Basin-scale Multiple Movable Nest HWRF Modeling System

--A pathway toward operational implementation

Xuejin Zhang & Thiago Quirino
UM/CIMAS & AOML/HRD

Collaborators:
AOML/HRD modeling group
NCEP/EMC HWRF Team

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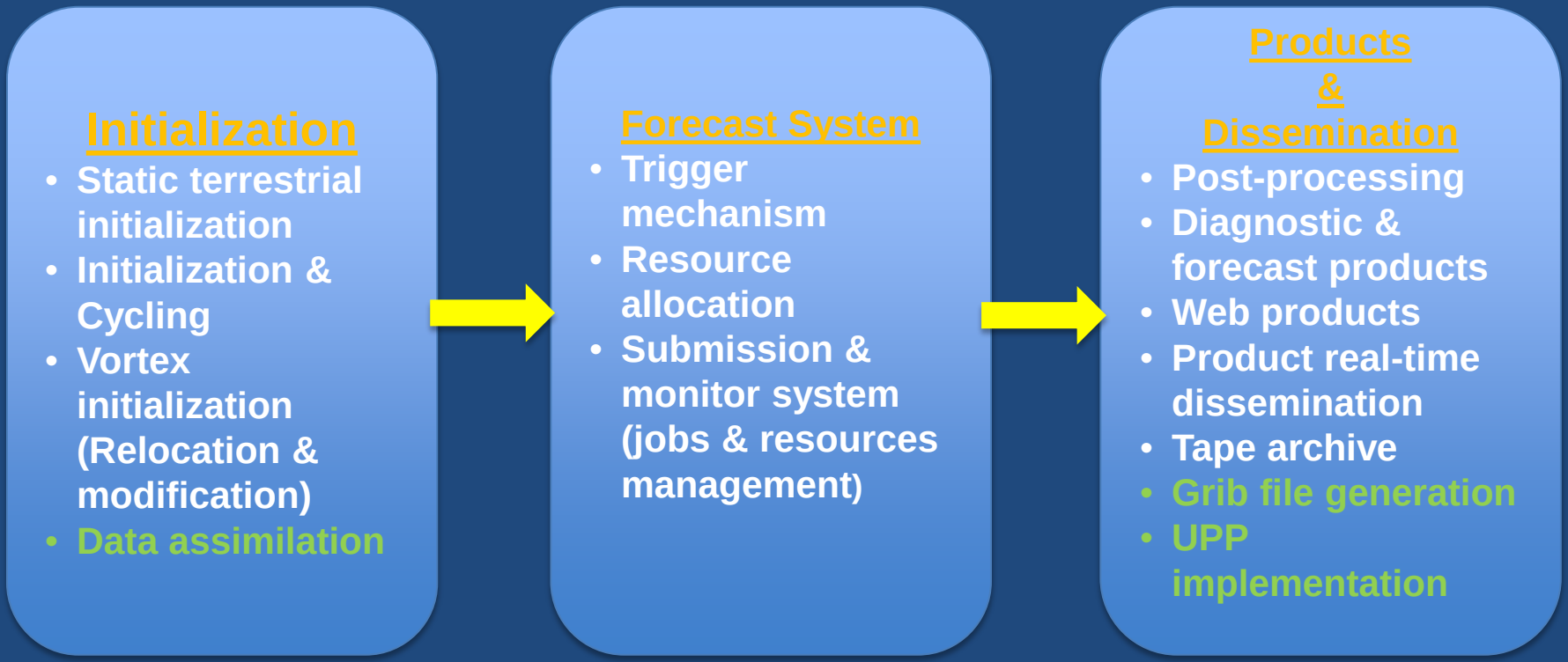
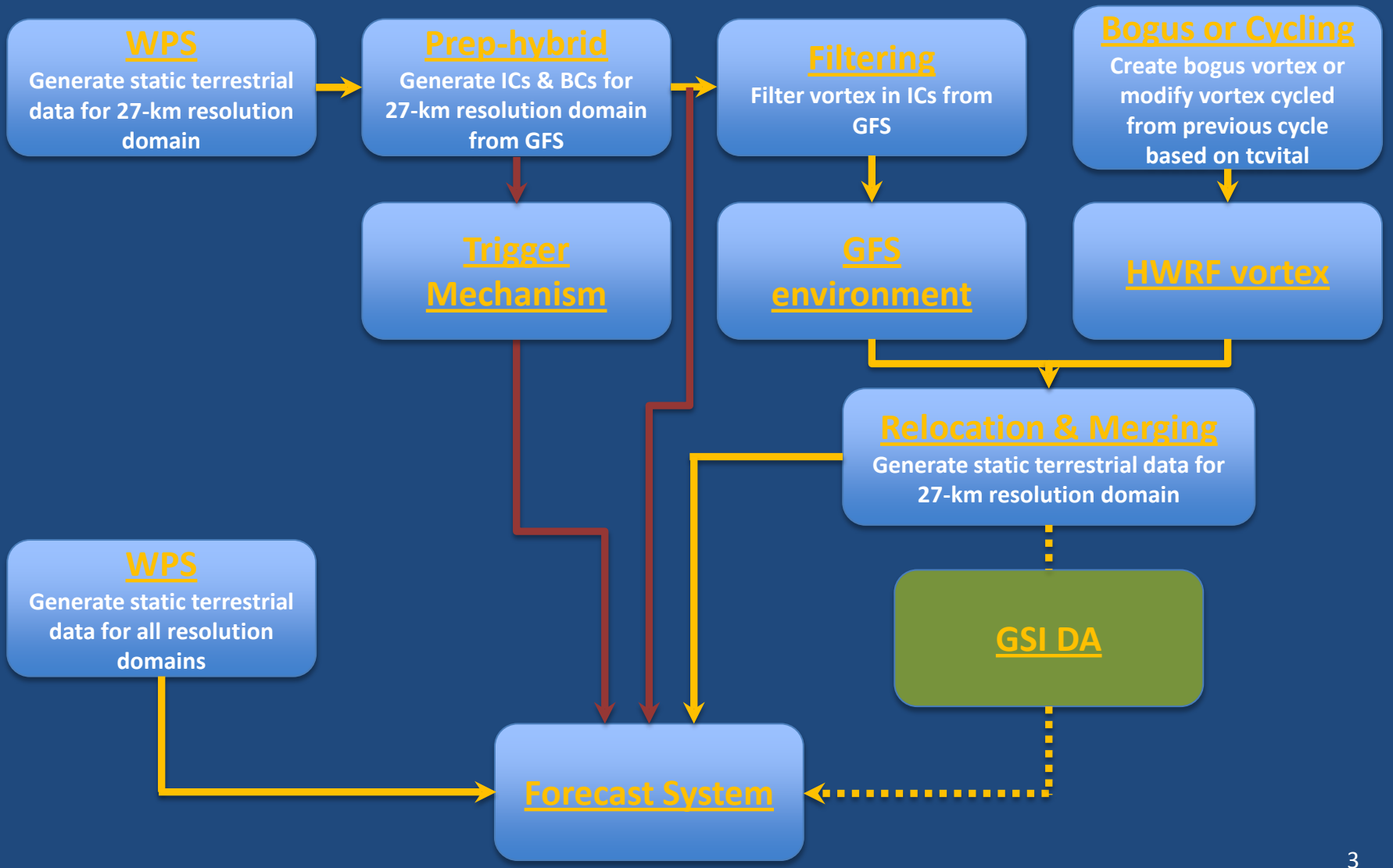
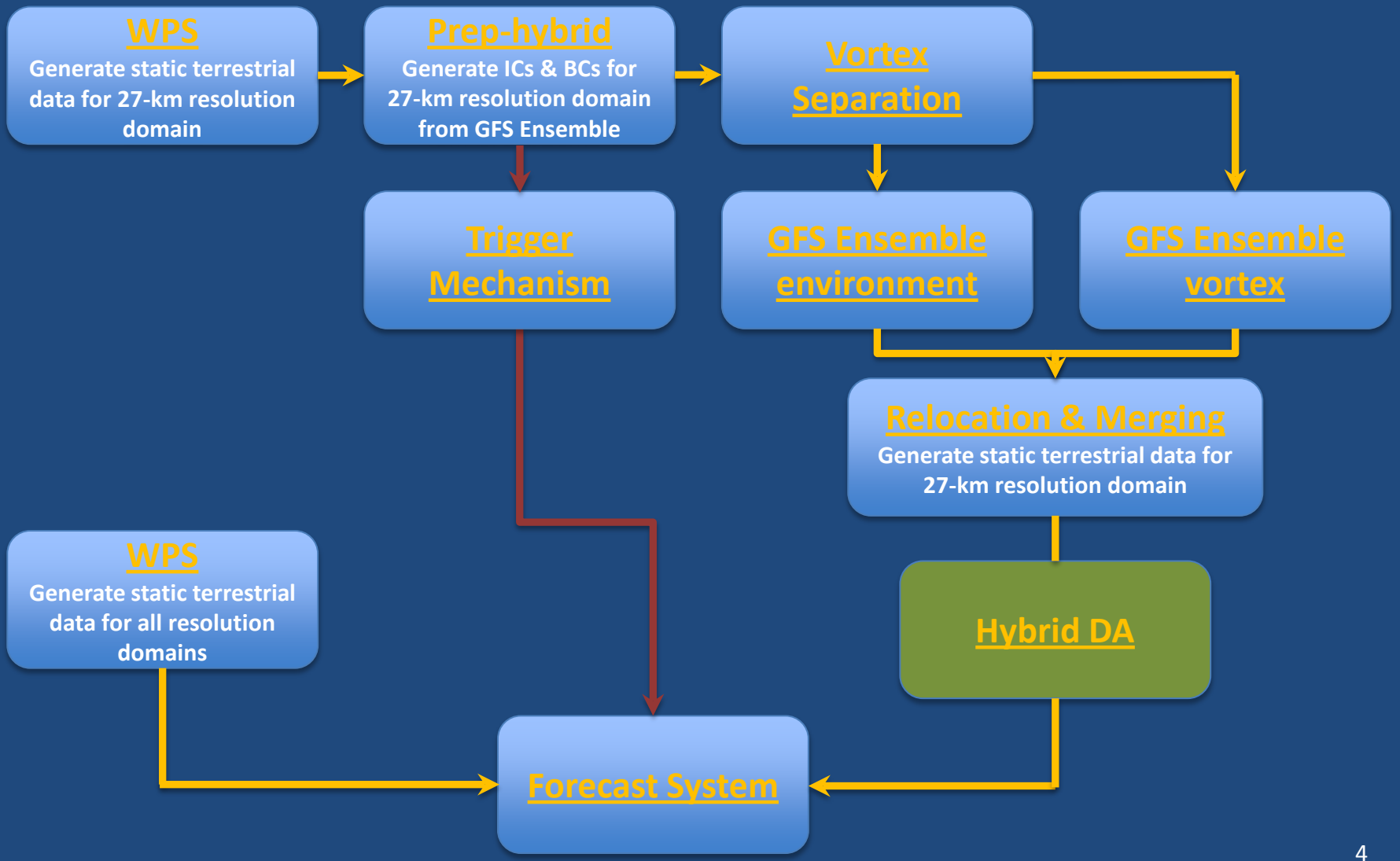
The Modeling System



