Moving Nest Features for HAFS

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Moving Nest Overview

Limits in Global Forecast Systems

- Current global GFS resolution of 13 km
- To accurately model hurricanes, we need 1-4km resolution to capture strong gradients in the storm core
- Not feasible to run large/global domain at that resolution in operational timeframes

High Resolution Nesting

- Storm-following nest to provide high resolution of tropical cyclones
- Storm-centered regional, basin-scale regional, and global configurations supported
- Storm-centric regional configuration for operational system

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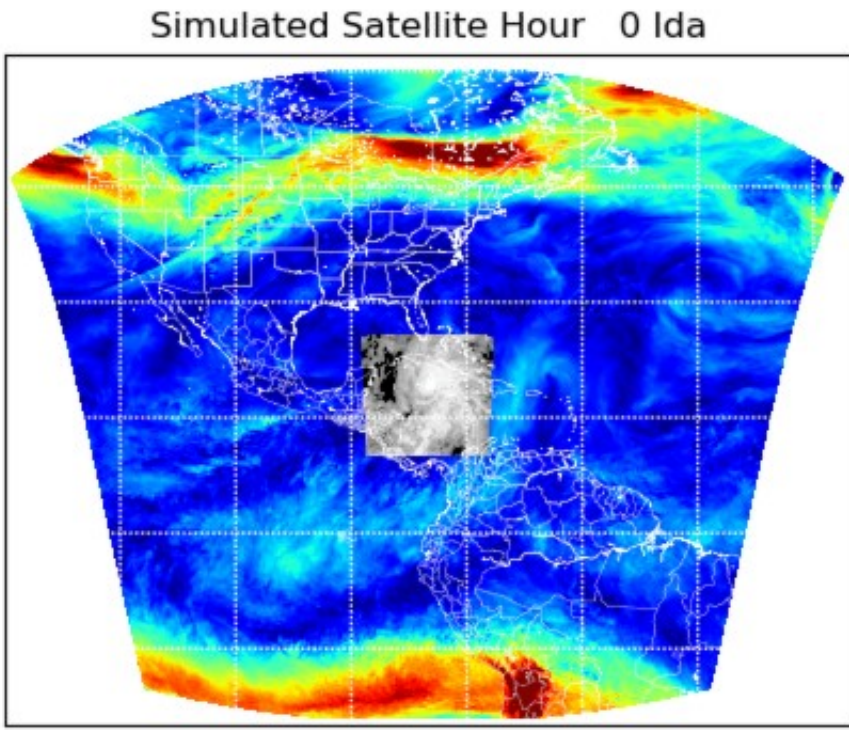
Moving Nest Implementa

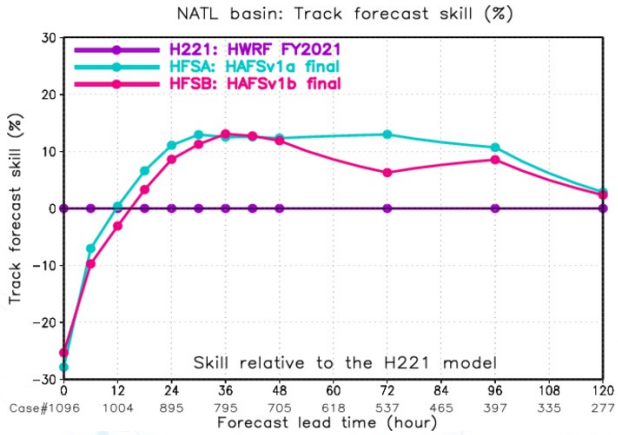
Development Accomplishments

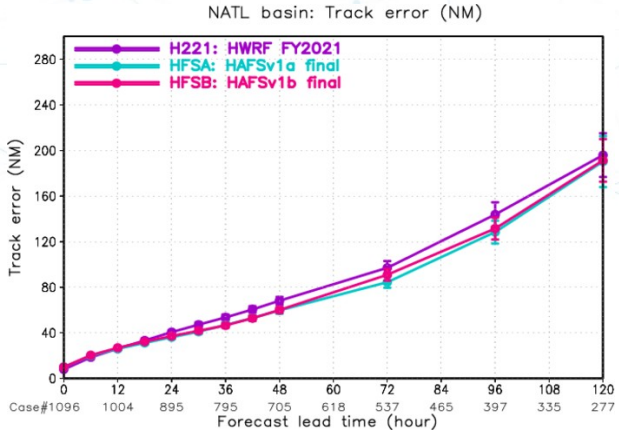
- Began running operationally for NOAA June 27
  - 6km regional parent
  - 2km moving nest
- Two configurations in operations
- Culmination of 4 years of development work



