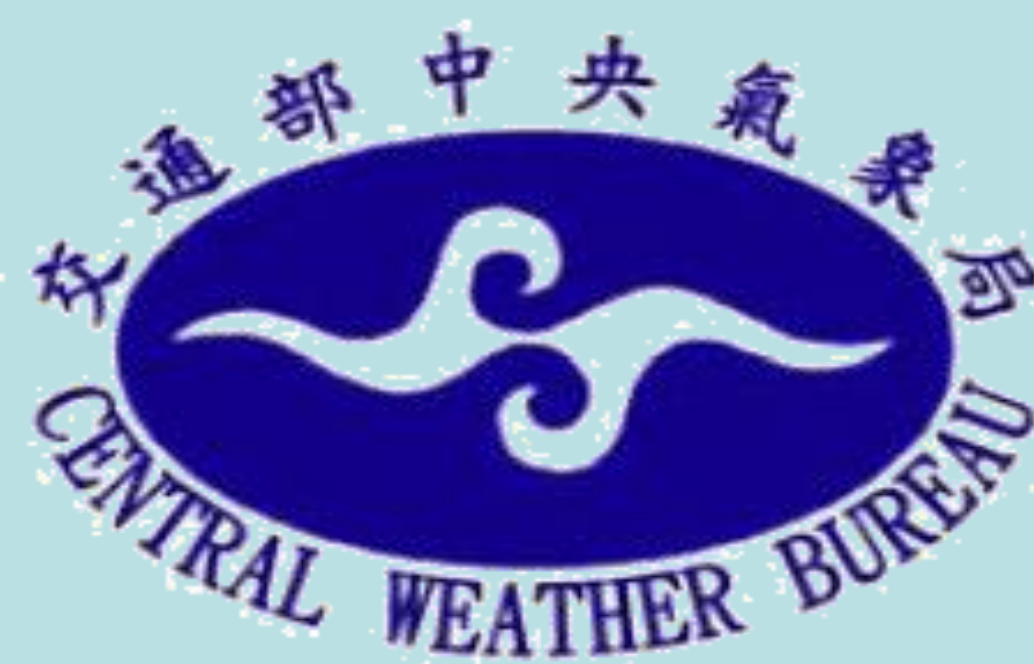


Asian Monsoon Years (2007-2012): Asian Monsoon Years (2007-2012): Variation of East Asian-Western North Pacific Monsoon and the Influences on Typhoon Activity near Taiwan



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Abstract

The first decade of this century is known as a busy period with unusually frequent climate extremes observed all over the world. In Taiwan, half of the typhoons of which the total accumulated rainfall amount is ranked as the top 15% in the 40 years (1970-2009) of typhoon and rainfall record appeared after 2000. The typhoon influence hours around Taiwan during 2000-2009 are noticeably more than before. We found this particularly active decade of typhoon activity around Taiwan is a local reflection of the variations of typhoon frequency over the entire northwestern Pacific region. The multi-decadal variations of typhoon frequency can be explained by the slow changes of East Asian and northwestern Pacific monsoons. The westerly monsoonal flow prevailing over Southeast Asia shows graduate southwestward expansion from Asia to the equatorial western Pacific, while the easterly winds associated with the southern rim of the Pacific subtropical high show graduate northeastward expansion from the west North Pacific to Asia continent. The concurrent variation of the monsoonal flow and the Pacific sub-high can result in an anomalous low pressure system over the northern South China Sea and Philippine Sea and unusually active decade of typhoons around Taiwan.

The Affecting Taiwan Typhoons

Taiwan is one of the regions most prone to the threat of tropical cyclones. Each year about 5-6 typhoons invade Taiwan and the vicinity – an “influence domain” around Taiwan extended 300 km (Fig. 1) away from the island’s coastal line- with 74.39% ACE of the “invading” typhoons (those entering the influence domain around Taiwan) during the peak season from July to September (Fig. 2).

Among the typhoons of which the total accumulated rainfall amount measured at 21 Taiwan stations is ranked within the top 15% (30 cases), 14 (46%) of them appeared after 2000. Although a graduate increase of the high rainfall cases is observed from 1970-1999, the case number after 2000 is outstanding (Fig. 3).

