NOAA HURRICANE FORECAST IMPROVEMENT PROJECT

Annual Meeting Opening Comments

Objectives for this meeting

- We need to creating a strategic plan for HFIP over the next 5 years and we would like to use this meeting to agree on a final plan using the HFIP teams.

- I propose we focus the program for the meeting in seeking answers to:

  - What areas of focus/themes are most important for HFIP to meet its goals over the next 5 years?
    - Initialization?
    - Cloud physics?
    - Boundary layer processes?
    - New data sources?
    - Ensembles?
    - Post processing
    - …?

- We also need to establish priorities for the focus areas established in 1.

The HFIP Project
Vision/Goals

- **Vision**
  - Organize the hurricane community to dramatically improve numerical forecast guidance to NHC in 5-10 years
- **Goals**
  - Reduce numerical forecast errors in track and intensity by 20% in 5 years, 50% in 10 years
  - Extend forecast guidance to 7 days with skill comparable to 5 days at project inception
  - Increase probability of predicting rapid intensification at day 1 to 90% and 60% at day 5

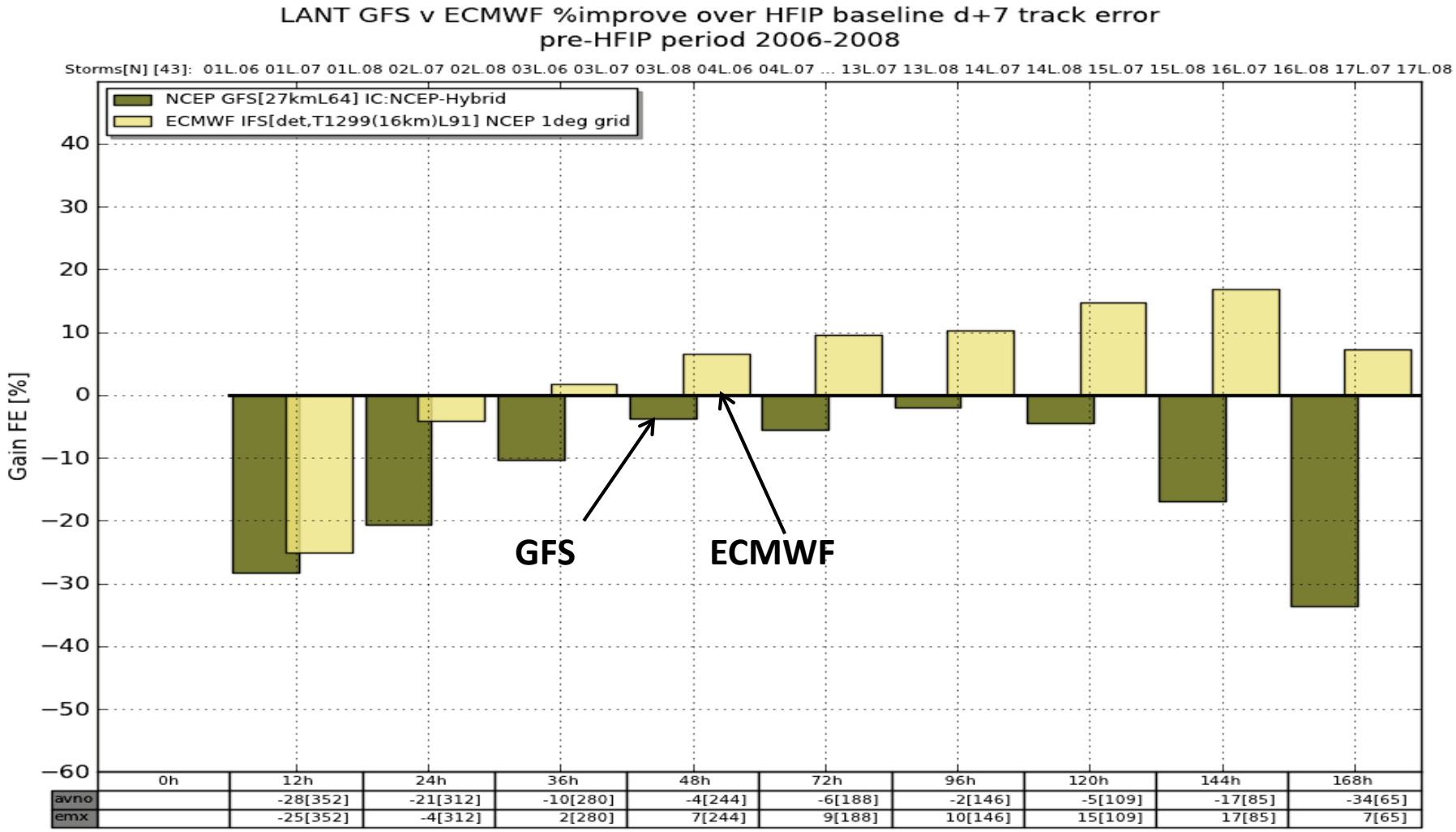
3

HFIP Progress and Accomplishments

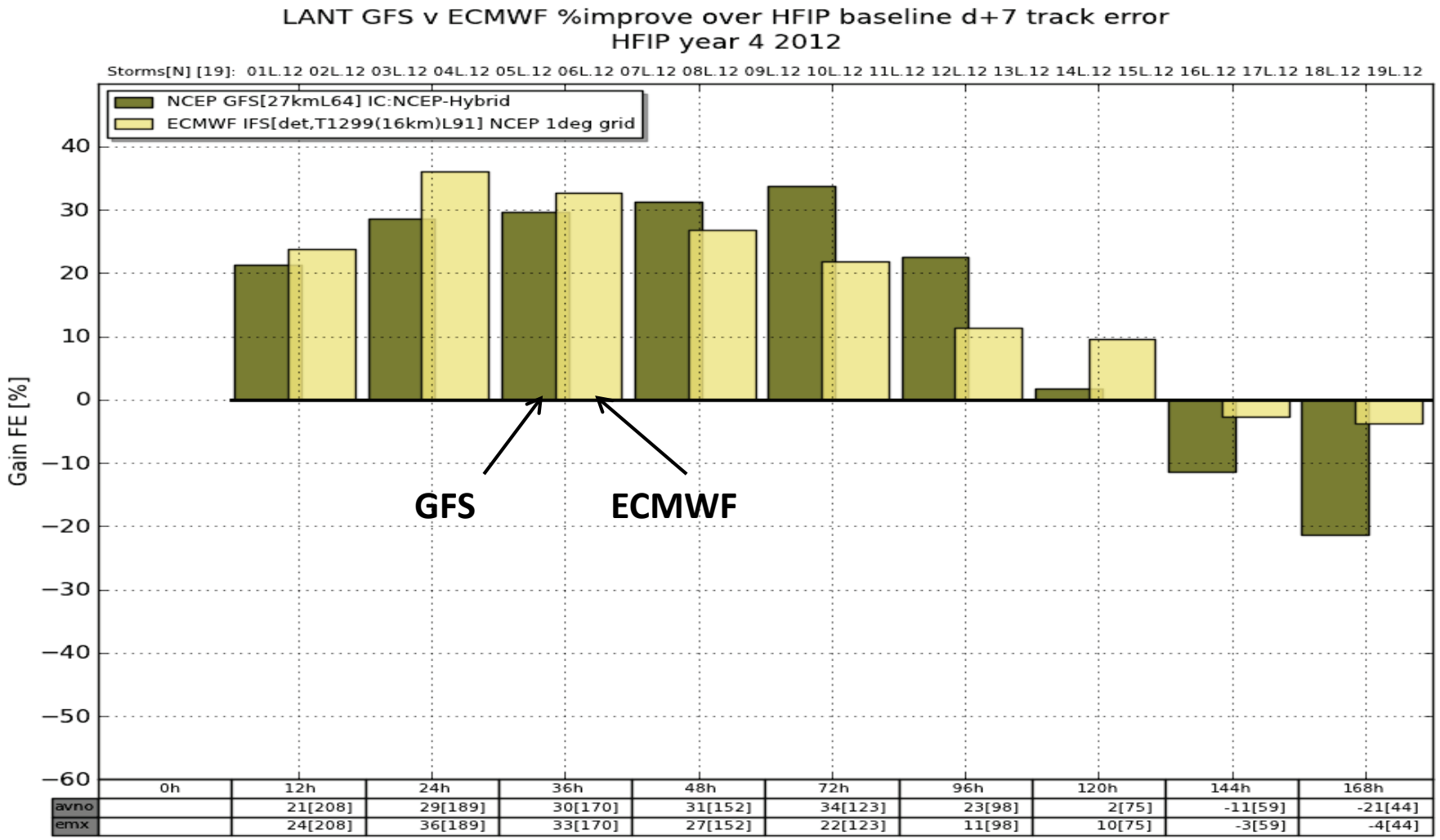
- 5-year Performance Goals Exceeded or Within Reach
  - New NCEP GSI-Hybrid DA Systems went operational in the Global Forecast System (GFS) in May 2012: track forecasts through 96 hours exceeded the 5-yr and approached the 10-yr goal. It is among the best dynamical models for hurricane track prediction, comparable to ECMWF for hurricane track at most lead times.
  - A third nest was added to operational HWRF in 2012 allowing an inner core resolution of 3 km. This and other changes led to another 20% improvement in both track and intensity forecasts over previous year. Improvements in HWRF continue.
  - Impact of radar data on intensity forecasts still debatable (we will hear the RDITT report later today). All aircraft data (including radar) may provide improvement of 10%-20% out to 72 hours.

The Global Model

NCEP vs ECMWF for Atlantic 2006-2008 % gain over HFIP baseline (track)

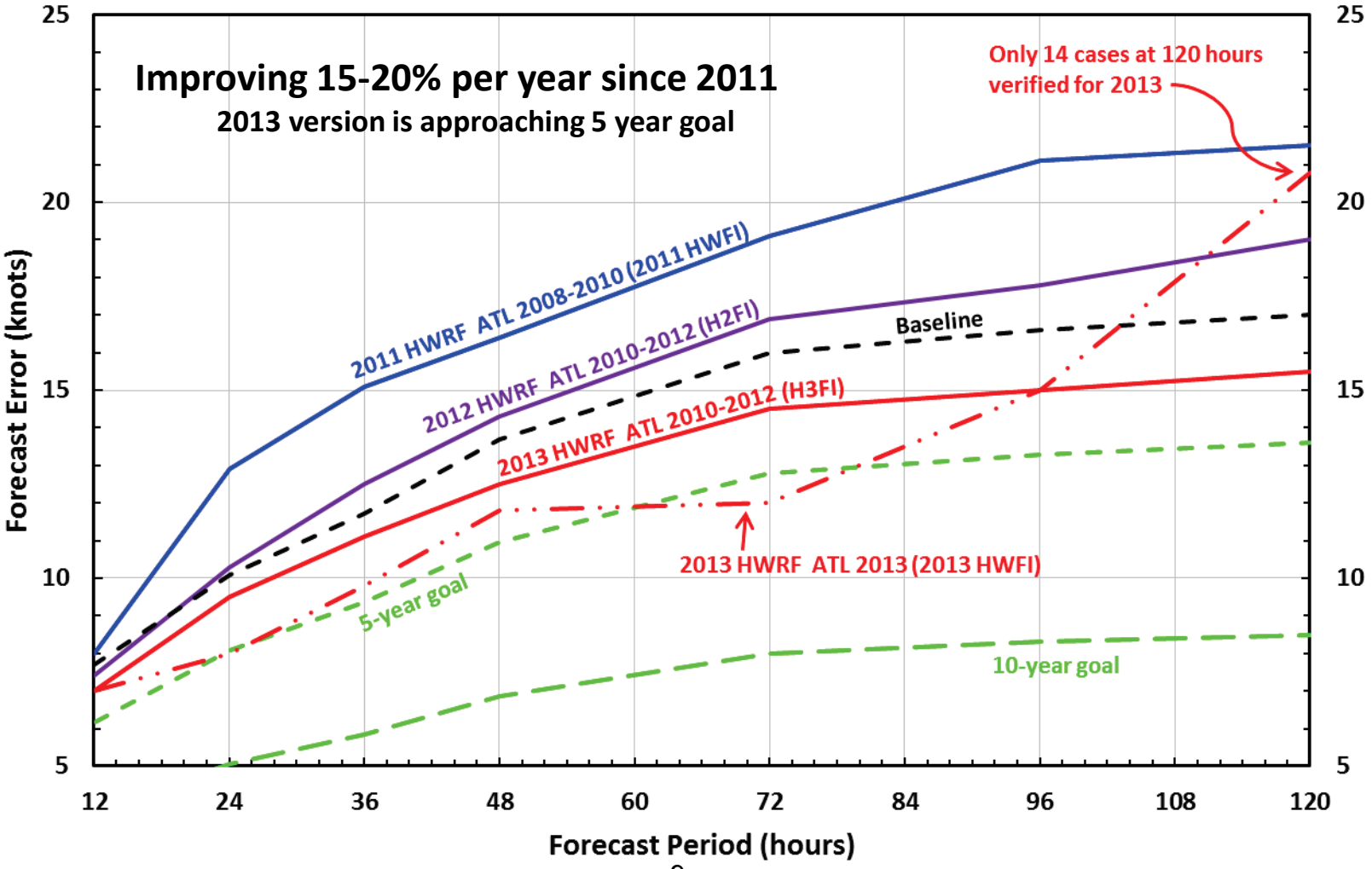


NCEP vs ECMWF for Atlantic 2012 % gain over HFIP baseline (track)

