Tropical Cyclone Research Sponsored by the Office of Naval Research

Ronald J. Ferek, Ph.D.
Marine Meteorology Program
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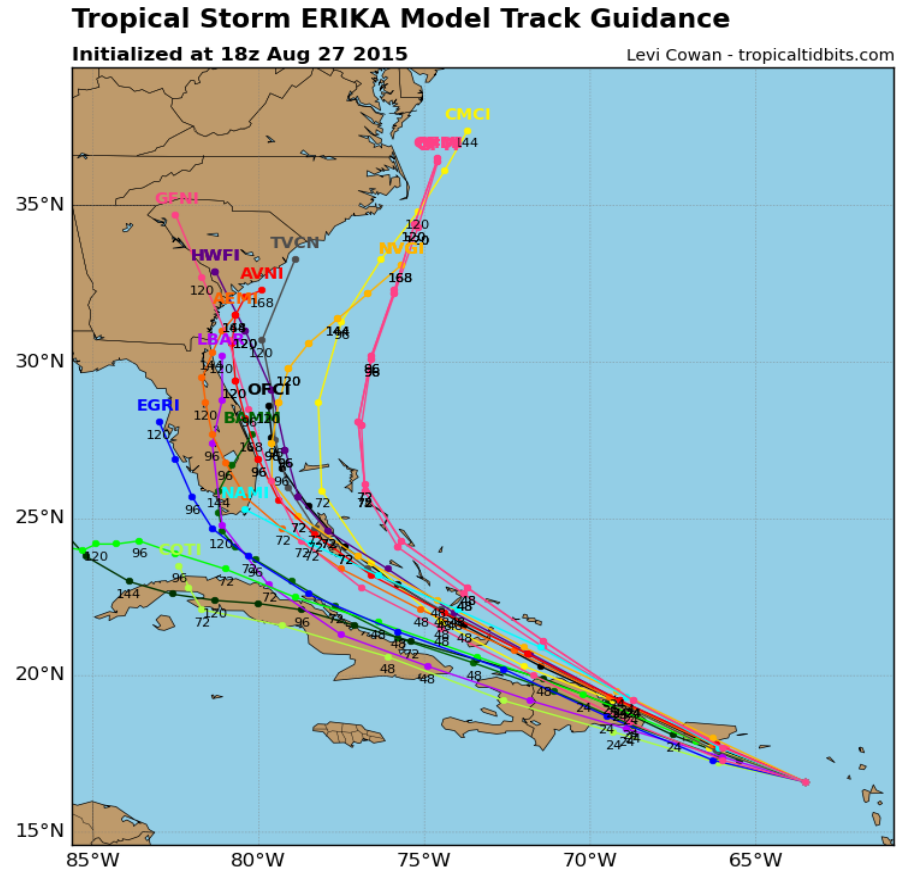
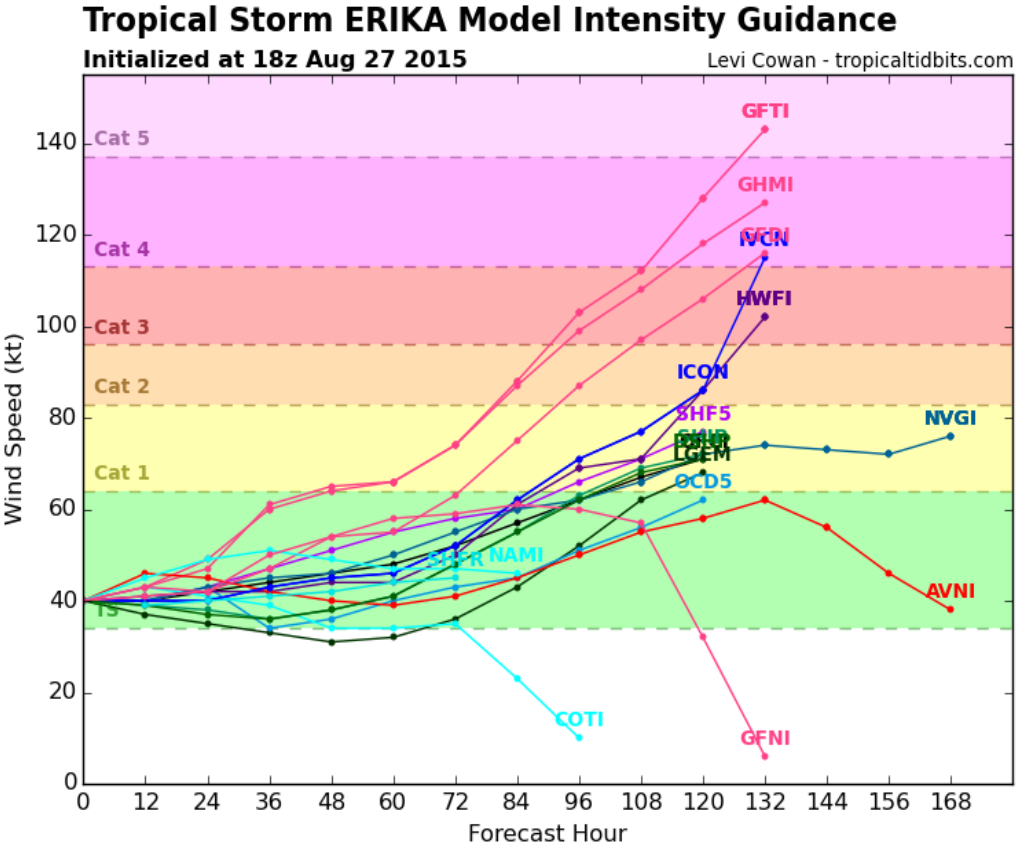
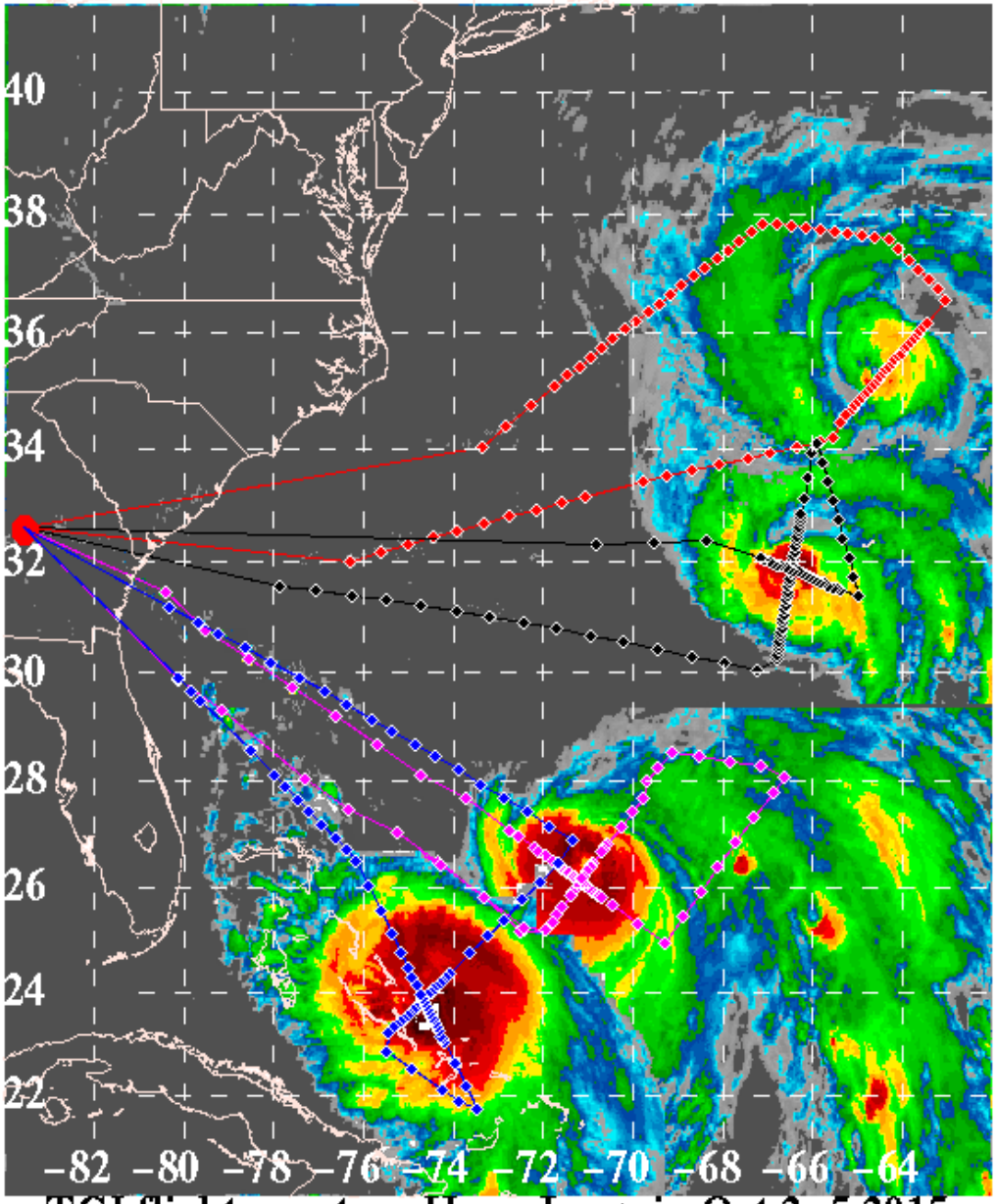
View of Hurricane Patricia from the WB-57 cockpit at 62,000', 10/23/15

