



Model Developments and Priorities

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Acknowledgement

Collaborators: EMC Hurricane Project (Lead: M. Avichal); DTC (Lead: K. Newman); HRD Modeling Group (Lead: Gopalakrishnan)
Computer resource: Jet supercomputer
HFIP support

Next HFIP Strategic Goals (Draft)

- Extend improvement of current forecast skill (track, intensity, and size) by 50%
- Extend forecast (track and intensity) guidance to 7 days with skill comparable to the 5-day forecast
- Reduce by 50% the forecast uncertainty associated with RI (95th percentile of intensity change distribution) at all lead times; e.g., reduce 48 h storm intensity error by at least 1 category.
- Improve guidance on timing, track and intensity for pre-formation disturbances by 20%
- Improve hazard guidance products and warnings, including storm surge, sustained wind, gusts, rainfall, and locally severe weather, at lead-time to 3-days (Dynamical model ensembles and probabilistic forecasts)
- Modernize the tropical cyclone product suite to incorporate better risk communication

Features of Current Models for Hurricanes

Features	HWRF	HMON	HWRF-B	GFS	GEFS	FV3GFS	FV3NES
SC/BC/G	SC	SC	SC/BC	G	G	G	BC/G
DA	Vor DA	N	Vor DA	DA	DA	DA	N
CYL	Partial	N	Partial	Full	Full	N	N
Ocn-CPL	Y	N	N	N	N	N	N
NEST	Y	Y	Y	N	N	N	Y
MOV	Y	Y	Y	N	N	N	N
MAX RES	2 KM	2 KM	2 KM	13 KM	27 KM	13 KM	3 KM
PHY	Hi-Res	Hi-Res	Hi-Res	GFS	GFS	GFS	GFDL

HWRF, HMON, GFS, GEFS: Operational

HWRF-B, FV3NES: HFIP real-time demo, stream 2

FV3GFS: Real-time parallel

Hurricane Model Developments and Priorities at EMC*

2018 season

- Yearly upgrades of HWRF & HMON
- Potential 3-way atmosphere/ocean/wave coupling
- Possible higher resolution or larger domains
- Improved DA and physics

2019 season

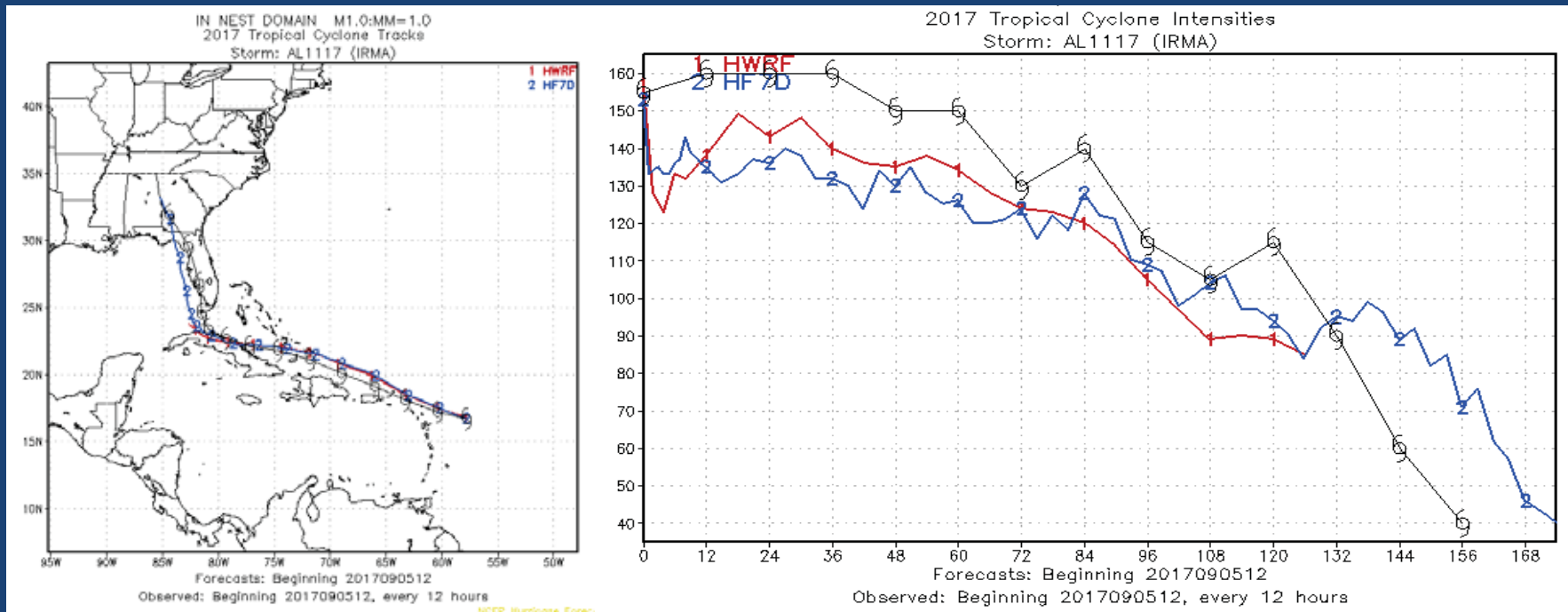
- Yearly upgrades of HWRF & HMON
- Potential fully cycled DA for HWRF
- Improved physics
- Explore higher resolution or larger domains
- Possible HWRF & HMON operational ensembles

