

Dear Chantal,

Thank you so much for handling our manuscript, and the reviewers for their comments and suggestions. We have made a major revision of the manuscript, addressing all of the concerns raised by Reviewers # 2&3. We have submitted the revised manuscript on to the editorial system. Below are our responses to the comments by the reviewers, with the original comments in **blue** and the responses in **black**.

If you have any questions and other instructions, please let me know.

Best regards,

Guoyu Ren

Response to Reviewer 2

Reviewer 2: comment 1

Grammatical and typo errors still appear occasionally so English editing is suggested.

Author: response to comment 1

Thank you for pointing this out. In the revised manuscript, we checked and corrected grammatical and typo throughout the manuscript.

Reviewer 2: comment 2

Line 584, please improve the wording of 'East Asian-South Asian summer monsoon' which can be confusing when reading.

Author: response to comment 2

Thank you for this comment and suggestion. In lines 596–598 of the revised version, we changed the sentence. The revised contents are as follows:

“Figure 10 shows a comparison of extreme drought and flood events per 30 years in the HRB (the first time period is 1426–1429 and the last is 2000–2017) with the East Asian summer monsoon index and the South Asian summer monsoon index (i.e. Asian summer monsoon index).”

Therefore, "Asian summer monsoon" in the new manuscript is the collective term for the East Asian summer monsoon and the South Asian summer monsoon.

Reviewer 2: comment 3

Line 592-595, “We found that extreme floods are significantly positively correlated with strong El Niño events at a multi-decadal scale... Extreme droughts and strong El Niño/La Niña events and extreme floods and strong La Niña events also showed positive correlations”. This point seemed to reveal unclear meaning between extreme events and ENSO.

Author: response to comment 3:

Thank you for this comment. In Line 651–654 and 673–678 of the revised manuscript, we added some sentences to make it clearer for describing the complex relationship between extreme events and ENSO, as well as the limitations and uncertainties of the results of this manuscript. The revised contents are as follows:

“This suggests that, on a multi-decadal scale, the strong ENSO events probably have some influence on annual and summer precipitation in the HRB, and the strong El Niño events have a greater impact on extreme floods than extreme droughts in the river basin on a whole.”

“The association of the Asian monsoon/ENSO and the HRB extreme drought/flood events in history is not straightforward. This may be the reason why the correspondence between precipitation and monsoon is still controversial in proxy data and modeling studies (e.g., Lu et al., 2019; Shi et al., 2021). It is also worth indicating that, due to the space limitation, this study provides only a very preliminary discussion of the relationship between extreme droughts/floods of the HRB with Asian summer monsoon and ENSO.”

Reviewer 2: comment 4

Table 5 can be removed since the info is already presented in Figure 7 and 8.

Author: response to comment 4

Thank you for pointing this out. In the revised manuscript, we deleted Table 5.

Reviewer 2: comment 5

Figure 6 should specify separate maps for drought and flood events, and what is the unit of the color bars, also for Figure 7?

Author: response to comment 5

Thank you for this comment and apologies for the lack of clarity. In the revised manuscript, we divided the original Figure 6 into Figure 6 and Figure 7. Moreover, notes on the colour bar have been added to Figures 6–8 in the revised version.

Response to Reviewer 3

Reviewer 3: Major comment 1

Their figure captions are still not satisfactory. Need more improvement as listed in below specific comments.

Reviewer 3: Major comment 2

The biggest remaining issues will be in their discussion. They need to carefully making discussion considering the time-scale. In addition, there may be no consensus on the similarity of the variability between the East and South Asian monsoon in recent period. How do they regard the monsoon situation when both flood and drought situations are pronounced, for example, in recent decades? Furthermore, the El Niño and La Niña events may also be related with East Asian monsoon in the interannual time-scale, therefore they may not be independent factors.

