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THE RELATIONSHIP BETWEEN MEIYU IN THE MID- AND LOWER REACHES OF THE YANGTZE RIVER VALLEY AND THE BOREAL SPRING SOUTHERN HEMISPHERE ANNUAL MODE

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1 INTRODUCTION

As confirmed by many studies[1-4], sea surface pressure is of interannual variations in subtropical Southern Hemisphere, which is defined as the Southern-hemisphere Annual Mode (SAM). It is in fact a seesaw effect of sea surface pressure symmetric longitudinally between the South Pole region and austral middle latitudes. SAM is in fact a correction to the Antarctic Atmospheric Oscillation (AAO) [3-5]. At present, more attention is paid to the structure of SAM and its influence on the climate in mid- and higher-latitudes of SH than to the links between SAM and anomalies of boreal general circulation and climate[6, 7]. This work focuses on the relation among SAM in boreal spring (April – May), Mei-yu (sustaining rains) in the middle and lower reaches of the Yangtze River and East Asian monsoon.

2 DATA AND METHODS

The Mei-yu usually starts from the mid- and late-June and ends in the mid- and late- July in the middle and lower reaches of the Yangtze. Here, the total rainfall for June and July, which is from the monthly records of 160 weather stations across China from 1951 to 2000, is used as that for the reaches of the river. The index for summer monsoon is that defined by Li and Zeng[8] for East Asia (1948 – 2000). The SAM index (SAMI) is a modified one based on that for AAO as determined by Gong et al. [3], which is the normalized difference of monthly mean sea surface pressure between 40°S and 70°S (in contrast, the difference between 40°S and 65°S is used in the AAO index). For the sea surface pressure, wind and vertical velocity from 1951 to 2000, the reanalysis data of NCAR / NCEP is used and relevant data of the subtropical high index are from the monthly bulletin of Climate Center, CMA.

First, correlation analysis and confidence tests are performed of SAMI and precipitation for June and July in the 160 stations to locate main correlated regions. Then, SVD analysis is applied to the austral sea surface pressure south of 10°S and the 160-station precipitation to identify the relationship between them to verify the conclusions drawn for the first step. Thirdly, composite analysis is conducted of the 850-hPa wind, vertical velocity and subtropical high index in relevant boreal regions in strong (weak) SAMI years for possible linkages among them.

3 RELATIONS BETWEEN SPRING SAM AND RAINFALL DURING MEI-YU IN CHINA

It is known from analysis that there is significant positive correlation in the middle and lower reaches of the Yangtze with the confidence level at 95% for the significance test of the difference in the shade. In other words, the larger the SAMI, the more the precipitation in these reaches of the river and vice versa. It is also known that a positively-phased SAMI in boreal spring is followed by more Mei-yu precipitation later and vice

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versa.

To verify the results of correlation analysis, the sea surface pressure for 10° – 90°S in boreal spring (April – May) and rainfall for the Mei-yu period (June – July) is SVD-decomposed. As shown in the result, strong spring SAM is precursory to more rainfall later in Mei-yu and vice versa. It is then clear that the intensity of spring SAM can be one of the predictors to indicate rainfall later in Mei-yu.

4 850-hPa WIND, VERTICAL VELOCITY AND SUBTROPICAL HIGH DURING MEI-YU IN YEARS OF ANOMALOUS SPRING SAM AND THEIR RELATIONS WITH SST

Following relevant WMO criteria for anomalies, 1979, 1989, 1995, 1996, 1998, 1999 and 2000 are the years in which SAM is anomalously strong, and 1951, 1952, 1953, 1960, 1965 and 1968 are the years in which SAM is anomalously weak, in spring. It is clear that years with anomalously strong spring SAM usually happened in 1980's and mid-1990's through the end of 20^{th} century while years with anomalously weak spring SAM were all in 1950's and 1960's, a fact that justifies the trend that precipitation has been increasing during Mei-yu periods in the middle and lower reaches of the Yangtze since 1980's.

For the wind field at 850 hPa, the composite 850-hPa wind differences for June and July in both strong and weak SAM years are analyzed to find that springs with high (low) SAM are usually followed by weak (strong) summer monsoon in East Asia. Besides, the South China Sea summer monsoon index by Li and Zeng[8] correlates with the SAMI for spring by –0.32 (with confidence test over the level of 95%), i.e. they are much negatively correlated. The results show that strong spring SAM events will come before weak tropical Southwest Monsoon later in summer. For the vertical velocity, zonal and meridional cross-sections of its differences for June and July are studied to find that years of strong spring SAM anomalies are followed by significant ascending motion in Mei-yu in the middle and lower reaches of Yangtze, thus favorable for the increase of precipitation and vice versa. For the subtropical high and summer monsoon, the former is compared between years of strong and weak spring SAM anomalies with the suggestion that the subtropical high is stronger and extends more westward in years of high SAM while it is weaker, locates more eastward and Mei-yu rainfall is less in years of low SAM. For the relation between spring SAM and SST, the coefficient of correlation is calculated between spring SAMI (April and May) and simultaneous global SST to show that high spring SAMI is accompanied with high SST over the South China Sea, western Pacific, Bay of Bengal, Arabian Sea and the entire Indian Ocean and followed by subsequent weak summer monsoon in East Asia; low spring SAMI is accompanied with low SST over these waters and subsequent strong summer monsoon in East Asia. Our conclusion is consistent with that for the 850-hPa wind differences earlier in this work.

5 CONCLUSIONS

(1) SAM positively correlates well with Mei-yu in the middle and lower reaches of the Yangtze such that strong springtime SAM is followed by more rainfall in Mei-yu in the reaches of the river and vice versa.

(2) SAM negatively correlates well with SST offshore China such that strong springtime SAM is accompanied by low SST offshore and weak summer monsoon in East Asia later while high SST offshore is followed by strong summer monsoon in East Asia.

(3) In the years of strong anomalous spring SAM, a significant wind shear dominates the middle and lower levels of the atmosphere over the middle and lower reaches of the Yangtze; in the years of weak anomalous spring SAM, the shear is more to the north over North China.

(4) How does SAM act on the Mei-yu rainfall over the middle and lower reaches of the Yangtze? What is the internal mechanism for their correlation? They remain unclear and need further study.

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