Understanding intensity changes signaled by tropical cyclone lightning

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Motivation

DeMaria et al. 2012

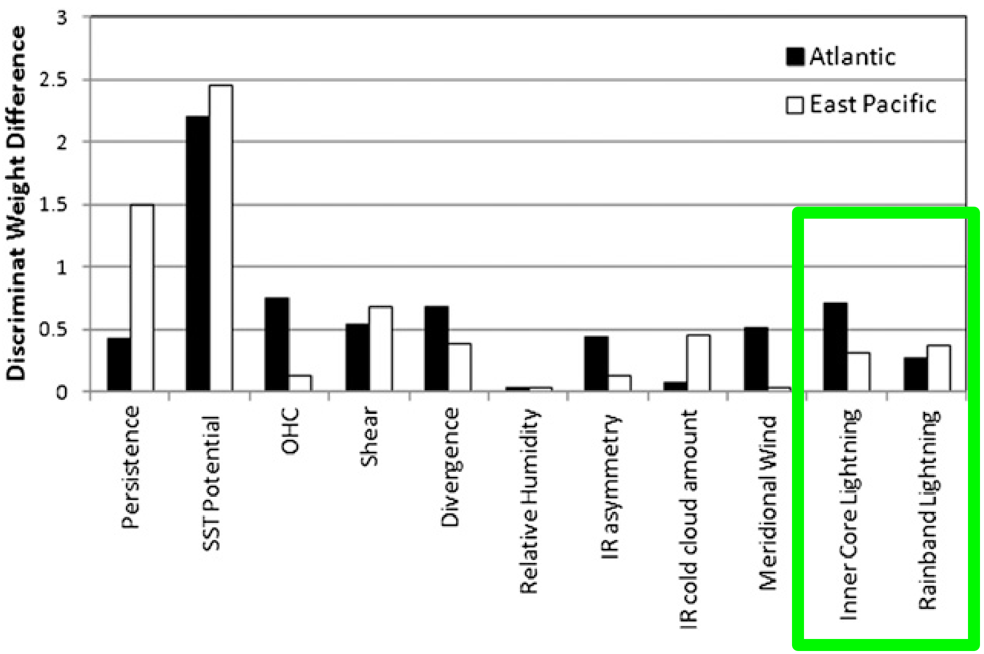
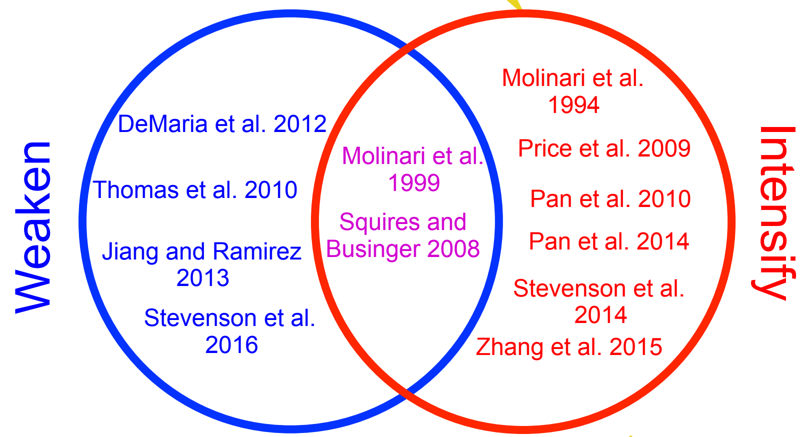
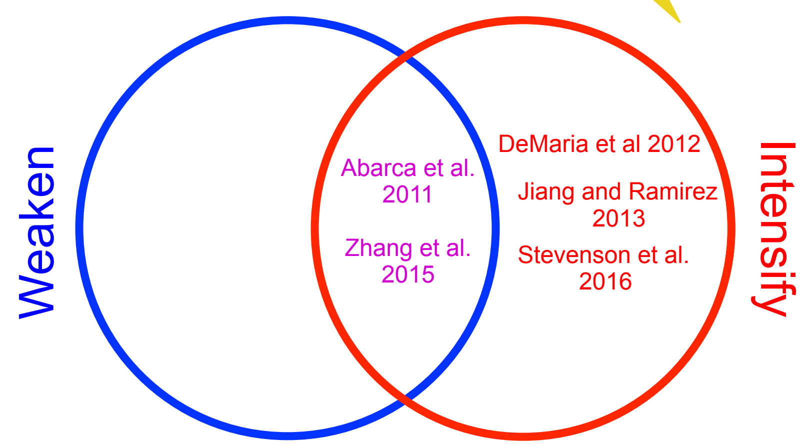


FIG. 9. The magnitude of the difference between the normalized discriminant weights for the RI and RW cases for the Atlantic and east Pacific samples.

- Inner core



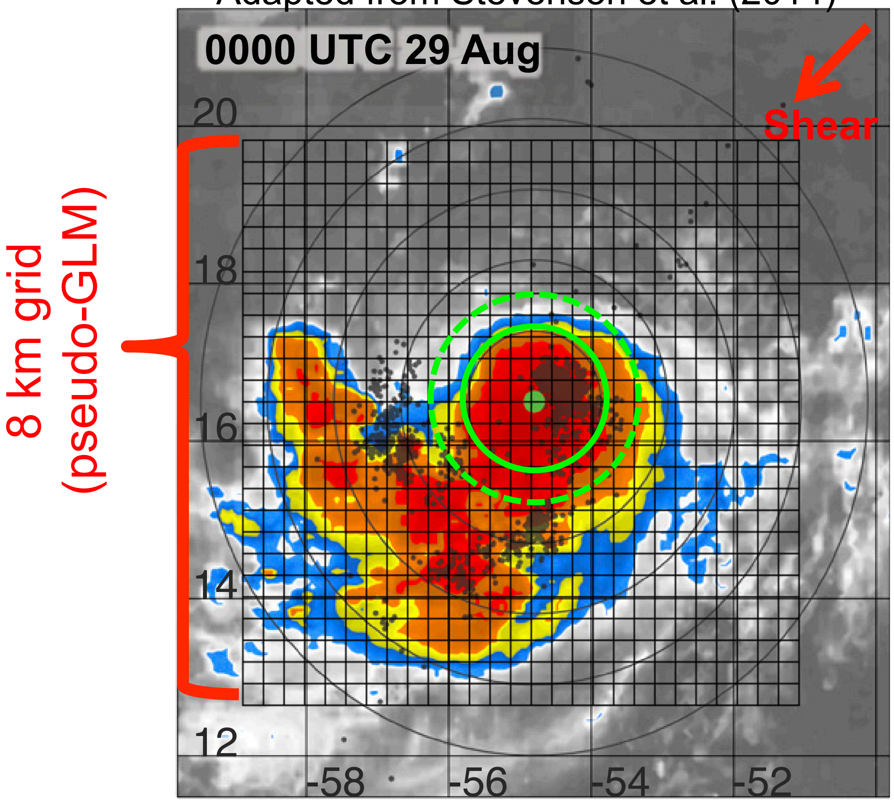
- Outer rainband



Inner core approach

- Identify concentrated "bursts" of lightning using WWLLN (2005–2014)