Author: response to Major comment 1&2

Thank you very much for your detailed comments and suggestions. We made a major change of the discussion in the revised manuscript referring to the comments, as you can see in file containing the traces. Time-scale of the discussion was focused on decadal, multi-decadal and centennial scales, with multi-decadal scale emphasized in particular. Uncertainties related to the explanations have been addressed, and needs to conduct further studies were emphasized. The discussion presented in this paper is preliminary, and our focus in the present work was on the reconstructed facts of the extreme droughts and floods variations. In response to the specific comments, we replied the concerns and showed the revision processes one by one.

Reviewer 3: Specific comment 1

L1-2, 36: It will be better to add “, China”, or “, central China” after “basin” in the title, and delete “China” from the key words, since “Hanjiang River basin” may not be familiar for most overseas readers.

Author: response to Specific comment 3

Thank you for this suggestion. In the revised manuscript, we made a change. The revised title is as follows:

“Extreme historical droughts and floods in the Hanjiang River basin, China, since 1426”

Reviewer 3: Specific comment 2

L24 and many others: Better to use en-dash “–” instead of hyphen for the year or page or value ranges. Also, in the figures and references.

Author: response to Specific comment 2

Thank you for this suggestion. In the revised manuscript, we made corrections, in the text, figure captions and references.

Reviewer 3: Specific comment 3

L26–28: The meaning of this sentence is not understandable.

Author: response to Specific comment 3

Thank you for this comment. In line 24–26 of the revised version, we changed the sentence. The revised contents are as follows:

“ Extreme droughts and floods were highly variable on multi-decadal to centennial-scale, and the frequencies were higher in the first and last one hundred years or so of the study period and lower in between. ”

Reviewer 3: Specific comment 4

L45–48: Better to refer the latest AR6 results.

Author: response to Specific comment 4

Thank you for the suggestion. In lines 46–50 of the revised version, we added citation of the AR6. The revised contents are as follows:

“The IPCC Sixth Assessment Report (AR6) states that 3–4 billion people globally would face physical water scarcity under 2.0°C and 4.0°C warming scenarios (IPCC, 2021). Furthermore, the risk of floods will double when the globe warms between 1.5°C and 3.0°C, and economic, agricultural, and potential hydropower losses will increase as warming increases further (IPCC, 2021).”

Reviewer 3: Specific comment 5

L55: Northeastern -> Northeast

Author: response to Specific comment 5

Thanks. In line 53–55 of the revised version, we made a correction. The revised contents are as follows:

“In China, since the late 1970s, the eastern region showed a pattern of "south floods and north droughts" (Sun and Chen, 2003; Hsu et al., 2014), with precipitation in North China, Southwest China and southern Northeast China going to decrease. ”

Reviewer 3: Specific comment 6

L59: “the precipitation in North” -> “that in North”.

Author: response to Specific comment 6

Thanks. In line 59 of the revised version, we made a change.

Reviewer 3: Specific comment 7

L131: Specify the measurement location of the runoff amount.

Author: response to Specific comment 7

Thank you for the comment. Since the detailed information could not be found in the reference, we decided to delete this controversial data in the revised manuscript.

Reviewer 3: Specific comment 8

L141–143: In Fig. 3, it is shown that after the 200 no drought occurred, while two floods happened. This statement will not be good.

Author: response to Specific comment 8

Thank you for the comments. In line 139–142 of the revised version, we made revision. The revised contents are as follows:

“ Since the early 1990s, the HRB as a whole has tended towards more frequent droughts, which severely impacted the ecological environment, the rational allocation of water resources and the water supply in the basin (Chen et al., 2006; Wang and Guo, 2010; Yin, 2015).”

Reviewer 3: Specific comment 9/10/11/12

Fig. 1: Better to omit minute/second values from the latitude/longitude labels, and enlarge a bit their font size.

Fig. 1: The insert in (a) need to be labeled as, for example, “(a)”, since some of the legends for “Huanjing River Basin” and “Yangtze Mainstream” are only for that inserted figure. Need to specify such legends. The present version of the legends in (a) may cause confusions.

Fig. 1: What is a green symbol in (b)?

Fig. 1: The elevation color bar units are wrong.

