# INTERANNUAL VARIABILITY OF ASIA-PACIFIC RAINFALLS AND NORTHWESTERN-PACIFIC TYPHOON ACTIVITY

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Abstract

The relationship between the interannual variability of rainfalls over the Asian-monsoon/western Pacific regions and typhoon activity over the northwestern Pacific is examined for the summer season. Revealed form the composite analysis, the excessive Asian-monsoon rainfalls are in association with an anomalous high to the east of Taiwan which is accompanied with enhanced typhoon activities at its southern rim, but with suppressed typhoon activities around its center. In the summers with excessive rainfalls over the tropical western Pacific, an anomalous low is centered at the vicinity of Taiwan that is accompanied with enhanced typhoon activities over the subtropical western Pacific.

## 1. Introduction

In the summer season, the stationary waves are dominated by the monsoon system. In the lower troposphere, major components of the monsoon circulation include the Asian low, Indian-ocean high, and the subtropical high over the North Pacific. Based upon the numerical study, Ting (1994) pointed out that the Asian-Pacific summertime stationary waves are mainly maintained by the heat source associated with the monsoon rainfalls over the India/Western Pacific region. Over the tropical western North Pacific, Harr and Elsberry (1995) found that the large-scale circulation variability is dynamically related to the tropical cyclone activity. The above results imply that the monsoon rainfall variability over the Asian-Pacific region and the northwestern-Pacific tropical cyclone activity may contain certain relationship through the linkage by the large-scale circulation. The purpose of this study is to examine the relationship among the Asian-Pacific rainfalls, large-scale circulation, and the northwestern-Pacific tropical cyclone (typhoon) activity in the interannual time scale.

## 2. Data

Three datasets are analyzed in this study: (1) the precipitation estimates compiled from the rain gauge measurement and satellite data by Xie and Arkin (1996); (2) wind fields from the NCEP/NCAR reanalysis data (Kalnay et al. 1996); (3) best typhoon track data issued by the Joint Typhoon Warning Center.
All the data cover the period of 1979-95.

## 3. Results

The 1979-95 climatology of the summer-mean precipitation is shown in Fig. 1a, where summer refers to June, July, and August. Major precipitation centers reside over tropical western Pacific and oceans adjacent to the Asian continent, such as Arabia Sea, Bay of Bengal, and South China Sea. The latter three areas are grouped as the Asian region to reflect its close linkage with the Asian monsoon. The tropical western Pacific area is group alone as the western Pacific region to contrast with the Asian region. Time series of the area-mean precipitation over the Asian region ($70^0$E-$120^0$E, $5^0$N-$25^0$N) and western Pacific region ($120^0$E-$150^0$E, EQ-$15^0$N) are displayed in Figs. 1b and 1c, respectively. The 1979-95 mean of area-averaged precipitation is 8.96 mm/day over the Asian region, and 10.08 mm/day over the western Pacific region. The correlation coefficient between the Asian-region and

western-Pacific region precipitation time series is 0.07. This statistic measurement indicates that the interannual rainfall variability over these two regions is more or less independent. When one standard deviation is used as a threshold, the extremely wet (dry) years over the Asian region occur in 80 and 84 (82 and 89). Over the western Pacific, the anomalous wet years are 79, 85, and 90, while the anomalous dry years are 82,88,93 and 95. The above dry and wet years will be employed to compile the composite charts for the atmospheric circulation and typhoon cyclone activity.

In order to illustrate more clearly the anomalous patterns associated with the change between the wet and dry years, we compute the difference between the composites of the wet and dry years. Shown in Figs. 2a and 2b are the difference charts of the 850 mb streamfunction by subtracting the dry composite from the wet composite for the Asian and western Pacific regions, respectively. The noticed feature of the Asian-region streamfunction composite is the anomalous high to the east of Taiwan. In a opposite manner, an anomalous low is centered at the neighborhood of Taiwan for the composite associated with the interannual variability of the western-Pacific precipitation.

The typhoon activity composites are computed from the same manner as the 850 mb streamfunction. The composites associated with the Asian and western Pacific precipitation changes are shown in Figs. 2c and 2d, respectively. The typhoon activity is portrayed by the accumulated frequency of the observed typhoon track data in a $1^0 \times 1^0$ grid mesh during the entire summer season. All positions of the 6-hr JTWC typhoon record with sustained surface winds exceeding 30 kt are converted into their nearest grid point for the computation and ploting purposes. The comparison between Figs. 2a and 2c reveals increased typhoon frequency around the southern rim of the anomalous high to the east of Taiwan and decreased frequency around the center. By comparing Figs 2b and 2d, one can find that the typhoon frequency tends to enhance to the center and northern part of the anomalous low around Taiwan, while suppressed typhoon frequency is found over the southern part of the anomalous low.

