Developing Hurricane Analysis and Forecast System: Initial Operational Capabilities and Future Priorities

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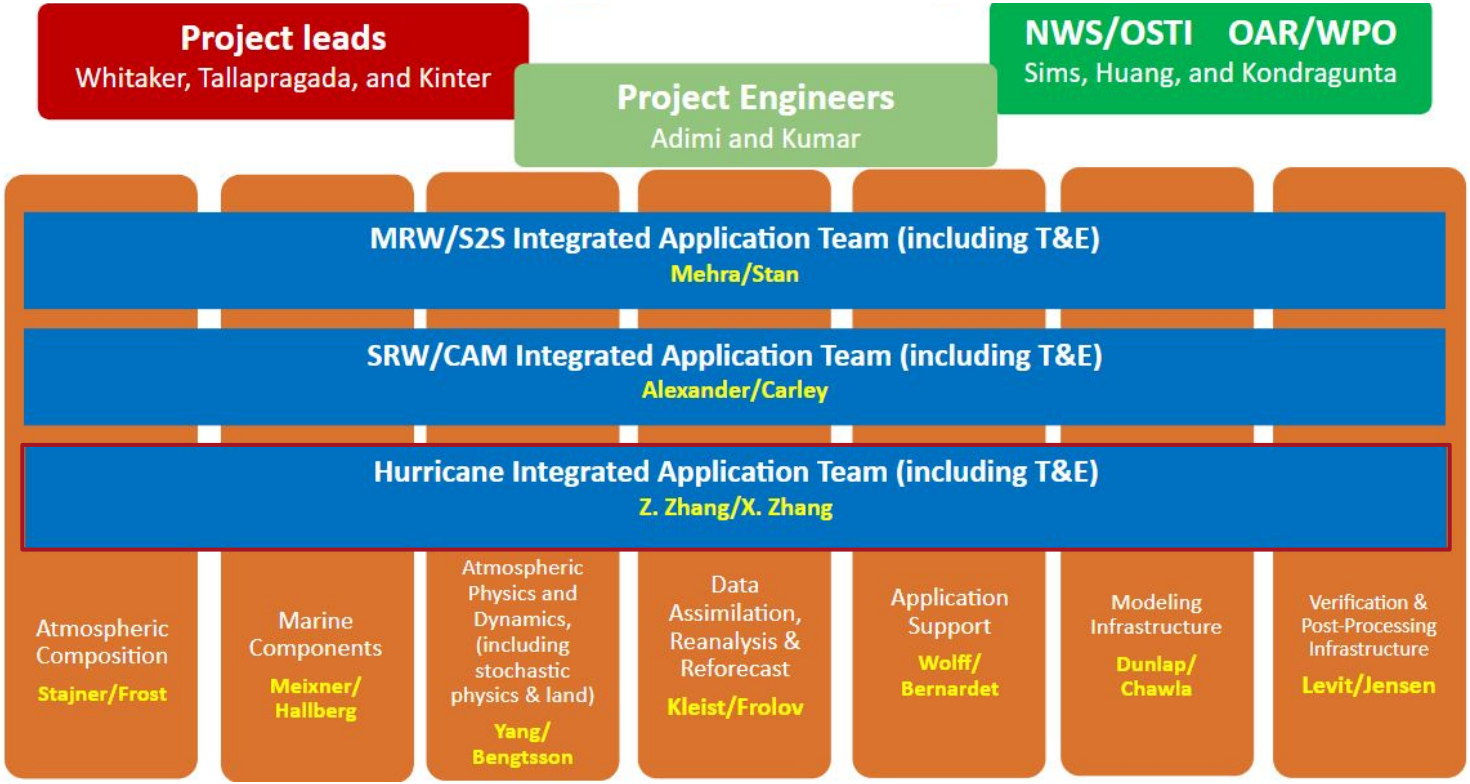
Background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Hurricane Integrated Application Team (including T&E)
