Reviewer 2

The authors thank the reviewer for their valuable comments.

The manuscript analyzed droughts which may lead to clay shrinkage using a statistical method based on ISBA model and predicted future droughts according to some GCMs. This work has some significance in helping people cope with drought, but overall, it lacks innovation, and its conclusions lack strong evidence.

We acknowledge that numerous papers have focused on the topic of drought and its effects. However, this study is innovative in that the assessment and comparison of historical and projected triggering conditions for clay shrinkage at a national scale has never been done before. In particular, it contributes to filling the knowledge gap on the impacts of climate change on society, which is crucial for adaptation.
We propose adding the following sentence in the Conclusion section: "**For the first time, historical and projected triggering conditions for clay shrinkage are assessed and compared over France at a national scale**".

We give the following answers to the reviewer's specific comments:

1- The introduction is overly verbose, and the main theme is unclear.

We agree that the Introduction section is too long. To clarify the article's point, we suggest shortening the introduction by deleting the first two paragraphs.

2- Has the model ISBA been calibrated ? If so, please provide details on the calibration process and the calibration results.

Thanks for this comment. We propose adding this paragraph at the end of Section 2.1:
"The ISBA model does not require calibration. Instead, its concept is to adjust the values of the parameters used in the different modeling steps based on the literature. As an example, the different values of the parameters used to model photosynthesis are detailed in Table 2 of Delire et al. (2020). ISBA has been compared with other land surface models as part of the International Land Model Benchmarking (ILAMB) system (Collier *et al.*, 2018). Some results, available in Appendix B3 of Friedlingstein *et al.* (2022), indicate that the performance of ISBA is reasonable compared to other models. In particular, a higher skill is found for modeling vegetation leaf area index (LAI), which is crucial for estimating soil moisture. Peano et al. (2021) also show that ISBA is able to achieve good skill in representing plant phenology compared to other LSMs."

3- Line 150. Why choose these GCM-RCM combinations? Judging from the results, there are significant differences between these models.

Thanks for this comment. As explained in the paper, the 12 couples for the DRIAS experiment were initially selected from the EURO-CORDEX ensemble (Jacob et al., 2014, 2020) based on eight criteria, including availability, realism over Europe, and dispersion (Robin et al., 2023). We propose adding this paragraph in Section 2.2:

"The six GCM-RCM couples used in this study are a subset of the 12 couples that make up the DRIAS-2020 dataset, which is based on CMIP5 simulations. Our motivation for further reducing the ensemble size to 6 couples is related to limited computational resources. The choice is based on the dispersion of precipitation and temperature changes during the summer season. This season is of particular importance given the phenomenon under study."

The following will be added to the Supplement:
The dispersion of temperature and precipitation changes for the DRIAS-2020 ensemble for the summer season are shown below, for RCP 4.5 and 8.5. These are available at https://www.drias-climat.fr/document/20200914_DRIAS-ScenarioRCP4.5_support_selection_modeles_v3.pdf and https://www.drias-climat.fr/document/20201214_DRIAS-ScenarioRCP8.5_support_selection_modeles_v3.pdf

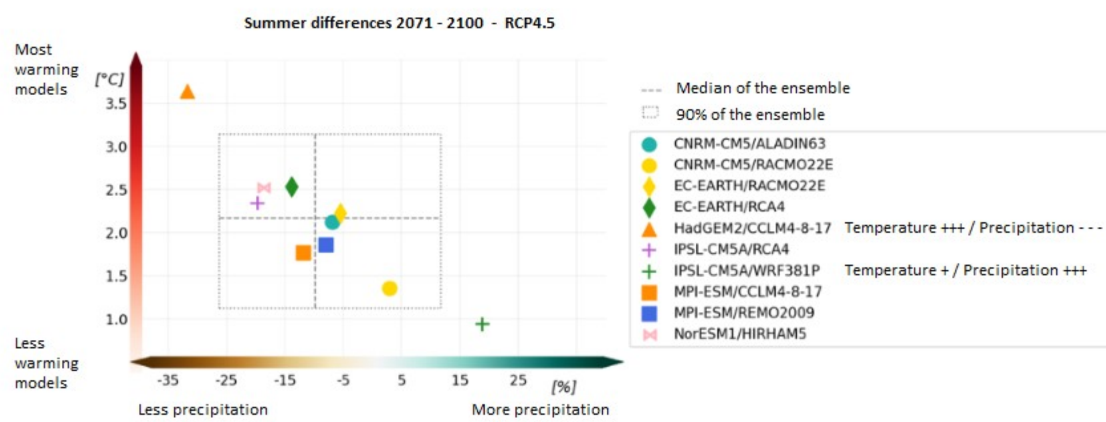

Figure 1: Dispersion of the DRIAS-2020 ensemble in temperature and precipitation changes for RCP 4.5 (adapted from DRIAS 2020).

