Comments in black and our response in blue

RC1: 'Comment on hess-2024-126', Anonymous Referee #1, 09 Jun 2024

The paper provides a comprehensive analysis of three primary classifications for a catchment: meteorological, attributes, and response. By correlating this information, the paper identifies characteristic classes of flood responses. The main findings show that meteorological data has a much greater impact on flood response compared to land cover and catchment attributes. However, certain catchment attributes were also found to be correlated with the response.

Response: Thank you very much for your careful review and constructive comments. We revised this manuscript substantially and provided point-by-point responses to all the comments and suggestions of reviewers accordingly.

Here are my main concerns about this paper:

1. The results don't contribute new knowledge about the streamflow-generating process. It's well known that streamflow is mainly controlled by factors such as precipitation, intensity, duration, and its distribution. A similar analysis using the rational method could yield the same results as presented in this paper.

Response: We appreciate your critical comments. In our study, the main motivations are to investigate some manageable flood event classes from massive events across China with statistical significance and to quantify the meteorological and physio-geographical controls of spatial and temporal variabilities of these flood event classes using the clustering method, constrained rank analysis and Monte Carlo permutation test. We agreed that this study did not contribute new mechanisms about the streamflow-generating process because the investigation was quite difficult from massive heterogenous flood events in space and time at large scale. However, existing studies usually focused on impacts of changes in meteorological or underlying surface conditions on specific flood metrics (e.g., magnitude, peak and timings) and their changes using trend separation method, correlation testing, mathematical modelling, and so on (Berghuijs *et al*., 2016; Tarasova *et al*., 2018; Liu *et al*., 2020). All of these studies were implemented at event scale or in catchments with certain landscapes and climates, which were insufficient for the comprehensive flood change investigation and generalized results (Tarasova *et al*., 2019; Zhang *et al*., 2020). Therefore, we explored the control mechanisms of meteorological and physio-geographical factors on spatial and temporal variabilities of flood events at class scale across China. The primary meteorological and physio-geographical control factors were identified for different flood event classes clustered from over one thousand flood events, and their contributions of the class variabilities were quantified for individual classes. All of these analyses were implemented in more heterogeneous catchments with wider meteorological and physio-geographical conditions and flood events, and provided more comprehensive insights into meteorological and physio-geographical controls of variabilities of flood event classes in China.

To make the novelty and contributions of our studies clearer, we made several revisions. The manuscript was revised as follows: *"Our study investigates comprehensive manageable flood event classes from 1446 unregulated flood events in 68 headstream catchments in China using the hierarchical and partitional clustering methods. Control mechanisms of meteorological and physio-geographical factors (e.g., meteorology, land cover and catchment attributes) on spatial and temporal variabilities of individual flood event classes are explored using constrained rank analysis and Monte Carlo permutation test."*

"Existing studies provide insights on impacts of changes in meteorological or underlying surface conditions on specific flood metrics (e.g., magnitude, peak and timings) and their changes using trend

separation method, correlation testing, mathematical modelling, and so on (Berghuijs et al., 2016; Tarasova et al., 2018; Liu et al., 2020; Wang et al., 2024). However, all of these studies are implemented at event scale or in catchments with certain landscapes and climates, which are insufficient for the comprehensive flood change investigation and generalized results (Tarasova et al., 2019; Zhang et al., 2020).”

“Over one thousand unregulated flood events at 68 heterogeneous catchments with wider meteorological and physio-geographical conditions are selected for our study.”

“This study provides more comprehensive insights into meteorological and physio-geographical controls of variabilities of flood event classes at large scale, and provides the mechanism supports for predicting flood event classes.”

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2. While the classification found in the paper may have value for local or basin analysis, most of the results cannot be applied to other regions or countries. The attempt to connect with other countries in the discussion is qualitative and not valid for

comparison without quantitative analysis. What is considered high or low, fast or slow in one country could be entirely different in another.

Response: Thank you very much for your constructive comments.

For the applicability of our study, we provided an approach to investigate some manageable flood event classes from massive events at large scale and to quantify the meteorological and physio-geographical controls of spatial and temporal variabilities of flood event classes. The approach could also be applied easily to other regions or countries if a great number of flood events were collected. The main motivations and implications of this study were clarified as follows: *"This study provides more comprehensive insights into meteorological and physio-geographical controls of variabilities of flood event classes at large scale, and provides the mechanism supports for predicting flood event classes."* in the introduction section, and *"Our study provided an approach to investigate some manageable flood event classes from massive events at large scale and to quantify the meteorological and physio-geographical controls of spatial and temporal variabilities of flood event classes. The approach could be applied easily to other regions or countries if a great number of flood events were collected." i*n the discussion section.

For the comparability of our study, we agreed that the results were difficult to quantitatively compare with most existing studies because the adopted classification methods and boundaries of individual classes were usually different. The widely-adopted classification method categories were presented in the revision to explain the comparability of classification results. "*According to the classification procedure, there are two widely-adopted approaches, namely the tree clustering methods (e.g., decision tree, regression tree, fuzzy tree and random forest) (Sikorska et al., 2015; Brunner et al., 2017) and the non-tree clustering methods (e.g., single linkage, complete linkage, average linkage, centroid linkage, ward linkage, k-mean, k-medoids) (Zhang et al., 2020; Zhai et al., 2021). The tree clustering methods as the hard clustering methods, are implemented to binarily split all the flood events successively into smaller classes of similar* *flood events according to the thresholds of flood response metrics until obtaining final classes (Sikorska et al., 2015; Brunner et al., 2017). The classification results could be applicable to other basins and the flood response characteristics of different studies would be directly comparable if the same thresholds are adopted. However, these methods assume that the boundaries of flood response metrics in different classes are clear and the thresholds of flood response metrics should be predefined and should not overlap among different classes (Olden et al., 2012; Sikorska et al., 2015; Zhai et al., 2021). Additionally, the classification is very sensitive to the thresholds, whose small changes would cause different flood event classes (Olden et al., 2012; Sikorska et al., 2015). Therefore, it will be difficult to define the thresholds clearly to get robust classification performance. The non-tree clustering methods as the soft clustering methods, are implemented to directly split all the flood events according to different division rules of the comprehensive similarity measures of flood event shapes or metrics (Olden et al., 2012; Zhang et al., 2020). The class boundaries of flood response metrics are not clear, which are mainly based on sufficient of heterogeneous flood events (Sikorska et al., 2015). The flood response characteristics of individual classes were usually qualitatively described to distinguish the differences among classes (Olden et al., 2012; Tarasova et al., 2019; Zhang et al., 2020). Therefore, the classification results obtained from different flood event samples are still difficult to quantitatively compare even though the flood response characteristics or hydrographs in the certain class are similar (e.g., high or low, fast or slow floods) (Zhang et al., 2024). However, these methods were widely-used due to their ease of use (Olden et al., 2012; Tarasova et al., 2019; Zhang et al., 2020)."*

We also discussed the reliability of our classifications in China and tried to make quantitative comparisons with the existing studies of other regions. In our study, a total of 1446 unregulated flood events in 68 headstream catchments were selected for classification. All the catchments were mainly spread across the flood-prone areas and in all the monsoon controlled climate types of China, except tropical climate in the islands (i.e., A). The selected flood events were sufficient to represent the flood response characteristics of headstream catchments in main river basins of China. Thus, our classification results and the control mechanisms of variability of flood event classes would be applied in other regions with similar climate types. The revisions were given as follows: "*thus the region in the monsoon controlled climate types is usually considered as the flood-prone area of China (China Institute of Water Resources and Hydropower Research and Research Center on Flood and Drought Disaster Prevention and Reduction, the Ministry of Water Resources, 2021).*" and "*Sixty-eight headstream stations spread across the flood-prone areas were selected with catchment areas ranging from 21 km*^{2} *to 4830 km*^{2}*, which were in all the monsoon controlled climate types of China, except tropical climate in the islands (i.e., A).*" in the section of study area and data sources, and "*All the selected flood events were sufficient to represent the flood response characteristics of headstream catchments in main river basins of China. Thus, our classification results and the control mechanisms of variability of flood event classes would be applied in other regions with similar climate types.*" in the discussion section.

The values of some critical metrics of individual classes were also quantitatively compared with those of existing studies in the discussion section. The revisions were given as follows: *"The specific values and boundaries of flood response metrics of individual classes were difficult to quantitatively compare with most existing studies because the adopted classification methods were usually different. However, the flood event classes with similar hydrographs or response mechanisms were also found in the existing studies. …… The flood response characteristics in these two classes are similar to the flash floods and short-rain floods in Austria (Merz and Blöschl 2003), and fast events in Switzerland (Brunner et al., 2018) and China (Zhai et al., 2021)."*

"The flood response characteristics are similar to the high unit peak flood in the west coast of the USA (Saharia et al., 2017) because both the response characteristics were mainly controlled by subtropical or tropical storms near the ocean in the Cf climate type. They are also similar to the slow events in China (Zhai et al., 2021) because the rates of positive changes are 0.01–0.94 h^{-1} *in our study, and 0.04–1.78* h^{-1} *in China (Zhai et al., 2021), and the rates of negative changes are 0.01–0.33* h^{-1} *in our study and 0.02–0.25* h^{-1} *in China (Zhai et al., 2021)."*

"The similar flood events are also reported, e.g., the low flashiness floods with the mean flood peak magnitude of 0.20–0.25 $m^3/s/km^2$ *and the mean coefficients of variation of approximate 0.90 in the northern part of central–eastern Europe (Kuentz et al., 2017), which is also controlled by the similar climate type (i.e., Df)."*

"The flood response characteristics are similar to the intermediate flood events in China (Zhai et al., 2021). For example, the coefficients of variation are 0.65–3.15 in our study and 0.78–3.07 in China (Zhai et al., 2021). The rates of positive and negative changes are 0.02–8.00 h^{-1} and 0.01–0.64 h^{-1}in our study, respectively, while those reported in Zhai et al. (2021) were 0.36–4.90 h^{-1} and 0.09–0.46 h^{-1} in China, respectively."

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3. Throughout the paper, the authors mainly describe numerical findings that could be presented in a table. I believe that the value of research lies in the analysis, discussion, and implications of the findings. Additionally, many of the figures contain irrelevant information that doesn't help highlight the findings.

Response: Your suggestion has been adopted. We summarized our results in a higher-level way and moved some detailed information into the supplementary tables (Tables S4 and S5). The examples were as follows:

"Table S4. Average, standard deviation, median, maximum and minimum of flood response metrics in different classes

Characteristic value	Class	$R(mm\cdot day^{-1})$	$Q_{pk}(mm\cdot day^{-1})$	CV	T_{bgn}	$T_{pk}(\%)$	$T_{drn}(h)$	$RQ_r(h^{-1})$	$RQ_d(h^{-1})$	N_{pk}
Average± Standard Deviation	1	43.97±29.94	2.04±2.51	0.90±0.26	2.28±0.49	27.14±9.60	103.92±43.39	0.13±0.32	0.04±0.07	1.31±0.51
	2	45.81±34.01	2.21±2.52	0.87±0.25	3.06±0.69	50.64±10.28	83.82±41.20	0.08±0.14	0.08±0.12	1.32±0.50
	3	143.97±108.33	5.23±6.04	0.84±0.22	3.24±0.61	33.90±15.02	145.26±68.99	0.25±0.62	0.12±0.28	2.67±0.76
	4	33.31±26.64	1.69±2.11	0.86±0.26	3.85±0.51	26.11±9.09	85.73±39.97	0.14±0.30	0.04±0.08	1.24±0.43
	5	65.79±43.80	2.98±3.68	1.40±0.43	3.43±0.61	23.74±13.60	202.88±85.42	0.18±0.62	0.03±0.04	1.24±0.46
Median	1	35.63	1.17	0.89	2.30	27.27	97.01	0.05	0.02	1.00
	2	37.84	1.36	0.84	3.03	49.04	76.99	0.04	0.04	1.00
	3	115.53	3.09	0.82	3.21	32.09	139.01	0.07	0.03	3.00
	4	25.09	1.00	0.83	3.79	26.39	79.01	0.05	0.02	1.00
	5	57.11	1.92	1.32	3.42	21.26	190.99	0.04	0.01	1.00
Maximum	1	171.48	22.92	1.97	3.24	57.14	357.00	4.58	0.74	3.00
	2	194.87	19.84	1.81	4.65	86.96	256.99	1.24	1.06	3.00
	3	610.70	34.79	1.45	4.72	79.91	493.99	6.89	2.45	4.00
	4	174.43	21.02	2.12	5.25	55.67	241.01	3.50	0.91	3.00
	5	201.00	27.18	3.15	5.24	81.56	465.00	6.76	0.31	3.00
Minimum	1	3.22	0.13	0.33	1.05	4.17	25.01	0.00	0.00	1.00
	2	1.11	0.07	0.32	1.09	32.65	13.99	0.00	0.00	1.00
	3	7.79	0.14	0.32	1.07	4.47	19.99	0.00	0.00	1.00
	4	1.17	0.04	0.29	2.88	5.56	16.99	0.00	0.00	1.00
	5	1.54	0.07	0.65	1.57	1.61	25.01	0.00	0.00	1.00

Table S5. Flood event number and their percentages of individual classes in all the selected catchments

