Improved Eyewall Replacement Cycle Forecasting Using ARCHER - a Modified Microwave-Based Algorithm

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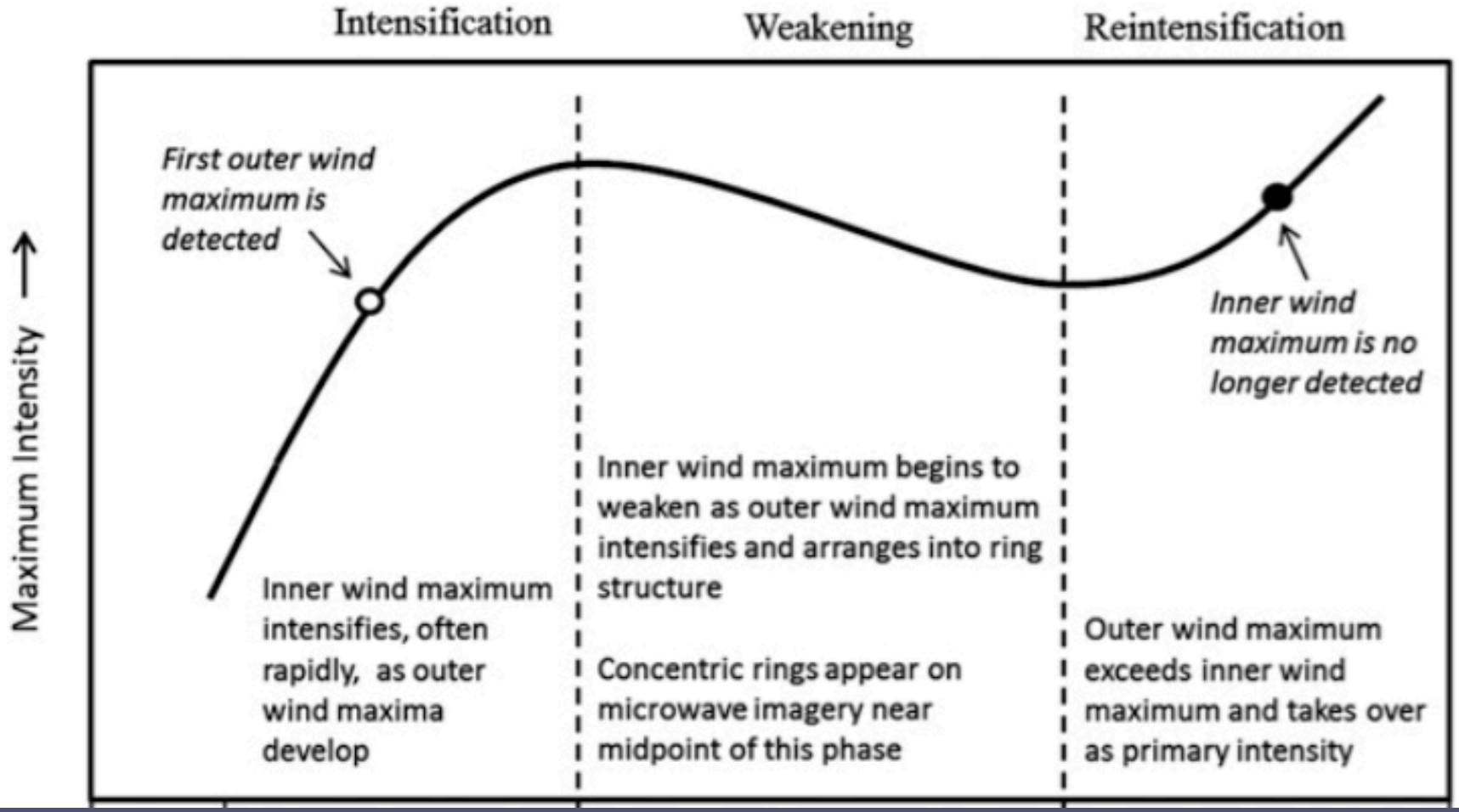
Sponsored by the NOAA Joint Hurricane Testbed

Motivation



Schematic of an eyewall replacement cycle.
Sitkowski et al 2011 Fig 8

Sitkowski, M., J. P. Kossin, and C. M. Rozoff, 2011: Intensity and structure changes during hurricane eyewall replacement cycles. *Mon. Wea. Rev.*, **139**, 3829-3847.

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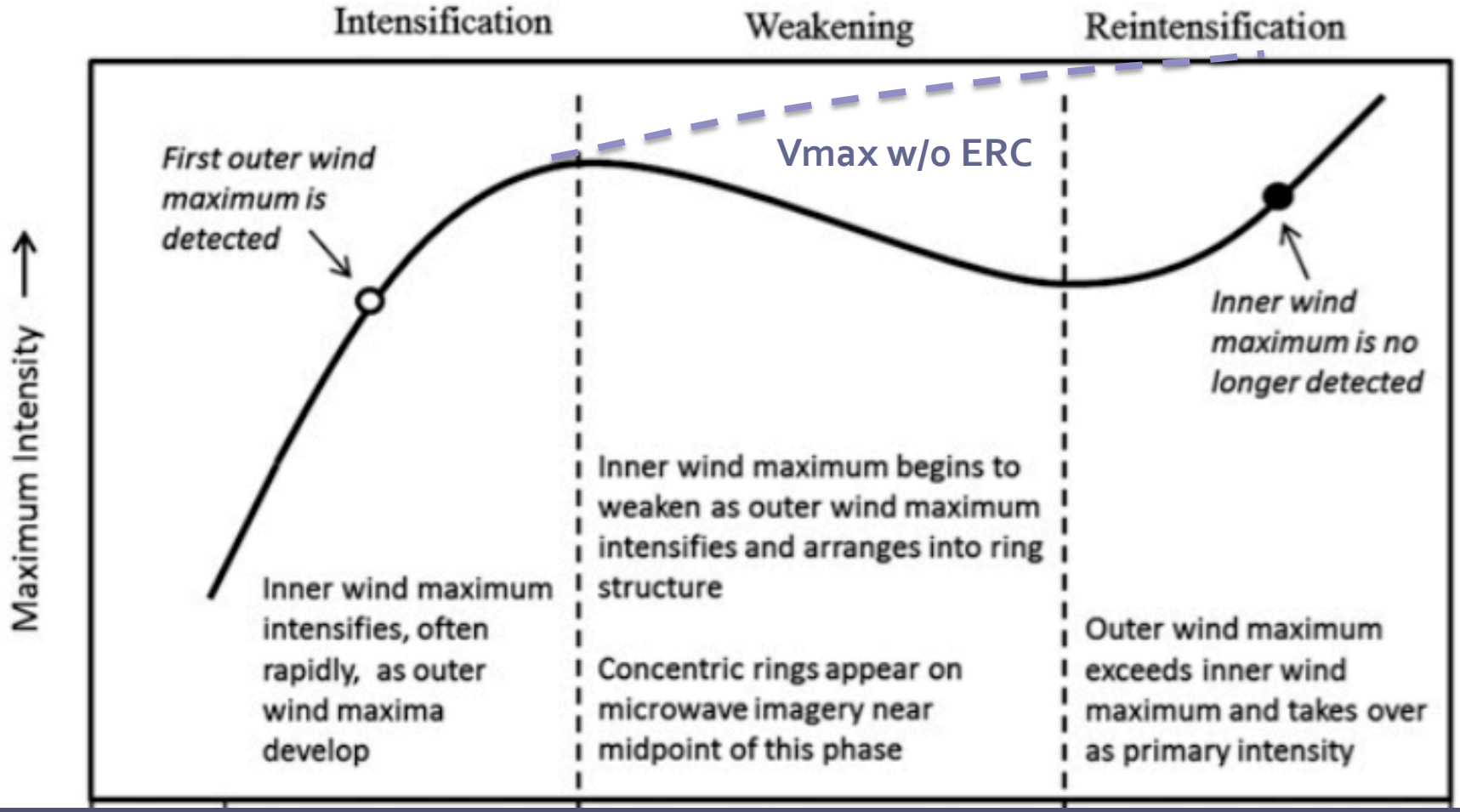

