Final response of "Comparison of methods for separating flood frequency of reservoir by sub-seasons"

General comments:

In this paper, three methods are used to determine the frequency of flows in the flood prone period (i) during six month of a year, (ii) divided into ten day sub-periods, (iii) above a chosen set of thresholds into a reservoir. The three methods consist of: (i) a curve fitting method using the von Mises (circular normal) distribution, (ii) a conventional ranking method and (iii) a more complicated fractal method to find the self-similarity of the three largest floods in each sub-period.

Authors' response:

Thank you for these comments, which represent a good summary of the methodology presented in the paper. However, A POT (Peaks-Over-Threshold sampling) method was used to select samples for the mixed Von Mises distribution method, which achieves the independence of flood sample and makes up for short flood records. Therefore, results based on POT method can reflect the rules of flood occurrence.

General comments:

No time series analysis is performed and there is limited discussion of reservoir levels in conjunction with inflows.

Authors' response:

1) In this paper, we try to find out the pattern or the rule of the flood timing of the research reservoir, so we have recorded the first three largest daily inflows of each year in the 43-year research period and thus there are 43 groups of the three largest daily inflows.

2) Discussion of reservoir levels in conjunction with inflows is presented in section 3.2(Analysis on flood control levels of different sub-seasons for Hongfeng reservoir) and accordingly conducts flood regulation calculation (Table 4) under three different regulation strategies (open-discharge strategy, strategy for operating in 1987 and strategy for check in 1990). Based on the flood regulation calculation in sub-seasons, we obtain the different ranges of flood control level in each sub-season as upper limit, with the fixed flood control level of the original plan as the lower limit. Both upper limit and lower limit are presented by reservoir level. Actually, flood control function of reservoir is to regulate the process of reservoir outflow, with maximum discharge and highest water level to meet requirements for flood control during a flood flow.

General comments:

In my opinion, this paper is not about hydrology, but mathematicity. However, in mitigation, a re-read of the paper finds on page 10432, lines 22-26, that the methods of flood regulation are limited in China: "Regulation for calculating design flood of water resources and hydropower projects of China requires that flood season separation should consider the design requirements of projects, and have appropriate flood timing according to seasonal varying flood patterns. This means design floods of different sub-seasons should be calculated based on flood characteristics for project design for practical construction and operation."

Authors' response:

1) This paper focuses on the most basic hydrology principle analysis----flood regulation although it presents three different resolutions by different methods.

2) In this paper we selected a reservoir in China to do case research, so the latter calculation should be consistent with the specific Chinese regulations about reservoir and hydro-projects. But the methods proposed in this paper can also be applied to reservoirs or projects in other countries considering that most of the world's reservoirs adopt fixed flood control level in flood season and they can also raise it a bit to create more benefits, and when they conduct such calculations, certainly they should follow their own regulations.

General comments:

In my opinion this paper lacks originality, does not address the scheduling problem, is rather parochial in its referencing, is not of sufficient interest nor of high enough standard.

Authors' response:

1) For Originality: Reservoirs have a significant role in resolving the tension between the water supply and demand, especially in China where vast water demands have intensified the problem of water scarcity. Regulation for calculating design flood of water resources and hydropower projects of China requires that flood season separation should consider the design requirements of projects, and have appropriate flood timing according to seasonal varying flood patterns.

2) For the scheduling problem: Main roles of reservoir are flood control and useful dispatching which are contradictory functions. In China, the flood control level in flood season is fixed and is determined by the historic annual maximum design flood data of reservoir. But it's impossible that the actual floods in the entire flood season every year are of the magnitude of the maximum design flood. As a result, sometimes in the flood season the reservoir is forced to abandon water, which is unreasonable and uneconomic. Therefore, this paper adopts sub-season design flood instead of regular annual maximum design flood and it is an important way to improve the efficiency of reservoir operation.

3) As for references: Some new references are added. The first reference is added to the second paragraph of section 1. The sentence "**Liu et al. (2005)** introduced the theory of changing point analysis and detailed the theory and analytical method of mean changing point and probabilistic changing point in flood sub-seasons for the Three Gorges Reservoir" has been modified as "**Liu et al. (2005, 2015)** introduced the theory of changing point analysis and detailed the theory and analytical method of mean changing point and probabilistic changing point in flood sub-seasons for the Three Gorges Reservoir". The last four papers are cited in newly-added paragraphs.