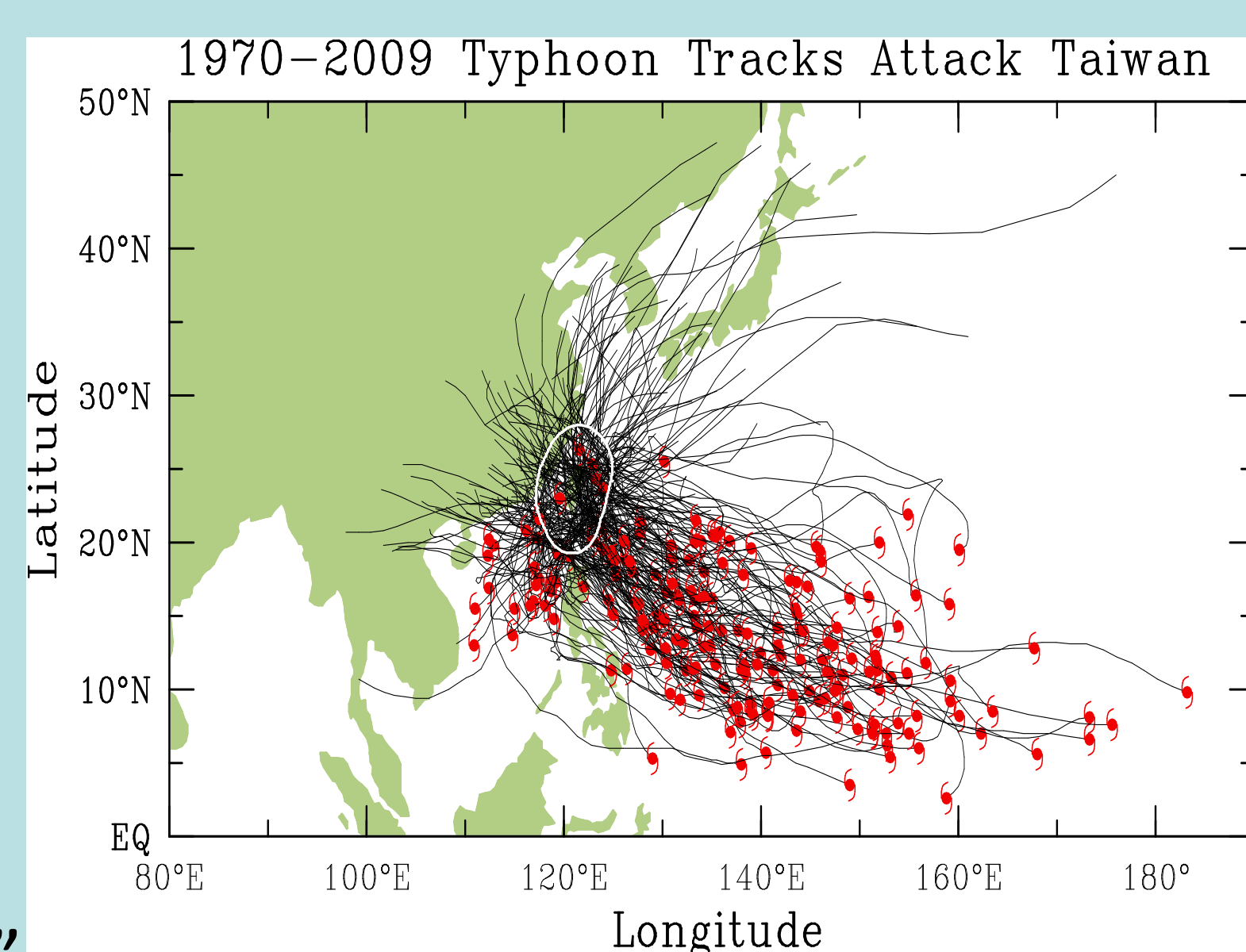


Figure 1

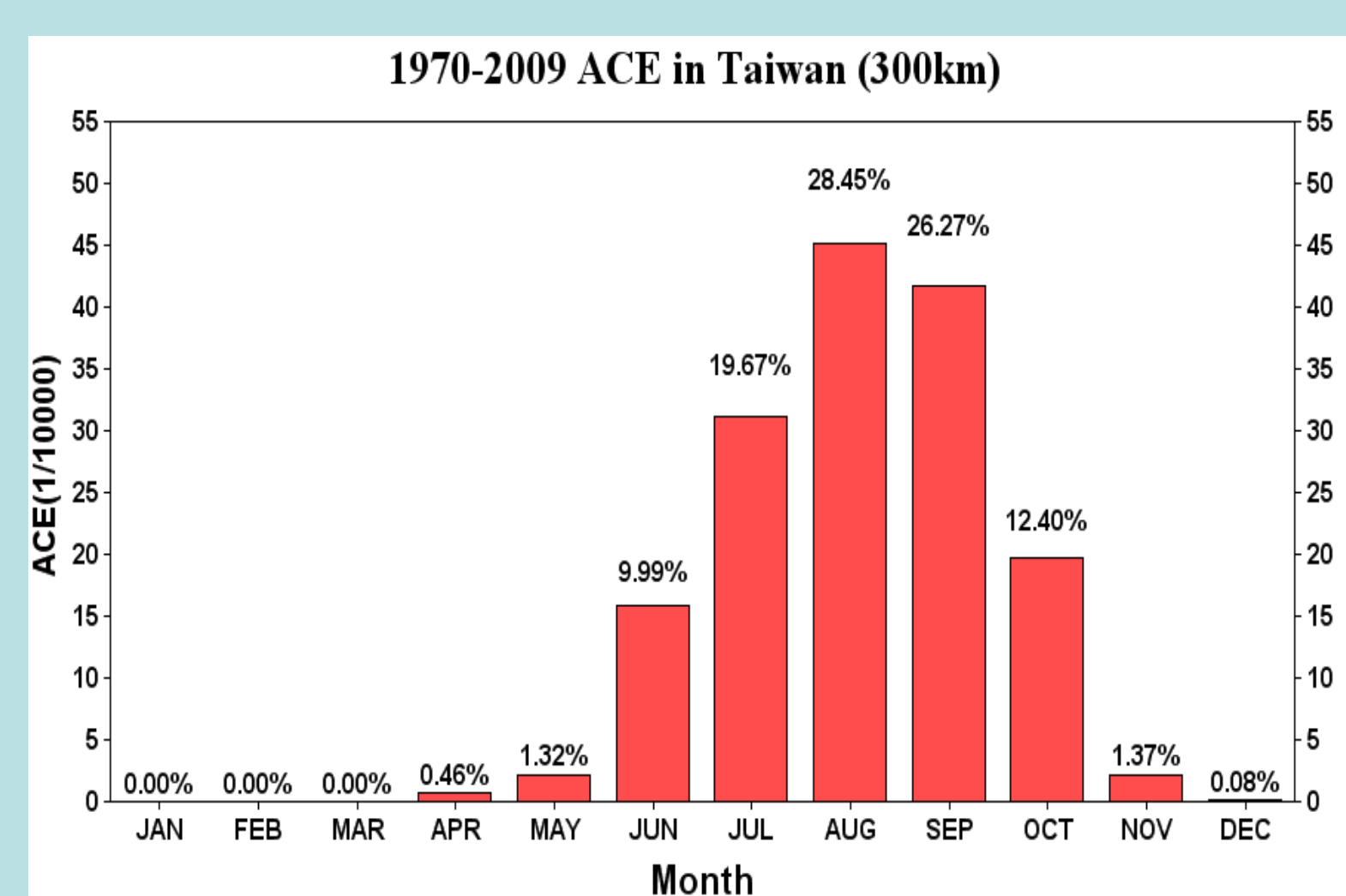


Figure 2

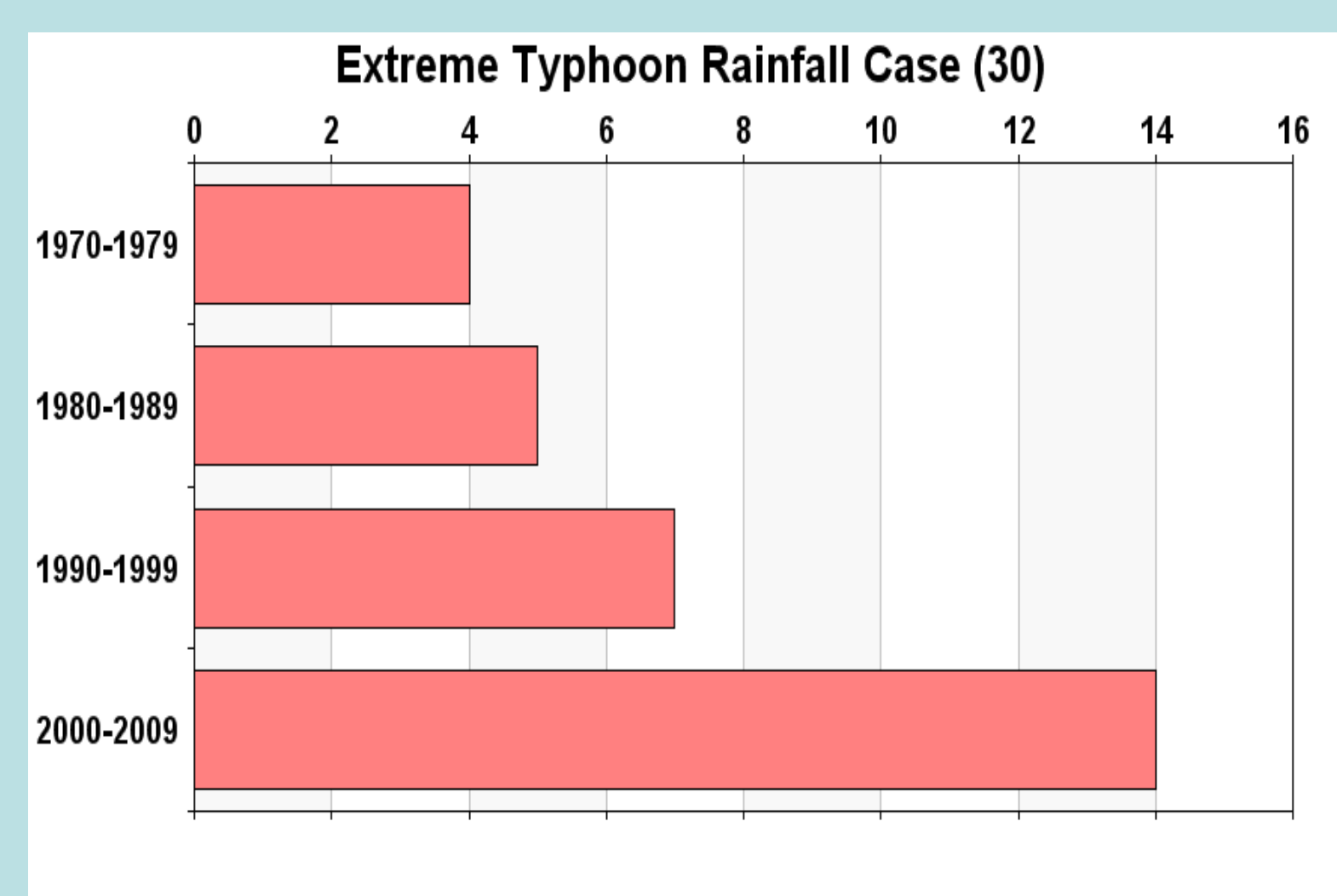


Figure 3

Typhoon Frequency Maps over the Northwestern Pacific

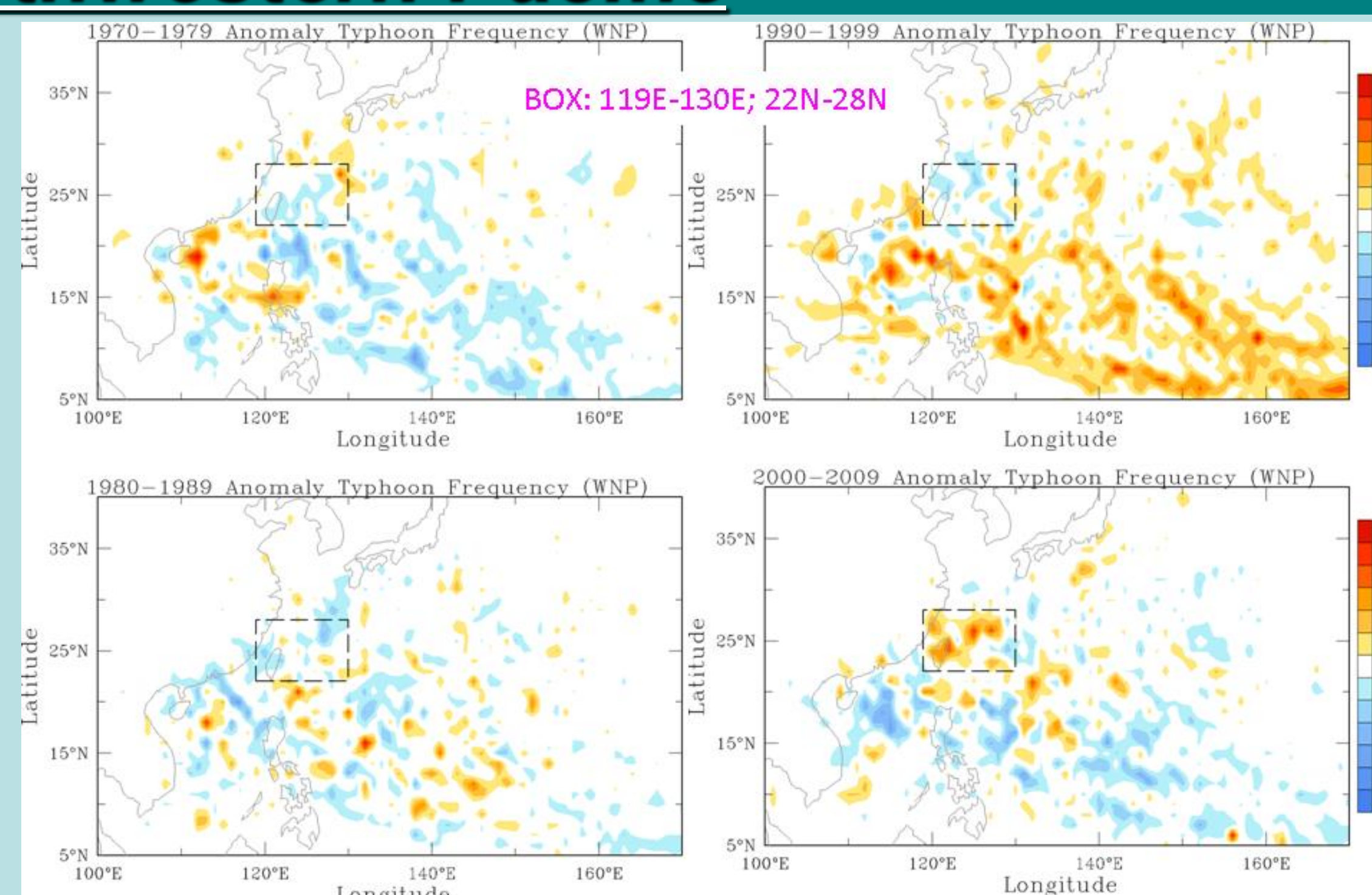


Figure 4

