



COAMPS-TC Stream 1.5

BAHAMAS

CUBA

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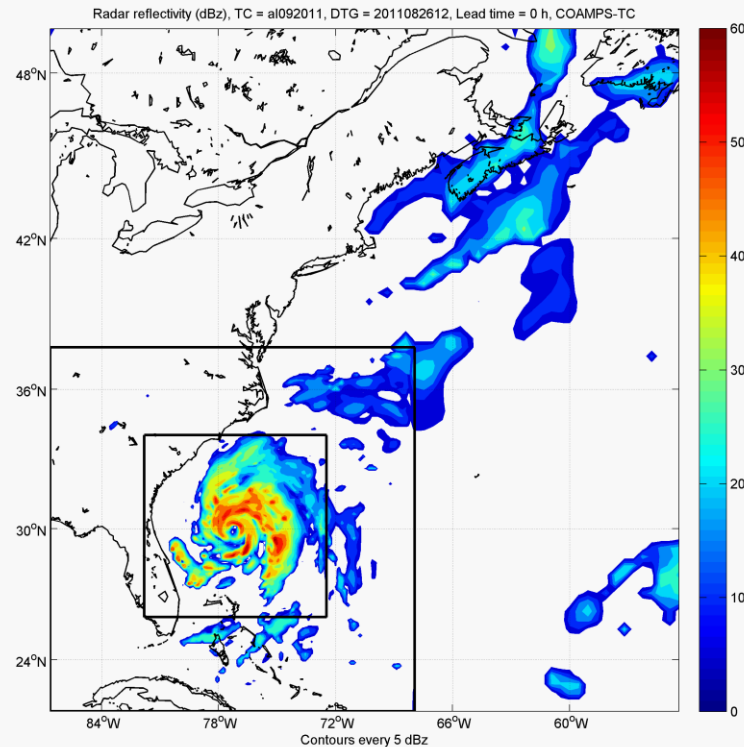
¹SAIC, Monterey, CA

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, dissipative heating, NRL PBL, NRL microphysics, shallow/deep conv.
- **Ocean:** 3D-Var (NCODA), NCOM, SWAN, Wave Watch III options
- **Ensemble:** COAMPS-TC EnKF DART, Coupled Ensemble Transform
- **HFIP Config.:** 45-15-5 km, GFS BCs, cycling DA, uncoupled and coupled

<http://www.nrlmry.navy.mil/coamps-web/web/tc> (Up to 150K hits / day)



COAMPS-TC

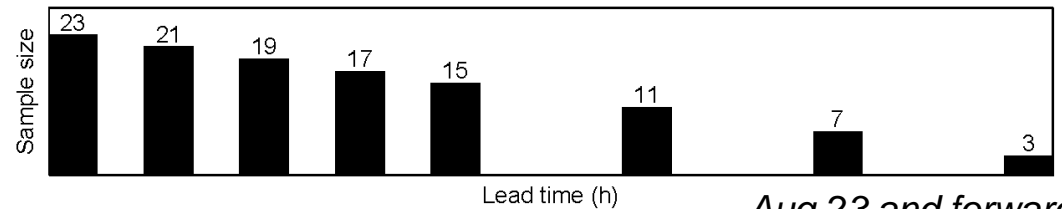
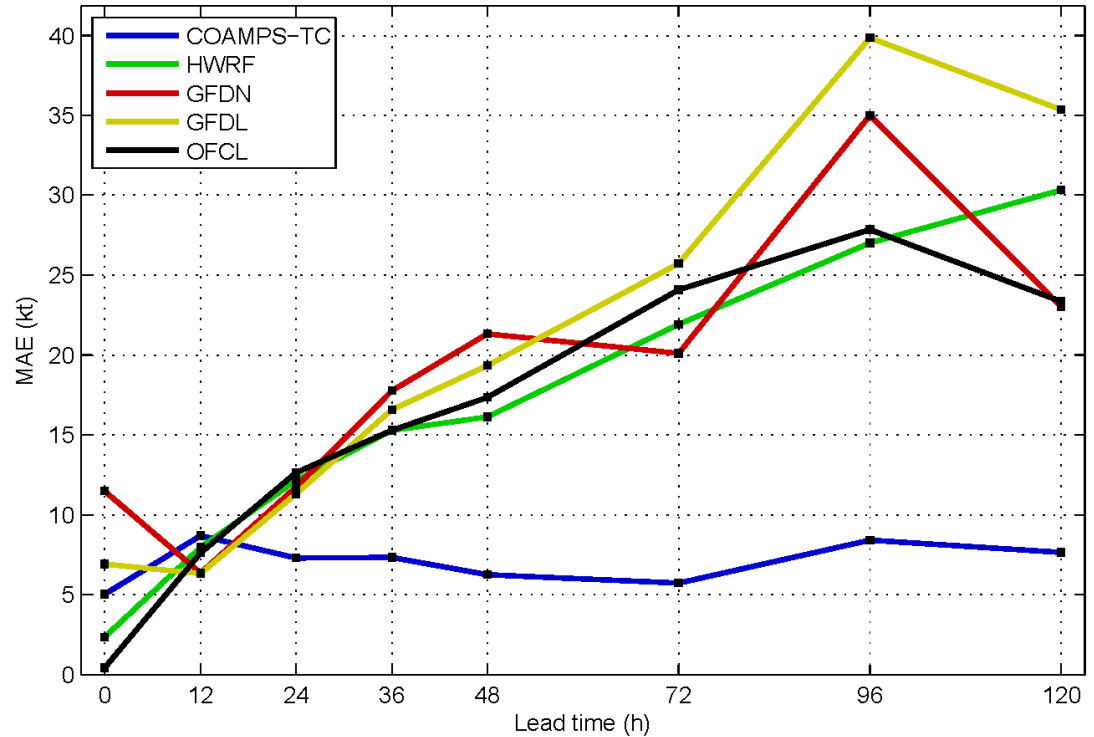
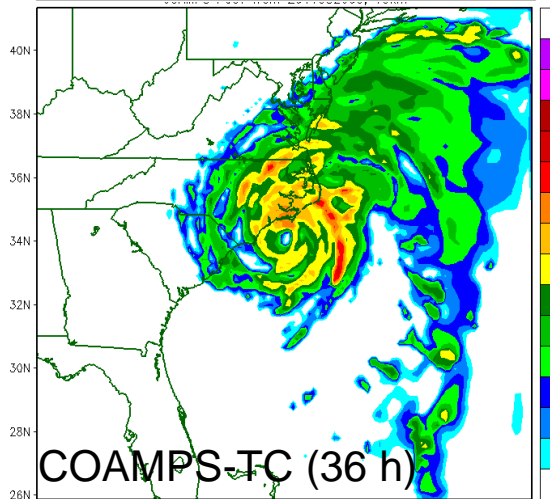
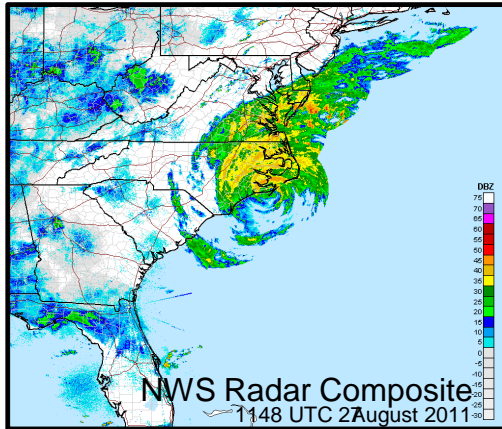
Lessons Learned from 2011 Real Time Exercise