Moving Nest Features

- **Accurate**
  - Track 5-10% more accurate than HWRF
  - Max Wind Speed also 5-10% more accurate
- **Fast**
  - Runtime Overhead 3%-7% compared to static nest
  - Scales with forward motion of storm
  - HWRF overhead is ~15-20%
- **Robust**
  - 2020-2022 retrospective testing, stress tests
- **Configurable**
  - Enabled via namelist options





Verification diagrams courtesy of Bin Liu/EMC

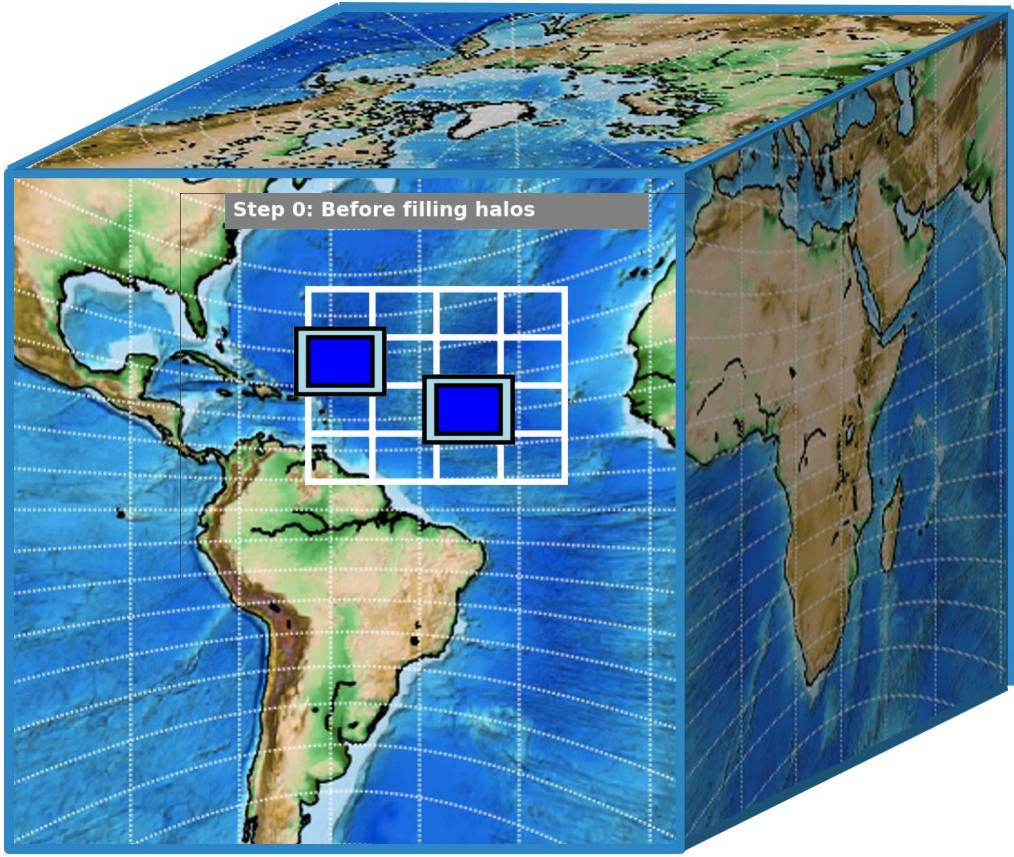
Implementation

Nesting Design

- Nest halo code used for downscaling and transmitting coarse resolution data
- Prognostic variables must all be moved
- Nest points are aligned with parent points
  - Enhanced efficiency
- Prognostic Variable Staggering
  - Mass and tracers are cell volume averages on A grid
  - Winds are staggered on D-grid