Adapted from Stevenson et al. (2014)



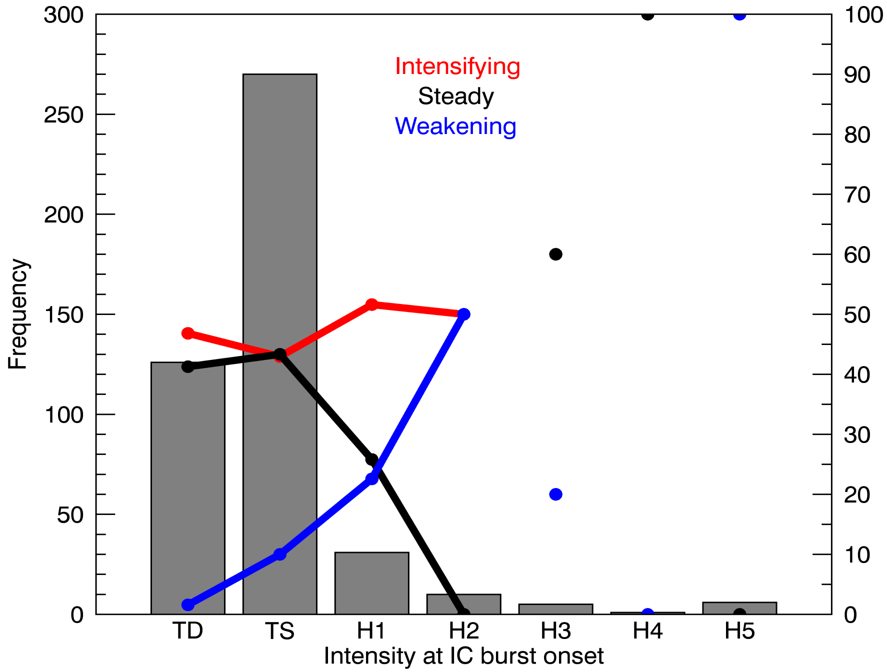
TDTSH1H2 inner core ≤ 150 km

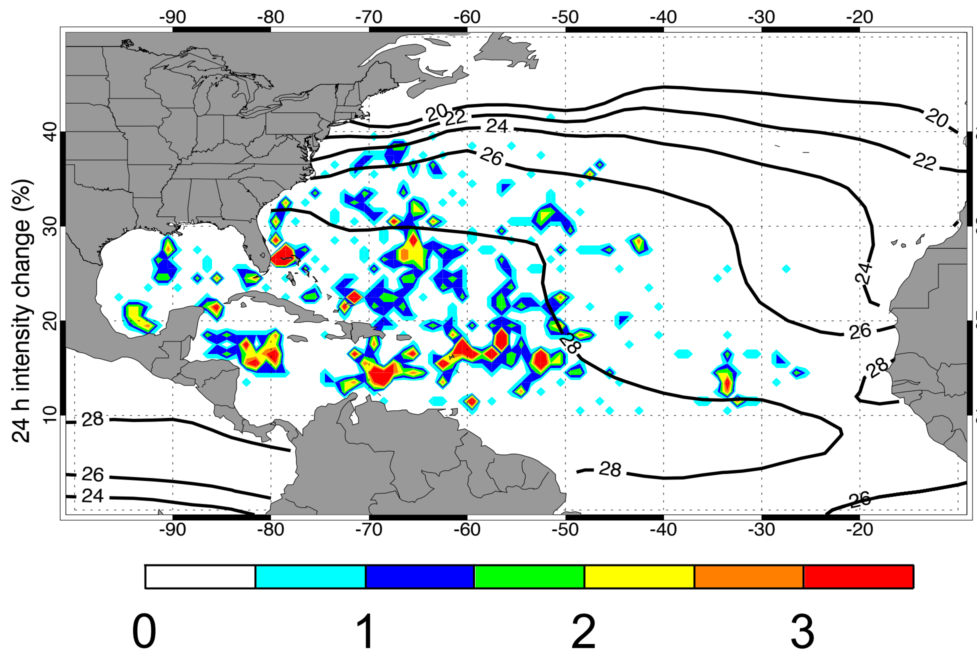
H3H4H5 inner core ≤ 100 km

- Max 8 km x 8 km lightning flash density must fall in upper quartile
- Average lightning flash density in IC must fall in upper quartile

