High-resolution Hurricane Reanalysis and Reforecasts using state-of-art operational HWRF model

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Motivation

COASTAL Act:

The Consumer Option for an Alternative System to Allocate Losses Act was signed into law on July 6, 2012.

Purpose:

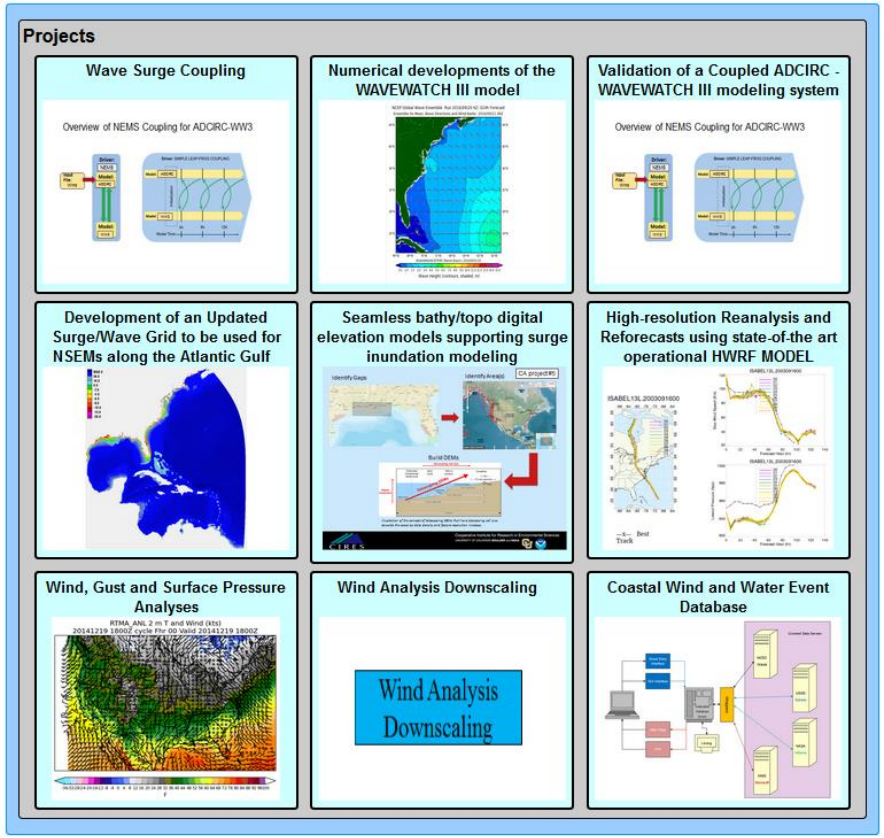
To lower costs to FEMA's National Flood Insurance Program (NFIP) by better discerning wind versus water damage in the case of "indeterminate losses."

(website: http://www.weather.gov/sti/coastalact)

Require:

NOAA to produce detailed "post-storm assessments" in the aftermath of a damaging tropical cyclone that strikes the U.S. or its territories.

COASTAL Act Component Projects



Role of HWRF in the COASTAL Act

- **Requires** a time history of mean wind, wind gust, surface pressure and air-sea temperature difference (atmospheric stability, AS) over the area impacted by a **land falling tropical cyclone** in order to estimate the strength and timing of damaging winds and also to force wave and surge models.

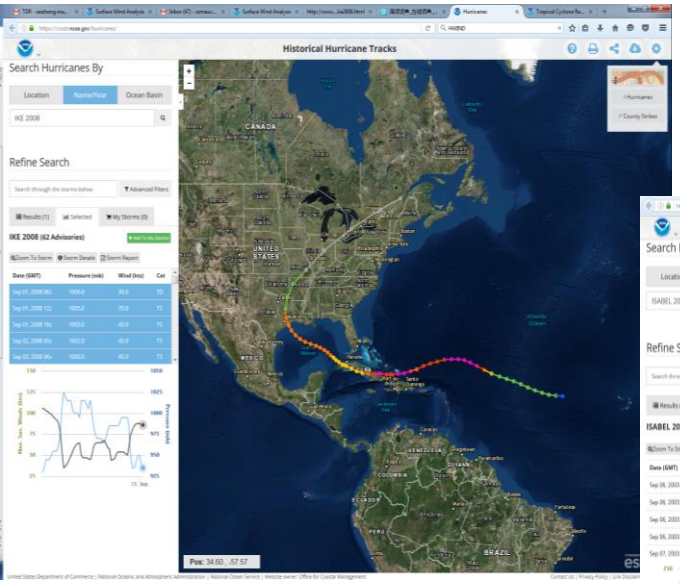
- **Provide** the background fields while Un-Restricted Mesoscale Analysis (URMA) will perform the mean wind, gust, and surface pressure and AS analyses.

Working Plan

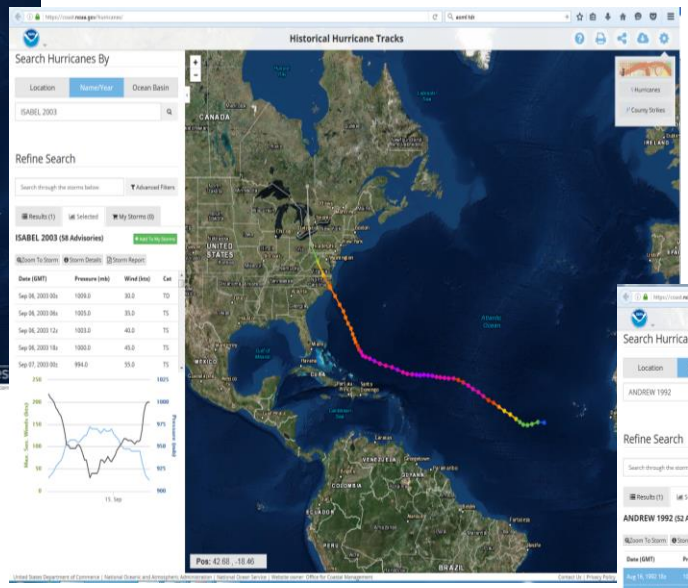
- **Year-1:**
  - **Design** deterministic and ensemble runs with the latest version of the operational HWRF.
  - Make preliminary deterministic and **ensemble** runs at the highest possible resolution for the chosen storms.
- **Year-2:**
  - Fine tune model configurations to produce **more accurate** hurricane analysis products
  - Work with downscaling and downstream applications (forcing ocean, wave, land, surge and inundation models) to **generate products** for selected landfalling storms that impacted US coastal regions.