• **What worked well?**

- Changes made prior to 2011 (physics and DA) improved the performance
- Large suites of tests (over 30 separate changes tested)
- System performed well for season in general (and 2010-2011)
- Stream 2: COAMPS-TC EnKF and Coupled COAMPS-TC

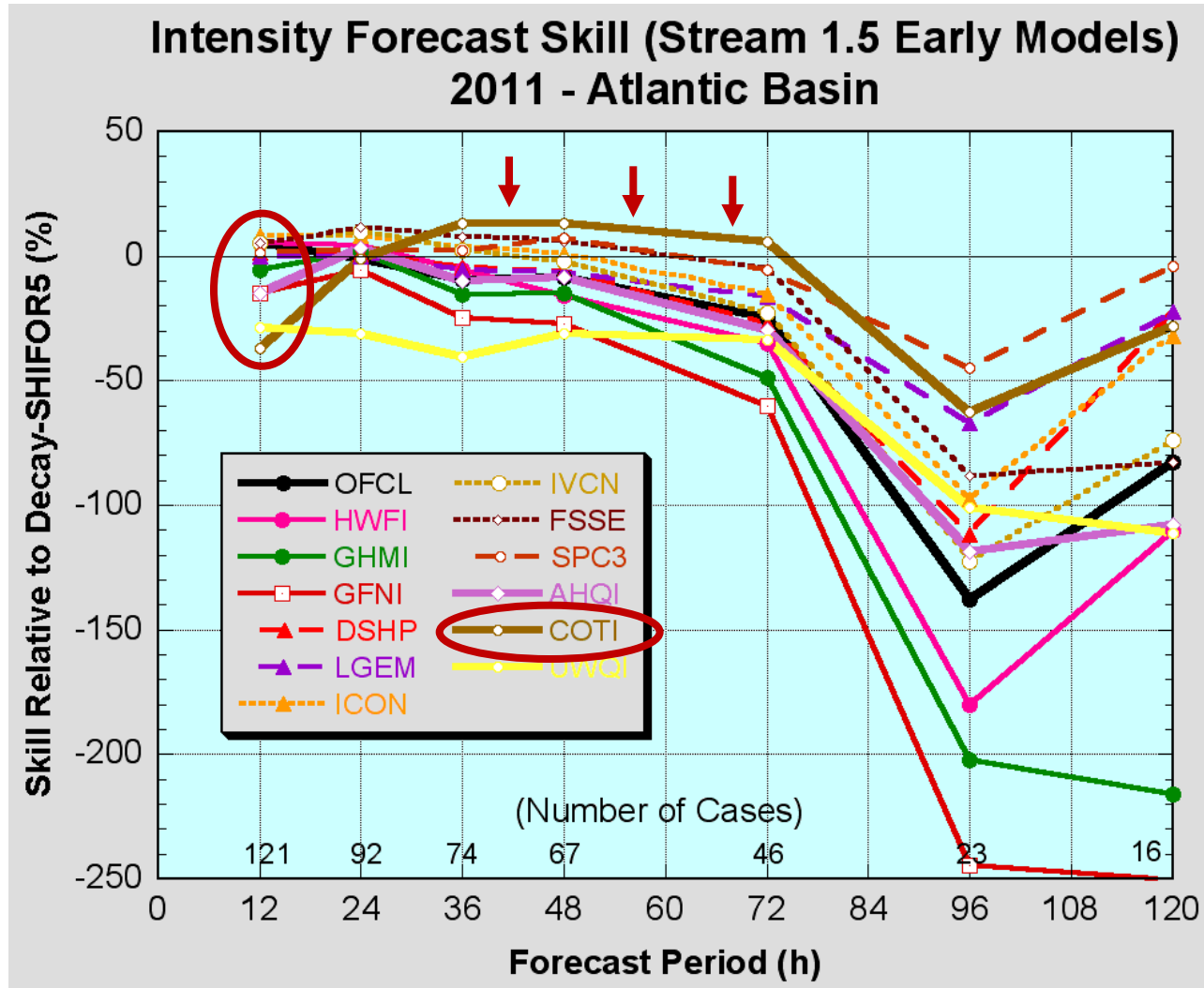
COAMPS-TC

Real-Time Hurricane Irene Forecasts



- Realistic precipitation shield and structure.
- COAMPS-TC did very well for Intensity for the 2011 season.

2011 Preliminary Stream 1.5 Verification



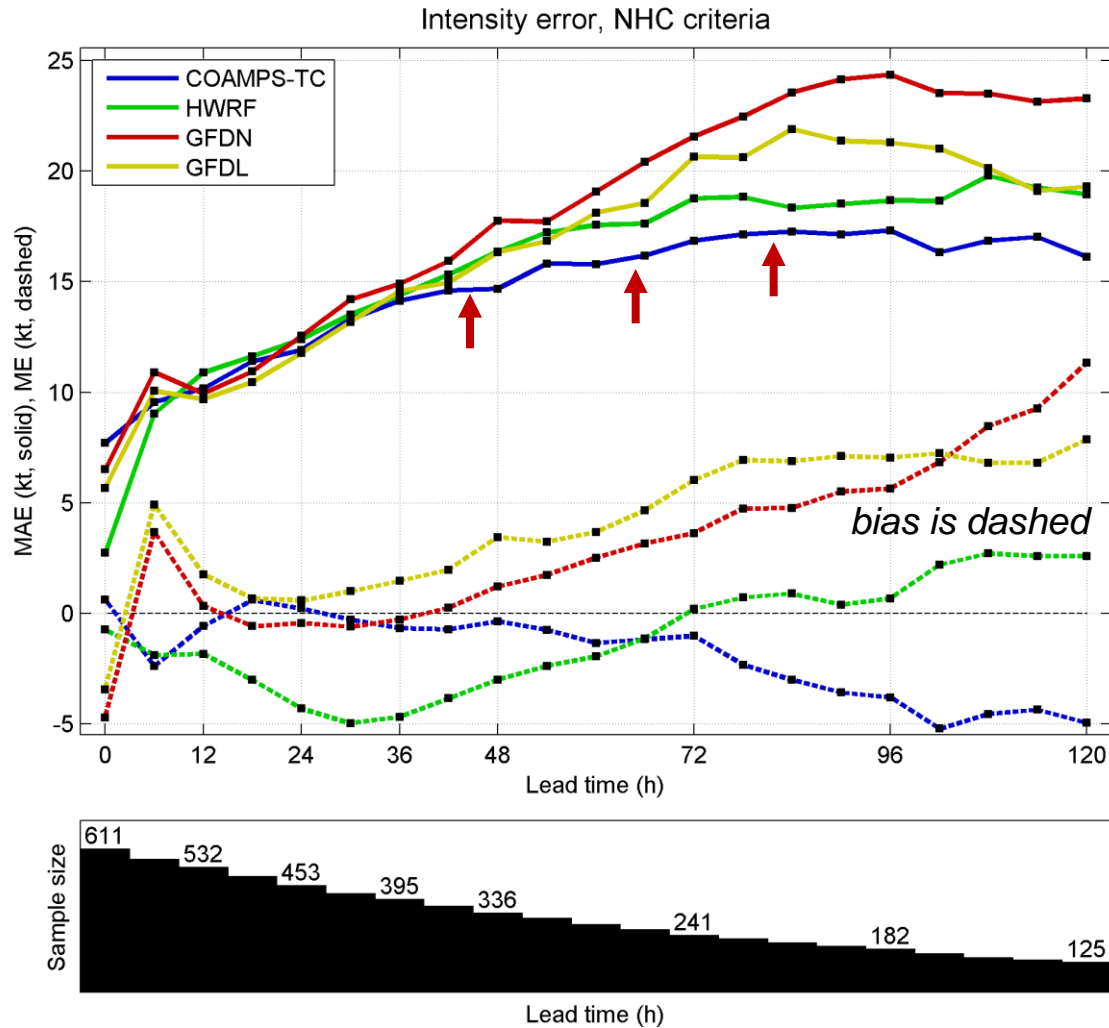
GFDL ensemble and A4PI (radar) omitted due to sample size.

