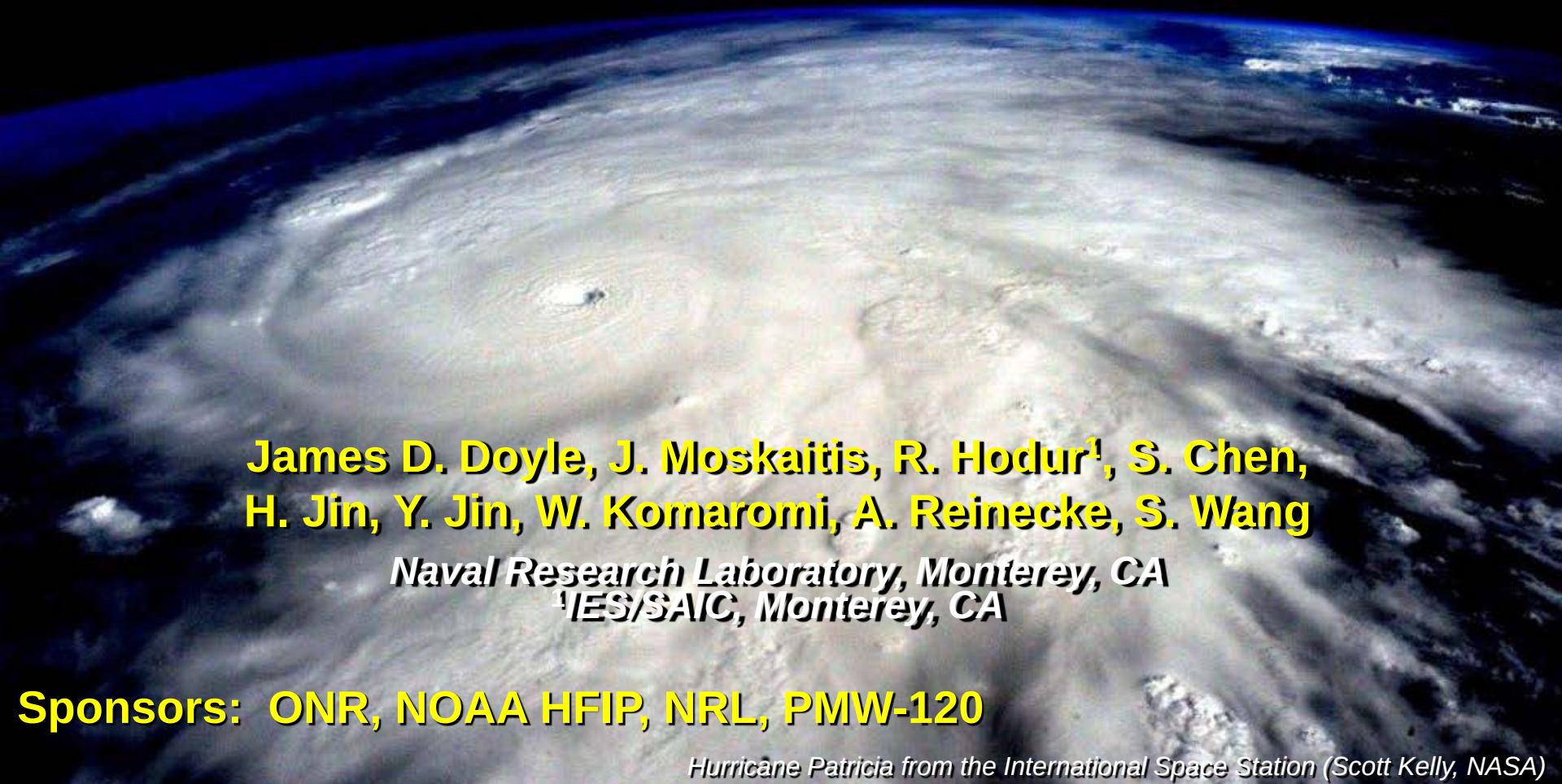
COAMPS-TC 2016 Version, Performance, and Future Plans



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Sponsors: ONR, NOAA HFIP, NRL, PMW-120

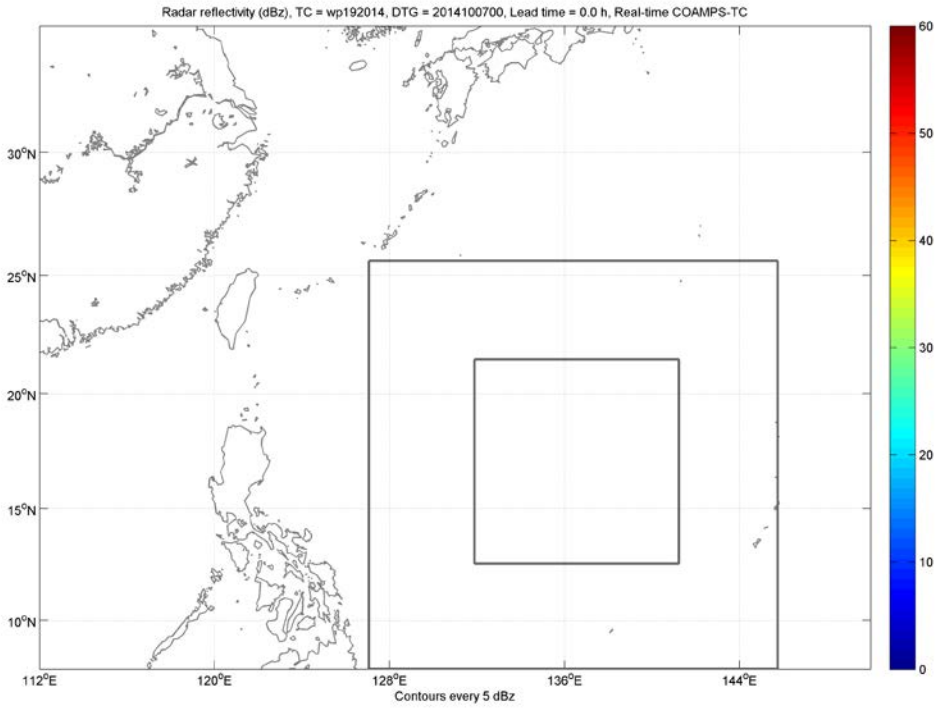
Hurricane Patricia from the International Space Station (Scott Kelly, NASA)

