Article ID: 1006-8775(2007) 02-0165-04

RELATIONSHIPS BETWEEN SPRING KUROSHIO SSTA AND SUMMER RAINFALL IN CHINA

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Abstract: Based on the data of SST and NCEP/NCAR reanalysis data, the relationship is analyzed of spring SSTA in the Kuroshio region with summer precipitation in China, summer 500 hPa field and water vapor transport, using the methods of Morlet wave, correlation and composite analysis. The results show that annual and interdecadal change of spring SST in the Kuroshio region is distinct. Spring SST displays a significantly increasing trend and there exist different periodic oscillations in the Kuroshio region, with the 23-year periodic oscillation being the most obvious. Troughs and ridges in the mid- and higher- latitudes turn deeper in high Kuroshio SSTA years. At the same time, the western Pacific subtropical high strengthens and stretches westwards. As a result, the warm / wet air from the west of the subtropical high locates in the mid- and lower- reaches of the Yangtze River and south China and summer rainfall in the above regions increases accordingly. Composite anomalous water vapor flux fields indicate that the vapor transport from the South China Sea and western Pacific and the vapor from the north converge over the mid- and lower- reaches of the Yangtze River and south China, which results in the increase of the summer rainfall in the mid- and lower- reaches of the Yangtze River and south China. On the contrary, the summer rainfall in the mid- and lower- reaches of the Yangtze River and south China decreases correspondingly in low Kuroshio SSTA years.

Key words: spring Kuroshio SST; summer rainfall in China; western Pacific subtropical high; water vapor transport

CLC number: P444 **Document code:** A

1 INTRODUCTION

Over the past few years, the effect of northwestern Pacific SST on the precipitation in China has been drawing more and more attention [1 – 3]. The Kuroshio is a powerful warm oceanic current in the northwestern Pacific, with huge fluxes of sensible and latent heat for the region and maximum net release of heat. The latter provides enormous amount of energy to the Northern Hemisphere [4] and the regional thermodynamic conditions at the sea surface have close relationship with the weather and climate in China. While most of the previous work focus more on winter and summer [5 – 11] than spring. It is then why this work will study the evolution pattern of the regional SST in the Kuroshio region itself and the correlation between its SST anomalies and summer precipitation, general circulation and transportation of water vapor in China.

2 ANNUAL AND INTERDECADAL VARIATION OF SST IN SPRING (MARCH – MAY) IN KUROSHIO REGION

Fig.1 gives the curves for standardized anomalous series of SST in the Kuroshio region over the spring of 1951 – 2003. It shows that the Kuroshio SST in spring was mainly of cold phase from early 1950s to mid-1980s but it showed an obvious trend of warming beginning from mid-1980s. As shown in the moving *t*-test series for 9 a in the figure, an abrupt climatic change took place in the Kurishio SST in spring 1987, which passed 99% confidence test, and SST turned

Received date: 2006-05-10; **revised date:** 2007-07-11

Foundation item: National Planning Project for the Research and Development of Key National Fundamental Research (2004CB418303); Innovative Project for Training Post Graduates in Jiangsu Province (E30000008098-2)

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from a cool state to a warm one.

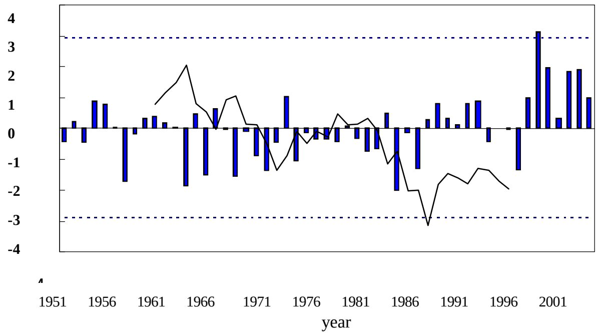

Fig.1 Year-to-year evolution of standardized anomalies of Kuroshio SST in the spring of 1951 – 2003. (the histogram) and its series of 9-a moving *t*-test (the solid line). The dashed line is the 99% confidence level.

3 RELATIONSHIP BETWEEN THE INDEX FOR SPRING KUROSHIO SST AND SUMMER PRECIPITATION IN CHINA

Fig.2 gives the correlation coefficient for the index of spring Kuroshio SST and summer (June – August) precipitation in China. It shows that the distribution of the correlation coefficient is significantly regional, with the plain in north China, southwestern Yunnan-Guizhou Plateau and northeast China (with the exception of Xiao Xing'an Mts.) in negative correlation, and northwest China, Sichuan Basin and the area to its northwest, Changjiang River valley and Xiao Xing'an Mts. in positive correlation. The maximum is greater than 0.27 in the center of the correlation in northwest China and reaches the 0.05 significance test. The distribution of correlation coefficients in China shows that in the years of high spring Kuroshio SST, precipitation in the summer of north China, southwestern Yunnan-Guizhou Plateau, northeast China (with the exception of Xiao Xing'an Mts.) will be less while it will be more over northwest China, Sichuan Basin and the area to its northwest, Changjiang River valley and Xiao Xing'an Mts., especially in the middle and lower reaches of the Changjiang River and south China, where floods easily occur. On the contrary, in the years of low spring Kuroshio SST, precipitation will be more over north China, southwestern Yunnan-Guizhou Plateau and most of the northeast China but less over northwest China, Sichuan Basin, Changjiang River valley and Xiao Xing'an Mts. and drought easily occurred in the middle and lower reaches of the Changjiang River and south China.

