Delayed Impacts of the El Niño Episodes in the Central Pacific on the Summertime Climate Anomalies of Eastern China in 2003 and 2007

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ABSTRACT

In the summers of 2003 and 2007, eastern China suffered similar climate disasters with severe flooding in the Huaihe River valley and heat waves in the southern Yangtze River delta and South China. Using SST data and outgoing longwave radiation (OLR) data from NOAA along with reanalysis data from NCEP/NCAR, the 2002/03 and 2006/07 El Niño episodes in the central Pacific and their delayed impacts on the following early summertime climate anomalies of eastern China were analyzed. The possible physical progresses behaved as follows: Both of the moderate El Niño episodes matured in the central equatorial Pacific during the early winter. The zonal wind anomalies near the sea surface of the west-central equatorial Pacific excited equatorial Kelvin waves propagating eastward and affected the evolution of the El Niño episodes. From spring to early summer, the concurring anomalous easterly winds in the central equatorial Pacific and the end of upwelling Kelvin waves propagating eastward in the western equatorial Pacific, favored the equatorial warm water both of the SST and the subsurface temperature in the western Pacific. These conditions favored the warm state of the western equatorial Pacific in the early summer for both cases of 2003 and 2007. Due to the active convection in the western equatorial Pacific in the early summer and the weak warm SST anomalies in the tropical western Pacific from spring to early summer, the convective activities in the western Pacific warm pool showed the pattern in which the anomalous strong convection only appeared over the southern regions of the tropical western Pacific warm pool, which effects the meridional shift of the western Pacific subtropical high in the summer. The physical progress of the delayed impacts of the El Niño episodes in the central equatorial Pacific and their decaying evolution on the climate anomalies in eastern China were interpreted through the key role of special pattern for the heat convection in the tropical western Pacific warm pool and the response of the western North Pacific anomalous anticyclone.

Key words: El Niño episodes, climate impact, eastern China

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1. Introduction

The El Niño episode is one of the most important factors affecting worldwide climate anomalies. The impacts of El Niño episodes on climate anomalies in East Asia have been researched in the last two decades. Wang and Zhu (1986) found that when an El Niño episode occurs, North-East Asia generally goes through a cooler summer. The review by Liu and Ding (1992) summarized observational results as well as possible physical mechanisms relating ENSO events and anomalous circulations in East Asia, drought/flood, anomalous typhoon activities, and cool summers in China. El Niño episodes can weaken the impact of the East Asian winter monsoon through strengthening the western Pacific subtropical high in boreal winter (Tao

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and Zhang, 1998).

However, the impact of El Niño episodes on the East Asian summer monsoon rainfall is usually more complex, greatly depending on different stages of the ENSO cycle (Fu and Teng, 1988; Huang and Wu, 1989). During a summer at the developing stage of an El Niño episode, a drought may be caused in North China, and summer rainfall may be above normal in the Yangtze River and Huaihe River valleys, but in the decaying stage of an El Niño episode, the below-normal summer rainfall and associated droughts tend to occur in the Yangtze River and Huaihe River valleys, while the summer monsoon rainfall may be normal or above-normal in North China, and large positive rainfall anomalies, including excessively heavy rainfalls and floods, may be observed in the region to the south of the Yangtze River (Huang and Wu, 1989). During different phases of El Niño, for the period of 1951–2000, the ENSO-related rainfall anomalies in East Asia consist of the positive center of action in southern China, eastern central China, and southern Japan during the fall of an El Niño developing year through the following spring. The negative center of action is over northern China during the summer and fall of an El Niño developing year (Wu et al., 2003).

How El Niño episodes affect the East Asian monsoon circulation is an important issue for understanding the relationship between El Niño and climate anomalies in East Asia. Zhang et al. (1996) investigated the East Asian monsoon circulation during the El Niño episodes of 1986/87 and 1991/92. They found that a southerly wind anomaly appeared in the lower troposphere along the coast of East Asia during the mature phase of the two episodes, and they suggested that the effect of El Niño on the variations of the East Asian monsoon is felt through the changes in convective activities over the western equatorial Pacific. When an El Niño episode achieves its mature phase, the convection, in the tropical western Pacific, is strongly suppressed by the evolution of positive sea surface temperature anomalies in the central-eastern equatorial Pacific, which exerts a significant influence on the East Asian monsoonal circulation. They thought that the existence of the southerly anomalies in the lower troposphere along the coast of East Asia appeared to be related to the Philippine Sea anticyclone anomaly, interpreted as a form of the equatorial Rossby wave response to the anomalous cooling near the equator. However, the El Niño episodes normally mature in the boreal winter, except that the 1986/87 episode analyzed in Zhang et al. (1996) matured in the summer of 1987. Wang et al. (2000) also emphasized the key role of the anomalous lower-tropospheric anticyclone located in the western North Pacific. The anomalies persisted until the following spring or early summer, causing the anomalous climate in East Asia. They argued that the development of the anomalous anticyclone was nearly concurrent with the enhancement of the local sea surface cooling. The mechanism responsible for the development and persistence of the Pacific-East Asian teleconnection is primarily attributed to a positive thermodynamic feedback between the anticyclone and the sea surface cooling in the presence of mean northeasterly trades (Wang et al., 2000; Lau and Wang, 2006). The above analysis and theory are confined to the subtropics and tropics. Wang et al. (2001) studied the delayed impacts of ENSO to the mid-high latitude circulation anomalies. Composite results suggested a delayed impact of ENSO on the East Asian summer atmosphere circulation. During the summer after the El Niño episode reaches its mature phase, an anomalous blocking high tends to occur in northeast Asia, which favors Meiyu rainfall two or three seasons after the mature phase of the warm episode (Wang et al., 2001).

