Dear reviewer,

Thanks very much for the review. The suggestions are very important for our manuscript. We have tried our best to revise the manuscript according your advices and explain the questions as much as we can. The details are listed as following which are also listed in the attached .pdf supplement file.

Best wishes,

Authors

(1) comments from Referees

The manuscript proposes new indices for the study of heat waves and extreme temperature especially for cities in China. I find the manuscript to be interesting and the methodology is novel. Unfortunately, the proposed methodology is not well descripted, and more details should be added. I find the overall information presented in this paper below the standards of the Natural Hazards and Earth System Sciences and I believe that the paper requires entire modifications and needs to go through the review process again.

Indeed, there are some aspects that are weak. The main problem is the proposed methodology for the new indices. More specific: â˘A ´c The physical explanation of the index HWI (line 151, page 7) should be added. â˘A ´c I believe that there is a mistake in the equation of the first index, HWI, (line 151, page7). Is the multiplication sign correct of the first parameter for the CD35? I can not understand why it is multiplication and not sum. The rate CD35/92 should be change to AD35/92. â˘A ´c Moreover, I believe that an example should be added. I was tried to create an example for better understanding. Lets say that in a year there are 35 days with temperature greater than 35oC, from these days, there are 15 consecutive days with temp>35oC. Moreover from the initial 35 days, 15 days have temperatures greater than 37 oC (with 10 consecutive days greater than 37 oC) and 5 days have temperatures greater than 40 oC (with 10 consecutive days greater than 40 oC). Based on these data: HWI=(35/92 x 15/3+1)x(15/92+10/3+1)x(5/92+3/3+1) = HWI=(0.38x5+1)x(0.163+3.333+1) x(0.054+1+1)=2.9 x4.496x2.054=26.78 In case there is a mistake in the equation, HWI=6.38x4.496x2.054=58.92.

Based on the classification of Table 1, it is obvious that there is a mismatch for the range of the index. Please provide the appropriate modifications and explanations.

In the case of AHWI, there is a misunderstanding. It is not clear, how it is possible to be several HWI in a year. HWI use for its calculation the days with temperature greater than 35 (37/40) in the three months (June, July, August 92 days). Based on it, it is not possible to have more than one value per year. Please give some explanations. Based on the above comment, HYI (line 173, page 8) can be not defined with the proposed way. Below the Authors can find

some minor comments and suggestions in case of resubmission. â˘A ´c Initially, I will suggest the description of the classification of the indices (table 1 and table 2) to be removed into methodology.

The analysis of figure 8 is not consistent with the figure 8. The scale of the diagram in figure 8 range from 0 to 900, the station Chongqing presents HWI equal to 800 while in the manuscript it is said ": : :sum value of HWIs in Chongqing reached 13.7: : :" (line 261, page 11). Similarly, the result about Changsha. Please made the appropriate modifications.

The section 3.1 can be changed to "variance of extreme temperature days" since in this paragraph it is analysed the trend of the extreme temperature days but the variance.

The quality of all figures is poor. The labels are too small, and it can not be read. â˘A ´c The authors should add more information about the secondary axis in figure 4 and 7.

The authors claim that the analysis is for 31 main stations in China, in figure 3, 6 and 5 are presented the results of 29 stations, while in figure 7 and 8 are presented the result of 26 stations. Similarly, in map of figure 9 is presented 29 station. Please provide the appropriate modifications.

(2) Author's response:

1. The explanation of the index HWI had been described in the manuscript (line 143-148, page 6) . HWI in this manuscript is established mainly based on statistical and empirical methods, which is created to compare the intensities and frequencies of heat wave events. The physical mechanism of heat waves is not the focal point in this manuscript.

2. The example of HWI is added in the part of Heat wave index (line 156-166, page 7). The equation of HWI has been checked for several times. The multiplication sign of the first parameter for the CD_{35} is correct. There is no mistake in the HWI equation. The differences in the three parentheses of HWI equation are to distinguish the importance of CD_{35}, AD_{37}, CD_{37}, AD_{40} and CD_{40}. For heat wave events, 3 continuous days are the shortest duration for HWs, in which daily Tmax exceeds 35℃. In other word, the continuous days in which daily Tmax exceeds 35℃ are the basic requirement of heat wave events. The HWI values are mainly determined by AD_{37}, CD_{37}, AD_{40} and CD_{40}. The CD_{35} represents the continuous days in which daily Tmax exceeds 35℃, which is the same meaning of AD_{35}. The discontinuous days in which daily Tmax exceeds 35℃ are not belonged to heat wave events, which are not included in HWI equation; but these discontinuous days are exactly considered in HYI equation. According to the example that the reviewer had proposed, the value of CD_{35} should

be 15, not 35; the values of AD_{37} and CD_{37} are 15 and 10; the values of AD_{40} and CD_{40} are 5 and 3. The calculation of HWI is, (15/92 x 15/3+1)x(15/92+10/3+1) x (5/92+3/3+1) =16.8.

