

## Reviewer 2

I appreciated the manuscript, particularly the clarity of the writing and the way the text guides the reader through the rationale and objectives of the work. The study addresses an interesting and relevant topic, namely the influence of water bodies on flood peaks at hourly versus daily timescales. Overall, the manuscript is well structured and readable, and the topic is timely given the increasing availability of sub daily hydrological data.

**Reply:** *Thank you very much for assessing our manuscript and highlighting the relevance of our work.*

I found that the motivation of the study would benefit from being emphasized more clearly in the introductory section. In particular, the availability of instantaneous peak flow (IPFs) information appears to represent a central element underlying the relevance of the work, yet this importance is not always highlighted as strongly as it could be. Strengthening the discussion around the limitations in the availability of IPF data, especially in comparison with daily observations, would help clarify why the present analysis is needed and what gap it is intended to address. Expanding on the challenges related to subdaily data availability would also reinforce the timeliness of the study.

**Reply:** *Thank you for stressing the need to better highlight the motivation for our study in the introduction. We rewrote the first part of the introduction to better highlight the relevance of information on IPFs and that such information is often lacking: 'Floods can develop rapidly at sub-daily time scales if they are triggered by intense convective storms, especially in small catchments (e.g., Blöschl, 2022). Therefore, information on maximum flows occurring at a sub-daily time scale, so called instantaneous peak flows (IPFs), is crucial for the design of flood protection infrastructure. Still, floods are often described using daily data because sub-daily data are less frequently available than daily data. Because information on IPFs is often not available, considerable research efforts have been put into estimating IPFs from more commonly available daily flow data (e.g., Fuller, 1914; Ding et al., 2015, 2016; Ding and Haberlandt, 2017; Ellis and Gray, 1966; Bartens et al., 2024; Fill and Steiner, 2003). Such estimates are derived by relating the ratio between daily mean flows and IPFs, which is referred to as the peak ratio, to catchment characteristics that are also available in ungauged basins (Ding et al., 2015).'*

In addition, the conceptual basis for comparing daily and hourly flood peaks could be further strengthened by making the underlying hypothesis more explicit. You stated that in many basin-scale studies, water bodies are not systematically incorporated when estimating peak flows, particularly when transferring information across temporal resolutions. This can obscure the physical mechanisms controlling the relationship between daily and subdaily peaks. Your study recall that attenuation effects are scale-dependent, with a disproportionately stronger damping at the hourly (and sub-hourly) scale, which in turn reduces the contrast between daily and hourly peaks downstream of reservoirs. Explicitly framing the study around this scale-dependent attenuation

would help clarify the novelty of the work and better justify the comparison at its core.

**Reply:** *Thank you very much for these suggestions on how to strengthen the framing of our study. We rewrote parts of the introduction to explicitly frame the study around the scale-dependent attenuation effect of reservoirs and lakes: ‘Both lakes and reservoirs can better buffer intense and short flood events than longer-lasting floods, because the flow volume of these events is usually limited (Xiong et al. 2019). This suggests that the attenuation effect of reservoirs on flood peaks may be scale dependent, which may reduce the contrast between daily and hourly flood peaks downstream of reservoirs.’ And ‘While previous research has relied on large-samples of catchments to estimate the differences between IPF and daily mean flows, it remains unassessed how the effect of standing water bodies influences the ratio between daily mean and instantaneous flow peaks downstream of water bodies, that is to which degree the attenuation effect of reservoirs on flood peaks is scale dependent. In this study we aim to address this research gap by asking how water bodies influence the ratio between IPF and daily mean flows and therefore the attenuation effect on daily vs. instantaneous peak flows.’*

A further point that could be improved is the clarity of the two methodological approaches and their respective roles. While the distinction between local case studies and the large-sample Swiss dataset is valuable, their complementary contributions are not fully highlighted. It would strengthen the abstract to briefly clarify how these approaches reinforce each other (e.g., process understanding from case studies versus generalization from the large-sample analysis).

**Reply:** *Thank you for this concrete suggestion on how to better highlight the value of the two complementary approaches, which we know emphasize in the introduction: ‘To address this question, we follow two approaches that complement and reinforce each other: a case study approach that strengthens process understanding and a large-sample analysis that allows us to draw generalizable conclusions. Using the case study approach, we first analyse the attenuation of sub-daily vs. daily peak flows by lakes and reservoirs at four locations in Central Europe, for which streamflow data are available up- and downstream of water bodies. This approach allows us to illustrate the differences in the dampening effect of water bodies on flood peak quantiles derived from datasets with different temporal resolutions. Using the large-sample approach, we second explore the impact of the catchment fraction influenced by a water body on the ratio between daily and hourly flood quantiles across Switzerland. This allows us to demonstrate that the results derived for the four case studies are generalizable to other catchments.’*

From my perspective, also the discussion could be strengthened by more clearly linking the modelling choices to hydrological processes. The random forest model incorporates several catchment descriptors, yet their role is not consistently interpreted in a physically meaningful way throughout the manuscript. Providing a more explicit

process-based explanation of the results would enhance the overall contribution of the study. In this context, it would be helpful to revisit all included predictors when discussing the outcomes, rather than focusing primarily on catchment and contributing area. Descriptors such as geological permeability and biogeographical region are potentially informative, but their influence is not clearly articulated and they are largely absent from the interpretation of the model results. A more balanced discussion that explains how each variable contributes, and why, would improve coherence and reinforce the connection between the data-driven analysis and the underlying hydrological mechanisms.