Authors' changes in manuscript:

References added in the revised version:

1) Pan Liu, Liping Li, Shenglian Guo, Lihua Xiong, Wang Zhang, Jingwen Zhang, Chong-Yu Xu. Optimal design of seasonal flood limited water levels and its application for the Three Gorges Reservoir, Journal of Hydrology, 527 (2015) 1045–1053

2) Yanlai Zhou, Shenglian Guo, Pan Liu, Chongyu Xu. Joint operation and dynamic control of flood limiting water levels for mixed cascade reservoir systems, Journal of Hydrology 519 (2014) 248–257

3) Ruan Yun, Vijay P. Singh. Multiple duration limited water level and dynamic limited water level for flood control with implications on water supply, Journal of Hydrology (2008) 354, 160– 170

4) Xiang Li, Shenglian Guo, Pan Liu, Guiya Chen. Dynamic control of flood limited water level for

reservoir operation by considering inflow uncertainty, Journal of Hydrology 391 (2010) 124–132
5) Zhiqiang Jiang, Ping Sun, Changming Ji, Jianzhong Zhou. Credibility theory based dynamic control bound optimization for reservoir flood limited water level, Journal of Hydrology 529 (2015) 928–939

General comments:

On Clarity: Methods were presented in an exceedingly confusing and unclear and imprecise manner. Results were then obscurely derived. Therefore it shows insufficient interest to HESS readers and fails to make a convincing case.

Author's response:

The aim of the separation of flood season of reservoir is to make better flood regulation schemes, which can make better use of the surplus water in flood season and increase benefits, such as by generating more electricity, without extra construction cost. Therefore, the statistical development of flood frequencies for sub-seasons within the annual flood season has potential to improve multipurpose reservoir system operation.

1) The first conventional statistical method used in this article is a basic one to separate annual flood season, which calculate the accumulative frequencies in flood-prone period and then obtain the separation result.
2) The Fractal method, which is more complicated, focus on the fractal dimension of each sub-season. With an assumed time length of a sub-season, its fractal dimension can be obtained. When prolonging the time length of the sub-season, a different fractal dimension can be obtained and by comparing these two fractal dimensions it can be determined whether the flood pattern in this long period of time has a feature of self-similarity. If the two fractal dimensions are nearly the same, then the time length of the sub-season is the prolonged one. Keep going in this way, then the whole flood season can be separated into several sub-seasons based on different fractal dimensions.
3) The Von Mises method uses the Von Mises distribution to simulate the pattern of flood timing, based on which accumulative flood frequencies can be obtained and then flood season can be separated into sub-seasons.
4) Applying the three methods to the separation of the flood season of Hongfeng Reservoir in the case study(Table .1, 2, 3), this paper then accordingly conducts flood regulation calculation (Table 4) under three different regulation strategies (open-discharge strategy, strategy for operating in 1987 and strategy for check in 1990). Based on the flood regulation calculation in sub-seasons, we obtain the different ranges of flood control level in each sub-season with the fixed flood control level of the original plan as the lower limit. As you can see in figure 5, there is a raise of the flood control level in each sub-season and with different methods for separation comes different flood regulation calculations and thus flood control level is raised to different extents. Under the requirement of flood control safety, adopting the new operation plans can help increase the total benefits of reservoir, especially in electricity generation and water supply, etc.
5) The core ideas of the three methods are stated above and clear, and details on how to realize what the methods try to achieve are given in the paper. Following the core ideas and the specific steps presented in the paper, researchers in this field can also conduct similar studies.
6) As for readers' interest, since published in discussion on Oct 14th, quite a few readers（total article views: 209, including HTML, PDF, and XML) have come to view this paper, showing their concerns and interests in this paper.

(http://www.hydrol-earth-syst-sci-discuss.net/12/10431/2015/hessd-12-10431-2015-metrics.html）

（update at Jan. 28, 2016）

HTML	XML	PDF	Total	BibTeX	EndNote
77	121	40	238	33	21

Authors' changes in manuscript:

To further summarize the three methods proposed in this paper and make them more understandable to readers, the first paragraph of the section "Conclusions" is replaced by the following paragraphs and some new references are added which have been listed before.

"The aim of the separation of flood season of reservoir is to make better flood regulation schemes, which can make better use of the surplus water in flood season and increase benefits, such as by generating more electricity, without extra construction cost. Therefore, the statistical development of flood frequencies for sub-seasons within the annual flood season has potential to improve multipurpose reservoir system operation. This paper is mainly concerned about the separation of flood season, yet it also has a lot to do with the dynamic control of flood control level in flood season. Dynamic control of flood control level in flood season is an emerging field in which relevant researches are scarce, due to the deep-rooted conventional mindset that flood control level should be fixed in the whole flood season. But there still are some researchers who have done much work. Zhou et al. (2014) extended the dynamic control models of flood control level from a single reservoir and cascade reservoirs to a mixed reservoir system; Yun and Vijay (2008) proposed a dynamic flood control level based on conditional probabilities of large storms; Li et al. (2010) proposed a dynamic control operation model that considers inflow uncertainty; Jiang et al. (2015) introduced a credibility-based fuzzy chance constrained model used to optimize the dynamic control bound and used fuzzy simulation technology to solve the model.

