Passive Microwave Properties Observed during Tropical Cyclone Intensification

George R. Alvey III [a], Jonathan Zawislak [b], Edward Zipser [a]

a The University of Utah, Salt Lake City, UT
b Florida International University, Miami, FL

I. Objectives

i. Test hypotheses from previous passive microwave studies *(Cecil and Zipser 1999, Jiang 2012, Zagrodonik et al. 2014)* that emphasized the importance of **areal coverage** and **symmetry** of precipitation (and "moderate" convection) for tropical cyclone (TC) intensification.

ii. Test the importance of convective bursts (**CBs**) for rapidly intensifying (RI) TCs

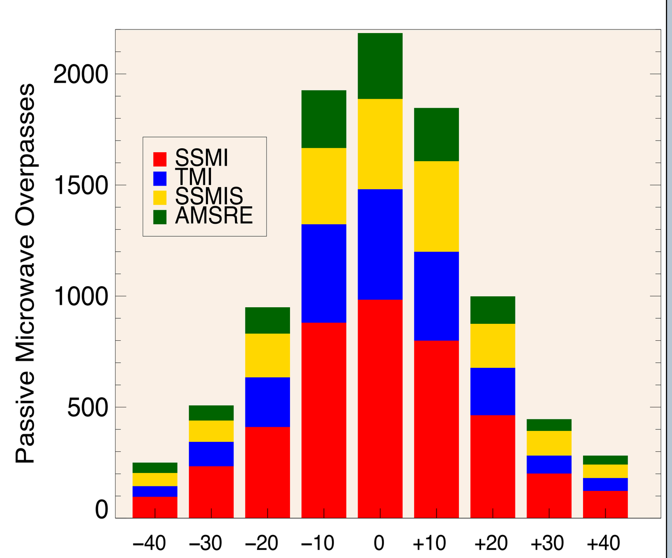
iii. Compare intensification periods during HS3 campaign with results from *Alvey et al. 2015.*

II. Data and Methods

This study synthesizes the following datasets to help evaluate the effects of inner core precipitation on intensification:

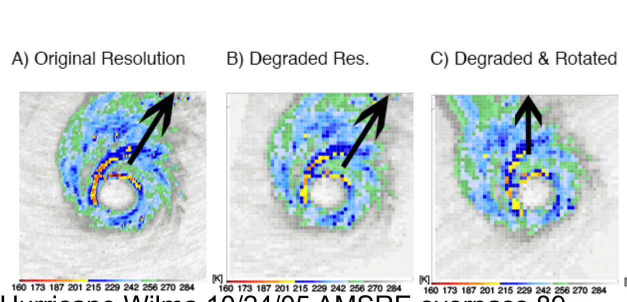
-Tropical Cyclone – Passive Microwave Dataset (TC-PMW) *using AMSR-E, TMI, SSMI[S] (1998-2012)*
-NHC Best Track *for maximum sustained wind and center position information*
-Statistical Hurricane Intensity Prediction Scheme (SHIPS) *for shear direction*

All cases undergoing extra-tropical transition, land interaction, and those overpasses with a fractional coverage less than 100% within 1 degree of the center are removed.



85 – 91 GHz Polarization Corrected Temperatures (PCT) as proxies for precipitation and convective intensity *Spencer et al. 1989*

- **< 250 K** Precipitation and "moderate" convection
- **< 190 K** "Strong" convection (degraded resolution)