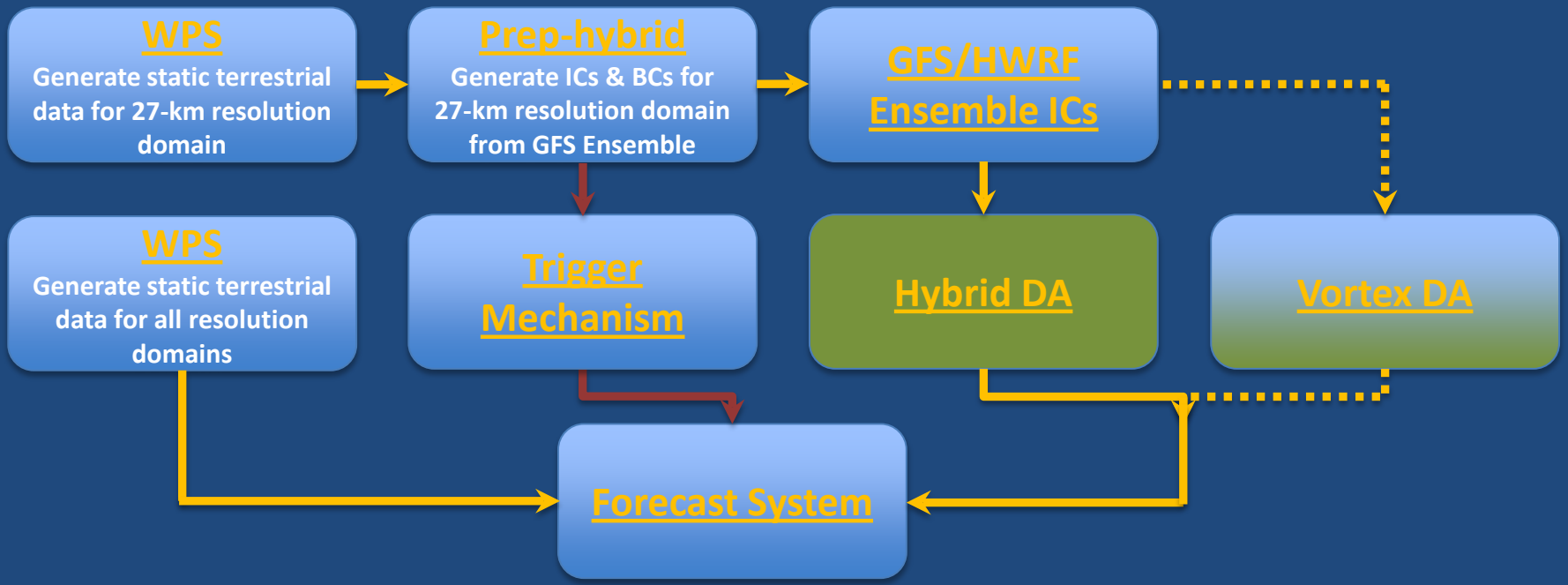
Initialization framework (Current)