Though the impact of El Niño episodes on the East Asian summer monsoon has not been understood fully, the ENSO cycle is an important factor in predicting the anomalous precipitation in eastern China (Chen, 1977). However, recent results show that the relationship between ENSO and summer precipitation in China has weakened in the last two decades (Gao and Wang, 2007). This weakening relationship has increased the difficulty of predicting the summer rainfall in China, which was explained by the interdecadal variation of the East Asian summer monsoon and tropical Pacific SSTs (Chang et al., 2000). According to the research work by Huang and Wu (1989), the convective activities are generally strong around the Philippines in the decaying stage of the El Niño episode, and the below-normal summer rainfall and associated droughts tend to occur in the Yangtze River and Huaihe River valleys. However, during 1997–1998, the strongest El Niño episode occurred in the equatorial central and eastern Pacific, and it brought severe floods in the Yangtze River valley in the summer of 1998. Huang et al. (2000) researched the impact of this El Niño episode on summer climate anomalies in East Asia. They found that the sea temperatures in the sub-layer of the western Pacific warm pool dropped in the summer of 1998, and consequently the western Pacific subtropical high shifted southward. This suggested that the convective activities around the Philippines, associated with the decaying evolution of El Niño episodes, directly affected the anomalous anticyclone in the western tropical Pacific, including the evolution of sea temperatures in the sub-layer of the western Pacific warm pool. Not only do the decaying evolution of the El Niño episodes affect the East Asian summer monsoon rainfall, but the styles of El Niño episodes also have different impacts on the summertime climate in East Asia. Recently, Weng et al. (2007) reported that El Niño Modoki and its climate impacts are very different from those of the canonical El Niño. El Niño Modoki is characterized by above-normal SST in the central equatorial Pacific, flanked by below-normal SST in both the east and west (Ashok et al., 2007). When an El Niño Modoki episode occurs, Japan and the Yangtze River valley in China are more likely to suffer from drought due to a weakened East Asian summer monsoon (Weng et al., 2007), whereas they did not discuss the next summer's rainfall anomalies in East Asia during the decaying stage of the El Niño Modoki episode.

In the summer of 2003 and 2007, eastern China suffered similar climate disasters, with floods in the Huaihe River valley and hot weather in the region to the south of the Yangtze River. Weng et al. (2007) argued that the 2002/03 El Niño episode should be classified as an El Niño Modoki episode rather than a canonical El Niño episode. Similarly, the 2006/07 El Niño episode also has a maximal positive SST anomaly in the central equatorial Pacific during its mature phase of the 2006/07 episode. This paper explores the delayed impacts of El Niño episodes in the central equatorial Pacific and their decaying evolution on the summertime climate anomalies of eastern China in 2003 and 2007. Section 2 describes the data used in this study. Section 3 shows the climate anomalies of eastern China in the summers of 2003 and 2007. Preceding El Niño episodes and their decaying evolution are analyzed in section 4. Physical progress of the impacts of El Niño episodes on the summertime climate anomalies in eastern China is examined in section 5. Section 6 includes the discussions and summary.

2. Data

The present study uses the National Oceanic and Atmospheric Administration (NOAA) optimum interpolation (OI) version 2 monthly mean SST (Reynolds et al., 2002) obtained through ftp://ftp.cdc.noaa.gov/Datasets/noaa.oisst.v2/. This SST dataset is available on a $1^\circ \times 1^\circ$ grid and covers the period of November 1981 to the present. A long term monthly mean is derived from the data for 1971–2000. The data used for the atmosphere circulations is the National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalysis data obtained from the NOAA Climate Diagnostics Center (Kistler et al., 2001). We used the monthly mean data at the standard pressure levels and on a $2.5^\circ \times 2.5^\circ$ grid. Daily averages of outgoing longwave radiation (OLR) on a 2.5° square grid, obtained through NOAA satellites, were used as a proxy for large-scale convective activity over the tropical and subtropical regions. Monthly mean OLR data was also used for depicting the evolution of the equatorial atmospheric convection. Figures about the equatorial Pacific subsurface temperatures, provided by the Climate Diagnostics and Prediction Division/NCC, are based on NOAA/PMEL TAO buoy data, TOPEX/POSEIDON sea-level data, and ships of opportunity (http://www.cpc.noaa.gov/products/analysis_monitoring/). The monthly mean surface temperature data and monthly accumulated precipitation from 160 land stations in China, provided by the National Climate Center, are used to look at the climate anomalies in the summers of 2003 and 2007.

3. Summertime climate anomalies of eastern China in 2003 and 2007

There is a large similarity between the summertime climate anomalies of eastern China in 2003 and 2007. Figures 1a and 1b are the seasonal mean (June–July–August) rainfall anomalies of eastern China during 2003 and 2007, respectively. More than 20% of the above-normal rainfall covered the whole Huaihe River valley, on the contrary, less than 20% of the below-normal rainfall covered the region south of the Yangtze River in 2003 and 2007. Figures 1c and 1d are the monthly mean rainfall anomalies of eastern China during July 2003 and 2007, respectively. It is obvious that the patterns are very similar to the seasonal mean anomalies in eastern China, with wider drought regions in southern China. In 2003, the persistent heavy rain events occurred in the Huaihe River valley from 30 June to 10 July (Bao, 2008). The persistent heavy rains caused severe flooding in the Huaihe River valley. In 2007, the total area mean precipitation of the Huaihe River is 465.6 mm from 29 June to 26 July of this year, which is only less than that of 1954, during the same period since 1953. The Huaihe River suffered the most severe drainage flooding. At the same time, a severe drought emerged in southern China. This distribution of wet/dry conditions in eastern-central China (Fig. 1d) is very similar to July 2003 (Fig. 1c), showing an anti-symmetric pattern along the Yangtze River.

