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Interactive comment on "Design flood estimation for global river networks based on machine learning models" *by* Gang Zhao et al.

Anonymous Referee #3

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This study aims to provide a reliable design flood estimation at global scale using improved methods and an expansive discharge dataset. The authors developed a three-phase model framework consists of standard parameter estimation methods and novel machine learning regressions. The framework mainly includes three parts: (1) estimating the gage-wise flood frequency curve using data from a global discharge station network. (2) clustering these stations into subgroups based on basin characteristics. (3) developing a machine learning-based regression model in each subgroup for design flood estimation based on the subgroup's shared basin characteristics. The authors also compared the accuracy of the results in different regions globally and compared the performance of the three machine learning regressions in flood estimation.

This study employs innovative methods to study a topic that is very relevant to HESS.

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Discussion paper

The manuscript is generally well-written, the methods are sound, and the result presentation is clear. I suggest considering the following comments in the revision:

1. The minimum drainage area of this study is 50kmˆ2 (Line 131). How is this cutoff selected? I wonder if there are gages with smaller drainage basins, and how would the method work with relatively low flows? You can also compare the flood estimation accuracy as a function of drainage area size based on the gages used in the study.

2. Can you provide insights into which of the four factors contributes the most to improving the system's estimation skills? The contribution is relatively easy to quantify with the traditional methods like multivariate regression, but it is not immediately clear with machine-learning methods that work like black boxes. I understand a quantitative analysis of this is non-trivial and is out of the scope of this study; a brief discussion could serve as a future work/direction.

3. The introductions of SVM and RF in section 3.4.2 and 3.4.3 are out of this study's context. I suggest including details on how these methods are implemented with the flood and other ancillary data in this study.

4. Section 3.5, both metrics used for validation, i.e. the RMSNE and RBIAS, focus on evaluating the deviation of the results to the truth. I suggest adding other metrics (such as the KGE and NSE) that account for the correlation, bias, and scattering at the same time.

5. There are a few places where acronyms are used without definition, e.g. line 71. They all need to be defined the first time they appear in the text.

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