

Review of the manuscript egosphere-2023-1597 Evaluation of root-zone soil moisture products over the Huai river basin by Liu et al.

## **SUMMARY**

The manuscript presents an intercomparison between eight root zone soil moisture (RZSM) products and in situ measurements. The differences are discussed in the light of the uncertainty in precipitation, air temperature and soil properties.

Overall, I think the study could be a valuable scientific contribution. However, at the current status, I think the manuscript should be improved in several parts before reaching good quality for a possible publication. Specifically, I think the Authors should put major effort into improving the descriptions of the products, the methods should be extended, the discussion should be integrated accordingly. Below I provide additional details about my major concerns followed by specific comments.

## **GENERAL COMMENTS**

### **Irrigation**

A major confusion in my opinion in the intercomparison is the role of irrigation. At L119 and L124 it stated that the study is conducted over a highly irrigated area. At L135 it is stated that soil moisture sensors are in areas without irrigation. It is not clear by reading if the RZSM products account for irrigation or not and if this can be a concern. Only later in the discussion (L452), it is stated that the overestimation of RZSM by ERA5 (Fig. 3) could be a signature of irrigation because the in situ RZSM observations do not capture irrigation. Does this mean that some RZSM products are based on model that take into account irrigation and others not? On the one hand, this information should better explained and discussed. On the other hand, I wonder what is the scientific meaning of comparing soil moisture in rainfed area to model that are accounting for irrigation.

### **Soil map and soil parameters (section 4.3.2 and section 5.2).**

The assessment of the soil properties is valuable. It should be noted, however, that high discrepancies come with the use of different pedotransfer functions (PTF) to derive soil hydraulic parameters (retention curve and hydraulic conductivity). I guess these parameters are used in each RZSM product but estimated with different PTFs. This could also explain part of the uncertainty. This information is missing in the manuscript but should be integrated.

### **Spatial aggregation and comparison at each site should be clarified and improved**

As far as I have understood (L267), the comparison is conducted between the spatial average of the 58 in situ observations. It is not well reported how much is the spatial extent of the 58 stations but looking at figure 1 I guess the station covers an area of around 300 x 200 km<sup>2</sup>. I then deduce that this spatial average is compared to the spatial average of the gridded products (i.e., each product has different resolutions, but more than one cell of the gridded products covers the area of the 58 stations). So first of all it should be better explain how many cells have also been aggregated for each product. Only later in the results section (L317) I discovered that a comparison has also been performed without aggregating spatially. So, first of all, this information should be provided also before in the methods. Moreover, I would also considering moving some plots that are now in supplement to the main manuscript to strengthen the

analysis. Anyway, I'm confused by the fact that the comparison is performed at each station. Does this mean that you have always one station against one cell of the gridded products? Please clarify.

#### **Section 2.4: description of the eight RZSM products**

The description of the eight products should be improved in several parts. The information provided for each product is not always consistent. Some products are better described and with more details than others. E.g., for MERRA-2, the description focuses on the precipitation. Instead, ERA5 does not have any information about. NCEP CFSv2 description is very short. Who provided that? What are the main properties? Some characteristics provided should also be put more in relation to the focus of the paper. E.g., for ERA5, the data assimilation system is described in detail. Is that relevant for the purpose of the paper. If yes, it should be clarified. Overall, the main differences between the products relevant for the present study (e.g., soil map, precipitation, land use, irrigation etc.) should be better highlighted. Table 1 should be extended accordingly. Please note that some relevant information are discussed only later but in my opinion they should be moved to the method section. This would help understanding and strengthening the discussion of the results. E.g., L410 The soil properties data used in the eight RZSM products were all derived from the FAO/UNESCO soil map of World except for CLDAS, which used the soil data developed by Shangguan et al. (2013), and SMAP L4, which used the HWSD soil properties over China. L426. Global precipitation and air temperature forcing data are used in the production of all RZSM products except for SMOS L4. L452. The overestimation of RZSM by ERA5 (Fig. 3) could be a signature of irrigation because the in situ RZSM observations do not capture irrigation.

#### **Figure quality**

Figures are not always readable and meaningful. I suggest putting some more effort into evaluating how to present the results. E.g.,

Fig 1. could also shows the pixel size of the products. This would help understanding spatial extend and intercomparisons.

Fig. 4 is not readable at all. Plots and texts are too small.

Fig. 5 can be improved by having only 8 histograms of the RZSM products and overlapping each histogram with the observation's histogram. This could help to visualize the differences.

Fig.6. The plots are hardly comparable. It could be evaluated to present one plot with all the cumulative precipitation, or histogram of the precipitation etc.

Fig.7. It is not clear to me what is actually presented. This is in line to the general comment above about aggregation. Are you comparing spatial averaged precipitation? What does standard deviation refer to? If you compare each rain gauge to pixel wise, how have you aggregated?

#### **Take-home-message**

I'm expecting to read the overall take-home-message. After performing this intercomparison, what can you conclude? Could we trust this products? Where and which conditions? How would you suggest further improving, studies etc.? This is missing throughout the manuscript but should be understandable from the abstract and more extended at the conclusions.

## **SPECIFIC COMMENTS IN ORDER OF APPEARANCE (L = LINE NUMBER)**

L13. I would not use the term “direct validation” but “assessment”.

L29. The abstract focused on describing the actual results. This is fine but I would also expect at the end to read the take-home-message. E.g., what do we learn by this study? Can we trust, use, apply RZSM products? Where? In which conditions? What in our view and based on this study would further suggest to improve the performances?

L108-109. Are these two lines really needed here? I would integrate this information later when you speak about comparison. E.g., L133 for the definition of RZSM.

L128. Table S1 shows the results of the assessment, and it does not provide additional information about the in situ stations. I would remove this cross reference here and rather add Figure 1 where the locations of the in situ stations are shown.

L263. I would extend a bit on the meaning and interpretation for PD, FAR and CSI.

L280. I was expecting to read more about the description of the equation after L280. Any text missing?

L293. I think here is a good place to cite table 3 as well.

L295. It is stated that SMOS-L4 underestimates and the other overestimated the observations. By looking at figure 2, I see the opposite. Please double check what you are plotting.

L306. Figure 3 shows spatial average of in situ soil moisture and its spatial variability. As far as I have understood (see general comment above on the spatial aggregation), the spatial average of the RZSM products is shown but, if possible, it could be interesting to show here also the spatial variability of the RZSM products.

L317. Description of the comparison at each site should be reported as well in the method (section 3.1) See also general comment above on the spatial aggregation.

L319. The method to calculate the anomalies is reported only in the supplement. I think should be moved to the method (section 3.1)

L585. After summarizing the main conclusions, I suggest summarizing the outlook of the study. See also general comments above.

Supplement. I think the supplement should have a title with the name of authors as well.