HFIP-TACC On-demand Test

- Diverse NOAA (HRD, ESRL, NCEP/NHC, NCO, EMC) and university (PSU, TAMU, TACC) team established on-demand capability to support operational hurricane forecasting.
- Built upon HFIP high-resolution test plan to use high resolution global (FIM at 15-km) and regional (ARW at 1.5-km using EnKF to assimilate Doppler radar superobs) models to demonstrate on-demand capability.
- NCEP model fields and Doppler radar superobs from NOAA P-3 aircraft flow automatically to TACC, research models run, output products generated for forecasters, and products transferred to NHC via NCO.
- Portions of process tested during Dolly and Fay, with a test of complete system during Gustav.

NOAA HFIP Use of TACC

F. Marks, F. Zhang, Y. Weng

GOAL:

1. Make progress on establishing operational value of higher resolution modeling (global and hurricane, including ensembles) to improving forecast performance.
2. Demonstrate potential of on-demand computing to hurricane forecast operations.
3. Inform future R&D needs for HFIP goals and objectives toward the development and implementation of next-generation HFS.
4. Focus research to provide tangible benefit within 3 - 5 years.

System Name:	Ranger
Operating System:	Linux
Number of Cores:	62,976
Total Memory:	123TB
Peak Performance:	579.4TFlops
Total Disk:	1.73PB (shared)
NOAA Allocation : (until 1 Jan 2009)	30M SUs

- Run up to 10 cases using ARW at 4 horizontal grid resolutions (40.5, 13.5, 4.5, and 1.5 km) with EnKF DA to use airborne Doppler radar data in inner core.
- Run 30-100 ensemble members for track and intensity with this configuration.
- Run similar configuration in real-time with GFS IC/BC and EnKF DA of airborne and ground-based Doppler radar data.
- Run FIM global model at 15-km horizontal resolution for 30 ensemble members.

Towards Real-time Assimilation of Airborne Radar Observations with EnKF: Same *Experimental Design as Test Cases*

WRF/ARW triply-nested domains for both EnKF analyses and free forecasts:

D1: 121x160x40.5km x 35 levels (similar to GFDL coarse domain)
D2: 121x160x13.5km x 35 levels
D3: 253x253x 4.5km x 35 levels (moving nest in forecast mode)

Time performance of standard real-time WRF/ARW forecast initialized with GFS

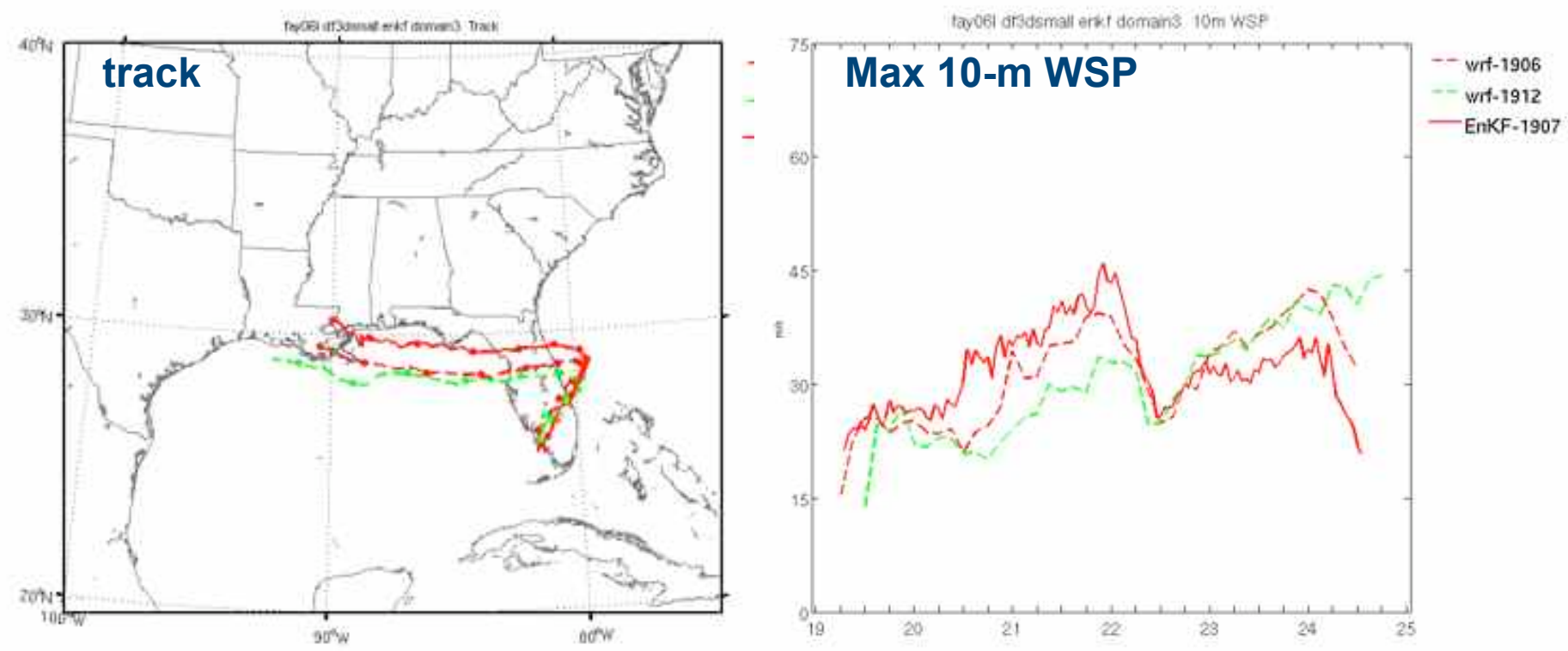
Waiting time for GFS completion: 4.5 h
Transfer GFS analysis and forecasts from NCEP to TACC: 0.3 h
Initialization of WRF/ARW with GFS using WPS: 0.4 h
126-h WRF free forecast with 512 processors: 2.7 h
Total time lapse: 7.9 h (3.4 h after GFS completion, 1.5 km is 7 h after)