Initialization framework (Future)



Initialization framework (Future final)



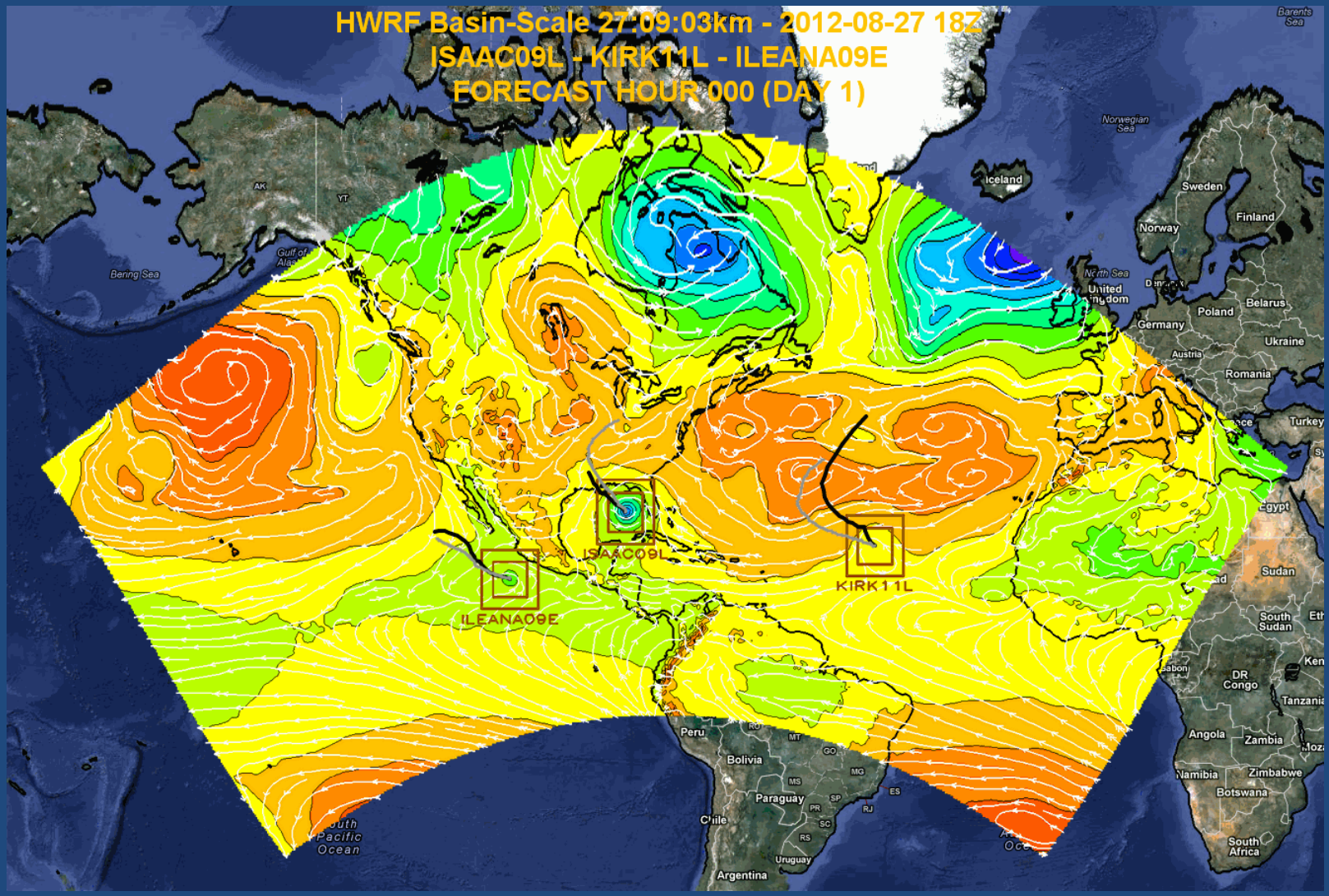
Trigger mechanism

- Decide forecast configuration from tcvital
  - Number of storms
  - Priority storm if number of storms more than four
  - Forecast length (Need genesis forecast product)
- Set up domain location
- Prepare vortex initialization domains (until hybrid DA available)
- Allocate resources (disk space, CPUs, running time, and post-processing resource)

Basin-scale Model Configurations

	2012 HWRF Operational	Basin-scale Model (Stream 2)
Domain	27 KM: 77.76˚ X 77.76˚ 9 KM: 10.56˚ X 10.2˚ 3 KM: 6.12˚ X 5.42˚	27 KM: 178.20˚ X 77.58˚ 9 KM: 10.56˚ X 10.2˚ 3 KM: 6.12˚ X 5.42˚
Vortex Initialization	Modified Vortex Initialization at 3 KM, with 30x30º analysis domain and GSI	27KM: GFS 9-3 KM: No, Downscaled
Cycling	Yes (3 km vortex only)	No
Ocean Coupling	27-9 KM: Yes 3 KM: No, Downscaled	27-9-3 KM: No
Physics schemes		
Microphysics	Modified Ferrier (High-Res)	Modified Ferrier (High-Res)
Radiation	GFDL	GFDL
Surface	GFDL (High_res)	GFDL (High_res)
PBL Scheme	2012 GFS (High_res)	2012 GFS (High_res)
Convection	SAS (High-Res), No CP (3 KM), Shallow Convection	SAS (High-Res), No CP (3 KM), Shallow Convection
Land Surface	GFDL Slab	GFDL Slab
GWD	Yes(27km); No(9-3km)	No(27km); No(9-3km)

