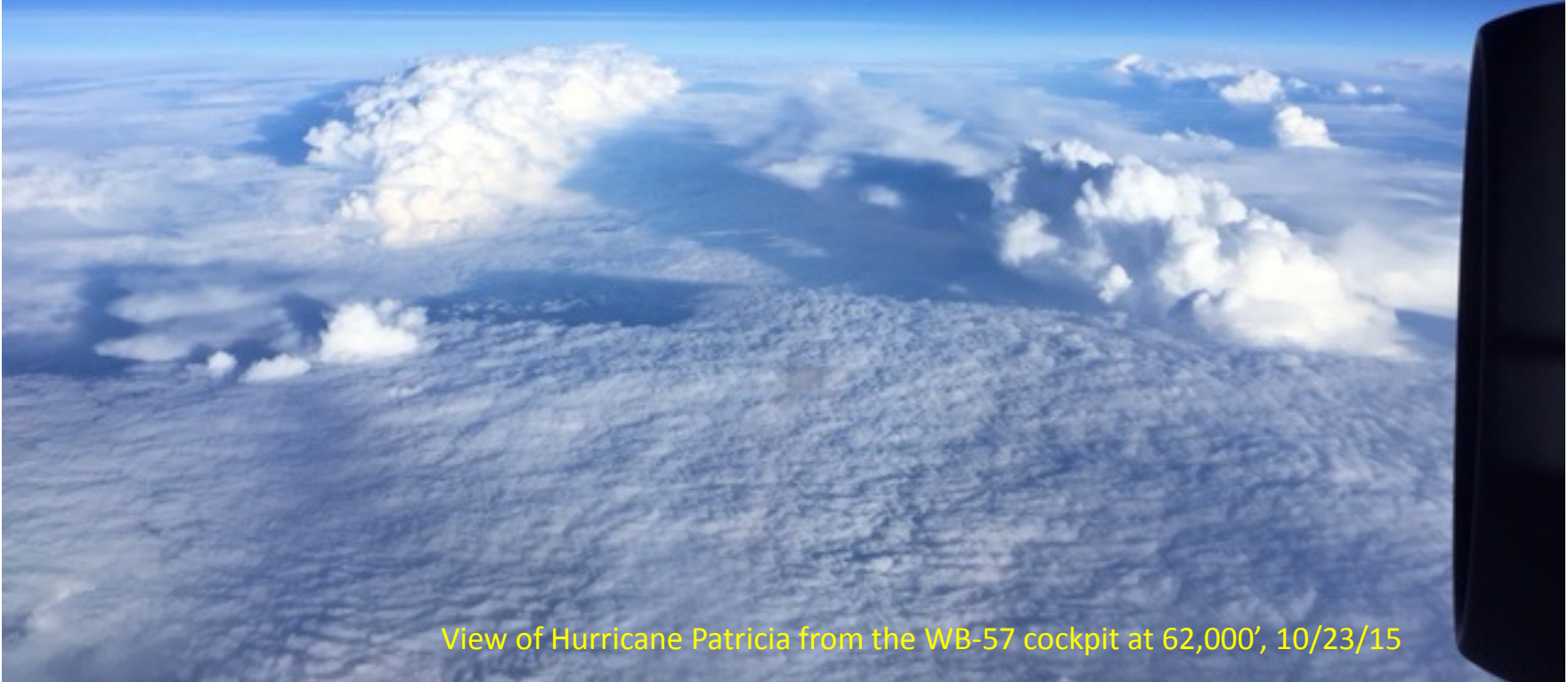


Tropical Cyclone Research Sponsored by the Office of Naval Research

Ronald J. Ferek, Ph.D.
Marine Meteorology Program
TCORF, 2017

View of Hurricane Patricia from the WB-57 cockpit at 62,000', 10/23/15



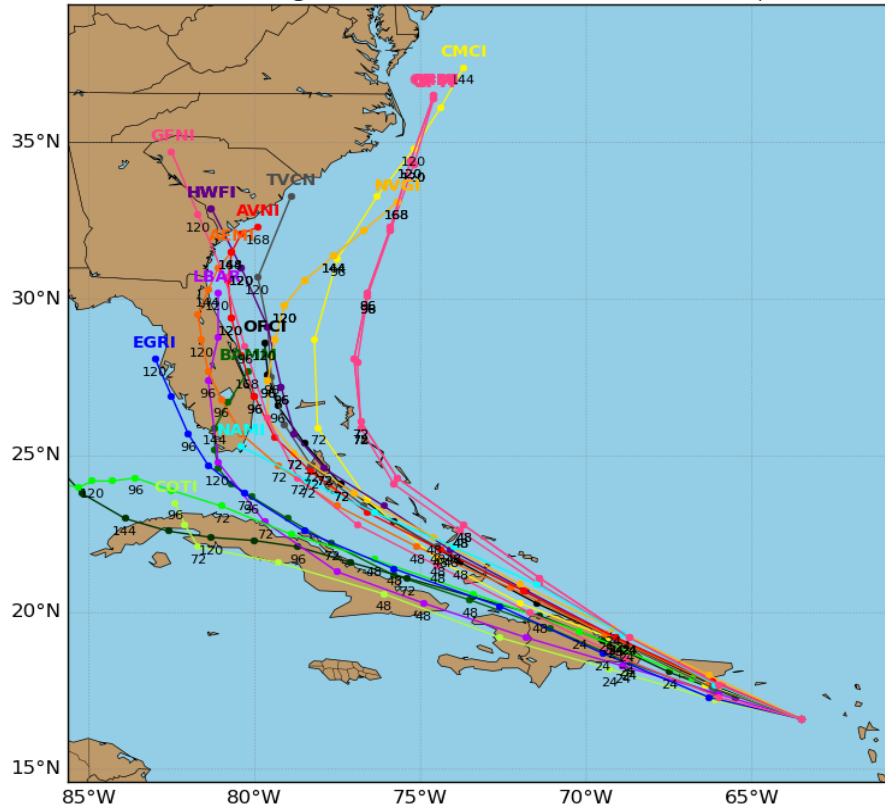


TCI-15 Case: ERIKA

Tropical Storm ERIKA Model Track Guidance

Initialized at 18z Aug 27 2015