Estimated real-time WRF/ARW forecast initialized assimilating airborne Vr data

EnKF ensemble initialized with most recent available GFS: no waiting time
Quality control and super-observation (SO) of Airborne data per hour: 0.3 h
Transfer airborne ~3000 SOs from P3 to TACC: 0.2 h
EnKF assimilation of 1-h SOs: 0.5 h
126-h WRF free forecast with 512 processors: 2.7 h
Total time lapse: 3.7 h (1.5-km is 7 h) after Doppler observations taken

ARW

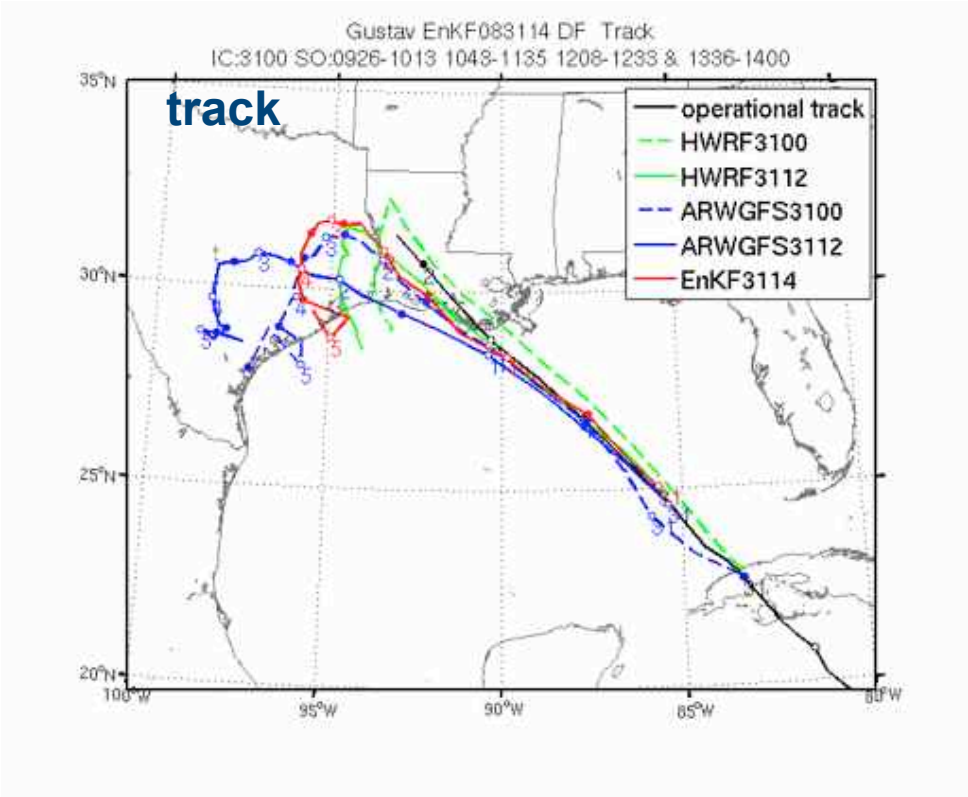
HFIP-TACC Real-time for Fay

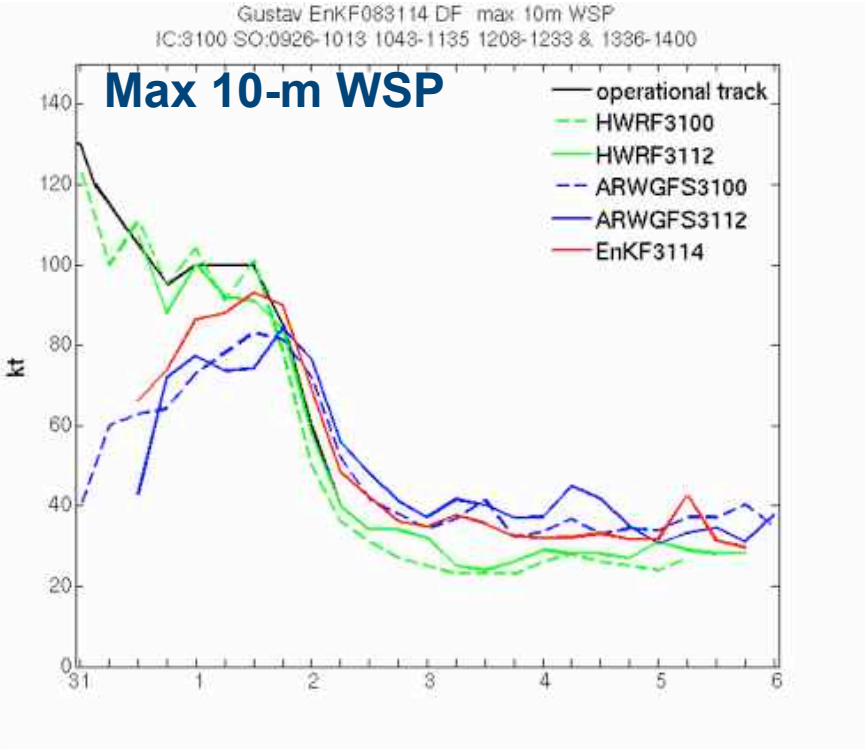


12Z, 19 Aug initialization with Doppler SO (EnKF)