The first conventional statistical method used in this paper is a basic one to separate annual flood season, which calculate the accumulative frequencies in flood-prone period and then obtain the separation result. The Fractal method focuses on the fractal dimension of each sub-season. With an assumed time length of a sub-season, its fractal dimension can be obtained. When prolonging the time length of the sub-season, a different fractal dimension can be obtained and by comparing these two fractal dimensions it can be determined whether the time length of the sub-season is the prolonged one based on self-similarity. Then the whole flood season can be separated into several sub-seasons based on different fractal dimensions. The Von Mises method uses the Von Mises distribution to simulate the pattern of flood timing, based on which accumulative flood frequencies can be obtained and then flood season can be separated into sub-seasons.

Applying the three methods to the separation of the flood season of Hongfeng Reservoir in the case study, this paper then accordingly conducts flood regulation calculation under three different regulation strategies. Based on the flood regulation calculation in sub-seasons, the different ranges of flood control level in each sub-season are obtained with the fixed flood control level of the original plan as the lower limit. Under the requirement of flood control safety, adopting the new operation schemes can help increase the total benefits of reservoir, especially in electricity generation and water supply, etc."

General comments:

On Novelty: Obviously, this study presents no novelty to the existing state of the field covered by HESS.

Author's response:

1) **Theoretical significance**: as mentioned before, operation in sub-seasons can increase benefits of reservoir. Yet, apparent shortcomings still exist in the methods used to separate flood season, which are

usually not able to reflect the flood changing pattern in flood season. Thus, it's necessary to do researches and make comparison between different methods in this field.

2) **Practical significance**: operation in sub-seasons is an important way to optimize flood control operation and increase the benefits for hydropower stations. Moreover, it's beneficial in the long term. Despite all these advantages, it hasn't been adopted yet by most of the reservoirs in the world. From this point of view, The methods proposed in this paper for conducting operation in sub-seasons have a broad prospect for application in reservoir operation in flood season, design flood estimation at construction stage and flood control risk estimation, etc. With the world's largest potential hydropower resources of 680 million Kw, China has 86 thousand reservoirs, most of which should adopt operation in sub-seasons according to their specific flood conditions. Inspired by this context, this paper makes a comparison among three different methods.

3) The ultimate goal for flood season separation is to raise the previous fixed flood control level considering different reservoir conditions in different sub-seasons. And flood season separation is significant in determining flood control levels in different periods of time in flood season, allowing better reservoir operation within different flood sub-seasons. Dynamic change of flood control level in flood season is an emerging field in which relevant researches are scarce, due to the deep-rooted conventional mindset that flood control level should be fixed in the whole flood season.

4) This article is mainly concerned about the separation of flood season, yet actually it also has a lot to do with the dynamic control of flood control level in flood season. There were only a few papers published in recent years about the dynamic control of flood control level, such as Joint operation and dynamic control of flood limiting water levels for mixed cascade reservoir systems (published by Yanlai Zhou et al on Journal of Hydrology in 2014) and "Optimal design of seasonal flood limited water levels and its application for the Three Gorges Reservoir" (published by Pan Liu et al on Journal of Hydrology in 2015).

So in general, this study presents a novelty.

General comments:

On Referencing: The manuscript have over-cited (grey) papers/reports which were written in Chinese or/and inaccessible to international readers. One can easily get lost in this hidden context.

Author's response:

1) As mentioned before, researches in this field are scarce while there were some relevant studies in China in recent years, so the papers cited in this article are mostly published in China by Chinese researchers.

2) We selected a reservoir in China to do case research, so the latter calculation should be consistent with the specific Chinese regulations about reservoir and hydro-projects, and existed flood regulation results in those reports. But the methods proposed in this paper can also be applied to reservoirs or projects in other countries considering that most of the world's reservoirs adopt fixed flood control level which is the upper limit for reservoir water level in flood season.

3)A particular case study is done in particular context but the methodology is universal because the ultimate goal is to separate the flood season reasonably and then raise the fixed flood control level in sub-seasons to create more benefits.

