Community Comment #1:

We would like to thank you very much for your helpful and constructive comment. We write our responses in blue underneath each of your comments.

Best regards,

Daniel Blank (on behalf of all co-authors)

I read through this interesting manuscript focused on assessing relationships between soil moisture (SM) and GRACE-based daily TWSA on a global scale. Thanks to the authors for this great contribution to the literature. I have two comments/suggestions that the authors may find relevant while revising their manuscript.

Thank you very much for contributing to the discussion of our manuscript and the positive and constructive feedback.

Lines 62-64. Daily TWSA has also been successfully employed to analyze the development and propagation of the water extremes using standardized drought and flood potential index (SDFPI). Please see Xiong et al. 2022a.

We have added the reference to the water extremes (drought/flood index) to our text.

More importantly,
Lines 388-389: From these lines, I understood that climate is (as portrayed herein) the major factor for a strong correlation between TWS and SM. [Line 401: not only surface water bodies but also human activities such as groundwater extraction in north India can affect these relationships significantly]. In my understanding, the larger the groundwater extraction for irrigation, the more positive will be the trends in SM, hence the more declining trends in TWS [due to the eventual loss of irrigated GW as runoff, evapotranspiration, and atmospheric moisture content]. Please see Xiong et al., 2022b (third paragraph of section 3.2). How do the authors relate the effect of such human-induced activities to their analysis? Additionally, how this human-related part (e.g., irrigation) is reflected in various SM products as we go deeper.
Overall, I could not find a sufficient description of human activities in the manuscript (though partly touched upon in line 260), which I think should be accommodated, at least as the explicit uncertainty discussion in the analysis and/or future research directions.

Similar to our response to the question of Reviewer 2 on the human influence above, we may stress that TWS based on satellite gravimetry as well as observation-based soil moisture capture the human influence on water storage, albeit with the differences that TWS is an integrative observation of water storage changes in all storage compartments, whereas soil moisture represents a subset only. While both observation-based soil moisture data and GRACE-based TWS observations can do so for the effects of irrigation on near-surface soil moisture, GRACE-based TWS observations can provide additional information on the effect of such human impacts on water storage dynamics in the deeper unsaturated zone and in the groundwater. While we agree with the comment above that groundwater extraction for irrigation purposes may be seen as a long-term TWS decline in the GRACE data, we doubt that this will necessarily lead to a positive trend in soil moisture as there are presumably high losses by ET and drainage, as also mentioned in the comment above. The combination of (near-surface) soil moisture products and TWS observations may shed light on how human activities and irrigation practices in particular translate into water storage changes in deeper soil zones. We want to stress, though,

that the focus of this study was on shorter-term storage changes and not on long-term trends. We will nevertheless add a comment in the uncertainty discussion of the revised manuscripts on overlapping trend signals in the unsaturated zone and in the groundwater that are difficult to disentangle in the TWS data.

References

Xiong et al., 2022a. A Novel Standardized Drought and Flood Potential Index Based on Reconstructed Daily GRACE Data. Journal of Hydrometeorology. https://doi.org/10.1175/JHM-D-22-0011.1

Xiong et al. 2022b. Leveraging machine learning methods to quantify 50 years of dwindling groundwater in India. Science of the Total Environment. https://doi.org/10.1016/j.scitotenv.2022.155474