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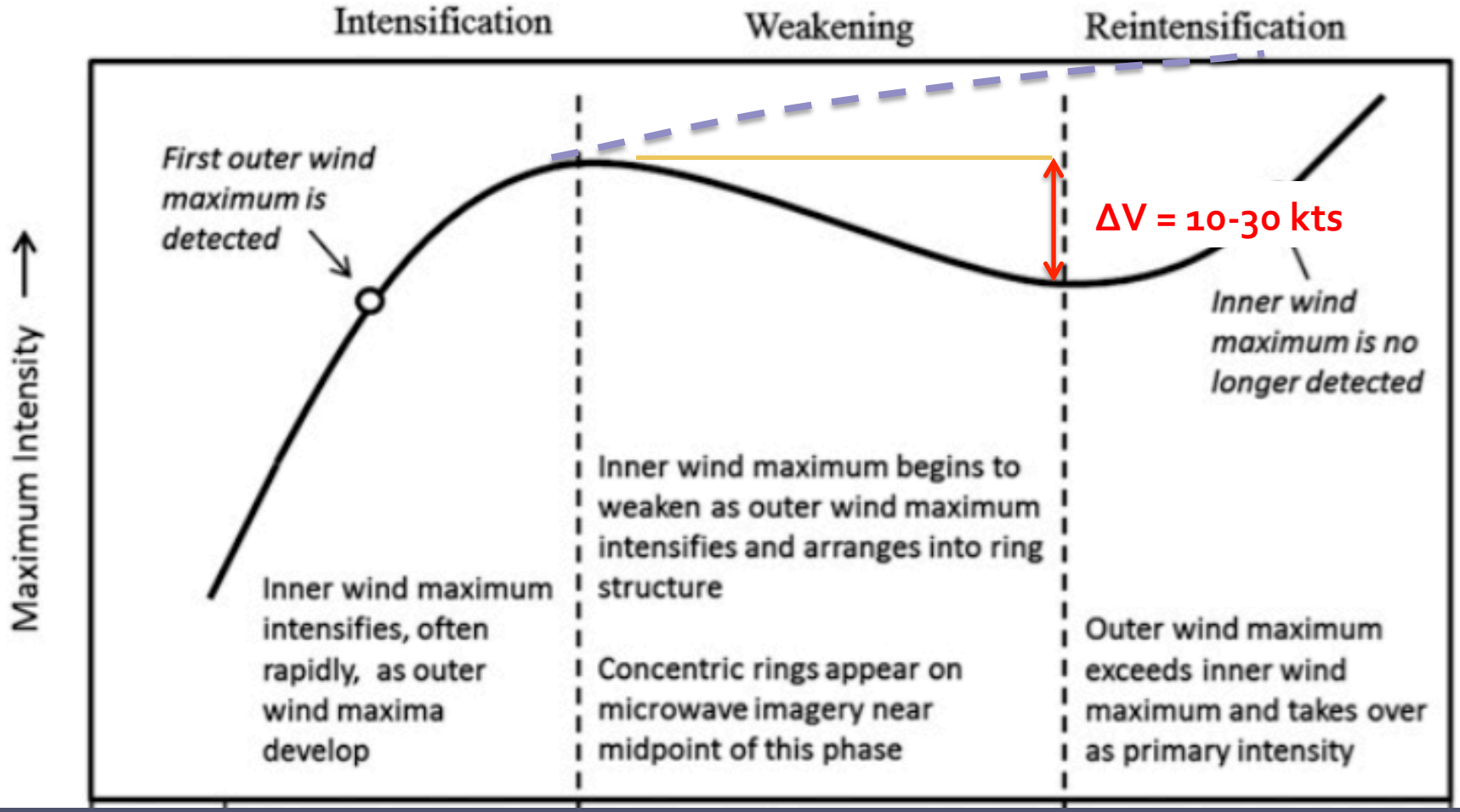

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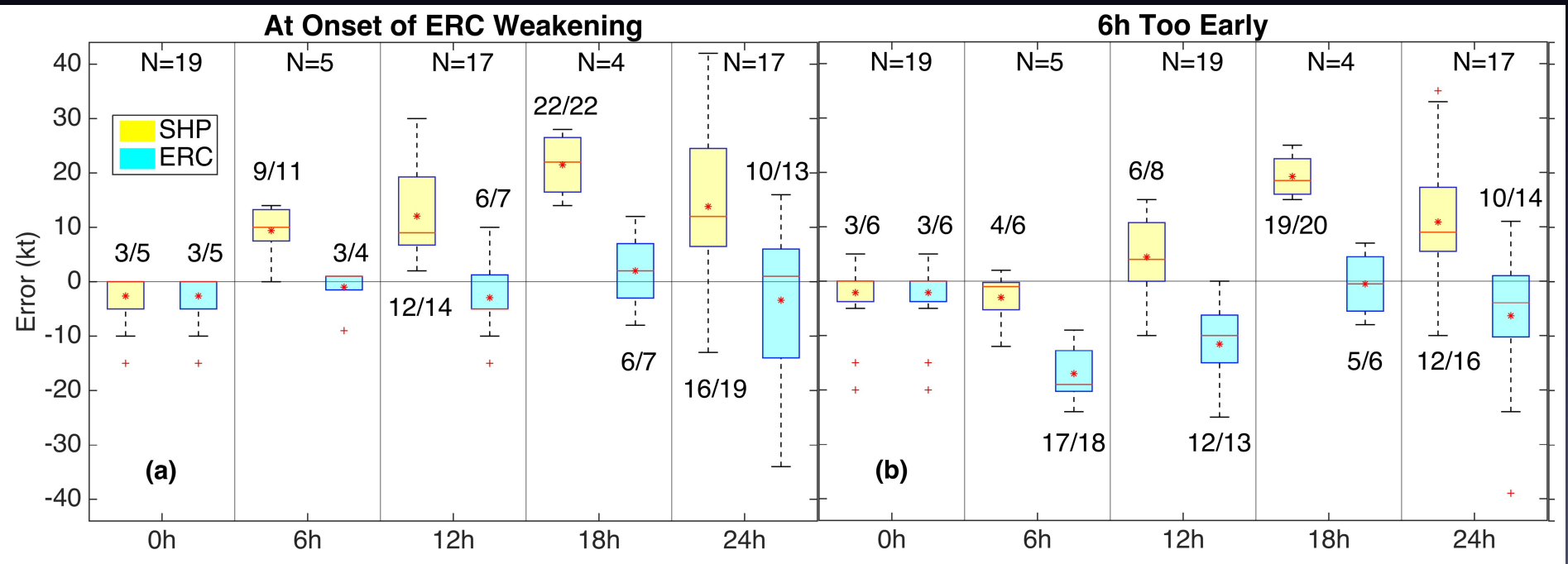
Background:

'E-SHIPS' model (J. Kossin and M. DeMaria)

- Forecast guidance tool (complement to SHIPS) to correct for SHIPS intensity during ERC.
- Currently transitioning to NHC operations.
- *Requires outside knowledge of the timing of the actual ERC*



