**12D.6 POSSIBLE INFLUENCE OF FEBRUARY-APRIL ARCTIC OSCILLATION ON THE ITCZ PATTERNS OF WESTERN-CENTRAL PACIFIC**

Miao Hu*, Dao-Yi Gong
Beijing Normal University, Beijing, China

## 1. INTRODUCTION

The meridional circulations associated with Arctic Oscillation (AO) are as strong in the tropical as in the mid-latitudes and a strong Hadley circulation is accompanied with high AO (Limpasuvan and Hartmann, 2000). In a word, the circulations in the tropical are sensitive to the strength of AO. Miller et.al (2003) have studied the relationship between AO and OLR (outgoing longwave radiation) in the global scale, and indicated that in the high AO years, OLR are relatively lower in the tropical Pacific and Atlantic Ocean, which means convection activities are stronger in these regions; however, they did not give explanation. In this study, we expect to analyze the daily patterns and activity of ITCZ (Intertropical Convergence Zone) in the Western-Central Pacific Ocean and understand the relationship between AO and ITCZ in the Western-Central Pacific Ocean. This work will help scientists to better understand the influence of extra-tropical system on tropical circulation and convection.

## 2. DATA AND METHODOLOGY

In this study the daily ITCZ activities are presented by gridded daily OLR data (2.5°*2.5°) from NCAR with sophisticated spatial and temporal interpolation, which extends from January 1979 to December 2008 (Liebmann and Smith, 1996). AO index are obtained from Climate Prediction Center and AO is defined as the leading mode of Empirical Orthogonal Function of monthly mean 1000mb height poleward of 20°N. The monthly wind and SST data are derived from NCEP/NCAR Reanalysis I (Kalnay, et al, 1996) and Hadley Centre observations (Rayner, et al, 2003), respectively, which all extend from January 1979 to December 2008.

To focus on the climatological position of ITCZs, we confine our study area within 130°E–150°W, 12.5°N–12.5°S. This area is divided into three zonal bands: northern band (12.5°N–5°N), equator band (2.5°N–2.5°S) and southern band (5°S–12.5°N). Based on the area percentage coverage of OLR values (≤205W • $m^{-2}$) within different zonal bands over the Western-Central Pacific Ocean, we can obtain ITCZ convection activity distributions. Following the method used by Chen et.al (2008), daily ITCZ patterns can be similarly divided into six spatial patterns, namely the North, South, Equator, Double and the Full ITCZ pattern.

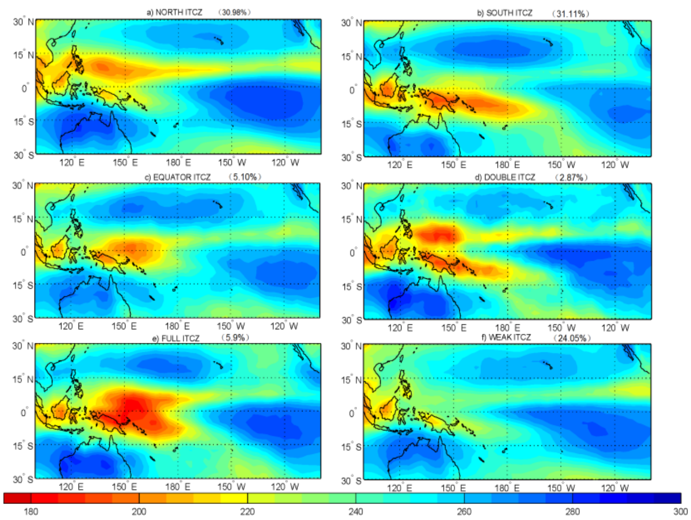


Figure1 The composite daily OLR for a)north, b) south, c) equator, d) double, e) full, f) weak ITCZ patterns for the period of 1979-2008. Units: W·$m^{-2}$

