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# ***NCEP/EMC Strategic Plans for Earth System Modeling***

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***NOAA-OAR-CPO and NOAA-NESDIS-JPSS TIM***

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# Outline



- Three-pronged Planning approach to enable change
  - Strategic plan/vision: High-end view, broader modeling enterprise
  - Roadmap: Where to go in 5-10 years, more detail, longer view
  - Strategic Implementation Plan: What to do right *right now* (*next 2-3 years*) to move towards vision of Strategic Plan and Roadmap
- Evolution of Community-based Unified Modeling System
  - What is NOAA's vision for the community? How do you get involved?
- What's next?
  - Upcoming model development/transitions: What's on the horizon?
  - Environmental Model Center (EMC) strategic changes: How is EMC evolving to meet these challenges?
- Summary and Next Steps



# Strategic Planning Approach for Unified Modeling



- Traditional approach would begin with long term vision codified in mature Strategic Plan, followed by Implementation Plan that lays out implementation details needed to execute the vision
- For challenges associated with unified modeling across spatial and temporal scales, a mature Strategic Plan is a long-term process
  - If we were to wait for a mature Strategic Plan before any implementation activities, many months or years would be lost towards the end goal
- Therefore we are taking a concurrent, parallel planning approach
  - **High-level/broad Strategic Plan** being led by NWS/OSTI (Hendrik Tolman)
    - High-level Strategic Plan + accompanying detailed Roadmap document
  - **Short-term (0 to ~2-3 years) Strategic Implementation Plan (SIP)** combines implementation activities with near-term strategic actions
    - Led by NWS/NCEP/EMC (Mike Farrar) with NOAA and external partners



# Strategic Vision

## *Key Elements*

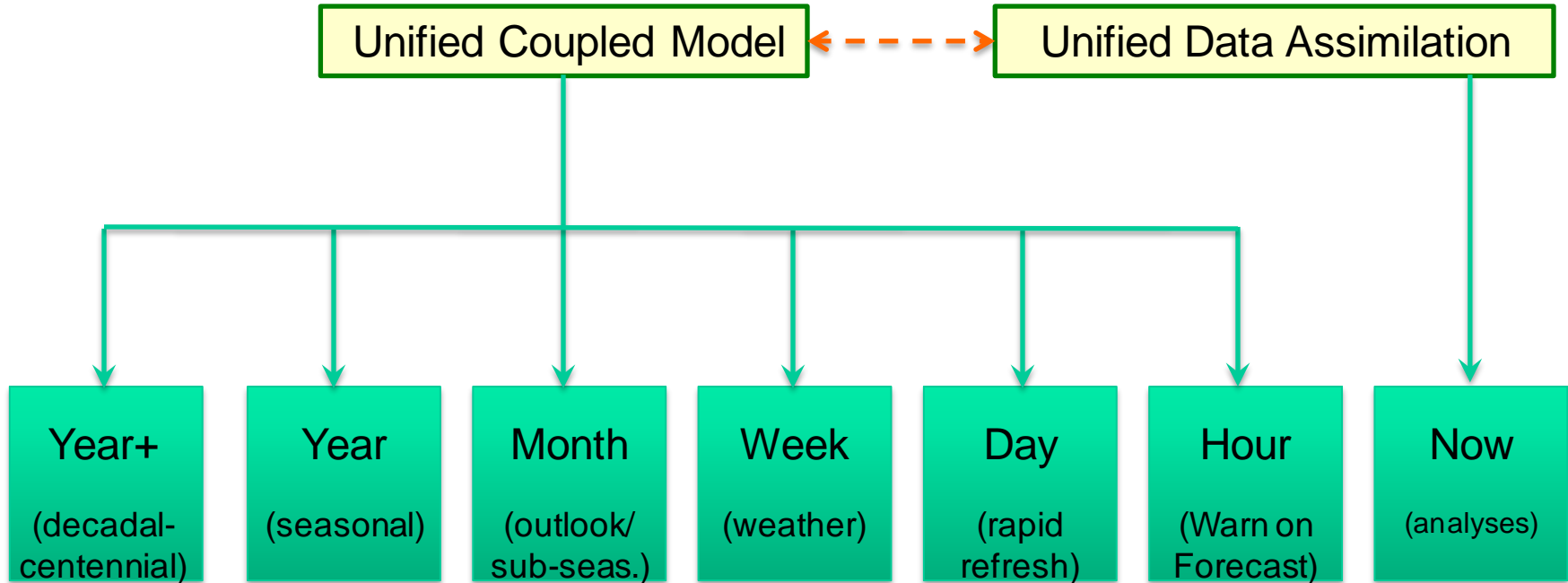


- Focus on products supporting mission requirements
- Unified modeling and data assimilation
  - Coupled, ensemble based, reforecast and reanalysis
  - Including pre- and postprocessing, calibration, verification validation
- Focus on *community* modeling
- Evidence-driven decisions
- Same standards for all who contribute
- Transparent and robust *governance*
  - Service requirements
  - Technical requirements / solutions
  - Prioritization