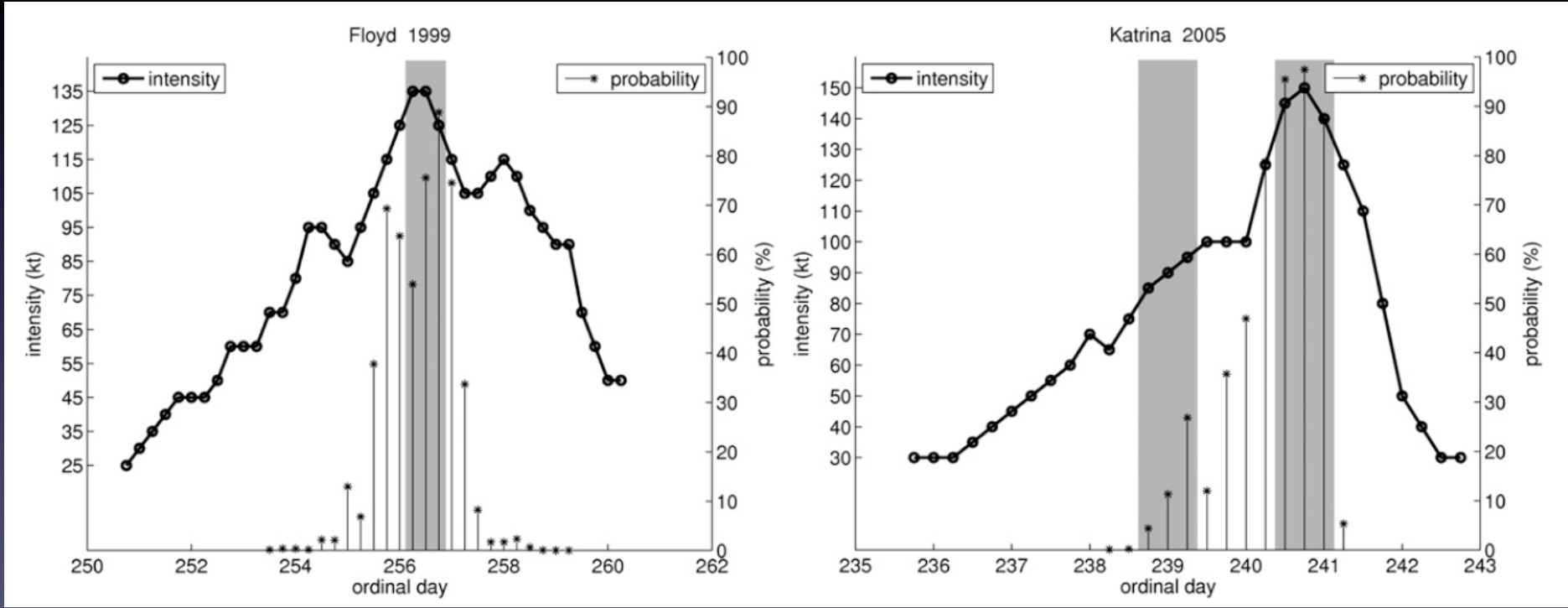
SHIPS (SHP) versus E-SHIPS (ERC) Intensity Errors

Kossin, J. P., and M. DeMaria, 2016: Reducing operational hurricane intensity forecast errors during eyewall replacement cycles. *Wea. Forecasting*, in press.

Background:

'pERC' model (J. Kossin and M. Sitkowski)

- Predicts the probability of a secondary eyewall formation using environmental and geostationary-satellite derived quantities.
- Does not use microwave imagery



pERC performance for Floyd (1999) and Katrina (2005)

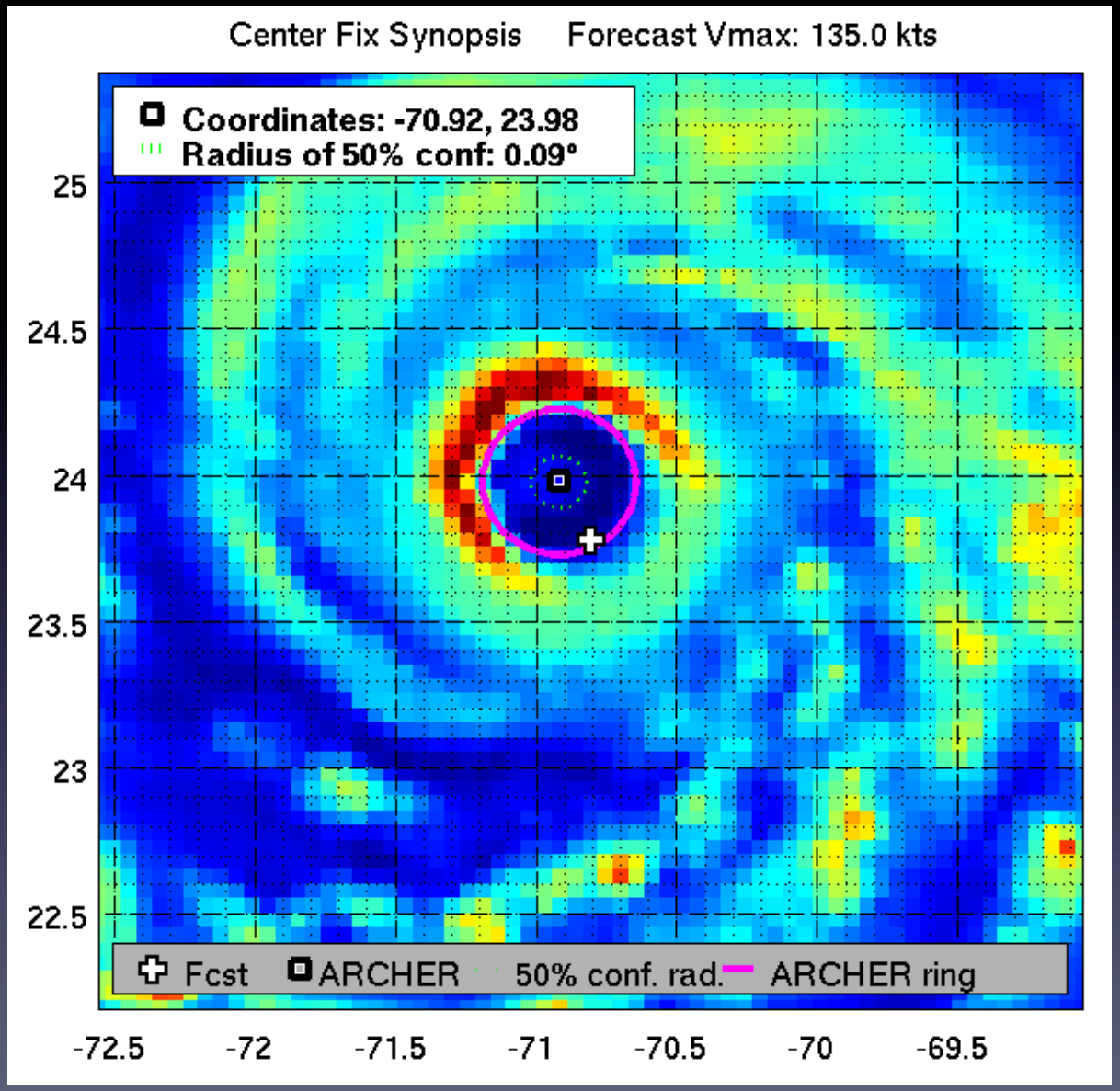
Kossin, J. P., and M. Sitkowski, 2009: An objective model for identifying secondary eyewall formation in hurricanes. *Mon. Wea. Rev.*, **137**, 876-892.

Background:

ARCHER capabilities

- Pattern matching of the primary eyewall ("ring radius")
- Generates a "ring score" that indicates the intensity of the eyewall pattern

(Example: Hurricane Floyd 1999)



Wimmers, A. J. and C. S. Velden, 2016: Advancements in Objective Multisatellite Tropical Cyclone Center Fixing. *J. Appl. Meteor. Climatol.*, **55**, 197–212.