4) The attachments are the Chinese papers cited in this article and links to these references are as follows:

Cao Yongqiang. Study on floodwater utilization and management. Resources & Industry, vol.6, no.2, pp.21-23, 2004.

http://xueshu.baidu.com/s?wd=paperuri%3A%28c2d25908e41a9e21e5dc90886bfc22a2%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_

en%2FCJFDTotal-ZIYU200402006.htm&ie=utf-8

Chen Shouyu. Methodology of fuzzy sets analysis to hydrologic system from research on flood period description. Advances in Water Science, vol.6, no.2, pp. 133-138, 1995.
http://xueshu.baidu.com/s?wd=paperuri%3A%28f4a4c3852f6dd9e48160f1d53deb0a64%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-SKXJ502.007.htm&ie=utf-8

Liu Pan, Guo Shenglian, Wang Caijun. Flood season staged for three gorges reservoir based on the change-point approach. Hydrology, vol.25, no.1, pp.18-23, 2005.
http://xueshu.baidu.com/s?wd=paperuri%3A%289c07f5a71bfafb73cef12f9d3482f7fe%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2Farticle_en%2Fcjfdtotal-swzz200501005.htm&ie=utf-8

Hou Yu, Wu Boxian, Zheng Guoquan. Preliminary study on the seasonal period's classification of floods by using fractal theory. Advance in Water Science, vol.10, no.2, pp. 140-143, 1999.
http://xueshu.baidu.com/s?wd=paperuri%3A%28b71dd1d43b221deffa8ead8ae22142f1%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-SKXJ902.007.htm&ie=utf-8

Fang Bin, Guo Shenglian, Liu Pan, Xiao Yi. Advance and Assessment of Seasonal Design Flood Methods. Journal of Hydroelectric Power, vol.33, no 7, pp. 71-75, 2007.
http://xueshu.baidu.com/s?wd=paperuri%3A%282a7028ac1ad6650ca950cda08cba7046%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-SLFD200707022.htm&ie=utf-8

Fang Bin, Guo Shenglian, Xiao Yi, Liu Pan, Wu Jian. Annual maximum flood occurrence dates and magnitudes frequency analysis based on bivariate joint distribution. Advance in Water Science, vol.19, no.2,pp. 505-511, 2008
http://xueshu.baidu.com/s?wd=paperuri%3A%28e393a921b1c5282060da6928d001a83d%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-SKXJ200804009.htm&ie=utf-8

Wei wei, Mo Chongxun, Liu Li, Jiang Qingling et al. Application of Watershed Rainfall Fractal Theory in Reservoir Flood Season Staging. Yellow River, vol.36, no.10, pp.39-41, 2014.
http://xueshu.baidu.com/s?wd=paperuri%3A%285b7c2fe9c23a196f5685f89ffd20f85d%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTotal-RMHH201410015.htm&ie=utf-8

Chen Lu, Guo Shenglian, Yan Baowei, Liu Pan. A new seasonal design flood estimation method. Engineering Journal of Wuhan University, vol.43, no 1, pp. 20-24, 2010.
http://xueshu.baidu.com/s?wd=paperuri%3A%2889c4965da7f931018b0ef5af200679af%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-WSDD201001005.htm&ie=utf-8

Liu Ying, Hu Min, Yu Guiying, Li Xiaobing. Theory of Fractal and its Applications. Jiang Xi Science, vol.24, no.2, pp. 205-209, 2006.
http://xueshu.baidu.com/s?wd=paperuri%3A%2842d79bf0dd6018f70d66607fd796945c%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-JSKX200602028.htm&ie=utf-8

Zhang Shaowen, Wang Wensheng, Ding jin, Chang Fuxuan. Application of Fractal Theory to Hydrology and Water Resources, Advance in Water Science, vol.16, no.1, pp. 141-146, 2009.
http://xueshu.baidu.com/s?wd=paperuri%3A%285f5795b01f33906252259bd8e604c23b%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-SKXJ200501025.htm&ie=utf-8

Zhang Jiansheng, Huang Qiang, Ma Yongsheng etc. Division of flood seasonal phases for reservoir and the evaluation method. Journal of Northwest A&F University (Nat. Sci. Ed.), vol.37, no.10, pp. 229-234, 2009.
http://xueshu.baidu.com/s?wd=paperuri%3A%28b997cc1e8c9ad354b61997be75315d27%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-XBNY200910040.htm&ie=utf-8

Dong Qianjin, Wang Xianjia, Wang Jianping, Fu Chun. Application of Fractal Theory in The Stage Analysis of Flood Seasons in Three Gorges Reservoir. Resources and Environment in the Yangtze Basin, vol.16, no.3, pp. 400-404, 2007.
http://xueshu.baidu.com/s?wd=paperuri%3A%2851f23f45857d01d9e5b84b21546c8473%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTotal-CJLY200703025.htm&ie=utf-8