# Strategic Vision

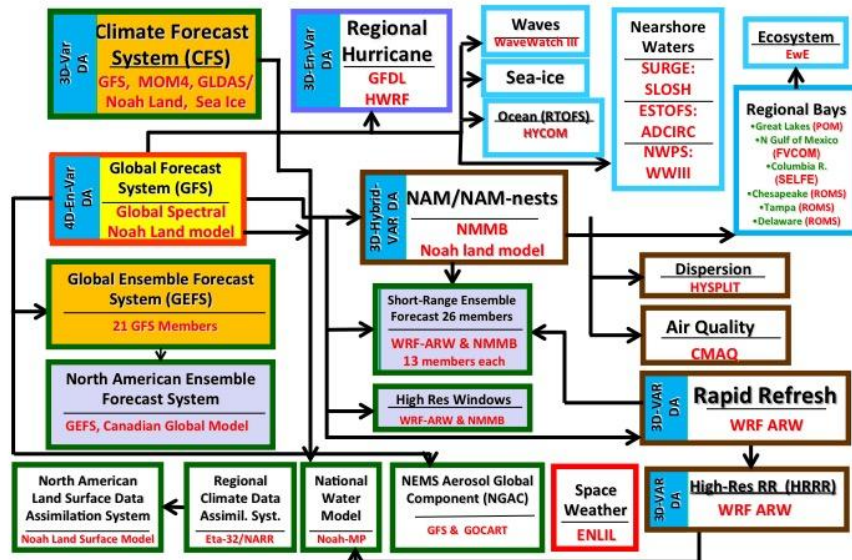
## *Temporal Domains*



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

# Roadmap

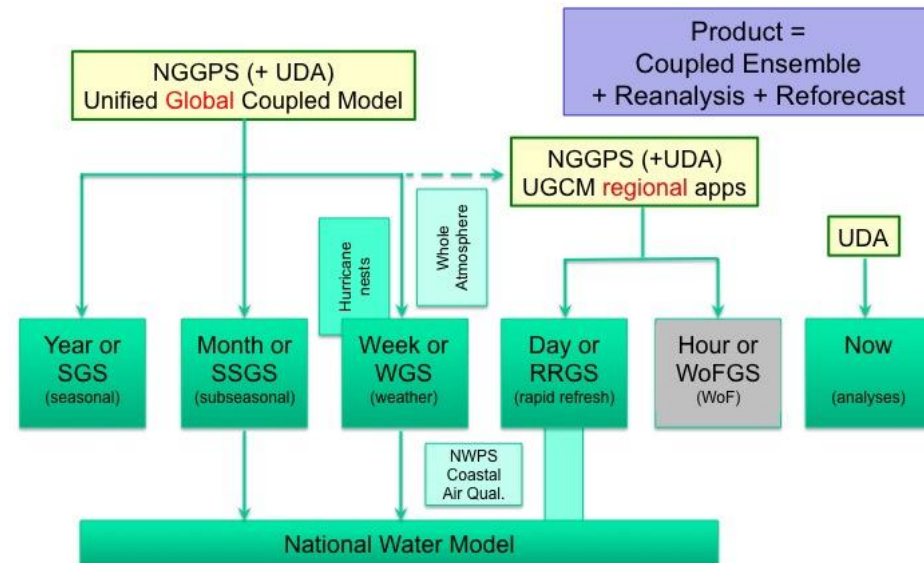
Production Suite ca. August 2016



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**



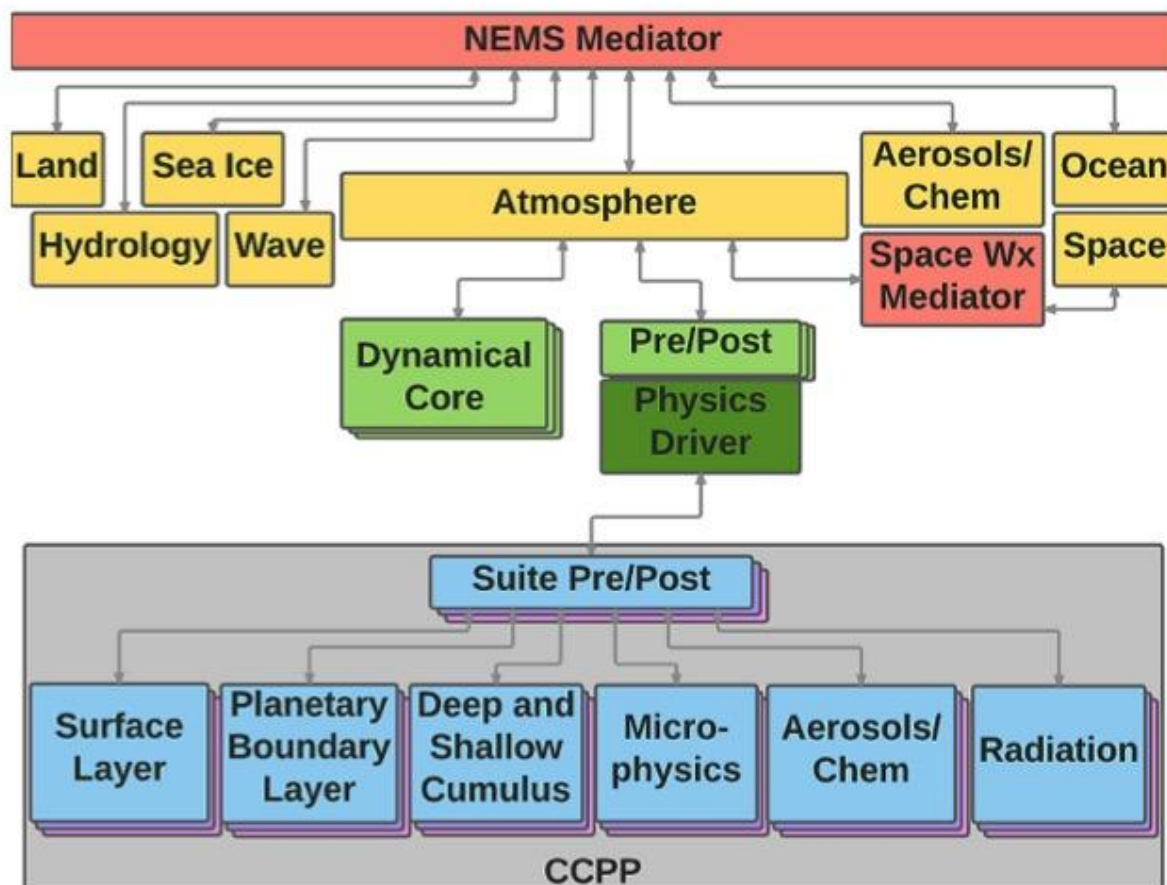
UDA: Unified Data assimilation  
SGS: Seasonal Guidance System  
SSGS: Subseasonal Guidance System

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

# Roadmap

***ESMF/NUOPC/NEMS architecture enables unified global coupled modeling and DA***

***Consistent with broader NOAA (UMTF) and US vision (National ESPC)***



Courtesy Developmental Testbed Center





# Roadmap

- What could the 5-10 year “end state” tentatively look like?
  - Living estimates below; corresponding resource needs on next slide

Element	Cadence	Range	Resol.	Ens.	Update	RR
<b>SGS</b>	7 d	9-15 mo	50 km (g)	28	4 y	1979-present
<b>SSGS</b>	24 h	35-45 d	35 km (g)	31	2 y	20-25 y
<b>WGS</b>	6 h	7-10 d	13 km (g)	26	1 y	3 y