3. The appropriate modifications on the classification of Table 1 has been done (line 553-554, page 21). We revise the description of each level of HWI, which becomes clear and easily understanding.

4. According to the definition of heat wave, the constant hot weather more than 3 continuous days in which daily Tmax exceeds 35℃ could be called one heat wave event. If the days (daily Tmax≥35℃) are not continuous, it could not be named one heat wave event. There may be several heat wave events occurring in one year. For example, in 2014, there were two HWs occurred in Chongqing city, separately lasting from 17 July to 31 July and from 2 August to 8 August. So the HYI index should contain all the HWs and the discontinuous days with extreme temperature (daily Tmax exceeding 35℃) in one year. We have checked AHWI and HYI equations and there are no mistakes in them. We believe that the description of the classification of the indices (table 1 and table 2) should be in the part of Heat wave index (line 245-260, page 11; line 289-292, page 12-13) , which are close to the analysis process of HW index and HYI index.

5. We have checked the analysis of figure 8; it is consistent with the figure 8. The scale of the diagram in figure 8 range from 0 to 900, which represents the sum value of HWIs of 60 years from 1955 to 2014. In order to make it clearer, the description in the manuscript has been changed (line 278-287, page 12).

6. We have checked the content of section 3.1. It contains variance of extreme temperature days and trend of the extreme temperature days. It is more proper to use the current title “3.1 Trend of Extreme Temperature days”.

7. We have developed the quality of all figure to resolve the problems. More information about the secondary axis in figure 4 and 7 are added.

8. There are no high temperature weather in which daily Tmax exceeds 35℃ in Kunming and Lasa cities. So the results of the other 29 stations are presented in figure 3, 5 and 6. There are no HWs in Changchun, Shenyang, Guiyang, Kunming and Lasa cities. So the results of 26 stations are presented in figure 7 and 8. In order to be more clearer, we make appropriate modifications and add explanation in the titles of figure 3, 5, 6, 7 and 8.

(3) Author's changes in manuscript

For advice 1, there is no change in the manuscript. The interpretation has been given.

For advice 2, the example of HWI is added in the part of Heat wave index (line 156-166, page 7). The content is as follow:

For HWI, there are two extreme situations. If there are no heat waves in one year, the value of HWI would be 1. If there are 92 continuous days of a year in which Tmax exceeds 40℃, the value of HWI would reach the biggest, 33792; for the real world, the second extreme situation would rarely occur except extreme catastrophe shocking. According to the statistics from 1955 to 2014 in China, the most serious heat wave event occurred in Changsha city in 2013 for which the value of HWI is no more than 140. The value of HWI is mostly determined by the number of continuous days in which Tmax exceeds 37℃, even 40℃. If the extreme hot days continue longer, HWI would be more serious. Taking the most serious heat wave event in Chongqing city for example, it lasted from 25 July to 19 August, 2006; the value of CD35 reaches 26; the value of AD37 is 21; the value of CD37 is 19; the value of AD40 is 9; the value of CD40 is 7. According to the HWI equation above, the HWI of this heat wave event reaches 98.2.

For advice 3, the description of each level of HWI (line 553-554, page 21) has been revised to make it clearer and easily understanding. The content is as follow:

Tab.1 The classification of HW hazards by the values of HWI

Heat Wave Index	Level of hazard	Description
HWI =1.0	No hazard	There is no HW event occurred.
1.0＜HWI≤ 1.5	Low hazard	The HW event must last at least 3 continuous days and less than 12 continuous days, in which there is no days above 37℃or 40℃.
1.5＜HWI≤ 3.0	Moderate hazard	The HW event must last at least 3 continuous days and less than 24 continuous days, in which daily Tmax exceeds 35℃.
3.0＜HWI≤ 6.0	High hazard	The HW event must last at least 3 continuous days and less than 36 continuous days, in which daily Tmax exceeds 35℃.
6.0＜HWI	Extreme high hazard	The HW event must last at least 4 continuous days in which daily Tmax exceeds 40℃.

