We thank all reviewers for their suggestions. The original comments are in black normal fonts. The answers are in blue italic fonts. Modified text is underlined. Figure, page and line numbers generally refer to the old manuscript. An indication of anticipated new figure, page and line numbers are provided in brackets.

Referee #1

General Comments:

This work is trying to assimilate SMOS brightness temperature, soil moisture product and TB difference between SMAP and SMOS into GEOS-5. The outputs are compared with each other, as well as against the SCAN and USCRN in-site soil moisture networks. By using strict mathematical test, inputs quality control and assimilation scheme, the result is reliable and reasonable. The method established in this paper imitates the SMAP Level 4 product but expands its technique. I think it is very useful for the future application of SMOS/SMAP product and further soil moisture-weather/climate model researches. This paper is recommended for publication.

We thank the reviewer for the encouraging review and for all suggestions.

However, I have some doubts, not necessarily comments to the authors:

1) Line 6, section 3.1, Is the spatially distributed the same concept as three-dimensional? If each grid was updated separately as said in Line 6-7, then which three dimensions are they?

Indeed, "spatially distributed" and "three-dimensional" refers to the same concept as was already noted in the text. The 3 dimensions are in space. This will be edited (p.5, L7 [p.6, L19]).

2) The variables listed in P4, Line 26-30 will be updated after assimilation loop as described in P7, Line 11-15. The variables includes part soil moisture/temperature defined in the land surface model but not all of them. In this case, the soil moisture/temperature will partly altered by the assimilation, is that right? How do the authors select which layer should be assimilated into? Will this selection affect the weather forecasting?

Indeed, the deeper layer soil temperature is not included in the Kalman filter update, but it will receive indirect updates though downward propagation of the information by the soil heat diffusion module of the Catchment model. The observations are most directly related to the surface layer (5 cm) soil moisture, but the observations are used to update all soil moisture variables related to the entire soil profile. This will be edited (p.7, L4 [p.7, L21]).

The modeling and assimilation system used in the study includes only the land (section 2.3), and impacts on weather forecasting are beyond the scope of the present paper. But we anticipate that weather forecasts would primarily be impacted by the updated soil

moisture (including surface and root zone) via evapotranspiration and by the surface temperature via sensible heat. The lower-layer soil temperatures should have at most a second-order impact.

3) Figure 7 indicates the changes due to assimilation. Large marks are assigned for statistically significant sites but it is really hard to distinguish them from the rest. Maybe the authors could use other symbols or give some explanations on how many sites are improved actually. Besides, what is the evaluation of simulation result without data assimilation while only changes are illustrated in Figure 7? I see the magnitude in changes is quite small, about 0.01, which is lower than the accuracy of SMOS/SMAP mission. If the model simulation doesn't match well (for instance, difference larger than 0.1), how important the improvements brought in by assimilation should be re- considered. I know the comparison between model and in-site observation is a very complicated issue and may be too much if it is discussed in this paper. What I rec- ommended is to add some simple figures which could give an estimation of model v.s. observation difference, without assimilation.

We will update the old Figure 8 ([Fig 9]) to also include the RMSD_ub values for all experiments. This should help to put the values of old Figure 7 ([Fig 8]) into perspective, as suggested by the reviewer. Text will be edited accordingly (p.14, L3 [p.14, L27]).

4) For Figure 8, the problem still exists. Figure 8 adopts a similar method used in an- other paper in De Lannoy and Reichle, Journal of Hydrometeorology, 2016. It is for sure that the correlation increase indicates the effect of assimilation but the correlation increase doesn't mean the absolute soil moisture value is improved. Usually in the cur- rent forecast model, soil moisture is a diagnostic variable which does not interact with the atmosphere directly. As mentioned in Line 21 *(p.1)*, if the soil moisture will be used to improve weather forecast, its absolute value is more important for evaporation/Bowen ratio calculation. By enlarging or restricting soil moisture, the land surface model in climate forecast could also collapse while correlation coefficient increases. Without seeing the soil moisture time series for particular site, or at least any time–series which reflect the variation, the conclusion that assimilation improved soil moisture simulation should be made with caution.

*It is not 100% clear to us what the reviewer means by improved "absolute soil moisture value." Our assimilation system is primarily designed to estimate or improve temporal variations of soil moisture by correcting for random errors. The long-term mean soil moisture values from the assimilation are intentionally the same as those of the underlying model. (This implies that the assimilation estimates can still be used in conjunction with the **model's** relationship between soil moisture and the Bowen ratio, without upsetting the forecast model's calibration.) In any case, when the model soil moisture is adjusted by the analysis updates, its absolute value changes at any given time. The correlation and $RMSD_{ub}$ metrics do measure this change (but would not measure a change in the long-term mean, which, again, does not occur by design).*

We will edit this (p.5 [p.5]), (p.5, L30 [p.6, L7-9]).

Minors:

P4, Line 3, "][" should be replaced by "[]" P4, Line 10, What is the SM uncertainty? Is it one of the products from SMOS?

- In fact, the "]..[" is correct, b/c we exclude 30º and 50º incidence angles from the interval. Since reviewer#3 also stumbled over it, we will spell it out. (p.4, L3 [p.4, L6])

- The SM retrieval uncertainty is provided inside the SMOS product. This will be clarified (p.4, L9 [p.4, L12]).