Article ID: 1006-8775(2007) 02-0169-04

RELATIONSHIPS BETWEEN ZONAL WIND ANOMALIES IN HIGH AND LOW TROPOSPHERE AND ANNUAL FREQUENCY OF NW PACIFIC TROPICAL CYCLONES

GONG Zhen-song (龚振淞), HE Min (何敏)

(Laboratory of Climate Study/CMA, National Climate Center, Beijing 100081 China)

Abstract: Relationships between large-scale zonal wind anomalies and annual frequency of NW Pacific tropical cyclones and possible mechanisms are investigated with the methods of correlation and composition. It is indicated that when ΔU_{200}-ΔU_{850} >0 in the eastern tropical Pacific and ΔU_{200}-ΔU_{850} <0 in western tropical Pacific, the Walker cell is stronger in the Pacific tropical region and the annual frequency of NW Pacific tropical cyclone are above normal. In the years with zonal wind anomalies, the circulation of high and low troposphere and the vertical motions in the troposphere have significant characteristics. In the time scale of short-range climate prediction, zonal wind anomalies in high and low troposphere are useful as a preliminary signal of the annual frequency prediction of NW Pacific tropical cyclones.

Key words: zonal wind anomalies in high and low troposphere; annual frequency of tropical cyclone; short-range climate prediction

CLC number: P434.4 **Document code:** A

1 INTRODUCTION

The annual frequency of tropical cyclones (to be shortened as annual frequency hereafter) making genesis in northwest Pacific and landfall in China are varying significantly on the interannual and interdecadal scales. Most of the study on climatic prediction of the annual frequency focus on the relationship between the El Niño episode and the annual frequency in northwest Pacific[1, 2]. Due to the lack of predictive signals with physical implication and prediction methods, short-term climatic prediction of tropical cyclones has remained difficult in China. In the 1990s, predictors of quasi-biennial stratospheric oscillation, sea level pressure, Southern Oscillation, sea surface temperature and 200-hPa zonal wind anomalies were used to isolate large amount of signals relevant to the long-term prediction of Atlantic hurricanes[3 – 5].

Basic conditions for the typhoon to form were summarized, which were the factors to be taken into account in predicting the genesis and development of tropical cyclones[6]. Few studies have been made, however, on the ways in which they affect the tropical cyclones in northwest Pacific on the monthly, seasonal and annual scales. To introduce circulation factors with physical implication in the short-term climate prediction of the annual frequency, the methods of correlation statistics and composite study are used. The difference field of the zonal wind anomalies between high and low troposphere (ΔU_{200}-ΔU_{850}) is used to study the relationship between the anomalous difference and the annual frequency so as to isolate the precursory signals for the prediction of the annual frequency.

The monthly mean global wind field data used here are extracted from NCEP / NCAR with the gridpoint interval at 2.5° × 2.5°. The data of the annual frequency are taken from Shanghai Typhoon Institute. The tropical cyclones referred to in this work are those who generated west of 180° and are higher than the level of tropical storms, excluding tropical depressions.

2 RELATIONSHIP BETWEEN ZONAL WIND ANOMALIES AND ANNUAL FREQUENCY

Received date: 2006-12-18; **revised date:** 2007-09-06

Foundation item: Research on predictive signals and methods for short-short climate of annual frequency of typhoons, a project from the research fund on typhoons of 2003 – 2004 at Shanghai Typhoon Institute

Biography: GONG Zhen-song (1977 -), male, native from Jiangxi province, M.S., mainly undertaking short-term climate prediction.

E-mail: gongzs@cma.gov.cn

2.1 *The correlation*

Fig.1 gives the distribution of the correlation between the difference field (ΔU_{200}- ΔU_{850}) and the annual frequency. It is known that the former is closely linked with the genesis and development of tropical cyclones.

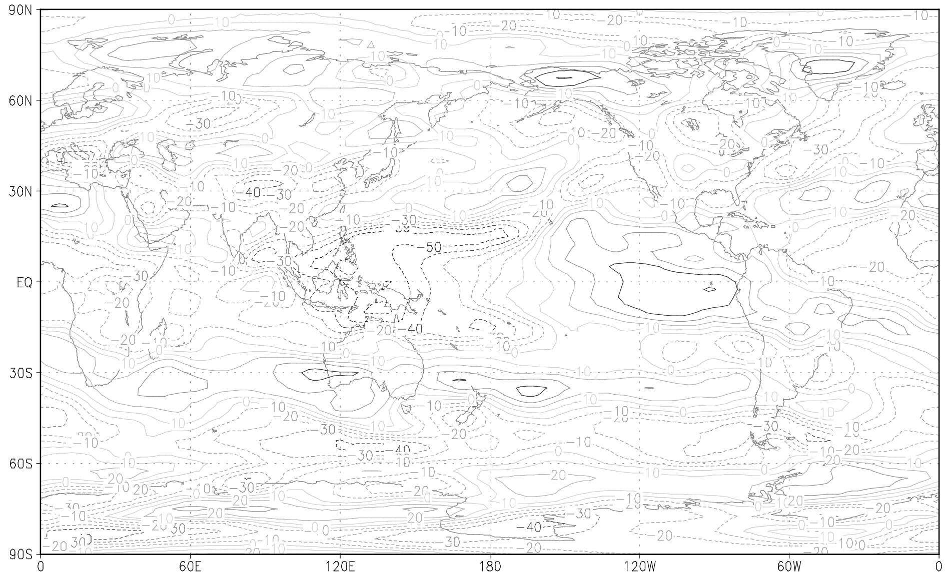

Fig.1 Correlation between the difference field of zonal wind anomalies between high and low levels and the annual genesis frequency of tropical cyclones in northwest Pacific.