Interesting multi-decadal variations shown in “typhoon frequency” maps (Fig.4). The 6-hourly typhoon data is obtained from NOAA’s IBTrACS project (<http://www.ncdc.noaa.gov/oa/ibtracs/>). The typhoon frequency is the count of the times (6 hr once) that the typhoon centers are observed at each 2.5x2.5° grid box. The decade of 1990-1999 is the most active period over the northwestern Pacific; however, the decade of 2000-2009 is the most active decade for typhoons near Taiwan, as presented by a shift of the frequency centers to the east of 140°E and north of 20°N in Fig. 4.

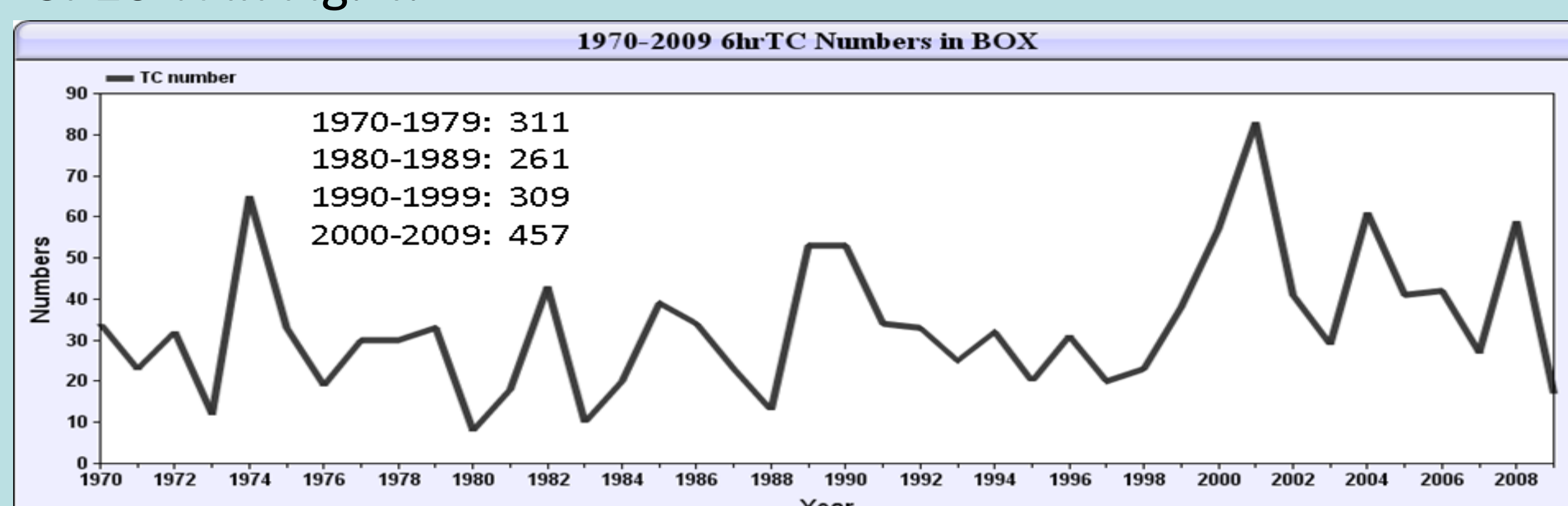


Figure 5

A box surrounding Taiwan defined as 119°E-130°E, 22°N-28°N is used for showing the decadal scale variations of typhoon frequency (Fig. 5). A large peak appears in 2001 and the frequency remains in a relatively high base level from 2001-2008. In 2009, the frequency drops to the minimum since 2000.

