GENERATION OF WINDSTORM IN THE EASTERN MOUNTAINOUS COAST OF KOREA

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I. INTRODUCTION

The formation of severe windstorm in the mountainous coast has been faced by open questions of several authors (Bosart and Seimon, 1988; Eom, 1975; Kanak., et al., 2007), because its occurrence is due to lee cyclogenesis associated with mesoscale convection and microphysical processes. Lee cyclogenesis accompanying windstorm in the coast is generally detected when downslope motion of air is organized into jetlike motion or the downslope motion exists over a steep terrain. In this study, windstorm generation is explained through numerical simulation by WRF Model-2.2.

II. NUMERICAL METHOD AND INPUT DATA

For the generation of windstorm around Kangnung city (K; $37^0$45N, $128^0$54E) in the eastern mountainous coast of Korea, the 3D-WRF 2.2 model was adopted for 48 hours numerical simulation from Ocrober 27 until 29, 2003 and one way, triple nesting was performed using a horizontal grid of 27 km covering a 91 x 91 grid square in the coarse mesh domain and a 9 km interval in the second domain and a 3 km in the third domain with the same grid square. NCEP/NCAR of FNL (1.0^0 x 1.0^0) meteorological data was used to the model. WSM 6 scheme was used for microphysical processes and YSU PBL scheme for the planetary boundary layer. Kain-Fritsch (new Eta) for cumulus parameterization, the five thermal diffusion model for land surface, RRTM long wave radiation scheme and dudhia short wave radiation schemes were also used.

III. RESULTS AND CONCLUSIONS

At 21 LST, October 27, before windstorm event in the study area, a low pressure with central pressure 1005 hPa was located in northeastern China and another center of 1011 hPa in the further northeastern area (Fig. 1). Whole Korean peninsula is underneath low pressure system. Before the passage of cold front through Gangneung city at 21 LST, wind was southerly or southwesterly of less than 5m/s.

However, as the low pressure system moved eastward at 09 LST, October 28, three hours before windstorm occurrenc in the both mountain and coast, especially intruding into the east sea, the low pressure was intensified under mososcale convection over the sea surface like cyclogenesis, appearing in the narrow displaced isobaric contours on a surface map and producing a strong wind in the mountainous coastal region. After cold front passage trough the study area, the wind strengthened to more than 9m/s at the city and 13m/s near Mt. Taegualyang (T) in the west of the city. The previous southerly and southwesterly changed to northwesterly and westerly wind.

At 21 LST, October 27, before windstorm event, positive geopotential height tendency line at 500 hPa level (20m/day) lies on the study area, where atmospheric depth of 500 hPa level should be expanded and negative vorticity induces upward motion of air, producing low wind speed (Figs. 2 and 3). On the other hand, at 09 LST, October 28, negative geopotential tendency line (-160m/day) lies on the study area, where the atmospheric depth of 500 hPa level should be much shrunken and positive vorticity induces downward motion of air, resulting in high wind speed more than 9m/s. According to Bernoulli theory, velocity is inversely proportional to vertical cross sectional area. Thus shrunken atmosphere in the mountainous coast induces a strong channel flow, resulting in a strong wind storm.

From night until the next day morning, October 28, synoptic southerly wind changed into downslope westerly wind passing over mountain terrain with steep dropoff in elevation (orography) and combined with land breeze, becoming a strong westerly windstorm in the mountainous coast (Fig. 4). This downslope windstrom showed a hydraulic jump in the lee side of the mountain and Froude numbers were 1.0 near the mountain top and 1.6 in the downwind side, Kangnung coastal city.

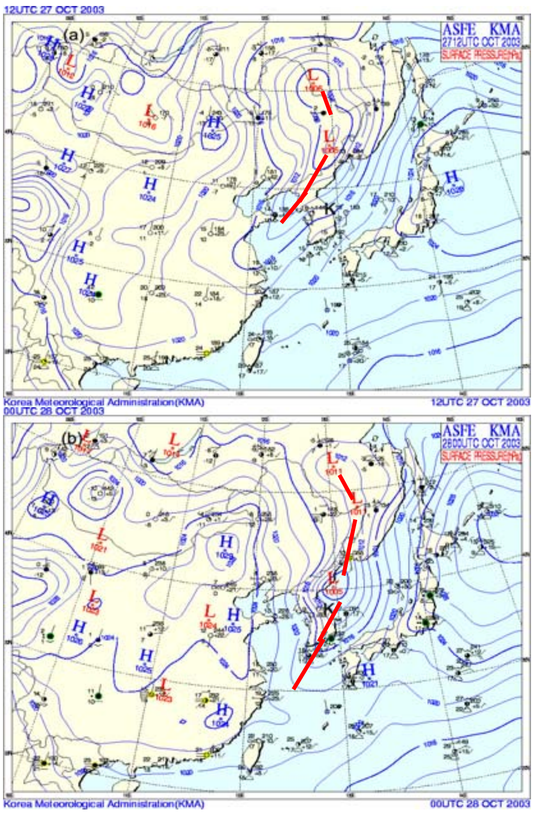

FIG. 1: Surface weather maps at (a) 21 LST (UTC=LST - 9 hrs), October 27, 2003 and (b) 09 LST, October 28 (two hours before windstorm occurrence at Kangnung city; K). Red line denotes cold front.