Results shown here with the “Q” designation were regenerated post-storm using the GHMI interpolator (what we had hoped to apply operationally).

*Of the Stream 1.5 models (SPC3, AHQI, COTI, UWQI), **COTI and SPC3 performed better than the current operational models. SPC3 was better than DSHP or LGEM; COTI was the only dynamical model competitive with statistical guidance.***

COAMPS-TC

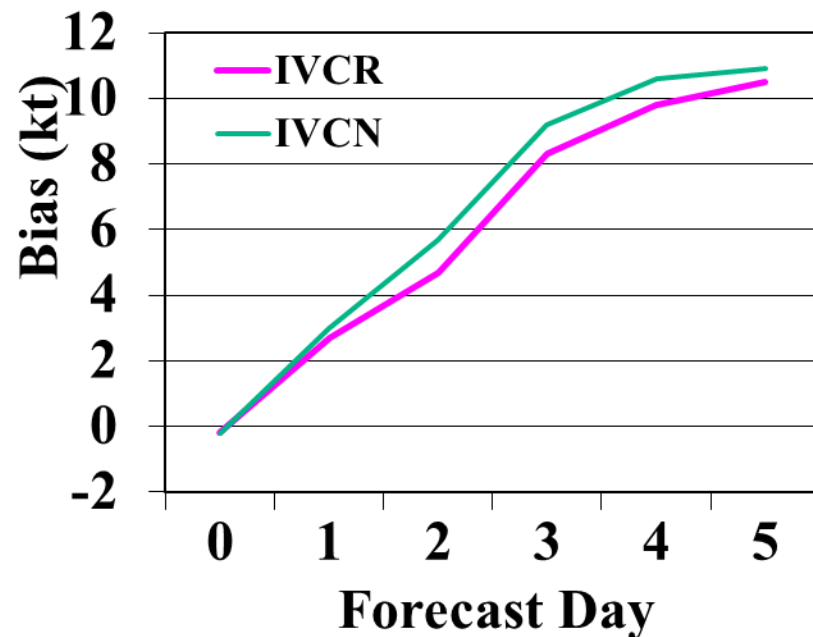
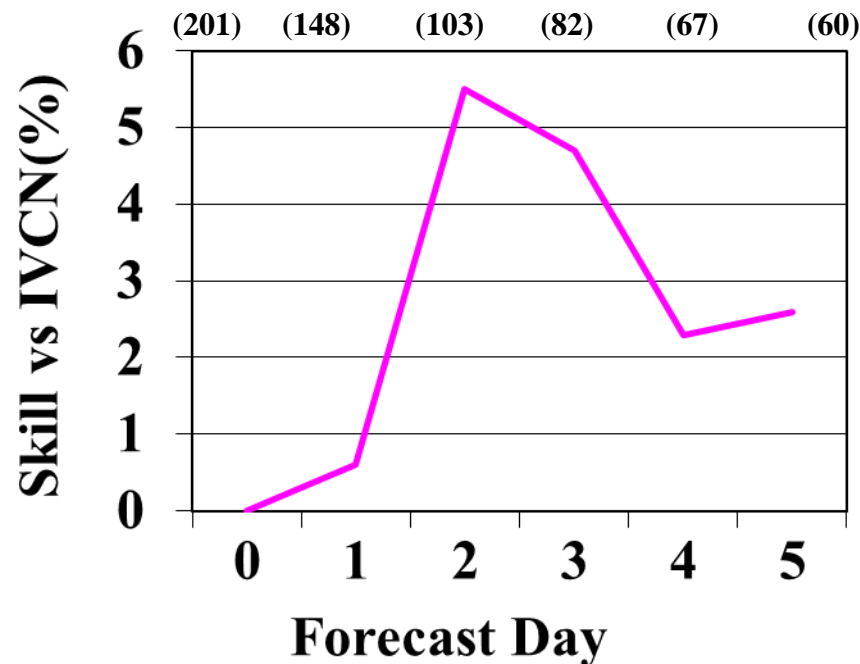
2010 and 2011 W. Atlantic Intensity Statistics



COAMPS-TC intensity forecasts verified well, particularly beyond 30 h where the error growth was considerably slower than other models.

IVCR Intensity Skill & Bias Relative to IVCN

W. Atlantic 2011



- IVCR is a consensus of GHMI+GFNI+DSHP+LGEM+HWFI+COTI+Rixx.
- IVCR was run real-time starting July 1, 2011 to test effects of COAMPS-TC (COTI) and deterministic RI aid (Rixx) on operational consensus.
- IVCR demonstrates improved skill and lower biases for Atlantic 2011 (missing 01L). Skill improvements significant at 2, 3, and 5 days.

COAMPS-TC

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- Stream 2: Mesoscale Ensemble and Coupled COAMPS-TC

• **What didn't work very well?**

- Initialization (spin-up, realistic structure, small RMW issues)
- Rapid intensification was often difficult to capture (e.g. Ophelia)
- Intensity for sheared storms was difficult (e.g., Maria, Katia)
- Track forecasts problematic at times (right bias during re-curvature)

COAMPS-TC

Improvements for 2012

• Initialization and Data Assimilation

- Improved synthetic observations and/or dynamical initialization (TCDI)
- New nonlinear balance step
- Additional satellite observations (AMSU/A radiances)
- Stream 2 testing of COAMPS-TC EnKF

• Physics

- New mixing within cloud
- Improved PBL (testing underway)
- Simplified Arakawa Schubert deep convection (testing underway)
- New microphysics (NRL-Schmidt, Thompson) (testing underway)

