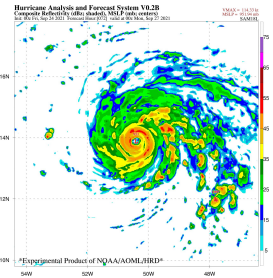
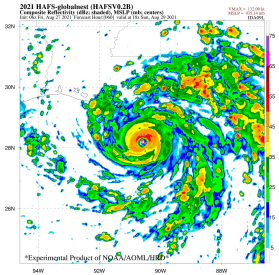


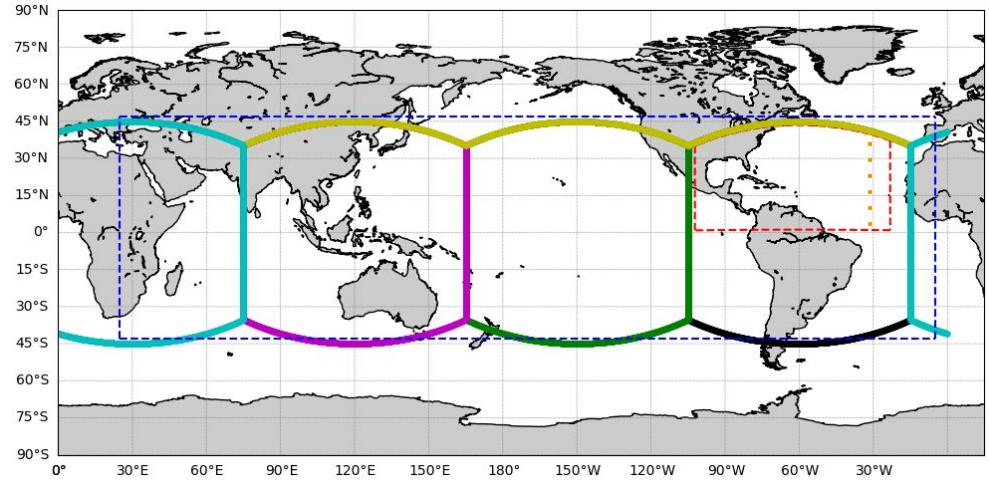
HAFSV0.2B 2021 Real-time Results



PIs: Andy Hazelton, Lew Gramer, Ghassan J. Alaka, Jr.
University of Miami CIMAS/NOAA AOML
Collaborators: Hyun-Sook Kim, Dan Rosen, Bin Liu, Zhan Zhang, Avichal Mehra, Sundararaman Gopalakrishnan, Morris Bender

2021 Grid Configuration and Model Setup

- Keep the 2020 “global tropical channel” FV3 layout, with 13-km global resolution (C768)
- Static 3-km nest covering most of the tropical Atlantic
- Requested resources to extend Atlantic nest from 2020 by ~6 degrees
- Nest was coupled to HYCOM for 2021
- 168h forecasts 4x daily
- 4560 cores in ~5 hours