2.2 *Expression and physical implication of zonal wind anomalies in high and low troposphere over tropical Pacific*

For the ease of discussion, indexes are used to describe the extent of zonal wind anomalies. Differences between two areas of high correlation (ΔU_{200}- ΔU_{850}) in equatorial eastern Pacific and western Pacific are used to indicate the zonal wind in tropical Pacific. With changed heating conditions of the underlying surface, the ascending and descending branches of the Walker cell will have anomalies in both location and intensity[7]. As a result, the zonal wind anomalies indicate the Walker cell anomalies; in the years of large indexes (of positive values), the Walker cell is relatively strong and the annual frequency is relatively large but otherwise relatively small.

2.3 *Zonal wind anomalies and interdecadal variation of the annual frequency*

Fig.2 gives the curves for the zonal wind index and the annual frequency, which have similar interdecadal variation. It shows that the zonal wind index is large, the Walker cell strong and the annual frequency high for the climatic phase from the 1960s to the mid-1970s but small, weak and low, respectively for the climatic phase from the late-1970s to the present.

3 PRECURSORY SIGNALS FOR ZONAL WIND ANOMALIES IN TROPICAL PACIFIC

The precursory signals are sought using the correlation between the difference field (ΔU_{200}- ΔU_{850}) and the annual frequency. It shows that the positive correlation in the east versus negative correlation in the west distribute consistently in this region from winter to the tropical cyclone season.

The zonal wind anomalous difference in the equatorial eastern Pacific for January is taken as the precursory signal for the prediction of the annual frequency. When it is larger (smaller) than zero, the annual frequency will be high (low) with a correlation coefficient of 0.44. The January precursory signal makes the prediction of the annual frequency valid for long duration. As their correlation has high confidence in the west Pacific, the index can be used to supplement forecasts of the annual frequency.

The difference between two areas of high correlation for May is used as a predictor to correct the prediction of the annual frequency. Fig.4 gives the interannual variation of the predictor and the annual frequency. Their correlation coefficient and probability are –0.66 and –0.75, respectively, which are much improved in the degree of confidence than those for January. When the Walker cell is strong (weak) in May in tropical Pacific, the annual frequency will be more (less). As shown in retrospective forecasts for 2001 – 2004 and forecasts for 2005 – 2006, the accuracy of the May predictor is much improved over that of January. For analyses of other aspects, refer to the Chinese edition of the journal.

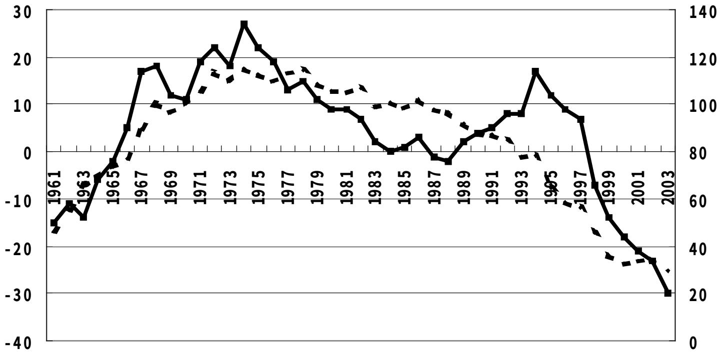

Fig.2 Curves for the zonal wind index of high and low troposphere for June – October (broken line, on the right coordinate) and accumulative anomalies of the annual frequency (1961 - 2003).

