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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Assimilation of vegetation optical depth retrievals from passive microwave radiometry" *by* Sujay V. Kumar et al.

Anonymous Referee #1

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Assimilation of vegetation optical depth retrievals from passive microwave radiometry Kumar et al., 2020

This manuscript shows the impact of microwave-based VOD and/or soil moisture data assimilation into the Noah-MP as part of LIS. The results are extensively evaluated using a wide set of independent estimates of various variables (incl. evapotranspiration, GPP, soil moisture, discharge). Overall, this is a great paper, worthy of publication after some clarifications and corrections.

Methodology:

- Why is VOD rescaled to MODIS LAI (GLASS) instead of rescaling it to the model LAI? There may be a large bias between the MODIS LAI and model LAI, which would violate

the Kalman filter assumptions. Perhaps show the spatial map of RMSD between the model LAI and the VOD after transformation to LAI (via GLASS)?

Another main concern with GLASS is that this product is filled with climatological values. Optical data do not have the same good coverage as microwave data (see also comment below). By now mapping VOD to GLASS, we basically undermine a key advantage of microwave data, i.e. we destroy the VOD information by mapping it to climatological LAI where insufficient LAI data are available. . .

- Why is VOD rescaled instead of installing an observation operator (H) that maps the model LAI to VOD? The latter would have the advantage that the Kalman gain would be able to capture more of the dynamic errors.

- Why is VOD (after rescaling) not bias-corrected, whereas soil moisture is?

- Isn't the SMAP VOD simply pre-calculated before retrieving soil moisture? The ATBD says that SMAP VOD is based on optical data (NDVI & stem index) and then used as an ancillary input to the soil moisture retrieval. It is then not surprising at all that the SMAP VOD corresponds more to optical LAI estimates (L. 222).

- Regardless of how SMAP VOD is pre-calculated or retrieved, the SMAP VOD and soil moisture estimates will have strongly correlated observation errors. Are these accounted for? If not, at least the individual errors should be increased to compensate for this lack or error correlations.

- The microwave retrievals are not at the same resolution as the model 1/8ˆo resolution. How does the 1-dimensional filter then work? There has to be some down- or upscaling.

- Data assimilation update vector: can you explicitly state the content of the update vector and does it change between VOD and SM assimilation experiments? (I do not think the vector should change with the experiment, but in between the lines of the text, I had the impression that it was changed; if done right, the update will naturally go

where it needs to go).

- Are the perturbations for all DA and OL experiments exactly the same?

- Soil moisture is rescaled via CDF-matching on a monthly basis. Is this monthly using multi-year information, or year by year?

Results:

- Fig 5: how is the change in unbiased RMSE or anomaly correlation for ET and GPP?

- L. 345: monthly mean? Year by year or multi-year means?

- L. 428: “seasonality in the anomalies and not the mean signal is the key factor in the CDF-matching”? But the CDF matching exactly tries to harmonize the mean signal of the observations and simulations. Rephrase?

- Around L. 510: one of the key results of the paper is in this paragraph and only supported by 2 time series at single points. It would be nice to have a more robust or convincing figure. For example, the correlation between RMSD(DA-OL) vs long-term mean soil moisture and vegetation for various DA experiments for all pixels, or something else that is spatially covering?

Textual issues:

- L. 70: typo guaranteed

- L. 177: write “1d”

- L. 292: pattern (without s; verb is singular)

- L. 340: indicate earlier on that the results are not shown.

- L. 365-368, Table 1: text and caption are cumbersome, consider rewriting to be more precise. Table 1 and caption are not clear. Caption first line “*for* DA configuration*s*”? These are percentage improvements *relative to the OL*? What are the 2 numbers in the evaluation against ALEXI? What is the purpose of the units here? The values are

all percentages, no?

- (!) Fig 6: panels or caption are not correct (RMSE-R).

- (!) Fig 9: caption is not correct.

- L. 498: switch the sentence to start with location C and then location D. Confusing now.

- Fig 11: LAI for location B: this is troublesome. The model LAI shows a clear interannual difference. With the DA, this interannual difference is removed. I am afraid that here, the VOD values are possibly rescaled to a multi-year average GLASS climatology, which inherently would not hold any interannual variability.

- L. 568: capitalize Kalman

- L.577-583: do something else than starting with “Though” in 3 subsequent sentences.

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