Thermodynamic and Kinematic Properties of Isolated Convective Cells in the Rainband Region of Atlantic Hurricanes

UNIVERSITY OF SOUTH ALABAMA

Peyton Barlow, Sam Sangster, Dr. Wesley Terwey

University of South Alabama, Department of Earth Sciences

Introduction

Isolated supercells and thunderstorms often reside in the vicinity of tropical cyclone rainbands and may produce tornadoes and severe wind damage[1]. Thus, understanding the local environments of these sorts of discrete cells in the rainband region is important. Previous work has shown the general environment of this region typically contains large magnitudes of low-level wind shear, moderate values of convective available potential energy (CAPE), and large values of helicity, which can support a variety of storm modes including supercells[2].

The goal of this project is to extract statistical information on the thermodynamics and kinematics of the local environments that these discrete cells form in. This information should improve our understanding of the rainband environments which are conducive to isolated thunderstorm formation.

Results

Type [# of cases]	Surface temperature (°C)	0-1 km helicity (m^2/s^2)	0-1 km helicity magnitude (m^2/s^2)	0-2 km helicity (m^2/s^2)	0-2 km helicity magnitude (m^2/s^2)	0-1 km temperature LR (K/km)	0-2 km temperature LR (K/km)	0-1 km theta-E LR (K/km)	0-2 km theta-E LR (K/km)	0-1 km VWS (m/s)	0-2 km VWS (m/s)
Inflow [36]	**26.7** *(0.9)*	**-201** *(239)*	**228** *(224)*	**-223** *(338)*	**284** *(302)*	**6.58** *(0.92)*	**5.69** *(0.62)*	**-5.85** *(0.93)*	**-5.12** *(0.64)*	**7.47** *(4.46)*	**8.71** *(5.00)*
Outflow [29]	**24.8** *(1.4)*	**-368** *(427)*	**445** *(370)*	**-423** *(472)*	**529** *(376)*	**5.31** *(1.16)*	**5.08** *(0.73)*	**-4.59** *(1.16)*	**-4.53** *(0.74)*	**11.66** *(5.55)*	**13.56** *(5.36)*
Environ. [77]	**26.8** *(1.27)*	**-390** *(337)*	**408** *(325)*	**-432** *(437)*	**491** *(381)*	**6.55** *(1.00)*	**5.65** *(0.57)*	**-5.85** *(0.99)*	**-5.10** *(0.59)*	**9.94** *(4.97)*	**10.62** *(5.20)*

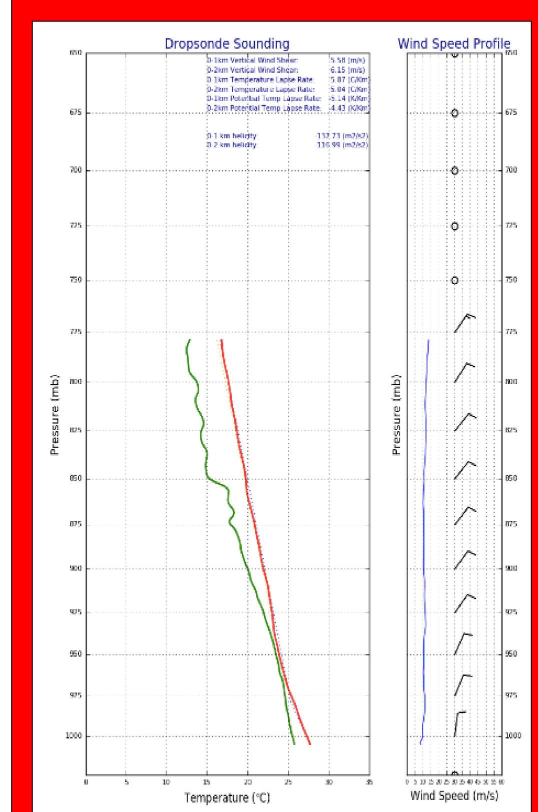
Average (*standard deviation*) for the following parameters:

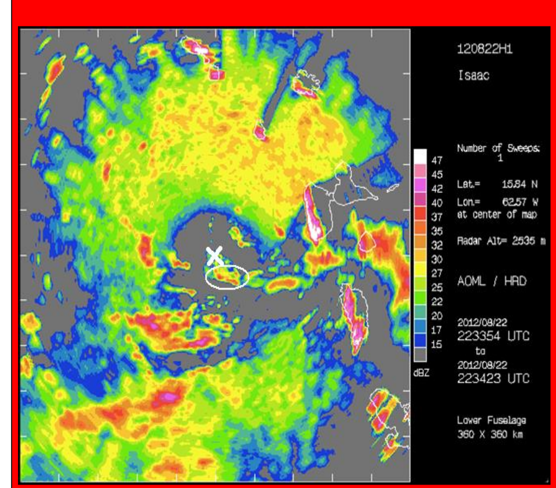
- surface temperature
- helicity
- helicity magnitude
- temperature lapse rates (LR)
- equivalent potential temperature LRs
- vertical wind shear (VWS)

Methods

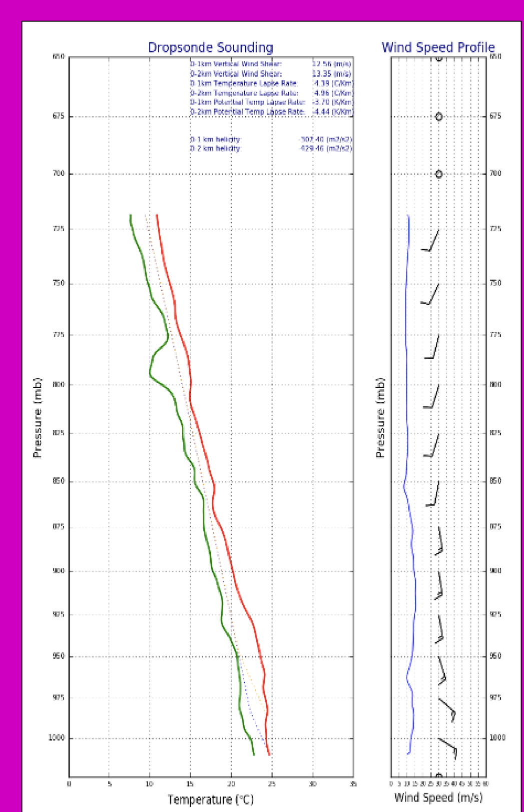
- Datasets from the National Oceanic and Atmospheric Administration (NOAA) hurricane research aircraft
- Lower fuselage and composited tail radar data were used to locate discrete cells.
- Discrete cell criteria:
  a) within 36 km of a dropwindsonde
  b) minimum cell size: 325 km^2
  c) maxmimum reflectivity of at least 32 dBZ
- Sondes were classified as either an inflow sonde, an outflow sonde, or an environment sonde based on:
  a) location with respect to the cell
  b) location of the cell with respect to the center of the storm
  c) temperature and dewpoint profiles
  d) wind velocities taking into account cell position and location relative to storm center
- Within each sonde type classification, thermodynamic and kinematic parameters were collected and statistically analyzed.