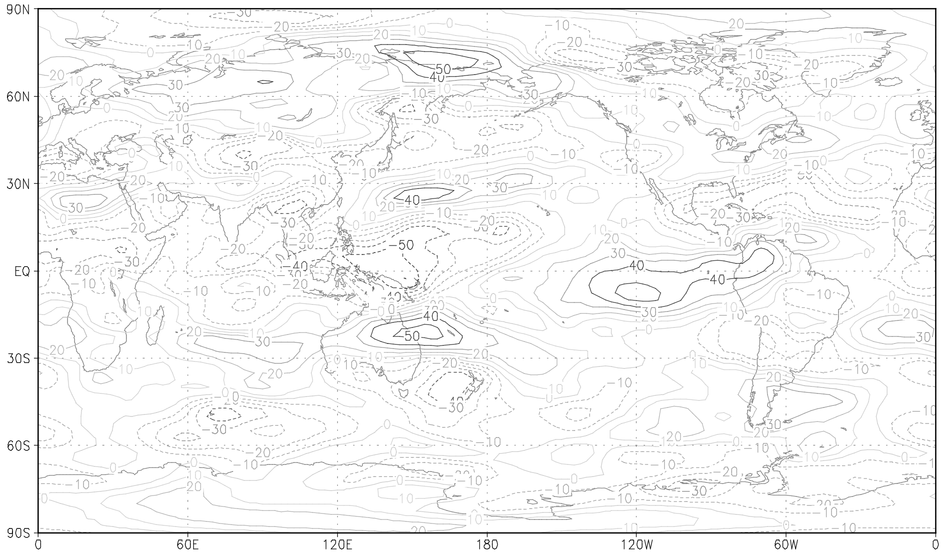

Fig.3 Correlation between the zonal wind difference field of May and the annual frequency in northwest Pacific.

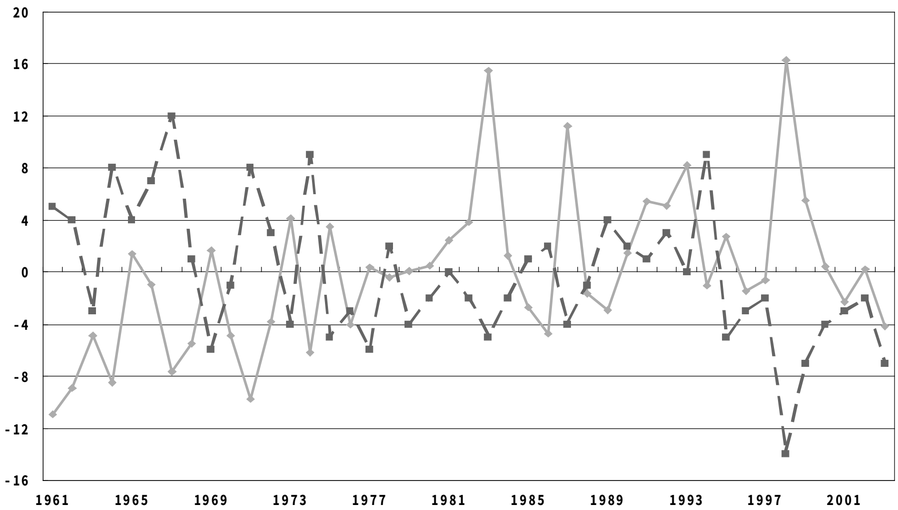

Fig.4 Interannual variation of the May predictor and annual frequency. Solid line: the predictor; dashed line: the annual frequency.

4 CONCLUSIONS AND DISCUSSIONS

(1) Large-scale zonal wind anomalies in tropical Pacific from June to October are well correlated with the annual frequency of cyclogenesis in northwest

Pacific. When ΔU_{200}- ΔU_{850}<0 in tropical west Pacific and ΔU_{200}- ΔU_{850}>0 in the equatorial eastern Pacific, the annual frequency is relatively more in northwest Pacific.

(2) The difference between two areas of high correlation (ΔU_{200}- ΔU_{850}) in tropical Pacific from June to October is defined to be the index for the zonal wind in high and low troposphere. It indicates the extent of the Walker cell anomalies. As a result, a large (small) index is accompanied with strong (weak) Walker cell and more (less) annual frequency of cyclogenesis in northwest Pacific.

(3) The correlation between the zonal wind anomalies and the annual frequency is consistent from the preceding winter to the current typhoon season. The precursory signal for the prediction of the annual frequency clearly indicates in the physical sense how preceding Walker cell anomalies affect the annual frequency. The precursory signals of the zonal wind anomalies for January and May can be used to make and supplement the forecast of the annual frequency.

(4) As the annual frequency is subject to the co-effect of a number of factors of the general circulation and underlying surface other than the zonal wind anomalies in high and low troposphere, other factors will have to be taken into account in routine forecast/

REFERENCES:

[1] LI Chong-yin. A study on the influence of El Niño upon typhoon action over western pacific [J]. 1987, 45: 229-235.
[2] HE Min, SONG Wen-ling, CHEN Xing-fang. El Niño and anti- El Niño episodes and northwestern Pacific typhoons [J]. Journal of Tropical Meteorology, 1999, 15(1): 17-25.
[3] GRAY W M, et al. Predicting Atlantic seasonal hurricane activity 6-11 months in advance[J]. Weather and Forecasting, 1992, 7: 440-455.
[4] GRAY W M, et al. Predicating Atlantic Basin seasonal tropical cyclone activity by 1 August[J]. Weather and Forecasting, 1993, 8: 73-86.
[5] GRAY W M, et al. Predicating Atlantic Basin seasonal tropical cyclone activity by 1June[J]. Weather and Forecasting, 1994, 9: 103-115.
[6] CHEN Lian-shou, DING Yi-hui. Introduction to West Pacific Typhoons [M]. Beijing: Science Press, 1979: 64-145.
[7] GU Jun-xi, ZHANG Ji-jia, CHAO Ji-ping, et al. Dictionary of Atmospheric Sciences [M]. Beijing: Meteorological Press, 1994: 671.