Landfalling storms selected

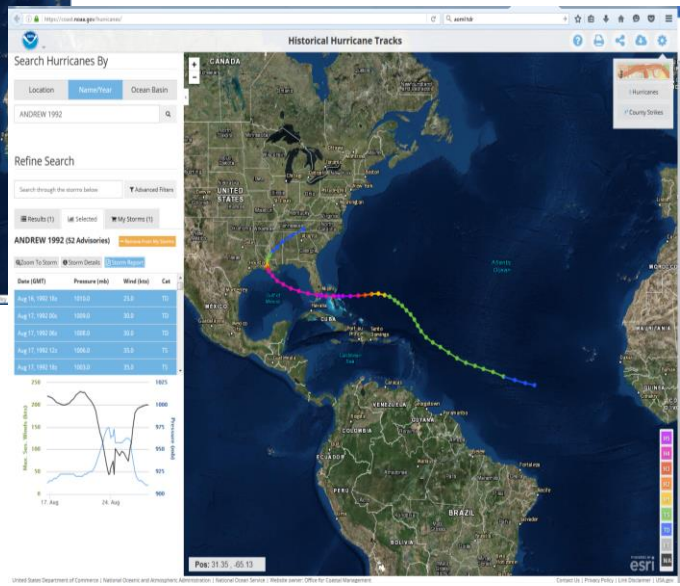
IKE (1-14, Sep, 2008)



Isabel (6-19, Sep,2003)



Andrew (16-28, Aug, 1992)



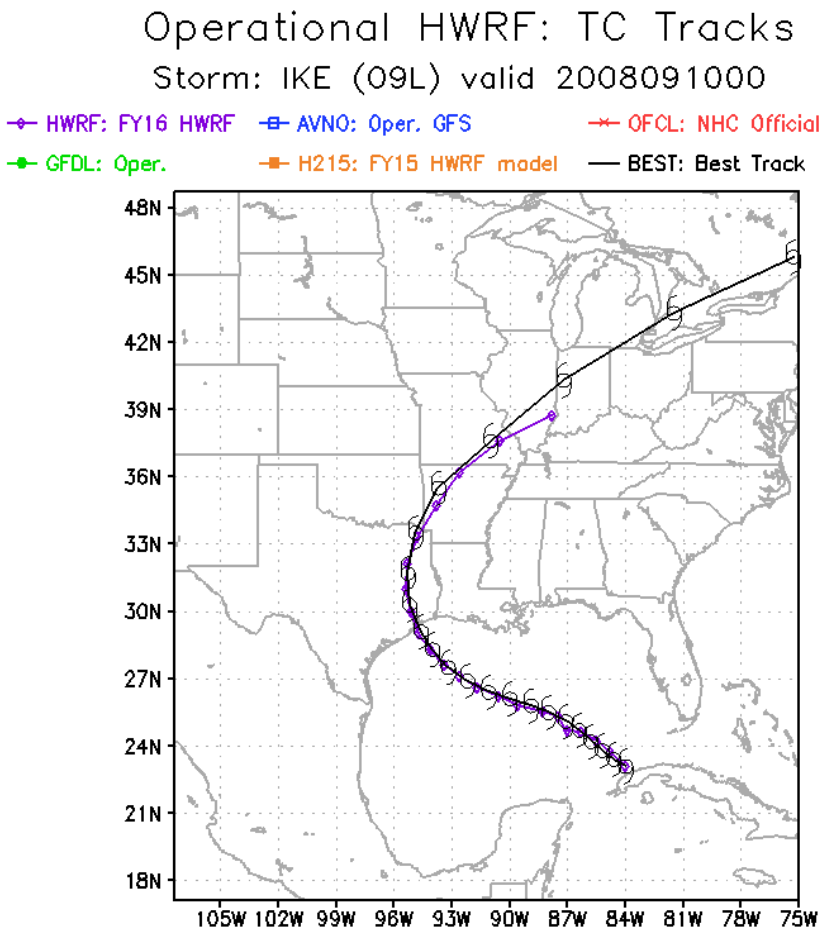
Milestones

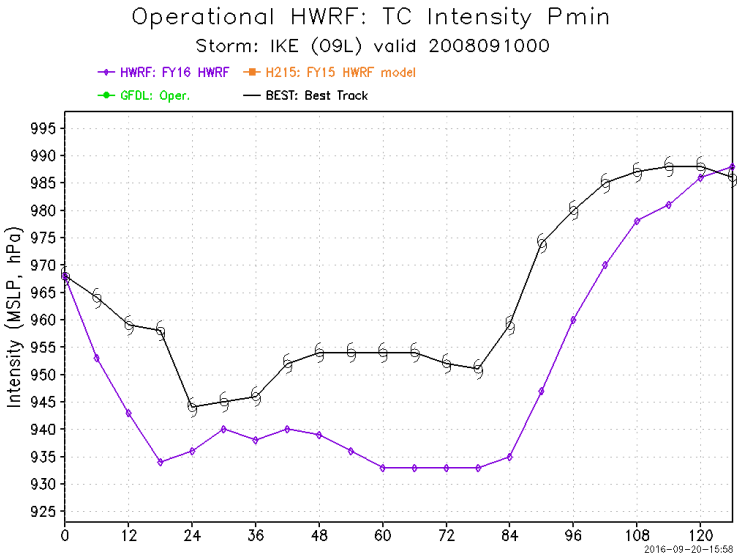
- Data Collection:
  - GFS Forecasts: 2.5deg Reanalysis & 1.0deg GEFS (not every day archived on HPSS)
  - Observations: conventional, satellites, TDR, and High Density Observation (HDOB) data
- Ensemble inputs generation for GSI hybrid data assimilation
- Experimental design:
  - NO DA, No ocean
    - Single cycle
    - Entire storm
  - DA-hybrid, ocean
    - Single cycle
    - Entire storm
- Prepare adequate validation and verification packages/tools to be used with available observations.

