

Response to Referee #2 (in blue italics)

The authors present the results of CMIP6 ScenarioMIP focusing on surface air temperature and precipitation. They find similar characteristics in the temperature and precipitation patterns to those simulated by CMIP5 models. They also depict the temperature and precipitation changes under the new scenarios in CMIP6, such as SSP1-1.9, SSP3-7.0 and SSP5-3.4OS.

This is a comprehensive study of CMIP6 ScenarioMIP, summarizing the results of multiple global warming scenarios from CMIP6 and providing some new insights. However, I feel some clarifications are needed to justify the results.

Thank you for your positive assessment and your help in clarifying our results.

Lines 212-213 “This suggests that the model response uncertainty increases for stronger responses”. Why does model response uncertainty increase for stronger responses?

We will elaborate in the text, by pointing out that models’ structural differences are encapsulated in their different climate sensitivities, and stronger forcings “exercise” that aspect of models more than weak forcings do. So, it is expected that for higher scenarios and later periods when climate sensitivity more strongly shapes the response, that response will be most variable among models that differ significantly in their climate sensitivities.

Line 223: The authors define “separation”, and use “a 21-year running mean” (Line 227) and “choose 0.1C as the threshold” (Line 228). Why is a 21-year running mean used here instead of a 9-year or 11-year running mean? The latter two running means I can understand aim to minimize the interannual variability, but what is the purpose of the 21-year running mean? Will the results of “separation” be sensitive to the two parameters of the running mean and 0.1C?

We used 21-year running means to more conservatively beat down internal variability, noting that it is not uncommon to find the 20 (or 21 for symmetry purposes)-yr span used as a smoothing option when looking at climate outcomes for average temperature and precipitation. Undoubtedly, changing to a shorter time-mean or asking for a larger separation than 0.1C would change the results and we now add this caveat explicitly.

Fig. 1. Are they annual mean time series of temperature and precipitation?

Yes they are, apologies for forgetting to specify that. We actually propose to redo this piece of the analysis by using decadal running averages, also in the definition of the standard deviation, to put less focus on year-to-year variations and concentrate on climate behavior.

Part 3.1.3 Would be it possible to show the difference between the SSPs and RCPs more explicitly? For example, plot the time series of the differences of temperature and precipitation between the SSPs and RCPs? Also show the spatial pattern of the difference, i.e., the global map of the difference of temperature and precipitation change/trend in the 21st century between the SSPs and RCPs? Besides, please explain

why are SSPs induced changes different from their corresponding RCPs? What is the factor accounting for the difference and through what processes? Additionally, please note the superscripts and subscripts in the denotations. For example, “ 2.6Wm^{-2} ” (Line 364), “ 0.5Wm^{-2} ” (Line 400), “CO₂, CH₄ and N₂O” (Line 419).

We corrected subscripts and superscripts, thank you for noticing that.

We describe how the CMIP6 ensemble has models with higher climate sensitivity and, in the text and Figure A7, we provide a description of the differences in radiative forcings between RCPs and SSPs and cite references for that. We think these are the main sources of differences in the global time series and we would rather not show year by year differences in time series between experiments where both the forcings and the models have changed. We also point at the results in Figure 1 of <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019MS001940> attesting to substantial differences in GHG forcings between the RCPs and the SSPs. Since the models may be modeling aerosols differently in CMIP6 (vs CMIP5) a straightforward comparison between the two scenarios/experiment results is not possible. We added some additional discussion and references in the text motivated by your inquiry, for example to Smith et al. 2020 (<https://doi.org/10.5194/acp-20-9591-2020>) discussing differences among models in radiative forcings and climate sensitivities and to Nicholls et al. 2020 (<https://doi.org/10.5194/gmd-13-5175-2020>) which evaluates differences between RCPs and SSPs with Reduced Complexity Models. As for differences in patterns, also in response to Reviewer 1's suggestions, we plan to show differences in the normalized patterns between CMIP5 and CMIP6, after aggregating over scenarios (as we do not find scenarios to be a strong source of variation). We hope this will be satisfactory.