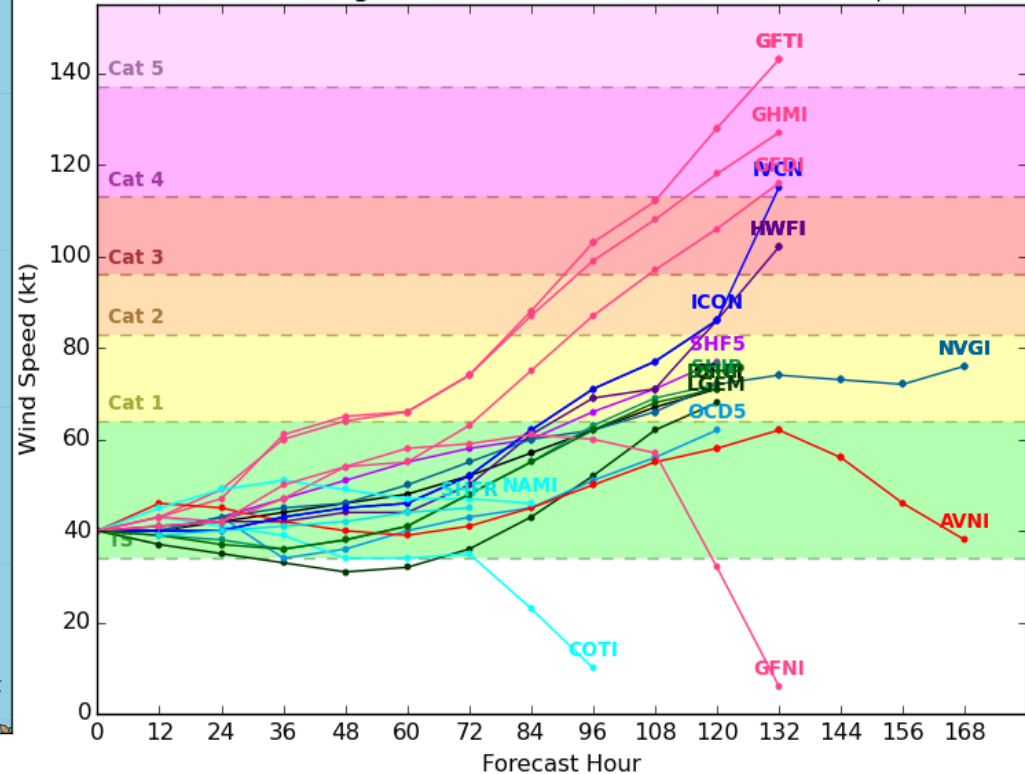
Levi Cowan - tropicaltidbits.com

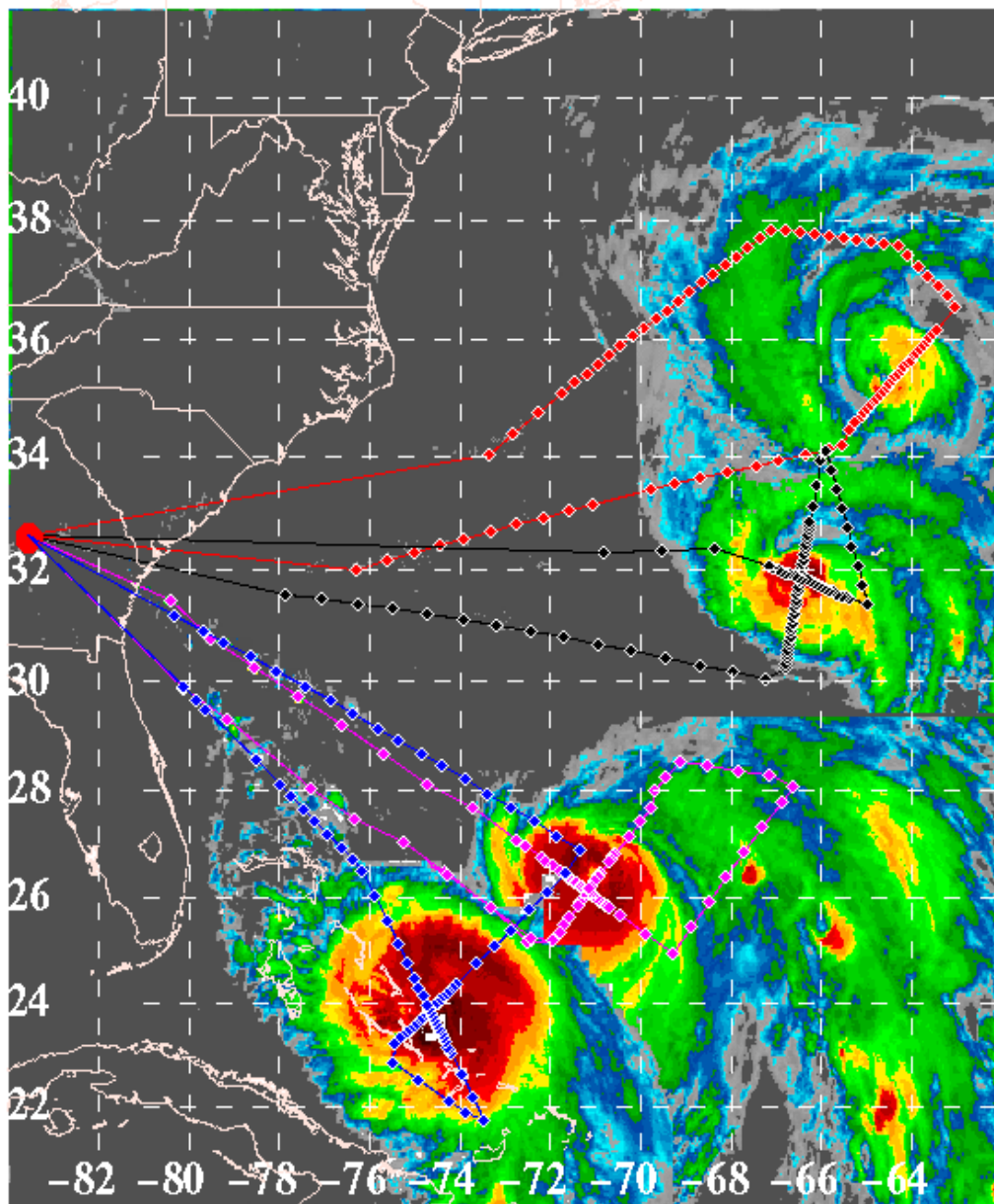


Tropical Storm ERIKA Model Intensity Guidance

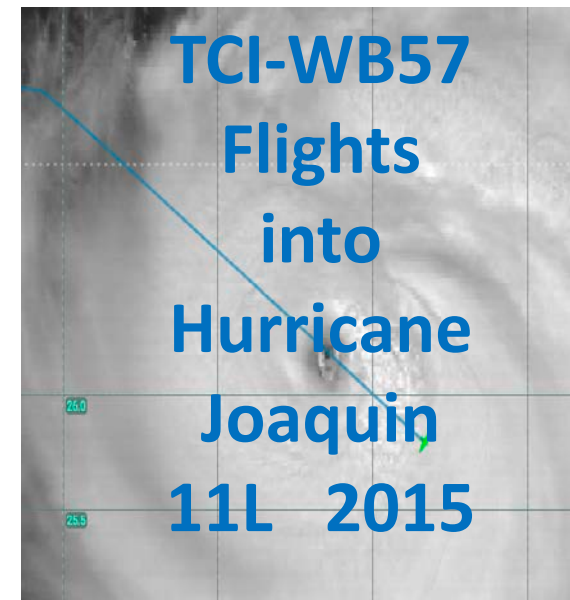
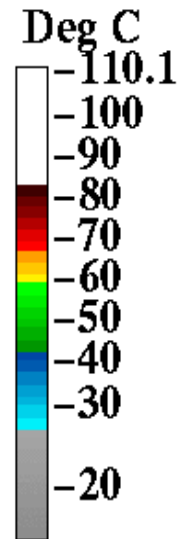
Initialized at 18z Aug 27 2015

Levi Cowan - tropicaltidbits.com





TCI flight montage Hurr Joaquin Oct 2-5 2015



- 4-day sequence of WB-57 flights dropped high-definition dropsondes (dots) over Hurricane Joaquin
- Strongest Atlantic hurricane in 5 years (Category 4) was poorly predicted by current operational models (P-3 and G-IV Recon was unavailable; SHOUT Global Hawk was down)
- Inbound/outbound segments observed the trough interactions that were bringing a record rain and flooding event to South Carolina