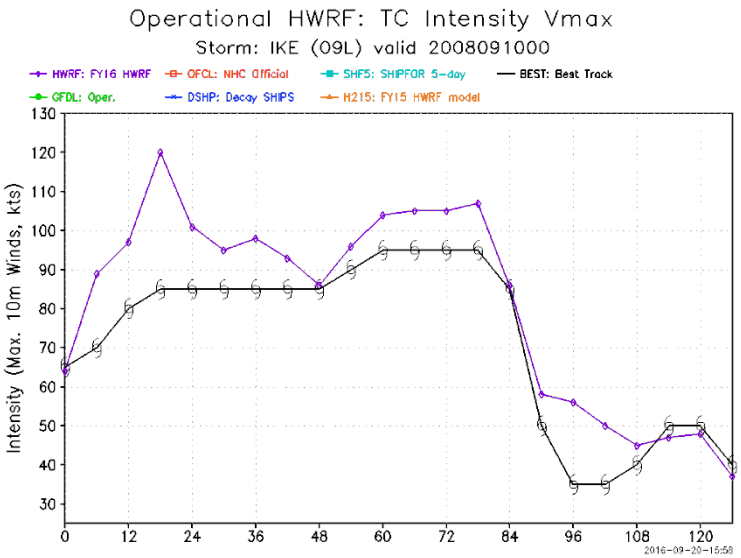
Case study with IKE
—— single cycle test

- **Single cycle**: 2008091000
- **HWRF System**: MergeH216
- **GFS input**: 2p5 deg, download from HPSS history archive data
- **Observations**: conventional and satellite available on HPSS
- **Experiment setup**:
  - run_gsi=no ;; GSI and FGAT initialization
  - run_ocean=no ;; POM coupling
  - ocean_model=POM ;; Selected ocean model: POM or HYCOM
  - atmos_model=WRF ;; Selected atmospheric model. Must be WRF
  - run_wave=no ;; Wave coupling?
  - wave_model=WW3 ;; Which wave model? Must be WW3
  - run_relocation=yes ;; vortex relocation
  - run_ensemble_da=yes ;; run the DA ensemble
  - run_ens_relocation=no ;; run relocation for ensemble members
  - run_satpost=yes ;; make synthetic satellite products
  - run_multistorm=no ;; run as a Multi Storm (even if 1 or No storms)

