# *Environmental modeling within NOAA: A vision for community-based unified Earth system modeling*

**NCEP Production Suite Review**

*December 4-6, 2017*

# NOAA's Research-to-Operations Cycle


*Courtesy Louis Uccelini*

# A Hierarchy of Plans

**1. UMC**

- Unified Modeling Committee: High-level NOAA Unified Modeling Overview
- **Horizon:** 5-10 Years
- **Scope:** NOAA

Online [1]

**2. Vision**

- A Strategic Vision for the US National Environmental Modeling Enterprise
- **Horizon:** 5-10 Years
- **Scope:** US Environmental Modeling Enterprise (Federal focus, integrated with Academia)

**3. Roadmap**

- Roadmap for the Production Suite at NCEP
- **Horizon:** 5-10 Years
- **Scope:** NCEP Production Suite (Unified Forecast System)

**4. SIP**

- Strategic Implementation Plan
- **Horizon:** 0-3 Years
- **Scope:** NCEP Production Suite (Unified Forecast System)

NGGPS '+'

*ftp://ftp.library.noaa.gov/noaa_documents.lib/NOAA_UMTF/UMTF_overview_2017.pdf

**(1) A broad "strategy document" from the NOAA Unified Modeling Committee (UMC; under the auspices of the NOAA Research Council); spans the entirety of the NOAA modeling enterprise, inclusive of bio-geo-chemical, social and physical.**

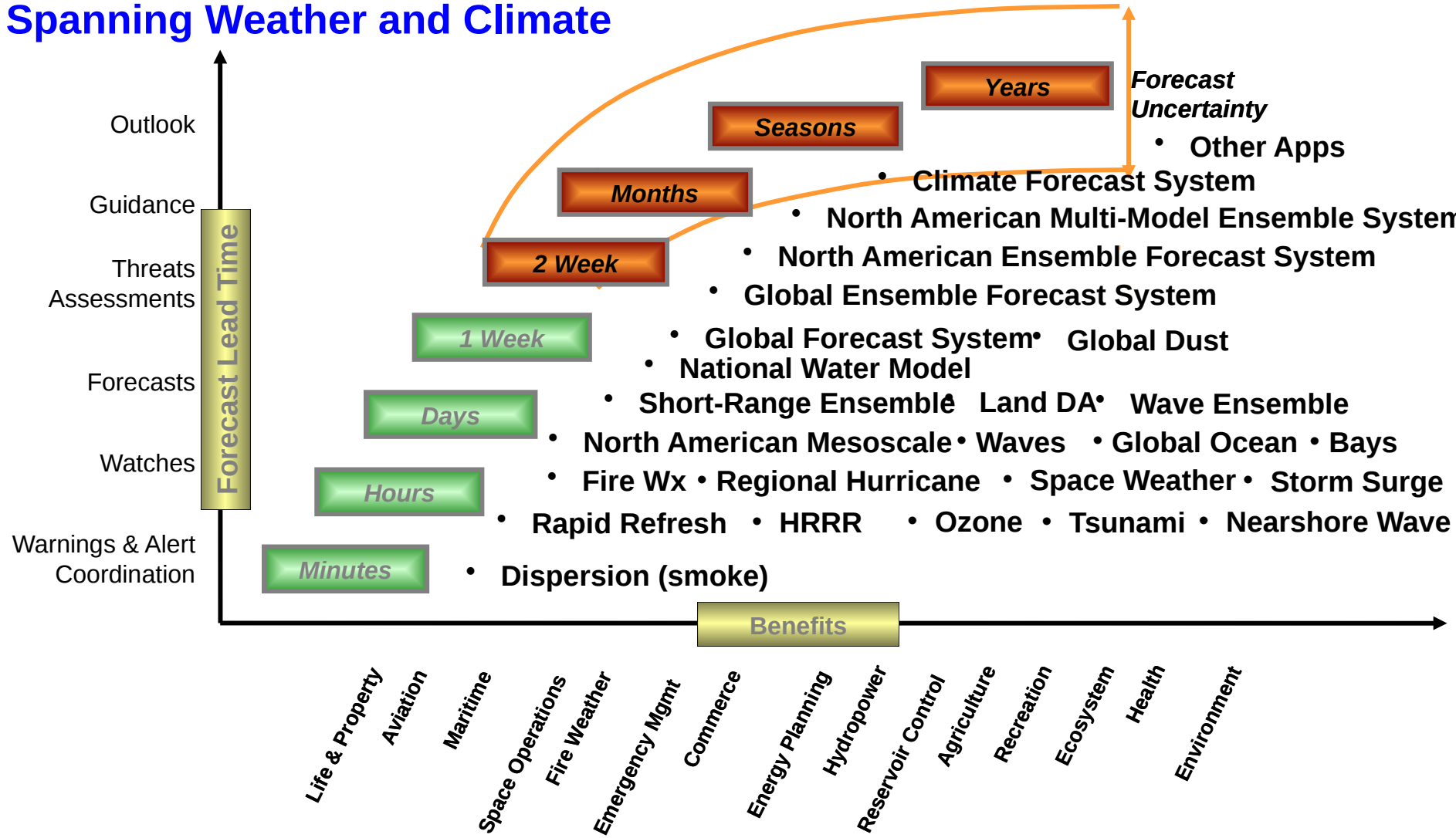
**(2) The NWS and OAR are developing a Strategic Vision Document looking out 10 years and bridging US Environmental Modeling Enterprise with the higher level NOAA UMC effort.**

