Manuscript ID: *egusphere-2025-2542*

Journal: *EGUsphere*

Improvement of the **Rnnmm-type** climate index approach with a spatio-temporal model based on the Hawkes process

We thank the reviewer for the careful reading and constructive suggestions. Below we respond point by point. Reviewer comments are in *italics*; our replies are in blue. All mentioned edits have been incorporated into the revised manuscript.

General comments

The paper proposes a geostatistical model based on self-exciting Hawkes processes for modeling the Rnnmm-type extreme climate index. It provides a detailed introduction to the proposed Hawkes process model. The performance of the model is evaluated through extensive cross-validation, with comparisons to Poisson models both with and without seasonality. The results are valuable for advancing research in the analysis and forecasting of climate extremes. The overall logic of the paper is systematic and complete. I provide several suggestions for improvement in the following sections. I recommend the paper for acceptance after minor revisions.

We appreciate the positive assessment. We implemented all minor revisions suggested below and clarified the presentation where indicated.

Specific comments

1. *Page 14, Line 306: MAD and MSE first appear in Sect. 5.1.1, but their definitions are only provided in Sect. 5.1.2 (page 18, lines 316–319). I suggest moving the definitions to Sect. 5.1.1 where these abbreviations first appear. If the meanings of MAD and MSE in Sect. 5.1.1 differ from those in Sect. 5.1.2, I recommend using different abbreviations to avoid confusion.*

   We moved the formal definitions of MAD and MSE to Section 5.1.1, where they first appear, and kept a short forward reference in Section 5.1.2. The meanings are identical across sections, so no distinct abbreviations are needed.

2. *Page 14, Lines 308–309: In the sentence "The results indicate that the combination of R3 with P1 yielded the lowest MAD and MSE values in most cases," Although this conclusion can be quantitatively supported by Tables 1–3, I further suggest including statistical values across all stations in the Tables or in the text. This would allow readers to more easily compare the performance of model A with different radius using a single representative value (e.g., mean or median MAD and MSE for all stations) that reflects overall performance across all stations.*

   We revised Tables 1–3 to include summary rows reporting the median MAD and MSE across all stations for each radius–weight combination. In Section 5.1.1, we added a brief explanatory note using these medians as representative statistics for model comparison, which reinforces the overall advantage of R_3 with $\mathbf{P}_1$.

3. *Page 19, Table 4: I suggest presenting the statistical data from Table 4 in the form of a map plot. The statistical values could be displayed using colored scatter points overlaid on the map, enabling readers to intuitively observe the spatial performance of the proposed model. You could also add a discussion on whether the model performs better at lower or higher elevations, or over flat versus complex terrain. The additional figure could include six subplots arranged in a 3 × 2 layout: subplot (3,2,1) showing MAD for Model A, subplot (3,2,2) showing MSE for Model A, subplot (3,2,3) showing MAD for Model B, subplot (3,2,4) showing MSE for Model B, subplot (3,2,5) showing MAD for Model C, and subplot (3,2,6) showing MSE for Model C.*

   We thank the reviewer for this helpful suggestion. However, instead of creating exactly a 3×2 panel figure, as suggested, we created a 1 × 2 one in which subplot (1) shows MAD for Models A, B and C, and subplot (2) shows the MSE. (Figure 1 below presents the subplot showing MSE for Models A, B and C). Each subplot overlays colored circles representing the stations on the study-area map with a radius length scale representing MAD/MSE measurement for comparability purposes. Section 5.1.3 now includes a discussion of performance by elevation and terrain complexity; we observe larger errors over complex terrain, consistent with expectations.