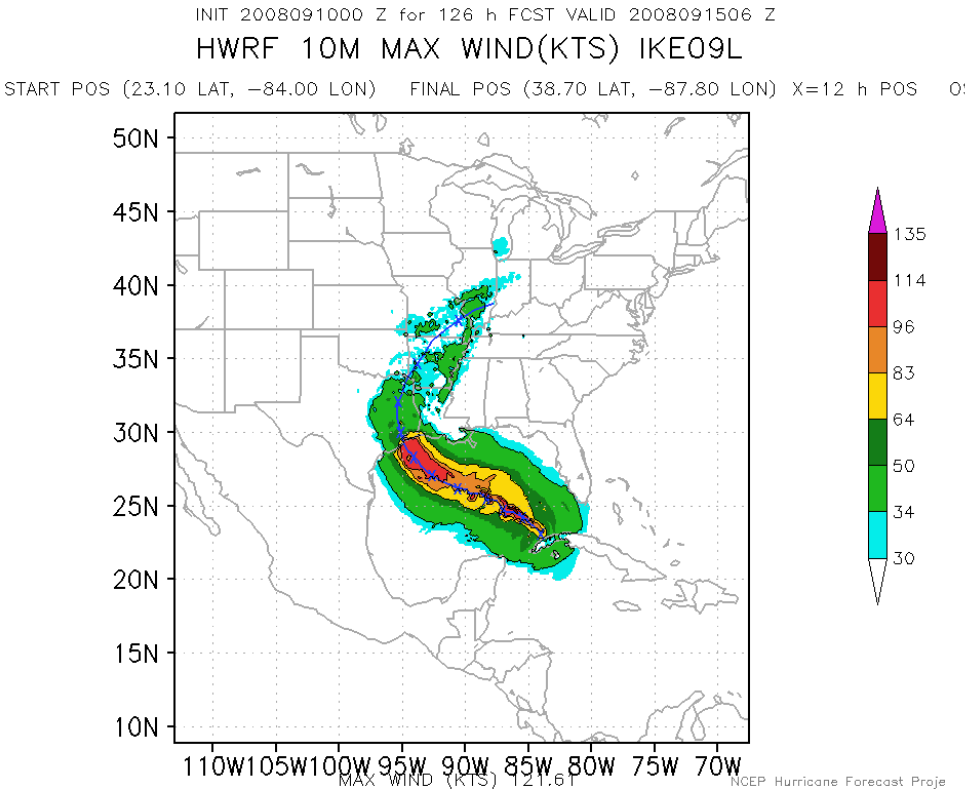
Track, MSLP and 10m-Wind

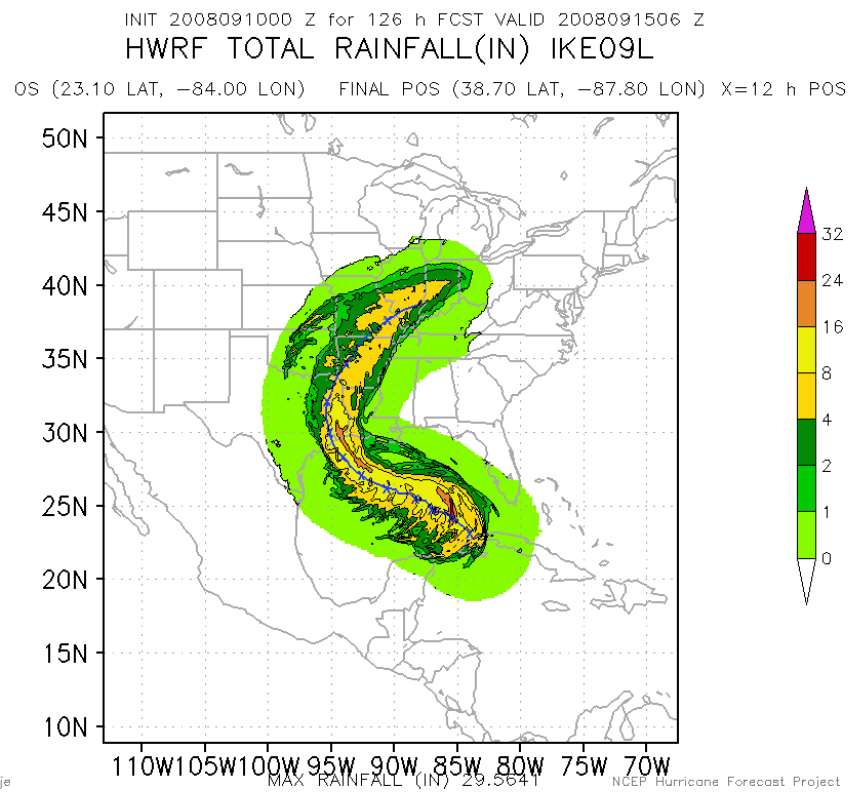






10m-Wind and Rainfall





HWRF output into Storm Surge Model Hindcast

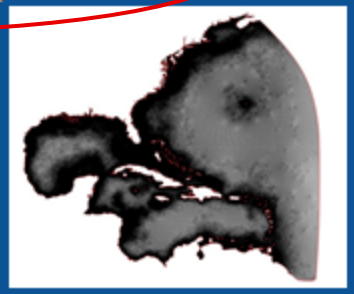
Storm Surge Model Setup

- ADCIRC-based modeling system
- Non-linear dynamics, tide and surge interaction, inland flooding
- Uncoupled (no waves, no rivers)

- HSOFS grid (~200m at the coast), covers the entire US East Coast

- Atmospheric forcing: HWRF fields, taken from RDHPCS tape
  hpss: /NCEPDEV/nesdis-jcsda/1year/Zaizhong.Ma/hwrf/ike_CTL

- Initial water level offsets:
  - +0.14 m (climatology-based)
  - +0.06 m (data-based)



HSOFS grid coverage

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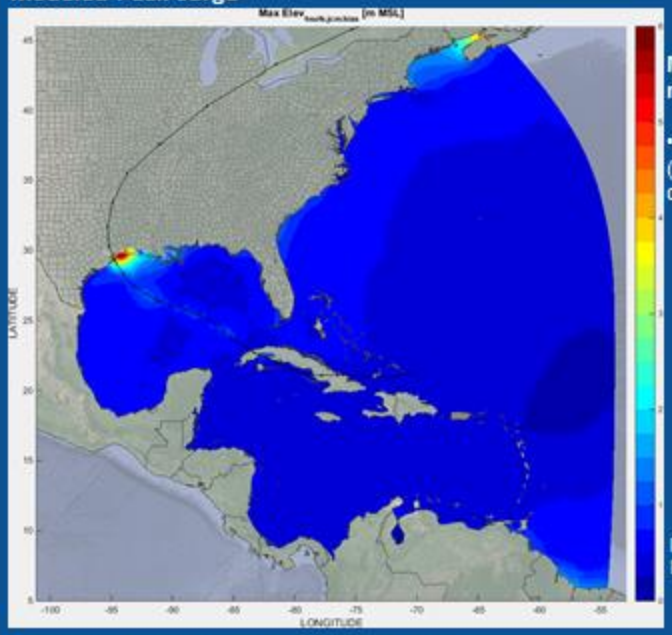
Modeled Peak Surge



