

Earth Syst. Sci. Data Discuss., referee comment RC2
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Comment on **essd-2021-84**

Anonymous Referee #2

Referee comment on "Development of observation-based global multilayer soil moisture products for 1970 to 2016" by Yaoping Wang et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-84-RC2>, 2021

Global soil moisture products were developed based on different combinations of existing soil moisture datasets and methods in this study. These products are gap-free, long-term, and multi-layer. I think the developed soil moisture products will be important given the lack of global and consistent soil moisture observations. The soil moisture datasets used to create the products were based on different techniques (e.g., remote sensing, modeling) and different specifications (e.g., soil depth, time step). Merging them together is a challenging task.

-The manuscript highlighted that the products are gap-free, long-term and multi-layer, but it seems the verification didn't assess these advancements. For example, compare to the existing datasets, how the products perform when/where gaps exist, and how the products perform in different layers.

-Fig. 3 includes bias, RMSE, and Corr of different statistics (i.e. climatology, seasonal cycle, trend,...). I am not sure if they can use the same range of color ramp in the same column to show the situations of different statistics because the statistics are in different units and magnitudes. It is unclear how seasonality was calculated and how the bias, RMSE and Corr of seasonality and trends were estimated.

-The products were developed by merging the different soil moisture datasets. I wonder if this would offset the temporal variability and trend of time series. Comparing the temporal variability and trend of the merged products with individual datasets (e.g., ESA CCI, ERA5...) like Fig. 5 would be helpful. Fig. 5 currently only shows the time series of the merged products.

-Abstract, provide a brief explanation of the better performance of the hybrid products without Earth System Models (ESMs) than those with ESM.

-P2 L40, elaborate "its spatial gaps remain unresolved".

-P2 L51-52, explain why Global Climate Models (GCMs) were not considered in the study and the differences in GCMs and ESMs.

-P3 L66, explain why the merged products would likely perform better.

-P3 L71, why in situ observations are not included in the unweighted averaging?

-P3 L78, it is unclear what are the variables that have/have no observations in ESMs

-P3 L90-93, this sentence is unclear. Please rephrase it. Observations of soil moisture/meteorological variables were used in some cases, but not in another. It is confusing in what cases observations were used. This is not presented in Fig. 1.

-P4 L95-100, explain why ORS datasets were divided into different time ranges, and what "concatenation" means.

-P5 L123, "the number of observations that falls into each land cover type is displayed in Figure S2". Fig. S2 only shows land cover type.

-Table S1 and others, why did a dataset have different used time periods?

-Section 3.3, it is interesting to compare SM anomalies with drought events. However, it seems the comparison is based on years instead of events. Furthermore, it is unclear how the drought events were selected and why only the two regions were considered.

-Fig. 6, what is the y axis? The meanings of some lines are provided, e.g., dashed orange line.

