Analysis on Extreme Temperature and Precipitation Event in Dabie Mountain in West Anhui during 1960-2013

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Abstract: This paper adopts the daily maximum temperature, minimum temperature and precipitation observation data in 1960~2013 of each county weather station in West Anhui to analyze changes of temperature and precipitation extremes in that area with linear method. Research shows: The days with nighttime and daytime extreme low temperature are decreasing obviously at the speed of 3.104 days/10 years and 1.157 days/10 years. The decrease amplitude of days with nighttime extreme low temperature is 2-4 times of that in daytime. The days with nighttime and daytime extreme high temperature are increased at the speed of 2.529 days/10 years and 0.638 day/10 years. The former has passed significance test, but the latter has not. The daily range is reducing at the speed of -0.076 ℃/10 years. The one-day maximum precipitation is rising at the speed of 3.411 mm/10 years, and five-day maximum precipitation is decreasing at the speed of -1.558 mm/10 years; the days with moderate rain are decreased -0.176 days/10 years; maximum continuous precipitation days are decreased -0.065 day/10 years; maximum continuous non-precipitation days are decreased -0.079 day/10 years. However, the significance test has not been passed. The precipitation frequency in that area becomes smaller.

1. Introduction

In the past 100 years particularly recent 50 years, the warning in the world and in China is obvious[1-3]; the intensity and frequency of extreme climate events are changed greatly. The events attract great attention of domestic and overseas experts and scholars, and abundant research findings are accumulated. Zhai Panmao and Ren Fumin found that the minimum temperature is increased, maximum temperature is decreased and daily range is decreased [4] according to the climate observation data in China during 1951-1990. Tang Hongyu found through analysis that the maximum temperature in China during 1951-2002 is not changed obvious or decreasing slightly in South China.

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and in North China becomes higher; the minimum temperature turns higher nationwide [5]. Liu Xuehua believed the extreme low temperature in the past 40 years dropped, while extreme high temperature rose; the frequency of rainy days and precipitation events became less frequent [5]. Sun Fenghua et al. studied the asymmetric change of maximum and minimum temperature in the Northeast China [6]. Liu Xiaodong researched in the Yellow River valley [8-9]. Extreme climate events always cause severe natural disasters, and even serious casualties [10-11].

Dabie Mountain in west Anhui is located between Yangtze River and Huai River at 115.20°E~117.14°E, 31.05°N~32.40°N. This area is high in southwest and low and flat in the northeast. Under the background of global warming, the extreme climate frequency in Dabie Mountain area is changed, such as drought, flood, freezing damage, high temperature and low temperature; meteorological disasters and derived secondary disasters occur every year to different degrees. Few studies focus on climate in this area, and there is no study on extreme climate there. This paper analyzes actually measured data of five stations in 54 years based on domestic and overseas advanced research findings, and tries to guide defense of the area for meteorological disasters through study on extreme temperature and precipitation events in Dabie Mountain in west Anhui.

2. Data and method

Fig.1 Regional division and station distribution

This paper selects the daily observation data of temperature and precipitation of five weather stations during 1960-2013 in Dabie Mountain, west Anhui, and divides the area into five sub-areas of Liuan, Huoqiu, Jinzhai, Shucheng, and Huoshan (see Fig.1).
Table 1 Indexes of temperature and precipitation extremes

| Index                                      | Definition                                                                 | Unit  |
|-------------------------------------------|---------------------------------------------------------------------------|-------|
| Daytime extreme high temperature          | Daily maximum temperature is larger than the 90th percentile during 1960-2013 | Day   |
| Daytime extreme low temperature           | Daily maximum temperature is smaller than the 10th percentile during 1960-2013 | Day   |
| Nighttime extreme high temperature        | Daily minimum temperature is larger than the 90th percentile during 1960-2013 | Day   |
| Nighttime extreme low temperature         | Daily minimum temperature is smaller than the 10th percentile during 1960-2013 | Day   |
| Daily range                               | Daily maximum temperature less daily minimum temperature                 | °C    |
| Maximum 1-day precipitation               | Maximum 1-day precipitation                                              | mm    |
| Maximum 5-day precipitation               | Maximum 5-day precipitation                                              | mm    |
| Days with moderate rain                   | Days with precipitation larger than 10mm                                  | Day   |
| Annual average precipitation intensity    | Days with maximum continuous precipitation smaller than 1mm               | Day   |
| Maximum continuous non-precipitation days |                                                                           |       |
| Maximum continuous precipitation days     |                                                                           |       |

This paper analyzes changes in temperature and precipitation extremes in Dabie Mountain in West Anhui with 11 indexes listed in Table 1.