Isaac-Ileana-Kirk real-time forecast

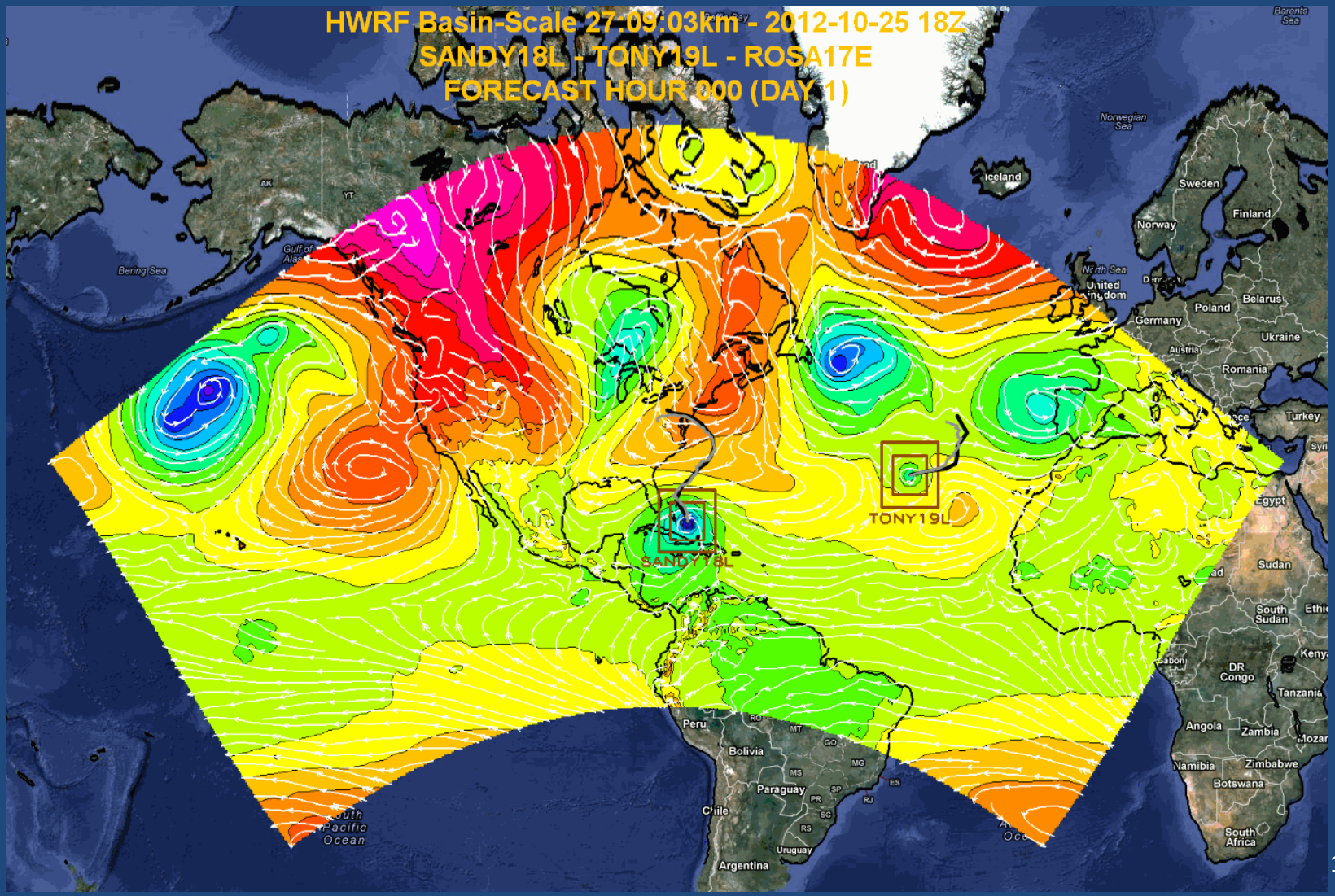


Retrospective & Real-time Forecasts

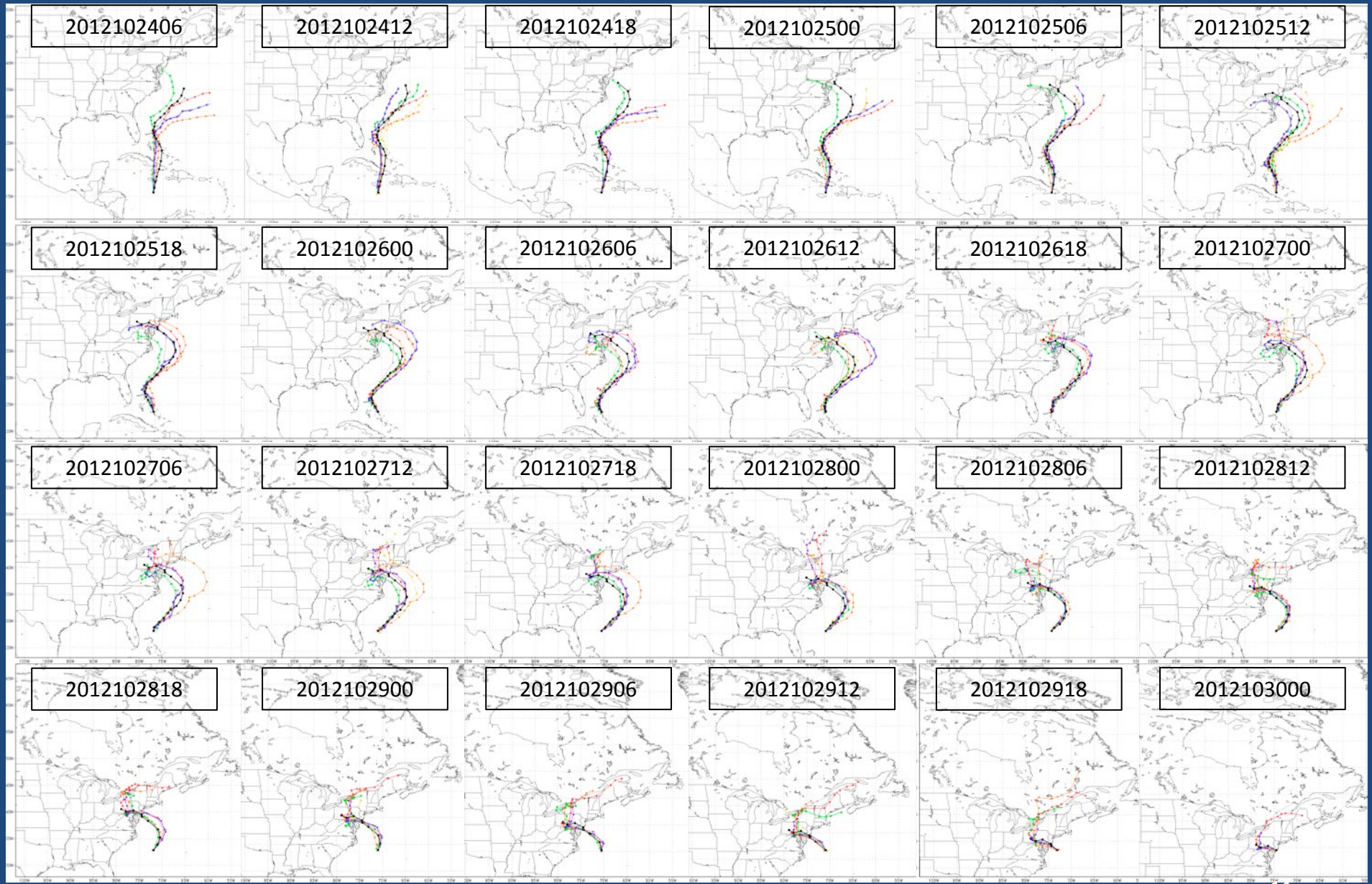
- Cycles start from 00Z 22 August 2012 by 11/14
- Real-time test: Sandy (24 cycles)
- Web products:
  - 3 categories (27km environment; 3km moving nest; multi-model)
  - 20 products