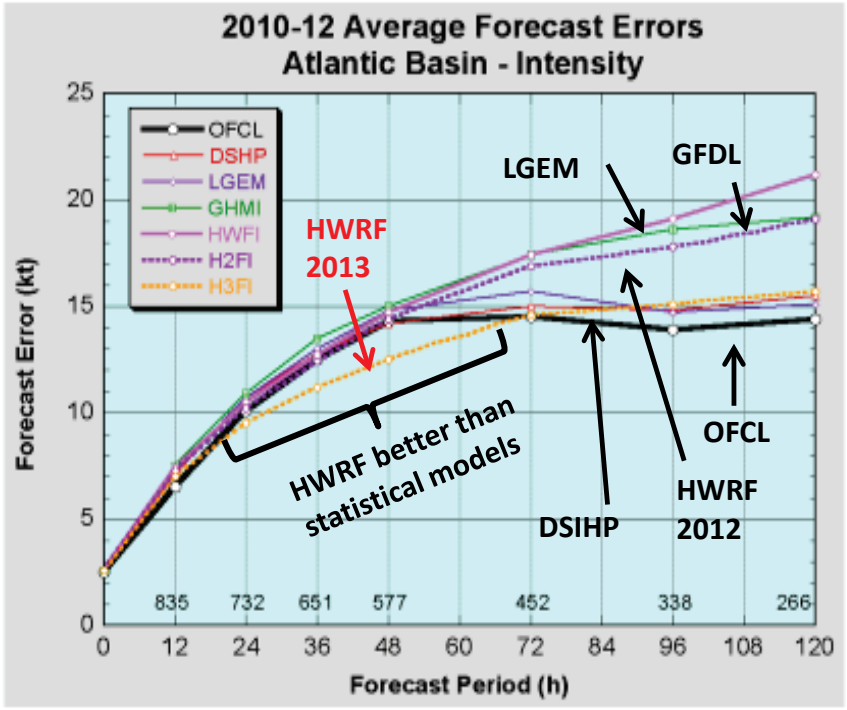


HWRF Results

HWRF Intensity ATL Basin
Cumulative Forecast Improvements

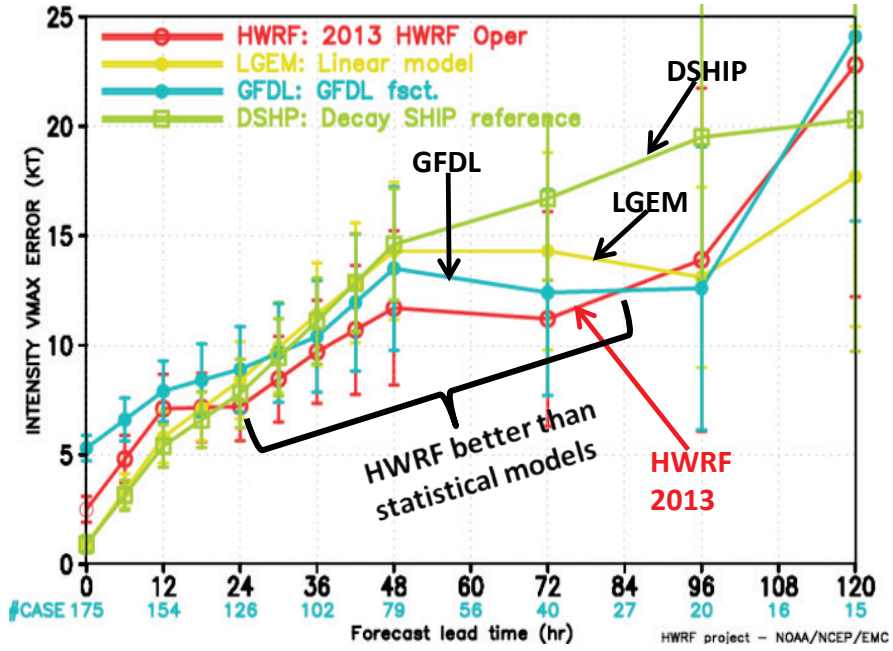


HWRF in Atlantic Intensity Forecasts



2010-2012 retro tests, HWRF beat top flight statistical models (LGEM, DSHIP) in 24-72 hour lead time

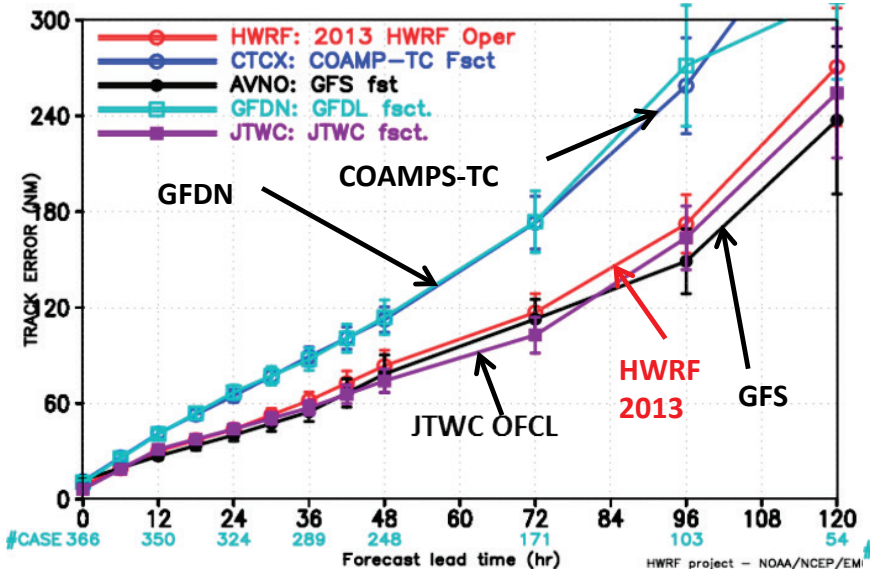
2013 preliminary results confirm pre–season evaluation of 2013 HWRF



