COAMPS-TC Status and Future Plans

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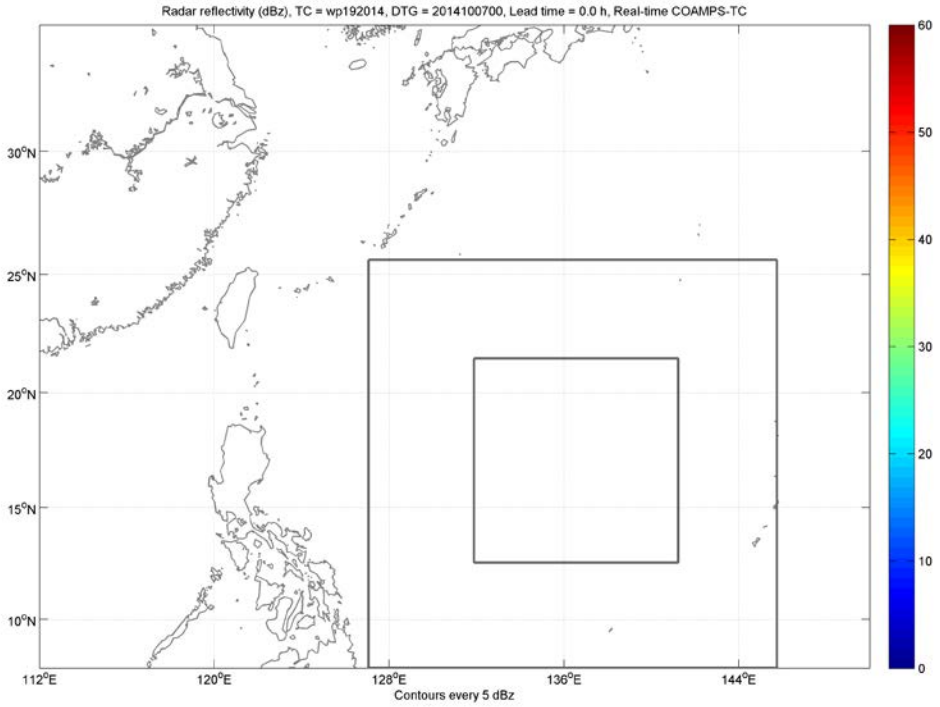
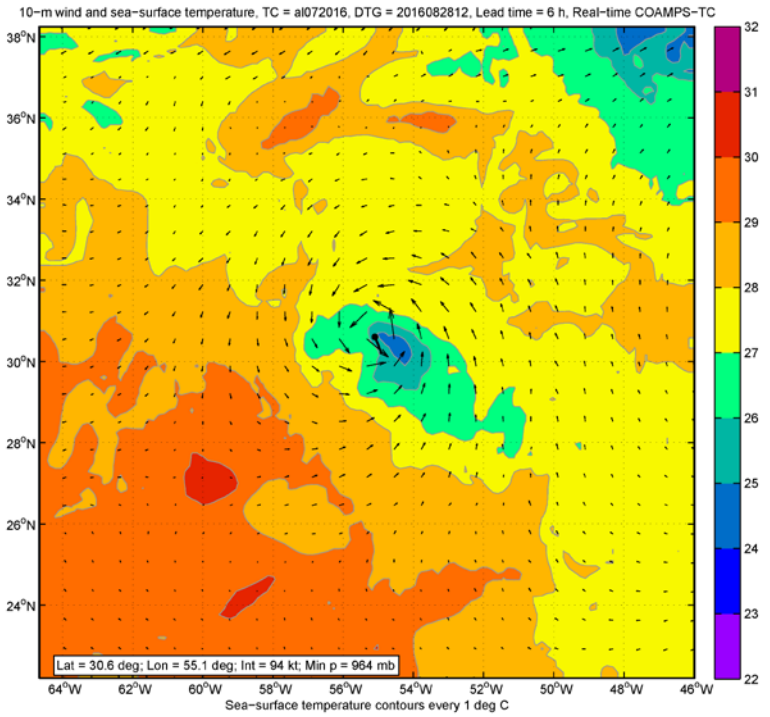
COAMPS-TC System Overview

- COAMPS-TC is a specialized version of COAMPS designed to predict tropical cyclone (TC) track, intensity and structure (wind radii)
- Features: TC-following nested grid meshes (4 km on inner mesh, 40L)
  Specialized TC PBL physics (C_D and PBL); Vortex initialization
  Coupled with NRL Coastal Ocean Model, NCOM
- Operational at Navy FNMOC since 2013 using NAVGEM BCs (**COTC**)
- "Real-time" mode at NRL since 2013 using GFS BCs (**CTCX**)

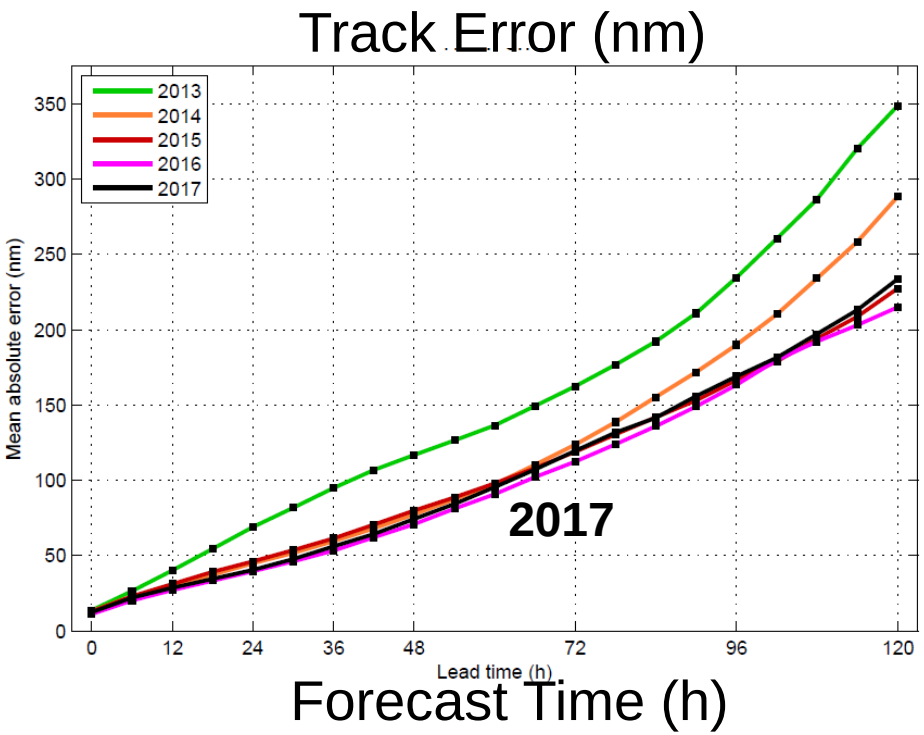
Vongfong (2014) Simulated Radar Reflectivity

