Dear Editors and Reviewers,

We appreciate the time and effort spent reviewing our work (ID: **egusphere-2022-540**, title: "**Study on Mother Wavelet Optimization Framework Based on Changepoint Detection of Hydrological Time Series**") by the editors and reviewers. Those comments are very helpful for revising and improving our manuscript, and have great significance to guide our future research. Following all comments, this is a substantially revised version of this paper.

Major revisions include the following:

(1) The abstract was rewritten, and a large number of acronyms were removed, mainly describing the methods and results.

(2) Check all figures and tables, and rewrite some titles with unclear descriptions or incomplete information.

(3) After the acknowledgement, a list of acronyms was added.

(4) We have deleted and corrected some numbers in the Funding.

To facilitate you and reviewers to view the revisions, we have prepared two versions of the manuscript (the marked version and the final version). All changes are marked in red in the manuscript, and the contents and line numbers are subject to the final version. In this letter, we have responded to reviewers' comments one by one and marked them in blue.

RC1: 'Comment on egusphere-2022-540', Geoff Pegram, 16 Oct 2022

This article has promise, but it needs repair before publication. I have marked up the version I was sent and its annotated version is being returned with this response. In the Abstract, it seems that Jiqing Li tidied up the text (mentioned at line 380). Please do a couple of things for me and the reader. The abstract should be a description of the work and the findings of the article. As it stands, I think that it is asking the reader to carry too many acronyms in their heads, if you are trying to get the main points across. You introduce a lot of them. That said, please make a collection of the acronyms in a list at the end of the text and before the references, and remind the readers of these in

your conclusion. Much as you are proud of your work, it is important to be aware that most potential readers will check the abstract, 50% flick through the figures (which should have meaningful stand-alone captions), then perhaps 30% of them the conclusions, and 15% of the cognoscenti the full article.

I will copy and list the more important remarks below my signature, which is my wont.

Comments: I will repeat here the more serious suggested corrections in the annotated version of this article, which I am returning for the authors' attention. The minor corrections are accessible in the article. On the major ones, I will lead with the first line of the text that I want to comment on, and then follow it in the next line with '%' before my remark.

Authors' Response:

Thank you for your reminder, and thank you for sharing with us the importance of abstracts, figures and conclusions to the article. In order to limit the number of words in the abstracts, we have used many acronyms, which really makes it not fluent and difficult to understand. With your guidance, we have a new understanding of this work by reviewing this manuscript half a year later. Therefore, the abstract was rewritten for the purpose of describing the work and results. Before the reference, an acronym list of the whole manuscript was added (Line 370), hoping to give readers a better reading experience. In addition, we re-examined each figure and its title, so that readers who give priority to the figure can get relevant information completely and accurately. Necessary information reminders are added in the conclusion and adjusted according to the revision. Figure 1 and Table 1 are very important contents, one for introducing the study framework and the other for introducing common mother wavelet (MWT). In the previous version, we ignored the importance of information comparison, which made them difficult to correspond with the content of the article. These problems have been solved in this revision.

Each of your suggestions is very valuable to us. We hope that our additions and adjustments will make the manuscript better. At the same time, to facilitate you to view the revised content, we have prepared two versions of the manuscript, namely the

marked version and the final version. The contents and line numbers of the two versions are consistent, but all changes in the former are marked in red. In the following, we have responded to your comments one by one, and the line number used is subject to the final manuscript.

RC1: 8 It is urgent to find a better way to divide HTS. Wavelet

% Reword this sentence I don't understand it

Authors' Response:

Thank you for your correction. The purpose of this sentence is to introduce series division and express its significance for inconsistent hydrological time series (HTS). In order to logically introduce the basic method used in the study, we have changed it to "Series dividing and wavelet transform are effective methods to reuse and analyse HTS." (Line 8).

70 HTS evolution accurately and fully mining its information, which provides a more practical

% What do you mean by 'practical'? useful? better? improved? 'practical' is defined from a dictionary as "concerned with the actual doing or use of something rather than with theory and ideas". I don't think you mean that

Authors' Response:

Thank you for your explanation. "Practical" is an inaccurate term. The main purpose of our work is to solve the problem that traditional mathematical statistical models cannot use inconsistent HTS. Changepoint detection and MWT optimization are important links. Therefore, we have changed this sentence to "Using the optimal MWT in CWT is helpful in catching the HTS evolution accurately and fully mining its information, which provides a feasible way to use inconsistent measured data for hydrological and hydraulic calculations." (Line 70) according to the context, and "practical" is replaced by "a feasible way".

Figure 1: The framework and main content of this study

% This is a very complex figure which I am having difficulty unravelling. I cannot follow your text in the pink panels. Your caption is minimal and should be an informative description of what we are supposed to see. I introduced 2 extra green arrows, assuming they are also involved ....?

Authors' Response:

The core of this study is the potential changepoint set construction, changepoint detection and MWT optimization. At your suggestion, we revised the color and content of Figure 1. First, the key methods and contents were marked with a blue background. Secondly, we refined the content to avoid problems caused by too much content and too small font. Finally, the relationship between the changepoint detection criteria and the MWT optimization framework was clarified, and they were drawn with dotted lines. We hope that our revision will make the framework logic clearer.

