CLIMATE CHANGE IN CHINA AND ITS INFLUENCE ON AGRICULTURE PRODUCTION IN THE LAST 40 YEARS

Zhang Jijia (章基嘉),

Chinese Academy of Meteorological Sciences, Beijing 100081

Xu Xiangde (徐祥德) and *Miao Junfeng* (苗俊峰)

Tianjin Meteorological Bureau, Tianjin 300074

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ABSTRACT

Using the meteorological data set for 1951—1990 over 160 stations, a series of 10-year running mean curves of temperature and precipitation averaged for the country and its 7 climate regions, as well as for each season, are obtained and analyzed. The six aspects of main results can be summarized about the climate change in China and its influence on agriculture production in the last 40 years.

Key words: climate change, agriculture production, temperature, precipitation, photosynthesis and temperature potential productivity of crops (PTPPC)

I. DATA, GRAPHS AND MAPS

Using annual and monthly mean temperature and precipitation data set for 1951—1990 over 160 stations provided by NMC / SMA in Beijing, the following graphs and maps have been obtained:

(1) The 10-year running mean curve of annual mean temperature averaged over the 160 stations for 1951—1990.

(2) The 10-year running mean curves of annual mean temperature averaged over each climate region in China (including Northeast China, North China, east part of Northwest China, west part of Northwest China, South China, Southwest China and the middle and lower valleys of the Changjiang River, and the same hereinafter).

(3) The 10-year running mean curves of each seasonal mean temperature (spring, summer, autumn and winter) over the country.

(4) The decade-averaged temperature anomaly distribution from 1950s to 1980s of this country, relative to the 40-year average for 1951—1990, and the mean temperature difference distribution between 1980s and 1950s over the country.

(5) The 10-year running mean curve of annual total precipitation averaged over the 160 stations for 1951—1990.

(6) The 10-year running mean curves of annual total precipitation averaged over each climate region in China.

(7) The 10-year running mean curves of each seasonal total precipitation over the country.

(8) The decade-averaged precipitation anomaly distribution from 1950s to 1980s relative to the 40-year average for 1951—1990, and the mean precipitation difference distribution between

1980s and 1950s over the country.

In addition, we have calculated the annual photosynthesis and temperature potential productivity of crops (PTPPC) (Li et al., 1988) for each of 160 stations for 1951—1990, and obtained the following graphs and maps:

(9) The 10-year running mean curve of the annual PTPPC averaged over the 160 stations for 1951—1990.

(10) The 10-year running mean curves of the annual PTPPC averaged over each climate region for 1951—1990.

(11) The decade-averaged annual PTPPC anomaly distribution from 1950s to 1980s relative to the 40-year average for 1951—1990, and the annual PTPPC difference distribution between 1980s and 1950s over the country.

II. RESULTS

With the above graphs and maps a comprehensive analysis of climate change and its influence on agriculture production in the last 40 years has been made. The main results can be summarized as follows:

(1) 1980s, as well known, is the warmest 10 years of the earth in the last century, meanwhile, as pointed out in this study, this decade is also the most clear warming 10 years in China for the last 40 years at least. The temperature averaged over the country for 1980s has increased by 0.16℃, relative to the mean value for 1951—1990 (Fig.1, curve *T*), which is very close to the global climate warming amplitude (0.20℃) for the last decade (WMO / ICSU, 1990; WMO / UNEP, 1990).

(2) However, the climate anomalous warming (i.e. increase of temperature above normal) of 1980s in China has its clear regional and seasonal speciality. The Northeast and North China, as well as the most part of the Northwest China are the most obvious warming regions of the country (temperature anomalies in the last decade reached +0.5℃, +0.33℃ and +0.29℃, respectively), their anomalous warming is not only above the mean amplitude of whole country, but also higher than the global mean value. As for the vast territory south to the Changjiang River, the temperature anomalies in 1980s are -0.00 to +0.03℃ only. It implies that there is no occurrence of climate anomalous warming in this wide area practically. The southwest region of

