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Exploring the potential of assimilating three-dimensional lightning discharge observations with an ensemble Kalman filter

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To predict severe storm development, it is essential to obtain good initial conditions with data assimilation. Many previous studies have assimilated radar observations into severe convective storms and shown the profound impact on Numerical Weather Prediction (NWP). In particular, a few studies have demonstrated the potential of next-generation phased-array weather radar (PAWR) observations for improving sudden severe rainfall prediction.

To further improve the accuracy of NWP for severe storms, it would be beneficial to assimilate lightning discharge observations. Hydrometeors may obtain electric charge via collision processes, and their charge separation depends on the surrounding environment. Therefore, lighting discharge observations would reflect microphysical processes more directly compared to radar reflectivity. Indeed, some studies have succeeded in assimilating two-dimensional lighting mapping observations for improving severe-convection prediction.

Recently, a precise three-dimensional lighting discharge detection method has been developed. This new observation would give precious information of the charge structure and hydrometeor distribution within a convective cloud. This study aims to explore the potential of assimilating the three-dimensional lightning discharge observation for improving severe-storm prediction. To do so, we use an ensemble Kalman filter with an NWP model including explicit lighting discharge processes. As the first step, ensemble-based correlations between two- and three-dimensional lightning discharge observations and the atmospheric variables are investigated. The results show that three-dimensional observations provide additional information compared to two-dimensional observations. We will perform data assimilation experiments and show the newest results up to the time of the conference.