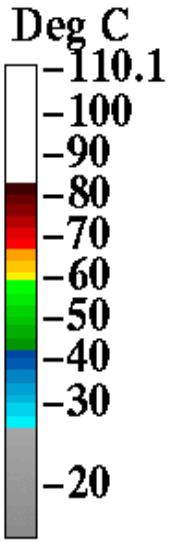
TCI-15 Case: ERIKA

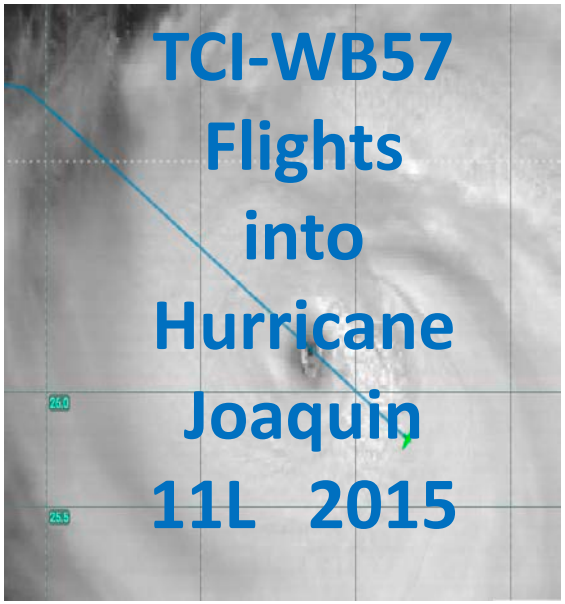






TCI flight montage Hurr Joaquin Oct 2–5 2015



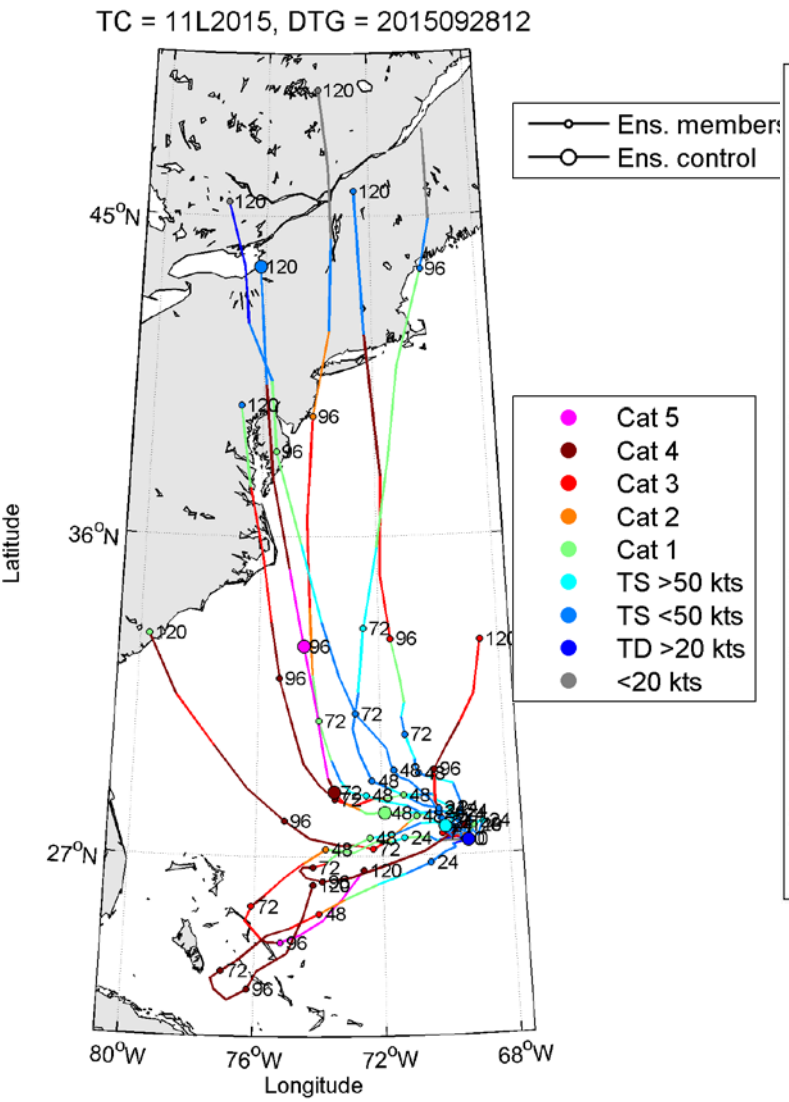


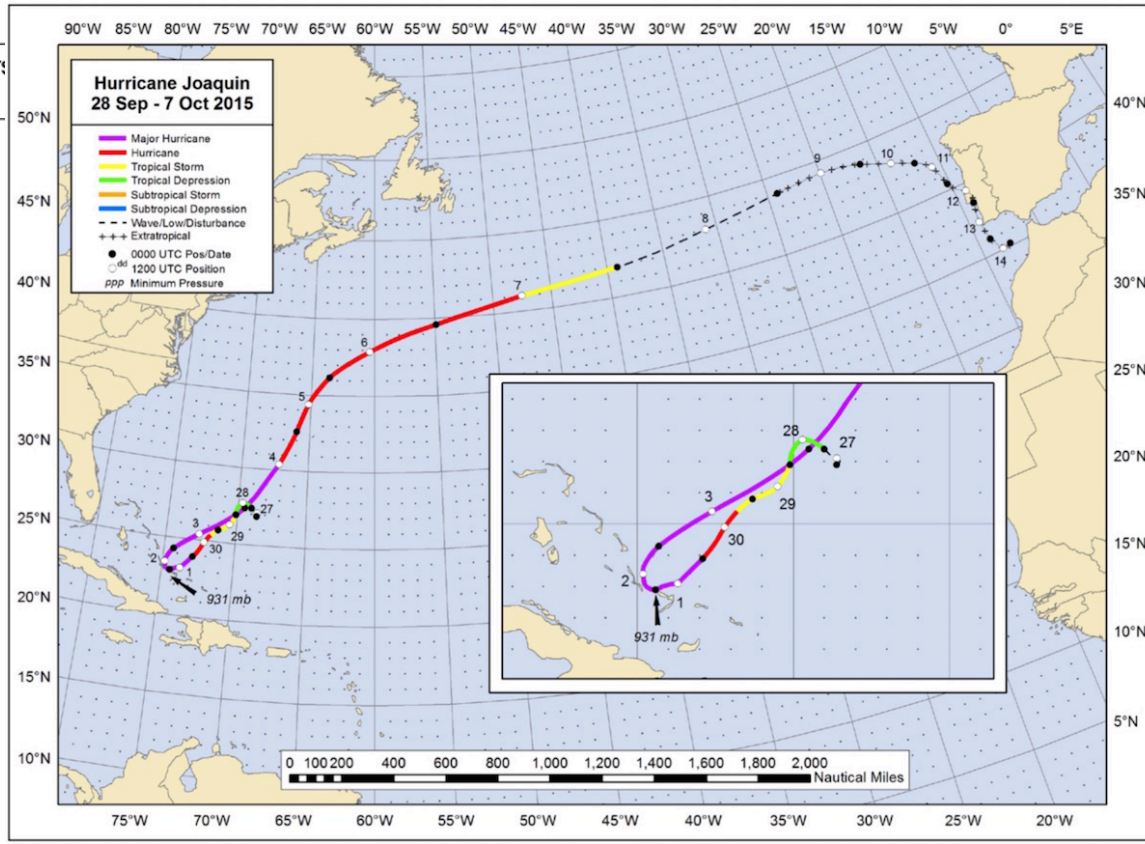
- 4-day sequence of WB-57 flights dropped high-definition dropsondes (dots) over Hurricane Joaquin
- Strongest Atlantic hurricane in 5 years (Category 4) was poorly predicted by current operational models (P-3 and G-IV Recon was unavailable; SHOUT Global Hawk was down)
- Inbound/outbound segments observed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

