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INFLUENCE FACTORS AND PREDICTION METHOD ON FLOOD/DROUGHT DURING THE ANNUALLY FIRST RAINY SEASON IN SOUTH CHINA

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Abstract: By using the significance test of two-dimensional wind field anomalies and Monte Carlo simulation experiment scheme, the significance features of wind field anomalies are investigated in relation to flood/drought during the annually first rainy season in south China. Results show that western Pacific subtropical high and wind anomalies over the northeast of Lake Baikal and central Indian Ocean are important factors. Wind anomalies over the northern India in January and the northwest Pacific in March may be strong prediction signals. Study also shows that rainfall in south China bears a close relation to the geopotential height filed over the northern Pacific in March.

Key words: statistical tests of wind fields; flood/drought; prediction methods

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1 INTRODUCTION

Influence factors and prediction methods for precipitation anomalies in the annually first rainy season (there two main rainy seasons in a year) in the south of China have been studied[1 – 5]. Few direct work has been done on the relationships between wind field anomalies during the rainy season and drought / flood for the region. The wind field anomalies of drought / flood years are one of the important causes for large-scale weather / climate anomalies. Besides, preceding wind field anomalies can also affect successive precipitation anomalies and the most dramatic case is the drought / flood in the valley of the Yangtze River. Weak winter monsoon in East Asia was found to be linked with successive droughts / floods in the valleys of the Yangtze and Huaihe Rivers in summer (Sun et al.[6, 7], Shi et al.[8, 9]). It was confirmed in numerical experiments that winter monsoons in China affect global atmospheric circulation two seasons afterwards (Ji et al. [10]). Differences in the circulation of strong and weak winter monsoons in China and subsequent wind fields were studied (Chen et al.[11]). It is then clear that discussing the characteristics of wind field anomalies during and before the rainy season helps to probe into the causation of drought / flood in the first rainy season in the south of China and identify strong precursory signals in the prediction of regional drought / flood.

In addition, there has not been an efficient method to conduct statistical verification of wind fields that are used as vector fields. Recently, a significance test for two-dimensional wind fields anomalies and statistical test for Monte Carlo simulation have been put forward to address the problem of statistically testing the vector field[12]. On the basis of it, the current work studies the characteristics of wind field anomalies during and before the dry / wet rainy seasons and sets up procedures for predicting the precipitation combining the results and other predictors.

2 DATA AND METHODS

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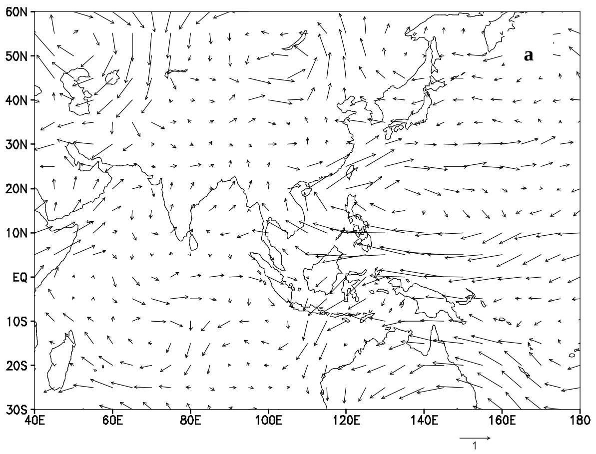
Data used in the work include monthly rainfall taken from 160 Chinese stations from January 1951 to February 2004 by the National Climate Center, monthly mean wind field, with resolution at 2.5° × 2.5°, from the reanalysis data of NCEP / NCAR from 1948 to 2003, 500-hPa geopotential height field from 1951 to 2003, with resolution at 10.0° × 5.0° and coverage of 10 – 85°N, 0° – 360°, by the China Meteorological Administration, monthly global SST gridpoints from 1950 to 2001 with resolution at 2.0° × 2.0° and coverage of 89°S – 89°N, 1 – 179°E, by the British Meteorological Office. The *F* statistic is computed for the significance test of composite wind field anomalies in the years with drought or flood. Refer to [12] for details.

Drought / flood years during 1951 – 1998 have been classified for the first rainy season. It is necessary to study the characteristics for the time after 1998 as our interest covers the period from 1951 to 2003. Following the description in [16], three methods are used in this work to identify common years of drought / flood. There are 10 flood years —1973, 1993, 2001, 1975, 1954, 1962, 1959, 1998, 1984 and 1957 and 7 drought years — 1963, 1991, 1958, 2002, 1985, 1967 and 1999.