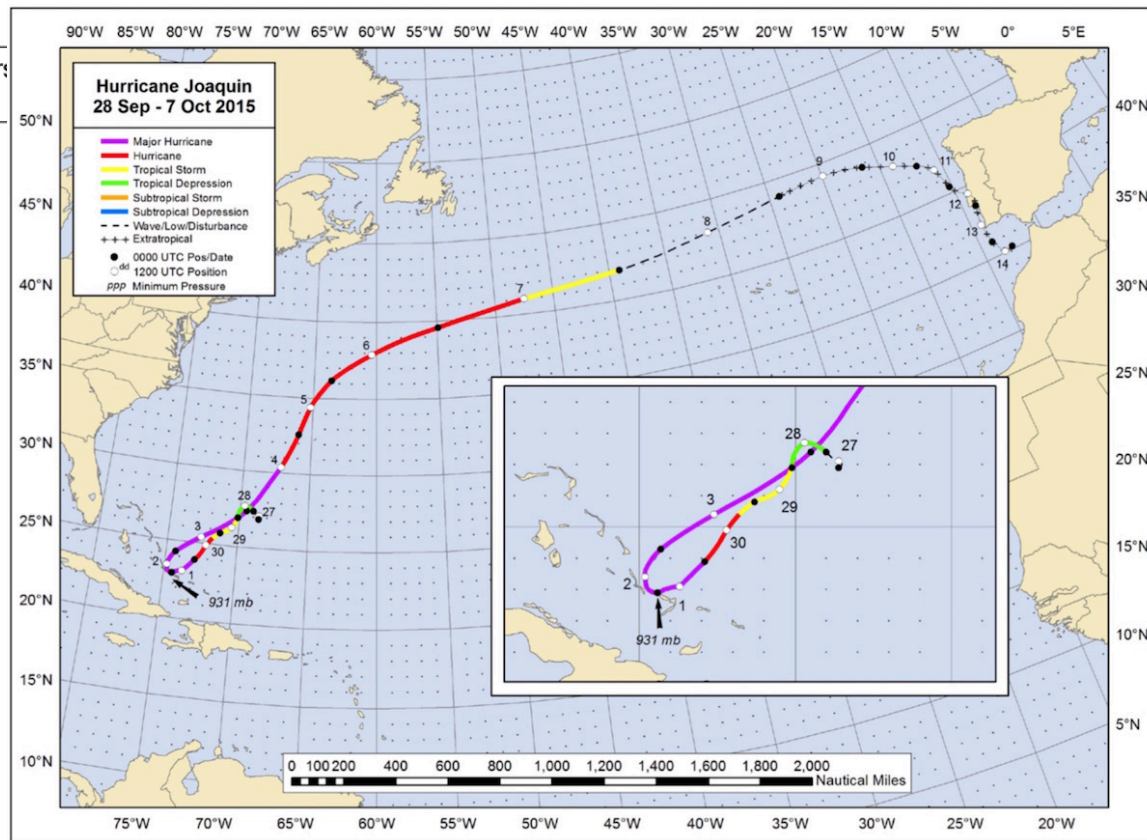
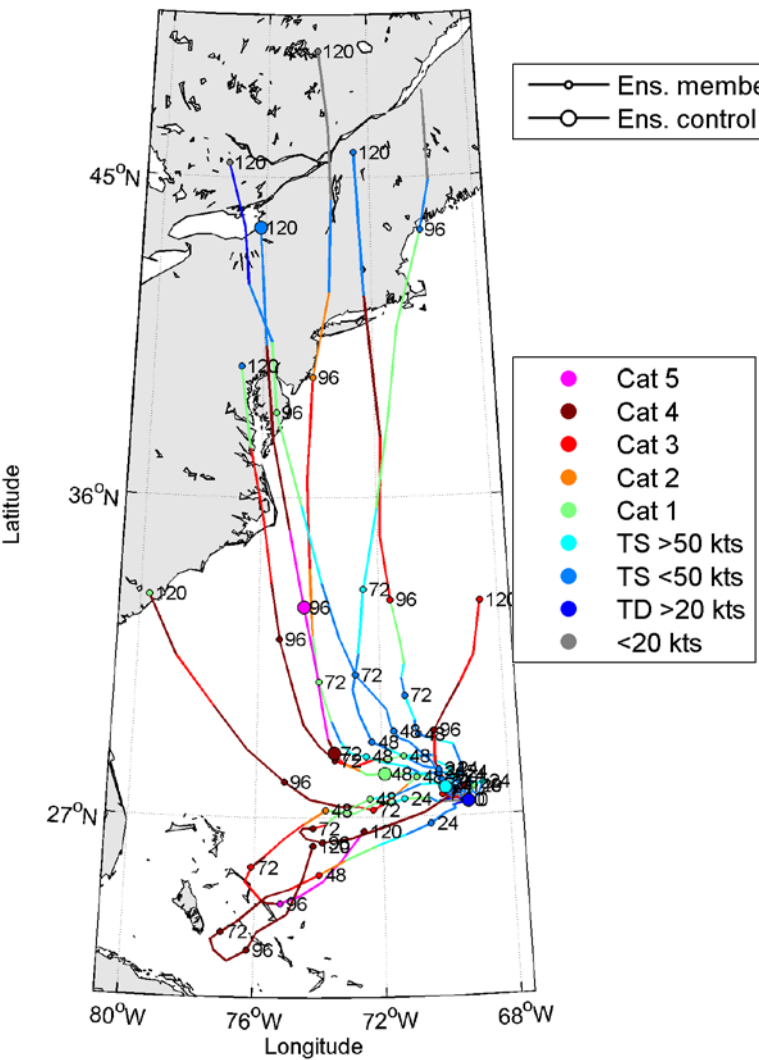


Hurricane Joaquin (2015)

