Predictability of a polar low over the Sea of Japan

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Over the Sea of Japan, polar lows (PLs) are frequently seen during winter seasons. Some PLs brings heavy snow to areas along the Sea of Japan and causes a traffic disturbance. We investigated the development of a PL occurred off the western coast of Hokkaido Island on 23 December 2016. The PL derived initially from a synoptic-scale cyclone formed the eastern flank of Korean Peninsula in a cold air outbreak on 22 December. The cyclone moved northeasterly across the Sea of Japan and situated at almost the same position for about one day. (Fig 1). Heavy snowfall has continued in the western Hokkaido Island by the PL, causing over the 600 flights were canceled at New Chitose Airport. The predictabilities of the PL in the operational model of Japan Meteorological Agency (MSM: Meso-Scale Model) were not high in case of longer lead time. Surprisingly, predictions of a rapid decrease of temperature in a lower troposphere at New Chitose Airport were underestimated even in 24 hours differences between these initial states.

To understand the characteristic of the PL in every initial run, we calculated a cyclone phase space (CPS). This parameter is objective ways to describe a classification of topical, extratropical, warm-seclusion, and hybrid cyclones (Hart, 2003), using the thermal wind index , which is determined from the geopotential height from 900hPa up to 600hPa. If a cyclone shows positive (negative) values of , this indicates it has a warm-core (cold-core) structure in a lower troposphere. And a parameter index B is also defined as a storm-motion-relative 900-600hPa thickness asymmetry across the cyclone within a 500km radius. If the values of B are positive (negative), this indicates the cyclone has basic structures like an Extratropical (Tropical) cyclone. Generally, PLs have warm-core and asymmetric structures on their mature stage, so these are similar to evolutions of Tropical cyclones. During 22-23 December, the system developed with the increase of index B, Extratropical cyclone-like evolution has seen in this period. On 23 December, index B has rapidly decreased, maintaining a warm-core structure, and the PL have been isolated. It indicated that the synoptic Extratropical cyclone had become the PL, associated with Tropical cyclone-like evolution. This transitions of the system were unclear as old initials. In this presentation, we will discuss if the significant differences in predictability on PL structures could be a major factor in precise temperature prediction over Hokkaido region, using a numerical experiment.

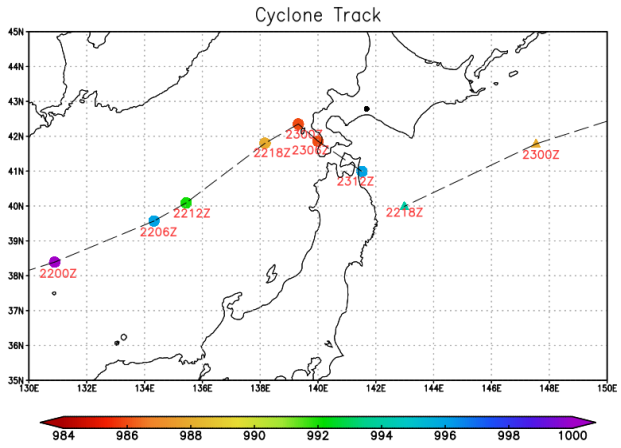

Fig 1 Cyclone track identified from ASAS, and the 6-hourly positions of the cyclone from its formation to its demise. The color of dots indicates the intensity of cyclone (minimum SLP(hPa)).

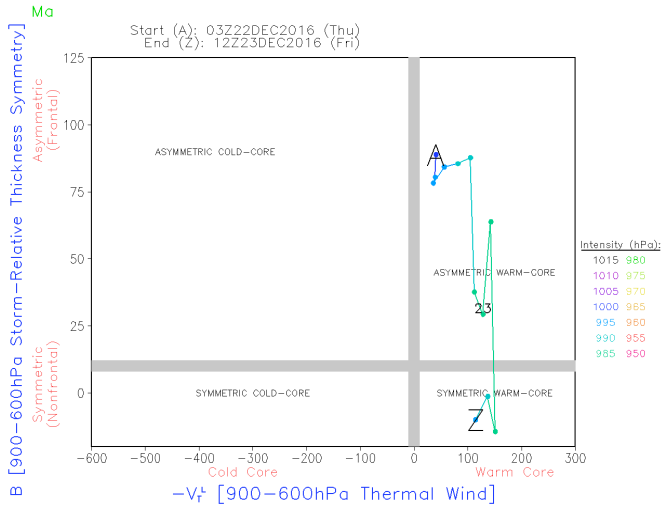

Fig 2 Cyclone phase diagram. The A indicates the beginning of the plotted life cycle within the available analyses and the Z indicates the end. A marker is placed every 12 h. The shading of each marker indicates cyclone MSLP intensity. Positions at 0000 UTC are labeled with the day.

References

Hart, R.E., 2003: A cyclone phase space derived from thermal wind and thermal asymmetry. Mon. Wea. Rev., 131, 585-616.