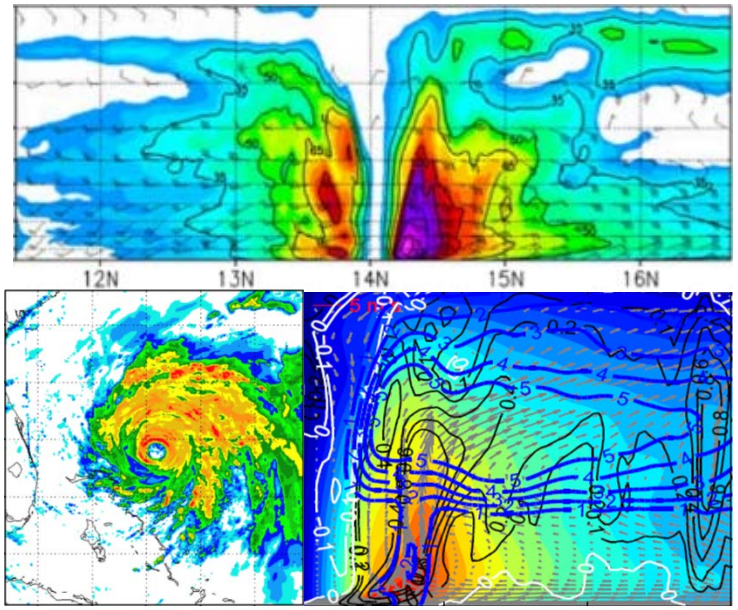
NOAA HURRICANE FORECAST IMPROVEMENT PROJECT



71st Interdepartmental Hurricane Conference

Frank Marks & Fred Toepfer

March 16, 2017

HFIP
Our Charter

- Improve hurricane forecast system and global forecast systems Track and Intensity Forecast Guidance to NHC
- Make better use of existing Observing Systems and define Future Observing System Needs
- Expand and Improve forecaster tools and applications to support NHC

Includes all necessary
Research, Demonstration, Development, Transition and Implementation

HFIP Performance Goals

Vision

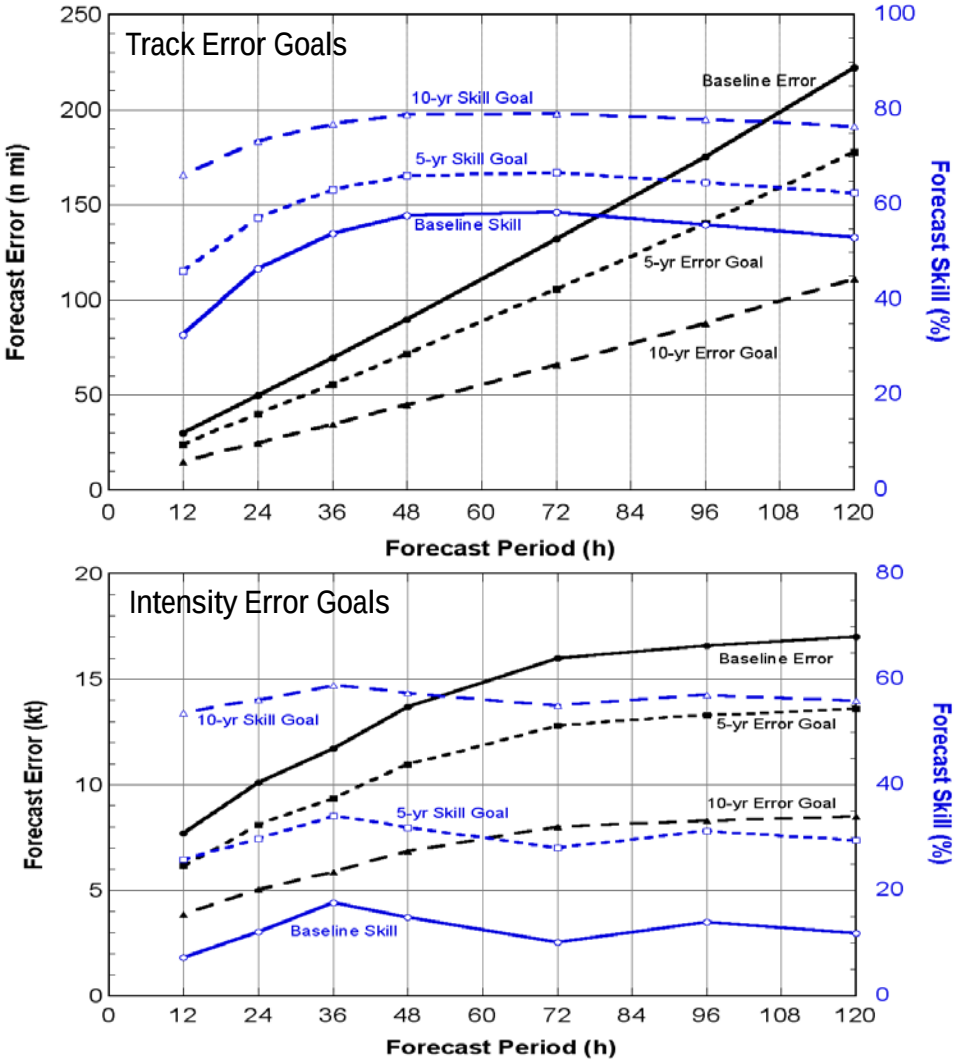
– Organize the hurricane community to dramatically improve numerical forecast guidance to NHC in 5-10 years