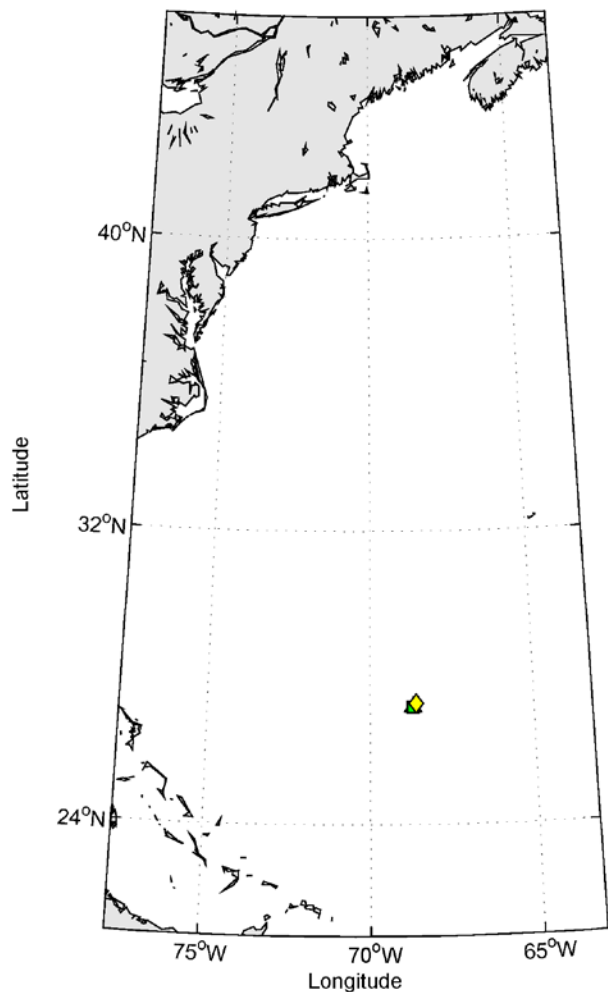
2015-09-28 12Z

COAMPS-TC ENS

TC = 11L2015, DTG = 2015092812



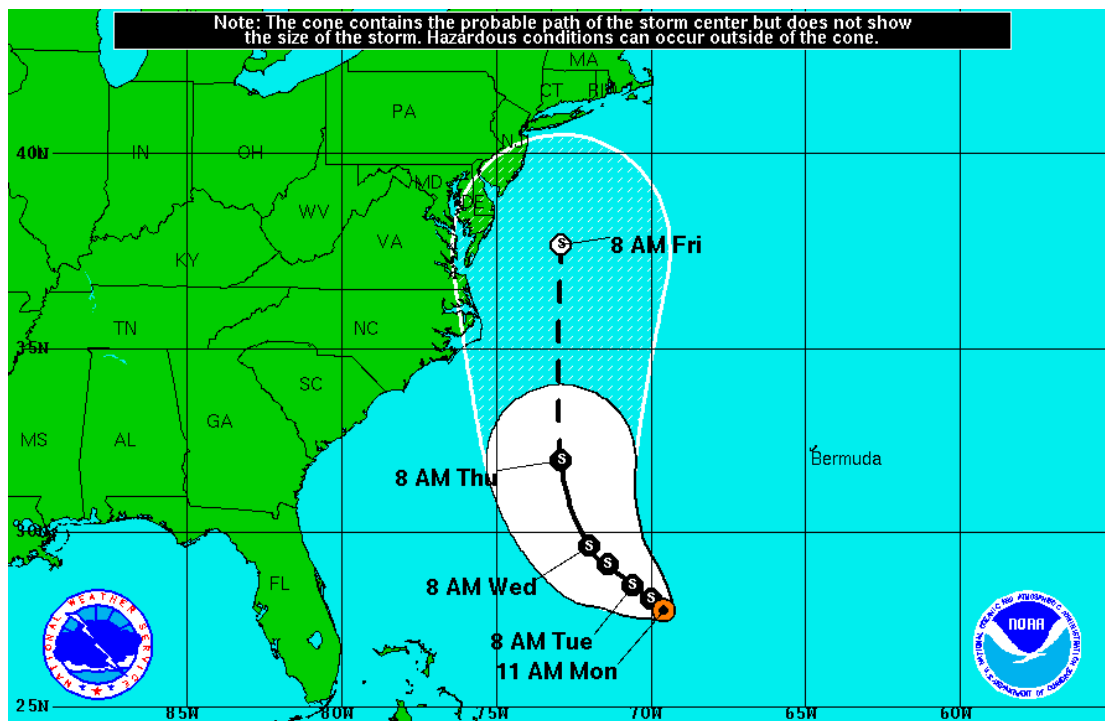
TC = al112015, DTG = 2015092800, Tau = 0 h, Mem = 11



(Courtesy of Jim Doyle)