2020 season and beyond

- Integrate HWRF & HMON into FV3
- Integrate multi-storms, high resolution nests into global system with moving nests strategy
- Advanced unified physics and data assimilation

*** All upgrades depend upon availability of computing resources at NCEP**

7-Day Forecast by Current Operational HWRF



Requirements of extending to 7-day forecast guidance:

- More computation resource
- Larger parent domain size (would fit in the basin-scale framework)

Basin-scale HWRF Developments and Priorities at AOML & EMC

- Satellite ensemble DA system (AOML)
- Ensemble prediction system (7-day genesis and probabilistic forecasts) (AOML)
- Genesis and probabilistic products (AOML)
- Ocean coupling (EMC)

Refer to G. Alaka's talk for details

Basin-Scale HWRF DA and Ensemble Prediction System

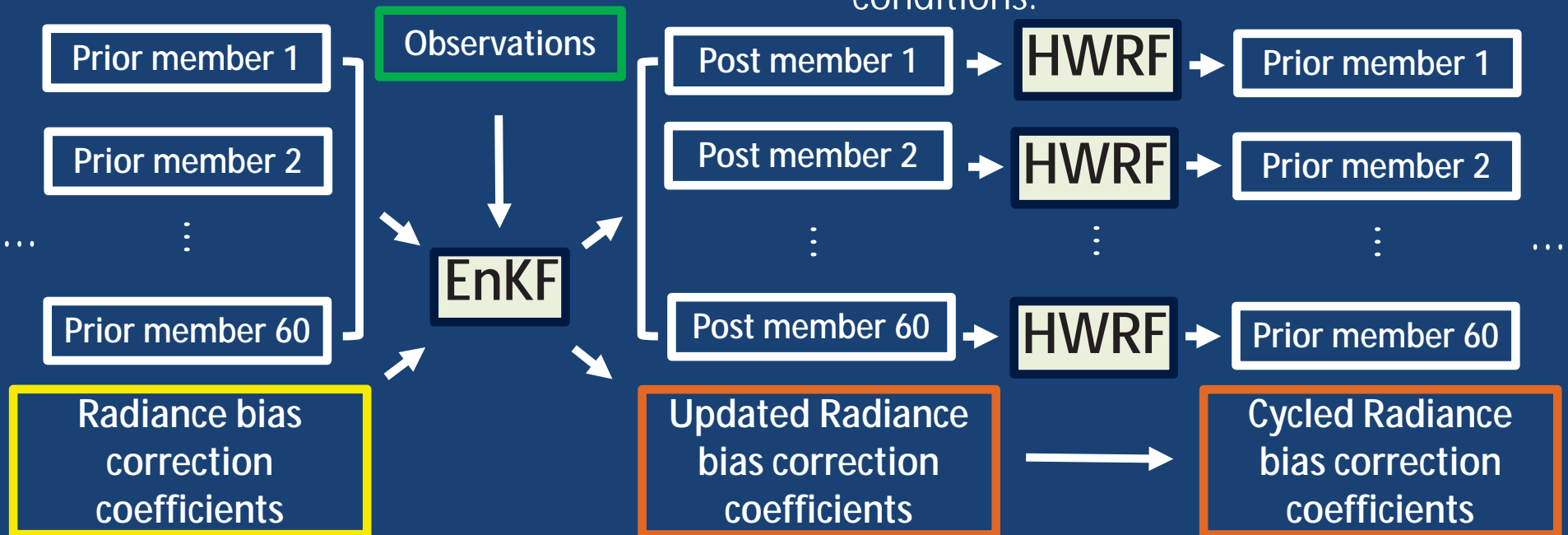