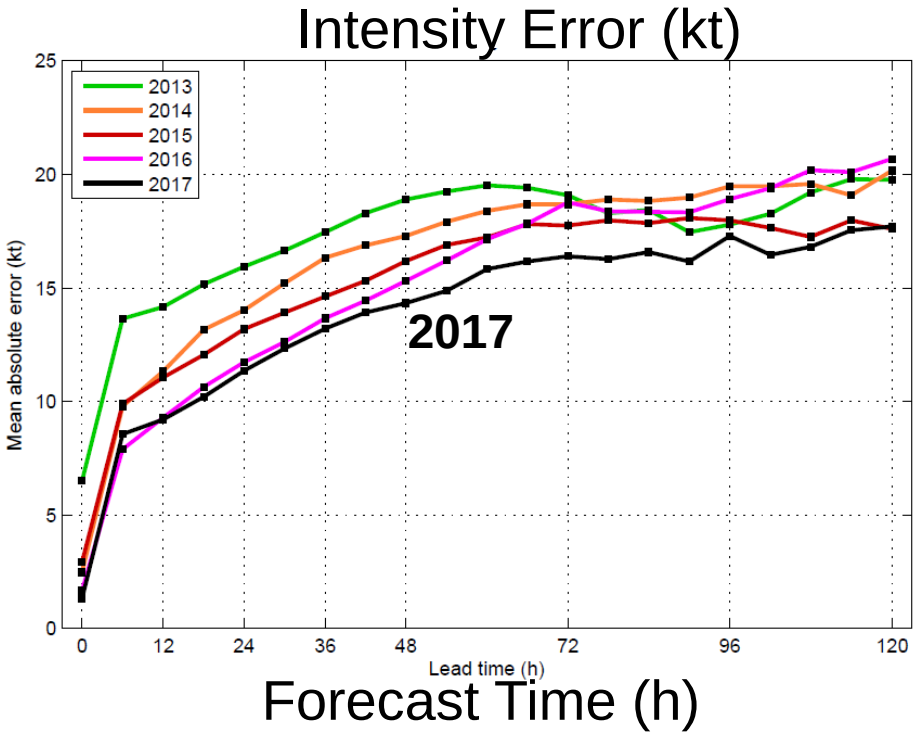


Gaston (07L) (12Z 28 Aug 2016)



COAMPS Performance History
2013-2017 (AL/EP/CP/WP)



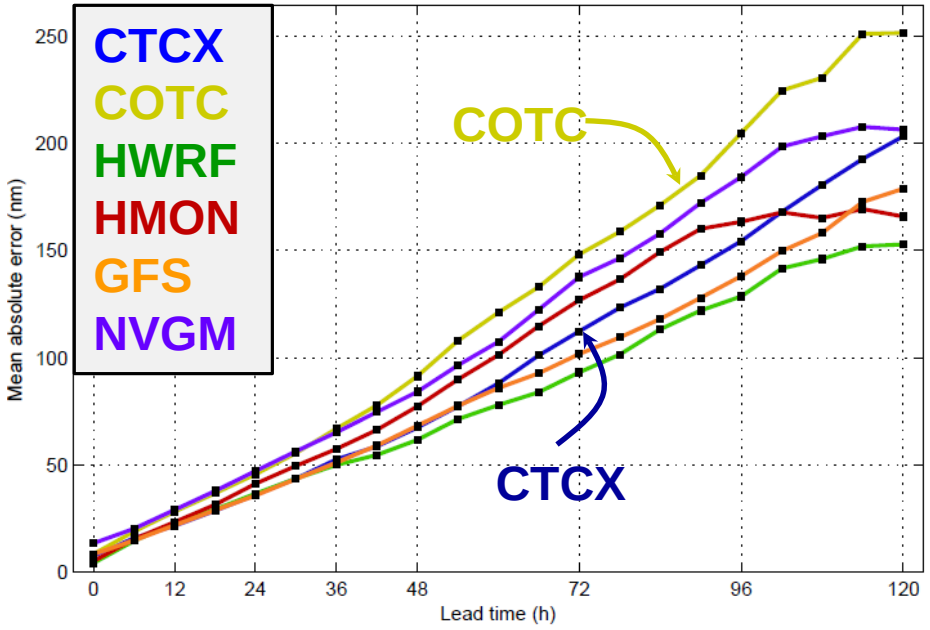


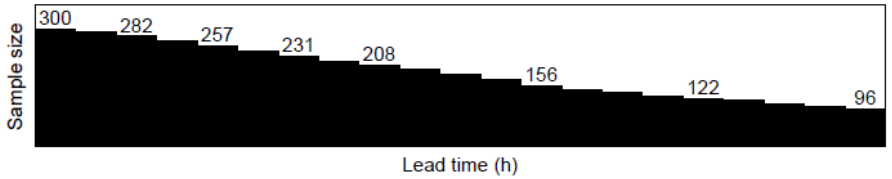
- Marked improvements in COAMPS-TC (CTCX) forecasts since 2013
- 2017 version of COAMPS-TC with 4 km horizontal resolution.
  - Intensity MAE improved substantially (~10% over 2016)
  - Forecasts improved for TCs with observed rapid intensification

