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ARTICLE

Trends in Monthly Temperature and Precipitation Extremes in the Zhujiang River Basin, South China (1961–2007)

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Abstract

Monthly temperature and precipitation time-series for the Zhujiang River Basin are analyzed in order to identify changes in climate extremes. Daily temperature and precipitation data from 1961 to 2007 of 192 meteorological stations are used. Two temperature indicators (monthly mean and monthly maximum mean) and three precipitation indicators (monthly total, monthly maximum consecutive 5-day precipitation, and monthly dry days) are analyzed. Tendencies in all five indicators can be observed. Many stations show significant positive trends (above the 90% confidence level) for monthly mean temperatures and monthly maximum mean temperatures. For all months, a significant increase in temperature from 1961 to 2007 can be observed in the entire basin with the coastal area in particular. Positive trends of precipitation extremes can be observed from January to March. Negative trends are detected from September to November. The number of dry days in October increased significantly at 40% of all meteorological stations. Stations with changes of monthly precipitation extremes are scattered over the Zhujiang River Basin. An aggregation of heat waves and droughts can be detected which is accompanied by significant increases of temperature extremes and the negative tendencies in precipitation extremes. The detection of tendencies in climate extremes essentially relies on a good data quality and high station density.

Keywords: temperature; precipitation; extremes; Zhujiang River Basin; China

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1 Introduction

In the context of climate change impacts in China, the analysis of observed climate extremes is of high scientific interest. In China's National Assessment Report on Climate Change [*Ding et al.*, 2007] and in numerous scientific articles [*Zhai et al.*, 1999; 2005; 2009a; 2009b; *Zhang et al.*, 2007] the variations of climatic trends in China and its various sub-regions are studied. Climatic changes in East and South China are mainly associated with the East Asian Monsoon conditions. An increase of temperature, especially in winter, and higher variability of precipitation in the last decades are the foremost effects compiled for China. An increase in temperature and precipitation extremes is likely to lead to prolonged and more frequent droughts and flood events. For a detailed climate change impact as-

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sessment and further adaptation procedures, a regionalization of observed climate extremes (e.g., on basin scale) is important.

In recent years, a number of regional studies [*Zhang et al.*, 2009a; 2009b; *Liu et al.*, 2009; *Yang et al.*, 2010; *Gemmer et al.*, 2010; *Fischer et al.*, 2010] investigated climate extremes and their variations for the Zhujiang River Basin. They deal with different climatic variables, time-series, and relatively low station density. *Gemmer et al.* [2010] observed increasing tendencies to dryer conditions and stronger precipitation intensities in the Zhujiang River Basin from 1961 to 2007. Increasing rates of seasonal air temperature in 1961–2007 have been detected by *Liu et al.* [2009] with the highest in winter and lowest in summer. They also observed increases in annual temperature and precipitation records. A trend to more wet conditions from 2001 to 2050 under the SRES-A1B scenario was projected by *Zhai et al.* [2009b] using ECHAM5 outputs.

These studies on climatic changes in the Zhujiang River Basin use different climatic indicators, number of stations, and time-series. The temporal focus was mainly on tendencies of annual and seasonal data. The present study analyzes changes of monthly temperature and precipitation extremes and their spatial pattern in the Zhujiang River Basin. The tendencies of climate indicators are assessed by trend tests. The objective of the study is to identify and analyze tendencies in monthly climate extremes, making use of the highest number of meteorological stations (192) and longest continuous and homogenous time-series available (1961–2007). The results will give important details to managing climate change adaptation and disaster management (e.g., flood and drought preparedness).

2 Regional setting, data and methods

The Zhujiang River (also known as the Pearl River) Basin is located in South China. It has an extent of about 579,000 km² [*Zhai et al.*, 2009a]. Situated in tropical and sub-tropical climates, the East Asian Monsoon influences the entire basin. The basin's west is mountainous with an elevation of up to 2,500 m. In the eastern part mainly flat or hilly low lands prevail (Fig. 1). Following the main topographical steps, the hydrological systems flow from the West and North towards the South-east Coast.

Daily data of temperature and precipitation from 192 national and provincial meteorological stations in the Zhujiang River Basin (Fig. 1) were provided by National Climate Center of China Meteorological Administration (CMA). Daily data is available for 1961–2007. Applying different relevant homogeneity tests [*Alexandersson*, 1986; *Buishand*, 1982; *Peterson et al.*, 1998], the data was successfully checked to be homogenous by the National Meteorological Information Center of CMA [*Song et al.*, 2004]. Five indicators have been defined on standardized classifications of CMA regulations. Monthly averages (maxima) were generated by the

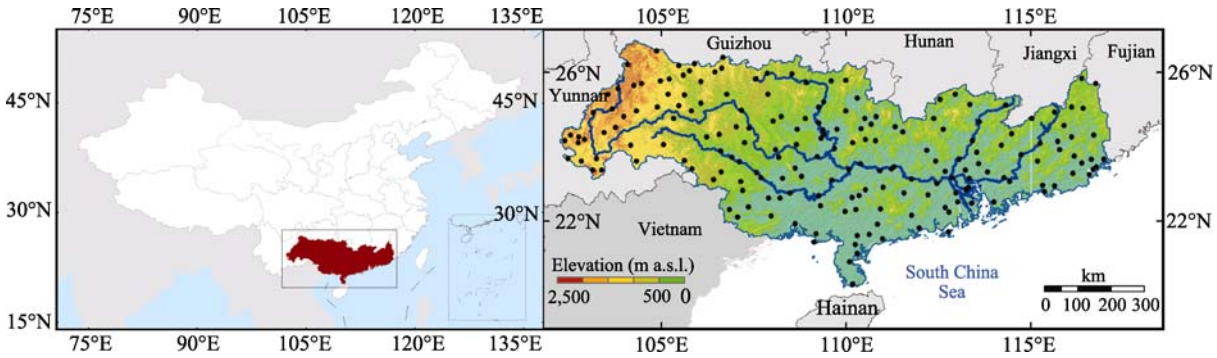

Figure 1 Location of meteorological stations of the Zhujiang River Basin, South China, elevation, and main rivers