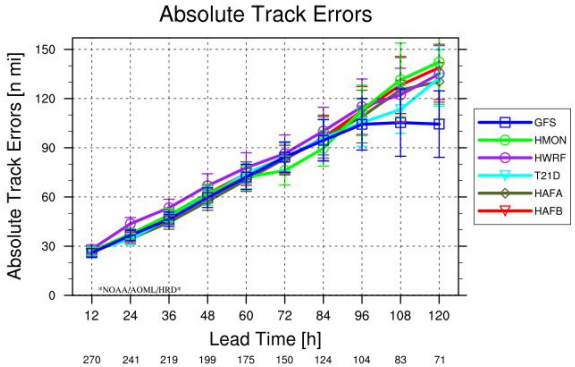


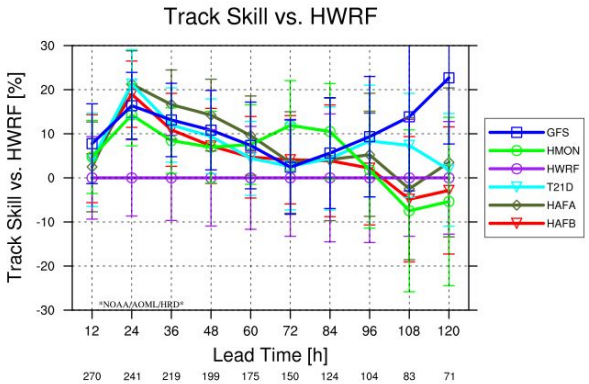
2021 nested grid

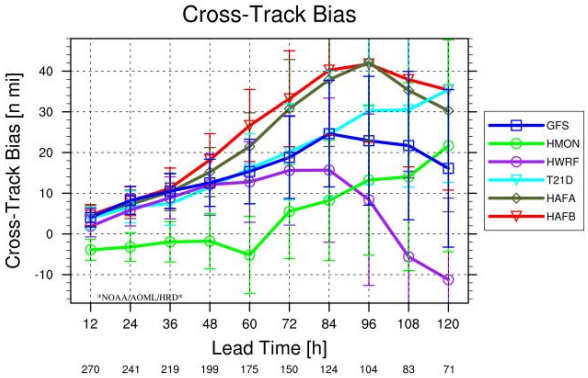
2020 nested grid

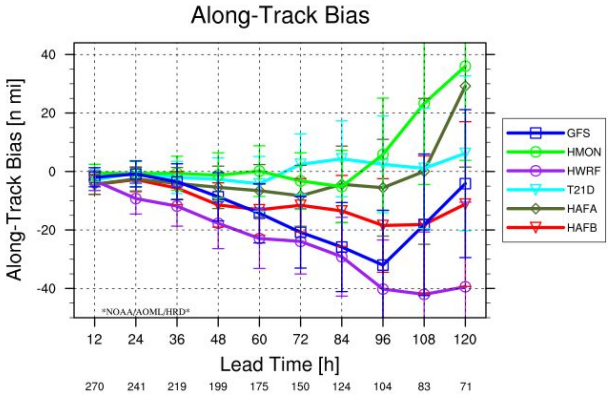
2021 HYCOM grid

Atlantic Track Performance



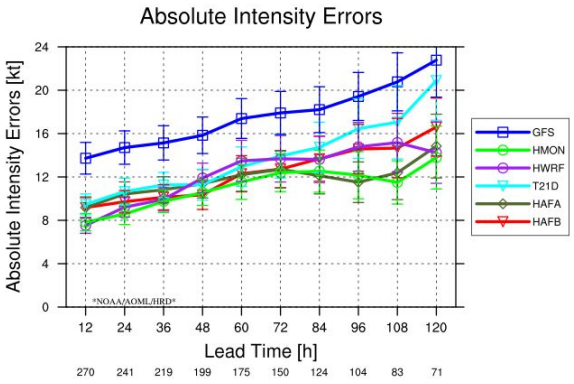


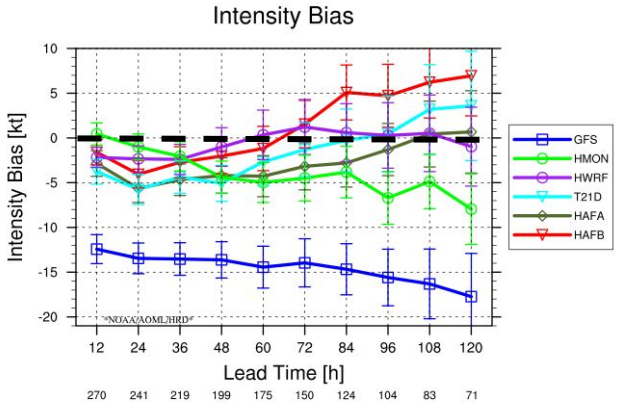


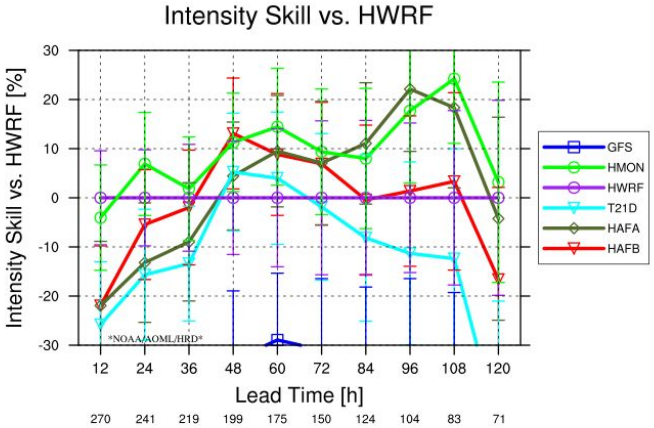


- GFS track outperformed all high-resolution models
- HAFS-B had a right bias overall again (though lower than 2020)
- HAFS-B had a slow bias as well (slightly smaller than GFS)

