



An Overview of Recent COAMPS-TC Development and Real-Time Tests

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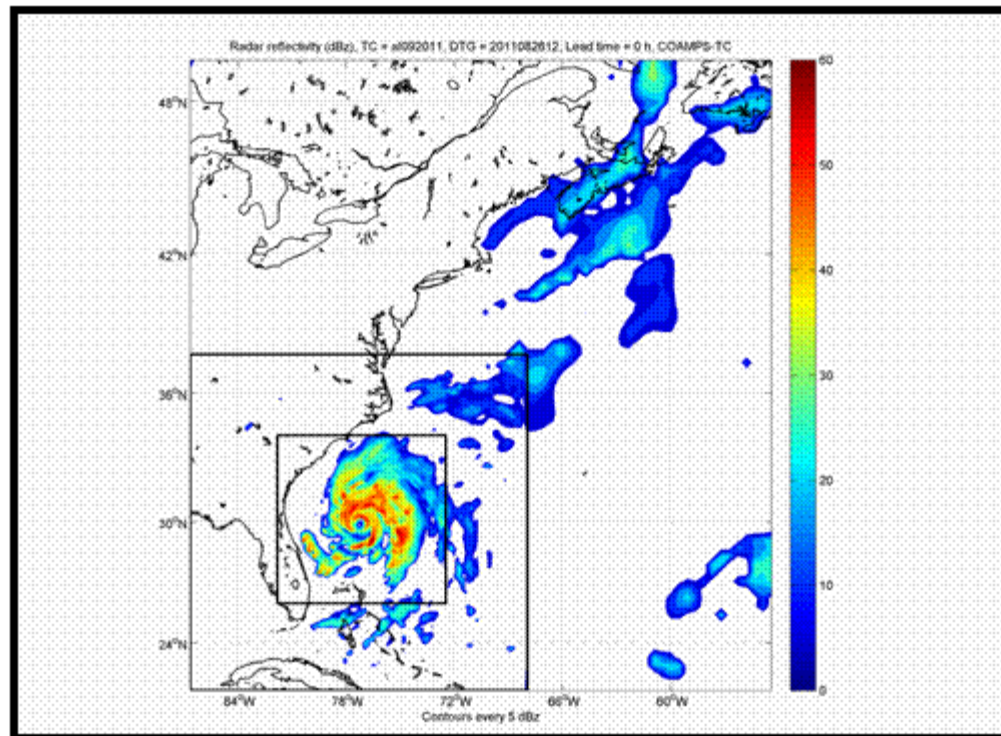
Acknowledgements: JTWC, ONR, PMW-120, NOAA HFIP, NOPP

Hurricane Irene 24 Aug 2011 1542Z (NASA TRMM)



COAMPS-TC System Overview

- Analysis: Vortex relocation, **synthetic observations** 3D-Var (NAVDAS)
- Atmosphere: Nonhydrostatic, moving nests, CBLAST fluxes, convection, **dissipative heating** **NRL TC PBL** **NRL microphysics.**
- Ocean: 3D-Var (NCODA), NCOM, SWAN, Wave Watch III options
- Ensemble: COAMPS-TC EnKF DART, Coupled Ensemble Transform
- Real-Time Testing: Navy pre-operational tests & NOAA HFIP partnership activity
45-15-5 km, GFS/NOGAPS BCs, cycling DA, uncoupled/coupled

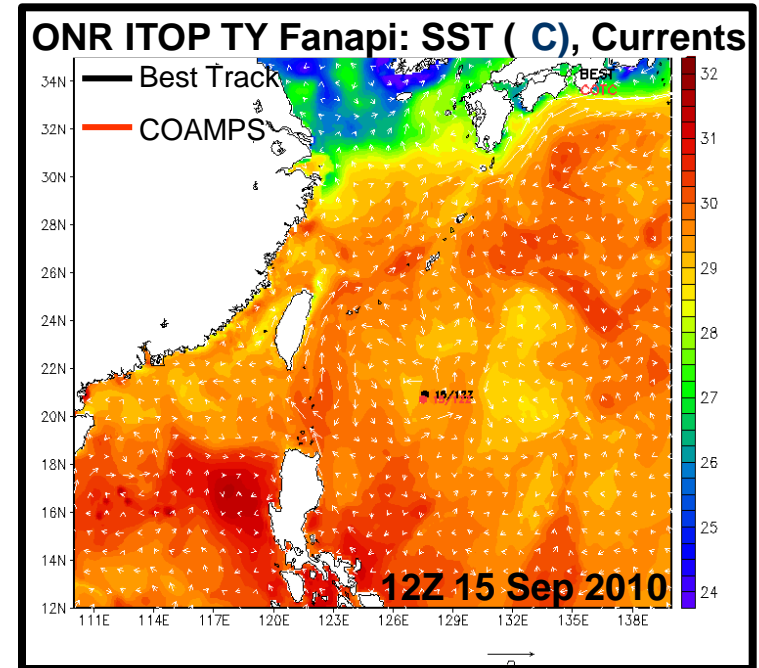
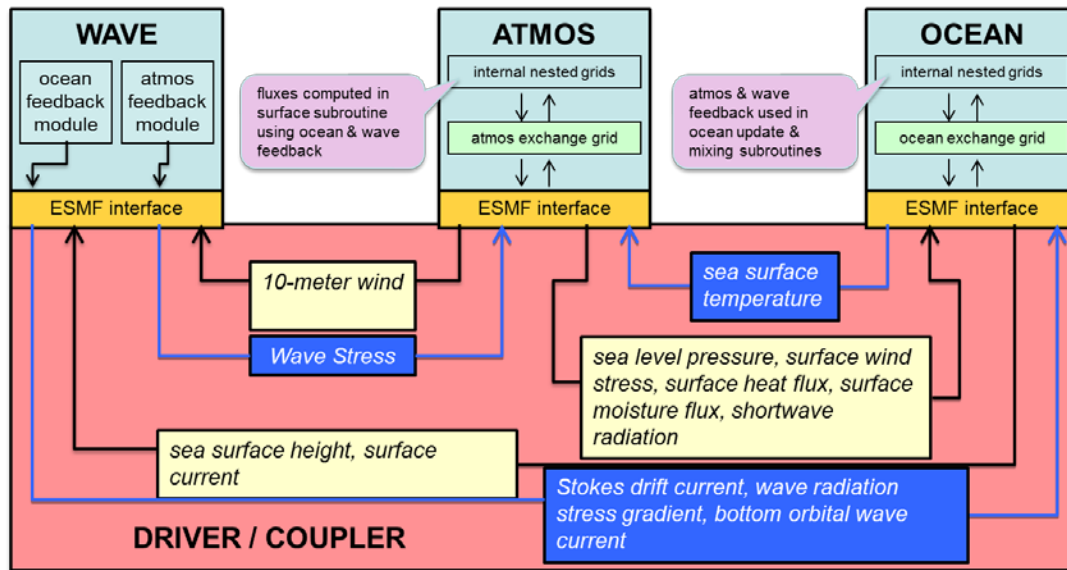