COAMPS-TC System Overview

- **Analysis:** **No cycling or Cycling: 3D-Var (NAVDAS), 4D-Var, EnKF DART**
- **Atmosphere:** **Nonhydrostatic, moving nests, TC physics**
- **Ocean:** **3D-Var (NCODA), 1D, 3D ocean (NCOM), wave (SWAN, WWIII)**
- **Ensemble:** **ICs, BCs, & vortex perturbations; EnKF & ETKF options**
- **Operations:** **45-15-5km for COTC (NAVGEM ICs BCs) & CTCX (GFS ICs BCs)**

Real Time: **i) Fully coupled (NCOM), ii) 27-9-3 km 11 member ensemble**

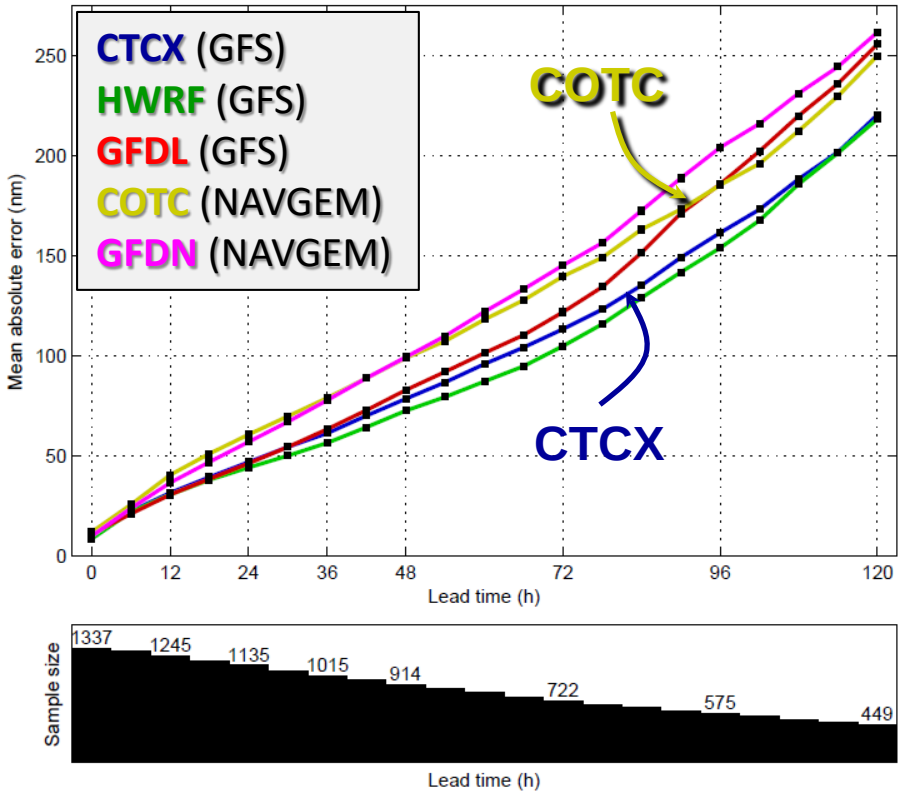
Vongfong (2014) Simulated Radar Reflectivity



