Comment on hess-2021-270

Anonymous Referee #1

Referee comment on "A space–time Bayesian hierarchical modeling framework for projection of seasonal maximum streamflow" by Álvaro Ossandón et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-270-RC1, 2021

The manuscript "A space-time Bayesian hierarchical modeling framework for projection of seasonal streamflow extremes" by Ossandón et al. proposes a Bayesian Hierarchical Model (BHM) to project seasonal streamflow extremes for multiple catchments in a river basin up to 2 months lead time. The spatio-temporal dependence is modelled through a Gaussian elliptical copula and Generalised Extreme Value margins with non-stationary parameters and covariates. The proposed model is used to model streamflow extremes at 7 gauges location in the Upper Colorado River Basin (UCRB). The proposed framework and its application to the UCRB are interesting and well presented. I have some (minor) comments, especially concerning the application of the model to the UCRB.

- Choice of the timescale of the indicator for seasonal streamflow extremes: why are 3-day maxima considered, and not, e.g. 1-day maxima or instantaneous (seasonal) peaks? Especially for small and mountainous catchments (catchment area ~10-20 km^2, as the 7 considered in this application) the 3-day maximum discharges are not really representative for flood events because of the fast response times of the catchments and the consequent high variability of the discharge in short periods of time. In such small catchments, maximum discharges at smaller timescales (e.g. instantaneous peak discharges) are better representatives for flood dynamics and magnitude of the peaks and, therefore, better indicators for flood risk management strategies.
- Selection and location of the sites: sites are selected for the application according to the length of the streamflow series available. The selection results in 7 sites (fig 2), mostly located very close to each other and not well distributed across the UCRB. Are there nested catchments? What are the implications of this uneven spatial distribution on application results?
- Choice of covariates: the authors state that :"In this basin, almost all extremes that cause severe flooding occur in spring as a result of snowmelt and precipitation" (lines 11-12) and "Floods are a concern in mountain regions such as the Upper Colorado River Basin (UCRB), where streamflow extremes happen in spring due to snowmelt in combination with precipitation and are projected to increase under future climate conditions" (lines 23-25). However, only (regional) covariates related to snowmelt processes are considered (SASWE and SAAMT). Why is measured precipitation not accounted for in this application? Why only considering the temperature in April and

not, e.g. the spring mean or max temperature? Furthermore, since the role of non-stationarity is emphasised in the paper, I am wondering whether the relevance of these 2 processes (snowmelt and precipitation) in causing flood events is unchanged during the observation period and if it is expected to be the same in the future, or if other processes are becoming more relevant, as observed in other parts of the world (e.g. summer floods due to extreme precipitation becoming more relevant in areas that used to be snow-dominated due to a warmer climate).

- Choice of regionally averaged covariates: the location parameter of the Generalised extreme values (GEV) distribution is modelled in a non-stationary way, as a function of time-dependent large-scale climate variables and regional mean variables (accumulated snow water equivalent (SASWE) and April mean temperature (SAAMT)). I have a couple of comments on this choice:

Why are the snow and temperature covariates spatially averaged? For such small catchments, wouldn't local covariates (e.g. the snow water equivalent accumulated within each of the 7 catchments) be more skillful to predict (local) streamflow extremes? Would the choice of local covariates improve the performance of the projections for the 7 sites shown in figure A4b and c?

The authors state that, for computing the regional average, they considered (and averaged over) all the snow and temperature stations in the UCRB. I would suggest adding a map, showing the location of such stations used for the covariates and/or a table with summary information. Considering that all the 7 sites are located very close to each other in one part of the UCRB (fig.2), are the selected stations of the covariates, representative for the sites where the streamflow is recorded? I also suggest plotting the timeseries of the local covariates (i.e., at each station) together with the regional average and the seasonal streamflow extremes.

- Line 3: what do the authors mean by 'connected in space'? does it refer to spatial correlation?
- Line 88-89: what do the authors exactly mean by ' the significance of their slope coefficients' posterior PDFs'? Does it mean that they checked whether 0 was included in the 90 or 95% credible bounds of the posterior distribution of the parameters? To the best of my knowledge, tests for significance of trends do not exist in the Bayesian context. Same at line 155.
- Lines 171-173 do not fit well into this paragraph.
- Line 193-194: large scale climate indices are used here with their short names and they are defined only later in this section.
- Line 289: the symbol for the Euclidean norm is missing.
- Line 315: what is the benchmark? Is it the stationary (regional) model?
- Figure 9: this representation of the results is not really easy to 'read' and it is hard to compare between the 2 panels.
- Lines 378-404 should not go into the 'discussion' section in my opinion since they are part of the results of the application.
- Figure A4: adding vertical lines or white space to separate the 7 sites would be beneficial for the interpretation of the figure