It is known from the comparisons that our classification of drought / flood years are generally the same as those in [14] and [3]. Student's *t*-test was run for the rainfall anomalies of drought / flood years to show that the difference between the two types of years surpass the 0.001 significance level. It shows that the difference in rainfall is quite large between the two types of years as classified in this work.

3 ANALYSIS OF WIND FIELD ANOMALIES DURING THE FIRST RAINY SEASON

It is known from the graphic 850-hPa wind field anomalies (Fig.1a & 1b) that there are southwesterly (northeasterly) anomalies in central and northern South



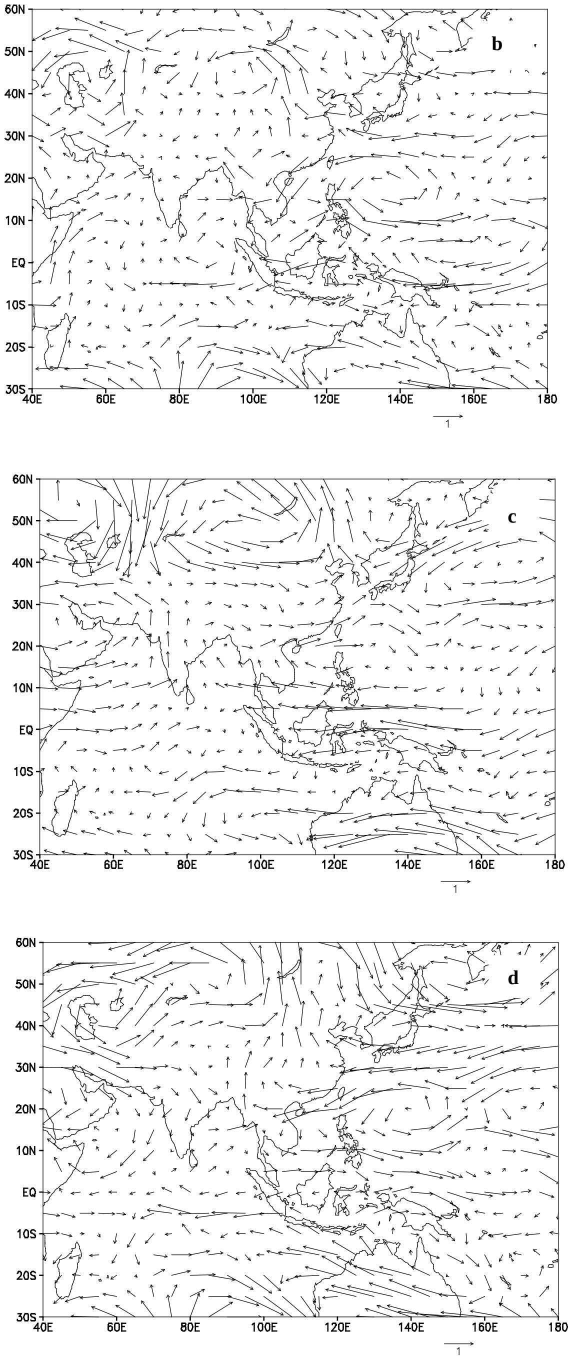


Fig.1 Composite wind field anomalies for the first annually rainy season in flood years at 850 hPa (a), drought years at 850 hPa (b), flood years at 500 hPa (c) and drought years at 500 hPa (d).

China Sea during flood (drought) years while there are southeasterly (northwesterly) anomalies in the west Pacific area east of the Philippines in flood (drought) years. Besides, there are southeasterly (northwesterly) anomalies in the northeastern part of Lake Baikal in flood (drought) years while there are northerly (southerly) anomalies in the central part of south Indian Ocean in flood (drought) years. It is known from the graphic 500-hPa wind field anomalies (Fig.1c & 1d) that the circulation pattern for 500 hPa is generally consistent with that for 850 hPa in either drought or flood years. The west Pacific subtropical high has a more westernmost point of ridge, larger intensity and more southward line of ridge in flood years than in average years; its westernmost ridge point is much more eastward and ridge line more northward in drought years, generally agreeing with the conclusions in [1] and [5].

4 ANALYSIS OF WIND FIELD ANOMALIES PRIOR TO THE FIRST RAINY SEASON

In order to reveal the anomalous characteristics of wind field prior to the first rainy season and identify strong signals for predicting the wetness of the season, composite two-dimensional wind field anomalies for the levels of 850, 500 and 200 hPa in the time prior to the rainy season of flood / drought years (preceding winter, autumn, September – current March) in south China within the region (40°S – 70°N, 30°E – 120°W) were analyzed and Monte Carlo statistical tests were performed. The focus was on the levels, months and regions that show the most significant anomalies of the wind field. As shown in the calculation, significant anomalies were found only in the wind fields of preceding January at 500 hPa and preceding March at both 500 hPa and 850 hPa.

