THE INFLUENCE OF CELL REGENERATION AND INDIVIDUAL STORM SPLITTING ON MESO-COMPLEX FORMATION

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I. INTRODUCTION

Cell regeneration and storm splitting are mechanisms that are of crucial importance for storm development and propagation. The cell regeneration is observed in front of the storm. It is associated with the updraft over gust-front head induced by low-level convergence ahead of the gust-front. This mechanism occurs periodically in time. The mechanism of cell regeneration is simulated successfully by 2-D and 3-D versions of cloud-resolving mesoscale models (Lin et al., 1998; Ćurić et al., 2003).

The other mechanism mentioned above is associated by storm development under strong low-level directional wind-shear. At first a counter-rotating vortex pair is formed at the storm flanks (Toutenhoofd and Klemp, 1983). Later the storm splitting into cyclonic (right-moving) and anticyclonic (left-moving) storms is observed. The splitting time depends essentially on precipitation intensity (e.g. hail) as it is documented by Van den Heever and Cotton (2004). Differences in development of splitting storms are significant and tend to be more expressed under presence of orography (Ćurić et al., 2007a).

Despite the fact that both mechanisms are caused by totally different factors they can interact. The influence of one mechanism to another one is not yet investigated. The stated goal of present paper is therefore to determine the mutual interaction between them. The essential problem considered in present paper is to answer whether the cell regeneration mechanism may suppress the storm splitting and enlarged the storm horizontal area, which in turn, lead to changed regime in precipitation. As a tool for achieving our goal we use the cloud-resolving mesoscale model developed by Ćurić et al. (2003).

II. PRESENTATION OF RESEARCH

A cloud-resolving mesoscale model has been used to simulate the storm development. The model developed by Ćurić et al. (2003) numerically integrates the time-dependent, nonhydrostatic and fully compressible equations. For investigation presented in this paper, the model was configured with the domain $115\,\text{km}\times 115\,\text{km}\times 18\,\text{km}$ with a 600 m grid-spacing in horizontal and 300 m in vertical. The simulations were terminated at 180 min. Long and short time steps are 3s and 0.5s respectively. The wave-radiating condition is applied for lateral boundaries. The upper boundary with the Rayleigh spongy layer is used, while the lower boundary is free slip.

Model microphysics treats two categories of non-precipitating (cloud water and cloud ice) and three categories of precipitating elements (rain, hail and snow). Two moment microphysical scheme as described by Ćurić and Janc (2007b) is used.

The reference state is homogeneous in the horizontal using a single sounding giving the values of temperature, humidity, pressure, wind velocity and direction. The model storm is initiated by introducing an ellipsoidal warm bubble with 1.5 K amplitude in its center having a horizontal radius of 10 km and a vertical radius of 1.5 km. The environmental conditions are as follows: the wind veered sharply (about 180°) from southeast to northwest above 750 m. The wind speed varies from 7 m/s near the ground to about 17 m/s at 9 km height. Large moisture content is occurred until 3 km height. Dew-point depression approaches nearly 2°C at p=900mb.

III. RESULTS AND CONCLUSIONS

After being initialized, the simulated cloud is propagated roughly by northwestern wind. The vertical velocity maximum attains 42 m/s after t=20 min of simulated time. Further in the text t means always the simulated time. Later on, it decreases successively to 20 m/s until t=70 min. The maximum cloud top height attains 13.5 km**.** After t=45 min, the new cell is formed in front side of the storm. Reflectivity field ($Z > 20\,\text{dBZ}$) as viewed from above at t=54 min is presented in Fig. 1. As noted the new cell is well expressed. It starts to develop and encircles enlarged horizontal area in time.

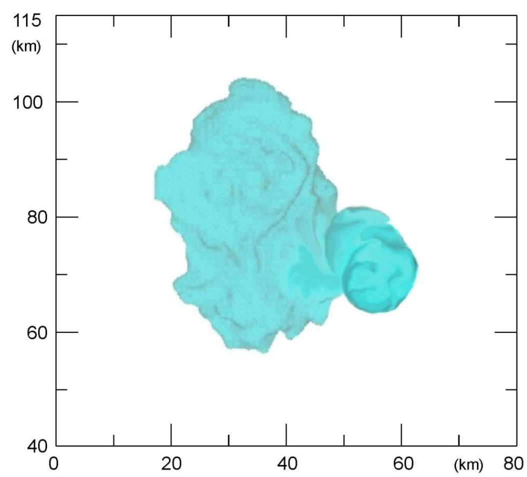

FIG. 1: Reflectivity field as viewed from above at t=54 min.

The vortex-pair is formed at the storm flanks after t=45 min. The cyclonic (to the right) and anticyclonic (to the left) cells tend to split. In agreement with observations and theory, the new cell propagates more to the right relative to mid-tropospheric wind. After t=86 min the new cell is merged at first by the right flank of the storm associated by cyclonic vortex. After next 10 min it is merged also by the left storm flank associated by anticyclonic vortex. In time, the unified meso-complex instead of two distinct storms with divergent tracks is observed as it is shown in Fig. 2. It is evident that the new cell suppressed the storm splitting through merging mechanism with storm flanks. Such mechanism seems to be important from the point of view of storm development, propagation and enlarged precipitation area.

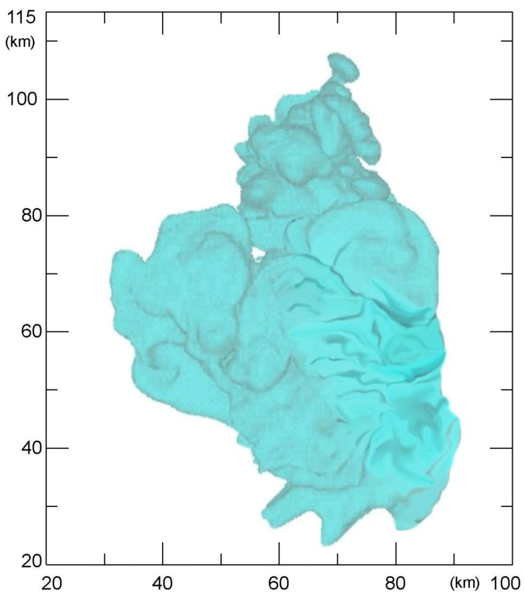

Fig. 2: As in Fig. 1 but for t=100 min.

All this finding achieved by cloud-resolving mesoscale model can be used in improved forecasting which is much better than the simple linear extrapolation of current conditions.

IV. ACKNOWLEDGMENTS

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V. REFERENCES

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