Numerical simulation of low-level misocyclones associated with winter convective cells: a case study from the Shonai area railroad weather project

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1. Introduction

In order to develop an automatic strong gust detection system for railroad, the Shonai area railroad weather project has investigated the property of wind gust using two X-band Doppler radars and the network of 26 surface weather stations since 2007. Through the project, we understand the aspect of wind gust but find problems to be solved, simultaneously. In particular, it is difficult to capture the near-surface structure of wind gust by the radar so that a numerical approach is effective in compensating near-surface information.

This study describes the numerically simulated structure of low-level misocyclones, one of which generated observed wind gust, associated with winter convective cells observed at 11 December 2008. In this case, convective cells were initiated along the cold front over the sea and misocyclones were embedded in the surface convergence line. Misocyclones were distributed at 2-4 km intervals and some of them landed.

2. Model description

The nonhydrostatic numerical model, JMA-NHM, is used to simulate the misocyclones. The model is initialized by MANAL, which data is an objective analysis made by JMA and horizontal resolution is 10 km, and no special observed data is assimilated in this case. The finest horizontal grid spacing is 250 m.

3. Results

The model succeeds in simulating convective cells and misocyclones along the surface convergence line. Figure 1 shows the time-height cross-section of the maximum vertical vorticity of the representative vortex. The simulated misocyclone is initiated below the height of 500 m, where the horizontal convergence is significantly strong. Then the misocyclone extends upward and reaches the height of 2 km. These simulated structure and evolution of misocyclones are similar to the results of Lee and Wilhelmson (1997a, b). The structure of the misocyclone changes in the vicinity of the landfall. After the landfall, the vertical structure of the misocyclone greatly tilts to the advected direction (see Fig.2).

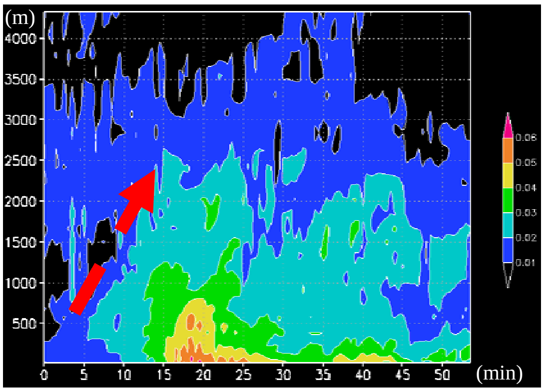

Fig.1 Time-height cross-section of the maximum vertical vorticity of the representative vortex.

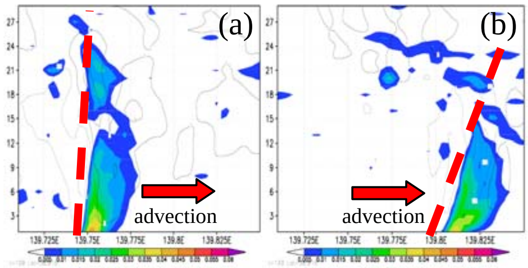

Fig.2 Vertical cross-sections of the vertical vorticity across the center of the representative vortex. (a) before landfall, (b) after landfall.

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References

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