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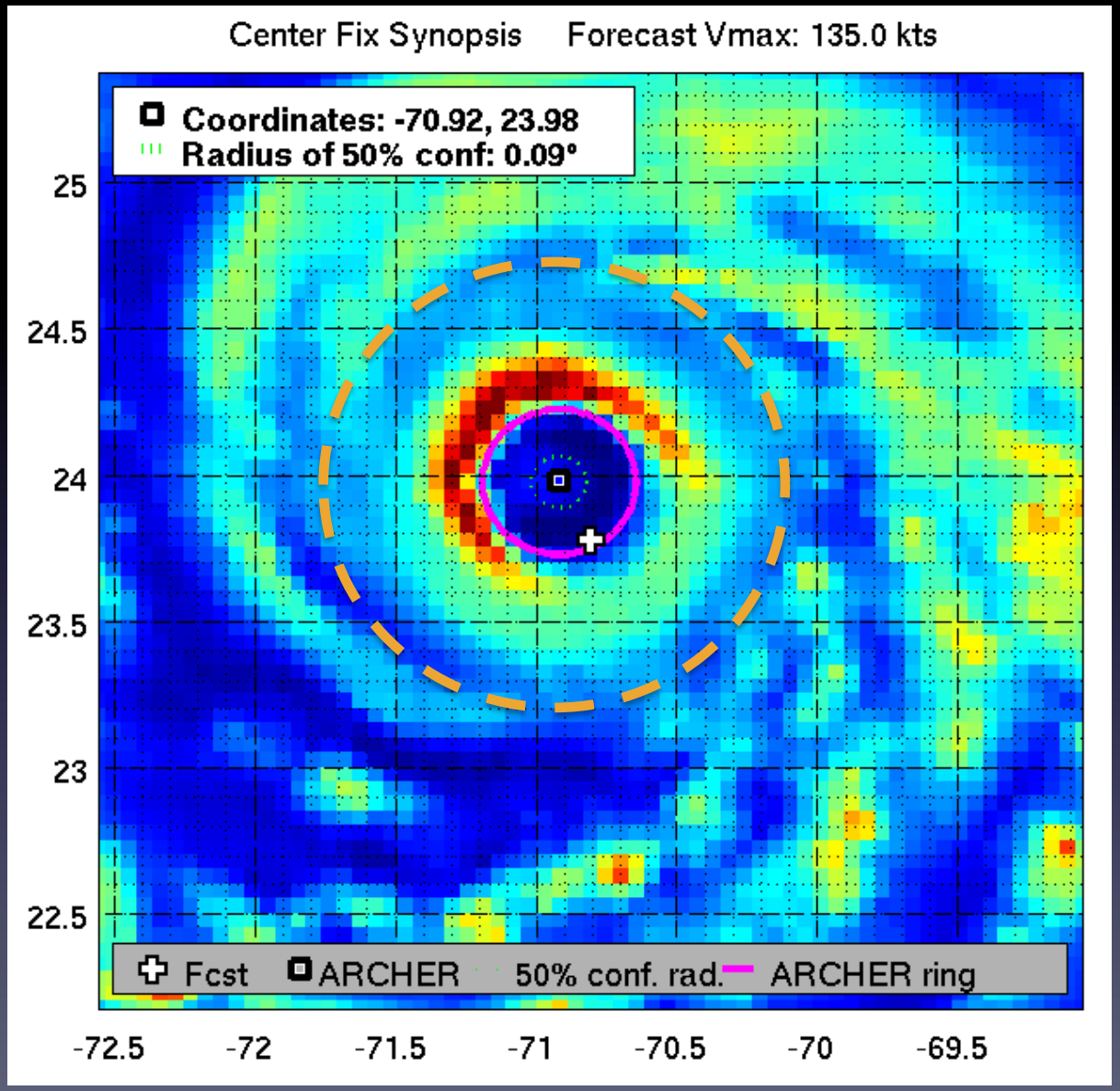

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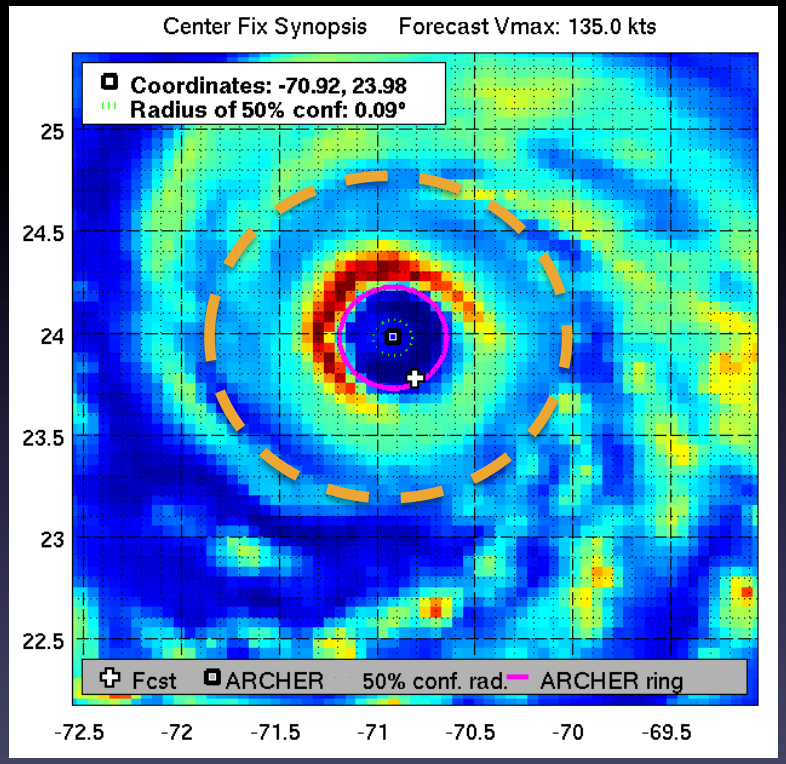
Project Summary

1. Create an automated analysis of microwave image components that relate to Eyewall Replacement Cycles using ARCHER.
2. Create a real-time display of this analysis as a forecasting aid.
3. Integrate this information into an improved ERC prediction tool.

Project Status:

1) Microwave image analysis



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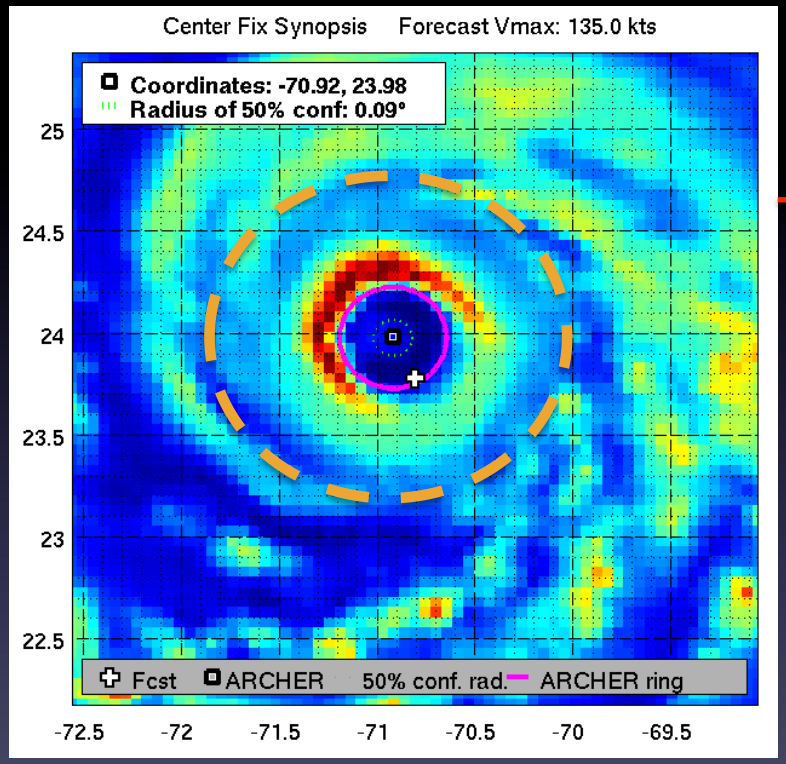