2017 Operational Statistics

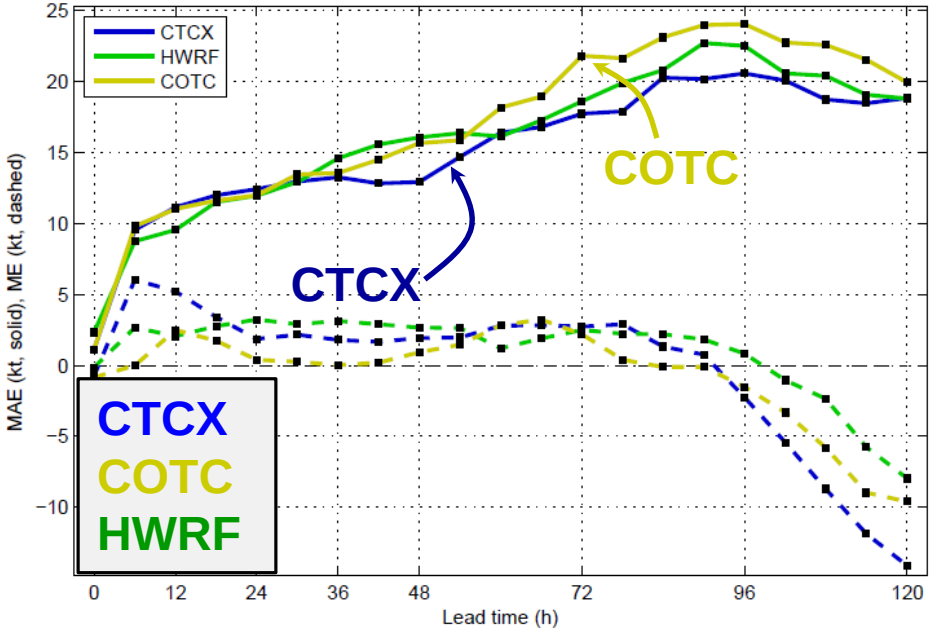
Western Atlantic

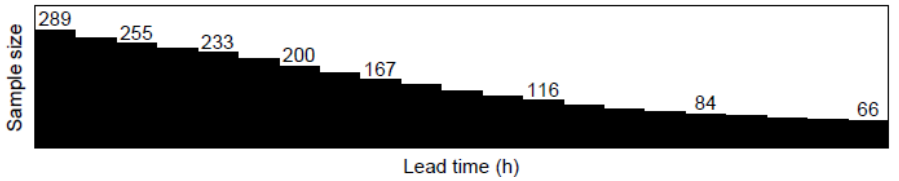
Position Error





W. Pacific *Intensity Error & Bias*

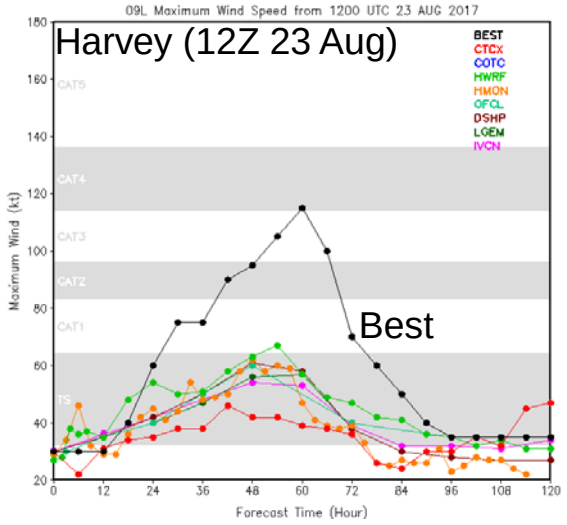


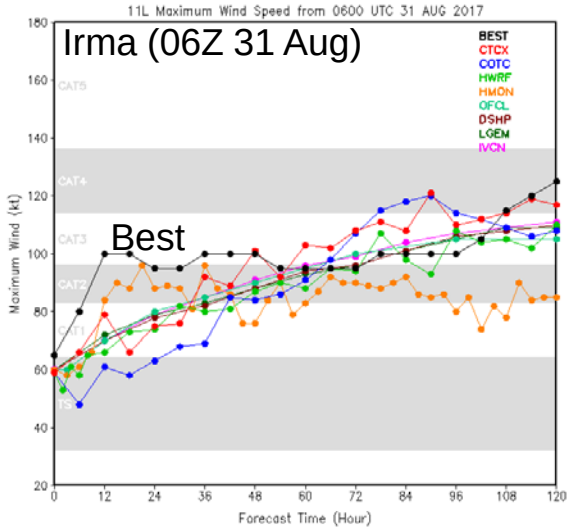


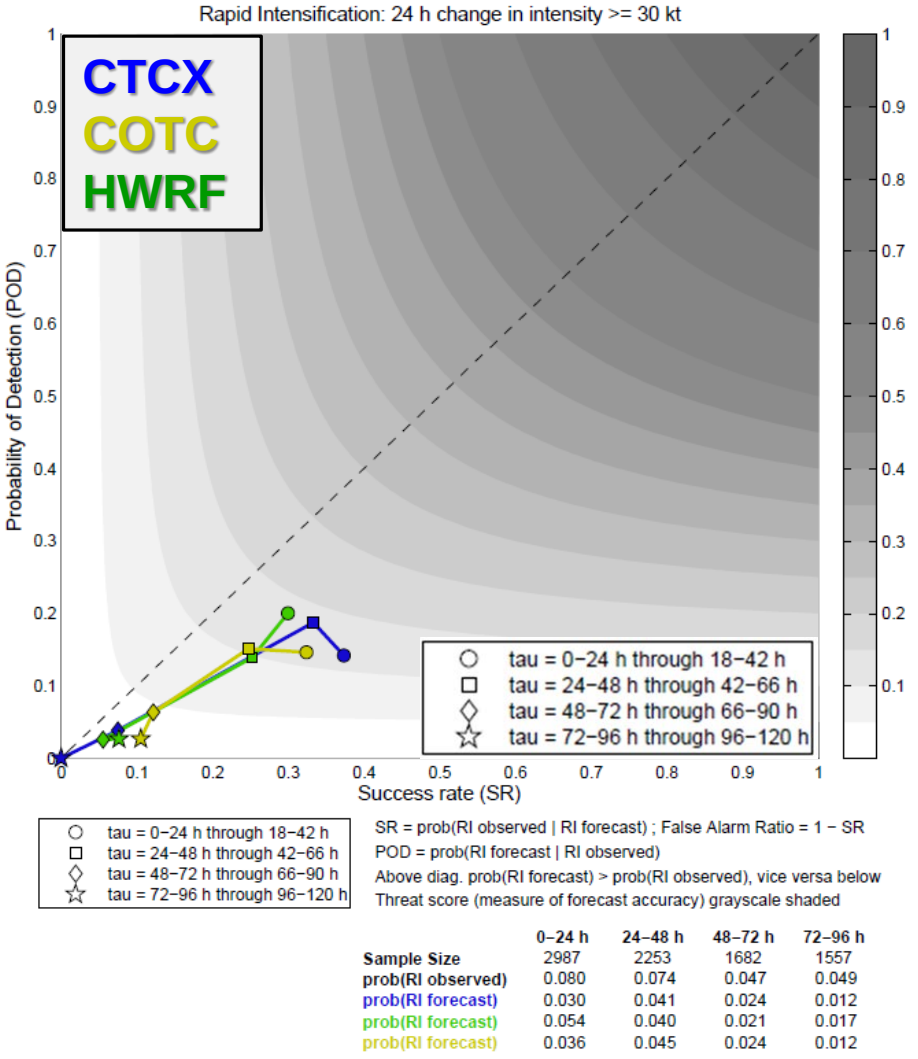
- CTCX (GFS based) track trails HWRF by less than 25 nm in first 72h (NE bias)
- COTC (NAVGEM based) track trails NAVGEM, CTCX
- WATL: CTCX generally has 0-3 kt greater intensity errors than HWRF
- WPAC: CTCX top performer for intensity