For advice 4, there is no change in the manuscript. The interpretation has been given.

For advice 5, in order to make it clearer, the description in the manuscript has been changed (line 278-287, page 12). The content is as following:

The sum value of HWIs in Chongqing is far bigger than other cities; the annual average value of

HWIs in Chongqing reached 13.7. Changsha had been the second hard hit city with most serious HW hazards, in which the annual average value of HWIs reached 9.5. There were 6 cities that have been threatened by severer HW hazards, include: Hangzhou, Fuzhou, Nanchang, Xi'an, Wuhan and Haikou; the annual average value of HWIs in each city is between 4 and 9. There were 7 cities threatened by moderate severe HW hazards; these cities include: Hefei, Zhengzhou, Nanjing, Jinan, Shijiazhuang, Nanning, and Shanghai and the annual average value of HWIs in each city is between 2 and 4. The remaining 11 cities encountered lighter serious HW hazards in which the annual average value of HWIs is between 0 and 2. As mentioned above, there were no HW hazards in 5 cities.

For advice 6, there is no change in the manuscript. The interpretation has been given.

For advice 7, we have added more information of the secondary axis in figure 4 and 7 and developed the quality of figures. The figure 4 and 7 are showed as following:

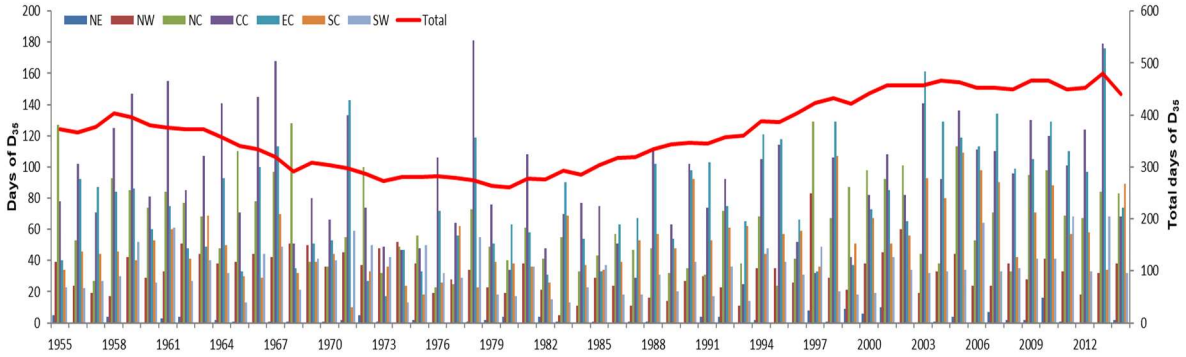
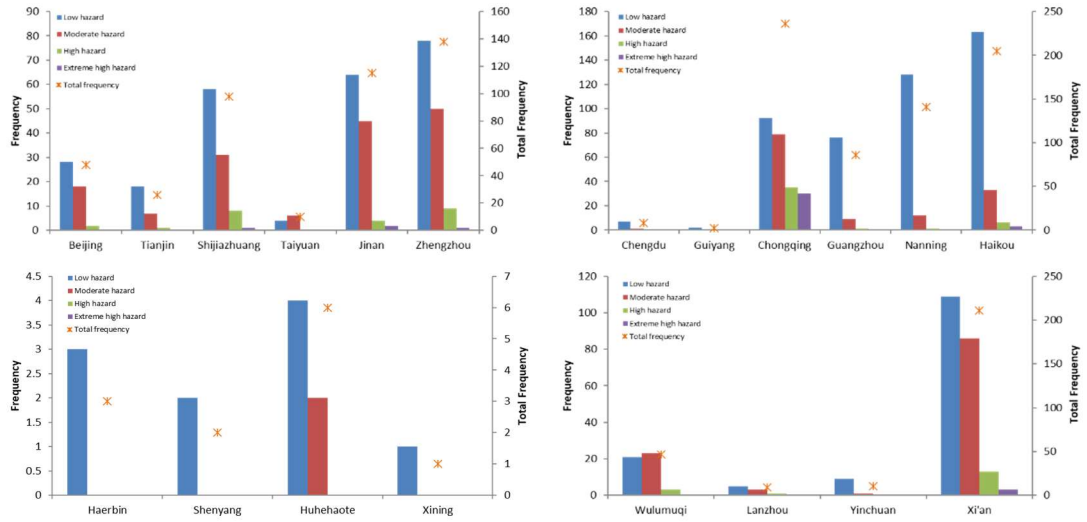