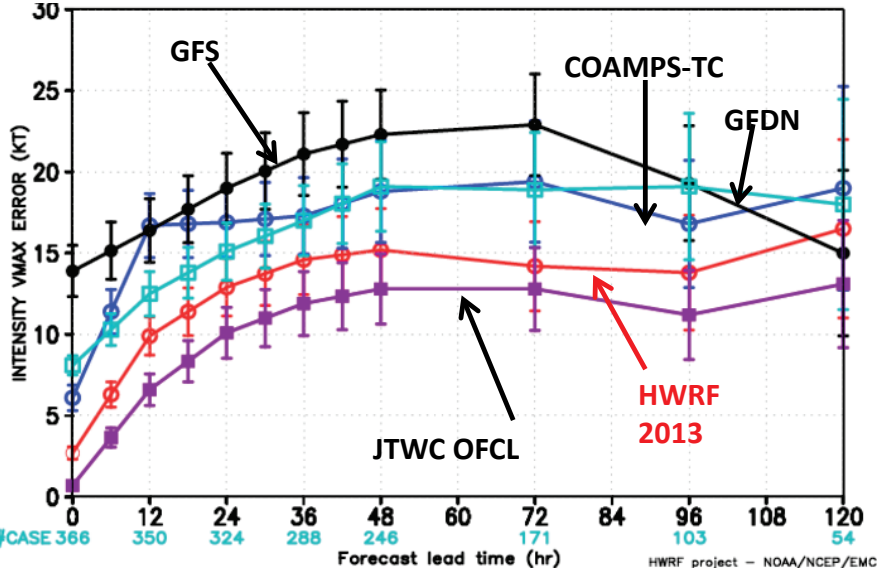
HWRF in WPAC

- **HFIP has been running HWRF in the WPAC for JTWC 2012-2013**
- **Results shown below indicate that the HWRF track forecasts are comparable to the global model and better than other regional models in the region**
- **HWRF Intensity forecasts are better that other model guidance in WPAC**
- **JTWC has been using HWRF model output in their operational forecasts**

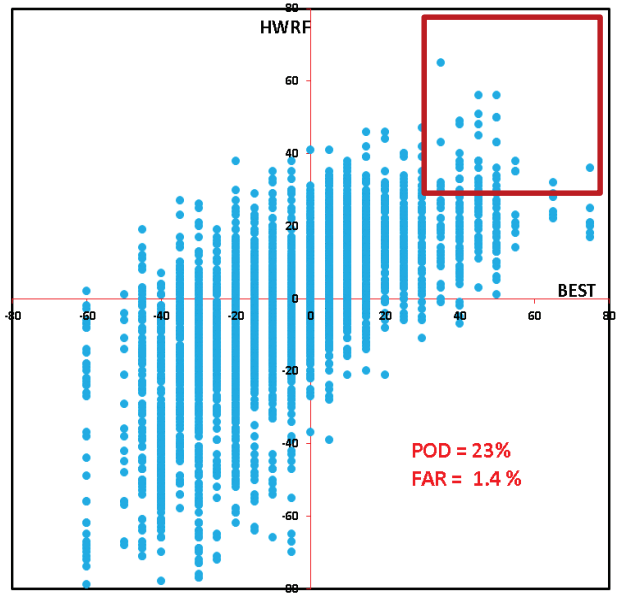
WPAC Track

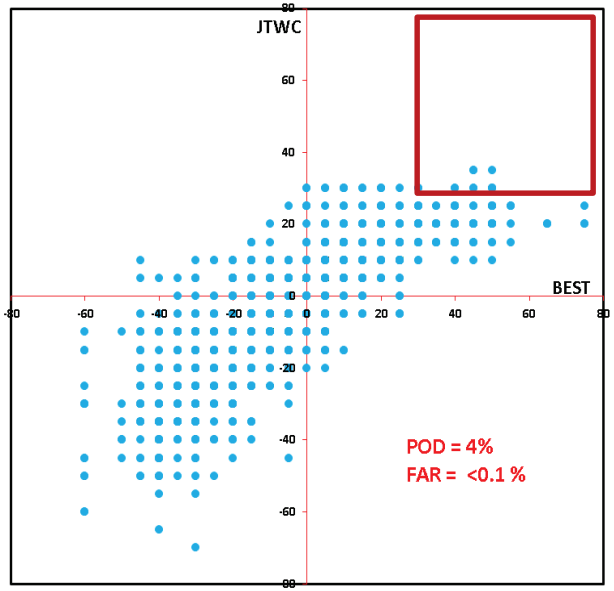


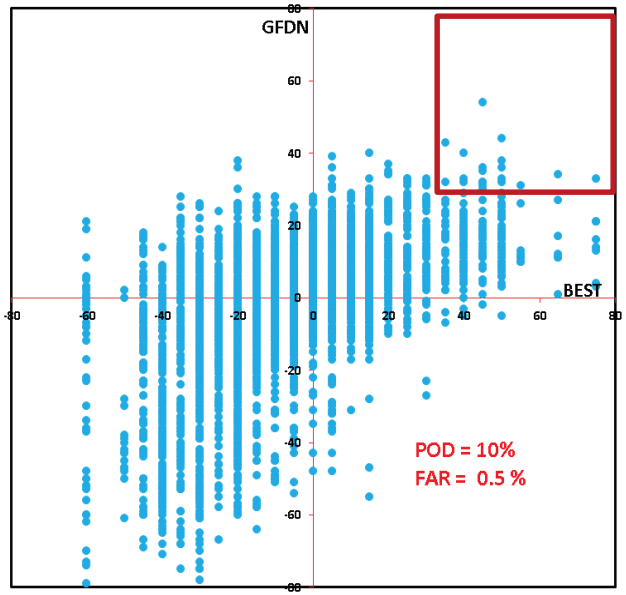
WPAC Intensity



HWRF in WPAC
Rapid Intensification Verification







- If one define an RI event as >30 kt / 24 h, then HWRF RI POD skill is ~ 23 % and by far has higher POD index as compared to other models and in other basins *(previous analysis of RI for WPAC from 2012 HWRF showed <10% skill)*.

- The POD index is much higher (43%) if one simply considers the intensity change tendency, say 6-h change of VMAX > 5 kt.

HWRF-based Ensemble Prediction System

HFIP Ensemble Team Report from NCEP/EMC

Zhan Zhang and HWRF Team

HWRF-based Ensemble Prediction System

- IC/BC Perturbations (Large scale):
20 member GEFS (ETR-based).