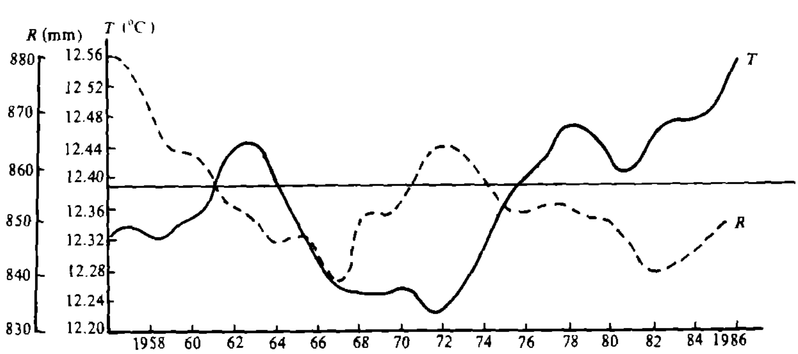

Fig. 1. The 10-year running mean curves of annual mean temperature (*T*) and total precipitation (*R*), averaged over 160 stations for 1951—1990.

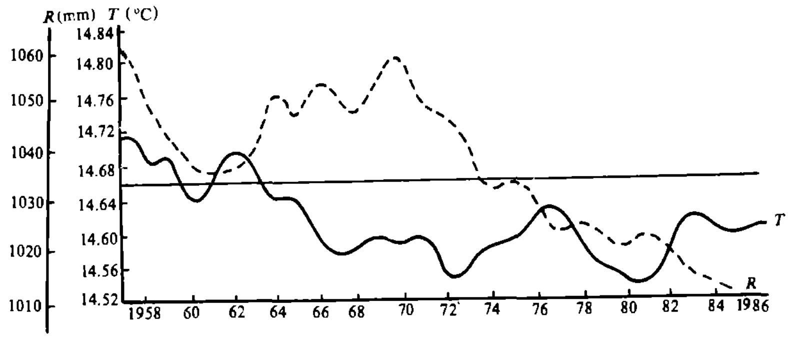

Fig. 2. As in Fig.1, but for Southwest China.

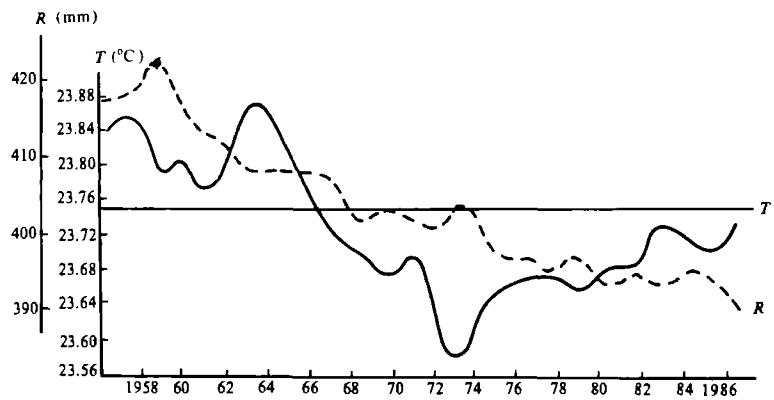

Fig. 3. As in Fig.1, but for summer.

China is a rather special area for climate change, as its annual mean temperature in the last decade was not increased, but still remained below normal, with temperature anomaly of −0.07℃ (Fig.2, curve *T*).

It is shown by the 10−year running mean curves of seasonal mean temperature averaged over the country, that the climate anomalous warming of China in the last decade occurred owing to anomalous warming of winter, spring and autumn (their contributions are +0.4℃, +0.12℃ and +0.14℃ respectively). As for the summer, though its seasonal mean temperature was rising since early 1970s, it still remained below normal, until to early 1990s (Fig.3, Curve *T*). It may account for the speciality of "warming winter and cooling summer" in climate change of China for 1980s on the background of global climate warming.

(3) The annual mean temperature variations in China for the last 40 years consist of quasi−periodic oscillations with a period about 14 years and short−time fluctuations with an interval near 3 years, which disappeared after 10−year running mean. In early 1960s and late 1970s, climate of China was warmer than normal, whereas in early 1970s there was a minimum of annual mean temperature and the climate was becomming coldest (Fig.1, curve *T*), in particular in the northeast region of the country with temperature anomaly of 0.3℃ below normal. Just in this period cold damage occurred frequently and exerted an unfavorable impact on crop

production in this area. Beginning from early 1980s annual mean temperature in whole country has a general tendency to rise above normal, i.e. the climate became really anomalous warming. In Northeast, North and Northwest China, the same tendency was observed, only in the southwest region annual mean temperature has decreased since early 1950s (Fig.2, curve *T*).