<b>RRGS</b>	1 h	18 h	3 km (r)	26	1 y	TBD
	6-12 h	30 h				
	6-12 h	60 h				
<b>WoFGS</b>	5-15 min	2-4h	1 km (r)	26	1 y	TBD
<b>Analyses</b>						
<b>Trad.</b>	6-24 h	---	Var. (g)	---	6 mo	---
<b>RUA</b>	15 min	---	TBD (r)	---	6 mo	---

(g) Global  
 (r) regional  
 Red: uncharted territory

SGS = Seasonal Guidance System  
 SSGS = Sub-Seasonal (Outlook) Guidance System  
 WGS = Weather Guidance System  
 RRGs = Rapid Refresh Guidance System  
 WoFGS = “Warn on Forecast” Guidance System





# Roadmap



- “End state” is associated with cost
- Requirement focus will shift high % of compute needs to CAM models-
- Total machine size needed for all element except for Warn on Forecast Guidance System (WoFGS) is approximately 37 PFlop
  - Peak performance, accounting for all elements in production suite and for fractional machine use-
- Data storage and access critical

	SGS	SSGS	WGS	RRGS	WoFGS
<b>PFlop</b>	0.19	0.33	4.98	9.17	89.1 <sup>a</sup> 8.91 <sup>b</sup>
<b>Fraction</b> <sup>c</sup>	1.3%	2.2%	34%	63%	---

