Earth Syst. Dynam. Discuss., referee comment RC2
https://doi.org/10.5194/esd-2022-32-RC2, 2022

Comment on esd-2022-32

Anonymous Referee #2

Referee comment on "Continental heat storage: contributions from the ground, inland waters, and permafrost thawing" by Francisco José Cuesta-Valero et al., Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2022-32-RC2, 2022

Cuesta-Valero et al. provide a new estimate of continental heat storage including ground, inland waters and permafrost thawing. For continental heat storage, an update to the previous estimate (Cuesta-Valero et al. 2021) is provided. For inland waters and permafrost thawing, models are used to derive the estimates. I have some major reservations about their methodologies, listed below.

(1). The observation-based estimate for ground heat storage and model-based estimates for inland waters and permafrost thawing are merged together to provide the continental heat storage. I doubt if they can be put together, and then eventually be used in von Schuckmann et al. GCOS assessment (the other components are all observation-based).

(2). Uncertainty estimates for ground heat storage. In this study the uncertainty of the ground heat storage has been reduced by an order compared to their earlier estimate (for example line 200-205). The new estimate suggests a global land heat storage of 84.8 +/- 0.8 mWm-2 (previous estimate is 97+/-6). I found it hard to believe such a small error range, it is simply not possible. Remember you are using only ~1000 station data to represent the entire land, even previous error range of 6 is a likely underestimation. I can’t understand this small number and I don’t understand how this small number is derived given the dataset is basically the same with the previous version.

(3). Uncertainty estimates for permafrost thawing. Only the uncertainty related to the soil thickness and ice saturation are taken into account. However, I think another major error come from the model and climate forcing. For example, the use of Mk3L and ERA-Interim, the errors/biases will definitely propagate into the estimate of this study. I have no idea how to resolve this, as it is related to the fundamental choices of this study: using models and reanalysis to drive the their estimates.

(4). Uncertainty estimates for inland waters. Is the ensemble spread used to estimate the uncertainty of heat storage in inland waters? If so, it is fundamentally different from the other two components, i.e. the assumption underlying this method is: model difference (whatever caused the difference) can fully represent the uncertainty. Such assumption is likely wrong as there are always common model biases. And such assumption is clearly different from the assumption for your permafrost thawing and ground heating uncertainty estimate, so they can not be simply added up, simply physically meaningless.

(5). How the final estimate of land heat storage uncertainty been derived? Are you assuming independency of the three components? Are they independent?

(6). Line 219: Please explain why "this large interannual variability is explained by the smaller surface of global lakes and reservoirs in comparison with the global land and permafrost areas"?

(7). Line 257. The total land heat storage is 23.9+/-0.4 ZJ. The error range is too small to believe. Look at Fig. 1a, there are only several places with observations, and the spatial variability is large (that means you need more data to resolve these variability), so I don't think the uncertainty can be so small. The uncertainty estimate should be better documented in this study, and any revision should be carefully assessed and validated.

To proceed (avoid rejection of this paper), I recommend the authors not putting the the estimates for the three estimates toghether, just presenting them separately, making a point that permafrost and lakes might be important in EEI, which is the best the authors' can do.. I disagree to put them together because some are model-based estimates, and the uncertainty etsimates are apparant very weak.