- Model Physics Perturbations (Sub-grid scale):
Stochastic Convective Trigger

P_{CSL}-P_{LFC} <= DP(w) + Rr (n)

Rr is white noise, ranging from -50hPa to +50hPa, n is nth ensemble member, used as random seed. No spatial and temporal correlations

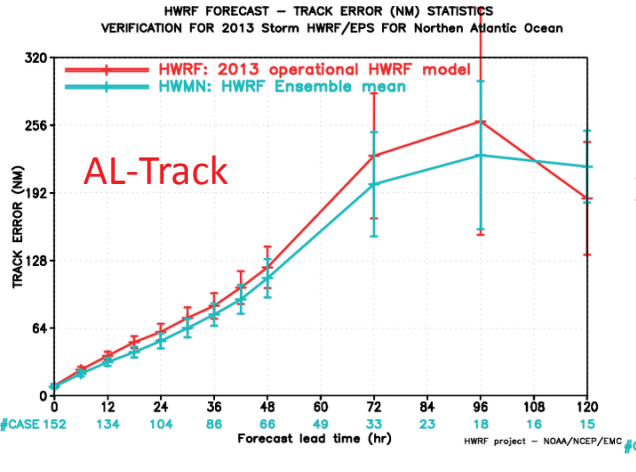
Real-time & Retrospective Experiments for 2013 Season

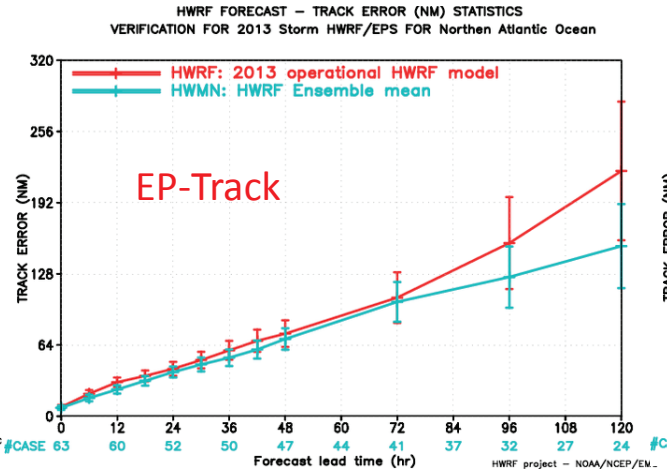
- Real time forecasts for all 2013 storms (August-November) at Atlantic basin;

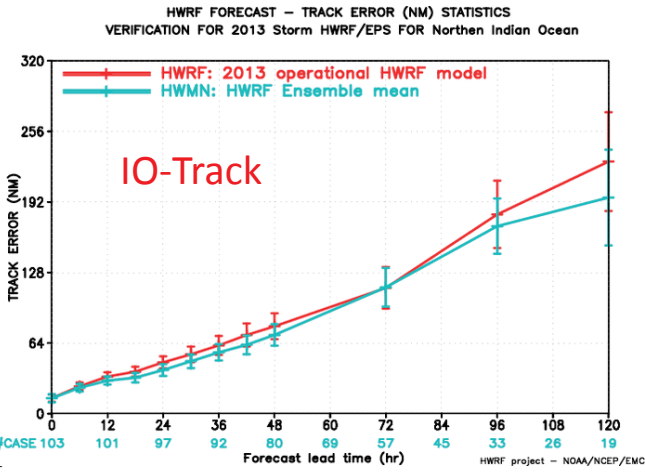
- Retrospective runs for all 2013 tropical cyclones at North Indian Ocean;

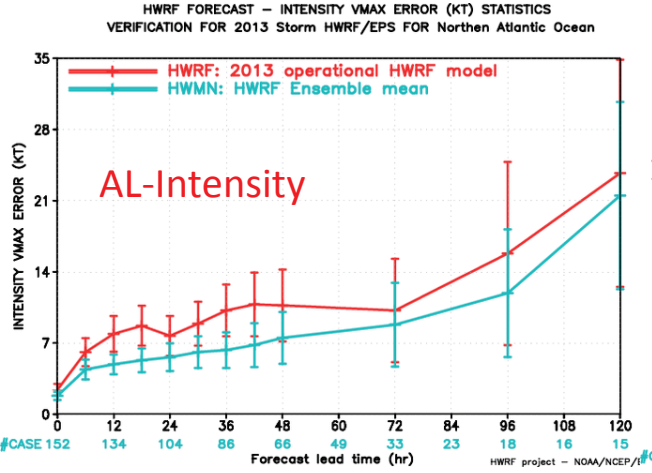
- Real time forecasts for hurricane Raymond at Eastern Pacific basin – Special Case

