Relationship of El Nino event to Natural Disasters

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ABSTRACT

El Nino event can introduce global climate anomaly and severe meteorological-oceanic disasters. Historical data shows that, the yearly typhoon occurrence frequency (F) value is less in El Nino year, moderate in normal year, and more in Anti--El Nino year, and a severe flooding would happen in the Yangtze--Huaihe Rivers in early summer following the El Nino event. However in 1990s', three continuous events happened in 1991, 1993 and 1994, and the strongest event in 1997--1998. As a result, the anomalous and very severe disaster situation was also observed in 1990s'. About every 20 years in the 20th century, a re-occurrence stage of extremely severe storm surge disasters (ESSSD) including 1-3 tidal disasters took place over the world. While in the latest stage in early 1990s', 5 times of ESSSD were unexpectedly observed. This situation should be considered as closely relating to anomalous continuous El Nino situation. The mechanism of impact of El Nino event is also studied in this paper.

1 Introduction

As well known, El Nino event, the large scale anomalous warming of sea surface temperature (SST) in the eastern--central equatorial Pacific can introduce global climate anomaly and severe meteorological-oceanic disasters. The strongest event in 1982--1983 lasted for one and half year with the maximum SSTA of +2.6°C. It introduced very rarely seen typhoon, flooding, drought and warm winter with the direct economic loss of about US $ 20--30 billions. While in 1990s', an anomalous El Nino event situation was observed (Bao & Xiang, 1996). 3 continuous events happened in early stage of 1990s': May, 1991--August, 1992, April, 1993--January, 1994 and October, 1994--March, 1995. An even stronger event with the maximum SSTA of +2.9°C was observed in 1997--1998. This anomalous El Nino situation was corresponding to more frequent and severe disasters in 1990s'. An extremely severe flooding took place in the Yangtze River and Songhuajiang--Nenjiang Rivers of China in summer of 1998. In this paper, the relationship between El Nino event and meteorological-oceanic disasters, as well as its mechanism is studied.

2 Typhoon

Typhoon in the NW Pacific Ocean is the most frequent and severe meteorological-oceanic disasters to national economy and people's lives and property in coastal regions. In this paper, it is shown that El Nino event closely relates to the frequency (F) of yearly typhoon occurrence. When El Nino event happens, sea surface temperature in the eastern--central equatorial Pacific Ocean raises anomalously. It directly introduces an anomalous lower SST in the tropical--equatorial western Pacific. The historical data (Table 1) shows that, F is less in El Nino year, moderate in normal year, and more in Anti--El Nino year (Bao & Xiang, 1992). It was especially true in 1990s'. Three low valleys of F curve are corresponding to thrice continuous events in early 1990s', and extremely few only, 13 typhoon were observed in summer of 1998 after the strongest event.

Table 1 El Ninuo event and the yearly typhoon occurrence frequency (F) and typhoon number landing on China (N) in 1950-1989

	F			N		
	mean value	maximum	minimum	mean value	maximum	minimum
El Nino year	26.1	33	20	6.7	9	4
Normal Year	28.1	35	22	8.0	12	5
Anti-El Nino year	30.5	40	23	9.3	12	5
40 years average	28.2			8.0		

Table 2 Starting season of El Nino event and drought-flooding in the Yangtze--Huaihe Rivers in 1951-1999

Starting season	Year	Flooding or drought					
Spring	Same year	1957	1963	1965	1969	1991	1993
		F	F	F	F	EF	F
	Next year	1958	1964	1966	1970	1992	1994
		ED	N	ED	N	D	ED
Summer	Same year	1972	1976	1997			
		F	N	N			
	Next year	1973	1977	1998			
		F	N	EF			
Autumn	Same year	1953	1982	1986	1994		
		N	F	D	ED		
	Next year	1954	1983	1987	1995		
		EF	EF	F	F		

D: Drought, ED: Extremely Drought, N: Normal, F: Flooding, EF: Extremely Flooding

Table 3 El Nino event lasting for 2 years and drought--flooding in the Yangtze--Huaihe Rivers in 1951--1999

Same year	1957	1982	1986	1997
	F	F	D	N
Next year	1958	1983	1987	1998
	ED	EF	F	EF
Third year	1959	1984	1988	1999
	ED	N	D	N

3 Flooding in Yangtze-Huaihe Rivers

The monsoon rainfall in China, flooding-drought in the Yangtze--Huaihe Rivers in early summer, is corresponding to sudden change of East Asian atmospheric circulation in summer, and gives a greatest effect on China economy. The historical data (Table 2 and 3) also shows that, in early summer after El Nino event, the Yangtze-Huaihe Rivers usually suffered severe flooding (Xiang et al, 1994) including 3 extremely severe floodings in 1954, 1991 and 1983. It was also very clear that, 3 severe floodings happened frequently in 1991, 1993 and 1995 corresponding to three continuous El Nino events in early 1990s'. And the most disastrous flooding hit Yangtze River basin and Songhuajiang-Nengjiang Rivers basin in summer of 1998. The direct economic loss only in Yangtze Rivers was as high as about US $ 30 billions. It should be closely related to the anomalous El Nino situation in 1990s'.