The temperature anomalies that mainly occurred in July are similar to the anomalous precipitation events. Figure 2 is the monthly mean temperatures and anomalies in July 2003 and 2007. The areas with temperatures higher than 30°C nearly cover the re-

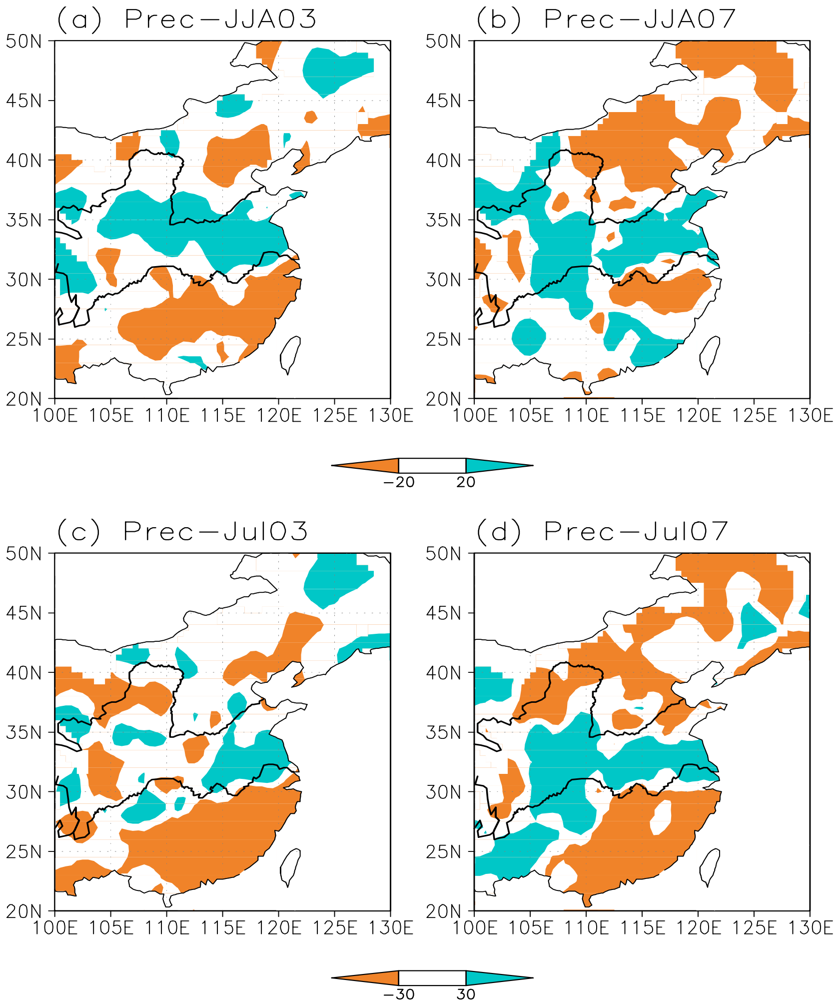

Fig. 1. The rainfall anomaly percentage of eastern China in June–July–August of (a) 2003 and (b) 2007 and in July (c) 2003 and (d) 2007. (Units: %)

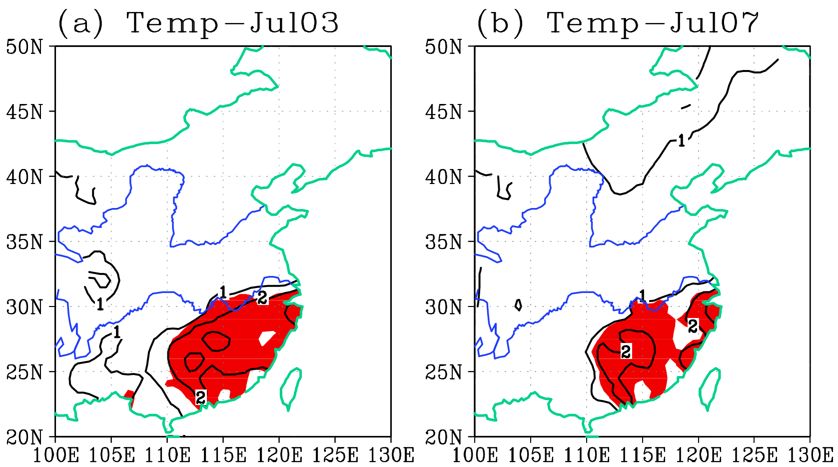

Fig. 2. The temperatures and anomalies of eastern China in July (a) 2003 and (b) 2007. (Units: °C). The regions with temperatures higher than 30°C are shaded and contour lines of the positive anomalies are 1°C, 2°C, and 3°C respectively.