Coupled COAMPS-TC

Air-Sea Interface Physics

Earth System Modeling Framework (ESMF)



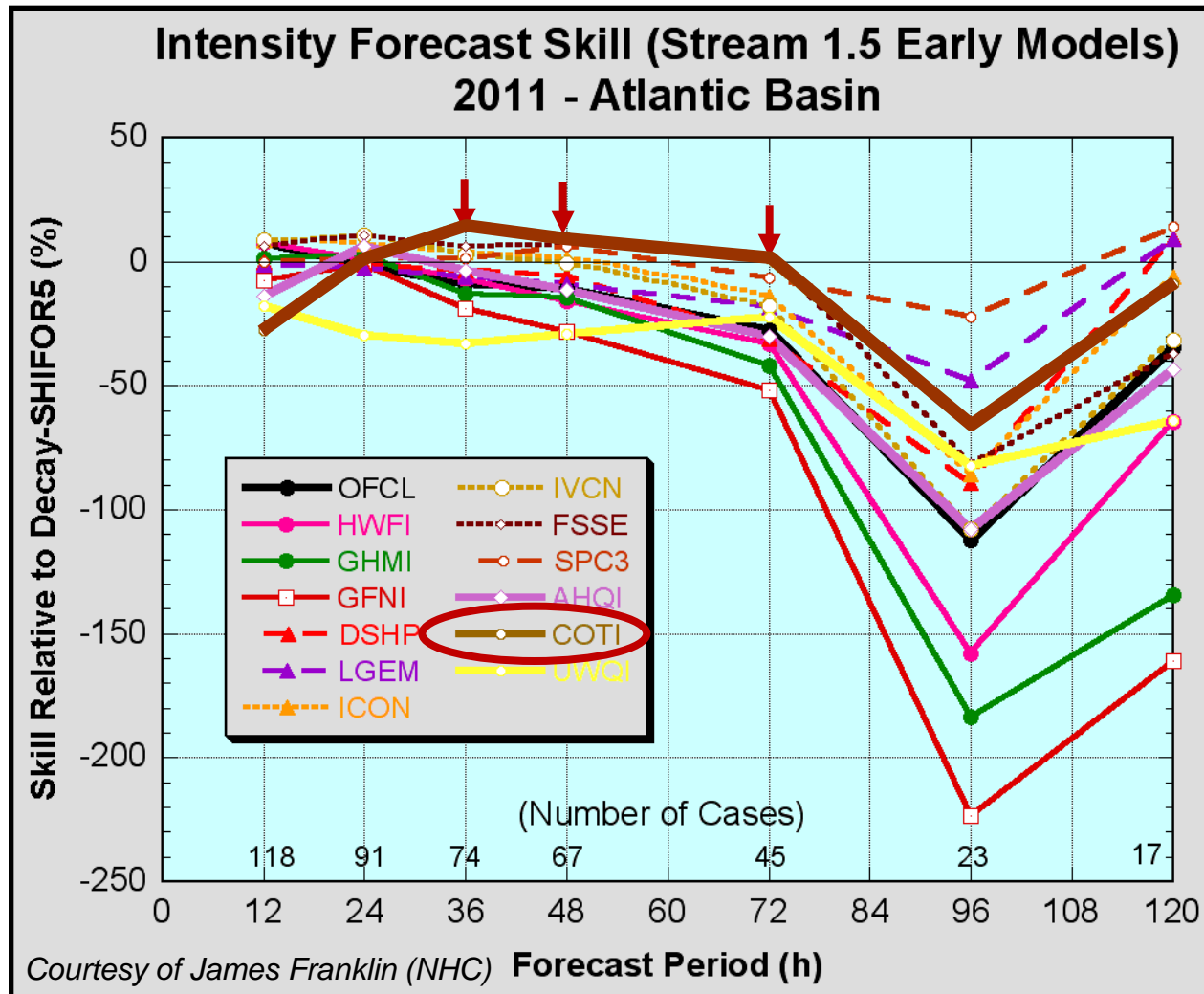
Coupled Real-Time COAMPS-TC Predicts SST Wake of 2-4 C in Agreement with Observations

COAMPS contains a community based (ESMF) coupler to facilitate flexible and generalized exchange between components.



W. Atlantic Intensity Forecast Skill

2011 Real Time HFIP Models



- **COAMPS-TC: Leading HFIP intensity model; skill exceeds the HFIP 5Y baseline.**
- **NOAA, Navy, research community partnership within HFIP has been very successful.**
- **Excellent opportunities for tech transfer.**



Comparison of Real-Time TC Models

Irene Intensity Errors (kt)

- **Widespread damage in Eastern U.S., catastrophic flooding in New England**
- **Maximum intensity of 105 kt (Cat. 3)**
- **Landfall in eastern NC at 75 kt (Cat. 1)**
- **Forecasts were for a Cat. 3 landfall**

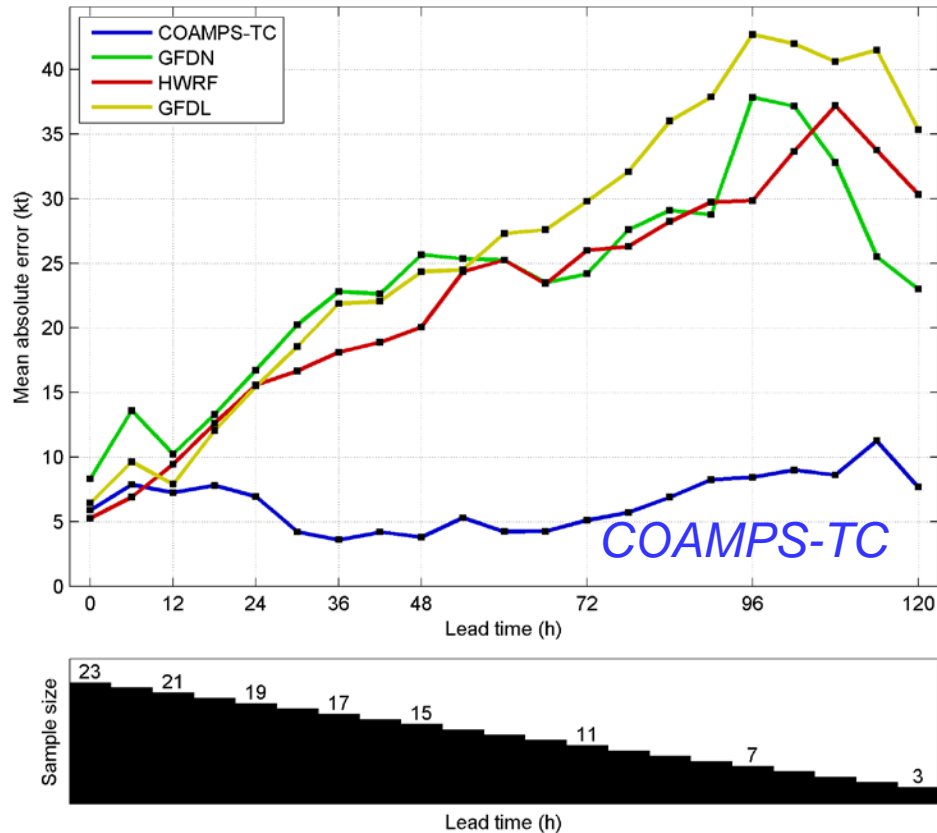
“INTENSITY REMAINS A BIG GAP IN STORM SCIENCE. The National Hurricane Center blew it on predictions of Irene’s wind speed – and it wasn’t the first time”. *Miami Herald, 9/2/2011*