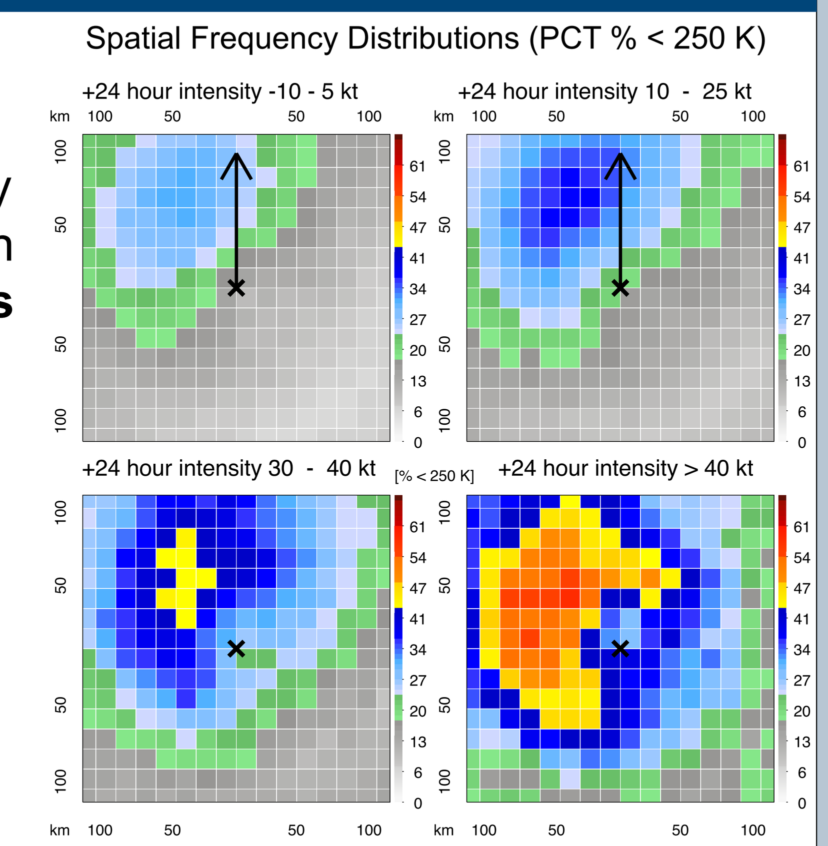
Hurricane Wilma 10/24/05 AMSRE overpass 89 GHz PCT. Black arrow indicates the vertical wind shear vector.

All TC-PMW overpasses are degraded to common resolution ~14 km. Snapshots are then rotated so the shear vector (black arrow) is pointing "up."