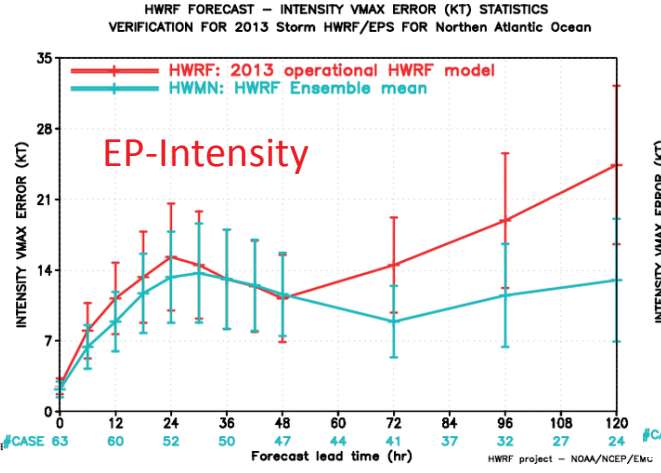
HWRF/EPS Verifications for 2013 Storms

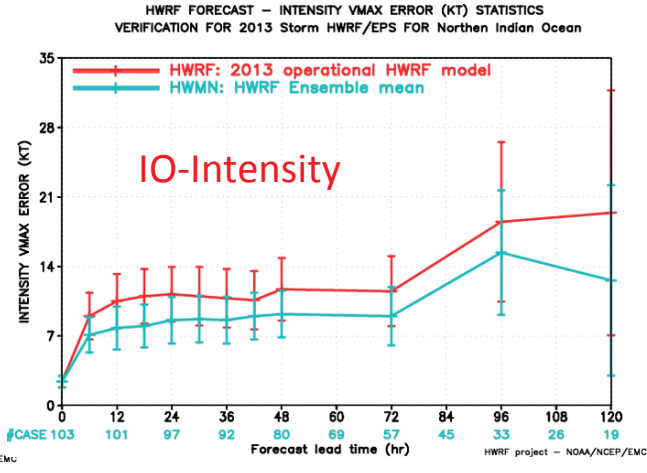












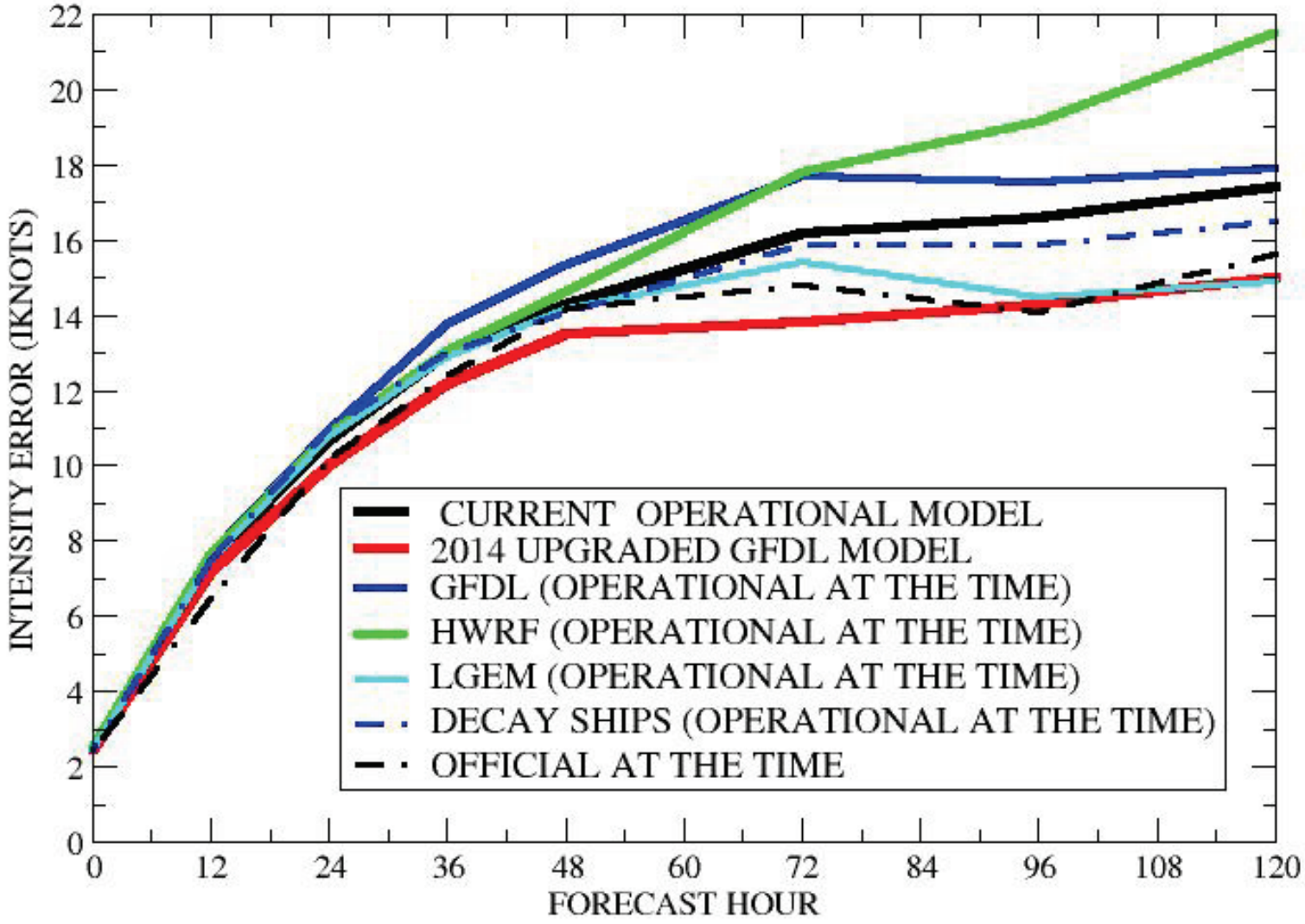
HWRF: 2013 deterministic operational hurricane forecast system

HWMN: mean of 20 ensemble members from HWRF-based EPS

The HWMN track/intensity forecasts are improved over HWRF at all lead times, all three basins.

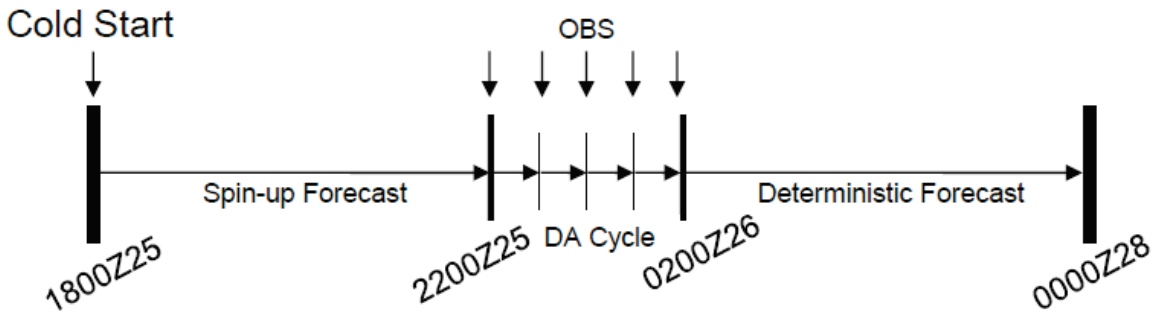
2008 & 2010-2012 ATLANTIC HURRICANE SEASONS

NUMBER OF CASES: (934, 891, 839, 782, 731, 631, 519, 426)