Model Variables

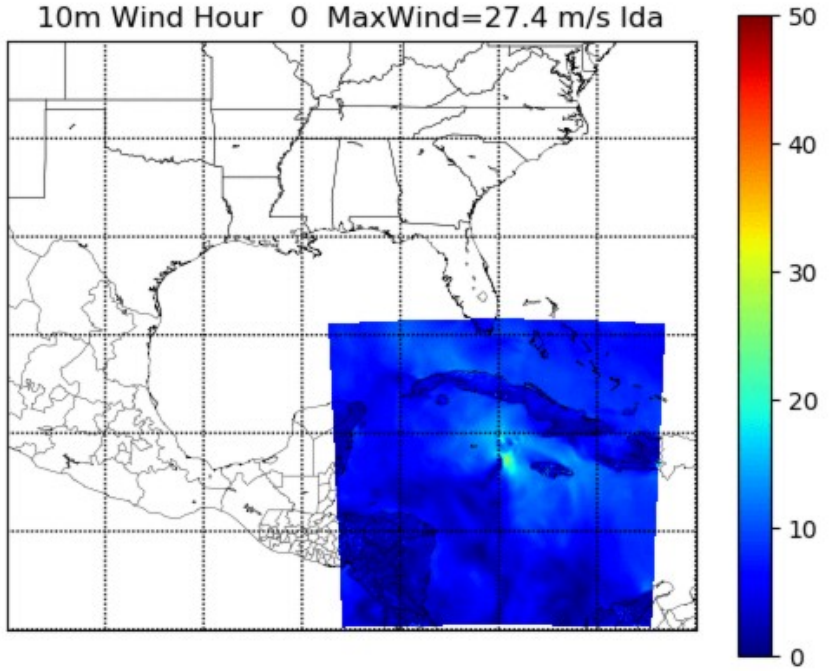
- Prognostic
  - T, delz, delp, u,v,w wind, humidity, tracers
- Physics
  - 56 separate variables in 1D vectors
- Static surface fields
  - High resolution
  - Nest resolution from files
- Grid distances, areas, Coriolis, etc.



Internal Tracker

- Internal tracker ported from HWRF based on GFDL tracker
- Center evaluated using 9 different variables

- Sea level pressure, 10m winds, vorticity
- 850mb wind, vorticity, geopotential
- 700mb wind, vorticity, geopotential



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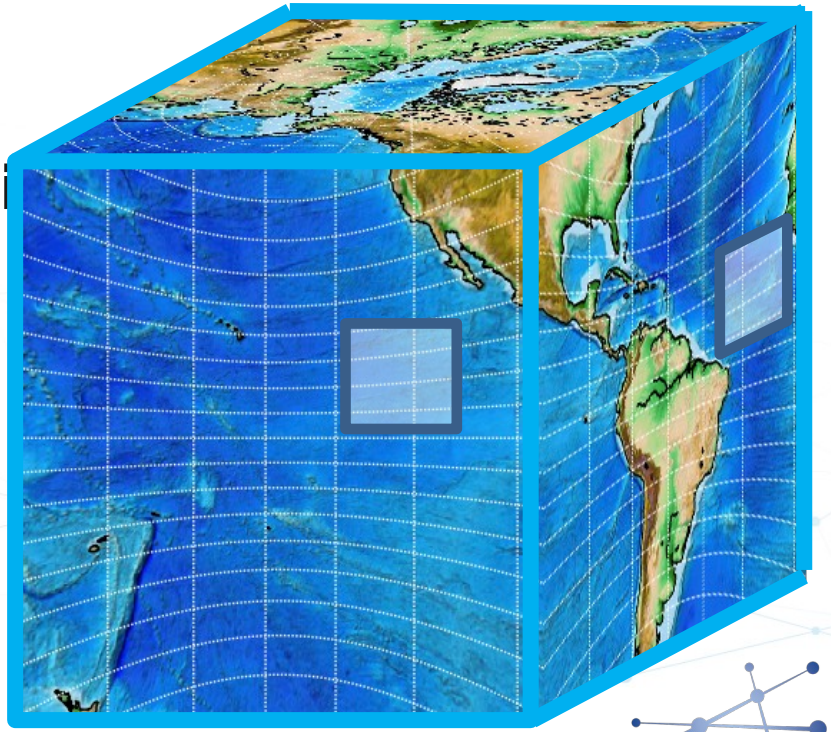
Multiple Moving Nest Desi



Multiple Moving Nests

- Regional, Basin, Global configurations
- Same parallelism as single moving nest
- Nests timestep concurrently with parent
- Nests aligned with parent grid
- Consider merging feedback when nest points overlap