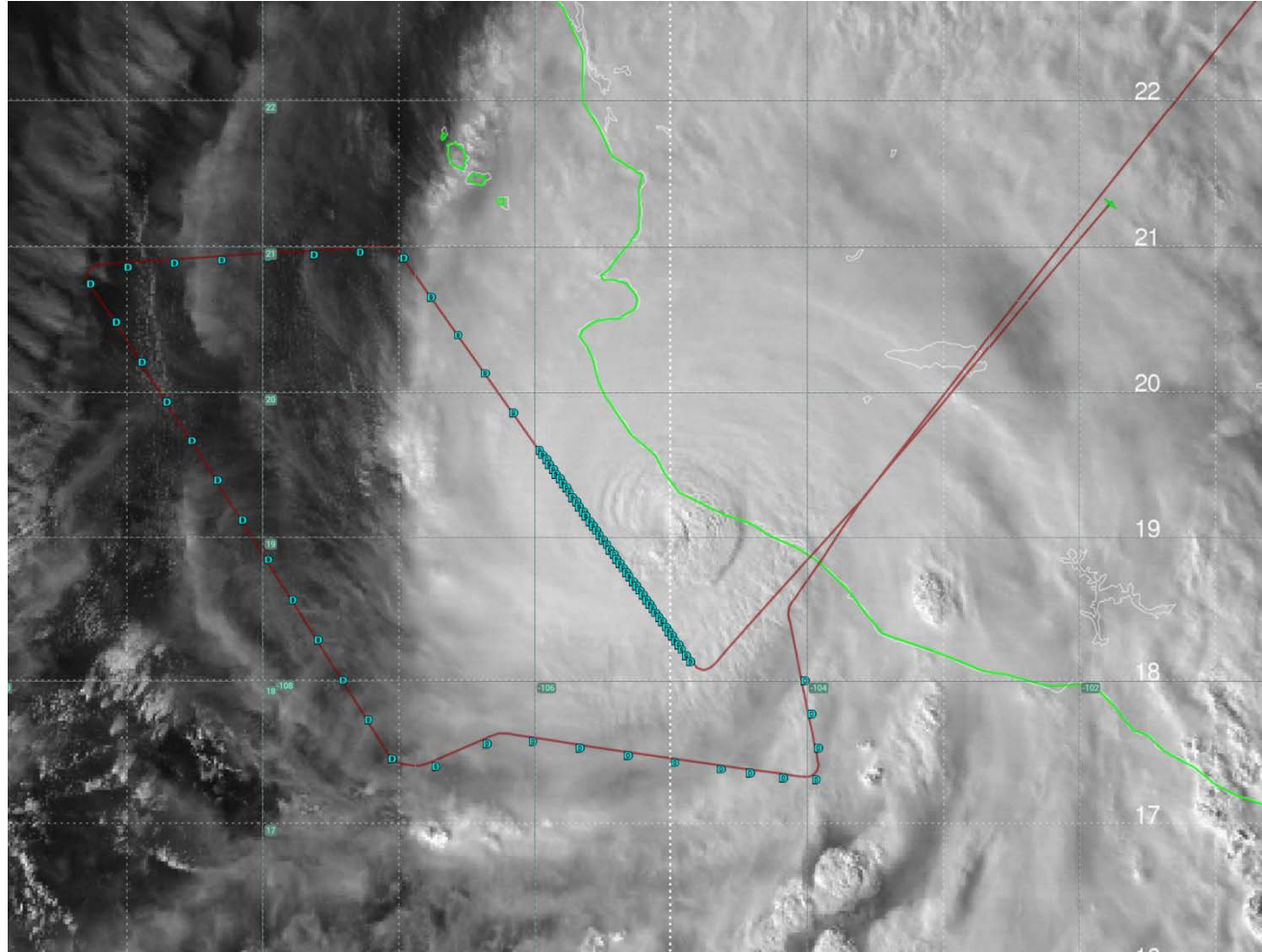
- Best track
 - Ens. control
 - Ens. mean
-
- ◆ Best track
 - Ens. members
 - ▲ Ens. control
 - Ens. mean

NHC 15Z official forecast



<p>Tropical Depression Eleven <i>Monday September 28, 2015</i> 11 AM EDT Advisory 3 NWS National Hurricane Center</p>	<p>Current Information: ● Center Location 27.8 N 69.6 W Max Sustained Wind 35 mph Movement WNW at 5 mph</p>	<p>Forecast Positions: ● Tropical Cyclone ○ Post-Tropical Sustained Winds: D < 39 mph S 39-73 mph H 74-110 mph M > 110mph</p>
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<p>Potential Track Area: Day 1-3 Day 4-5</p>	<p>Watches: Hurricane Trop.Storm</p>	<p>Warnings: Hurricane Trop.Storm</p>
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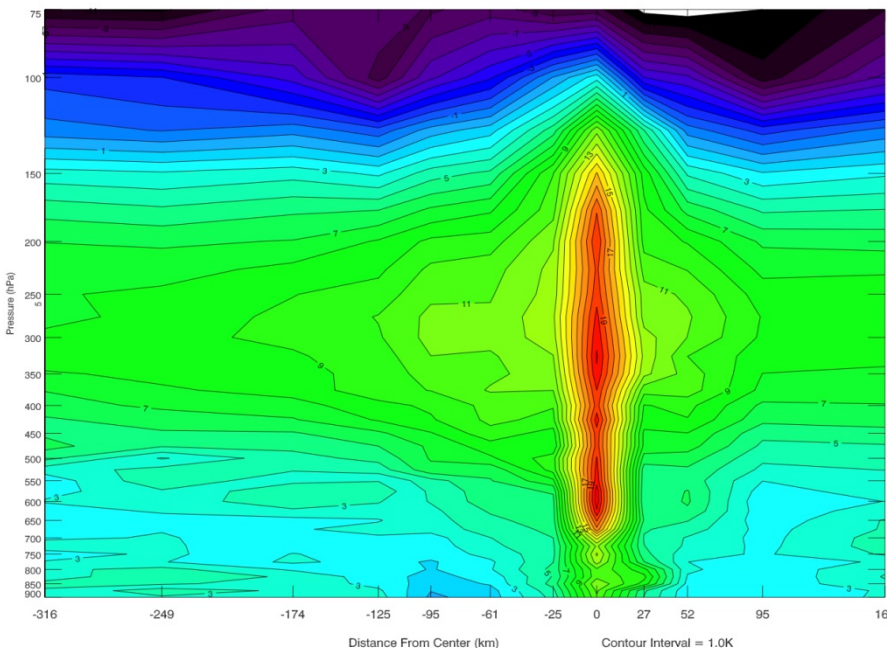


