Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
https://doi.org/10.5194/hess-2021-78-RC2, 2021

Comment on hess-2021-78

Anonymous Referee #2

Referee comment on "Technical note: Introduction of a superconducting gravimeter as novel hydrological sensor for the Alpine research catchment Zugspitze" by Christian Voigt et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-78-RC2, 2021

I found the presentation of preliminary data from the ZUGOG observatory to be an interesting extension of the microgravity method into alpine environements. To my knowledge it is the first deployment of its kind in the high alpine environment and presents unique considerations concerning the spatial sensitivity of the instrument. I do no share the novelty or significance concerns of RC1; I think the preliminary presentation is inline with other publications (e.g., https://doi.org/10.5194/essd-11-1501-2019) and rapid publication is of greater benefit to those who might consider similar deployments (myself included).

The paper hints at the fact that a mountain-top deployment is both an advantage and disadvantage - increase in sensitivty to distant mass change is accompanied by an (unwanted) increase at near distance. Perhaps the ideal location would be in a flatter region atop a mountain (of course in most cases it's limited by infrastructure). I agree with the proposal to collect gradient data between meters to better define the region of sensitivity.

I agree that a second send of AG measurements will greatly improve the manuscript by constraining the drift rate.

Creutzfeldt (2013) is an important reference for the discussion on the relation between spring discharge, storage, and gravimetry.

Creutzfeldt, B., Troch, P., Güntner, A., Ferré, T. P. A., Graeff, T., & Merz, B. (2013). Storage-discharge relationships at different catchment scales based on local high-precision gravimetry. Hydrological Processes, 28(3), 1465–1475. https://doi.org/10.1002/hyp.9689

Does the very high correlation between the residuals and SWE have implications for the uniformity of the snowpack? I think that's an important aspect of this deployment, that because the gravity meter integrates over a large area, it inherently "smooths" the heterogeneous snowpack. But probably there is a level of heterogeneity where the assumption of uniform snowpack is not valid?

I encourage the authors to explore the relation between SWE-corrected residuals and spring discharge (e.g., in a figure). Although the discussion of recession constant is useful for bounding the thickness of groundwater storage, that could also be done by integrating spring discharge and dividing by area.

The figures are well prepared and relevant to the text.

Fig. 5: Although the figure is useful for showing the asymmetry of the gravimeter footprint, the magnitude of the contribution to g of each individual prism isn't useful, and the log colorbar-scaling can be misleading. Suggest showing instead the cumulative sensitivity contours—i.e., the region within which 30% of the signal originates, 60%, 90%, etc.

490: Do 0.27 and 0.56 m refer to thicknesses of free-standing water (i.e., terrestrial water storage)? "Groundwater heights" would imply the values depend on the porosity of the porous media, as measured in a monitoring well.

495: Why is the precipitation admittance factor (90 µGal/m) so much higher than the SWE admittance factor (29.8 µ/m)? It may be interesting to discuss how the former is much higher than the infinite slab, and the latter lower.

505: "Problematic" is unclear.

526-529: This sentence is unclear (its difficult to tell how the first part justifies the latter).

572-582: I found this paragraph to be vague and of limited importance.