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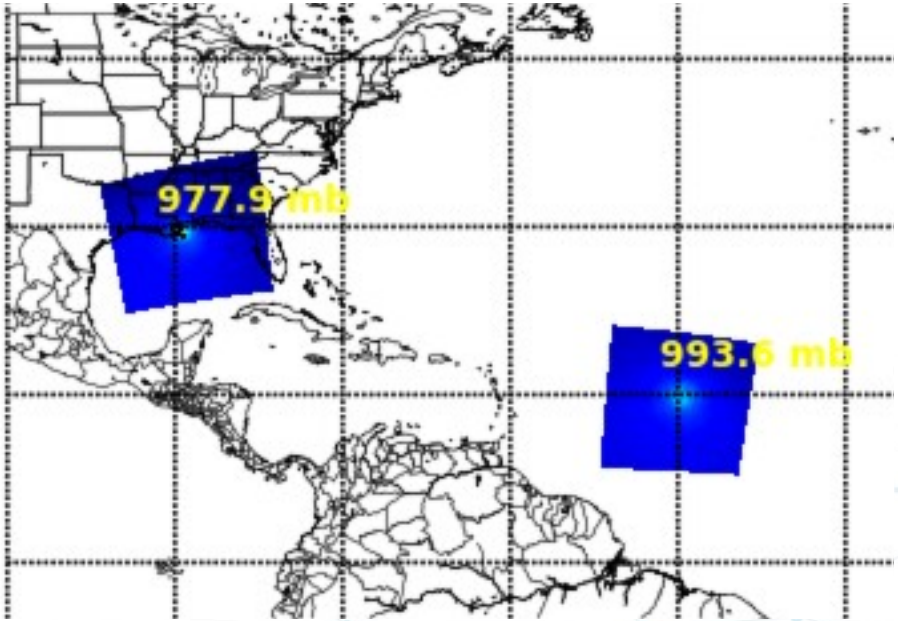
Multiple Moving Nests

- Dual nest cases now running
  - Coarse and high resolution
- Validation underway
- Nest Tests:
  - 3 moving nests
  - Overlapping nests
  - Mix Static & moving nests



Sally and Teddy, Sept. 2020

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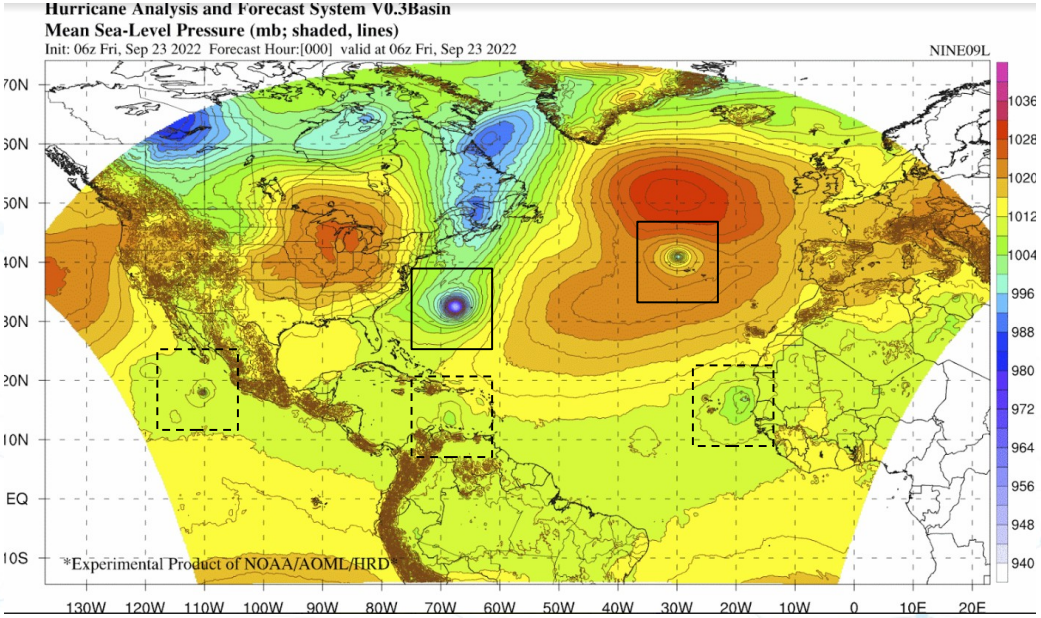
HAFS-Basin