Author: response to comment 9/10/11/12

Thank you for these comments and apologies for our carelessness. In the revised manuscript, we corrected Figure 1, referring to the suggestions. The redrawn figure would be clearer to be read.

Reviewer 3: Specific comment 13

L165: “historical” -> “Historical”

Author: response to Specific comment 13

Thank you for the suggestion. In the revised version, this has been corrected.

Reviewer 3: Specific comment 14

L181–182: Need to add reference for this precipitation dataset.

Author: response to Specific comment 14

In lines 180–182 of the revised version, we added the reference. The revised contents are as follows:

“The instrumental data (started in 1951) comes from the monthly precipitation dataset “China National Ground Meteorological Station Homogenized Precipitation Data Set (V1.0)” (Yang and Li, 2014).”

Reviewer 3: Specific comment 15/16

L196: Is “Vientiane Cave” correct?

L196–197: Need to show the location, and brief explanation on how past East or South Asian monsoon activities were reconstructed.

Author: response to Specific comment 15/16

Thank you for the comments. In Lines 193–199 of the revised manuscript, we made corrections. The revised contents are as follows:

“Asian monsoon index. The East Asian summer monsoon index dataset (1426–1949) reconstructed by Zhang et al. (2008b) was used in this study. They conducted a climate reconstruction of East Asian summer monsoon strength based on accurate dating by using high-resolution stalagmite $\delta^{18}\text{O}$ series of Wanxiang Cave in Wudu (33°N, 104°E), Gansu province. Moreover, the updated South Asian summer monsoon index dataset (1426–2000) by Shi et al. (2017) was also used. This dataset used eight additional Indian tree-ring width chronologies from the South Asian summer monsoon core region to update the earlier reconstruction by Shi et al. (2014).”

Reviewer 3: Specific comment 17

L196: Two “Zhang et al. (2008)” exist in the reference list. Need to specify which.

Author: response to Specific comment 17

Apology for the carelessness. According to the order of appearance in the manuscript, in the revised version, we amended "Zhang et al., 2008" to "Zhang et al., 2008a" in line 57, and "Zhang et al. (2008)" in line 194 is amended to "Zhang et al. (2008b)". The corresponding references are revised as follows:

“Zhang, R., Wu, B., Zhao, P., and Han, J.: Interdecadal transition of summer climate in eastern China in the late 1980s and its possible causes, Acta. Meteor. Sinica., 5, 697–706, doi: CNKI:SUN:QXXB.0.2008-05-004, 2008a (in Chinese).

Zhang, P., Cheng, H., Edwards, R. L., Chen, F., Wang, Y., Yang, X., Liu, J., Tan, M., Wang, X., Liu, J., An, C., Dai, Z., Zhou, J., Zhang, D., Jia, J., Jin, L., and Johnson, K. P.: A Test of Climate, Sun, and Culture Relationships from an 1810-Year Chinese Cave Record, Science, 322, 940–942, doi: 10.1126/science.1163965, 2008b.”

Reviewer 3: Specific comment 18/19

Table 1: Second column: Is the left inequality sign correct?

Table 1: Third, fourth, and fifth columns: Use minus sign, not hyphen.

Author: response to Specific comment 18/19

Thank you for the careful reading of our manuscript. In the revised version, we made corrections to Table 1.

Reviewer 3: Specific comment 20

L284–286: This method may cause confusions. Precipitation is for “May–September” or “Annual” precipitation? In addition, what is “average precipitation”?

Author: response to Specific comment 20

Thank you for this comment. In Lines 286–294 of the revised manuscript, we added an explanation of the terms. The contents are as follows:

“Precipitation anomaly percentages were calculated for May–September of 1951–2017. The method is [annual May–September precipitation-average May–September precipitation] / average May–September precipitation (both annual and average May–September precipitation is calculated based on precipitation data for each site from May–September for 1951–2017, and average May–September precipitation is the mean of annual May–September accumulated precipitation in the whole period). The precipitation anomaly percentages at the eight sites were then averaged to give the basin-averaged precipitation anomaly percentages for the HRB. Figure 3 shows a comparison of the drought and flood grades established in this study and the precipitation anomaly percentages during the period of 1951-2017.”

