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Initial condition sensitivity and error growth of cold vortex process in Northeast China

zhina jiang (1) and Donghai Wang (2)

(1) State Key Laboratory of Severe Weather (LaSW), Chinese Academy of Meteorological Sciences, Beijing 100081, China(zhina_jiang@hotmail.com/+86-10-68409478), (2) State Key Laboratory of Severe Weather (LaSW), Chinese Academy of Meteorological Sciences, Beijing 100081, China (wdh@cams.cma.gov.cn)

Conditional nonlinear optimal perturbation (CNOP), which is the initial perturbation that acquires the maximum nonlinear evolution at the forecast time with some initial constraint condition, is computed for a regional mesoscale primitive equation model. Computation is carried out over a 48-hour optimization time interval for one cold vortex process during July 2006. The norm used is loosely related to dry total perturbation energy. Attention is given to errors on the synoptic scale including position and structures during the cold vortex process. The results show that CNOP exhibits the properties of localness and baroclinicity. For this cold vortex process, CNOP is mainly located in the north area of the cold vortex. At the optimization time, the initial errors spread upscale over larger areas and become equivalent barotropic.

The cold vortex is most sensitive to the variables in the middle of the troposphere, especially the temperature. Though the dry total energy norm is adopted, the moisture energy developed in the lower troposphere, which is equivalent to the kinetic energy and larger than potential energy. However, the kinetic energy dominates the upper troposphere. The above numerical experiment helps us to further understand the mechanism of error growth during the cold vortex.