Hydrology and Earth System Sciences Discussions

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Review of " Evaluating downscaling methods of GRACE data: a case study over a fractured crystalline aquifer in South India" by Pascal et al.

Anonymous Referee #1

Referee comment on "Evaluating downscaling methods of GRACE (Gravity Recovery and Climate Experiment) data: a case study over a fractured crystalline aquifer in southern India" by Claire Pascal et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-39-RC1, 2022

General comment

The paper presents a method for a non-static temporal and spatial validation of the downscaled GRACE (Gravity Recovery and Climate Experiment) data at a resolution deemed appropriate for assessing groundwater storage and irrigation. The authors have combined in situ measurements (e.g groundwater level (GWL) with data-driven (e.g Random Forest and ML) models within an extensive validation framework. Their motivation was driven by the lack of comprehensive dynamic validation strategies for GRACE-derived downscaled products in both time and space to cope with changing hydrological processes through the seasons. In general, their results show that the bias-corrected ML and RF improved the correlation with in situ measurement as compared to the to the LR reference. However, the scaling factor method (SF) degraded the performances and cannot be used at 0.5â□¦ resolution as a valid downscaling approach. They also highlighted the flaws of static GRACE dowscaling methods in catchments or areas with hydrological processes varying across the year.

I found the paper very nice to read and has some novelty in both philosophy and methodology dealing with downscaling the GRCAE product which are of interest to the audience of HESS. It is well written and structured in coherent sections with appropriate content.

- By start reading the paper the sentence L 6-8 in the abstract " The point is that the performance of GWS downscaling methods may vary in time due to changes in the dominant hydrological processes through the seasons. To fill the gap, this study investigates the dynamic performance of GWS downscaling by developing a new metric for estimating the downscaling gain (new validation) against non-downscaled GWS"

draw my attention. This is one of the main motivations behind this work. However, I was not able to see an explicit consideration of the variability of the dominant hydrological processes in the proposed methodology nor in the results and discussions. If this has been done within the GLEAM model to simulate the soil moisture (SM) storage then this deserves better description and thorough discussion in the results and discussion section.

Detailed comments

- It may be better to add the native resolution of the SM CCI product to the text (L. 145). Sure, the information exists in the Table 2.
- Why there is a need to check whether the downscaled product fits to the validation data better than the LR (original GRACE) product?
- In Fig. 2. How the uncertainty envelope was calculated? Can you add this to the text in the appropriate section?
- In L. 276 you reported that " …revealing that the RF suffers from overfitting". Firstly, can you add the R2 value for the test set in the RF? Secondly, do you think the data quality is responsible for the overfitting of the RF during the test phase?
- L. 280 "…already revealing the uncertainty induced by the deconvolution with GLEAM RZSM". I don't understand how the lower performance as compared to in situ is attributed to the uncertainty? This needs to be clarified. In addition, I think that there is a need for better developing the uncertainty issue in this paragraph. This deserves better discussion here although a section on other uncertainty sources in validation already exists in the discussion.