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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Spatiotemporal analysis of flash flooding events in mountainous area of China during 1950–2015" *by* Nan Wang et al.

Anonymous Referee #1

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In this paper, the authors analyse the spatiotemporal characteristics of the flash flooding events (FFEs) observed in China for the period of 1950–2015, by using Mann-Kendall (MK) test, wavelet analysis, monthly frequency and index of dispersion.

General comments.

The authors try to evaluate the spatiotemporal characteristics of the FFEs in China by using a very large database, formed only by date and location of the events. No further information is available for each FFE, such has peak discharge or intense precipitation. The work is surely interesting as the timing features of FFEs have been extensively mapped, and provide a valid frame for further analyses on flash floods at smaller spatial and temporal scale. Anyway, often the obtained results cannot provide substantial information just for the intrinsic nature of the data and the too large areas

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Discussion paper

of the geomorphological regions, thus weakening some possible impacts of the work (such as enabling disaster estimation and prevention on the national scale, row 15). Classical statistical and mathematical methods have used to perform the analyses, nevertheless the results of some analyses are uncertain. Thus, many relevant issues need further deepening, as stated in the following.

First, in the title, the word "Statistical" may be added before "Spatiotemporal" to clearly indicate the approach followed in this study. Moreover, the authors specify that the analysis is focused to the mountainous areas of China, though in the text there is no mention at all about this fact. On the other side, the FFEs database is global, as shown in the figure 1. So, the call to the "mountainous areas" may be deleted, if not furtherly motivated in the text. The authors should provide further information about the specific criteria used for identifying the FFEs used in the analyses (e.g., distinguishing flash floods from normal floods). Moreover, a single climatic event may have caused different floods in a large watershed, or in conterminous smaller watersheds. Thus, within the database, the authors may have detected FFEs as floods caused by distinct climatic events (with different occurrence date), or as floods observed at different locations of a watershed at the same occurrence time. The reader may be confused in trying to understand the various analyses if this basic information is not clearly assessed. For the same aim, also the data aggregation used for the different analyses should be better defined all over the text (as correctly done in row 101).

As previously stated, the spatial scale of the study is very large, though the database is subdivided into six (not enough) smaller regions. This basic choice evidently weakens the search for relations between FFEs and climatic/physical features, such as rainfall and soil moisture that are generally locally varying variables. In fact, some results, only graphically visualized, show uncertain behaviours, probably due to peculiar features of the watersheds within the large regions. For example, this is the case of the skewness of the monthly frequencies (represented in figure 8 and in table 3), and of the regression analysis (represented in figures 11 and 12). To overcome partially the problem, the

visualization of the results through further, properly detailed, tables can be useful for comparing the statistical behaviours of the six different regions of China.

Some analyses show different behaviours within each geomor-region, that hardly can be averaged into a single specific behaviour. As an example, the intra-annual frequency distribution of FFEs has been divided into right-skew, left-skew and symmetry, but quite all the geomor-regions show great variability. As concern the temporal periodic analysis, the search for the inter-annual variation of the FFEs should be performed at the geomor-region space scale, and then physically explained.

From a formal point of view, the work is well structured, and it is based on a huge database, valuable for a statistical analysis. The subject is very interesting, and the text should be rewritten only in some specific section for the sake of clarity. The presentation of the results has to be improved in some parts. The list of references is exhaustive and well chosen. The quality of the figures is high, but some of them should be substantially improved. All the suggestions/corrections proposed for improving the text are listed in the following specific comments.

As a result of the review, I recommend major corrections for this manuscript before publication on Natural Hazard and Earth System Sciences.

Specific comments.

Some requests on specific topics are listed below. - Section 2.3. The subdivision of the entire study area into 133 watersheds based on third-order stream is not a completely exhaustive information on their features. In fact, the large range of the watersheds area needs some further explanations that can be inserted in table 1. - Section 3.1. The two-tailed test for the Sen's slope can be better defined. - Section 4.1. At the start of the section 4.1, before presenting the results, it is useful a short mention to the method used for assessing the significance of the trends. Moreover, the mean annual change rates of the various regions (rows 171-173) do not coincide with the slope of the regression equations showed in figure 2. In order to increase readability,

the authors should represent the regression equations as FFEs=a+b*(current year-1950). Moreover, the results evidenced high intensities in two phases (1985–1998 and 2000–2010) for most regions. Can the authors discuss about the probable reasons of the lower number of FFEs before 1985 (lower quality/quantity of information, lower precipitation . . .)? - Sections 4.1 and 4.2 need some further explanation as regards the database (data and location of FFEs) used for analyses. Section 4.1 copes with the trend in the FFEs global number series of each geomor-regions, while section 4.2 deals with the different watersheds of the geomor-regions. This different data aggregation should be better defined; otherwise, it can be easily misunderstood. Moreover, control the pertinence of the word "mutation" in the title of section 4.2. - Section 4.3. This section try to find oscillation periods of the FFEs database at large and small scales, but the global result shows a complex timing frame that should be adequately explained. The authors are requested to relate the potential periodic features to some external (physical, climatic or planetary) factors, which could reinforce this potential result. On the other side, the wavelet analysis has been referred to the whole China, while in the previous analysis the six geomor-regions have shown peculiar behaviours. Why did not the authors perform this analysis to the FFEs database of the different geomor-regions? Can the authors try to match this result with the two peaks, 1998 and 2010, closely related to the precipitation anomalies caused by the EASM and El Niño Modoki? - 4.4.1 and 4.4.2 have the same titles. - Subsection 4.4.1. The results showed in rows 253-258 cannot be easily related to figure 8, which contains different coloured lines. Probably, the authors presents the results related to the mean monthly frequency of each geomor-region. If my understanding is true, some uncertainties appear in the results (and in table 3). For example, the NWB region also shows a symmetry distribution like the SEM and SWM regions. If not, authors should help the reader in understanding the presented results. Moreover, the worthy attempt to relate behaviour of FFEs with seasonality of precipitation can be further improved. - Section 5. The title of the subsection 5.1 is not good. The section contains regression analyses between number of FFEs and some potential physical factors (not impacts) which may induce