4 RELATIONSHIP BETWEEN SPRING KUROSHIO SST AND 500 hPa GEOPOTENTIAL HEIGHT FIELD

It is shown from the composite distribution of summer 500 hPa geopotential height field for the anomalous years of Kuroshio SST in spring, its differences and *t*-test distribution (figure omitted) that years of high SST are accompanied by a deeper and more eastward major trough in East Asia near the Bering Sea. Another major trough is also deeper and more westward in the northern Qinghai-Tibet Plateau. The ridges over the eastern Europe and northeastern Asia are also deeper than usual with a meridional prevailing airflow. The western Pacific subtropical high strengthens and extends westward. Under this circumstance, the warm and humid airflow west of the subtropical high meets with cold air from the north over the middle and lower reaches of the Changjiang River and south China, which is favorable for precipitation in the middle and lower reaches of the Changjiang River and south China. Things are basically the opposite in low SST years. The troughs and ridges are weak in the middle and high latitudes. The development of a blocking high is not favorable for blocking. The whole airflow is mainly zonal. The western Pacific subtropical high weakens and withdraws to the east, unfavorable for precipitation over the middle and lower reaches of the Changjiang River and south China.

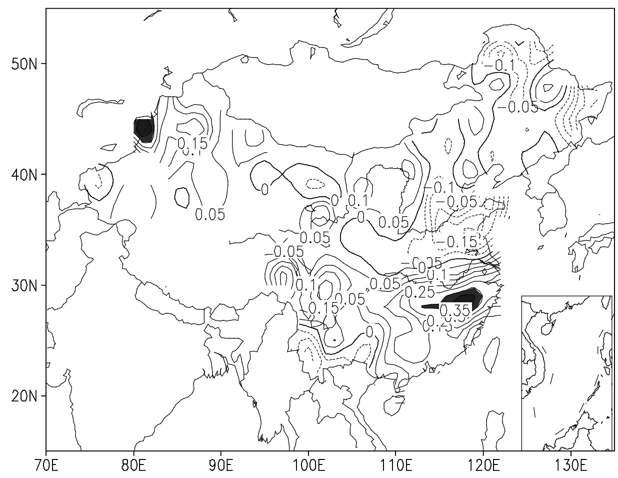

Fig.2 Contours of the coefficient of Morlet wavelet transformation for the Kuroshio region in the spring of 1951 – 2003.

It is known from Tab.1 that high Kuroshio SST in spring will be accompanied with strong and large western Pacific subtropical high with more westward point of ridge extension. The case is just the opposite when the Kuroshio SST is low in spring.

5 RELATIONSHIP BETWEEN SPRING KUROSHIO SST AND TRANSPORTATION OF WATER VAPOR IN EAST ASIA IN SUMMER

It is known from the analysis of divergence field (Fig.3) for composite anomalies of water vapor flux and 850 hPa wind field in the summer of East Asia corresponding to years of either high or low Kuroshio SST in spring that in the years of high Kuroshio SST in spring, the transportation of water vapor from the South China Sea and western Pacific is stronger than

