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STUDY ON THE RELATIONSHIP BETWEEN THE DECADAL VARIATIONS OF ANNUALLY FIRST RAINY SEASON PRECIPITATION OF GUANGXI AND SEA SURFACE TEMPERATURE OF INDIAN OCEAN IN SOUTHERN HEMISPHERE

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Abstract: Decadal circulation differences between more and less rainfall periods in the annually first rainy season of Guangxi and their association with sea surface temperature (SST) of the austral Indian Ocean are investigated by using the NCEP/NCAR reanalysis data. The results are shown as follows. A pattern in which there is uniform change of the Guangxi precipitation shows a 20-year decadal oscillation and a 3-year interannual change. In contrast, a pattern of reversed-phase change between the north and the south of Guangxi has a 6-year interannual periodicity and quasi-biennial oscillation. In the period of more precipitation, the surface temperature in Eurasia is positively anomalous so as to lead to stronger low pressure systems on land and larger thermal contrast between land and ocean. Therefore, the air column is more unstable and ascending flows over Guangxi are intensified while the Hadley cell is weakened. Furthermore, the weaker western Pacific subtropical high and South Asia High, together with a stronger cross-equatorial flow, result in the transportation of more humidity and the appearance of more precipitation. The correlation analysis indicates that the Indian Ocean SST in Southern Hemisphere is closely associated with the variation of the seasonal precipitation of Guangxi on the decadal scale by influencing the Asian monsoon through the cross-equatorial flow.

Key words: Guangxi; annually first rainy season rainfall; decadal variation; SST in Indian Ocean

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1 INTRODUCTION

Due to a geographical location of bordering with the sea and the influence from the East Asian monsoons, precipitation appears within a concentrated period of the year in Guangxi that easily results in damage-inducing droughts and floods. It is therefore important to forecast their occurrence and evolution. Based on kinematic factors active inside the atmospheric circulation, much work has been done to study the characteristics and causations of the droughts and floods for this time of the year in Guangxi [1 - 9], with the focus on the effect of the general circulation and anomalies of the North Pacific SST while few efforts have been spent studying the decadal variations of the raining season precipitation and their relationships with the SST of the austral Indian Ocean. As shown in literature, one of the main sources of water vapor for the precipitation from East Asian summer monsoon is the anti-cyclonic airflow from the Miscarene High, which recurves after crossing the equator, transporting to the northeast a southwesterly of warm and humid air from the Bay of Bengal and an Arabian Sea trough. Conceivably, the variation of SST anomalies of the Indian Ocean is inevitably having some impacts on the transfer of this channel of water

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vapor to play a role in the amount of precipitation during the annually first raining season in Guangxi. In this paper, based on more detailed analysis of the causation for the circulation responsible for the decadal variation of the precipitation during the raining season, the regions that are the key to the change in preceding SST over the Indian Ocean will be identified in order to have access to signals that can be used in forecasting.

2 DATA USED

The data used in this work include the following sources. (1) Monthly mean reanalysis data from NCEP / NCAR. It covers a 40-year time from 1961 to 2000 and contains such elements as wind, geopotential height, vertical velocity and surface temperature. The horizontal resolution is 2.5°×2.5° (144×73 in grid number) for the 17 isobaric surfaces in the vertical direction. The Gausian grid is applied to the surface temperature data that is horizontally resolved at *T*62. (2) Monthly mean SST data from GISST. At a resolution of 1° × 1°, it spans from 1948 to 2000. (3) Monthly observations of precipitation. They are taken from 88 weather stations covering the period from 1961 to 2000.

3 SPATIAL AND TEMPORAL VARIATIONS OF GUANGXI PRECIPITATION

To examine the spatial and temporal variations of the precipitation for this raining season, EOF decomposition is applied first (Fig.1). It shows that the first two eigenvectors are 37.6% and 12.3% in corresponding variance contribution and their accumulative variance contribution is as high as 49.9%, which reflects the most dominant pattern of spatial distribution. The time coefficients of the first and second eigenvectors are analyzed for the power spectra to know that the variation of the Guangxi precipitation is composed of two patterns; one is a overall pattern that is marked by a decadal oscillation of about 20 years and an interannual period of about 3 years and the other is a north-south reversed-phase pattern that is featured with 6-year and quasi-biennial oscillations.

