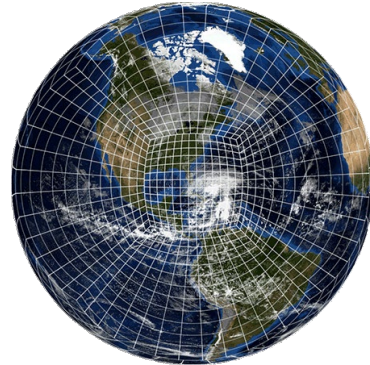




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# EMC Implementations



***NOAA Production Suite Review  
November 19, 2019***



# EMC Completed Model Upgrades

- Because of phase 1&2 WCOSS CY19 moratorium, only GFS and HYSPLIT were implemented to operations during CY19.

Model version#	Implementation date
RTMA/URMA v2.7	12/4/18
AQM (CMAQ) v5.1	12/18/18
GFS/GDAS v15.1	6/12/19
HYSPLIT v7.5	6/12/19
GFS/GDAS v15.2	11/7/19



# EMC Model Upgrades for FY20/21

Model version#	Implementation Date
GFS/GDAS v15.2	11/7/19, implemented
NWPS v1.3	Feb 2020, planned*
RTMA/URMA v2.8	Mar 2020, planned*
RAP/HRRR v5/v4	June 2020, planned*
HWRF v13	June 2020, planned*
HMON v3	June 2020, planned*
RTOFS Global v2	July 2020, planned*
HREF v3	July 2020, planned*
GEFS v12 (unified with NGAC & GWES)	Aug 2020, planned*
AQM (CMAQ) v6	Dec 2020, planned*
GFS/GDAS v16 (unified with GWM)	Feb 2021, planned*



# Implementation Planning

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- Currently in partial implementation moratorium due to hardware upgrade on current WCOSS system
  - Due to end Jan 22, 2020
- Current 10 year WCOSS contract ends in February 2022 and there will be a 12-month moratorium to transition to the new supercomputers starting in February 1, 2021
- Roughly 12 months to implement models between moratoriums
- Based on NCO staffing, only 23 implementation slots for 25 model upgrades requested



# 25 Requested Upgrades



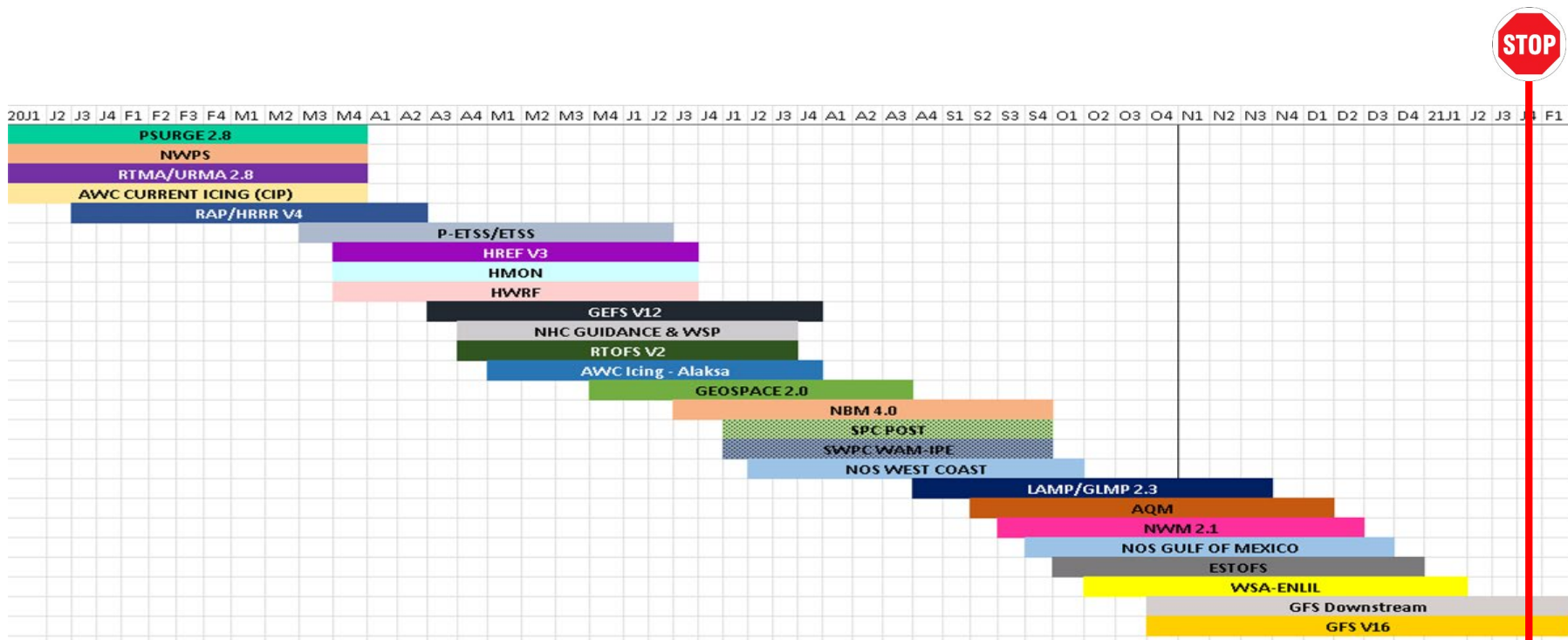
- PSURGE
- Near Shore Wave Prediction (NWPS)
- RTMA/URMA 2.8
- RAP/HRRR v4
- Air Quality Model (AQM)
- AWC Current Icing (CIP)
- Probabilistic/Deterministic Extra Tropical Storm Surge (P-ETSS/ETSS)
- HMON
- HWRF
- Global Ensemble (GEFS) v12
- NHC Guidance and Wind Speed
- RTOFS
- AWC Icing – Alaska (IPA)\*\*
- HREF v3
- GEOSPACE v2.0
- National Blend of Models (NBM) v4.0
- SPC Post Processing
- SWPC WAM-IPE\*\*
- NOS West Coast OFS
- LAMP/GLMP v2.3
- National Water Model v2.1
- NOS Gulf of Mexico OFS
- ESTOFS
- WSA-ENLIL
- GFS V16

\*\*Indicates New Model





# Model Code Delivery Dates





# Next Steps

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- MDC will prioritize model upgrades
- NCO will develop the implementation plan based on prioritization, code delivery dates, and staffing levels

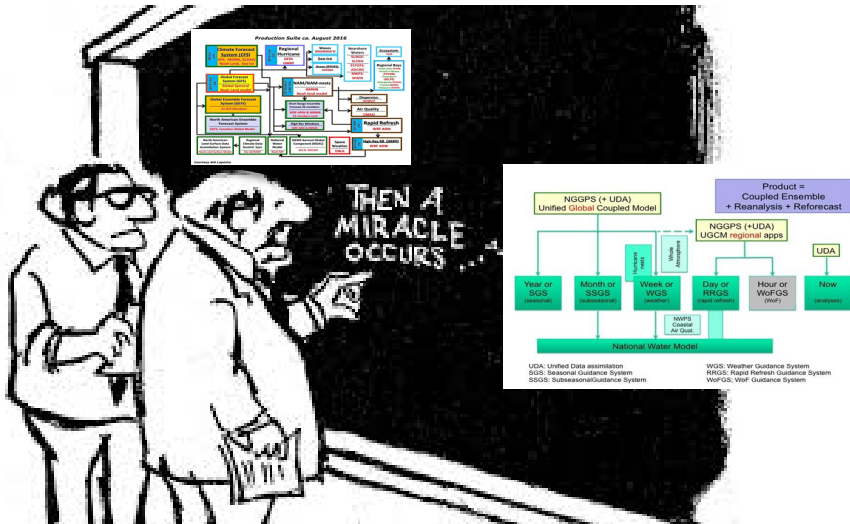


# Stopping legacy systems

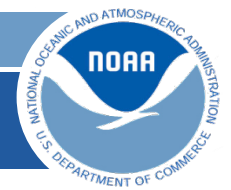


- Decisions within the UFS are based on evidence. This is the standard used to decide when to turn off legacy Operational modeling systems.
- Process for turning off a legacy system, based on NWS Governance:
  - Field Office (e.g., EMC) identifies system to discontinue
  - FMC Director (e.g., NCEP Director) approves
  - Request submitted by FMC Director into CaRDS process
    - For model “upgrades”, the request goes directly to the AFS Director for Review
  - Request submitted to Mission Delivery Council for approval
  - Disseminate SCN for 6-month comment period (Major Change)