No landfall within 24 h and
no unfavorable environments included

Results

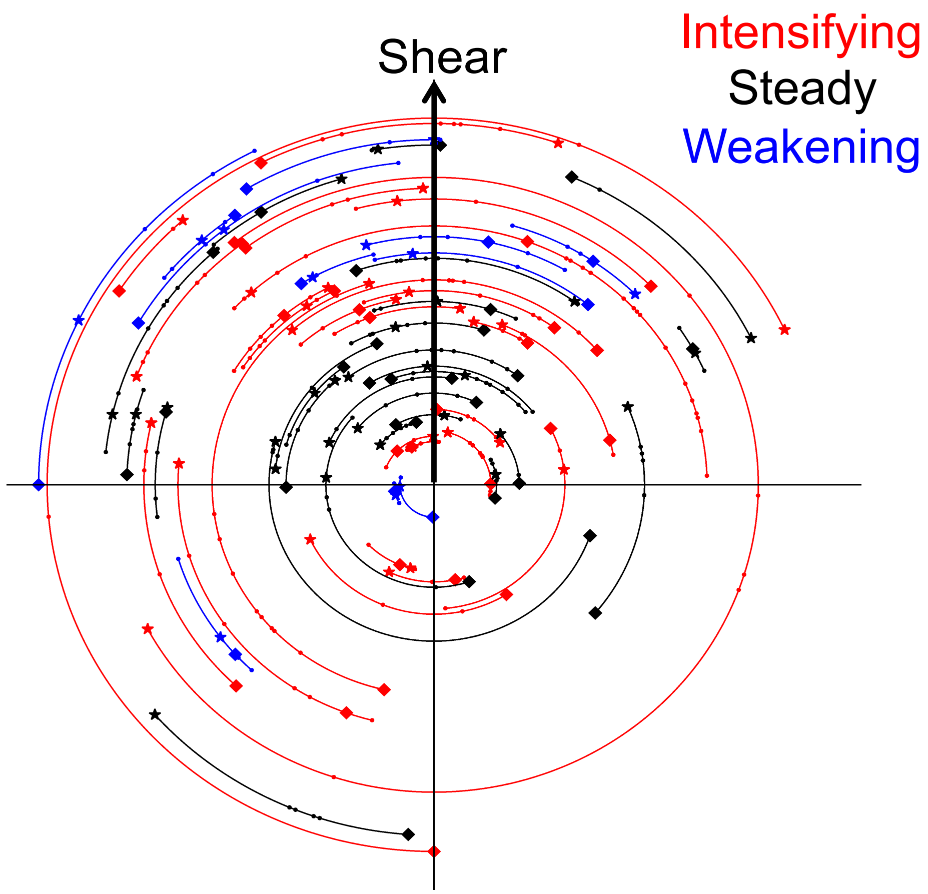




- Most IC bursts in weaker TCs (TDTS)
- More intensify 24 h after burst onset

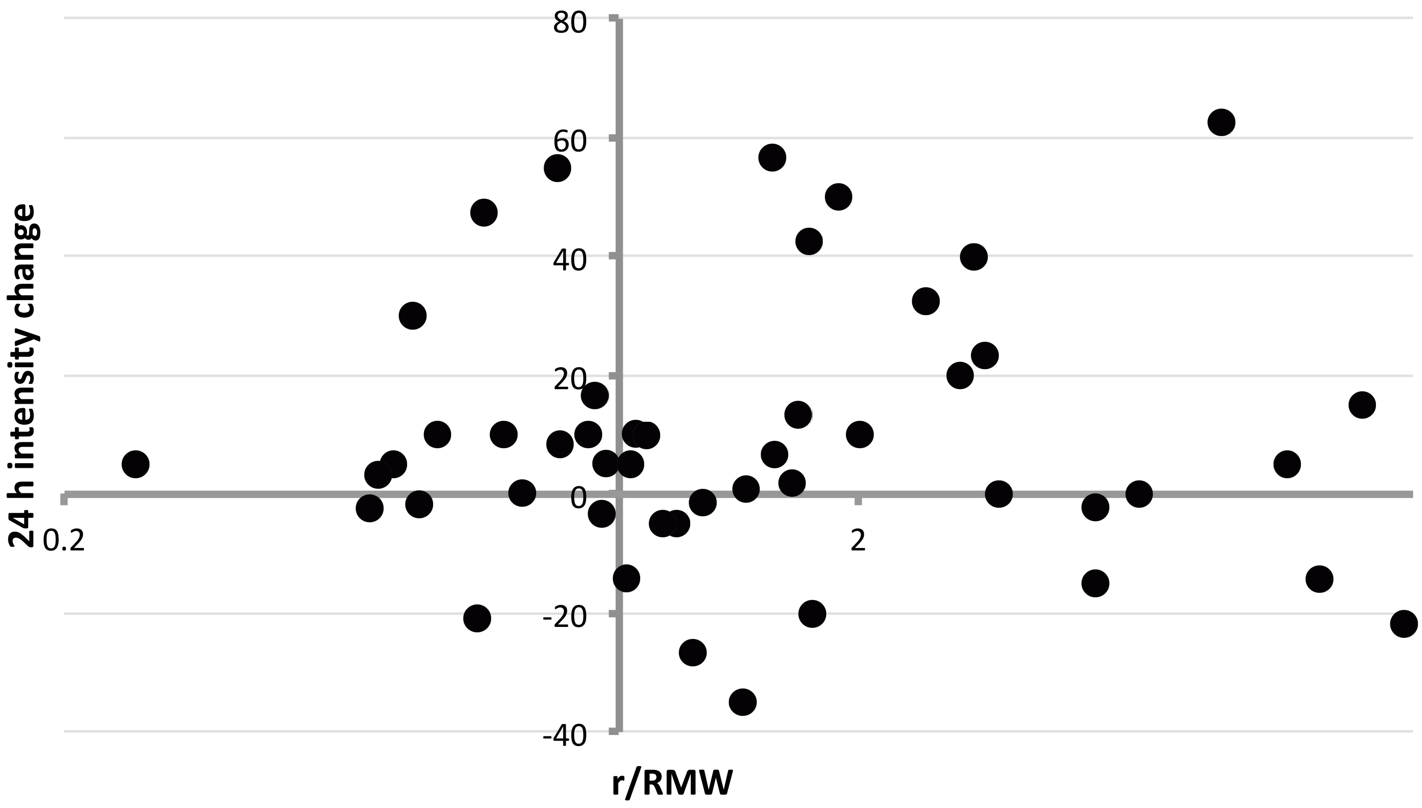
Results

- Long-lived bursts (> 4 h) that rotated upshear tend to be associated with TC intensification
  – Did not observe in E. Pac



