Convective Storm Nowcasting Using a Deep Learning Approach

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Valuable information is contained in meteorological data, which could be used for convective storm nowcasting. For example, by assimilating radial velocity and reflectivity of multiple radars, the convective-scale variational Doppler radar analysis system (VDRAS) can provide useful lower-atmosphere meteorological fields such as temperature, wind, etc. However, effectively extracting such information has been problematic due to a lack of methodology. Recent advancements in deep learning techniques now make it possible. This study investigates the feasibility and performance of an end-to-end deep learning nowcasting method. We use a convolutional neural network (CNN), trained with VDRAS meteorological analysis and observational radar data. The CNN method eliminates the need for handcraft feature engineering. We also examine the influence of meteorological analysis and observational data on nowcasting skill. Operationally-produced historical data of the Beijing–Tianjin–Hebei region in China was used to train the nowcasting system and evaluate its performance. Our results show that the deep learning method improves nowcasting skill compared with traditional machine learning methods. While reasonable skill can be obtained using only analysis or observational data, combining the two datasets yields superior performance, demonstrating that the retrieved meteorological fields such as perturbation temperature and vertical wind (i.e., buoyancy and updraft) are necessary to analyze convective processes, such as contains crucial information for nowcasting convective initiation and development.

Keywords: Nowcasting, Deep Learning, Radar