Basins	*Stations*	*Abbreviations*	*Flood event number of class*						*Percentage(%)*				
			1	*2*	*3*	*4*	*5*	*Total*	*1*	*2*	*3*	*4*	*5*
Songliao	*Dongfeng*	*DF*	*0*	*3*	*1*	*9*	*1*	*14*	*0.0*	*21.4*	*7.1*	*64.3*	*7.1*
	Jingyu	*JY*	*0*	*3*	*1*	*9*	*0*	*13*	*0.0*	*23.1*	*7.7*	*69.2*	*0.0*
	Muling	*ML*	*0*	*0*	*2*	*7*	*3*	*12*	*0.0*	*0.0*	*16.7*	*58.3*	*25.0*
	Yitong	*YT*	*0*	*6*	*0*	*7*	*1*	*14*	*0.0*	*42.9*	*0.0*	*50.0*	*7.1*
	Total		*0*	*12*	*4*	*32*	*5*	*53*	*0.0*	*22.6*	*7.5*	*60.4*	*9.4*
Yellow	*Huating*	*HT*	*0*	*2*	*0*	*7*	*2*	*11*	*0.0*	*18.2*	*0.0*	*63.6*	*18.2*
	Luanchuan	*LC*	*4*	*6*	*2*	*27*	*0*	*39*	*10.3*	*15.4*	*5.1*	*69.2*	*0.0*
	Qiaotou	*QT*	*0*	*4*	*1*	*17*	*0*	*22*	*0.0*	*18.2*	*4.5*	*77.3*	*0.0*
	Tantou	*TT*	*7*	*2*	*2*	*16*	*5*	*32*	*21.9*	*6.3*	*6.3*	*50.0*	*15.6*
	Total		*11*	*14*	*5*	*67*	*7*	*104*	*10.6*	*13.5*	*4.8*	*64.4*	*6.7*
Huaihe	*Beimiaoji*	*BM*	*0*	*0*	*0*	*0*	*12*	*12*	*0.0*	*0.0*	*0.0*	*0.0*	*100.0*
	Dapoling	*DP*	*0*	*6*	*1*	*5*	*9*	*21*	*0.0*	*28.6*	*4.8*	*23.8*	*42.9*
	Huangnizhuang	*HN*	*1*	*0*	*1*	*4*	*4*	*10*	*10.0*	*0.0*	*10.0*	*40.0*	*40.0*
	Lixin	*LX*	*0*	*5*	*5*	*4*	*4*	*18*	*0.0*	*27.8*	*27.8*	*22.2*	*22.2*
	Luzhuang	*LZ*	*1*	*0*	*0*	*4*	*6*	*11*	*9.1*	*0.0*	*0.0*	*36.4*	*54.5*
	Peihe	*PH*	*5*	*0*	*1*	*5*	*7*	*18*	*27.8*	*0.0*	*5.6*	*27.8*	*38.9*
	Qilin	*QL*	*2*	*0*	*0*	*1*	*7*	*10*	*20.0*	*0.0*	*0.0*	*10.0*	*70.0*
	Xiagushan	*XG*	*3*	*3*	*1*	*3*	*9*	*19*	*15.8*	*15.8*	*5.3*	*15.8*	*47.4*
	Xinxian	*XX*	*3*	*3*	*2*	*2*	*14*	*24*	*12.5*	*12.5*	*8.3*	*8.3*	*58.3*
	Yangzhuang	*YZ*	*0*	*5*	*1*	*2*	*2*	*10*	*0.0*	*50.0*	*10.0*	*20.0*	*20.0*
	Zhongtang	*ZT*	*2*	*3*	*1*	*4*	*5*	*15*	*13.3*	*20.0*	*6.7*	*26.7*	*33.3*
	Zhuganpu	*ZG*	*4*	*2*	*1*	*2*	*17*	*26*	*15.4*	*7.7*	*3.8*	*7.7*	*65.4*
	Ziluoshan	*ZL*	*3*	*2*	*2*	*8*	*6*	*21*	*14.3*	*9.5*	*9.5*	*38.1*	*28.6*
	Total		*24*	*29*	*16*	*44*	*102*	*215*	*11.2*	*13.5*	*7.4*	*20.5*	*47.4*
Yangtze	*Anhe*	*AH*	*5*	*3*	*2*	*3*	*1*	*14*	*35.7*	*21.4*	*14.3*	*21.4*	*7.1*
	Anren	*AR*	*8*	*14*	*3*	*3*	*5*	*33*	*24.2*	*42.4*	*9.1*	*9.1*	*15.2*
	Baitugang	*BT*	*1*	*3*	*1*	*6*	*0*	*11*	*9.1*	*27.3*	*9.1*	*54.5*	*0.0*
	Biyang	*BY*	*1*	*1*	*0*	*10*	*0*	*12*	*8.3*	*8.3*	*0.0*	*83.3*	*0.0*
	Chengcun	*CC*	*11*	*3*	*9*	*0*	*0*	*23*	*47.8*	*13.0*	*39.1*	*0.0*	*0.0*
	Dutou	*DT*	*6*	*8*	*1*	*8*	*0*	*23*	*26.1*	*34.8*	*4.3*	*34.8*	*0.0*
	Gaotan	*GT*	*4*	*5*	*4*	*6*	*4*	*23*	*17.4*	*21.7*	*17.4*	*26.1*	*17.4*
	Jiahe	*JH*	*6*	*6*	*1*	*0*	*0*	*13*	*46.2*	*46.2*	*7.7*	*0.0*	*0.0*
	Jiajiafang	*JJ*	*2*	*4*	*0*	*4*	*1*	*11*	*18.2*	*36.4*	*0.0*	*36.4*	*9.1*
	Jinping	*JP*	*3*	*2*	*6*	*2*	*4*	*17*	*17.6*	*11.8*	*35.3*	*11.8*	*23.5*
	Jitan	*JT*	*0*	*2*	*2*	*3*	*4*	*11*	*0.0*	*18.2*	*18.2*	*27.3*	*36.4*
	Juwan	*JW*	*4*	*3*	*0*	*8*	*1*	*16*	*25.0*	*18.8*	*0.0*	*50.0*	*6.3*
	Liangshuikou	*LK*	*24*	*6*	*6*	*26*	*3*	*65*	*36.9*	*9.2*	*9.2*	*40.0*	*4.6*
	Liqingdian	*LQ*	*0*	*6*	*2*	*14*	*7*	*29*	*0.0*	*20.7*	*6.9*	*48.3*	*24.1*
	Loudi	*LD*	*7*	*5*	*6*	*2*	*5*	*25*	*28.0*	*20.0*	*24.0*	*8.0*	*20.0*
	Miping	*MP*	*3*	*3*	*5*	*3*	*5*	*19*	*15.8*	*15.8*	*26.3*	*15.8*	*26.3*
	Pingshi	*PS*	*5*	*3*	*1*	*8*	*5*	*22*	*22.7*	*13.6*	*4.5*	*36.4*	*22.7*
	Shahebu	*SH*	*3*	*3*	*2*	*2*	*0*	*10*	*30.0*	*30.0*	*20.0*	*20.0*	*0.0*
	Shanggao	*SG*	*10*	*2*	*2*	*3*	*2*	*19*	*52.6*	*10.5*	*10.5*	*15.8*	*10.5*
	Shijie	*SJ*	*3*	*4*	*0*	*4*	*2*	*13*	*23.1*	*30.8*	*0.0*	*30.8*	*15.4*
	Shimenkan	*SM*	*16*	*25*	*2*	*5*	*2*	*50*	*32.0*	*50.0*	*4.0*	*10.0*	*4.0*
	Shuangfeng	*SF*	*9*	*8*	*7*	*8*	*1*	*33*	*27.3*	*24.2*	*21.2*	*24.2*	*3.0*
	Shuangjiangkou	*SK*	*8*	*3*	*12*	*1*	*0*	*24*	*33.3*	*12.5*	*50.0*	*4.2*	*0.0*
	Sifen	*SI*	*4*	*2*	*2*	*0*	*2*	*10*	*40.0*	*20.0*	*20.0*	*0.0*	*20.0*
	Tangdukou	*TD*	*10*	*19*	*1*	*2*	*1*	*33*	*30.3*	*57.6*	*3.0*	*6.1*	*3.0*
	Tanghe	*TH*	*0*	*3*	*1*	*5*	*9*	*18*	*0.0*	*16.7*	*5.6*	*27.8*	*50.0*
	Tonggu	*TG*	*5*	*2*	*0*	*0*	*10*	*17*	*29.4*	*11.8*	*0.0*	*0.0*	*58.8*
	Tongtang	*TO*	*14*	*6*	*5*	*2*	*1*	*28*	*50.0*	*21.4*	*17.9*	*7.1*	*3.6*
	Wuxigou	*WX*	*4*	*5*	*0*	*7*	*1*	*17*	*23.5*	*29.4*	*0.0*	*41.2*	*5.9*
	Xiawan	*XW*	*6*	*0*	*0*	*2*	*3*	*11*	*54.5*	*0.0*	*0.0*	*18.2*	*27.3*
	Xixia	*XI*	*1*	*1*	*3*	*5*	*6*	*16*	*6.3*	*6.3*	*18.8*	*31.3*	*37.5*
	Xupu	*XP*	*12*	*14*	*4*	*5*	*1*	*36*	*33.3*	*38.9*	*11.1*	*13.9*	*2.8*
	Yanling	*YL*	*18*	*4*	*4*	*7*	*0*	*33*	*54.5*	*12.1*	*12.1*	*21.2*	*0.0*
	Yanta	*YA*	*6*	*2*	*1*	*4*	*0*	*13*	*46.2*	*15.4*	*7.7*	*30.8*	*0.0*
	Yuanken	*YK*	*2*	*3*	*1*	*0*	*7*	*13*	*15.4*	*23.1*	*7.7*	*0.0*	*53.8*
	Yucun	*YC*	*12*	*0*	*18*	*3*	*1*	*34*	*35.3*	*0.0*	*52.9*	*8.8*	*2.9*
	Yuexi	*YX*	*14*	*4*	*11*	*5*	*3*	*37*	*37.8*	*10.8*	*29.7*	*13.5*	*8.1*
	Zhangdou	*ZD*	*4*	*3*	*0*	*5*	*0*	*12*	*33.3*	*25.0*	*0.0*	*41.7*	*0.0*
	Total		*251*	*190*	*125*	*181*	*97*	*844*	*29.7*	*22.5*	*14.8*	*21.4*	*11.5*
Southeast	*Anxi*	*AX*	*1*	*3*	*4*	*6*	*0*	*14*	*7.1*	*21.4*	*28.6*	*42.9*	*0.0*

	Longshan	*LS*	*1*	*3*	*16*	*3*	*0*	*23*	*4.3*	*13.0*	*69.6*	*13.0*	*0.0*
	Tunxi	*TX*	*5*	*3*	*1*	*1*	*3*	*13*	*38.5*	*23.1*	*7.7*	*7.7*	*23.1*
	Xufan	*XF*	*1*	*3*	*5*	*1*	*0*	*10*	*10.0*	*30.0*	*50.0*	*10.0*	*0.0*
	Zhaoan	*ZA*	*1*	*5*	*12*	*8*	*4*	*30*	*3.3*	*16.7*	*40.0*	*26.7*	*13.3*
		Total	*9*	*17*	*38*	*19*	*7*	*90*	*10.0*	*18.9*	*42.2*	*21.1*	*7.8*
Pearl	*Hezikou*	*HZ*	*42*	*17*	*7*	*22*	*1*	*89*	*47.2*	*19.1*	*7.9*	*24.7*	*1.1*
	Huishui	*HS*	*3*	*3*	*0*	*4*	*0*	*10*	*30.0*	*30.0*	*0.0*	*40.0*	*0.0*
	Libo	*LB*	*5*	*0*	*0*	*6*	*0*	*11*	*45.5*	*0.0*	*0.0*	*54.5*	*0.0*
	Xiaogulu	*XL*	*2*	*24*	*0*	*0*	*4*	*30*	*6.7*	*80.0*	*0.0*	*0.0*	*13.3*
		Total	*52*	*44*	*7*	*32*	*5*	*140*	*37.1*	*31.4*	*5.0*	*22.9*	*3.6*
	Total		*347*	*306*	*195*	*375*	*223*	*1446*	*24.0*	*21.2*	*13.5*	*25.9*	*15.4*

”

More specifically, in the results section, the comprehensive introductions of flood response characteristics of different classes (Section 4.2), and control mechanisms of meteorological and physio-geographical factors (Section 4.4) were given to avoid the repeated present the results in the tables and figures. Additionally, the discussions were strengthened in the discussion section, particularly for the comparison of our flood event classification with the existing studies.

The figures were redrawn following the comments of you and the second reviewer, including Figures 1, 4, 5, 6, 8 and 10.

Minor comments:

Line 40. You refer many times in the text to behavior characteristics what I consider response types. When we talk about behavior, you are trying to characterize the catchment dynamic which is intrinsic to each catchment. In other words, you try to characterize the low filter function that transform input to outputs. I would suggest changing the word behavior for response which is a more precise word for what you are analyzing.

Response: We replaced the word “behavior” with “response” in the whole manuscript.

Line 77. The expression "solid data foundation" is a biased description of your research.

Response: It was revised as "*provides the mechanism supports for predicting flood event classes*".

Line 94. This is not the right way to refer to information extracted from a webpage. Check the referring rules from the journal.

Response: The websites were removed from the manuscript because the detailed data sources were given in the section of Code/Data availability.

Line 109. How dense is the meteorological gauge network? How can we be sure that they are representative of the basin analyzed?

Response: The meteorological stations in the buffer zone with a radius of 100 km of individual catchment centers were selected. All the selected meteorological stations were added in Figure 1. The total number of meteorological stations was 466 and no less than eight stations were within or around individual catchments.