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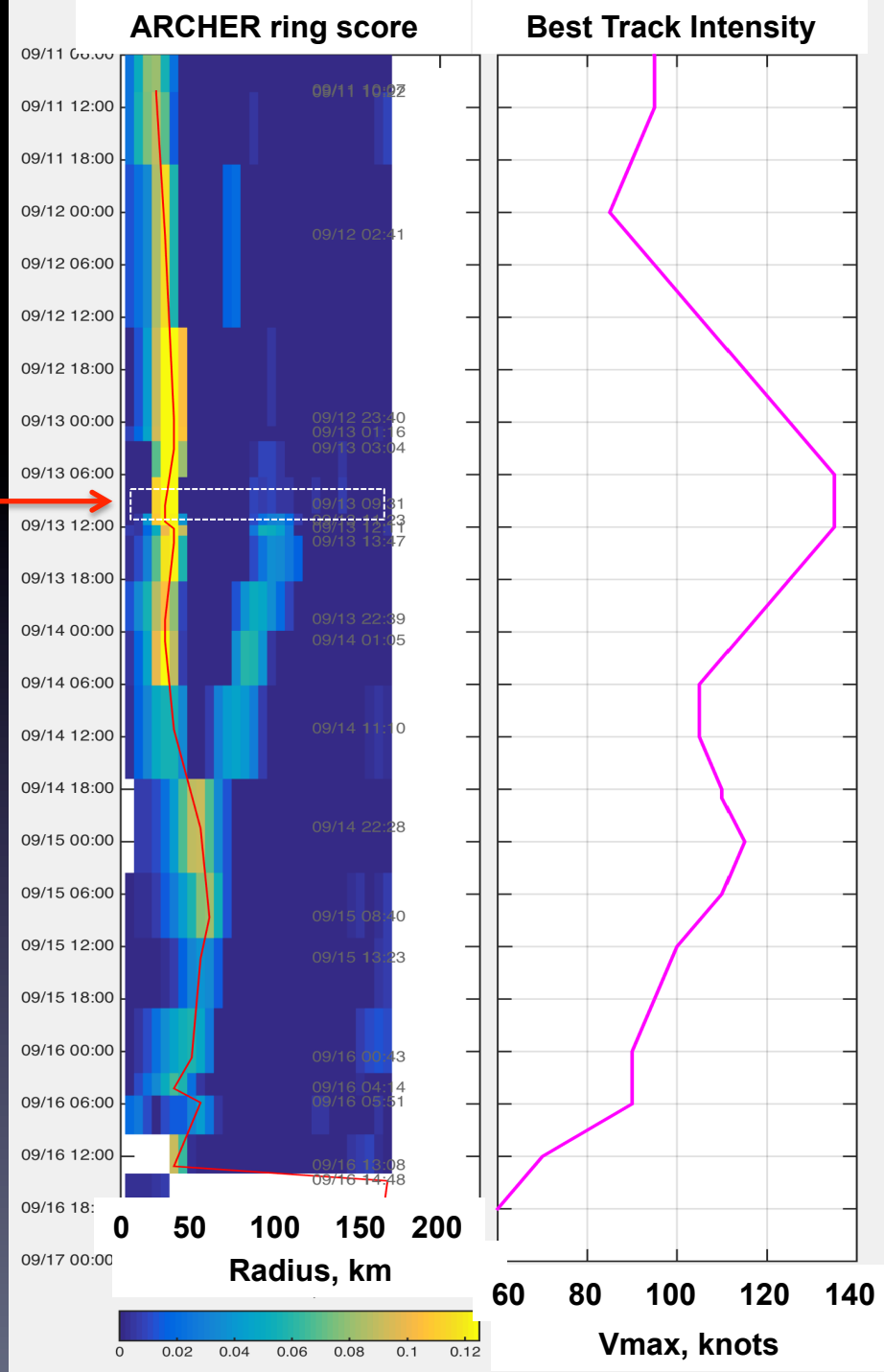
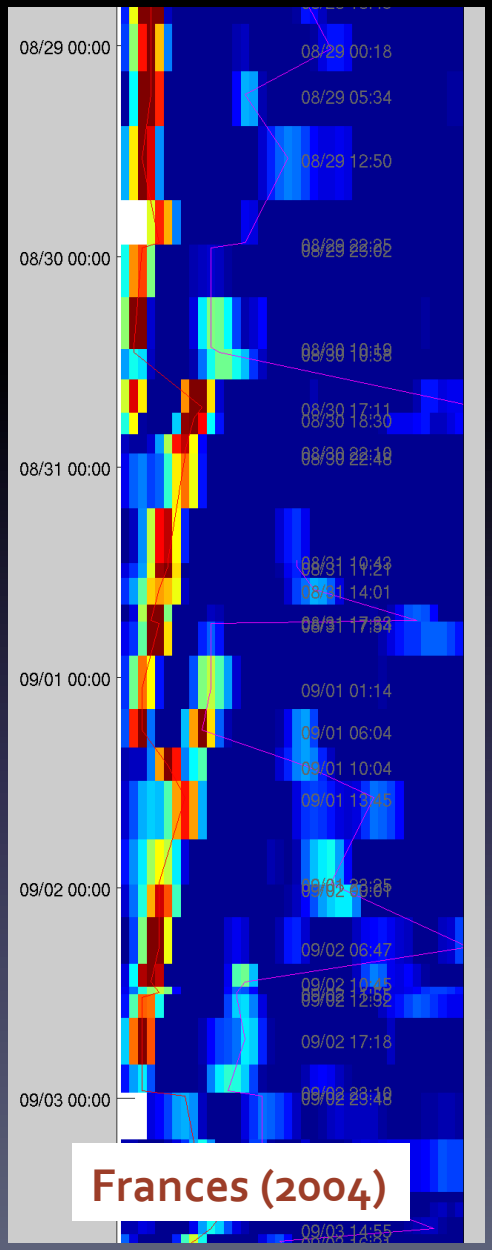
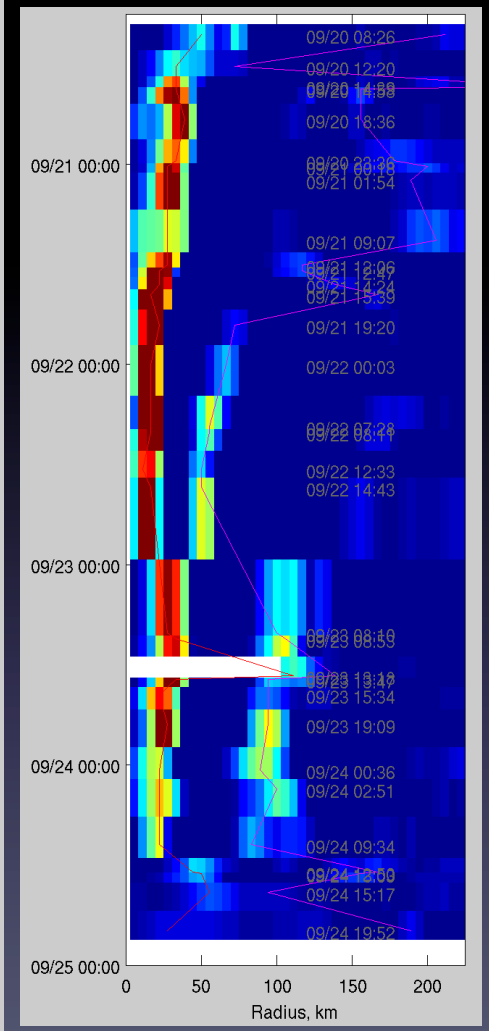


- Time series of ARCHER ring score confirm the close diagnostic relationship between ring score and secondary eyewall formation

