

Earth Syst. Dynam. Discuss., author comment AC3
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Reply on RC3

Josep Cos et al.

Author comment on "The Mediterranean climate change hotspot in the CMIP5 and CMIP6 projections" by Josep Cos et al., Earth Syst. Dynam. Discuss.,
<https://doi.org/10.5194/esd-2021-65-AC3>, 2021

Dear Referee,

The authors would like to thank you for your time and the revision of our preprint. The suggestions will be of great value to improve the manuscript. The main impression we extract from your comments is that our work is lacking some physical justification of the hotspot and the projections. We will try to take it into account in the revised work by more carefully studying the current knowledge on the drivers of the Mediterranean hotspot and their implications through the different CMIPs.

We would also like to take advantage of this message to discuss specifically some of the comments received (*italics refer to your comments*):

- *The manuscript would be of higher value if there are some comparisons with similar works performed in other geographic sectors of the world. For example, there are some recent efforts focusing on regional climate issues in China (Zhu et al. 2020, 2021, Li et al. 2021: <https://doi.org/10.1007/s00376-020-9289-1> ; <https://doi.org/10.1016/j.scib.2021.07.026> ; <https://doi.org/10.1007/s13351-021-0067-5>).*

Thanks a lot for the suggestion. We will consider adding such a comparison in the revised manuscript discussion.

- *Although CMIP5's RCP scenarios are close to CMIP6's SSP scenarios with the relevant nomenclature, there are indeed subtle differences for greenhouse gases, especially for emission of aerosols. This seems ignored in the present manuscript. In a more general manner, differences between CMIP5 and CMIP6, as analysed in the manuscript, include many aspects involving both anthropogenic emissions and improvement of models' physics and resolution. It seems that one cannot make a clear idea or conclusion, with what presented in the manuscript.*

Thanks for letting us know that the manuscript seems to be lacking comments on the differences between RCPs and SSPs. Even if the authors consider that in section 2.1 (l.80) their differences are reviewed, we will try to make it clearer in the new iteration of the manuscript.

Regarding the conclusions that can be extracted from the manuscript in terms of CMIP5 and CMIP6 differences, there is no clear statement that can be drawn without being speculative. Therefore, the authors have based their understanding of the differences between CMIPs on the current literature, such as differences in the cloud feedbacks, aerosol forcings and aerosol-cloud interactions.

- *The ensemble-processing algorithm, based on models' performance and independence, imposes an observation constraint. The authors state that its use can make closer the results of CMIP5 and CMIP6, and make smaller the spreading of each ensemble among its members. They also point out a few exceptions. Are there any explanations? Generally speaking, the manuscript seems a little too descriptive and lacks physical interpretation.*

Thanks for pointing this out. The authors agree that further physical interpretation of the outcome of the weights should be conducted.

In the manuscript, we based the justification of the CMIP6 ensemble shifting towards CMIP5 on the emergent constraints work from Nijesse et al. 2020 and Tokarska et al. 2020. Their work states that models with higher climate sensitivity aren't consistent with the observed global warming trends. We have conducted further tests and found out that this is not a good explanation for our constraining weights obtained in the Mediterranean region. This is displayed in the figures shown below. Figure 1 represents the performance weights (left) and the full weights (right) against their 2081-2100 warmings with respect to 1986-2005 for DJF (a) and JJA (b). It aims to highlight which effect has each weight (independence and performance) on the ensemble distribution shifts.

The differences between the left and right panels highlight how the independence weighting is the one reducing the warming from the CMIP6 ensemble rather than the performance weighting. CMIP6 Performance-only weights shift the ensemble to the high end of changes for JJA while they keep the ensemble quite unchanged for DJF. Contrarily, the addition of independence weighting shifts it to the lower end for both seasons. It can also be seen that the addition of independence weighting doesn't affect the CMIP5 mean state.

Therefore, an interpretation of the weights that shall be included in the revised manuscript is that CMIP6's distribution is moving towards the CMIP5 ensemble because of the independence weighting effect.

As a final justification of why the simple explanation on the basis of the ECS is not applicable, we display, in Figure 2, the performance (left) and full (right) weights against the model's ECS for DJF (a) and JJA (b). The figure shows how performance gives weight to models with high ECS in JJA and doesn't down-weight them in DJF. Therefore we can't see a clear relationship between low performance and high model's ECS.

In the revised manuscript we will base the justification of the weighted CMIP6 shift on the causes and effects of independence discrimination.

- It is a little disappointing to see only mean climate (for both surface air temperature and precipitation) is processed here, without consideration of any extreme climate events or their representative indices.

The authors agree that it would be very interesting to assess extreme climate events.

Nevertheless, we have considered that the paper is already too dense to add this kind of indices. Thanks for the suggestion, it will definitely be part of our future work.

Nijse, F. J. M. M., Cox, P. M., and Williamson, M. S.: Emergent constraints on transient climate response (TCR) and equilibrium climate sensitivity (ECS) from historical warming in CMIP5 and CMIP6 models, *Earth Syst. Dynam.*, 11, 737–750, <https://doi.org/10.5194/esd-11-737-2020>, 2020.

B. Tokarska, M. B. Stolpe, S. Sippel, E. M. Fischer, C. J. Smith, F. Lehner, R. Knutti, Past warming trend constrains future warming in CMIP6 models. *Sci. Adv.* 6, eaaz9549 (2020).

Please also note the supplement to this comment:

<https://esd.copernicus.org/preprints/esd-2021-65/esd-2021-65-AC3-supplement.pdf>