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## Reply on RC1

Elisa Ragno et al.

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Author comment on "Applying Non-Parametric Bayesian Network to estimate monthly maximum river discharge: potential and challenges" by Elisa Ragno et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-229-AC1>, 2021

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We would like to thank the Reviewer for taking the time to review our work in detail.

Non-parametric Bayesian Networks are tools for defining the joint distribution function of a set of variables. This joint distribution may be used to generate river discharge samples (or samples of any other variable in the model if required). The advantage of such method is that the joint probability distribution is determined by defining the dependence between pair of variables. Such a non-parametric joint probability distribution is then more flexible compared to a theoretical parametric multivariate distribution because the dependence between variables is not fixed by the theoretical parametric model, but it depends on how the variables (nodes of the network) are connected to each other (arcs and parenting order). The dependence between pairs of variables can be determined based on prior knowledge of the underlying system dynamics, so it can be case-dependent. As the Reviewer mentioned, other studies have implemented such methods, and references are provided in the manuscript – but applications in hydrology remain scarce. Here we further explore the potential of such methods in providing estimates of river discharge by defining the joint distribution between environmental variables that are used for physical-based hydrological models and which are considered drivers of the discharge generation process. Then, we use the joint probability distribution to derive discharge via conditional probability, rather than characterizing the joint occurrence of the modelled variables, which is the most common implementation of multivariate distribution functions.

We agree with the Reviewer's comment that the lack of comparison of the NPBN-based results and previous studies makes it difficult to appreciate the advantages and challenges of the proposed model. In the revised manuscript, we will improve the discussion and we will provide a better overview of other approaches. We would like to add also that the aim of this study was to provide a comprehensive analysis of the suitability of Non-Parametric Bayesian Networks (NPBNs) to derive river discharge via conditional probability given its several advantages in terms of the characteristics of NPBNs compared to other process-agnostic models (Lines 44-49).