

Influence of intensive agriculture and geological heterogeneity on the recharge of an arid aquifer system (Saq-Ram, Arabian Peninsula)

The paper "*Influence of intensive agriculture and geological heterogeneity on the recharge of an arid aquifer system (Saq-Ram, Arabian Peninsula)*" presents a water budget estimation of regional groundwater recharge flux for an arid aquifer system. The approach is well driven and the paper is really well written. I do have three remarks.

- 1) The authors claim that there is a strong spatial heterogeneity of groundwater recharge over the domain. However, such heterogeneity is barely discussed and not illustrated. A representation of the variation of the estimated recharge flux over the studied region would be a great asset. It would be interesting to have such a map and to discuss about the heterogeneity of the estimated recharge in the results. Moreover, it is not clear for now how the water budget has been computed and how the other component of the water budget has been assimilated and combined with the satellite-based products. Are the authors computed the water budget on a regular grid over the whole region? The method section (2.4) is more a theory section and is missing information about how the water budget was practically computed.
- 2) The authors present an estimation of the regional groundwater recharge about 2.4 mm.y^{-1} (with an uncertainty of 1.4 mm.y^{-1}). Beside that, it is unclear if all the uncertainties presented in the paper are for 1 or 2 σ . Knowing that each component of the water budget contained large errors, it is not clear to me how the authors can have such a precise estimate of groundwater recharge. I would rather think that estimation of such a small recharge flux would be very challenging as the cumulative effects of the errors in each water budget components are also large. It would be great to have a discussion about what is really quantified in the "uncertainties" and what are the major limits of such estimation of recharge flux with a large-scale water balance approach. Also, what are the effects of boundary conditions (lines 187, 188) in the calculation of natural discharge?
- 3) In section 4.4, the authors are discussing the focused groundwater recharge. I do miss a complement discussion about the effects/importance of the ephemeral stream (so-called wadi systems) in groundwater recharge processes at this scale. Are these systems quantified in the approach or ignored. In both cases, it is not clear.

Minor comments

In the abstract, I think the JPL, CSR, GSFC, VIC, etc. might be removed to facilitate the comprehension.

The authors use the word “global” (e.g. line 31, 75 etc.) several times in the text. Is the word “large-scale” or “regional” would better fit? This study is not at a global scale.

To sum-up, the present paper is an interesting study lacking of some clarity in the approach and discussion about the reliability of the proposed estimates of groundwater recharge. The scientific quality is good but the scientific significance is not as well because the authors are using a well-established method and I do not see the real contribution to scientific progress for such a study. Maybe the authors can be better explicit about the real significance of such a study. The figures are good quality overall.

This manuscript can be accepted with some minor revisions in my opinion.