Article ID: 1006-8775(2006) 01-0097-02

CHARACTERISTICS AND CAUSE ANALYSIS OF WESTERN PACIFIC SUBTROPICAL HIGH DURING THE HUAIHE RIVER FLOODS IN 2003

JIN Rong-hua (金荣花), Jiao Mei-yan (矫梅燕), Xu Jing (徐　晶), Qin Hua-feng (秦华锋)

(National Meteorological Center, Beijing 100081 China)

Key words: the Huaihe River floods; Western Pacific subtropical high; abnormal characteristics; cause analysis

CLC number: P447 **Document code**: A

1 INTRODUCTION

In summer, different assembly of the intensity, location and vertical structure of the subtropical high and the earlier/later time of its seasonal northwards jump bring about different precipitation patterns over China. Therefore, subtropical high activity and its cause during the occurrence of extreme climatic event over China and the cause of China drought/flood are studied to improve weather forecasting.

Since 1990s, many theoretical studies on physical mechanisms of subtropical high activity have been done[1-4], which focus on the effect of tropical diabatic heating and the spatial nonuniform heating on the subtropical high formation and variation, but rarely consider the influence of dynamical environment change generated by abnormal activity of westerly systems or subtropical upper jets on it. Herein, on the basis of dynamical theory and synoptic principle, the subtropical high activity and its impact on the Huaihe River floods in 2003 are analyzed, and the effect of abnormal feature of westerly, subtropical and tropical circulation on the subtropical high activity and its formation mechanism are further studied, which are expected to be helpful to operational summer rainfall forecast in China.

2 DATA

The analyzed data are based on the NCEP global girded reanalysis daily averages at horizontal resolution of 2.5° × 2.5° latitude/longitude from 1971 to 2000 and from June to July, 2003 and the 24-h intensively observed precipitation and the subtropical high ridge line locations from National Meteorological Center.

3 SPATIAL & TEMPORAL DISTRIBUTION OF RAINFALL DURING 2003 HUAIHE RIVER FLOODS

The 2003 Huaihe River floods occurred from June 20 to July 22, 2003, which was 14 days longer than the normal Meiyu length (19 days) and had severe rainfall in 29 days (with daily rainfall average larger than 25 mm). It is divided into three stages, and the principal rain belt went northwards gradually like waves. Consequently, it is the long-time persistence of severe rain belt over the reaches of Huaihe River that causes the floods.

4 SUBTROPICAL HIGH ACTIVITY DURING 2003 HUAIHE RIVER FLOODS

4.1 Meridional activity of subtropical high

By analyzing the evolution of 500-hPa ridge line from June to July 2003, it is found that the subtropical high goes northwards steadily in 3 meridionally fluctuating processes, which coincided with the variation of the principal rain belt, indicating the subtropical high restricts rain belts.

Analysis of the climatic features of subtropical high meridional activity concludes that the subtropical high ridge line location is southward of the mean in 24 out of 33 days and especially steady during the 24 days from June 29 to July 22, 2003; and its second seasonal

Received date: 2005-01-06; **revised date:** 2006-05-30
Foundation item: Research on Floods-Causing Heavy Rains in the Valley of Huaihe River in 2003, a project from the National Meteorological Center
Biography: JIN Rong-hua (1969-), female, native from Heilongjiang Province, Senior Engineer, M.S., mainly undertaking the analysis and study of medium-term weather forecast.
E-mail: jinronghua2003@yahoo.com.cn

northward jump, in terms of 5-day running mean of the location of the subtropical high ridge line, was completed on July 21,2003 when the subtropical high steadily went across 25ºN, which was abnormally latter than the mean (normally on July 8).

4.2 Meridional activity of Subtropical high

From the longitude-time cross-section of 500-hPa geopotential height along 25ºN from June to July, 2003, it can be seen that the west boundary of subtropical high is mostly westward of the normal, and during its three westward extensions from the central part of North Pacific, the 588-gpdm contour got across 120°E and its west boundary reached the westernmost point on June 23, July 2 and July 17, 2003, respectively.

