CHINESE GEOGRAPHICAL SCIENCE
Volume 12, Number 4, pp. 329 – 332, 2002
Science Press, Beijing, China

CHARACTERISTICS OF CHANGE IN TEMPERATURE DURING THE PAST 50 YEARS IN JILIN PROVINCE OF CHINA

ZHAO Xin – yi, WAN Jun, WU Xiu – qin
(Department of Urban and Environmental Sciences, Peking University, Beijing 100871, P. R. China)

ABSTRACT: Based on the monthly mean temperature, the changing processes and tendencies of temperature during 1951 – 2000 in Jilin Province, which is in Northeast China, are analyzed. And the spatial characteristics of the change are submitted. In the past 50 years the temperature of Jilin Province was increasing just like the other areas in the world. Since 1990, the increasing of temperature has been more obvious than that in the previous 40a. From the west to the east, the province has larger temperature rising. According to Principal Component Analysis(PCA) of temperature field, Jilin Province is divided into 3 regions and the degree of becoming warmer is different from region to region. During the period of 1951 to 2000, the annual temperature in Jilin Province has been rising, so has the temperature in winter and summer. The average temperature in the 1990s was 0. 5 – 2. 0℃ higher than that in the 1950s. From the west to the east, the increasing of temperature became smaller.

KEY WORDS: temperature change; spatial characteristics; Jilin Province

CLC number: P467 Document code: A Article ID: 1002-0063(2002)04-0329-04

In the past tens of years the increasing of temperature in the world has been paid more and more attention to. The newest research of IPCC(Intergovernmental Panel on Climate Change) pointed out that the global average surface temperature had increased by 0. 6 ± 0. 2℃ over the 20th century and the last 20-year was the warmest during recent 100 years(IPCC Ⅱ, 2001). According to the increase of global temperature, lots of areas in China are becoming warmer(LIN and YU, 1990; LIN and ZHAO, 1996; DENG *et al.*, 1999). Based on research results, more obvious increasing of temperature is in Northeast China. So study on the process, tendency, and spatial characteristics of this kind of change is necessary. In this paper the change of temperature from 1951 to 2000 in Jilin Province is discussed.

1 DATA AND METHOD

The monthly mean temperature data of 47 weather stations in Jilin Province from 1951 to 2000 are collected. The annual temperature is computed and the temperature in January and that in July represent the temperature in the winter and summer respectively.

The average temperature of Jilin Province is calculated by the data from every station so as to show the temperature change during 1951 – 2000 in Jilin Province. Because of the dispersion of these stations, the average value can be thought to be representative of the average temperature of Jilin.

In order to study the changing tendencies of temperature, we fit the change processes with straight lines and take ten times of their slope as climatic inclinations, which indicates the changing value of temperature per 10a. And running mean is used to describe the temperature change in long period.

The average temperatures of every ten years, which are 1951 – 1960, 1961 – 1970, 1971 – 1980, 1981 – 1990, and 1991 – 2000, are calculated in order to study the change of temperature decade by decade. And the average values are called the temperature of the 1950s, 1960s, 1970s, 1980s, and 1990s respectively. Principal Component Analysis(PCA) is used to study the spatial divergency. PCA is one of tools to study the temporal and spatial characteristics of meteorological element field(HUANG, 1990).

Received date: 2002-07-12
Foundation item: Under the auspices of the National Natural Science Foundation of China(No. 49971073).
Biography: ZHAO Xin-yin(1968 –), female, a native of Baicheng City of Jilin Province, Ph. D., Her research interests include climatic change and its impact.

In this paper the oblique rotated PCA is used to reveal the regional characteristics of the temperature change. The temperature field, which is composed of the temperature data from 1961 to 1990(the standard 30 years for the study on climatic change) of the 47 stations in Jilin Province, is divided into 3 regions.

2 CHANGE OF TEMPERATURE IN JILIN PROVINCE

2.1 The Change of Annual Temperature

In the past 50a, the temperature in Jilin Province was increasing (Fig. 1). The climatic inclination of temperature was 0.3℃/10a. The temperature in 1998 was the highest in the 50a, just like the state of global average temperature (TRENBERTH, 1999). By the running mean by 5a, some of warm and cold periods can be seen. Especially, the warm period, which began from the middle of the 1980s, corresponded with that of most areas in the world. And this warm period exists and becomes remarkable until now. Since the end of the 1980s, the temperature in the last warm period has exceeded that of the 1950s.