Developed by J. Poterjoy

Data Assimilation Step

EnKF updates HWRF ensemble and radiance bias correction coefficients for next cycle.

Forecast Step

A 6-h HWRF forecast runs from each posterior EnKF member using GFS surface and lateral boundary conditions.



Basin-Scale HWRF DA and Ensemble Prediction System



MSLP (red lines) and 850-mb vorticity increments for single member

Provided by J. Poterjoy

Prior obs-space error statistics from 12 weeks of cycling DA

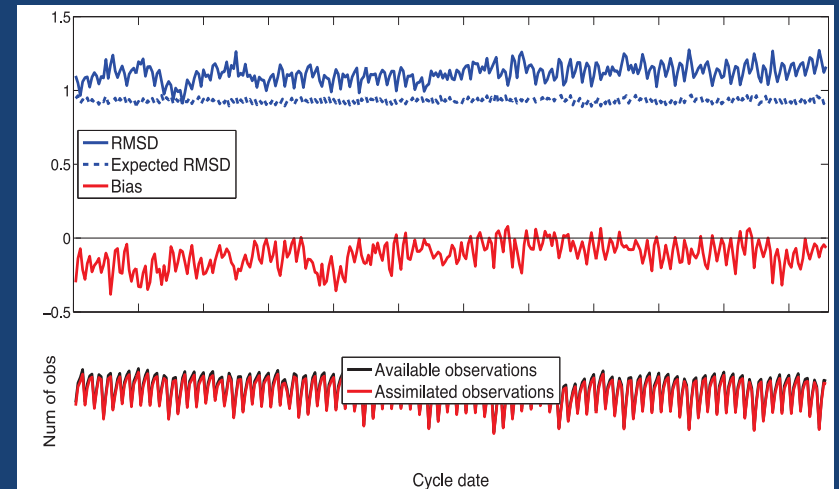
Domain-averaged errors

- Time series of domain-average prior errors show relatively steady DA/forecast performance over experiment period (20 July – 12 October).
- Temperature and moisture tend to have larger biases than wind variables (not shown).

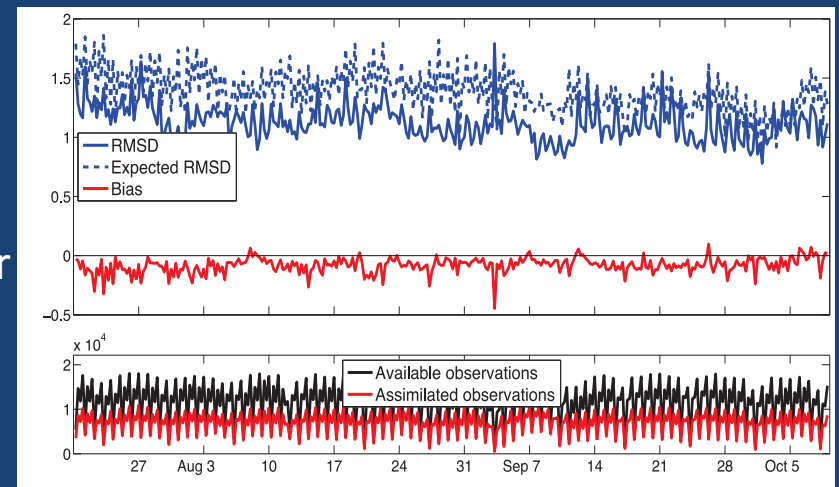
NO SYSTEMATIC DRIFTING!!