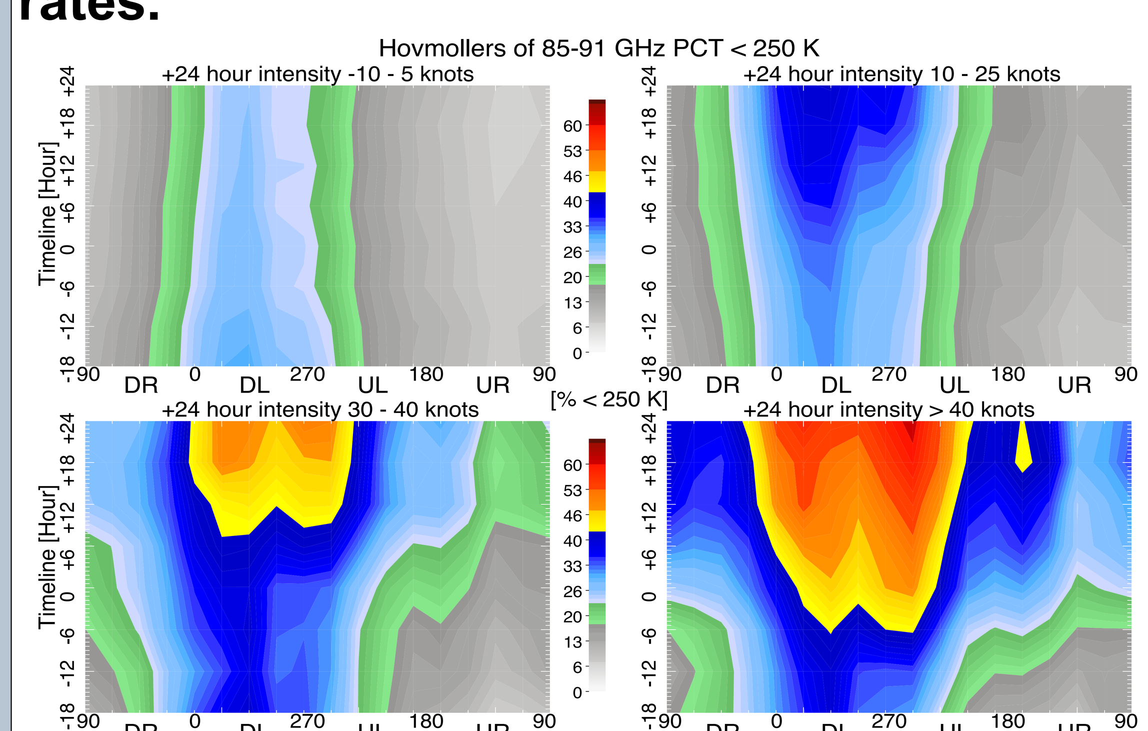
III. Precipitation Properties

(A) Precipitation and "Moderate" Convection

Steady state storms have the lowest frequency of precipitation in all quadrants. **As intensification rates increase, precipitation occurrence increases in all quadrants, an indication of greater symmetry.**

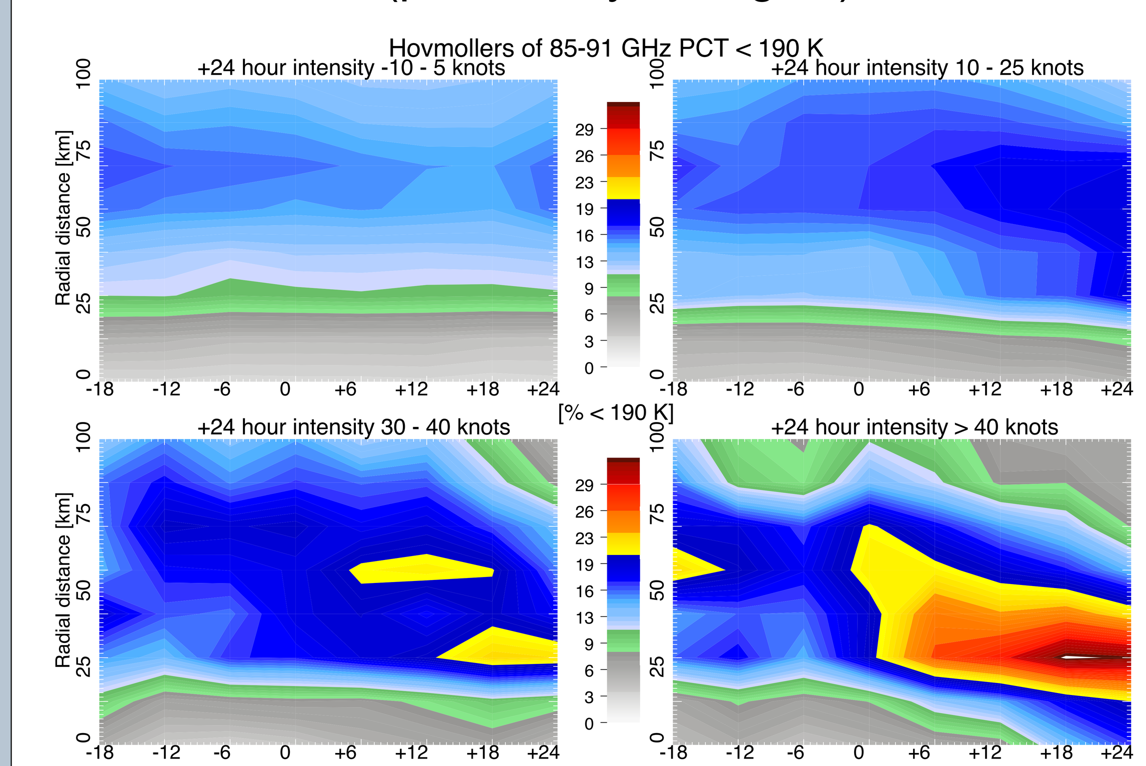


Symmetrization and occurrence of precipitation (during and prior to onset) increases with increasing intensification rates.