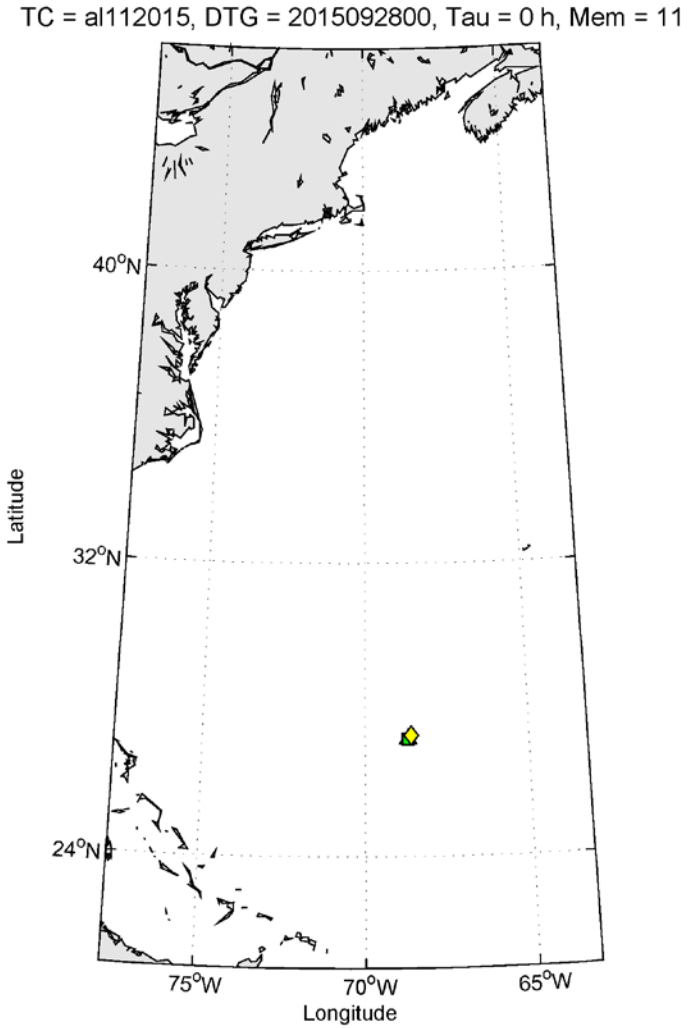
Hurricane Joaquin (2015)