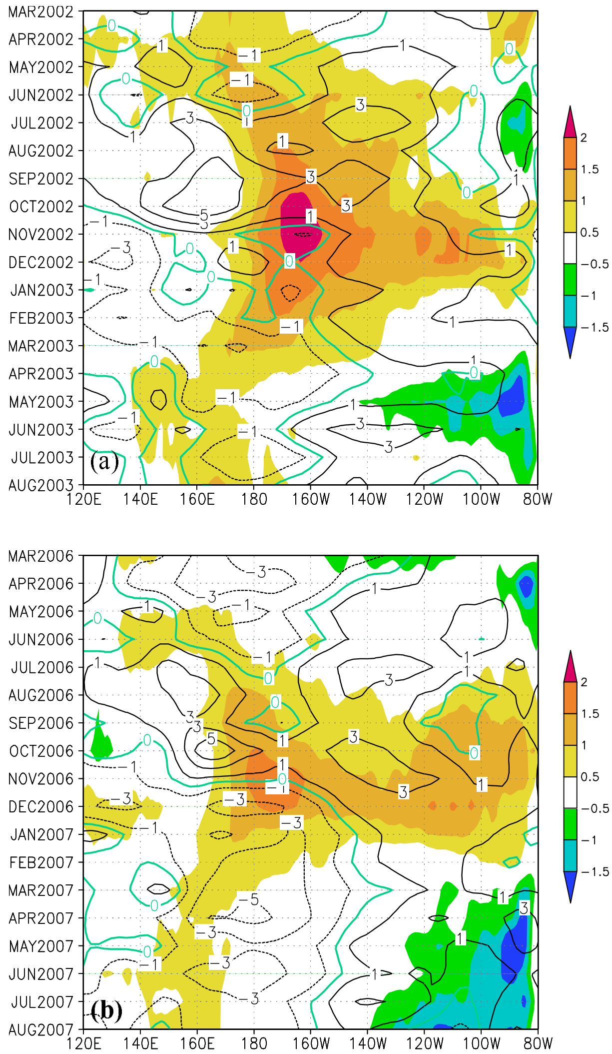

Fig. 3. Monthly mean anomalies of zonal wind (contour lines) and SST (shaded) averaged between 5°N–5°S relative to the mean seasonal cycle during (a) 2002/2003 and (b) 2006/2007.

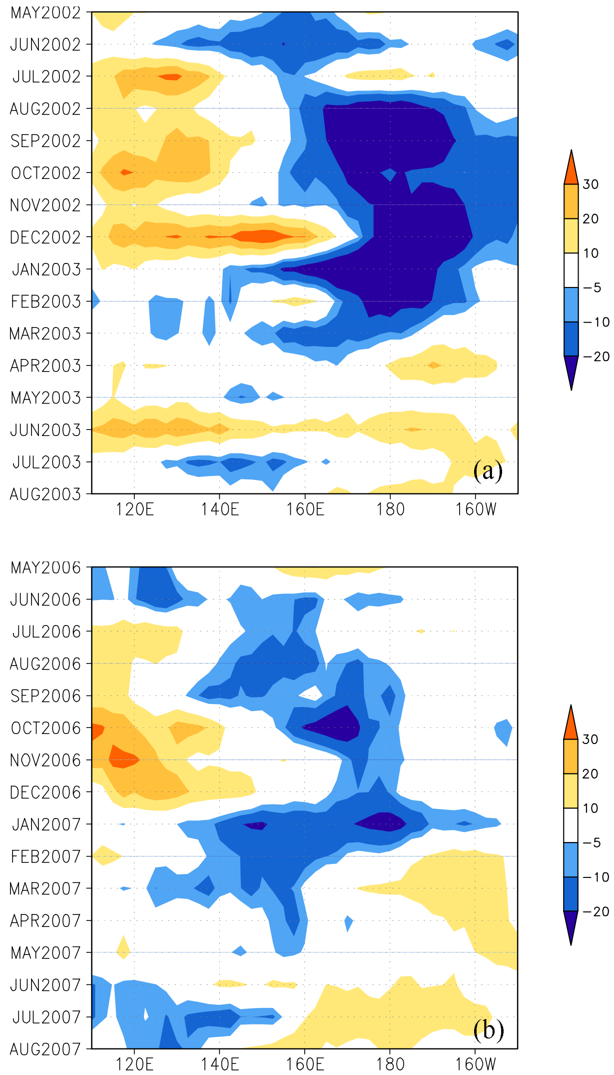

Fig. 4. Monthly mean anomalies of OLR (shaded) averaged between 5°N–5°S relative to the mean seasonal cycle during (a) 2002/2003 and (b) 2006/2007. (Units: W m^{-2})

gion south of the Yangtze River in eastern China, both in 2003 and 2007. The temperature anomaly showed that all of east-southern China had higher than a 1°C positive anomaly in July of these two years, and even higher than a 2°C positive anomaly occurred in the Hunan, Jiangxi, Zhejiang and Fujian provinces. Hot weather enveloped most parts of the southern Yangtze River delta and the South China.

4. Preceding El Niño episodes in the central Pacific and their decaying evolution

4.1 *Developing and mature stage*

The evolution process of the 850-hPa zonal wind anomalies and the SST anomalies in the equatorial Pacific during the 2002/03 El Niño episode and 2006/07 El Niño episode can been seen in Fig. 3. In May 2002, anomalous westerly wind in the western Pacific led to a 1°C or higher warming near the date-line (Fig. 3a). Following the westerly wind anomaly in May, another westerly wind burst was developing in the western Pacific in late June (McPhaden, 2004). The westerly wind anomalies near the sea surface of the western tropical Pacific advected the western Pacific warm water into the central Pacific, and in August 2002, positive SST anomalies, higher than 1.5°C, formed in the equatorial central Pacific (Fig. 3a). Anomalous westerly wind forcing continued to excite warm equatorial Kelvin waves propagating eastward (McPhaden, 2004). Strong westerly wind anomalies in the western tropical Pacific, therefore, promoted the peak phase of the El Niño episode during October–December 2002. However, this El Niño episode was just a moderate episode occurring in the equatorial central Pacific. When the El Niño episode achieved its mature phase, the convective activities in the western Pacific were suppressed during the anomalous heating over the central equatorial Pacific (Fig. 4a). This east-west dipole of the convection anomalies is the same as Zhang et al. (1996).

