

Thank you very much for your careful review and constructive suggestions with regard to our manuscript “Contributions of climate change and groundwater extraction to soil moisture trends”. Those comments are all valuable and very helpful for revising and improving our paper, as well as the importance guiding significance to our researches. We thank the reviewer for the constructive comments and suggestions, which are in the text below. Our itemized response is followed. In addition, we have uploaded the revised manuscript according the comments (marked in red).

Line 59: Not accurate. Any evidence showing that the LSMs can represent the soil moisture trends?

Response: We revised this sentence to “*Land surface models (LSMs) can be used to calculate soil moisture trends at regional or global scales (Li et al.,2011; Jia et al., 2018)*” and add corresponding references at the same time. Please see Line 60-62 and Line 523-524.

Line 59: "Recently" – Soil moisture has been simulated in LSMs over a few decades – not "recently"

Response: We revised as suggested. Please see Line 62.

Line 68: "to 45%" -> "45% to"

Response: We revised "to 45%" to "45% to". Please see Line 69.

Line 71: Vague: What kind of remote sensing data and model?

Response: Based on the comment, we added “*using remote sensing data ESA-CCI and modeling of soil moisture by Community Land Model 4.5 (CLM4.5) in China*” in the revised paper. Please see Line 73.

Line 82: Repeating sentence. I would delete it.

Response: We deleted it as suggested.

Line 88-90: Is this part of the LS3MIP effort?

Response: Yes, this is part of the LS3MIP effort.

Line 105: No idea on the "coarse resolution": You should clarify what spatial resolution was used in your study at/before this point.

Response: We added the spatial resolution ($0.9^{\circ} \times 1.25^{\circ}$) at this point. Please see Line 105.

Line 137: Two Zeng et al., 2016 papers were found in the list of references. Double check it.

Response: We revised it to “2016b”.

Line 137-140: I have some serious concern about the assumption that the irrigation represents the level of water consumptions – any evidence?

Response: The monthly irrigation data is based on the FAO and compare with other researches (Wada et al.,2011; Doll et al., 2012), the level and the pattern of water consumptions was comparable. And we modified this sentence in the manuscript to avoid misunderstanding. Please see Line 140.

Wada, Y., L. P. H. van Beek, C. M. van Kempen, J. W. T. M. Reckman, S. Vasak, and M. F. P. Bierkens.: Global depletion of groundwater resources, *Geophys. Res. Lett.*, 37, L20402, 2010.

Döll, P., and Coauthors.: Impact of water withdrawals from groundwater and surface water on continental water storage variations. *J. Geodyn.*, 59–60, 143–156, 2012.

Line 184-185: Did "March-October" apply to grid cells in the Southern Hemisphere?

Response: Yes. In fact, we do this because we are trying to avoid the error caused by frozen soil.

Line 189: Some explanation of the "trajectory method" is necessary here. Readers need to understand what the method is and what the method can provide. Eq 3,4,5,6: I really had difficulty in understanding these equations. First, symbols in Eq 3,4 and 5,6 should not be the same, as they represent different terms. I did not quite get the rationale of Eq 3. It is very confusing. I suggest the authors re-design the variable names in these equations and made them easy to follow in the revised manuscript.

Response: The “trajectory” refers to studying the change of GW extraction that occur within a certain period of time for a given grid or region. We can study the effect on soil moisture due to GW extraction in this way. And we re-designed the variable names as suggested. Please see Line 189-191.

Line 209: linear correlation of the time series? Clarify it.

Response: Yes, and we clarified it on the Line 209.

Line 211: These results only indicate whether the models captured the interannual variability of the soil moisture, if you were calculating the correlation coefficients of the time series. It's not about "soil dynamics"

Response: We revised it according the suggestion. Please see Line 214.

Line 214: How were the difference calculated? Is it the difference between the long-term means?

Response: Yes, it is the difference between the long-term means.

Line 222-224: Not accurate. Better to say "GW extraction caused significant increase in ..."

Response: We revised it according the suggestion. Please see Line 227.

Line 226: You should explain how Fig 3 can show the model generally captured ...

Response: This is because the high correlation and the standard deviation ratios close to 1. And we revised it according the suggestion. Please see Line 231.

Line 229: when you use 'significantly', there must be some statistical evidence. I would delete

it

Response: Based on the suggestion, we deleted it.

Line 242: "different methods" for doing what?

Response: It means to match the soil depth of observations to the corresponding soil layer of simulations at different areas (columns 5 and 6 of Table 2). Line 247.

Line 326: "negligible" or "not negligible"?

Response: Not negligible. We modified it.

Line 328: Again, I feel the metrics in Eq 3-6 are confusing. A good metric of contribution should be between 0 and 100%. Negative and >100% contributions are hard to follow. I strongly suggest the authors seek other metrics (if there is any) to indicated the relative contribution, which I believe will greatly improve the writing quality of this paper.

Response: The negative contribution is because that the surface soil moisture is decreasing, while GW extraction slows down the reduction trend (but still decreasing), $T_{gw} - T_{ctl}$ in Eqs. (5) is positive, but T_{gw} is negative. We added explanation in the revised paper for better understanding. Please see Line 339-341.

Line 378-382: I am glad to see discussions about the implications, although I was expecting more suggestions on the regional groundwater extraction.

Response: Based on the comments, we added some discussions about the impact of the regional groundwater extraction into the conclusion sections. Please see Line 388-392.

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Once again, thank you very much for your comments and suggestions.