Extracted Comments – egusphere-2025-4992X

This document contains all comments extracted from the annotated PDF version. Each comment is listed with page number and full text content.

Page / Line	Comment
1	General suggestion on presentation style: In scientific writing, clarity often benefits from using the most natural "language" for each conceptual layer of a model: – Physics is best expressed through mathematics (e.g., conservation equations, balance terms). – Algorithms through pseudocode or schematic logic (e.g., the recursive structure of the Overflow Algorithm). – Results through narrative explanation (e.g., discussion of model behavior or uncertainties). In the current version of Section 2 (Model Implementation), some of these layers appear mixed within the same paragraphs, which makes it harder to distinguish between physical principles and computational logic. Presenting each layer in its most natural form could make the model architecture clearer and more intuitive to follow.
1	The abstract might briefly mention whether atmospheric forcing (e.g., pressure, temperature, wind) is considered or neglected, as this strongly constrains the realism of surface hydrology on Hesperian Mars.
1	Abstract scope definition: The abstract would benefit from a clear statement in the opening lines defining whether the study primarily presents a model development framework or a planetary hydrological reconstruction. This distinction is crucial for readers to understand the purpose of the paper and for ensuring consistent interpretation of results
2/ 29	Clarifying that the detailed geomorphological evidence concerns Martian fluvial features would improve readability and avoid confusion about whether the models' resolution is being compared to Earth or Mars data. _x000D_ Suggestion: "On Mars, geomorphological evidence of ancient fluvial activity is often preserved in far greater spatial detail than can be resolved by existing global hydrological models developed for Earth. This discrepancy further limits the direct application of such models in planetary studies."
2/27	A reference would be helpful here. The statement that global hydrological models are solved only over continental domains, with oceans prescribed as fixed boundary conditions, underpins the authors' main argument about their limited transferability to Mars. Citing a methodological or review paper describing this modeling constraint (e.g., WaterGAP, PCR-GLOBWB) would strengthen transparency. While this may be self-evident to terrestrial hydrology specialists, adding a source would improve clarity and accessibility for the broader interdisciplinary readership typical of EGU publications.
3/ 69	Minor language comment: "his current high-resolution topographic map" → should be "its current high-resolution topographic map" (referring to Mars' topography
3	Suggestion for structural clarification: In Section 2 ("General Model Description"), the distinction between the physical hydrological processes being represented and the numerical implementation of these processes is sometimes blurred. Readers could benefit from a clearer separation

	between (1) the physical concepts (e.g., water redistribution among basins) and (2) the algorithmic realization of these concepts (e.g., recursive routines and bypass mechanisms). Introducing brief subheadings or transitional sentences to distinguish these levels of description would improve readability and conceptual clarity.
4/ 93	"Information" is always singular in English - therefore this should read: "All of this informaion is gathered..."
4/ 96	“A word of cautious” → should read “A word of caution”.
5/ 104	Consider revising to something like: “This approach ensures computational efficiency, as the model only needs to load and apply the pre-computed database.”
5/ 118	The phrase ‘allows to identify’ is ungrammatical in English. Consider rephrasing for clarity, e.g.: "allows the identification of depressions — that is, DEM cells without an outlet, surrounded by eight neighboring cells with equal or higher altitude."
5/ 120	Unclear phrasing. It is not entirely clear whether the algorithm assigns a pit label to each depression or to each DEM cell. Perhaps clarify as:_x000D_ "The algorithm marks the lowest cell in each depression as a pit cell, which is then used to delimit the watershed."
7/ 141	This should read: "For the meta-depression, it is the elevation of the lowest spillover point of its two child depressions (Z_{ri}^{max} and $Z'^{l\,max}_{i}$)."
7/ 163	Suggestion for rephrasing: "The hydrological model governs the redistribution of excess water along the depression hierarchy graph. Using the pre-computed functions stored in the hydrological database, the model reconstructs and updates the hierarchical structure at runtime based on the parameters summarized in Table 1. For each depression i (represented by a node in the binary tree), the variables describing its hydrological state—water volume (V_i), outgoing discharge (Q_i^{out}), activity state (a_i), lake surface area (A_i), and elevation (Z_i)—are continuously updated during the simulation."
8/ 172	Comment: It is not entirely clear whether the initialization can be done in two alternative ways — (1) globally, by applying a uniform Global Equivalent Layer (GEL), or (2) locally, by injecting water at a specific georeferenced point. If both options exist, consider introducing the paragraph by stating that two initialization methods are available, and then specify which one was used in this study.
8/ 194	Comment: The unit should be written m s^{-1} (with a space) according to SI conventions, not m.s^{-1}.
9/ 200	Suggestion for rephrasing: “where β represents the fraction of precipitation that contributes to runoff.” This reads more naturally and aligns with standard phrasing in hydrological literature.
9/ 208	"... on the planet."
9	Suggestion for structural clarity: The description of the overflow algorithm could benefit from a more formal or schematic presentation (e.g., pseudocode or a simple flow diagram). This would make the recursive logic immediately clear and help distinguish the computational implementation from the physical hydrology being represented.
10/ 252	Minor clarity suggestion: The sentence “The evaporation process can be expressed as:” may sound physically descriptive, although the following equation represents the model’s algorithmic computation of evaporation rather than the physical process itself. A phrasing such as “In the model, the evaporation routine is represented as” could better reflect that this is an implementation step within the algorithm.
11	Application on Mars: While the model effectively represents surface hydrology and overflow dynamics, it currently seems uncoupled from atmospheric and climatic parameters such as pressure, temperature, and wind, which would strongly affect evaporation and surface exchange processes under Hesperian conditions. In particular,