Maximal elevations, in meters MSL

- Maximal total water levels (tides+surge) over the period of the model run

Maximal Model Elevation, meters MSL

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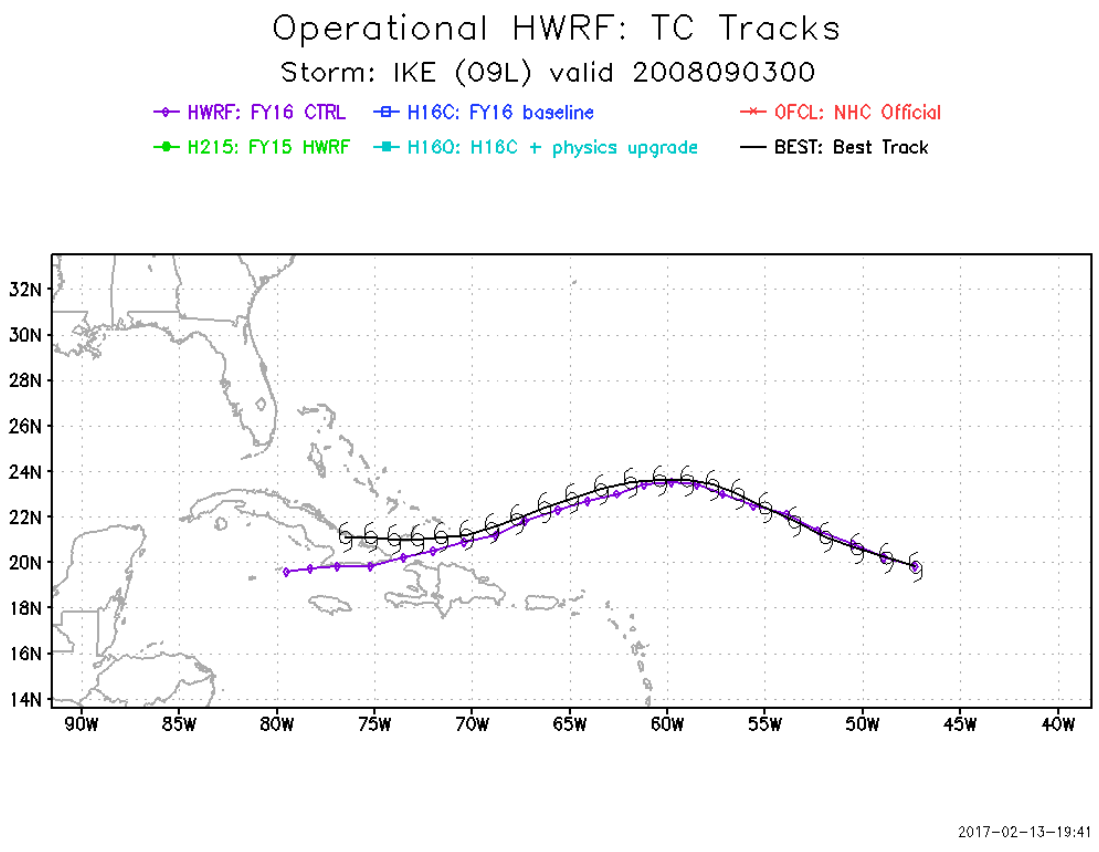
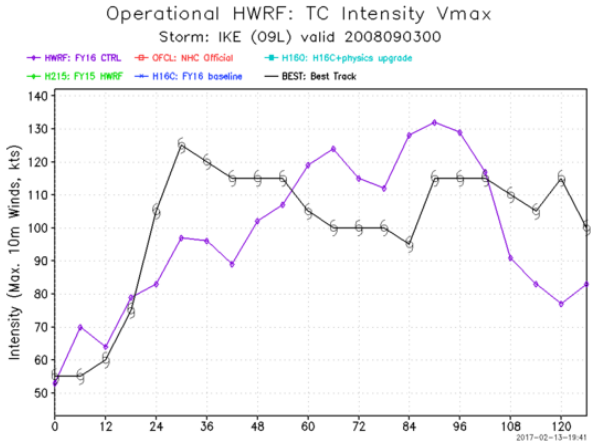
Case study with IKE

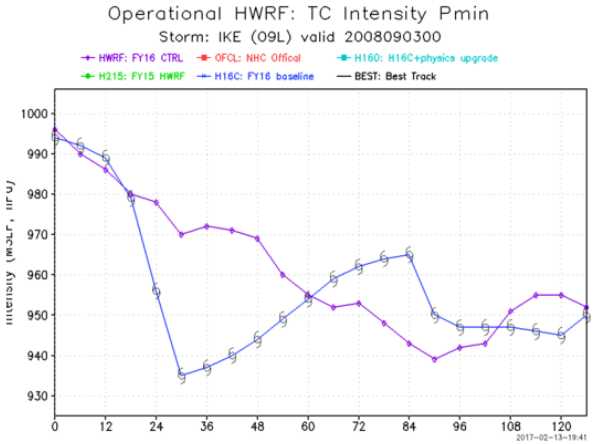
—— Entire Storm Test

- **Period**: 1-14, September 2008
- **HWRF System**: MergeH216, still no DA, no ocean
- **GFS input**: 2p5 deg, downloaded from HPSS history archive data
- **Status**: Experiments for entire peroid haven't completed on Theia yet, just finished for 1-6, September.
- **Preliminary Results** just focus on track, intensity and etc.

