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Discussions
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Interactive comment on "Evaluation of soil moisture in CMIP5 simulations over contiguous United States using in situ and satellite observations" *by* Shanshui Yuan and Steven M. Quiring

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RESPONSE TO THE REVIEWER #1'S COMMENTS

We appreciate the reviewer's encouraging comments, and agree with the suggestions. Your comments will improve the manuscript. In accordance with these suggestions, we have revised the manuscript carefully. Responses to each comment are provided below.

Detailed comments

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Discussion paper

1. Section 2.1, page 4. The authors modified sub-regions from previous studies. Will this modification affect the results? For instance, do the land cover types in the new sub-regions differ from previous studies?

Response:

Thanks for this question. We have generally used the same sub-regions as in previous studies, but four sub-regions (Northern Great Plains, Southern Great Plains, Midwest and Southeast) were modified so that we could include more in situ soil moisture measurements. The original boundaries of each sub-region were based on the land cover types and were applied in soil moisture related research (Mei and Wang, 2012). We found the land cover types in the modified sub-regions do not change greatly. In Northern and Southern Great Plains, the main effect of the modification is including more soil moisture sites in eastern Oklahoma where the dominate land cover type is Savanna. Savanna is also the main land cover type in central Oklahoma. In the Midwest, the modified region expands northward. Most of the sites (5 of 6) that were added are located in cropland region. This is consistent with the dominant land cover, since cropland covers more than 90% area of the Mideast. In the original Southeast, evergreen forest is the main land cover type. The land cover types in the modified Southeast is mixed by evergreen forest, deciduous forest and mixed forest. This is the only change we found between the original and modified sub-regions. So, we compared observed in situ soil moisture in the Southeast sub-region using the original boundaries and the modified boundaries to evaluate whether changing the spatial extent of the sub-region had a significant impact on the observed soil moisture measurements. We plotted the area averaged monthly in situ soil moisture using the original boundaries and the modified boundaries in Fig.1.

The figure shows in both 0-10 cm and 0-100 cm soil layers, area-averaged soil moisture in the Southeast sub-region using the original boundaries is highly correlated with the soil moisture in modified Southeast sub-region. Therefore, we conclude that the modified sub-regions have relatively little impact on the area-averaged observed soil

moisture. In addition, both the modeled and observed soil moisture are calculated using the same boundaries. Therefore, the change in the regional boundaries does not affect the appropriateness of the model evaluation reported in this paper. For these reasons, we are confident that the modified regions used in this paper do not have a significant impact on the results.

Reference

Mei, R., and Wang, G.: Summer Land–Atmosphere Coupling Strength in the United States: Comparison among Observations, Reanalysis Data, and Numerical Models, Journal of Hydrometeorology, 13, 1010-1022, doi:10.1175/JHM-D-11-075.1, 2012.

2. Page 5, line 2. The authors mentioned that soil moisture data were collected from 8 different networks. Do the 8 networks use same way to measure soil moisture? If no, then is there any significant biases among networks?

Response:

Thanks for this great question. The eight networks use different methods to collect soil moisture data. In this study, the eight networks we used have been shown by Dirmeyer et al. (2016) to have relatively low random errors. The goal of this paper is to evaluate ESM simulated soil moisture using soil moisture observations. A detailed evaluation of the in situ networks is out of the scope of this study. However, we agree that differences between these networks may affect the results. Therefore, we have reported this issue in the limitations section of our paper to highlight potential future work.

Reference

Dirmeyer, P. A., Wu, J., Norton, H. E., Dorigo, W. A., Quiring, S. M., Ford, T. W., Santanello, J. A., Bosilovich, M. G., Ek, M. B., Koster, R. D., Balsamo, G., and Lawrence, D. M.: Confronting Weather and Climate Models with Observational Data from Soil Moisture Networks over the United States, Journal of Hydrometeorology, 17, 1049-1067, 10.1175/JHM-D-15-0196.1, 2016.

3. Comparison between point measurements and gridded value is a big challenge, especially in a big grid box. Can simple spatial average method solve the issue?

Response:

Thank you for the question. Due to the complex spatial variability of soil moisture, a simple spatial average is not the ideal approach to upscaling soil moisture. It may result in the loss of some spatial information. We realize using more advanced aggregation methods may improve the accuracy of this analysis. However, since our evaluation focused on a coarse temporal scale (monthly scale), the influence of the spatial aggregation method is less important. Spatial averaging is commonly used to compare station data to modeled data. For example, Xia et al. (2015) used state-wide averaged soil moisture from stations in Alabama, Colorado, and Oklahoma to validate NLDAS-2 model simulations.

Reference

Xia, Y., Ek, M. B., Wu, Y., Ford, T., and Quiring, S. M.: Comparison of NLDAS-2 Simulated and NASMD Observed Daily Soil Moisture. Part I: Comparison and Analysis, Journal of Hydrometeorology, 10.1175/JHM-D-14-0096.1, 2015.

4. Page 6, line 14. Add a space between "<" and "0.25".

Response:

This change has been made.

5. Section 3.1, page 8. The content in this page is about the evaluation of individual models. Generate another section to present these results.

Response:

This is a good suggestion. We created Section 3.2 to discuss the evaluation of individual models.

6. Page 27, Figure 9b. It is better to change 1 m to 100 cm at the top of the figure, because it is important to keep expressions consistent throughout the paper.

Response:

Thanks for the comment. “1 m” in Figure 9b has been changed to “100 cm”.

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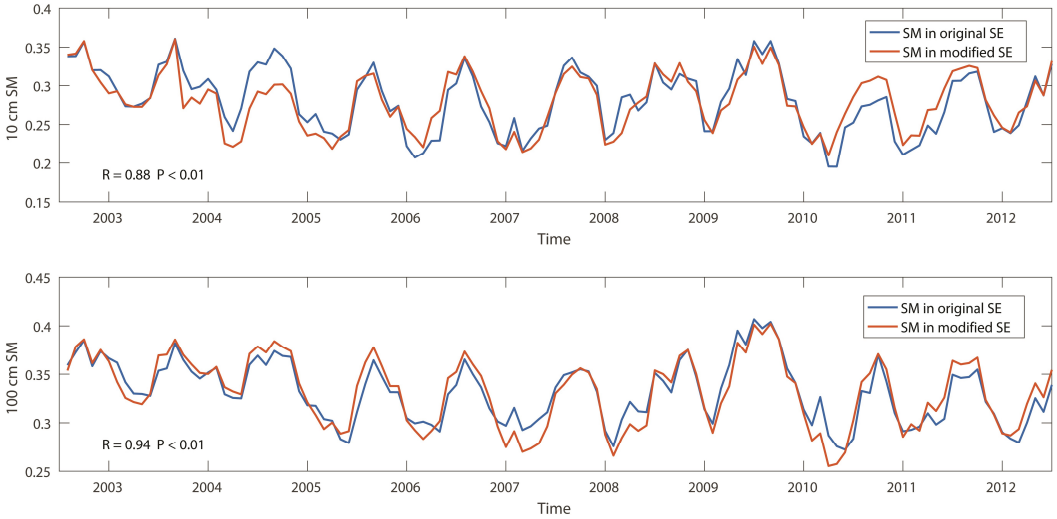

Fig. 1. Spatial averaged monthly soil moisture in the original Southeast (blue) and in the modified Southeast (red). Upper (lower) figure shows soil moisture in 0-10 cm (0-1 m) soil layer.

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