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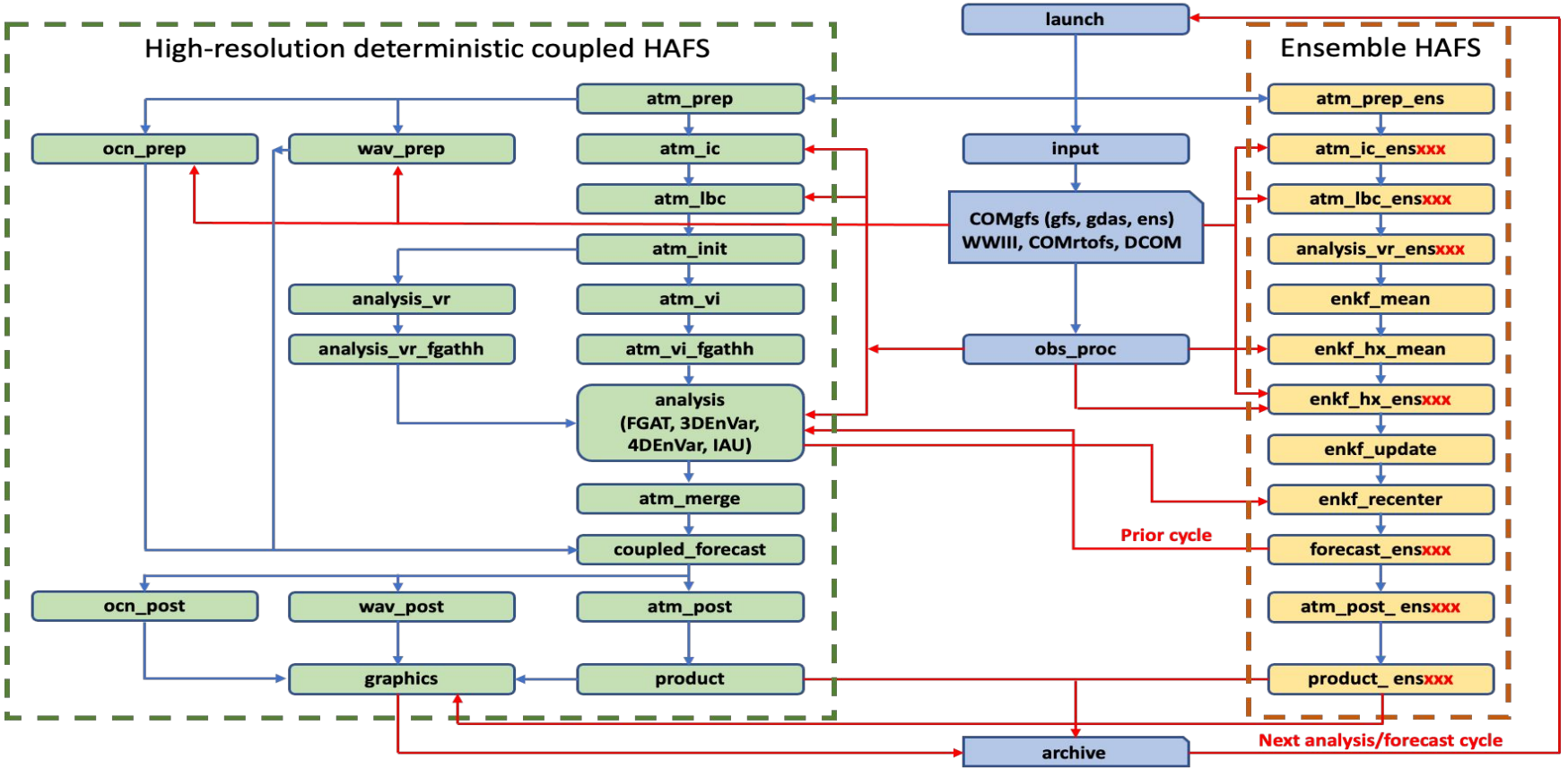
Marine Components
Meixner/ Hallberg
Atmospheric Physics and Dynamics, (including stochastic physics & land)
Yang/ Bengtsson
Data Assimilation, Reanalysis & Reforecast
Kleist/Frolov
Application Support
Wolff/ Bernardet
Modeling Infrastructure
Dunlap/ Chawla
Verification & Post-Processing Infrastructure
Levit/Jensen