2015-09-28 12Z

COAMPS-TC ENS

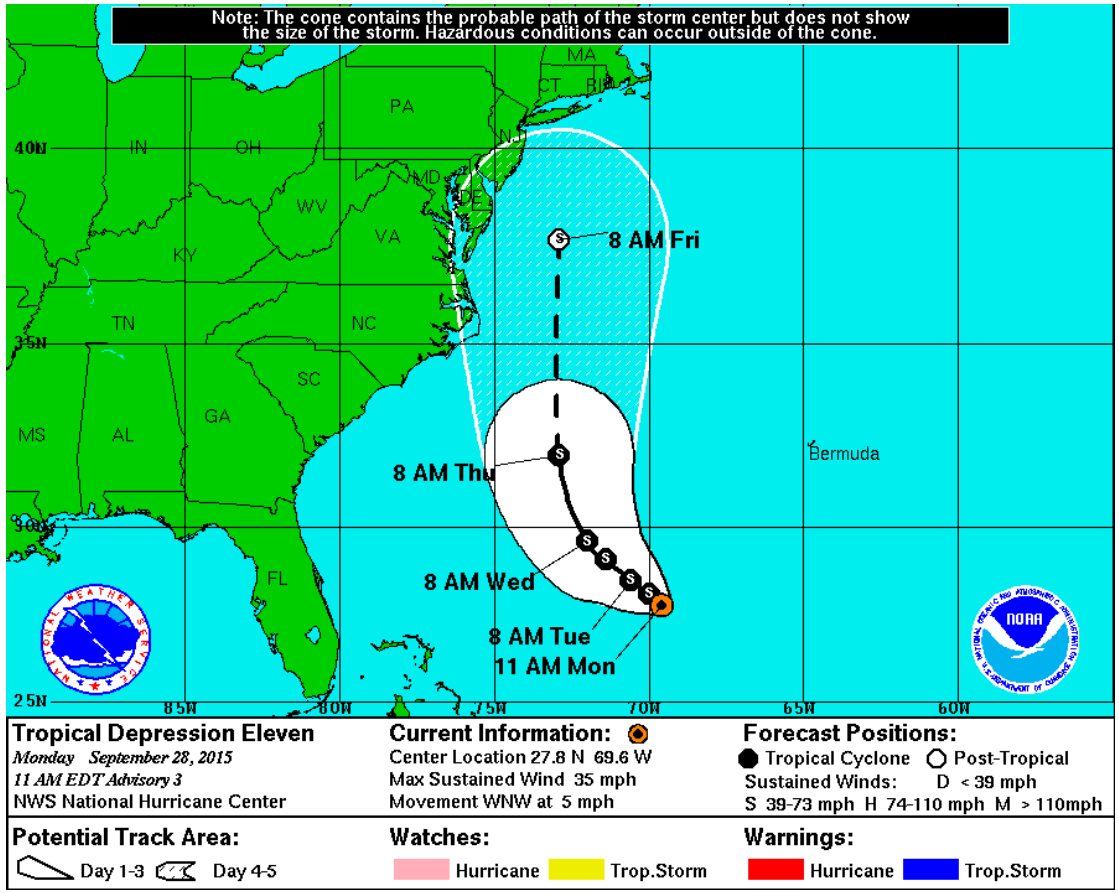


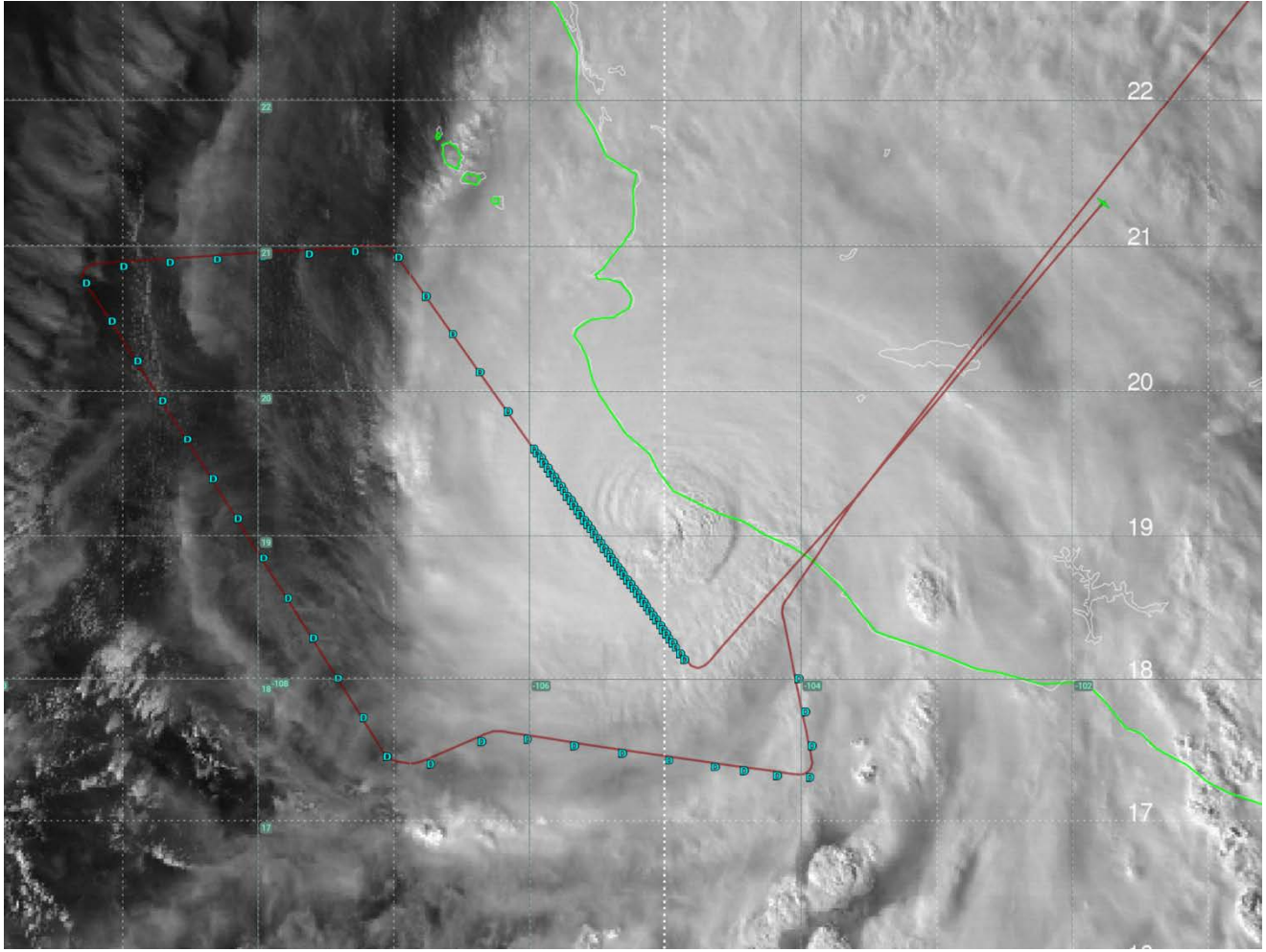




(Courtesy of Jim Doyle)