	wind stress would influence overflow direction, flow intensity, and the effective spillover discharge and accumulation rate, potentially altering basin connectivity. If such atmospheric or topographic factors cannot be implemented in the current version of the model, it would still be valuable to acknowledge this limitation explicitly in the discussion.
11	In the Application on Mars section, the phrasing sometimes makes the modeled results sound like a reconstruction of Mars' actual ancient hydrology. While specialists will understand that this is a conceptual exploration under assumed boundary conditions, a brief reminder could help prevent readers from interpreting the model as a factual reconstruction. Adding short clarifications such as "in the simulation" or "according to the modeled scenario" would make the scientific intent fully unambiguous.
13/ 311	Since this represents a shift in spatial scale and purpose from the globally oriented framework described earlier, you might consider briefly mentioning in the abstract or introduction that the model is also tested at specific Martian sites to demonstrate its applicability.
13/ 317	If this equation (Eq. 8) is not dynamically implemented in the model but only used to determine a fixed input value or range for E E, you might consider simplifying the description. In that case, it would be sufficient to state something like: "The evaporation parameter E was estimated using the bulk aerodynamic formula (Eq. X, [ref.]) and the resulting value (or range) was used as model input." This would clarify that the equation is used conceptually rather than computationally, and improve readability
13/ 323	For improved readability, you might consider moving the detailed input parameters and fixed coefficients to an appendix (e.g., "Model configuration" or "Parameterization details"). This would help distinguish the conceptual description from the implementation details and make the main text easier to follow
14/ 337	This section introduces a parameter-space exploration with 48 simulations, which is very interesting, but it came as a bit of a surprise since it's not mentioned in the abstract or introduction. Is this conceptual exploration intended as part of the main model application, or as a separate validation exercise? Clarifying this earlier in the text would help readers understand the structure of the study.
16/ 372	Suggestion:_x000D_ "Figure 4 demonstrates that a unique steady state is reached for each GEL value, regardless of the initial water distribution or the evaporation rate. In this section, we analyse the resulting global water distribution for the four GEL scenarios. Figure 5 presents the steady-state distribution of water reservoirs, shown as sky-blue histograms. The left column displays the distribution as a function of latitude (1° bins), and the right column shows the distribution as a function of longitude."
17	Comment: In Fig. 5, the latitude axis appears inverted (north on the left, south on the right). This unconventional orientation may confuse readers, as latitudinal plots typically increase northward toward the right. If possible, consider mirroring the figure so that the axis follows the usual geographic convention.
20	Comment – presentation and model evaluation: The Application section presents a substantial amount of quantitative output in prose form. Consider summarizing these results (e.g., outflow locations, discharge rates, GEL scenarios) in a concise table or schematic overview to improve readability. This would also help separate model behavior from physical interpretation. importantly, the summarized data should be explicitly used to evaluate whether the