HAFS Overview



Adopted from Bin Liu's workflow

HAFS Current Status

Workflow

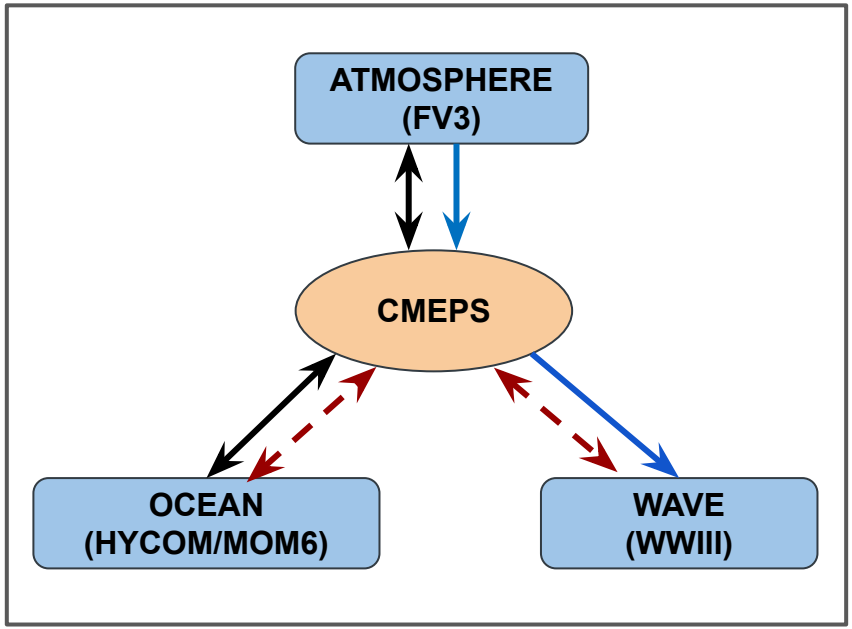
- Configurable moving nest capability
- Optional vortex initialization
- Configurable storm-region and/or entire domain data assimilation
- Post-process both parent and nest domain
- Research and forecast products

Moving nest

- Storm following nest
- Full physics nest motion
- Auto storm tracking
- Namelist option for moving nest
- Optimized running moving nest

Ocean/Wave coupling with moving nest

- HYCOM ocean coupling with HAFS parent
- Downscale HAFS parent SST for nest domain
- One-way coupling with WW3: generate HAFS/wave IC/BC from GFS/wave



HAFS Current Status

Utilities for DA and VI

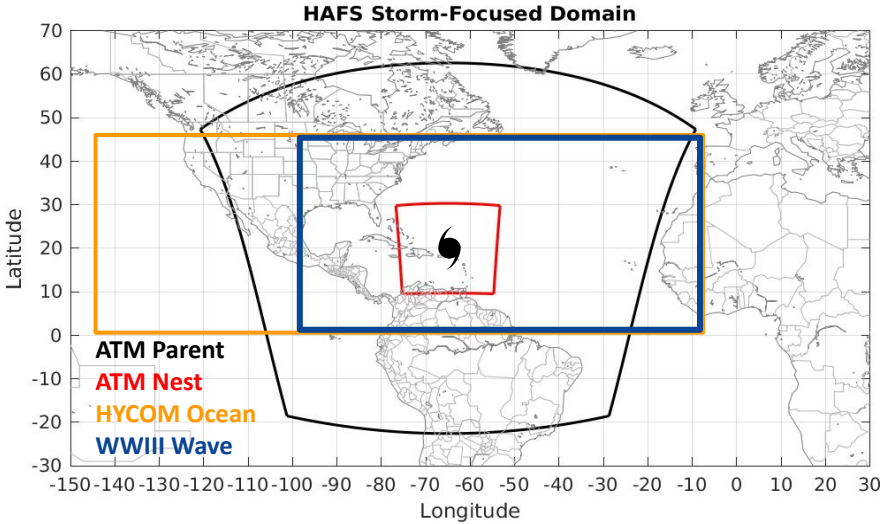
- Interpolating/remapping functions
- Merging domains
- Interface to Data Assimilation
- Vortex consistency
- First Guess at Appropriate Time (FGAT)

