DISSERTATION

DYNAMIC MODEL FOR SPACE-TIME WEATHER RADAR OBSERVATION AND NOWCASTING

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ABSTRACT OF DISSERTATION

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A general framework of the dynamic model for space-time radar observations has been developed in the current research. There exist three difficulties in modeling space-time radar observations: 1) high dimensionality due to the high-resolution radar measurements over a large area, 2) non-stationarity due to the storm motion, and 3) non-stationarity due to evolution (growth and decay). These difficulties are addressed in this research. To deal with the storm motion, an efficient radar storm tracking algorithm is developed in the spectral domain. Based on this new technique, the Dynamic and Adaptive Radar Tracking of Storms (DARTS) is developed and evaluated using the synthesized and the observed radar reflectivity. To tackle the high dimensionality and model the spatial variability of radar observations, a general modeling framework is formulated and the singular value decomposition (SVD) is used for dimension reduction. To deal with the dynamic evolution and model the temporal variability of radar observations, the motion-compensated temporal alignment (MCTA) transformation is developed. In this analysis the evolution of radar storm fields is modeled by the linear dynamic system (LDS) in the low-dimensional subspace. The applications of the dynamic modeling for space-time radar observations are further demonstrated. Spatial and dynamic characteristics are obtained based on the estimated model parameters using three months of radar observations. The characteristic temporal scales are quantified for

this dataset. The correlation between the temporal characterization and the spatial characterization of observed radar fields are explored. The simulation capability of different spatiotemporal radar reflectivity fields is demonstrated. Evaluation of the space time variability is particularly important in the context of adaptive scanning of storm systems. The short-term prediction of radar reflectivity fields based on the space-time dynamic model is evaluated using observed radar data. The simulations of the DARTS for real-time applications are also conducted and evaluated.

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