Reviewer 3: Specific comment 21

L314: Add published year of Xie et al.

Author: response to Specific comment 21

Thanks. In the revised version, we added the published year of the reference.

Reviewer 3: Specific comment 22

L341: “dashed” -> “dotted”?

Author: response to Specific comment 22

Thank you for this suggestion. In line 348 of the revised version, we changed that.

Reviewer 3: Specific comment 23

L357–286: Need to add references for these records.

Author: response to Specific comment 23

In lines 365–371 of the revised version, we added references. The revised contents are as follows:

“ *There were many records in the HRB regarding the drought in 1928, such as: "The sun is harsh in the summer, and the rivers are parched" (Wen, Shaanxi Volume, 2005); "The victims had eaten all the bark and grass within hundreds of miles and recently had to dig the soil in the mountains to eat, causing many of them to die from dry stools" (Wen, Henan Volume, 2005); and "Last year (1928), a severe drought affected a vast area within a thousand li (ancient Chinese length unit, equivalent to 0.5km) radius from spring to summer" (Wen, Hubei Volume, 2007).* ”

Reviewer 3: Specific comment 24

L487, L512: 1953 -> 1935.

Author: response to Specific comment 24

Thank you. In the revised version, it has been corrected.

Reviewer 3: Specific comment 25

Table 5: Better to divide this table into two tables for the situations in droughts in North China and floods in the Yangtze River.

Author: response to Specific comment 25

Thank you for the suggestion. In conjunction with another reviewer's comments, we removed Table 5 from the revised version.

Reviewer 3: Specific comment 26/27/33/34

Fig. 9: What are the darker or lighter grey parts indicated? What are curves in (b) and (c)?

Figs. 9, 10, L591 etc.: The target period is not exactly the multiple number of 30-year. How do they treat the fraction years?

Fig. 10, left panel: Better to add number labels on the horizontal axis to be, like “1525, 1615, 1705...” with 90 intervals to match with the 30-year period divisions.

Fig. 10 right column: Omit “-1” from the horizontal axis label, instead add numerals from zero to 8 or 10.

Author: response to Specific comment 26/27

Thank you for the comments and suggestions. We have made a revision of the figures accordingly.

In lines 596–598 of the revised version, we explained Figure 10 (original Figure 9) in more detail. In addition, in order to present a more standardised comparison for 30-year period, we changed the period of comparison between strong ENSO events and extreme drought/flood

events to 1530–1979 (in lines 646–647 of the revised version), and modified Figure 11 (original Figure 10).

Reviewer 3: Specific comment 28

L565: Need to add the region of flood or drought conditions.

Author: response to Specific comment 28

Thank you for this comment. In the revised version, we made a correction referring to this suggestion, adding the flood and drought areas in the figure (Current Figure 10).

Reviewer 3: Specific comment 29

L567: In case “summer monsoon” is used, which monsoon index is referred to “East Asian” or “South Asian” or both?

Author: response to Specific comment 29

Thank you for this comment and suggestion. In lines 596–598 of the revised version, we changed the sentence. The revised contents are as follows:

“Figure 10 shows a comparison of extreme drought and flood events per 30 years in the HRB (the first time period is 1426–1429 and the last is 2000–2017) with the East Asian summer monsoon index and the South Asian summer monsoon index (i.e. Asian summer monsoon index).”

Therefore, “Asian summer monsoon” in the new manuscript is the collective term for the East Asian summer monsoon and the South Asian summer monsoon.

Reviewer 3: Specific comment 30/31

L567-569: In a centennial year time-scale, it can be regarded as “monsoon was generally weak” and extreme drought events were relatively more likely, but in a decadal time-scale, for example, in late 16th century, extreme floods are common but no droughts were recorded. How they consider such decadal scale conditions?

L570–575: Very rare floods in the 18th century may not be well explained by these monsoon indexes, since even in the similar monsoon index levels, for example, in the 15th century by the East Asian monsoon index, or the early 20th century by the South Asian monsoon index are observed, though a number of extreme floods occur.