This paper adopts linear tendency estimation method to analyze temperature and precipitation extremes, acquires change tendency of temperature and precipitation by the least square method, analyzes inter-annual change rate of elements with the linear tendency value, and carries out 95% significance test.

3. Changes in temperature extremes

3.1. Days with nighttime extremely low temperature

Fig.2a shows the change tendency of nighttime extreme low temperature in Dabie Mountain, in West Anhui during 1960-2013. The days with nighttime extreme low temperature are decreased obviously at the speed of 3.104 days/10 years. The decrease amplitude in Winter shall be 2.883 days/10 years obviously at maximum. The five stations all show decrease trend, in which the decrease speed is 2.883 days/10 years in Jinzhai, 4.191 days/10 years in Liuan, 4.061 days/10 years in Huoqiu, and 2.011 days/10 years in Huoshan (see Table 2).

3.2. Days with nighttime extremely high temperature

According to Fig.2b, the days with high nighttime temperature in Dabie Mountain, West Anhui during 1960-2013 are increased obviously at the speed of 2.529 days/10 years. The increase amplitude in Autumn is the largest, at the speed of 3.25 days/10 years.

The nighttime extreme high temperature is increasing obviously at the speed of 3.945 days/10 years, 2.962 days/10 years and 2.745 days/10 years respectively in Jinzhai, Huoshan and Huoqiu (see Table 2).
3.3. Days with daytime extremely low temperature

Fig. 2c shows the change tendency of daytime extreme low temperature in Dabie Mountain, in West Anhui during 1960-2013. The daytime extreme low temperature days is reducing at the speed of 1.157 days /10 years. In the five stations, the maximum decrease trend is 1.753 days/10 years, and the significance test is not passed.

Among the five measurement stations in Dabie Mountain in west Anhui, the decrease amplitude with nighttime extreme low temperature in four stations is 2-4 times of that in daytime (see Table 2).

3.4. Days with daytime extremely high temperature

According to Fig.2d, the days with high daytime temperature in Dabie Mountain, West Anhui during 1960-2013 are increased at the speed of 0.638 day /10 years. The significance test is not passed. The daytime extremely high temperature change in all stations is smaller than that in nighttime.

3.5. Daily range of temperature

According to Fig.3, the daily range in Dabie Mountain, West Anhui is reducing by 0.076 °C/10 years generally, but the significance test is not passed. The large amplitude occurs in Winter and...
Summer, respectively by $0.238^\circ C/10$ years and $0.229^\circ C/10$ years. The daily range in four out of five stations dropped. That of Jinzhai is dropped the maximum, by $0.262^\circ C/10$ years (see Table 2).

**Table 2. Change tendency of extreme temperature in each station of Dabie Mountain, West Anhui during 1960-2013**

(Unit: day/10 years; $^\circ C/10$ years for daily range; bold items have passed 95% confidence test)

| Station name | Days with nighttime extreme low temperature | Days with daytime extreme low temperature | Days with nighttime extreme high temperature | Days with daytime extreme high temperature | Daily range |
|--------------|--------------------------------------------|------------------------------------------|-------------------------------------------|------------------------------------------|-------------|
| Huoqiu       | -4.061                                     | -0.945                                   | 2.745                                     | 1.233                                    | -0.099      |
| Huoshan      | -2.011                                     | -0.939                                   | 2.962                                     | 0.886                                    | -0.088      |
| Jinzhai      | -4.32                                      | -0.896                                   | 3.945                                     | 0.19                                     | -0.262      |
| Liuan        | -4.191                                     | -1.753                                   | 1.715                                     | 1.026                                    | 0.024       |
| Shucheng     | -1.087                                     | -1.255                                   | 1.277                                     | 1.078                                    | 0.09        |

**Fig.3:** Daily range change tendency in Dabie Mountain, West Anhui during 1960-2013 (the description can be seen in Fig.2)

4. Changes in precipitation extremes

4.1. Maximum 1-day precipitation and maximum 5-day precipitation

Fig.4a and Fig.4b respectively show the change trend of maximum 1-day and 5-day precipitation in
Dabie Mountain, West Anhui during 1960–2013, rising respectively by 3.41mm/10 years and 1.55mm/10 years. The test is not passed. In the 5 stations, the maximum 1-day precipitation in four stations is increased, but it is only increased obviously in Luan by 8.072mm/10 years. The maximum 5-day precipitation in three out of five stations is increased, and in two is decreased. Moreover, statistical data is not significant (see Table 3).