5 ANALYSIS OF THE CAUSE FOR SUBTROPICAL HIGH ACTIVITY IN 2003

5.1 Effect of 500-hPa westerly circulation on the subtropical high

With the time series of 500-hPa westerly circulation index over the mid- and high- latitudes of Asia from June to July, 2003, it can be inferred that 500-hPa circulation persists in a meridional pattern, in that the index is mostly lower than the mean and higher than it for only 7 days.

This meridional pattern is responsible for the polar cold air going southwards, which makes 500-hPa mid-latitude westerly frontal zone stronger and southward of the usual over the eastern China and nearby waters off the coast so that the subtropical high is restricted from further northwards jump and remains to the south of the mean.

5.2 Relation of upper subtropical system activity to subtropical high variation

By analyzing zonal section of a 200-hPa subtropical jet along 40 ºN over the Eastern Asia and time series of a 300-hPa transient vertical velocity averaged from 115ºE to 125ºE along 30ºN from June to July, 2003, it is found that the subtropical jet center stays active over the Eastern Asia until July 14, 2003. Subsequently, it recedes westwards and its strength decreases quickly. During its control over the Eastern Asia, the subtropical jet center extends to the east of 130 °E three times and the 300-hPa transient vertical velocity changes to minus values while the subtropical high area index decreases and recedes eastwards significantly and vice verse.

By investigating the evolution of 100-hPa South Asia high from June to July, 2003, it can be seen that South Asia high was mostly of the western pattern with occasional belt-like distribution, and its ridge line location averaged from 110°E to 130°E was near or south of 30 ºN until it leaped northwards on July 23, 2003. Subsequently, the 500-hPa subtropical high ridge line location averaged from 110°E to 130 °E was steadily to the north of 27 °N. Evidence suggests that the persistent westward and southward location of South Asia high center in 2003 mainly contributed to the southward location and late northward jump of the subtropical high. With the longitude-time cross-section of 100-hPa South Asia high characteristic contour and vorticity advection along 30°N, it is found that its three zonal fluctuations coincide with three meridional oscillations of subtropical high and the date when the South Asia High eastern ridge tip reaches the easternmost position agrees with the one when the subtropical high western tip arrives at the westernmost position. It follows that the eastward extension of South Asia high generates the vertical nonuniform change of vorticity advection, which motivates descending motion in the upper level of subtropical high northern edge to cause the high to go northwards and extend westwards.

5.3 Impact of tropical convective activity on the subtropical high

The Asian monsoon region and ITCZ had two abrupt severe convective developments almost at the same time, which were coordinated with the two northwards jumps of the subtropical high corresponding to the start and end of the 2003 Huaihe River floods respectively. During two convective developments, tropical cyclones became very active with the geneses of Typhoons Soudlor (200306), Imbudo (200307) and Koni (200308). On the other hand, the OLR ascending tendency in the Asian monsoon region and ITCZ displays weakening convection while the subtropical high was steady and southward of the mean. Due to these facts, the summer tropical convective activity is an important contributor to the subtropical high activity.

REFERENCES:

[1] WEN Min, HE Jin-hai. Ridge movement and potential mechanism of western Pacific subtropical high in summer [J]. Journal of Nanjing Institute of Meteorology, 2002, 25(3): 289-297.

[2] XU Hai-ming, HE Jin-hai, ZHOU Bing. The features of atmospheric circulation during Meiyu onset and possible mechanisms for westward extension (northward shift) of Pacific subtropical high [J]. 2001, Quarterly Journal of Applied Meteorology, 12(2): 150-158.

[3] LIU Yi-min, WU Guo-xiong, LIU Hui, et al. The effect of spatially nonuniform heating on the formation and variation of subtropical high part III: condensation heating and south Asia high and western Pacific subtropical high [J]. Acta Meteorologica Sinica, 1999, 57(5): 525-538.

[4] REN Rong-cai, WU Guo-xiong. On the short-term structure and formation of the subtropical anticyclone in the summer of 1998 [J]. Acta Meteorologica Sinica, 2003, 61(2): 180-195.