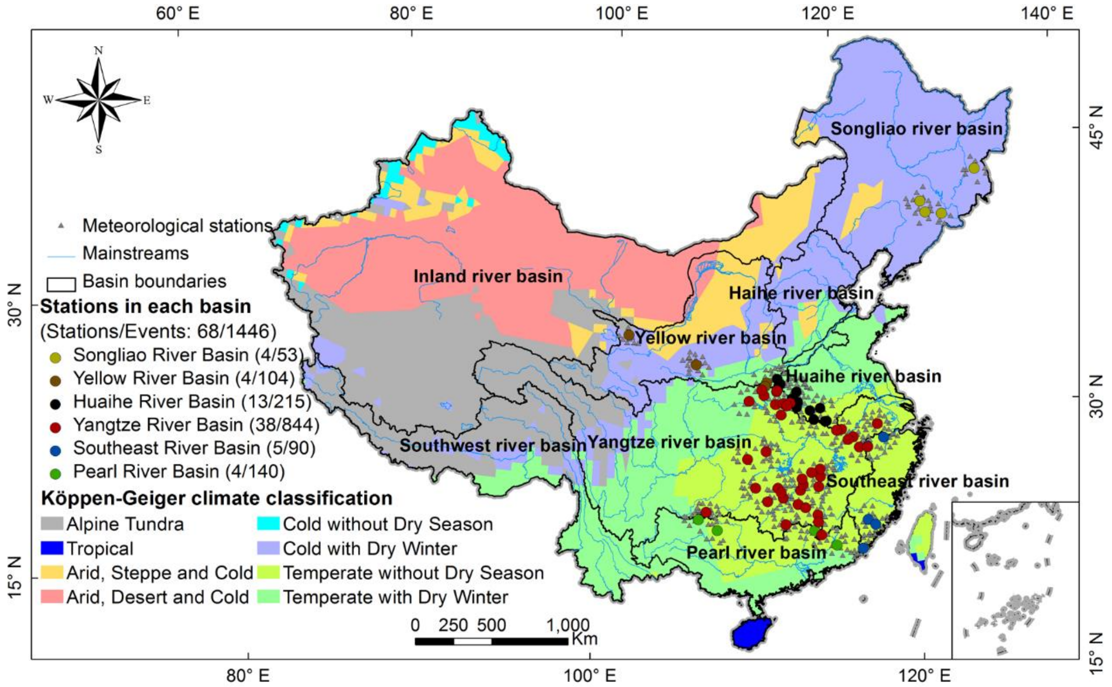

Figure 1. Spatial distributions of all the selected flood events and their corresponding climate types

Additionally, the relationships between flood events and meteorological factors were well captured by the catchment hydrological model (Zhang *et al*., 2024), which could well demonstrate the representatives of all the control factors.

Some revisions were given as follow.

"*All the meteorological stations in the buffer zone with a radius of 100 km of every catchment centers were selected. The station number was 466 in total and no less than eight stations for each catchment.*"

"All these control factors well represented the meteorological and underlying surface conditions of individual catchments because all these flood events were captured satisfactorily by the catchment hydrological model developed using these factors (Zhang et al., 2024)."

References

Zhang, Y. Y., Zhang, Y. Q., Zhai, X., Xia, J., Tang, Q., Zhao, T., and Wang, W.: Predicting flood event class using a novel class membership function and hydrological modeling, Earth's Future, 12, e2023EF004081. https://doi.org/10.1029/2023EF004081,2024.

Figure 1. The gauge distribution is strongly biased to Yangtze and Huai Rivers. How can you develop an analysis by basin with this low density in the other basins?

Response: The selections of hydrological stations and flood events were mainly based on the basin area, flood prone area, data availability and quality (i.e., no regulations of human activities), and so on.

The flood events in headstream catchments were selected, which were mainly in the Huaihe River Basin in the south–north climate zone of China, and the Yangtze, Southeast and Pearl River Basins in the Southern China. The flood events were more likely to occur in all these basins than those in the Songliao and Yellow River Basin in the Northern China. Thus, the densities of flood events and gauges in the Huaihe River Basin and Southern China were much greater than those in the Northern China, i.e., $0.09–0.48\times10^{-4}$ station/km^2 and $3.09–7.96\times10^{-4}$ events/km^2 in the Huaihe River Basin and Southern China, $0.03–0.05\times10^{-4}$ station/km^2 and $0.42–1.36\times10^{-4}$ events/km^2 in the Northern China. Additionally, although the station densities in the Huaihe and Yangtze River Basins were greater than those of Southeast and Pearl River Basins, the flood event densities were approximately close, all of which were around $3.09–7.96\times10^{-4}$ events/km^2 (see the Table S1 in the Supplement).

The explanations were added in the manuscript as follows: *"The densities of flood events and gauges in the Huaihe River Basin and Southern China were much greater than those in the Songliao and Yellow River Basins in the Northern China because of the higher occurrences of flood events (Table S1 in the Supplement) (China Institute of Water Resources and Hydropower Research and Research Center on Flood and Drought Disaster Prevention and Reduction, the Ministry of Water Resources, 2021)."*

"Table S1. Total numbers and densities of hydrological stations and flood events in different river basins

Basin	Area (10^4km^2)	Number		Density	
		Station	Flood event	Station (10^{-4} station/km^2)	Event (10^{-4} event/km^2)
Songliao River Basin	124.92	4	53	0.03	0.42
Yellow River Basin	75.24	4	104	0.05	1.38
Huaihe River Basin	27.00	13	215	0.48	7.96
Yangtze River Basin	180.85	38	844	0.21	4.67
Southeast River Basin	24.02	5	90	0.21	3.75
Pearl River Basin	45.36	4	140	0.09	3.09

"

Additionally, the representatives of flood event classes would be investigated if more events were selected in future works. It was revised in the discussion section as follows. *"However, several works should be paid attention for further improvements of our study……"* and *"The representatives of individual classes should be further investigated particularly in the basins with low densities of flood events……"*

Line 139. PCA is known to work well for linear factors. Did you check for non-linear relationships?

Response: We tested the independence and linear correlations among different flood response metrics using the ANOVA test and correlations test. The results showed that T_{bgn} is independent from R, RQ_r, RQ_d and N_{pk}; Q_{pk} is independent from T_{pk}; and N_{pk} is independent from RQ_r and RQ_d. Expect these independent metrics, all the other metrics have linear correlations with each other. Therefore, non-linear relationships do not exist among the flood response metrics and the PCA can be used for the dimensionality reduction analysis.

The revisions were given as follows:

"…involving the `aov`, `cor` *and* `princomp` *functions in stats Package (version 4.1.3) for independence test, linear correlation test…"*

"By the tests of independence and linear correlation for all the flood response metrics, T_{bgn} *is independent from* R, RQ_r, RQ_d *and* N_{pk}*;* Q_{pk} *is independent from* T_{pk}*; and* N_{pk} *is independent from* RQ_r *and* RQ_d*. Expect these independent metrics, all the other metrics have linear correlations with each other (Table S3 in the Supplement)."*

"Table S3. Results of independence and linear correlation tests among different flood response metrics

Methods		Correlation coefficient for the correlations test								
		R	Q_{pk}	CV	T_{bgn}	T_{pk}	T_{drn}	RQ_r	RQ_d	N_{pk}
p-value for ANOVA test	R		**0.68**	**0.14**	*0.00*	**0.06**	**0.14**	**0.26**	**0.34**	**0.34**
	Q_{pk}	**0.00**		**0.41**	*0.02*	*-0.03*	**-0.18**	**0.75**	**0.77**	**0.08**
	CV	**0.00**	**0.00**		**0.06**	**-0.24**	**0.18**	**0.38**	**0.19**	**-0.21**
	T_{bgn}	*0.93*	*0.45*	**0.02**		**-0.12**	**0.07**	*0.04*	*0.04*	*-0.04*
	T_{pk}	**0.02**	*0.19*	**0.00**	**0.00**		**-0.14**	**-0.19**	**0.11**	**0.14**
	T_{drn}	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**		**-0.19**	**-0.28**	**0.23**
	RQ_r	**0.00**	**0.00**	**0.00**	*0.12*	**0.00**	**0.00**		**0.68**	*-0.03*
	RQ_d	**0.00**	**0.00**	**0.00**	*0.15*	**0.00**	**0.00**	**0.00**		*0.02*
	N_{pk}	**0.00**	**0.00**	**0.00**	*0.17*	**0.00**	**0.00**	*0.31*	*0.38*	

Note: the bold value indicates that the test passes the 95% significance test, and the italic value indicates that the test does not pass the 95% significance test."

Line 163-168. You are presenting the same information as Table 2. You should summarize.

Response: These sentences were summarized as follows: *“In the meteorological category, 17 factors related to precipitation, potential evapotranspiration and aridity index are selected, including the amounts, intensities and timing factors during flood events, in the antecedent period and at annual scale.”*

Line 173-178. You are presenting the same information as Table 2. You should summarize.

Response: These sentences were summarized as follows: *“For the physio-geographical factors, the 10 catchment attributes are selected, including catchment location, area, elevation and slope, river density and slope.”* and *“Seven land cover factors are selected, including the area fractions of paddy, dryland, forest, grassland, water, urban and rural area to the total catchment, respectively for the seven land cover periods.”*

Table 2. Factors are hard to visualize. Add a bullet for each one.

Response: It was revised accordingly which were given as follows.

“Table 2. Meteorological and physio-geographical factors in our study

Factor categories		*Factors*	*Data sources*	*Flood event effects*
Meteorology	*Precipitation*	• *pcp_ant: cumulative amount in the antecedent seven days (mm);* • *pcp_dur:total amount during the flood event (mm);* • *pcp_av: mean amount during the flood event (mm hr^{-1});* • *pcp_max: maximum intensity during the flood event (mm hr^{-1});* • *pcp_max: maximum intensity during the flood event (mm hr^{-1});* • *pcp_Tbeg: precipitation timing;* • *pcp_Tdur: precipitation duration (days);* • *pcp_ann: annual mean amount (mm);* • *pcp_year: amount in the year when the flood event happens (mm)*	*Hourly precipitation in hydrological yearbooks; daily precipitation at 466 meteorological stations*	*Flood yield process*
	Potential evapotranspiration	• *pet_ant: cumulative amount in the antecedent seven days (mm);* • *pet_dur: total amount during the flood event (mm)* • *pet_max: maximum intensity during the flood event (mm hr^{-1})* • *pet_ann: annual mean amount (mm);* • *pet_year: amount in the year when the flood event happens (mm)*	*Daily maximum and minimum temperature at 466 meteorological stations*	*Flood yield process*
	Aridity index	• *SPEI_ant: mean value in the antecedent seven days;* • *SPEI_dur: mean value during the flood event ;* • *SPEI_ann: annual mean value;*	*Daily maximum and minimum temperature at 466*	*Flood yield process*

		- SPEI_year: mean value in the year when the flood event happens	meteorological stations	
Physio-geography	Locations	- Longitude: longitude of catchment center - Latitude: latitude of catchment center	Global positioning system	Meteorological conditions
	Catchment attributes	- Slope: catchment slope (%); - Area: catchment area (km^2); - Length: catchment slope length (km); - Elevation: average elevation of catchment (m); - MaxiElev:maximum elevation of catchment (m);	Digital elevation model (size: 30 m×30 m)	Flood yield and overland routing processes
	River attributes	- Rivden: river density (km/km^2); - RivSlope: river slope (%); - Rwd: ratio of river width to depth (m/m);	Digital elevation model (size: 30 m×30 m)	Flood routing processes in river system
	Land covers	- Rpaddy: area fraction of paddy to catchment (%); - Rdryland: area fraction of dryland to catchment (%); - Rforest: area fraction of forest to catchment (%); - Rgrass: area fraction of grass to catchment (%); - Rwater: area fraction of water to catchment (%); - Rurban: area fraction of urban to catchment (%); - Rrural: area fraction of unused land to catchment (%)	Land covers in 1990, 1995, 2000, 2005, 2010 and 2015 (size: 30 m×30 m)	Flood yield and overland routing processes

”

Line 193-196. These lines should be at the beginning of the paragraph with a more detailed explanation of the method used.

Response: This paragraph was revised following your comments and a more detailed explanation of the constrained rank analysis was added.

“The constrained rank analysis is adopted to quantify the direct or combined effects of control factor categories on spatial and temporal variabilities of individual flood event classes for both the distributed and lumped analyses. The widely adopted methods of constrained rank analysis are the Redundancy Analysis (RDA) and the Canonical Correlation Analysis (CCA). The RAD is a linear model and the CCA is a unimodal model, both of which are the extended methods of principal component analysis combined with regression analysis. These methods have strong advantages to solve multiple linear regressions and interactions between dependent and independent variable matrixes which are transformed into a few independent composite factors (ter Braak, 1986; Legendre and Anderson, 1999), and are beneficial to quantify the effects of independent variable matrix on dependent variable matrix and to find the most important factors, which have been commonly used in testing the multispecies response to environmental variables in the biological or ecological sciences (Legendre and Anderson, 1999), effects of physio-geographical factors and human activities on diffuse nutrient losses or water quality (Zhang et al., 2016; Shi et al., 2017), and so on. The constrained proportion is the percentage of explained variance by independent variable matrix to the total variance of dependent variable matrix, which is usually

considered as the effect contribution of individual meteorological and physio-geographical factors or categories on total variabilities of flood event classes. If the contribution sum of individual factor effects is less than the entire contribution of all the factors, the interactive effects are among the factors and the difference between the summed and entire contributions is the combined contribution (Zhang et al., 2016). The selection is based on the first axis length. The CCA is proposed when the first axis length is greater than 4.0, while the RDA is proposed when the first axis length is less than 3.0. Otherwise, both CCA and RDA are proposed (ter Braak, 1986; Zhang et al., 2020).”

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Zhang, S.L., Zhou, L.M., Zhang, L., Yang, Y.T., Wei, Z.W., Zhou, S., Yang, D.W., Yang, X. F., Wu, X.C., Zhang, Y.Q., and Dai, Y.J.: Reconciling disagreement on global river flood changes in a warming climate, Nat. Clim. Change, 12, 1160–1167, https://doi.org/10.1038/s41558-022-01539-7, 2022.

Zhang, Y., Zhou, Y., Shao, Q., Liu, H., Lei, Q., Zhai, X., and Wang, X.: Diffuse nutrient losses and the impact factors determining their regional differences in four catchments from North to South China, J. Hydrol., 543, 577-594, https://doi.org/10.1016/j.jhydrol.2016.10.031,2016.

Line 208. You should be more specific about how you got that. What are the values inside the table? Explain more.

Response: The method and results of principal component analysis were introduced specifically.

In the method section: *"The main flood response metrics in the individual PCAs were determined according to the load coefficient matrix. If the load coefficient is over 0.45, the corresponding flood response metric are considered to be highly correlated with the PCA."*

In the result section: *"By the principal component analysis, five independent PCAs are found with the total cumulative variance of 85.7%, which are greater than the threshold (80.0%) (Table 3). Thus, the first five PCAs are selected in our study. According to the load coefficient matrix, the first PCA is related with magnitude (R and Q_{pk}), variability (CV) and rates of changes (RQ_r and RQ_d) with the load coefficients of 0.61, 0.97, 0.47, 0.84 and 0.84, respectively, and all of these metrics explain 33.3% of total variances of flood response metrics. The second PCA is related with R, CV, T_{pk} and N_{pk} with the load coefficients of 0.51, -0.47 and 0.56, respectively, and all of these metrics explain 17.0% of total variances. The third PCA is mainly related with T_{drn} and T_{pk} with the load coefficients of -0.48 and 0.48, respectively, and all of these metrics explain 16.0% of total variances. The fourth and fifth PCAs are mainly related with timings (T_{bgn} and T_{pk}) of flood event and maximum flood peak with the load coefficients of 0.92 and 0.64, respectively. The explained variances are 10.8% and 8.6%, respectively."*

Line 209. Typo. What is the value 33.2 or 33.3%?