	model performs as intended — i.e., whether it reproduces the expected large-scale hydrological patterns under the chosen assumptions.
20/ 440	Misspell: it should read "highlight"
20/ 447	The phrase “The second river with the highest flow” reads slightly awkwardly and could be misunderstood. Consider rephrasing as either: “The river with the second-highest flow is located at the junction between Simud Vallis and Lobo Vallis (36°W, 35°N),” or “Another major river with one of the highest flow rates is located at the junction between Simud Vallis and Lobo Vallis (36°W, 35°N).” This would improve clarity and precision.
20	Comment – presentation and model evaluation: The Application section presents a substantial amount of quantitative output in prose form. Consider summarizing these results (e.g., outflow locations, discharge rates, GEL scenarios) in a concise table or schematic overview to improve readability. This would also help separate model behavior from physical interpretation. Importantly, the summarized data should be explicitly used to evaluate whether the model performs as intended — i.e., whether it reproduces the expected large-scale hydrological patterns under the chosen assumptions.
23/ 492	This should read: "as a fuction of degree"
23/ 508	Comment – language clarity: The phrase “The absence of theses depressions… due to his resolution” is unclear and grammatically incorrect. Consider revising to “The absence of these depressions in the pre-TPW topography, caused by its coarser resolution, leads to a significant reduction in the estimated water storage capacity of this area
23	Comment – model scope clarity: Unless the model is explicitly defined as a modular component intended for integration into future coupled frameworks (e.g., GCM–hydrology coupling), this paragraph risks overstating completeness. Consider clarifying whether the model aims to represent a full planetary hydrology or serve as a foundational tool for broader climate–hydrology simulations.
26	Comment (model scope): It may help to explicitly acknowledge that the model treats liquid water as a passive medium, without coupling to atmospheric, climatic, chemical, or biological processes. Without knowledge of Hesperian climate or potential biogenic influences, the flow patterns obtained should be framed as topographic flow potentials rather than reconstructions of actual hydrological states.
26	The model treats surface runoff as an isolated system, assuming precipitation–evaporation balance but without atmospheric coupling or climate dynamics. Consider explicitly stating this limitation, since the absence of circulation, temperature gradients and transient weather feedbacks strongly constrains the model’s physical realism for ancient Mars.
26	Comment – physical limitations: The model does not seem to include phase transitions such as freezing or melting, which would significantly influence overflow dynamics and connectivity between basins. For example, transient ice cover could block spillover and alter water routing. A

	short clarification or limitation statement on this point would strengthen the physical credibility of the application.
26	Wind stress and surface tilting effects are not represented, yet these could alter overflow coordinates and timing by shifting local water levels. Even a steady wind can create asymmetries in wide, shallow basins. A brief note acknowledging this limitation would clarify the physical scope of the model and justify the use of the term "physically consistent."
26	Comment – missing atmospheric assumptions: The model necessarily assumes atmospheric conditions allowing liquid water stability, but these assumptions are not specified. A short clarification of the adopted pressure–temperature regime (e.g. approximate surface pressure, mean temperature, and atmospheric composition) would greatly improve clarity and physical transparency. It would also help readers assess whether the simulated evaporation and overflow processes are plausible under Hesperian conditions.
26	Comment – scope clarification needed: The paper would benefit from a clearer distinction between (a) the modelling framework itself and (b) the physical interpretation of early Martian hydrology. If no explicit atmospheric assumptions are imposed, this should be stated clearly, and the conclusions limited to demonstrating model functionality rather than reconstructing actual Hesperian conditions.
27	Suggested addition – Perspective: Sections 4.2–4.3 already outline the logical next steps toward coupling the hydrological model with atmospheric and subsurface processes. Emphasizing this trajectory in a short Perspective paragraph after the Conclusions would highlight the scientific maturity of the work. The present model establishes a crucial physical foundation for later integration into a global Planetary Evolution Model (PEM), where hydrological, climatic, and potentially biogeochemical feedback can be explored together. Explicitly framing the study as a methodological cornerstone within this broader research program would both clarify the scope of the current results and strengthen the paper's long-term scientific significance.