Atlantic Intensity Skill

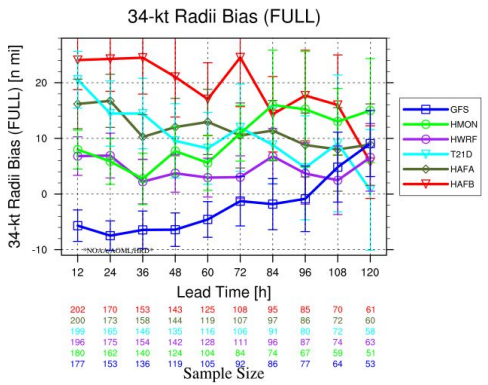


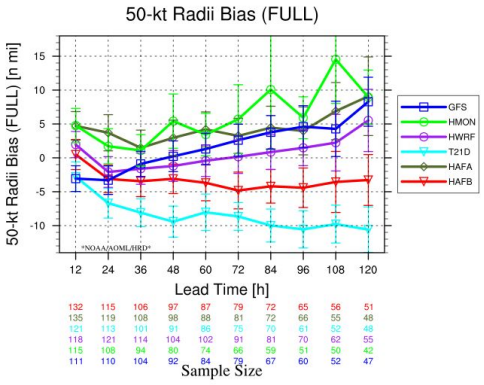


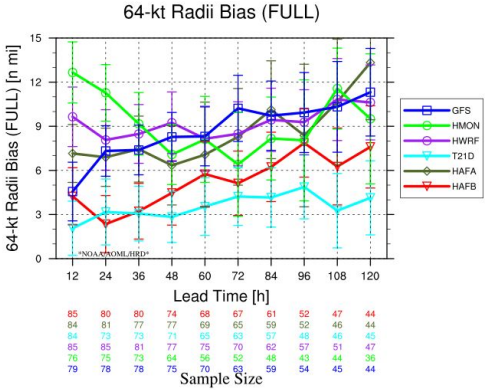


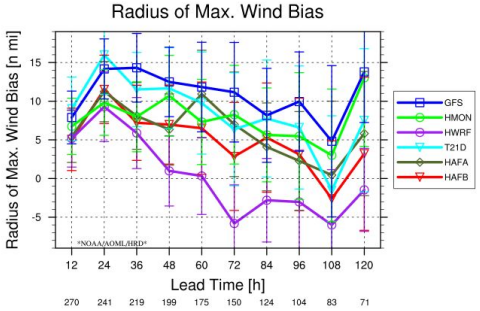
- Intensity guidance had generally similar performance for the first ~72h
- HAFB was slightly worse than HAFA/HMON at Days 4-5
- Bias was well-calibrated on Days 1-3, slight high bias at Days 4-5
- 48 hours was where HAFS-B showed the best performance relative to HWRF (after spinup due to lack of DA)

Atlantic Radii Skill



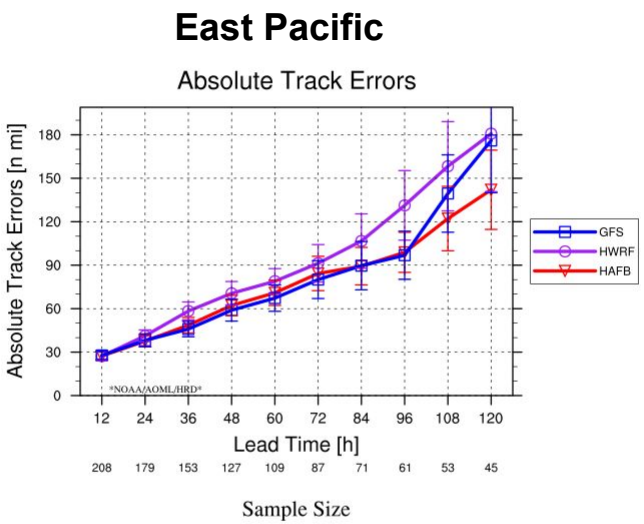


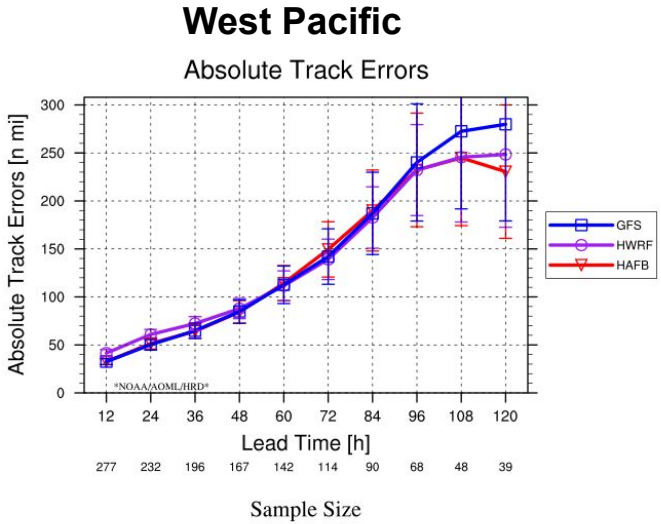




- HAFB had a positive R34 bias early
- RMW bias also slightly positive early, but better at longer range
- R64 was slightly too large on average in all models

Global Skill



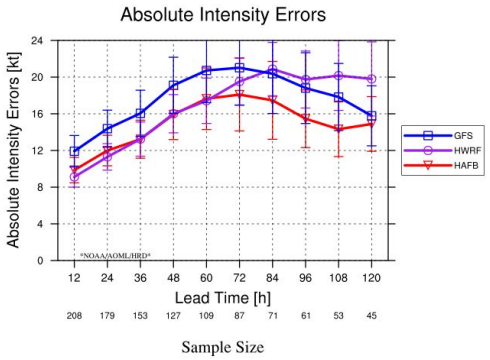


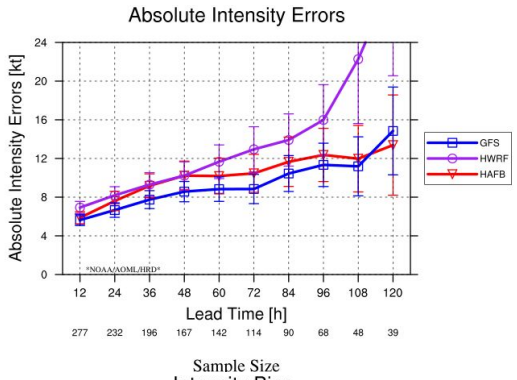
- Assessment of global skill is an important part of the HAFS-globalnest (HAFS-B) configuration
- Track results for the East Pacific and West Pacific are mostly neutral, maybe slightly better than the operational GFS at longer lead times