TCI Observations over Hurricane Patricia, 23 October, 2015

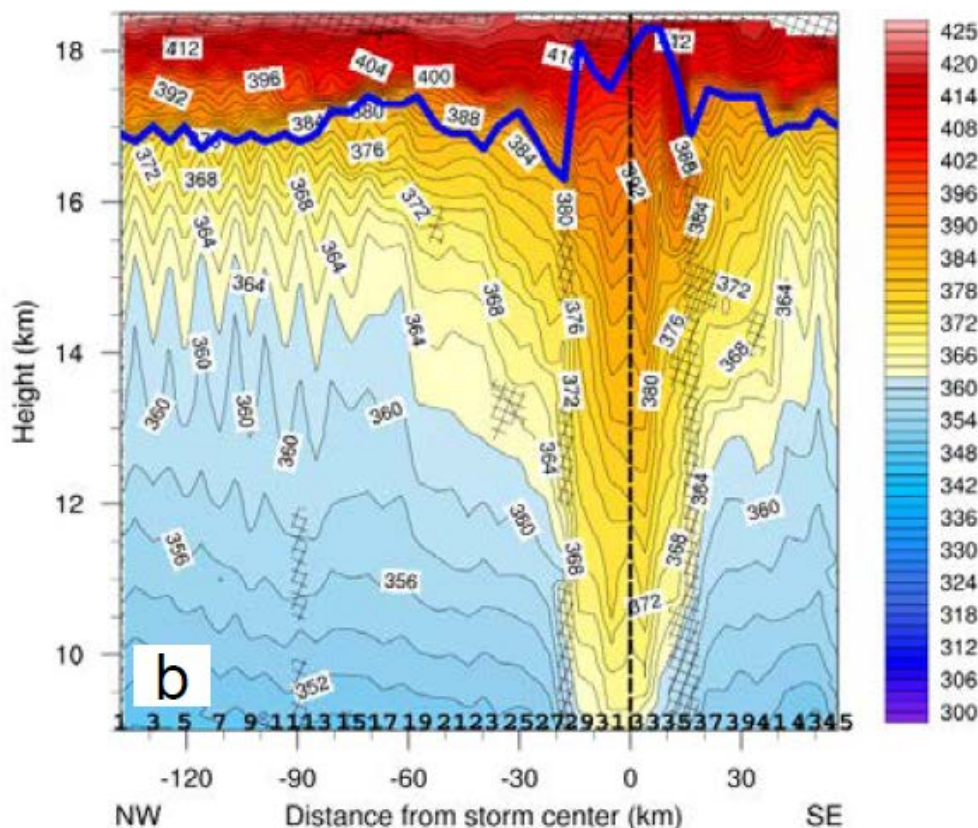
- 46 high-definition dropsonde sequence (green dots) over the eye of Hurricane Patricia 5-6 hours before landfall; most detailed observations ever collected
- Strongest hurricane ever observed (Category 5) was very poorly predicted by current operational models (48-hr forecast was for Cat 1)

Analyses of Patricia Dropsondes

Patricia(20E) OCT 23, 2015 1957-2146 UTC
 WB-57 Dropsonde Temperature Anomaly (Storm Center-Environment) Using Jordan Annual Mean Tropical Sounding



(Courtesy of Derrick Herndon and Chris Velden)