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



NHC - "We've clearly met the 5 year goals, particularly intensity, but concern about where we can make further gains."

HFIP Priorities for 2017 (NWS President Budget Reductions)

- OAR Budget holding steady
- NWS Budget Reduced; Program Integrity Maintained
- System Development Priorities
  - FV3 Based Regional Modeling System under development
  - Development of Moving Nest Technology in FV3
  - Global-to-local scale predictions with emphasis on multi-scale interactions
- Evolution of Hurricane Forecast System includes:
  - Improved forecasts for land falling storms and downstream applications
  - Precipitation after land fall
  - Continued focus on high-resolution multi-model ensembles (NOAA-Navy)
- NOAA OCIO Takes over Jet in FY18

We Will Achieve Long Term Goals – just will take a little longer!

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HFIP Annual Meeting Recap
Issues and Challenges

- 2016 issues
  - Matthew HWRF **RI failure**
  - **Strong bias for HWRF weak systems**
  - Hermine genesis failure
  - Nicole genesis failure
  - Matthew genesis very good
  - **GFS underpredicts genesis**, more in EPAC than ATL, worse than EC and UK. 5-day worse than 2-day
  - **GFS ensemble underdispersive.**

HFIP Annual Meeting Recap
NHC priorities

- HWRF RI
- Satellite DA
- HMON guidance verification
- HWRF weak storm over prediction
- GFS genesis issues
- GFS ensemble issues
- Work with ensemble tiger team to develop products useful for forecast guidance
- Upgrades to statistical dynamic models e.g., HCCA

HFIP Annual Meeting Recap
2017 Science Priorities

- **Focus HRD, EMC, & NHC HFIP** resources on Matthew and Hermine to address RI, ensemble spread, and initialization issues by bringing model , physics, and DA teams to bear on common problem.
- **Physics Team** - Need more work on this model bias - initialization, physics, etc.? Idealized runs needed. Any role in spin down? RI? Need to add DA team in any physics evaluation to ascertain impact on DA.
- **Ocean Model Impact Tiger Team (OMITT)** - Need to start stratifying cases that have potential strong ocean impact
- **DA Team** – Work with model teams to solve spin down issue. Focus should be with operational HWRF system.

HFIP Annual Meeting Recap
2017 Science Priorities (Continued)

- **Model Team** – need more evaluation of HMON to satisfy NHC. Should include physics and DA team evaluations.
- **Ensemble Team** - Need NHC and JTWC involved in identifying ensemble products that improves forecast guidance.
- **Post-processing & Verification Team (PPAV)** - Need to develop evaluation/ verification focused on weak storm/non developing over prediction. Basin scale HWRF? Upgrade to statistical dynamic models e.g., HCCA. Work with ensemble team to provide NHC timely products to evaluate multi model ensemble for guidance.

Questions?