ARW

HFIP-TACC Real-time for Gustav

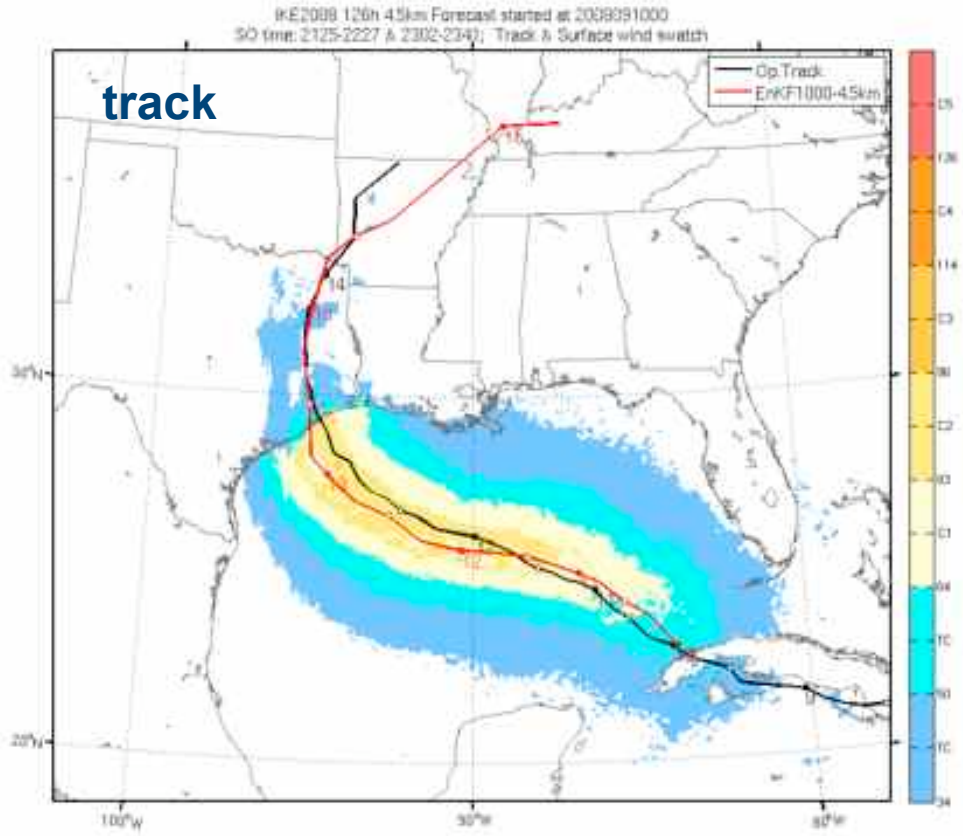




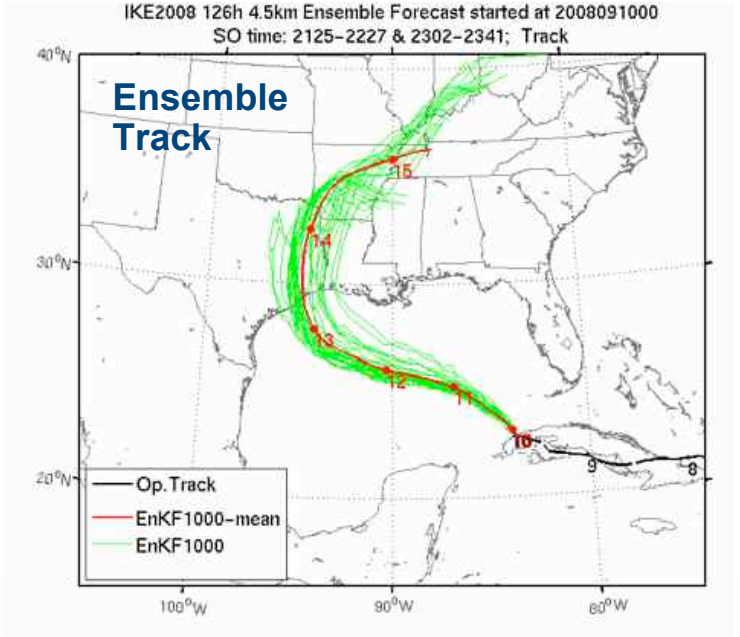
00Z, 31 Aug initialization with Doppler SO (EnKF)