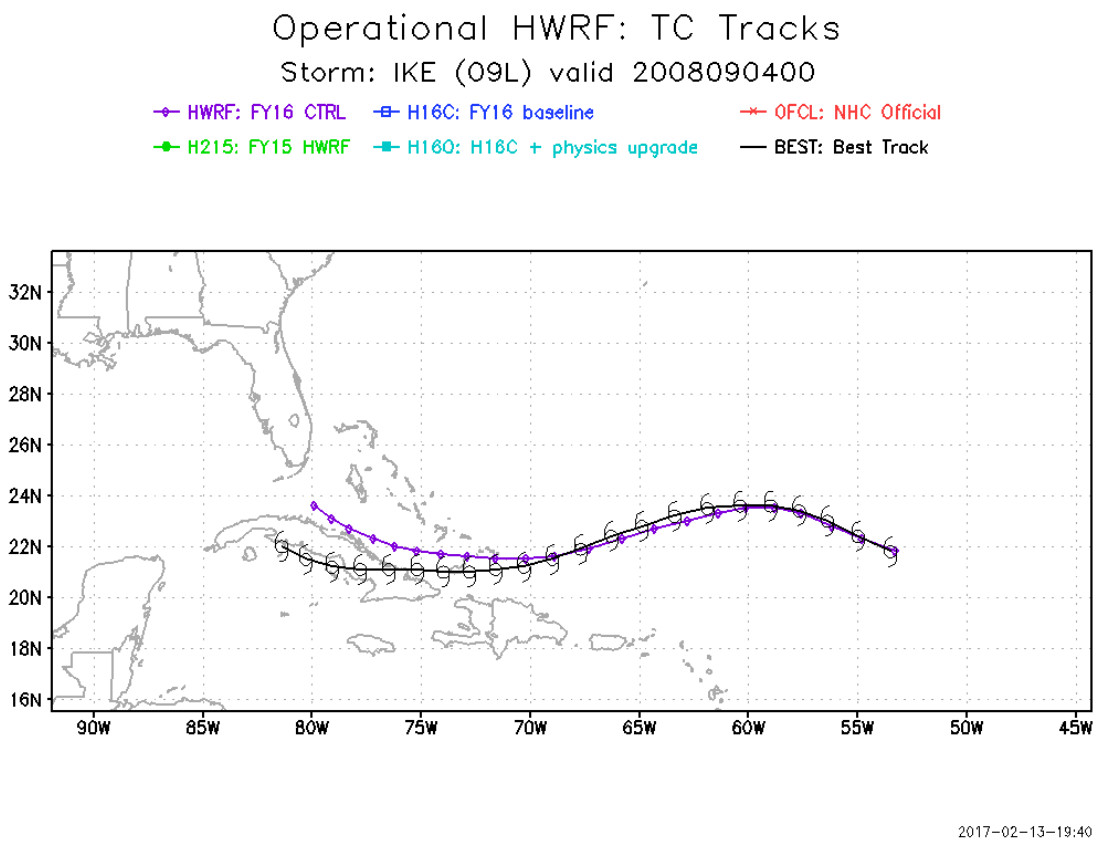
Preliminary results
—— at 2008090300

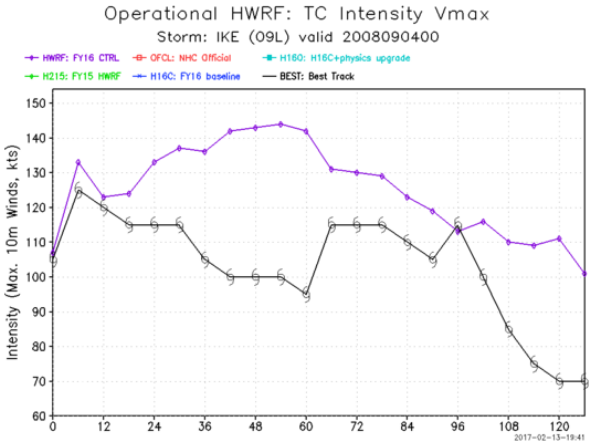


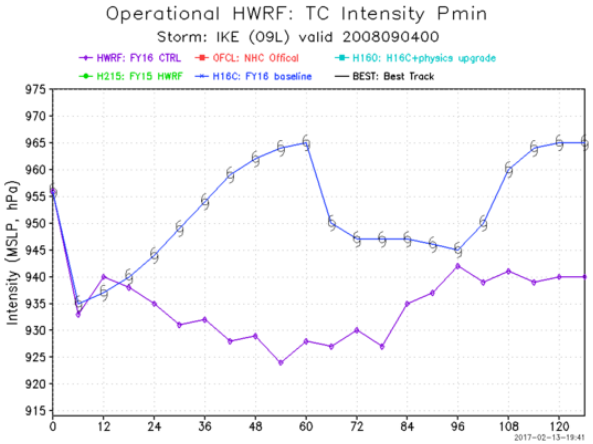




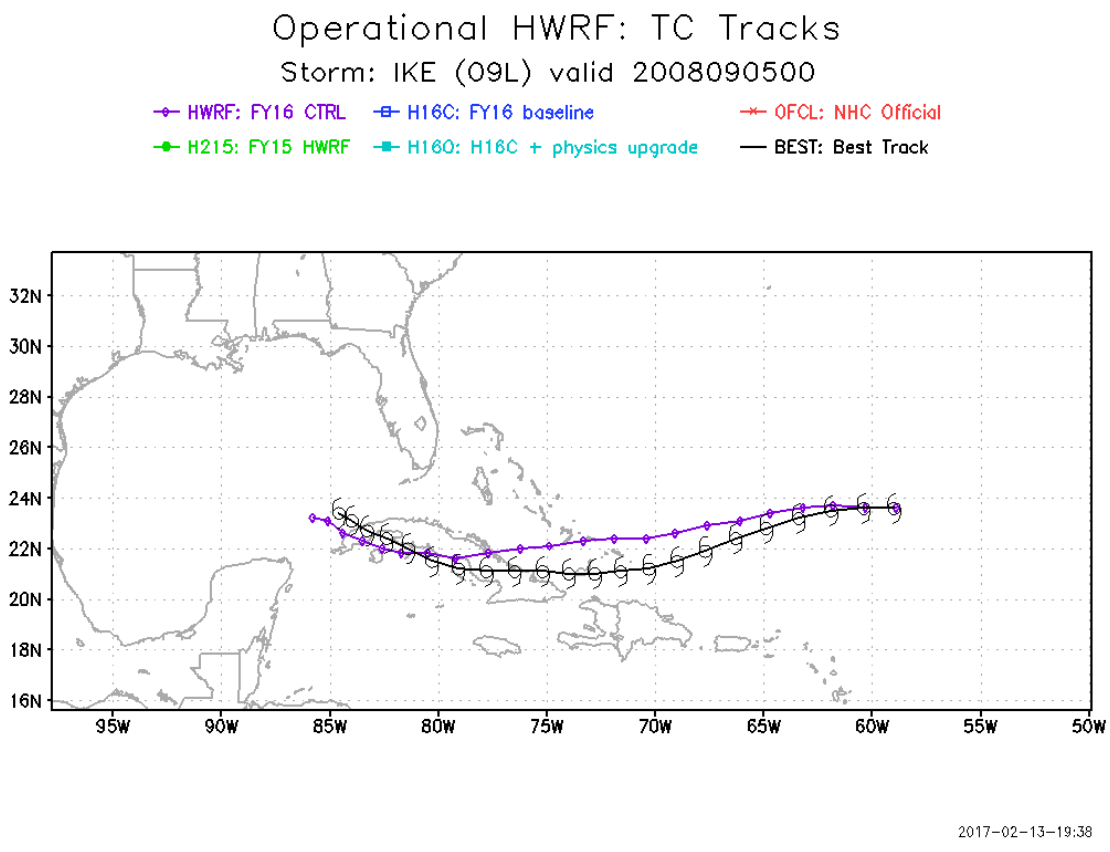
Preliminary results
—— at 2008090400

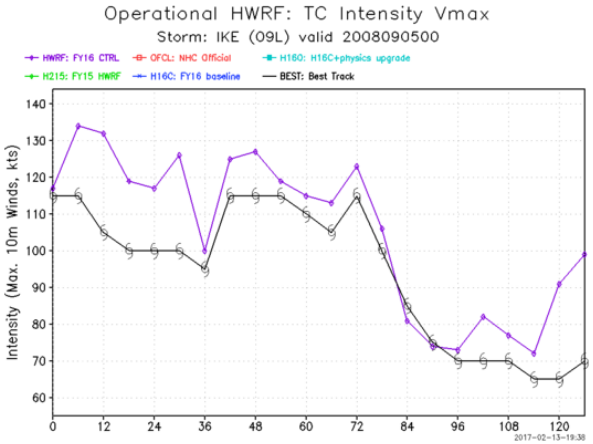


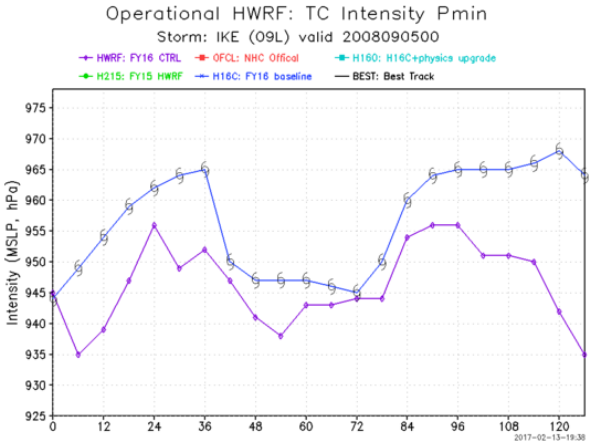




Preliminary results
—— at 2008090500

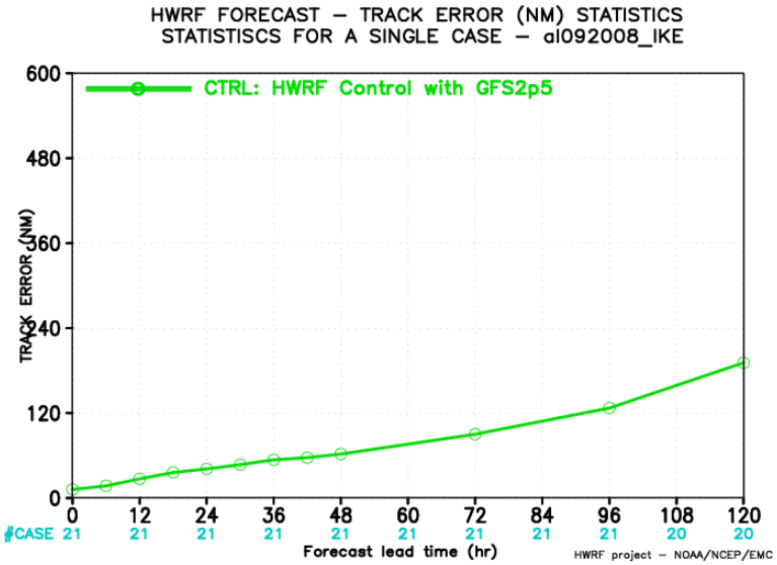