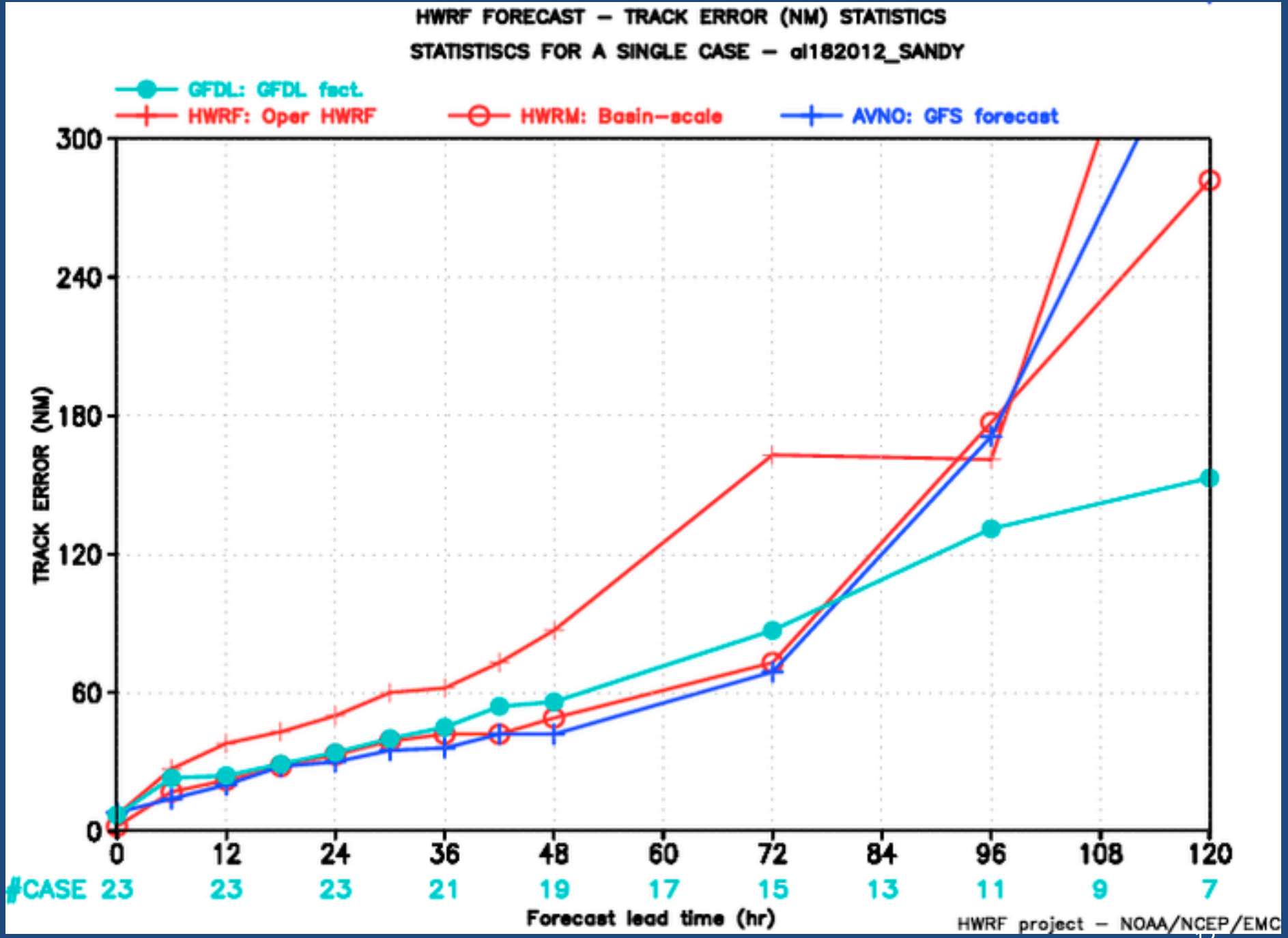
https://storm.aoml.noaa.gov/basin

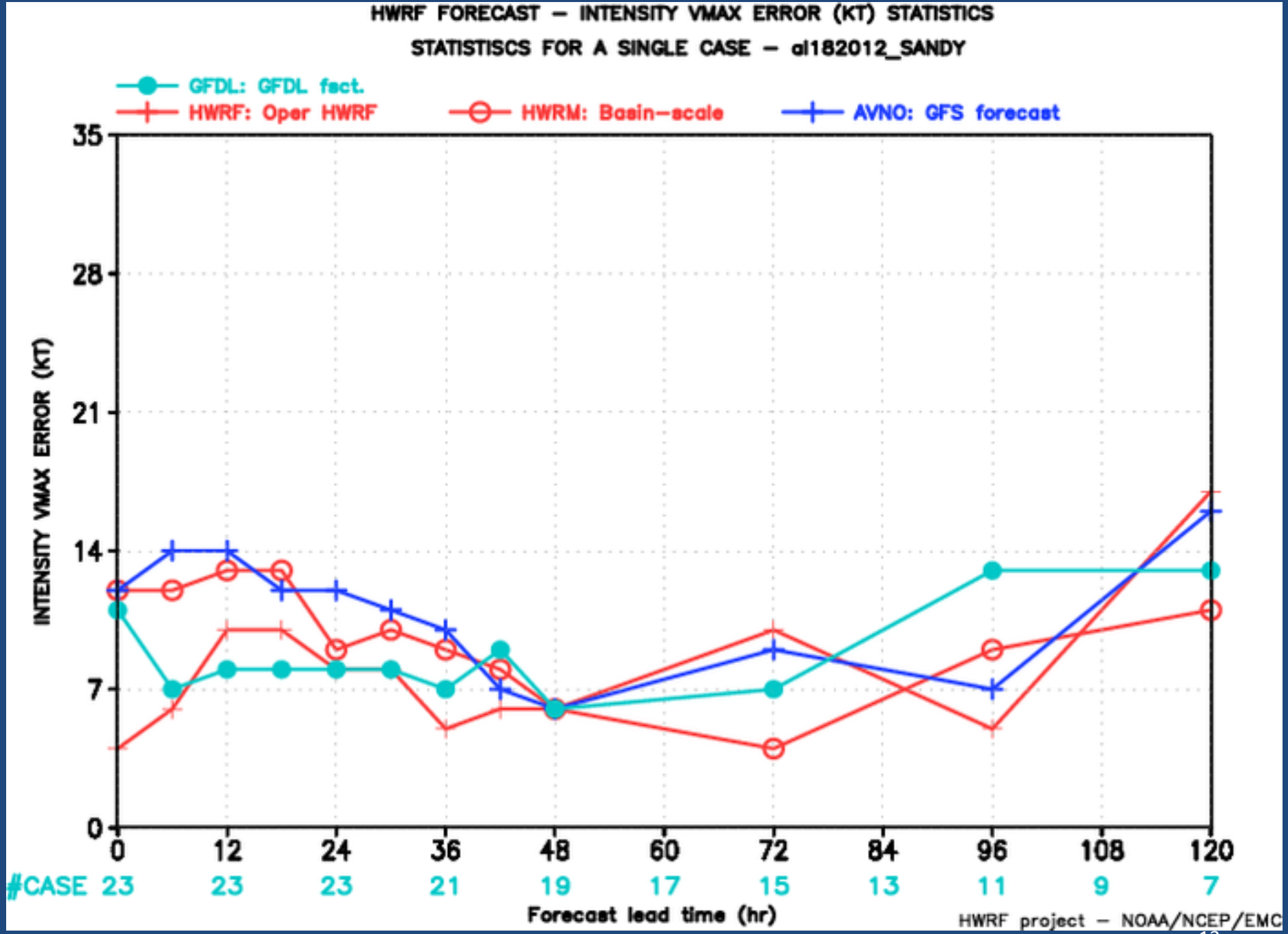
Model functionality and Sandy real-time forecast