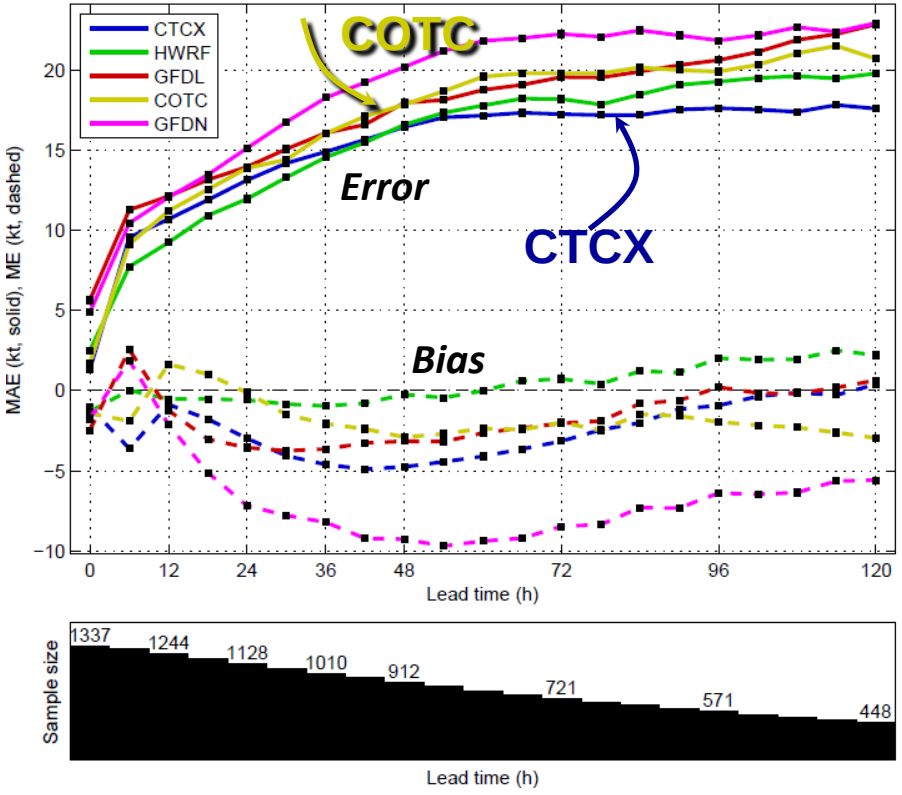
2015 Operational Statistics

Atlantic, WestPac, CentPac, and EastPac

Position Error



Intensity Error & Bias

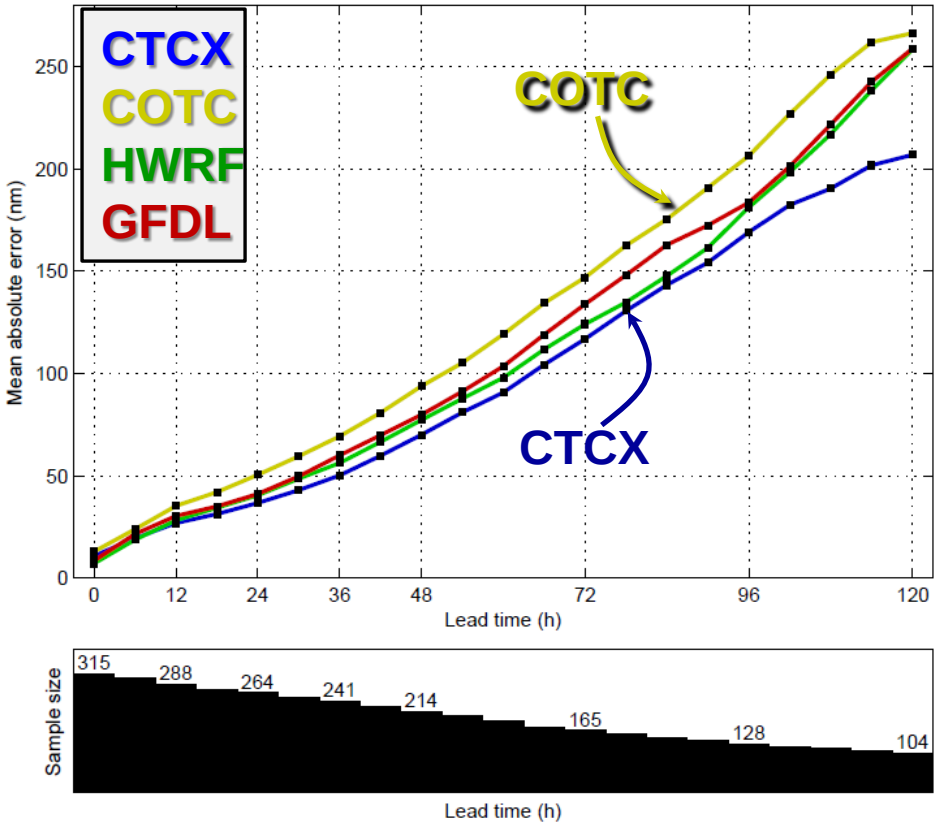


- For position, CTCX errors similar to HWRF. COTC track errors are similar to or better than GFDN.
- For intensity, CTCX has lowest errors for lead times beyond 48 h. COTC outperformed GFDN. Negative intensity bias.
- Extremely large sample of cases in 2015 due to El Niño