## 4. Concluding remarks

When the excessive precipitation occurs over the tropical oceans adjacent to the Asian continent, a lower-tropospheric anomalous low resides to the east of the Taiwan in accompanied with the weakened typhoon activity around its center and intensified typhoon activity around its southern rim where anomalous easterlies exist. Over the tropical western Pacific, during the anomalous wet years a lower-tropospheric anomalous low are located at the vicinity of Taiwan which is related to enhanced typhoon activity at its center and northern part where are dominated by the anomalous easterlies. In the southern part of this anomalous low, the typhoon activity is weakened in associated with the anomalous westerlies.

## 5. References


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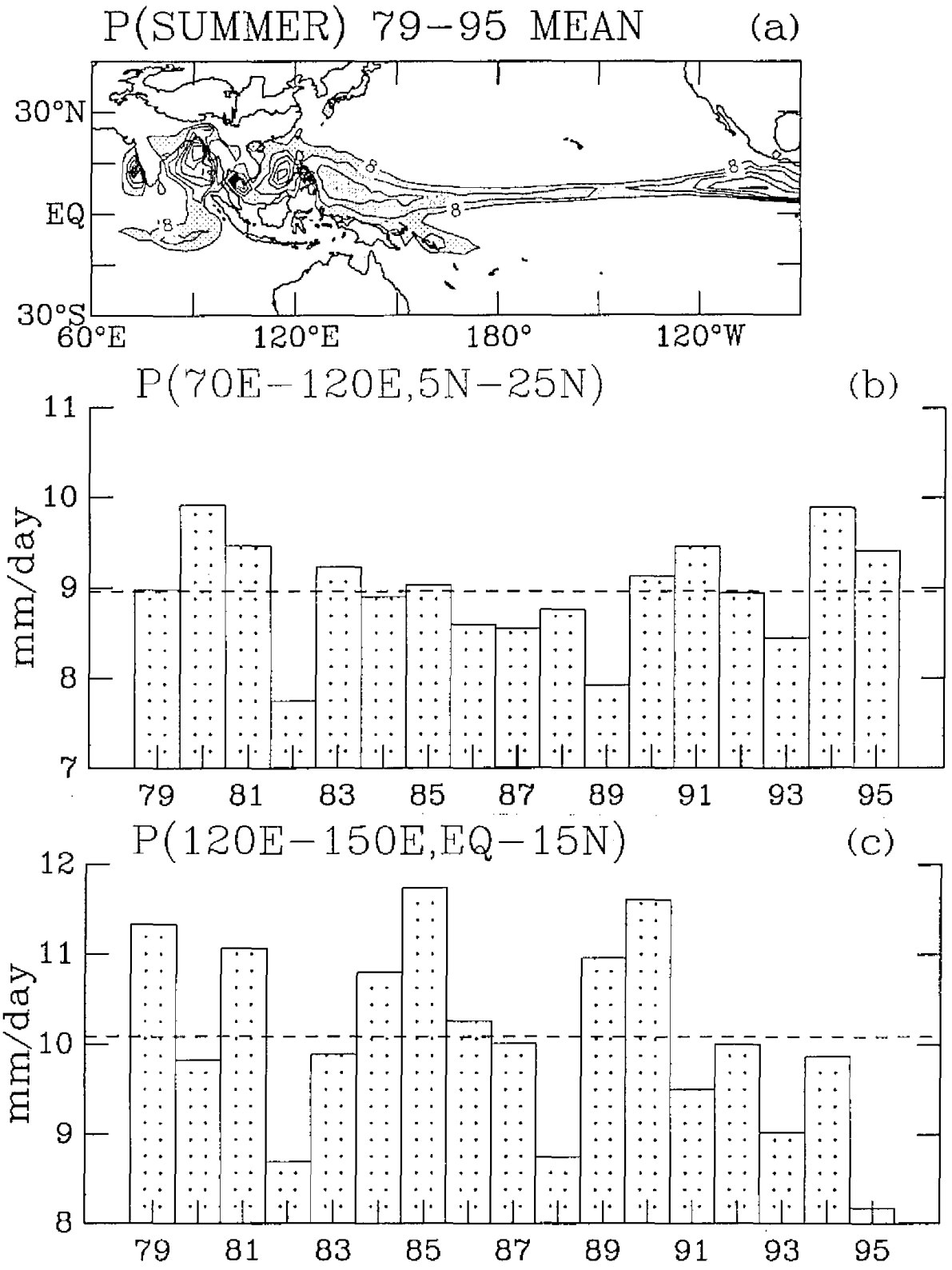


Fig. 1 (a) The 1979-95 climatology of summer-mean precipitation. (b)/(c) Time series of area-averaged precipitation over the Asian region/western-Pacific region. In (a), contour intervals are 2 mm/day. Precipitation values larger than 10mm/day are heavily shaded, while those between 8-10 mm/day are lightly shaded.