- Successor to Basin-Scale HWRF
- Multiple nested domains
- Permits cycled data assimilation
- Goal is to cover NHC AOR

- Better capture storm-storm interactions



HAFS-Basin diagram courtesy of Gus Alaka, NOAA/HRD

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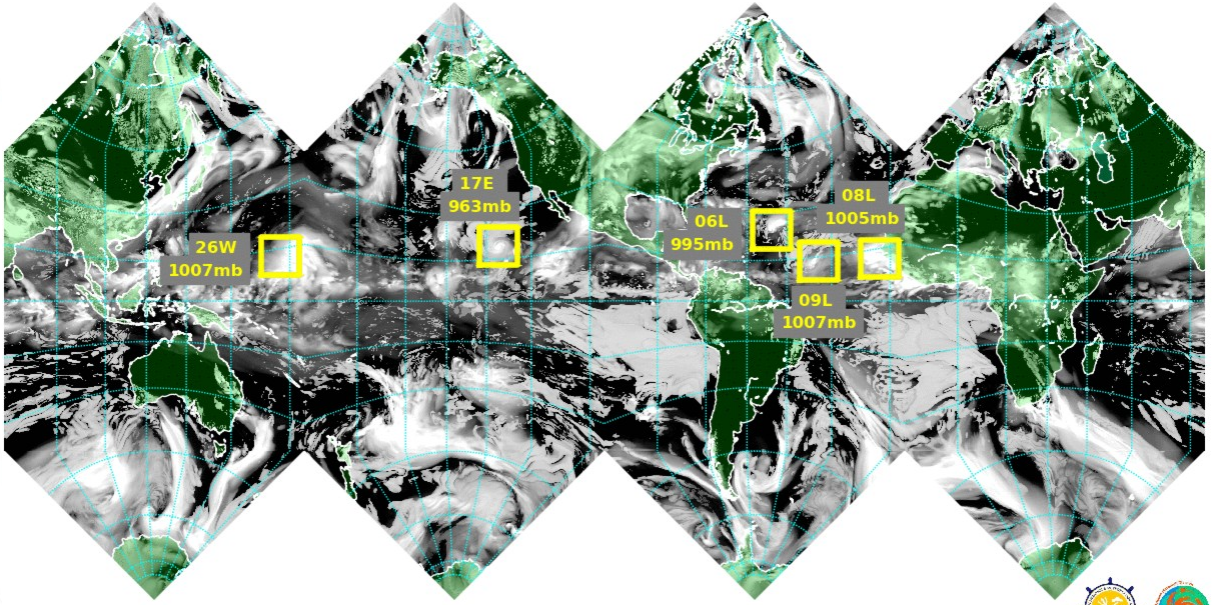
HAFS Roadmap – 2023 Season and Future

Accomplished

- Storm-centered
- Operational 2023
- Two configurations

Long Term

- Basin-scale
- Multi Storm
- Refinement Ratios
- Global



NOAA AOML/HRD

Questions?

AOML Hurricane Model Viewer
https://storm.aoml.noaa.gov

AOML's Hurricane Modeling and Prediction Program
https://www.aoml.noaa.gov/hurricane-modeling-prediction/

