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CHARACTERISTICS OF CLIMATE WARMING AND IMPACT ON CLIMATE ZONES CHANGE IN GUANGDONG

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Abstract: Based on temperature data in Guangdong in the past 50years, statistical methods are used to analyze the characteristics of temperature in spatial and temporal variation. The results show that land surface temperature warms by 0.16 °C/10a in Guangdong. The range of warming was lower than the average of nationwide and global land surface. Furthermore, the temperature has a larger increase tendency in winter and spring and coastal areas than in summer and autumn and inland areas. Climate zones move towards the north obviously. North tropical zone is expanding, south subtropical zone is reducing and central subtropical zone is relatively stable. Under the global climate warming, characteristics of climate warming in Guangdong were influenced by atmosphere general circulation, sea surface temperature and human activities etc.

Key words: climate warming; displacement of climate zones; Guangdong province

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1 INTRODUCTION

It is estimated that climatic zones will move towards the poles by 100 km for every 1°C rise in global mean temperature, though at rates that are unlikely homogeneous[1]. There are northern tropical zone, southern subtropical zone and central subtropical zone inside the Guangdong province. Over the past ten years, climate in the province has warmed up substantially, together with much increased thermal resources[2, 3] and more and more summertime episodes of extremely high temperature and wintertime episodes of moderate temperature[4, 5]. These characteristics of climate change have resulted in gradual shifts of climatic zones from south to north. Based on [2], this work studies the characteristics of climate change over the recent 50 years in terms of land surface temperature, coastal sea temperature, atmospheric circulation and air pollution, and makes an outlook on the trend of displacement of climatic zones around 2020.

2 CHARACTERISTICS OF CLIMATIC WARMING IN GUANGDONG AND CAUSATION ANALYSIS

2.1 Characteristics of climatic warming

Fig.1 shows the tendency of annual mean air temperature over the past 50 years in Guangdong. There have been two significant abrupt changes of annual mean air temperature in the province over the past 50 years[6], one in 1987 and the other in 1998. It is shown in a running *t* test that the *t* value is respectively 5.16 and 6.71 and both reach the 0.001 significant level of confidence. During the period 1987 – 2004, the annual mean temperature is 21.9°C across the province, 0.3°C higher than the climatological reference. Climatic warming is the most obvious in winter but relatively mild in summer, with the amplitude of warming much larger in the coastal south than the mountainous north. Two areas of high values are mainly over the Pearl River Delta and Hanjiang River Delta where the temperature increases by 0.7 – 0.9°C, possibly related with the urban heat island effect .

2.2 Analysis of climatic warming

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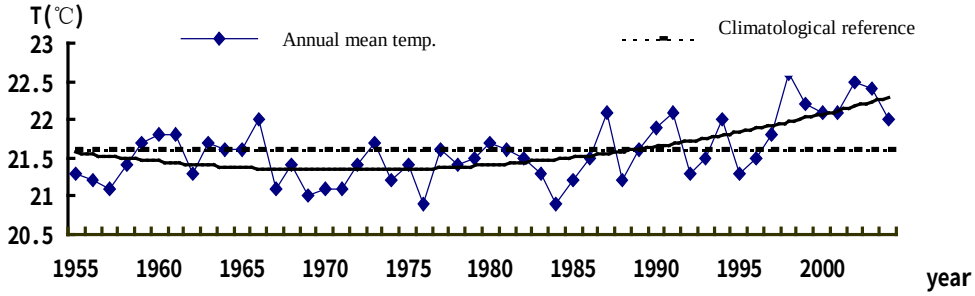


Fig.1 Variation tendency of annual mean temperature from 1955 to 2004 in Guangdong province.

Global mean temperature has risen by 0.6±0.2°C since 1860[1]. According Fig.2.4 in [7], global land surface temperature (LST) has been increasing at a rate of 0.22°C / 10a over the period 1955 – 2003 and SST at a rate of 0.089°C / 10a. It is known from relevant analysis that LST is roughly in phase between Guangdong and the globe.