<sup>a</sup> Assuming same spatial coverage as RRGS

<sup>b</sup> Assuming 10% of spatial coverage as RRGS

<sup>c</sup> State before implementation of WoFGS



# Strategic Implementation Plan (SIP) for Unified Modeling



- Goal: Single plan that integrates R&D, testing/eval, R2O and implementation activities of NOAA + external partners in common goal of building National unified modeling system across temporal and spatial scales
  - Use Next Generation Global Prediction System (NGGPS) as foundation to build upon
- Community: Engage community on several levels for varying roles:
  - **Researchers, Users, Stakeholders**: Conducts research and testing on publicly available model baseline; long-term science contributions; builds next-gen STEM workforce
  - **Trusted Super-users**: Select R&D users that test/evaluate prototype models under development by core development partners prior to baselining and public release
  - **Core Development partners**: Orgs actively involved in development of next-gen operational unified modeling system. Orgs include NOAA ops, R&D and program offices; NCAR; NASA/GMAO; Navy/NRL; JCSDA
  - **Operations**: Centers that own/operate operational version of unified modeling system. For NOAA, this equates to the NCEP Production Suite
- Approach for SIP development: Begin with existing core R&D partners to quickly draft SIP components via functional area Working Groups; then bring together broader community in public workshop to begin building SIP version 1.0



# Strategic Implementation Plan (SIP) *Working Groups*



- *Governance*
  - Decision making, roles/responsibilities, advisory boards, org. alignment
- *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.
- Testing and Testbeds
  - 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; moving nests for hurricanes
- Model Physics
  - Common Comm. Physics Pkg (CCPP); stochastic, scale-aware physics
- Data Assimilation
  - FV3 integ. between NOAA, NASA; Joint Effort for DA Integ (JEDI); coupled DA
- Ensembles
  - Strategy across scales; model uncertainty
- Post-Processing
  - Comm. PP infrastructure; std formats/tools
- Component Model sub-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



# Strategic Implementation Plan (SIP) *Schedule*



- Nov 2016: SIP Planning Meeting at ESRL (Boulder, CO)
- Dec 2016: Establish Working Group membership and co-chairs
- Jan 2017: Brief approach at AMS Town Hall Meeting (Seattle, WA)
- Mar 2017: WGs initial recommendations/findings/SIP inputs due
- Apr 2017: Community Workshop (College Park, MD)
  - More on next slide ... “How can you get involved?”
- ~ Summer/Fall 2017: Meeting to draft SIP v1.0 (location TBD)
  - Incorporate Community inputs; SIP v 1.0 will be initial, “living” document
- Potential for forums at upcoming major conferences
  - AGU (Dec 11-15, 2017; New Orleans)
  - AMS (Jan 7-11, 2018; Austin TX)
  - *Any others? Seeking additional ideas from the community...*



# NOAA NGGPS FV-3-based Unified Modeling System: *Vision for Community*



Mission of FV3 Community: Improve environmental modeling forecast capability unified across time and space for both research and operations

- Develop the next generation of scientists
- Conduct research for improved scientific understanding and innovation
- Engage with community to improve transition of research to operations
- Build the world's best operational capability

The FV3 community will be guided by:

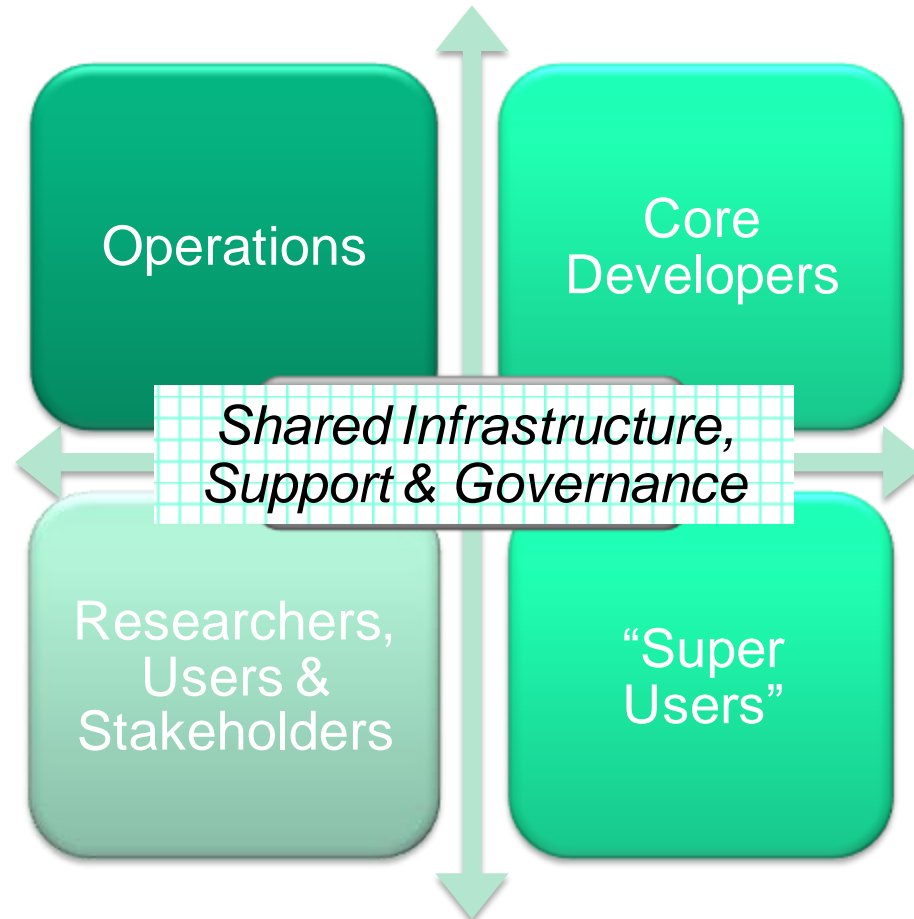
- Shared goals, objectives and "ownership" with transparent governance
- Inclusive and collaborative development, testing and evaluation
- Balance of operational, research and end-user needs and priorities
- Scientific capability and credibility
- Strong partnership between research and operations