The analysis above reveals that the most prominent overall characteristic of the Guangxi precipitation is that of decadal variation. To discuss this issue in more detail, the time coefficient of the first eigenvector is processed with 9-year moving averaging for decadal variation (Fig.1c). As shown in the result, the 9-year mean curve has experienced two stages of variation from 1968 to 1993 and the difference between their

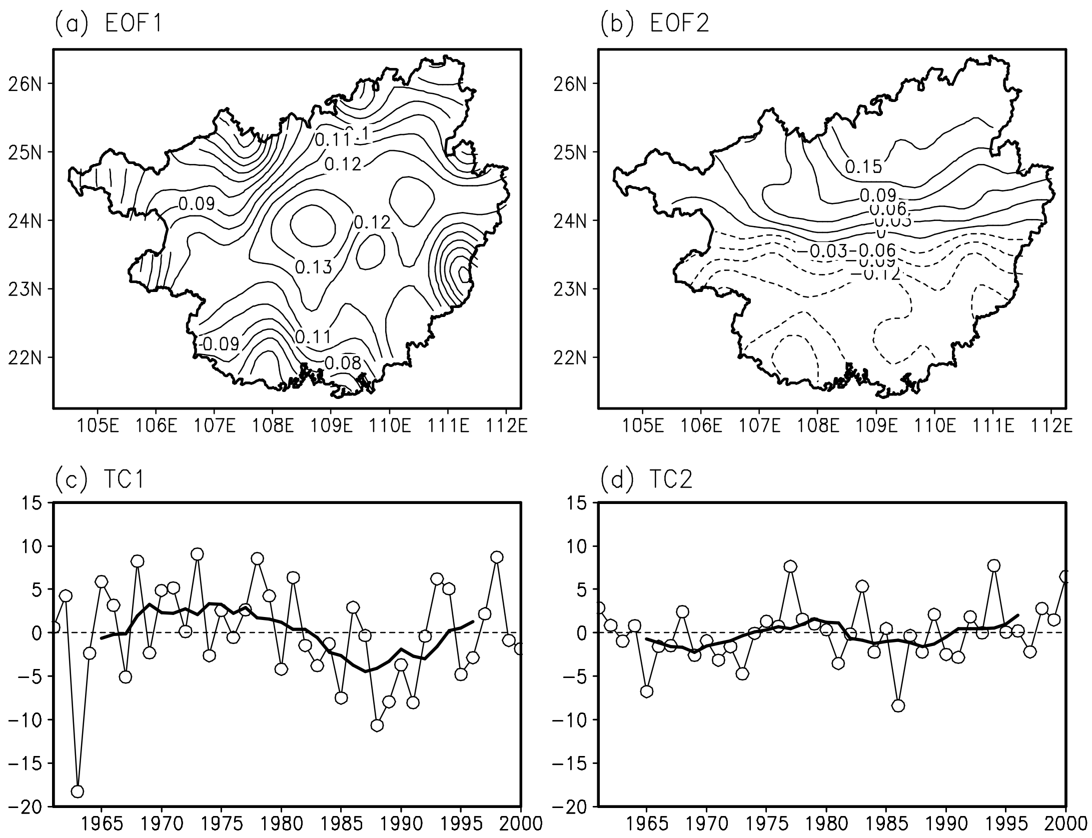

Fig.1 The modes of the first eigenvector (a) and second eigenvector (b) as EOF-decomposed for the precipitation and their corresponding first time coefficient (c) and second time coefficient (d). The solid line is the 9-point moving curve.

mean values reaches the 95% confidence level, indicating significant changes. Then, against what background does the difference occur? Is it reflecting the decadal variation of the atmospheric circulation? Does it have certain linkage with external forcing factors, like the changes in SST? To address these questions, composite analysis is conducted to compare the circulation of the two stages of precipitation (Fig.2). Then, the result is based to investigate into the effects of SSTA on the circulation and their role in causing the anomalous variation of the precipitation.

