Review EGUSPHERE-2023-1597

Evaluation of root-zone soil moisture products over the Huai river basin

This paper presents a study on the evaluation of different global root zone soil moisture products and local observations for the Huai River Basin in China. The authors present detailed information on the local conditions, and the different gridded products used. They comprehensively compare the different products with each other and with the observations. Also, the authors provide a discussion on the potential reasons for the differences found. In general, it is an interesting study with a lot of analyses and clear visualization of the results. Nevertheless, I have a few comments that must be addressed before the manuscript can be published.

General comments:

<u>The influence of land cover, vegetation and root representation:</u>

The authors clearly discuss potential reasons for the mismatch between in situ RZSM observations and the global products, such as forcing data and soil texture maps. Also, shortly 'different model structures and parameterizations' (L89) are mentioned as potential cause for differences. I do think there is one more very important aspect that is missed here: the role of land cover and vegetation, vegetation roots, and soil evaporation and transpiration model representation. Vegetation is usually represented by land cover maps (that are usually prescribed similar to soil maps), which can be very different for the different models. Other relevant vegetation model properties could be Leaf Area Index (see for example Nogueira et al., 2020) or the root parameterization (e.g. Stevens et al., 2020 and Van Oorschot et al., 2021). Furthermore, transpiration of crops is very dependent on the growing season, which might be not represented by the global products. I think these issues should be specifically addressed in the introduction and discussion of the results.

<u>Introduction</u>

L49-67: I think this paragraph is intended to describe the state-of-the-art of global surface soil moisture, and root zone soil moisture products. The authors mention many long names of different products, which shows the detailed literature review done for this study. However, for the reader it would be more clear if the paragraphs gives a more general overview, rather than all the specific products, by answering questions such as: Why do we only have SSM direct retrievals, and not RZSM? What is available for global RZSM? How are the RZSM products generated in general?

L76-94: I think this should go before L68-75.

<u>Scale issue:</u>

The authors mention that the scale mismatch is a relevant aspect for the differences between RZSM observed in this study (L75 and Sect. 5.4). However, it is not clear from the methodology how the gridded products are aggregated to match the in situ measurements, and how the scale of the different products compare to the size of the HRB selected area. Moreover, how heterogeneous is the selected area in terms of precipitation, temperature, vegetation, and soil moisture observations? Since the results are mostly based on averages of the area, does the heterogeneity play a role?

<u>Discussion:</u>

The authors explain potential causes for the mismatches between the satellite products and the observations by using specific analyses of the precipitation, temperature and soil type. Many performance metrics have been used throughout the analyses, but I think the use of these different

metrics could be exploited more in the discussion. Different metrics represent different aspects of the timeseries, which could explain different processes. The authors could relate the causes in section 5.1 and 5.2 more specifically to the different metrics used. Here, also the vegetation/land cover aspect should be included as mentioned before. Lastly, how easily can we extrapolate these results to other regions?

<u>Irrigation</u>

The role of irrigation in this study is confusing, due to the following statements:

- L119: '76% is irrigated'
- L135: 'Stations are located in areas without irrigation'
- L562: 'heavily irrigated HRB in China'
- L452: 'a signature of irrigation'
- L573: 'indirectly account for irrigation'

I understand that the entire HRB is heavily irrigated, but in this study we only look at the Huaibei Plain which has only rainfed crops as indicated in Fig. 1. It remains unclear to me which area is used for the gridded products, the entire HRB or only the Huaibai Plain? This is not entire clear from the methods. If it is the Huaibai plain (which would make more sense), then irrigation is not an issue in this paper, and should not be emphasized.

Specific comments:

- L20,21: What are L4 and L3 here?
- L59: I think ERA5, MERRA2 and NCEP CFSv2 are not the only existing global products, it might be good to emphasize this with for example 'amongst others'.
- L75: etc. is not very scientific
- L99: it is maybe not 'difficult', but 'out of scope'
- L113: Fig. 1 instead of Figure 1
- Figure 1: There are two red lines in the figure, so the legend is not entirely clear
- L144-145: performance metrics of P and T with respect to ground observations? This is not clear.
- L200: 'Saha and coauthors, 2011' is not a valid reference
- Chapter 2 Datasets: The authors use many different units for scale, for example 0.5°x0.5° (L137); 1:5 million (L150); 30x30 arcseconds (L163). It would be helpful for the reader to include for each scale metric a rough comparison to for instance kilometre to easily compare the resolution of the different products.
- Section 2.1 'The HRB study area': for the reader the full name of HRB would be more clear
- Section 2.3 and 2.4: the authors describe a lot of different products, but it is not directly clear from these sections what is actually used for this study. Both sections could be much more concise when only referring to the relevant information for this study. For example, it is not directly relevant that ERA5 'covers the period from January 1940 to present … ocean waves' (L170). Table 1 gives a very concise overview, and could be valued more and referred to more often in the text.
- Table 1: a reference would be more informative than the 'data access' column
- Section 4.1: the first paragraph is not easily readable for the author due to all the numbers. All the numbers are also presented in Table 3, so it suffices to only mention the highly relevant numbers in the text here. Table 3 could also be combined with Fig. 2, same for Fig. 8 and Table 4.

- Figure 2 and 8: to improve visualization I would recommend to include density of points with colours (for example https://stackoverflow.com/questions/20105364/how-can-i-make-a-scatter-plot-colored-by-density)
- Figure 4:
  o The labels are not readable because of the small font
  o What are the lines? A fit through the data points? Why do the authors use a different lay-out for a scatterplot than in Fig. 2 and 8?
- Figure 8 and Table 4: I think it is more convenient to use degree Celsius than Kelvin for temperatures.
- L381: 'good agreement' is a subjective statement, I think it is questionable if a R>0.4 is 'good'.
- Figure 9: This figure implies that also the models differentiate soil moisture for layer 0-30cm and 30-100cm, while for most models this is not the case?
- Abstract: the statements about the explanations of the differences are quite strong, because we know there is many other factors that play a role.