Global Skill

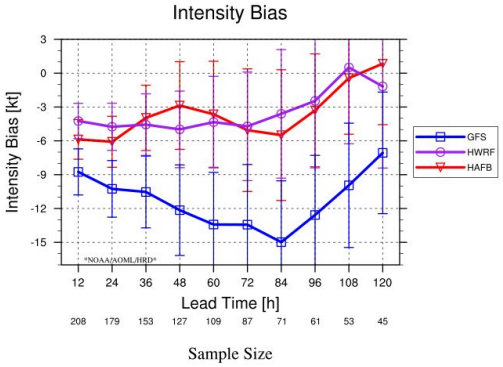
East Pacific | **West Pacific**

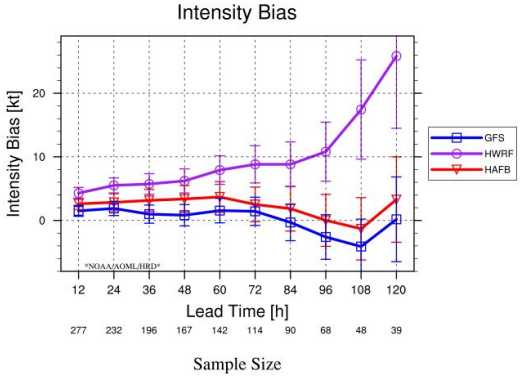
Intensity Error





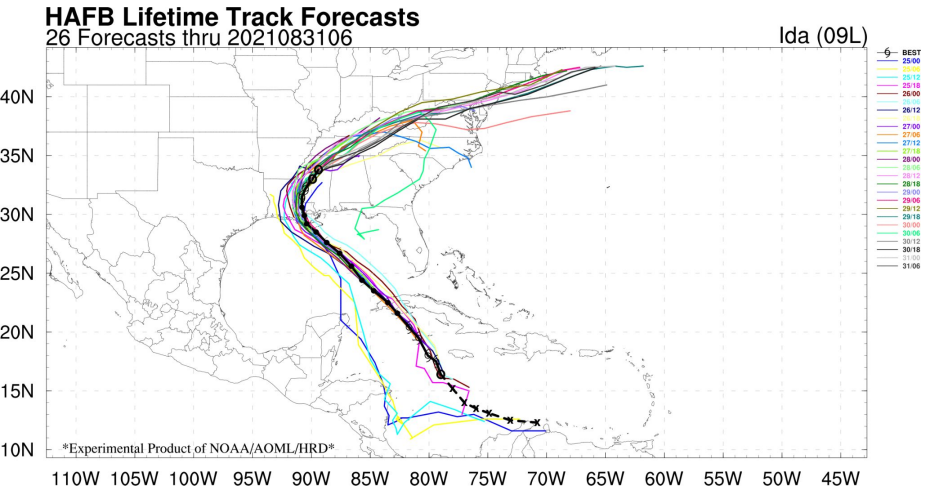
Intensity Bias

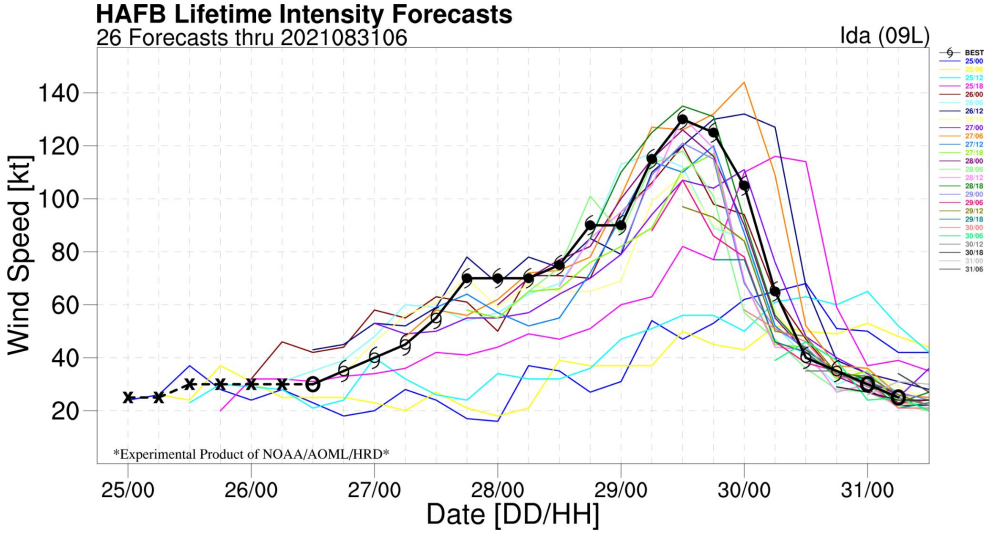




- HAFB had lower intensity errors than GFS in the EPAC
- Downstream advection of high-res disturbances?
- Highlights the importance of a multiple-nested global configuration eventually
- WPAC intensity results were mostly similar to GFS (further from the high-resolution nest)