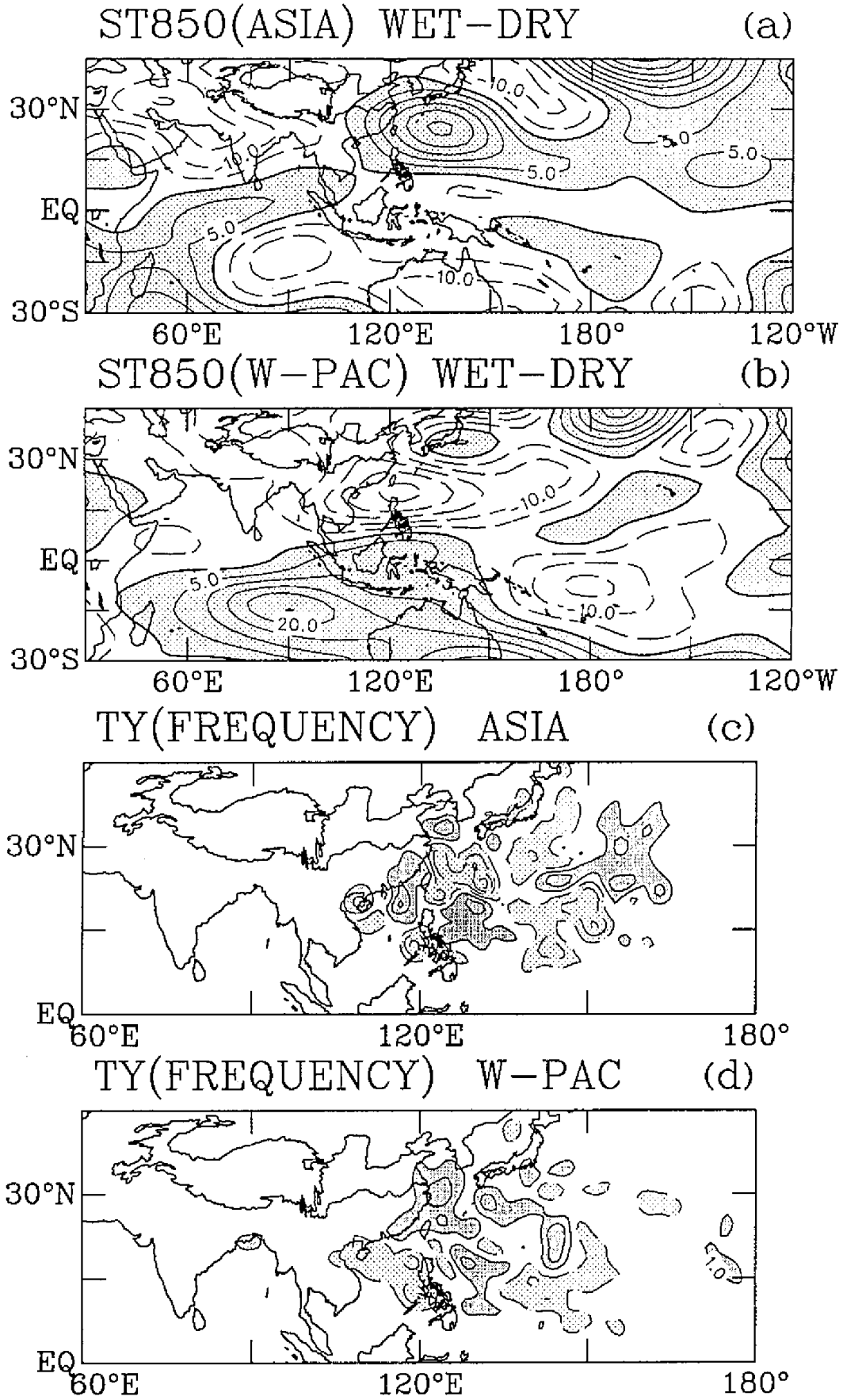


Fig. 2 (a)/(b) 850 mb streamfunction composite charts extracted from the difference between the anomalous wet and dry summers over the Asian region/western-Pacific region. The corresponding typhoon frequency anomaly is shown in (c)/(d). Contour intervals in (a) and (b) are $5 \times 10^5 m^2 s^{-1}$, and 0.1 in (c) and (d). Positive values in (a) and (b) are shaded. In (c) and (d), values larger than 0.1 is heavily shaded, while values smaller than -0.1 are lightly shaded.