



EGUsphere, referee comment RC1  
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## **Comment on egusphere-2022-971**

Anonymous Referee #1

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Referee comment on "Root zone soil moisture in over 25% of global land permanently beyond pre-industrial variability as early as 2050 without climate policy" by En Ning Lai et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-971-RC1>, 2023

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### **Review for "Root zone soil moisture in over 25 % of global land permanently beyond pre-industrial variability as early as 2050"**

this study analyzed the future changes of the total soil moisture for the four different SSP scenarios. Using 14 ESM in CMIP6, deviation of total soil moisture from the PiControl scenario, permanent departures beyond the Picontrol variability and the time of emergence of those permanent departures are evaluated. Also, this study analyzed regional total soil moisture variability results according to the SSP scenarios in detail and presents the robust results of multi ensemble ESM in some regions like Mediterranean in terms of remarkable dry departure. Regions such as Northern Africa, South-Eastern South America and Southern Asia resulted in considerable wet departures. In many regions, these dry and wet intensities displayed to intensify as the effects of global warming. The priority of this study is to quantitatively organize the regional results according to the SSP future scenarios over global domain. However, as mentioned in chapter 3.5, there are many limitations in relation to the analysis of future SSP scenario results, and additional explanations on the results and data seem to be needed. Detailed comments are below.

#### **Major Comments:**

- **Regarding the title, this study expressed root zone soil moisture in over 25% of global land permanently beyond pre-industrial variability as early as 2050. However, in practice, the analysis of total soil moisture is the main focusing variable in ESM in CMIP6, and since the percentage value differs depending on the scenario, it is necessary to modify the tilt to reflect these aspects.**
- **As mentioned in the limitations part of this text, ESM have uncertainties in**

certain regions. For example, in this study, North Africa like SAH desert regions are historically very dry but tend to show wet departures in the future. it comes out as a wet case because the 95% percentile wet departure threshold is low in very dry regions like dessert, it seems more necessary to reflect the climatological soil moisture distribution and land type since the consequences that desert areas becomes wet are considered unacceptable. Also, some regions show contrasting wetting and drying signals for different scenarios, which shows a high regional uncertainty according to ESM, which makes the results less reliable. It seems reasonable to add an analysis to the results by latitude or by representative land type.

- Regarding total soil moisture analysis using different ESMs in CMIP6, future scenario results have forcing and ESM dependency issues. Therefore, in order to derive general results, it seems necessary to understand and explain how the amount of total soil moisture changes in terms of precipitation and run off in terms of water balance. In this study, a detailed regional analysis of dry and wet conditions was presented in detail, but explanations for the reasons for the results are considered insufficient. A scientific understanding would be better if given an additional explanation of energy balance or water balance for the variation of soil moisture.
- This study result presents the land surface area with a wet departure is projected to be larger than that with a dry departure for SSP scenarios. As mentioned, this result was confirmed by Dirmeyer et al. (2016), it is different from the contents of drier soil condition are more globally prevalent, and it is explained that the influence of vegetation is large when using total soil moisture. According to Dirmeyer et al. (2016), a seasonal difference was also reported that JJA became drier in summer but wet in winter. In this study, it seems necessary to include a discussion that reflects the seasonal cycle, and further explanation is needed on whether the results are robust in terms of annual mean calculation and how the effect of vegetation on total soil moisture is reflected in the results in detail.

#### **Minor Comments:**

- this study analyzed 14 selected ESM, it is need to provide additional explanation of 14 selected model for brief introduction to the version and characteristics of the land model is each ESM and the number of ensemble members in part 2.1(data)
- how about displaying the remaining 10 models in figure 2 for 80-year average values of the regional monthly total soil moisture content ffrom PiControl scenario as supplements?
- In this study, analysis results for future SSP scenarios of 14 ESM in CMIP6 were provided. It seems necessary to find out what the reliability of the results of each model scenario run is, supplementary explanations on land variable performance in historical runs, or what has been reported in previous studies.