“CHALLENGES IN PREDICTING THE INTENSITY OF STORMS.” *New York Times, 8/27/2011*

“HOW IRENE’S FORECAST MISSED THE MARK AND WHY IT COULD HAPPEN AGAIN.” *CNN, 8/30/2011*

“IRENE FORECASTS ON TRACK; NOT UP TO SPEED ON WIND.” *Associated Press, 8/28/2011*

“IRENE EXPOSES PROBLEMS FORECASTING HURRICANE INTENSITY” *Alaska Dispatch, 8/28/2011*



After 00Z 23 September
No interpolation to account for late model fields

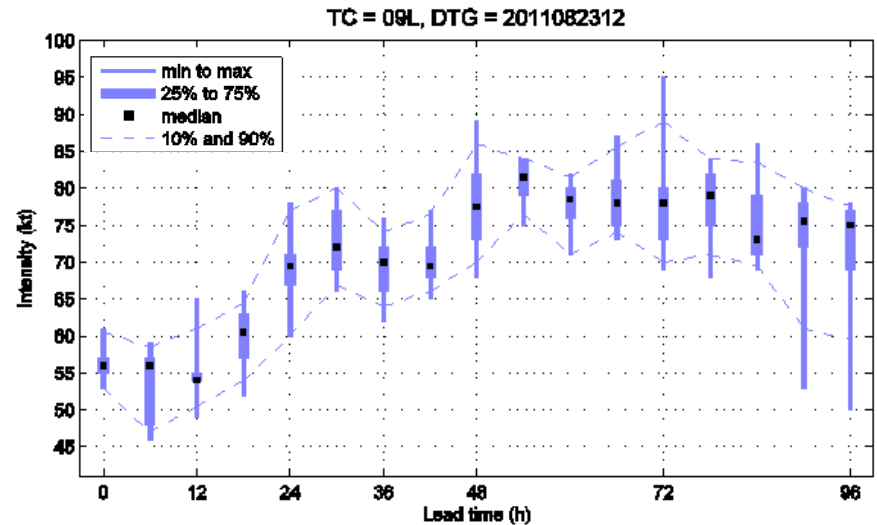
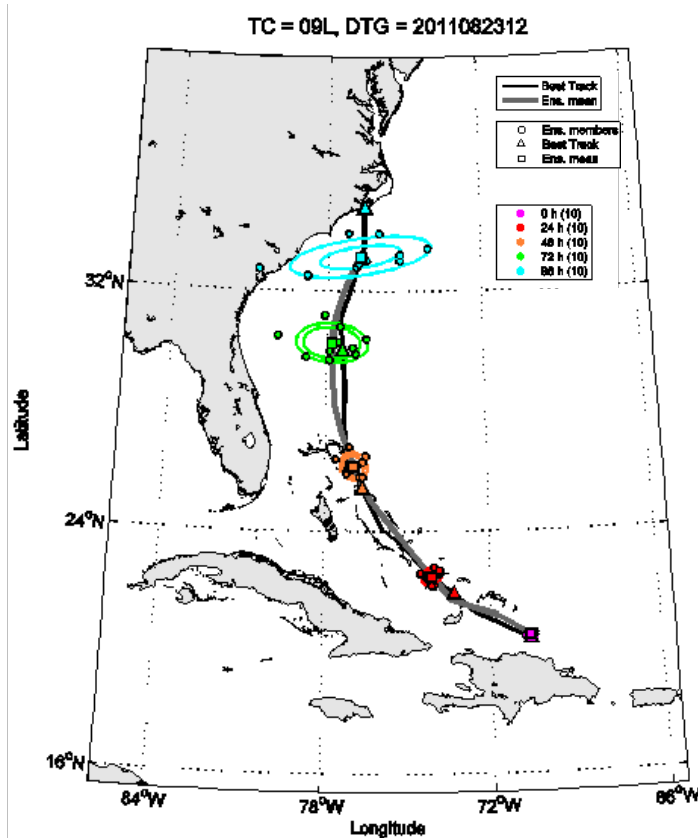
- **COAMPS-TC performed well for Irene as part of the HFIP real-time demonstration, particularly during the critical landfall forecast period.**
- **COAMPS-TC skillfully predicted precipitation event (>15” in NC, and 10-15” in N.E.)**



COAMPS-TC Ensembles

Ensemble Kalman Filter: Irene Example

10 Member 5-km Resolution Ensemble System (COAMPS-TC DART)



TC position from individual ensemble members every 24 h and ellipses that encompass the 1/3 and 2/3 ensemble distributions.