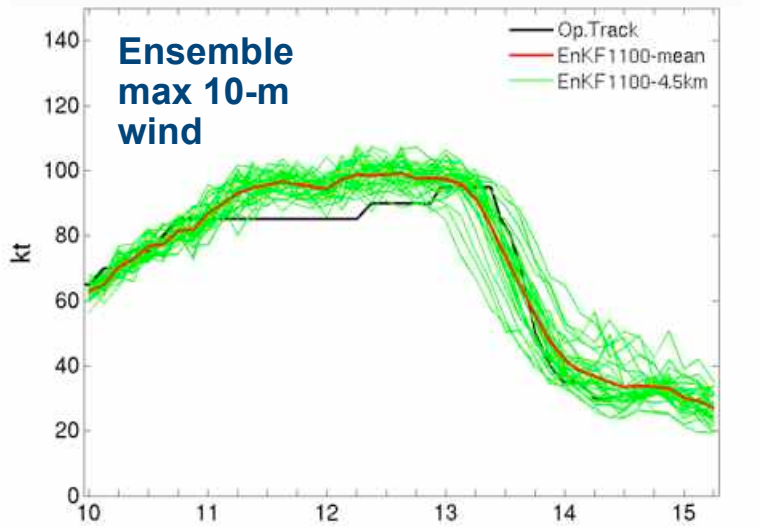
ARW

HFIP-TACC Real-time for Ike



Max 10-m wind swath



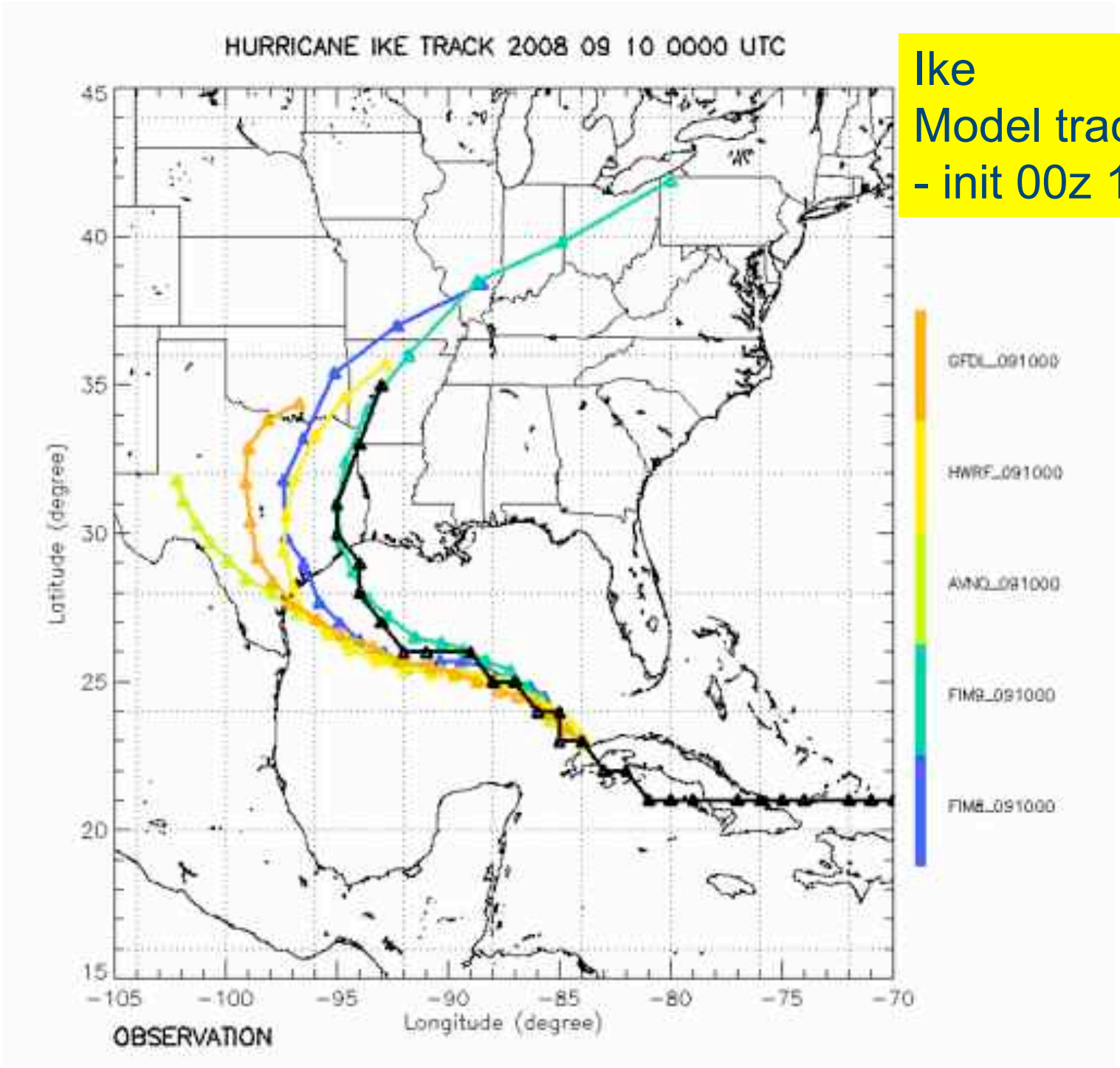


00Z, 10 September initialization with Doppler SO (EnKF)