Ida Case Study





- After genesis, track forecasts were accurate (some were slightly slow)
- Most forecasts correctly showed RI and peak as a strong Category 4

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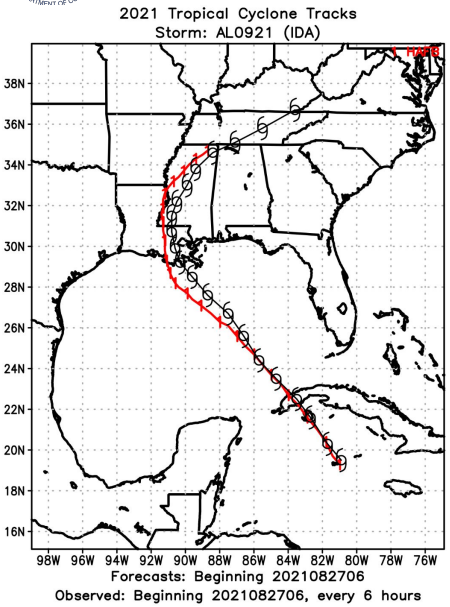
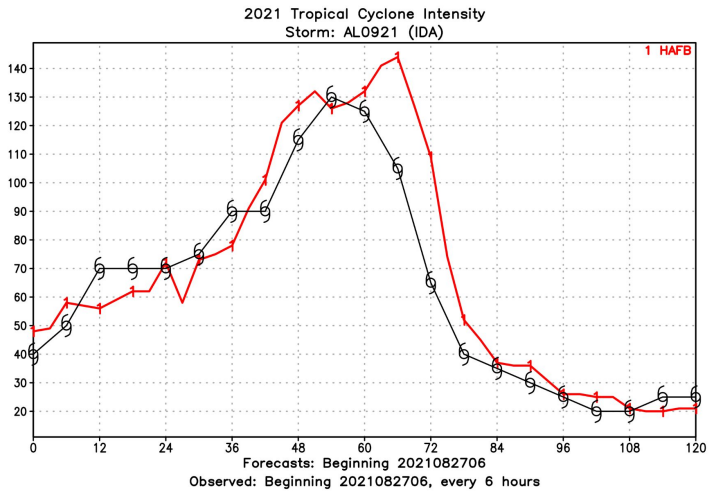
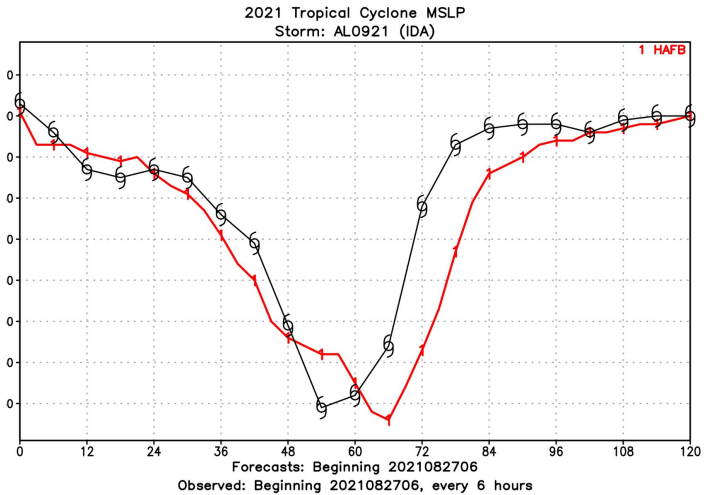
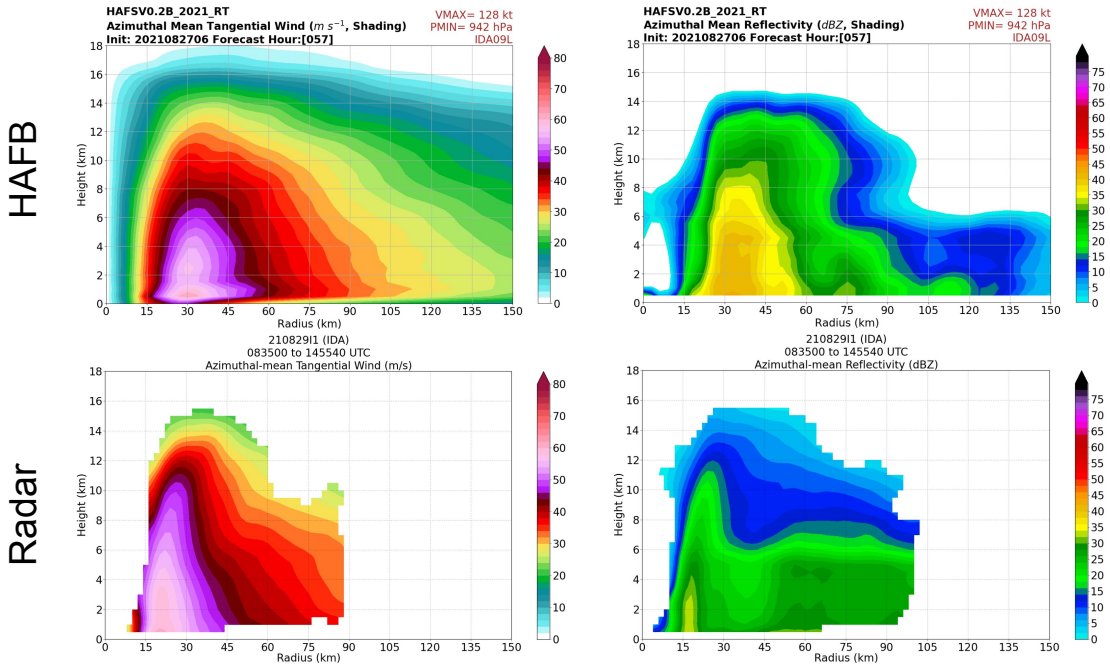