# Transition of NCEP Production Suite to Unified Forecast System Applications



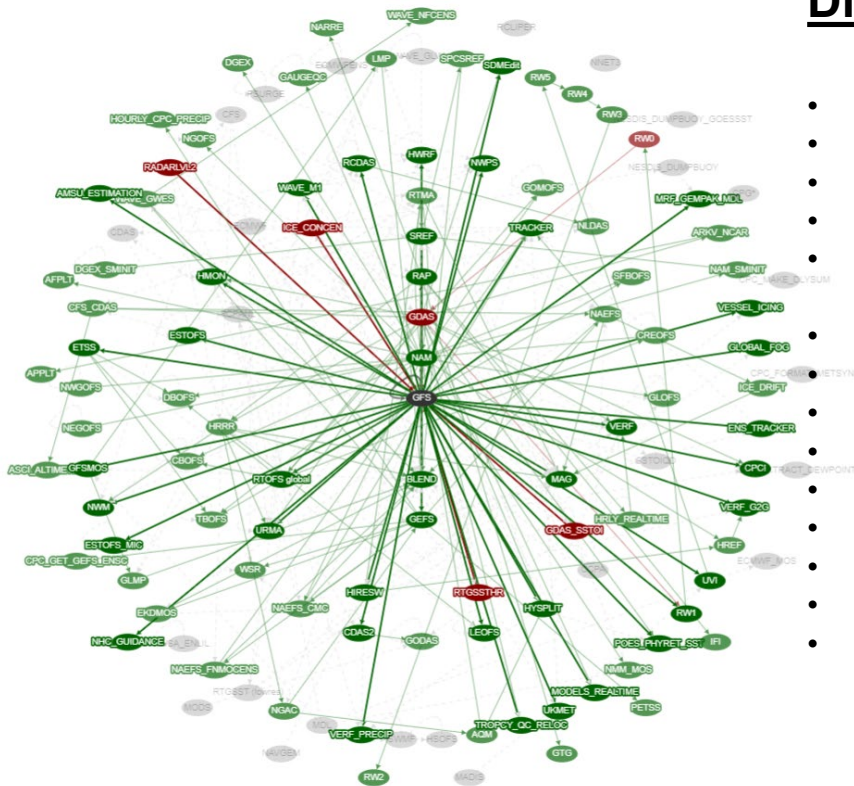


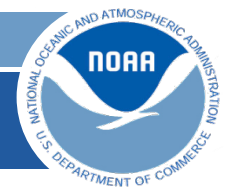


# Current State of NCEP Production Suite

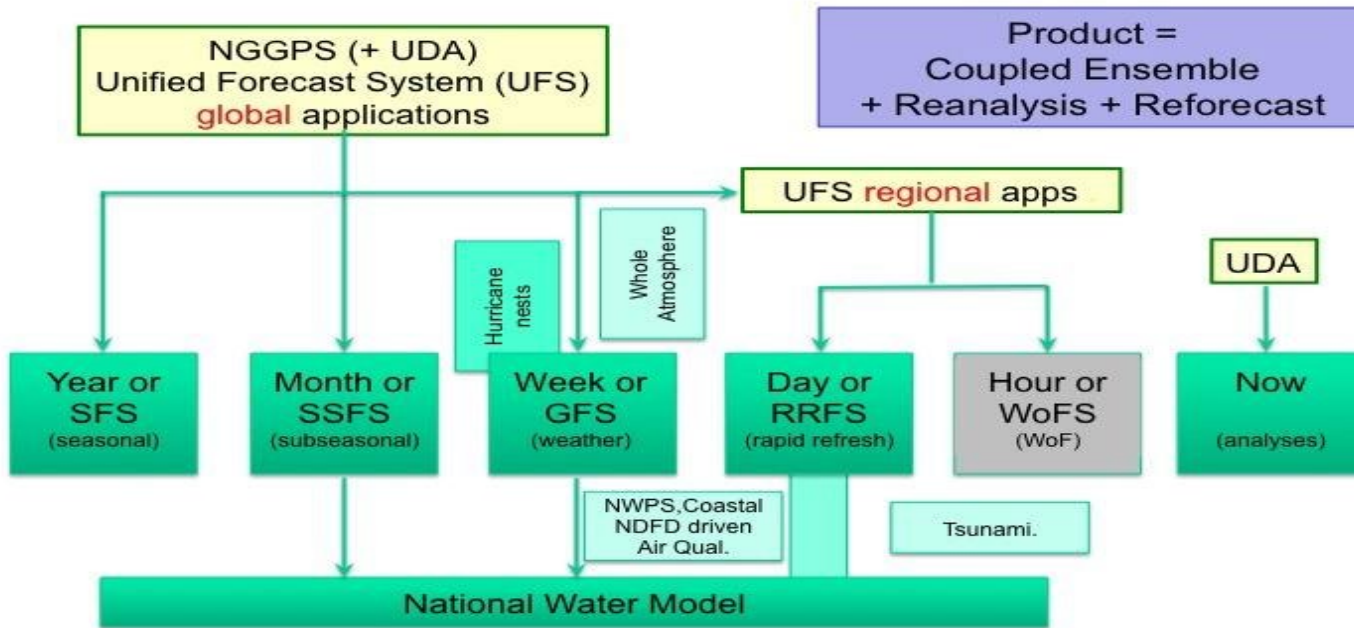
## Distinct Modeling Systems of NPS:

- **NAM Nests: High-Resolution NMMB Nests (84 hrs)**
- **NWPS: SWAN Near Shore Wave Prediction System**
- **NGAC: Global Spectral Model for Aerosols (5 days)**
- **NLDAS: Regional Land Data Assimilation System**
- **NAEFS: North American Ensemble Forecast System (GEFS+Canadian Ensembles)**
- **NWM: WRF Hydro for Water Prediction (5 days)**
- **RTMA/URMA: Regional Mesoscale Analysis**
- **RTOFS: HyCOM Global Ocean Model (5 days)**
- **SREF: Short Range Ensemble with WRF ARW, NMMB (84 hrs)**
- **Waves: Global multigrid WaveWatch III Model (10 days)**
- **Wave Ensembles: Global WaveWatch III Ensembles (10 days)**
- **Great Lakes: WaveWatch III for great lakes (10 days)**
- **Space Weather: Global Spectral Whole Atmosphere Model**
- **Space Weather: WSA EnLil Solar Wind Prediction Model**



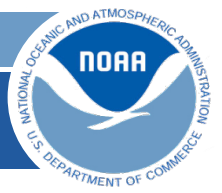


# NPS Transitioning to UFS Applications

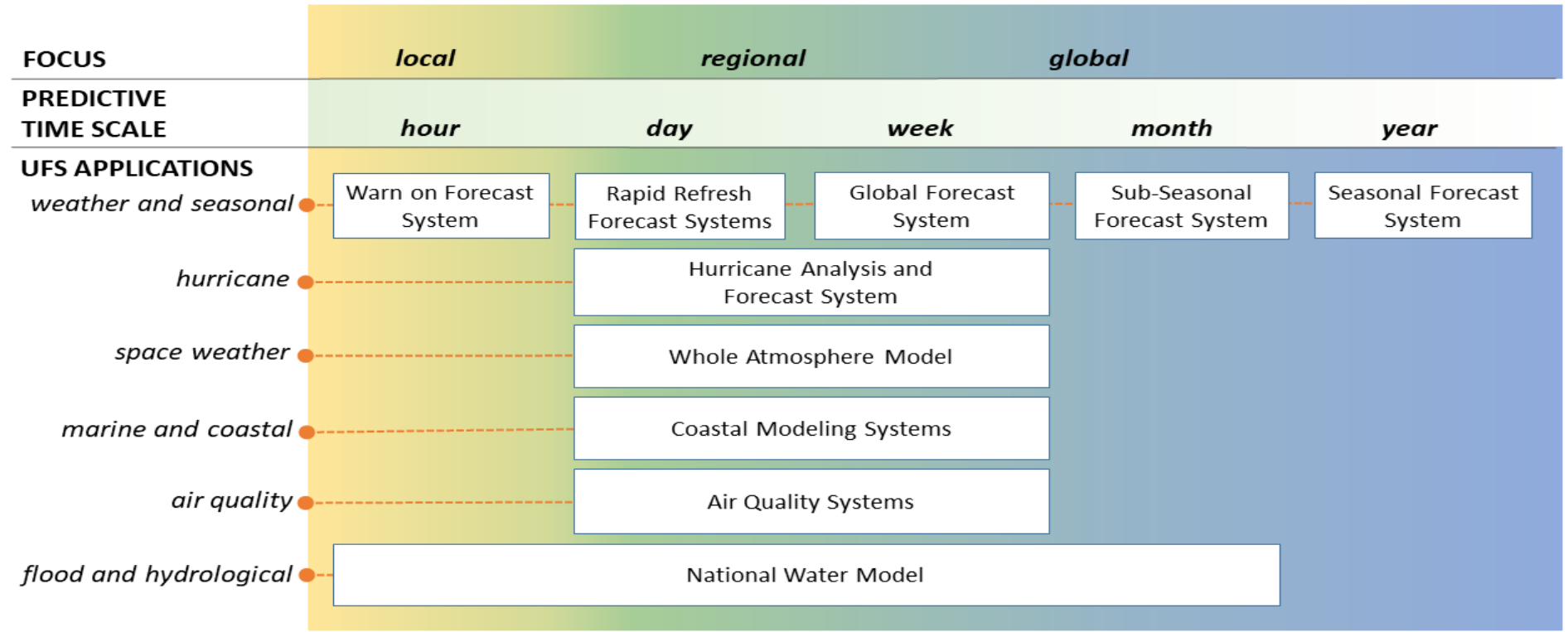


UDA: Unified Data assimilation  
SFS: Seasonal Forecast System  
SSFS: Subseasonal Forecast System