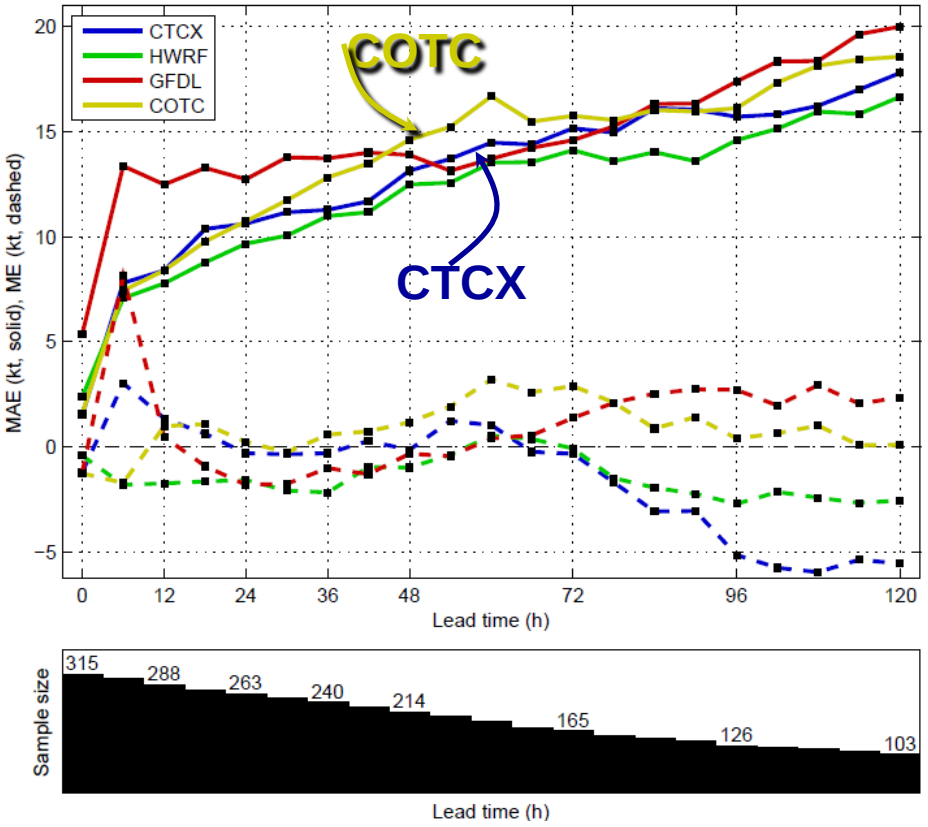
2016 Operational Statistics

Atlantic Basin

Position Error



Intensity Error & Bias

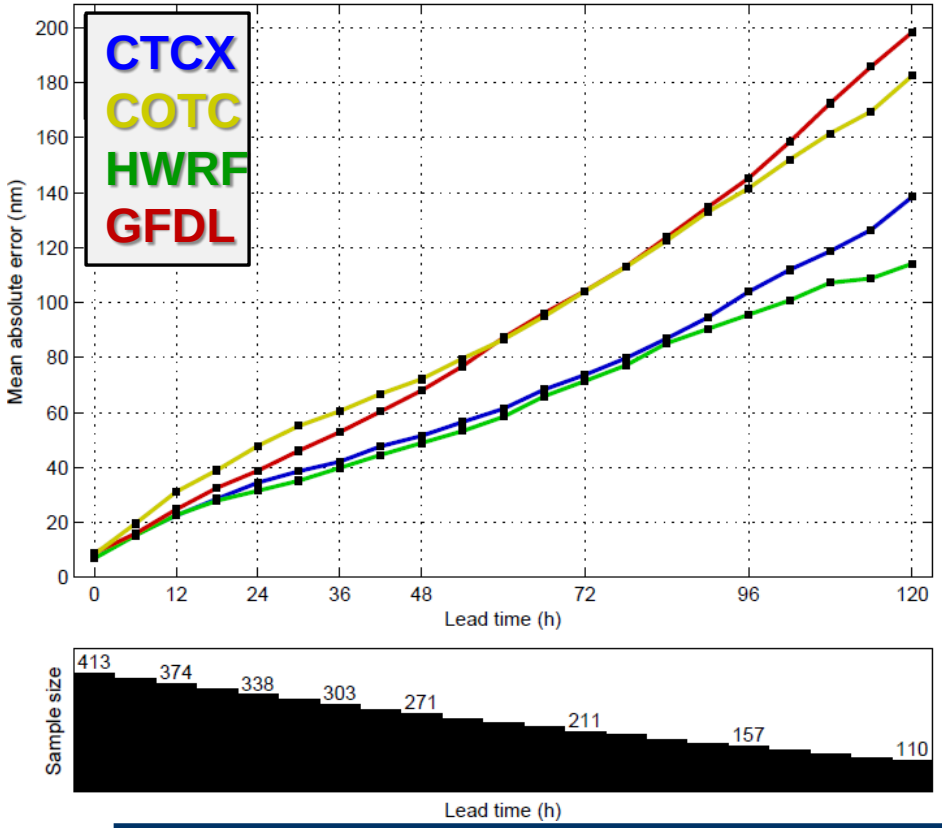


- COTC (NAVGEM) and CTCX (GFS) continued to perform very well in 2016
- CTCX was the top limited area dynamical model for track, and trailed HWRF slightly for intensity

