Replies to RC3: Anonymous Referee #3, 28 Dec 2023

The study investigates the ability of active and passive based remote sensing soil moisture products and land reanalyses to capture documented drought events and drought trends during the period 2000-2020. The drought events are characterised in different parts of the world by their severity, duration and spatial extent. The events are placed in the context of dry season soil moisture trends and potential reasons for diverging soil moisture trends between the different products are investigated. It is found that all the products capture the selected drought events. Significant differences between the products are found – for example, responses in surface soil moisture tend to be weakest for the active remote sensing products. For the global reanalyses, ERA5 and ERA5-land have a greater tendency for drying trends, whilst MERRA-2 has a greater tendency for wetting trends. Based on other reanalysis variables (evapotranspiration, runoff, precipitation) and observational data, it would appear that the ERA5 and ERA5-land trends are more reliable overall.

The authors have done a detailed and robust evaluation of the different products and have done well to disentangle the reasons (or potential reasons) for the divergences in the results. However, I think the introduction and discussion sections need to be more concise, with some of the detail removed. Further, I think the paper could be strengthened by linking the results to studies where reference soil moisture datasets (e.g. in situ data) have been used to validate drought events and trends (e.g. Li et al., 2020). This would give more weight to the conclusions of the study. Furthermore, I think the rationale for the approach used in this study needs to be more clearly communicated in the abstract and conclusion. Please also see the minor comments below.

We thank the reviewer for the positive feedback.

As a response to Reviewer #1, we decided to reframe the study and focus on the potential of long-term satellite observations for characterising soil drying, which includes i) long-term negative changes in soil moisture, and ii) agricultural drought events. Thus we will first focus on the global soil moisture trends, and in a second step investigate the agricultural drought events as a use case to show the impact of the diverse trend representation on the drought detection capabilities of the products. This change will also be reflected in the introduction and the discussion sections.

To strengthen the link with existing literature, we will move the referenced literature on the validation of the products, which are currently cited in the dataset section, to the discussion and extend it. This will also help to shorten this Section 2 as requested by Reviewer #2.

Line 46: Replace "trigger" with "triggers"

Will be replaced if still applicable in the restructured manuscript.

Lines 76-94: I agree with the rationale for the evaluation approach. However, I still think the authors should link the results to studies where reference datasets have been used in the discussion section (5), as it would reinforce the findings in this study.

We will move (and extend) the referenced literature on validation of the products in the discussion.

Line 148: Suggest to replace "as for" with "to"

The description of C3S soil moisture will be removed since the product will not be considered anymore in a revised manuscript (cf. reply to Reviewer #2).

Section 2.1.2 ERA5

It is important to mention here that in ERA5, T2m/RH2m pseudo observations are assimilated in the soil moisture analysis (see for example de Rosnay et al., 2013). These observations tend to have an important impact on root-zone soil moisture and latent/sensible heat fluxes with the atmosphere (see e.g. Fairbairn et al., 2019). The sensitivity of ERA5 to drought events could potentially be increased by assimilating these observations.

Thanks for this additional information. We will include it in the description of ERA5.

Line 381: Suggest to replace "the average" with "average"

Will be replaced.

Line 399: Suggest to replace "of" with "for"

Will be replaced.

Line 401-403: Please rephrase for clarity and maybe split into two sentences.

Will be rephrased.

Line 497: Suggest to replace "and display" with "display"

Will be changed accordingly.

Line 526: Sentence starting with "Despite the considerable spread…" Please rephrase as sentence does not make sense.

The sentence will be rephrased.

Line 532: Suggest to replace "largest deviations" with "the largest deviations"

Will be changed accordingly.

Line 564: Sentence starting with "These regional differences…". Please rephrase for clarity.

We will rephrase this sentence.

Line 570: Suggest to replace "of MERRA-2" with "for MERRA-2" and replace "of ERA5" with "for ERA5".

Will be changed accordingly.

De Rosnay, P., Drusch, M., Vasiljevic, D., Balsamo, G., Albergel, C. and Isaksen, L., 2013. A simplified extended Kalman filter for the global operational soil moisture analysis at ECMWF. *Quarterly Journal of the Royal Meteorological Society*, *139*(674), pp.1199-1213.

Fairbairn, D., de Rosnay, P. and Browne, P.A., 2019. The new stand-alone surface analysis at ECMWF: Implications for land–atmosphere DA coupling. *Journal of Hydrometeorology*, *20*(10), pp.2023-2042.