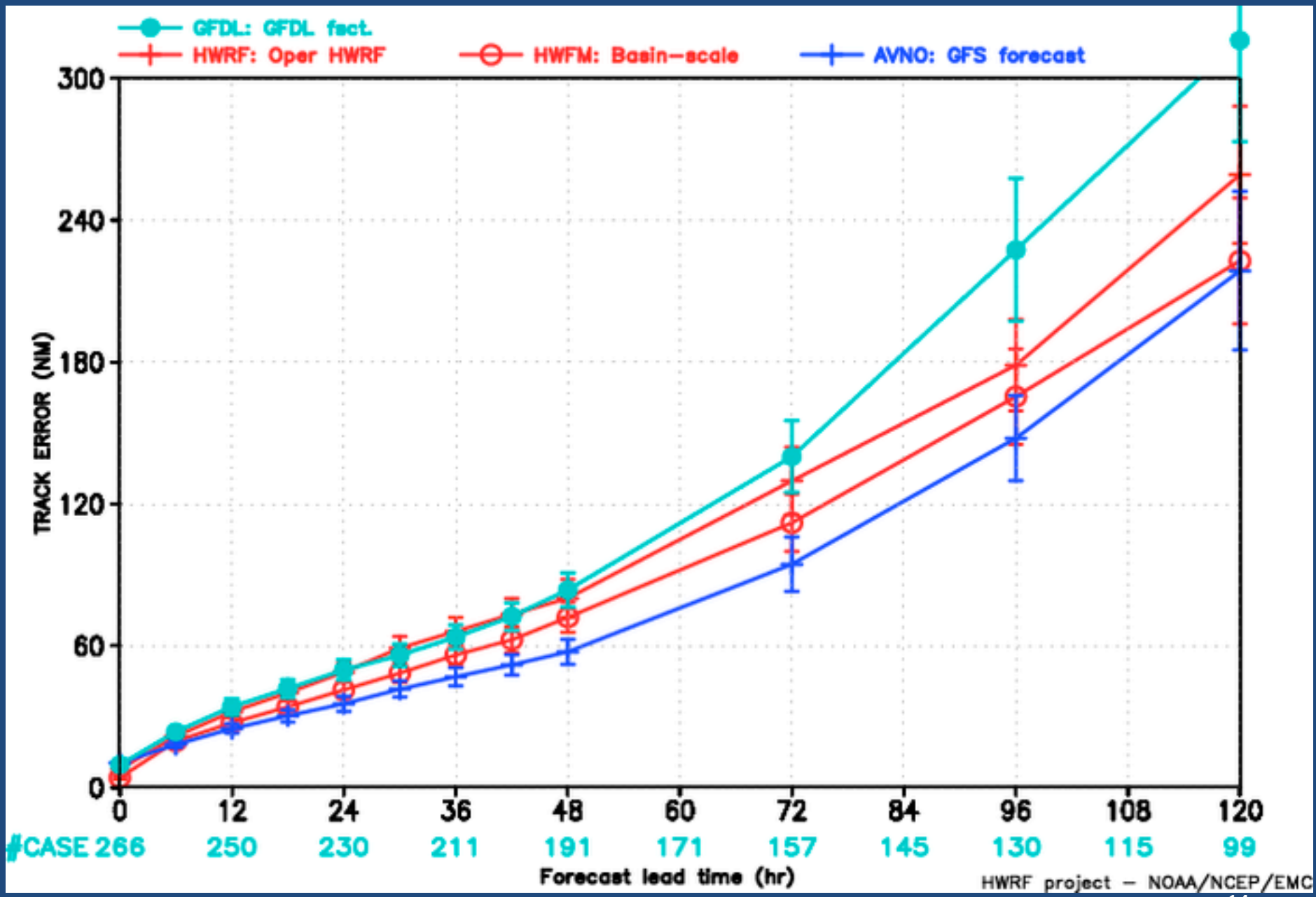
Hurricane Sandy Track Forecasts



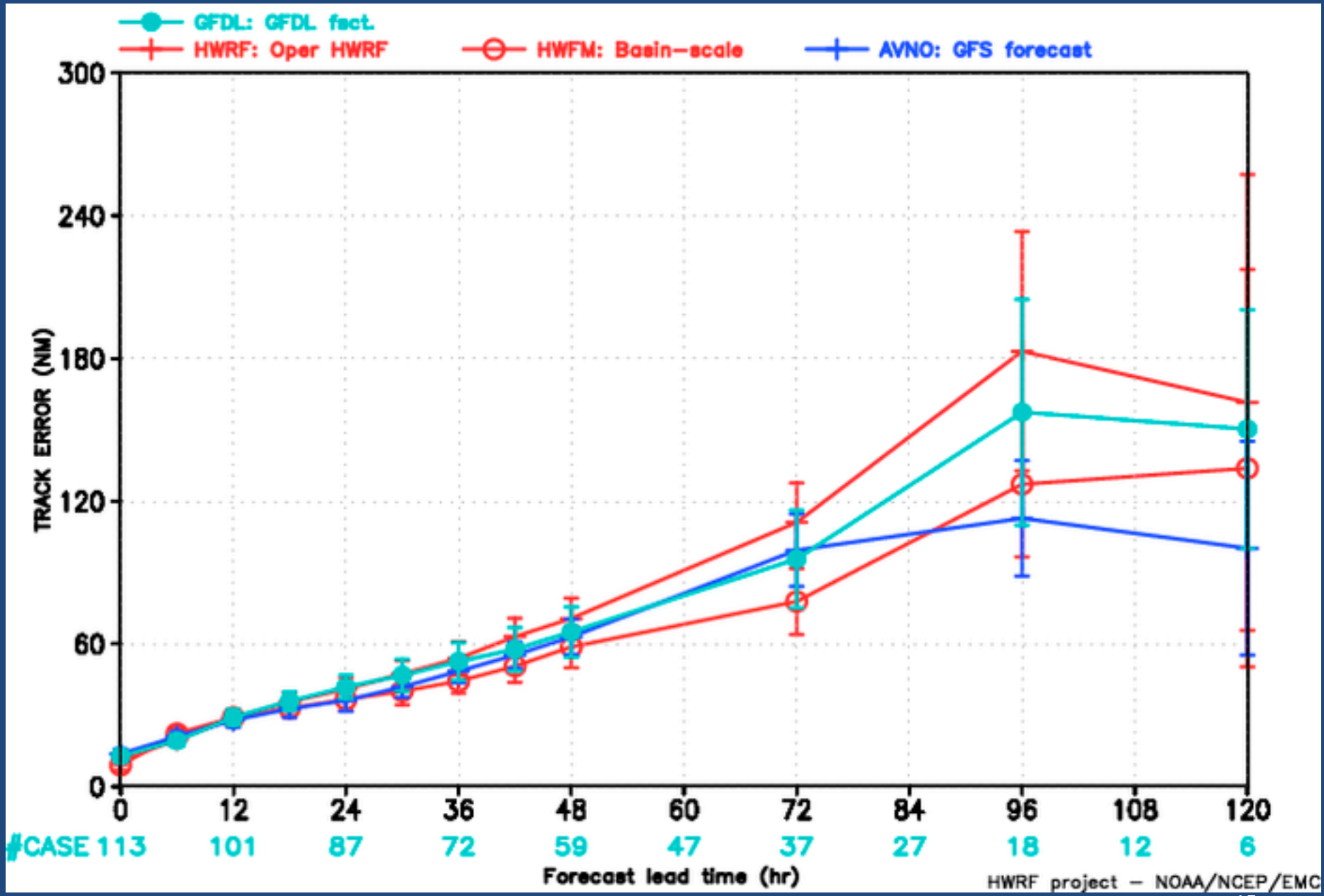

HWRF FORECAST – TRACK ERROR (NM) STATISTICS
STATISTISCS FOR A SINGLE CASE – al182012_SANDY
GFDL: GFDL fact.
HWRF: Oper HWRF
HWRM: Basin-scale
AVNO: GFS forecast
TRACK ERROR (NM)
300
240
180
120
60
0
0 12 24 36 48 60 72 84 96 108 120
#CASE 23 23 23 21 19 17 15 13 11 9 7
Forecast lead time (hr)