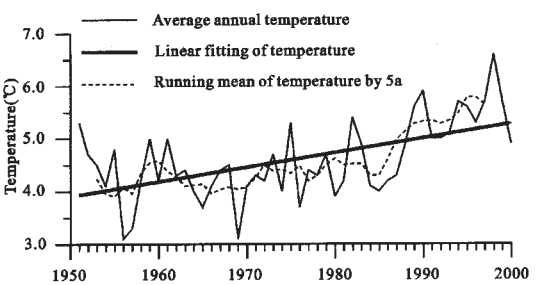


Fig. 1 The change of annual temperature in Jilin Province from 1951 to 2000

2.2 The Change of Temperature in July and January

In the past 50a, the temperatures in July and January in Jilin Province increased just like that of the annual mean value(Fig. 2). But the climatic inclination of temperature in January was 0.5℃/10a, and it was 10 times higher than that in July, which was 0.04℃/10a. The maximum temperature of January in the past 50a appeared in 1992, while that of July in 1997. During the period from the end of the 1970s to the middle of the 1980s the temperature decreased in July but increased in January. So in Jilin Province the winter was becoming warmer obviously and the summer also became warmer though the rate of temperature increasing was lower during the last 50a. Especially from the end of the 1980s the temperatures in January as well as in July were increasing to the warmest period during the 50a.

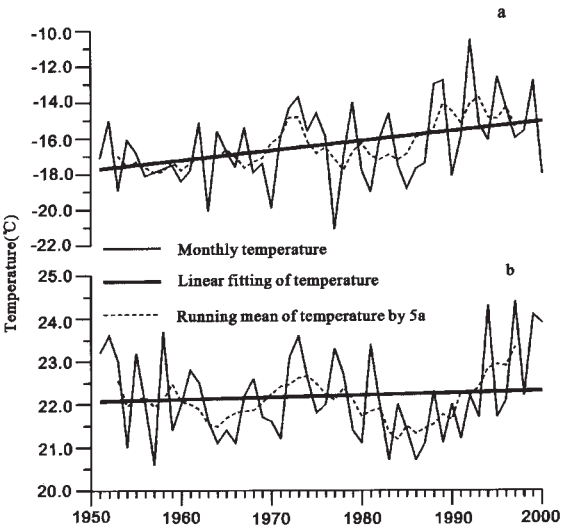


Fig. 2 The change of temperature of January (a) and July (b) in Jilin Province from 1951 to 2000

2.3 The Change of Temperature Decade by Decade from the 1950s to the 1990s

The annual temperature in Jilin Province has been rising decade by decade in the past 50a except for the less dropping in the 1960s. Especially, since the 1980s the temperature was much higher and the temperature in the 1990s was the highest in the past 5 decades(Table 1). The temperature in the 1990s was 1.2℃ higher than that in the 1950s and 1.3℃ higher than that in the 1960s. The differences between the temperatures in the 1980s and the 1950s, and the 1980s and the 1960s were 0.5℃ and 0.6℃ respectively. This kind of change also took place in temperature in January and the degree of temperature increasing was much higher. For example, the increasing of temperature in January from the 1950s to the 1990s was 2.6℃, and that from the 1950s to the 1980s was 0.8℃. In the meanwhile the temperature in July increased by 0.4℃ from the 1950s to the 1990s, and decreased by 0.7℃ from the 1950s to the 1980s. So the higher temperature in the 1990s than the 1950s can be known from the annual temperature and temperature in January as well as in July; however the higher temperature in the 1980s than the 1950s can be known only from the annual temperature and temperature in January but not in July.