Results

- RMW derived from FLIGHT+ dataset



Results

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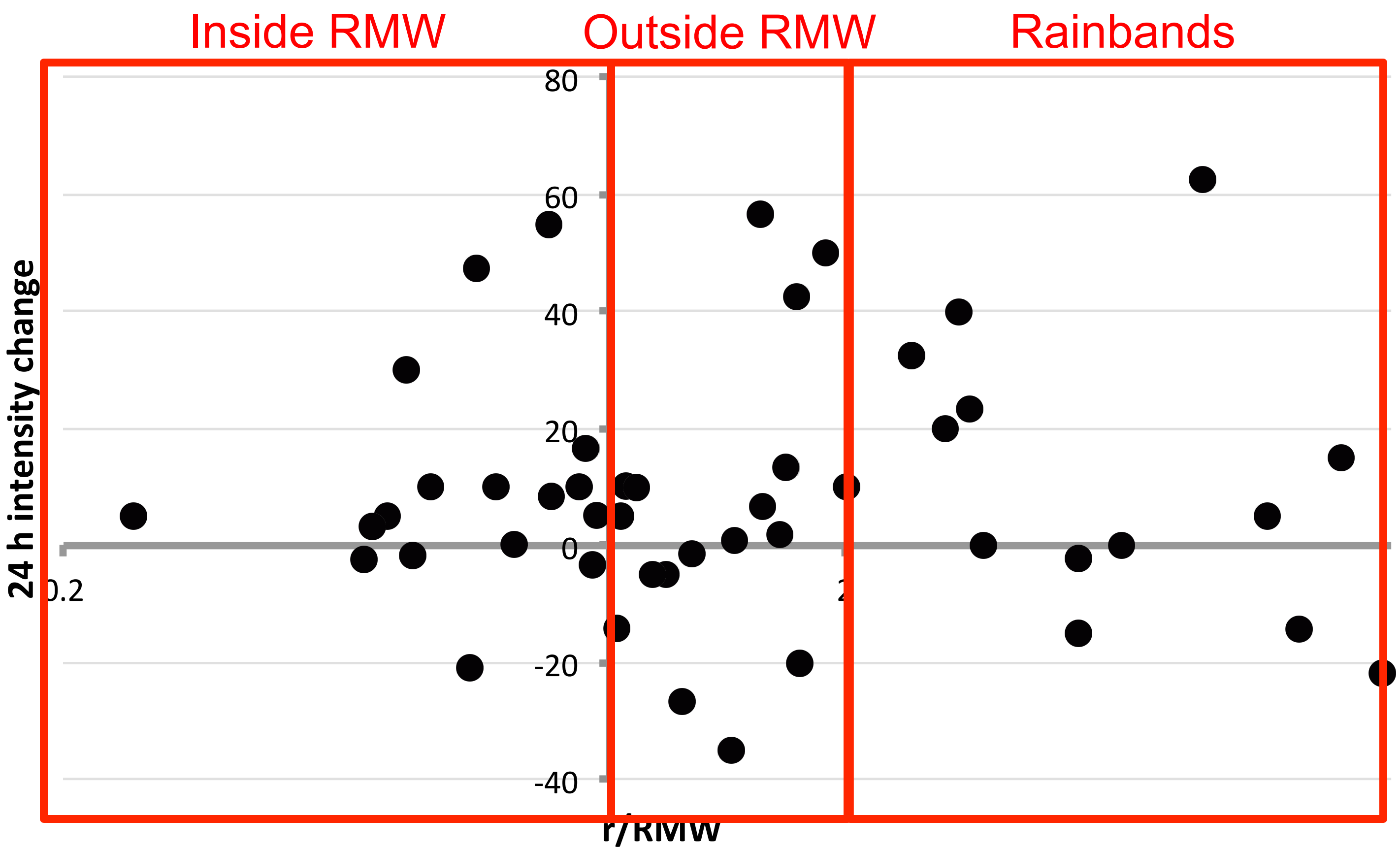
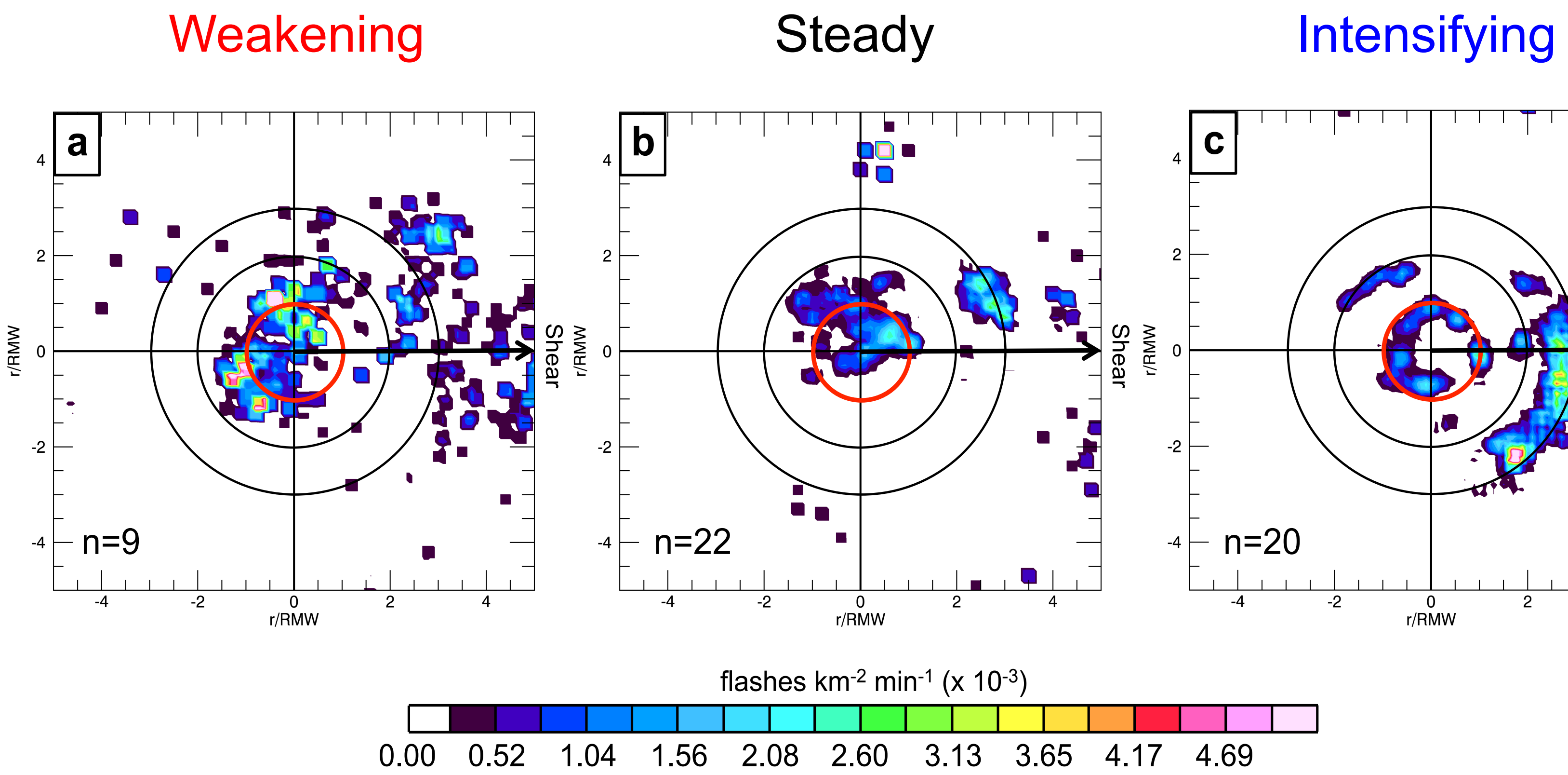


