

An Observational and Numerical Study of a Polar Low over the Japan Sea on 19 December 2003

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A meso-scale polar low (Harley, 1960) was observed over the Japan Sea on 19 December 2003. Its detailed structure and evolutionary process were investigated in the present study by using almost all available observational data, including the GOES (Geostationary Operational Environmental Satellite)-9, NOAA (National Oceanic and Atmospheric Administration)-17 satellite imagery, the FNL (Final Analyses) data issued by NCEP (National Center for Environmental Prediction), the surface observational data and the sounding data of Japan Islands. The polar low initiated over the northwestern part of Japan Sea within a synoptic-scale parent low, and dissipated over the east of Japan Islands with a lifetime about 20 hours. It is of interest that two concentric “eye” walls associated with this polar low were found in satellite images at its most mature stage. Also, a “warm core” structure of this polar low was found. The intertwinement of the cold air from the Asian continent and the warm air over the ocean with each other provided a favorable condition for the development of this polar low.

In order to better understand the development mechanism of this polar low case, a high-resolution simulation of using the latest numerical model RAMS (Regional Atmospheric Modeling System)-4.4 with 8 km x 8 km horizontal resolution was performed. The initial and lateral boundary conditions were supplied by FNL data. The 24-h simulation initiated from 12 UTC 19 December 2003 reproduced the main structure of this polar low case reasonably well. The vorticity budget analysis indicated that the stretching term played an important role in the development of this polar low. The MPV (Moist Potential Vorticity) and the energy budget analyses showed that the barotropic instability seems to be dominant factor in the polar low development.