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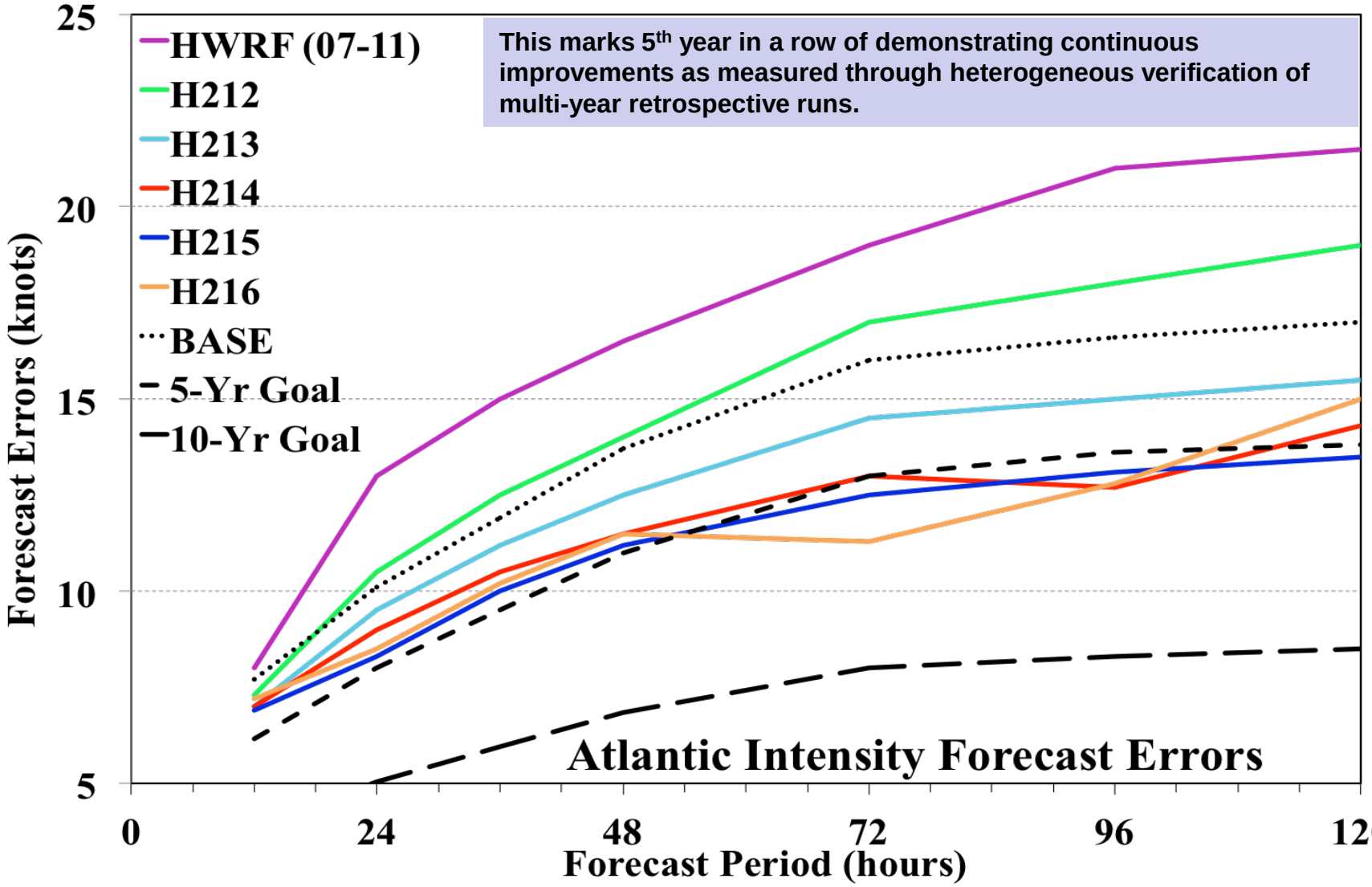
HFIP Highlights for 2016

- 2016 HWRF operational implementation
  - Increased vertical resolution (from 61 to 75 levels) to a 10-Hectopascal top
  - Increased the size of nested domains with smaller time-steps; and assimilation of additional data .
  - HWRF upgraded to the scale-aware SAS convective scheme with the F-A microphysics scheme
  - HWRF model guidance outperformed JTWC operations up to Day-3 for intensity skill.
- HWRF into NMM-B named HMON
  - Ran in real-time during 2016 hurricane season
  - Operational implementation planned for 2017 season
- NHC Operational forecast improvements
  - EPAC track forecast exceeded all time records for 12-96hr in 2016; model guidance was very close
  - 20% improvement for HFIP goal stated as accomplished progress may be slowing but still holding
- Basin-Scale HWRF
  - Basin-scale HWRF configuration comparable to operational HWRF-H216
  - Products web page with HWRF Basin-scale near real-time products with 18/6/2 km res is available
- Multi-model regional ensemble efforts
  - Development of new ensemble-based products beyond the typical mean/standard deviation that could be used by NHC forecasters to improve forecasts
  - HWRF/COAMPS-TC/GFDL (3-model ensemble) showing promise
- Storm Surge
  - Implemented HSSOFS (hurricane storm-surge on-demand fcst sys) model in June. NHC can initiate runs on-demand near/at landfall. (NOS/CSDL & HFIP)