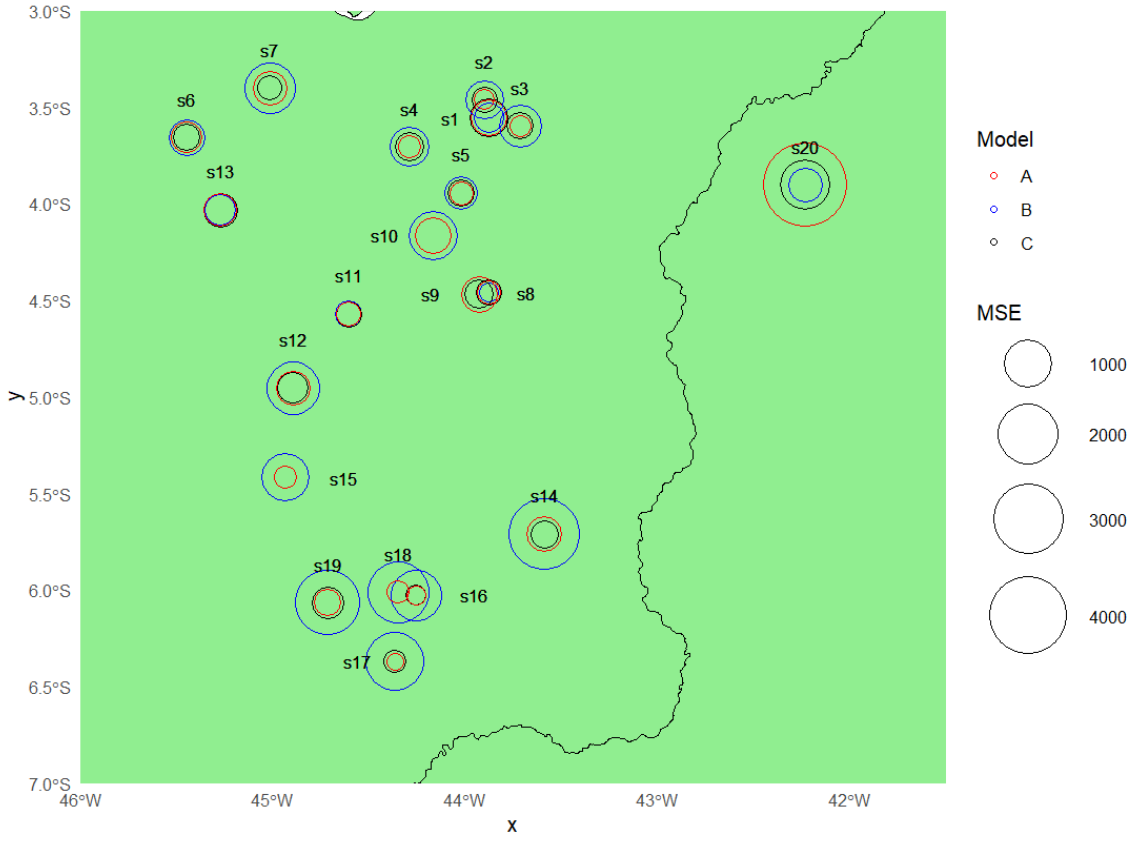

Figure 1: Spatial distribution of the Mean Squared Error (MSE) estimated by the competing models across monitoring stations.

4. *Finally, from a practical application perspective, I suggest presenting results that demonstrate when extreme precipitation is likely to occur in Maranhão based on your modeled Rnnmm-type extreme climate index. For example, you could indicate which months, seasons, or years tend to experience extreme precipitation. If this is not feasible, you could alternatively provide a time series plot showing both the Rnnmm-type extreme climate index and the observed number of extreme precipitation events, with the left y-axis representing the Rnnmm-type extreme climate index and the right y-axis representing the observed extreme precipitation events counts, x-axis represent the time series. I believe this would add significant value by highlighting the practical contributions of your work to improving climate extremes forecasting.*

   We added a new time-series figure with the R20mm-type index on the left y-axis and observed extreme-event counts on the right y-axis, sharing the time x-axis. We also summarize seasonal patterns (months/seasons with higher likelihood) in Section 5.2 and highlight how these results support practical anticipation of extreme precipitation in Maranhão.

Technical corrections

5. *Page 1, Manuscript Title: Consider changing "Rnnmm type" to "Rnnmm-type" for consistency with "Rnnmm-type extreme climate index" as shown in line 2 of the same page.*

   Done.

6. *Page 2, Line 48: The text does not provide the full form of the abbreviation IMERG. The authors should also include the full form of IMERG when it first appears on this line.*

   We now expand to "Integrated Multi-satellite Retrievals for GPM (IMERG)" at first use and use IMERG thereafter.

7. *Page 16–17, Tables 2–3: The abbreviation MSA in Tables 2 and 3 appears to be a typographical error; please correct it to MAD.*

   Corrected "MSA" to "MAD" in both tables.

8. *Page 20 Figure 2, you should clearly point it out that which axis is the Estimated function $\Lambda_3(t)$, since your plot does not show title and unit for x-axis and y-axis. I suggest you add a title and unit (if possible) for the x-axis and y-axis. Addtionaly, the fontsize for xticks and yticks is too small, you should increase the fontsize.*

   Figure 2 now includes explicit axis titles and units where applicable (time on x; estimated cumulative intensity $\Lambda_3(t)$ on y), a clear panel title, and increased tick/label font sizes for readability.