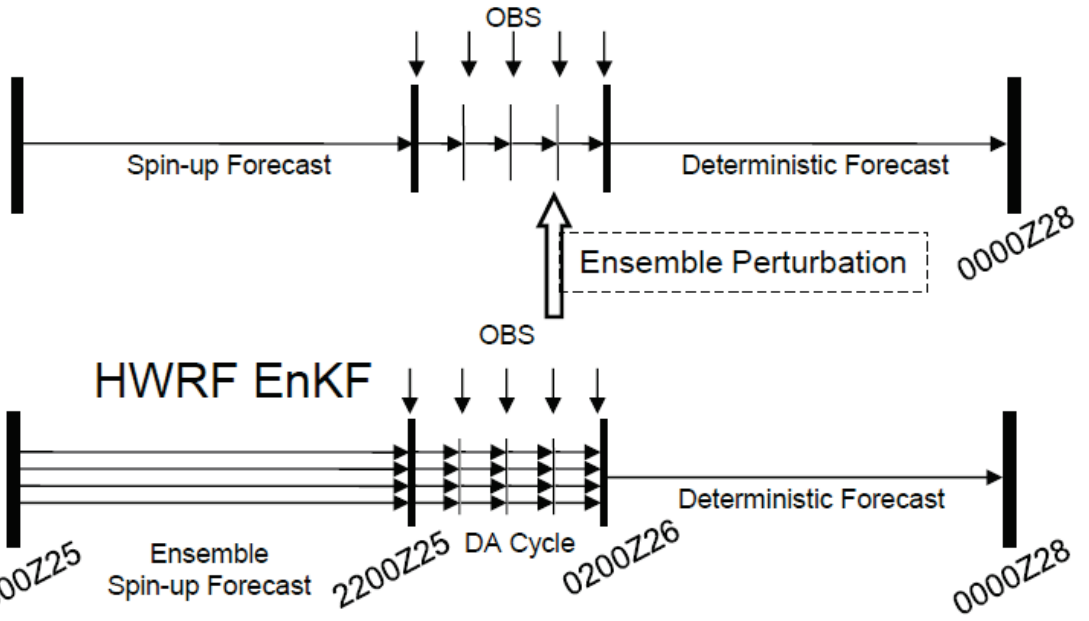


DA cycling configuration (mission 1)

GSI3DVar

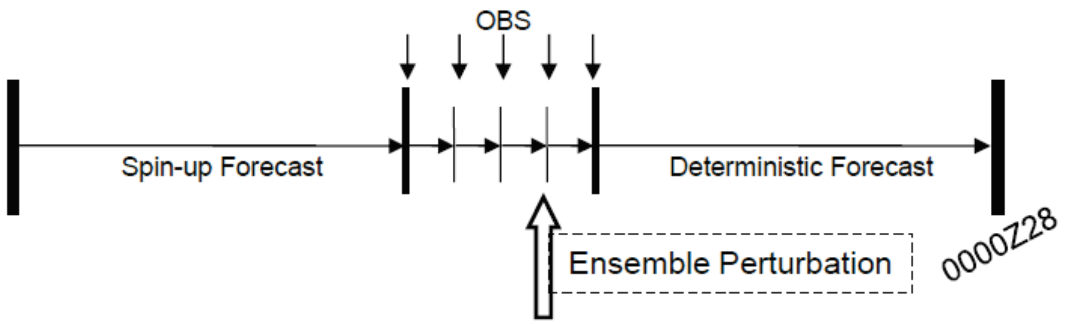


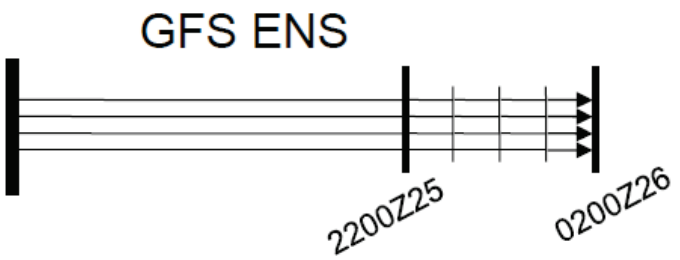
Hybrid



DA cycling configuration (mission 1)