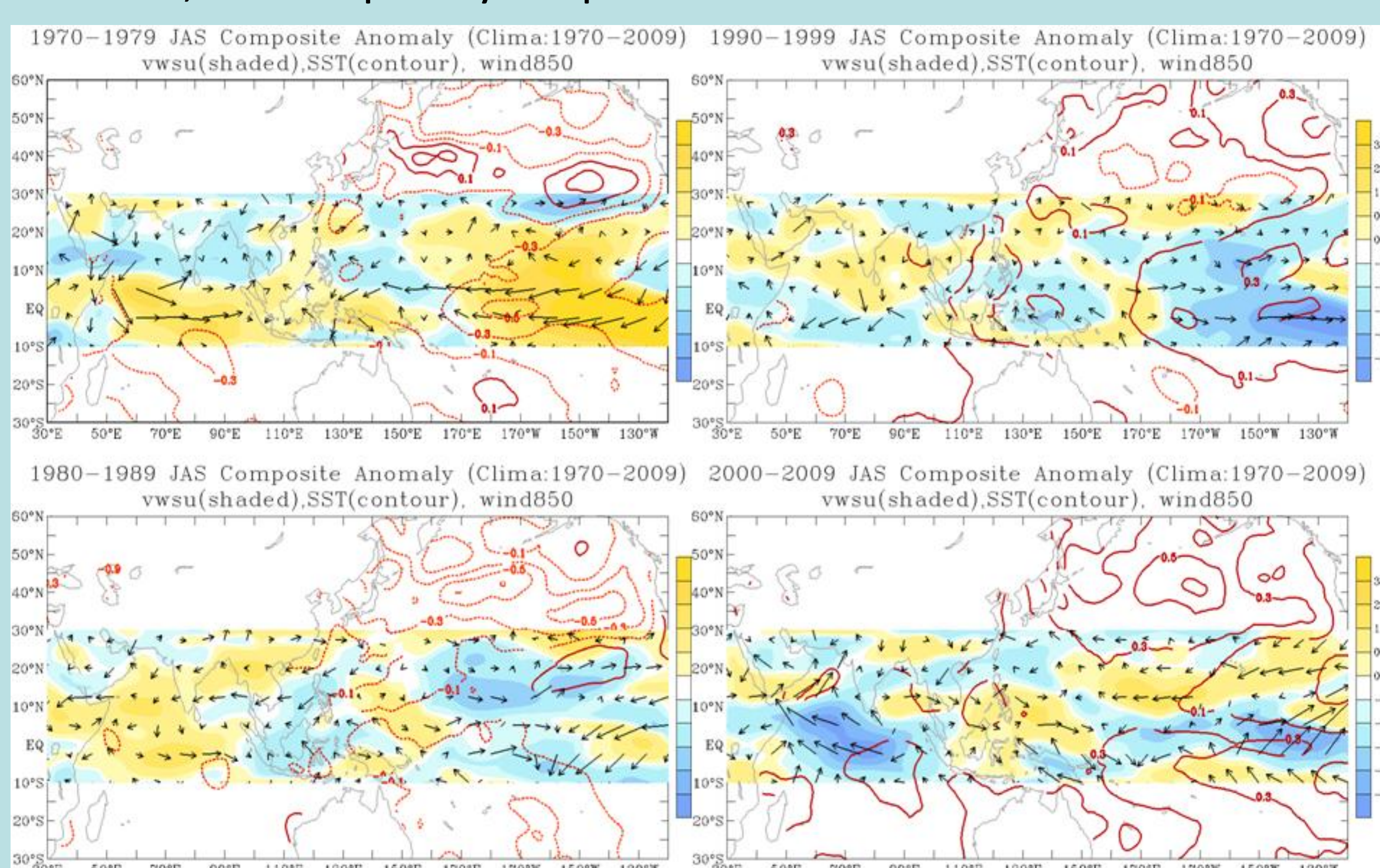


Figure 6

Supporting factors for the multi-decadal variations of typhoon frequency are found in the maps (Fig. 6) of the anomaly composite of vertical wind shear | U200-U850 | (shaded), SST (contour) and 850-hPa winds. The vertical wind shear over the western Pacific warm pool (0°-15°N, 130°E-160°E) shows negative anomaly during 1990-1999, while positive anomaly during 2000-2009. The typhoon frequency is higher during the decade with weaker wind shear.

