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Earth System Science Data Discussions

Interactive comment on "Gap-Free Global Annual Soil Moisture: 15km Grids for 1991–2016" *by* Mario Guevara et al.

Anonymous Referee #2

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OVERVIEW

The study has developed a gap-filled, and downscaled with topography-derived information, long-term annual (15 km) global soil moisture dataset based on the ESA CCI satellite soil moisture products. The assessment of the dataset with respect to in situ observations has been carried out through annual comparisons as well as in terms of long-term trends (1991-2016).

GENERAL COMMENTS

The paper is mostly well written and clear. The topic of the paper is interesting for the readership of Earth System Science Data as a global scale gap-filled annual soil moisture dataset is surely useful for many applications. However, I believe the paper needs

major changes before the publication as several parts are not properly described and other sections need to be improved or summarized. I have listed below my comments with the indication of their relevance.

1) MAJOR: The factors used in the downscaling and gap-filling algorithm should be described in details. Two figures (Figures 2 and 3) are not mentioned in the text. It seems a part is missing. The reader needs to know the details on the methodology employed and which factors have been found to be more important. Which Digital Elevation Model is used? Additionally, other static factors such as vegetation and soil types are not considered. Why? The discussion on the approach employed for downscaling and gap-filling needs to be included in the paper. Why do the authors select such approach?

2) MAJOR: I have found particularly challenging performing gap-filling over dense forest regions in the Amazon and in Congo. Satellite soil moisture data cannot be used in such regions due to dense forest that mask the soil moisture signal. How is it possible to extend the signal there only based on topography? I would suggest to perform a more detailed validation in these areas. I strongly suggest to perform a comparison with modelled datasets (e.g., ERA5 soil moisture) to have an assessment of the performance over dense vegetated areas. A similar comment can be done for high latitude areas in which frozen soils and snow completely mask the soil moisture signal. Please perform a detailed validation over these areas, too.

3) MAJOR: The trend analysis is very interesting. However, as above, we need more details on how trends are computed. For instance, in situ stations are available only at some points over the Earth, are the same locations used with the satellite-derived datasets? If not, the comparison is wrong. Similarly, in situ stations are not available every year, and for the full year. How are the data aggregated in time and space? These details are needed. I expect the results are strongly impacted to these choices.

4) MODERATE: The machine learning downscaling approach provides soil moisture

data with a resolution higher than the original ESA CCI product. However, I am always doubtful on these downscaling approaches as instead of resolution it should be higher spatial sampling. The higher spatial resolution should be tested, but I am aware it is very hard to do (I have this comment for all downscaling studies). The authors should demonstrate that the downscaled product is able to reproduce features at higher resolutions with respect to the parent ESA CCI product. It is not done in the paper, that's why I believe higher spatial sampling, and not spatial resolution, is more appropriate.

5) MODERATE: Several performance scores have been used in the paper. However, I don't think it is necessary to use all of them. The authors should discuss what information each performance score is providing for the assessment of the dataset, not simply to list many numbers. Indeed, Tables 2 and 3 are hard to read and not informative. Please summarize only the more relevant scores in a figure.

6) MAJOR: The range of values of ESA CCI soil moisture products has little value, as the satellite products are rescaled to match the range of variability of modelled soil moisture from GLDAS. Therefore, the range of values is that obtained from GLDAS. For the analysis shown in Figure 4, and similarly for the trend analysis, the soil moisture datasets should be rescaled between the minimum and maximum of each time series and expressed as relative soil moisture (between 0 and 1). Then the data should be aggregated and the range of values and the trends can be assessed.

7) MODERATE: I believe the discussion section must be rewritten. General results are mostly discussed, whereas it should be closely related to the results shown in the paper. I believe it should be shorter and better focused.

SPECIFIC COMMENT (L: line or lines)

L307: Why the "angle between satellite sensors and the earth surface" is useful for determining soil moisture? It has no sense and I believe it is wrong.

RECOMMENDATION

Based on the above comments, I suggest a major revision before the possible publication on Earth System Science Data.

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