

## **Anonymous Referee #2**

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This paper discusses how to obtain a better estimation of distributed precipitation for the well-known upper Indus Basin by inverting its hydrological balance. By using regionally-averaged glacier mass balance data to estimate precipitation gradients in the area, and a distributed hydrological model to compute accumulation and melt, the authors suggest that the precipitation needed to sustain the observed mass balance is higher than the one observed by ground or ridded products. An evaluation is also provided by using corrected precipitation as an input to estimate average annual runoff for sub-basins.

I think that the topic discussed by this paper is relevant. The idea of inverting the local hydrological balance is an interesting approach to solve the problem of gauges deficiencies (i.e., a sparse distribution and/or instrumental under catch), which is a frequent hydrological problem in mountain catchments (see for example results in Fig. 8). Such an approach has been already proposed in the past, to my knowledge, but new applications can help to understand its added value. The application to the UIB is also interesting given the well known reasons that the authors recall in the Introduction (a high demand of water, a growing population in the area etc).

**Thank you. Inversions have been conducted in the past based on streamflow. We will include those studies in the introduction. We have tested the approach using glacier mass balances in a sub-basin of the upper Indus [Immerzeel et al., 2012], however without the rigorous uncertainty analysis and validation of the present study.**

My suggestion here is that the paper would benefit from more details about both methods and results discussion. These could help the reader to understand in a more exhaustive way the implications of the analysis that has been presented. As examples, why and how did you chose to consider up to four different products to estimate ETa? I agree with you that this can help to account for data uncertainty, but I think it would be useful to show why this operation is better than considering just one source. I also think that more details could help when introducing, for example, the geostatistical conditional simulation used to interpolate precipitation gradients. Please consider also to provide additional details about the formulation of the simple model you mention as Eq. 2 and about the hydrological fluxes that are not reported explicitly in the same Equation.

**We will elaborate both sections and this was also suggested by reviewer 1.**

**Evapotranspiration is notoriously difficult to monitor. There are hardly any direct measurements of actual ET in the upper Indus, and even if there are they are not representative for basin wide ET, which varies considerably even at sea level without**

**mountains. We choose to take into account the uncertainty in ET in our stream flow estimates and we choose for products covering re-analysis datasets, a global hydrological model and an energy balance model. We will add a discussion on ET and sublimation the manuscript as we as a justification for our choice.**

**We will also provide further details about the geostatistical interpolation. See also our reply to Bettina Sheafli where we explain the use of a standardized semi-variogram and the geostatistical conditional simulation.**

**We will add a discussion regarding our water balance equation in particular related to groundwater and sublimation.**

As additional (minor) examples:

- Line 26 page 4756: what is currently still poorly understood about UIB hydrology?  
Please provide examples that could help the reader here;
- Line 5 page 4761: please consider including an equation explaining the positive (or negative) lapse in space;
- Line 13 page 4761: which temperature threshold do you consider to start melting?
- Section 2.3: why did you choose the log-Gaussian and/or the Gaussian distributions?
- Line 2-4 page 4764: which is the time period when these accumulation measurements were made? Is it consistent with the period considered by the analysis?
- Line 20 page 4766: maybe remove “of”?

**These will be taken care of in the revised manuscript.**