Results

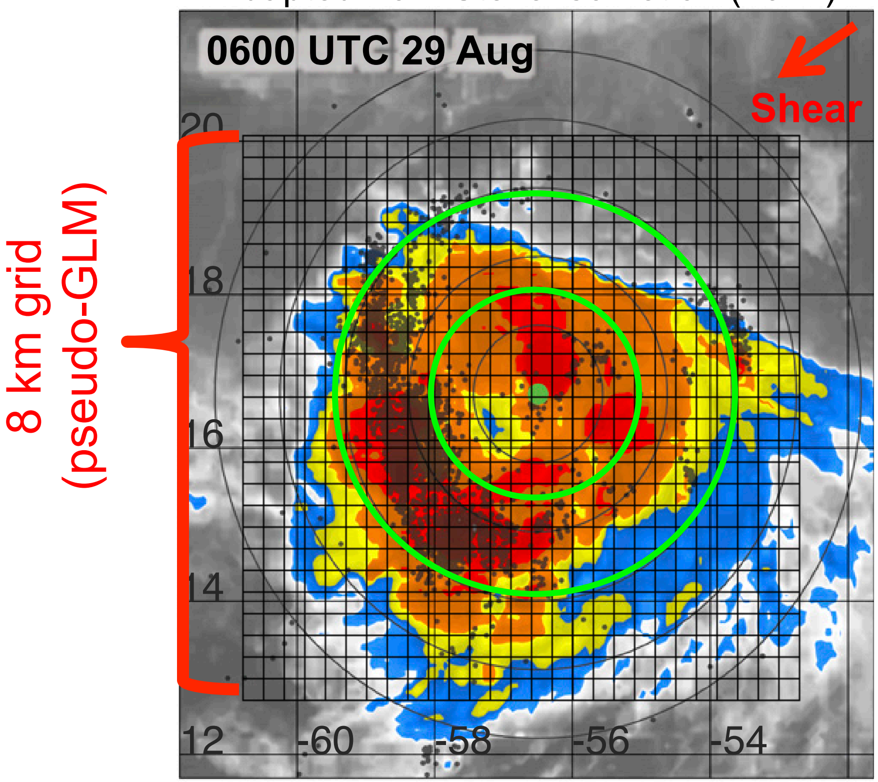


Radial rings at RMW, 2x RMW, 3x RMW

Outer rainband approach

- Identify azimuthally extensive active outer rainband lightning (2005–2014)

Adapted from Stevenson et al. (2014)

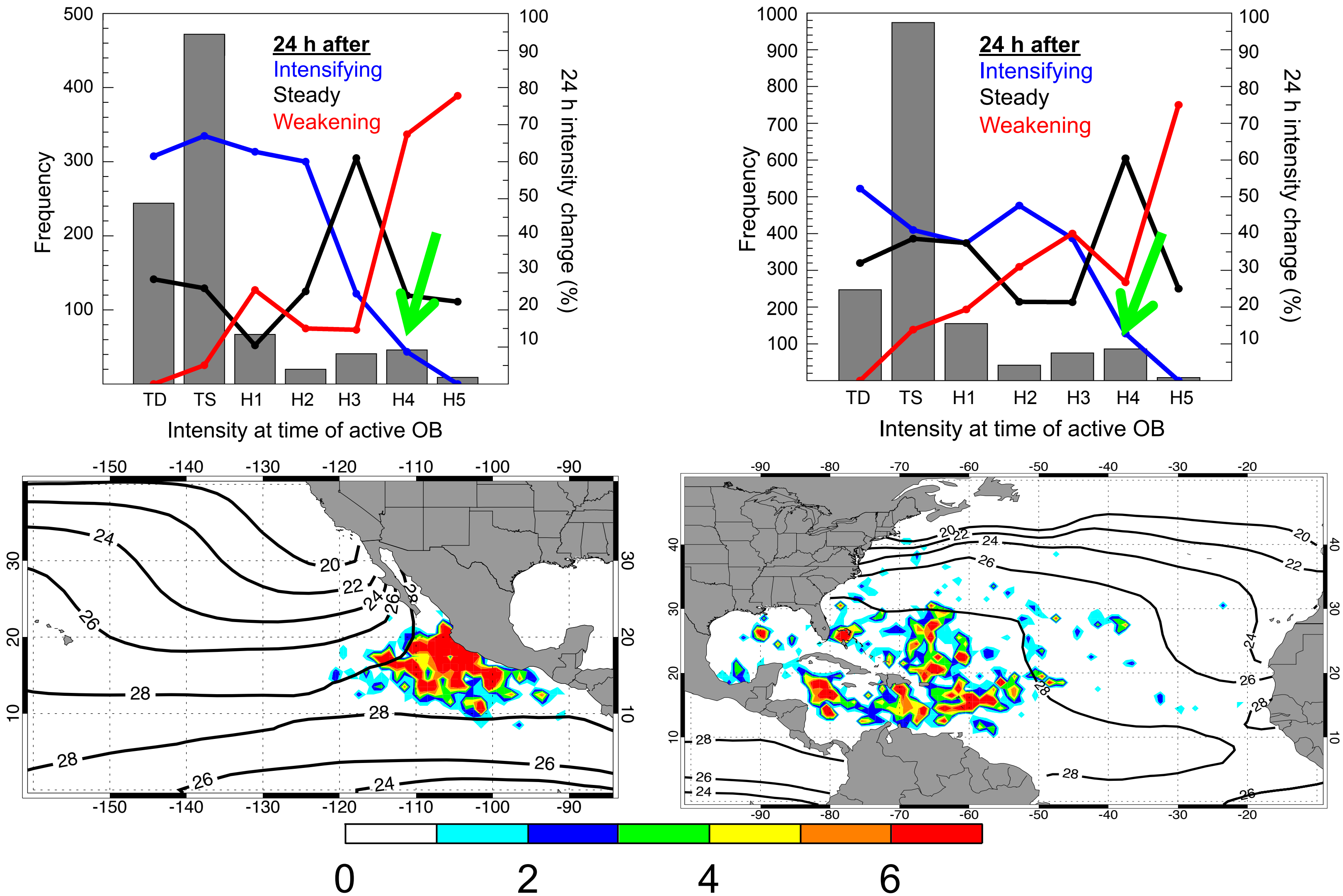


150 km ≤ Outer rainbands ≤ 300 km

- Max 8 km x 8 km lightning flash density must fall in upper quartile
- Number of grid boxes meeting above threshold must also fall in upper quartile