Rapid Intensification

2017 Atlantic, Eastern, and Western Pacific







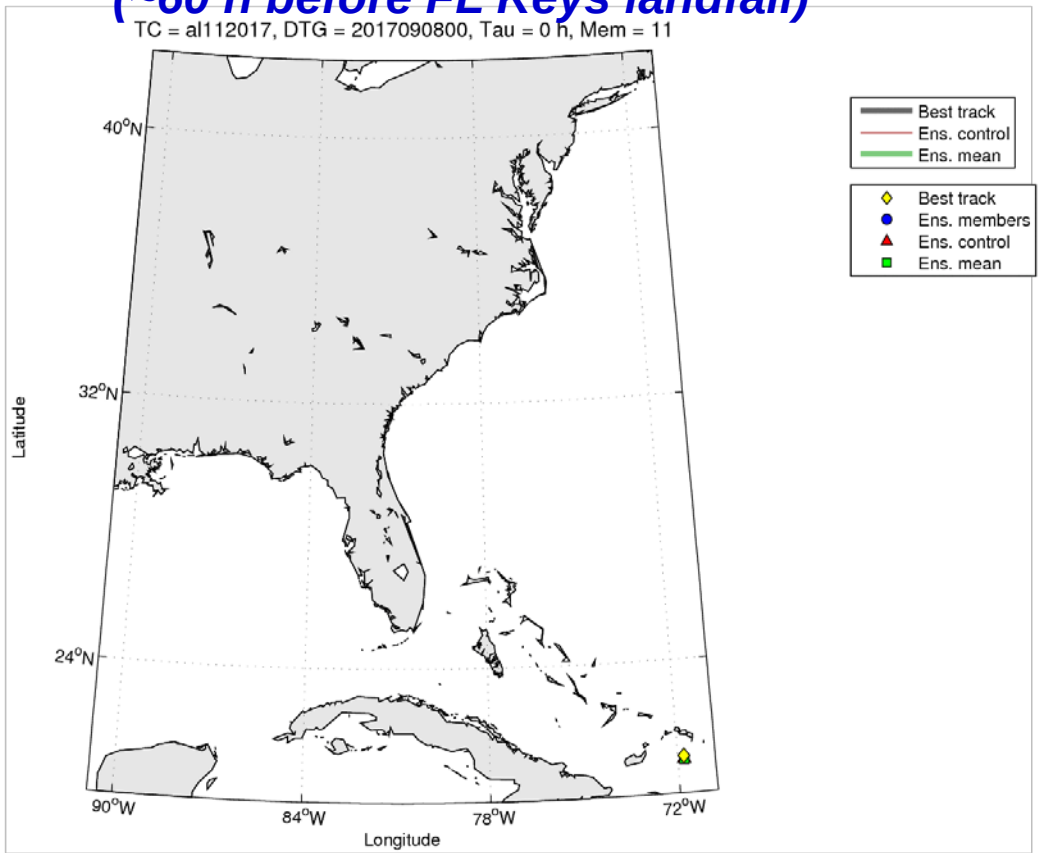
	0–24 h	24–48 h	48–72 h	72–96 h
Sample Size	2987	2253	1682	1557
prob(RI observed)	0.080	0.074	0.047	0.049
prob(RI forecast)	0.030	0.041	0.024	0.012
prob(RI forecast)	0.054	0.040	0.021	0.017
prob(RI forecast)	0.036	0.045	0.024	0.012

CTCX, COTC and HWRF exhibit similar skill for rapid intensification (relatively poor)

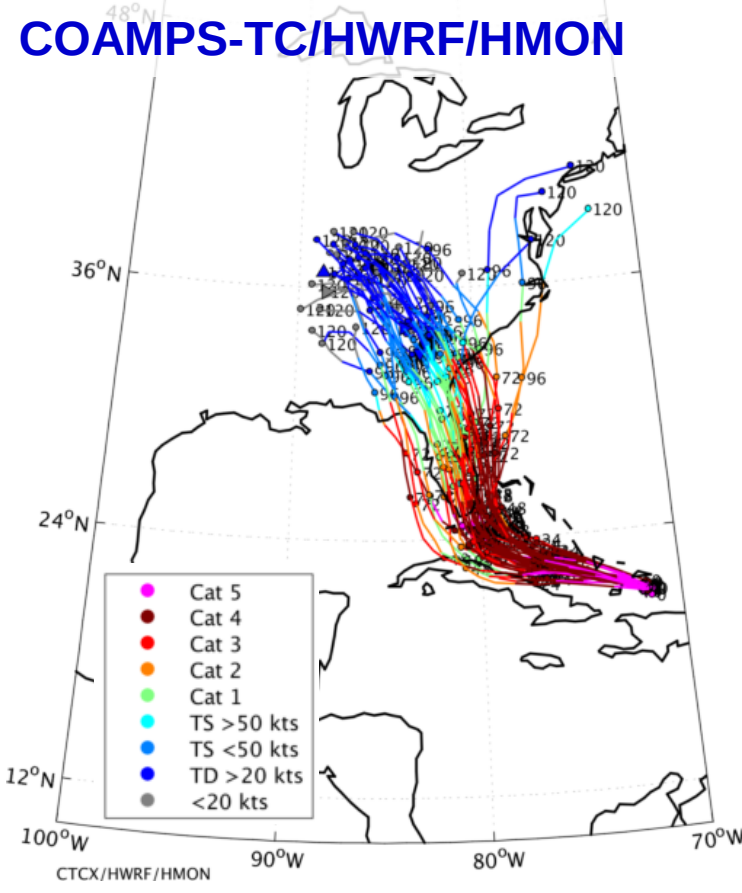
HFIP High-Resolution Ensemble

- Intensity changes (RI) may not be predictable in a deterministic sense.
- Multi-model ensembles are more capable of accounting for forecast uncertainty
- Real-time HFIP ensemble: COAMPS-TC (4km), HWRF (3km), HMON (3km)
- COAMPS-TC & HWRF control consensus and ensemble mean outperform their single-model counterparts in deterministic validation

Irma (11L), 2017090800 initial time (~60 h before FL Keys landfall)



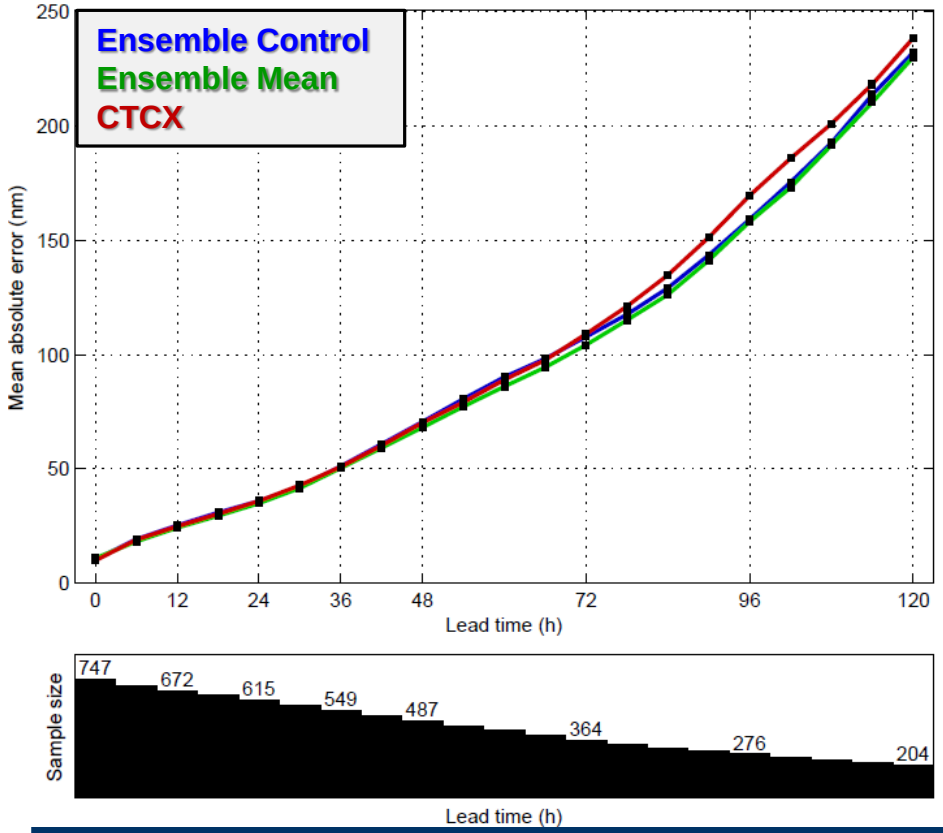
Multi-Model HFIP Ensemble COAMPS-TC/HWRF/HMON



