

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
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Comment on hess-2022-61

Anonymous Referee #2

Referee comment on "Challenges and benefits of quantifying irrigation through the assimilation of Sentinel-1 backscatter observations into Noah-MP" by Sara Modanesi et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-61-RC2>, 2022

General comments:

The study idea is to explore the possibility of improving the irrigation water use simulation by direct assimilation of sentinel1 backscatter in co- or cross-polarization, which contains both soil moisture and vegetation information, with the Noah MP land surface model. The results suggested that assimilating Sentinel 1 backscatters data can slightly improve irrigation simulation over some test sites (especially the VH polarization DA). Still, poor parametrization of the Noah-MP irrigation module does not allow the DA to improve the irrigation simulation significantly. This study and the previous study (Modanesi et al., 2021) provide valuable insights into the limitations and benefits of assimilating Sentinel-1 backscatter with the land surface model for improving irrigation simulation. However, I have some concerns regarding the improvement in accumulated irrigation after DA, the spatial mismatch between the model and the test sites scale, and the accuracy of the benchmark datasets used for the validation. Please see my comments for details.

Specific comments:

1- L65: I think studies that focused on calculating the Evapotranspiration through the energy balance algorithm should also be mentioned here as examples for consumptive water use estimation using optical and thermal sensors.

2- L77: Consider the following study along with Lawston et al., 2017 that shows the more recent and high-resolution SMAP-Sentinel1 SM product also contains the irrigation signal.

Jalilvand, R. Abolafia-Rosenzweig, M. Tajrishy, and N. N. Das, "Evaluation of SMAP/Sentinel 1 High-Resolution Soil Moisture Data to Detect Irrigation Over Agricultural

Domain," in IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 14, pp. 10733-10747, 2021, DOI: 10.1109/JSTARS.2021.3119228.

3- L97: The irrigation module of the Noah-MP model calculates the ideal IRR needed for the crop to avoid water stress which is different from the actual irrigation (the farmer might over or under irrigate the fields). How do you account for that?

4- L179: Here, you are talking about the time and location of irrigation. I think GVF looks a little out of context here; some explanation regarding where GVF is used in the Noah MP model is needed.

5- L250: typo, de Kalman should be changed to the Kalman

6- L378: [Major] I can't entirely agree with this statement that the accumulated irrigation has improved compared to the OL run. Looking closely at Figure 6e, the DA underestimation of irrigation during the mid-summer months of 2015 and 2017 resulted in the overall lower accumulated irrigation (the OL run simulation during the same period closely matched the observed irrigation). In other words, the underestimation during these months compensated for overestimations in other months (e.g., the late summer months of 2016 and 2017), and the right result is obtained here for the wrong reasons! Please comment on this.

7- L383: The most considerable overestimation by the DA run relative to the observed irrigation occurred in July 2016 (Figure 6e), which is right after a significant precipitation underestimation by MERRA2. This contrasts with what is mentioned at the end of this paragraph.

8- L385: The size of the Budrio site is much smaller than your benchmark soil moisture product spatial resolution (ASCAT 12.5 km); the other Italian site or the German site would be a better choice for the SSM time series comparison shown in this figure.

9- Figure 6) It is difficult to compare the 3 time series in Figure 6 as it shows 3 years of data. As the study focuses on irrigation, adding an inset (or possibly another figure) that focuses on one irrigation season can give the readers a better idea of how DA improves or degrades different parameter simulations during the irrigation season.

10 - L425 and L478: The same result is reported on the benefits of LAI DA relative to the SSM DA in this very recent study by Nie et al. 2022, which can be discussed here.

Nie, W., Kumar, S. V., Arsenault, K. R., Peters-Lidard, C. D., Mladenova, I. E., Bergaoui, K., Hazra, A., Zaitchik, . F., Mahanama, S. P., McDonnell, R., Mocko, D. M., and Navari, M.: Towards Effective Drought Monitoring in the Middle East and North Africa (MENA) Region: Implications from Assimilating Leaf Area Index and Soil Moisture into the Noah-MP Land Surface Model for Morocco, *Hydrol. Earth Syst. Sci. Discuss.* [preprint], <https://doi.org/10.5194/hess-2021-263>, in review, 2021.