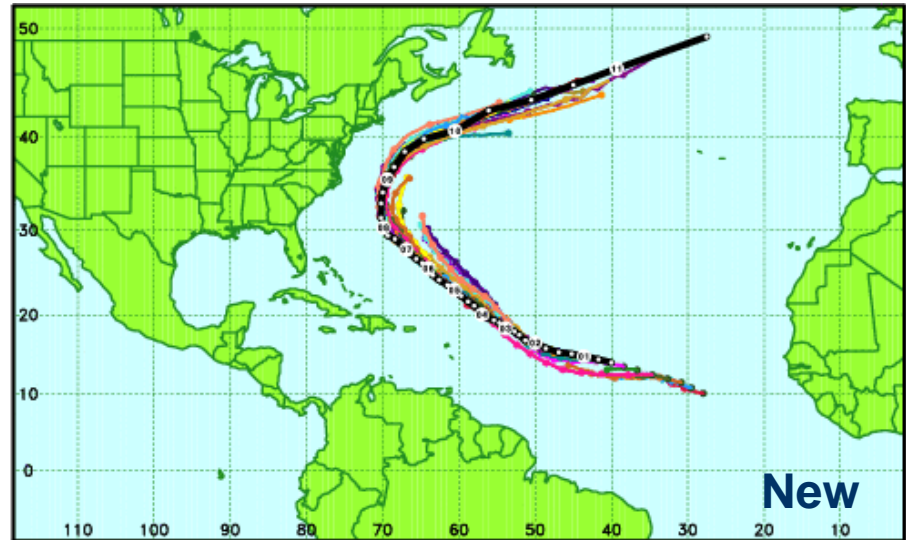
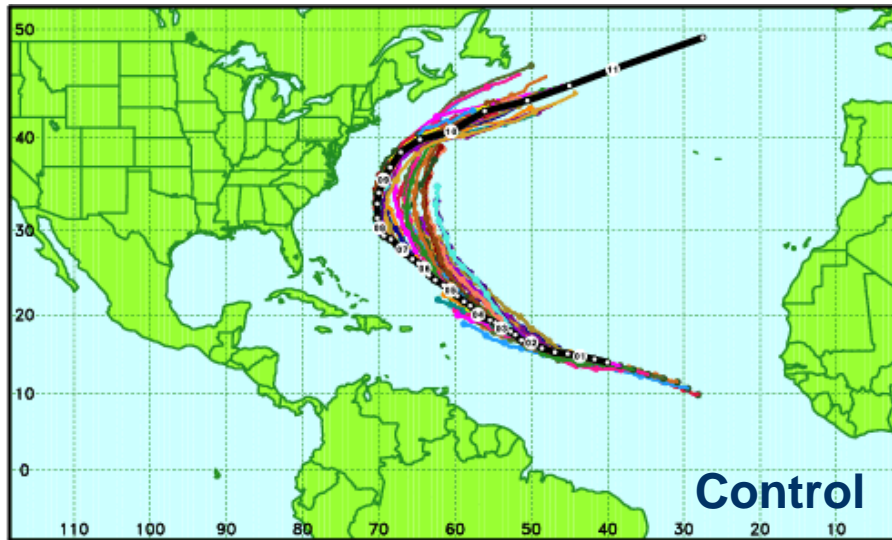
• Other Stuff

- Stream 2 testing of coupled COAMPS-TC
- Improved nest tracker
- Iron out IT issues at FNMOC related to file transfers

COAMPS-TC Development

New Version

Effects of New Synthetics and New Physics on Forecast of Katia (2011) using COAMPS-TC



Track forecasts are greatly improved using new distribution of synthetics and changes to model physics

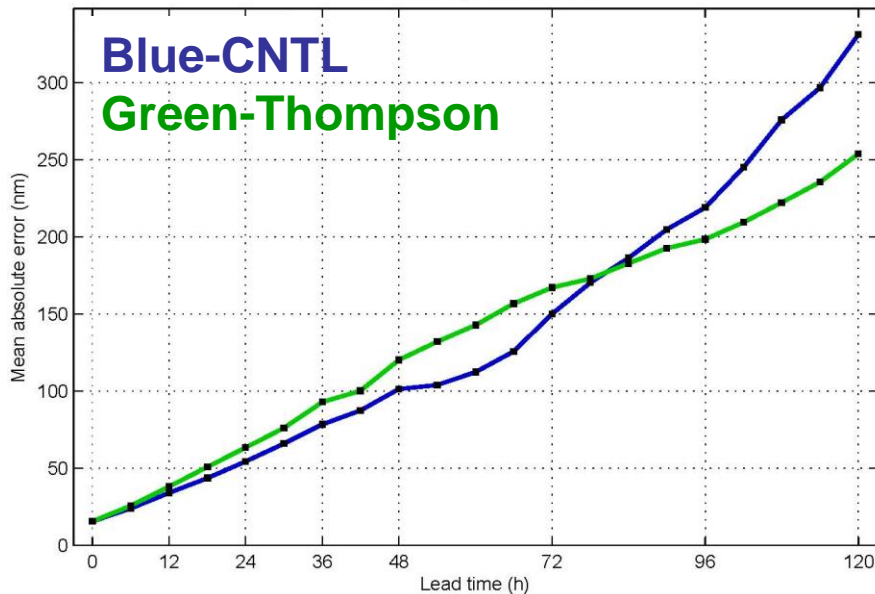


COAMPS-TC: Physics Improvements

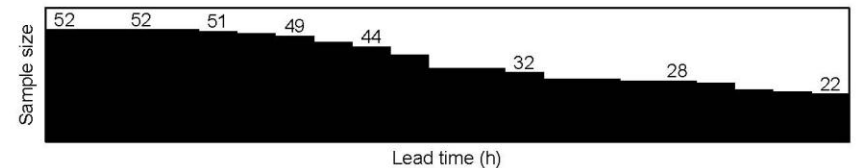
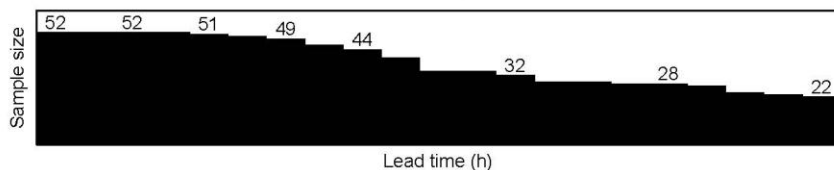
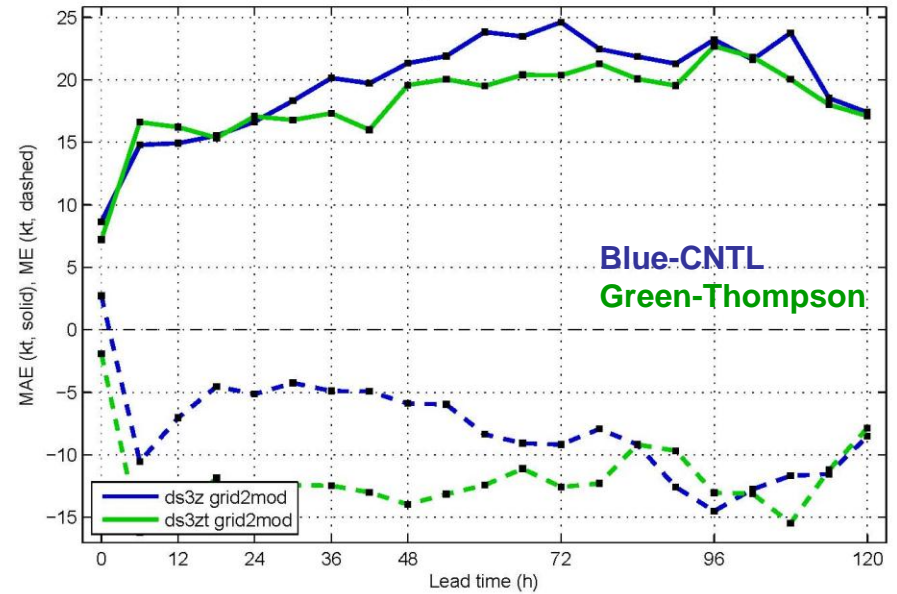
Evaluation of the Thompson Microphysics Scheme

- G. Thompson (2008) V3.3 implemented in COAMPS-TC:
- two-moment for cloud ice and rain
- single-moment for cloud water, snow, and graupel
- prescribed number of cloud droplets (100 cm^{-3})

Track error, NHC criteria



Intensity error, NHC criteria



- New Thompson microphysics being tested in collaboration w/ NOAA (HFIP).
- New version of NRL microphysics (J. Schmidt) shows promise.