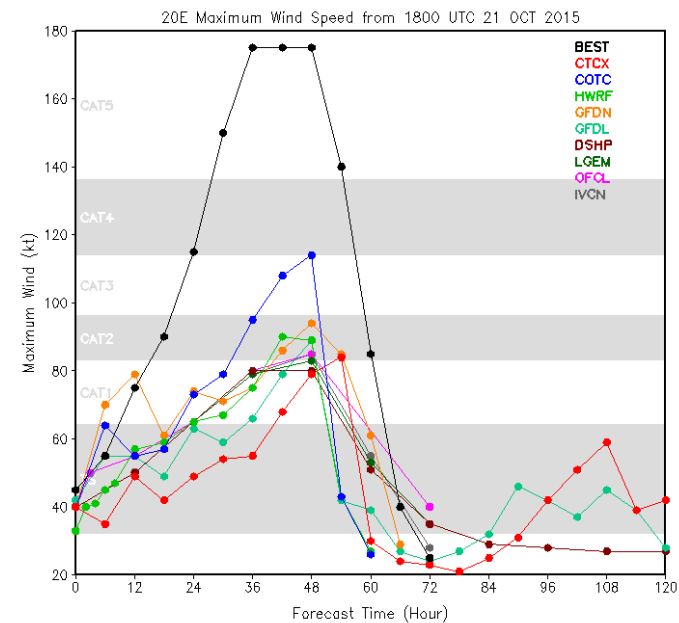
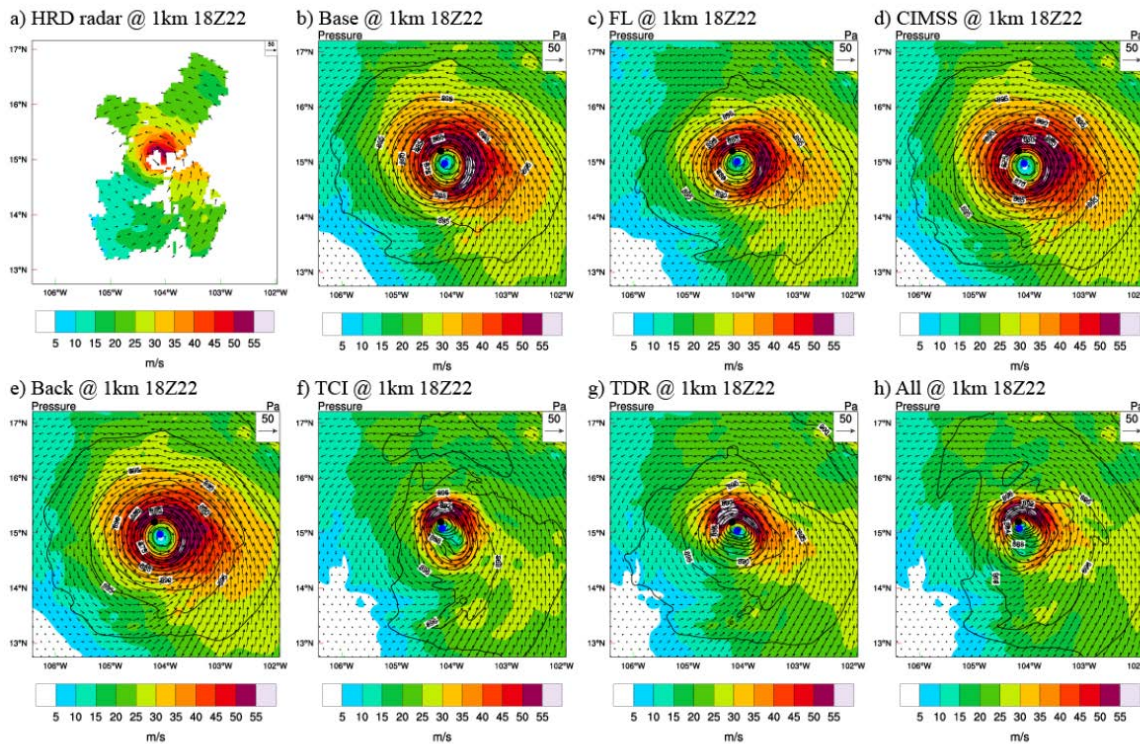
(Courtesy of Patrick Duran)

The high-resolution HDSS profiles during Patricia offer an unprecedented detailed three-dimensional sampling of a full-troposphere hurricane warm core

- Patricia had the largest-ever observed tropical cyclone warm core anomaly ($\sim 22\text{C}$), leading to the record lowest EPAC/ATL sea level pressure (872 hPa)
- Dropsonde data (potential temp.) was sufficiently detailed to resolve gravity waves



Hurricane Patricia (2015)

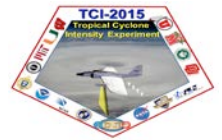


(Courtesy of Xuguang Wang)

The high-resolution HDSS profiles during Patricia offer an unprecedented detailed three-dimensional sampling of a full-troposphere hurricane

- Dropsonde observations gave the best initial condition for Patricia
- Models could not sustain the structure and intensity of Patricia even after DA of these obs.!

TCI-15 Lessons Learned



- **Erika**

- Operational forecasts: *Poor* for track and intensity
- Failure cause: UNDERSTOOD (global model accuracy generally cannot resolve small track errors relative to the high terrain)
- Excellent case for an ensemble forecast system

- **Joaquin**

- Operational forecasts: *Very poor* for track and Rapid Intensification
- 🧠 Failure cause: NOT FULLY UNDERSTOOD (upstream influence of EPAC TC Marty? Inaccurate global boundary conditions driving mesoscale errors?)
- ✓ Ensemble system captured the uncertainty of the track and intensity

- **Patricia**

- Operational forecasts: Very good for track; *very poor* for RI (~100 kt error!)
- 🧠 Failure cause: NOT UNDERSTOOD (missing physics in mesoscale models?)
- ✗ Even with excellent obs. and DA, models (and the ensemble) did not capture the structure or extreme rapid intensification

- ***Improvements are needed in obs. and mesoscale models (still in Basic research)***
- ***In the near term, multi-model ensembles can be exploited for skill improvements and communicating uncertainty***
- ***Longer-range skillful genesis forecasting needs improvements in global models***