

Comment on hess-2021-273

Anonymous Referee #2

Referee comment on "Optimizing a backscatter forward operator using Sentinel-1 data over irrigated land" by Sara Modanesi et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-273-RC2>, 2021

General comments:

Irrigation is the largest human intervention in the water cycle, yet it is poorly represented in the land surface (LSM) and hydrological models. One way to account for irrigation is by assimilating the observations that contain the irrigation signal, such as radar backscatter (σ^0) or satellite soil moisture retrieval. One important step prior to the assimilation is removing biases between the model and the observation through calibration. In this study, the Noah MP model is coupled with a backscatter observation model (WCM), and Sentinel-1 σ^0 observations were used to calibrate the model. Furthermore, The impact of activating the irrigation schemes within the Noah MP model, using different backscatter polarization (VV or VH) and cost functions in model calibration, is investigated. I found the study interesting; however, as a calibration study, I expected that the results be more focused on the calibration rather than evaluating the performance of the LSM. I also have some concerns regarding the mixed results obtained regarding the activation of the irrigation module. Please see my comments for detail:

Specific comments:

- L175: The size of the Budrio test sites is much smaller than the model resolution (almost 1/200 of the model spatial resolution). I do not think it is a good choice for validation purposes.
- L300-305: It is not indicated which vegetation indicator (VWC, NDVI, or LAI) is finally chosen to represent V1 and V2 in equation 2 and 3. Moreover, it is not clear whether it is assumed that V1=V2 and a unique descriptor is used for both of them or not? According to the rest of the paper, I suppose that LAI is the chosen vegetation indicator, but I think this should be explicitly mentioned here.
- Section 2.4: As mentioned in L95, assimilating the SSM or VWC retrieval instead of MW brightness temperature or σ^0 can be problematic due to inconsistent ancillary data used in their production, and σ^0 is a better choice for assimilation. However, as is explained

in section 2.4, assimilation of σ^0 requires the NOAH MP model to be coupled with a WCM model to simulate σ^0 . In turn, the WCM model has many empirical parameters and simplifying assumptions such as not accounting for scattering interactions between ground and vegetation and assuming a linear relation between soil σ^0 and the SSM that can increase the uncertainty of the estimated σ^0 . Given this, can the authors clarify why assimilating σ^0 is a better choice relative to the assimilation of SSM and VWC?

- L356: Another interesting comparison would be comparing the performance of a third calibration approach which is, deactivating the irrigation scheme and calibrating the model only during the non-irrigated season, with the current approach (activating the irrigation scheme and calibrating for the entire period) during the non-irrigated season. This would also be an interesting comparison for the future study in which σ^0 will be assimilated to see whether calibrating during the irrigation season with the activated irrigation module is beneficial for the ultimate goal of irrigation quantification or not.
- L405-416: I am not convinced that the improvement in the simulation of SSM by Noah MP is due to the activation of the irrigation module for two reasons:
 - In most of the previous studies, it is shown that coarse-scale MW products are not able to detect irrigation signals at the plot scale (e.g., Brocca et al., 2019, Zaussinger et al., 2018, Dari et al., 2020) unless there is intensive flood irrigation over a large area such as California central valley in which fields are flooded, and the water level is sustained throughout the irrigation season (Lawston et al., 2017). Moreover, to have a fair comparison, other metrics such as RMSE or bias should also be reported alongside the Pearson correlation (R).
 - The deterioration in LAI simulation when irrigation is activated makes more sense to me as the spatial resolution of the Proba-V LAI product is 1km, and the possibility of detecting the irrigation signal is higher relative to the coarse-scale SSM products.

Please comment on this.

6. L435-446: I think the part of this significant difference between simulated and observed irrigation and missing the irrigation events is related to the spatial mismatch between the model and the test site, as it is mentioned in the first comment. Please comment on this.