COAMPS-TC

Stream 1.5 Plans and Issues

- **COAMPS-TC Intensity Skill:**

- Performed quite well over the past 2 seasons

- **Continued improvements for physics, data assimilation and initialization, air-sea coupling**

- Priorities: Initialization of vortex, large-scale DA, microphysics and PBL

- **Real-time COAMPS-TC tests in 2012**

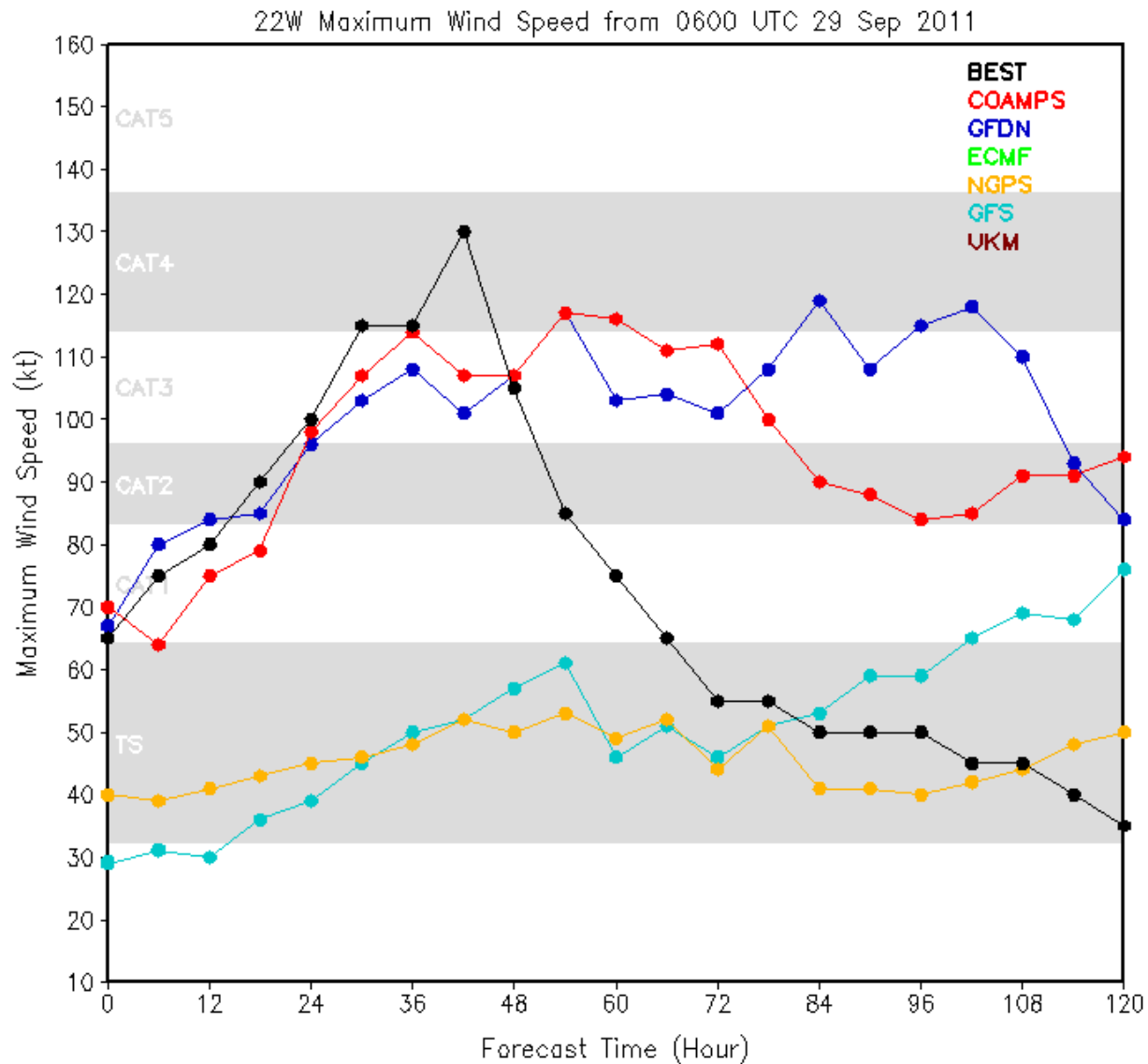
- Stream 1.5: 3-5 km resolution, GFS LBCs, 6 h cycle, new microphysics, improved DA and initialization, possibly improved PBL
- Stream 2: EnKF (10-20 members, 5 km), ensemble of ensembles?, fully coupled system

- **Continue to diagnose and improve system**

- New tools (adjoints, observation impact), many new diagnostics (Frank!)
- Continue to collaborate with NHC and HFIP partners

COAMPS-TC

Real-Time Forecasts of Typhoon Nanmodal

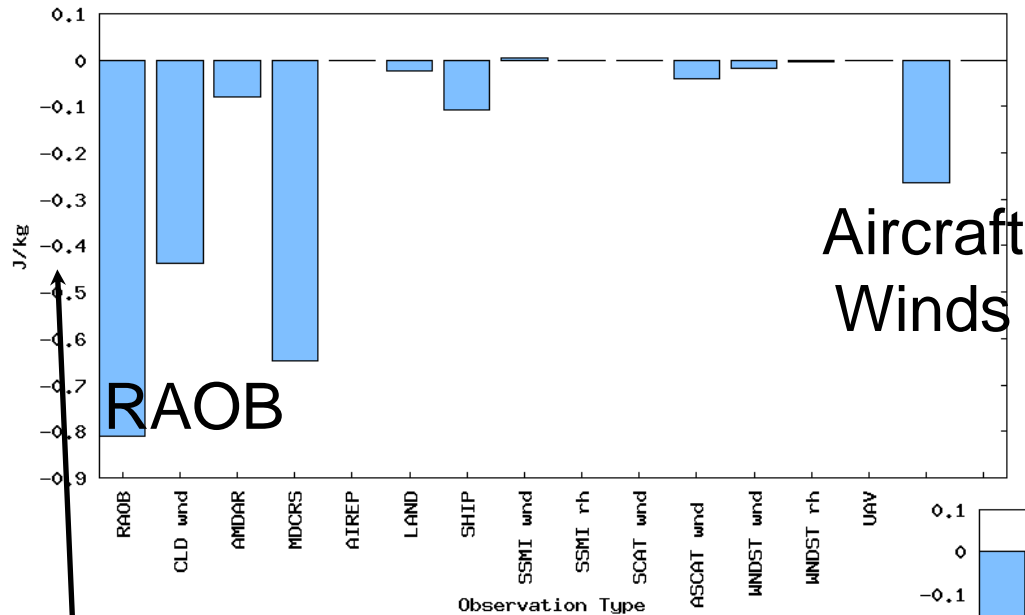


COAMPS Observation Impact

Adjoint Based Diagnostics for Hurricane Earl

Impact of Hurricane Hunter Winds (Per Forecast in J/kg)