Median, minimum, maximum, and 10% and 90% distributions are shown

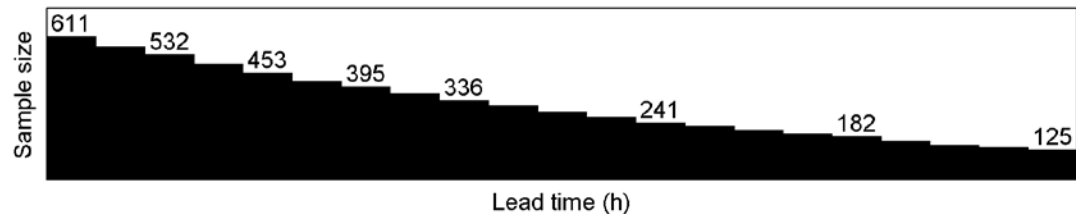
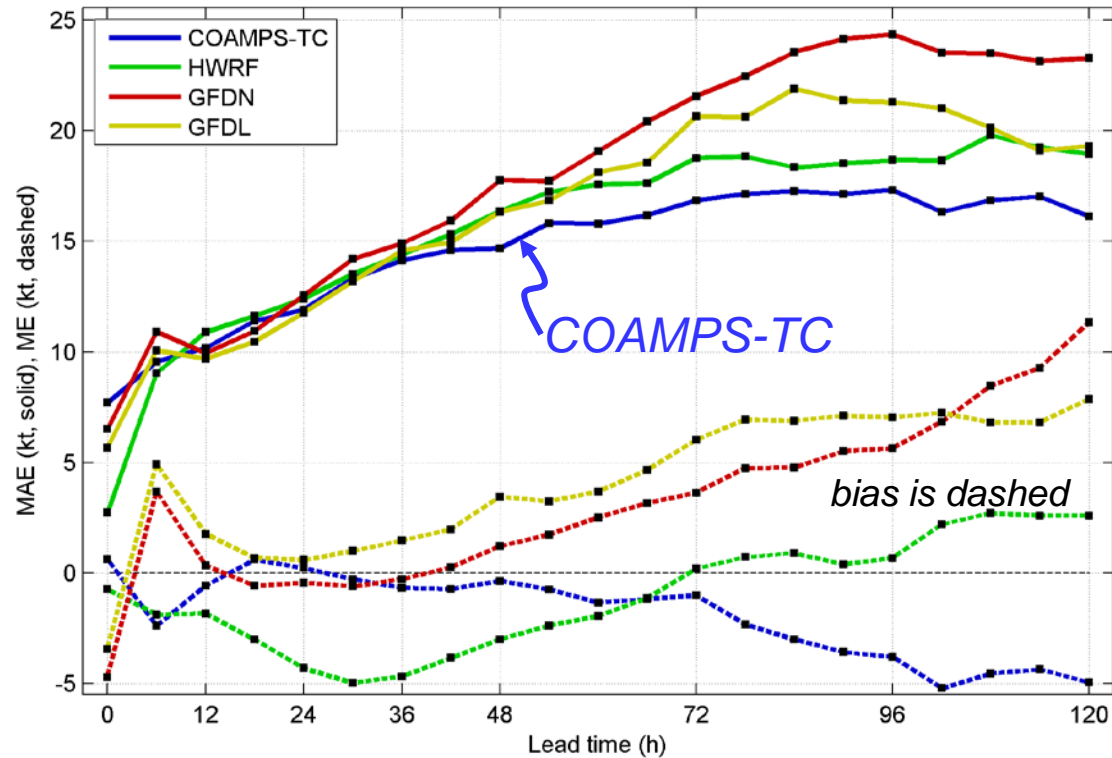
- **COAMPS-TC Ensemble System** was demonstrated in real time as part of HFIP.
- **Probabilistic intensity forecasts** are very promising (and best future approach).
- **Paves the way for multi-model ensemble approaches (HFIP).**



W. Atlantic Intensity Error

2010 and 2011

Intensity error, NHC criteria



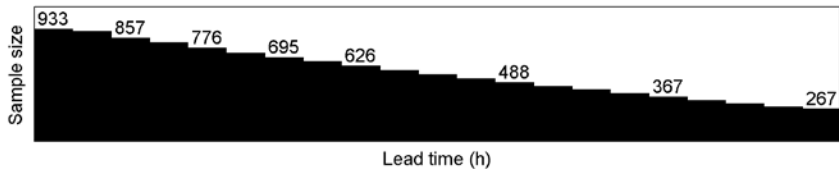
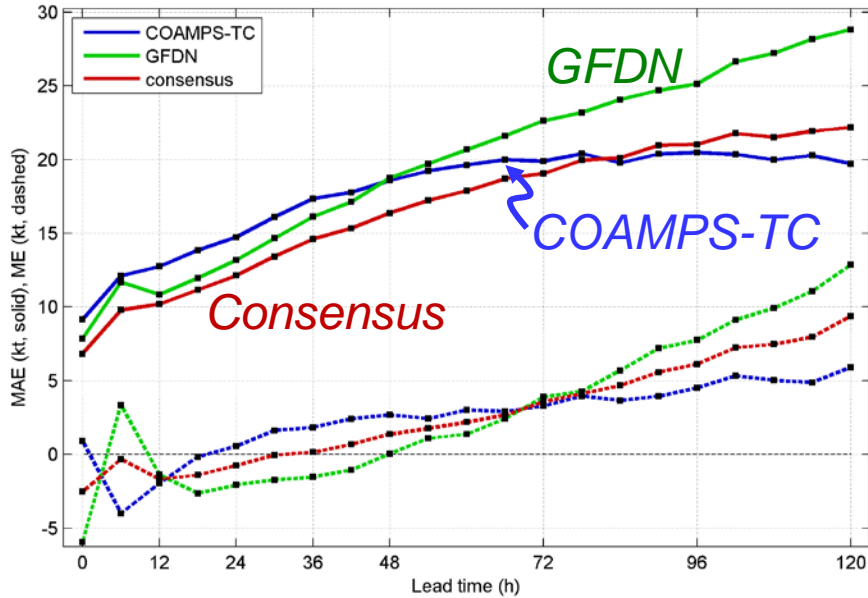
- As part of NOAA HFIP and Navy evaluation efforts, COAMPS-TC has been tested in real time over WATL, EPAC, WPAC, CPAC, IO, SH in 2009-2011.
- COAMPS-TC intensity forecasts verified well for 2010 and 2011, particularly beyond 30 h where the error growth was much slower than other models.



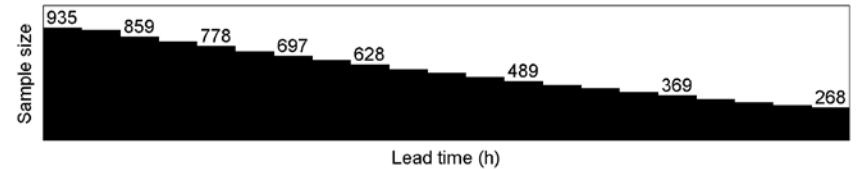
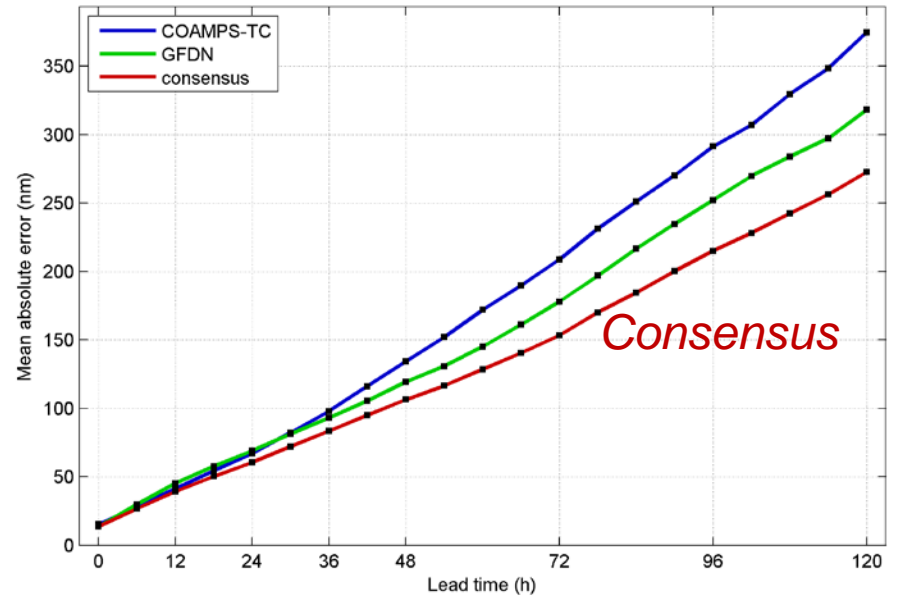
COAMPS-TC in W. Pacific 2009-2011

