

Response to Editor

Comment: Both reviewers agreed that the manuscript provides a valuable contribution to the use of machine learning approaches and spatial interpolation techniques for regionalizing intensity-duration-frequency curves through different time scales. Both referees recommend publication after minor corrections.

Referee #1 presents interesting questions primarily concerning the sensitivity of the results in relation the temporal downscaling methods used by ML approaches, the potential inclusion of other climatic predictors in the analysis, the selection of the geographical regions representing the complex landscape of mainland China, the impact of missing data imputation approaches, reliability of the interpolated IDF curves for some regions with lower prediction accuracy, the ML model hyperparameters selection approach, the impact of non-stationarity on the estimation of long return periods. The authors have adequately addressed all these concerns.

Referee #2 asks the important questions about the limitation of this study, among other questions. The authors have provided clear explanations about the limitations of this study, and this should be clearly stated in the manuscript.

Response:

We appreciate the time and effort you and the reviewers have dedicated to evaluating our manuscript. We are pleased to learn that the reviewers found our work to be a valuable contribution to the field. We have carefully reviewed the comments and have revised our manuscript based on our responses to these comments. We have utilized the track changes function in Microsoft Word to clearly mark all modifications. Below is a detailed summary of the main changes made in the revised manuscript. The cited line numbers refer to those in the unmarked version of the manuscript opened in Microsoft Word:

(1) **Interpretability of machine learning and sensitivity analysis of key input variables:** To address the mechanisms behind the machine learning (ML) approach, we conducted a feature importance analysis using Shapley Additive Explanations. The results, which highlight the contribution of daily extreme precipitation features, have been added to the Discussion section (Lines 581-593) and Figure S4 in the Supplementary Material.

(2) **Potential inclusion of other climatic predictors:** We have clarified in the Data and Methods section that we intentionally restricted the predictors to precipitation-

derived variables to test the predictive potential inherent within the precipitation data (Lines 256-260). We also acknowledged in the Discussion section that including temperature or humidity could be a valuable direction for future research (Lines 694-699).

(3) **Selection of geographical regions:** To provide an additional regional perspective, we conducted an evaluation using the nine major river basins of China as an alternative regionalization scheme. These results have been added to the Supplementary Material (Figure S3, Tables S23 to S30) and referenced in the Data and Methods section (Lines 144-146).

(4) **Reliability in lower accuracy regions:** We have added statements in the Discussion section advising users to exercise caution when using the regionalized IDF curves in the Northwestern (NW) and Southwestern (SW) regions due to lower prediction accuracy and station scarcity (Lines 675-677).

(5) **ML model hyperparameter selection:** We conducted an additional Bayesian optimization to test the sensitivity of our results. The analysis confirmed that the accuracy obtained with the selected parameters is similar to that of the default parameters, justifying the validity of our choice. These findings have been added to the Supplementary Material (Tables S18–S22) and mentioned in the Data and Methods section (Lines 288-290). Furthermore, we acknowledged in the Discussion section that the exploration of more comprehensive hyperparameter combinations and additional machine learning methods is a direction for future improvement (Lines 694-699).

(6) **Impact of non-stationarity:** We added a statement in the Discussion section acknowledging that our study assumes stationarity and suggesting that future work should investigate how these regionalization methods perform under non-stationary conditions driven by climate change (Lines 682-687).

(7) **Limitations of the study:** We have expanded the Discussion section to elaborate on the limitations of the study (Lines 663-690).

(8) **Acronym list:** We added a table of acronyms as an Appendix to improve readability.

(9) **Comparison with existing datasets:** We added a statement to clarify the differences in focus between our study and that of Ren et al., highlighting the unique value of each study (Lines 677-682).

(10) **Guidance on resolution selection:** We added practical guidance in the Conclusion section to help users choose between the 0.1° and 0.5° datasets based on their specific applications (Lines 744-750).

(11) **Clarification, formatting and corrections:** We have clarified certain ambiguities (such as Lines 297-299), added explanations for figures and tables (such as Lines 380-381), and corrected formatting and grammatical errors (such as Line 108) as suggested by Reviewer 1.

We believe these revisions have significantly strengthened the manuscript. If any further clarification or revisions are needed, we will be happy to provide them. Thank you once again for your time and evaluation.