SST change has significant impact on province's LST. According to the statistics of 1961 – 2003, the annual mean temperature is correlated with SST off Guangdong by a coefficient of 0.93. For the period 1960 – 2003, SST rises at 0.089°C / 10a across the globe but 0.16°C / 10a at marine stations offshore Guangdong.

The weather and climate in Guangdong are much affected by the subtropical high in western Pacific[8]. The winter and spring, in which temperature increases significantly, are also the seasons when the indexes of intensity and area become much larger for the western Pacific.

As shown in the statistics, mean wind speed is correlated with temperature by –0.4524 in the winter of the province. From 1971 to 2004, the speed of land surface wind has decreased by 9.1% in winter and 4.8% in spring. The decrease of winter wind speed from upper level to land surface is one of the main causes for large temperature rise in the winter and spring of the province.

With rapid urbanization and ever increasing use of land for urban construction and traffic transportation, the area of provincial farmland has reduced to 222.938 hectares in 2001 from 259.854 hectares in 1985. Heat island effect is becoming more and more obvious in towns and cities, with mean effect estimated at 0.049°C / a[9, 10]. In the aspect of air pollution, as coal and oil are two main sources of energy for Guangdong, thermal power plants are major discharging outlets of SO_2, causing serious acid rain[11]. The index is 0.4 – 0.7 (ranging from 0 to 1) for the optical thickness of aerosols averaged over the province in 2002, indicating serious air pollution[12].

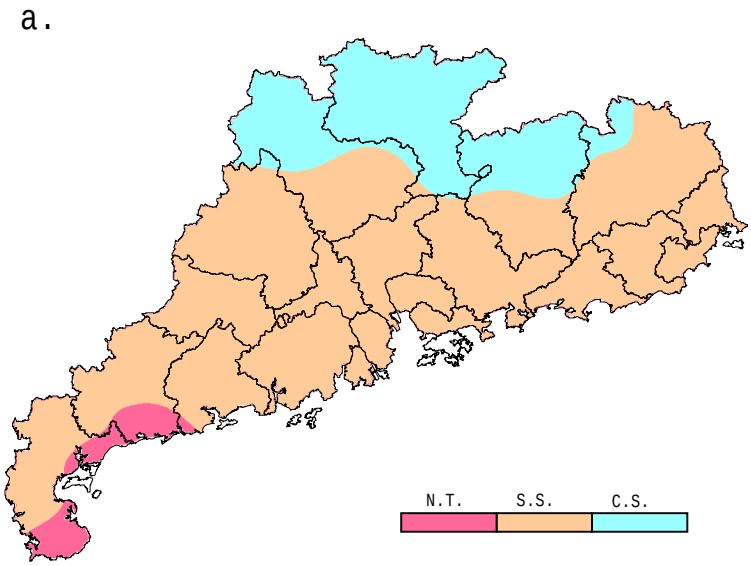
3 DYNAMIC VARIATION OF THE CLIMATIC ZONES AND OUTLOOK FOR THE FUTURE

In dividing the climatic zone, the current paper follows the standard by Lu et al.[13] (Tab.1). To ensure the stability of the dividing indexes and reflect the dynamic change of climatic zones, a 30-year running mean is used to process the climatic data for 1961 – 2004. The result shows that the northern boundary of the southern subtropical zone was going through Huaiji, Yingde, Longmen, Xingning and Jiaoling, the central subtropical zone covered 16 cities (counties) and northern tropical zone included only Xuwen. For 1998 – 2000, the northern tropical zone extended to Dianbai, Wuchuan and urban Zhangjiang and Maoming while the southern subtropical zone had Zijing.

