## Reviewer 2

The manuscript "Rainfall erosivity mapping in mainland China using 1-minute precipitation data from densely distributed weather stations" presents rainfall erosivity maps over China where 1-minute precipitation data was used. While the overall content is suited for this journal, the manuscript requires quite some work before further consideration for publishing. Remarks:

- The manuscript needs to be checked for grammatical errors. The introduction, for example, needs further work.

Response: We have revised the entire manuscript to correct any grammatical errors.

- The authors only present their erosivity product (in countable figures, in fact) without discussing the implication their new maps would have compared to the already available ones, e.g. on soil/land conservation practices, etc. The whole manuscript therefore just reads like a short report presenting a rainfall erosivity map (and some brief inter-comparisons) over China without really providing the reader with any new information.

Response: Thank you for your suggestions. When combined with other factors in RUSLE/RUSLE2, such as the newly released *K* factor maps (Gupta et al., 2024) and the Cover-Management factor, this newly developed dataset—based on high-resolution ground precipitation observations from the past decade—can significantly improve the accuracy of soil erosion forecasting. We have included the application of this newly developed map in the revised manuscript (**Lines 274-276**).

In this revision, we have primarily added two key components. First, we provided potential sources of discrepancies in rainfall erosivity estimates across different studies. This analysis can be found in **Lines 210-220** and **Table 1**. Second, we presented the impacts of precipitation data and algorithms on estimating rainfall erosivity across mainland China (**Lines 231-252** and **Figure 7**).

Building on this, we found that with current technology, the accuracy of determining $I_{30}$ during erosive rainfall events is much lower than that of $E$. The main source of deviation in rainfall erosivity estimates stems from uncertainties in $I_{30}$. This will assist in improving rainfall erosivity algorithms and future predictions, thereby deepening our understanding of water erosion.

The authors only present a qualitative assessment of their grid maps and do not provide any quantitative measures in their performance evaluations. They need to quantify (in numbers; say in terms of correlation coefficient, rmse, bias, …) how their erosivity product compares to the others.

Response: We have also added quantitative evaluation metrics in **Figure 5** of the revised manuscript.

**Specific comments:**

L20: "… overestimate China's mean annual rainfall erosivity by 31%—65%, …" - So here you assume your product is the reference?

Response: We have revised this statement. Please refer to **Lines 20-22** in the revised manuscript.

L37: "… challenge due to the unrealistic for a dense …" – Grammar.

Response: It has been revised in the revised manuscript (**Lines 38-39**).

L38: "… simply the calculation" – do you mean 'simplify the calculation'?

Response: This sentence has been change into "simplify the calculation". Please refer to **Line 40**.

L39-40: "Various E-I models have been developed, employing linear, polynomial, exponential, logarithmic, and power-law functions…" Various EI models? Where is the literature on these developed models? You need some citations here.

Response: The references have been added. Please refer to **Lines 41-44**.

L41-43: "Studies have indicated that E values derived from 1-hourly in-situ precipitation data tend to underestimate those obtained from 1- minute data by approximately 10% (Agnese et al., 2006; Yin et al., 2007) …"
Maybe expound on this. According to the cited studies, why does 30 min precipitation underestimate the kinetic energy compared to 1 minute rainfall data?

Response: The *E* value for an erosive rainfall event is calculated as follows:

$$e_r = 0.29[1 - 0.72\exp(-0.05 i_r)] \quad (1)$$

$$E = \sum_{r=1}^{n} (e_r \cdot P_r) \quad (2)$$

where $E$ (MJ·ha$^{-1}$) is the total energy of the erosive event, and $r_{event}$ (MJ·mm·ha$^{-1}$·h$^{-1}$) is the event rainfall erosivity. For 1-minute in-situ precipitation data, $i_r$ (mm/h) is the rainfall intensity for the $r_{th}$ minute, $e_r$ (MJ·ha−1·mm−1) is the unit energy for the $r_{th}$ minute, $P_r$ (mm) is the rainfall amount for the $r^{th}$ minute, $n$ is the rainfall duration in minutes.