Song Lisong. Analyses on Sudden Change in Low Tide Level Series of the Caoe River. Journal of Sediment Research, no.1, pp. 69-71, 2002.
http://xueshu.baidu.com/s?wd=paperuri%3A%28d009e4aee3dcf34ebfb2998b67baf553%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTotal-NSYJ200001010.htm&ie=utf-8

Ding jing, Liu Guodong. Estimation of Fractal Dimension for Daily Flow Hydrograph. Si Chuan Water power, vol.18, no.4, pp. 74-76, 1999.
http://xueshu.baidu.com/s?wd=paperuri%3A%28c4c3b59100a1420251f030fcaa35f3ae%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2Farticle_en%2Fcjfdtotal-scsl199904029.htm&ie=utf-8

He Linwei, Cai Guoping. A Bi-directional Optimization Method for Continuous Structures Subject to Von Mises Stress Constraints. Chinese Quarterly of Mechanics, vol.32, no.1, pp. 19-26, 2011.
http://xueshu.baidu.com/s?wd=paperuri%3A%2848e00f65d03652635b9ad5c5a168e292%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_

en%2FCJFDTotal-SHLX201101004.htm&ie=utf-8

Fang Bin, Guo Shenglian, Xiao Yi etc. Annual maximum flood occurrence dates and magnitudes frequency analysis based on bivariate joint distribution. Advances in Water Science, vol.19, no.4, pp. 506-511, 2008.
http://xueshu.baidu.com/s?wd=paperuri%3A%28e393a921b1c5282060da6928d001a83d%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-SKXJ200804009.htm&ie=utf-8

Shi Yuezhen, Li Miao, Zheng Yangqi. Flood season staged in Xiangjiang river basin based on fractal theory [J]. Bulletin of Soil and Water Conservation, vol.30, no.5, pp. 165-167, 2010.
http://xueshu.baidu.com/s?wd=paperuri%3A%286be378b403dc77ec736a3766cb9610ee%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTOTAL-STTB201005038.htm&ie=utf-8

Li Jiqing, Ji Changming, Lu Qiyou etc. Flood control limited level of Hongfeng reservoir during the former flood season [J]. Journal of North China Electric Power University, vol.34, no.4, pp. 27-31, 2007.
http://xueshu.baidu.com/s?wd=paperuri%3A%28db28dedc01270fa01af692bdfaf3d169%29&filter=sc_long_sign&tn=SE_xueshusource_2kduw22v&sc_vurl=http%3A%2F%2Fen.cnki.com.cn%2FArticle_en%2FCJFDTotal-HBDL200704006.htm&ie=utf-8

Specific comment:
Also, it is not clear, from the time series of the top three highest flows in Figure 2, that ranking has been maintained - in the intervals 6-2 to 6-22 and on 7-12, it appears that the m maximum flow in a 10-day period is lower than the 3rd largest flow, which is nonsense

Authors' response:

1) When using the fractal method, we try to find out the pattern or the rule of the flood timing of the research reservoir, so we have recorded the first three largest daily inflows of each year in the 43-year research period and thus there are 43 groups of the three largest daily inflows. When plotting them on graph, we got three series which you can see in figure 2.
2) Taking the largest series as an example, the horizontal axis does represent date, but points in this series don't come from the same year but from 43 years, so 43 points form a series. Noting that there are some years in which the largest daily inflows are lower than the second largest of latter years, and they occurred on very near dates, so the graph may be confusing by making you think it's unreasonable that some part of the largest series is below the second or third largest series, but the points are actually from different years. In order to find out which period is flood prone and the overall magnitude of floods in different period , we have to plot those three series in the above way.

Author's changes in manuscript:
To make the confounding Fig.2 clear for readers, the following sentences are added to the start of the second paragraph of section 3.1.2:
"The first three largest daily inflow series in a 43-year research period are adopted as research sample and thus 43 points form a series. Note that there are some years in which the largest daily inflows are lower

than the second largest of latter years, and they occurred on very near dates in different years, so some parts of the three series are tangled.”

Specific comment:

It is worrying that in Figure 4, the ’mixed von Mises’ distribution which is a composite of three distributions, misses the observations’ frequencies by 10 days [late] for the two highest probabilities of flood prone time intervals, which is not useful.

