

Long-term variability of Typhoon activity near Taiwan and its association with the large-scale circulation variability

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Abstract

Extreme rainfalls resulting from Taiwan-approaching tropical cyclones (TCs) pose a threat to the property and lives of people in Taiwan. The precipitation observed at island-wide rain gauge stations when 191 TCs approached or even made landfalls on Taiwan in the period from year 1971 to year 2008 are analyzed. It is found that a significant change occurred at late 1990s, and that the frequency of TCs which generate extremely intense rainfalls doubled after late 1990s (Chen 2008).

This study investigates the relation between the long-term variability of large-scale circulation in western North Pacific (WNP) and the abrupt increase in extremely intense rainfall associated with Taiwan-approaching TCs. Before the link is established, the temporal changes in two factors are identified, i.e., the number of TCs that approach Taiwan and the intensity of extreme rainfalls associated with TCs. First of all, after late 1990s, the annual number of Taiwan-approaching TCs increases significantly while the annual number of TCs generated in WNP decreases. This indicates that, after late 1990s, the tracks of WNP TCs have changed and more WNP TCs moved toward Taiwan. Such abrupt change has also been observed by Tu et al. (2009) and Lee and Jia (2008). Second, the capability of TCs in generating extremely intense rainfall as they approached Taiwan significantly increased after late 1990s.

From the perspective of the large-scale variability, this study tries to answer two questions: why the tracks of WNP TCs changed and why Taiwan-approaching TCs generate more intense rainfalls after late 1990s. The long-term variation of the coupled atmosphere and ocean circulation were examined and preliminary results are presented. On one hand, the vorticity of the low-level atmosphere (850hPa) near Taiwan shows consistently positive anomaly since late 1990s. This agrees with Tu et al. (2009) and implies an intensified WNP monsoon trough which provides a favorable environment for TC activity. On the other hand, in regions near Taiwan, the abrupt changes in the coupled air-sea system are likely to favor deep convection development. The changes include the warm-up in SST and the drop in both tropopause temperature and tropopause pressure. The increased vertical temperature difference between high and low level atmospheres could possibly allow TCs to develop deeper convection and generate extremely intense rainfall.

Keywords: Taiwan-approaching tropical cyclones, extremely intense rainfall

References

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