From these equations, we can conclude that the *E* value of an erosive rainfall event is determined by rainfall intensity and the corresponding precipitation magnitude. 1-hour and 30-minute precipitation data fail to capture the precise rainfall process. In other words, the precipitation intensity derived from 1-hour and 30-minute precipitation data tends to be smoothed compared to that derived from 1-minute data, which leads to an underestimation of the kinetic energy of erosive rainfall events. In this study, we further quantitatively assessed the impact of precipitation data with different temporal resolutions on *E* estimates. Based on RUSLE kinetic energy algorithm, our results show that values calculated from minute-level data are 1.21 times higher than those from hourly data, with more significant differences observed in the northwest of China. Please refer to **Lines 248-249** and **Figure 7e**.

L44-46: "…Compared to the radar remote sensing-based E values, the multi-year averaged annual rainfall kinetic energy calculating using E-I method was smaller with biases ranging from -6.17% to -12.5% across distinct regions worldwide."
So the authors of the cited literature assumed RS-based E values were correct? It is known that remote sensing (RS) products can have shortcomings, as they rely on non-exact methods that are developed to translate the remotely-sensed signals to a variable of interest. Why did they use data derived using RS methods as the reference?

Response: Dai et al. (2023) used the *E* values calculated using raindrop physical measurements from ground disdrometers as the reference. We have revised the related sentences to obtain more clearer description (**Lines 49-53**).

L48: "…When the in-situ data is used, I30 tend to be increasingly underestimated with increasing time intervals of precipitation data" - Citation/justification needed

Response: Please refer to **Lines 56-57**.

L49: "It has reported …" >> it has *been* reported

Response: This sentence has been rearranged in the revised manuscript. Please refer to **Lines 57-59**.

L50-51: "… Consequently, the in-situ precipitation data with 1-minute temporal resolution are the best suitable data for deriving I30 of an rain event. …"
an >> a
The authors just state this without providing any reasons/explanations; why is precipitation at 1-min resolution suitable?

Response: We have added the explanation in the revised manuscript. Please refer to **Lines 55-59**.

L50-56: "Recent years, there occurs some gridded precipitation datasets with high temporal resolution. However, it should be caution when the gridded data are directly used to calculate I30, because large underestimation in I30 has been widely reported . " – *in recent years ; this whole section needs to be revised/rephrased (and checked for grammatical mistakes).

Response: This sentence has bee revised. Please refer to **Lines 59-61**.

L58-59: "Based on the analysis presented, the following conclusion can be drawn: The bias in estimating the I30 of individual rainfall events is significantly larger than that for estimating E under the latest available datasets. The estimation error of I30 is the most crucial source of inaccuracies in determining rainfall erosivity. " – based on the analysis presented where? This section needs to be rephrased/restructured as it is difficult to follow.

Response: The related sentences have been revised. Please refer to **Lines 66-69**.

L71: "…different precipitation events" – such as?

Response: This sentence has been rearranged, and this rephrase is deleted. Please refer to **Lines 78-79**.

L71-… : "Thus, this study aims to develop …"
Too short. The authors need to introduce the study with a bit more detail.

Response: This sections have revised. Please refer to **Lines 79-82**.

L79: "…integrity level exceeding 90% …"
What is this integrity level exactly? How is it defined?

Response: We have described the data integrity index in the revised manuscript. Please refer to **Lines 87-90**.

L90: Fig 1a: "number of station" >> number of stat*i*ons

Response: The mistake has been corrected. Please refer to the name of **Figure 1a**.

L98: "…interpolated spatially into 0.5° grids by using the Thin Plate Spline method …"
Any justification why this interpolation method was used in the CMA grid data? … the authors use Kriging instead when spatially interpolating their grid erosivity products; have they considered using a Spline-based method similar to CMA? What is the implication of using one over the other especially in relation to erosivity spatial interpolation?
Also, how did the authors reconcile the 0.25deg resolution of your grids (see section 2.1.1) with the 0.5deg CMA grid in your comparative analyses?

Response: 1) The monthly gridded precipitation dataset, released by the CMA, is generated using the Thin Plate Spline method. One possible reason for selecting this method is its easy implementation through ANUSPLIN software. However, this method is best suited for point files with fewer than 2,000 elements. Once the number of points exceeds 2,000, the computational load increases rapidly. Since our study involves approximately 60,000 points, it was nearly impossible to perform spatial interpolation using this method on a PC (e.g., CPU 3.00 GHz, memory 31.7 GB, 18 cores).