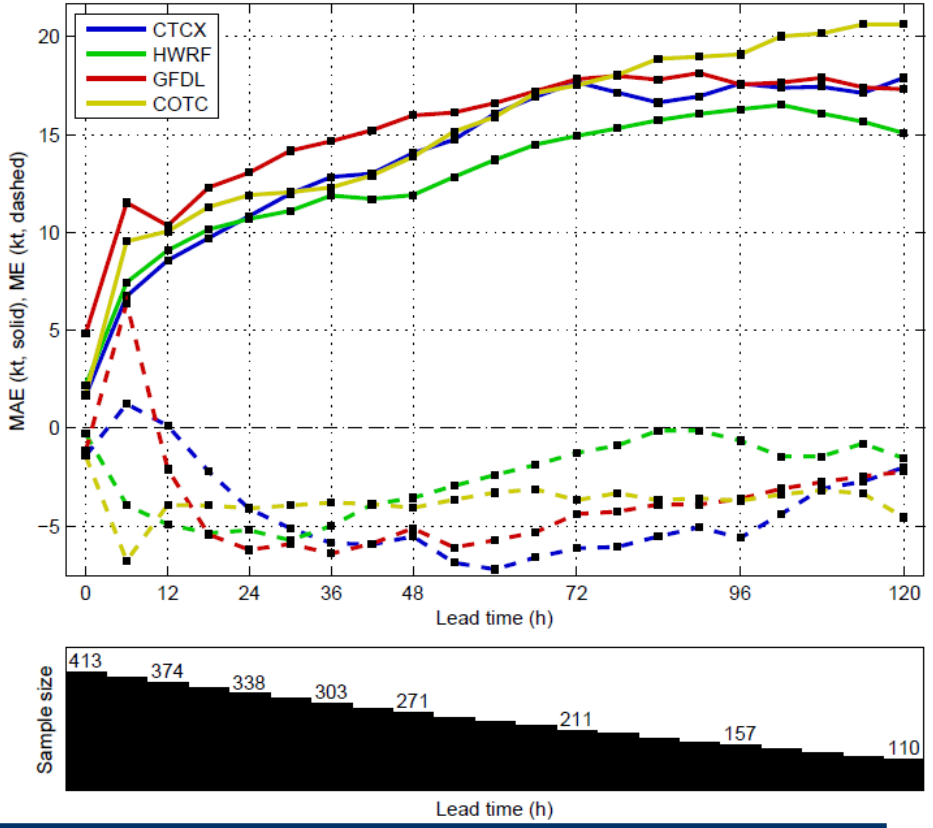
2016 Operational Statistics

E. Pacific Basin

Position Error



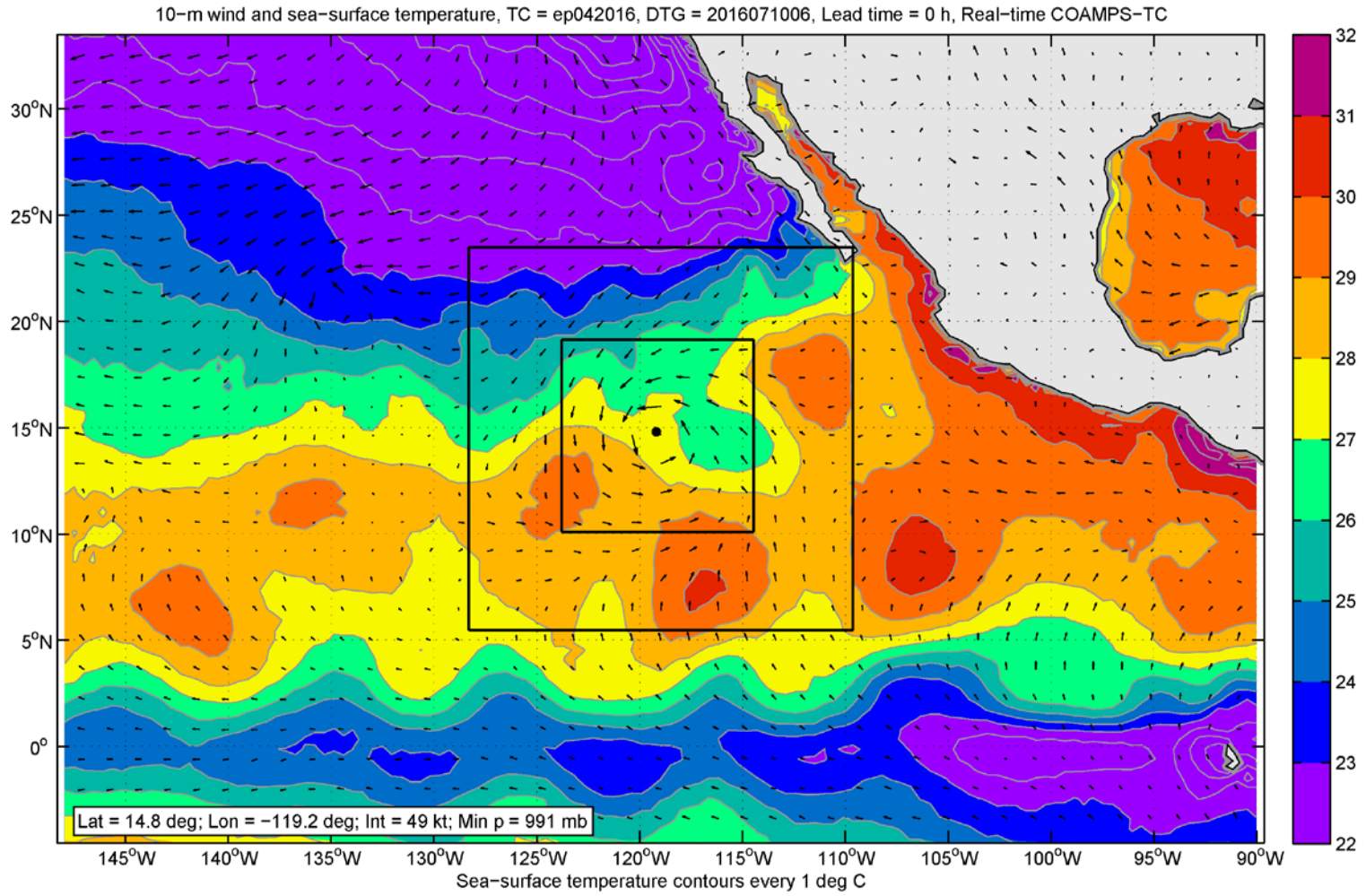
Intensity Error & Bias



- For track, HWRF is the best performing model overall but is nearly tied with CTCX through 84 h lead time. GFDL and COTC are well behind.
- For intensity, HWRF and CTCX have similar intensity errors through 24 h, but after that HWRF has the lowest intensity MAE. All models have a negative intensity bias.

Atmosphere-Ocean Coupling

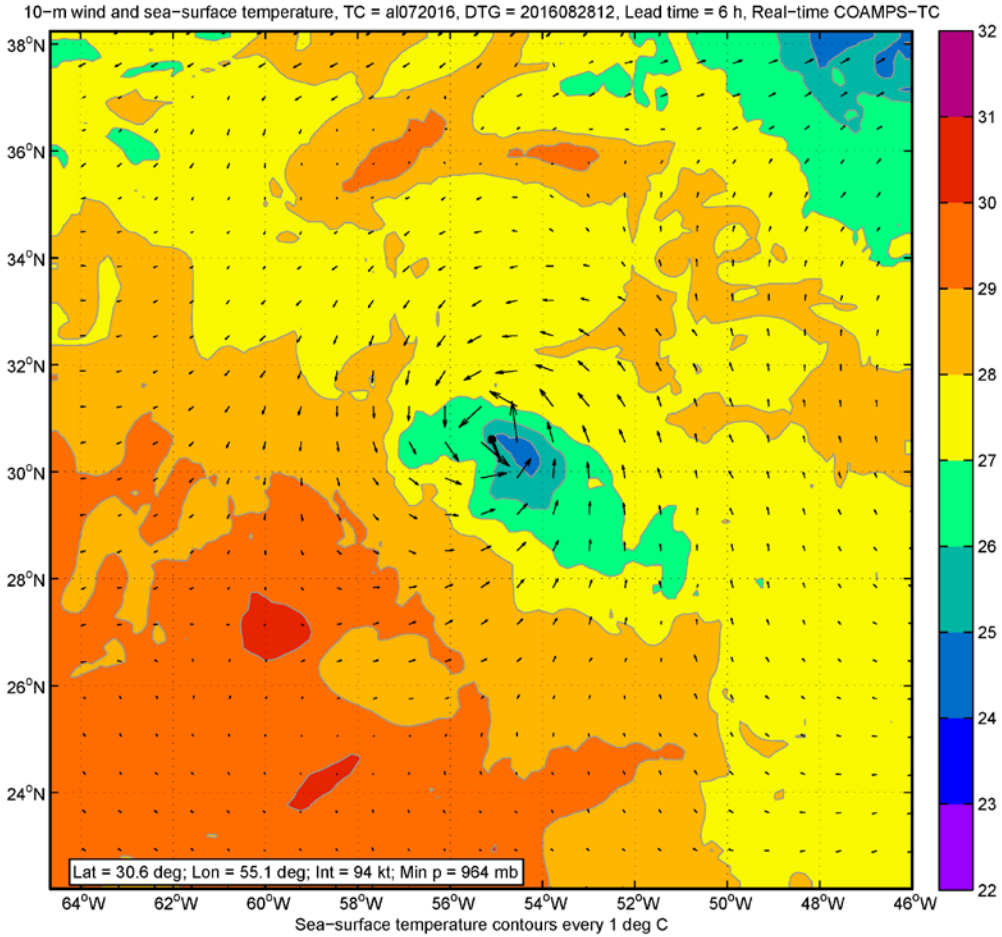
04E SSTs, 10-m winds, TC position and track