## 3. RESULTS

### *3.1 ITCZ Spatial Patterns*

* *Corresponding author address:* Miao Hu, Beijing Normal Univ., Academy of Disaster Reduction, Beijing, China 100875; email: hu_miao@mail.bnu.edu.cn

Figure 1 shows the composite daily OLR distribution for the north, south, equator, double full and weak ITCZ patterns. The OLR minimum presents a distinctive convection center and distribute characteristic for each ITCZ type, which is consistent with the definition of ITCZs. And their frequencies are calculated as a percentage of the number of a certain ITCZ days over the total 30 years. The results demonstrate that over the Western-Central Pacific Ocean the North (31%), South (31%) and Weak (24%) ITCZs represent the three major ITCZ daily distribution patterns, which account for 86% of all observations; meanwhile, the other three types (Equator, Double and Full ITCZs) are the minor and occur infrequently.

### *3.2 Relationship between AO and ITCZs*

| Month | North ITCZs | North ITCZs (ENSO removed) | Weak ITCZs | Weak ITCZs (ENSO removed) |
|---|---|---|---|---|
| 2-4 | 0.29 | 0.26 | -0.13 | -0.18 |
| 3-5 | **0.41** [b] | **0.41** [b] | **-0.38** [b] | **-0.42** [b] |
| 4-6 | **0.49** [c] | **0.49** [c] | **-0.32** [a] | **-0.34** [a] |
| 5-7 | **0.47** [c] | **0.41** [b] | **-0.36** [b] | **-0.30** [a] |
| 6-8 | **0.43** [b] | **0.34** [a] | **-0.35** [a] | -0.27 |
| 7-9 | **0.42** [b] | **0.33** [a] | **-0.37** [b] | -0.28 |
| 8-10 | **0.33** [a] | 0.29 | **-0.35** [c] | -0.23 |
| 9-11 | -0.04 | 0.04 | -0.17 | -0.02 |

a：90%, b：95%, c：99%

Table1 The correlation coefficients between Feb-Apr AO index and North/Weak ITCZ frequencies for the period of 1979-2008

We use the time-lag correlation analyses to investigate the relationship between ITCZ patterns and AO index of Jan-Mar, Feb-Apr and Mar-May. The correlations of ITCZ and Jan-Mar AO are relatively weak, with correlation coefficients definitely insignificant (between 0.1 and -0.1). In contrast, Feb-Apr and Mar-May AO index have very significant relationship with ITCZs. In the following sections, the question is focused on the possible influence of Feb-Apr AO (AO for short). Among six patterns, the frequencies of the North and Weak ITCZ patterns have strong correlation with AO index; the south ITCZs frequency shows a weak and insignificant negative correlation with AO (the strongest correlation is only -0.2), and from May to July their correlation also very weak; no significant association is found between the other three ITCZ patterns and AO. In Table 1, statistical results show that AO index has a pronounced positive (negative) correlation with north (weak) ITCZ from Mar-May to Aug-Oct, with a strongest correlation in Apr-Jun (Mar-May). Furthermore, it is noticed that no matter the ENSO signal excluded or not from AO and ITCZs, the correlation coefficients are similar, which indicates that ENSO might be an unimportant factor in the relationship between AO and ITCZ patterns.

The North and Weak ITCZ frequencies have significant correlation with AO, and share the same characters in interannual and interdecadal variation, which can be seen by comparing the time series of AO, North ITCZs and Weak ITCZs (Fig.2). Although AO is not the only factor impacting ITCZ variation, from above analysis we can conclude that Feb-April AO strength is really a remarkable factor relating to the North and Weak ITCZ frequency fluctuation.

