

## ***Interactive comment on “Assimilation of SMOS Brightness Temperatures or Soil Moisture Retrievals into a Land Surface Model” by Gabriëlle J. M. De Lannoy and Rolf H. Reichle***

**Anonymous Referee #3**

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In order to investigate the impact of the different assimilation schemes (Tb & SM retrieval assimilation) on the skill of surface and root-zone SM estimates, the authors assimilated five years of SMOS Tb data or SM data into the GEOS-5 land surface model and RTM model, using a spatially distributed EnKF. They found that different assimilation systems show surprisingly different spatio-temporal increment patterns, leading to very different adjustments to the modeled soil moisture trajectories. Nevertheless, the various schemes yield SM estimates with similar average skill metrics, introducing significant improvements over the model-only simulations. The manuscript was very well structured. However, considering the complexity of the information delivered, some minor adjustments were needed, for the sake of reader's ease in understanding.

C1

Specific comments: 1. The concept of total soil profile water ( $\Delta w_{tot}$ ) was used to investigate the innovations, increments and relevant statistics (e.g. in Figure 1, 2, 5, 6). On the other hand, this  $\Delta w_{tot}$  is a diagnostic variable (e.g. an aggregated variable representing changes in  $cat_{def}$ ,  $sr_{fexc}$ ,  $rz_{exc}$ ) and is not a member of the state vector for Tb & SM assimilation. It is not clear if the analysis has been done for  $cat_{def}$ ,  $sr_{fexc}$  and  $rz_{exc}$ , what is the necessity left (or add value) for doing analysis for  $\Delta w_{tot}$ ?

It is suggested to use  $cat_{def}$  for Figure 1,2,5 & 6, instead of  $\Delta w_{tot}$ . Or, if the authors would like to stick with their choice, a verification/clarification is needed.

2. Paragraph 2 on Page 12 (e.g. between line 4 and line 12). (a) It is said " ... The  $cat_{def}$  increments pertain to the entire profile depth ... and have a relatively small impact on the upper 5cm SM ..., would scale to about 0.1 mm for a 5cm soil layer". First of all,  $cat_{def}$  is a state variable of CLSM and would exert only second order effects on surface SM (Koster et al. 2000). It is not clear how the authors scaled the  $cat_{def}$  increments to surface SM; (b) "The increments in  $rz_{exc}$  are relatively smallest, because this variable is not perturbed by design". The  $rz_{exc}$  is another state variable of CLSM and was also member of the state vector used by the assimilation system. So, with such context, what does it mean "... not perturbed by design" here?

3. line 16, page 2, gage-based -> gauged-based;

4. line 17, page 2. Not clear what does it mean here by "inconsistent"? Did you mean here that the ST observed by a different satellite other than the one for SM?

5. line 3, page 4, range between 30 and 50 deg?

6. line 30, page 4. Reichle et al. (2015) is not detailed enough for an overview of the CLSM model variables. Please update them with following references: Koster, R. D., M. J. Suarez, A. Ducharne, M. Stieglitz, and P. Kumar, A catchment-based approach to modeling land surface processes in a GCM, Part 1, Model Structure, J. Geophys. Res., 105, 24809-24822, 2000.

C2

Ducharne, A., R. D. Koster, M. J. Suarez, M. Stieglitz, and P. Kumar, A catchment-based approach to modeling land surface processes in a GCM, Part 2, Parameter estimation and model demonstration, *J. Geophys. Res.*, 105, 24823-24838, 2000.

7. Section 2.3, there are lots of information in this subsection. However, it is difficult to follow without further checking other references. More specifically, for the concept of "footprint scale" and 36-km grid, how they were relevant and how exactly they varied with latitude and longitude are not clear. Perhaps a schematic will help? Furthermore, could the authors help to use a flowchart here to show that RTM converted CLSM simulations into Tb and then this calculated Tb was used to compute O-F residuals in the assimilation system, while considering the geometric relations between "footprint scale" and "36km grid"? Such flowchart will help tremendously the readers to have an overview of the whole processing chain, which is the most fundamental for understanding the topic of this manuscript.

8. line 26, page 5, how were the weights assigned, with different depths?

9. line 1-2, page 6, any reference for this statement?

10. section 3.1, again, this is also fundamental for readers to understand the manuscript. Could the authors help to add a flowchart here to show the difference between the Tb and SM assimilation algorithm?

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