Table 1 The difference of average temperatures in Jilin Province between 1950s and 1980s, and between 1950s and 1990s (℃)

1950s - 1980s			1950s - 1990s		
Annual	January	July	Annual	January	July
0.5	0.8	-0.7	1.2	2.6	0.4

3 SPATIAL DIVERGENCY OF TEMPERATURE CHANGE IN JILIN PROVINCE

3.1 Tendency of Temperature Change

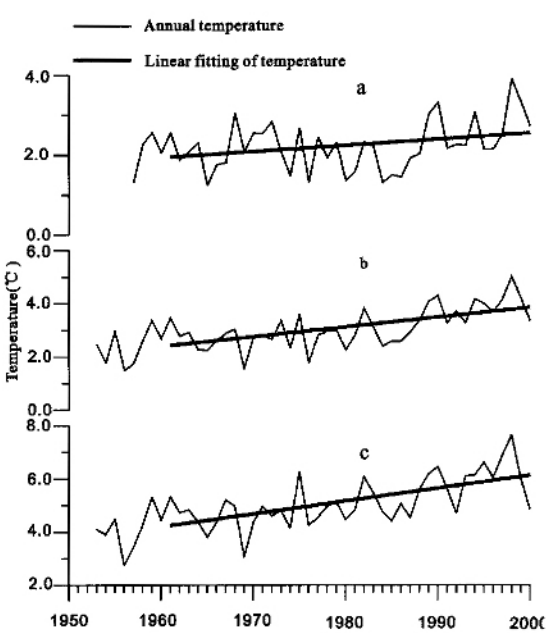
Because of the difference of the beginning years of work among the stations, the period from 1961 to 2000 was taken to calculate the climatic inclination to study the spatial divergency of the tendencies of temperature change. The annual temperatures were increasing in all of the areas of Jilin Province. The climatic inclinations were all positive but the values of inclination were different. The climatic inclinations were larger in the western and southern areas than the northern and eastern parts. The maximum of the climatic inclination was in the northwestern area while the minimum in the area of Changbai County. The climatic inclination, which indicates the rate of temperature increase, was 0.4 – 0.5℃/10a in the northwestern and southern area, 0.3 – 0.4℃/10a in the middle of Jilin Province, and 0.1 – 0.2℃/10a in the eastern area. And in all of the province the rate of temperature increase in winter was higher than that in summer(Table 2, Fig. 3).

3.2 Change of Temperature Decade by Decade from the 1950s to the 1990s

The differences of average temperature in every decade from the 1950s to the 1990s shows the spatial divergency. In all Jilin Province, the annual temperatures were higher in the 1980s and the 1990s than that in the 1950s. But the degree of warming was different from area to area. The increasing temperature in the 1990s was highest in the western Jilin, which was 1.5 – 2.0℃, and lowest in the northeastern area, which was 0.5℃ or so. The increasing temperature in the 1980s was lower than those in the 1990s by 0.2 – 1.0℃. Similar to this, the higher temperatures in winter (expressed by temperature in January) in the 1980s and the 1990s than in the 1950s was most obvious in western Jilin, then from the southeastern area, the middle area, to the northeastern area, the increasing temperature was becoming smaller. The increasing degrees of temperatures in January between the 1950s and the 1990s were 2.0 – 5.0℃, while those between the 1950s and the 1980s were 1.0 – 1.8℃. The higher rate of temperature change among decades in western area was more outstanding in winter. The summer(July) was cooler in the 1980s than in the 1950s in Jilin Province except for the western area, in which the temperature increased in the 1980s. But the temperature in July was higher in all of Jilin in the 1990s than the 1950s. In the 1980s, the winter was warmer and summer was cooler in the most area of Jilin Province, just like most of the other areas in the world. But in the 1990s the winter as well as summer became warmer in all of the Jilin Province.

Table 2 The climatic inclination of temperature change in some areas in Jilin Province(℃/10a)

Qian Gorlos			Hailong			Dunhua			Yanji			Changbai		
Ann.	Jan.	Jul.	Ann.	Jan.	Jul.	Ann.	Jan.	Jul.	Ann.	Jan.	Jul.	Ann.	Jan.	Jul.
0.5	1.1	0.3	0.4	0.5	0.2	0.4	0.4	0.2	0.3	0.3	0.2	0.2	0.5	0.1



(a. Changbai County; b. Dunhua County; c. Qian Gorlos County)
Fig. 3 The annual temperature change and its tendency in the past 50a

3.3 The Regional Characteristics of Temperature Change

In order to discuss the spatial patterns of temperature change, the PCA was used to analyse the characteristics of annual temperature change. The first three oblique rotated loading vectors can give 95% of the variance, which is to say the change of temperature in Jilin Province was consistent. Since the first loading vector is positive in all of Jilin Province, the increasing

of temperature in the past 50a can be proved. But the loading value is different from the west to the east, so the spatial divergence can be seen. The second and third loading vectors reflect the difference between the western area and the eastern one. Based on the three loading vectors, the province can be divided into three regions(Fig. 4). The region A includes the western Jilin Province from Baicheng to Meihekou - Huadian - Jiaohe; the region C includes the area east to the Changbai - Helong - Longjing; the other area belonges to the region B. From region A, to region B and region C, the increasing of temperature became smaller. The region A was warmer, which was outstanding in China, but region C was under the level of most of other areas. These 3 regions were similar with the climate area in Jilin(MA *et al.*, 1999). This kind of spatial change of temperature in Jilin Province was connected with the humid divergency of the province, which will be studied in another paper.