No landfall within 24 h

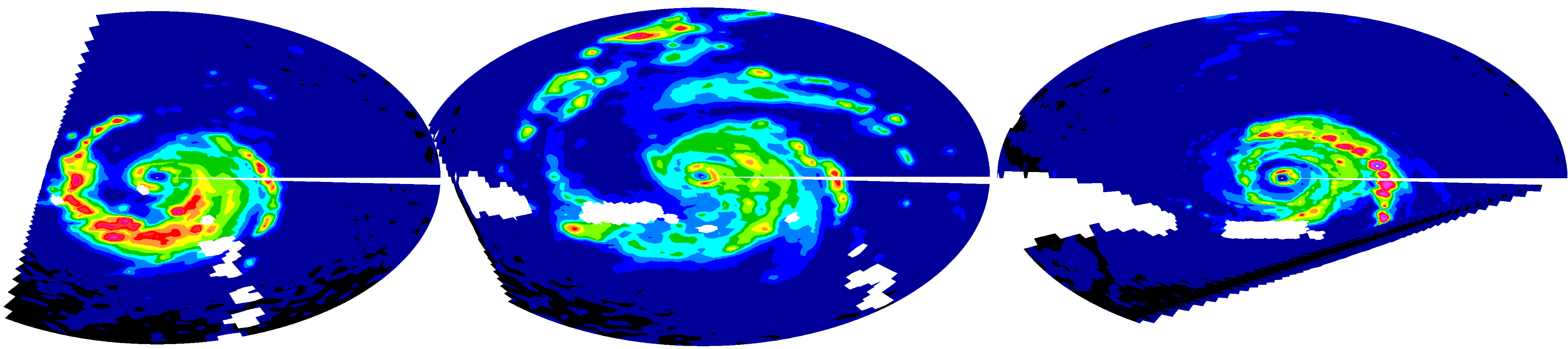
Results



24 h after
Intensifying
Steady
Weakening
Frequency
24 h intensity change (%)
TD
TS
H1
H2
H3
H4
H5
Intensity at time of active OB
0
2
4
6

Results

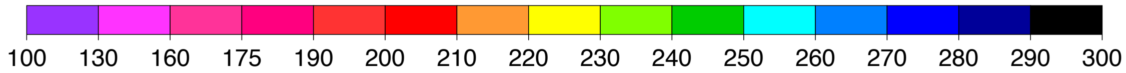
- 85 GHz calibrated microwave imagery
  - Data courtesy of Chris Rozoff



SSMIS
30 Aug 2010
1049 UTC

SSMI
30 Aug 2010
2107 UTC

TMI
31 Aug 2010
0438 UTC



Results

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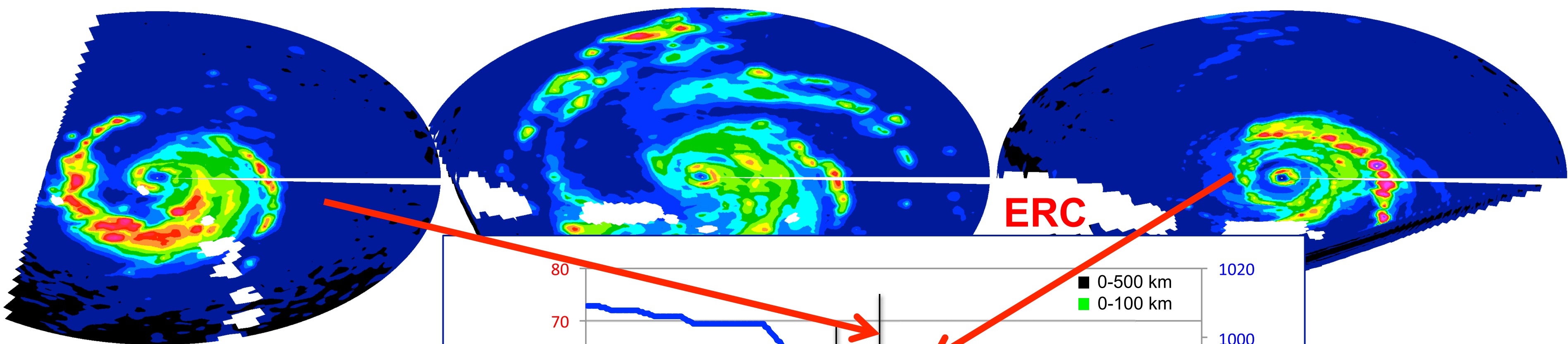
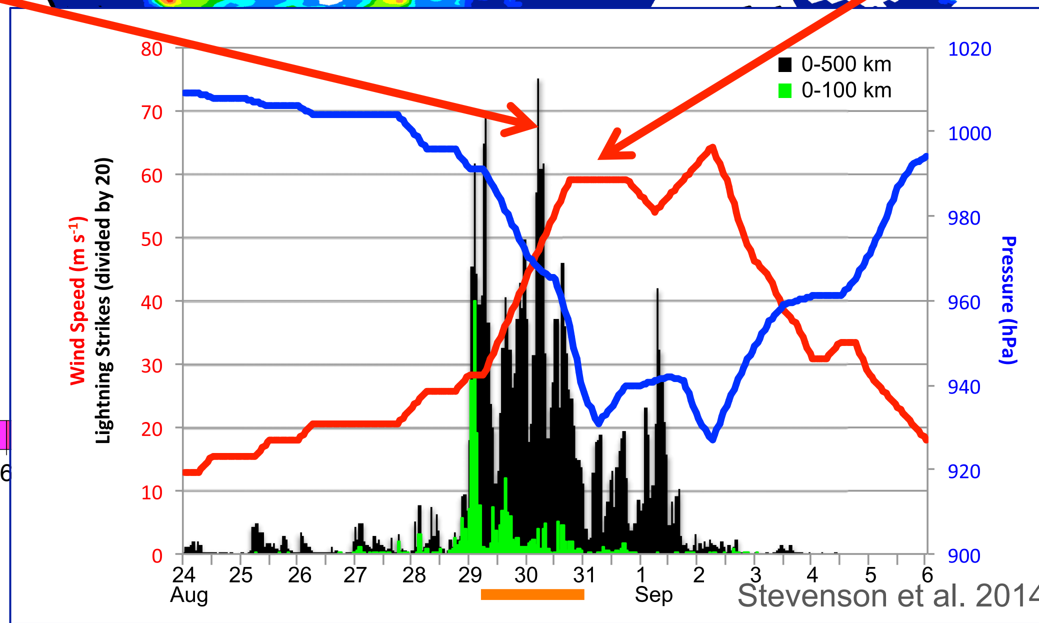