Authors’ response:

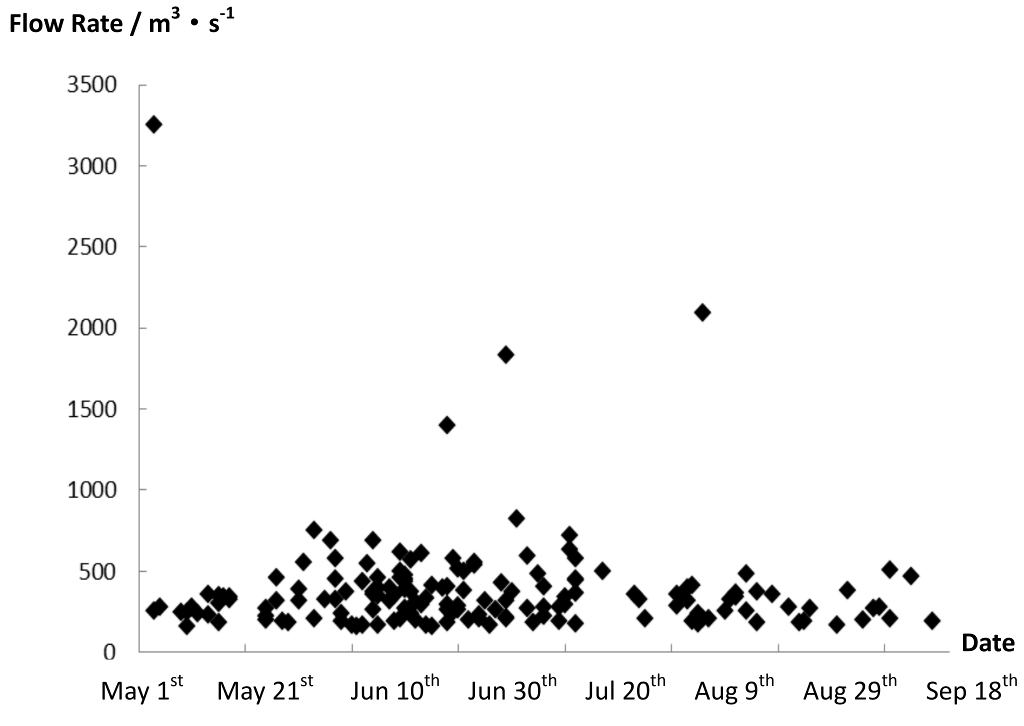
1) In figure 4, the fitting curve is not completely consistent with the actual distribution, but fitting cannot be 100% accurate. What we want to draw from the fitting graph is in which period flood is the most prone to occur and then separate the flood season accordingly, and the lag during June on the graph has little impact on the flood season separation as we combine June and July into one sub-season.

2) The scatter plot used to draw figure 4 is as follows. **We used POT method to take flood samples and plot the following graph, based on which we calculated flood frequency in every 10-day period and then obtained figure 4.**

Author’s changes in manuscript:

In order to account for the ten-day lag between the theoretical Von Mises curve and the observations’ frequencies, the following sentences are added to the end of the last paragraph of section 3.1.3.

“As is seen in Fig.4, there is a roughly ten-day lag between the theoretical Von Mises curve and the observations’ frequencies during June, but it has little impact on the flood season separation because what matters most is in which period flood is the most prone to occur, and June and July are combined into one sub-season.”



Specific comment:

The reservoir draw-dawn levels are offered in Figure 5, but the way these are obtained is obscure.

Authors' response:

1) Considering that this paper mainly highlights the methods for flood season separation, so there are not so many details in this paper about the determination of the flood control level in each sub-season, and by figure 5 we just want to show that flood control levels can be raised above the original fixed one based on the flood season separation.

2) Based on the flood regulating calculations in sub-seasons, we obtain the range of flood control level in each sub-season, with the fixed flood control level of the original plan as the lower limit.

3) As you can see in figure 5, there is a raise of the flood control level in each sub-season and with different methods for separation comes different flood regulating calculations and thus flood control level is raised to different extents.

4) To make the flood regulation calculation more clear, the three operation strategies are shown in the following table. With the inflow data and operation strategy, then the outflow results can be obtained, according to which the range of flood control level can be determined.

(WL = water level)

	1236.0m<WL≤1236.5m	1236.5m<WL≤1237.0m	1237.0m<WL≤1238.0m	1238.0m<WL
open-discharge strategy	all 4 spillway gates opened	all 4 spillway gates opened	all 4 spillway gates opened	all 4 spillway gates opened
strategy for operating in 1987	one central spillway gate opened	two central spillway gates opened	one central and two side spillway gates opened	all 4 spillway gates opened
strategy for check in 1990	no spillway gate opened	two central spillway gates opened	one central and two side spillway gates opened	all 4 spillway gates opened

Authors' changes in manuscript:

To make readers understand the goal in this study, namely the raise of flood control level and then creating more economic benefits, we replace the confounding Fig.5 with a Table 5, in which the range of flood control level in each month during the flood season is given. Also, a Table 6 is given, which concerns about the increase of electricity generation with the three methods over the original plan and the actual case. And thus the last sentence of section 3.2 is replaced with the following sentences.