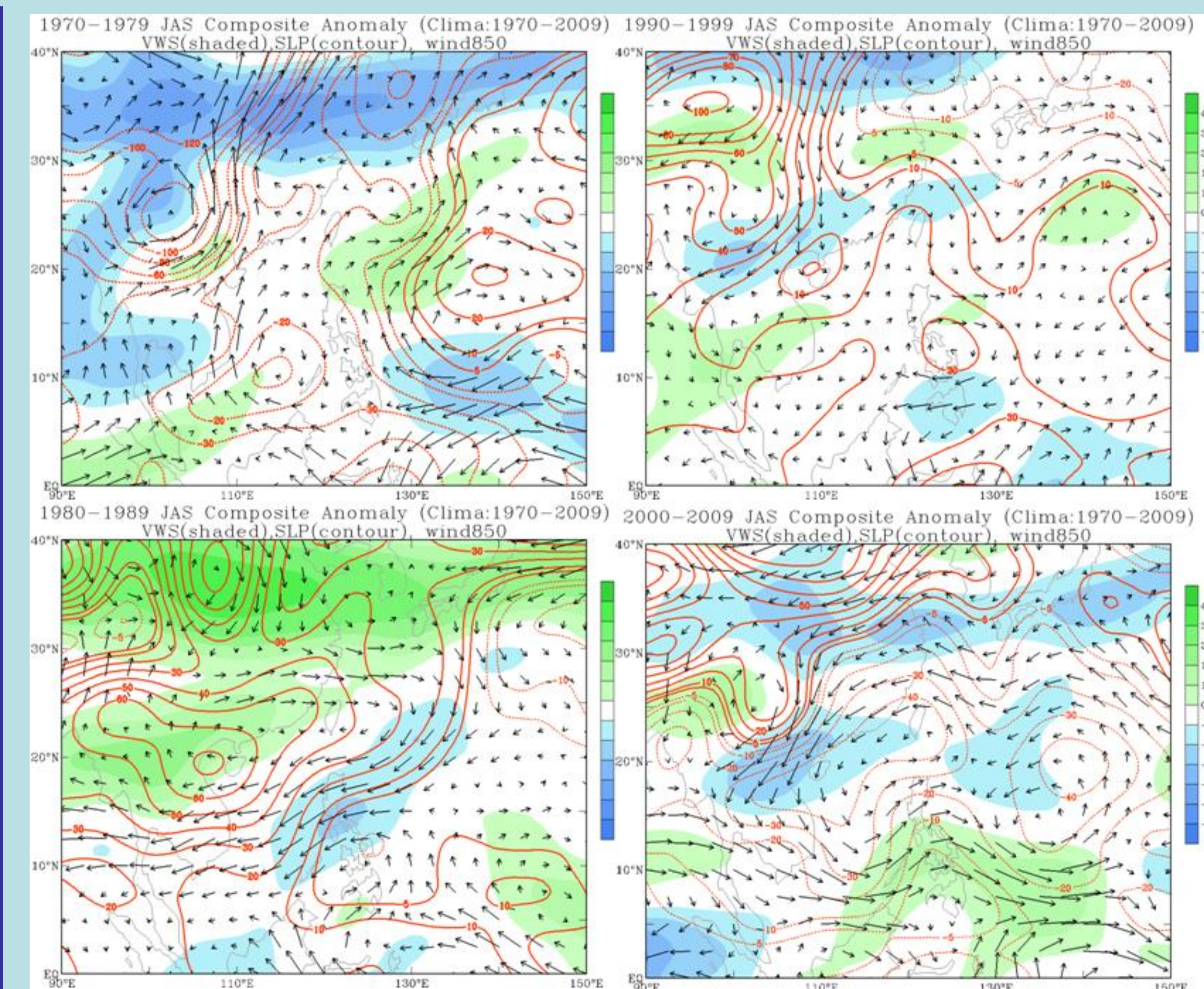


Figure 7 shows a distinct low pressure anomaly (contours) resembles a mixture of monsoon trough and gyre over the northern part of the South China Sea and the Philippine Sea during 2000-2009. The low pressure anomaly is not seen in other decades. The vertical wind shear anomaly (color) is positive to the south of the cyclonic circulation and negative near the center and at the northern rim of the low pressure system. This anomalous circulation and pressure pattern can be a key factor for explaining why the decade of 2000-2009 was a period with active typhoons and intense rains in Taiwan.