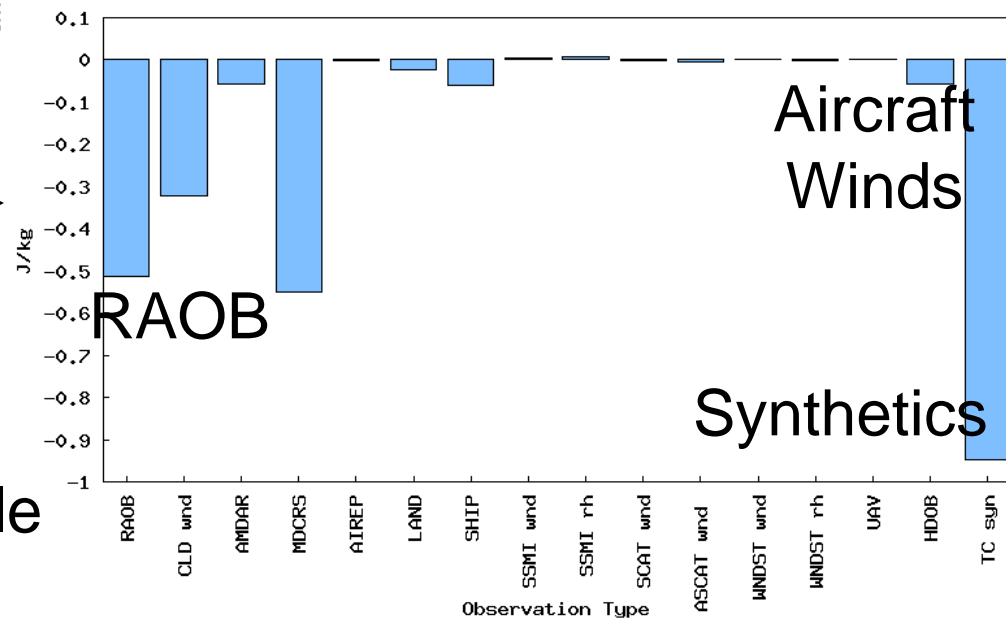
Without Synthetics



Adjoints for COAMPS-TC and NAVDAS (3DVar) have been Developed and Used to Compute the Observation Impact on Forecast Error

Negative Values Indicate Forecast Improvement

With Synthetics

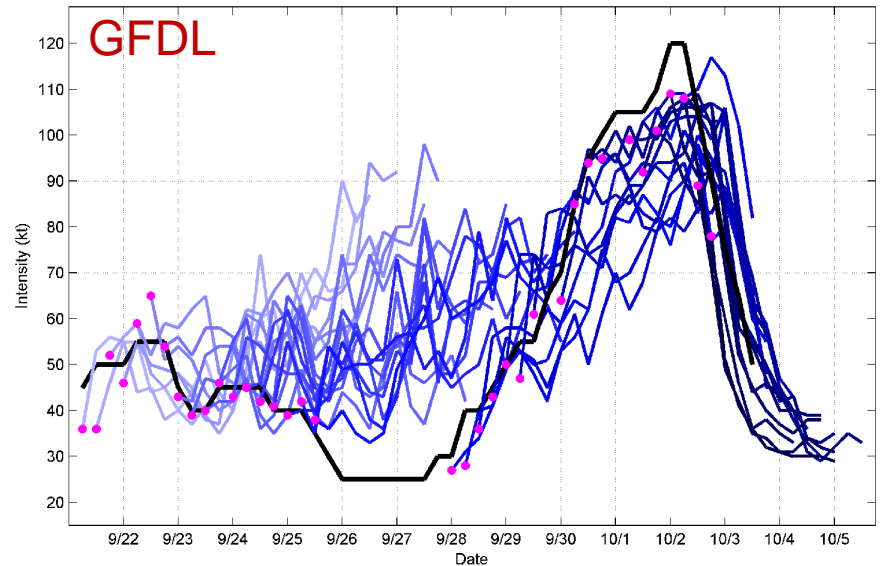
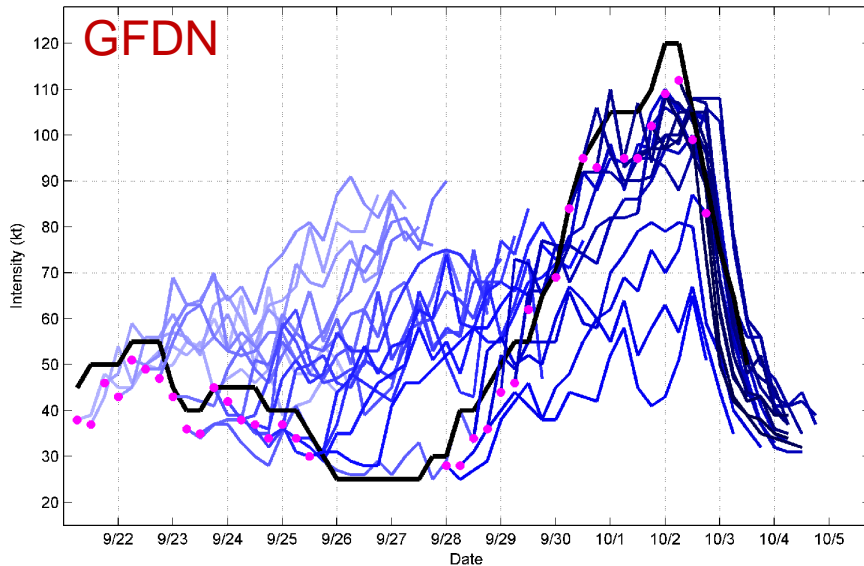
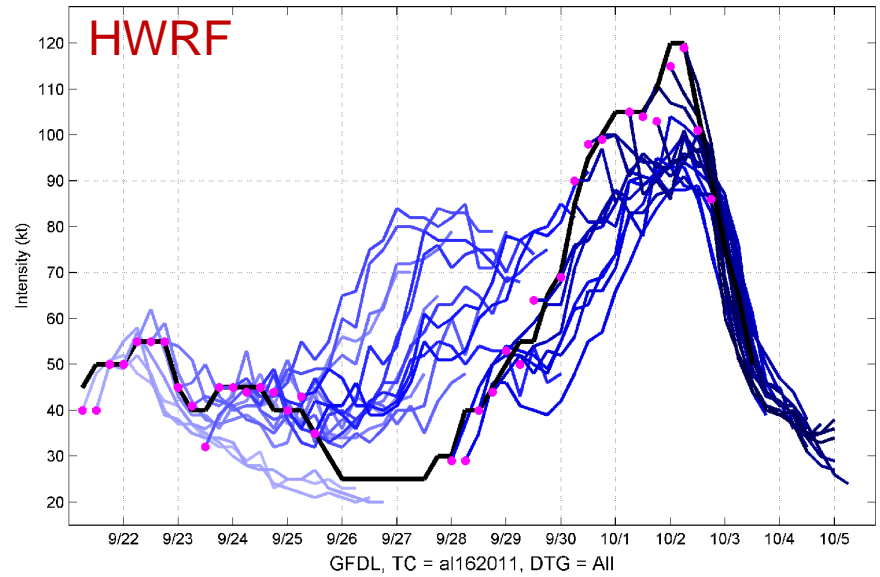
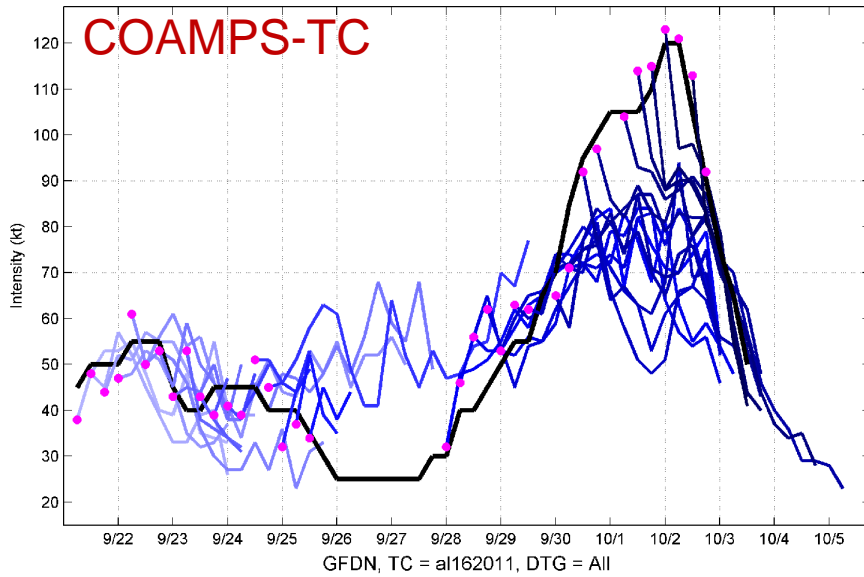


