European Conference on Severe Storms 2015
14–18 September 2015, Wiener Neustadt, Austria
ECSS2015-60

Tornado numerical analysis: A case study of EF3 and EF4 tornadoes over Arkansas on April 27, 2014

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A worth noting extreme meteorological conditions in Midwest states of United States of America (U.S.A.) lasting from 27 to 30 April 2014 triggered the scientific interest worldwide. A closed upper air low, associated with a closed cyclonic circulation and a frontal activity on the surface, moved through the Northern Plains towards the Midwest states. Over the course of the four-day period, the fontal activity caused severe convection weather including hail and straight line winds, while numerous tornadoes were observed from Nebraska to North Carolina. On April 27, 2014, twenty five tornadoes were confirmed across Nebraska, Iowa, Missouri, Oklahoma, Louisiana and Arkansas, including at least five EF2, one EF3 and one EF4 event. In this study we focus on the EF3 and EF4 tornadoes that took place on April 27, 2015, in Arkansas State, and caused 15 fatalities, 192 injuries and significant damage on properties and crops. At 00:06 UTC on April 28 (18:06 local time on April 27), a destructive EF3 tornado developed 9.6 km west of Ferndale (Pulaski County) and tracked 23.22 km. The EF4 tornado developed at 00:25 UTC (18:06 local time), 1.6 km southwest of Palarm (Faulkner County) and tracked almost 40 km.
The aim of this study is twofold: (a) to investigate the ability of European Centre for Medium-Range Weather Forecasts (ECMWF) to capture the convective weather conditions and (b) to numerical investigate both tornadoes with the use of Weather Research and Forecasting (WRF) model, so that to capture convective weather environment, characterized with high values of Convective Available Potential Energy (CAPE) and wind shear.
ECMWF's synoptic conditions of middle and lower atmosphere along with the daily composite mean and anomalies from NCEP/NCAR reanalysis are presented. In addition, numerous dataset from weather observations and remote sensing data, fulfil the synoptic discussion. The numerical simulation was performed using the non-hydrostatic WRF model, initialized with ECMWF gridded analyses, with telescoping nested grids that allow the representation of atmospheric circulation ranging from the synoptic scale down to meso-scale. ECMWF's numerical products captured very well the synoptic conditions for all lead times, simulating the southerly upper air flow, convective precipitation and enhanced risk of high CAPE values. Further, the high spatial and temporal resolution numerical products from WRF experiment depicted also very well the severe convective environment with lead times of 12 hours in terms of CAPE and wind shear.