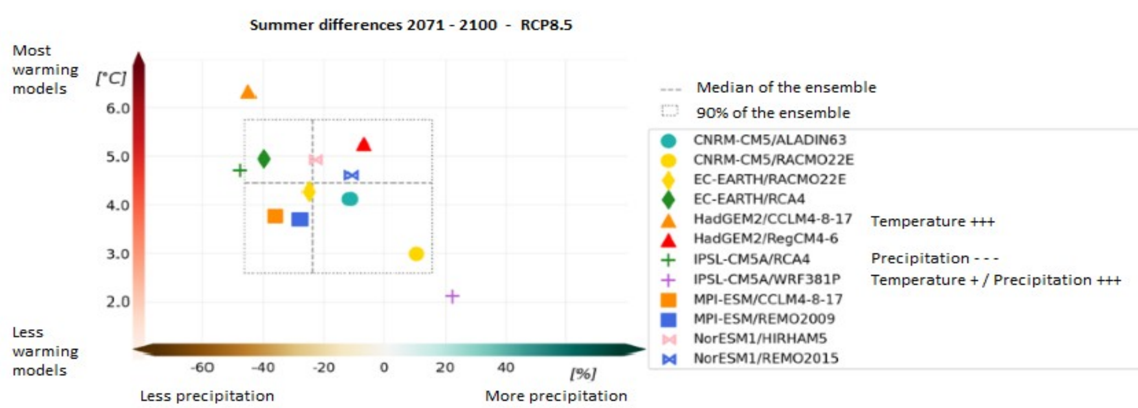

Figure 2: Dispersion of the DRIAS-2020 ensemble in temperature and precipitation changes for RCP 8.5 (adapted from DRIAS 2020).

The six GCM-RCM couples we selected are represented as circles, diamonds and squares of different colors in Figures 1 and 2.
For both RCPs, these six pairs:
- correspond to a duplicated GCM, with two different RCMs
- do not feature the most extreme precipitation and temperature changes of the DRIAS-2020 ensemble.
The first point is for consistency, and the second point for robustness. With only 6 different models, a single model with a very different behavior would bias results towards extremes.

4 – Section 3.1. The historical results lack a comparison with observations.

We will add this short paragraph to Section 2.1:
"The soil moisture simulated by ISBA has also been extensively validated against field data from several study sites, measured for example by Frequency Domain Reflectometry (FDR) probes (Decharme *et al.*, 2011) or lysimeters (Sobaga *et al.*, 2023). However, observations of soil moisture at 1m are scarce, and such comparisons are therefore not applicable on a national scale."

A comparison of YDMI and subsidence insurance claim data has already been done and commented for a subset of 20 municipalities in Barthelemy et al. (2024). It showed that the annual number of claims is positively correlated with the YDMI, although the former is not trivial to interpret as it is affected by several sources of uncertainty. Because of this last point, it is not relevant to perform the same analysis at the national level. We nevertheless made a comparison of YDMI with annual numbers of requests for recognition of the state of natural disaster issued by municipalities in section 4.1 of the article, both of which are in agreement.

5 – Line 215. Why only choose third quartile of YDMI as an indicator. Does it have special significance? Generally, 50th percentile is more commonly used.

The third quartile of YDMI was chosen as indicator as it enables to characterize upper trends, and it more robust than the maximum. Similar trends of increasing YDMI over time are noticeable considering the 50th percentile, as shown in the picture below:

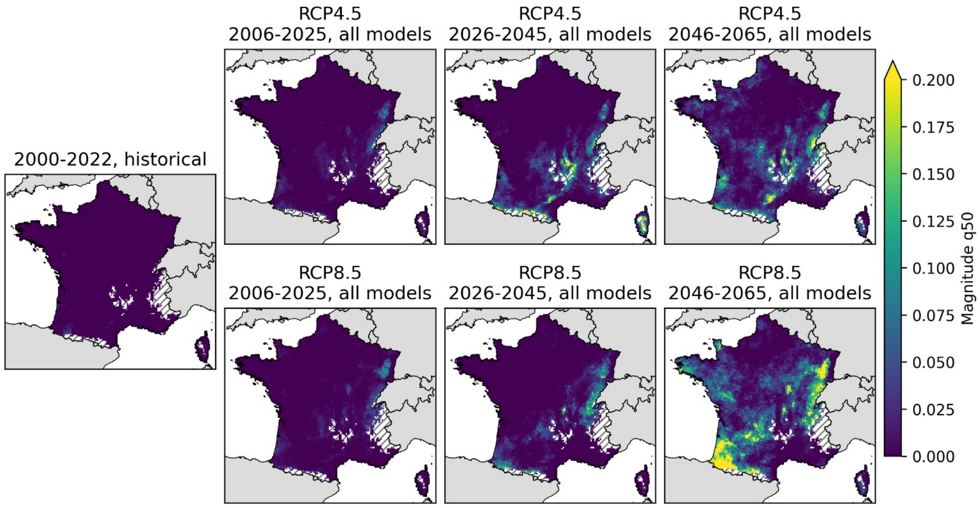

Figure 3: Median of YDMI, separating time horizon and RCP. Areas ith gray hatching correspond to filtered moutain area (average altitude > 1100 meters).

6- Figure 3-Figure 6. From the figure, the trend of the different model are inconsistent. What has caused the significant differences between the different models? Can we draw meaningful conclusions from results with such significant results?

As a reminder, climate models are numerical programs that simulate the various components of the climate system, such as the atmosphere, ocean, and continental surfaces. Climate models are used to assess the consequences of climate change by inputting increasing CO_2 concentrations and observing how this affects system variables. Their horizontal resolution ranges from 100 km for global climate models to 10 km for regional climate models. The physical processes involved are extremely complex and sometimes occur at spatial scales below the resolution of the model. For example, small clouds, which have a significant impact on climate, can measure only several hundred meters and therefore cannot be represented individually in climate models. This requires simplifying assumptions and parameterizations. The assumptions chosen vary from one modeling group to another, leading to contrasting predictions. This is explained (in French) in Risi and Bony (2019). It is therefore perfectly normal for the different climate models to predict contrasting results. This characteristic is the main motivation for basing conclusions on an ensemble rather than a single climate model. Moreover, the fact that the majority of simulations point to increasing drought characteristics indicates that this is a meaningful conclusion of the study.

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