In May 2006, westerly wind anomalies emerged in the western equatorial Pacific (Fig. 3b). From July to October 2006, persistent anomalous westerly winds developed in the western equatorial Pacific and favored the warming episode in the central equatorial Pacific. The SST showed positive anomalies, higher than 1.5°C, in the central equatorial Pacific during October–December 2006, indicating that a weak to moderate El Niño episode matured in the central Pacific. At this time, the positive OLR anomalies appeared around the maritime continent (Fig. 4b), that is to say, anomalous cooling over the western Pacific formed when the El Niño episode achieved the peak phase, although it is not a strong episode. As seen in Fig. 3 and Fig. 4, it is clear that the process during the developing and mature stages of the El Niño episode is very similar to that of 2002.

4.2 *Decaying stage*

Before the 2002/03 El Niño episode decayed in the central equatorial Pacific, easterly anomalies appeared in the far western Pacific in November 2002 (Fig. 3a). Cold Kelvin waves, directly forced by anomalous easterly winds, obviously propagated eastward, along with the end of easterly anomalies in March 2003 (Fig. 5a). From February 2003, the easterly anomalies in the central Pacific advected anomalous warm water from the central equatorial Pacific to west of the dateline in the sea surface. Warm SST anomalies were reduced to only about 0.5°C and confined to west of the dateline since April 2003 (Fig. 3a). From spring to early summer, the concurring anomalous easterly winds in the central equatorial Pacific and the end of upwelling Kelvin waves propagating eastward in the western equatorial Pacific, favored the equatorial warm water both of the SSTs and the subsurface temperatures in the western Pacific (Fig. 3a and Fig. 5a). This scenario favors the warm state of the western equatorial Pacific in the early summer, but not implying the warm water in the whole western tropical Pacific. Consequently, the equatorial OLR appeared as negative anomalies between 120°E to 160°E in July 2003 (Fig. 4a), and the OLR of the western tropical North Pacific indicated a persistent strong convection in the southern region of the warm pool from late June to late July (Fig. 6a).

As seen in Fig. 3b, anomalous easterly winds first emerged in the western equatorial Pacific in November 2006. Like the decaying evolution of the 2002/03 El Niño episode, the cold Kelvin wave, excited by the anomalous easterly winds, propagated eastward until February 2007 (Fig. 5b), and then the 2006/07 El Niño episode began its decaying stage. By March 2007, warm SST anomalies were reduced to only 0.5°C and confined to west of the dateline (Fig. 3b). As seen in Fig. 5b and Fig. 3b, the subsurface warm water in the western equatorial Pacific was maintained from April to July 2007, and the weak SST positive anomalies in the eastern parts of the western equatorial Pacific tended to induce strong convection in the western equatorial Pacific in July 2007 (Fig. 4b and Fig. 6b).

5. Possible physical progresses for the delayed impact on climate anomalies in eastern China

5.1 *Convective activities in the western tropical Pacific*

Based on nine cases of persistent heavy rain events in the Huaihe River valley, Bao (2008) discussed the relationship between persistent heavy rain events in the Huaihe River valley and the distribution pattern of convective activities in the western tropical Pacific warm pool. The northern edge of the West Pacific subtropical high continues to lie in the Huaihe River valley and is associated with the persistent "north weak south strong" distribution pattern of convective activities in the western Pacific warm pool.

As seen in section 4, the convection in the western equatorial Pacific has two similar characteristics between the periods of the 2002/03 El Niño episode and the 2006/07 El Niño episode (Fig. 4). One is the suppressed convection in the western equatorial Pacific during the mature phase of two El Niño episodes; and the other is the active convection in the western equatorial Pacific in July. In order to examine the anomalous convective activities in the whole western tropical Pacific, Fig. 7 is given to contrast the two cases. When the El Niño episode matured in the central Pacific during October–December 2002, the convective activities were suppressed in the western tropical Pacific, and the western North Pacific anomalous anticyclone, interpreted as a form of the equatorial Rossby wave response to the anomalous cooling in the western tropical region, covered the Philippine Sea (Fig. 7a). The convection in the western tropical Pacific was also

