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VARIATION FEATURES OF SOMALI CROSS-EQUATORIAL FLOW AND ITS IMPACT ON THE LOCATION OF THE SUBTROPICAL HIGH RIDGE FROM JULY TO SEPTEMBER

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Abstract: The variation features of the cross-equatorial flow and its impact on the ridge position of the subtropical high have been analyzed in this paper. It is shown as follows. (1) The intensity of the Somali cross-equatorial flow is increasing in winter and summer in the past 44 years and the airflow of Northern Hemisphere exchanges more and more intensively with that of Southern Hemisphere. (2) The Somali cross-equatorial flow in May has the most impact on the ridge position of the subtropical high in the typhoon season, presenting a positive correlation. (3) The diagnosis is consistent with the real situation in 2005.

Key words: cross-equatorial flow; subtropical ridge position; correlation analysis; diagnosis

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1 INTRODUCTION

Cross-equatorial airflows are significantly associated with the variation of the atmospheric circulation in the Southern and Northern Hemispheres, especially the low latitudes. Research achievements [1 - 3] are also more than those for the relationships between the cross-equatorial airflow and the subtropical high activity in July – September. It is, however, realistically important to probe into some characteristics of the cross-equatorial airflow and its relationships with the subtropical high activity in July – September for the following reason. In summer, the subtropical high is so closely linked with the activity of precipitation and typhoons in China [4] that if (the ridge and northernmost boundary of) the former is located northward, it will be likely to have more typhoons in Fujian and vice versa [5].

2 SOURCE AND BRIEF ACCOUNT OF DATA USED

The sum of the subtropical high ridge location over July – September is divided by 3 to depict the location of the ridge during the typhoon season, for which the characteristic monthly quantities and indexes of the subtropical high are provided by the National Climate Center.

The monthly mean gridpoint data are from the National Climate Center, which cover the Northern Hemisphere at a resolution of 5°×10°.

The 850-hPa wind fields used in this work, which are historical monthly mean data and real-time monthly mean data, come from the National Climate Center and *Monthly Bulletin of Climate Watch*, which cover the period from 1961 to 2004 with the gridpoint interval being 5°×10°. In this study, the monthly mean data covering the domain of 40°S – 40°N, 0° – 180°E for the period of 1961 – 2005 are used in the analysis.

3 CLIMATOLOGICAL CHARACTERISTICS OF CROSS-EQUATORIAL AIRFLOW

3.1 *Channels of cross-equatorial airflow*

To study basic climatological characteristics of the cross-equatorial airflow, 30-year (1971 – 2000) mean of 850-hPa meridional wind (V component) is determined for each of the 12 months. Fig.1 gives the curve of its mean wind speed, which has been increased 10 folds and the same below, for May – September at the equator. It shows that there are six main channels between 0° and 180°E. Except for an

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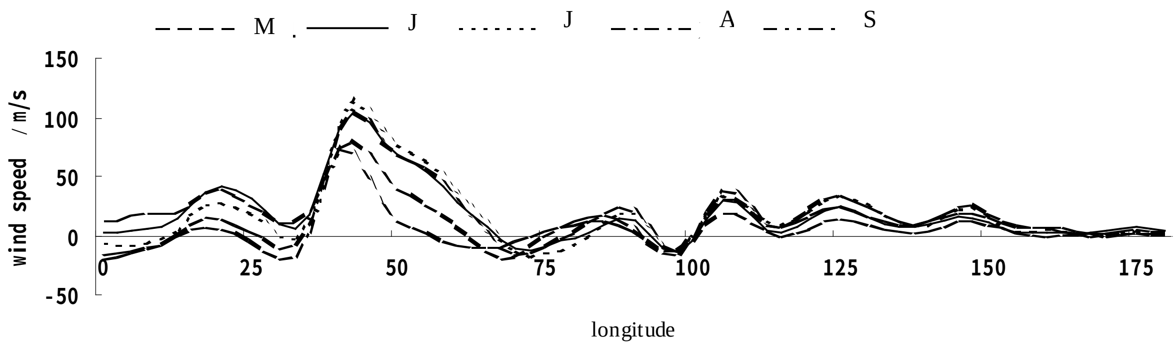

Fig.1 Curves of mean meridional wind speed (*V* component) across the equator at 850 hPa in May – September. "M, J, J, A, S" in the figure stand for May, June, July, August and September, respectively.

extra channel at 15°E – 20°E, the other five are generally consistent with those obtained by Shi et al [1]. Among the six channels, the one at 45°E – 60°E has the strongest cross-equatorial airflow, which is in the neighborhood of Somali.