GFS: Weather Forecast System  
RRFS: Rapid Refresh Forecast System  
WoFS; Warn on Forecast System



# NPS Transitioning to UFS Applications

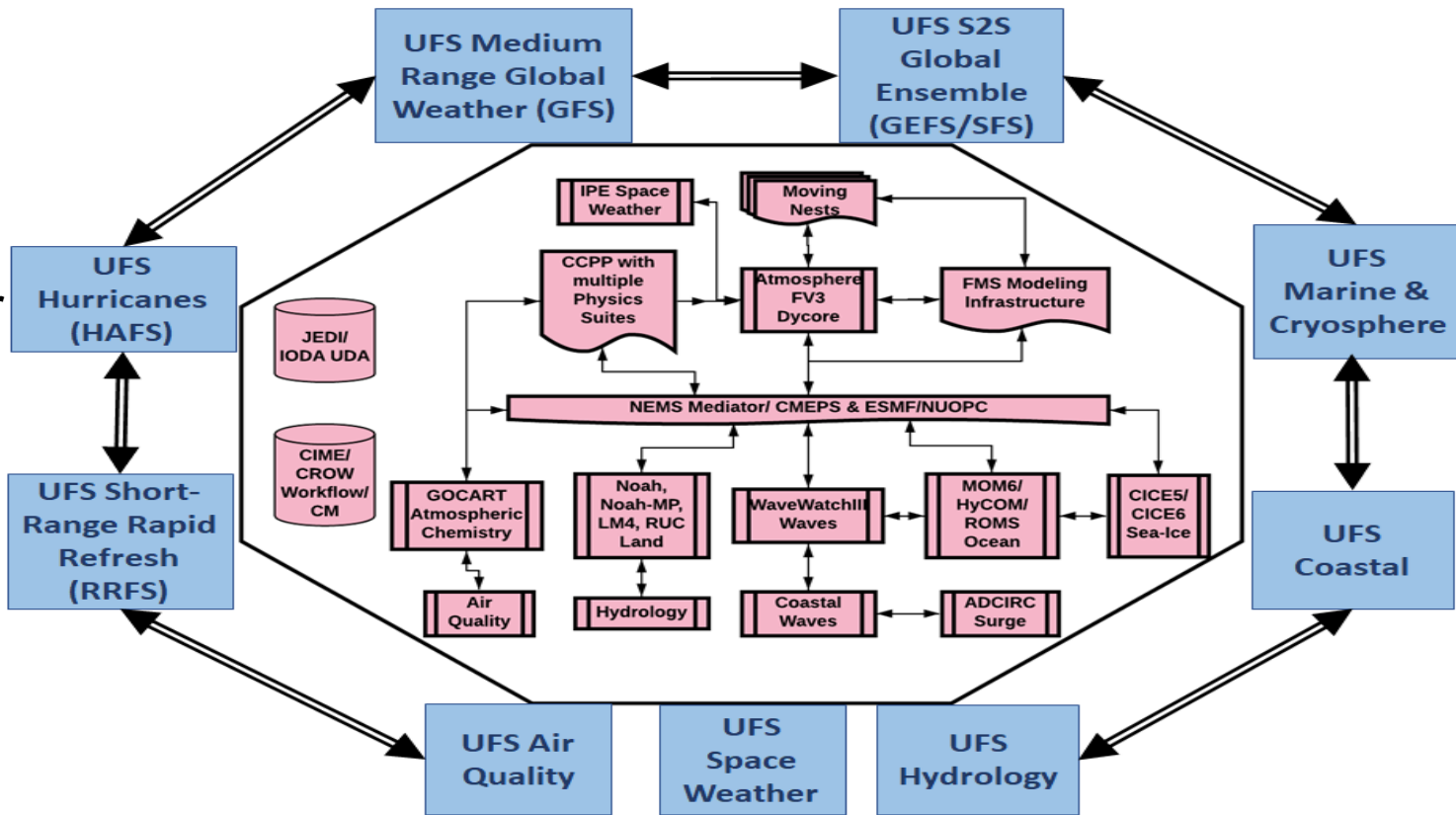




# NPS Transitioning to UFS Applications

“UFS is configurable into multiple applications that span local to global domains and predictive time scales from less than an hour to more than a year.”

Conceptual UFS applications in production covering all NPS applications, maintaining the dependencies between the applications and products.



# Shared Community Infrastructure Support for UFS Development

## Infrastructure for data assimilation:

Joint Effort for Data assimilation Integration  
(**JEDI**)

## Infrastructure for coupling models together:

- NOAA Environmental Modeling System (**NEMS**) coupler
- based on the Earth System Modeling Framework (**ESMF**)
- using National Unified Operational Prediction Capability (**NUOPC**) conventions

## Infrastructure for interoperable physics:

- Common Community Physics Package (**CCPP**) framework

## Infrastructure for Code Management:

- Git based repositories with Gitflow

### 1. Coupling components

New ESMF/NUOPC mediator (CMEPS/NEMS)

### 2. Interoperable atmospheric physics

CCPP & CPF frameworks

### 3. Community-friendly workflow

CIME - CROW unification, CIME Case Control System

### 4. Hierarchical model development capabilities

Extensions of CIME data models, unit, & system testing

### 5. Forecast Verification: Comparison to Observations

Extension of MET+

### 6. Software Repository Management

NCAR manage\_externals tool

### 7. User / Developer Support

DTC and CESM Capabilities

**NOAA-NCAR MoA Work Areas**



## Filling in the “Miracle” (a bit)

- **Plans for moving from current “Quilt/Ferris Wheel” to UFS Applications**
- **Some plans are firm (through FY 2021), some are targets**
- **Targets are operational cycles that can be influenced by UFS and EPIC activities**
- **Evidence-based decision making**