NHC 15Z official forecast

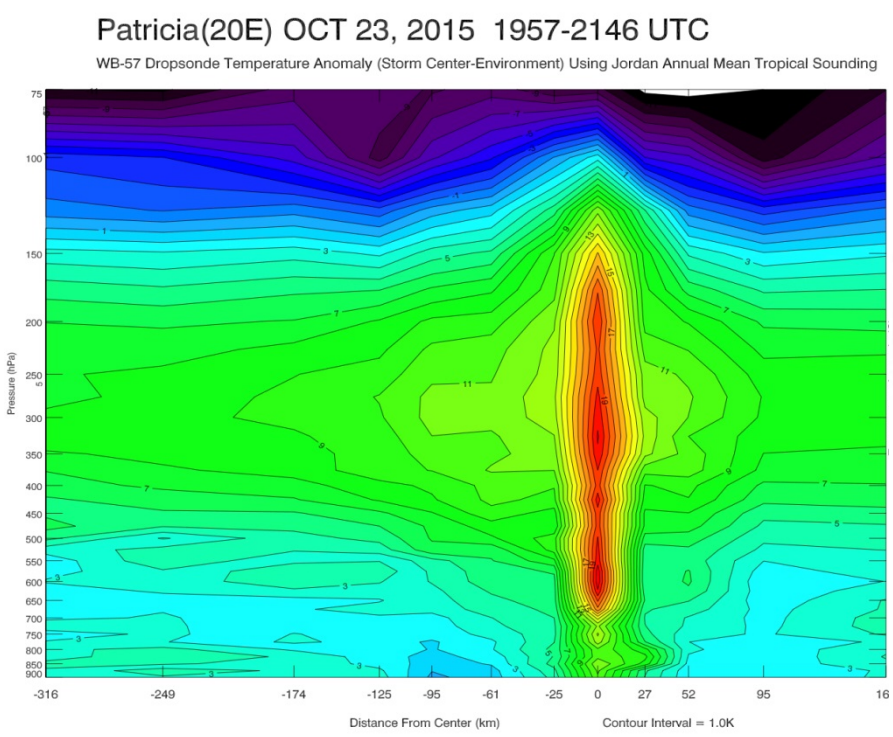




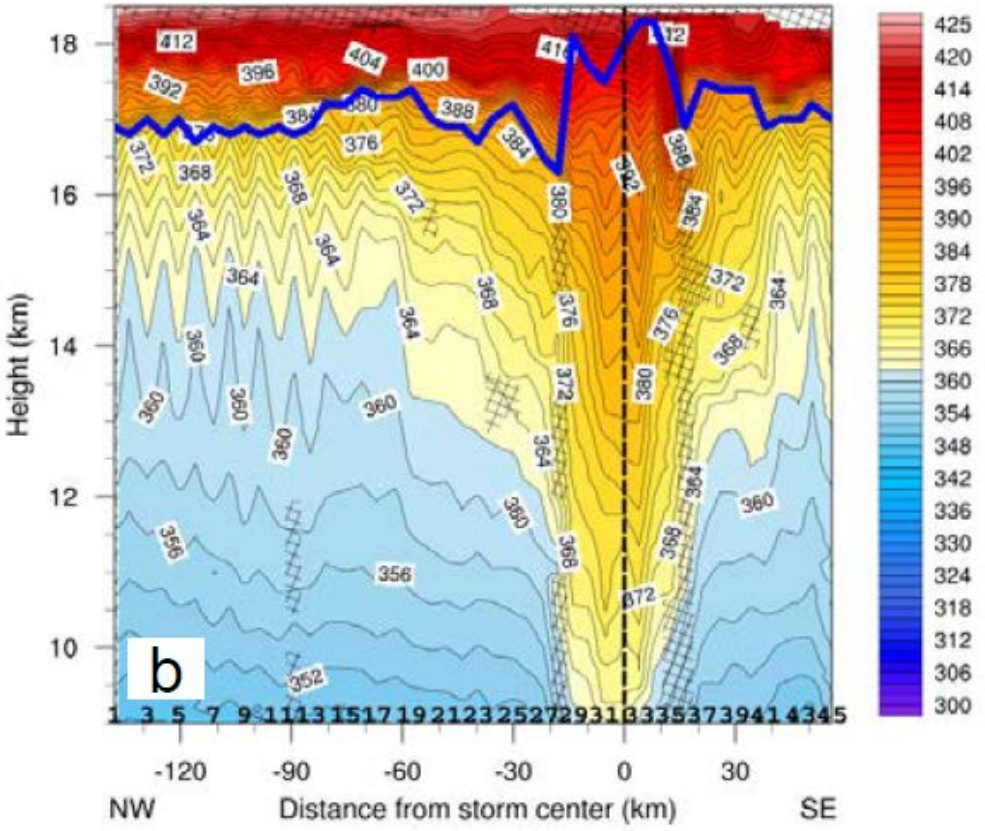
TCI Observations over Hurricane Patricia, 23 October, 2015

