MS Defense Announcement
Alexander DesRosiers
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October 27, 2020
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Defense
Virtual in Teams (Link to be sent next week)

Post Defense Meeting
Virtual in Teams (Link to be sent next week)

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Airborne Radar Quality Control and Analysis of the Rapid Intensification of Hurricane Michael (2018)

Improvements made by the National Hurricane Center (NHC) in track forecasts have outpaced advances in intensity forecasting. Rapid intensification (RI), an increase of at least 30 knots in the maximum sustained winds of a tropical cyclone (TC) in a 24 hour period, is poorly understood and provides a considerable hurdle to intensity forecasting. RI depends on internal processes which require detailed inner core information to better understand. Close range measurements of TCs from aircraft reconnaissance with tail Doppler radar (TDR) allow for the retrieval of the kinematic state of the inner core. Fourteen consecutive passes were flown through Hurricane Michael (2018) as it underwent RI on its way to landfall at category 5 intensity. The TDR data collected offered an exceptional opportunity to diagnose mechanisms that contributed to RI.

Quality Control (QC) is required to remove radar gates originating from non-meteorological sources which can impair dual-Doppler wind synthesis techniques. Automation of the time-consuming manual QC process was needed to utilize all TDR data collected in Hurricane Michael in a timely manner. The machine learning (ML) random forest technique was employed to create a generalized QC method for TDR data collected in convective environments. The complex decision making ability of ML offered an advantage over past approaches. A dataset collected by the Electra Doppler Radar (ELDORA) containing a variety of scans from a tornadic supercell, bow echo, and mature and developing TCs was mined for predictors. Previous manual QC performed on the data was used to classify each data point as weather or non-weather. This varied dataset was used to train a model which performed with over 99% accuracy on withheld testing data. Creation of a dual-Doppler analysis from a tropical depression using ML efforts that was comparable to manual QC confirmed the utility of this new method. The framework developed was capable of performing QC on the majority of the TDR data from Hurricane Michael.

Analyses of the inner core of Hurricane Michael were used to document inner core changes through- out RI. Angular momentum surfaces moved radially inward and became more vertically aligned over time. The hurricane force wind field expanded radially outward and increased in depth. Intensification of the storm became predominantly axisymmetric as RI progressed. TDR-derived winds are used to infer upper-level processes that influenced RI at the surface. Tilting of ambient horizontal vorticity, created by the decay of tangential winds aloft, by the axisymmetric updraft created a positive vorticity tendency atop the existing vorticity tower. A vorticity budget helped demonstrate how the axisymmetric vorticity tower built both upward and outward in the sloped eyewall. A retrieval of the radial gradient of density temperature provided evidence for an increasing warm core temperature perturbation in the eye. Growth of the warm core temperature perturbation in upper levels aided by subsidence helped lower the minimum sea level pressure which correlated with intensification of the near-surface wind field.