Homogeneous Intensity (Wind) Forecast Error (Kts)

Intensity error, NHC criteria



Homogeneous Track Forecast Error (nm)

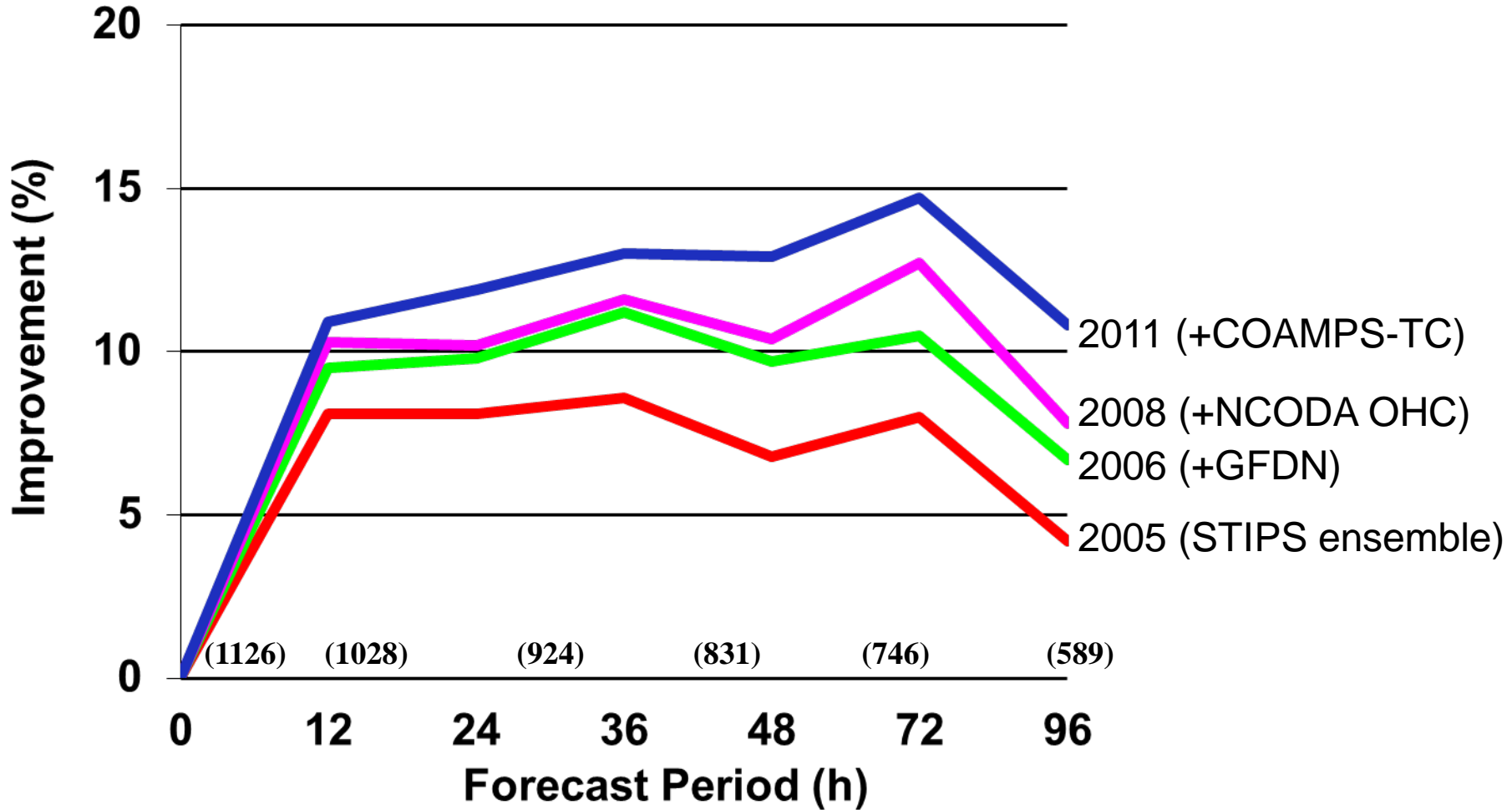


- COAMPS-TC intensity forecasts are generally better than GFDN (48-120 h).
- Consensus of COAMPS-TC and GFDN intensity is better than either model (0-72 h).
- Consensus of both models improves the track skill also.



