Reply to Referee 3 in black :

Authors: We thank the referee for the constructive assessment of our manuscript. From our understanding, the reviewer was convinced by the use of the case study and the KarstMod lumped rain-snow-discharge model to test the sensitivity of karst spring discharge to the expected rise in air temperature under various scenarios. Referee 3's comments will help us to amend the text of the article on the points identified. To do this, we will follow the reviewer's recommendations.

In this reply, we have numbered each comment from the referee using the notation R3 (Referee 3) followed by the comment number.

R3.1: The manuscript addresses an important topic, but I recommend that the authors clarify and nuance their novelty claim regarding the effects of temperature increase on karst spring discharge. There is now a small but growing body of work that has already used modelling approaches to quantify climate-change or warming impacts on karst recharge and spring behaviour (e.g. Doummar et al., 2018; Fan et al., 2023; and related numerical-modelling studies on karst groundwater under climate scenarios). Rather than presenting the study as the first to model the impact of temperature increase on karst discharge, it would be more accurate and convincing to position the contribution in terms of its specific combination of features: (i) a mid-altitude Alpine karst system with a strongly seasonal snowpack, (ii) the use of a parsimonious rainfall–snow–discharge conceptual model (KarstMod with a degree-day snow routine), (iii) a scenario design based on simple temperature perturbations consistent with TRACC-type warming trajectories, and (iv) a quantitative focus on seasonal metrics, particularly changes in summer/August low flows. Framing the contribution in this way would acknowledge prior work while clearly highlighting what is genuinely new and distinctive in the present case study and modelling set-up.

Authors: The reviewer suggests slightly restructuring the topic announcement. We will follow the reviewer's recommendations, based on the proposed text.

R 3.2: I suggest adding a short clarification on the climate scenarios and the choice of perturbations. At present, the manuscript may give the impression that the French TRACC storyline is essentially a temperature-only scenario, whereas in reality regional climate projections provide concurrent changes in temperature, precipitation and other variables. In the modelling set-up, you chose to hold precipitation constant and perturb only temperature (+2 °C, +4 °C), which effectively turns your experiments into temperature-sensitivity tests rather than full climate-scenario runs. This is a reasonable and useful first-order approach to isolate the role of warming on snow processes, recharge timing and evapotranspiration, but it should be clearly framed as such. I recommend that you (i) explicitly acknowledge that realistic future scenarios involve both temperature and precipitation changes, (ii) justify why precipitation is kept unchanged here (e.g. to avoid adding precipitation-scenario uncertainty and to focus on snow-related mechanisms), and (iii) state that using full regional climate projections (with modified precipitation) would be a logical next step for more comprehensive impact assessments.

Authors: We agree that we are applying a first-order approach on temperature sensitivity based on the TRACC storyline. Precipitation is kept unchanged as the study focuses specifically on the hydrological response to temperature change and snow processes. We already specify those points in the manuscript: in the introduction (lines 82-83), method section (lines 349-352; 364), discussion (lines 511-513) and conclusion (line 621). In the conclusion (lines 630-635) we also discuss the fact that a further step would be to use full regional projections for predictive modelling. While these elements are already present in the manuscript, we will reframe and clarify them in the revised version following Referee 3's suggestions.

R 3.3: In the discussion of evapotranspiration responses to warming, the manuscript rightly mentions the role of increasing temperature (via the Oudin PET formulation) and briefly of rising atmospheric CO_2, but it would be important to acknowledge that changes in phenology (longer growing seasons, earlier leaf-out, shifts in vegetation activity) are also expected to significantly affect both potential and actual ET. Earlier onset and extended duration of transpiration can partly offset or amplify temperature-driven PET changes and will influence the seasonal partitioning between ET and recharge. I recommend adding a short paragraph noting that future ET trajectories will not depend on temperature and CO_2 alone, but also on phenological shifts and vegetation dynamics, which are not explicitly represented in the present modelling framework. This will better situate your experiments within the wider set of ecohydrological feedbacks expected under climate change.

Authors : We agree that evapotranspiration responses to warming also depend on vegetation dynamics and phenological shifts, which can modify both the magnitude and seasonal distribution of water losses and are not explicitly represented in our modelling framework. Climate warming is well documented to advance spring leaf-out and extend the growing season ((Menzel and Fabian, 1999; Richardson et al., 2013) with direct consequences for seasonal ET and recharge partitioning. In the revised manuscript, we will add a short paragraph in the Discussion acknowledging these ecohydrological feedbacks and situating our temperature perturbation experiments within this broader context.

Specific comments

R 3.4 : Section 3.1 is missing information about the spatial distribution and discretization of model parameters and the subcatchments . The subcatchments should be additionally delineated in Fig 1.

Authors: KarstMod is a lumped model, not a spatialized model. The specificity added by the snow routine, with non-spatialized sub-catchments, is explained in part 3.3. We propose to explain more clearly in section 3.1 the fact that KarstMod is a lumped model.

R 3.5 L174 Groundwater recharge: It should be mentioned how this was estimated

Authors: At line 174 we explain how groundwater recharge is estimated by comparing surface discharge to groundwater discharge at the outlet of the massif: "Groundwater discharge predominates in the volumes of water measured at the outlet of the massif. On average, it accounts for 86% of the total discharge, while surface flow accounts for only 14%. From an annual water budget point of view, the previous percentage gives a rough estimate of the area of the watershed contributing to groundwater discharge." We also propose to change "surface of the watershed" to "area of the watershed" to avoid any ambiguity.

R 3.6 L256f This information should be provided earlier in the model description (Section 3.1), where it is currently missing.

Authors: See response to comment 3.4.

R 3.7 L257 compartment E – add reference to Figure or explain what this is

Authors: There is no reference to compartment E line 257 or in this part of the manuscript.

R 3.8 L331 either a notation table should be provided, or the parameters should be explained everytime when used. Same applies for Table 1- I'd suggest either adding a column explaining the variables or referring to a notation table

Authors: All parameters are presented explained in Table 1. We will add a reference to Table 1 at line 331.

Technical corrections

R 3.9 L171 precipitation is – there is no plural form

Authors: We will correct this.

R 3.10: L187 add reference or link to the used version of Karstmod

Authors: The link to the used version of KarstMod is provided line 639 :

"The KarstMod modelling software used in this study is freely available online (https://hal.science/hal-02071006)."

References :

Menzel, A. and Fabian, P.: Growing season extended in Europe, Nature, 397, 659–659, https://doi.org/10.1038/17709, 1999.

Richardson, A. D., Keenan, T. F., Migliavacca, M., Ryu, Y., Sonnentag, O., and Toomey, M.: Climate change, phenology, and phenological control of vegetation feedbacks to the climate system, Agric. For. Meteorol., 169, 156–173, https://doi.org/10.1016/j.agrformet.2012.09.012, 2013.