**Reply:** *Thank you for your suggestion on how to strengthen the discussion. We added a more balanced discussion of the results presented in Figure 5, expanding beyond the role of contributing area percentage in shaping the D/H ratio: ‘While catchment area and contributing area percentage are the most important predictors of the D/H ratio, other predictors such as the biogeographical region, a metric for catchment similarity in terms of climate, geology, and vegetation, and other catchment characteristics such as permeability and an indicator for flashiness, only have limited predictive power (Fig. 5)’*

### **Specific comments**

Given that the study is largely descriptive, the interpretation of the results would benefit from additional supporting information or analyses, as detailed below.

- Title

The geographical scope of the study is generally clear in the manuscript, but the title could better reflect the full spatial extent of the analyzed catchments. Since the study includes basins beyond a single national context, aligning the title with the broader geographical coverage would improve consistency between the framing of the work and its actual domain. Since some of the analyzed catchments are located in Germany, I suggest reconsidering the title.

**Reply:** *Thank you for highlighting this inconsistency. We widened the geographical scope of the title to: ‘The influence of lakes and reservoirs on estimated flood peaks at hourly vs. daily timescales in the Alps’*

- Return periods and additional analyses

Given the descriptive nature of the study, I suggest adding graphs for at least one additional return period (e.g., 25-year floods). This would allow Figures 3 and 4 to include additional curves and help highlight the influence of return period. Alternatively, the authors should explain why additional return periods were not considered and clarify why the analysis stops at the selected values.

**Reply:** *We justified the focus on the 10-year flood in the large-sample analysis as*

*follows: ‘We focus on 10-yearly extreme flows since these represent a good compromise between regular floods (e.g., 2-yearly) and more extreme floods (e.g., 30-yearly) and because they can still be estimated reliably given the rather small sample at hand, which would not be the case for very rare floods with longer return periods.’*

- Robustness of flood estimates

In the sentence “Additionally, we can estimate these 10-yearly floods fairly robustly, given that the streamflow records for most stations exceed 10 years by a large margin,” I suggest being more specific about what “a large margin” means. Please provide quantitative information on record length (e.g., median, minimum, or range of years).

**Reply:** *We specified that ‘80 % of catchments have at least 40 years of data’.*

- Figure 2

I understand that the distinction between upstream and downstream stations is conveyed through transparency differences. However, this is not immediately clear. I suggest increasing the transparency contrast to make the distinction more visually evident.

**Reply:** *We clarified the meaning of the two different transparency levels in the figure caption: ‘...with upstream and downstream catchments highlighted in saturated and transparent colors, respectively.’*

- Lines 205–208

I suggest explicitly recalling the relevant figures after each description of the effects of water bodies on high flows, to facilitate interpretation and improve readability.

**Reply:** *We added appropriate figure references to each of these statements: ‘(1) sub-daily and daily flows become more similar to each other (Fig. 2); (2) sub-daily flows decrease more strongly than daily flows (Fig. 3a) and (3) absolute extreme flows decrease (Fig. 2).’*

- Figure 4

It would be helpful to visualize the relationship between the x and y variables more clearly, for example by adding the regression line and reporting the  $R^2$  value directly in the figure. This would allow readers to better assess the strength and magnitude of the relationship.

**Reply:** *We refrained from adding a regression line because what we wanted to highlight in this figure is the role of reservoir influence (contributing area fraction) rather than catchment area.*

- Line 235 (definitions)

Some parts of the discussion appear repetitive, and multiple terms are used to refer to similar concepts. The term “non-water-body-influenced” is introduced here. Is this equivalent to catchments with a contributing area percentage below 60%? The sentence currently combines several definitions (“weakly correlated,” “contributing area percentage below 60%,” and “non-water-body-influenced”), making it difficult to follow. I suggest reformulating this section to clearly define each category and their relationships.

**Reply:** *Thank you for highlighting the need for clarification. We reformulated to: ‘There are substantial differences in the D/H ratio between weakly water-body-influenced (contributing area percentage below 60%) and strongly water-body-influenced catchments (contributing area percentage above 60%).’ We avoid using the term non-water-body influenced in this context to avoid confusion.*

- Lines 239-240

It is not entirely clear why the model is trained on weakly influenced catchments and then applied to predict the D/H ratio in strongly influenced ones (lines 239–240). The rationale behind this choice should be more explicitly stated. As it stands, the reasoning is only implicit, leaving some ambiguity about the intended purpose of this modelling strategy.

I suggest clarifying whether the objective is to establish a baseline relationship under near-natural conditions and then assess deviations induced by strong water body influence, or whether there is another justification. Providing a clear explanation of this choice, along with its implications and limitations, would improve the transparency of the methodology and help the reader better understand the interpretation of the results.

**Reply:** *We clarified the rationale behind this choice both in the methods and results section as follows: ‘We train this model on the weakly influenced catchments and attempt to predict the D/H ratio of the strongly influenced catchments to highlight the importance of including water-body influence information to explain the D/H ratio in regulated catchments.’*

- General readability

In several places, sentence readability could be improved where multiple definitions are introduced simultaneously (lines 235-245). Shorter sentences and clearer structure would help readability.

**Reply:** *We rewrote the section highlighted as described above and went through the*

*entire manuscript again to improve and clarify sentence structure.*

### **Final recommendation**

Overall, the manuscript addresses an important topic and is clearly written. However, based on the points raised above, particularly regarding the need for clearer terminology, stronger emphasis on the study motivation, and additional supporting analyses, I recommend major revisions before the manuscript can be considered for publication.