SSMIS
30 Aug 2010
1049 UTC

MI
g 2010
UTC



Stevenson et al. 2014

Results

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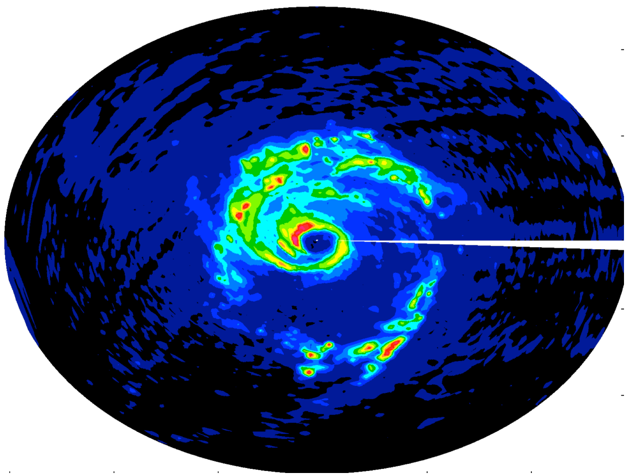
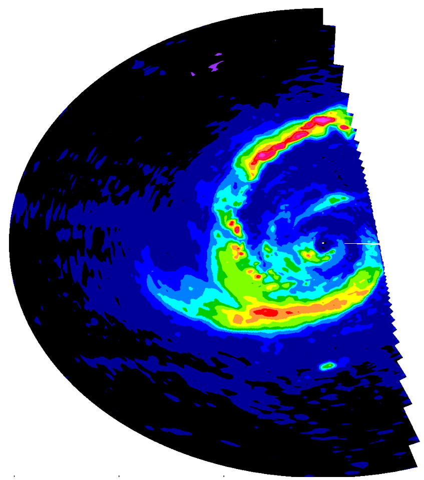
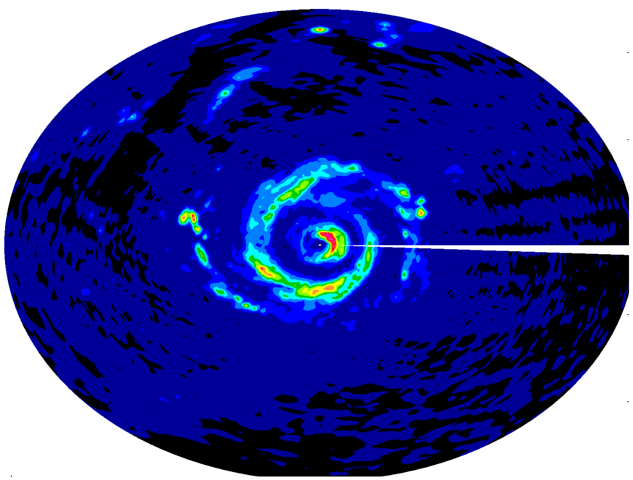