3.2 *Intraannual variation of the cross-equatorial airflow*

Addressing from the viewpoint of practical application, this work determines the intensity of the cross-equatorial airflow through the channel near Somali and studies it based on the calculation. The channel at 45°E – 60°E on the equator is shifted five degrees of longitude to the east when seeking the airflow intensity, i.e. the area at 0° – 10°N, 50°E – 65°E becomes a channel for statistics. It is attributed to the fact that airflows form the Southern Hemisphere show an orientation of NE-SW in the primary axis and area of relatively large wind speed and the statistical domain in [3] and the convenience of statistical work. The intensity of the regional cross-equatorial airflow is derived for the time from 1961 to 2004.

$$SJ(\sum_{i,j} V_{ij} /35$$

where *i*=1，2…5(0° - 10°N) ，j=1,2…7(50° - 65°E), *V* is the meridional wind speed at 850 hPa, and *SJ* is the mean intensity of the cross-equatorial airflow over Somali for a particular year. It will be referred to as the index of intensity of cross-equatorial airflow, which is the only air current that goes across the equator in this work if not specified. It is known from the calculation expression that a positive index indicates the passage of a southerly in the channel across the equator from the Southern to Northern Hemispheres; the larger the numeral is, the stronger the cross-equatorial airflow will be; a negative index indicates the presence of a northerly across the equator from the Northern to Southern Hemispheres; the smaller the numeral, the stronger the cross-equatorial airflow will be. The tendency of intensity is basically consistent with that of [1].

It is known from the monthly mean of the intensity index that significant transitory phases exist in the winter-half and summer-half year as airflows exchange with each other between the two hemispheres, which take place in September – October and May – June, respectively. The former is completed when airflows traveling from Southern Hemisphere to Northern Hemisphere are replaced by those going from Northern Hemisphere to Southern Hemisphere. The latter is completed when they take place otherwise. The northward flow is the strongest in July while the

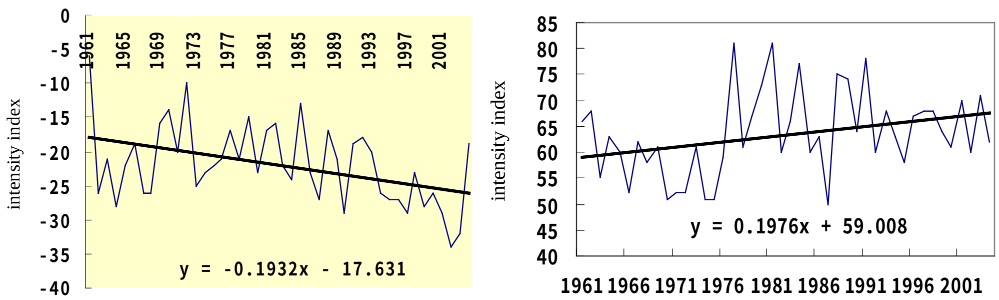

Fig.2 Evolution curves of the intensity index of the cross-equatorial airflow for Jan. (a) Jul. (b) over the past 44 years. The abscissa is the year.

southward flow is the strongest in January.

3.3 *Tendency of cross-equatorial airflows evolution*

Fig.2 gives the curves of variation of the cross-equatorial airflows in January (winter) and July (summer) over the past 44 years. It is known from the bold, straight line (of the tendency) that the northward, winter airflows crossing the equator from the Northern Hemisphere tend to increase over the past 44 years, and the coefficient is -0.42 and the confidence passes the 0.01 level of the correlation between the January and July cross-equatorial airflows. It is then known that the cross-equatorial airflows tend to increase in both winter and summer over the past 44 years. Viewed from the monthly evolution and tendency (Tab.1), however, the strengthening tendency is evident not only in July but also over the entire summer (May – October); the intensity of the airflows is also strengthening in both January and the entire winter (November – April). It is shown that airflows have been exchanging more and more intensely between both hemispheres in the winter and summer of the past 44 years. It is expected that the observed evolution may result in a climate that is easier to deviate from the normal state and extreme weather and climate events that are prone to take place more frequently.