Fig. 4 Time series of D_{35} in different climate zones of China from 1955 to 2014



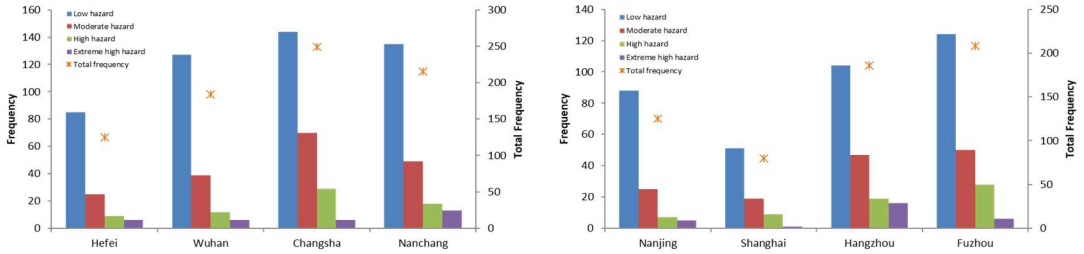


Fig. 7 Frequency of Low, Moderate, High and Extreme high HW hazards in 26 cities from 1955 to 2014 (Top left: NC; Top right: SW & SC. Middle left: NE; Middle right: NW & QT; Bottom left: CC; Bottom right: EC)

Notes: There are no HWs in Changchun, Shenyang, Guiyang, Kunming and Lasa cities in the past 60 years. Therefor there are 26 cities shown in this figure.

For advice 8, appropriate modifications and explanation in the titles of figure 3, 5, 6, 7 and 8 have been added. The content is as following:

Fig.3 Distribution of D_{35} in 29 cities from 1955 to 2014 (Green color: NE; Blue color: NW; Red color: NC; Purple color: CC; Black color: EC; Orange color: SC; Cyan color: SW; Yellow color: QT); Boxes indicate the interquartile spread (25th and 75th quantiles) with the horizontal line indicating the ensemble median and the whiskers showing the extreme range of D_{35} in 29 cities

Notes: There are no high temperature weather in which daily Tmax exceeds 35℃in Kunming and Lasa cities in the past 60 years. Therefor there are 29 cities shown in this figure.

Fig.5 Comparison between D35 and HWs per year in 29 cities of China from 1955 to 2014

Notes: There is no high temperature weather in which daily Tmax exceeds 35℃in Kunming and Lasa cities in the past 60 years. Therefor there are 29 cities shown in this figure.

Fig.6 Distribution of amounts and frequencies of HWs in 29 cities from 1955 to 2014 (upper graph: amounts of HWs; lower graph: Frequency of HWs. Green color: NE; Blue color: NW; Red color: NC; Purple color: CC; Black color: EC; Orange color: SC; Cyan color: SW; Yellow color: QT); Boxes indicate the interquartile spread (25th and 75th quantiles) with the horizontal line indicating the ensemble median and the whiskers showing the extreme range of HWs frequencies and amounts in 29 cities

Notes: There is no high temperature weather in which daily Tmax exceeds 35℃in Kunming and Lasa cities in the past 60 years. Therefor there are 29 cities shown in this figure.

Fig.7 Frequency of Low, Moderate, High and Extreme high HW hazards in 26 cities from 1955 to 2014 (Top left: NC; Top right: SW & SC. Middle left: NE; Middle right: NW & QT; Bottom left: CC; Bottom right: EC)

Notes: There are no HWs in Changchun, Shenyang, Guiyang, Kunming and Lasa cities in the past 60 years. Therefor there are 26 cities shown in this figure.

Fig. 8 The sum values of HWIs in 26 cities from 1955 to 2014

Notes: There are no HWs in Changchun, Shenyang, Guiyang, Kunming and Lasa cities in the past 60 years. Therefor

there are 26 cities shown in this figure.