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# Numerical analysis of the development process of meso-scale vortical disturbances causing a severe snowstorm

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Meso-beta-scale vortical disturbances (hereafter MBSDs) which are formed and develop over the Japan Sea in winter often cause a severe snowstorm in the coastal region of the Hokuriku District. A snowstorm caused by the passage of developed MBSDs brought about several power failures and traffic accidents in the Niigata prefecture on 13th January 2010. Previous studies revealed that the MBSD causing a severe snowstorm had a warm core structure, and suggested that the CISK and the WISHE instability mechanism were important in the development process of the MBSD (Araki et al., 2011, JpGU Meeting MIS021-02). In this study, in order to more quantitatively examine the development process of the MBSD and to investigate the effect of the lower boundary condition, we performed numerical simulations using the JMA-nonhydrostatic model (JMA-NHM) with a horizontal resolution of 2km (2km-NHM). The 2km-NHM well reproduced MBSDs that had features both spatially and temporally similar to those of the observed MBSDs.

Firstly, results of sensitivity experiments without the condensational heating showed that the condensational heating directly contributed to the development process of the MBSD. In addition, results of sensitivity experiments without heat fluxes from the sea surface suggested that heat fluxes eventually had an effect to modify the environment of the vortex. In fact, in any experiment without the sensible heat flux, the environmental surface potential temperature was lower than that with the sensible heat flux and the lower atmosphere was stably stratified. In other words, heat fluxes are considered to indirectly contribute to the development of the MBSD with maintaining the unstable stratification of the environment. These are consistent with the results of Yanase et al. (2004) dealing with the Polar Low over the Japan Sea.

Secondly, sensitivity experiments which changed the sea surface temperature (SST) of the Japan Sea were performed. Results of experiments with SST constant in time showed that heat fluxes from the sea surface was more enhanced in experiments with the higher SST resulting in MBSDs with deeper convection. Experiments with a north-south gradient in SST showed that the north-south distribution of SST affected the development of MBSD through the baroclinicity. In addition, MBSDs simulated in these experiments moved more southward than the others. This suggests that an anticyclone vortex formed by relatively cold air advection at the rear of the MBSD in these experiments with a north-south gradient in SST, which forms a vortex pair (Ito and Iga, 2011, JpGU Meeting MIS021-01), causes the southward displacement of the MBSD. As a result of experiments changing the SST in the region containing the MBSD only for three hours from the start of calculation, it was suggested that the distribution of the SST in the area where MBSD located in the early stages of evolution, was important to the development of MBSD causing the severe snowstorm.

Keywords: Vortical Disturbances, NHM, severe snowstorm