#Reviewer 1

This study employs a globally validated mechanistic ecohydrological model to simulate the ecohydrological responses to variations in solar radiation. A notable aspect of the author's approach is the avoidance of the simplistic method of merely adjusting incoming shortwave radiation. Instead, the study utilizes climate sensitivities derived from CMIP6 scenario simulations as inputs for the ecohydrological model. This innovative experimental design accounts for more realistic climate feedbacks.

Response:
Thank you for your positive evaluation of the manuscript, we will address the remaining comments as explained in the following.

Line 65, could you elaborate on how the term "pure" solar radiation change is defined? Given that the G1 simulation introduces some degree of land-atmospheric feedback at the local scale, it would be beneficial to clarify the meaning of "pure."

Response:
With "Pure" we referred to the difference between the control scenario and the G1 simulation because the G1 simulation increases CO_2 and decreases solar radiation, but maintains the temperature unaltered, which helps to isolate only the effects of changes in solar radiation. Hence, we call it 'pure' because it largely excludes the climate effect. However, as noticed by the reviewer "pure" is likely not the best term and we have modified it to "solar radiation changes in absence of large-scale temperature change".

Line 90 requires further explanation. Why is it impossible?

Response:
Compared to the short-term analysis (the second option), in the third option the feedback of the climate system to changes in solar radiation overlap with increased temperature, and the two effects are co-occurring, which makes them impossible to separate in the CMIP6 results without running other experiments. For our purpose, as we want to obtain a response to a change in solar radiation without confounding factors - as much as possible - we did not use these long-term sensitivities for the T&C simulations. This will be further clarified in the revised version.

Line 96 raises a question regarding the relevance of reporting climate sensitivities for the third case, as it seems tangential to the ecohydrological model. Conversely, why didn't you simulate the ecohydrological response to long-term climate feedback?

Response:
There have been other studies before looking at global-scale impacts of solar radiation changes on hydrology, the scope here was different. Our scope was first to look at what is the local/regional effect of changing solar radiation on the ecohydrology variables

without allowing the overall global climate to change, and second to provide a mechanistic interpretation and explanation for the observed changes from a land-surface perspective. For these two scopes, the T&C model was deemed adequate.
We did not include long-term T&C simulations because long-term sensitivities are affected by overall changes in climate dynamics, which tends to emphasize the global scale climate changes induced by an initial perturbation in solar radiation rather than the effect of solar radiation itself.

Line 101, does the G1 experiment solely modify surface solar radiation? I seek additional clarification on why most induced changes in climate variables are directly associated with radiation changes in this experiment (Line 117). What distinguishes G1 from the method mentioned in Line 80 (i.e., the first way)?

Response:
The G1 experiment consists of two main contrasting changes: an increase in CO_2 and a change in solar radiation to keep global temperature unaltered. Changes in CO_2 might have a minor effect on climate in this experiment, however since global temperature, which is the most closely related variable to express overall changes in climate (e.g., Seneviratne et al., 2016) remains constant, there is no feedback from a warmer or colder Earth, thus most of the induced changes in climate variables should be directly related to changes in solar radiation and to a minor extent CO_2. This is the experiment used in CMIP6 to isolate solar radiation effects, and the results are of high significance to build the no global climate feedback (SRnc) scenario. Please note that even though the changes in climate are induced mostly by solar radiation, other variables might still change a bit as illustrated in Fig. 1 in response to this solar radiation change. This will be clarified in the manuscript. By construction, using the "first way" will only modify Rsw without any change in any other variable.

Line 118 calls for an explanation of the model selection process.

Response:
We screened all the GCM models and found only the six models mentioned in the article providing results for the given experiments listed in Table 1. This will be clarified in the revised version.

In Table 1, it's noted that only one model (IPSL-CM6A-LR) is used to calculate short-term climate sensitivity and SRnc. When comparing ecohydrological responses between SRsc and SRnc, does this imply the exclusive use of this model? If not, how was the structural uncertainty among different models addressed? Moreover, including a line to detail the calculation of climate sensitivity based on the four experiments would be helpful.

Response:
Actually, we used four models (IPSL-CM6A-LR, CESM2-WACCM, CNRM-ESM2-1

and MIROC-ES2H) to compute the sensitivities for the SRnc scenario and three models (IPSL-CM6A-LR, MRI-ESM2-0 and CESM2) to compute the sensitivities for the SRsc scenarios. IPSL-CM6A-LR happened to have both the experiments for the SRnc (G1) and SRsc (abrupt-solm4p/abrupt-solp4p) scenarios. It is true that there will be uncertainty between the different CMIP6 models, this is accounted for by calculating the climate sensitivity based on the slope of the linear regression between the different models, so that uncertainty in the different models is smoothed. We will further clarify in the manuscript how we computed the climatic sensitivities, but basically these are the slopes of the linear regressions between changes in meteorological variables and surface solar radiation as obtained from the CMIP6 models."

Lines 132 and 133 necessitate further elaboration on the rationale for selecting the first decade and the last 50 years for computation.

Response:
The first decade was chosen as representative of a short-term response because it is expected that global temperature had not yet changed significantly over this period of time, at the same time we needed enough years to average internal climate variability and remove the uncertainty associated with the selection of one specific year. The last 50 years are instead characterized by a different global temperature which impact the overall Earth climate, so we chose this period as characteristic of "long term" climate effects induced by an initial change in solar radiation. The length of 50 years was also chosen to minimize the uncertainty associated with internal climate variability. We will further clarify these points in the manuscript.

Line 158, the term "no climate feedback" might be misleading since this scenario does involve feedback.

Response:
Thanks for the comment, we will modify this in the manuscript to "no temperature feedback".

Line 176, it would be interesting to know why leaf area index was not considered as a vegetation variable.

Response:
LAI is a prognostic variable in the T&C model and its changes have been simulated, however, they were not shown as the pattern of LAI is highly positively correlated with GPP. We have now included this analysis in the Supplementary Material.

There seem to be typographical errors at Lines 251 (fig. 3g?) and 254 (Fig. 3a?). Please verify the correct figure references.

Response:

Thanks for the comment. Yes, it is a typo and we will revise it in the revised version.

References

Seneviratne, S., Donat, M., Pitman, A. *et al.* Allowable CO_2 emissions based on regional and impact-related climate targets. *Nature* **529**, 477–483 (2016). https://doi.org/10.1038/nature16542