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Comment on essd-2021-82

Anonymous Referee #2

Referee comment on "ERA5-Land: a state-of-the-art global reanalysis dataset for land applications" by Joaquín Muñoz-Sabater et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-82-RC2, 2021

The paper provides a description of the ERA5-Land product and an evaluation of it mainly against in-situ but also one satellite-based dataset (skin temperature). The same evaluation is also done for ERA-Interim and ERA5, which indicates the added value but also limitations of ERA5-Land. Further, the downscaled ERA5-Land meteorological data (surface air temperature and surface net radiation) is used to force the land evaporation model GLEAM.

This paper is highly important. ERA5-Land will be to a great extent used, and this paper will be the first reference and primary inspiration and guidance to many. Overall, the paper is great, especially those parts in which performance differences between ERA5-Land and ERA5 are discussed are very interesting. However, I also see several aspects that need clarification and improvement. In general, figures/caption and, in some parts, also language should be substantially polished. I suggest a moderate revision. I provide a number of suggestions below and in the attached commented paper pdf.

(1)
I see mainly four reasons why ERA5-Land is supposed to be superior to ERA5:
(i) higher spatial resolution of static land model parameters
(ii) higher spatial resolution of downscaled forcing
(iii) reduced impact of discontinuities by longer spin-ups for the segments
(iv) newer LSM version used in ERA5-Land
How does trend analysis benefit from these four reasons? Indeed, ERA5-Land will be used for trend analysis but since it is not included in the evaluation, what are the expected improvements relative to ERA5? The skill improvement that is currently presented was probably mainly due to the higher spatial resolution, I am wondering how relevant (for which variables) higher spatial resolution is for trend analysis? If it is decided not to provide a trend analysis in this paper, it would be useful to read about the authors' opinion as a first guidance for the user community regarding trend analysis. Thinking of trend analysis of river discharge, it should be emphasized that crucial factors like land use change are not included in the land surface model. I recommend a discussion section on implications of the current results + reanalysis setups for trend analysis.

(2)
One application of ERA5-Land will be to force other land models with higher temporal and

spatial resolution atmospheric input. An application is indicated by the evaluation with GLEAM, though differences between ERA5 and ERA5-Land driving GLEAM were very small. Consider to extend the related discussion section (e) and include a discussion of the benefits from downscaled precipitation for other land models.

(3)
The new PET variable is included in the portfolio of ERA5-Land, which is briefly mentioned with a note of caution on its use because the atmosphere is not affected by the water-unlimited land surface assumed for PET. That seems to me being a general issue of PET. How is this different for the ERA5-Land PET from other PET approaches e.g. discussed in https://doi.org/10.5194/hess-23-925-2019 ?

(4)
Results indicate higher bias for ERA5-Land energy fluxes. Was the EC data corrected for energy balance closure gap?

(5)
I found it interesting that the river discharge skill mostly improved for ERA5-Land relative to ERA5. Based on the snow depth evaluation, I would have assumed that discharge for watersheds with significant snow melt might deteriorate due to lacking assimilation of snow obs in ERA5-Land compared to ERA5. It could be discussed more in detail why snow DA did not help ERA5 to perform better. Further, river discharge of large-scale routing models are often evaluated not at daily but at coarser resolution, e.g. monthly, due to large uncertainties of routing parameters that makes it unrealistic to predict the timing of peaks at daily resolution. To be more comparable with other routing scheme results, Figure 13 (with reduced (a) figure, see annotated pdf) could be also provided for monthly resolution.

(6)
The main technical aspect of the production of ERA5-Land, that was not sufficiently explained to me, is how the "Integration of the land surface model in 24 cycles" works. Please provide longer explanation of what is done here and why.

(7)
Regarding water management applications, it's important to mention to the user community that ERA5-Land lacks a groundwater storage. Something that should be clarified at some place.

(8)
Figure quality and captions would strongly benefit from a thorough revision, such as
- Conistent use of (a) (b) etc. instead of top/middle left/right that is also sometimes used
- Explanation of abbreviations and variable names in caption
- Same chronological order of ERA reanalysis products (currently ERA5-Land sometimes comes last, sometimes first in figures).
- Consistent use of variable names.
For related and other comments, see annotated pdf.

(9)
The lake temperature skill of ERA5-Land depended a lot on the lake depth information. The evaluation was thus stratified by whether lake depth improved (got more realistic) in ERA5-Land compared to ERA5. It's unclear on which information this stratification was made. How can a higher spatial resolution can lead to less realistic lake depth in ERA5-Land?

(10)
Figure 15:

the spread of the bias values for the Bowen ratio is strongly increased for ERA5-Land. Either it's wrongly calculated/shown here or requires clarification.

(11)
Several more comments are included in the annotated pdf.

Please also note the supplement to this comment:
https://essd.copernicus.org/preprints/essd-2021-82/essd-2021-82-RC2-supplement.pdf