

Interactive comment on “An emergent constraint on Transient Climate Response from simulated historical warming in CMIP6 models” by Femke J. M. M. Nijse et al.

Anonymous Referee #2

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Review for “An emergent constraint on Transient Climate Response . . .” by F. Nijse et al. In this paper authors apply the concept of “emergent constraints” to new CMIP6 model data aiming to restrict a possible range of Earth climate system sensitivity to CO₂ doubling. The topic of the paper is of considerable importance especially in the light that many of CMIP6 model demonstrate increased sensitivity to CO₂ forcing (5K+/2xCO₂). The paper fits well within the scope of the journal. I recommend the paper for publishing in general but I think some aspects of the paper should be improved.

General comments:

C1

1. The concept of emergent constraints must be explained much better. Please expand your definition “By definition, we expect . . .” of emergent constraints on line 55 to be understandable for an inexperienced reader. Why TCR has to be correlated with GMST changes across a model ensemble? Models are different, some could have wrong dynamics and incorrect response (Green) function correspondent to CO₂ forcing etc. From the paper conclusions it follows that some of the models have wrong TCR while other models are based on the same principles and use more or less the same parameterizations, so why one should believe that TCR/GMST change ratio should be the same for models and for real climate system?

2. Authors must be more careful with the use of definitions.

As far as I understood, the TCR is defined as the change of model/climate system GMST (in K) from equilibrium conditions at the moment of CO₂ doubling (1%/year forcing for CO₂ only). Then what is TCR in “idealized” conditions?

“Global warming” is a general concept, you cannot relate/correlate it with TCR in K (line 50, line 55 etc).

3. It could be interesting to have CMIP5 model results for comparison on Fig.2a and Fig.4 as well.

4. It should be pointed out that GMST changes are estimated with respect to the non equilibrium state (1970-80 average). Will the green line at Fig.2a cross TSR=0 near the out-of-equilibrium temperature-in-1975 (around -0.4K)?

5. Why 13 models only for CMIP6? Zelinka et al., GRL, 2020 analyzed 27 CMIP6 models. . .

Special comments:

Lines 20-25. TCR and ECS are introduced for ESMs where they are well defined characteristics for each ESM. On the next line (line 26) paper says that “both TCR and ECS remain uncertain”. What do you mean here?

C2

Line 50. Relationship between historical warming (expressed in terms of GMST) and TCR?

Line 55-60. "By definition, we expect...". What "definition" do you mean? What are "idealized" conditions? (Are they somehow different from the ones used in your definition of TCR on lines 20-25)?

Line 80. Could you please provide link to the data.

Line 107-108 Can you illustrate the similarity between aerosol forcing in 1970-80 and 2010-2020?

Line 120. "The major uncertainty...". This sentence falls out of the context.

Line 122. Can you give a number for correlation between TCR and ΔT .

Line 129-131. Move this sentence upward to line 85 (definitions of the table 1)?

Line 200 (Appendix). Appendix does not clarify anything. Either remove or expand it.

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