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Hydrology and Earth System Sciences
Discussions

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' comments regarding the response to the Reviewer 1 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' comments:

Potential overlap with the paper by Chen and Goldscheider (JHyd, 2014). We are trying to discourage the practice of publishing similar material several times.

Answer: There is no overlap with the paper by Chen & Goldscheider (2014). The cur-

rent study presents entirely new research questions, new data, new results and new conclusions. The model tested and evaluated in this manuscript is a further development of the model introduced in the study by Chen & Goldscheider (2017). The major novel aspects include:

1) The new research questions (presented in the introduction) focus on variable flow and storage over the entire hydrologic year, including the period of snow accumulation and snowmelt, and on potential impacts of climate change on the dynamic water balance. Accordingly, extensive new data series (including winter and spring) were considered. 2) The updated model adopts the HBV-snow routine and is able to simulate snow storage and snowmelt and their influence on groundwater recharge processes. 3) The earlier model considers baseflow / slow flow as a constant value, which is insufficient for long-term climate-change impact predictions. In the updated model, we applied the linear reservoir approach by Hartmann et al. 2011 to simulate transient slow-flow components, depending on groundwater recharge and recession coefficients. 4) The laterally adjacent and hydrogeologically connected non-karst area is included in the current model domain. The updated model is able to simulate variable infiltration of surface runoff from the non-karst area into the underground karst drainage network. 5) In the updated model, the spatial discretization of the catchment area is much finer by using the elevation bands approach, which allows for a better representation of the spatial variability of meteorological variables.

In response to comments by reviewer 1 about the specifics of your model, you reply "We will add a brief discussion".

Answer: Our model is construced by using a hybrid-struture: a combined lumped-parameter and distributed-parameter approach. Basically, the lumped-parameter model represents water storage and drainage in the soil and epikarst. The distributed paramter model represents the underground karst drainage network in the karst area, and the network of surface streams in the non-karst area; these linear structues drain the flow generated from the lumped paramter model. Due to the new developements, the current model is able to simulate simultaneously all system outlets for a complete hydrological year, including priods of snow accumuation, snowmelt and rainfall; additionally, the current model is able to reproduce system discharge behavior during drought periods, as the system baseflow was implemented as a function of groundwater recharge and recession coeffient. In this study, the simulation started in late autumn (November 2013), during very low flow conditon. The discharge of QS during this time consists of slow flow components from the karst area. This hydrologic state was used to define the initial model condition.

In response to the comment of also reviewer 1 about the unclear relevance of your findings for the general hydrogeological knowledge, you again reply "we will".

Answer: Reviewer 1 wrote "The conclusions are valid but they do not seem to be relevant for the general hydrogeological knowledge. The authors should try to generalize them".

We are thankful for this comment, and we will include new and more generalized conclusions, which also demonstrate the broader relevance and transferability of our modeling approach and scientific findings. The general conclusions can be summarized as follows:

Because of their unique hydraulic characteristics, karst aquifers respond faster and stronger on hydrological events and seasonal variations, including snow accumulation and melting, than other types of aquifers. The frequency and intensity of extreme events and the seasonal patterns of precipitation and snow regimes are projected to change in a changing climate. Karst systems are especially vulnerable to these changing hydro-meteorological conditions. However, because of their hydrogeological complexity and hydraulic heterogeneity, every karst system has its individual characteristics, and different karst springs respond differently on changing climatic conditions. Therefore, site-specific investigations are required. The holistic modeling approach presented in our study can be adapted to other types of karst systems and can be

used for studying impacts of climate change on alpine karst water resources.

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