- Slight left/slow bias (typical of most HAFS runs)
- Initial slow ramp up followed by sudden RI, consistent with obs

Ida 2021082706 Structure Analysis



- Wind structure was very consistent with obs near peak intensity
- RMW slightly smaller in observations
- Moat region more pronounced in observations

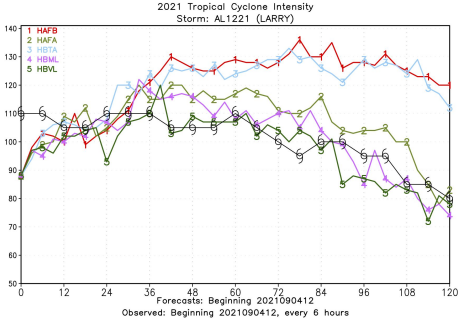
Design of Sensitivity Experiments

- Wanted to test some of the differences between HAFS-A and HAFS-B
- Two testable differences were tracer advection (hord_tr = 8 vs. -5) and PBL scheme mixing length (elmx/rlmx = 300 vs. 100)
- We also included a test with L91 (not feasible in real-time)
- Larger nest and ESG grid were two options that we could not test
- A few different test configurations were designed to be progressively closer to HAFS-A in the physics/dynamics options:
  - HBTA (hord_tr = 8 instead of the hord_tr = -5 used in HAFSV0.2B)
  - HBML (hord_tr = 8 + elmx/rlmx = 300 instead of the 100 used in HAFSV0.2B)
  - HBVL (hord_tr = 8 + elmx/rlmx = 300 + L91 instead of the 75 used in HAFSV0.2B)
- Tested on several high-profile 2021 cases

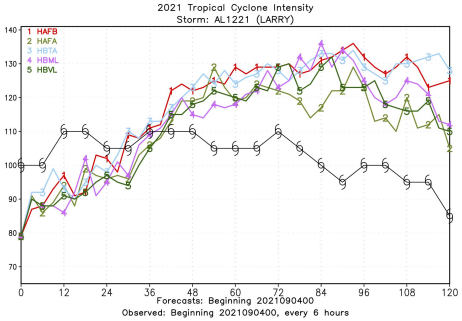
Sensitivity Experiment Examples

Real-time High Bias Cases

Larry 2021090412

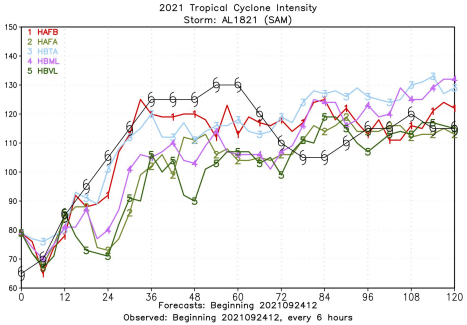


Larry 2021090400

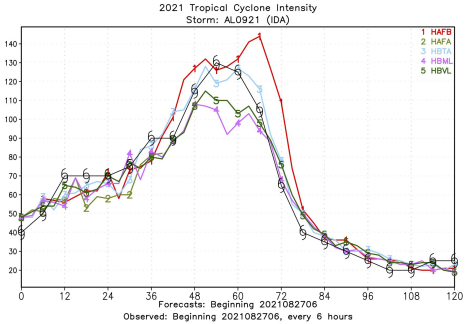


Real-time RI Cases

Sam 2021092412



Ida 2021082706



- Larry was a main high bias case
- Tracer advection didn't alter the results much
- Mixing length was more important, and L91 to some extent
- Opposite results for RI cases: smaller mixing length cap did better
- Needs to be configured to capture *both* RI and weakening events correctly