flash floods. - Subsection 5.1 can be improved by writing it in a more clear way, in order to avoid repetitions and uncertainties (see notes for row 305 and figure 11). Moreover, the relations between number of FFEs and physical factors (precipitation index, soil moisture) are very uncertain, due to the large spatial scale of the study. The authors, when necessary all over the text, should better stress this fundamental point.

Technical corrections.

Text. - Row 18. "Periodic" is an adjective not a noun. - Row 117. Change "Where" with "where". Add the information "i<j". - Row 121. Change "Formula" with "the following formula". - Row 123. Change "Where" with "where". Change "vise" with "vice". - Row 135. Change "Where" with "where". - Rows 135-136. The sentence "here, Morlet wavelet was chosen as the mother wavelet function" may be inserted within round brackets. - Row 146. Change "Where" with "where". - Rows141-142. Move the sentence "However, if a monthly . . . 5% significance level" at the end of the row 149. - Row 157. Change "Where" with "where". - Row 168. Separate the words "Figure 2c". - Row 169. Separate the words "Figure 2f". - Rows 174-176. The increase of the number of FFEs for NWB is vaguely defined (speeding rate), though the NWB and TP regions seem to have the same exponential behaviour. - Row 179. Separate the words "yellow line". - Row 184. Separate the words "Figure 3". Change "33% watershed of all" with "33% of all watershed". - Rows 186-188. The sentence is not clear, rewrite in a better English style. - Row 187. Separate the words "Figure 3". - Row 189. Change "southeast" with "southeastern". - Row 200 (caption of figure 3). Change "Where" with "where". - Row 208. Separate the words "Figure 4". - Row 209. At this first appearance, define the meaning of the symbol "Xa", where X is a number. - Row 224. Change "were" with "are". - Row 225. Change "corresponded" with "correspond". - Rows 227-229. The sentence is not clear, rewrite in a better English style. - Row 234. Separate the words "Figure 7". - Row 247. Separate the words "Figure 8". - Row 250 (caption of figure 8). Delete "Where". - Rows 254-255. The sentence is not clear, rewrite in a better English style. - Row 274. Separate the

words "Figure 10". - Row 278. Do the authors intend "regular distribution of monthly FFEs occurrence"? - Rows 290-291. The definition of the factor R90p is not clear (cumulative precipitation formed only by daily precipitation greater than 90th percentile of 1980-2010 precipitation?). Moreover, here it is indicated as seasonal precipitation, while caption of figure 11 indicates R90p as annual total precipitation. - Row 293. Separate the words "Figure 11". - Row 304. How is assessed the statistical significance of the correlation? - Row 305. The importance of the role of the soil moisture on FFEs has been assessed before in row 289. - Row 330. The word "similar" is repeated in the same sentence. - Row 334. It is not clear what is the heavy rainfall center. Maybe it has to be related to figure 13 (not cited)? Moreover, change "center" with "centre". - Row 344 (caption of figure 13). Delete "Where". - Row 356. Do not start a sentence with "And". - Row 360. "Periodic" is an adjective not a noun. - Row 367. Delete the words "of all" or change the sentence. - Row 381. Change "the new insights" with "new insights".

Figures. - Figures 1 and 3. Change the NWP symbol into NWB (as in the description of the six geomorphologic regions of table 1). - Figure 2. The equations represent the relationships between the year and the number of FFEs for each regions. The suggestion is to change regression equations as previously suggested for rows 171-173. - Figure 4. At the end of the caption, add the words "for the entire China". - Figure 5. After the words "of FFEs" in the caption, add the words "for the entire China". Delete the article "the" at the start of the parts (a) and (b) of the caption. - Figure 6. At the end of the caption, add the words "for China". - Figure 8 seems not to agree with figure 1c, even if this can be a trivial problem of scale representation. In fact, some geomorregions of figure 8 show regional FFEs values in months like February and November, which have no concordance in figure 1c. Can the authors provide an explanation? - Figure 9. The caption can be shortened deleting the words "Maps showing the" and "Where". - Figure 11. The graphs are in logarithmic scale; therefore, both the labels of the variables have to be indicated with logarithm. Moreover, the suggestion to be clearer in the definition of variables all over the work here is fundamental. In fact,

it is not clear what the points could be (Number of FFEs for each location within a watershed of a region?). In other words, while the red points of figure 1 are obviously all the FFEs collected for this work, it is not clear what the points of figures 11 and 12 really could be. - Figure 13 is not cited in the text. The six graphs for each year do not correspond to the four months May-August of the caption.

Tables. - Table 2. For the sake of readability, add the total number of watersheds for each regions. This can be very useful for a better understanding of the following analyses.

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