 # Reviewer 1 & 3

accepted as is.

We thank the reviewers for reviewing our manuscript.

 # Reviewer 2

The manuscript has been substantially improved in response to the previous review. Most of my earlier concerns have been adequately addressed. I only have a few remaining comments that I recommend the authors consider before publication.

We thank the reviewer for their positive feedback and additional comments on the revised manuscript. Please find our detailed responses below.

1. The new analysis of the feasible parameter space is very useful. However, Table 2 shows that only approximately 0.4–0.8% of the sampled simulations satisfy all three constraints for the landscape-explicit model across the four catchments. Given how restrictive the combined constraints are, I suggest slightly moderating statements that describe the resulting simulations as "credible" or "physically realistic." More cautious wording such as "consistent with the imposed observational and process-based constraints" would better reflect what the analysis demonstrates.

Thank you for the detailed suggestion for the revision. We have revised relevant statements throughout the manuscript. We now describe these simulations as being "consistent with the imposed observational and process-based constraints" or similar wordings as suggested by the reviewer.

Lines 23-24:

> "By contrast, the constrained calibration reduces the KGE for stream DOC concentrations but produces internal DOC dynamics consistent with the imposed observational and process-based constraints."

Line 544-546:

> "This is consistent with our experience that although a landscape-explicit model represents a structural advancement, it may not always produce internal DOC dynamics consistent with imposed observational and process-based constraints."

Lines 598 – 601:

> "The constrained calibration slightly reduces model performance for stream DOC concentration simulation for the landscape-explicit model structure while producing internal DOC dynamics consistent with the imposed observational and process-based constraints. In contrast, the performance of the lumped model structure is significantly reduced under the constrained calibration."

Lines 602-604:

> "For evaluating the effectiveness of spatial management on stream DOC (e.g., changes that do not occur homogeneously over the entire catchment, such as increasing C input in the

upland in this study), a landscape-explicit model structure provides results consistent with observation-based analysis, while a lumped structure does not."

2. The added sensitivity analysis is helpful, and the manuscript now clearly acknowledges the uncertainty associated with TWI-based riparian delineation. However, the sensitivity test was conducted only for the Rappbode catchment. I suggest making this scope more explicit when discussing the robustness of the conclusions, so that readers do not interpret the test as having been conducted independently across all four catchments.

We thank the reviewer for this helpful comment. We have revised the manuscript to explicitly clarify that this sensitivity analysis was conducted only for the Rappbode catchment and therefore should not be interpreted as demonstrating robustness to riparian-zone delineation across all four catchments.

Lines 558-564:

"In addition, the estimated extent of the riparian zone was sensitive to the selected TWI threshold, highlighting uncertainty in the TWI-based delineation. In the Rappbode catchment, changing the riparian extent by ±25% resulted in a wider range of model performance for stream DOC simulation, while the main findings remained unchanged (Text S3). Because this sensitivity analysis was conducted only for Rappbode, its results should not be interpreted as demonstrating robustness to riparian-zone delineation across all four catchments. However, given the broadly similar catchment characteristics and the consistent modelling framework applied across sites, a comparable response might be expected in the other catchments."

3. The revised manuscript states that the main mQM Fortran source files are provided with the manuscript, but the input data required to run the model for the four study catchments remain available only upon reasonable request. This appears somewhat inconsistent with the response letter, which indicated that the underlying data and source code would be made publicly available through an accessible link. I recommend that the authors either provide a public repository for the required input data and computational workflow, or revise the wording so that the stated level of reproducibility and data availability is fully consistent.

Thank you. We have published the source code and input data to run the model in a public repository.

Lines 613-615:

"The model's source code, execution workflow, and input data are publicly available in the Helmholtz Codebase repository (https://codebase.helmholtz.cloud/hdg/mqm-doc) and archived on Zenodo (https://doi.org/10.5281/zenodo.22273576)."

With these minor clarifications, I believe the manuscript would be suitable for publication.

We thank the reviewers and the editor for their valuable time and comments that helped improve this manuscript.