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SPECIAL TOPIC ON REGIONAL CLIMATE CHANGE

Observed Climate Change in East China during 1961–2007

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Abstract

By using *in situ* daily observations in East China during 1961–2007 and NCEP reanalysis data, the methods of statistical analyses, urban minus rural and observation minus reanalysis, it is revealed that the observed climate change and surface warming in East China were mainly induced by urbanization. The results show that East China has experienced two warmer periods of 1930s and 1980s in the past century; from 1951 to 2007, the regional mean temperature increased at a rate of 0.14°C per decade; heat waves happened in urban center more frequently, and local climate showed a warming and dry trend; there was no significant linear trend in regional mean precipitation in the past 50 years. Urbanization was a crucial element for the regional warming; about 44% of the warming was due to heat island effect in the mega city.

Keywords: East China; urbanization; climate change

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1 Introduction

Global warming is the main feature of climate changes, and the characteristics and the possible causes are among the core issues in current climate change research [*Ren et al.*, 2008]. According to the IPCC Fourth Assessment Report (AR4), 11 of the last 12 years (1995–2006) ranked among the 12 warmest years in the instrumental records of global surface temperatures (since 1850); the linear trend for the past 50 years was almost twice that for the last 100 years [*IPCC*, 2007a]. *Ding et al.* [2003] found that the temperature in China had increased 0.4–0.5°C over the past 100 years, which was slightly lower than the global mean, and the fastest warming happened in the northwest, north and northeast regions, and urbanization was an important source of uncertainty in the temperature assessment [*Gong and Wang*, 2002].

Both China's largest freshwater bodies — the Dongting Lake, the Yangtze River, as well as the most developed economic zone: the Yangtze River Delta economic zone, are located in East China. The unique location and high intensity of human activities have unique effect on climate. *Zhou et al.* [2009] found that the regional temperature increased at a rate of 0.57°C per decade during 1979–2005; the 10-year warming in East China was approximately 0.5–0.9°C; satellite data showed the tropospheric temperature over East China increased 0.25–0.50°C [*IPCC*, 2007b]. However, some other results [*Lin and Guan*, 2008] showed that

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the regional mean summer temperature decreased from 1961 to 2004.

During the 12th Five-Year Plan (2011–2015), East China will face both opportunities and challenges. Additional challenges include coping with more frequent extreme weather and disasters, such as heavy precipitation, flooding, heat waves, typhoon, fog and haze, lighting, and sea level rise. Study on regional climate change and the projections are significantly important for regional adaptation, which can provide scientific and technological support for local governments to make climate change strategies. This paper analyzes the regional temperature, precipitation, and high-impact weather from 1873 to 2007, as well as the implications of rapid urbanization process in the regional warming.

2 Data and methodology

In this paper, East China (Fig. 1) refers to 6 provinces (Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, and Shandong) and 1 municipality (Shanghai).

2.1 *Data*

(1) Observational data in the period of 1961–2007 include daily mean, maximum and minimum temperatures, precipitation, and relative humidity.

(2) Centennial records of annual mean temperature from 7 stations.

(3) NCEP/NCAR reanalysis data from 1981 to 2007.

(4) Nighttime light imagery from DMSP/OLS during 1992–2007.

2.2 *Methodology*

Optimal interpolation technique is adopted to interpolate station data (temperature and precipitation during 1951–2007) into grid data with the purpose to reduce area weight bias due to different numbers of weather stations and inhomogeneity.

Observation minus reanalysis (OMR) [*Kalnay and Cai*, 2003] and urban minus rural (UMR) approaches are adopted to estimate the possible contributions of urbanization and land use to temperature trends, where urban and rural division is mainly based on demographic data or satellite nighttime lights data [*Yang et al.*, 2011; *Gallo et al.*, 1999; *Hansen et al.*, 1999].

A heat wave event is defined as when the daily maximum temperature $\geqslant 35^{\circ}$C, and the minimum temperature $\geqslant 25^{\circ}$C for three or more consecutive days.

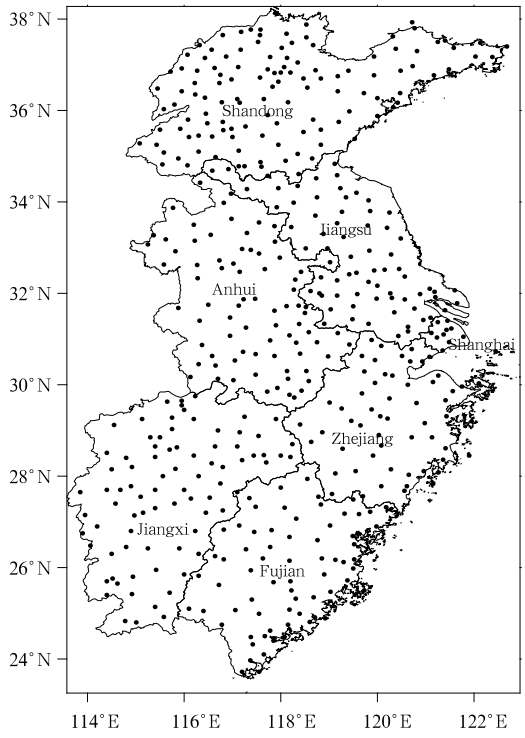

Figure 1 Study area and locations of the stations

3 Temperature

3.1 *Temperature change from 1873 to 2007*

Figure 2 shows the variation of annual mean temperature at each centennial station with records up to 2007. As the solid orange line shows, Shanghai's annual mean temperature went up at a rate of 1.43°C per 100 years, significantly higher than the global average over the past 100 years (0.74°C per 100 years). The two periods of 1905–1945 and 1980–2007 were the most obvious warming stages. From 1994 to 2007, annual mean temperatures in Shanghai were persistently high for 14 consecutive years.

From 1900, Qingdao displayed a significant warming trend (1.01°C per 100 years); the temperatures in Fuzhou and Jinan had no obvious trend; Xiamen had