How Predictable Summer Arctic Cyclones in 2012 and 2016 Were?

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Arctic cyclones (ACs) have a long lifetime and a wandering track in the Arctic region. The structures of the ACs are characterized by the warm and cold cores at upper and lower levels, downward and upward drifts at upper and lower levels, and barotropic relative vorticity. ACs have large impacts on the Arctic systems like the sea water temperature and the sea ice. ACs also have social impacts on the Northern Sea Route of ships and the Polar Route for airplanes. Therefore, accurate predictions of ACs are important for environmental and social concerns.

Extreme ACs occurred in August 2012 and 2016. The AC in 2012 (AC2012) was generated over the north of the Eurasia on 2 August 2012. The minimum sea level pressure (SLP) of 964 hPa for the AC2012 was recorded on 6 August 2012. On the other hand, the cyclogenesis of the AC in 2016 (AC2016) was over the north of the Scandinavian Peninsula on 11 August 2016. The minimum SLP of 967 hPa for the AC2016 was recorded on 16 August 2016. Although the positions of the cyclogenesis were different, both ACs recorded the minimum SLP over the Pacific sector of the Arctic Ocean. In both cases, the AC merged with a cyclone connecting with an upper polar vortex over the Arctic Ocean few days before the development of the AC. Some previous studies indicated that the AC2012 contributed greatly to the record low sea-ice extent in that summer. Similarly, it is thought that the AC2016 could have an influence on the decrease in sea-ice cover, since sea ice extent in early September of that year was the second lowest on record.

In this study, we investigated the predictability of the extreme ACs in August 2012 and 2016, using operational medium-range ensemble forecasts provided by The Interactive Grand Global Ensemble (TIGGE). The minimum SLP of the AC2012 on 6 August was well predicted by CMC, ECMWF, and JMA (NCEP and UKMO) members 2 (3) days in advance. Some ECMWF and NCEP members initialized in late July 2012 also predicted the development of the AC2012. On the other hand, the minimum SLP of the AC2016 was more predictable than that of the AC2012. The development of the AC2016 was well predicted by ECMWF members 6 days in advance and by CMC, JMA, NCEP and UKMO 3 –5 days in advance. Comparisons between higher- and lower-skill members revealed that the accurate prediction for the development of the upper warm core could lead to the accurate prediction of the AC development in both cases. Baroclinic growth and subsequent nonlinear dynamics during the merging contributed to the development of the upper warm core. Even if the baroclinic growth was predicted well, predicted AC did not develop when the merging was not predicted accurately. Therefore, a correct prediction of for the AC track is one of the important factors for accurate prediction of the AC development. The predicted cyclone track was similar to the observed cyclone track when the upper-level wind was predicted well. In conclusion, the accurate prediction of the upper-level wind can lead to the correct prediction of the ACs through the development of the upper warm core.

Keywords: Arctic cyclone, warm core, cyclone merging, ensemble forecast