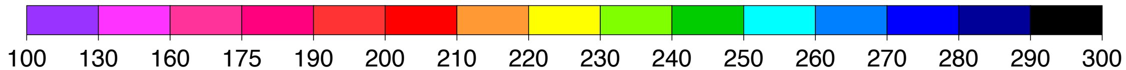
AMSR2
15 Sep 2014
1646 UTC



AMSR2
16 Sep 2014
1730 UTC

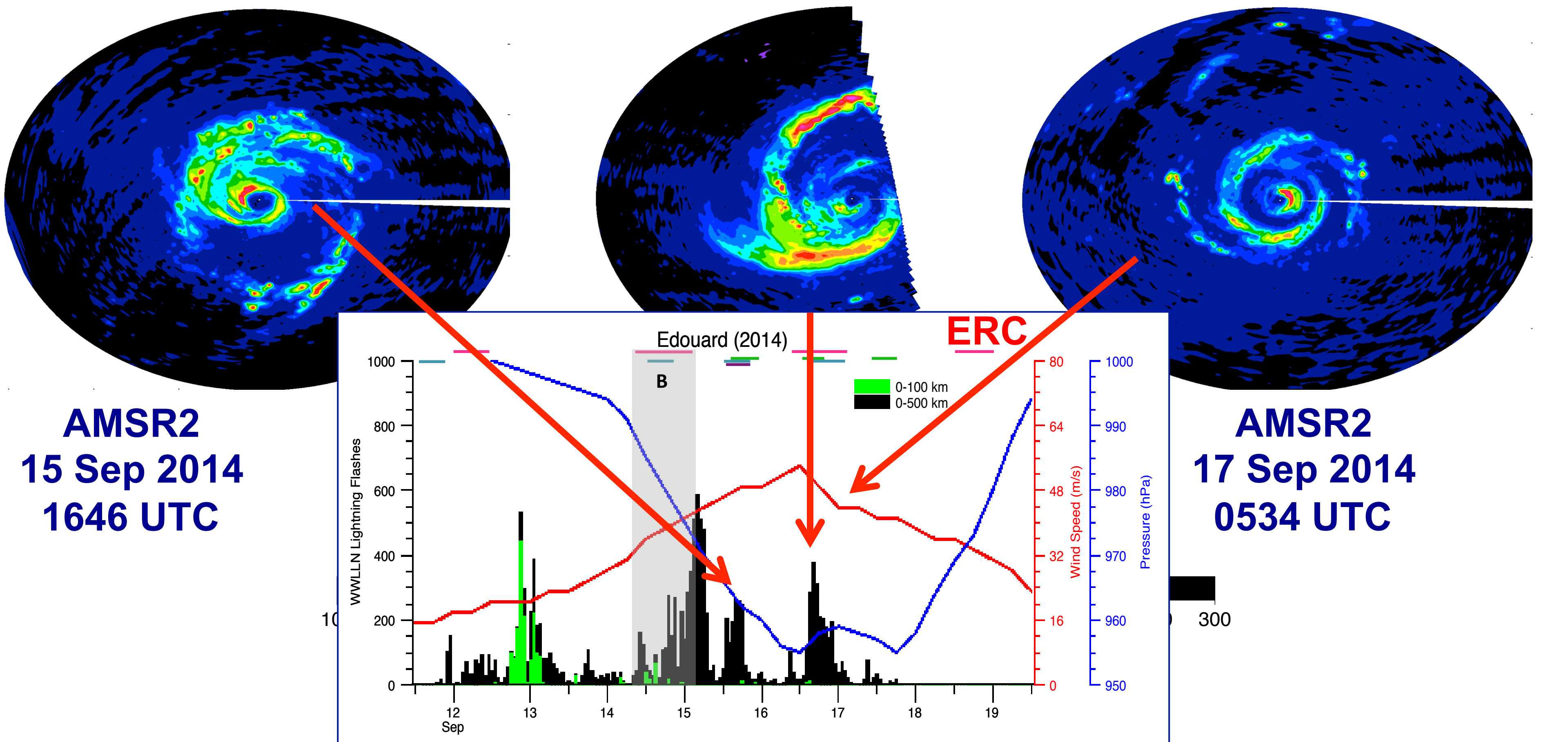


AMSR2
17 Sep 2014
0534 UTC



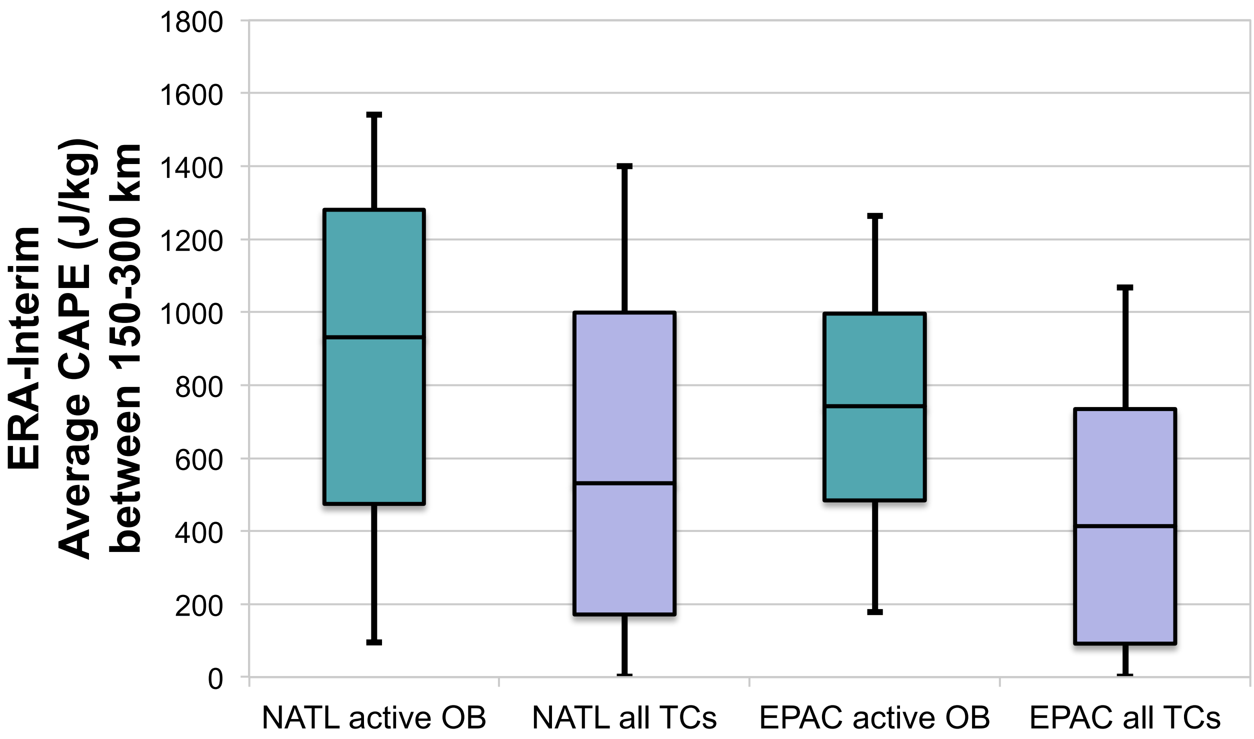
Results

- 85 GHz calibrated microwave imagery
  - Data courtesy of Chris Rozoff



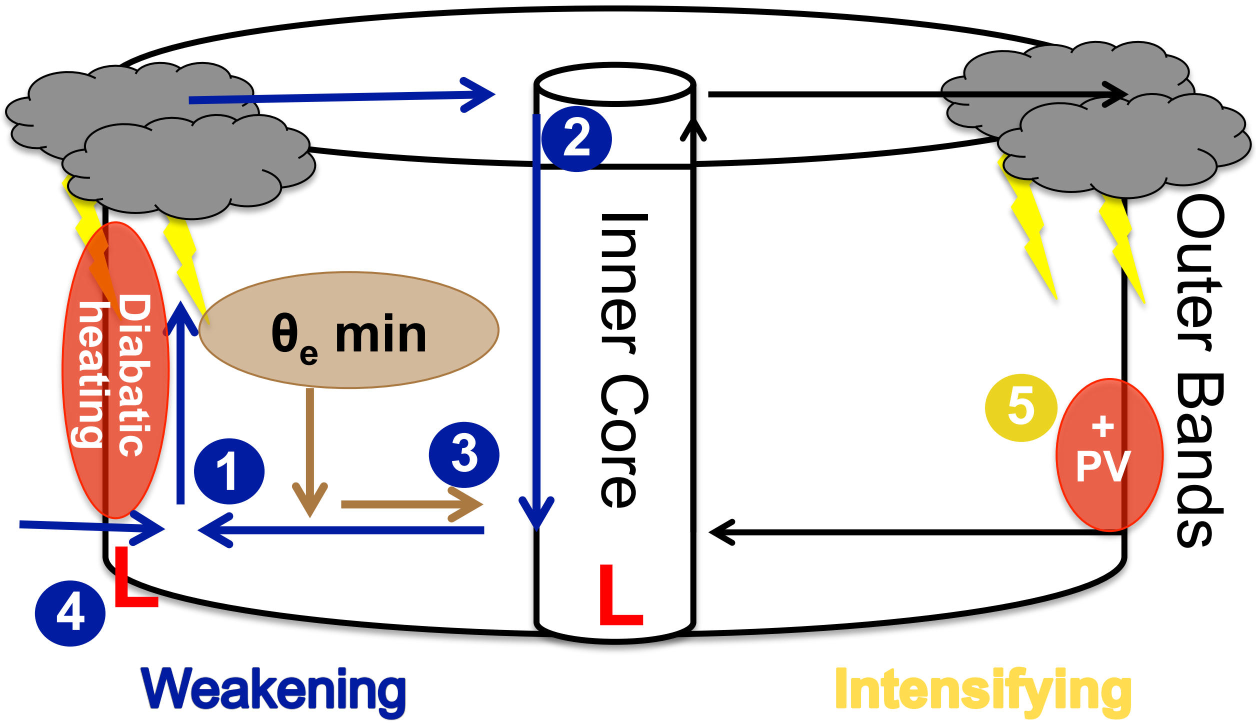
Results

- DeMaria et al. (2012) suggested OB lightning was a measure of convective instability of the storm environment



Motivation

- Others (e.g., Wang 2009) suggest strong convection in OB can have many negative impacts on TC intensity



1. Reduce radial inflow
2. Compensating subsidence
3. Flush low-θ_e air into the boundary layer inflow
4. Hydrostatic pressure reduction
5. Act as a source of PV

Current work

Earl (2010)

29 Aug 2010 2000–2300 UTC

Karl (2010)

16 Sep 2010 2100–0000 UTC