Infrastructure

- WriteGrid component for multiple domains
- FMS support telescopic & multiple nests

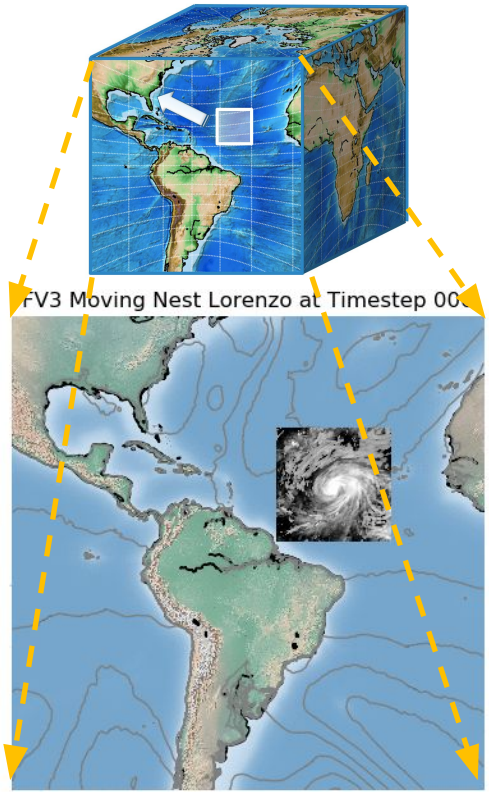
Data Assimilation

- Storm-region inner-core DA
- DA cycling for entire parent domain for the coarser res. (~6km)
- 3DEnVAR with GDAS (or HAFS ensemble)
- Additional obs. Assimilated
  - Tail Doppler Radar (TDR)
  - Next Generation Weather Radar (NEXRAD)
  - Drifting corrected Dropsondes
  - Metar observations
  - GOES-16 AMVs
  - Test CIMSS Rapid scan winds