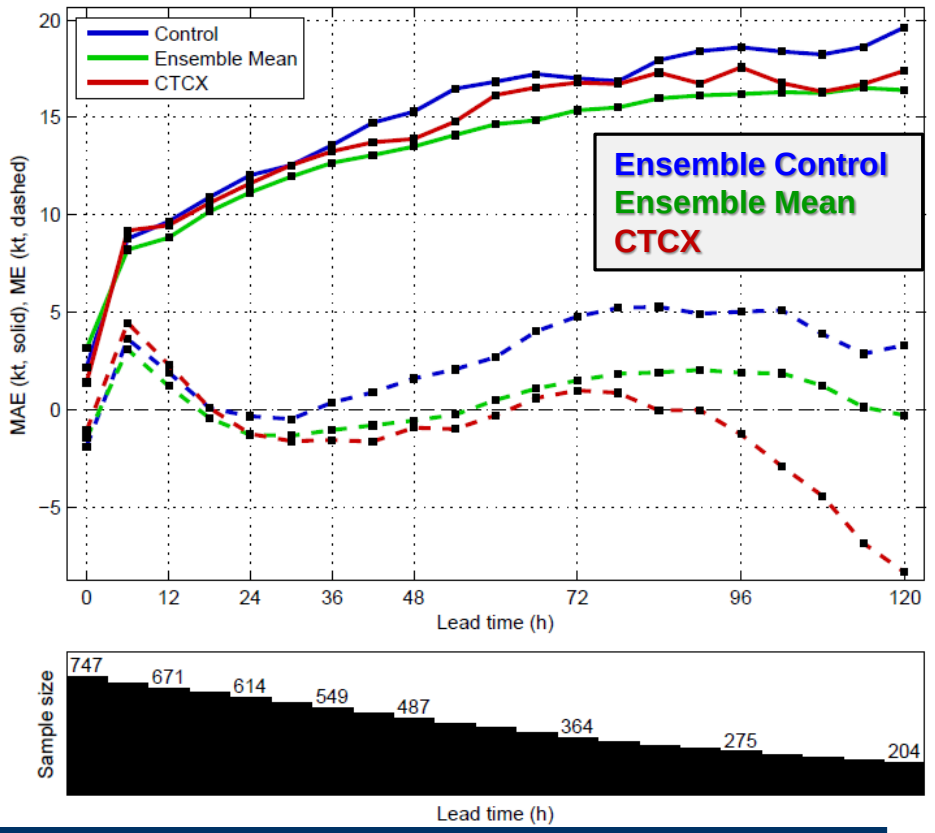
COAMPS-TC Ensemble System
2017 Statistics

Ensemble control vs Ensemble mean vs CTCX

ATL/EPAC/WPAC Track MAE



ATL/EPAC/WPAC Intensity



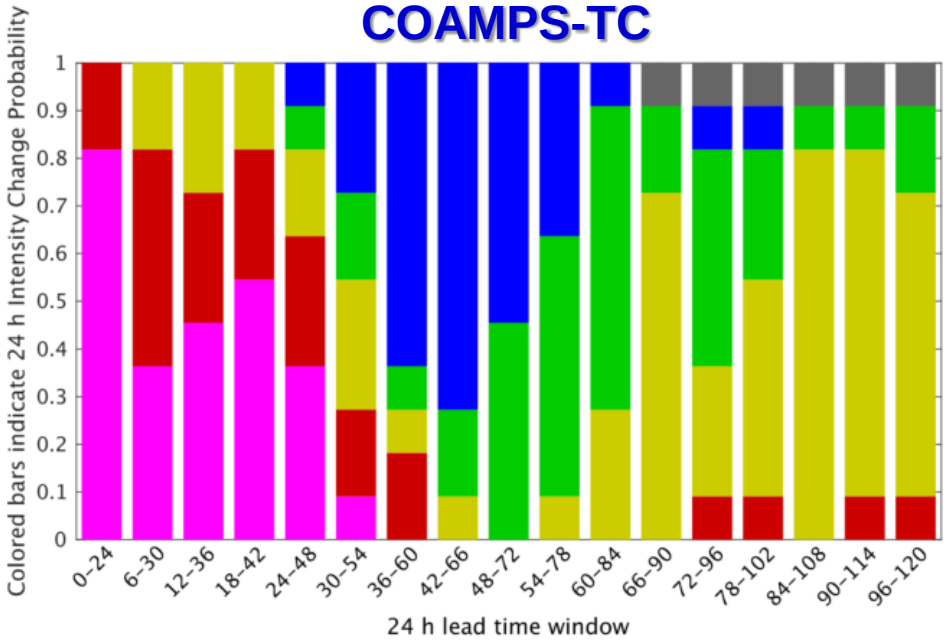
Track: Ensemble mean similar or better MAE w.r.t. control for most lead times
Intensity: Ensemble mean has a lower MAE than CTRL and CTCX through 72h (ATL) and 120h (ATL/EPAC/WPAC)

COAMPS-TC Ensemble System
2017 Real-Time Products

Ensemble forecast products: 24 h intensity change probabilities

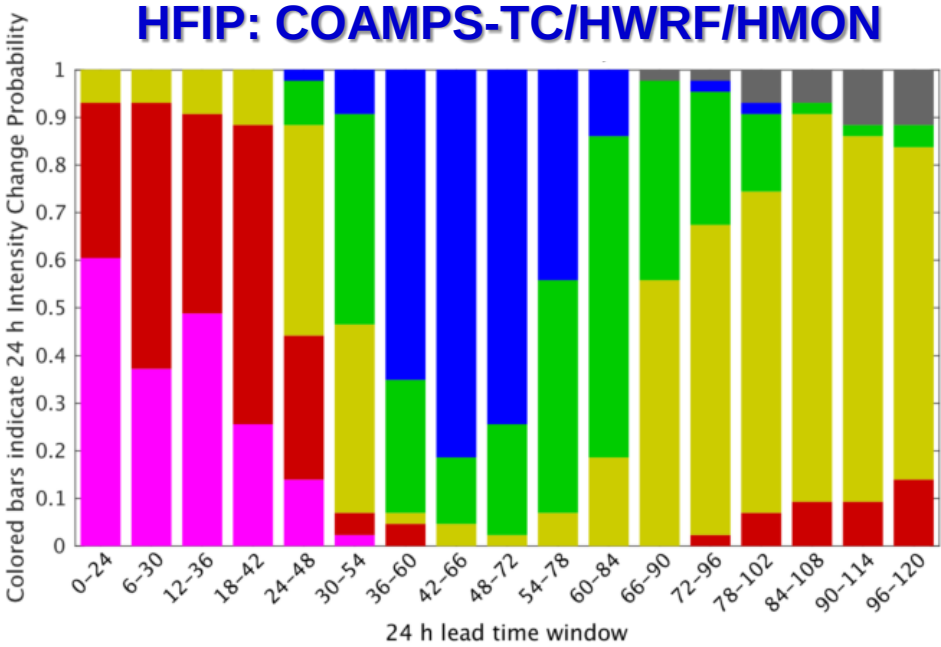
Harvey (09L), 2017082406 initial time (~48 h before TX landfall)

COAMPS-TC



Δ I >= 30 kt (Rapid Intensification)
10 kt <= Δ I < 30 kt (Moderate Intensification)
-10 kt < Δ I < 10 kt (Steady Intensity)
-30 kt < Δ I <= -10 kt (Moderate Weakening)
Δ I <= -30 kt (Rapid Weakening)
TC already dissipated or dissipates during window