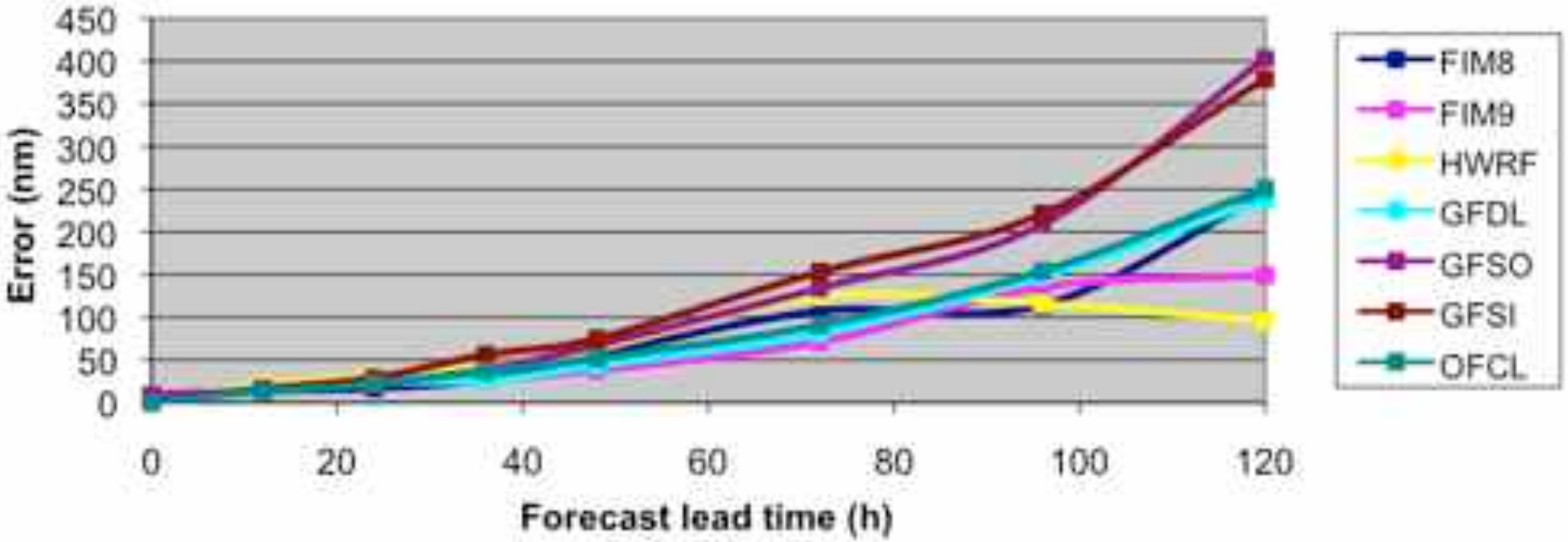
ARW

HFIP-TACC FIM component high-resolution global model runs for improved hurricane forecasts

- FIM global model developed at NOAA Earth System Research Laboratory - Boulder, CO, with help from NCEP
- Uses unique global grid (soccer-ball-like horizontal, adaptive vertical coordinate)
- Quickly transferred -- Ported to Texas Area Computing Center (TACC) in 3 days
- 10-day forecasts at 15km global resolution run twice daily allowed by TACC resources starting 30 August, +20-member 30km global ensemble. All firsts for NOAA.
- Improved hurricane forecasts for both FIM model runs, especially for higher-resolution 15km FIM (FIM9).