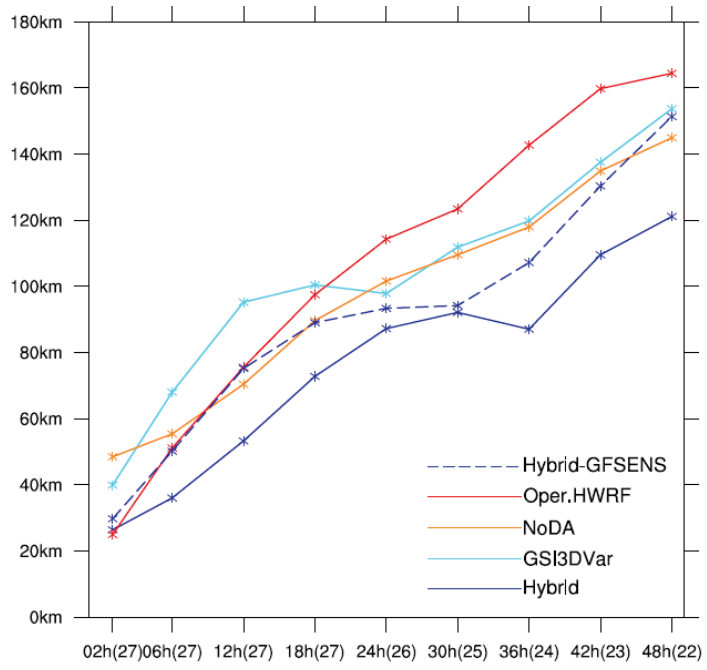
Hybrid-GFSENS



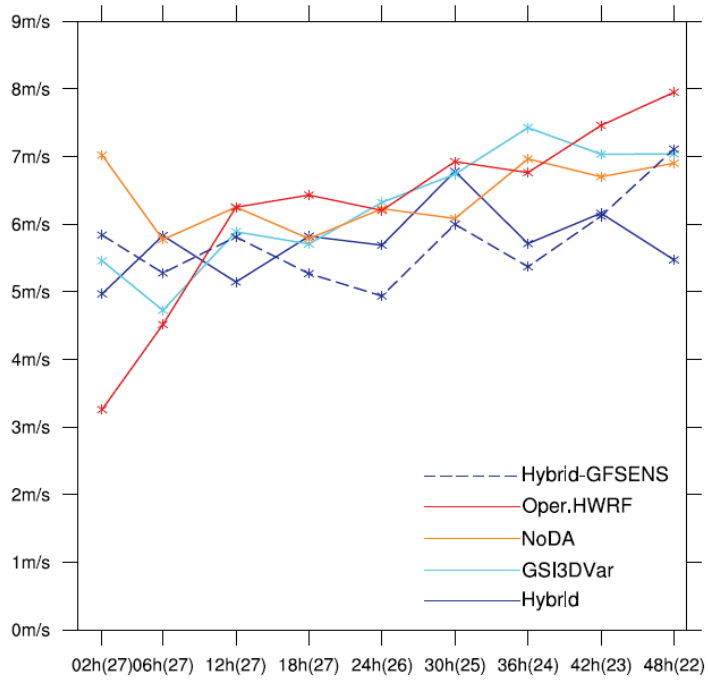


Results from OU (X. Wang)
Impact of radar data

Track



Max Wind



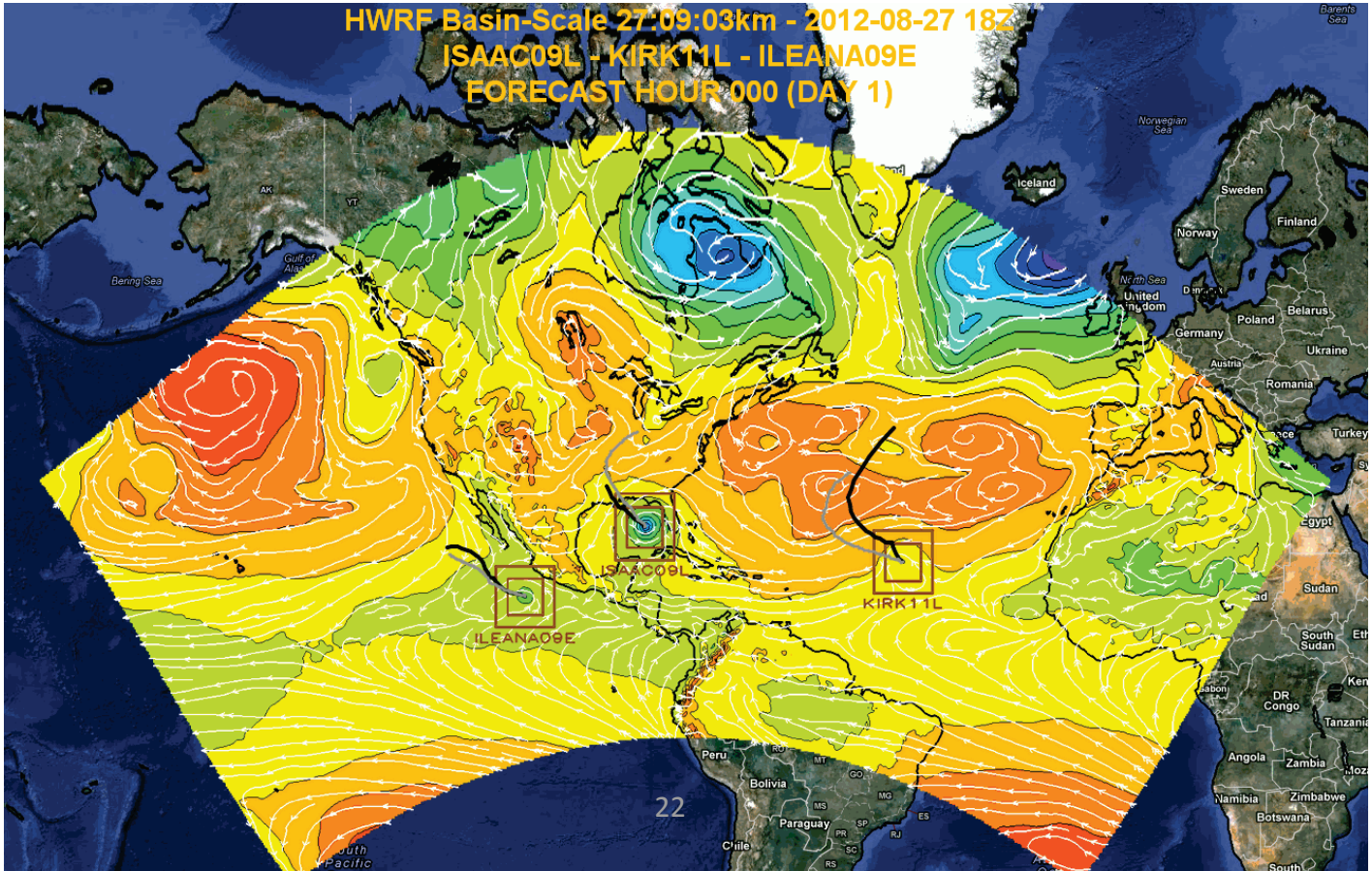
HFIP Overall Strategy

Long term: At the end of the 10 year HFIP Project

- Merge the regional model with the global model
- Start by developing a basin scale system
  - Large outer domain but still within a Global model
    - Global model only provides boundary conditions to outer domain
  - Multiple inner nests, one set for each storm (9km, 3km)
    - Two inner domains per storm, fully interactive with outer domain
- Outer domain may be expanded to be global.
  - Inner nests will then fully interact with the global model
- Run as an ensemble
- The global to regional models all constructed from the same model (NMM B-grid) and run within the future operational NOAA Environmental Modeling System (NEMS) framework.

HWRF Architecture Plans
Next 3 to 5 Years

- Advancements to Operational HWRF – Transition to NMM-B/NEMS Multi-Scale Modeling System with multiple moveable nests
- Planned development, testing and evaluation leading to potential transition to operations in the next 3-5 years



HFIP Scientific Review Committee

- The SRC provides feedback and guidance contributing to the cohesion of near-term (next year or two) and longer range strategies for improving hurricane forecasts

- Being outside of the daily project functioning, the SRC provides a broader assessment of HFIP progress and future approaches
  - Review and suggest possible changes to annual HFIP plans
  - Review proceeding year accomplishments
  - Review the long term HFIP model system development and observing strategy plans
  - Review the objectives and makeup of the demonstration system each season

- Organizational meeting 4th Quarter 2012

- 2 day review held 26 and 27 February, 2013.

HFIP Scientific Review Committee Membership

Name	Organization	Expertise	Term (years)
Mike Montgomery	NPS	TC dynamics	3
Dave Nolan	Miami	TC regional models	3
Gary Barnes	UH/Manoa	TC structure	3
Jim Price	Woods Hole	Coupled models	2
Bob Hart	FSU	TC environment interaction	2
Jim Goerss	NRL Monterey	Global models/ensembles	2

HFIP Scientific Review Committee: Recommendations*

- Revisit Intensity Goals
  - Present intensity goals are unreachable and/or impossible; reduction of the largest error (e.g., 90th percentile) error values may be more meaningful
  - Consider metrics for defining size and shape of storm, and/or accuracy of the precipitation field structure

- Improve HFIP Model Physics and Initialization
  - Broaden capabilities in HWRF for idealized simulations
  - Improve model physics and vortex initialization focusing on microphysics, boundary layer structure, and turbulent mixing -- not ocean and air-sea coupled modeling
  - Develop a self-consistent, flow-dependent data assimilation system

- Further Integrate the HFIP and HWRF Efforts with Community
  - Initiate a visiting scientist program at NOAA laboratories
  - Be open minded, accept criticism, and willing to restructure modeling frameworks if necessary