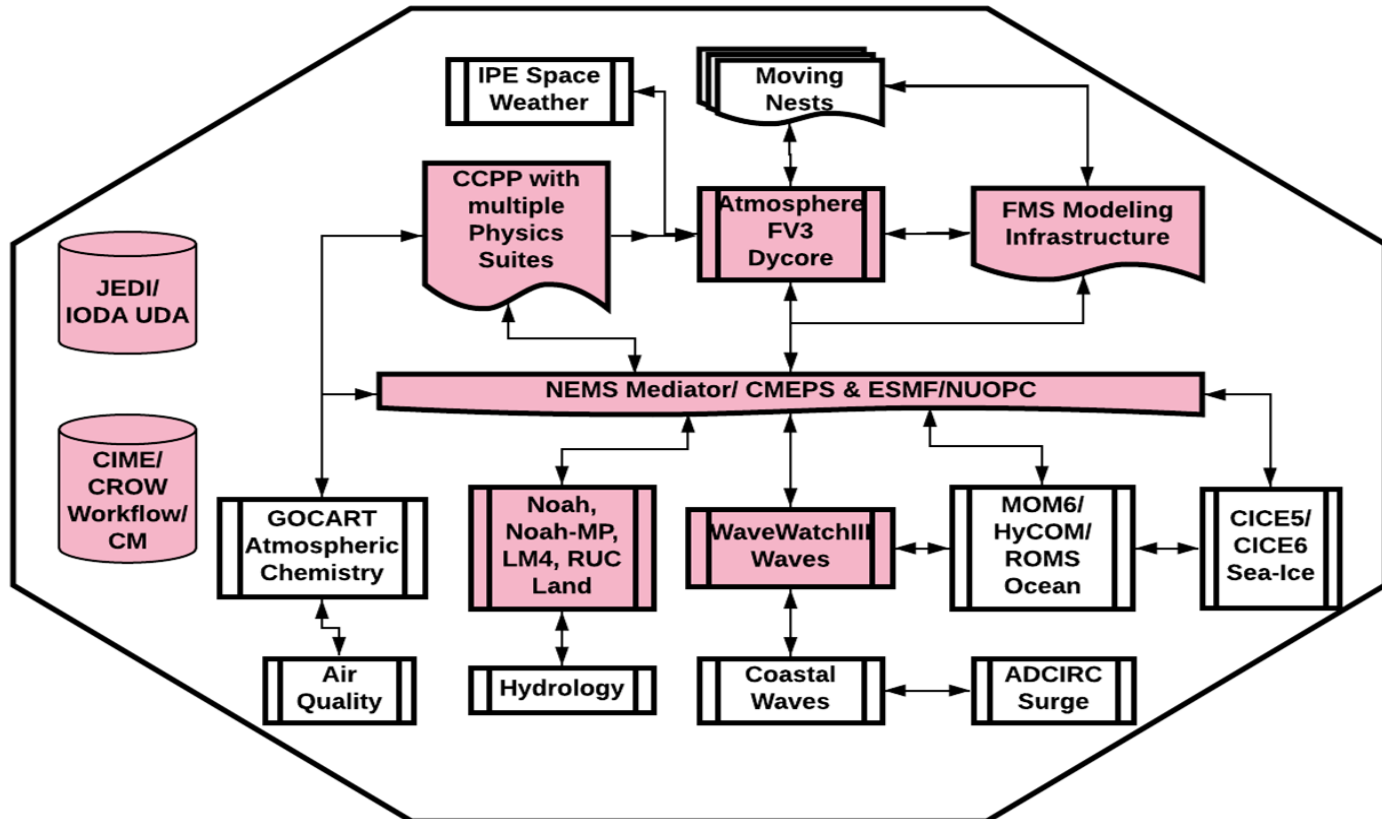
# UFS Medium Range Application (GFS)

## FY19: GFSv15.1

## FY21: GFSv16

- 64 → 127 levels, raise model top from 54km to 80km
- New advection algorithms from GFDL
- Advanced physics chosen from Physics Test Plan
- Two-way interactive coupling to WaveWatchIII
- Data Assimilation Upgrades

**Combines GFS, GDAS and Global Wave Models**





# UFS Sub-Seasonal Application (GEFS)

## FY20: GEFSv12

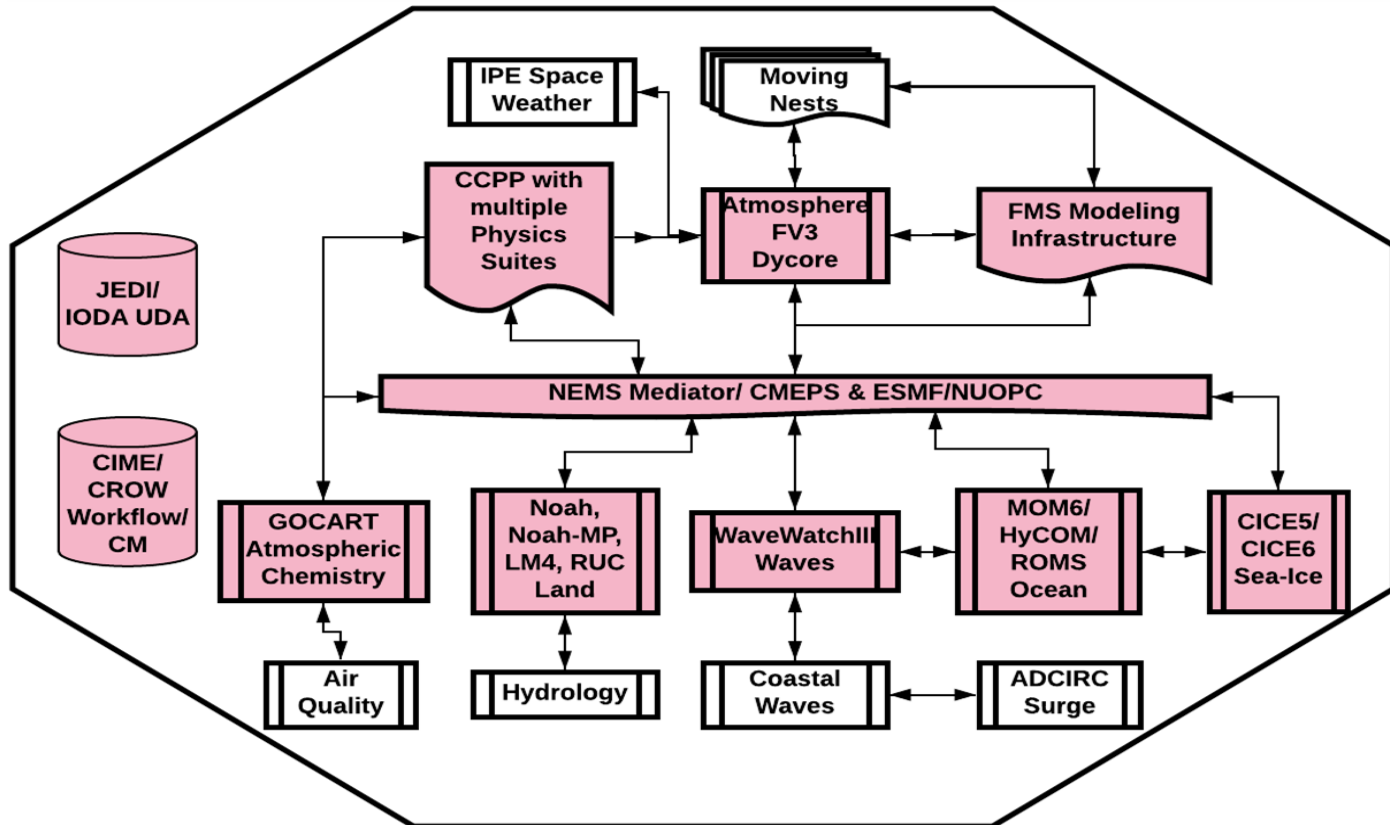
- 20 year (1999-2018) reanalysis & 30 year (1989-2018) reforecast
- FV3 Dynamic Core, C384L64 (~25km)
- 31 members, 16-day forecasts 4 cycles/day
- Extension to 35 days forecasts
- GFSv15 Physics + Advanced stochastic physics
- Uncoupled (NSST + 2-Tier SST)

## FY24: GEFSv13 + GFS v17

- FV3+MOM6+CICE5+WWW3+GOC ART Coupled Model

Coupled System for Medium Range to Sub-Seasonal Scales, Weakly Coupled DA, Coupled Reanalysis and Reforecasts

Combines GFS, GDAS, GEFS, SREF, NAM, RAP, RTOFS, Global Wave Ensembles, Global Aerosols





# UFS Seasonal Application (SFS/CFS)

## FY19:

- Benchmark 1 FV3+MOM6+CICE5 with CFSR ICs **completed**
- Benchmark 2: FV3GFS+MOM6+CICE5 with ocean ICs from 3DVAR **completed**

