

## ***Interactive comment on “ERA-Interim/Land: a global land water resources dataset” by G. Balsamo et al.***

**G. Balsamo et al.**

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The Authors wish to thank the Reviewer for the comments and recommendations. We have addressed the points of concern raised. We welcome the comment on the work being interesting to a lot of HESS readers and we hope the improved version will ease readability. We provide responses to the 6 minor comments in a point-by-point reply (R:) after each comment:

1. In Abstract, the author announced that ‘ERA-interim/Land is a global land-surface dataset covering the period 1979-2010 and describing the evolution of soil and snow pack’, however, I found that only soil moisture/temperature and snow variables are included on the website of ERA Interim/LAND. I am confused especially about the

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words ‘a global land –surface dataset’. I understand that a land-surface dataset could include turbulent latent and sensible heat fluxes, soil temperature and moisture, albedo etc. However, when I check ERA-interim/Land from <http://apps.ecmwf.int/datasets/>, I found soil moisture, soil temperature, but without turbulent fluxes. The turbulent fluxes are as important as soil moisture for climate change and water balance studies. The authors have verified ERA-Interim/Land turbulent fluxes with better performance. The RMSE result in Fig. 5 does show that ERA-interim/Land has a better performance than ERA-Interim at most flux stations. So my question is why haven’t ECMWF provide a list of the land surface fluxes produced by new land surface scheme of ERA-interim/Land?

R: This is an important point and indeed the Authors recognize that all elements of the water cycle are of interest. Turbulent fluxes will be archived for all future land surface reanalysis produced in ERA-CLIM and ERA-CLIM2 projects. Archiving a new variable is a particularly sizeable effort and so unfortunately not possible for Era-Interim/Land.

2. GPCP has a spatial resolution of 2.5 x 2.5 degree grid size, which is coarser than ERA-Interim precipitation dataset. First question is about the difference in the spatial resolution. Why GPCP is considered, not other high resolution dataset of precipitation, such as TRMM, GPCC? Secondly, I am wondering what’s the benefits of using coarser spatial resolution data of precipitation, especially when relating to heat fluxes in Fig. 5, river discharge in Fig. 6. Because they have also improved the parameterization scheme in the land surface model, so how do they define whether the improvements in Fig. 5 and Fig. 6 is due to or related to GPCP-rescaled precipitation, or updating of bare ground evaporation, or revised soil hydrology?

R: The merging of GPCPv2.1 and ERA-Interim has been done with a scale selective method as detailed in Balsamo et al. (2010) that verified its validity in data rich areas. This method preserves the feature at higher resolution (coming from ERA-Interim) while correcting large-scale errors. The doubts of the reviewer are legitimate and there is not a solution that fits all needs of precipitation bias corrections, largely due to observation availability limitations. When bias correction is applied in data-poor

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areas it is not clear whether this is always beneficial (this is the case of snow dominated area where ERA-Interim without bias correction of precipitation performs better). Satellite-based products are also limited in their capacity of detecting precipitation over land (due to aliasing with land emissions) or their specific orbit, along with the temporal extend (TRMM is not available since 1979, and only cover the tropics/mid-latitudes). Clarifications are added to the text.

3. The authors said 'ERA-Interim/Land preserves closure of the water balance', due to they have calibrated ERA-Interim/Land precipitation with GPCP, is the water still balanced after the calibration?

R: The numerical closure of the land surface scheme is well established in model comparison exercises such as AMMA-ALMIP or EU-WATCH and does not represent a concern. The absence of a data assimilation step implies that water conservation is accurate to a numerical level. This is not the case in the operational numerical weather prediction where data assimilation analysis increments add and subtract water to the Earth System non-conservatively.

4. The authors just show root mean square error in Fig. 5. However other statistical variables are not included. How about the correlation coefficient and mean bias? Why didn't they plot a Taylor diagram for the turbulent fluxes same as soil moisture in fig.10?

R: The root-mean square is inclusive of skill and bias and that is why is shown. Correlation and mean-error would appear on a Taylor diagram but given that values are very close from a station to another the clouds of points will make it difficult to distinguish the sites.

5. Fig. 7 is again really interesting to me. Besides, I have downloaded ERA-Interim/Land soil moisture over the Tibetan Plateau, and discovered that the soil moisture of ERA-Interim/Land is better than ERA-Interim over the bare soil of Tibetan Plateau. Please see Fig. 1 below. This also supports the author's conclusion, however, whether the turbulent fluxes have a similar behavior still needs more works to be continued.

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Fig.1 Comparison of ERA-interim/Land, and ERA-interim against soil moisture measurement network over the Tibetan Plateau (Su et al. 2011)

R: We thank the Reviewer for this interesting result. The availability of ERA-Interim/Land is precisely to stimulate local studies that have potential to feedback into model improvements. Reference to this work is made in the text to indicate research areas that can lead to future improved reanalyses versions.

6. I don't really understand the sentence 'This method "calibrates" the monthly precipitation amount addressing the issue of non-conservation typical of data assimilation systems,' does it mean non-conservation for water and energy? ERA-interim also employs data assimilation systems. Can we say ERA-interim has non-conservation of water and energy? The authors said that ERA-interim/Land preserves closure of the water balance in Abstract? So don't they contradict each other?

R: The global hydrological cycle over land in atmospheric reanalysis, such as ERA-Interim, is subject to precipitation errors that have a dominant role in a water resources dataset. The land surface data assimilation component of ERA-Interim (Mahfouf et al. 2000) corrects for precipitation errors quite efficiently (c.f. Balsamo et al. 2009, Appendix), however the soil moisture analysis increments added to the different soil layers are not conserving the overall water budget and do not necessarily preserve the water distribution in the soil column. A land reanalysis in which the meteorological forcing of precipitation is the sole water input conserves the global land surface water budget and dynamics and therefore can be more suitable for trend studies since it is more resilient to spurious trends (see also the discussion in Albergel et al. 2013).

Reference: Su, Z., Wen, J., Dente, L., van der Velde, R., Wang, L., Ma, Y., Yang, K., & Hu, Z. (2011). The Tibetan Plateau observatory of plateau scale soil moisture and soil temperature (Tibet-Obs) for quantifying uncertainties in coarse resolution satellite and model products. *Hydrol. Earth Syst. Sci.*, 15, 2303-2316

R: Reference added.

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