Response: The value is 33.3%, and it was corrected accordingly.

Line 210. What clustering methods are you referring here?

Response: The clustering methods are the the hierarchical and *k*-medoids methods. It was revised as follows: *"Compared with the classification performance of these two clustering methods (i.e., the hierarchical and k-medoids methods) among individual optimal cluster numbers……"*

Line 226-254. You are just describing the data that could be summarized on an appendix table.

Response: The revised sentences were given as follows: *"The value ranges of flood response metrics in different classes are presented in Figure 3 and Table S4 in the Supplement. For the magnitude* *metrics, both total flood volume (R) and maximum flood peak (Q_{pk}) variations are the same among different classes. The metric values in Class 3 are the largest, followed by Classes 5, 2, 1 and 4. For the variability metrics (CV), the events are the most variable in Class 5, and are slightly variable in the other Classes with the mean CV being less than 1.0, i.e., 0.90±0.26 (Class 1), 0.87±0.25 (Class 2), 0.86±0.26 (Class 4) and 0.84±0.22 (Class 3). For the timing and duration metrics (i.e., T_{bgn}, T_{drn} and T_{pk}), 73.2% of flood events in Class 1 occur before the wet season (i.e., January - May), and 58.5%, 67.7% and 57.0% of flood events in Classes 2, 3 and 5 occur in the earlier wet season (i.e., June - July), and 52.8% of flood events in Class 4 occur in the latter wet season (i.e., August - September). The mean duration (T_{drn}) is the longest in Class 5, followed by Classes 3 and 1. The mean T_{drn} values in Classes 4 and 2 are the shortest, i.e., 85.73±39.97 h and 83.82±41.20 h. The timings of maximum flood peaks (T_{pk}) are usually the largest in Class 2 with the mean of 50.6%±10.3%, which means that the flood peaks mainly occur in the middle or late stages of flood events. The flood peaks usually occur in the early stage of flood events in the other classes (i.e., Classes 1, 2, 4 and 5). Particularly in Class 3, the mean T_{pk} value is only 23.7%±13.6%.*

For the rates of changes, RQ_r in most classes are much greater than RQ_d because the flood peaks usually occur in the early stage of flood events, except Class 2. The largest values of both RQ_r and RQ_d are in Class 3 because of the greatest flood peak. The smallest RQ_r values are mainly in Classes 2 because of the late occurrences of flood peaks, while the smallest RQ_d values are mainly in Class 5 because of the long durations of flood recession. For the flood peak number (N_{pk}), 71.2%, 69.9%, 76.5% and 77.1% of flood events has one flood peaks in Classes 1, 2, 4 and 5, respectively, and multiple flood peaks (i.e., two–four) exist in 94.4% of total flood events in Class 3, accounting for 33.8% (two peaks), 48.7% (three peaks) and 11.8% (four peaks), respectively. "

The characteristic values of flood response metrics in different classes were provided in Table S4 of Supplement.

“Table S4. Average, standard deviation, median, maximum and minimum of flood response metrics in different classes

Characteristic value	Class	$R(mm{\cdot}day^{-1})$	$Q_{pk}(mm{\cdot}day^{-1})$	CV	T_{bgn}	$T_{pk}(\%)$	$T_{drn}(h)$	$RQ_r(h^{-1})$	$RQ_d(h^{-1})$	N_{pk}
Average± Standard Deviation	1	43.97±29.94	2.04±2.51	0.90±0.26	2.28±0.49	27.14±9.60	103.92±43.39	0.13±0.32	0.04±0.07	1.31±0.51
	2	45.81±34.01	2.21±2.52	0.87±0.25	3.06±0.69	50.64±10.28	83.82±41.20	0.08±0.14	0.08±0.12	1.32±0.50
	3	143.97±108.33	5.23±6.04	0.84±0.22	3.24±0.61	33.90±15.02	145.26±68.99	0.25±0.62	0.12±0.28	2.67±0.76
	4	33.31±26.64	1.69±2.11	0.86±0.26	3.85±0.51	26.11±9.09	85.73±39.97	0.14±0.30	0.04±0.08	1.24±0.43
	5	65.79±43.80	2.98±3.68	1.40±0.43	3.43±0.61	23.74±13.60	202.88±85.42	0.18±0.62	0.03±0.04	1.24±0.46
Median	1	35.63	1.17	0.89	2.30	27.27	97.01	0.05	0.02	1.00
	2	37.84	1.36	0.84	3.03	49.04	76.99	0.04	0.04	1.00
	3	115.53	3.09	0.82	3.21	32.09	139.01	0.07	0.03	3.00
	4	25.09	1.00	0.83	3.79	26.39	79.01	0.05	0.02	1.00
	5	57.11	1.92	1.32	3.42	21.26	190.99	0.04	0.01	1.00
Maximum	1	171.48	22.92	1.97	3.24	57.14	357.00	4.58	0.74	3.00
	2	194.87	19.84	1.81	4.65	86.96	256.99	1.24	1.06	3.00
	3	610.70	34.79	1.45	4.72	79.91	493.99	6.89	2.45	4.00
	4	174.43	21.02	2.12	5.25	55.67	241.01	3.50	0.91	3.00
	5	201.00	27.18	3.15	5.24	81.56	465.00	6.76	0.31	3.00
Minimum	1	3.22	0.13	0.33	1.05	4.17	25.01	0.00	0.00	1.00
	2	1.11	0.07	0.32	1.09	32.65	13.99	0.00	0.00	1.00
	3	7.79	0.14	0.32	1.07	4.47	19.99	0.00	0.00	1.00
	4	1.17	0.04	0.29	2.88	5.56	16.99	0.00	0.00	1.00
	5	1.54	0.07	0.65	1.57	1.61	25.01	0.00	0.00	1.00

”

Figure 4. I would try 2 columns. Left: Flood event distribution. Right: Frequency histogram. Currently, it is too small to watch some differences in the distributions.

Response: This figure was redrawn following your comments.

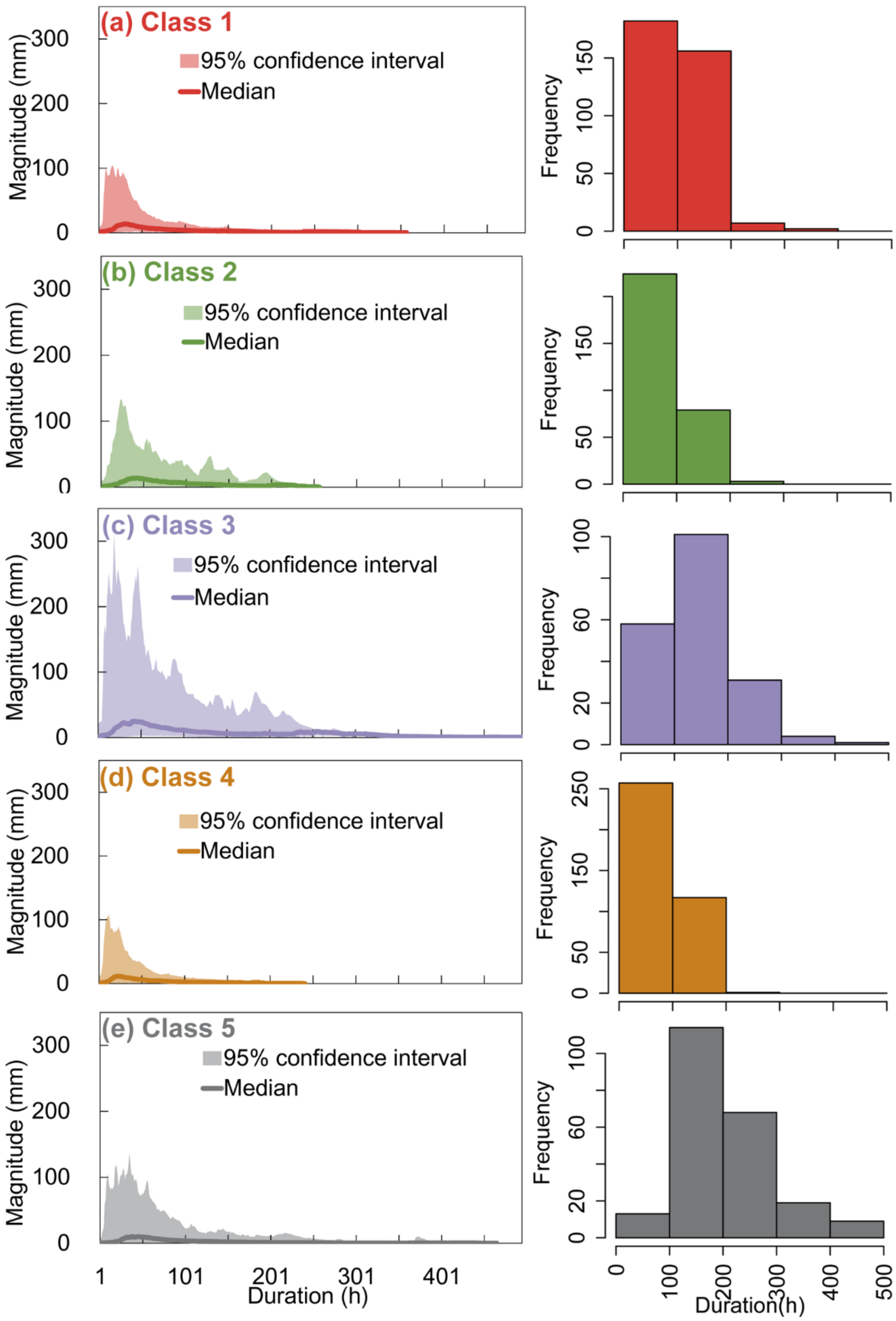

Figure 4. Flood event distributions in the 95% confidence interval and their median, and their duration frequencies of Classes 1–5 (a–e)

Line 268-283. You should add a discussion about your results. You are mainly describing information that could be in an appendix table.

Response: We reorganized this paragraph to clearly introduce the main spatial distributions of individual classes.

"The spatial distributions of individual classes are showed in Figure 5 and Table S5 in the Supplement. The moderately fast flood event class (i.e., Class 1) is mainly in the Pearl and Yangtze River Basins, accounting for 37.1% (52/140) and 29.7% (251/844) of total events, respectively. Specifically, Class 1 is dominant in the Xiawan, Yanling and Songgao catchments in the Yangtze River Basin, and Hezikou catchment in the Pearl River Basin. The highly fast flood event class (i.e., Class 2) is mainly in the Pearl River Basin, accounting for 31.4% (44/140) of total events, particularly in the Xiaogulu catchment. The highly slow and multipeak flood event class (i.e., Class 3) is mainly in the Southeast River Basin, accounting for 42.2% (38/90) of total events, particularly in the Longshan catchment. The slightly fast flood event class (i.e., Class 4) is mainly in the Yellow and Songliao River Basins, accounting for 64.4% (67/104) and 60.4% (32/53) of total events, respectively. The most obvious catchments are Biyang in the Yangtze River Basin, Qiaotou and Luanchuan in the Yellow River Basin, Jingyu and Dongfeng in the Songliao River Basin. The moderately slow flood event class (i.e., Class 5) is mainly in the Huaihe River Basin, accounting for 47.4% (102/215) of total events, particularly in the Beimiaoji and Qilin catchments. Therefore, the Classes 1 to 3 are mainly in the Temperate without Dry Season climate region in southern China (Figure 1), the Class 4 is mainly in the Cold with Dry Winter climate region in northern China, and the Class 5 is mainly in the transition region between Temperate without Dry Season climate and Cold with Dry Winter climate."

More discussions about the reasons of the spatial differences of individual classes were also provided in the discussion section.

"Classes 1 and 2 are mainly in the southern China, particularly in the Pearl and Yangtze River Basins, which are controlled by the temperate climate without a dry season. Storms with high intensities and short durations before the wet season in the southern China are likely to cause flood events with great magnitudes and variabilities (Class 1) or fast flood events with a high single peak and short durations (Class 2) (Gao et al., 2018)".

“Class 3 is mainly in the Southeast River Basin controlled by the tropical cyclone climate. Severe storms with high intensities and durations are likely to cause high slow flood events with multiple peaks (Class 3) (Yin et al., 2010; Zhang et al., 2020) .”

“Class 4 is mainly in the northern China controlled by the cold climate with dry winters. The heavy storms ahead of westerlies trough mainly occur in the latter wet season in this region, which usually have low intensities and short durations (Gao et al., 2018). Thus they are likely to cause the small fast flood events (Class 4),……”.

“Class 5 is mainly in the south–north climate zone of China (i.e., Huaihe River Basin), which has the dual climate characteristics of both south and north monsoons. Storms characterized by a long period of continuous rainy meteorological with high frequency and low intensities (e.g., Meiyu rainfalls) in the earlier wet season are likely to cause moderate slow flood events with long durations (Gao et al., 2018; Sampe and Xie, 2010).”

We also added a table in the supplement (Table S5) to show the class distributions and their percentages of all the selected catchments.