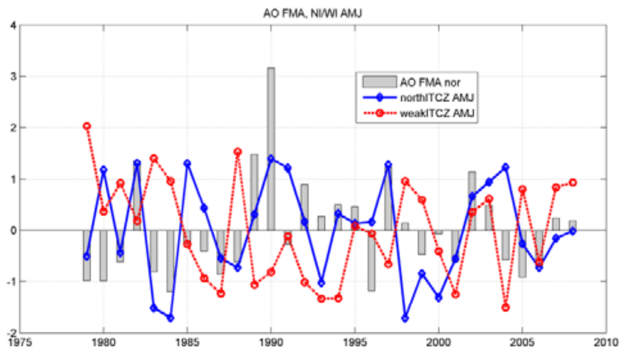


Figure 2 Time series of normalized AO index (Feb-Apr) and North/Weak ITCZs frequency (Apr-Jun). Grey bar: AO index; Solid lines: North ITCZs; Dashed lines: Weak ITCZs.

### *3.3 Related wind and SST anomalies*

The lower tropospheric atmosphere circulation (850 hPa wind field, Fig.3) and SST anomalies (Fig.4) corresponding to the AO co-change significantly in the tropical Pacific Ocean. When AO is in the positive phase, there is an anomalous westerly and warmer SST in the critical north ITCZ active region from equator to 15°N, while from equator to 15°S there is an anomalous easterly and insignificant change of SST. The wind and SST anomalies share the same character of the equatorial asymmetry and thus enlarge the gradient between south and north of equator, which can result in the reinforced convection in the north of the equator, as well as the more frequencies of north ITCZ; maybe this phenomenon is related to the mechanism of the positive feedback of Wind-Evaporation-SST (Xie and Philander, 1994).

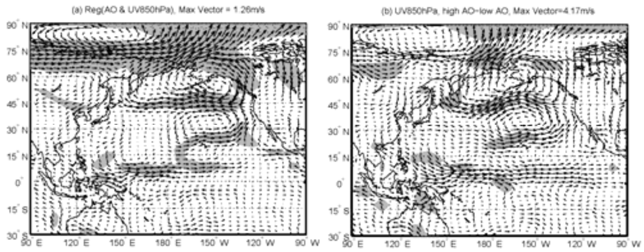

Figure 3 (a) Regression coefficients of 850hPa wind upon Feb-Apr AO (ENSO removed); (b) Composites of 850hPa wind anomalies in Apr-Jun. Years of composites: 1982, 1990, 1997 and 2002 for high AO; 1979, 1980 and 1984 for low AO. Units are $ms^{-1}$. Shading: 90% level.

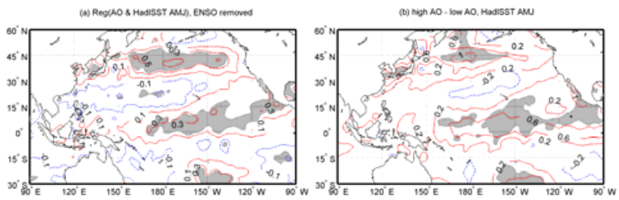

Figure 4 (a) Regression coefficients of SST upon Feb-Apr AO (ENSO removed); (b) Composites of SST anomalies in Apr-Jun. Solid lines: positive correlations/anomalies; Dashed lines: negative correlations/anomalies; the contour interval is 0.2 for (a) and 0.4 for (b). Unit is degree. Shading: 90% level.

## 4. CONCLUSIONS

The daily patterns and activity of ITCZ over the Western-Central Pacific Ocean has been analyzed, and there exist significant relationships between AO and ITCZ patterns. In accordance with the central activity region the daily ITCZ can be divided into six patterns—north, south, equator, double, full and weak pattern, respectively. Feb-Apr AO index has a pronounced positive (negative) correlation with the frequency of north (weak) ITCZ from Mar-May to Aug-Oct, with a strongest correlation in Apr-Jun (Mar-May). The lower tropospheric atmosphere circulation (850hPa wind field) and SST anomalies corresponding to the AO change significantly in the tropical Pacific Ocean. The wind and SST anomalies share the same character of the equatorial asymmetry and thus enlarge the gradient between south and north of equator, which can result in the reinforced convection in the north of the equator, as well as more frequencies of north ITCZ.

## 5. REFERENCES


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