- 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



(Courtesy of Derrick Herndon and Chris Velden)

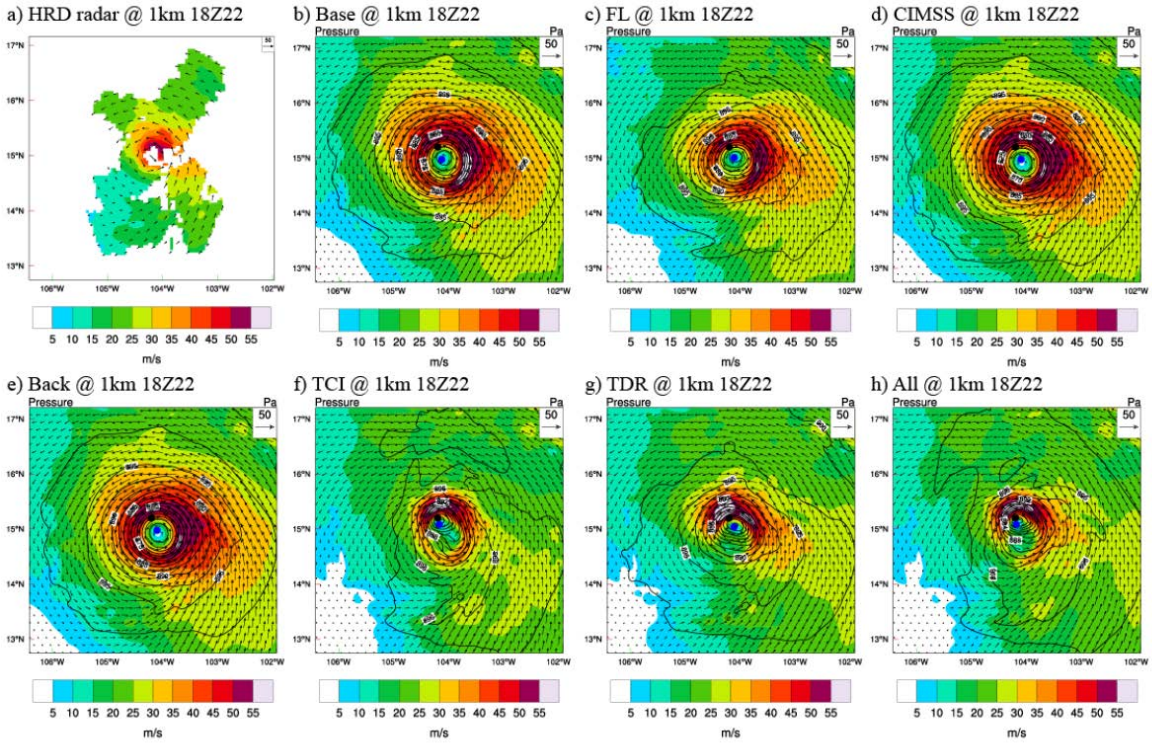


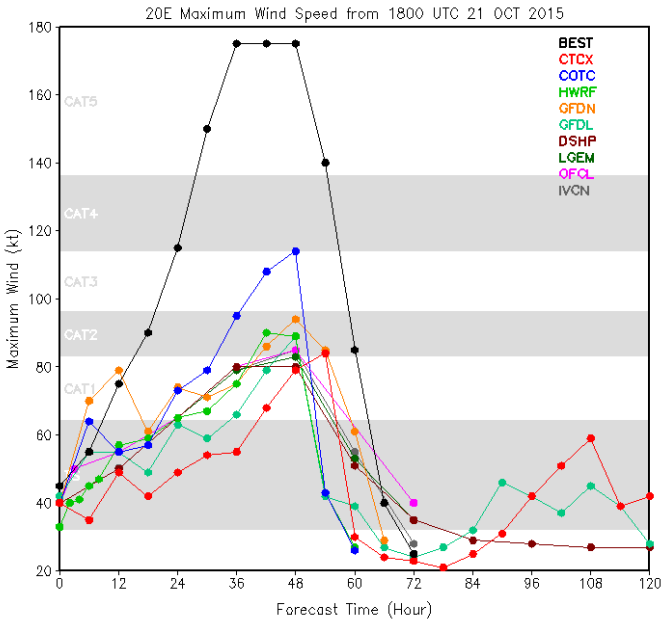
(Courtesy of Patrick Duran)

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 (~ 22C), 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?)
  - X 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***