Conclusions

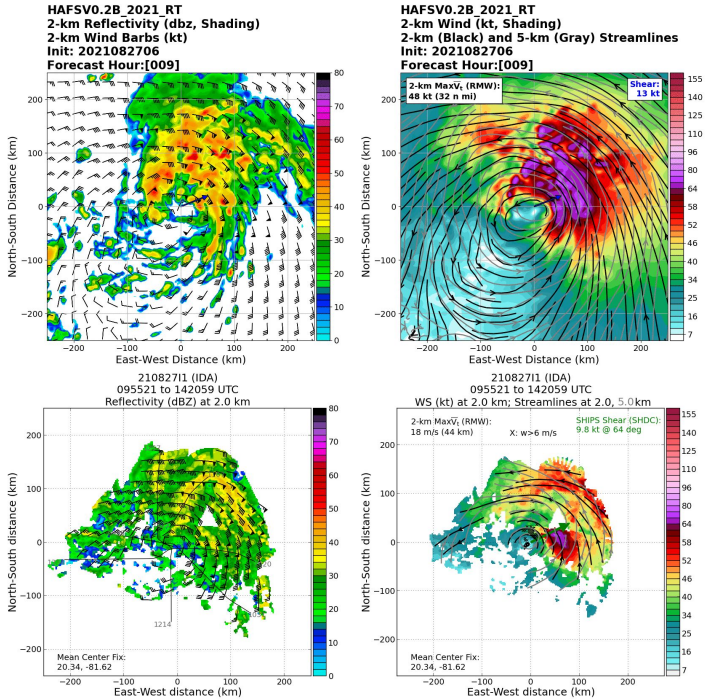
- HAFS-B (HAFS-globalnest) had comparable track skill to other HAFS and GFS-based guidance
- Good intensity skill in the first 2-3 days of the forecast, slight high bias at longer leads (mostly from Hurricane Larry)
- Impressive results (from the global domain) in the East Pacific: shows the value of the evental multiple-moving-nest configuration
- Rapid intensification of Hurricane Ida and structure evolution was well forecast
- Sensitivity tests show that vertical resolution and PBL structure are critical
- Physics, dynamics, and resolution need to work together to cover the full range of intensity change (RI and weakening)

Extra Slides

Ida 2021082706 Structure Analysis

HAFB

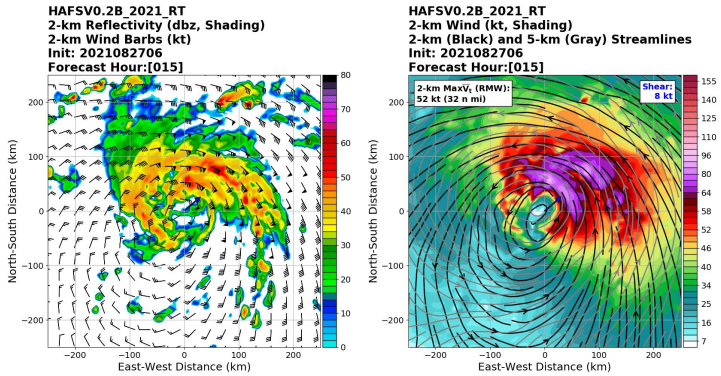
Radar



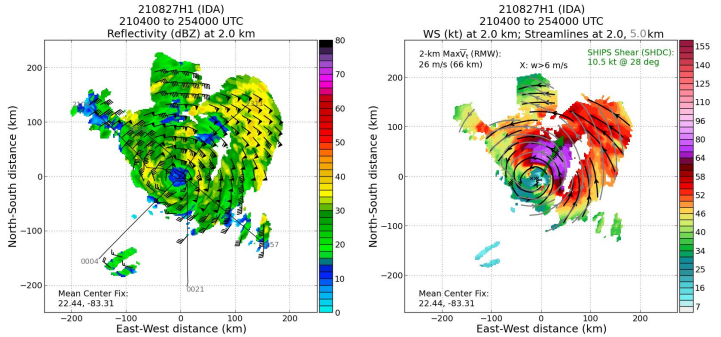
- August 27, 15Z (1st flight)
- Initial wind+precip field was very asymmetric
- HAFS-B represented this well

Ida 2021082706 Structure Analysis

HAFB



Radar



- August 27, 21Z (2nd flight)
- Vortex was interacting with Cuba
- Broad wind field and large band to the NE was well-represented by HAFS-B