Table 1: Properties and application range of 16 wavelet systems

% This table is fairly complex and I think you should expand the caption. After all we can count to 16!

Authors' Response:

Table 1 is used to introduce the properties and application range of 16 commonly used MWT. As you said, because we have studied wavelet transform for a long time, we mistakenly think that readers are familiar with the naming methods of wavelet system and MWT. In this revision, we have listed all the commonly used MWT symbols, which can be directly used for programming calculation as model parameters. In this way, the MWT used in the wavelet changepoint detection can be found, and the reader can grasp their properties (Line 84).

88-89 Equations

% Indent your equations - they'll all fit the inward jump - see the example I clipped from a review

Authors' Response:

Thank you for your correction. We have checked all the equations and their numbers in the manuscript to ensure that they are continuous and correctly indented.

177 – 188

% Indent subsets (1), (2) & (3). Then in (3), indent a bit more the 4 sub-subsets â□ â□¡ â□¢ & â□£ (!) and end off with some text after line 188. As it stands, it's a maze!

Authors' Response:

This paragraph is mainly used to describe the operation steps and criteria of changepoint detection. After careful consideration, we have corrected the changepoint detection framework to changepoint detection criteria. Therefore, the changepoint detection is sorted out into three steps and incorporated into the previous paragraph to highlight the four criteria (Line 169). In addition, we used symbols to replace some repetitive nouns in order to simplify the content.

Figure 4: Results of M-K test for Pingshan Station and Yichang Station

% Your Figure 4 caption is uninformative. Figure 3 is OK, because the text following that is helpful.

Authors' Response:

Figure 3 shows the potential changepoint detection results of the cumulative anomaly method, and Figure 4 shows the changepoint detection results of the M-K method. We have shrunk Figure 4 and moved it above the description text. At the same time, we have adjusted and supplemented the titles of the 6 pictures in the manuscript，so that the readers who first read the figures can fully understand the information.

Table 3

% Make the text and table caption more informative

Authors' Response:

We added a column in Table 3 and named it "MWT Systems". The MWT that can

detect the changepoint has been classified into the corresponding MWT system. In this way, the contents of Table 1, Table 3 and Table 4 really correspond, and the logic is clearer. Thank you for your suggestion.

25 It can be seen from Table 3 that among the 8 MWT systems, only Daubechies, Symlets, Coiflets, Dmeyer and Fejer-Korovkin can be used to detect the existence of changepoints in HTS.

% This information should be placed above the table, with db*, sym*, coif*, dmey, & fk* linked & explained.

Authors' Response:

Of the 16 commonly used wavelet systems, 8 are biorthogonal. They are Haar, Daubechies, Biorthogonal, Coiflets, Symlets, Meyer, ReverseBior and Fejer-Korovkin, with a total of 59 MWT (Table 1). However, after applying them to the study area one by one, only Daubechies, Symlets, Coiflets, Dmeyer, and Fejer-Korovkin can detect the changepoints (Table 3). No changepoint is unreasonable for the study area where it is known that the construction of large and medium-sized reservoirs has changed the HTS consistency. The essence of wavelet transform analyzes the similarity between HTS and MWT. This is the first step for HTS to screen MWT that meet its own characteristics. Therefore, to show this process in detail, we have added a column in Table 3 to classify MWT into MWT Systems.

263 test (Figure 3 and Figure 4).

% 4 pages back!! Here, refresh the reader:- why are change-points interesting?

Authors' Response:

By comparing the results of cumulative anomaly method, M-K test and wavelet changepoint detection, we can analyze their contribution to the construction of potential changepoint set. This sentence has been replaced by "The number of 4-Series of changepoints detected is 19, 18, 19 and 17 respectively. Compared with the cumulative anomaly method and M-K test, the wavelet changepoint detection has the highest contribution to the construction of the potential changepoint set, followed by the

cumulative anomaly method." (Line 248). In addition, we also added a paragraph to analyze the role of constructing potential changepoint set (Line 260).

310 Table 4

% Try not to split the table over 2 pages

It would be nice if you remind the reader what db and fk stand for. They are defined obliquely in Table 1, but you would help the reader as to what these mean at this stage. It's too much to carry in one's head among the large number of other acronyms. You authors have worked on these for months and they are familiar to you, not us who have a few days to grasp the story which is new and complex ....

Authors' Response:

Thank you for your suggestion. This is our negligence. Tables 1 and 3 have been adjusted to correspond to the contents of Table 4. In Table 1, we combine abbreviations and quantities, and give the symbols of commonly used wavelet functions in each wavelet system, so that the wavelet functions used in the study can be found. In Table 3, we added a column to clarify the relationship between the MWT and its system that can detect the changepoint of HTS in the study area. It is hoped that this can clearly show the process of optimizing MWT based on the accuracy of changepoint detection and MWT system.