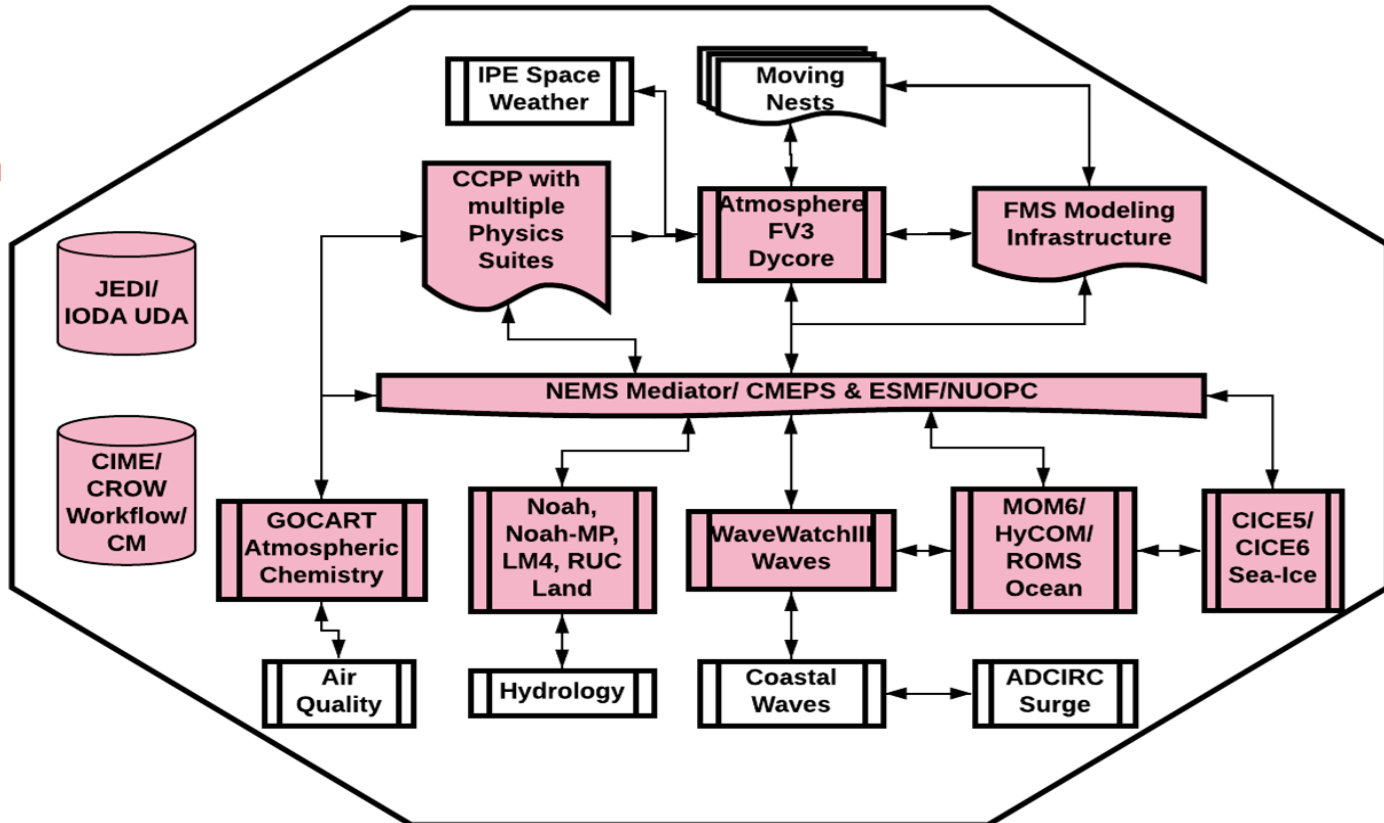
## FY20-21:

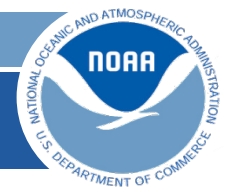
- Benchmark 3: Benchmark 2 but with CPC ice analysis
- Benchmark 4: FV3GFS+MOM6+CICE5+WW3
- Benchmark 5: Benchmark 4 but with Fractional Masks
- Benchmark 6: FV3GFS+MOM6+CICE5+WW3 (weakly coupled, initialized w/marine JEDI)
- Benchmark 7: Physics Tuning Experiments +GOCART+Land

FY22-23: Coupled System Sub-seasonal Reanalysis and Reforecasts

FY24: SFSv1/CFSv3

Fully Coupled System for Seasonal Scales, Weakly Coupled DA





# UFS Hurricane Application (HAFS)

## FY19-20: HAFS Experimental Configurations (FY19/20)

- HAFS 0.A: The NATL basin focused standalone regional domain configuration
- HAFS 0.B: The NATL basin focused global-nesting domain configuration

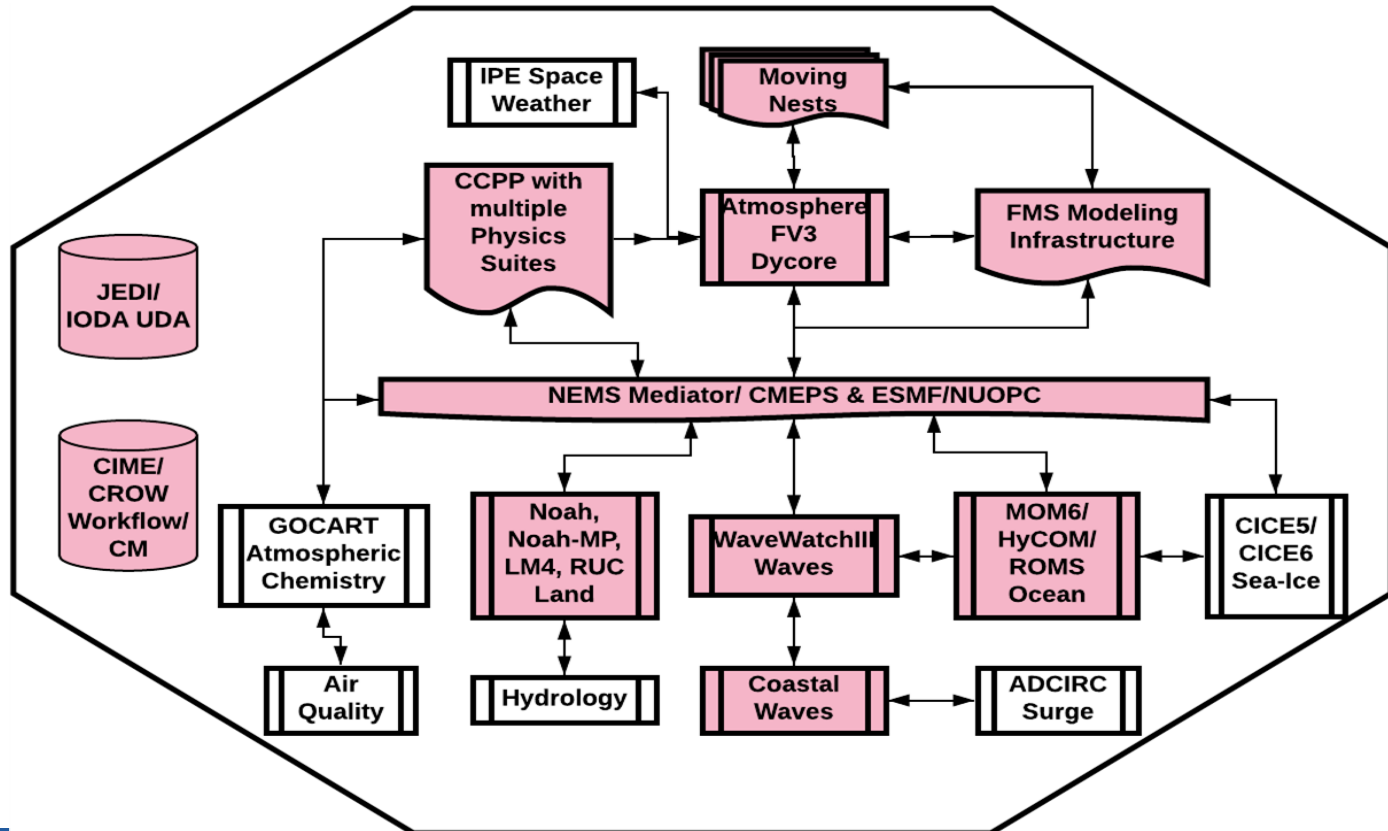
## FY22: HAFSv1 (Regional)

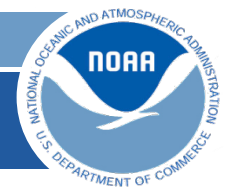
## FY23: HAFSv2 (Basin-Scale Multi-Storm)