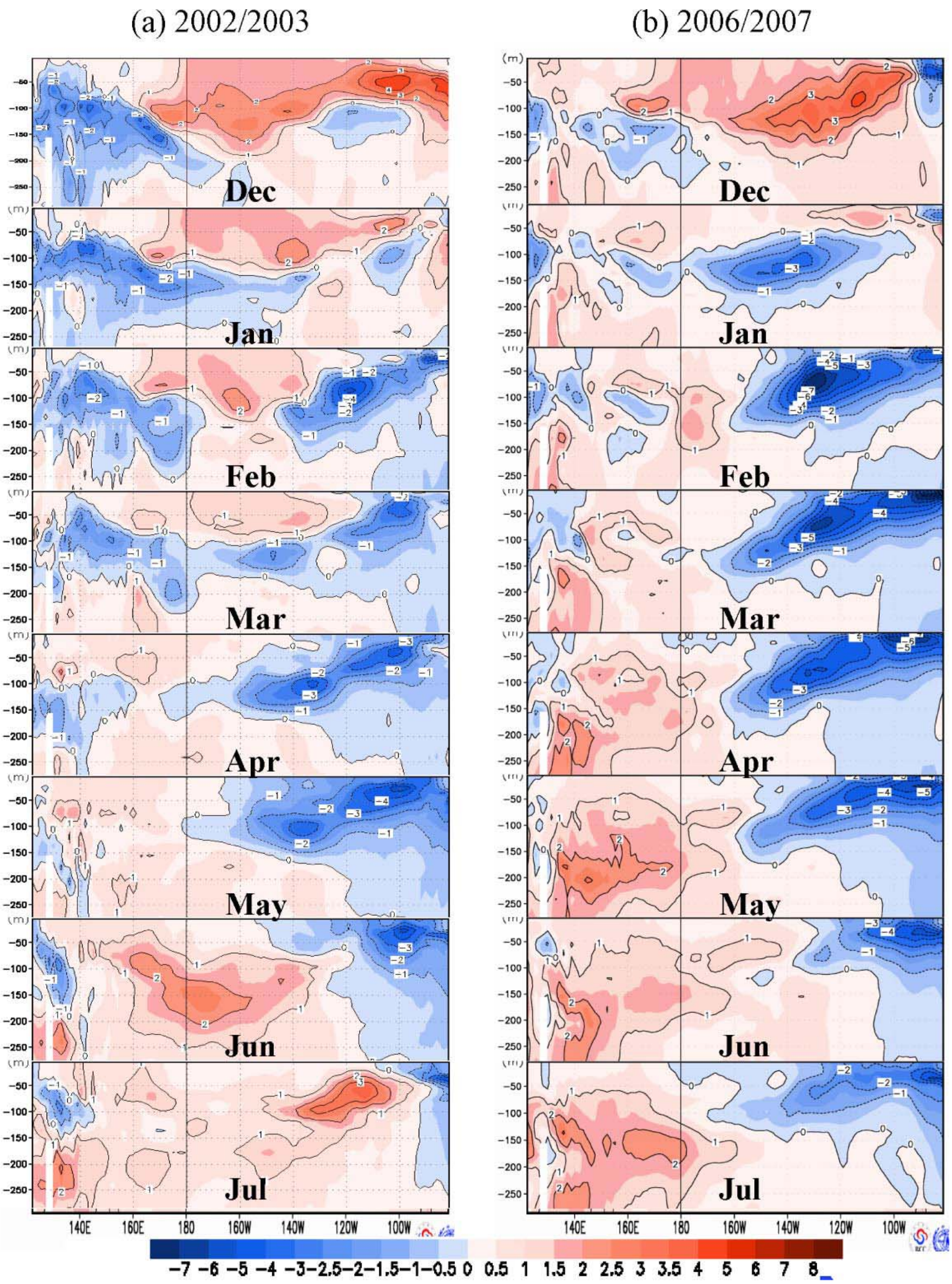

Fig. 5. Equatorial depth-longitude sections of monthly mean ocean temperature anomalies of (a) 2002/2003; and of (b) 2006/2007 (Units: °C). (This figure, provided by the Climate Diagnostics and Prediction Division/NCC, is based on NOAA/PMEL TAO buoy data, TOPEX/POSEIDON sea-level data, and ships of opportunity.)

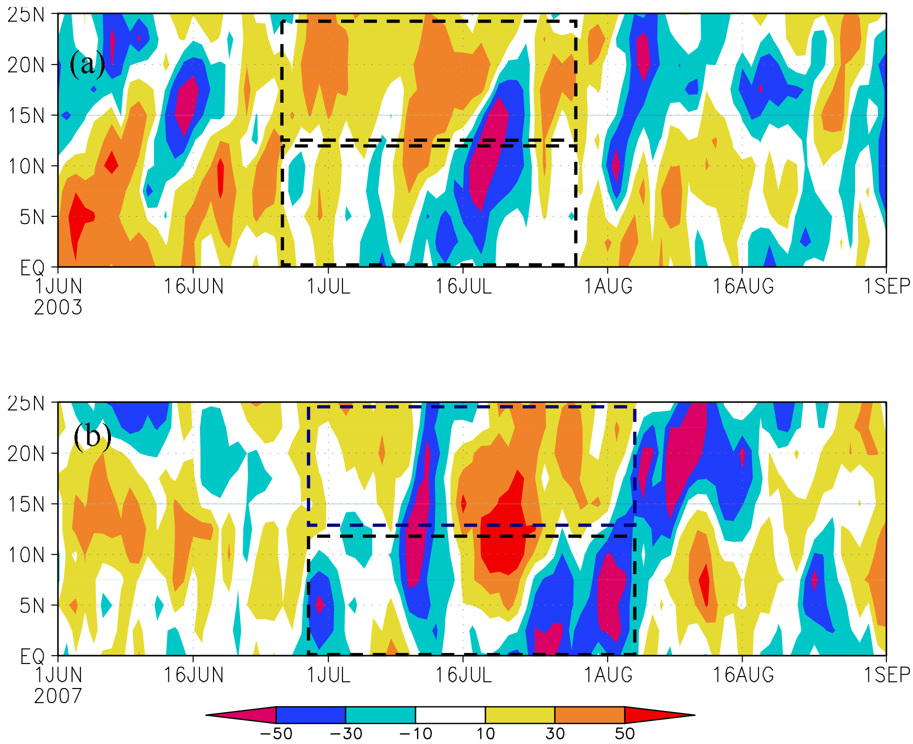

Fig. 6. Daily mean anomalies of OLR (shaded) averaged between 110°–140°E from June to September (a) 2003 and (b) 2007. (Units: W m^{-2})