“Table S5. Flood event number and their percentages of individual classes in all the selected catchments

Basins	*Stations*	*Abbreviations*	*Flood event number of class*						*Percentage(%)*				
			1	*2*	*3*	*4*	*5*	*Total*	*1*	*2*	*3*	*4*	*5*
Songliao	*Dongfeng*	*DF*	*0*	*3*	*1*	*9*	*1*	*14*	*0.0*	*21.4*	*7.1*	*64.3*	*7.1*
	Jingyu	*JY*	*0*	*3*	*1*	*9*	*0*	*13*	*0.0*	*23.1*	*7.7*	*69.2*	*0.0*
	Muling	*ML*	*0*	*0*	*2*	*7*	*3*	*12*	*0.0*	*0.0*	*16.7*	*58.3*	*25.0*
	Yitong	*YT*	*0*	*6*	*0*	*7*	*1*	*14*	*0.0*	*42.9*	*0.0*	*50.0*	*7.1*
	Total		*0*	*12*	*4*	*32*	*5*	*53*	*0.0*	*22.6*	*7.5*	*60.4*	*9.4*
Yellow	*Huating*	*HT*	*0*	*2*	*0*	*7*	*2*	*11*	*0.0*	*18.2*	*0.0*	*63.6*	*18.2*
	Luanchuan	*LC*	*4*	*6*	*2*	*27*	*0*	*39*	*10.3*	*15.4*	*5.1*	*69.2*	*0.0*
	Qiaotou	*QT*	*0*	*4*	*1*	*17*	*0*	*22*	*0.0*	*18.2*	*4.5*	*77.3*	*0.0*
	Tantou	*TT*	*7*	*2*	*2*	*16*	*5*	*32*	*21.9*	*6.3*	*6.3*	*50.0*	*15.6*
	Total		*11*	*14*	*5*	*67*	*7*	*104*	*10.6*	*13.5*	*4.8*	*64.4*	*6.7*
Huaihe	*Beimiaoji*	*BM*	*0*	*0*	*0*	*0*	*12*	*12*	*0.0*	*0.0*	*0.0*	*0.0*	*100.0*
	Dapoling	*DP*	*0*	*6*	*1*	*5*	*9*	*21*	*0.0*	*28.6*	*4.8*	*23.8*	*42.9*
	Huangnizhuang	*HN*	*1*	*0*	*1*	*4*	*4*	*10*	*10.0*	*0.0*	*10.0*	*40.0*	*40.0*
	Lixin	*LX*	*0*	*5*	*5*	*4*	*4*	*18*	*0.0*	*27.8*	*27.8*	*22.2*	*22.2*
	Luzhuang	*LZ*	*1*	*0*	*0*	*4*	*6*	*11*	*9.1*	*0.0*	*0.0*	*36.4*	*54.5*
	Peihe	*PH*	*5*	*0*	*1*	*5*	*7*	*18*	*27.8*	*0.0*	*5.6*	*27.8*	*38.9*
	Qilin	*QL*	*2*	*0*	*0*	*1*	*7*	*10*	*20.0*	*0.0*	*0.0*	*10.0*	*70.0*
	Xiagushan	*XG*	*3*	*3*	*1*	*3*	*9*	*19*	*15.8*	*15.8*	*5.3*	*15.8*	*47.4*
	Xinxian	*XX*	*3*	*3*	*2*	*2*	*14*	*24*	*12.5*	*12.5*	*8.3*	*8.3*	*58.3*
	Yangzhuang	*YZ*	*0*	*5*	*1*	*2*	*2*	*10*	*0.0*	*50.0*	*10.0*	*20.0*	*20.0*
	Zhongtang	*ZT*	*2*	*3*	*1*	*4*	*5*	*15*	*13.3*	*20.0*	*6.7*	*26.7*	*33.3*
	Zhuganpu	*ZG*	*4*	*2*	*1*	*2*	*17*	*26*	*15.4*	*7.7*	*3.8*	*7.7*	*65.4*

	Ziluoshan	*ZL*	*3*	*2*	*2*	*8*	*6*	*21*	*14.3*	*9.5*	*9.5*	*38.1*	*28.6*
	Total		*24*	*29*	*16*	*44*	*102*	*215*	*11.2*	*13.5*	*7.4*	*20.5*	*47.4*
Yangtze	*Anhe*	*AH*	*5*	*3*	*2*	*3*	*1*	*14*	*35.7*	*21.4*	*14.3*	*21.4*	*7.1*
	Anren	*AR*	*8*	*14*	*3*	*3*	*5*	*33*	*24.2*	*42.4*	*9.1*	*9.1*	*15.2*
	Baitugang	*BT*	*1*	*3*	*1*	*6*	*0*	*11*	*9.1*	*27.3*	*9.1*	*54.5*	*0.0*
	Biyang	*BY*	*1*	*1*	*0*	*10*	*0*	*12*	*8.3*	*8.3*	*0.0*	*83.3*	*0.0*
	Chengcun	*CC*	*11*	*3*	*9*	*0*	*0*	*23*	*47.8*	*13.0*	*39.1*	*0.0*	*0.0*
	Dutou	*DT*	*6*	*8*	*1*	*8*	*0*	*23*	*26.1*	*34.8*	*4.3*	*34.8*	*0.0*
	Gaotan	*GT*	*4*	*5*	*4*	*6*	*4*	*23*	*17.4*	*21.7*	*17.4*	*26.1*	*17.4*
	Jiahe	*JH*	*6*	*6*	*1*	*0*	*0*	*13*	*46.2*	*46.2*	*7.7*	*0.0*	*0.0*
	Jiajiafang	*JJ*	*2*	*4*	*0*	*4*	*1*	*11*	*18.2*	*36.4*	*0.0*	*36.4*	*9.1*
	Jinping	*JP*	*3*	*2*	*6*	*2*	*4*	*17*	*17.6*	*11.8*	*35.3*	*11.8*	*23.5*
	Jitan	*JT*	*0*	*2*	*2*	*3*	*4*	*11*	*0.0*	*18.2*	*18.2*	*27.3*	*36.4*
	Juwan	*JW*	*4*	*3*	*0*	*8*	*1*	*16*	*25.0*	*18.8*	*0.0*	*50.0*	*6.3*
	Liangshuikou	*LK*	*24*	*6*	*6*	*26*	*3*	*65*	*36.9*	*9.2*	*9.2*	*40.0*	*4.6*
	Liqingdian	*LQ*	*0*	*6*	*2*	*14*	*7*	*29*	*0.0*	*20.7*	*6.9*	*48.3*	*24.1*
	Loudi	*LD*	*7*	*5*	*6*	*2*	*5*	*25*	*28.0*	*20.0*	*24.0*	*8.0*	*20.0*
	Miping	*MP*	*3*	*3*	*5*	*3*	*5*	*19*	*15.8*	*15.8*	*26.3*	*15.8*	*26.3*
	Pingshi	*PS*	*5*	*3*	*1*	*8*	*5*	*22*	*22.7*	*13.6*	*4.5*	*36.4*	*22.7*
	Shahebu	*SH*	*3*	*3*	*2*	*2*	*0*	*10*	*30.0*	*30.0*	*20.0*	*20.0*	*0.0*
	Shanggao	*SG*	*10*	*2*	*2*	*3*	*2*	*19*	*52.6*	*10.5*	*10.5*	*15.8*	*10.5*
	Shijie	*SJ*	*3*	*4*	*0*	*4*	*2*	*13*	*23.1*	*30.8*	*0.0*	*30.8*	*15.4*
	Shimenkan	*SM*	*16*	*25*	*2*	*5*	*2*	*50*	*32.0*	*50.0*	*4.0*	*10.0*	*4.0*
	Shuangfeng	*SF*	*9*	*8*	*7*	*8*	*1*	*33*	*27.3*	*24.2*	*21.2*	*24.2*	*3.0*
	Shuangjiangkou	*SK*	*8*	*3*	*12*	*1*	*0*	*24*	*33.3*	*12.5*	*50.0*	*4.2*	*0.0*
	Sifen	*SI*	*4*	*2*	*2*	*0*	*2*	*10*	*40.0*	*20.0*	*20.0*	*0.0*	*20.0*
	Tangdukou	*TD*	*10*	*19*	*1*	*2*	*1*	*33*	*30.3*	*57.6*	*3.0*	*6.1*	*3.0*
	Tanghe	*TH*	*0*	*3*	*1*	*5*	*9*	*18*	*0.0*	*16.7*	*5.6*	*27.8*	*50.0*
	Tonggu	*TG*	*5*	*2*	*0*	*0*	*10*	*17*	*29.4*	*11.8*	*0.0*	*0.0*	*58.8*
	Tongtang	*TO*	*14*	*6*	*5*	*2*	*1*	*28*	*50.0*	*21.4*	*17.9*	*7.1*	*3.6*
	Wuxigou	*WX*	*4*	*5*	*0*	*7*	*1*	*17*	*23.5*	*29.4*	*0.0*	*41.2*	*5.9*
	Xiawan	*XW*	*6*	*0*	*0*	*2*	*3*	*11*	*54.5*	*0.0*	*0.0*	*18.2*	*27.3*
	Xixia	*XI*	*1*	*1*	*3*	*5*	*6*	*16*	*6.3*	*6.3*	*18.8*	*31.3*	*37.5*
	Xupu	*XP*	*12*	*14*	*4*	*5*	*1*	*36*	*33.3*	*38.9*	*11.1*	*13.9*	*2.8*
	Yanling	*YL*	*18*	*4*	*4*	*7*	*0*	*33*	*54.5*	*12.1*	*12.1*	*21.2*	*0.0*
	Yanta	*YA*	*6*	*2*	*1*	*4*	*0*	*13*	*46.2*	*15.4*	*7.7*	*30.8*	*0.0*
	Yuanken	*YK*	*2*	*3*	*1*	*0*	*7*	*13*	*15.4*	*23.1*	*7.7*	*0.0*	*53.8*
	Yucun	*YC*	*12*	*0*	*18*	*3*	*1*	*34*	*35.3*	*0.0*	*52.9*	*8.8*	*2.9*
	Yuexi	*YX*	*14*	*4*	*11*	*5*	*3*	*37*	*37.8*	*10.8*	*29.7*	*13.5*	*8.1*
	Zhangdou	*ZD*	*4*	*3*	*0*	*5*	*0*	*12*	*33.3*	*25.0*	*0.0*	*41.7*	*0.0*
	Total		*251*	*190*	*125*	*181*	*97*	*844*	*29.7*	*22.5*	*14.8*	*21.4*	*11.5*
Southeast	*Anxi*	*AX*	*1*	*3*	*4*	*6*	*0*	*14*	*7.1*	*21.4*	*28.6*	*42.9*	*0.0*
	Longshan	*LS*	*1*	*3*	*16*	*3*	*0*	*23*	*4.3*	*13.0*	*69.6*	*13.0*	*0.0*
	Tunxi	*TX*	*5*	*3*	*1*	*1*	*3*	*13*	*38.5*	*23.1*	*7.7*	*7.7*	*23.1*
	Xufan	*XF*	*1*	*3*	*5*	*1*	*0*	*10*	*10.0*	*30.0*	*50.0*	*10.0*	*0.0*
	Zhaoan	*ZA*	*1*	*5*	*12*	*8*	*4*	*30*	*3.3*	*16.7*	*40.0*	*26.7*	*13.3*
	Total		*9*	*17*	*38*	*19*	*7*	*90*	*10.0*	*18.9*	*42.2*	*21.1*	*7.8*
Pearl	*Hezikou*	*HZ*	*42*	*17*	*7*	*22*	*1*	*89*	*47.2*	*19.1*	*7.9*	*24.7*	*1.1*
	Huishui	*HS*	*3*	*3*	*0*	*4*	*0*	*10*	*30.0*	*30.0*	*0.0*	*40.0*	*0.0*
	Libo	*LB*	*5*	*0*	*0*	*6*	*0*	*11*	*45.5*	*0.0*	*0.0*	*54.5*	*0.0*
	Xiaogulu	*XL*	*2*	*24*	*0*	*0*	*4*	*30*	*6.7*	*80.0*	*0.0*	*0.0*	*13.3*
	Total		*52*	*44*	*7*	*32*	*5*	*140*	*37.1*	*31.4*	*5.0*	*22.9*	*3.6*
Total			*347*	*306*	*195*	*375*	*223*	*1446*	*24.0*	*21.2*	*13.5*	*25.9*	*15.4*

”

References

Gao, S.T., Zhou, Y.S., Ran, L.K.: A review on the formation mechanisms and forecast methods for torrential rain in China. Chinese Journal of Atmospheric Sciences, 42 (4), 833-846, https://doi.org/10.3878/j.issn.1006-9895.1802.17277, 2018. (in Chinese)

Yin, Y.Z., Gemmer, M., Luo, Y., Wang, Y.: Tropical cyclones and heavy rainfall in Fujian Province, China. Quatern int., 226(1–2):122-128, https://doi.org/10.1016/j.quaint.2010.03.015, 2010.

Figure 5. This is too small. You could move this figure to the appendix and add a figure with a more informative visualization, maybe zoon in a small area. Maybe you should correlate with some of the PC factors in space, etc.

Response: This figure was redrawn and the area with high densities of stations were zoomed to present detailed distributions of flood event classes. We also drew the spatial distributions of load coefficients of all the principal components (PCA1–5) which were provided in the Supplement.