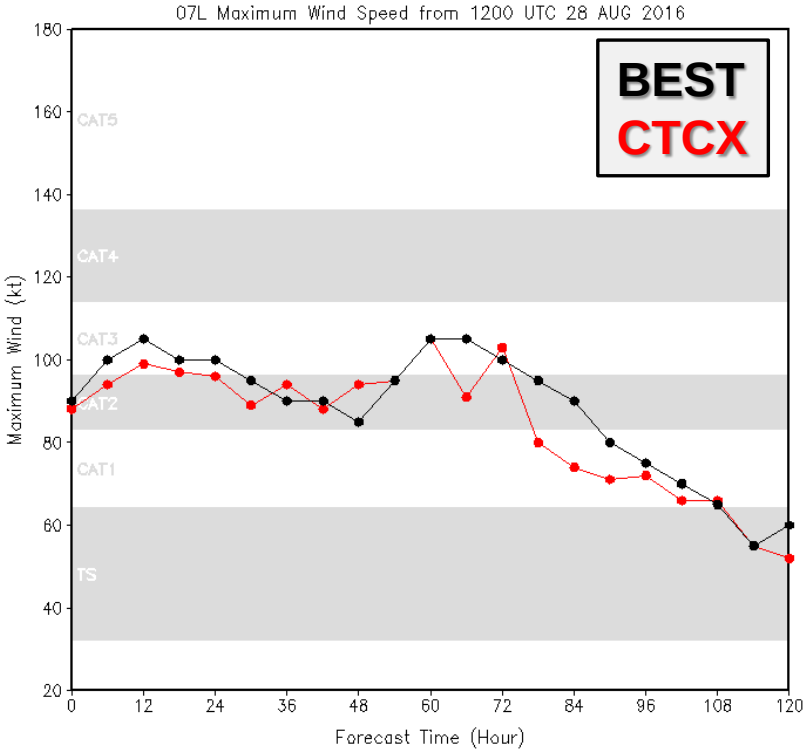


- 2016 model has atmospheric model coupled to NCOM ocean model
- Example: SST evolution for 04E through a N-S oriented SST gradient

Atmosphere-Ocean Coupling

07L SSTs, 10-m winds, TC position and track



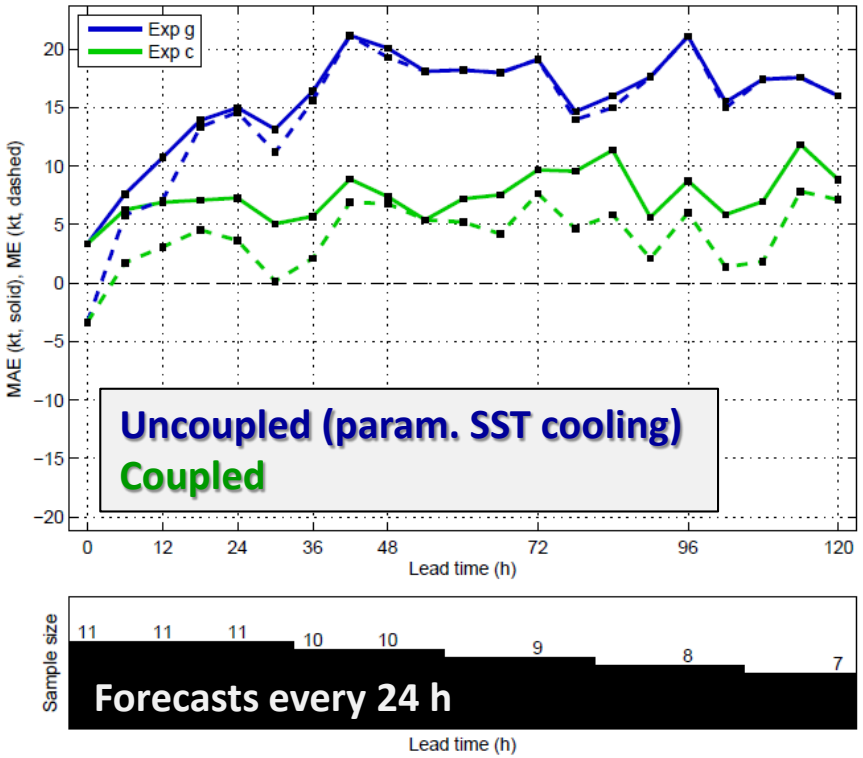


- NCOM model run at 5 km resolution for ocean response under TC
- Example: SST evolution for 07E, showing storm-induced SST cooling

Atmosphere-Ocean Coupling

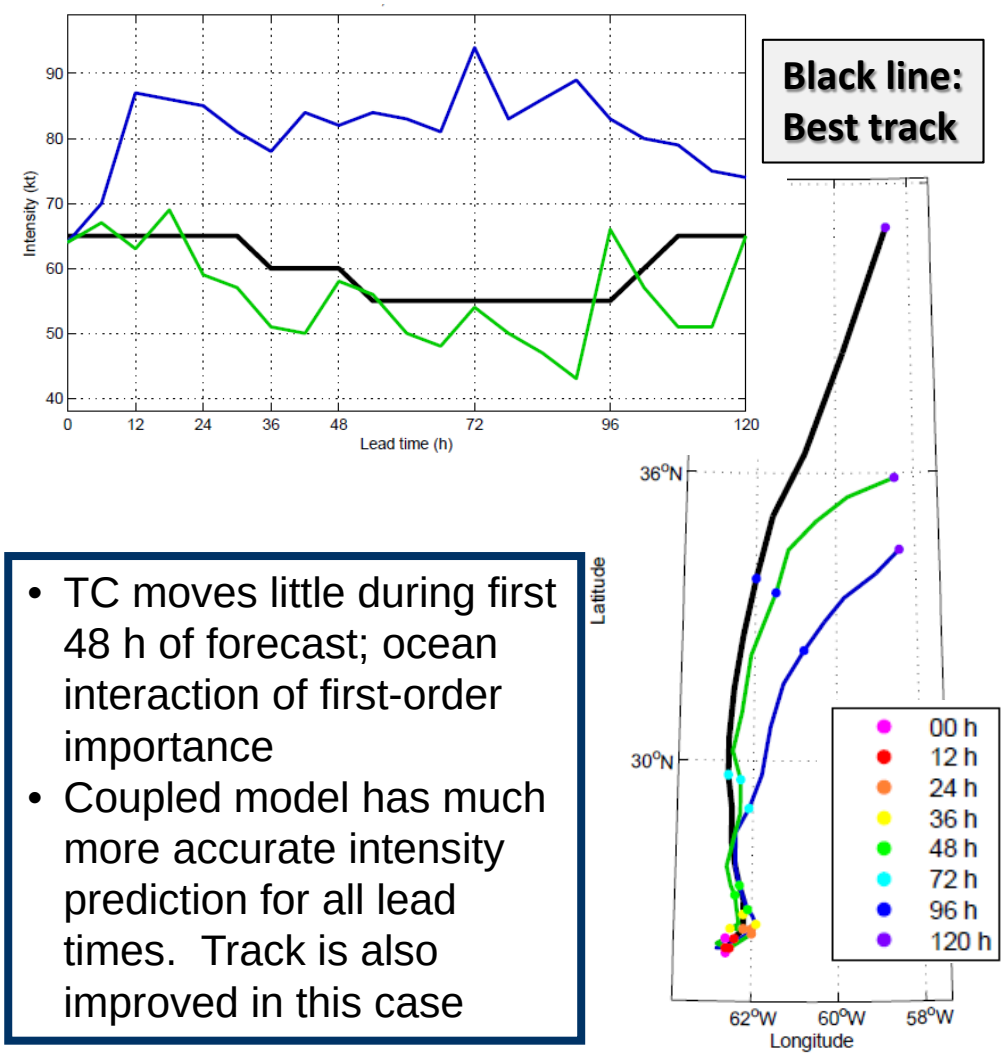
Benefits of Coupling

Hurricane Leslie (2012): Intensity Error & Bias



For a very slow-moving TC such as Leslie, the coupled model substantially outperforms uncoupled model in intensity prediction

