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Moisture Attribution and Sensitivity Analysis of a Winter Tornado Outbreak

Maria Molina (1) and John Allen (2)

(1) Central Michigan University, Department of Earth and Atmospheric Sciences, United States (maria.janet.molina@gmail.com), (2) Central Michigan University, Department of Earth and Atmospheric Sciences, United States (JohnTerrAllen@gmail.com)

The 21-23 January 2017 tornado outbreak resulted in more than 80 tornadoes, 200 injuries, 20 fatalities, and over $1 billion (United States [U.S.] dollars) in losses, ranking as one of the highest-frequency three-day January tornado events in U.S. history (1954-2019). Gulf of Mexico sea surface temperatures preceding the event were the warmest on record for the month of January (1982-2019). Would this tornado outbreak have occurred if Gulf of Mexico surface waters were not at record warmth? To answer this question, moisture attribution was conducted using the National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory HYSPLIT model and a Lagrangian-based algorithm. These results revealed that boundary layer moisture contributions to the tornado outbreak originated from the southeastern Gulf of Mexico and northwestern Caribbean Sea. The National Center for Atmospheric Research (NCAR) Weather Research and Forecasting (WRF) model was subsequently used to recreate the tornado outbreak. Several convection resolving simulations were initialized, using actual and perturbed sea surface temperatures. Results provide insight into the influence of upstream surface water temperatures on tornadic convection development. It is shown that surface water temperatures which are remote to the U.S. (e.g., Caribbean Sea, Yucatan Channel) can influence the evolution and morphology of severe convection.