Community Engagement: Upcoming April 2017 Workshop open to all

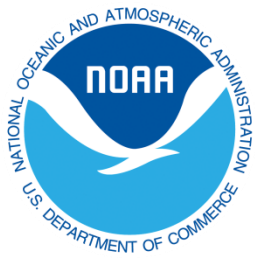
***Unprecedented opportunity to develop and advance a world-class unified modeling system for the Nation!***



# NOAA NGGPS FV-3-based Unified Modeling System: *Vision for Community*



***Inclusive of Public, Private, and Academic Sectors***



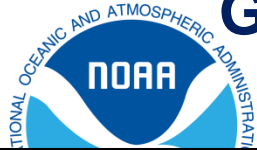
# Evolution of Community-based Unified Modeling System

## *How do YOU get involved?*



- Community Modeling Workshop: College Park, MD (April 18-21, 2017)
  - Refinements of community vision; input on how community will engage;
  - How community-based unified modeling *will actually work*
    - Governance, code repositories, testing and evaluation, etc.
  - Priorities on development of unified system + how it impacts schedule
  - Further information at: [https://www.weather.gov/sti/stimodeling\\_nggps](https://www.weather.gov/sti/stimodeling_nggps)
- Get involved in Strategic Implement. Plan (SIP) Working Groups
  - Working Groups seeking members from broad R&D community
  - To inquire, contact: [michael.farrar@noaa.gov](mailto:michael.farrar@noaa.gov)
- Participate in NGGPS calls for proposals
  - Anticipate initiating next Federal Funding Opportunity in Fall 2017 for Summer 2018 award





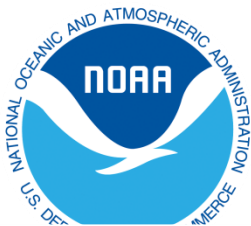
# GFS Changes Implemented/Planned (FY15-20)

*(Blue represents significant upgrade)*



GFS Implementation	Q2FY15 GFS V12.0	Q3FY16 GFS V13.0	Q3FY17 GFS V14.0	Q3FY18 GFS V15x (beta)	Q3FY19 GFS V15.0	Q3FY20 GFS V16.0
<b>Resolution</b>	T1534 (13 km) L64	T1534 (13 km) L64	T1534 (13 km) L64	C768 (13 km) L64	C1152 (9 km) L128	C1152 (9 km) L128
<b>Physics</b>	RTG SST RRTMG McICA Hybrid EDMF PBL GLDAS/Noah LSM	Noah LSM Upgrades	NSST Noah LSM Scale-aware SAS TKE Moist EDMF PBL	NUOPC Physics Driver	Advanced Physics TBD	Advanced Physics (TBD)
<b>Dynamics</b>	<ul style="list-style-type: none"> <li>- Semi-Lagrangian</li> <li>- Tracer fixer</li> <li>- Gravity wave drag</li> </ul>	None	None	FV3	No change	No change
<b>DA</b>	<ul style="list-style-type: none"> <li>- T574 Ensemble</li> <li>- CRTM v2.1.3</li> <li>- SSMIS, MetOp-B IASI</li> <li>- GOES hourly AMVs</li> </ul>	<ul style="list-style-type: none"> <li>- All-sky radiances</li> <li>- 4D Hybrid</li> </ul>	JPSS, CrIS and GOES-R Ready SEVIRI IR; VIIRS GOES WV Winds GPSRO RARS & DBNET	GSI for FV3 <ul style="list-style-type: none"> <li>- GOES-R &amp; JPSS data</li> </ul>	<ul style="list-style-type: none"> <li>- JEDI/Unified forward operator</li> <li>- L128 mod</li> </ul>	DA on FV3 grid
<b>Products</b>	<ul style="list-style-type: none"> <li>- Frozen precipitation fraction</li> </ul>	<ul style="list-style-type: none"> <li>- Hourly output</li> <li>- Five more levels</li> </ul>	1/8 degree products	TBD	TBD	TBD
<b>Significant Component</b>	Semi-Lagrangian 13 km Improved Physics	4D EnVAR LSM upgrades	NEMS/ESMF LSM upgrades	GFS/FV3 (prototype only)	Operational GFS/FV3	<ul style="list-style-type: none"> <li>- Advanced Physics/CCPP</li> <li>- DA on FV3 grid</li> </ul>
	Jan 14, 2015 Done	May 11, 2016 Done	May 10, 2017 Planned	Planned	Planned	Planned