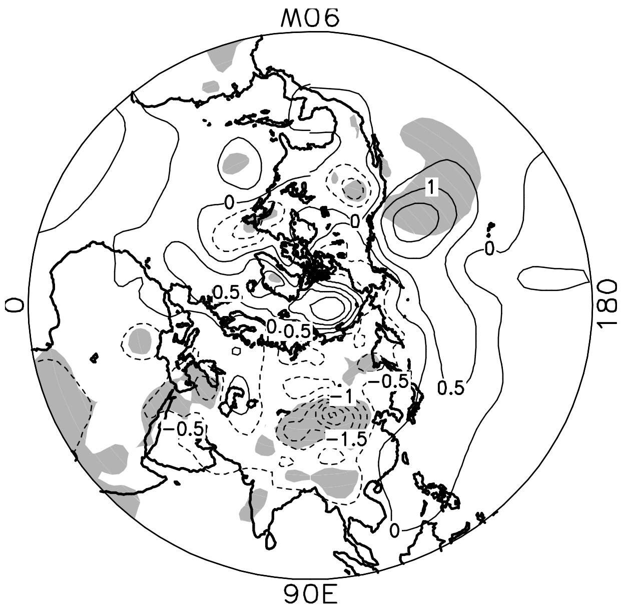

Fig.2 The distribution of sea surface pressure difference during periods of anomalously more and less precipitation in the annually first raining season of Guangxi. Unit: hPa. The shaded area is where the 0.05 significance test has been passed.

4 THE EFFECT OF AUSTRAL MID-LATITUDE INDIAN OCEAN SST ON THE DECADAL VARIATION OF THE GUANGXI PRECIPITATION

It is discovered that the decadal variation component of the first eigenvector time coefficient is significantly negatively correlated with the austral mid-latitude Indian Ocean in the preceding February and March (Fig.3). The region that passes the 0.05 significance test is over 60°S – 36°S, 45°E – 95°E with the center being more than -0.7 in correlation. It shows that the variation of the austral mid-latitude Indian Ocean SST plays a regulatory role in the decadal variation of the Guangxi precipitation. From the comparison of the decadal variation curves (Fig.4b), it is shown that negatively anomalous SST in the preceding February – March prior to the year 1982 is corresponding to anomalously more rain in the raining season while positively anomalous SST in the same preceding months from 1983 to 1993 is corresponding to anomalously less rain. The original correlation is only -0.102 while the decadal correlation is as high as -0.699, indicating that the decadal anomalies of the February – March SST have significant impacts on the precipitation of Guangxi during the raining season.

How does the significantly negative correlation establish between the SST and the decadal anomalies of the precipitation? It is known that Guangxi, a low-latitude part of China, is also subjected to the monsoons from East and South Asia and abundant water vapor brought about by monsoonal rain originates from the Southern Hemisphere. It is then inferred that the SST in austral Indian Ocean may eventually result in the decadal anomalies of the Guangxi precipitation by affecting the monsoon via the cross-equatorial flow.

See the Chinese edition of the journal for more details.

5 CONCLUSIONS

(1) For the overall distribution pattern of precipitation in the annually first raining season of Guangxi, the decadal variations are the most important characteristics. There is also a spatial distribution pattern in which the northern Guangxi is in reversed phase relationships with the southern part.

(2) Relatively more precipitation is accompanied with vigorously developed continental low pressure systems, anomalously strong high pressures over North Pacific, considerable land-sea thermal contrast, anomalously strong summer monsoons, anomalously weak western Pacific subtropical high and South Asian high which are both northward situated, much enhanced circulation from a southern trough splitting off from the westerly, increased cross-equatorial airflows over the South China Sea, and the western Pacific subtropical high that is eastward located. The conditions above are all favorable for the transfer of water vapor west of the subtropical high towards Guangxi. The difference in vertical circulation shows that a descending difference flow covers all levels over the equatorial region while Guangxi is located where there is a significant ascending difference flow, which weakens the Hadley cell and then the subtropical high; the anomalously strong ascending airflow has strengthened convection over Guangxi and resulted in more precipitation and vice versa with the circulation situation of less precipitation.

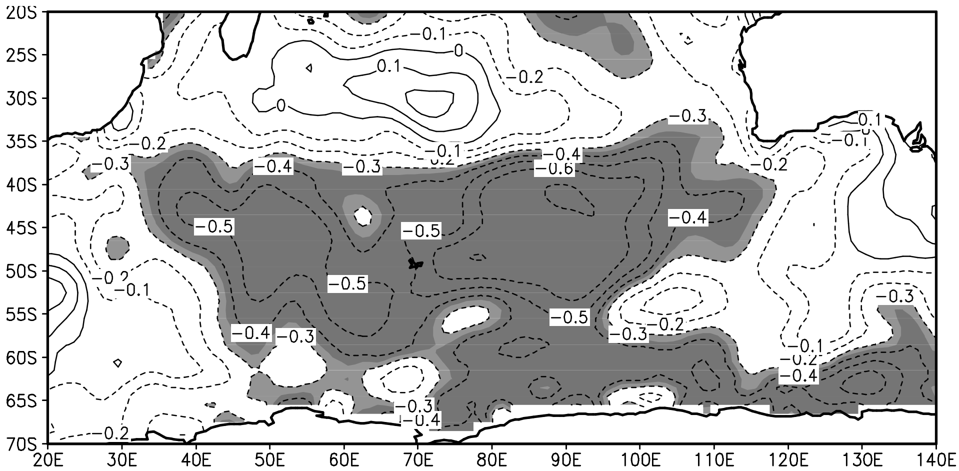

Fig.3 The distribution of the correlation between the decadal variation of the Guangxi precipitation and SST in southern Indian Ocean in preceding February and March. The shaded area is where the 0.05 significance test has been passed.

