# A New Machine Learning-Based Tornado Detection Algorithm for the WSR-88D Network

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Using single-radar products from the WSR-88D network, the New Tornado Detection Algorithm (NTDA) utilizes a random forest machine learning technique for automatically identifying potential tornadoes to improve the performance of the current operational Tornado Detection Algorithm (TDA). The random forest is trained on tornadic and non-tornadic events (non-tornadic includes severe wind and hail greater than 58 mph and 1 inch in diameter, respectively) from 2013 to 2016, totaling almost 10,000 individual points. The radar products include both base and derived products, where both dual-pol and velocity-derived products were generated using the linear least-squares derivative (LLSD) method (Smith and Elmore 2004, Mahalik et al. 2019). These include the total gradients of radial velocity, velocity spectrum width, differential phase, and correlation coefficient, as well as azimuthal and radial (divergent) shear of radial velocity.

The NTDA utilizes areas of LLSD azimuthal shear (AzShear) exceeding 0.006 $s^{-1}$ to determine regions that should be examined by the random forest. Objects of AzShear are found using a neighborhood depth-first search. Next, data is extracted in a set radius around the maximum AzShear of an object. The radar-derived data for each object is presented to the random forest consisting of 500 individual trees. Each tree gives a binary prediction of whether the detected rotation object is tornadic or non-tornadic. The algorithm marks the detection as tornadic if the fraction of trees predicting tornadoes is above 50%. The NTDA also tracks the predicted tornadic signatures and produces trends and output variables correlated to rotational and updraft strength.

The algorithm performance will be tested on cases from 2017 and later and compared to the performance of the current operational TDA used by the WSR-88D network. Preliminary results indicated promising results in a limited number of test cases. Technical details of the algorithm and additional performance, with results, will be discussed. The final product will be tested in the 2020 Hazardous Weather Testbed Experimental Warning Program to investigate potential improvements and the utility for forecasters.

Keywords: Tornado, Machine learning, NEXRAD, Nowcasting, Severe weather