HFIP: COAMPS-TC/HWRF/HMON



Δ I >= 30 kt (Rapid Intensification)
10 kt <= Δ I < 30 kt (Moderate Intensification)
-10 kt < Δ I < 10 kt (Steady Intensity)
-30 kt < Δ I <= -10 kt (Moderate Weakening)
Δ I <= -30 kt (Rapid Weakening)
TC already dissipated or dissipates during window

New product to display the 24h intensity change probabilities

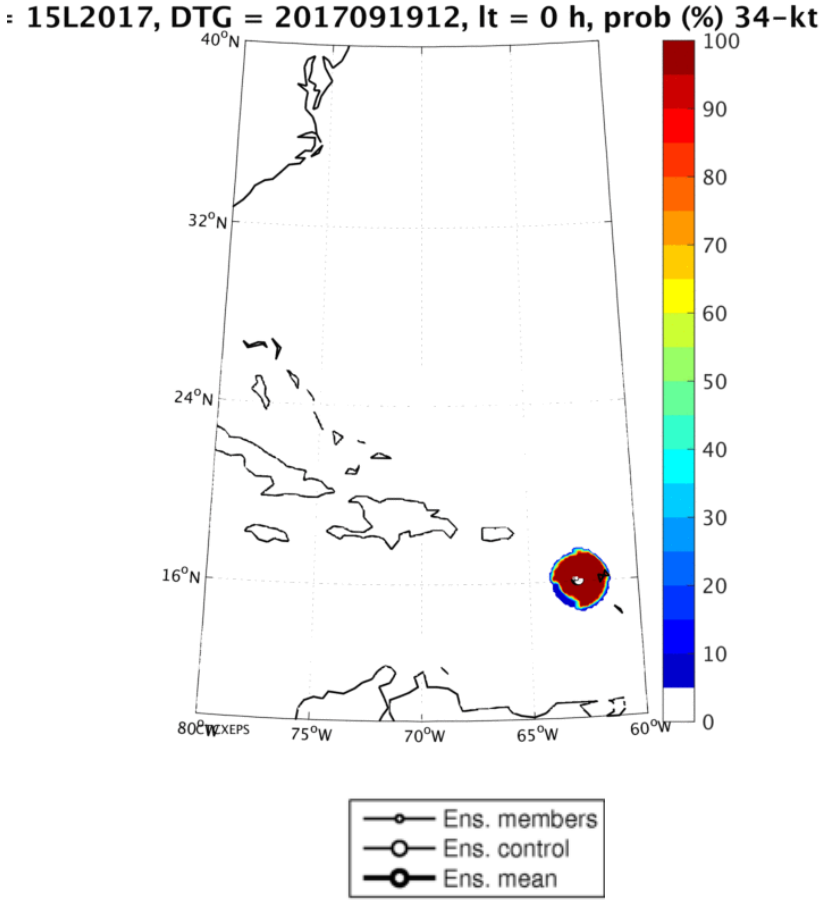
https://www.nrlmry.navy.mil/coamps-web/web/ens?&spg=1