Today



# Implementation Plan of FV3GFS (FY17-FY19)



FY 17				FY 18				FY 19			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Evaluate FV3 structure and document FV3 modeling system											
	Implement FV3 dycore in NEMS@										
		Couple FV3 to GFS physics (NUOPC physics driver) perform forecast-only experiments, tuning and testing&									
			Develop DA techniques % (native grid vs physics grid; New data)								
			Cycled experiments, New physics options, benchmarking, computational efficiency & optimization								
				Preprocessing and post-processing, up & downstream dependencies							
Q3FY19 FV3GFS Configuration						Test and Implement NGGPS Verification tools					
						3-year retrospective + real-time parallels, EMC and Community Evaluation					
				Early experimental implementation of FV3GFS (~13km L64) w/cycled DA				Code delivery, NCO Parallel & operations		NEMS/ FV3GFS in operations	

@ The targeted FV3GFS resolution is ~10km L128 with model top ~80 km.

& New physics: Scale-aware convection and PBL, Double-moment cloud and aerosol-aware microphysics, Unified convective and orographic gravity wave drag etc

% ~25km L128 4D-EnVAR data assimilation

@ The targeted FV3GFS resolution is ~10km L128 with model top ~80 km.  
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 % ~25km L128 4D-EnVAR data assimilation



# FV3-GFS

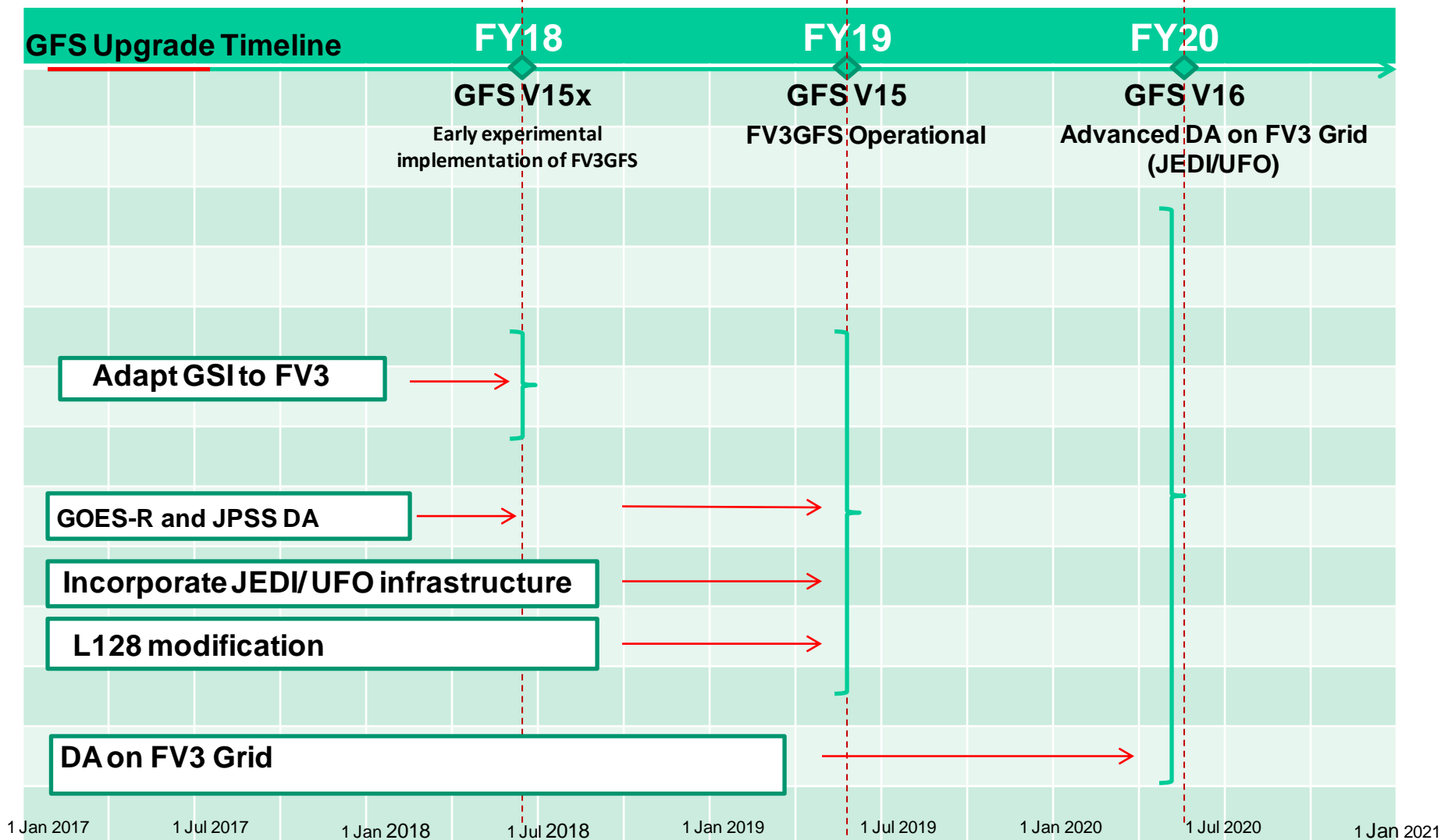
## ***Development/Implementation Plan***