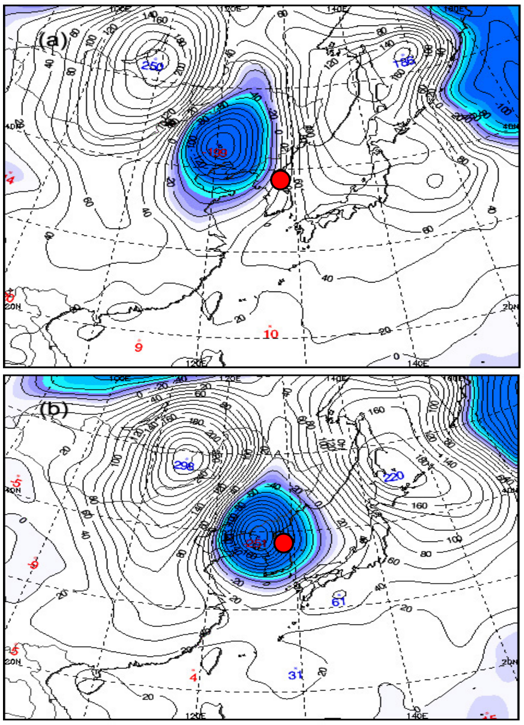

FIG. 2: 500hPa height change for 24 hours (m/day) called Geopotential tendency at (a) 21 LST, October 27, 2003 in the expansion (20m/day) and (b) 09 LST, October 28 in the shrunken (-160m/day). Circle denotes Kangnung city.

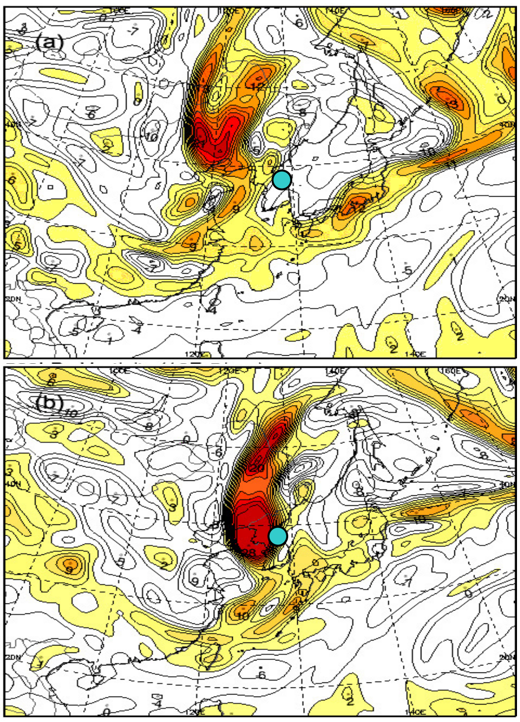

FIG. 3: (a) relative vorticity (10^{-5}/sec) at 500 hPa at 21 LST, October 27, 2003 and (b) 09 LST, October 28. White area denotes negative vorticity (upward motion) and red area, vice verse.

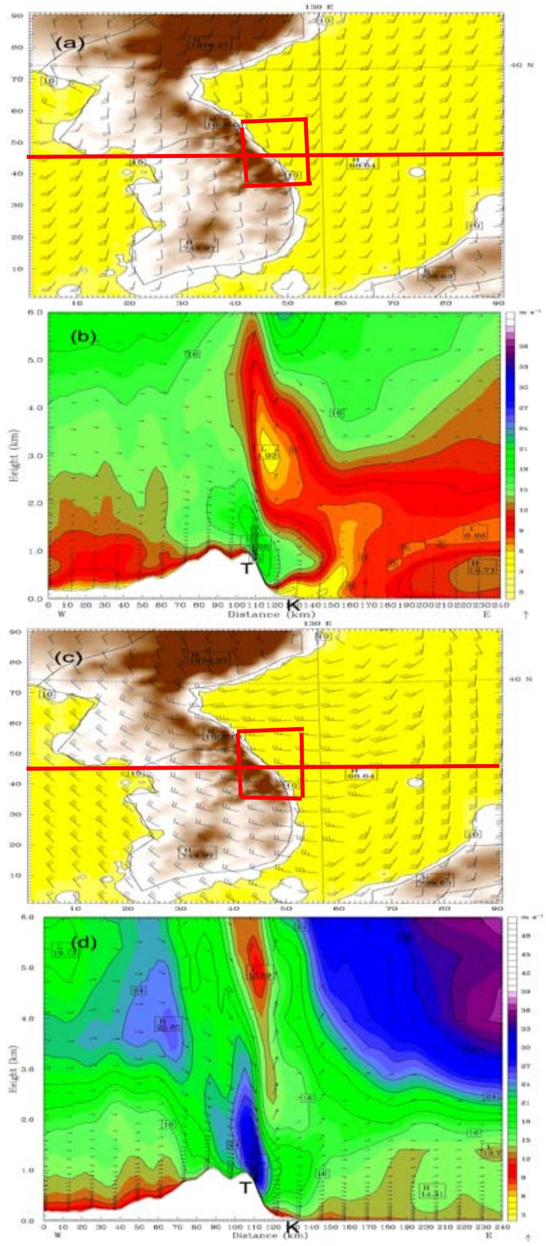

FIG. 4: (a) Surface wind (m/s; full bar-5m/s) and (b) vertical profile of horizontal wind in a box on a horizontal line in (a) at 21 LST, October 27. (c) and (d) at 11 LST, October 28. T and K denote Mt. Taegulyang (865m) and Kangnung city.

IV. AKNOWLEDGMENTS

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