## FY24: HAFSv3 (Global Multi-Storm)

Atmosphere-Ocean-Wave Coupled System Hurricanes, Weakly Coupled DA

Combines HWRF, HMON, and Hurricane Waves





# UFS Short-Range Application (RRFS)

## FY20: HREFv3

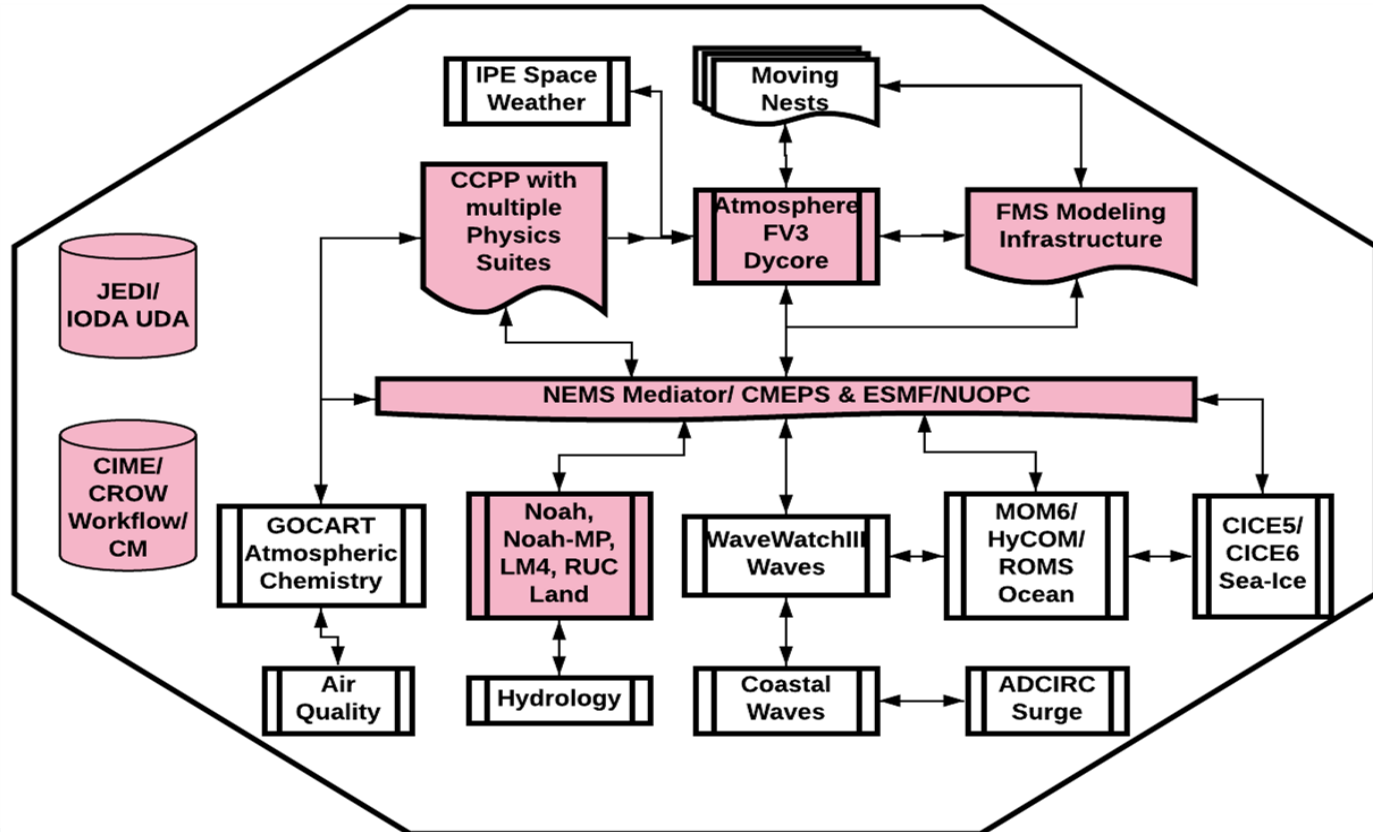
Replace poorly performing members with FV3-CAM

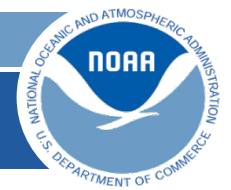
## FY23: RRFSv1

Rapid Refresh Forecast System (Ensembles) for Severe Weather Prediction

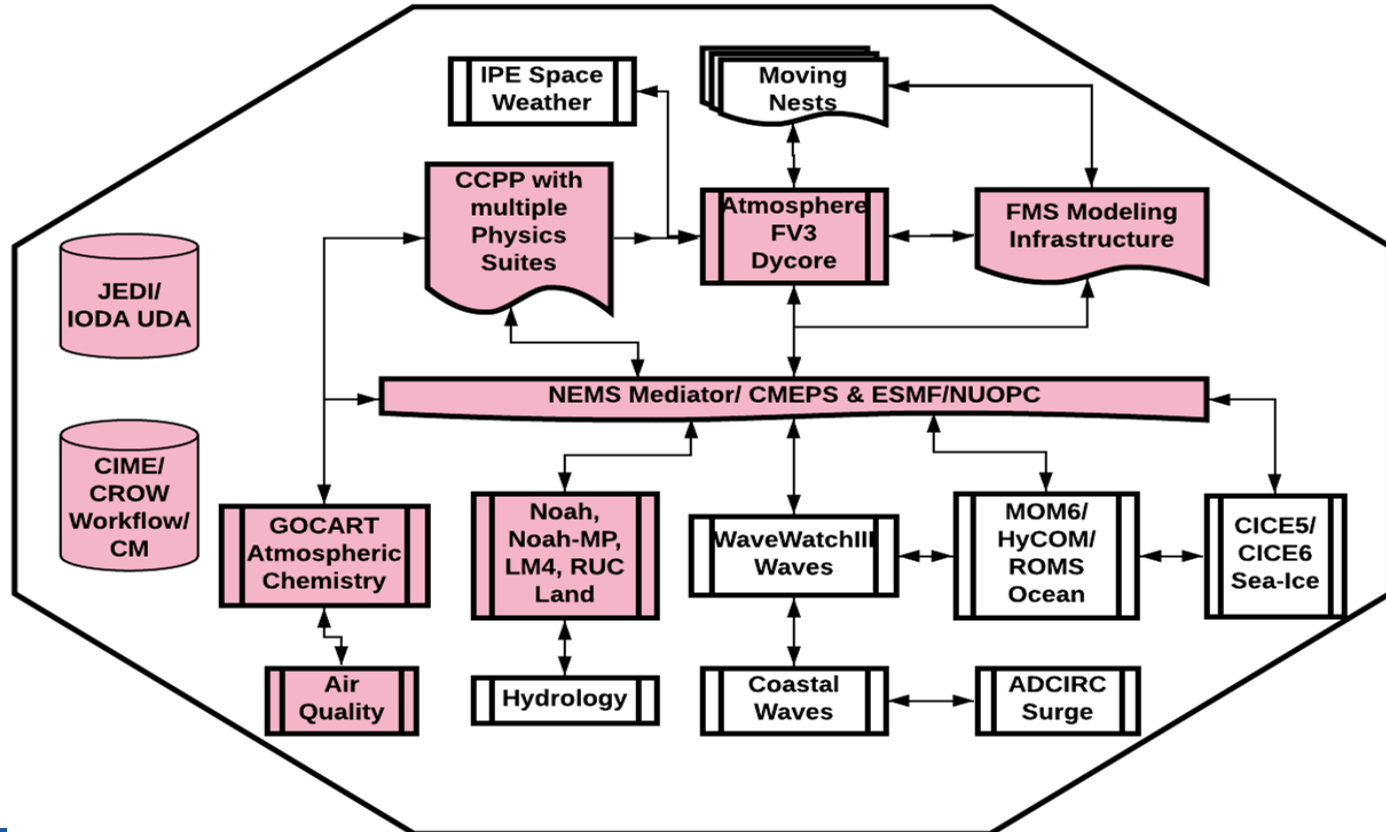
Combines NAM Nests, HiResWindow, HREF, and HRRR

