Effect of SST in the Sea of Japan on the Winter Cyclones

*趙 寧[1]、岩崎 慎介[2]、磯辺 篤彦[2,1]
*Ning Zhao[1], Shinsuke Iwasaki[2], Atsuhiko Isobe[2,1]

1. 九州大学総合理工学府大気海洋環境システム学専攻、2. 九州大学応用力学研究所
1. Kyushu University, 2. Kyushu University RIAM

Introduction: Zhao et al. (2016, JGR) showed that the extratropical cyclone passage results in a localized surface cooling along the subpolar front in the winter Sea of Japan (Fig. 1) because of the cold-air outbreaks associated with the cyclones. It is reasonable that the SST alters atmospheric processes and, thus, a two-way coupling process may occur between SST (hence, the front) and the following cyclones which passing near the Sea of Japan, although the detailed process remains unclear. Using the WRF model Version 3.7.1 (WRFV3), we attempt to uncover such potential effect of the SST altered by the previous cyclones on the following ones during winter in the Sea of Japan.

Methods: We used the cyclone deepening rate as the indicator, and we chose 0.1 Bergeron as the criterion. Any cyclone, with CDR changed over Bergeron and last over 6 hours, would be regarded as “Affected”. There are 26 cyclones simulated in this study.

Results: According to our results, there were nearly one-fourth of cyclones remains unchanged, while others were largely modified. Analyses showed the cold air invasion over the Sea of Japan may be the key to make the cyclones sensitive or insensitive. When the northwesterlies located over the Sea of Japan, the atmosphere above became cold and unstable. A strong low-level baroclinic zone was found at the southern region of Japanese archipelago. With such situation, cyclones generate and pass through a southern path, over the Kuroshio region and Sea of Japan. The colder SST could therefore affect the cyclones aloft easily. When the northwesterlies located over the Okhotsk Sea, the atmosphere over the Sea of Japan was relatively warmer and more stable. Cyclones mainly generated over the continent where the colder SST of the Sea of Japan could hardly affect.
As for the “Affected” cyclones, Yamamoto (2013) suggested a weakening effect of the cold Sea of Japan on the cyclogenesis. However, we found, in this study, half of simulated cyclones was found to be intensified, i.e. CDR was increased over 0.1 Bergeron. Only 6 cyclones were weakened as Yamamoto (2013) suggested. Furthermo, the time series of the central SLP showed the intensified cyclones had an oscillated response. Such oscillation clearly indicated the existence of another effect of the cold Sea of Japan on the extratropical cyclones, and further results and analyses will be showed during the Meeting.

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