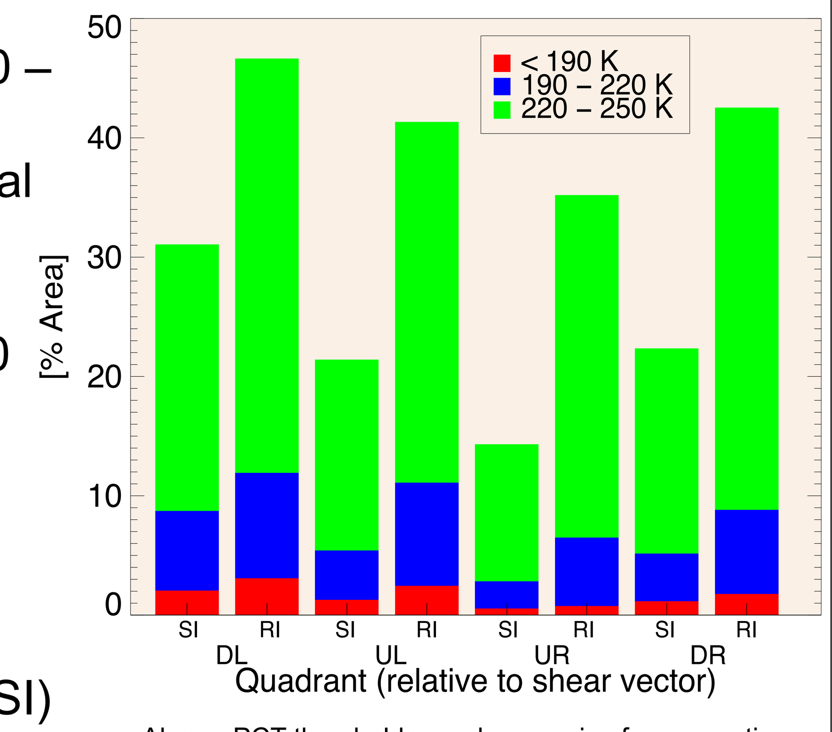
(B) "Strong" Convection

As intensification rates increase, the **occurrence of strong convection increases prior to and during intensification**. The maximum in frequency also contracts inward (particularly during RI).



(C) PCT Partitioning

While PCTs 190 – 250 K have the highest fractional areas, **ALL** thresholds (including < 190 K) have **statistically significant differences** between slow intensification (SI) and rapid intensification periods.



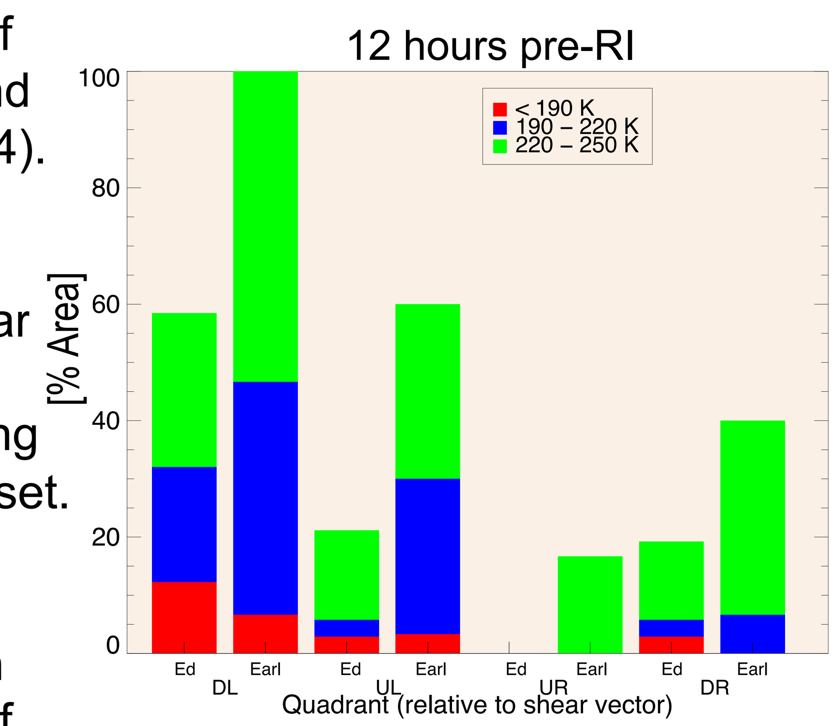
Above: PCT thresholds used as proxies for convective intensity: < 190 K ("strong" convection), 190–220 K ("moderate" convection), 220–250 K (precipitation). The fractional area [%] for each threshold is calculated in quadrants 0–60 km from the center at the onset of RI and SI storms.