Convective scale Ensemble DA



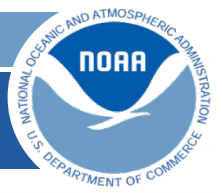


# UFS Air Quality Application (AQM)

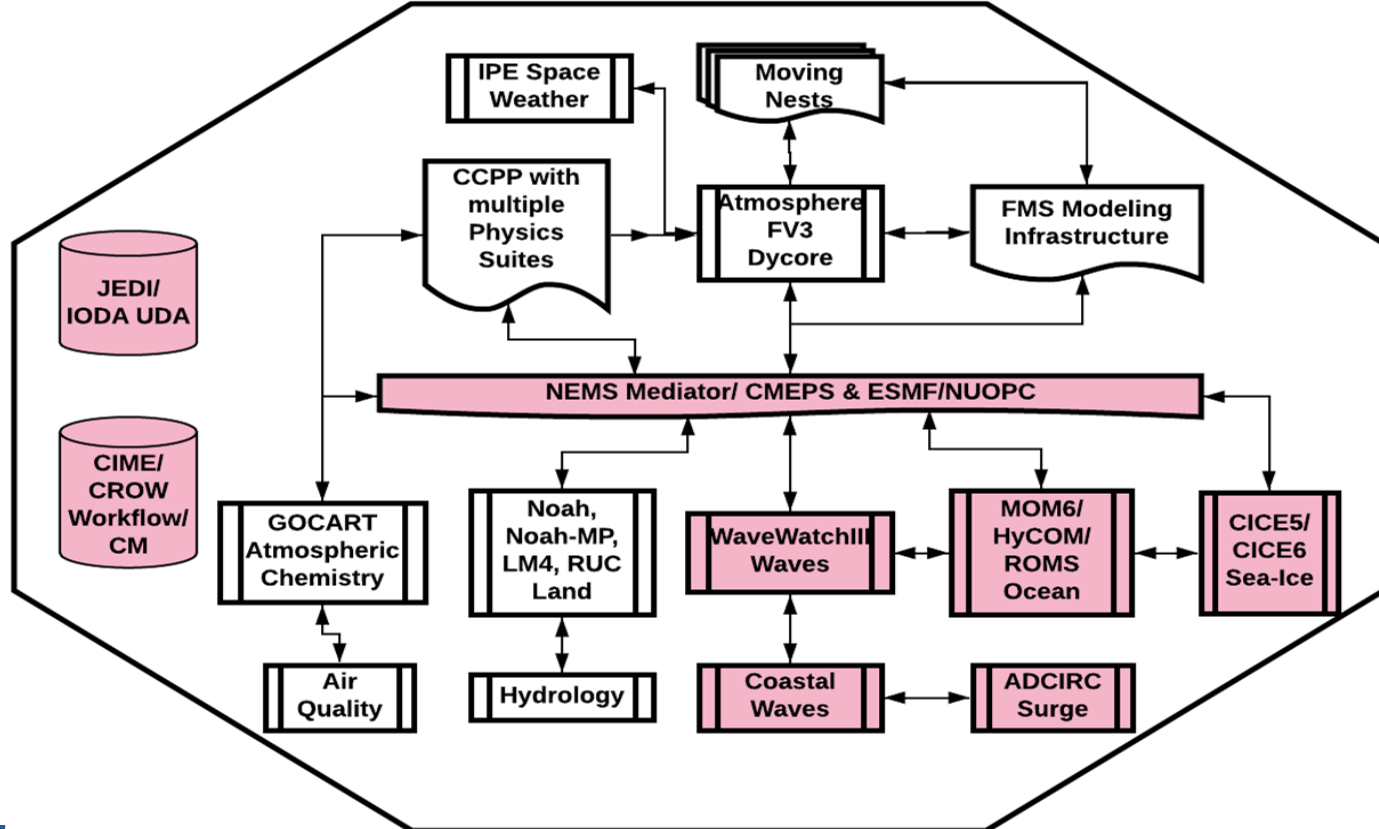


FY23: CMAQ v6

FV3-SAR with CMAQ +  
Aerosol DA

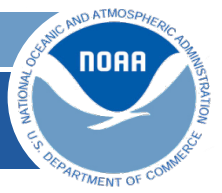


# UFS Marine and Coastal Applications

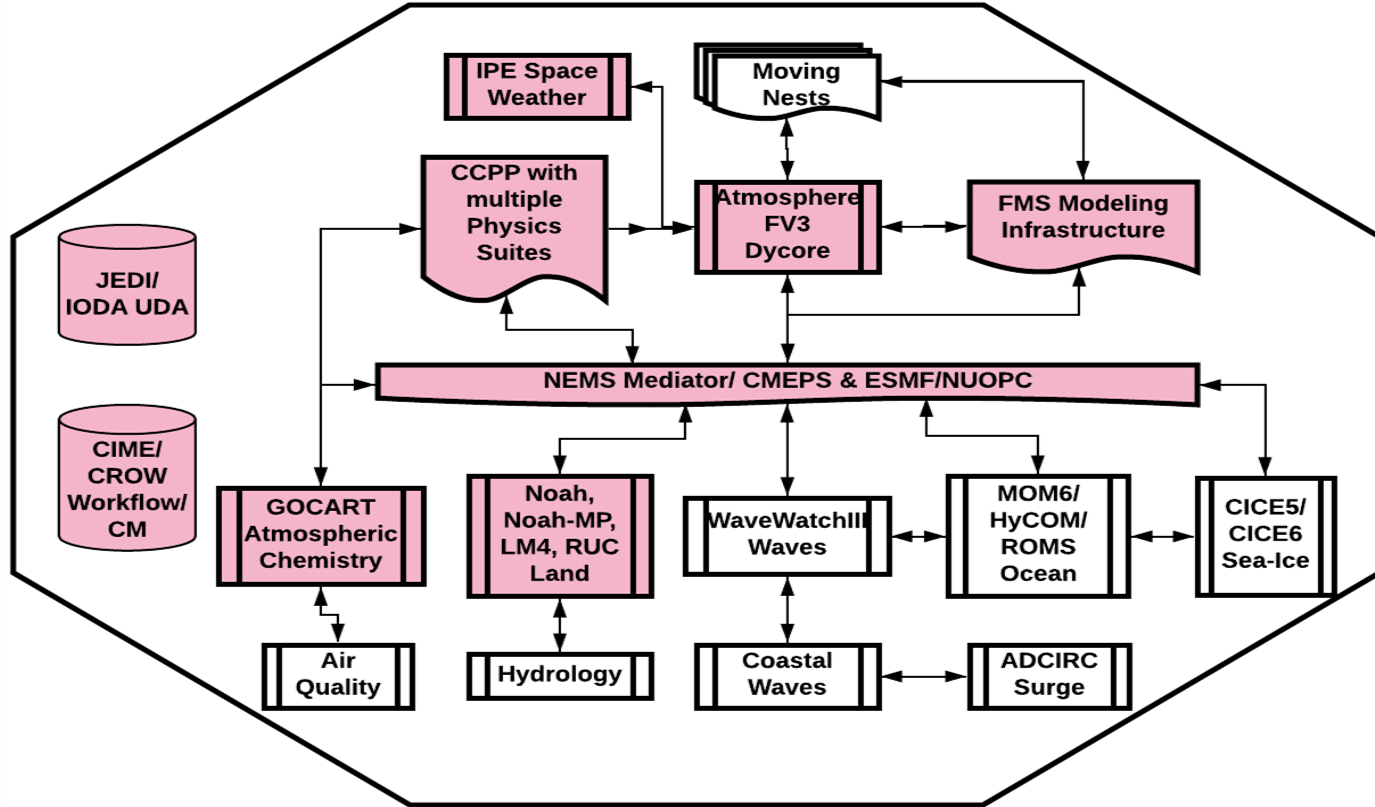


**FY24: Ocean/Wave/Sea-Ice/Surge/Coastal Predictions**

**Marine components with Marine JEDI based DA**



# UFS Space Weather Applications

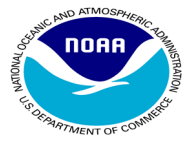


**FY24: FV3 Deep Atmosphere Dynamics for Whole Atmosphere and IPE Space Weather, with DA**



# Public Release of GFS

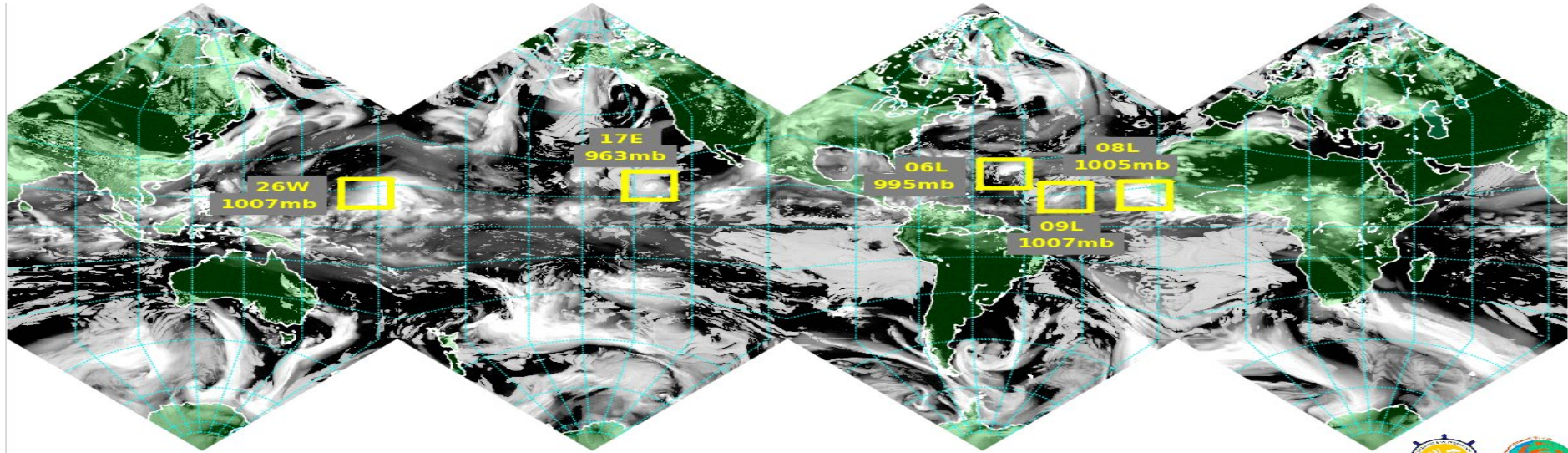
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- Tentative date: January 31, 2020
- Where: [github.com](https://github.com) (ufs-community)
- Supported Capabilities to be included in the Public Release
  - Global Atmosphere configuration (including CCpp) for C96, C192, C384, C768 with 64 vertical levels - output formats: NetCDF (model output)
  - Physics suites -- Operational GFS v15 and one experimental suite (latest development for GFS v16)
  - Capability to generate input files from model data in GRIB2 format (chgres)
  - Capability to interpolate from native grid to grids that easily interface with visualization packages (UPP - GRIB2)
- Other codes are available but unsupported
- Have fun with it!