4 Storm surge disaster

Storm surge of more than 1 m caused by typhoon usually introduces very severe disasters to coastal region. The Bengladesh, USA and China are three countries most suffered by storm surge. Historical data showed that, about every 20 years in the 20th century, a reoccurrence stage of extremely severe storm surge disaster (ESSSD) including 1-3 tidal disasters took place over the world (Bao, 1994). The recent stage was in 1969--1970. Among them, a very strong storm surge of about 6 meters high in the Bengladesh killed about 300,000 persons in November 12-13, 1970. 20 years later, the "Centural Hurricane"--Hugo struck South and North Carolinas, USA with direct economic loss of US $ 9 billions in August, 1989. Another very high storm surge killed 138,000 persons of the Bengladesh at nighttime of April 29, 1991. To our surprise, another three ESSSDs unexpectedly happened: Hurricane Andrew hit the southern end of Florida, USA with a new record of direct economic loss of about US $25 billions on August 24, 1992. One week later, Typhoon 9216 (Porry) struck 8 provinces of eastern China coast on August 29, 1992 with economic loss of about RMB 9 billions (Fig. 1). Then at nighttime of August 21, Typhoon 9417 (Gladys) landed on Wenzhou, Zhejiang. It killed more than 1,000 persons and made economic loss of RMB 17 billions. Altogether 5 times of ESSSD were too much and too severe in a short time period of 4-5 years. This situation should be considered as closely relating to anomalous continuous El Nino situation.

5 Warm winter and sea ice in the Bohai Sea

Most of scientists believe that more CO_2 releasing is the cause of global climate warming especially warm winter. However, we suggested another supplemental cause, El Nino event (Xie & Bao, 1990). In 1950-1989, the winters following El Nino event were rather warmer with light or normal sea ice situation in the Bohai Sea, while the winters following Anti-El Nino event were rather cold with normal or heavy sea ice situation in the Bohai Sea. It is especially true in the recent 20 years. There were 6 times of El Nino events with two strongest events in 1982-1983 and 1997-1998. There were only two weak Anti-El Nino events in 1988-1989 and 1998-1999. Therefore, continuous warm winters and light sea ice took place lasted for almost 20 years excepting in winter of 1988-1989 and 1999-2000. The air temperature anomaly in winter in the northeast Asia was usually as high as + 10°C. The January temperature of Beijing in 1992 and 1995 created two new highest records in past 123 and 126 years. While in winter of 1999-2000 after an Anti-El Nino event, it was warmer in December than normal, but very cold in January.

6 Theoretical explanation

The mechanism of impact of El Nino event is also studied in this paper. It is found that El Nino event strongly correlate to the subtropical high (Bao & Xiang, 1992). The significant correlation coefficient ($r \geq 0.4$) between El Nino event and 500 mb height field exists from same autumn to next summer with the highest correlation coefficient in NW Pacific and NW Atlantic in same winter- next spring after the event (Fig. 2). During the strongest season, El Nino event gives its impact by two-dimensional Rossby wave series from the northern subtropical latitude to the middle--higher latitudes of northern and southern hemisphere (Fig. 3) (Xiang & Bao, 1993, Bao & Xiang, 1995). As a result, El Nino event gives a great impact to global atmospheric circulation and climate, as well as natural disasters.

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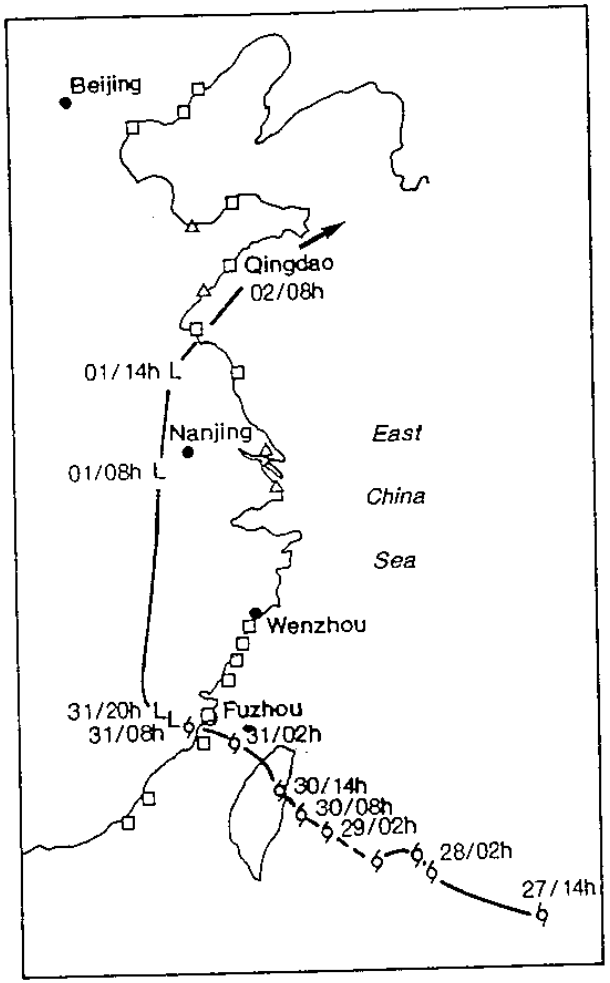