HWRF project – NOAA/NCEP/EMC


HWRF FORECAST – INTENSITY VMAX ERROR (KT) STATISTICS
STATISTISCS FOR A SINGLE CASE – al182012_SANDY
GFDL: GFDL fact.
HWRF: Oper HWRF
HWRM: Basin-scale
AVNO: GFS forecast
INTENSITY VMAX ERROR (KT)
35
28
21
14
7
0
0
12
24
36
48
60
72
84
96
108
120
#CASE 23 23 23 21 19 17 15 13 11 9 7
Forecast lead time (hr)
HWRF project – NOAA/NCEP/EMC

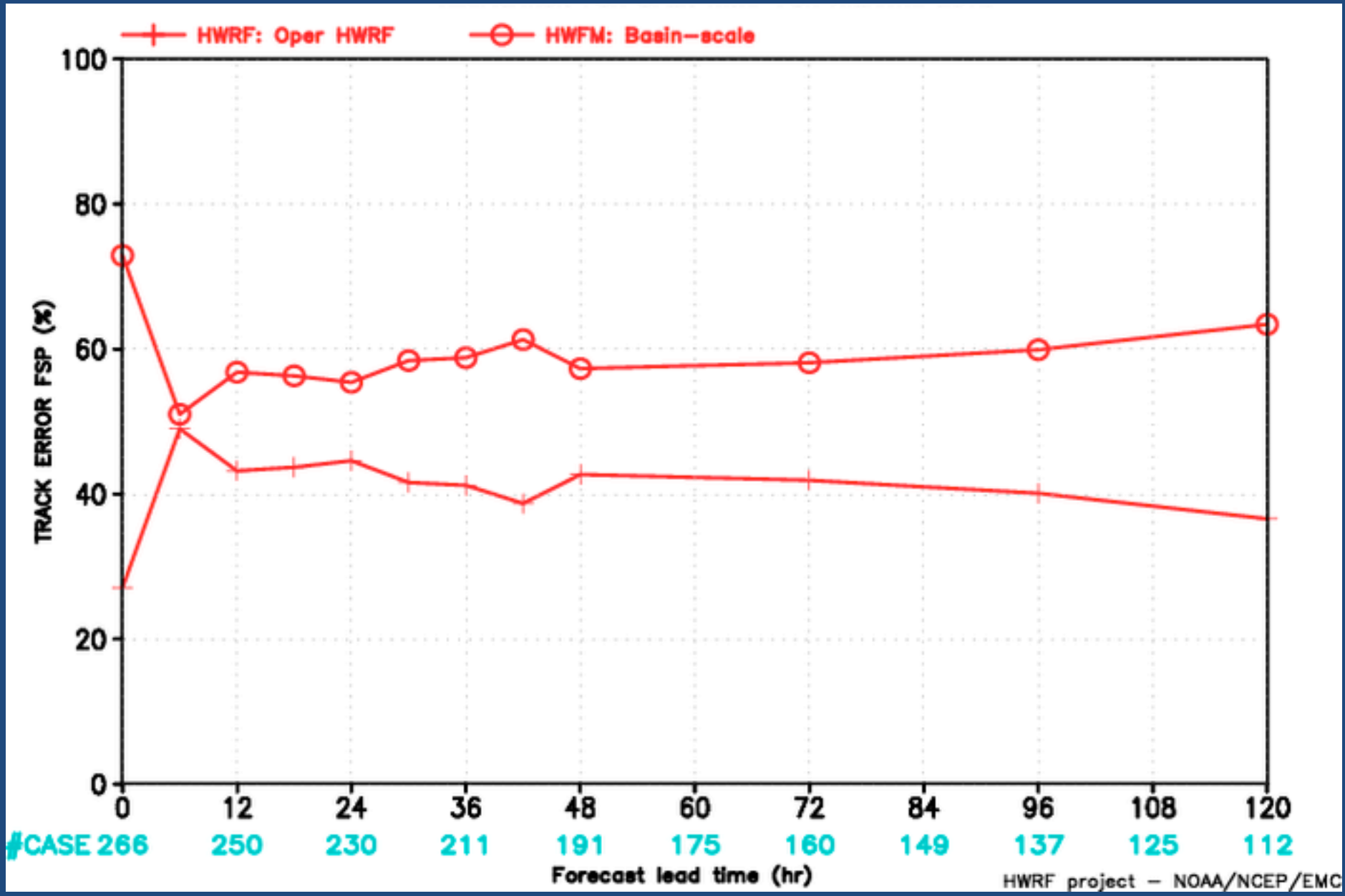
Track error (Atlantic 09-19)