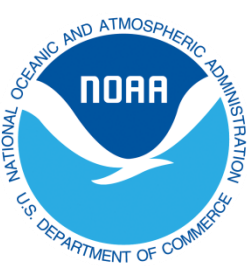


- After Q3FY17 NEMS/GSM implementation (last spectral model upgrade), *all resources are diverted to FV3 implementation task*
- Benchmark FV3GFS with fully cycled DA to match or exceed the skill of operational GFS
- Experimental early (parallel) implementation of FV3GFS in Q2FY18
- Simultaneous development and testing of advanced physics and higher resolution for FV3GFS
- First official implementation of FV3GFS in Q2FY19

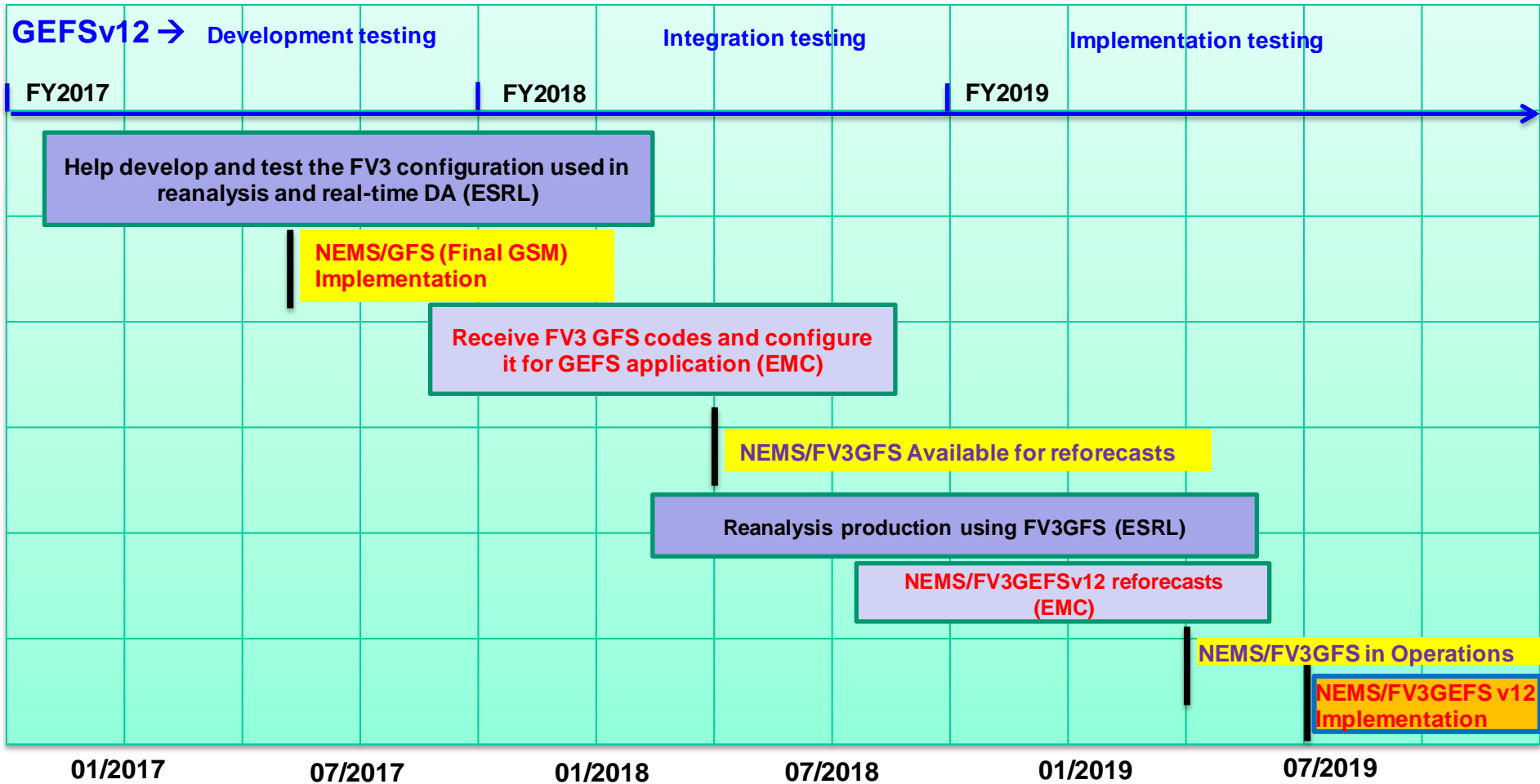


# FV3 GFS Data Assimilation Plan (as of 30 Nov 2016)





# Proposed Plan for FV3-based GEFS v12 (sub-seasonal ensemble system) with reanalysis and reforecast



**Proposed changes:** 1) Start producing FV3-based reanalysis for GEFS v12 in ~Q1 FY18, using the configuration of FV3GFS. 2) Reforecasts will commence soon after starting the reanalysis, uncoupled\*, with 2-tier SST approach, and will include extension to 35 days



# GEFS Implementation Plans

## *Implications of Changes*



- GEFS v12 implementation will use FV3 dycore, in close coordination with the FV3 deterministic GFS development
- GEFS v12 implementation will be consistent with EMC's global modeling strategies of unified system
- Reanalysis production is performed with FV3 system, not the obsolete spectral dycore
- ESRL reanalysis team participates in bringing FV3-based assimilation system online more quickly and testing an FV3-based GEFS,
  - *Reduces risk of delays with FV3GFS implementation*



# CFS Development Plans

## *Status quo vs. alternative*

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- Climate Forecast System (CFS) = **Seasonal** forecast model
- EMC's current/official development path follows sequential FV3 development starting with GFS (under NGGPS)
  - GFS (FY19) > GEF/Sub-seasonal (FY20+ > CFS/Seasonal (FY22?)