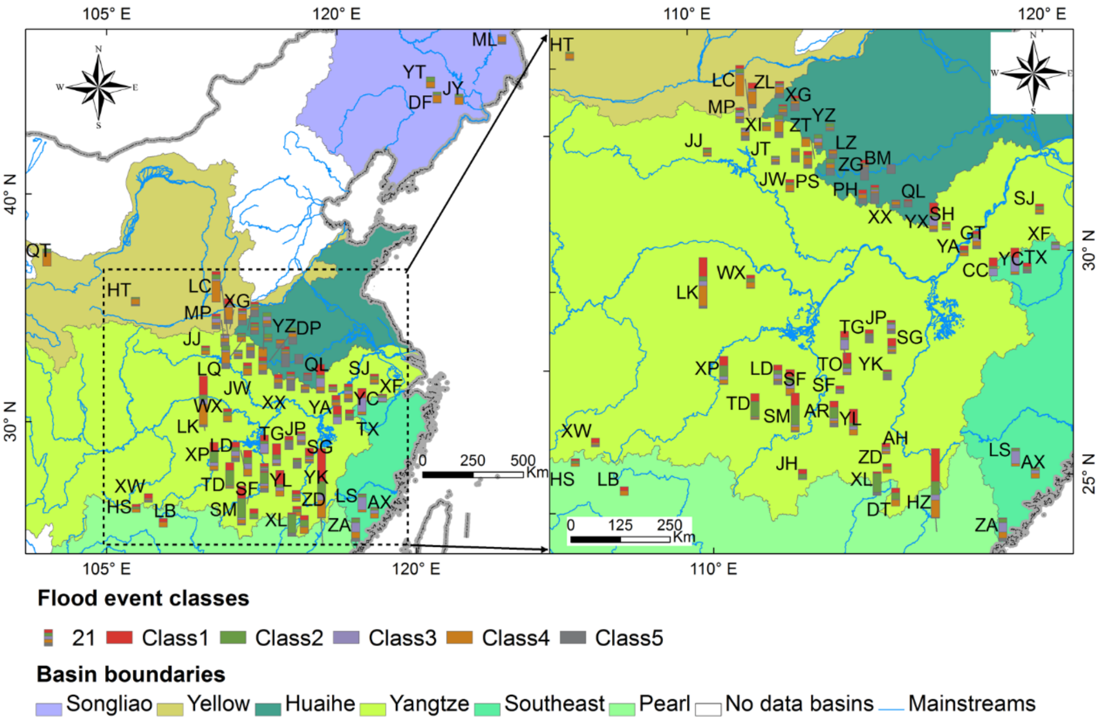

Figure 5. Spatial variabilities of individual flood event classes in major river basins

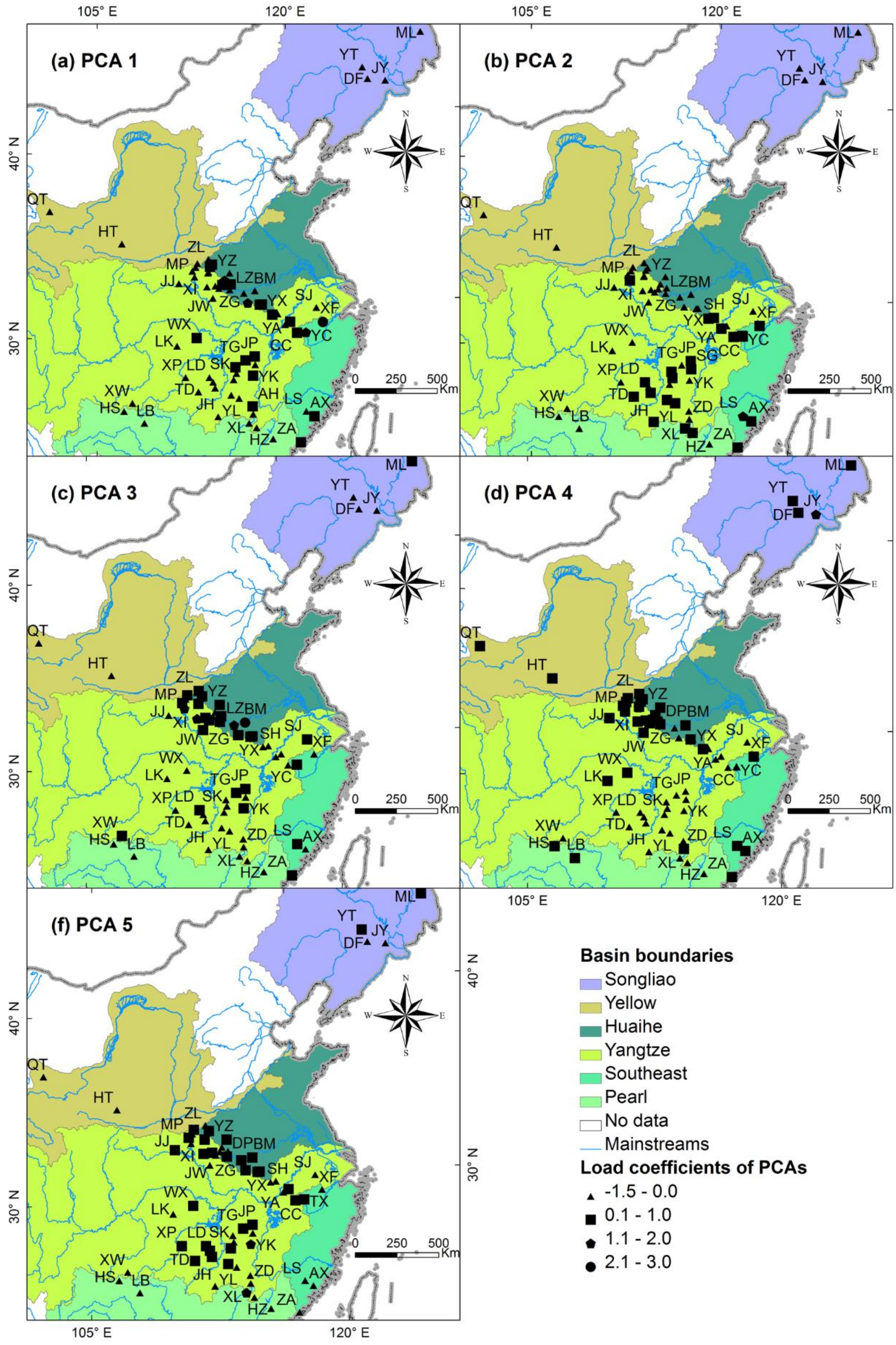

Figure S1. Spatial distributions of load coefficients of all the principal components.

Line 288. How can you talk about class per basin if some of them have a few gauges?

Response: It was revised to "*In the headstream of Songliao River Basin,.....*"

Line 292. Why does the class 5 increase over time?

Response: The increase in Class 5 was probably due to the increase in precipitation amount and duration caused by climate change. This sentence was revised as follows: "*In the headstream stations of Huaihe River Basin, the Class 5 gradually prevail with the annual mean percentage of 41.5±23.7% (n=102), particularly after 2007, whose percentage reaches 63.2±15.8% (n=79). The event numbers of both Classes 1 and 2 gradually decrease, accounting for 33.1±24.4% (n=11) and 8.7±7.1% (n=5) of annual flood events in the period of 1993-1999 and 2011-2015 for the Class 1, respectively, and 20.3±20.9% (n=9) and 2.7±1.3% (n=1) in the period of 1993-1999 and 2011-2015 for the Class 2, respectively. The explanations are that the total precipitation amount and duration probably increase due to the climate change (Dong et al, 2011; Jin et al., 2024).*".

References:

Dong, Q., Chen, X., and Chen, T.: 2011. Characteristics and changes of extreme precipitation in the Yellow-Huaihe and Yangtze-Huaihe Rivers Basins, China, J. Climate, 24(14), 3781-3795, https://doi.org/10.1175/2010JCLI3653.1, 2011.

Jin, H., Chen, X., and Adamowski, J. H. S.: Determination of duration, threshold and spatiotemporal distribution of extreme continuous precipitation in nine major river basins in China, Atmos Res, 300, 107217, https://doi.org/10.1016/j.atmosres.2023.107217, 2024.

Section 4.4.1. you mainly describe the same information presented in the figure 7. You should add an analysis or discussion about the implication of your findings.

Response: This section was revised as follows: *"According to the Monte Carlo permutation test between flood response matrix and control factor matrix (i.e., meteorological and land cover categories) in the individual catchments (Figures 7 and S2–5 in the Supplement), the factors only in the meteorological category are statistically significant for the temporal variabilities of flood events in all* *the classes, particularly the precipitation factors (e.g., amount, intensity) and aridity index during the events. Taking the Class 1 as an example, the total and mean precipitations, and aridity index during the event (r_{pcp_dur}=0.65–0.99, n=14; r_{pcp_av}=0.70–0.97, n=7; r_{SPEI_dur}=0.52–0.97, n=7) are the major control factors in 44.7% (17/38) of total catchments of the Yangtze River Basin, and Tunxi catchment of the Southeast River Basin and Hezikou catchment of the Pearl River Basin. The contributions of control factors are statistically significant only in the Liangshuikou and Hezikou catchments. In the Liangshuikou catchment, 96.3% of temporal differences are explained, in which the meteorological and land cover categories explain 92.5% and 3.8%, respectively. In the Hezikou catchment, 66.7% of temporal differences are explained, in which the meteorological category and the combined impact explain 49.4% and 17.3%, respectively.*

In the Class 2, the significant control factors are in the catchments of Yangtze (18.4%, 7/38), Yellow (25%, 1/4) and Pearl (50%, 2/4) River Basins, particularly the total and mean precipitations, and aridity index during the event with the correlation coefficients of 0.61–0.99, 0.58–0.99 and 0.50–0.98, respectively. The contributions only in the Shimenkan, Tangdukou and Xiaogulu catchments are statistically significant with the total values of 90.7–96.8%. The contributions of meteorological category are the greatest with the values of 71.9–95.9%. In the Class 4, the significant control factors are in the catchments of Yellow (75%, 3/4), Songliao (50%, 2/4) and Pearl (50%, 2/4) River Basins, particularly the total precipitation during the event, and the aridity index in the corresponding year with the correlation coefficients of 0.53–1.00 and 0.45–0.93, respectively. The contributions only in the Liangshuikou and Hezikou catchments are statistically significant with the total values of 87.0–98.1%. The factors in the meteorological category also contribute the most considerably with the values of 76.8–82.1%. In the Classes 3 and 5, the contributions are not statistically significant in all the catchments because of the smaller numbers of flood events. However, several important control factors are also statistically significant in the catchments of Yangtze (26.3%, 10/38) and Southeast (40%, 2/5) River Basin for Class 3 (e.g., total and mean precipitations during the event with the correlation coefficients of 0.77–0.99 and 0.70–1.00, respectively), and Huaihe (61.5%, 8/13) and Yangtze (26.3%, 7/38) River Basin for Class 5 (e.g., the aridity index in the corresponding year and during the event, and the annual mean precipitation amount with the correlation coefficients of 0.62–0.86, 0.68–1.00 and 0.65–0.92, respectively).”

Furthermore, more discussions were given for the control factors and their contributions in the discussion section: *" Similar results were reported in Kuentz et al. (2017), which are that the climatic variables (e.g., precipitation, temperature and aridity index) play the most important role for 75% of total flow signatures and catchment attributes (e.g., area, elevation, slope and river density) are more important for the flood flashiness."*

"The contribution of meteorological category is the largest in the Class 2, particularly in the Tangdukou catchment of Yangtze River Basin because the flood events in this class usually show quick responses to the precipitation, while the contribution is the lowest in the Class 5 because the river density and river morphology play important roles in the flood storage capacity and routing time in the river system. "

"The contributions of catchment attribute category in the slow flood event classes (e.g., Classes 3 and 5) are usually larger than those in the fast flood event classes (e.g., Classes 1, 2 and 4) because the catchment attribute factors are significantly correlated with the flood response metrics in the Classes 3 and 5, particularly the catchment maximum elevation and river density. "

Figures 7 and 8. Do you need a big figure only to show almost non-significance in the factors?

Response: Figure 7 were divided into five subfigures for individual classes. The figure for Class 1 was provided in the manuscript and the other figures for Classes 2–5 were provided in the Supplement.

We also used a table to present the effect contributions of control factor categories on the temporal variabilities of all the flood event classes. The table was given as follows.

“Table 4. Effect contributions of control factor categories on the temporal variabilities of flood event classes

Classes	*Stations*	*Meteorology*	*Land cover*	*Combination*	*All*
Class1	*Hezikou*	*49.4%*	*0.0%*	*17.3%*	*66.7%*
	Liangshuikou	*92.4%*	*3.8%*	*0.1%*	*96.3%*
Class2	*Shimenkan*	*87.1%*	*0.0%*	*3.6%*	*90.7%*
	Tangdukou	*95.9%*	*0.0%*	*0.0%*	*95.9%*
	Xiaogulu	*71.9%*	*0.0%*	*24.9%*	*96.8%*
Class3	-	-	-	-	-
Class4	*Hezikou*	*82.1%*	*0.0%*	*16.0%*	*98.1%*
	Liangshuikou	*76.8%*	*0.0%*	*10.2%*	*87.0%*
Class5	-	-	-	-	-

”

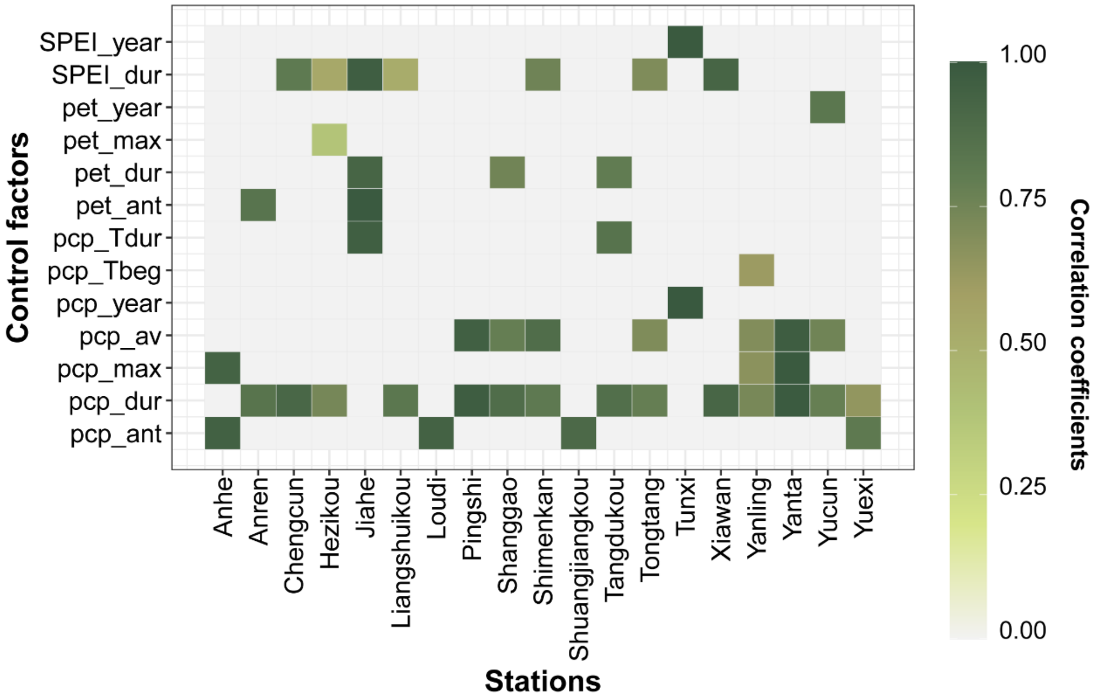

Figure 7. Significant control factors and their correlation coefficients for the temporal variabilities of flood event Class 1 in the individual catchments. The gray color means the control factor without statistical significance. *Note: Anhe, Anren, Chengcun, Jiahe, Liangshuikou, Loudi, Pingshi, Shanggao, Shimenkan, Shuangjiangkou, Tangdukou, Tongtang, Xiawan, Yanling, Yanta, Yucun and Yuexi catchments are from the Yangtze River Basin; Tunxi catchment is from Southeast River Basin; Hezikou catchment is from Pearl River Basin.*