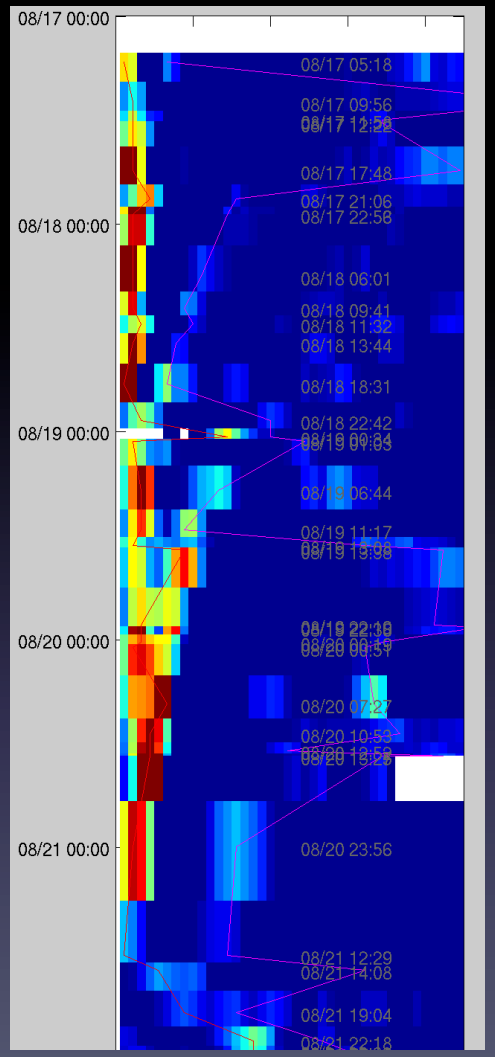
It's not just Floyd…



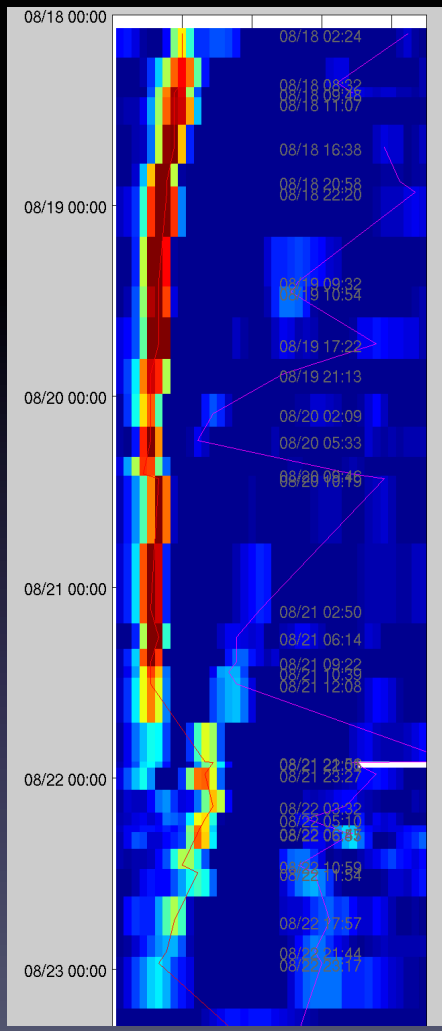
Frances (2004)



Rita (2005)



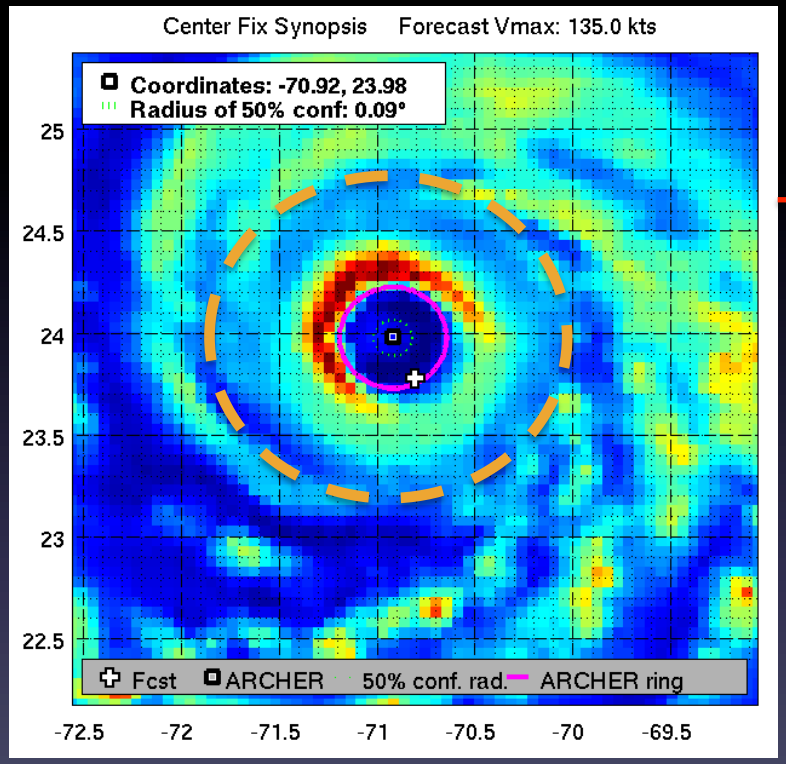
Dean (2007)



Bill (2009)

Project Status:

2) Real-time display



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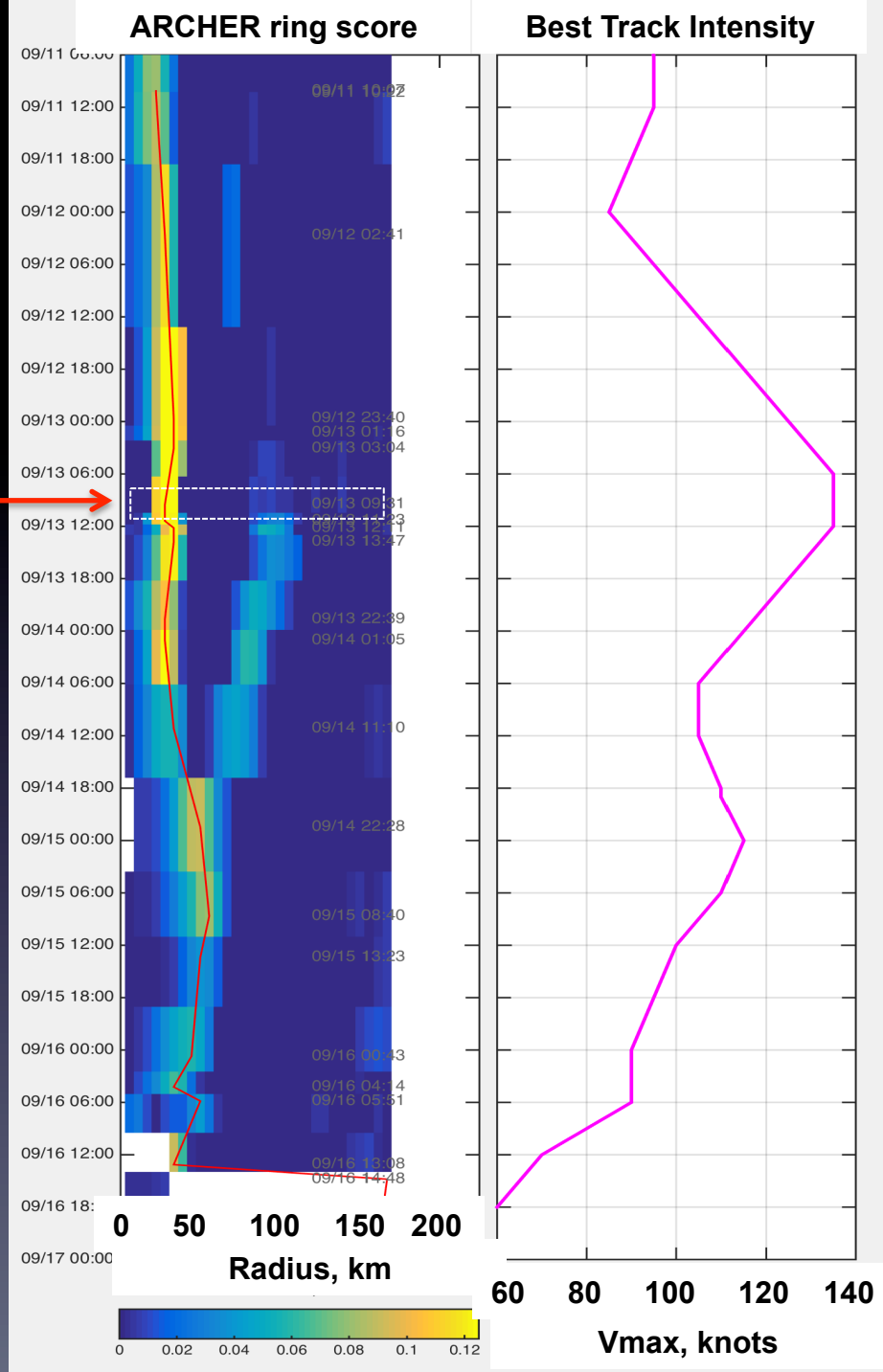