W. Pacific Intensity Consensus

Benefit of Inclusion of COAMPS-TC

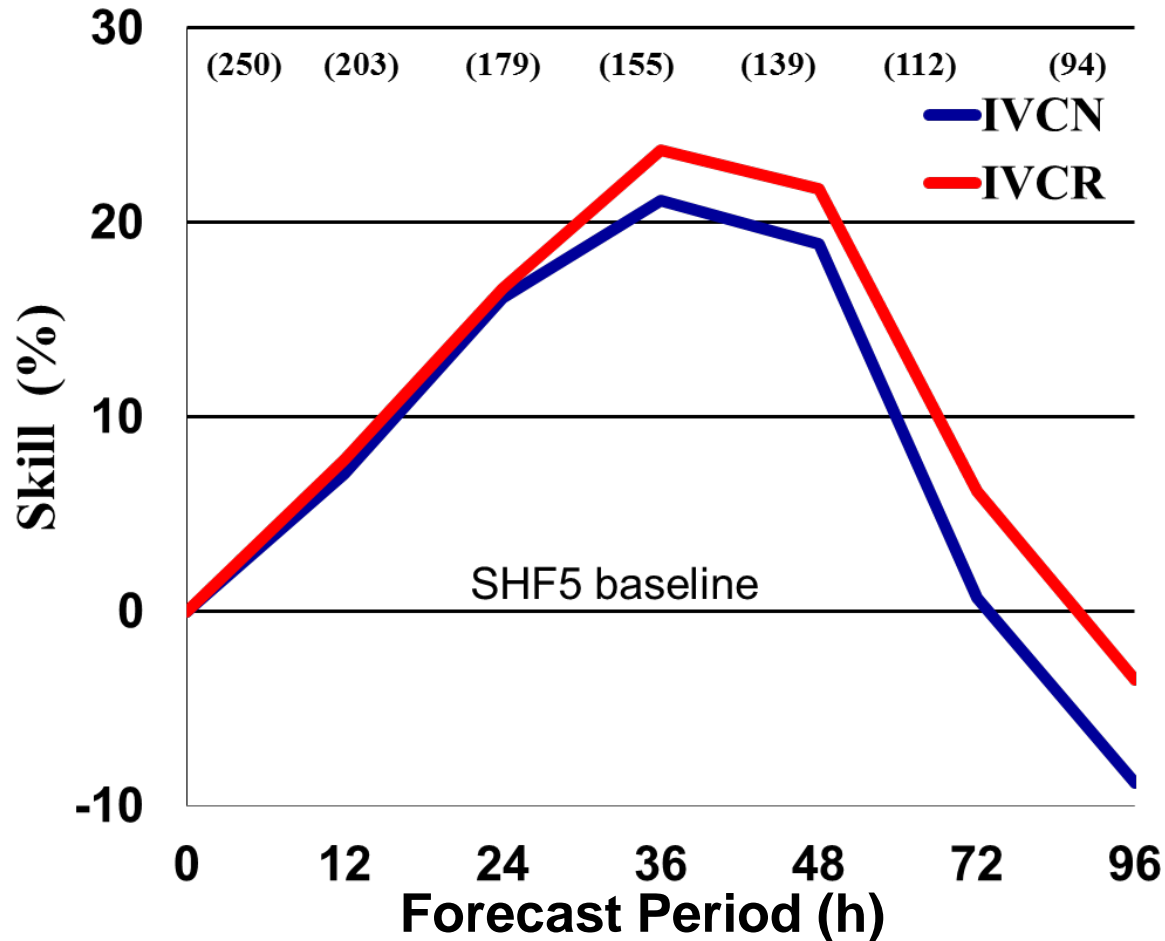


Inclusion of COAMPS-TC improves intensity consensus relative to statistical baseline (ST5D) for WP 2009-2010.



Experimental Atlantic Intensity Consensus

Benefit of Inclusion of COAMPS-TC



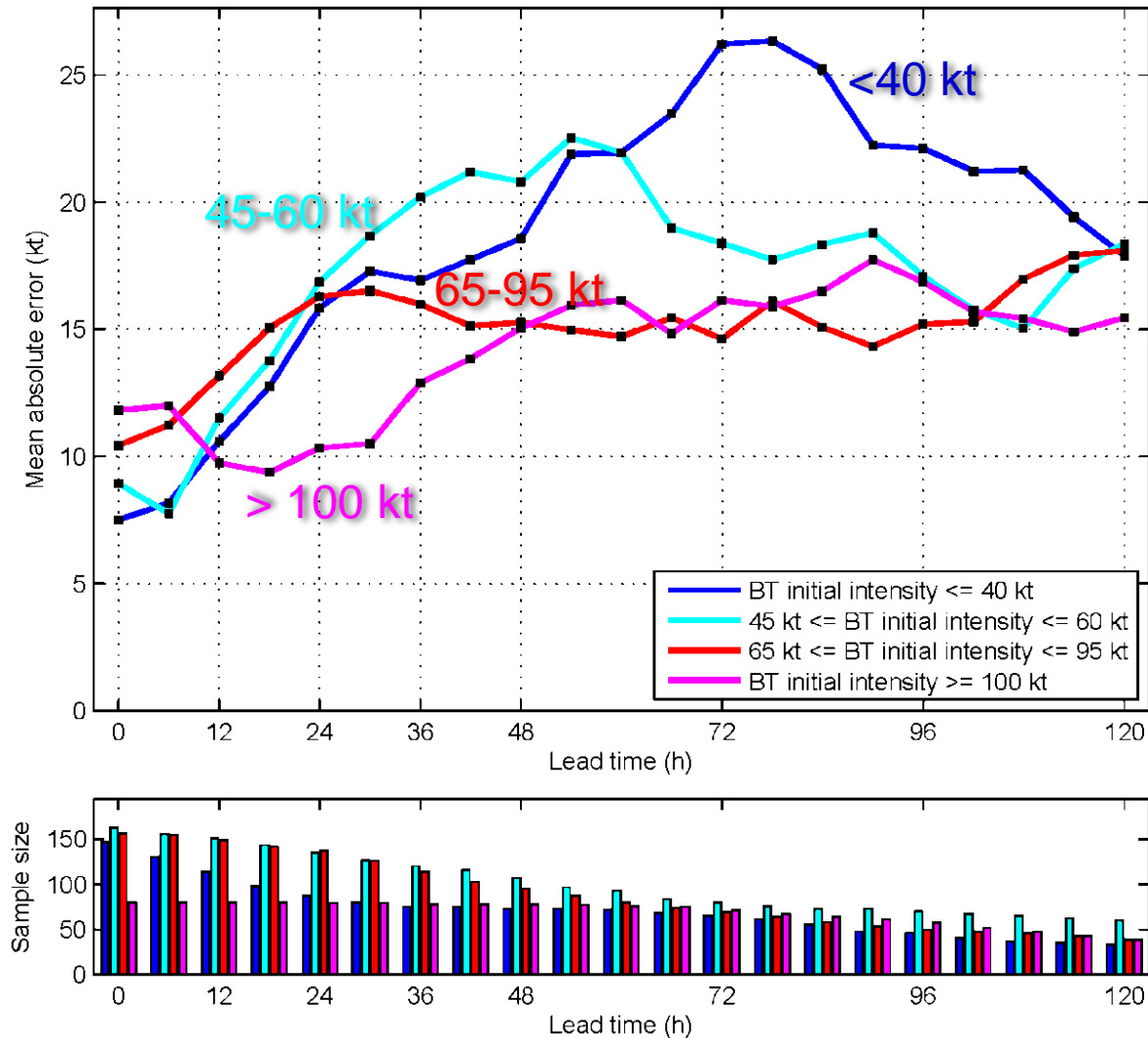
- IVCN includes IVCN members + COAMPS-TC and deterministic RI aid.
- Run in real-time at NRL for WATL season. Skill is relative to SHIFOR.
- COAMPS-TC improves consensus (highly significant > 36 h).



Weak Storm Predictability Challenge

COAMPS-TC Intensity Skill (2008-2010 W. Atlantic)

COAMPS-TC intensity MAE for different best-track initial intensities

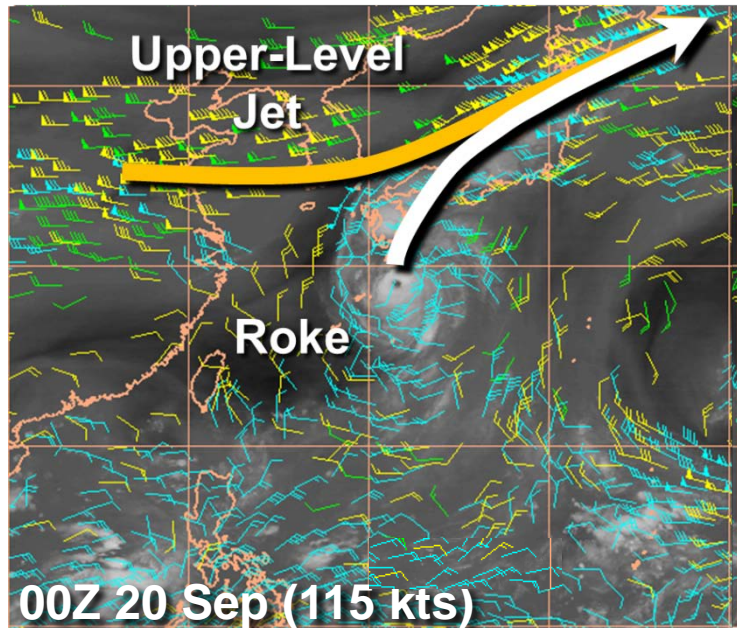


- Weak storms (at the initial time) have larger intensity (and track) errors.
- Challenging scenario is a weak storm that undergoes RI before landfall.