**(3) Also emanating from an NWS-OAR partnership, is a Roadmap document that lays out how we can move the NCEP Production Suite towards the vision described in the Vision Document.**

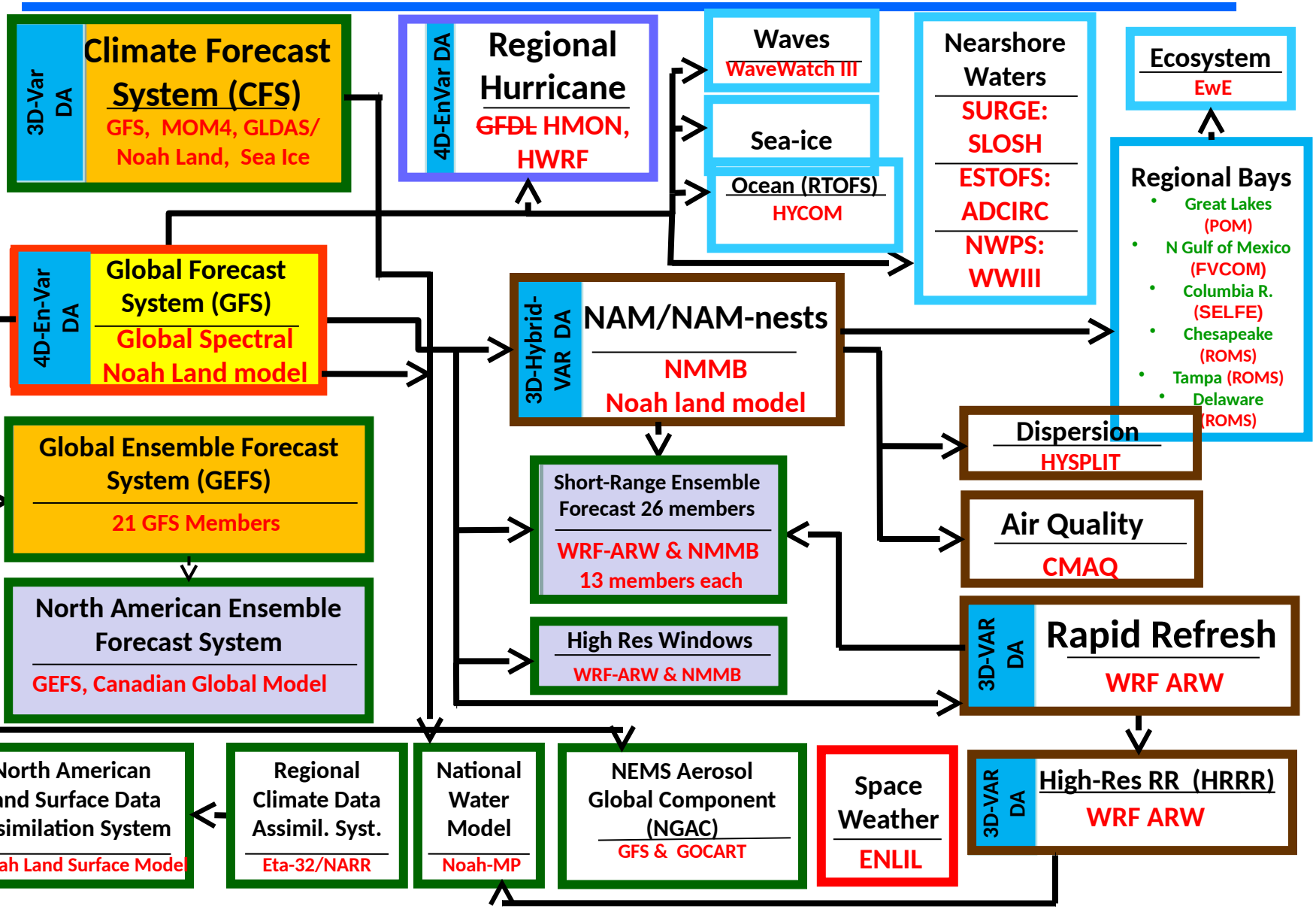
**(4) At a practical level, the Strategic Implementation Plan (SIP), describes NOAA's concrete steps over the next 3 years to build the Next Generation Global Prediction System based on the Unified Forecast System, beginning with numerical weather prediction across scales and in partnership with with the community (all stakeholders).**