2) Different spatial interpolation methods have some impact on the results, though the overall effect is minor. We compared *R* factor maps generated using different interpolation methods in ArcGIS (Figure 1). The three methods selected were Spline, Kriging, and Inverse Distance Weighted. Overall, the national average *R* factor values obtained from these different interpolation methods were quite similar and all effectively reflected the spatial distribution pattern of *R* factors across China. Therefore, we chose the widely-used Kriging interpolation method in geosciences to generate the *R* factor map for mainland China.

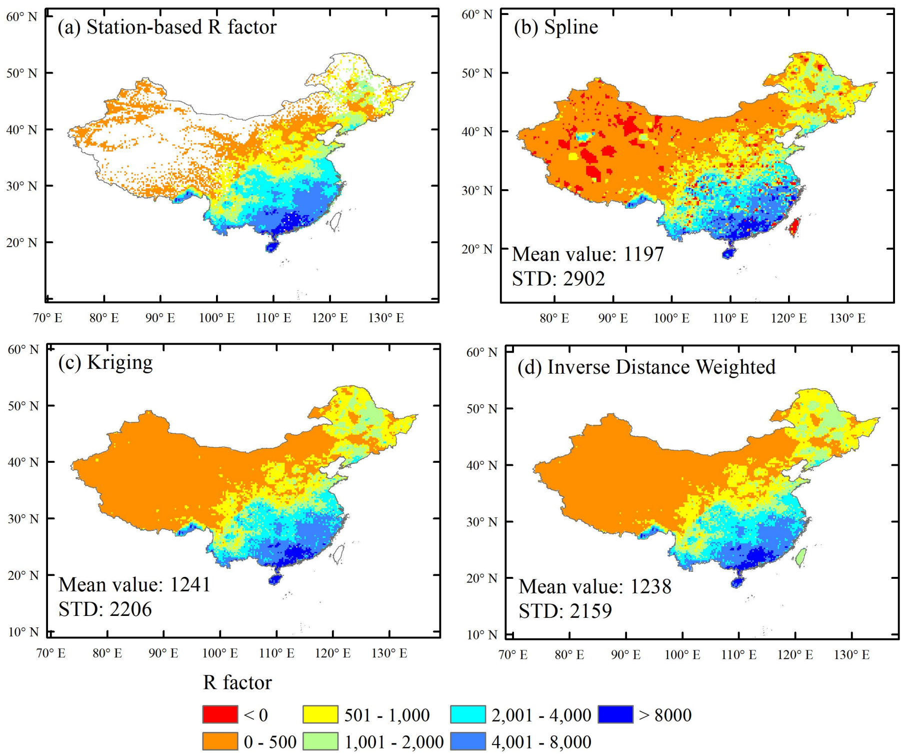

Figure 1. (a) Station-based *R* factor map for mainland China; (b) *R* factor map generated using the Spline interpolation method; (c) *R* factor map generated using the Kriging interpolation method; (d) *R* factor map generated using the Inverse Distance Weighted interpolation method.

3) Although approximately 57% of all grids in mainland China have in-situ precipitation observations on a national scale, we remain concerned about the potential presence of high *R*-factor values in areas with limited 1-minute data. Since the *R* factor has a strong positive correlation with annual precipitation, we used the monthly gridded precipitation data in this study to identify regions with high mean annual precipitation but no 1-minute records, rather than to calculate rainfall erosivity. The related analysis can be found in **Lines 172-184**.

L130-133: "…cold season (January to March, November to December). Subsequently, the median and standard deviation of event rainfall erosivity are computed for the warm and cold seasons…"
The authors define 2 cold season periods. Are the 2 cold seasons separated/differentiated when performing these std dev. and median analyses?

Response: I apologize for the confusion caused by this sentence. The cold season refers to the months from January to March and November to December. We have revised this sentence accordingly. Please refer to **Lines 145-146** for the updated version.

L153-156: "Kriging … the impacts of the spatial interpolation method on the accuracy of the *R* factor map in these regions …"
Other than kriging, have the authors tested other interpolation methods on their 'quality-checked' precipitation datasets? E.g. the spline-based method used in the CMA grids.

Response: Thank you for your suggestion. We have tested three interpolation methods. Please refer to our response for Line 98.

L169-172: "…(ERA5) precipitation data … This study used this released gridded dataset to calculate the mean annual rainfall erosivity from 2014 to 2020 for the Dawang-Chayu area …"
This ERA5 dataset should be described in the earlier data description section. Also, why didn't the authors use ERA5-Land, which is at a relatively higher spatial resolution than ERA5?