Tab.1 Statistics of monthly evolution tendency of the intensity of cross-equatorial airflows

months	Tendency equations	Intensity tendency for winter-half year	Intensity tendency for summer-half year
Jan.	y = -0.1932x - 17.631	Increasing	
Feb.	y = -0.2158x - 11.599	Increasing	
Mar.	y = -0.1707x - 4.3415	Increasing	
Apr.	y = -0.0235x - 7.2431	Increasing	
May	y = 0.1255x - 2.7104		Increasing
Jun.	y = 0.2721x + 39.31		Increasing
Jul.	y = 0.1976x + 59.008		Increasing
Aug.	y = 0.2116x + 49.02		Increasing
Sept.	y = 0.1235x + 17.329		Increasing
Oct.	y = 0.05x - 11.216	Southerly increasing	Northerly decreasing
Nov.	y = -0.1891x - 11.282	Increasing	
Dec.	y = -0.1373x - 16.724	Increasing	

Tab.2 Comparison of the location of subtropical high ridge in typhoon seasons between the years of strong and weak intensity of Somali cross-equatorial airflows in May

Strong years	2000	1990	2001	2002	1961	1971	1999	1962	1969	1981	1985	Mean
Intensity	2.3	2.0	1.8	1.6	1.3	1.3	0.8	0.5	0.5	0.5	0.5	
Ridge (°N)	29.0	26.3	27.7	24.0	29.3	28.0	29.7	27.7	26.0	26.0	29.0	25.5
Assessment	√	√	√	×	√	√	√	√	√	√	√	
Weak years	1992	1997	1967	1964	1998	1965	1968	1987	1993	1996		
Intensity	-1.9	-1.6	-1.5	-1.3	-1.1	-1.0	-1.0	-0.9	-0.8	-0.8		
Ridge (°N)	28.0	25.0	23.3	29.0	23.7	24.0	24.0	22.7	25.0	23.7		25.5
Assessment	×	√	√	×	√	√	√	√	√	√		

4 EFFECT OF CROSS-EQUATORIAL AIRFLOWS ON THE LOCATION OF SUBTROPICAL HIGH RIDGE IN THE TYPHOON SEASON

It is known from the correlation between the cross-equatorial airflows and the location of the ridge of the subtropical high in July – September that the coefficient is relatively high in May and the preceding October, being 0.44 and 0.32 respectively, with the confidence level exceeding 0.01 and 0.05 respectively. As May and October are the months of transition for the exchange of airflows, the change in intensity precludes that of the ridge location of the subtropical high in July – September. The good matching relationship is also supported by a statistical result of the links between the strong and weak categories of Somali cross-equatorial airflows in May, 10 years for each, and the location of the subtropical high ridge in July – September (See Tab.2). The probability is 18/21 (85.7%) and confidence is over the 0.01 level.

5 DISCUSSIONS

In order to show more about the relationships between Somali cross-equatorial airflows and the location of the subtropical high ridge in July – September, the correlation has been determined between the index of the former and 500-hPa circulation in the three months (Figure omitted). It clearly shows that there is a "- + -" teleconnection from high and middle latitudes to low latitudes in regions from East Asia to the western Pacific; positive correlation is especially significant in mid-latitudes in which the correlation coefficient is as high as 0.43 and confidence level passes 0.01 at the correlation center. The figure also shows significant negative correlation in the low-latitude areas between 70°E and 90°E in which the correlation coefficient is as high as -0.54 at the correlation center with the confidence level exceeding 0.001.

It is then shown that if the Somali cross-equatorial airflow is strong compared to normal in May and the 500-hPa convergence is northward located in July – September, which are displayed as low (high) geopotential height in low latitudes (middle latitudes from East Asia to western Pacific), it will be favorable for the bulk and the ridge of the subtropical high to locate more northward than usual; they are true otherwise. It is consistent with the conclusion by Bi et al.[3]. It is then concluded that the intensity of the cross-equatorial airflow over Somali can be taken as a precursory signal for indicating the change in the location of the subtropical high ridge in July – September.

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

6 CONCLUSIONS

Apart from what has been concluded above in the analysis of the association between the evolution of the Somali cross-equatorial airflows over the past 44 years and their effect on the change of the location of the subtropical high in July – September, it is worth of more discussion of the possibility of whether the evolution is related with anomalous climate and extreme weather and climate events over the past few years.

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