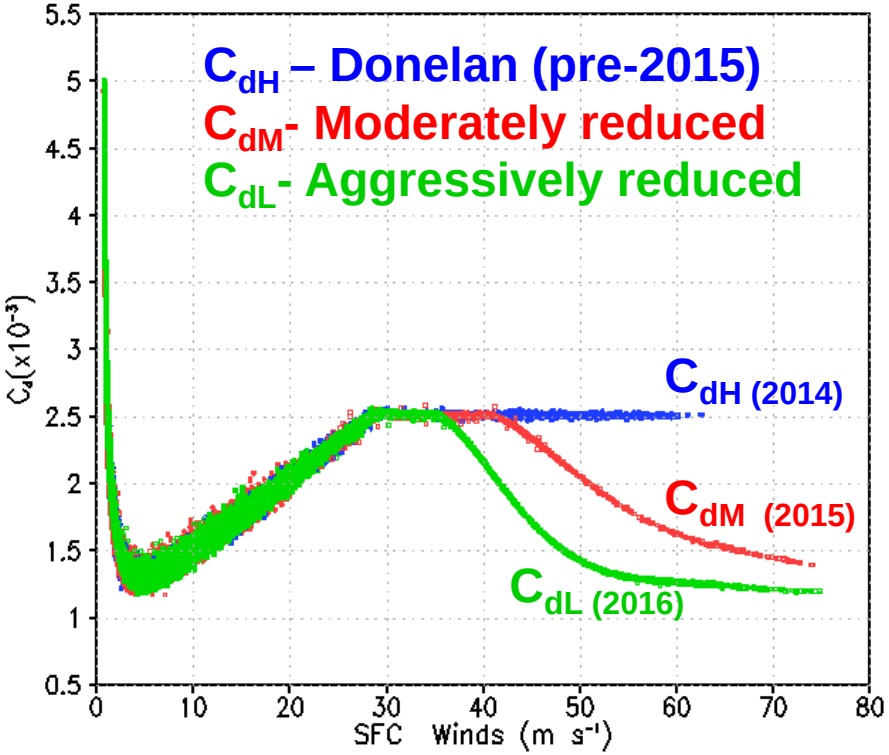
Hurricane Leslie (2012): 2012090600 forecast

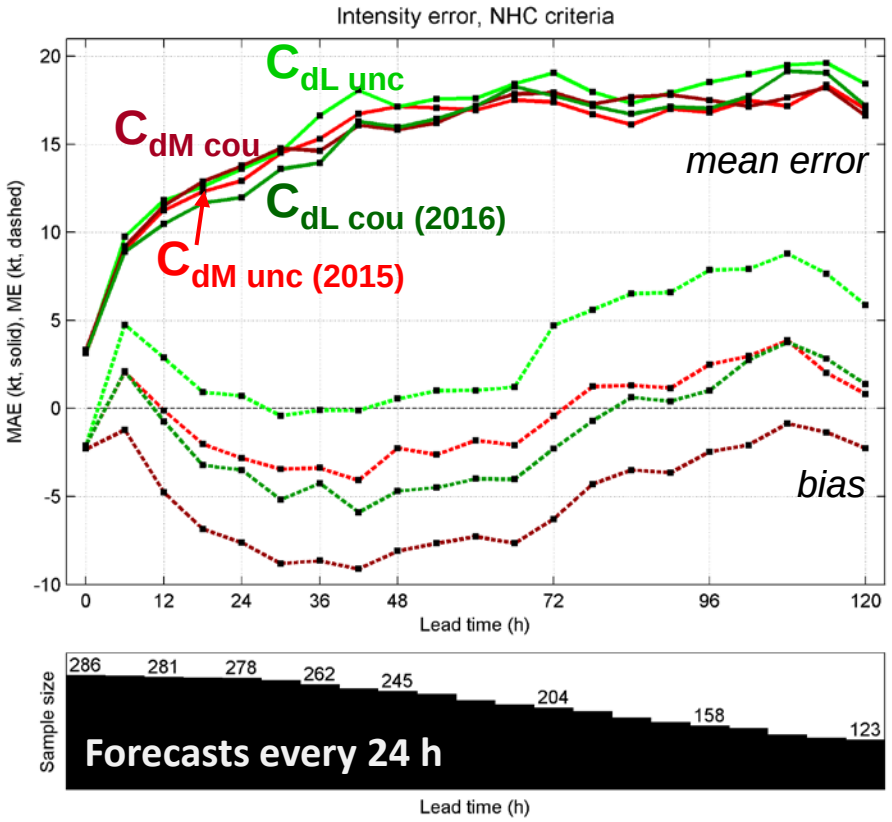


- TC moves little during first 48 h of forecast; ocean interaction of first-order importance
- Coupled model has much more accurate intensity prediction for all lead times. Track is also improved in this case

New Surface Drag Parameterization

A series of C_d formulations have been evaluated for a large retrospective sample, including 44 TCs during 2012-2015 in the ATL, WPAC and EPAC basins.