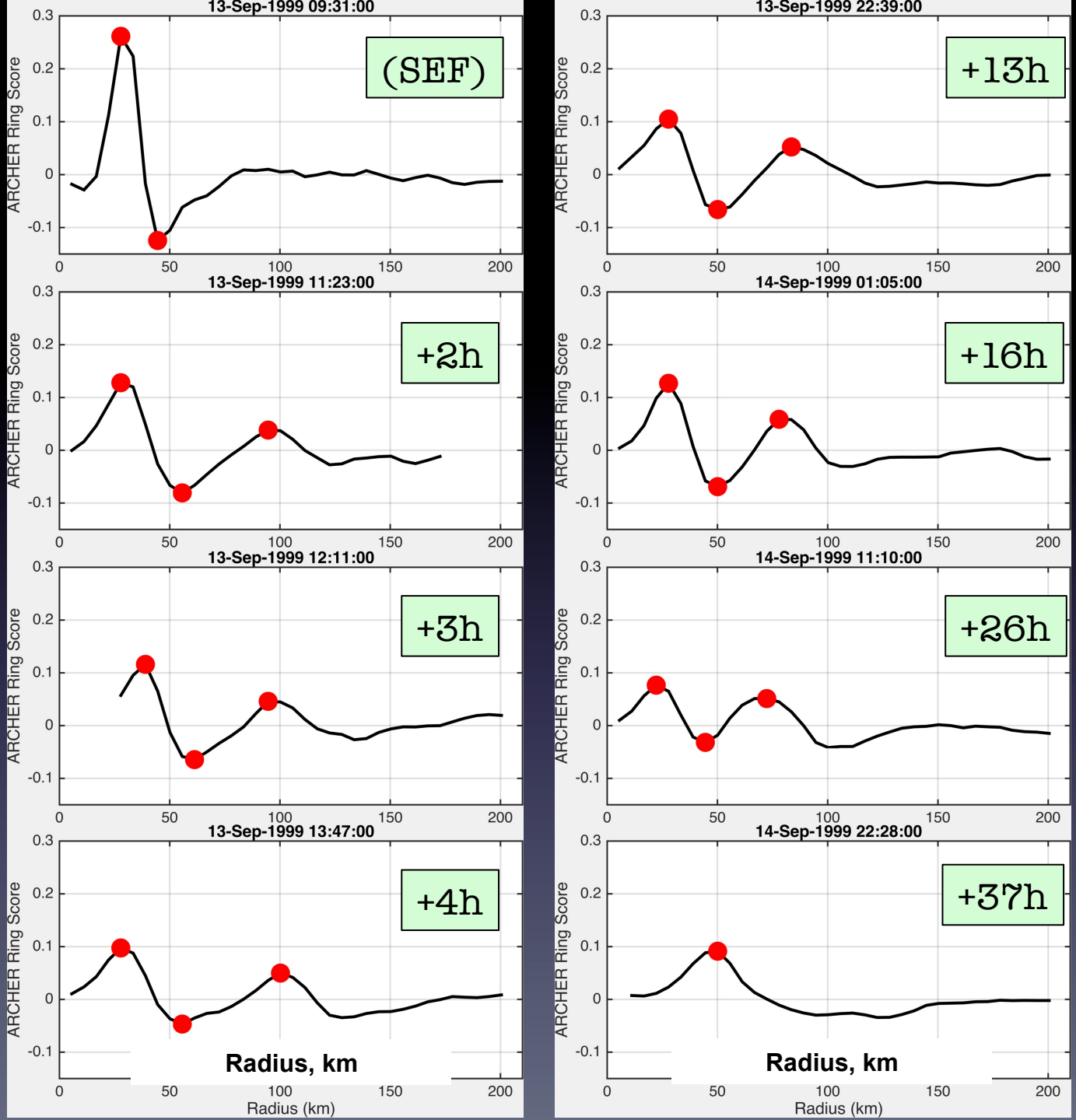
- Elements of ARCHER ring score diagnostics are also appropriate for an online graphical display. This will be ready by July 2016.

Project Status:

3) Development of an improved ERC prediction tool

Example: ARCHER Ring Score profiles From Floyd (1999)

- The evolution of the ring score peaks (minima and maxima) is the key to constructing a microwave-based, probabilistic forecast of ERC.

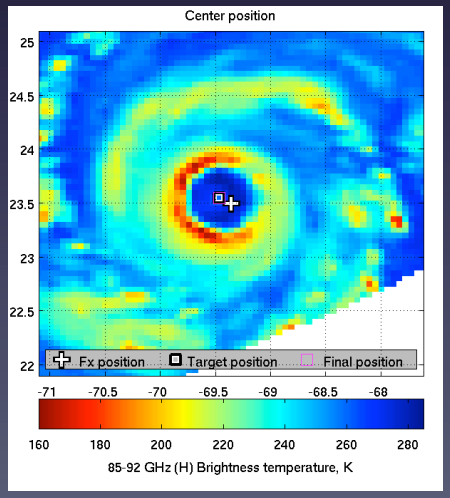


Project Status:

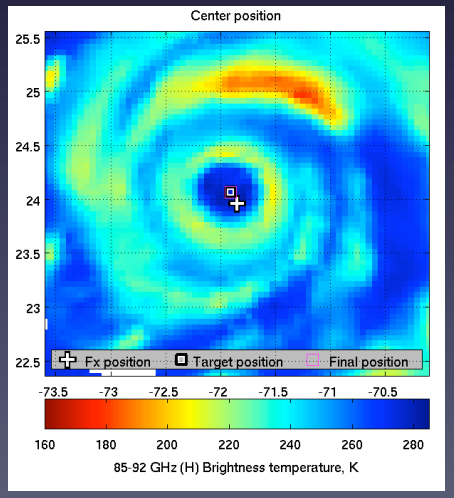
Cal/Val database development

- We have constructed a database of NATL 85-92 GHz imagery from 1999-2011
- It consists of all TC images where Vmax >= 85 knots -> 83 events of ERC total
- We have also included a subjective determination of the three phases of ERC (following Sitkowski et al 2011) (below)