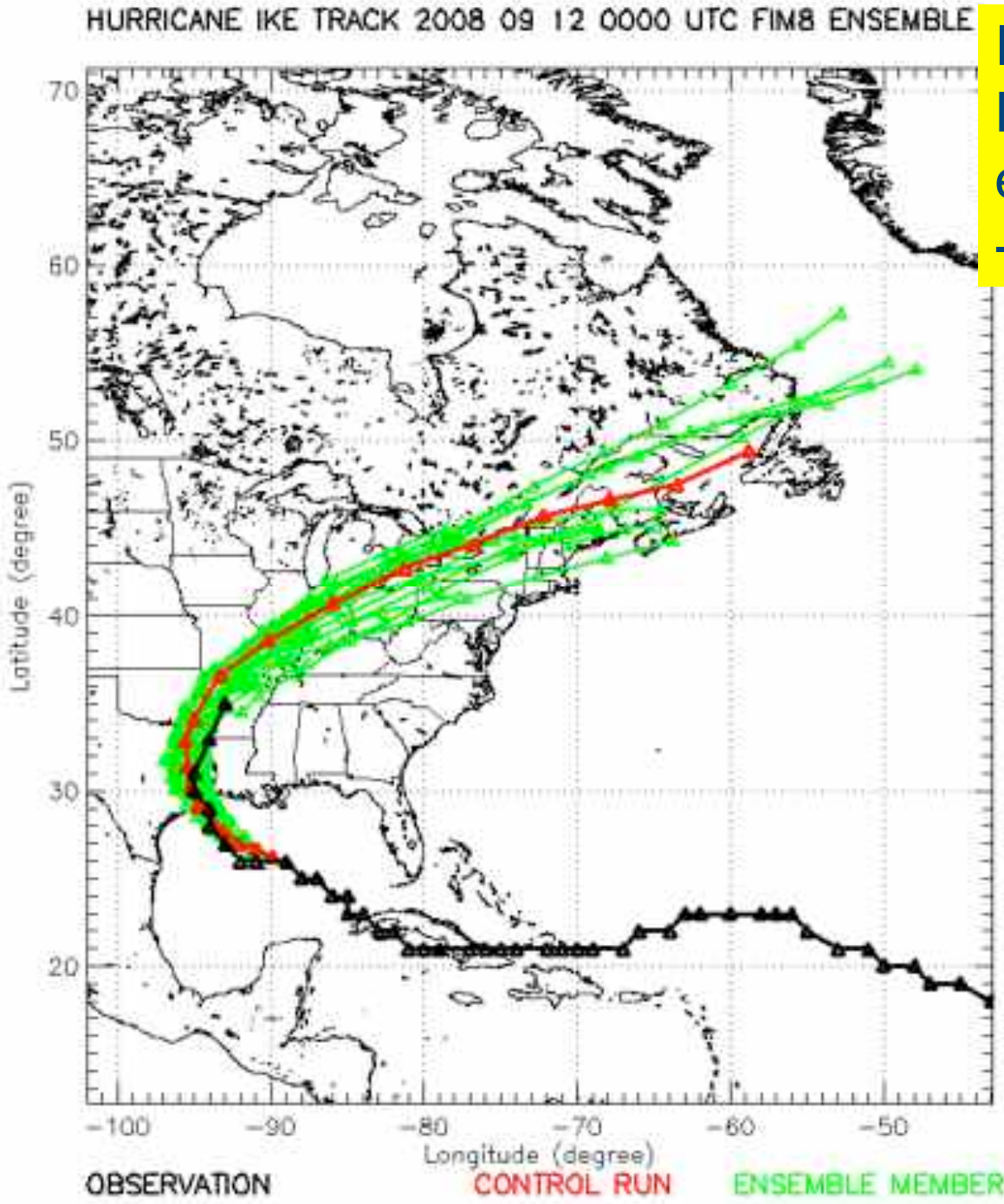

HURRICANE IKE TRACK 2008 09 10 0000 UTC
Ike
Model tracks
- init 00z 10 Sep
GFDL_091000
HWRF_091000
AVNO_091000
FIM9_091000
FIM8_091000
Latitude (degree)
Longitude (degree)
45
40
35
30
25
20
15
-105
-100
-95
-90
-85
-80
-75
-70
OBSERVATION
FIM

Ike Position Error (all forecasts initialized 8 Sept and after)