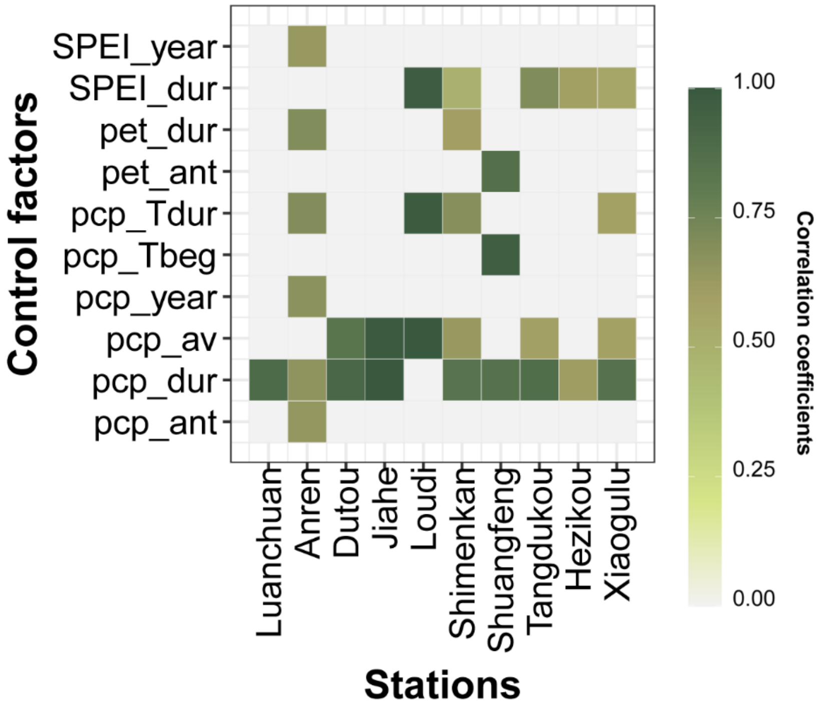

Figure S2. Significant control factors and their correlation coefficients for the temporal variabilities of flood event Class 2 in the individual catchments. The gray color means the control factor without statistical significance.

Note: Anren, Dutou, Jiahe, Loudi, Shimenkan, Shuangfeng and Tangdukou catchments are in the Yangtze River Basin; Luanchuan catchment is in the Yellow River Basin; Hezikou and Xiaogulu catchments are in the Pearl River Basin

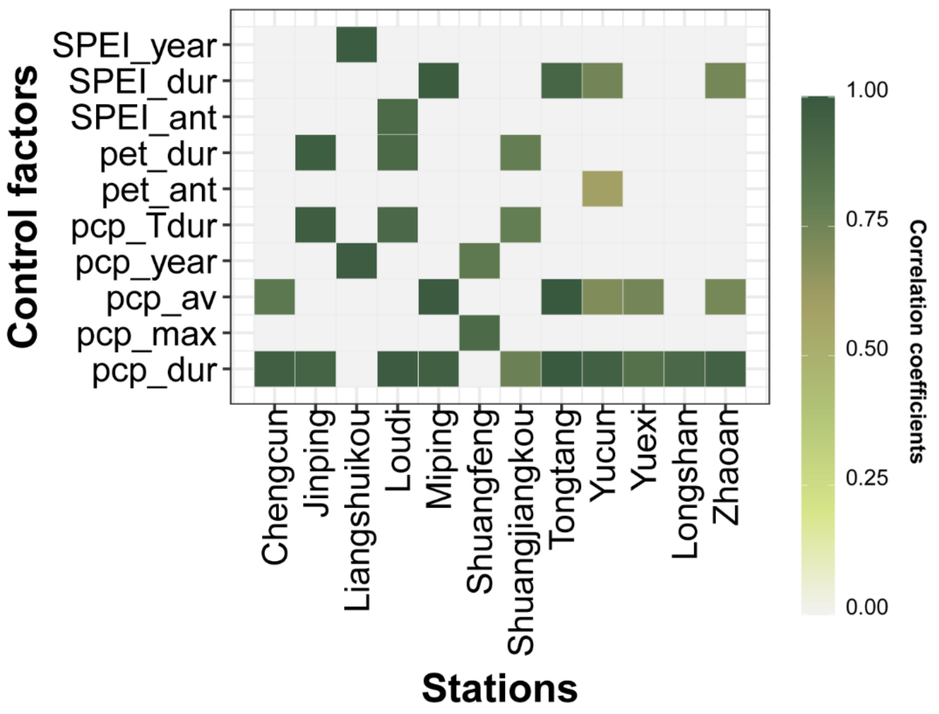

Figure S3. Significant control factors and their correlation coefficients for the temporal variabilities of flood event Class 3 in the individual catchments. The gray color means the control factor without statistical significance.

Note: Chengcun, Jinping, Liangshuikou, Loudi, Miping, Shuangfeng, Shuangjiangkou, Tongtang, Yucun and Yuexi catchments are in the Yangtze River Basin; Longshan and Zhaoan catchments are in the Pearl River Basin

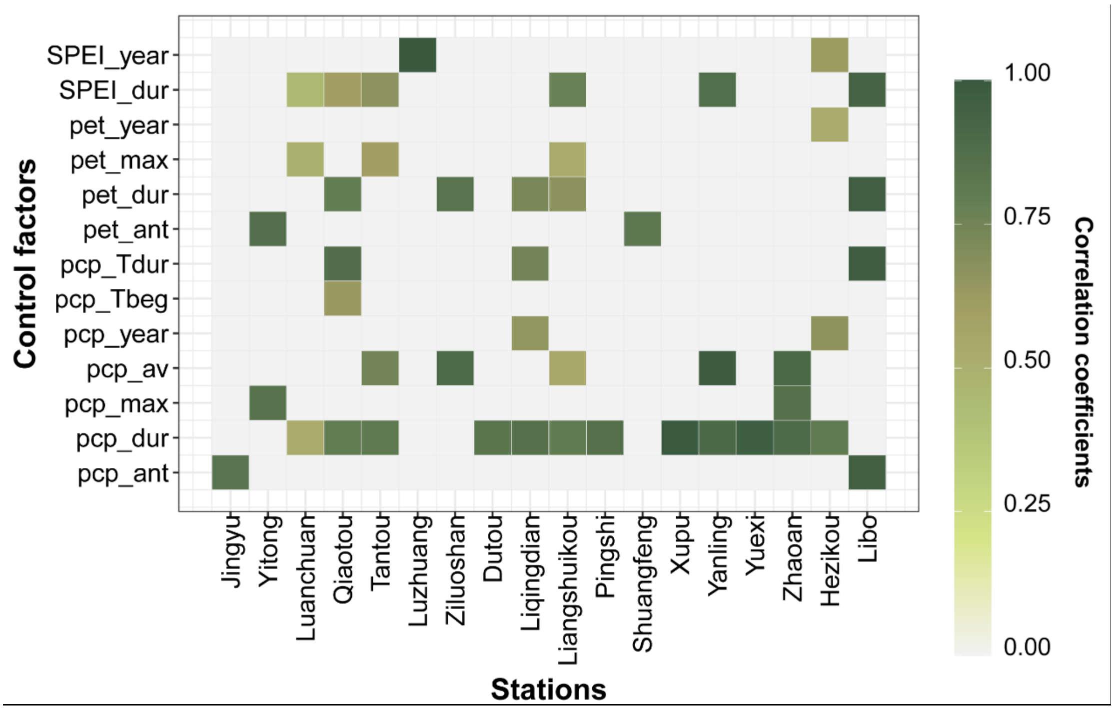

Figure S4. Significant control factors and their correlation coefficients for the temporal variabilities of flood event Class 4 in the individual catchments. The gray color means the control factor without statistical significance.

Note: Jingyu and Yitong catchments are in the Songliao River Basin; Luanchuan, Qiaotou and Tantou catchments are in the Yellow River Basin; Luzhuang and Ziluoshan catchments are in the Huaihe River Basin; Dutou, Liqingdian, Liangshuikou, Pingshi, Shuangfeng, Xupu, Yanling and Yuexi catchment are in the Yangtze River Basin; Zhaoan catchment is in the Southeast River Basin; Hezikou and Libo catchments are in the Pearl River Basin

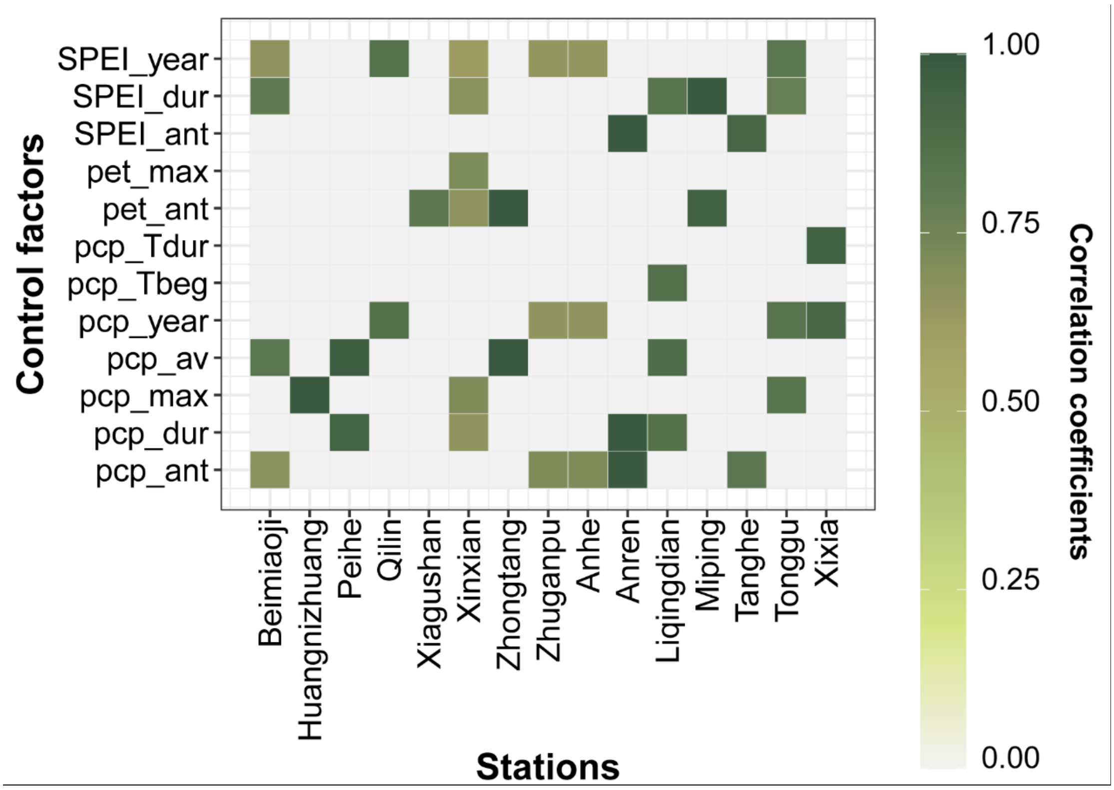

Figure S5. Significant control factors and their correlation coefficients for the temporal variabilities of flood event Class 5 in the individual catchments. The gray color means the control factor without statistical significance. *Note: Beimiaoji, Huangnizhuang, Peihe, Qilin, Xiagushan, Xinxian, Zhongtang and Zhuganpu catchments are in the Huaihe River Basin; Anhe, Anren, Liqingdian, Miping, Tanghe, Tonggu and Xixia catchments are in the Yangtze River Basin.*

Figure 9. A rainbow color scale is not recommended because it is very difficult to recognize visually what value is higher than others.

Response: This figure was redrawn following your comments.

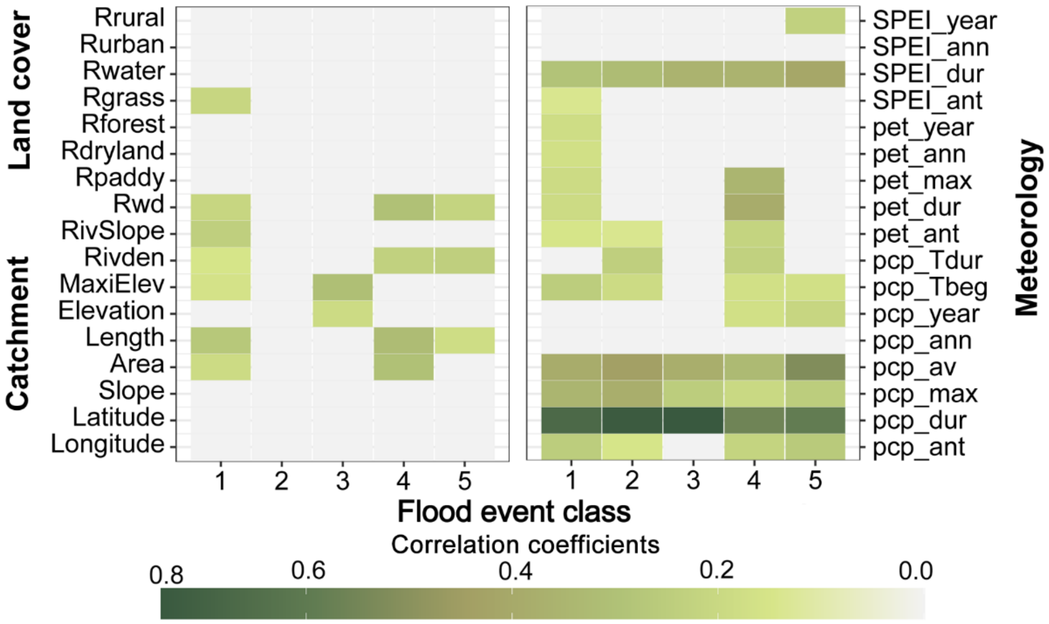

Figure 8. Significant control factors and their correlation coefficients for the variabilities of individual flood event classes (i.e., Classes 1–5). The gray color means the control factor without statistical significance.