The largest and most significant differences between RI and SI for **"strong convection"** (PCT < 190 K) are found **left of shear**.
The largest differences between RI and SI for **PCTs 190 – 250 K** are found in the **upshear** quadrants.

(D) Edouard (2014)

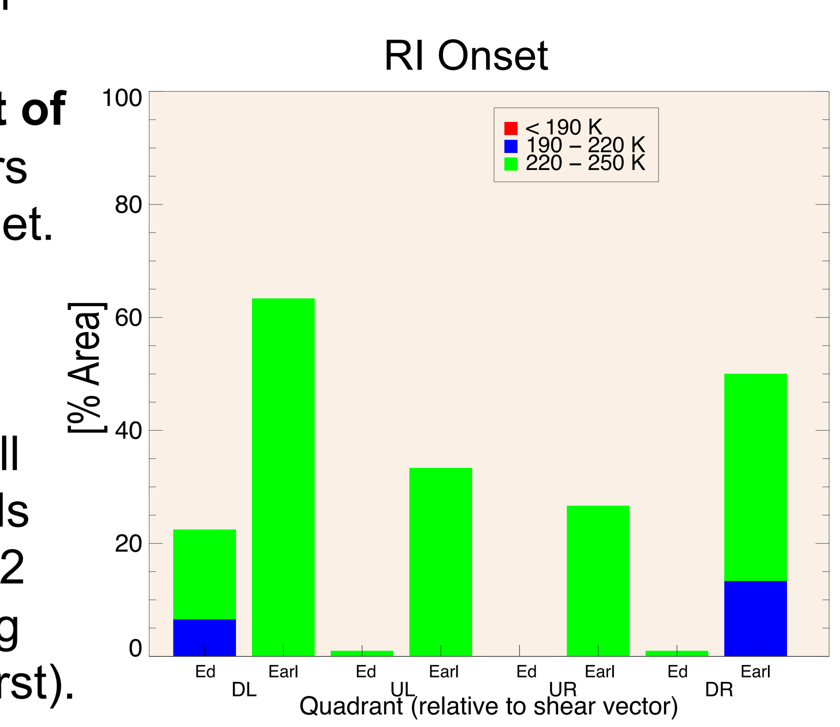
Comparison of Earl (2010) and Edouard (2014).

Both storms exhibit a similar inner core evolution during pre-RI and onset.