COAMPS-TC Ensemble System

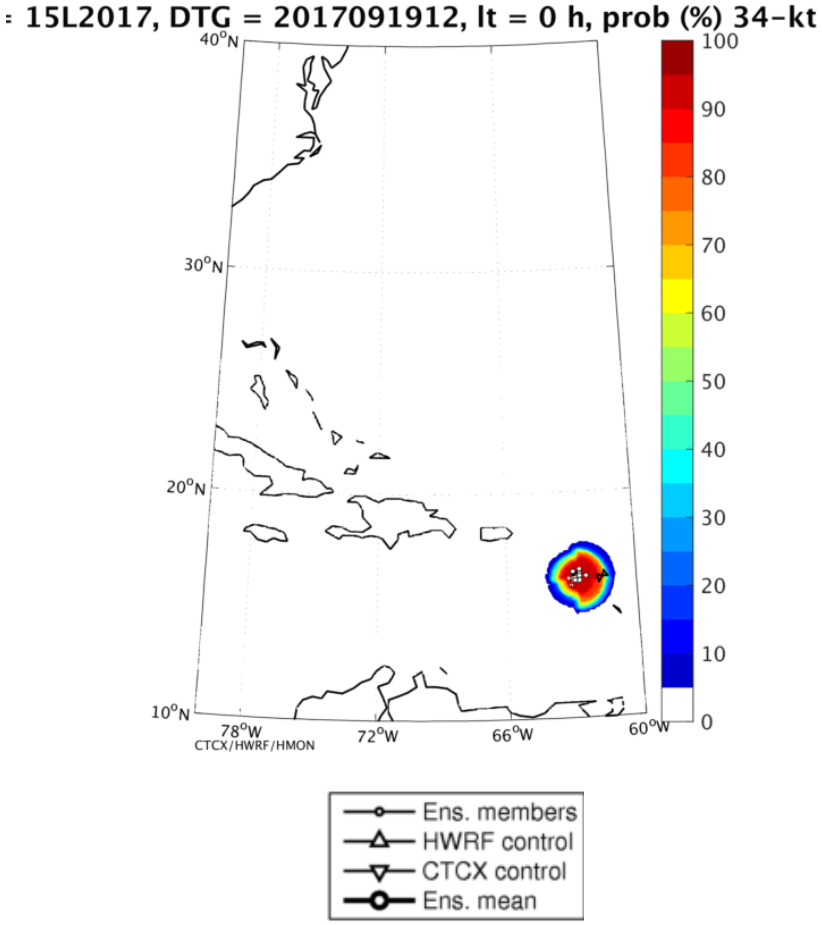
2017 Real-Time Products

10-m wind threshold exceedance probability

COAMPS-TC



COAMPS-TC / HWRF / HMON

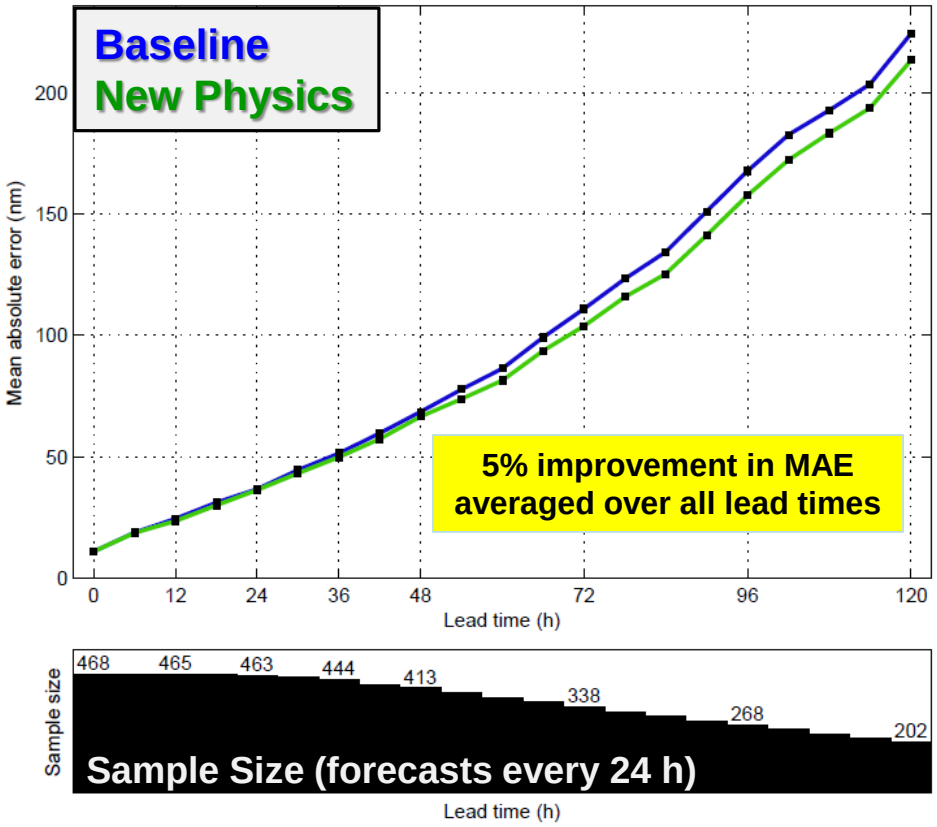


Available for 34 kt, 50 kt, and 64 kt thresholds, with both animations as shown above and static images for 120h forecasts

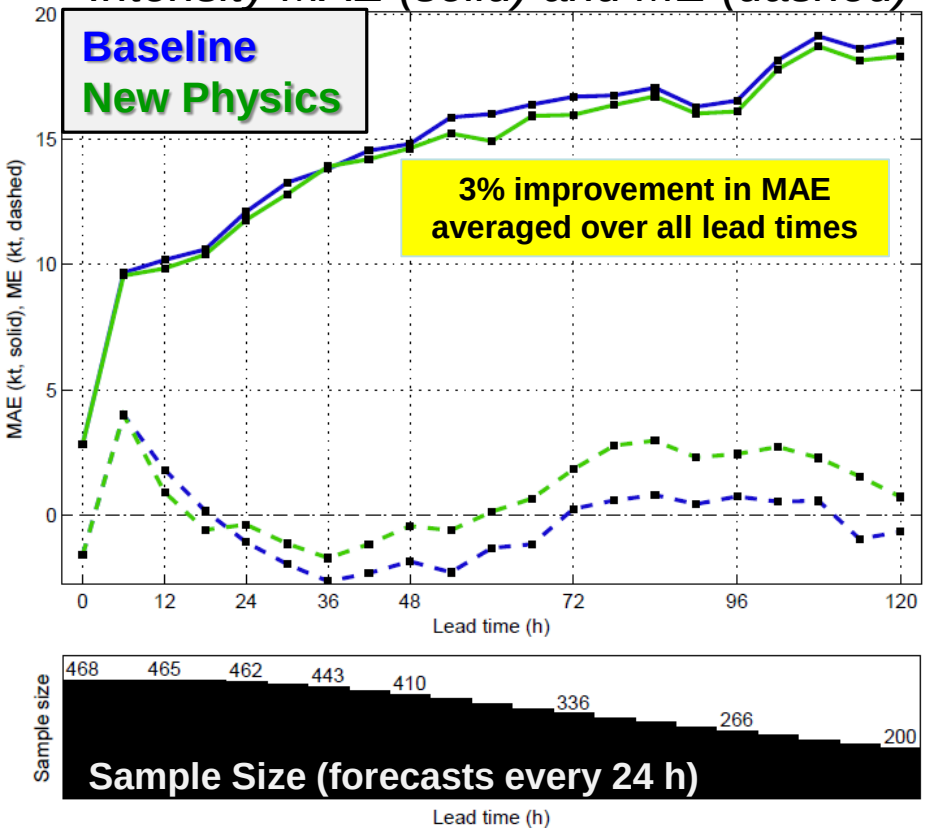
https://www.nrlmry.navy.mil/coamps-web/web/ens?&spg=1

COAMPS-TC Upgrades for 2018
Physics Improvements

Track MAE



Intensity MAE (solid) and ME (dashed)



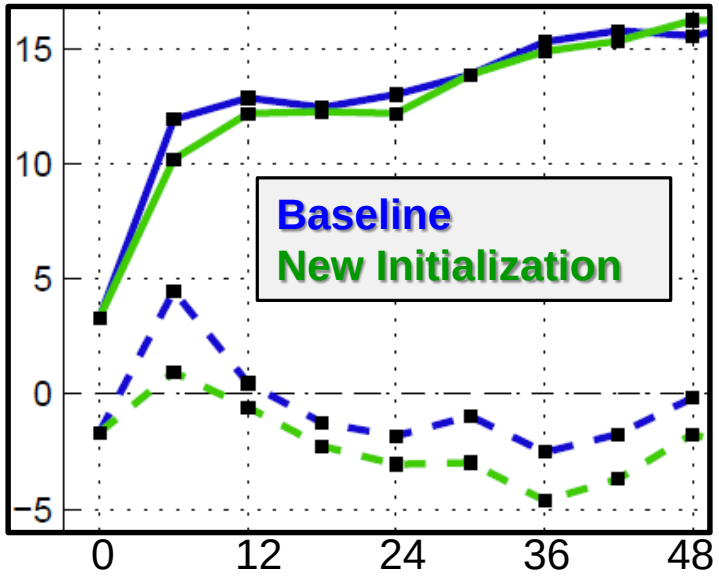
- **New Physics**: i) improved shallow cumulus, ii) snow-ice interaction with Fu-Liou radiation
  - **Track** improvement is largest in the W. Pacific basin, in part due to reduced NE bias
  - **Intensity** improved for initially weak TCs - intensifying weak storms more rapidly
  - **RI** statistics are also improved.
- Experiments underway with improved Kain-Fritsch & Tiedke schemes to address NE bias

COAMPS-TC Upgrades for 2018

Initialization Updates

TCs initially of hurricane intensity often have a transient "spin-up" during the first 12 h.

Intensity MAE (solid) and ME (dashed)

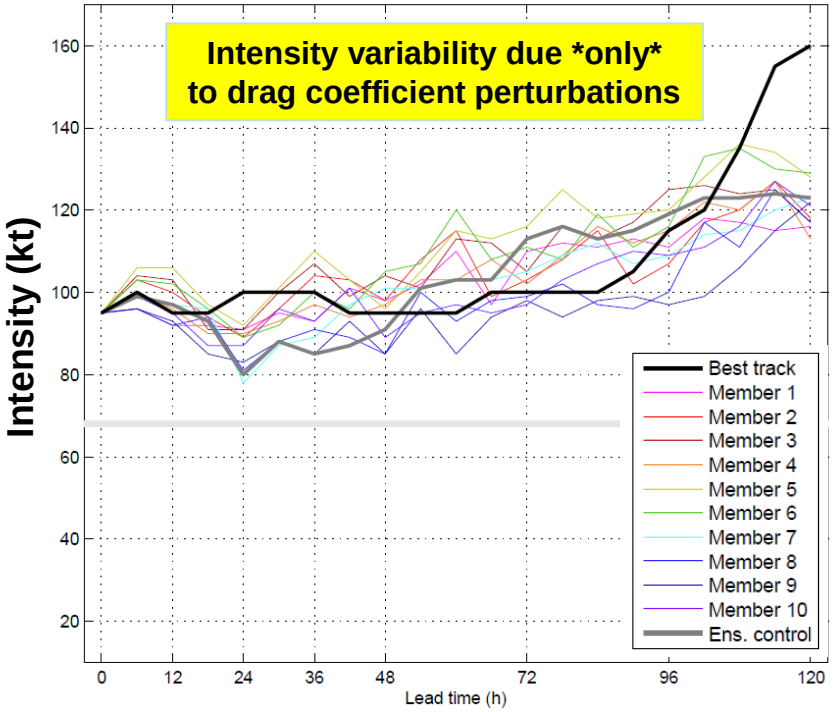


Intensity summary statistics for TCs initially Cat 1 – 3 strength show much improved MAE and bias at 6 h lead time