Line 354-361. What about the high collinearity between meteorological factors? If you have many factors representing the same, the relative importance decreases. I would try to group them for more general characteristics because you have many factors in the range r=0.15-0.21.

Response: We selected the potential control factors of meteorology and physio-geography as many as possible to comprehensively detect the control mechanisms according to the existing studies (Ali *et al*., 2012; Brunner *et al*., 2018; Merz and Blöschl, 2003; Zhang *et al*., 2022). Our adopted constrained rank analysis is the extended method of principal component analysis combined with regression analysis. It has strong advantages to solve multiple linear regressions and interactions between dependent and independent variable matrixes which are transformed into a few independent composite factors (ter Braak, 1986; Legendre and Anderson, 1999), and is beneficial to quantify the effects of explanatory metrics on a response metrics and to find the most important factors. It has been commonly used in testing the multispecies response to environmental variables in the biological or ecological sciences (Legendre and Anderson, 1999), effects of physio-geographical factors and human activities on diffuse nutrient losses or water quality (Zhang et al., 2016; Shi et al., 2017), and so on. Therefore, although some factors have high collinearities, all the factors are transformed into a few independent composite factors firstly, and then multiple linear regressions and interactions between dependent and independent composite factors are detected.

The constrained rank analysis method is explained in more detail as follows: *"The widely adopted methods of constrained rank analysis are the Redundancy Analysis (RDA) and the Canonical Correlation Analysis (CCA). The RAD is a linear model and the CCA is a unimodal model, both of which are the extended methods of principal component analysis combined with regression analysis. These methods have strong advantages to solve multiple linear regressions and interactions between dependent and independent variable matrixes which are transformed into a few independent composite factors (ter Braak, 1986; Legendre and Anderson, 1999), and are beneficial to quantify the effects of explanatory metrics on a response metrics and to find the most important factors, which have been commonly used in testing the multispecies response to environmental variables in the biological or ecological sciences (Legendre and Anderson, 1999), effects of physio-geographical factors and human activities on diffuse nutrient losses or water quality (Zhang et al., 2016; Shi et al., 2017), and so on."*

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Zhang, S.L., Zhou, L.M., Zhang, L., Yang, Y.T., Wei, Z.W., Zhou, S., Yang, D.W., Yang, X. F., Wu, X.C., Zhang, Y.Q., and Dai, Y.J.: Reconciling disagreement on global river flood changes in a warming climate, Nat. Clim. Change, 12, 1160–1167, https://doi.org/10.1038/s41558-022-01539-7, 2022.

Zhang, Y., Zhou, Y., Shao, Q., Liu, H., Lei, Q., Zhai, X., and Wang, X.: Diffuse nutrient losses and the impact factors determining their regional differences in four catchments from North to South China, J. Hydrol., 543, 577-594, https://doi.org/10.1016/j.jhydrol.2016.10.031,2016.

Line 362-392. You are just summarizing the results. Where is the analysis and discussion?

Response: These paragraphs were revised following your constructive comments. The results were comprehensively summarized, and the analysis were presented. The revisions were given as follows:*” The significant control factors are mainly the meteorological factors in the antecedent seven days and during the flood events for the Class 2, the meteorological factors during the flood events and catchment elevation for the Class 3, the meteorological factors in the antecedent seven days, during the flood events and at the annual scale, and the catchment factors related to slope and river for the Classes 4 and 5, respectively. The specific factors are the precipitation and potential evapotranspiration in the antecedent seven days ($r_{pcp\_ant}=0.15$ and $r_{pet\_ant}=0.14$), precipitation and aridity index during the flood events ($r_{pcp\_dur}=0.73$, $r_{pcp\_av}=0.44$, $r_{pcp\_max}=0.38$, $r_{pcp\_Tbeg}=0.19$, $r_{pcp\_Tdur}=0.24$ and $r_{SPEI\_dur}=0.32$) for the Class 2, the precipitation and aridity index during the flood events ($r_{pcp\_dur}=0.74$, $r_{pcp\_av}=0.38$, $r_{pcp\_max}=0.25$, and $r_{SPEI\_dur}=0.36$) in the meteorological category, and the catchment center elevation ($r_{Elevation}=0.19$) and maximum elevation ($r_{MaxiElev}=0.31$) in the catchment attribute category for the Class 3, the precipitation and potential evapotranspiration in the antecedent* *seven days ($r_{pcp\_ant}=0.22$ and $r_{pet\_ant}=0.22$), precipitation, potential evapotranspiration and aridity index during the events ($r_{pcp\_dur}=0.56$, $r_{pcp\_av}=0.33$, $r_{pcp\_max}=0.20$, $r_{pcp\_Tbeg}=0.17$, $r_{pcp\_Tdur}=0.23$, $r_{pet\_dur}=0.39$, $r_{pet\_max}=0.35$, and $r_{SPEI\_dur}=0.36$) and at the annual scale ($r_{pcp\_year}=0.17$) for the meteorological attribute category, and the catchment area ($r_{Area}=0.30$), mean length ($r_{Length}=0.32$), river density ($r_{Rivden}=0.23$) and ratio of river width to depth ($r_{Rwd}=0.30$) in the catchment attribute category for the Class 4, and the precipitation in the antecedent seven days ($r_{pcp\_ant}=0.26$), precipitation, potential evapotranspiration and aridity index during the events ($r_{pcp\_dur}=0.59$, $r_{pcp\_av}=0.52$, $r_{pcp\_max}=0.25$, $r_{pcp\_Tbeg}=0.17$ and $r_{SPEI\_dur}=0.41$) and at the annual scale ($r_{pcp\_year}=0.21$ and $r_{SPEI\_year}=0.23$) for the meteorological attribute category, and the catchment mean length ($r_{Length}=0.18$), river density ($r_{Rivden}=0.24$) and ratio of river width to depth ($r_{Rwd}=0.22$) in the catchment attribute category for the Class 5, respectively.*

For the contributions of individual control factor category, 73.3%, 85.4%, 65.9% and 65.7% of total spatial and temporal variabilities of flood events are explained by all the control factor categories in the Classes 2–5, respectively (Figure 9b–e). The meteorological category explains most of the variabilities, i.e., 46.6%, 50.5%, 39.2% and 36.5% in the Classes 2–5, respectively. The combined impact takes second place, which explains 22.8%, 33.0%, 20.6% and 23.7% of total variabilities in the Classes 2–5, respectively, followed by the catchment attribute category (i.e., 0.0%, 5.8%, 6.1% and 5.5% in the Classes 2–5, respectively). The impacts of land cover category in the Classes 2–5 are not significant.

Therefore, the total variabilities of flood events in the Class 1 are mainly controlled by the total precipitation amount and its intensity during the events which determine the magnitudes of total flood yield and flood peak, the catchment slope length and river slope which affect the flood routing processes, e.g., total duration of flood event and occurrence time of flood peak. The total variabilities in the Class 2 are also mainly controlled by the total precipitation amount and its intensity during the events. The total variabilities in the Class 3 are mainly controlled by the total precipitation amount, its intensity and the aridity index during the events which determine the total magnitudes and occurrence time of flood yield, and the catchment elevation which determine the flood routing time. The total variabilities in the Class 4 are mainly controlled by the total precipitation amount, potential evapotranspiration and the aridity index during the events which determine the total magnitude and occurrence time of flood yield, and evapotranspiration, as well as the catchment area, slope and river morphology which determine the *flood routing time and river storage capacity. The total variabilities in the Class 5 are mainly controlled by the total precipitation amount and the aridity index during the events which determine the total magnitudes and occurrence time of flood yield, as well as the river density which determine the flood routing time in the river system."*

Figure 11. You should present only the figures that support your statements (4 maximum). Other figures could be in the appendix.

Response: It was revised accordingly.

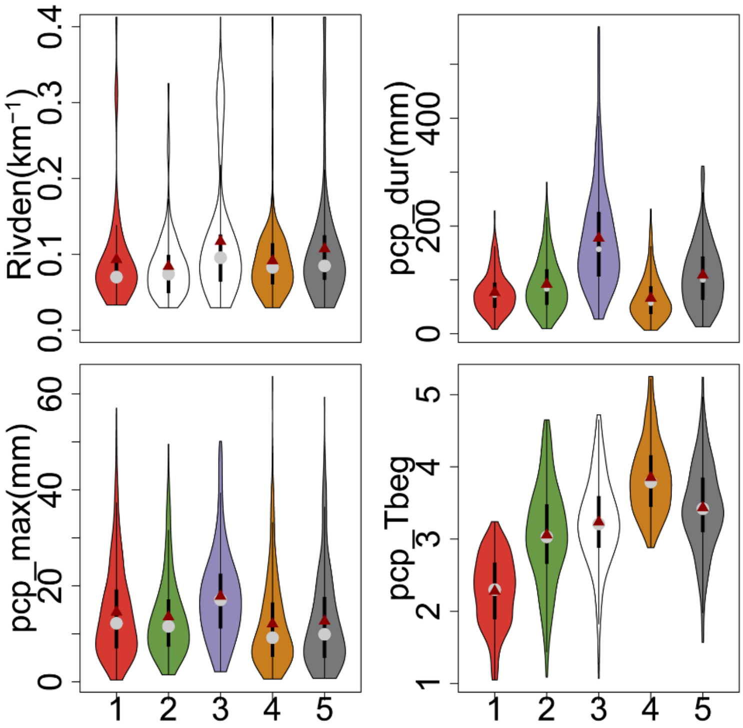

Figure 10. Variations of four critical control factors among Classes 1–5. The solid darkred dot and gray dot define the mean and 50th percentile values, respectively. Each black box means the 25th and 75th percentile values, and the vertical line defines the minimum and maximum values without outliers. The violin shape means the frequency distribution of control factor, and the unfilled shape means the control factor without statistical significance.

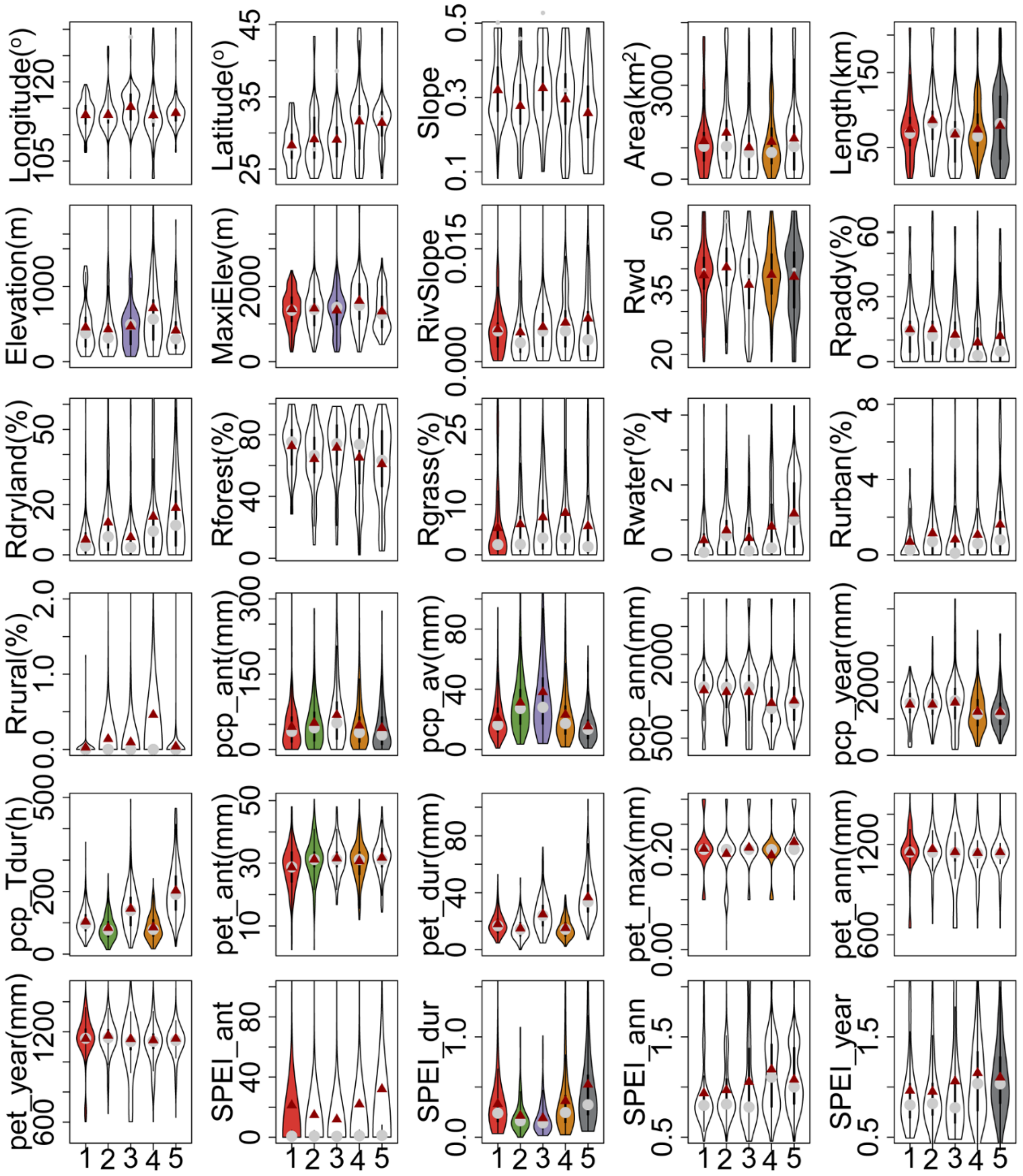

Figure S6. Variations of the other 30 critical control factors among Classes 1–5. The solid darkred dot and gray dot define the mean and 50th percentile values, respectively. Each black box means the 25th and 75th percentile values, and the vertical line defines the minimum and maximum values without outliers. The violin shape means the frequency distribution of control factor, and the unfilled shape means the control factor without statistical significance.