"Ranges of flood control level of Hongfeng reservoir in the months during flood season with three methods are shown in Table 5. Based on the flood regulating calculations in sub-seasons, the range of flood control level in each sub-season is obtained with the fixed flood control level of the original plan as the lower limit. As is seen in Table 5, there is a raise of the flood control level in each sub-season and with different methods for separation comes different flood regulation calculations and thus flood control level is raised to different extents. With the separation results reservoir operation calculation is conducted and the results of electricity generation under dynamic control of flood control level are shown in Table 6. Comparing with the original plan with a fixed flood control level at 1236m and the actual case, the electricity generation under the separation of flood season with the three methods has all increased to various degrees.”

Specific comment:

The tables are uninformative; for example in Table 1, we have a wording problem. The "Number of times" in a chosen 10-day period should be labelled "Distribution of frequency", "Frequency" should be labelled "Cumulative Frequency (%)"; it is irritating to have to unpack these labels to understand the rather unconventional presentation while reading.

Authors’ response:

Agreed

Author’s changes in manuscript:

The wording problem of the tables has been modified. The label “number of times” and label “frequency” in table 1 have been relabeled as “Distribution of frequency” and “Cumulative Frequency (%)” respectively. The label “number” in table 2 has been relabeled as “situation”. Tables after revision are as follows and other changes are shown in **bold**.

Table 1 in the manuscript is replaced with the following table 1.

Table 1. Frequency of the Occurence of the First Three Largest Peak **Inflows**.

Month	Ten-day period	Annual largest peak **inflow**		second largest peak **inflow**		Third largest peak **inflow**	
		Distribution of frequency	Cumulative Frequency (%)	Distribution of frequency	Cumulative Frequency (%)	Distribution of frequency	Cumulative Frequency (%)
April	**1st -10th**	0		0		0	
	11th-20th	0		1	2.326	0	
	21th-30th	0		0		0	
May	**1st -10th**	0		3	9.302	1	2.326
	11th-20th	1	2.326	3	16.279	4	11.628
	21th-31st	2	6.978	1	18.605	5	23.256
June	**1st -10th**	4	16.279	3	25.581	5	34.884
	11th-20th	9	37.216	6	39.535	5	46.512
	21th-30th	10	60.465	6	53.488	6	60.465
July	**1st -10th**	4	69.767	7	69.767	2	65.116
	11th-20th	3	76.744	3	76.744	5	76.744
	21th-31st	5	88.372	1	79.070	3	83.721

Aug.	1st -10th	1	90.698	2	83.721	1	86.047
	11th-20th	1	93.023	2	88.372	1	88.372
	21th-31st	0		2	93.023	0	
Sep.	1st -10th	0		0		1	90.698
	11th-20th	0		3	100	3	97.674
	21th-31st	1	95.366	0		0	
Oct.	1st -10th	0		0		1	100
	11th-20th	1	97.674	0			
	21th-31st	1	100	0			
total		43	100	43	100	43	100

Table 2 in the manuscript is replaced with the following table 2.

Table 2. Box-counting Dimensions of Different Flood Sub-seasons.

sub-seasons	situation	time length *T*	starting date (d/m)	ending date (d/m)	Correlation coefficient *R*	Slope *b*	*Dc*
Pre-rainy season	A	20	1st May	20th May	0.97	0.29	1.71
	B	31	11th May	31st May	0.95	0.30	1.70
	C	42	21th May	1st July	0.93	0.42	1.58
Main flood season	D	40	1st June	20th July	0.92	0.44	1.56
	E	50	1st June	20th July	0.96	0.43	1.57
	F	61	1st June	31st July	0.97	0.40	1.60
	G	71	1st June	10th Aug.	0.97	0.28	1.72
Late flood season I	H	31	1st Aug.	31st Aug.	0.96	0.46	1.54
	I	41	1st Aug.	10th Sept.	0.97	0.38	1.62
	J	51	1st Aug.	20th Sept.	0.97	0.44	1.56
Late flood season II	K	20	1st Sept.	20th Sept.	0.98	0.49	1.51
	L	30	1st Sept.	30th Sept.	0.97	0.39	1.61
	M	40	1st Sept.	10th Oct.	0.97	0.38	1.62

Table 3 in the manuscript is replaced with the following table 3.

Table 3. Peak Flows of Design Floods of Different Sub-seasons.

method	Frequency/%	Annual largest flow /$m^3 \cdot s^{-1}$	Pre-rainy season/$m^3 \cdot s^{-1}$	Main flood season /$m^3 \cdot s^{-1}$	Late flood season	
					I	II
frequency method	1	1886.0	534.0	2595.5	771.0	570.17
	0.02	3586.8	663.6	3782.9	1021.4	777.49
Copula function	1	1886.0	1559.7	2089.7	1436.5	1436.5
	0.02	3586.8	3111.3	3641.7	2846.2	2846.2

Table 4 in the manuscript is replaced with the following table 4.