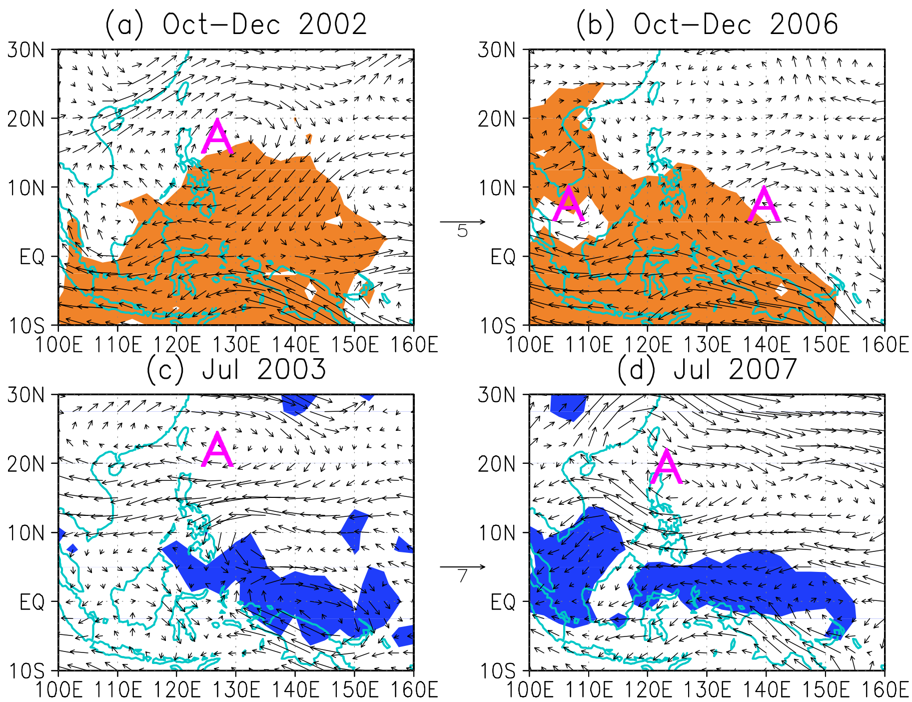

Fig. 7. 850 hPa wind anomaly (vector, Units: m s^{-1}) and OLR anomaly (shaded) in (a) October–December 2002, (b) October–December 2006; (c) July 2003; and (d) July 2007. Only OLR anomalies more than 10 W m^{-2} in (a) and (b) are shaded, and only OLR anomalies less than −10 W m^{-2} in (c) and (d) are shaded. Letter A denotes anomalous anticyclone.

weakened during the mature phase of the 2006/07 El Niño episode (Fig. 7b). Two separate anomalous anticyclone centers formed over the western tropical North Pacific.

In section 4, the decaying evolution of the 2002/03 El Niño episode and the 2006/07 El Niño episode showed that the anomalous equatorial zonal winds and the sea temperatures, in the surface and the subsurface, determined the thermal status of the western equatorial Pacific in the following early summer. The anomalous active convection in the western equatorial Pacific can be seen in Fig. 7c and Fig. 7d. Due to the anomalous easterly winds advecting the warming water westward in the central equatorial Pacific from spring to early summer (Fig. 3), and the end of the cold Kelvin waves propagating eastward in late winter or early spring, the active convection in the western tropical Pacific was strong in the western equatorial Pacific. Nevertheless, the weak warm SST anomalies of the western equatorial Pacific and the persistent easterly anomalies in the central Pacific from spring to early summer, meant that the thermal status of the western tropical Pacific was not extra warm in the early summers of 2003 and 2007. In this manner, the convective activities in the western Pacific warm pool showed the special pattern in which the anomalous strong convections only appeared over the southern regions of the warm pool in the early summers of 2003 and 2007, especially for the periods in July (Figs. 7c, d).

5.2 *Western North Pacific anomalous anticyclone*

The location of the rain belt in eastern China has a close relationship with the movement of the western North Pacific anticyclone in the summer. Southwesterly flow, from the western part of the subtropical high, brings a lot of water vapor to the northern edge of the western North Pacific subtropical high, inducing the abundant rainfall there. When the northern edge of the subtropical high lies in the Yangtze River valley, the persistent heavy rains tend to occur in the Yangtze River valley. If the northern edge of the subtropical high lies in the Huaihe River valley, the persistent heavy rains tend to occur in the Huaihe River valley (Bao, 2008).

The thermal state of the western tropical Pacific and the convective activities around the Philippines has an obvious effect on the meridional shifts of the western Pacific subtropical high in the summer (Huang et al., 2007). In July 2003 and 2007, due to the active convection anomalies in the southern regions of the western Pacific warm pool, although the western North Pacific subtropical anticyclones shifted southward, the anomalous anticyclones also moved a little southward, and Figs. 7c, d show the western North Pacific anomalous lower-tropospheric anticyclones with the centers located in 20°–25°N. In this way, the abundant water vapor was transported to the Huaihe River valley by the anomalous anticyclones. At the same time, the southern Yangtze River delta and the South China were also controlled by the anomalous anticyclones, resulting in the drought and heat wave in July 2003 and 2007.