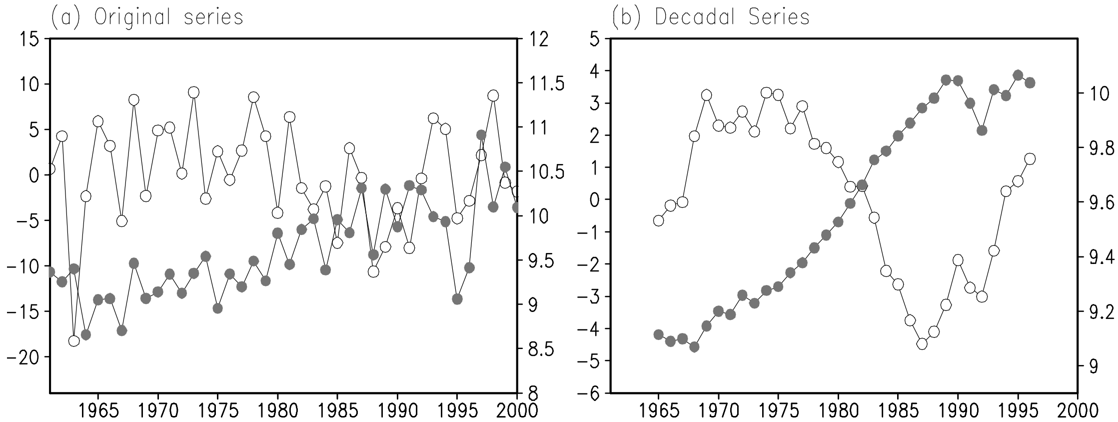

Fig.4 The variation of the first eigenvector of the Guangxi precipitation (curve with hollow circles, on the left coordinates) and the mean SST for southern Indian Ocean in the preceding February and March. (curve with solid circles, on the right coordinates, unit: °C). a. The original series; b. The decadal series of 9-year moving.

REFERENCES:

[1] WU Heng-qiang. Analysis of the predictors of the serious waterlogging during the early flood season in Guangxi [J]. Meteor. Mon., 1999, 25(11): 29-33.

[2] WANG Yuan-chao. Relationship between the variation of summer wind and the rain or draught in flood season of Guangxi [J]. J. Meteor. Res. Appl., 22(3): 18-20.

[3] HUANG Yong-xin. Statistic Analysis of the relationship between drought and flood in flood season in Guangxi and the prior strong signal [J]. J. Meteor. Res. Appl., 2000, 21(suppl.): 7-12.

[4] KUANG Xue-yuan, ZHONG Li-hua, HUANG Xue-song. Characteristic of flood and draught in annually first flood period of Guangxi and the causes analysis [J]. J. Meteor. Res. Appl., 22(4): 5-8.

[5] DENG Li-ping. WANG Qian-qian. On the relationship between precipitation anomalies in the first raining season (April-June) in southern China and SST over offshore waters in China [J]. J. Trop. Meteor., 2002, 18(1): 45-55.

[6] CHEN Yi-min, QIAN Yong-fu. Numerical study of influence of the SSTA in western Pacific warm pool on precipitation in the first flood period in South China [J]. J. Trop. Meteor., 2005, 21(1): 13-23.

[7] JIAN Mao-qiu, LUO Hui-bang, QIAO Yun-ting. Linkage between the interannual variation patterns of seasonal SST in Indian Ocean-Pacific and their relationship with the summer rainfall over China [J]. J. Trop. Meteor., 22(2): 131-137.

[8] ZHANG Tian-yu, SUN Zhao-bo, LI Zhong-xian, et al. Relation between spring Kuroshio SSTA and summer rainfall in China [J]. J. Trop. Meteor., 2007, 23(2): 189-195.

[9] LIANG Jun-mai, LI Yao-xian, LI Xiu-cun. Impact of El Niño on the drought and flood during the flood season of Guangxi [J]. J. Meteor. Res. Appl., 2001, 22(1): 24-26.

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