Table 4. Results of Flood Regulation **with the Mixed Von Mises Distribution**.

Frequency (%)	Sub-seasons	Typical flood	Initial water level /m	Straery 1		Scheme 2		Scheme 3	
				highest water level /m	maximum discharge / $m^3 \cdot s^{-1}$	highest water level /m	maximum discharge / $m^3 \cdot s^{-1}$	highest water level /m	maximum discharge / $m^3 \cdot s^{-1}$
1	**1st May – 31st May**	"96.5"	1239.4	1240.0	1396.3	1240.0	1399.6	1240.0	1383.2
	1st June -31st July	"91.7"	1238.3	1240.0	1391.2	1240.0	1391.0	1240.0	1391.0
		"96.7"	1236.8	1240.0	1396.7	1240.0	1432.7	1240.0	1432.7
	1st Aug-30th Sept	"00.8"	1239.9	1240.0	1368.7	1240.0	1370.8	1240.0	1368.5
0.02	**1st May – 31st May**	"96.5"	1240.7	1242.5	2390.9	1242.5	2394.0	1242.5	2395.1

	1st June	"91.7"	1241.1	1242.5	2392.3	1242.5	2410.6	1242.5	2410.6
	-31st July	"96.7"	1237.8	1242.5	2403.3	1242.5	2406.1	1242.5	2395.4
	1st Aug-30th Sept	"00.8"	1241.5	1242.5	2405.5	1242.5	2407.5	1242.5	2405.4

An extra table 5 is given.

Table 5. Ranges of Flood Control water Level in Flood Season with Different Methods

(unit: m)

	May	June	July	August	September
original plan	1236.0				
conventional statistical method	1236.0 - 1236.8			1236.0 - 1239.1	1236.0 - 1239.4
fractal method	1236.0 - 1238.0	1236.0 - 1236.8		1236.0 - 1239.5	1236.0 - 1239.7
Von Mises Distribution method	1236.0 - 1239.1	1236.0 - 1236.8		1236.0 - 1239.6	1236.0 - 1239.6

Evenmore, operation calculation is conducted and the results of electricity generation under dynamic control of flood control level are shown in Table 6.

An extra Table 6 is given.

Table 6. Increase of Electricity Generation with Three Separation Methods over the Original Plan and the Actual Case

	Original plan	Actual case	Conventional statistical method	Fractal method	Von Mises method
Electricity generated (10^4 Kw*h)	6273	6053	6611	6625	6628
Absolute increase over the original plan (10^4 Kw*h)	/	/	238	252	255

Increase in percentage over the original plan	/	/	3.73%	3.95%	4.00%
Absolute increase over the actual case (10^4 Kw*h)	/	/	558	572	575
Increase in percentage over the actual case	/	/	9.22%	9.45%	9.50%

Fig. 5 is changed as follows.

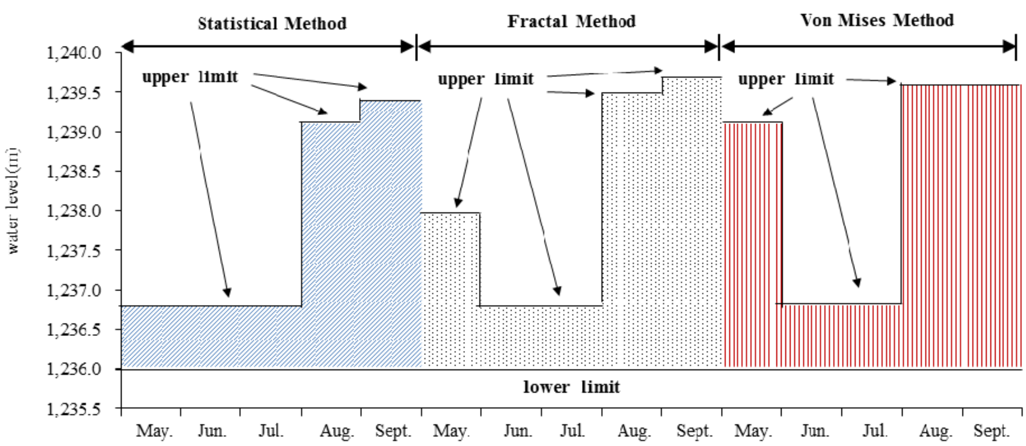


Figure 5. Results of flood control levels of Hongfeng Reservoir by sub-seasons with three methods.