Northern India is the main region where composite two-dimensional 500-hPa wind field anomalies are at the 0.01 significance level in the January precedent to flood / drought years (Fig.2a) and northwest Pacific (5 – 55°N, 120°E – 160°W) is the region where composite two-dimensional 850-hPa and 500-hPa wind field anomalies are at the 0.01 significance level in the March precedent to flood / drought years (Fig.2b & 2c). As shown in the analysis, a stationary deep trough over East Asia is more southward and stronger than average in the preceding March of the flood year but just the opposite in the drought year. In the areas where there are significant wind field anomalies at 850 hPa and 500 hPa in March, most of the correlation coefficients between components of the composite winds and precipitation in the first rainy season pass the 0.01 significance test (Tab.1), indicating that the preceding anomalies of wind fields in these areas are strong signals for predicting the precipitation. For analyses of other aspects, refer to the Chinese edition of the journal.

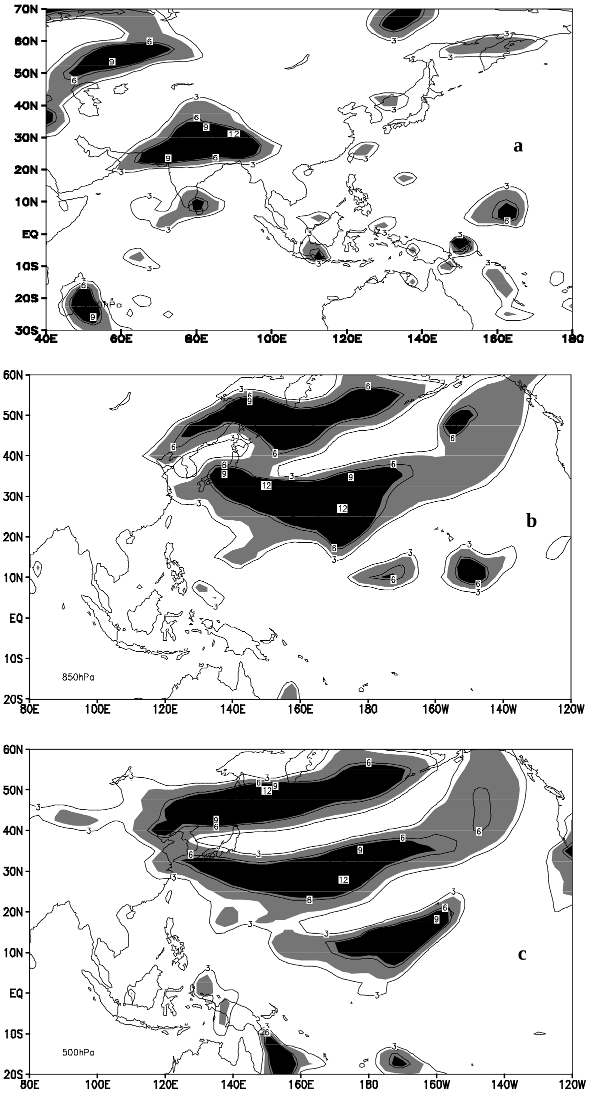


Fig.2 The F statistics of composite two-dimensional wind field anomalies in time precedent to the first annually rainy season. (a) January at 500 hPa; (b) March at 850 hPa; (c) March at 500 hPa. The light and dark shades are the regions at 0.05 and 0.01 significance levels, respectively.

5 CONCLUSIONS

(1) The location and coverage of key zones are obtained where the west Pacific subtropical high has significant impacts on precipitation anomalies in the annually first rainy season of south China, using the significance tests of two-dimensional wind field anomalies and Monte Carlo simulation tests. The 850-hPa wind field anomalies in the northeastern part of Lake Baikal and southern part of central Indian Ocean also influence precipitation anomalies in the season.

(2) The relationship is studied between the wind field anomalies and precipitation in periods prior to the rainy season of the drought / flood year and the preceding geopotential height fields. As shown in the result, important information for the prediction is contained at the middle and lower levels of 500 hPa and 850 hPa in the atmosphere. Spatially, northern India and northwest Pacific are key regions to be

closely watched for precursors and January and March are the key months but February is much less relevant in terms of wind field anomalies. For March, the geopotential height field in north Pacific is closely related with the wetness in the first rainy season.