Author: response to Specific comment 30/31

Thank you for the comments.

It is unfortunate that, because of the subject matter and space limitations of this manuscript, a very detailed comparative analysis of the correlation between extreme events and monsoons is not possible. In lines 598–599 and 617–626 of the revised manuscript, we made some changes to discuss about the results and limitations of this manuscript. Obviously, further investigation needs to be done to solve the possible influence of monsoon variability on the

HRB precipitation. Our analysis in this manuscript has been focused on the variation characteristics of the historical extreme droughts and floods. The causes and mechanisms of the variation observed will be examined in the future. The contents are as follows (In lines 617–626):

“In the 18–19th century, when the Asian summer monsoon gradually strengthened, there were six extreme drought events and 12 extreme flood events in the HRB, which were generally lower than those in previous period in occurrence of extreme drought and flood events. Specifically, there were relatively few extreme events in the 18th century and an increase in extreme events in the 19th century, with 10 extreme floods and three extreme droughts in the 19th century, more than three times as many extreme floods as extreme droughts. This sharp contrast between extreme droughts and extreme floods may illustrate that the increased Asian summer monsoon on multi- to century scales was conducive to more rainstorms and floods in the HRB. However, the correspondence of the stronger summer monsoon and the low occurrence of both extreme droughts and floods in the 18th century may indicate the complexity of the mechanisms by which the extreme drought and flood events in the basin occur.”

We have also changed the wording on the discussion of monsoon and ENSO influence in Line 673–678 of the revised manuscript as follows:

“The association of the Asian monsoon/ENSO and the HRB extreme drought/flood events in history is not straightforward. This may be the reason why the correspondence between precipitation and monsoon is still controversial in proxy data and modeling studies (e.g., Lu et al., 2019; Shi et al., 2021). It is also worth indicating that, due to the space limitation, this study provides only a very preliminary discussion of the relationship between extreme droughts/floods of the HRB with Asian summer monsoon and ENSO.”

Reviewer 3: Specific comment 32

L584–589: A vague correlation analysis. What did they use an index for the drought and floods grades in a 30-year time window?

Author: response to Specific comment 32

Thank you for this comment. The original sentence was indeed vague. In lines 639–642 of the revised version, we made a new explanation. The changed contents are as follows:

“The correlation between the average of extreme drought/flood grades in the HRB and the average of Asian summer monsoon indices (i.e. the average of East Asian summer monsoon index and South Asian summer monsoon index) at a 30-year time window was analyzed. There was a significant negative correlation between them ($p < 0.01$).”

Reviewer 3: Specific comment 35

L609–611: Confusing statements. Which monsoon East or South Asian influence more on the HRB precipitation and how?

Author: response to Specific comment 35

Thank you for this comment. Based on your comment, we removed this controversial section from the revised version.

Reviewer 3: Specific comment 36

L633–634: The meaning of this sentence is not understandable.

Author: response to Specific comment 36

Thank you for this comment. In lines 691–692 of the revised version, we made revisions referring to the suggestion. The sentence now reads as follow:

“When both droughts and floods occur in a given year, the disaster situation in summer tends to be selected for our statistics.”

Reviewer 3: Specific comment 36

References: Need to reorder alphabetically.

Author: response to Specific comment 36

Thank you for the suggestion. After a careful checking, we found that the references were in alphabetical order. However, we sorted them again following the CP's request and your suggestion.

References

- Chen, H., Guo S., Guo, H., Xu, G., and Xu, D.: Analysis of spatial and temporal trends of precipitation and temperature in the Hanjiang River basin from 1951 to 2003, *Resour. Environ. Yangtze Basin*, 3, 340–345, doi: CNKI:SUN:CJLY.0.2006-03-013, 2006 (in Chinese).
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- Yang, S., and Li, Q.: Methodology for homogeneity analysis of precipitation series in China and improvement of dataset update, *Climate Change Research*, 276–281, doi: 10.3969/j.issn.1673-1719.2014.04.008, 2014 (in Chinese).
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