Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-534-RC3, 2019

Hydrology and Earth System Sciences
Discussions
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Interactive comment on "Data assimilation for continuous global assessment of severe conditions over terrestrial surfaces" *by* Clément Albergel et al.

Anonymous Referee #3

Received and published: 30 November 2019

The paper evaluates LDAS-Monde using a range of different data products and illustrates how LDAS-Monde results can be used for applications, such as e.g. drought monitoring. Overall, the LDAS-Monde system is great, but the paper needs a thorough revision. In particular, there are too many 'trivial' results, which are repeatedly highlighted. These need to be removed (i.e. if we assimilate an observation, then obviously, the results will be closer to that observation) in favour of a discussion of the evaluation against independent observations. Further comments are listed below.

Section 2.1.3

- Are the perturbations chosen to get an optimal data assimilation system? Please

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discuss.

- How are the cross correlations between the errors in the various soil layers defined, and the error correlations between LAI and soil moisture?

Section 2.3

- ASCAT has an approximate resolution of 25 km. How are these coarse data assimilated/downscaled into the 0.1ˆo model simulations?

- 'CDF matching ' refers to rescaling of the entire CDF, and is not a correct terminology when only rescaling the mean and variance.

- How exactly are the LAI data 'interpolated' from 1 km to 0.25 degree? Do you mean interpolation to bridge cloudy pixels and then aggregation (upscaling)?

- Is the LAI also 'converted from the observation space to the model space' as is done for soil moisture? Please describe how? If there is no such rescaling, then the results may be trivial, i.e there will be more impact of a non-rescaled LAI assimilation than when doing a gentle nudging with rescaled soil moisture. However, since you use a KF variant, there probably is some rescaling for both (otherwise the KF assumptions would be violated).

Section 2.4

- How exactly is the 'climatology' defined? Is it seasonally varying, how much smoothing is applied, etc?

- The spinup period for the 0.1ˆo simulation seems unrealistically short. How was it initialized? Could you cycle over the short April-December period multiple times?

- Table II: An observation operator is a function, not a variable; also explain what you mean by control variable (updated variables) for readers who are new to the field. In fact, the control vector enters the observation operator, which in turn selects a subset of relevant variables to produce the observation prediction.

Section 2.5

- Why is there no skill evaluation in terms of anomalies? Would be interesting.

- Which variable in LDAS-Monde output is related to SIF and how?

Section 3

- Overall, it is a bit disconcerting that trivial design results are shown repeatedly. Assimilate a variable, and sure, the model will get closer the assimilated observations. The results need to be thoroughly revised (both text and figures) to eliminate the trivial results. They can be mentioned once, but then the focus needs to be on the independent evaluation. It is also not correct to say that results "improve" if they simply get closer to the assimilated observations (e.g. L. 375, L. 516, . . .). This holds both for the global assessment and for the case studies, e.g. all of L. 505-512 is 'trivial' and can be removed.

- The snow cover results (Fig 7-8) can be removed. It is too trivial that there would be no impact on snow cover by assimilating soil moisture or LAI. Or else, explain in detail how either variable would affect the snow cover.

- The independent validation (e.g against in situ SSM) shows no substantial improvement in any of the metrics due to data assimilation. Have the in situ data been thoroughly filtered to remove bad points? Why exactly do the authors see an advantage of LDAS_ERA5 for these variables relative to the open loop (L. 458)? There is some added value, but there is also significant degradation, i.e. I would say it is an equal game here.

- L. 535 & L. 545: 'more sensitive to' is perhaps not the correct wording? Sensitivity would be quantified by something like the Jacobian. There is simply a larger update in LAI than in SSM by design, and this propagates in time differently due to the difference in memory for both variables (at this point in the paper, I am actually suspecting that LAI is assimilated with a bias, see comment above).

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- Could you evaluate the impact of LAI and SSM assimilation in terms of runoff for the high-resolution simulation?

The text needs careful revision. There are too many incorrect sentences, it is annoying. Here are only some random examples:

L. 104: “this. . . are”: rewrite sentence

L. 168: “system is bale. . .”: what does this mean?

L. 186: “1%”: of what?

L. 191: “, scaled with and 0.02”: makes no sense

L. 195 and further is a repetition of the text around L. 188: combine and condense

L. 198: “. . .is assumed to be 20% and a similar assumption is made. . .”: split sentence. ‘Similar’, but not identical? Please be precise and say which error is applied.

L. 207: replace ‘as well as’ by ‘or’ to avoid the impression that multiple forcing data sets are combined in a way.

L. 281: LDAS-ERA5; later on LDAS_ERA5

L. 412: w.m-2 –> W.m-2

L. 615: The *C*urrent

L. 632: references seem off, GLDAS , MERRA-2?

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