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## Energy Structure Analysis of Vorticity Driven by Thermal Gradient in Developing Cumulonimbus Clouds and Application to Data Assimilation

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It is an essential problem for forecasting Mesoscale Convection Systems to understand the mechanism of interaction between atmospheric flow and vortices with the development of cumulonimbus clouds using a numerical weather model. In this research, potential temperature gradient based vorticity which is the expression of baroclinic is obtained to analyze the energy structure of the vorticity field in developing cumulonimbus. First, applying the variational method enables us to obtain a diagnostic equation in which the equation of motion, conservation law of mass, and entropy are considered as constraints. Second, Fourier analysis was performed on the vorticity field in the cross-section of the convective core in the isolated cumulonimbus simulation. The temporal change of the spectrum of the vorticity field indicates that the rotational intensity of potential temperature gradient based vorticity increases at the same time as the degree of baroclinicity increases. It was also found that the same tendency can be seen in the analysis of the vorticity field of developing clouds using the environment of the heavy rainfall event in the Kuma River basin that occurred on July 4, 2020. We are planning to analyze the vorticity field in the cluster of cumulonimbus clouds and consider the difference in the energy structure of the vorticity field due to the difference in model resolution. Third, we conducted the data assimilation experiment assuming the use of vertical vorticity estimated by doppler radar observation. As a result, the change in the potential temperature and vertical wind through the error covariance matrix generates coherent convection in the computations.