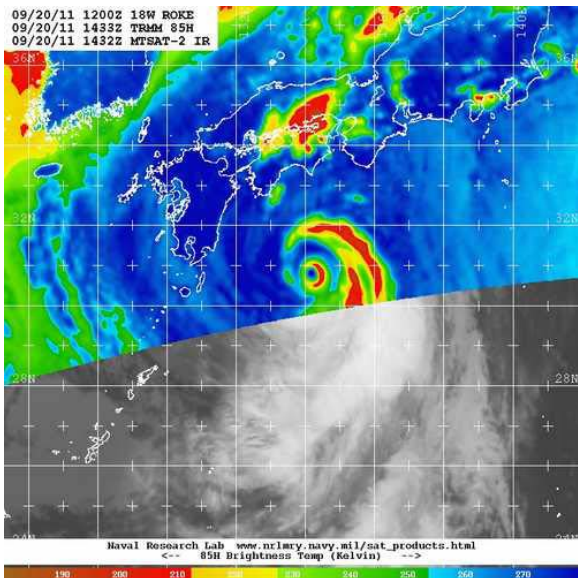
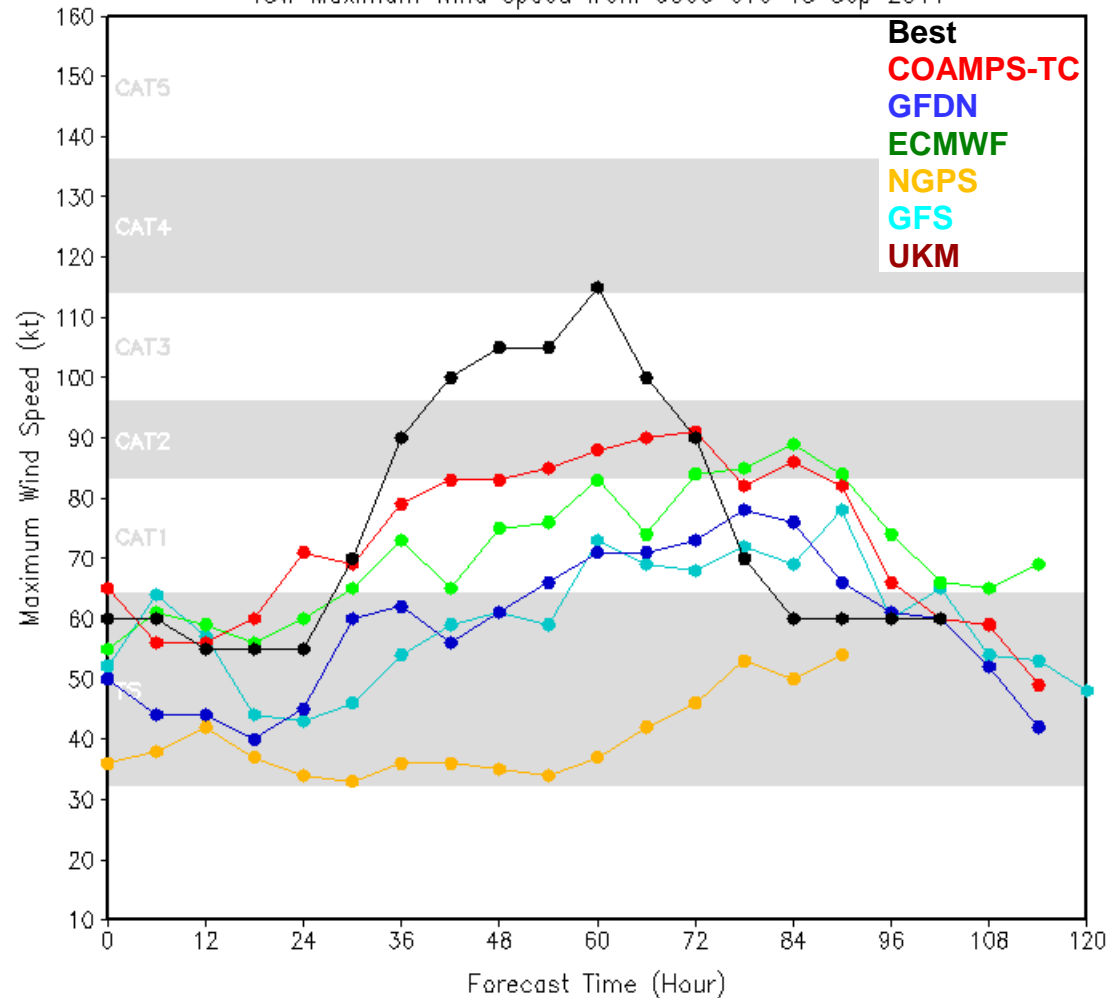


Rapid Intensification Challenge

Closer Look at Roke (18W) in W. Pacific



18W Maximum Wind Speed from 0000 UTC 18 Sep 2011



- TY Roke remained weak for days, underwent rapid intensification (RI), and threatened Tokyo.
- Models (COAMPS-TC) failed to capture the RI.
- Outflow merged with upper jet during RI.



COAMPS-TC Development 2012 System

• Analysis and Initialization:

- **New satellite obs. (radiances)**
- **TC Dynamic Initialization (TCDI)**

• Physical Parameterizations:

- **“Hybrid” hurricane PBL**
- **New microphysics**

• Air-Sea Coupled Model:

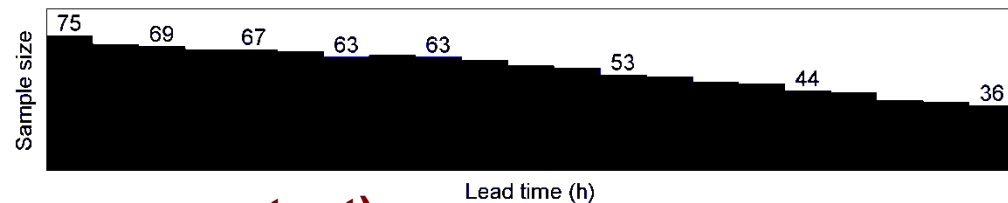
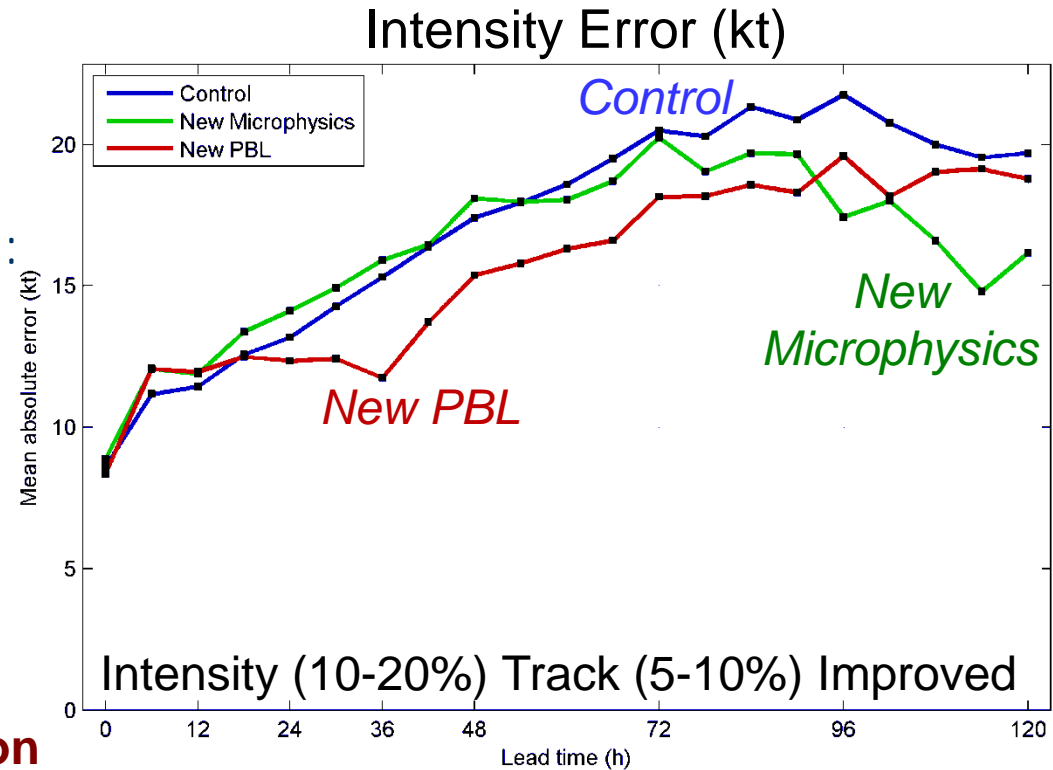
- **Generalized coupling interface**

• Ensemble Kalman Filter:

- **Improvements to data assimilation**

• Other Capabilities:

- **New nest tracker**
- **New diagnostics (including high-frequency output)**





COAMPS-TC

Summary

➤ Promising Intensity Skill:

- COAMPS-TC intensity forecasts verified well in 2010-11 in WATL & WPAC
- Improved (in 2012) data assimilation, physics (TC PBL, microphysics)
 - 10-20% improvement in intensity, 5-10% improvement in track
- Advancements to the ensemble (EnKF) and coupled capabilities

➤ Challenges:

- Intensity: i) Rapid intensification; ii) Weak storms
- Regional model track skill lags best GCMs
- Vortex initialization, multi-scale DA, physics (PBL and microphysics)

➤ Future Plans:

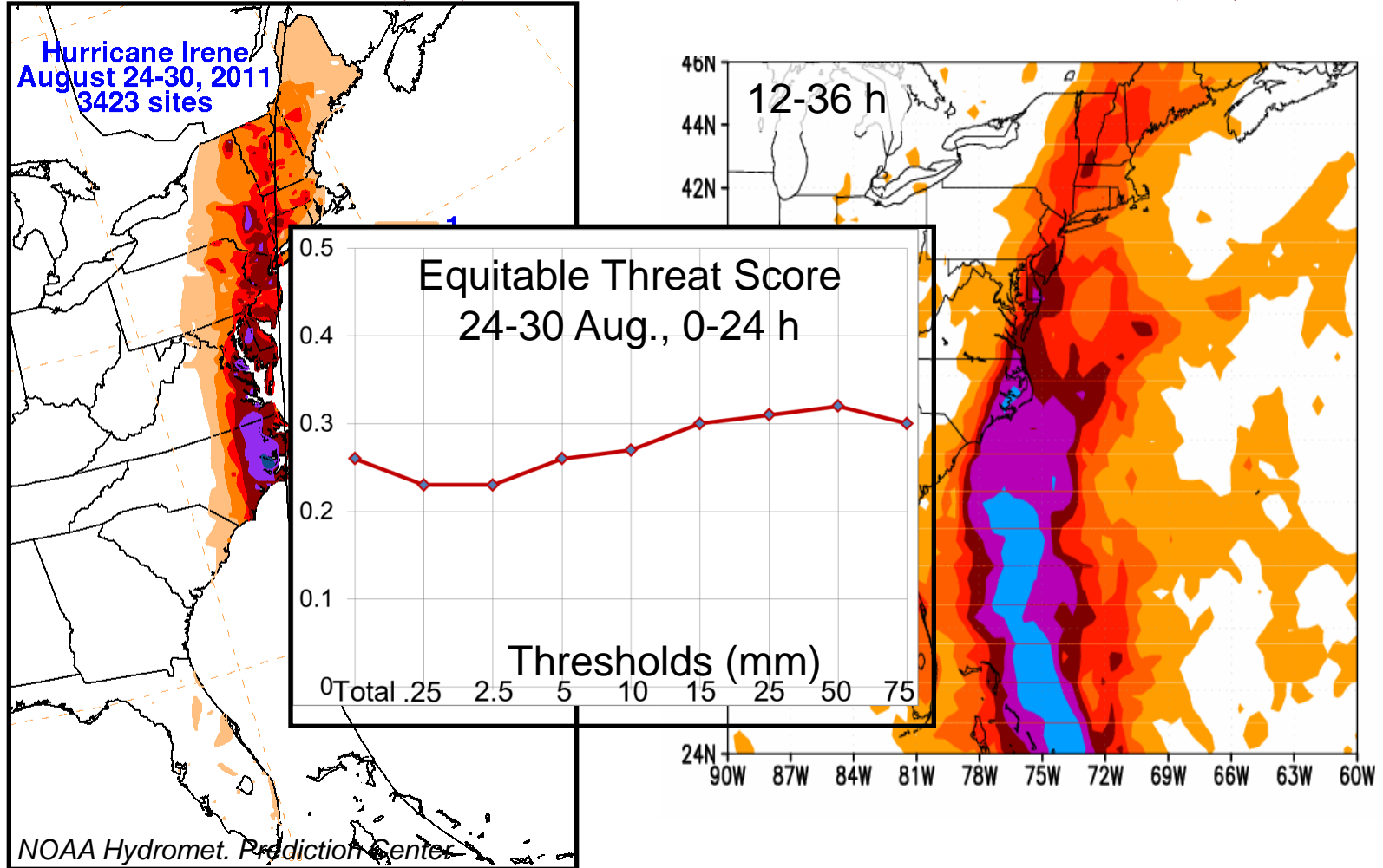
- Transition COAMPS-TC to Navy operations in FY12 (Ops Test)
- Advance COAMPS-TC components (physics, DA, coupling, ensemble)
- Continue partnership with community: ONR, JTWC, NHC, NOAA HFIP, NASA



COAMPS-TC Real Time Forecasts Accumulated Precipitation (24-30 Aug 2011)

Observed (in)

Prediction (in)



Model accumulated precipitation maximum at landfall is ~15" in agreement with observations, slight underforecast in NE U.S., but overall captures the structure.