6. Discussions and summary

6.1 *Discussions*

Did the El Niño episodes in the central equatorial Pacific determine the anti-symmetric climate anomalies along the Yangtze River in the following summer? Now we examine the 1994/95 El Niño episodes and the 2004/05 El Niño episodes in the central equatorial Pacific. These two episodes also looked as El Niño Modoki events by Weng et al. (2007). The developing, mature, and decaying processes of zonal wind and SST in the equatorial Pacific from March 1994 to August 1995 and from March 2004 to August 2005 (Figures omitted) are similar to the evolution processes of 2002/03 and 2006/07 showed in Fig. 3. The 2004/05 episode, however, is a relative weak warm event. In July 2005, a persistent heavy rain event occurred from 5–10 July in the Huaihe River valley, which led to the above-normal rainfall in the Huaihe River valley. As the precipitation amount over the Huaihe River valley in July 2005 was not as large as in 2003 and 2007, the anti-symmetric climate anomalies pattern along the Yangtze River was not very obvious this year. However, in July 1995, the above-normal rainfall occurred in the middle and lower reaches of the Yangtze River valley, which is associated with the southward shift of the western Pacific subtropical high. Figure 8 is the equatorial depth-longitude sections of monthly mean ocean temperature anomalies in July 1995. The subsurface temperatures showed the weak negative anomalies in the western equatorial Pacific. Actually, the cold status in the subsurface of the western equatorial Pacific persisted from the preceding winter to the early summer in 1995. On this condition, the thermal state of the western equatorial Pacific could not produce the active convection in the western equatorial Pacific, and neither in the southern region of the western Pacific warm pool. Thus, the anomalous center of the western Pacific subtropical anticyclone was located in the region south to 20°N in the early summer of 1995. As for the reason of the anomalous cold subsurface temperatures in the western equatorial Pacific, it was not clear, perhaps due to other factors related

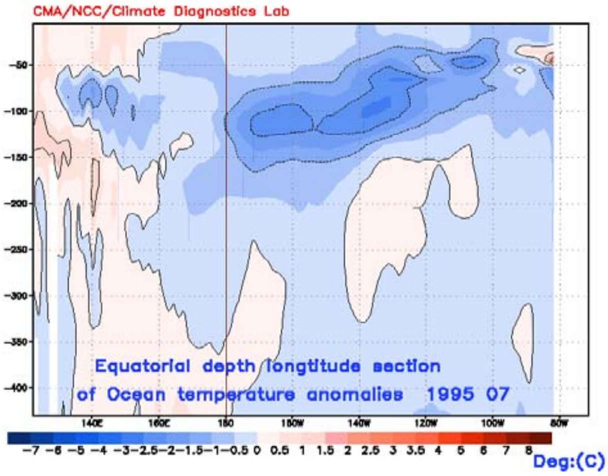

Fig. 8. As in Fig. 5 but for July 1995.

with the tropical air-sea interaction.

6.2 *Summary*

The climate disasters of eastern China in the summers of 2003 and 2007 brought new challenges for the seasonal prediction and the relationship between El Niño episodes and the summer monsoon rainfall in China. In this study, we suggested a possible physical process for the delayed impacts of the El Niño episodes in the central equatorial Pacific and their decaying evolution on the summertime anti-symmetric climate anomalies along the Yangtze River, focusing on the typical cases of 2003 and 2007.

During the developing stage of the El Niño episodes in 2002 and 2006, anomalous westerly winds in the western Pacific favored and led to the warming episodes in the central equatorial Pacific through exciting the warm Kelvin waves propagating eastward. The positive SST anomalies, higher than 1.5°C, formed in the central Pacific and achieved their peak phase during the El Niño episodes in the early winter. During the decaying stage of the El Niño episodes in 2003 and 2007, easterly wind anomalies appeared in the low levels of the western and central equatorial Pacific regions, leading to the decay of the El Niño episodes and the advecting of anomalous warm water in the sea surface from the central equatorial Pacific to west of the dateline in the spring. The concurring anomalous easterly winds in the central equatorial Pacific and the end of cold Kelvin waves propagating eastward ahead of time, favored the warm water of both the SST and subsurface temperatures in the western equatorial Pacific. Due to the easterly anomalies in the western and central equatorial Pacific and the decaying evolution of the moderate El Niño episode in the central Pacific, the warm state of the western tropical Pacific was not quite as strong.

Under the condition of the thermal state over the western tropical Pacific in the early summer of 2003 and 2007, especially for July, the convective activities in the western Pacific warm pool showed the pattern in which the anomalous strong convections only appeared over the southern regions of the western tropical Pacific warm pool, which effects the meridional shifts of the western Pacific subtropical high in the summer. In this manner, the center of the anomalous subtropical high, located between 20°–25°N, was the response to the thermal distribution in the western Pacific warm pool, and affected the anti-symmetric climate anomalies pattern along the Yangtze River in July 2003 and 2007.

However, the 1994/95 El Niño episode did not correspond to the climate anomalies of eastern China in the summer of 1995. So, the fact that the moderate El Niño episodes matured in the central equatorial Pacific during the early winter, are possible climatic backgrounds, but not the direct factor for the following summertime anti-symmetric climate anomalies over eastern China. The decaying evolution process of the El Niño episodes in the central Pacific is important for the thermal status of the western tropical Pacific in the following early summer, which is the direct cause for the western North Pacific anomalous anticyclone.

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