# Seamless Suite of Operational Numerical Guidance Systems

## Spanning Weather and Climate



# NOAA's Operational Numerical Model Guidance Suite



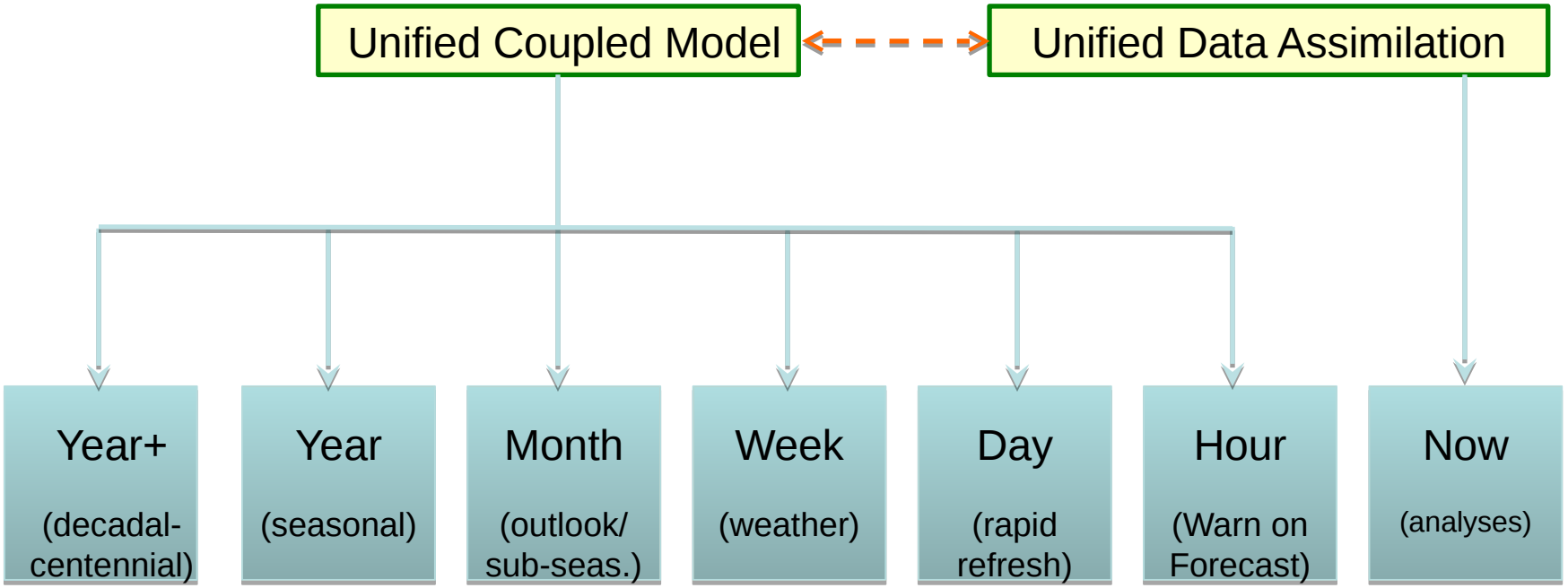
# Strategic Vision
## *Evolution of NCEP Production Suite*

- End State:
  - Simplified production suite under unified modeling framework
  - Single dycore, coupled, ensembles … for all scales
  - Active engagement from community (R&D, testing, validation)
- Transitional activities:
  - NGGPS evolution with FV3 dynamic core (GFS, GEFS, CFS)
  - Meso-unification (multi-model ensemble/HREF, eventual WoF)
  - Evolution of community modeling for ESM components (ocean, waves, land surface model, etc.)
  - Strategic Implementation Plan (SIP) with community partners
- Limiting factors (issues/risks):
  - HPC (research, development, testing, operations)
  - Scientific & Tech challenges (DA, single dycore vs. multi-model, 2-way coupling, ensemble calibration, dissemination, etc.)