Tab.1 The correlation of zonal wind *u*, meridional wind *v* and composite wind *V* with precipitation *r* over significant regions precedent to the first rainy season from 1951 to 2003

Month, geopotential height and coverage of significant regions	*u* & *r*	*v* & *r*	*V* & *r*
Jan. 500 hPa N. India (22-35°N, 70-95°E)	0.346	0.124	0.342
Mar. 850 hPa NW Pacific (45-55°N, 135°E-170°W)	-0.398	-0.440	-0.362
Mar. 500 hPa NW Pacific (25-35 °N, 135 °E-170 °W)	0.484	0.006	0.484
Mar. 500 hPa NW Pacific (40-55 °N, 120 °E-170 °W)	-0.330	-0.409	-0.335
Mar. 500 hPa NW Pacific (25-35 °N, 130 °E-170 °W)	0.469	0.307	0.470
Mar. 500 hPa NW Pacific (5-20 °N, 170 °E-160 °W)	-0.454	-0.342	0.389

REFERENCES:

[1] LIANG Jian-yin. The interannual variations of the subtropic high ridge position over western pacific in June and its influence on precipitation in south of China [J]. Journal of Tropical Meteorology, 1994, 10(3): 274-279.

[2] LIN Ai-lan. The study of strong signals and conceptual models of monthly precipitation anomaly forecast in Guangdong first raining spell [J]. Journal of Tropical Meteorology, 2002, 18(3): 219-226.

[3] CAI Xue-zhan, WANG Yan. XU Jin-jing. Diagnostic analysis on impact of convective activity anomalies over tropic on flood/drought during the first rainy season in South china [J]. Journal of Tropical Meteorology, 2002, 18(2): 157-164.

[4] DING Wei-yu, LIANG Jing-ping. Relationship between the variations of OLR over South China Sea and the precipitation in rainy seasons in South China [J]. Journal of Tropical Meteorology, 2002, 18(3): 276-282.

[5] LIANG Jian-yin, WU Shang-sen. Guangdong precipitation anomalies in summertime and summer monsoon [J]. Journal of Tropical Meteorology, 1999, 15(1): 38-47.

[6] SUN Shu-qing, SUN Bai-min. The relationship between the anomalous winter monsoon circulation over East Asia and summer drought/flooding in the Yangtze and Huaihe River valley [J]. Acta Meteorologica Sinica, 1995, 53 (4): 440-450.

[7] SUN Shu-qing, SUN Bai-min. The relationship between East Asian winter monsoon anomalies and drought / flood weather in the summer of Yangtze and Huaihe Rivers Valleys [J]. Xinjiang Meteorology, 1997, 20(6): 4-7.

[8] SHI Neng, ZHU Qian-gen, WU Bin-gui. The East Asian summer monsoon in relation to summer large scale weather-climate anomaly in China for last 40 years [J]. Scientia Atmospherica Sinica, 1996, 20(5): 575-583.

[9] SHI Neng. [J]. Features of the East Asian winter monsoon intensity on multiple time scale in recent 40 years and their relation to climate [J]. Journal of Applied Meteorological Science, 1996, 7(2): 175-182.

[10] JI Li-ren, SUN Shu-qing. Model study on the interannual variability of Asian winter monsoon and its influence [J]. Advances in Atmospheric Sciences. 1997, 14(1): 1-22.

[11] CHEN Jun, SUN Shu-qing. Eastern Asian winter monsoon anomaly and variation of global circulation part I: a comparison study on strong and weak winter monsoon [J]. Chinese Journal of Atmospheric Sciences, 1999, 23(1): 101-111.

[12] SHI Neng, GU Jun-qiang, HUANG Xian-xiang, et al. Significance test and Monte Carlo test used in composite analysis of window field and applications [J]. Chinese Journal of Atmospheric Sciences, 2004, 28(6): 950-956.

[13] SHANG Yao-ting, FANG Kai-tai. Introduction to Multivariate Statistical Analysis [M]. Beijing: Science Press, 1982.

[14] WU Shang-sen, LIANG Jian-yin. Temporal and spatial characteristics of the drought and flood during the rainy season in south China [J]. Journal of Tropical Meteorology, 1992, 8(1): 87-92.

[15] LIN Ai-lan, WU Shang-sen. Variations and trend prediction of rainfall of rainy season in south China in 1951 – 1991 [J]. Journal of Tropical Meteorology, 1996, 12(2): 160-166.

[16] SHI Neng, YUAN Xiao-yu, CHEN Lu-wen, et al. Summer floods and droughts in Zhejiang and their precursory features [J]. Journal of Nanjing Institute of Meteorology, 2001, 24(4): 498-504.