4.2. Days with moderate rain

Fig.4c shows change trend of moderate rain days, which is -1.76mm/10 years. The significance test is not passed. The days with moderate rain in three out of five stations are on a slight down trend, while in two stations are slightly rising; the test is not passed for both (see Table 3).

4.3. Annual average precipitation intensity

Fig.4d shows change trend of annual average precipitation intensity. The trend of 241mm/10 years precipitation in Dabie Mountain, west Anhui during 1960-2013 is rising obviously. The precipitation amount in 5 stations is rising; the amount is the maximum in Luan, increasing greatly by 0.323mm/10 years. The significance test is not passed for other stations (see Table 3).

4.4. Maximum continuous non-precipitation and precipitation days

Fig.4e and Fig.4f shows respectively the maximum continuous non-precipitation and precipitation days in Dabie Mountain, West Anhui during 1960-2013. The two items both dropped slightly by 0.065 and 0.076, and both failed the test.

In the five stations, the maximum continuous precipitation days in four are reduced slightly, but only in Luan reduced greatly by 0.54 day/10 years. The maximum continuous non-precipitation days in three stations are on a slight rising trend, while in two stations is slightly reduced; the test is not passed for all stations (see Table 3).

Table 3 Change tendency of precipitation indexes in each station of Dabie Mountain, West Anhui during 1960-2013

| Station name | Maximum 1-day precipitation | Maximum 5-day precipitation | Days with moderate rain | Annual average precipitation intensity | Maximum continuous precipitation days | Maximum continuous non-precipitation days |
|--------------|-----------------------------|----------------------------|-------------------------|----------------------------------------|----------------------------------------|------------------------------------------|
| Huoqiu       | 1.012                       | -2.15                      | 0.228                   | 0.195                                  | -0.267                                  | 0.202                                    |
| Huoshan      | 4.681                       | -5.005                     | -0.546                  | 0.186                                  | **0.559**                               | -0.751                                   |
| Jinzhai      | 0.62                        | 7.762                      | -0.539                  | 0.24                                   | -0.008                                  | 0.505                                    |
| Luan         | **8.072**                   | 5.12                       | -0.355                  | **0.323**                              | **-0.54**                               | 0.237                                    |
| Shucheng     | -2.708                      | 2.063                      | 0.431                   | 0.261                                  | -0.138                                  | -0.515                                   |
Fig. 4 Change tendency of precipitation in Dabie Mountain, in West Anhui during 1960-2013
(The full line is linear tendency, \(L\) is linear tendency per 10 years, and \(P\) is the significance level)

5. Discussion and conclusion

To sum up, the following conclusion could be drawn through analysis on data of Dabie Mountain Weather Station in West Anhui during 1960-2013.

(1) The days with nighttime and daytime extreme low temperature are decreasing obviously at the speed of 3.104 days/10 years and 1.157 days/10 years in Dabie Mountain, West Anhui during 1960-2013. The decrease amplitude of regional or nighttime extreme low temperature is 2-4 times of that in daytime. Moreover, the nighttime extreme low temperature reduce is particularly obvious in Huoqiu, Jinzhai, Liuan and Huoshan. The impact of landform is not discussed in this paper.
(2) The days with nighttime and daytime extreme high temperature are increased at the speed of 2.529 days/10 years and 0.638 day/10 years in Dabie Mountain, West Anhui during 1960-2013. The former has passed significance test, but the latter has not.

(3) The daily range is reducing at the speed of -0.076°C/10 years in Dabie Mountain, West Anhui during 1960-2013.

(4) The 1-day maximum precipitation is rising at the speed of 3.411 mm/10 years, and 5-day maximum precipitation is decreasing at the speed of -1.558 mm/10 years; the days with moderate rain are decreased -0.176 days/10 years; maximum continuous precipitation days are decreased -0.065 day/10 years; maximum continuous non-precipitation days are decreased -0.079 day/10 years. However, the significance test has not been passed. The precipitation frequency in that area becomes smaller.

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