Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2019-86-AC2, 2020

Earth System Dynamics
Discussions
Open Access
EGU

Interactive comment on "An emergent constraint on Transient Climate Response from simulated historical warming in CMIP6 models" *by* Femke J. M. M. Nijsse et al.

Femke J. M. M. Nijsse et al.

f.j.m.m.nijsse@exeter.ac.uk

Received and published: 24 March 2020

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

Reviewer comments are listed in italics below, followed by our responses in normal font.

Anonymous Referee #2 Received and published: 5 March 2020

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 dou-

Printer-friendly version

Discussion paper

bling. 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:

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 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?

— Response: we have added further explanation of the concept and assumptions (see response to comment 2 below).

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).

— Response: the paragraph about TCR has been rewritten, making clear that there is only one definition of TCR, and that global warming is defined here as rise in GMST. We further explicitly acknowledge that emergent constraints assume there is no systematic error in the relationship, with a reference to Winkel, Myneni & Brovnik (Earth system dynamics, 2019) and how this emergent constraint is in line with theoretical expectation (JM19).

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

—Response: We've added the CMIP5 models to Figure 2a, but Figure 4 became too crowded with both model ensembles.

4. It should be pointed out that GMST changes are estimated with respect to the nonequilibrium 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)?

—Response: we have adjusted the limits of the figure so that the intercept is visible. The intercept location is highly dependent on the regression method, with those methods assuming the error to be solely in the y-variable (OLS, Hierarchical) getting a positive intercept, while methods assuming similar errors in x and y (orthogonal distance regression), portraying a negative intercept. Per the theoretical foundations of JM19, we expect an approximate zero-intercept in this non-equilibrium regime.

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

—Response: at the time of submission, there were only 13 models for which all necessary information was available, including future scenarios. Now a larger set of 24 models is available. We have also included the emergent constraint with 31 models that ends in 2014 for which scenarios runs are not required.

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?

—Response: We have clarified that the TCR and ECS values that we seek relate to the real climate system. These real-world values are still poorly known, even though ECS and TCR are well-defined for each model.

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

—Response: Added.

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)?

—Response: The paragraph has been rewritten. ‘By definition’ has been changed to ‘from physical principles’, and it has been made clear we use the normal definition of TCR.

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

—Response: In addition to a reference to the ESGF nodes, we will upload all the code, including the data, to Code Ocean.

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

—Response: we have added a graph computing the spread in effective radiative forcing in the appendix. This graph shows that the spread is highest in the sixties and early seventies.

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

—Response: we have removed the sentence and moved the reference to the introduction.

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

—Response: Yes, the correlation is 0.84 for CMIP6, and 0.63 for CMIP5. Added.

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

—Response: done.

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

—Response: the Appendix has been rewritten completely and a figure has been added for extra clarity. The pseudo-code has been replaced by normal equations for easier understanding.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2019-86, 2020.