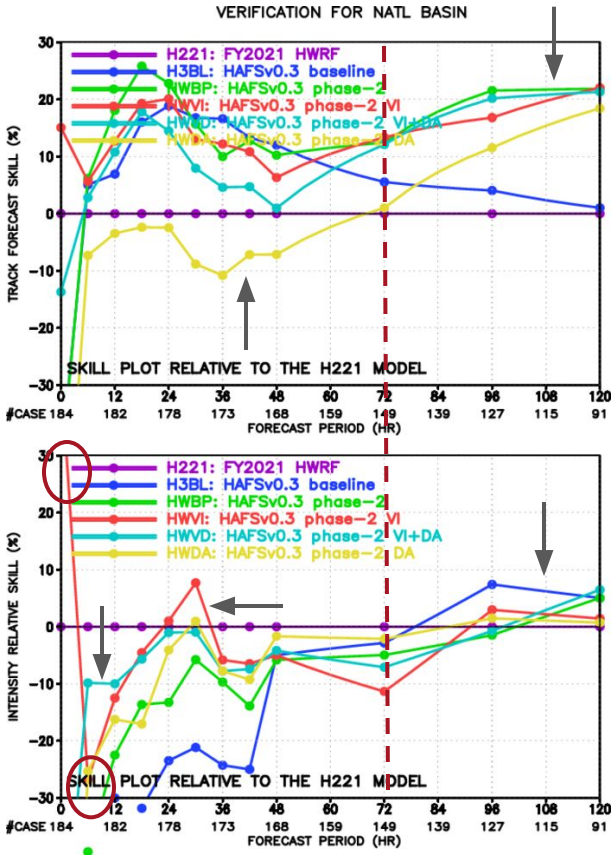
HAFS Development Priorities: before IOC

- **Merge HAFS developments back to ufs-weather-model**
  - Moving nest related developments
  - Static and moving nest coupling
  - WriteGrid component support for moving nest
  - Merge GSI FGAT capability back to GSI master
- **Workflow**
  - MET-TC based verification package into workflow
  - Optimized workflow
- **Science Evaluation**
  - T&E for each of new components and configurations
- **Real-time HFIP demo**
  - T&E for each of new components, configurations and other basins
- **Physics optimization in current suite**
- **HAFS Pre-processing**
  - Generate a regional ESG grids for moving nest configuration
  - Generate IC for regional ESG parent and nest
  - Optimize ICs for Ocean and Waves