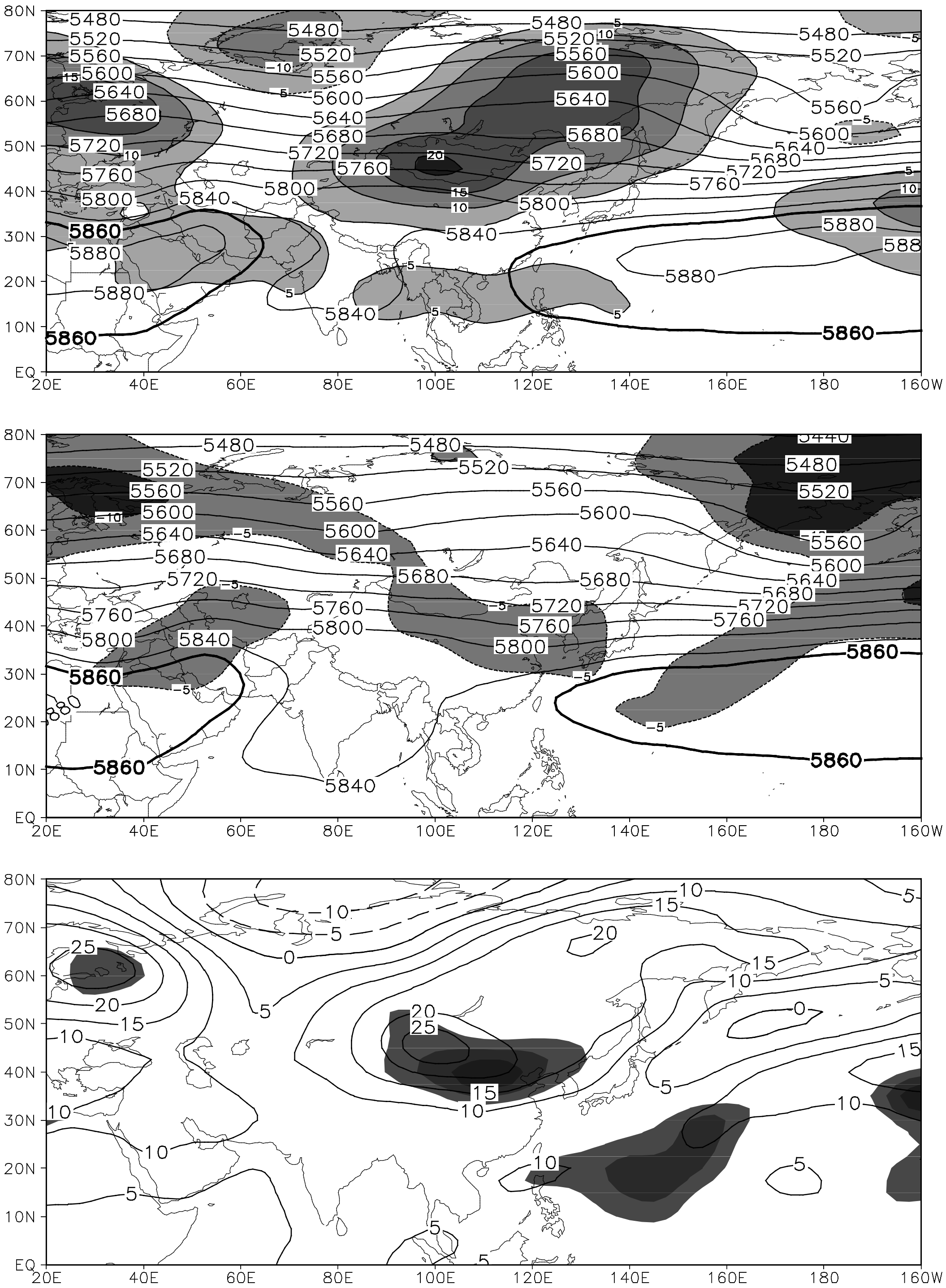

Fig.3 Years of anomalously higher Kuroshio SST (a) and anomalously lower Kuroshio SST (b) in spring from 1951 to 2003 in association with composite geopotential mean field at 500 hPa and its difference (c, which is the result of subtracting low values from high values). Unit: gpm. The shaded areas in (a) and (b) are regions where the absolute values of the mean composites are larger than 5. The shaded areas in (c) are regions which pass the 0.02 significance *t* test.

climatological mean years such that less water vapor is transported to areas north of the Changjiang River valley but more water vapor stays in south China and Changjiang River valley, resulting in dramatically increased precipitation in the middle and lower reaches of the Changjiang River and south China. On the contrary, in the years of low Kuroshio SST in spring, there is a divergence zone of water vapor in the Changjiang River valley and south China, unfavorable for precipitation in these areas.

Tab.1 Correlation coefficients for Kuroshio SST in spring versus 500-hPa western Pacific subtropical high in summer

Location of northern boundary	Ridge line	Point of westernmost extension	intensity	area
0.05	0.10	-0.34	0.30	0.33

For analyses of other aspects, refer to the Chinese edition of the journal.

6 CONCLUSIONS AND DISCUSSIONS

Kuroshio SST in spring correlates well with precipitation in China. When it is relatively high, there will be less precipitation in northeast China and north China but much more precipitation in the valley of Changjiang River and south China, easily leading to floods. On the contrary, when it is relatively low, there will be more precipitation in northeast China and north China but much less precipitation in the valley of Changjiang River and south China, easily leading to drought.

When the Kuroshio SST is relatively high in spring, the 500-hPa major East Asian trough near the Bering Sea deepens, the northwestern Pacific subtropical high strengthens and extends westward, and the transportation of water vapor from the South China Sea and western Pacific is stronger than the climatological mean year, which is favorable for precipitation in the middle and lower reaches of the Changjiang River and south China. When the Kuroshio SST is relatively low in spring, there is a zone of water vapor divergence in these areas, which is unfavorable for precipitation there.

Driven mainly by the atmosphere, the variation of SST in the middle and high latitudes is resulted from air-sea interactions[12]. As the air-sea interactions are very complicated in the middle latitudes, it needs thorough study for probing into the physical mechanisms responsible for the effect of Kuroshio waters on the summer precipitation in China, for it involves not only the factors of the ocean, snow cover, and land surface but also the interactions among systems in the middle and high latitudes.

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