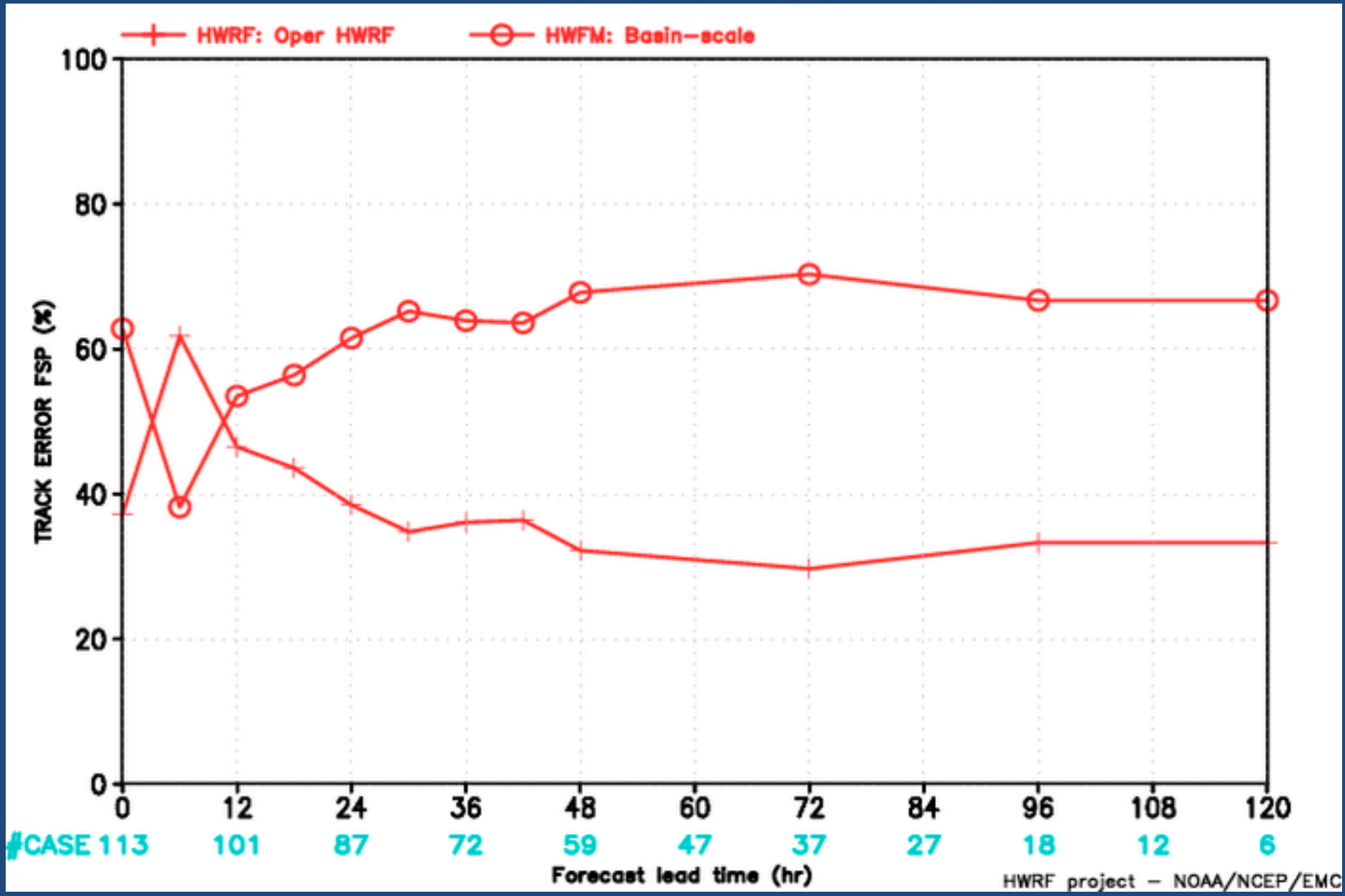
Track error (East Pacific 09-17)



Track error FSP (Atlantic 09-19)



Track error FSP (East Pacific 09-17)



Future work

- Complete the season retrospective forecasts
- Diagnose differences among good and bad cases
- Automate vortex initialization and create a benchmark
- Test different initial conditions from different DA systems
- Implement UPP for basin-scale modeling system

Challenges

- Optimize the code to meet the operational time constraint
- Initialize the forecast system
- Ocean coupling
- Post-processing
- Forecast products

Basin-scale HWRF Configuration Test

	Number of Nest Domains	Wall Clock Time	CPUs
27 km	No	50 mins	196
27-9-3 km	2 (1 storm)	137 mins	196
27-9-3 km	4 (2 storms)	256 mins	196
27-9-3 km	6 (3 storms)	363 mins	196
27-9-3 km	8 (4 storms)	430 mins	196

Note: Optimization ongoing

Conclusion

- The modeling system is under development and shows significant improvement on track forecast
- Vortex initialization through DA or cycling is an essential part to improve intensity forecasts
- Forecast efficiency will be critical to the pathway toward operational implementation