COAMPS-TC

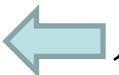
Intensity Challenges: Ophelia

COAMPS-TC, TC = al162011, DTG = All

HWRP, TC = al162011, DTG = All



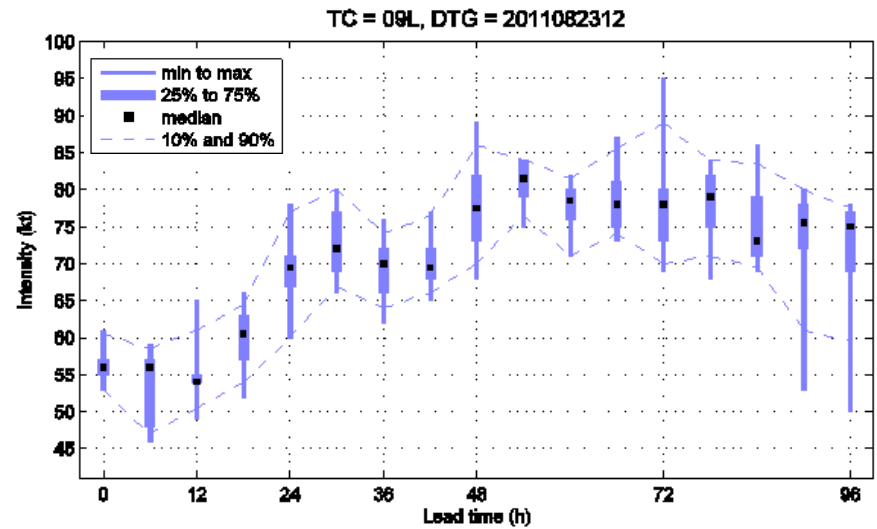
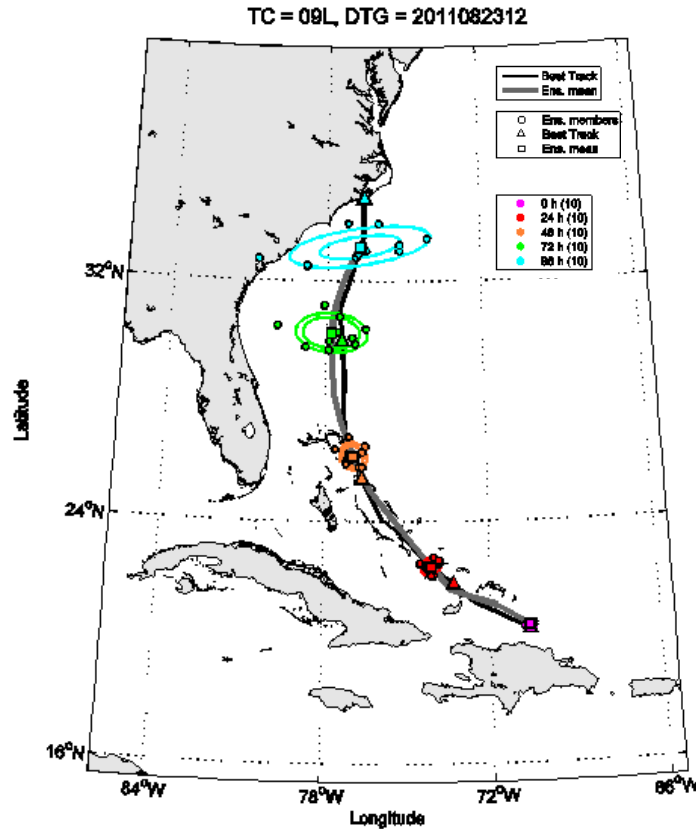
Ophelia presented challenges for accurate intensity forecasts.



COAMPS-TC Stream 2

Real-Time High-Resolution Ensemble DA in 2012

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.

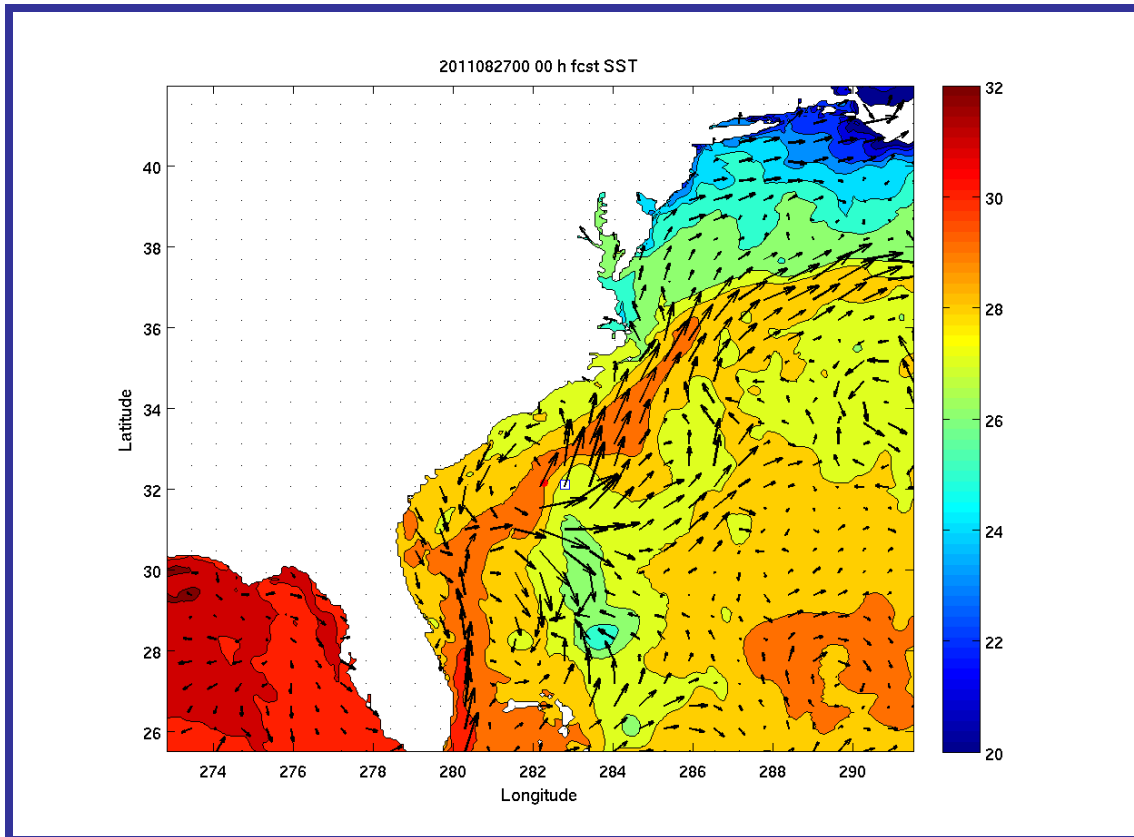
Median, minimum, maximum, and 10% and 90% distributions are shown

COAMPS-TC Ensemble System is a new capability demonstrated in real time.