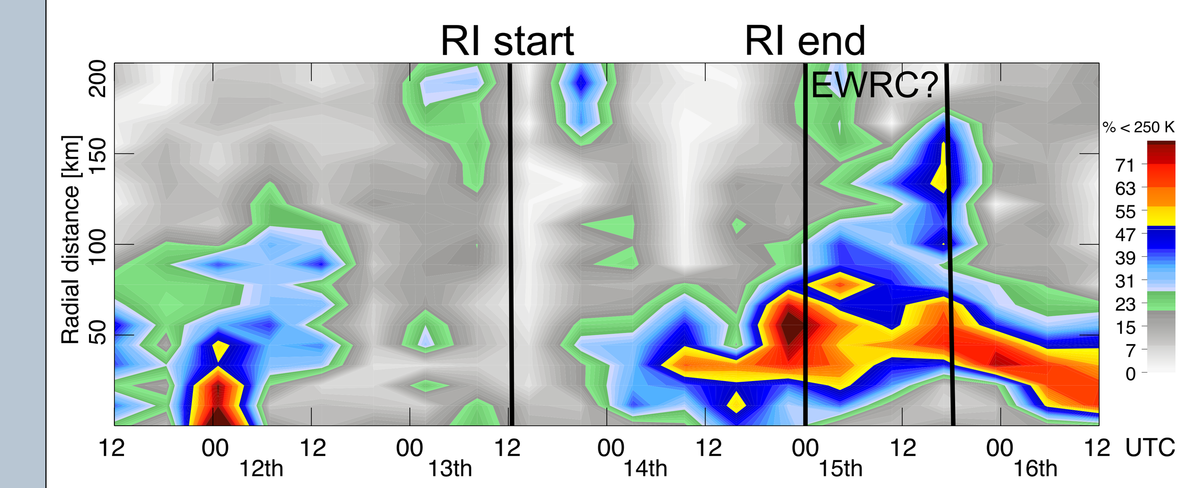


CBs with a relatively **high occurrence** of **ALL PCT** thresholds **left of shear** 12 hours prior to RI onset.

Both storms feature a **decrease** in all PCT thresholds at **RI onset** (12 hours following convective burst).



Previous studies have speculated upon the importance of CBs in vortex alignment for Earl (2010) *Rogers et al. 2015, Stevenson et al. 2014*. A similar evolution may have also occurred in Edouard (2014).



Radial occurrence of PCT < 250K for Edouard (2014). Frequency of **inner core precipitation** noticeably **increases** on the 14th during **rapid intensification**.

IV. Conclusions

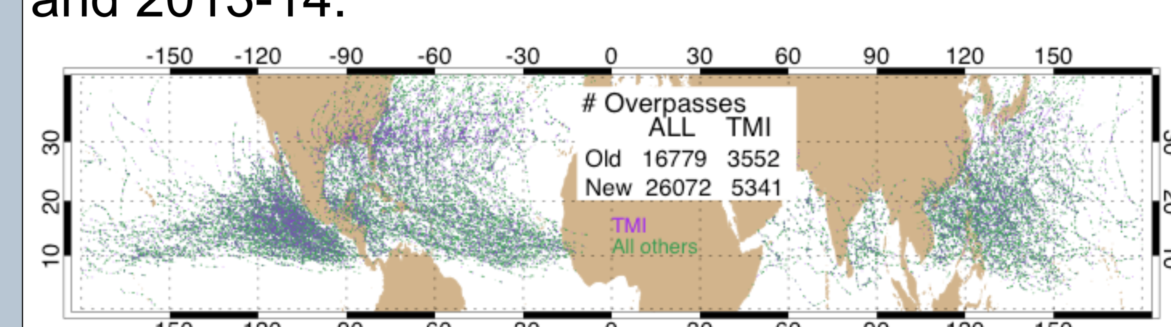
The occurrence of inner core precipitation prior to, during, and following the onset ("0 hour") not only increases with intensification rate in all quadrants, but also the **symmetry** (measured by the occurrence in the upshear quadrants) **distinguishes those that undergo RI** (greater symmetry) versus those with slower intensification rates (less symmetry).

As intensification rates increase, the occurrence of "strong" convection (proxy using 85–91-GHz PCT < 190 K) noticeably increases.

The increased precipitation occurrence in the upshear quadrants of RI storms leads to a more symmetric distribution of precipitation initially than SI storms, and reiterates the importance of shear-oriented quadrant-based analyses.

V. Future Work

TC-PMW expanded to Central Pacific, Western Pacific, Indian Ocean, Southern Hemisphere, and 2013-14.



Examine precipitation sensitivity to environmental changes. Analyze outlier cases (i.e. RI with high vertical wind shear, etc.) and Category 3-5 storms with the larger dataset.

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Contact: George Alvey g.alvey@utah.edu