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A case study on the local front prior to the cumulonimbus cloud and the verification of JMA-NHM simulation

NAGUMO, Nobuhiro[1*] ; YAMADA, Yoshinori[1] ; KAWABATA, Takuya[1] ; SATO, Eiichi[1]

[1]Meteorological Research Institute

The local fronts observed over the Kanto plain on July 23, 2013 have been analyzed that is the origin of the isolated cumulonimbus cloud in Tokyo metropolitan area and verified numerical simulation by JMA-NHM.

The local fronts and cumulonimbus cloud formation have been examined based on the data from dense observation network around Kanto plain including Doppler radar for Airport Weather (DRAW) at Haneda, Doppler lidar installed in Tokyo Institute of Technology (Ookayama Campus) and surface meteorological data by Japan Meteorological Agency (JMA). The verification of numerical simulation was based on the results of 500 m horizontal resolution of Japan Meteorological Agency Non-Hydrostatic Model (JMA-NHM). As the initial and boundary data, JMA Meso-analysis data of 15 UTC July 22, 2013 have been adopted. The first simulations have been done with 5 km resolution covering East Japan and then nesting of 1 km and 500 m resolution have been done covering a large part of Kanto Plain. The simulation of 500 m resolution has been analyzed for 10 hours from 02UTC July 22, 2013 and the boundary process is based on Deardorff (1980).

The formation of cumulonimbus clouds in Kanto plain is often explained by the convergence of southerly wind and easterly wind. The southerly warm moist wind flows from Sagami Bay and Tokyo Bay by high pressure system in the south of Japan or sea breeze. The easterly wind flows from Kashima Bay. However, in one case of on July 23, it was found that the trigger of cumulonimbus was convergence with two different directions of sea breeze fronts and in addition gust front also plays an important role. The daytime sea breeze front is formed along the Sagami and Tokyo Bay, has entered inland at 1 m/s approximately. Several isolated cumulonimbus clouds have been formed in the rear of sea breeze front and some of them have been lost later, to form a gust front. The spread speed of gust front was about 3 m/s. The sea breeze front that was located in front of the gust front turned the direction to northwest. This sea breeze front and original northeast direction of front from Tokyo Bay have formed the convergence over Tokyo metropolitan area.

On the other hand, numerical simulations have predicted the strong rainfall in the Kanto plain but not all precipitation have been expressed. Comparing JMA-NHM 500 m resolution simulation with DRAW at Haneda, the horizontal distribution of sea breeze front was close to the position of real position. The simulations also have expressed the isolated cumulonimbus rear of sea breeze front. But the gust front spreading was small to the real one.

Doppler lidar had identified the horizontal and vertical structure of these fronts. The simulated structure by JMA-NHM can be compared with Observation. The knowledge of the representation of simulation leads to improve forecast accuracy. We would like to go on to investigate the similarities or difference between simulation and observation of these front structures.

Keywords: convective cloud, local front, numerical simulation