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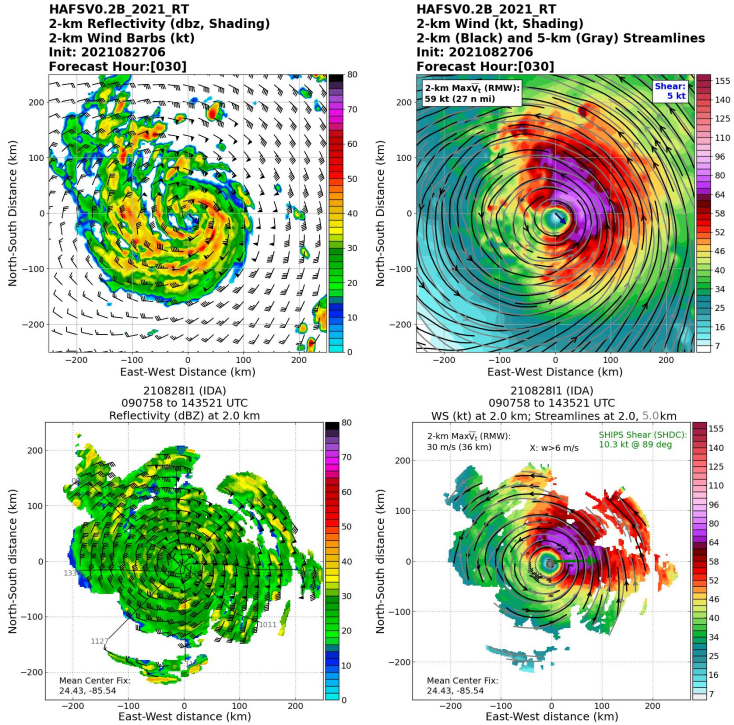
HAFB

Radar

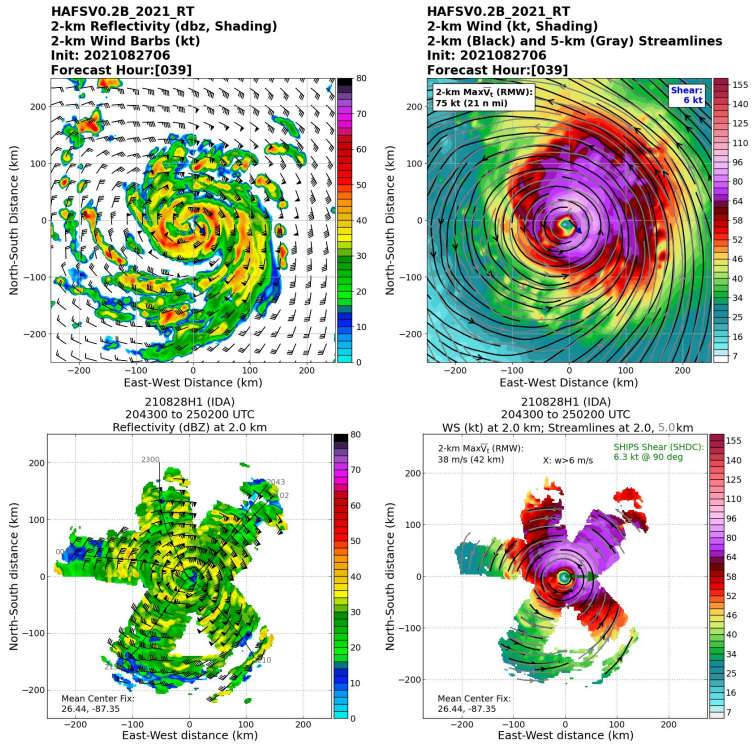


- August 28, 12Z (3rd flight)
- Precipitation was more symmetric
-

Ida 2021082706 Structure Analysis

HAFB

Radar

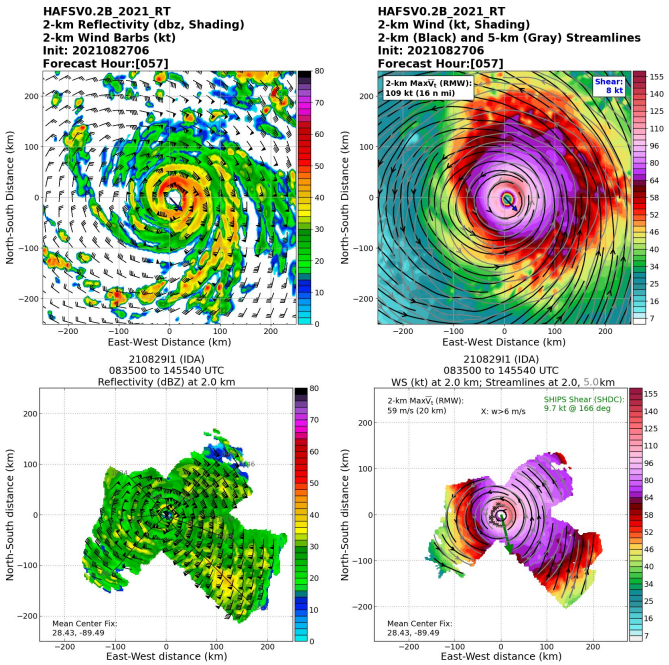


- August 28, 21Z (4th flight)
- Core was becoming more compact
- HAFS-B reproduced this structure
- Wind field was much more symmetric, with hurricane force winds around the eyewall at 2 km
- TC was primed for RI

Ida 2021082706 Structure Analysis

HAFB

Radar



- August 29, 15Z (5th flight)
- Extreme wind field post-RI
- Strongest winds in the NE quadrant
- Eye was slightly too large in HAFB (common model issue)