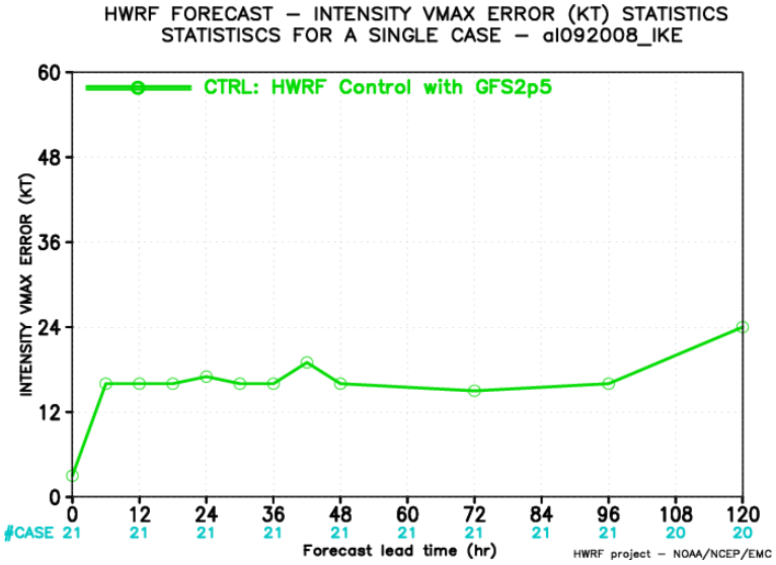


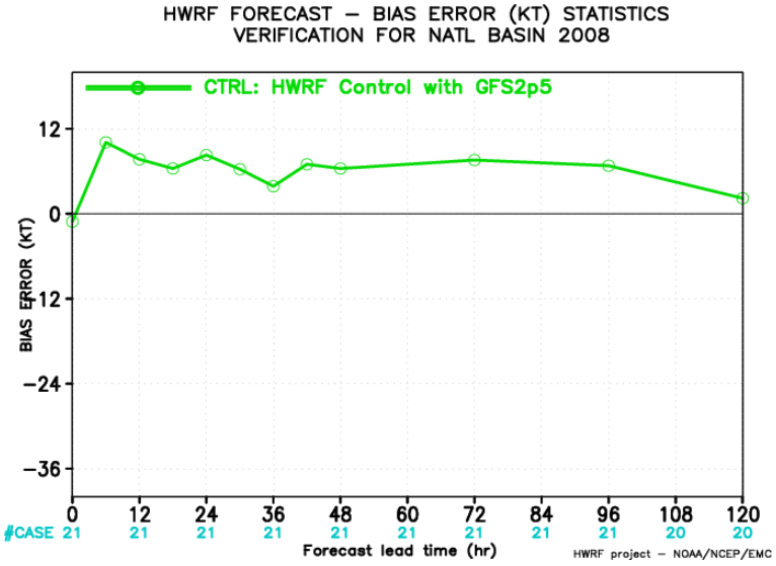


Preliminary results

—— Statistics

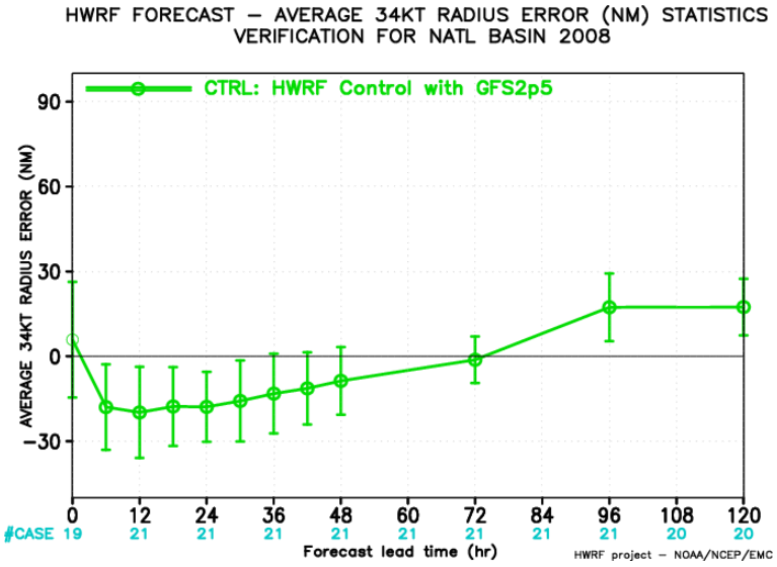


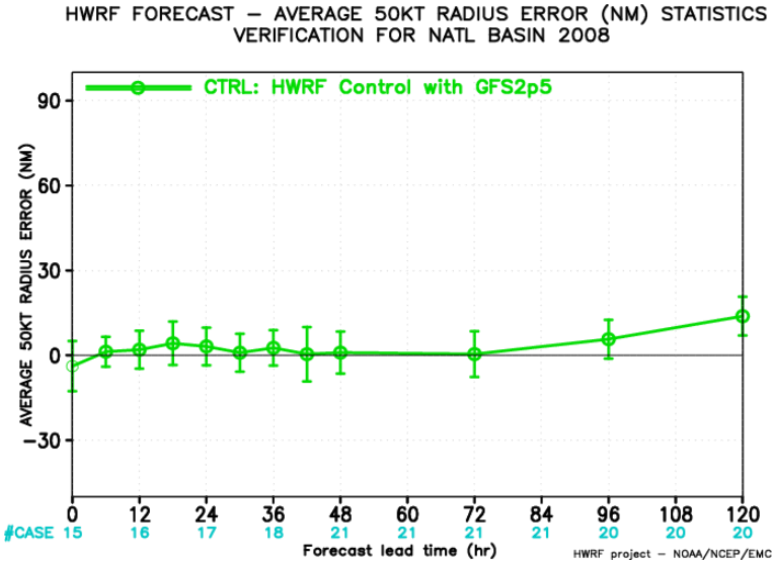


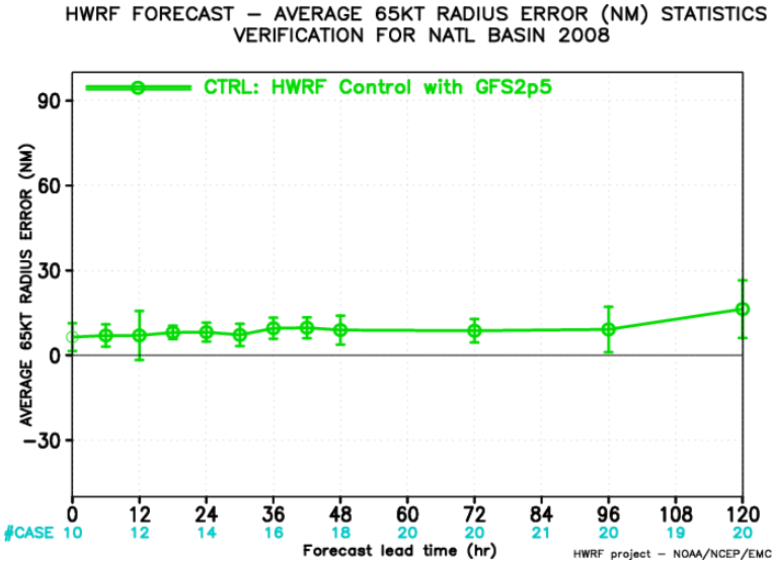


Preliminary results Cont.

—— Statistics







Next steps…

- Hurricane IKE:
  - Complete the Control experiments for IKE: No DA, No Ocean and 2p5 GFS
  - Perform DA experiments:
    - Generate ICs for DA hybrid, turn on the DA option
  - Turn on the Ocean option
  - Test GEFS (1.0 deg)
- Update HWRF system once FY17 configuration is finalized.
- Data Denial experiments
- Explore generation of ensembles
- Work on the other two land-falling Hurricanes (2003 Isabel and 1992 Andrew).
- Post-storm Assessments.
- Provide HWRF output to whole working group for COASTAL Act.