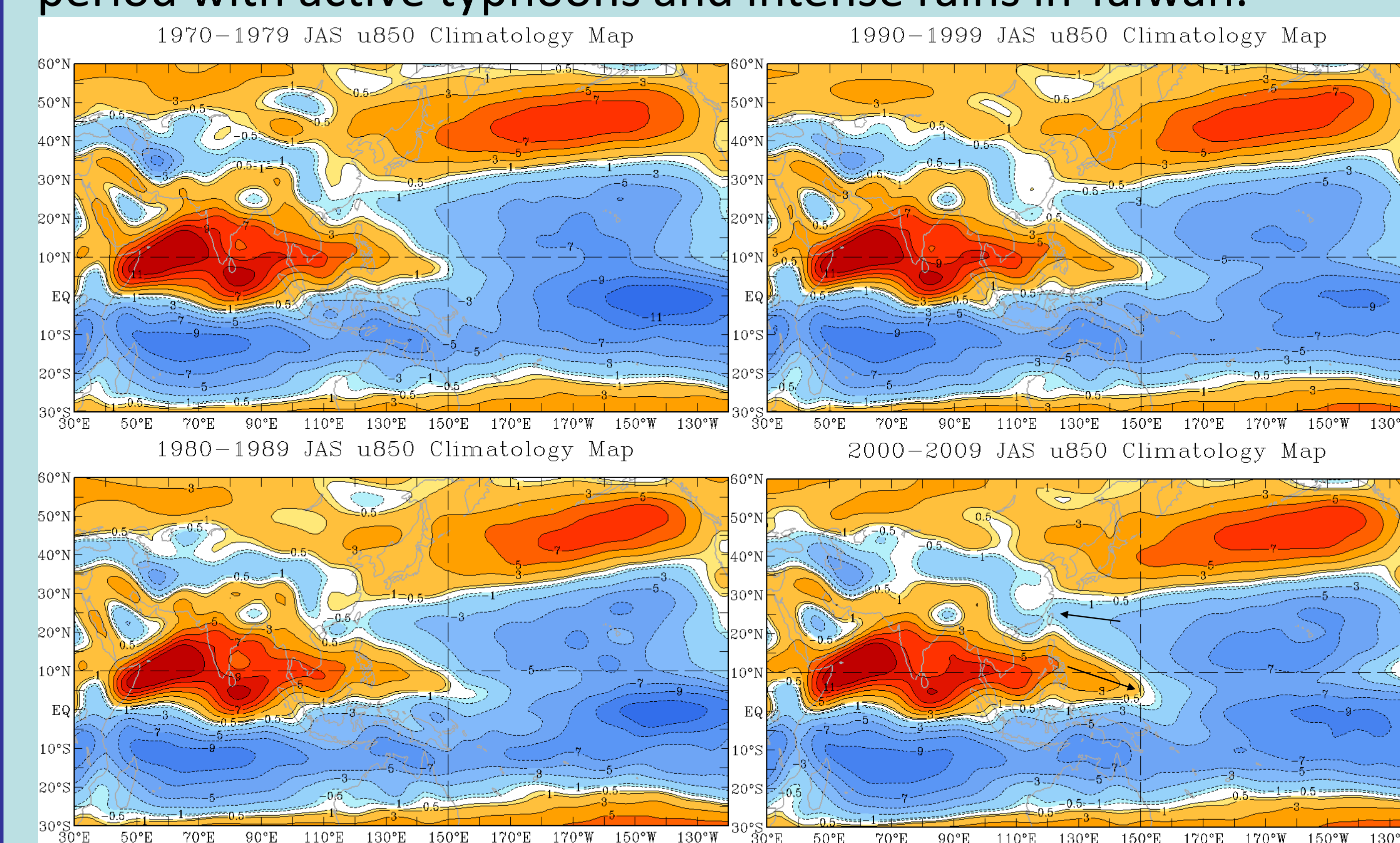


Figure 8 suggests that the strong cyclonic circulation over northern South China Sea and the Philippine Sea is a local reflection of large-scale variations. It is associated with a graduate southeastward expansion of the monsoonal westerly winds from Indian Ocean through the South China Sea to the equatorial western Pacific, and a graduate northwestward expansion of the Pacific subtropical high.

Conclusion

The concurrent variation of the monsoonal flow and the Pacific sub-high resulted in an anomalous low pressure system over the northern South China Sea and Philippine Sea. It can explain why 2000-2009 is an unusually active decade of typhoons around Taiwan.

Acknowledgements

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