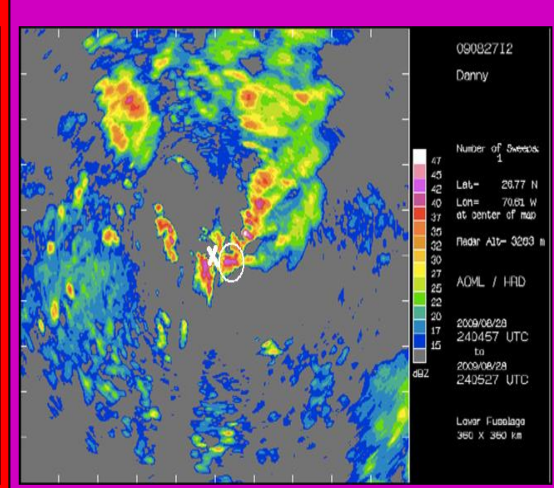
Inflow



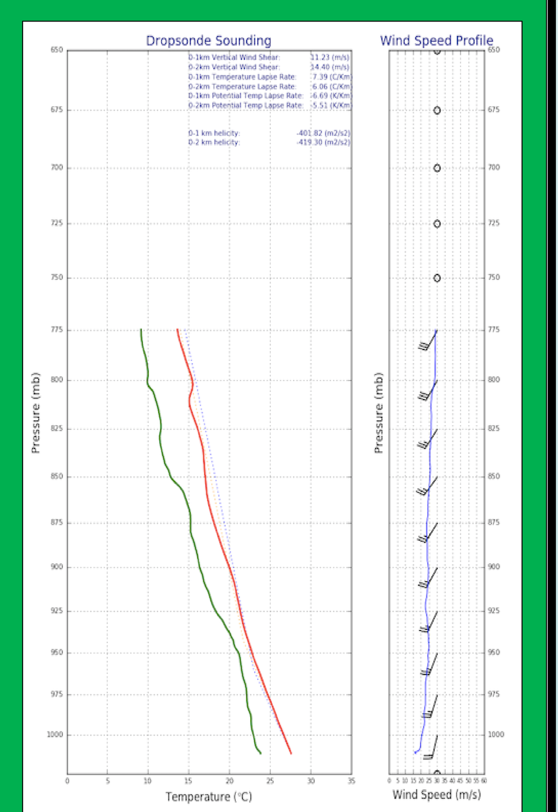


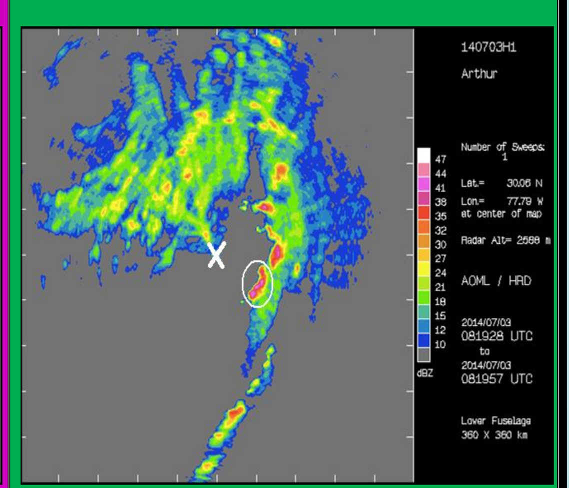
Outflow





Environment





Conclusions

- Inflow sondes are similar to environment sondes except for lower helicity and vertical wind shear values.
  - The lower shear in the inflow sondes may indicate that the shear in the general environment may be too strong to initiate and sustain convection.
- Outflow sondes have cooler surface temperatures, lower temperature lapse rates, and larger values of helicity and vertical wind shear.
  - As expected, the outflow sondes are dominated by cold pools emanating from the cells, giving them cooler temperatures and higher shear values.
- The environment soundings show high values of temperature lapse rate and helicity, indicative of a general environment containing a significant amount of instability and shear.

- **Future work**
  - Perform t-tests and ANOVA between variables within the inflow, outflow, and general environment classifications to determine which parameters are statistically significant against each other.
  - Add additional instability and kinematic parameters.

References

1. N. Akter and Tsuboki K., 2010, *Characteristics of Supercells in the Rainband of Numerically Simulated Cyclone Sidr*, *SOLA*, **6A**, 25-28, 10.2151/sola.6A-007
2. M. D. Eastin and Link M.C., 2009, *Miniature Supercells in an Offshore Outer Rainband of Hurricane Ivan (2004)*, *American Meteorological Society*, **137**, 2081-2104.

Results (cont.)