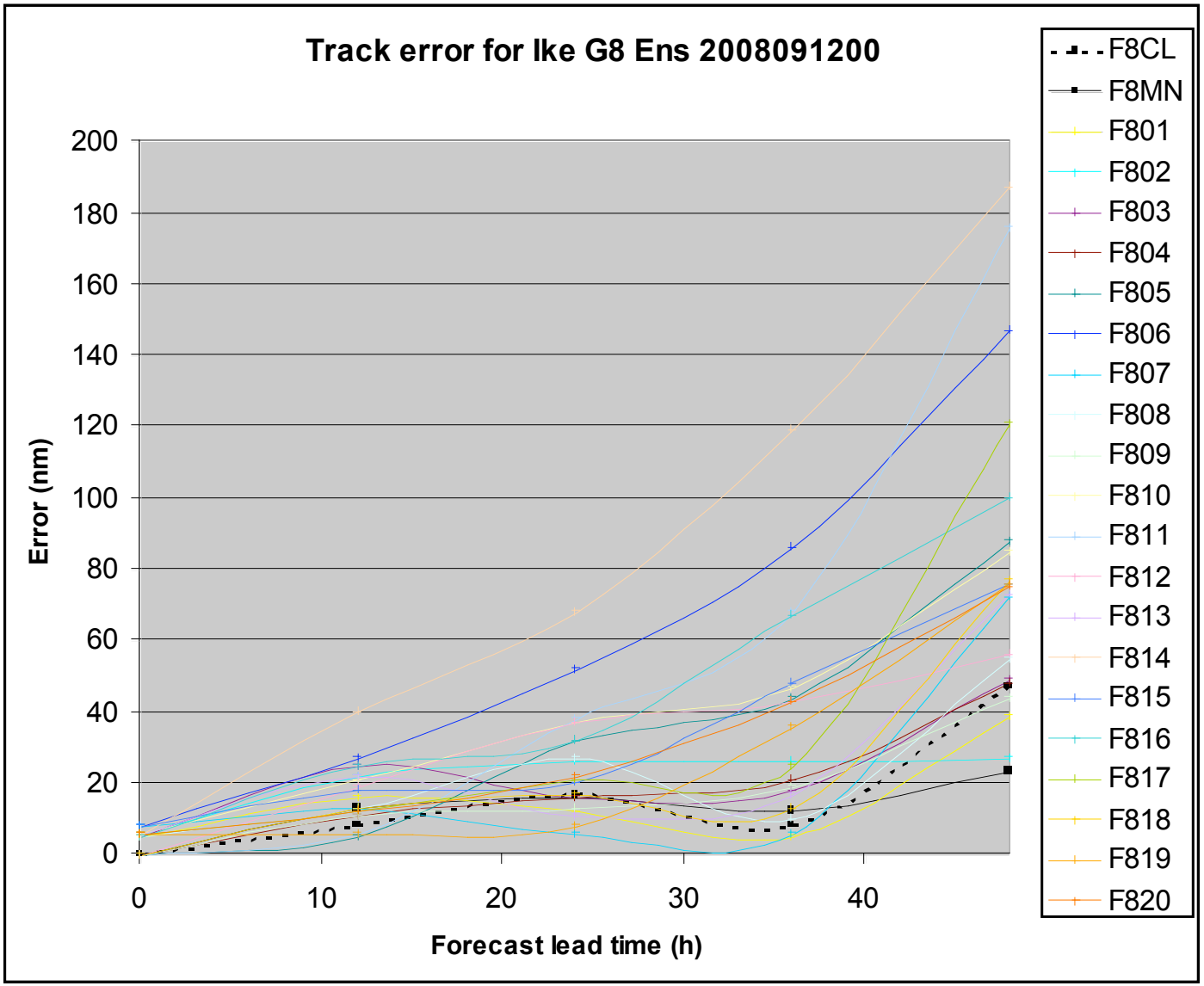
Ike:

Higher resolution FIM (15km - FIM9) provides better 5-day position forecasts than coarser-resolution FIM (30km - FIM8).



Ike fcst tracks -- FIM 20-member ensemble - G8 - init 00z 12 Sep

FIM



Results from first FIM (30km) ensemble run.
Mean FIM ensemble track provides very good 48-h position forecast (22 km).

HFIP-TACC FIM component high-resolution global model runs for improved hurricane forecasts

- 10-day forecasts at 15km global resolution run twice daily allowed by TACC resources starting 30 August, ensemble (20-member) 30km global ensemble runs started 12 Sept.
- All firsts for NOAA to run at such high resolution for real-time global deterministic and ensemble forecasts
- Improved 3-5 day hurricane forecasts for FIM model runs over GFS for Gustav, Hanna, and Ike, especially for 15-km FIM
- Higher-resolution (15km vs. 30km) produces clearly improved hurricane track forecasts, especially for Ike, Hanna

HFIP-TACC On-demand Test

- Demonstrated new mode of hurricane model research, akin to how NOAA conducts hurricane field work (IFEX).
- 4 major long-term benefits to HFIP and NOAA:
  1. Demonstrated challenge to run models in operational setting. Working with operations deepened appreciation for getting job done, and built relationships for future collaboration.
  2. Established procedure that NOAA can implement in future. Capability flattens process for forecast guidance, enabling more groups to participate.
  3. Expanded talent pool of hurricane research modelers who can work in and operational modeling environment. With experience gained they become potential future NOAA employees.
  4. Storms simulated in real-time test add to cases chosen for HFIP high resolution test. Each storm tested to date (Dolly, Fay, Gustav, Ike) offer unique challenges for both operational and research models.