

Tornado Occurrence Forecasting Method Based on a Simplified 4DVAR Radar Data Assimilation and Traditional Radar Echo Identification and Nowcasting Technique: Preliminary Results.

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This study presents a detecting and forecasting method for the tornado occurrence, combining a numerical mesoscale model and a radar echo tracking technique. This method consists three components. One is a simplified four-dimensional variational data assimilation (4DVAR) system for Doppler radar observations based on National Center for Atmospheric Research's VDRAS (Variational Doppler Radar Analysis System). A non-hydrostatic cloud-resolving model, its adjoint, and a minimization procedure of a cost function are used for the assimilation of radial velocity and reflectivity data into the cloud model to retrieve unobserved model variables with dynamical consistency. A rapid update cycle using VDRAS can improve the background field that is made from routine observations and forecasts by WRF (Weather Research and Forecasting) model, resulting in the retrieval and the forecast of severe precipitation and wind fields with a high accuracy. Especially, this numerical analysis information helps letting us know the existence of strong mesocyclones in the real-time framework. Parallel to numerical analysis, contiguous regions exceeding thresholds of reflectivity ($> 35\text{dBZ}$) are identified by Dixon and Wiener's TITAN cell identification technique. Then, a vorticity check is performed as the second component using VDRAS analysis data, in which a region of a cell is regarded as a tornado warning area if the cell includes columns associated with high vorticity (> 0.01 per second). In the third component, tornado warning areas are forecasted for the time periods up to an hour by a simple extrapolation-based nowcasting technique. The performance of this tornado occurrence forecasting method was evaluated for severe tornadic and non-tornadic storms occurred over the Kanto plain, Japan. Four Doppler radar data are used in this applications, and the results suggests that this method shows some promise, especially noted that tornado warning areas were identified 30-40 minutes in advance of the occurrence of some tornadoes. This capability was mainly due to the dynamic retrieval using VDRAS.

Keywords: 4DVAR Data Assimilation, Tornado, Nowcasting