IMPACTS OF EL NINO AND LA NINA ON FLOW DISCHARGE OF THE YANGTZE RIVER

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The El Nino/La Nina is the earth's dominant source of year-to-year climate variations (Rasmussen and Wallace, 1983). El Nino events occur during the periods in which the eastern and central equatorial Pacific Ocean is warmer than the normal. La Nina events produces a strong reversion of the average tropical circulation: intense easterly trade winds, unusually cool ocean temperatures in the eastern and central equatorial Pacific, abundant rainfall in eastern Australia and southeast Asia, and very dry weather over the typically dry places in the eastern equatorial Pacific. Generally, during a strong El Nino the ocean temperature is on average 2°C - 3.5°C above the normal between the date line and the west coast of South America. Whereas during La Nina the temperature is on average 1°C - 3°C below the normal. The variations caused by the El Nino and La Nina events in tropical atmospheric heating radiate energy to higher latitudes in wave-like disturbance patterns that can influence atmospheric pressure patterns, winds, and storm tracks thousands of kilometers away (Trenberth et al., 1998). Any El Nino/La Nina event may touch the lives of more than a billion people around the globe and the influences can be devastating, as illustrated by some of the effects of the unusually strong El Nino of 1982-83: Drought in many nations of the western and southwestern Pacific Rim, flooding over wide areas of South America, in western Europe, as well as in the Gulf Coastal states and some Caribbean islands; and severe storms in the western and northeastern United States (Glantz, 1995). The 1997/98 El Nino is the most powerful event since the observation period began in 1870 (WMO, 1999). Its destruction worldwide made El Nino a household word just about everywhere on the globe, even in remote rural areas. Estimates of global loss range from US$ 32 billion (source: Sponberg, 1999) to US$ 96 billion (source: Swiss Re, 1999). In China, the 1997/98 El Nina and the subsequent La Nina are the most important factor for the catastrophic flood in the Yangtze River basin, and the direct economic loss was estimated at 166 billion yuan (20 billion 1998 US dollars) (source: WMO, 1999). These two El Nino events prompt a worldwide program of intensive research on this subject. Most of the research reported and studied the impacts of El Nino on tropical weather and climate system, such as the tropical storms, Tornado, flooding and hurricane etc (Ropelewski and Halpert, 1987; Enfield and Mayer, 1997; Grimm, 2003; Zubair, 2003). However, relatively little attention has been given to the impacts on the river discharge in sub- tropical region.

The Yangtze River is the third longest and fourth largest river in the world. Its water discharge is the largest in the western Pacific Ocean and the fourth largest in the world (Yu and Yue, 2002; Eisma, 1998). The climate change caused by El Nino/La Nina must influence the variability of runoff of the Yangtze River. This research analyzes the impacts of El Nina/La Nina events on the flow discharge of the Yangtze River, employing the measurement data of El Nino index (SST Index: the sea-surface temperature anomalies in

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the Nino 3.4 region) and flow discharge at Datong hydrologic station (the near-to-sea station of the Yangtze River) during the period of 1950~2000. On the basis of the El Nino and La Nina events threshold: +/- 0.5°C for the SST Index Ocean Nino Index, there are 15 events of El Nino and 13 events of La Nina (Fig.1 and Table 1) (NOAA/ National Weather Service, 2005).

From the power spectrum curve of SST Index (Fig.3a), the frequency are combinations of three fundamental frequencies at 0.201, 0.274, 0.347, corresponding to periods of 5.0 a, 3.6 a and 2.9 a. From the power spectrum curve of monthly mean flow discharge (Fig.3b), the frequencies are combinations of the 0.137, 0.431 and 1.000, corresponding to periods of 7.3 a, 2.3 a and 1 a. Compared with the power spectrum of SST Index and flow discharge, both of the time series have the frequencies of 0.274 and 1.000, corresponding to the periods of 3.6 a and 1 a, which indicated that there exists some correlation between the El Nina/ La Nina events and the flow discharge of the Yangtze River.

From the correlogram map of SST Index and flow discharge record (Fig.4), both of the series are nonstationary series, and these two timing series have similar autocorrelation coefficient distributions at the lag range of 1 to 12 month, which indicates that there are some relationships between these two timing series.

From the above analysis, there exit some relationships between the El Nina/La Nina events and the flow discharge of the Yangtze River. To identify its relationship, we statistically analyze the anomalies of discharge during the events of El Nina and La Nina from 1950 to 2000. Of all of the 15 El Nino events, 4 events have positive anomalies and 11 events have minus anomalies, the average discharge during the 15 El Nino events is four percent less than the overall mean discharge during the period of 1950~2000 (Fig.5a and table 2). Of all of the 13 La Nina events, 7 events have positive anomalies and 6 events have minus anomalies. The average discharge during the 15 La Nina events is six percent more than the overall mean discharge (Fig.5b and table 3).

Keywords: El Nino; La Nina; Flow discharge; The Yangtze River

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