# Strategic Vision
## *Key Elements*

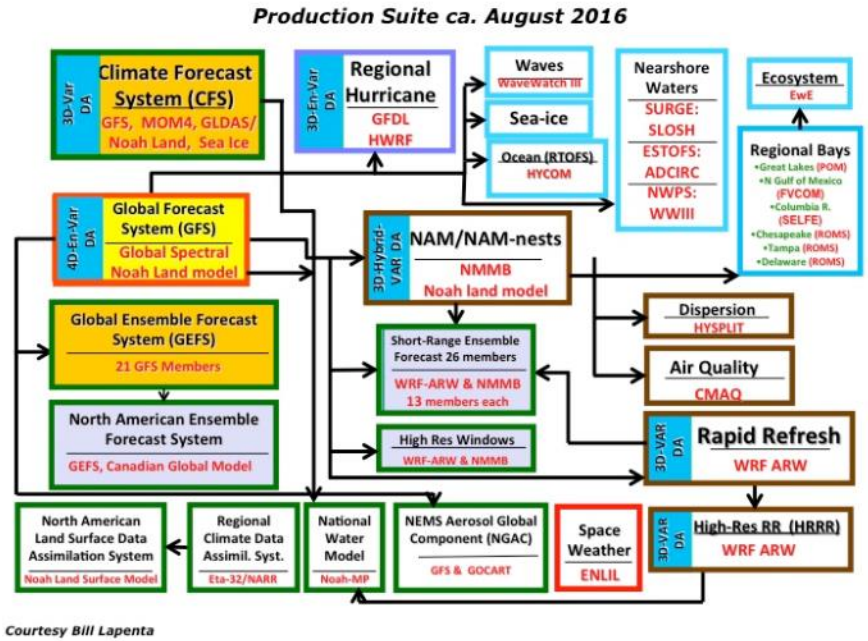
- Focus on products supporting mission requirements
  - Impact-based Decision Support Services
- Unified modeling and data assimilation
  - Coupled, ensemble based, reforecast and reanalysis
  - Including pre- and postprocessing, calibration, verification validation
  - *Use NGGPS as a foundation to evolve a unified modeling system*
- New system using *community* modeling, built upon:
  - Evidence-driven decisions
  - Same standards for all who contribute
  - Transparent and robust *governance*
    - Service requirements >> technical requirements / solutions
    - Collaborative prioritization and decision making
  - Coordinate partner activities under single plan

# Strategic Vision
## *Temporal Domains*



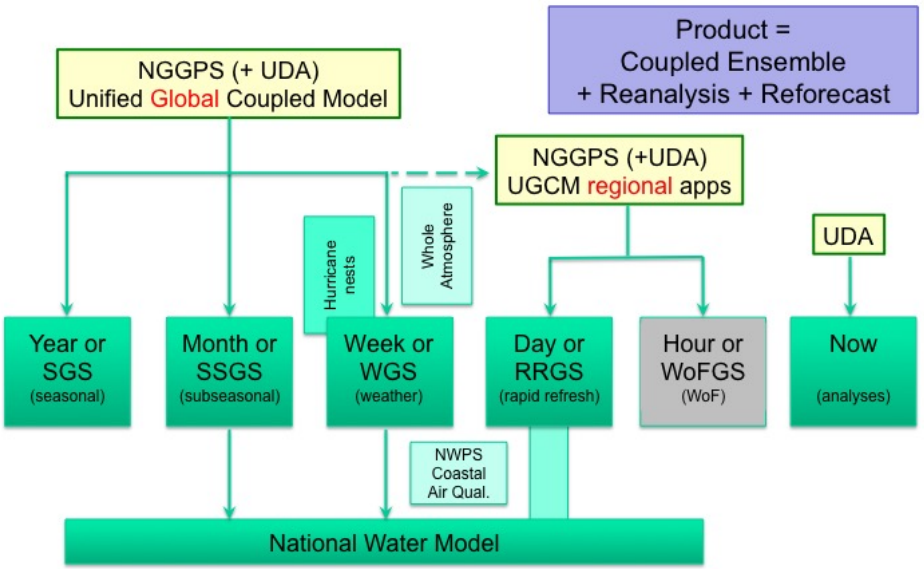

| | | | | | | |
|---|---|---|---|---|---|---|
| Global | Global | Global | Global | | | Global |
| | | Regional refinement | Regional refinement | | | |
| Down-scaling | Down-scaling | | | Regional | Regional | Regional |