Response: We have added a description of the ERA5 data in the Data Section. Please refer to **Lines 108-113**.

The ERA5-Land dataset (0.1°, hourly, 1950 to present) is a replay of the land component of the ERA5 climate reanalysis, providing a consistent view of land parameter evolution over the past few decades at an enhanced resolution compared to ERA5 (Hersbach et al. 2020). Xu et al. (2022) compared the performance of ERA5 and ERA5-Land precipitation over mainland China and conclude that while both datasets exhibit similar spatial-temporal patterns, ERA5 performs better in terms of categorical metrics. Therefore, we selected ERA5 precipitation data to calculate rainfall erosivity in regions with high annual precipitation and no 1-minute precipitation records.

In addition, the process of bias correction in estimating rainfall erosivity using reanalysis precipitation data is more important than the choice of the dataset itself. This is because the biases in rainfall erosivity estimates from reanalysis data are both significant and unavoidable.

In this study, due to the high annual precipitation and absence of 1-minute precipitation records in the Dawang-Chayu area of the Tibetan Plateau, rainfall erosivity values for this region were obtained from the ERA5-based dataset developed by Chen et al. (2022). The details of the bias correction process are outlined in Chen et al. (2022).

Reference:
Hersbach, H., Bell, B., Berrisford, P., et al., 2020. The ERA5 global reanalysis. Q. J. R. Meteorol. Soc. 146 (730), 1999–2049.
Xu, J., Ma, Z., Yan, S., et al., 2022. Do ERA5 and ERA5-land precipitation estimates outperform satellite-based precipitation products? A comprehensive comparison between state-of-the-art model-based and satellite-based precipitation products over mainland China. J. Hydrol., 605, 127353.
Chen, Y., Duan, X., Ding, M., 2022. New gridded dataset of rainfall erosivity on the Tibetan Plateau. Earth Syst. Sci. Data, 14 (6), 2681-2695.

L180-…: "The newly generated *R* factor map over mainland China is compared with the existing maps… When compared with the map developed by Yue et al. (2022), the correlation is good overall, but our calculated values are significantly lower."
This is too short. Correlation coefficient (r) and the coefficient of determination (r^2) only show the 1:1 agreement between data and does not really provide the reader with any new information. Needs further discussion on why the high correlation with both products (Panagos et al., and Yue et al.'s product), and why the underestimation relative to Yue et al.'s product.
Also, the authors just mention the high correlation without quantifying the correlation (r) value. There needs more comparisons and discussions where other performance metrics (such as RMSE, Bias, etc.) are also included.

Response: 1) The discrepancies in *R* factor maps observed across various studies have been further discussed in the revised manuscript (**Lines 210-220** and **Table 1**).

2) The quality of precipitation data, along with its spatial and temporal resolution, and the methods used to calculate rainfall erosivity, can all influence the results of erosivity estimations. Due to the unavailability of data from other studies, it is challenging to pinpoint the reasons for the discrepancies in the *R* factor. Therefore, we approached the issue from a different perspective, attempting to quantify the impact of various datasets and algorithms on the calculation of rainfall erosivity. This helps identify the key factors affecting the accuracy of erosivity estimates (**Lines 232-252** and **Figure 7**).

3) The values of performance metrics have been added in the revised manuscript. Please refer to **Figure 5** for details.

L195-…: "…watersheds, there is no consistent pattern (Figure 5b )." - Again, too short. Why the inconsistency between the products? The authors should discuss why their results are different from earlier works/products.

Response: Please refer to the response for Line 180.

L199-203: Figure 5a is not described in the figure caption. Also, this figure (Fig5a) should part of the site[s] description section. It is not one of the results from this study.
The authors also define the interquartile range, but do not use this anywhere in the text. Some details in the caption are also unnecessary – e.g., the IQR description and "the plot and line box are the average and median values, respectively " --- this is indeed how box plots are designed/constructed so no need to mention the obvious.

Response: In the revised manuscript, this figure has been reorganized as Figure 6, with a caption added to Figure 6a (**Line 224**).

A description of this map has been included in Section 2.1.2 (**Lines 124-127**).

Additionally, the redundant description of the box plots in Figure 6 has been removed in the updated version."

L205: https://doi.org/10.n888/Terre.tpdc.301206 - This doi is not accessible

Response: The correct website is "https://doi.org/10.11888/Terre.tpdc.301206".