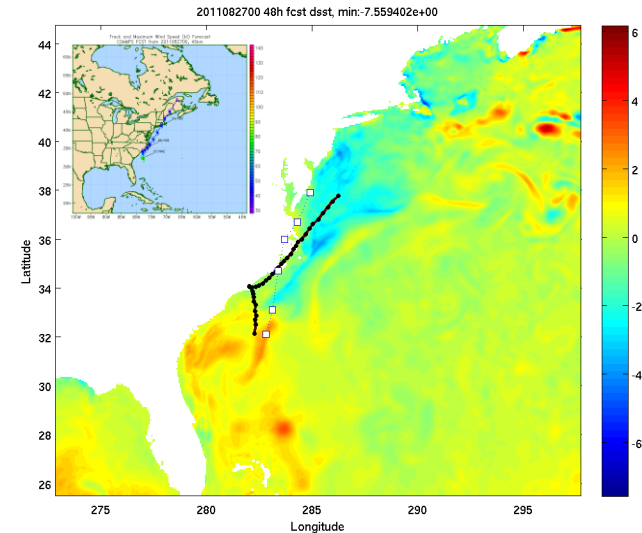
COAMPS-TC Stream 2

Real-Time Coupled Forecasts During 2012 Season

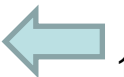
SST and Currents for Hurricane Irene



48 H SST difference



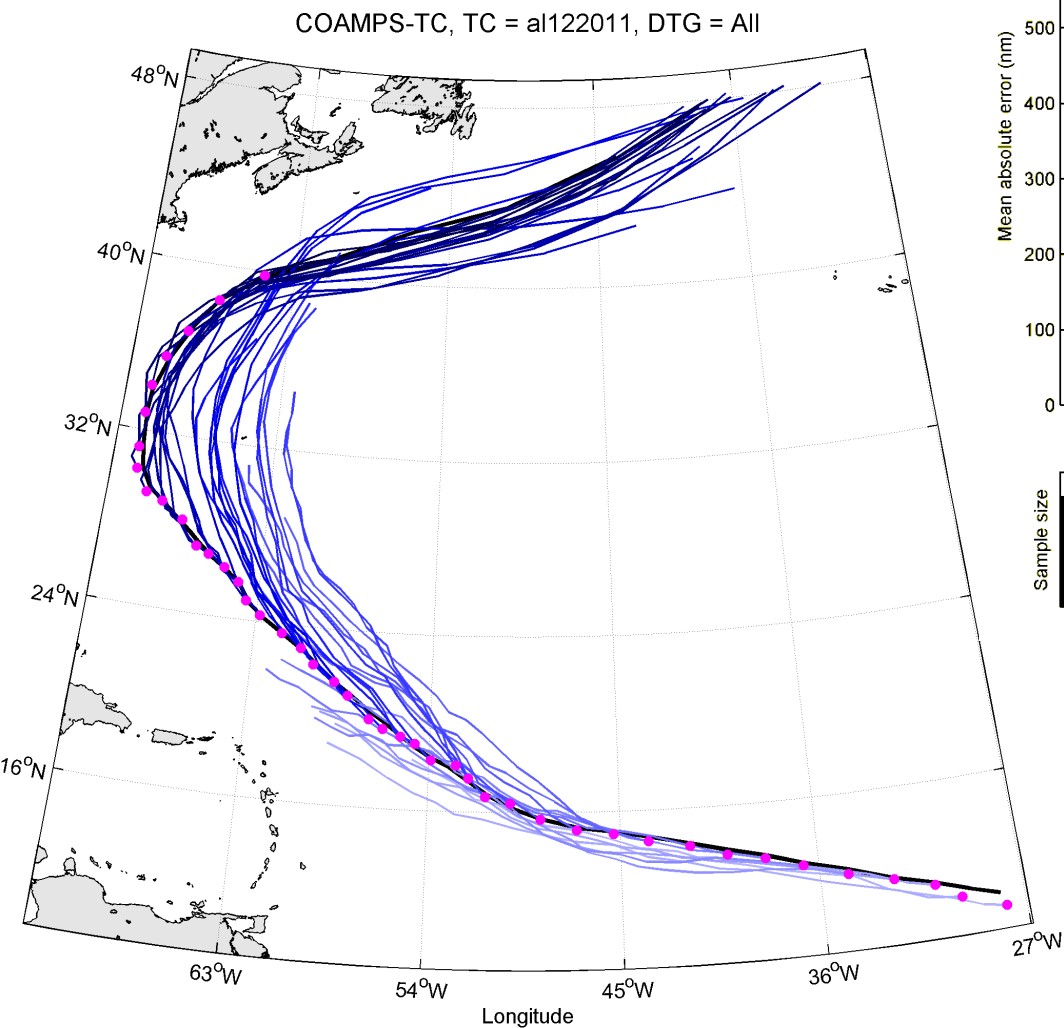
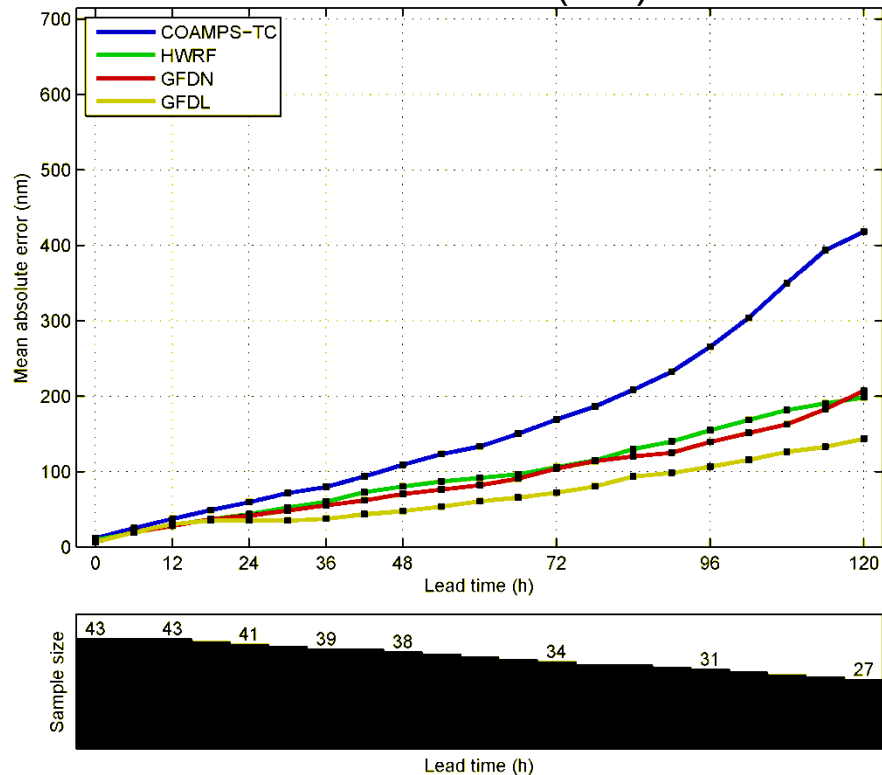
Significant hurricane induced SST cooling along the coastal area during Irene.



COAMPS-TC

Track Challenges

Track Error (nm)



Track of Katia was poorly forecasted, particularly during recurvature. Research is ongoing to address this.