Comments on the paper titled "Improving simulated soil moisture fields through assimilation of AMSR-E soil moisture retrievals with an ensemble Kalman filter and a mass conservation constraint" by B. Li, D. Toll, X. Zhan, and B. Cosgrove

Summary

This paper addresses an interesting topic since it describes an ensemble Kalman filter based data assimilation scheme with a mass conservation. By using this new updating scheme, the actual value of Advanced Microwave Scanning Radiometer (AMSR-E) soil moisture retrievals were assimilated into the Noah land surface model to improve the estimation of the soil moisture. This technique was compared with the conventional scheme in the Little Washita watershed of Oklahoma. And the assimilation results, being tested with the site measurement, demonstrated the advantage of the mass conservation scheme in providing better estimates in the deeper profile, yielding physically consistent estimates of fluxes and maintaining the water budget.

These conclusions are convictive, but some minor issues needs to be addressed as presented in the following comments. So, I suggest this paper be published after a few minor revisions.

Major comments

(1) It was assumed that the AMSR-E soil moisture retrieval is only representative of soil moisture in the top 5 cm soil (as stated in this paper, the AMSR-E sensor measures about 1–2 cm from the surface). To transfer the observation information from the surface to the deep layers, a mass-conservation data assimilation scheme was developed. In this study, however, the AMSR-E data were used to update the top two layers (10cm and 30cm respectively). Is it reasonable for this assimilation? What consequence will occur when only soil moisture of the top surface layer is updated using Eq. (5)?

(2) To test the assimilation results from the three simulation runs (Control, conventional DA, DA MassCon), basin averaged daily series were evaluated for the soil moisture and flux. But the basin averaged values just provide a rough or coarse evidence of the assimilation capability due to the fact that they will mask the detailed spatial variations of these states. So, it is not necessarily convincible

that DA MassCon is a capable scheme, if it only improves basin-averaged simulated soil moisture fields and fails to effectively ameliorate detailed soil moisture estimation. So I suggest the author make a comparison at the grid (0.01 degree for the Noah model resolution) or the point scale between the assimilated results and the ARS observations. That is, pick up the series of assimilated results from the grids corresponding to ARS measured points (about 20 points as shown in Figure 1), and calculate the correlations and errors of the paired series. Maybe a table is good enough to exhibit these results.

Minor comments

(1) The area of Little Washita watershed is about 611 km^2, and the AMSR-E retrievals holds the resolution of 25×25 km^2. But the paper says on Page 8136, Line 13, "the experiment site contains about 5 to 6 AMSR-E pixels". Is that right? Is the area of the experiment site not equal to the area of Little Washita watershed since $25 \times 25 = 625$ $km^2 > 611$ km^2?

(2) Page 8137: Line 15: Is the Eq (2) right in which the subsurface runoff is equal to the hydrologic conductivity?

(3) Page 8139, Line 10, the symbol F in Eq(4) should be written as F_t to represent the time step.

(4) Page 8140, It is hard for me to understand the Eq. (6) for distributing the water increment to the layer 3 and layer 4. As the formation expressed, it can be rewritten as

$\begin{pmatrix} Y_3 \\ Y_4 \end{pmatrix}_t^a = \begin{pmatrix} Y_3 \\ Y_4 \end{pmatrix}_t^f - \frac{1}{d_3 + d_4}(\Delta C_1 d_1 + \Delta C_2 d_2)$. But I don't think it is a right formation because ΔC_1 and ΔC_2 are variables of single values. Please check it and give an explanation for this equation.