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Interactive comment

Interactive comment on "Dynamics of water fluxes and storages in an Alpine karst catchment under current and potential future climate conditions" *by* Zhao Chen et al.

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Reply to Editor's comment regarding the response to Ronald Green on the manuscript "Dynamics of water fluxes and storages in an Alpine karst catchment under current and potential future climate conditions" by Zhao Chen et al.

Editor's comment: The huge fraction of rainfall that recharges has been politely pointed as unusual. I find it inappropriate to reply that "We will discuss the possible overestimation of recharge percentage of precipitation". You must either argue why such percentage (95%) is right or why your model is wrong. Certainly, constraining the model with an overestimated recharge does not sound appropriate, because calibration will

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twist all model parameters to yield numerically consistent, but conceptually erroneous, results.

Answer: We agree that a recharge of 95% appears unusual. However, very high recharge rates in mountainous karst areas, ranging between 60% and 90%, are also reported in the literature (e.g. Malard et al 2016). In alpine regions, low temperatures and high precipitation (P) favor low evapotranspiration (ETP). In our test site, and other alpine karst areas, soil and vegetation are almost entirely missing in the elevated parts, and the limestone is extremely karstified, so that water infiltrates directly into open fractures, as can be seen on the photo (Fig. 1, the lower parts of the area are covered by shallow soil and forest, causing higher ETP and lower recharge).

We are convinced that our conceptual model is appropriate, as it is based on detailed hydrogeological field investigations, including 18 tracer tests (Goldscheider 2005, Göppert & Goldscheider 2008, Sinreich et al. 2002). The overall size of the karst system, the catchment areas of the individual springs and the general configuration of the underground drainage network are exceptionally well known, which is a major advantage of this test site.

However, the quantification of recharge is associated with uncertainties and the value of 95% is probably an overestimation. Possible reasons include:

1) The interpolation of precipitation is uncertain. Most weather stations used for interpolation are located outside the study area, at lower elevations. Uncertainty depends on the density of observation points and the interpolation method (e.g. Ohmer et al 2017). 2) Discharge quantities during very high flow conditions are also uncertain. We measured continuously water stages at all gauging stations, and we performed numerous flow measurements (salt-dilution method) to establish rating curves, which were used to obtain continuous hydrographs for all system outlets. However, most flow measurements were done during low to moderately high flow conditions, and the rating curves had to be extrapolated for very high flows. Therefore, substantial uncertainties

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have to be expected for very high flow conditions (e.g. Baldassarre & Montanari 2009, Coxon et al 2015). 3) Another source of uncertainty is that evaporation from snow was not taken into account in the current model. However, some studies suggest that snow evaporation can be significant in some high elevated catchments (e.g. Leydecker & Melack 2000).

In conclusion, we are convinced that our hydrogeological understanding and conceptual model are appropriate (very low uncertainties). The measurement and interpolation of precipitation, ETP, discharge and, as a consequence, recharge are associated with inherent uncertainties, related to the remoteness and complexity of this alpine karst catchment. The resulting recharge of 95% is probably an overestimation, but it is the best estimation that we can obtain, and it is not far above the reported range of recharge values for high alpine karst catchments.

We will discuss these uncertainties in the revised manuscript.

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Fig. 1. View on the summit “Hochifen” and karstic limestone plateau “Gottesacker” in the study region.

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