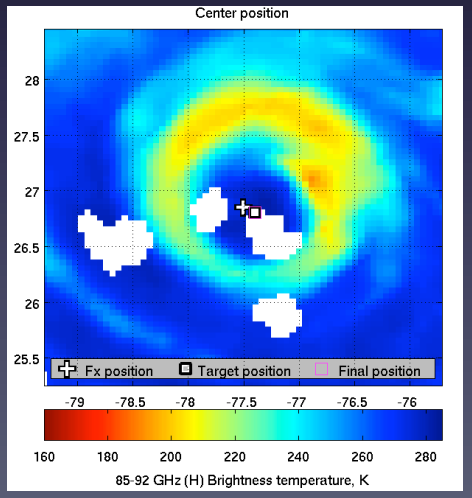
Phase 1
Initial SEF development



Phase 2
Eyewall equalization

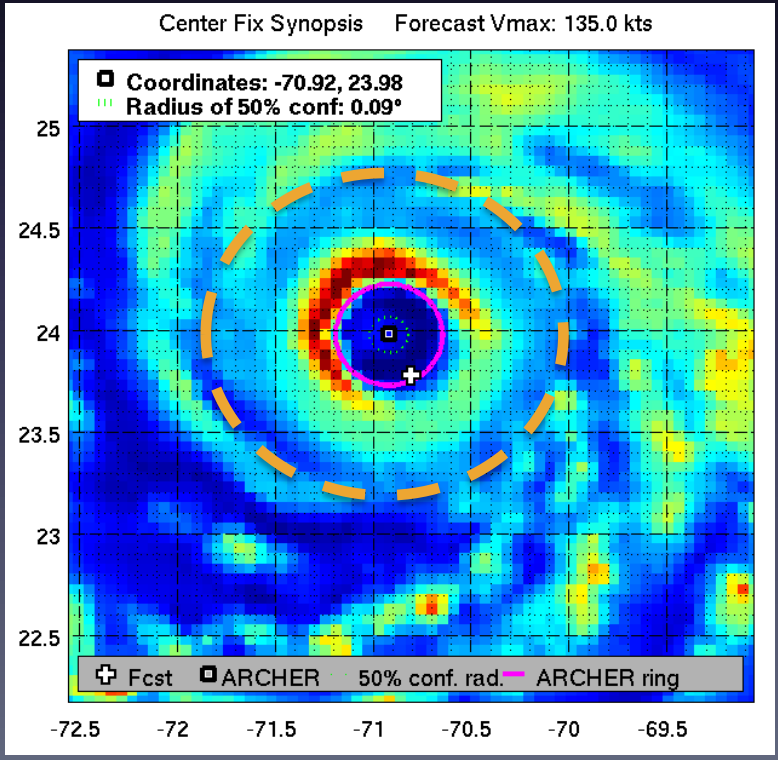


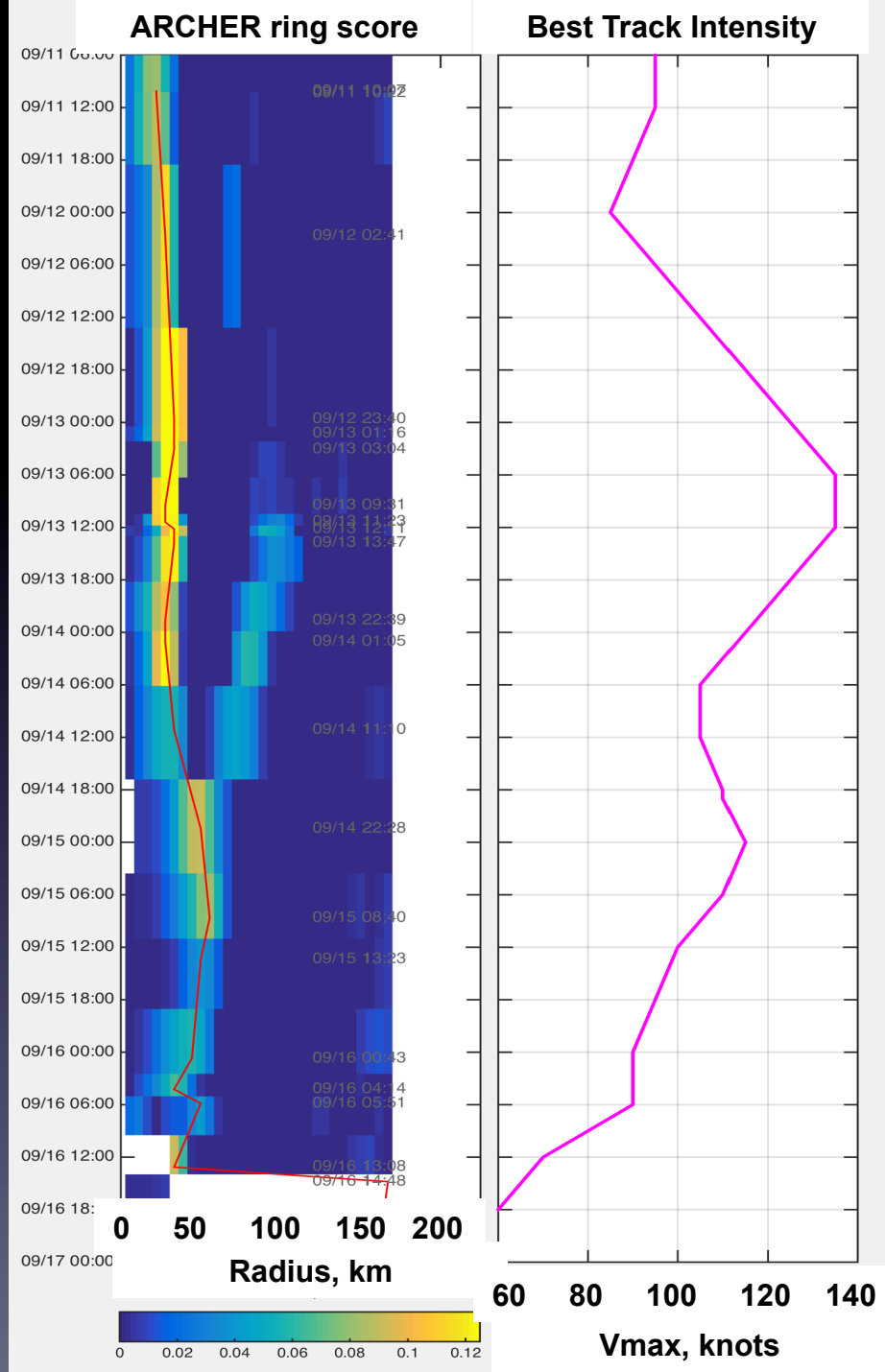
Phase 3
ERC completion



Upcoming (major) milestones

- July 2016 (Year One): Create a real-time online display of the ARCHER secondary eyewall detection and trend analysis (to be added to CIMSS ARCHER website)





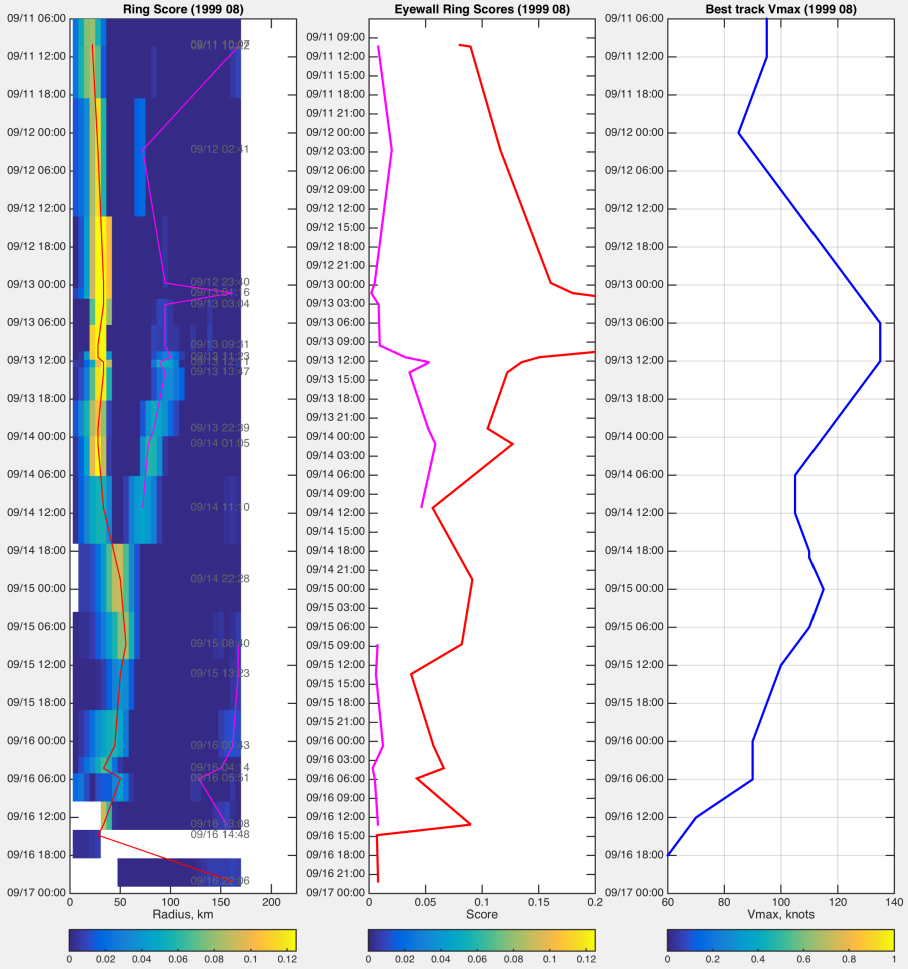
Upcoming (major) milestones

- Year Two:
  - Finalize the multiple eyewall detection module for ARCHER
  - Receive feedback from NHC and finalize the online display
  - Produce a microwave-inclusive probabilistic forecast model of ERCs (similar to pERC)

Metrics for success

1. Rating the ability of ARCHER to recognize secondary eyewalls
2. Validating the "probability of ERC onset" derived from trends in the microwave imagery. These will be tested using Brier Scores and reliability diagrams (as with pERC).
3. Validating the ability of these products to predict intensity change.

Extras


Ring Score (1999 08)
Eyewall Ring Scores (1999 08)
Best track Vmax (1999 08)
Radius, km
Score
Vmax, knots

Project Status:

3) Development of an improved ERC prediction tool