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What is the source of chaos in MCS?

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Non-Gaussian probability density functions (PDFs) in convection initiation (CI) and development are investigated by using a particle filter with a storm-scale numerical prediction model (NHM-PF). An observation system simulation experiment (OSSE) is conducted with a 90-min assimilation period, a small domain ($48\times48\times50$ grids), storm scale grid spacing (2 km), 48 observations, and 1000 particles. Pseudo-surface observations of potential temperature (PT), winds (U, V), and water vapor (QV), and pseudo-radar observations of rainwater (QR) in the lower troposphere are created in a nature run that simulated a well-developed cumulonimbus. As a special feature for stabilizing the filter, we dynamically estimate observation errors using the Bayesian estimation method.
The results of the OSSE (PF) shows a significant improvement in comparison with ensemble simulations without any observations. Moreover, the dynamical estimation of the observation errors clearly contributes to avoid the filter collapse as shown in the root mean square errors to the truth. From the ensemble means of PF, it is obvious that the trigger of the CI is updrafts in a frontal boundary of air masses.
The Gaussianity of PDFs for PF in grids in the CI area is evaluated by using the Bayesian Information Criterion to compare goodness-of-fit of Gaussian, two-Gaussian mixture, and histogram models. The PDFs are strongly non-Gaussian when NHM-PF produces diverse particles over the CI period. The non-Gaussian PDF of updraft is followed by the upper-bounded PDF of relative humidity, which produces non-Gaussian PDFs of QV and PT. The PDFs of cloud water and QR are strongly non-Gaussian throughout the experimental period. We conclude that the non-Gaussianity of the CI originated from non-Gaussianity of the updraft.