An Analysis of the Extratropical Transition of Hurricane Arthur (2014) from a JPSS Proving Ground Perspective

Michael Folmer¹, Emily Berndt², Jeffrey Halverson³, Jason Dunion⁴, and Mitch Goldberg⁵

¹University of Maryland, ESSIC, CIC – NOAA/AWS OP/TP/AB/WPC and NESDIS/SAO
²University of Alabama in Huntsville – NASA SPoRT
³University of Maryland Baltimore County (UMBC)
⁴University of Miami/CIMAS - NOAA/AOML Hurricane Research Division, NOAA

The Problem

- During Arthur (2014), the Air Mass RGB product and the SPoRT ozone products were available to National Center forecasters via the Proving Ground to monitor Arthur’s extratropical transition.
- The Air Mass RGB provides a wealth of qualitative information about the horizontal distribution of synoptic features but forecasters are also interested the vertical distribution of temperature, moisture, and ozone.
- NOAA Unique CrIS/ATMS Processing System (NUCAPS) soundings are available to forecasters in AWIPS-II but soundings are typically used to forecast severe convection.
- This project focuses on an additional application for NUCAPS soundings and investigates their utility for anticipating stratospheric drying in the pre- and post-extratropical transition (ET) environment.

Background

- The RGB Air Mass product is able to identify temperature and moisture characteristics surrounding synoptic features.
- Arthur made landfall just north of Oregon Inlet, North Carolina at 0800 UTC 4 July 2014 as a Category 2 Hurricane.
- During 4 July, Arthur interacted with the upstream mid-latitude trough and accelerated northeastward.
- The dry upper-level air associated with the upper-level trough is colored orange in the MODIS Air Mass RGB (Fig. 1).
- The NUCAPS ozone anomaly product (Fig. 2) confirms the dry air is of stratospheric origin (blue shading).

1800 UTC 4 July 2014 Arthur After Landfall

- NUCAPS soundings (Fig. 3, 4) confirm upper-level thermodynamic characteristics in the Air Mass RGB.
- NUCAPS soundings reveal mid-, low-level characteristics that aren’t detected in the RGB.
- Mid-level dry air found below upper-level moisture detected in the RGB, see example profile (Fig. 4).
- Dropwinsondes (Fig. 5) near the storm edge confirm the mid-level dry air in the NUCAPS profiles (Fig. 6).
- NUCAPS profiles give vertical distribution of mid-level dry air in the near storm environment.

0600-0700 UTC 5 July 2014 Arthur before Extratropical Transition

- At this stage in the ET, the tropical cyclone is moving rapidly NNE ahead of the digging shortwave.
- Both Profile 16 (Fig. 9) and 18 (Fig. 10) capture the slant-wise descent of the stratospheric drying at mid-levels associated with the shortwave, yet the Air Mass RGB shows less drying near 18.
- Profiles 17 (Fig. 11) and 21 (Fig. 12) show the dry air has not penetrated the storm yet.
- The cross section (Fig. 13) confirms the presence of a tropopause fold near the cyclone.

1700 UTC 5 July 2014 after Extratropical Transition

- Profiles 13, 14, and 15 (Figs. 15-17) show dry air higher up in the troposphere, with moisture at low-levels.
- Profile 16 (Fig. 18) shows mid-level dry air underneath upper-level moisture seen in the Air Mass RGB to the east of the upper-level low. This would indicate that the stratospheric intrusion continues its slant-wise descent in the western quadrant (coincident with a dry slot), possibly assisting in creating low-level instability, leading to enhanced wind gusts.
- The cross-section (Fig. 19) shows the tropopause fold and an increase in NW flow (throughout troposphere after ET) and possibly caused by descent of dry air.

Summary and Future Work

- Additional storms will be added to this research to develop a foundational understanding of how NUCAPS soundings and the Air Mass RGB can be used by forecasters to identify and monitor the features associated with the extratropical transition of tropical cyclones.
- Initial training materials will be made available to forecasters at the National Hurricane Center and Ocean Prediction Center in the summer of 2016 and a first assessment will be conducted to combine the Air Mass RGB and NUCAPS to create a more complete synoptic to mesoscale analysis.
- Acknowledgement: This research is funded by the JPSS Proving Ground/Risk Reduction program