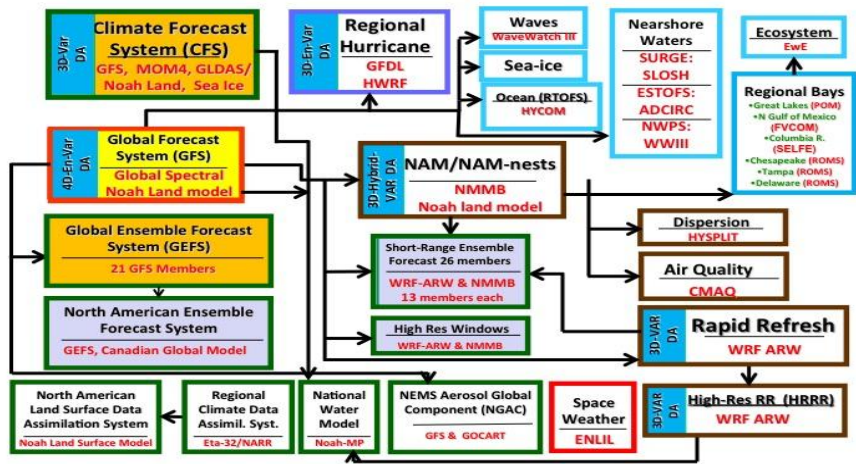


# Thank you!



# Strategic Vision

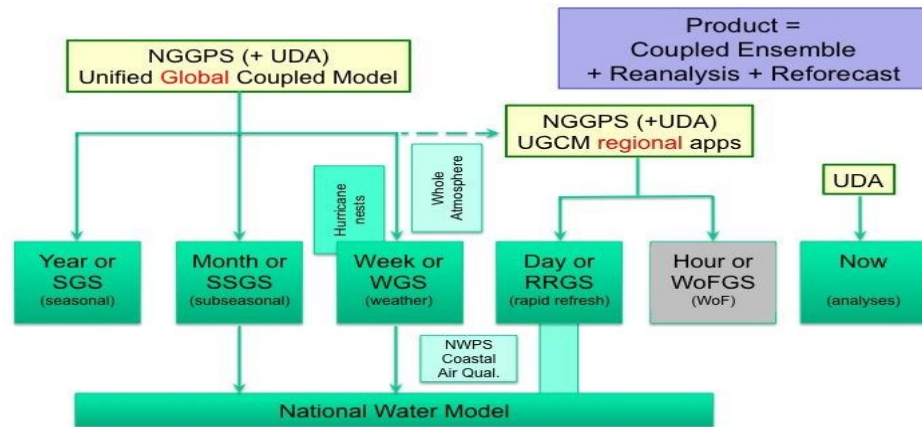
Production Suite ca. August 2016



Courtesy Bill Lapenta

**Starting from the quilt of models and products created by the implementing solutions rather than addressing requirements ....**

**... we will move to a product based system that covers all present elements of the productions suite in a more systematic and efficient way**



UDA: Unified Data assimilation  
 SGS: Seasonal Guidance System  
 SSGS: Subseasonal Guidance System

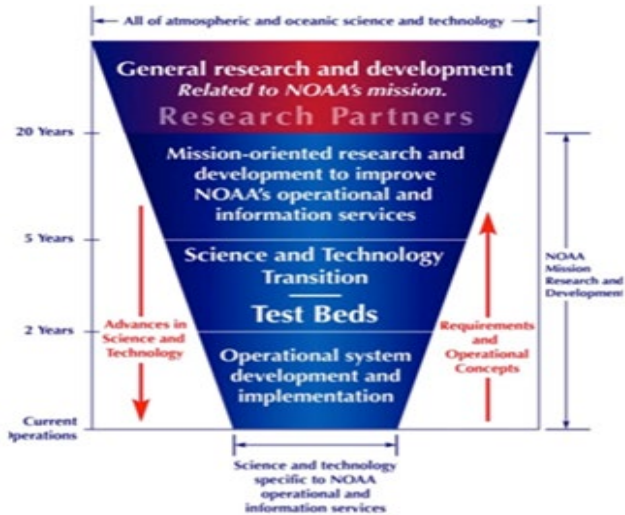
WGS: Weather Guidance System  
 RRGs: Rapid Refresh Guidance System  
 WoFGS: WoF Guidance System



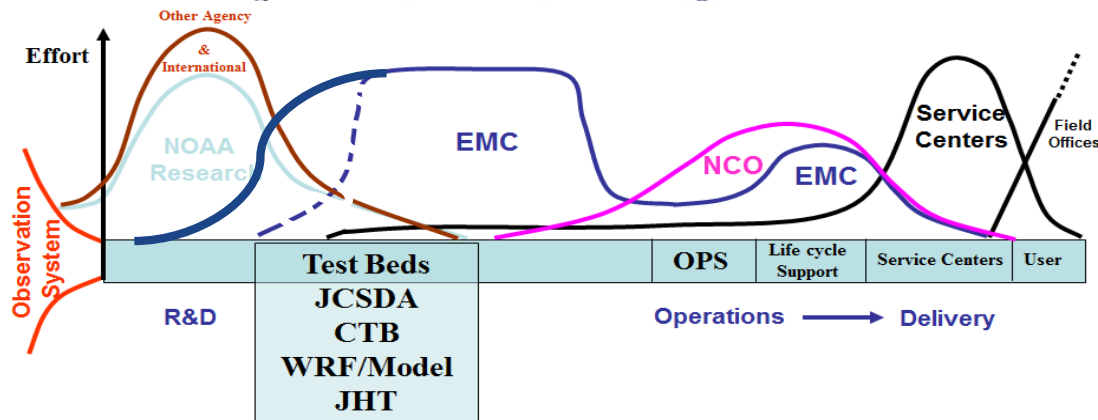
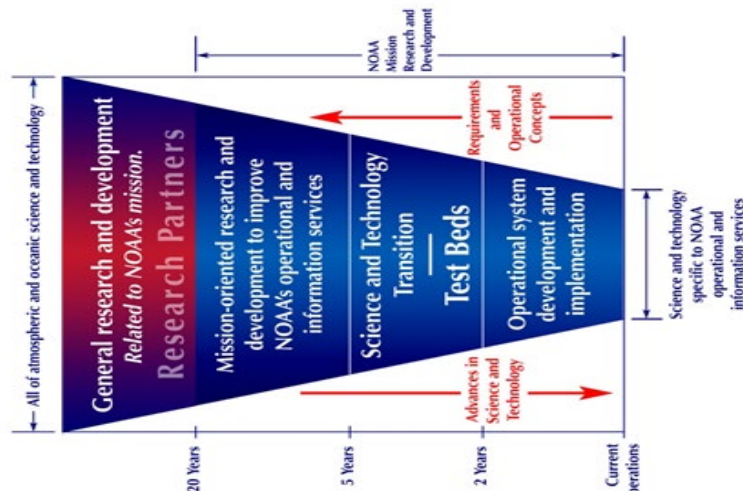
# Opportunities for NOAA



- Aligning with the R&D community



Courtesy Louis Uccellini





# Future direction/evolution of NWS modeling suite

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- **Strategic vision and Roadmap**
  - Evolution of NCEP modeling suite to a unified modeling system
- **Next Generation Global Prediction System (NGGPS)**
  - Foundation for new unified modeling system
- **Short-term transitional evolution of CAM models**
  - Incremental steps toward long-term unification with FV3
- **Advancing Hurricane Modeling**
  - Transitioning to FV3-based applications
- **Unified Data Assimilation**
  - Within the JEDI Framework
- **Independent, community-based verification**
  - Evidence-based decisions supported by agreed-to metrics



# NPS Transitioning to UFS Applications

Conceptual UFS applications in production covering all NPS applications.

Components of UFS are configured to develop distinct applications while maintaining the dependencies between the applications and products