Provided by J. Poterjoy

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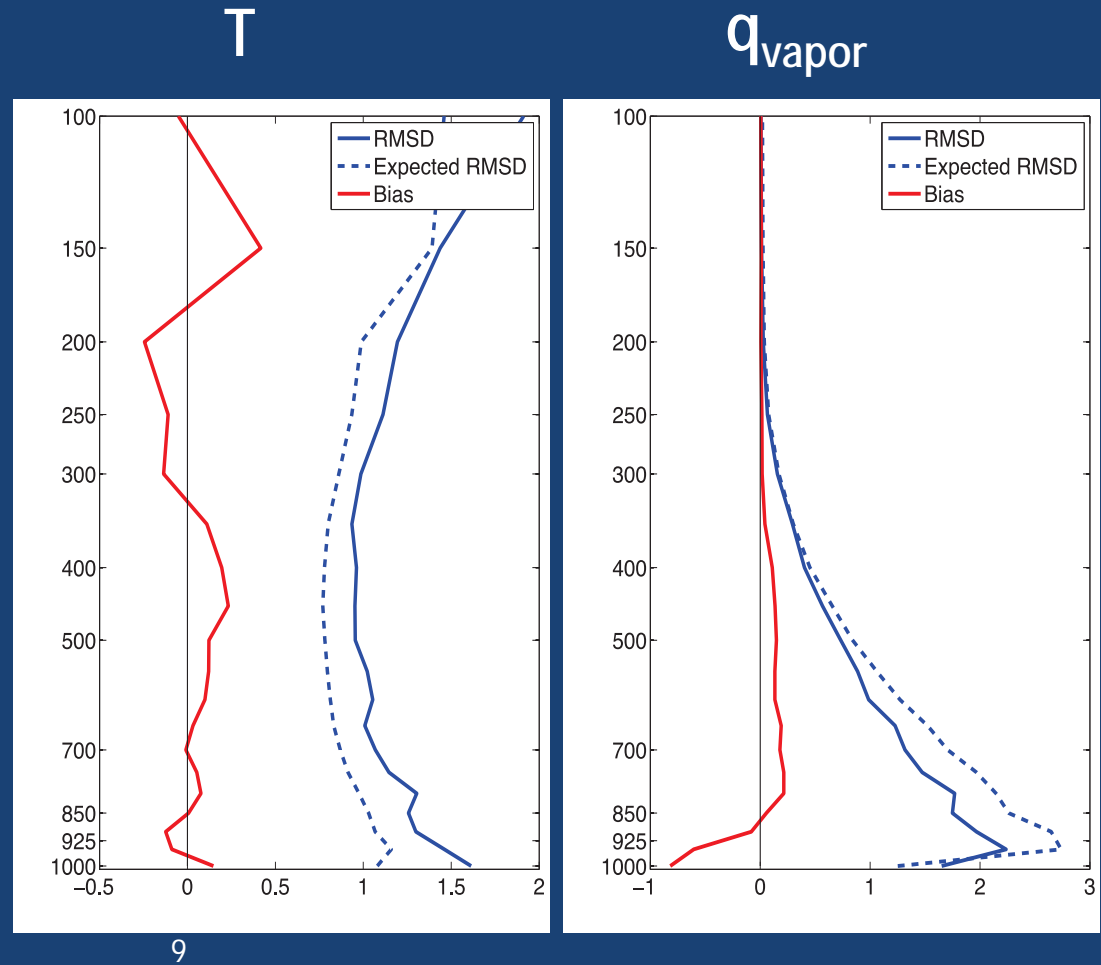
q_{vapor}



