 to Figure 14, for example as a stippling masking non-significant anomalies, which is a standard way of including significance test on plots. In the current format, comparing Figure 14 and 16 by eye is difficult. The statistical test can compare the reference period vs. the late-21st century period for the full-forcing plots, and the full-forcing vs. GHG-only late-21st century differences for the GHG-only plots.

Figure 4 may be merged with Figure 1 (if new figures with new variables are to be included).

Figure 12 is barely discussed. It could be removed or moved to the supplement. Also, why the reference periods are different, for example, compared to Figure 2?