

The article presents an update to the SPLASH model, incorporating analytical solutions to reduce its computational demand. These analytical solutions consider topographical characteristics that are often overlooked in land-surface models, such as the effect of terrain slope on infiltration. Additionally, the article describes the model's parameterization using global datasets of observed soil textural properties and meteorological data. To describe different water and energy processes, the model employs a set of equations selected and calibrated using the observed datasets. Overall, the model demonstrates good performance in representing fluxes and environmental states, even outperforming the benchmarked VIC model for some environmental variables. Therefore, I consider that with minor correction this manuscript can be published in the GMD journal as it will be a good contribution to the modelling community.

Please find below some general and specific comments about the article.

I wonder if the authors could provide a general overview of the model structure at the beginning of the model description, including, if possible, a schematic representation. This would help the reader understand the connection between the different components described in subsequent sections. The author might also consider adding a diagram to illustrate the model parameterization. This would guide the reader through the description of the method sections, showing the dataset used for parameter calibration and the one used for validation. Additionally, it would be useful for the reader to find model parameters and variables summarized in one or two tables. The table contents should specify the type of variable (input/output/parameters), the corresponding units, and the potential source of information.

If one of the main goals of the manuscript is to enhance the current version of the SPLASH model, I wonder why it was not also compared with previous versions of the model. Additionally, while it is mentioned that the new updates improve simulation times, it would be very useful for users to understand how the speed of this version compares to the previous one.

Is it possible to provide different values, not steady-state, for initial conditions, as specified in subsection 2.3? Or does this section only apply to the analysis performed in the manuscript? If so, the initial conditions section should be moved to a more appropriate location, perhaps to the simulation protocol section. Additionally, to reduce the influence of the initial conditions, is a warm-up period considered in the analysis performed later in the evaluation section?

Since global simulations have been added to the manuscript, it is not clear how the model was parameterized at the 1 and 5 km resolution. Specifically, how were model parameters aggregated into the coarser resolution? It would make easier to the reader to clearly describe in separated subsections how the point scale and global simulations were performed. In any case, results at the coarser scale show a decrease in performance for different variables, which is expected, as heterogeneity may not be well represented by spatial aggregation at the coarser resolution.

The discussion section appears to conclude abruptly, leaving the reader without clear takeaways from the article. To enhance the reader's understanding and provide a comprehensive summary, it is recommended to include a dedicated conclusion section. This section will emphasize the main findings and key insights obtained throughout the article.

Overall, it is essential to ensure that all figures and their accompanying labels or text are appropriately sized. The readability of text in the majority of figures is compromised when the document is printed.

Consider using specific titles for each section instead of simply starting with a generic term like "Methods." Given the manuscript's length, employing distinct and relevant names for each section will enhance readability. It in turn will facilitate the reader's ability to locate information pertaining to each specific numerical experiment. This is especially important for distinguishing between experiments conducted on a point scale and those involving global scale simulations.

Density plots require a colorbar to explain difference on colour variations, also, a more detailed description is required for figures description.

There are quite a lot of typos, so I recommend to carefully look at the entire document before submitting it again. Line 780: "Ssince", Line 360: "soving", Line 432: "abovementioned". Also, subscript text of some variables are not properly formatted, e.g. Figure 14 description.

Figure reference is missing in line 463.

The term  $t_0$  in the equation 44 is not described.

Change "determination coefficient" to "coefficient of determination" in line 466

Figure 4 is misleading the reader as it shows that the water table within the cell varies not only with depth but also along the x/y axis, which is not true as the equations do not describe such variation. Therefore, I suggest that the author update the figure or provide a more specific description on the figure description.

Figure 15 has a very poor resolution, labels are unreadable. It would be good if the background can be deleted as it does not provide any additional or useful information.

The use of the first person to describe the authors' assumptions should, at the very least, reflect the contribution of all authors. Thus, I recommend the authors to use the "we" instead of "I" when the first person is used (e.g. Line: 694).

Line 480: Some parameters have already been described (Line 364), so to avoid repetition delete the ones that have been already described. Or are they different from the previous ones?

Line 483: information related to the HPC has already been mentioned in previous section (line 435), also the use of this specific HPC could be added to the acknowledgement section instead of the main section, as it does not add any additional information that contribute to the understanding of the article.

GMD do not recommend the use of footnotes as they usually disrupt the flow of the document (Line 98, 364, 370, 428, 496).

Line 500: what does the number 17, in brackets, means?

Line 574, what does the number 29 mean at the end the sentence, is it the figure number? If so please add the reference code.

Figure 36: Axis label of figure 36b, FTS, is not defined.

Figures 25, 30, 31, 32, 38, and 41: Add a description of climatic zones initials or refer the reader to the section where the climatic zones are defined.