

# ***Interactive comment on “ESD Ideas: Global climate response scenarios for IPCC AR6” by Rowan T. Sutton and Ed Hawkins***

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We thank the referee for their thoughtful comments on our article. We repeat the comments here, together with our responses.

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This article proposes a new methodology to fill the gap of the current existing IPCC scenarios. I should admit that I am not a climate modeler and have expertise in integrated assessment modeling. Thus I can comment from that perspective and need other climate expert's points of view. I list the main arguments below.

1) The current title and abstract lead misunderstanding of the contents and should be reconsidered. In the abstract, there is a problem statement “but the IPCC has not de-

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veloped similar discrete scenarios”. However, the issue is wrongly stated. First, after SRES IPCC never develops scenarios. IAMC (Integrated Assessment Modeling Consortium) generated RCPs and SSPs during the last decade but they are certainly different from IPCC. Second, assuming that the RCPs and SSPs are a set of scenarios addressed by the authors here, the authors are correct within the CMIP context in a way that the socioeconomic scenarios are not discrete because the full-scale climate models cannot be run for such a large number of scenarios. To this end, a series of past IPCC assessment reports used simple climate models to represent CMIP3 and CMIP5 climate model behavior with ranges of embedded parameter ensembles. So, the issue is neither nonexistence of discrete scenarios nor how to use the scenarios. I think what the authors demonstrate in this paper is just one of the examples of how to use the CMIP results (not the scenario issue).

RESPONSE: We accept that IPCC did not itself generate the RCPs and SSPs and will correct this point. We also agree that simpler climate models have often been used to explore a wider range of socio-economic scenarios than is possible with complex (CMIP-class) climate models, although WGI (which is the focus of our Idea) has placed great emphasis on the specific set of socio-economic scenarios used for CMIP.

However, the focus of our Idea is not socio-economic scenarios at all but rather the representation by IPCC of information about uncertainty in the climate response to anthropogenic forcing. In past assessment reports this information has usually been expressed in terms of a likely range based on CMIP results, e.g. the likely range for global mean surface temperatures under a particular socio-economic scenario. Our argument (following Sutton 2018 & 2019) is that such an approach is flawed because it does not meet policy-maker needs for risk assessments which require specific attention to high impact scenarios even if they are considered unlikely to arise (noting that according to IPCC calibrated language unlikely means only  $\leq 33\%$  chance). We therefore propose as an alternative that IPCC should develop and exploit a set of scenarios to sample the uncertainty in the climate response, and in doing so should pay specific

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attention to high impact scenarios. Our paper then explains a simple way in which this can be done.

We have modified the abstract and introductory paragraph to explain our aims more clearly. We disagree that the title is misleading as it focuses specifically on climate response scenarios which are the subject of our paper.

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2) Following the above point, the series of IPCC reports in WG3 has shown the climate implications with probability and uncertain ranges of climate models. In the assessment, climate sensitivity has been already considered to generate the parameter ensemble of simple climate models sampling various parameters simultaneously. Thus, figure 1 panel c has been already addressed. The new thing here would be to show the climate outcomes explicitly comparing with climate sensitivity. Perhaps, it would be new but it needs confirmation from the climate expert.

RESPONSE: Please see our response to the previous point. For the reasons summarised there (and see also Sutton 2018 & 2019), describing climate implications using “probability and uncertain ranges of climate models” is not the most appropriate way to inform risk assessments. Our proposal is that WGI should employ a set of global climate response scenarios (with specific attention to high impact scenarios) and that these same response scenarios should also be investigated and assessed by WGII (to explore consequences for impacts and adaptation) and WGIII (to explore the consequences for mitigation) alongside their use of socio-economic scenarios. We have added this important point at the end of the paper.

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3) Although it is not the IPCC coordinated activity, it would be worthwhile to acknowledge that in integrated assessment modeling, the discrete scenario proposal has been made and they are now working on that.

RESPONSE: The paper cited is focused on filling gaps in emissions scenarios. It does not address climate response scenarios, which are the focus of our paper.

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4) Finally, in the paper, I can find the term “each SSPs”, but it seems to be a set of SSPs and climate target combination by looking at the figure. For example, SSP1-26 is a combination of SSP1 and radiative forcing target 2.6W.

RESPONSE: We accept this point and have revised the paper and figure to clarify which are the relevant SSPs.

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