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Extra Slides

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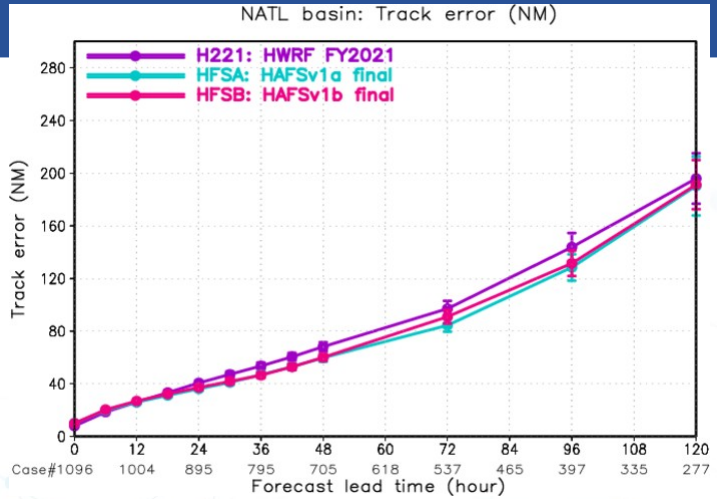
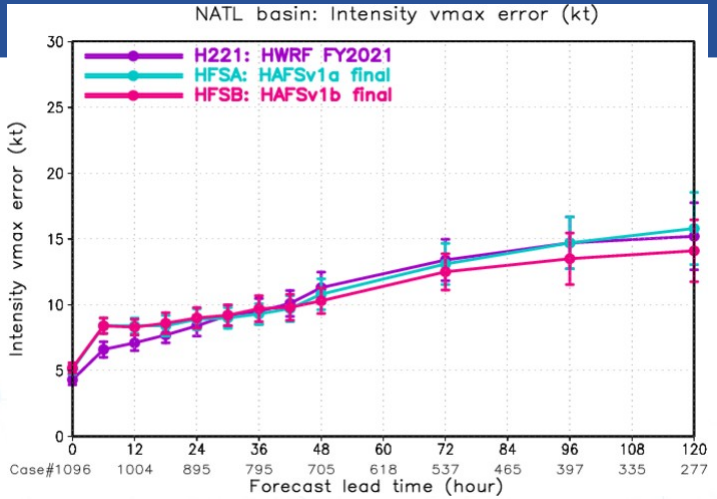

NATL basin: Track error (NM)
H221: HWRF FY2021
HFSA: HAFSv1a final
HFSB: HAFSv1b final
Track error (NM)
Case#1096 1004 895 795 705 618 537 465 397 335 277
Forecast lead time (hour)


NATL basin: Intensity vmax error (kt)
H221: HWRF FY2021
HFSA: HAFSv1a final
HFSB: HAFSv1b final
Intensity vmax error (kt)
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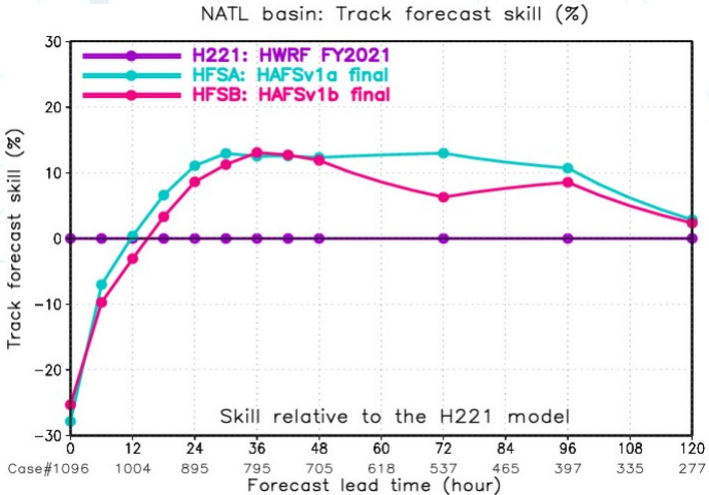
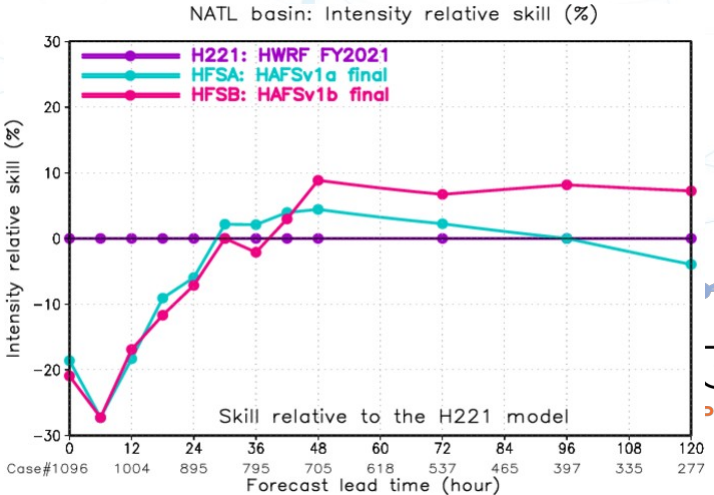

NATL basin: Track forecast skill (%)
H221: HWRF FY2021
HFSA: HAFSv1a final
HFSB: HAFSv1b final
Track forecast skill (%)
Skill relative to the H221 model
Case#1096 1004 895 795 705 618 537 465 397 335 277
Forecast lead time (hour)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