Ensemble Updates

- Refinement of the initial intensity perturbations: Eliminates unrealistically large perturbations and unrealistically weak initial intensities.
- Perturbed C_D: Introduces additional spread for intense TCs to account for uncertainty in the parameterization of C_D

Hurricane Irma Example



COAMPS-TC
Summary and Future Plans

➢COAMPS-TC Much Improved for Track & Intensity in 2016/17:

- Improved intensity (ocean coupling; new vortex initialization; new C_D param)
- Multi-model high-res. ensemble (HFIP NOAA/Navy) promising
- Upgrades in 2018: Physics to address spin-up and track NE bias, Ensemble update

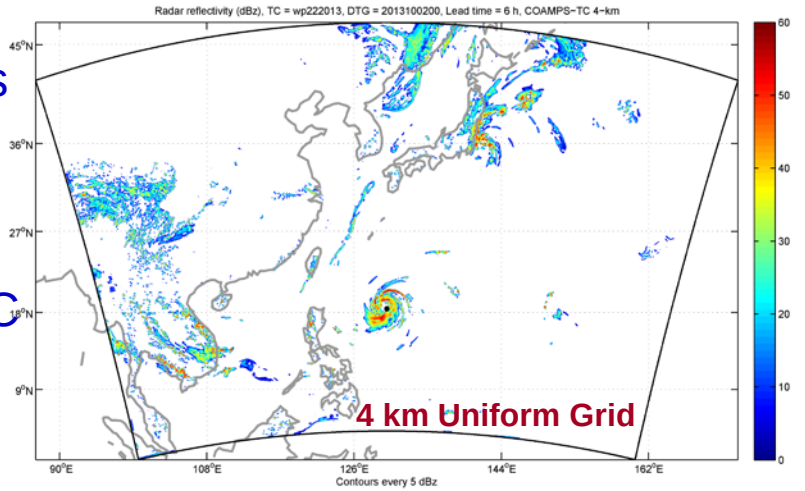
➢Key Gaps:

i. Lack of TC observations
ii. Inadequate data assimilation methods in the TC
iii. Uncertainties in physics
iv. Poor prediction of rapid intensification
v. Insufficient research and operational computing

➢Future Plans:

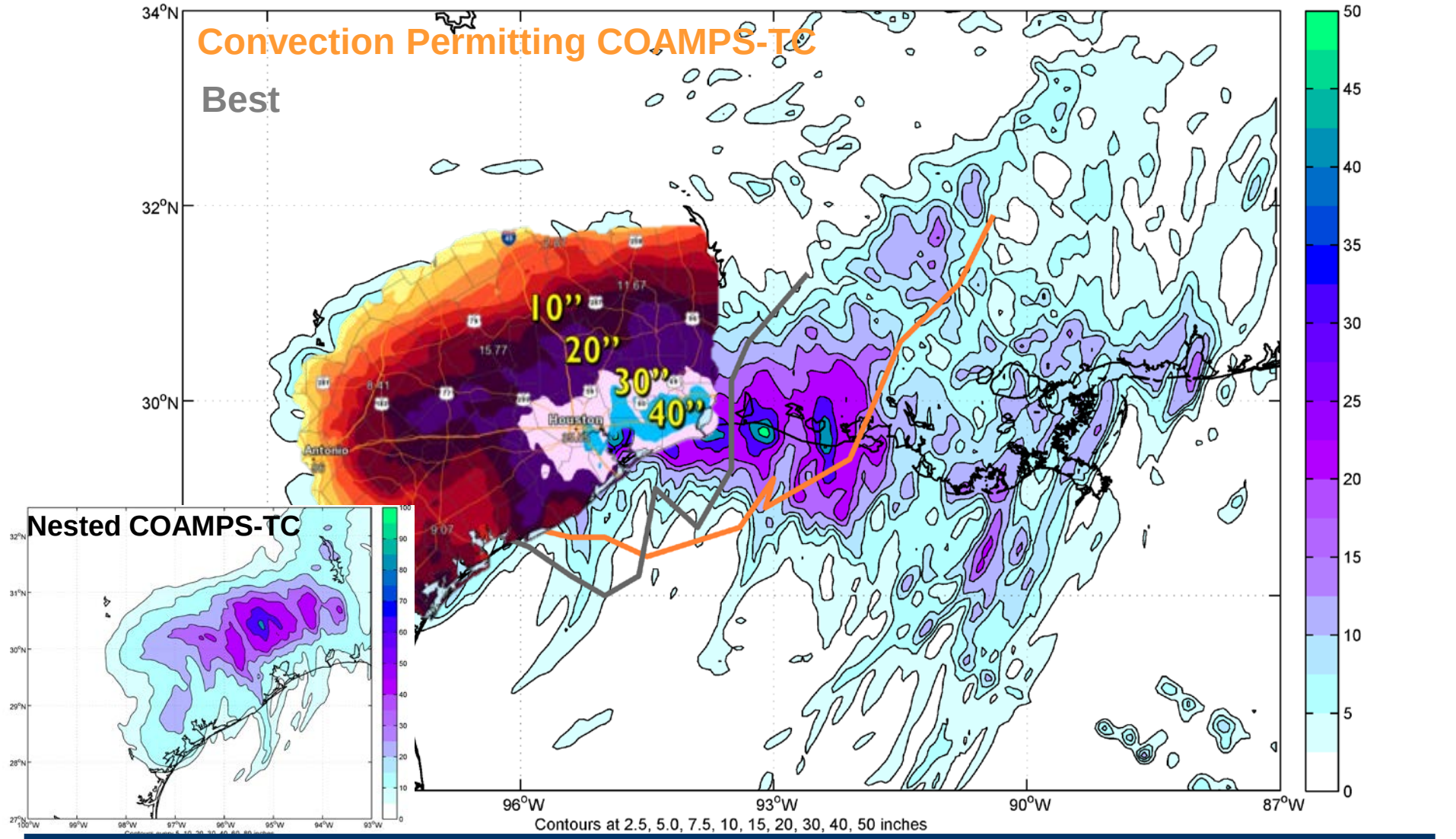
- 2018: Physics, initialization upgrades (June 1)
  Transition COAMPS-TC ensemble to ops
- 2019+
  - 4D-Var/hybrid, improved physics, waves
  - New models:
    Convection Permitting COAMPS-TC
    NEPTUNE (~2024)
- Utilize field observations: ONR TCI, HRD

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



Convection Permitting COAMPS-TC

Harvey (09L) 2016082606 initial time: Precipitation forecast challenge



Convection-permitting COAMPS-TC track takes Harvey offshore, closer to best track than nested CTCX. Axis of heaviest precipitation is near the coast instead of inland.