Prior obs-space error statistics from 12 weeks of cycling DA

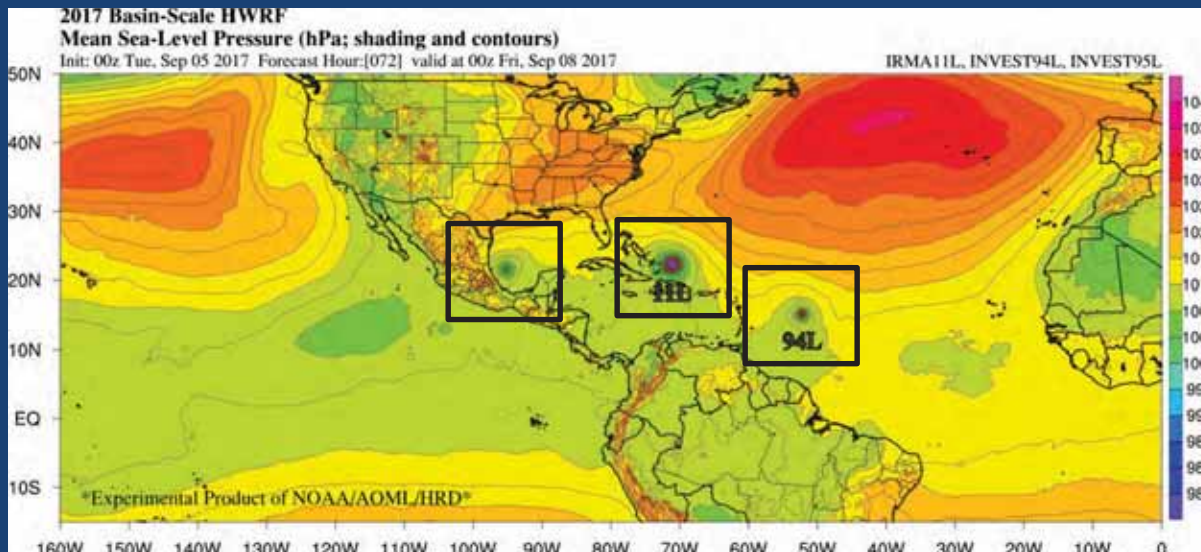
Time-averaged errors

- Temporal- and horizontally-averaged error statistics for observations binned vertically.
- The most noticeable deficiency is a large q_{vapor} bias below 950 mb.

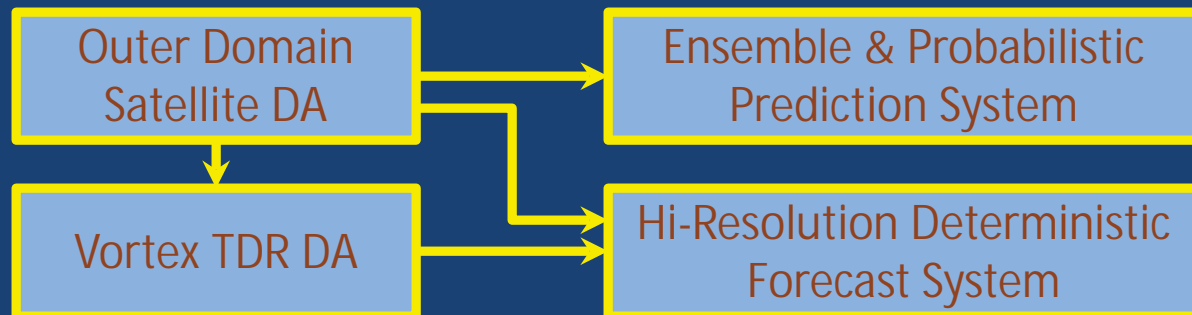


Provided by J. Poterjoy

Suggested Pathway for Model Developments and Priorities



- **Potential R2O transitions [low costs]**
 - All current basin-scale HWRF developments are built in the operational HWRF workflow, scripting, and source code using software packages in NOAA's R&D supercomputers
- **Research and forecast applications**
 - Basin-scale HWRF DA has no dependence on GFS for initial conditions and GEFS radiance bias correction, thus allowing for more vigorous validations of the HWRF potential model and physics upgrades
 - Basin-scale HWRF system provides a platform for satellite DA research that transitions seamlessly into community packages used by operational models
 - Basin-scale HWRF system is capable of probabilistic multi-scale weather prediction and deterministic forecast of TC track and intensity



Extra slide

Time Stats of Basin-scale HWRF Ensemble DA System

- Cost of major components*
 - Retrieve necessary GFS files and observation files: ~ 5 mins
 - Calculate obs-space information with GSI: ~ 20 mins/per member
 - Perform EnKF update: ~ 50 mins (includes storing output files in com directory)
 - Run 6-h ensemble forecast: ~ 20 min/per member
 - 120 cores per member

* Resources: 3660 cores (153 nodes) on Jet during HFIP demo reservation period