# Strategic Vision
## *Simplify Modeling Suite*




***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: SubseasonalGuidance System

WGS: Weather Guidance System
RRGS: Rapid Refresh Guidance System
WoFGS; WoF Guidance System

# Strategic Implementation Plan (SIP) for Unified Modeling

- Common Goal: ***Single integrated plan*** that coordinates activities of NOAA + external partners in ***common goal*** of building a national unified modeling system across ***temporal*** and ***spatial*** scales
  - **Next Generation Global Prediction System (NGGPS)**: *foundation to build upon for community Earth system model*
  - Activities include R&D, testing/eval, V&V, R2O, shared infrastructure
- Approach for SIP development:
  - Began with existing *core R&D partners* to organize in *functional area Working Groups* (WGs) responsible for drafting respective functional SIP components
  - Bring together *broader community*, first as invited WG members, followed by *public workshops* (College Park, MD; April 2017 and August 2017)
  - ***End product will be SIP version 1.0, a 3-year plan (FY 2018-2020)***
    - Long term: SIP to be rolling 3-year plan to be updated annually
    - **Save the date: 1/31/2018 – 2/1/2018!**
  - Stand up Governance Structure (in process)

# Strategic Implementation Plan (SIP)
## *Working Groups*

- *Governance*
  - Decision making, roles/responsibilities, advisory boards, org. alignment, etc.
- *Communications and Outreach*
  - Common messaging strategy
- *Convective Allowing Models (CAMs)*
  - Intermediate steps to CAM ensembles, Warn on Forecast; test/eval w/community
- System Architecture
  - NEMS evolution; community approach
- Infrastructure
  - Standards/doc; CM; code repository; etc.
  - Role of testbeds; regression testing; etc.
- Verification & Validation (V&V)
  - V&V of ops forecasts vs. R&D testing/eval
  - Unified/standard tools and data formats
- Dynamics and Nesting
  - FV3 transition on global wx/S2S/climate
  - Nests for hurricanes (moving?)
- Model Physics
  - Common Comm. Physics Pkg (CCPP); stochastic, scale-aware physics
- Data Assimilation
  - NOAA, NASA integ. w/FV3; coupled DA
  - Joint Effort for DA Integration (JEDI)
- Ensembles
  - Strategy across scales; model uncertainty
- Post-Processing
  - Comm. PP infrastructure; std formats/tools
- Component Model groups
  - Marine models *+ NOS coastal/bay models*
  - Aerosols and Atmospheric Composition
  - Land Sfc Models (LSMs) *+ hydrology (OWP)*

- *New WG or addition*  - Augmentation of existing NGGPS group

# Summary

- A golden opportunity to unite the ops and R&D communities with a next-gen unified modeling system
- NOAA moving to replace legacy models (e.g., Global Spectral Model) with new FV3-based NGGPS modeling system; migration already underway!
- NOAA working with R&D community (NASA, NCAR, DoD, JCSDA, academia, etc.) to evolve NGGPS into a community-based unified modeling system for both R&D and operations

***NOAA and partners are working with community to evolve NGGPS towards a National unified modeling system across time and spatial scales…join us!***

# EMC is adapting to these new opportunities

- EMC reorganized. Why?
  - Shift from legacy multi-models to unified modeling framework
  - Break down stovepipes (e.g., no more separate models and pre-/post- processing applications for separate Global, Meso and Marine branches)
  - Address gaps/shortfalls (e.g., DA, V&V/diagnostics, systems engineering)
    - Bring together functions for consistency and greater efficiency
  - Create new management structure to more effectively manage EMC as an integrated system, rather than as a collection of separate models
- *<u>Bottom line</u>: EMC reorg is designed to more effectively manage model development and operations for the new unified modeling framework*

# Org Chart: Current
## Environmental Modeling Center (EMC)

# Org Chart: New
## Environmental Modeling Center (EMC)

# Modeling and Data Assimilation Branch (MDAB)

- **Summary:**
  - Consolidates model dynamics, physics, and DA from legacy Global, Meso, and Marine Branches
  - Maintains a manageable span of control over complex scientific areas and number of employees supervised by means of 3 Groups

# Engineering and Implementation Branch (EIB)

- **Summary:**
  - Consolidates engineering and implementation functions to more efficiently and consistently support all modeling groups.
  - Separates implementation functions from model science chain of command, better enabling the application and enforcement of common standards required for implementing code on NCEP's operational systems

# Verification, Post-processing and Product Generation Branch (VPPGB)

- **Summary:**
  - Consolidates verification and evaluation functions to more efficiently and consistently support all modeling groups.
  - Removes evaluation functions from model science chain of command, ensuring *independent* evaluations

# Questions?