(4) In the last 40 years, the variations of annual total precipitation averaged over the country consists of a 14-year quasi-periodic oscillation with alternate dry and wet episodes and a general tendency to dry since early 1950s (Fig.1, curve *R*). The phase of quasi-periodic oscillations in both temperature and precipitation was nearly opposite to each other, forming an alternation of two basic climate patterns of "warming-dry" and "cooling-wet". Such combinations of temperature and precipitation often bring serious difficulty to crop production in the area of water deficiency. From the viewpoint of regions, the north part of Northeast China has three decades with precipitation above normal in the last 40 years, and in particular, the 1980s climate pattern over there maintains "warming-wet", which is very beneficial for agriculture. Conversely, North China, including Shandong Province is characterized by a "warming-dry" pattern in 1980s, being unfavorable for agriculture. In southwest region of China the first 20 years were rich in precipitation, but the last 20 years ——deficient, forming a "cooling-dry" pattern (Fig.2, curves *T* and *R*). In 1980s the most part of Northwest China was characterized by a "warming-wet" pattern, thus, the conditions for agriculture became better than those in 1970s, in particular of its east part.

(5) As an index of agriculture climate resources, the PTPPC can not be constant, but varies with the climate change. There were two periods with annually averaged maximum of PTPPC before 1980s (Fig.4): one was observed in the mid 1960s, and the other ——in the late 1970s, whereas in the early 1970s a minimum of PTPPC was observed. The difference between max. and min. is about 43 kg • mu^{-1} • $year^{-1}$ (15 mu = 1 hectare), which is equivalent to 3.5% of its 40-year mean. The PTPPC has a clear tendency to increase in 1980s, with 26 kg • mu^{-1} • $year^{-1}$ being higher than its normal. It implies that climate warming could be favorable to agriculture, but such favorable possibility can be realized only by a proper supply of water resources in the same area.

(6) The regional variability of PTPPC is clearly different from each other. In Northeast China its relative variability is 5.9%, whereas in North China—— 10.4%. The east part of Northwest China has a relative variability of 5.7%, and its west part——16.2%, being the highest in the country. In Southwest and South China the relative variability is 3.6% and 3.9%,

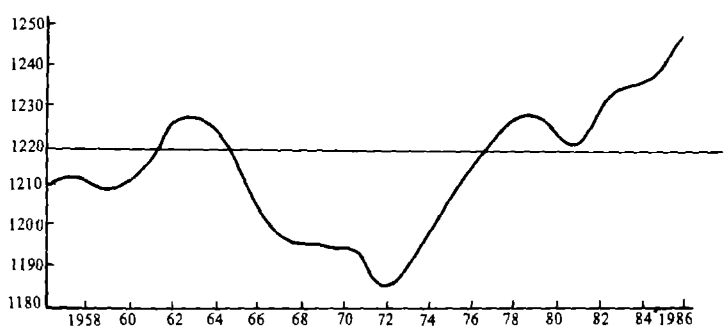

Fig. 4. The 10-year running mean curve of annual PTPPC, averaged over 160 stations (unit: 5 kg / mu).

respectively, while in the middle and lower valleys of the Changjiang River it decreases to 3.2%, which is the minimum value of the country. Therefore, it is clear that the relative variability of PTPPC in the north part of China is sufficiently higher than that in the south. Obviously, the higher the relative variability of PTPPC, the greater the instability of the climate resources of radiation and heat, and vice versa. It should be paid more attention in making a long-term program of agricultural production. The practical calculation has shown that the PTPPC index is mostly dependent on the temperature, therefore, the improvement must be carried out on two ways: the first is to take account of moisture in calculation of PTPPC, and the second is to estimate the climate (i.e. photo-temperature-moisture) potential productivity of different crops, in the near future.

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