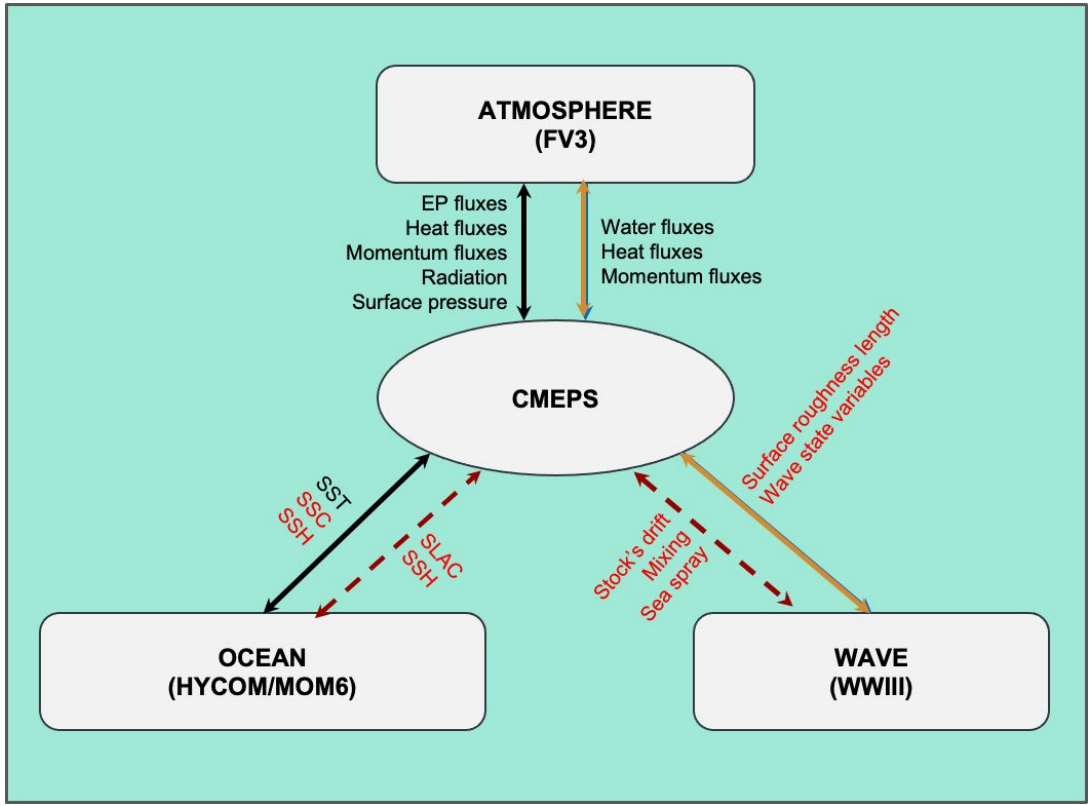


HAFS Development Priorities: after IOC

- **Moving nest**
  - Multiple storms
  - Flexible nesting refinement
- **Data assimilation**
  - New data ingestion including all-sky radiance
  - 4DEnVar
  - Atmosphere/Ocean coupled DA
  - Multi-scale DA
  - JEDI infrastructure
  - JEDI transition
- **Physics evaluation, transition & development**
  - PBL for TC application
  - NOAH-MP evaluation
  - saSAS upgrade, transition, & evaluation
  - Microphysics parameterization upgrade
- **Ocean model transition**
  - Develop MOM6
  - Prepare HYCOM to MOM6 transition



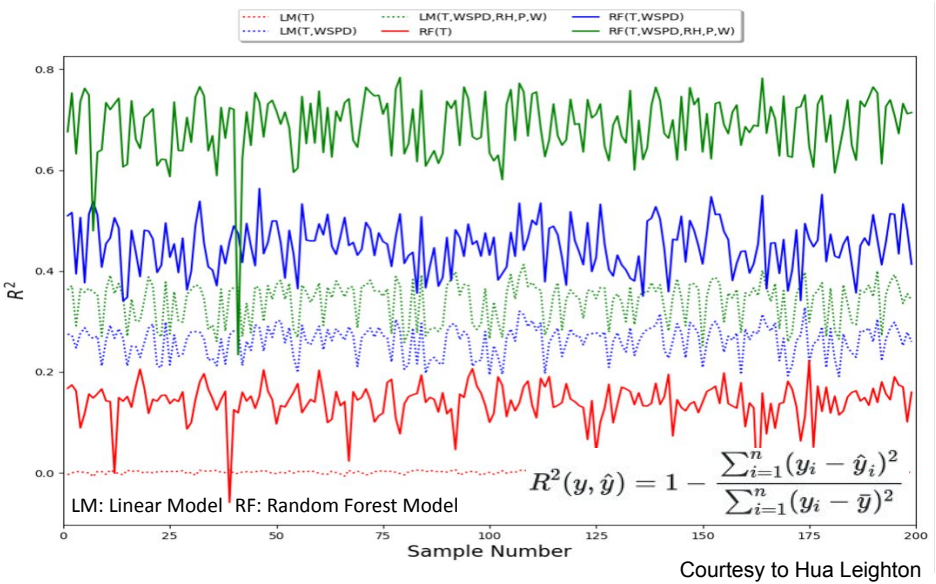
HAFS Development Priorities: Future Coupling



HAFS Development Priorities: future challenges or innovation

- **Moving nest**
  - Global moving nest
- **Data assimilation**
  - Efficiency vs. accuracy
  - Computer technology advancement
  - Atmosphere/Ocean coupled DA: strongly vs. weakly
  - All-sky radiance: CRTM vs. RRTMG
  - New DA methodology: scale-aware, particle filter, etc.
  - DA and physics parameterizations
- **Observations**
  - New observations
  - Observation strategy
- **Products**
  - Ensemble products
  - Product fidelities

- **Physics**
  - AI and physics parameterizations
  - Sub-kilometer physics
  - Physics interactions



Courtesy to Hua Leighton

Summary

- HAFS is ready for 2022 hurricane season real-time HFIP demo
- HAFS is aiming to initial operational implementation in 2023 hurricane season
- HAFS development and operational implementation will prioritize the following aspects:
  - Moving nest refinement
  - Multiple moving nests
  - New DA methodologies and data
  - New physics for high-resolution
  - Synchronize development to NOAA's Unified Forecast System (UFS)

Dare to rethink! Dare to be innovative! Dare to be wrong!