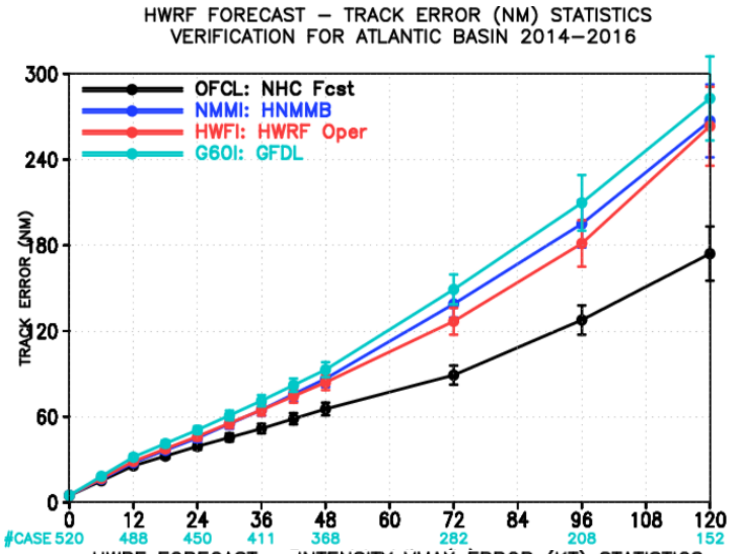
HFIP R&D HPC
Configuration of Jet System

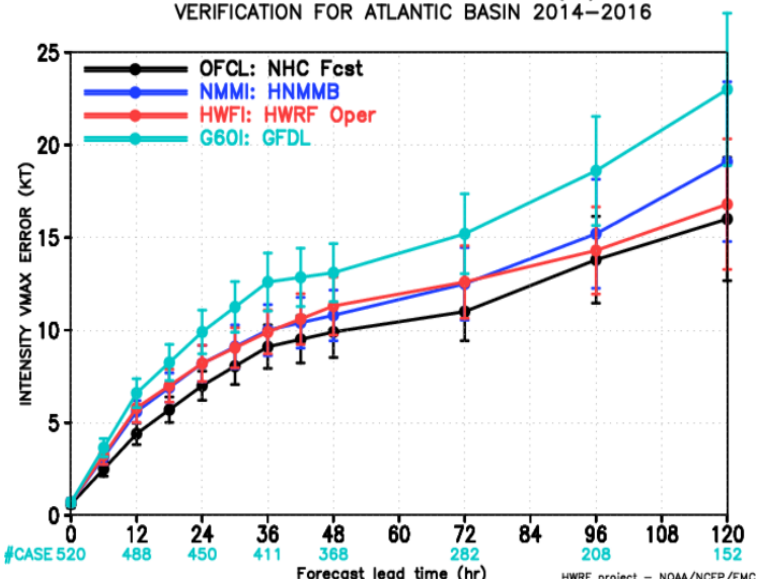
	Install Date	Total Cores	Performance (Tflops)	Storage (TB)
Phase 1 (Njet)	Aug 2009	3184	35.6	350
Phase 2 (Tjet)	Aug 2010	10600	113.0	416
Phase 3 (Ujet)	Oct 2011	16648	182.0	1166
Phase 4 (Sjet)	Aug 2012	22088	272.0	1613
Phase 5 (Vjet)	Aug 2014	24456	340.26	3261
Phase 6 (Xjet)	Oct 2015	32520	576	3773
Phase 7 (Xjet+) expansion	Aug 2016	45388	820	4400

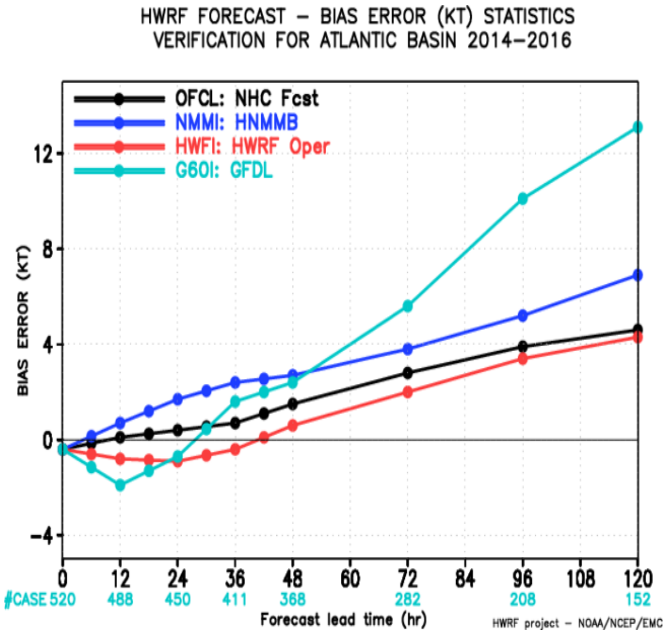
2016 HWRF: Continuing the Trend of Incremental Improvements in Intensity forecasts



2014-16 HMON Retrospective Test Atlantic Basin: Early Model







- HMON has **lower track errors than GFDL** at all lead times.
- Intensity errors are **significantly lower than GFDL** and comparable to HWRF but both errors and bias are larger than HWRF at longer lead-times but still **lower than GFDL.**