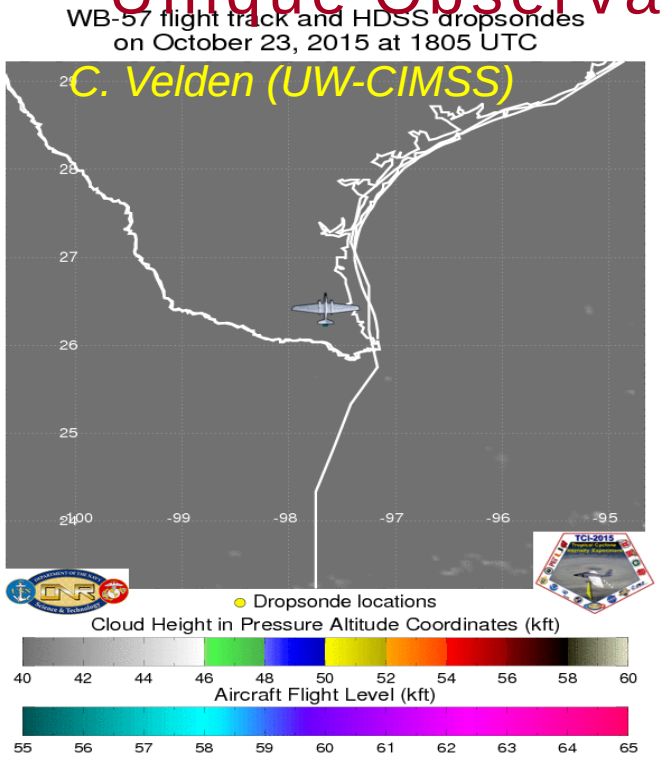




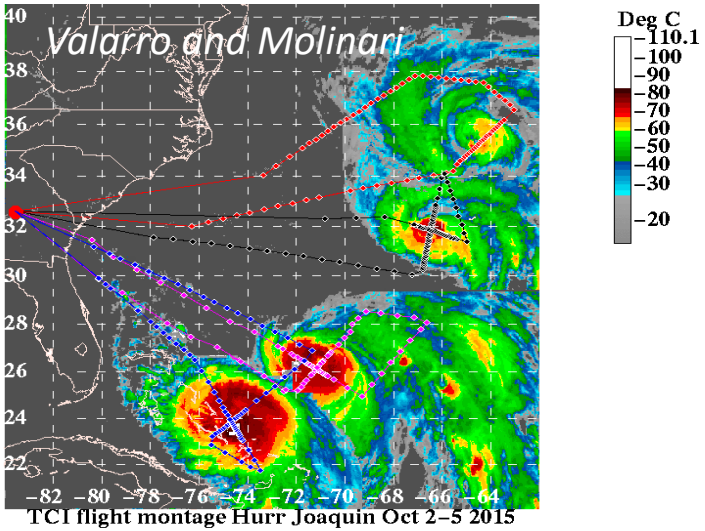
- The C_{dM} performs best for intensity for **uncoupled forecasts**
- The C_{dL} performs best for intensity for **coupled forecasts (basis for 2016 COTC)**
- The C_d has significant impact on intensity distribution and pressure-wind relation

ONR Tropical Cyclone Intensity (TCI) 2015

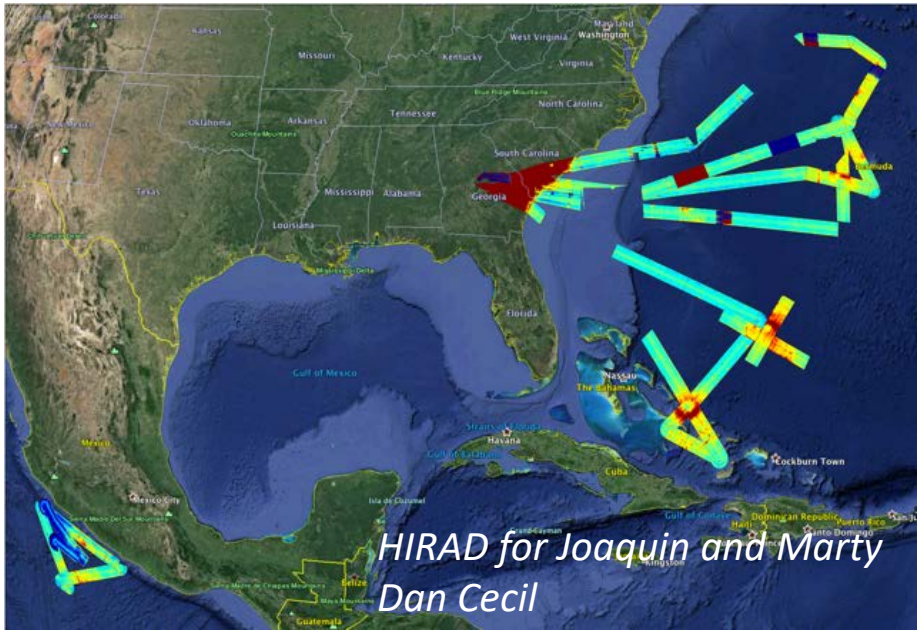
Unique Observations of Marty, Joaquin, Patricia



- **Unprecedented set of dropsonde and HIRAD observations in Hurricanes Marty, Joaquin, Patricia**
- **~800 sondes deployed in 4 TCs in 11 WB-57 flights.**
- **Systematic high-resolution obs of inner core and outflow from 60 kft.**
- **Verification & DA experiments underway**



WB-57 Flight Track and Dropsondes in Hurricane Patricia



COAMPS-TC
Summary and Future Plans

➢COAMPS-TC Much Improved for Track & Intensity in 2015/16:

- Improved "spin-down" and intensity error (new vortex initialization; new C_D param.)
- Improved track errors (new initialization; new terrain)
- Coupled COAMPS-TC with ocean model NCOM (2016)
- Multi-model high-res. ensemble (NOAA/Navy) and air-ocean coupling promising.

➢COAMPS-TC Future Plans:

- 2017 Priorities (Target 4 km resolution)
  - TC physics: new PBL (EDMF), refinement to C_D parameterization
  - Analysis: Improvements to vortex initialization
  - Coupling: Ocean (NCOM), ocean DA with NCODA
  - Ensemble: 3 km ensemble (w/ HFIP): WATL, EPAC, WPAC (11 member)
- 2018+ Priorities
  - TC physics: Emphasis on PBL, fluxes, microphysics
  - Analysis: 4D-Var/EnKF, satellite DA
  - Ensemble: Stochastic physics
  - Coupling: Ocean, waves, coupled DA
  - Resolution: i) ~1 km (nest following) ii) ~4 km basin scale
- Utilize field observations: ONR TCI,NASA HS3…

6-120h Simulated Radar Reflectivity (00Z 2 Oct 2013)