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A spatially hybrid hydrological modeling approach using subbasin-specific model structures

Dear Dr Zhu,

Thank you for submitting your manuscript to Environmental Modelling and Software.

I have completed my evaluation of your manuscript. The reviewers recommend reconsideration of your manuscript following major revision. I invite you to resubmit your manuscript after addressing the comments below. Please resubmit your revised manuscript by **Dec 30, 2025**.

When revising your manuscript, please consider all issues mentioned in the reviewers' comments carefully: please outline every change made in response to their comments and provide suitable rebuttals for any comments not addressed. Please note that your revised submission may need to be re-reviewed.

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Environmental Modelling and Software values your contribution and I look forward to receiving your revised manuscript.

Kind regards,

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Environmental Modelling and Software

Link to the iEMSs 2024 announcements and newsletter https://conference.iemss.org/

Editor and Reviewer comments:

Reviewer #1: The authors present a well written manuscript but there are questions that must be answered before the paper may be published. There are also spelling and grammar errors listed after the main questions and comments.

Main Comments/Questions
1. Since your own results demonstrate that regional calibration (without internal data) can degrade mass balance performance (PBIAS), does the success of the Hybrid Model (HybM) rely on error cancellation between the upstream and downstream subbasins? How can you attribute the NSE improvement to the "hybrid structure" rather than simply the increased degrees of freedom allowed by splitting the watershed's parameter sets? This needs to be addressed in the manuscript.

2. What quantitative metric or threshold (e.g., mean slope degree, elevation variance) was used to categorize the subbasins? Without a specific, reproducible definition of "gently sloping," is the decision boundary arbitrary? If a different threshold were used (shifting 2-3 subbasins from one category to the other), how sensitive is the model performance to this structural choice? In the revised manuscript, these questions need to be discussed.

3. You explicitly admit that the current architecture ignores inter-subbasin groundwater flow and assumes exchange only happens via the channel network: how does this assumption impact the validity of your current case study in the Babao River watershed, which is highly mountainous? Aren;t you forcing the "physically-based" modules to adopt unrealistic parameter values to compensate for the missing lateral groundwater flow paths?

4. Why is the Hybrid Model considered superior when its PBIAS is substantially higher than the spatially consistent physical model? In hydrological modeling, particularly for water resource management, isn't the preservation of mass balance (low bias) as critical as the NSE? Doesn't this result suggest the Hybrid model is "curve fitting" at the expense of physical mass conservation?

5. Given that frozen soil dynamics are a dominant control on infiltration and runoff in this specific watershed, does omitting this process render the "semi-physically based" modules effectively conceptual? If the physical equations (e.g., Darcy's Law for interflow) are missing the governing variable (frozen ground permeability), can the model truly be classified as "physically based" in this context, or is it a more complex conceptual model?

6. Beyond the setup burden, how does the framework guard against parameter inconsistency? If two adjacent subbasins have similar characteristics but are assigned different structures (or separate configuration files), what prevents a user from assigning conflicting parameter values (e.g., vastly different soil porosity for the same soil type) across the boundary? Does the framework enforce any parameter continuity constraints?

Corrections
Page 6 line 101: spatially consistent method and spatially varying method -> spatially consistent methods and spatially varying methods
Page 10 line 191: each subbasins -> each subbasin
Page 16 line 297: generate -> generates
Page 16 line298: convey -> conveys
Page 13 line 233: such the -> such as the
Page 4 line 59: vis -> via
Page 22 line 405: Law and, with the -> Law and with the
Page 26 line 458: assumption that successfully -> assumption that successful
Page 30 line 535: spatial heterogenous -> spatial heterogeneity

Page 36 line 646: remains central challenges in hydrology community -> remain central challenges in the hydrology community
Page 36 line 662: studies in watershed -> studies in watersheds

Reviewer #2: This manuscript demonstrates a new approach that integrates physically-based simulation algorithms with spatially explicit distributed simulation units. The experimental results show improvement through comparison. While the manuscript is well-written, it contains several grammatical errors that require attention prior to publication.

More information and support

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