4 DISCUSSION

According to the facts in this paper, in the past 50a Jilin Province was becoming warmer just like the most area of China as well as the world. This is fitted to the global warming concerning to the increase in the concentration of green house gases(GHGs). And because of lying in the higher latitude, the degree of temperature increase in Jilin Province was higher than most of other areas. Another reason why Jilin Province became warmer in the near 50a can be attributed to the drier climate.

This also can be used to explain the spatial divergence of temperature inclination in Jilin. From the west to the east in Jilin the climatic inclination of temperature was smaller and smaller while the climate became more humid. And the degree of temperature increasing was connected with the altitude. The higher the altitude, the higher the rate of temperature increase. In Jilin the larger climatic inclination can be found in the drier northwestern area or the higher northeastern part. So based on the temperature change in Jilin Province, the relative humid and altitude were two important factors which impact the climatic inclination.

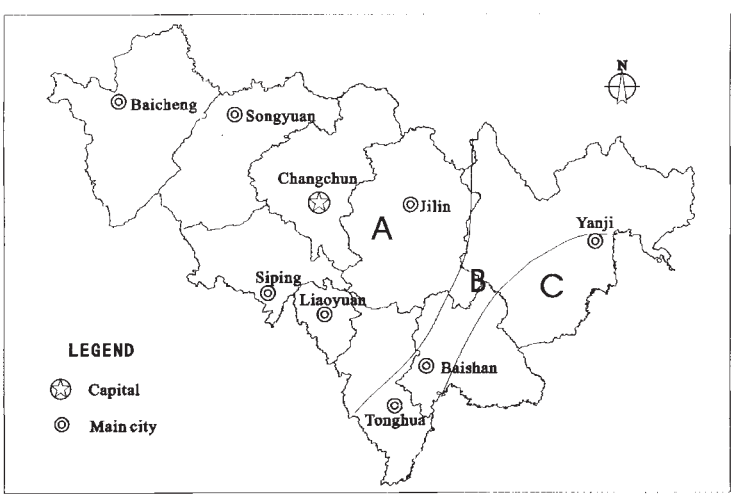


Fig. 4 The spatial divergency of temperature change in Jilin Province

REFERENCES

DENG Hui-ping, LIU Hou-feng, ZHU Ting-cheng, 1999. Temperature and precipitation changes over Songnen Steppe and their impacts since mid-20th century[J]. *Scientia Geographica Sinica*, 19(3): 220 - 224. (in Chinese)

HUANG Jia-you, 1990. *Statistical Analysis and Methods of Prediction in Meteorology*[M]. Beijing: Chinese Meteorological Press. (in Chinese)

IPCC II, 2001. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*[M]. Cambridge: Cambridge University Press.

TRENBERTH K E, 1999. The extreme weather events of 1997 and 1998[J]. *Consequences*, 5(1): 3 - 15.

LIN Xue-chun, YU Shu-qiu, 1990. The climatic change in the last 40a in China[J]. *Meteorological Monthly*: 16(10): 16 - 21. (in Chinese)

LIN Zhen-yao, ZHAO Xin-yi, 1996. Spatial characteristics of changes in temperature and precipitation of the Qinhai-Xizang (Tibet) Plateau[J]. *Science in China (Series D)*, 39(4): 442 - 448.

MA Shu-qing, XI Zhu-xiang, AN Gang, 1999. Study on the variation laws of the agricultural boundary temperature of Jilin Province[J]. *Scientia Geographica Sinica*, 19(1): 63 - 68. (in Chinese)

YE Wei-qiang, 1997. Study on the climatic change during 1951 - 1990 in northern China[Z]. The Bachelor Degree Paper of Peking University. (in Chinese)