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Discussions

Interactive comment on "Improving Soil Moisture Prediction of a High–Resolution Land Surface Model by Parameterising Pedotransfer Functions through Assimilation of SMAP Satellite Data" *by* Ewan Pinnington et al.

Anonymous Referee #2

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Accurate soil moisture simulation has always been a tough issue due to various sources of errors, including biased forcing, unrealistic model parameters, defect model structure and/or parameterizations. Focusing on uncertainties in pedotransfer functions, this study calibrates some of the key pedotransfer parameters through the assimilation of SMAP soil moisture product, and have obtained lower RMSD and higher correlation coefficients in posteriors. Independent evaluation against COSMOS observations also suggests promising results.

In general, this work presents a good example of utilizing satellite data to improve land

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Discussion paper

surface models. The current layout and interpretation within the manuscript are mostly valid to me, except some remained concerns on the detailed DA implementations and soil moisture evaluations, as depicted below.

1. My biggest concern is on the comparison of modeled soil moisture from a relatively 'thick' layer of 0-0.1 m with SMAP retrievals, which in most conditions corresponds to only a few centimeters of the topsoil (~2.5 cm, according to Zheng et al. 2019). Under some circumstances, soil moisture may vary a lot with depth. Is soil moisture mostly consistent and exhibits less vertical gradient within the 0-0.1m layer across the study domain? Otherwise the evaluation and the subsequent conclusions presented in this study maybe questioned. Please elaborate. Reference: Zheng, D., Li, X., Wang, X., Wang, Z., Wen, J., van der Velde, R., Schwank, M., & Su, Z. (2019). Sampling depth of L-band radiometer measurements of soil moisture and freeze-thaw dynamics on the Tibetan Plateau. Remote Sensing of Environment, 226, 16-25

2. Looks typo in the third equation of Eq(1): should âĹĚ_e f_clay be âĹĚ_f f_clay ?

3. For the pedotransfer parameters shown in Table 1, are they independently calibrated grid by grid, or they share the same values across the whole domain?

4. L138-140: it is interesting to know to which depth each COSMOS monitors soil wetness. Together with results shown in section 3, it can help understand to what extend the innovation introduced into the surface layer can propagate into deep soils. That being said, I also expect the authors to spend a short paragraph to discuss this issue.

5. L149-150: how is the observation operator like? Do you simply spatially average estimates from all the 1 km grids, and how do you project increments from the 9 km grid back to the 1 km grids? Please clarify. In addition, which variables are exactly included in the joint state-parameters?

6. L153: "...by a factor a four..."–not sure how this is done, may need to provide more

details on the implementation of inflation.

7. Fig. 3: if possible, better to show prior and posterior distributions of some of the soil hydraulic parameters (e.g. θsat,Ksat) in Eq(1) as well, as they directly regulate soil water within the land model.

8. L192: urban areas are known to have problems in both remote sensing and land surface modeled soil moisture. I would suggest excluding urban areas in all the plots in Figs.(2, 4-5). Meanwhile, the authors may want to show some of the COSMOS sites in these plots to help better interpret results in Figs. 8-11.

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