Figure 6: Changepoint trajectory

% Make your figure captions more informative. The reader should not have to trawl through the text to find what you are presenting. Remember that, of those who open the article there are 4 sorts: 1. The casual person who checks the title and possibly the abstract; then 2. the skimmer who checks the abstract and the figures; 3. the reader who having done 1 & 2 will check the conclusion as well; finally 4. the keen hydrometeorologist who reads the lot. I guess that the percentages of the 4 groups from 1 to 4 is: 50%, 25%, 15% & 10%

Authors' Response:

Thank you for your sharing. This is a profound view on the importance of articles,

abstracts, figures and conclusions. Figure 6 is the analysis result of continuous wavelet transform on the evolution of HTS at Pingshan Station and Yichang Station. The reference lines in the figure are HTS main cycle and changepoint year respectively. It was our negligence that we did not mark the meaning of the reference line in Figure 6. In this revision, we checked the title, content and remarks of each figure, and showed the information as comprehensively as possible, so that the readers who have priority to see the picture can find the content they want.

5 Conclusion

% In the conclusion, redefine the acronyms in full for the reader. It's standard and neater.

Authors' Response:

We have listed the full names of all acronyms in the conclusion. In addition, according to your suggestion, we have sorted out all the acronyms in the manuscript and put it after the acknowledgement.

400 References

% Please indent the leading line of the articles by ten small spaces [.....] - it makes them easier for the reader to locate.

Authors' Response:

Thank you for your suggestion. We have adjusted the format of the reference using hanging indentation (two words). It is hoped that this will make it easier for readers to locate references.

RC2: 'Comment on egusphere-2022-540', Anonymous Referee #2, 28 Jan 2023

Dear Authors

The manuscript is well written, and anyone can understand the results well. The only question that arises for the readers at the beginning is, what is the difference between examining the time of changing point in your study and the Pettitt test (which has been examined in various studies)? (https://doi.org/10.2307/2346729)

And the second question is whether the studied stations are not affected by the reservoir releasing? Is the data used controlled or not?

Best regards

Authors' Response:

Thank you very much for your recognition of our work. You put forward two good questions. Let's think about the significance of this work again.

The Yangtze River is the largest river in China, with numerous tributaries and abundant hydropower resources. Therefore, many hydropower stations have been built, resulting in complex hydrological situation and poor consistency of hydrological time series (HTS). Pettitt test is one of the commonly used changepoint detection methods. In this work, the Mann-Kendall (M-K) test, which is similar to its changepoint detection principle, is selected to construct a potential changepoint set. Through example analysis, we have found that only one detection method is not enough. Such as, the cumulative anomaly method can detect more changepoints, but the recognition accuracy is low; the M-K test provides few potential changepoints, but the overall accuracy is high; the wavelet changepoint detection provides many potential changepoints and high overall accuracy, but it is easily limited by marginal utility. Although building a set of potential changepoints improves the calculation efficiency, for rivers with complex hydrological conditions, the consistency method is also needed to further judge the change degree of HTS before and after the potential changepoints. In the framework of mother wavelet (MWT) optimization, the set of potential changepoints is constructed based on the cumulative anomaly method, M-K test and wavelet changepoint detection. Of course, other methods can be used to replace it, such as the Pettitt test.

Pingshan and Yichang are both important hydrological stations in the Yangtze River, but large and medium-sized reservoirs Ertan and Three Gorges have been built in their upstream, resulting in their actual HTS is affected by the operation of the reservoir. Therefore, the evolution characteristics of the current HTS are the result of human factors and climate change, which are not consistent. The analysis of the traditional hydrological model is based on the assumption that the HTS meets the "independent and identical distribution", so there is doubt about the reliability of the

analysis results of the inconsistent HTS. In this work, we proposed to divide non-consistent HTS into consistent subsequences for model use through changepoint detection.

Thank you again for your question. In order to provide readers with a better reading experience, we have revised the abstract and conclusion, added the acronym list, and checked the title and content of each figure and table. All changes are marked in red in the manuscript.

Referee Comments: Sarah Buchmann

Notification to the authors: Checking your paper, I noticed that your Table 3 contains coloured cells. Please note that this will not be possible in the final revised version of the paper due to HTML conversion of the paper. When revising the final version, you can use footnotes or italic/bold font. For now, the process will continue, but please note that the final version cannot be published by using coloured tables.

Authors' Response:

Thank you for your reminder and suggestions. We have deleted the background color from Table 3 and used bold text and a number in the upper right corner to indicate the changepoint and the optimal mother wavelet. For the above information, we have written notes below Table 3. In addition, we have used Coblis – Color Blindness Simulator to detect the color matching of images to ensure that all readers can capture the information conveyed by the images through color differences.

We tried our best to improve the manuscript, and here we did not list the changes but marked in red in revised manuscript. We appreciate for your hard work earnestly, and hope that the correction will meet with approval. Once again, thank you very much for your comments and suggestions.

Yours sincerely,

Jiqing Li, Jing Huang, Lei Zheng, Wei Zheng