Fig. 1 Track of Typhoon 9216 (Polly) and Its impact
□ Station breaking highest tidal level record
Δ Station creating 2nd highest tidal level record

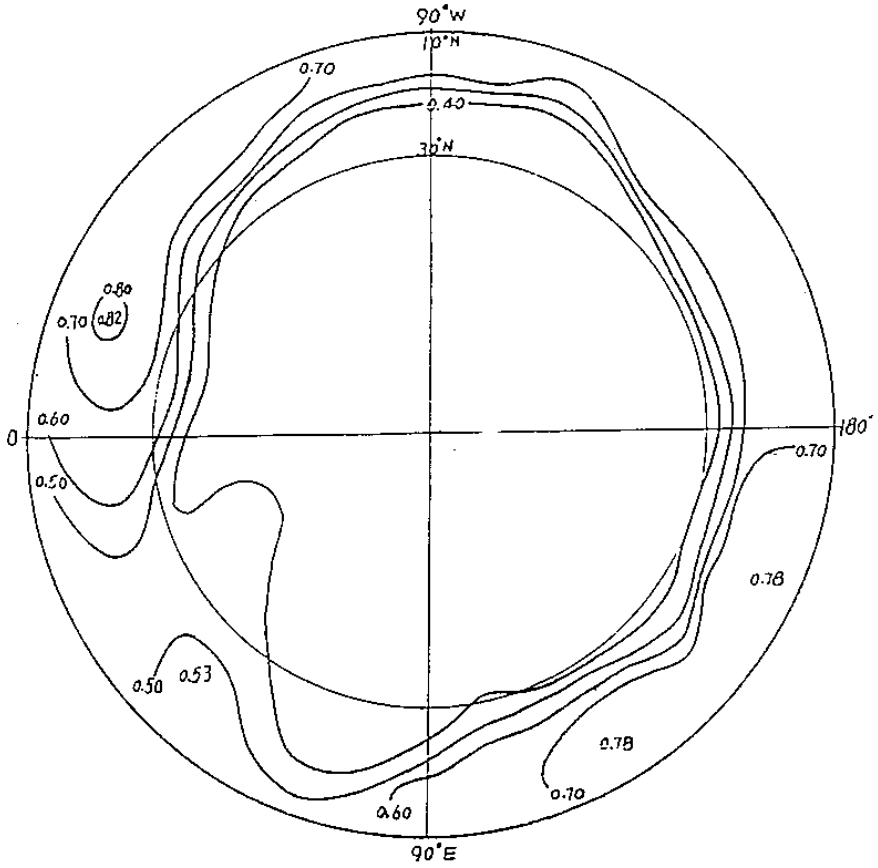

Fig. 2 Distribution of significant correlation coefficient ($r \geq 0.4$)between El Nino event and 500 mb height field in winter of same year

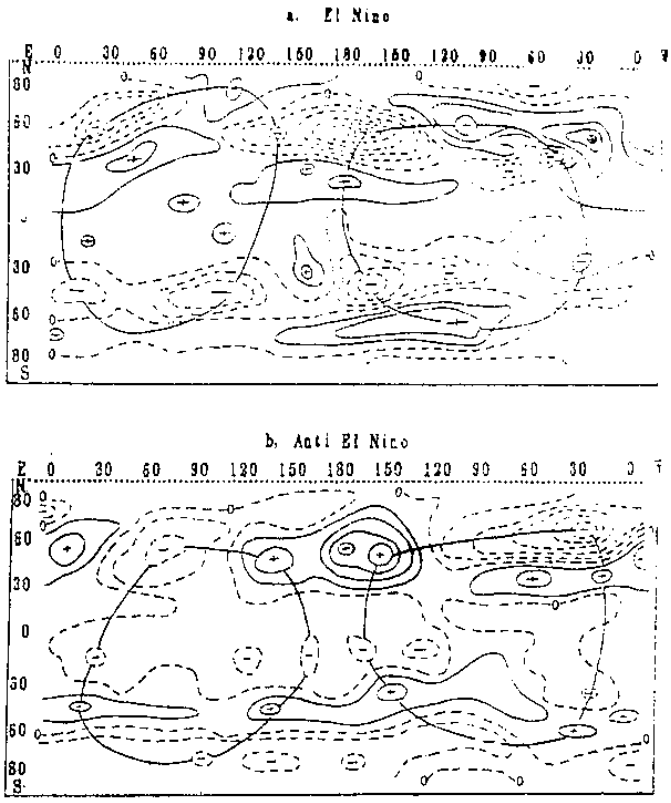

Fig 3 Composited 500 mb height anomaly field
in Fenruary of next year of El Nino event