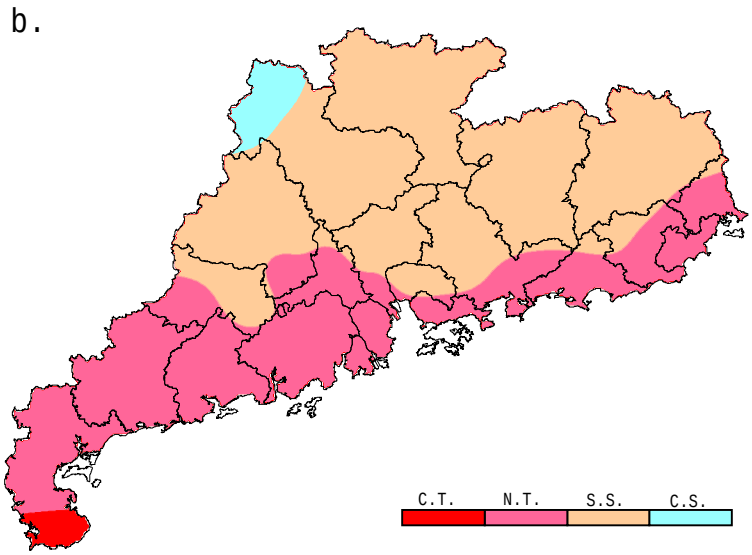
Tab.1 Indexes and standards for dividing climatic zones

Zones	Main Index	Secondary indexes	
	⩾10 ℃ accumulated temp. (℃)	Number of days ⩾10 ℃	Monthly mean temp. (℃)
C.Sub. Trop.	5 500－6 500	250－285	5－10
S.Sub. Trop.	6 500－8 000	285－360	10～15
N. Trop.	8 000－9 000	360－365	15－20
C. Trop.	9 000－10 000	365	20－26

It is known from the table that climatic warming has speeded up after 1998 and the amplitude is especially large in winter and spring, revealing an accelerating trend for climatic zones to shift northward. In this work, all elements of the climatic zones divided above are processed with 30-year running mean and used to infer what will be like till 2020. It is estimated that by 2020 Xuwen (the southernmost part) will be in the central tropical zone, most of the coastal part becomes the northern tropical zone and only the northwestern part of province will be included in the



N.T., S.S. C.S. stand for northern tropical, southern tropical and central zones, respectively.



C.T., stands for central tropical zone. Others carry the same meaning as in (a).

Fig.2 Present state of climatic zone division (a) and outlook for 2020 in Guangdong (b).

central subtropical zone contains (Fig.2).

For analyses of other aspects, refer to the Chinese edition of the journal.

4 CONCLUSIONS

(1) Decadal, seasonal and local characteristics have obvious uniqueness in the climatic warming of Guangdong. They all reach high levels of significance as shown in the statistic verification. It is the authors' view that apart from the influence from global climatic warming, governing factors for Guangdong's warming-up include the subtropical high, SST in the South China Sea and human activity. The rise of South China Sea SST and strengthening of the subtropical high are having direct impact on the climatic warming of Guangdong, especially in winter and spring. This time of the year will witness substantial weakening of the northeast monsoon, more frequent appearance of moderate winter and spring and decreasingly fewer periods of low temperature and sustained rain in spring, usually seen in the past.

(2) The rise of South China Sea SST and strengthening of the subtropical high are fastening the warming-up of coastal Guangdong than the mountainous areas in the north, which will increase the

horizontal contrast in thermal amount during winter and spring and favor the northward push of the northern tropical zone. If the current trend holds, Xuwen will be classified into the central tropical zone, the central subtropical zone will withdraw from the province except a few counties in the northwest.

(3) The change of climatic zones seems to be going on quietly, but intriguing issues are drawing more and more attention. For instance, merremia boisiana, calonyctlon acuelatum and ipomoea cairica are tropical plants. They were found in the area of Guangzhou in 2004. It shows that heat conditions typical of northern tropical zone may be close to or reached in some parts of the city, though it still belongs to the southern subtropical zone climatologically. It will be valid to believe that vegetation within the province will continue to change as the climate keeps warming up.

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