- GFDL's HiFLOR climate model runs with old version of FV3 and MOM4 ocean model
  - Next generation GFDL model plans to use latest FV3 and MOM6
  - Since this is consistent with EMC's plans for FV3-based CFS, EMC and GFDL are now **exploring joint development**





# Environmental Modeling Center (EMC) Strategic Changes



*How is EMC evolving to meet new challenges?*

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- Instill Project Management (PM) discipline
  - PM training for all federal employees and contractor team/area leads
  - Quarterly PM Reviews for all EMC development and implementation projects
- Shift model development resources from legacy models to FV3
  - Next NAM and GFS (GSM) implementation will be the last, then freeze (port to Cray)
  - GFDL and EMC working early prototype parallel runs for FV3-GFS: already underway!
  - All global and meso model developers have FV3 as first element in FY17 Perf. Plans
- EMC reorganization
  - Old org structure (separate Global, Meso, and Marine Branches) built around legacy architecture of independent models; **reorganize around unified modeling system**
  - Consolidate science in single **Modeling & DA branch**: all work together inside unified framework; break down old global vs. meso stovepipes
  - New **Verification, Post-Processing, and Production Generation branch**: consolidate resources for efficiency and consistency; verification independent from development
  - New **Systems Engineering and Implementation branch**: consolidate resources for efficiency and consistency; greater focus on NEMS and community systems arch



# Summary and Next Steps



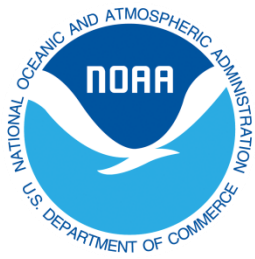
- NGGPS provides golden opportunity; foundation to build upon to unite the ops and R&D communities with a next-generation National unified modeling system
- Strategic planning organized around 3-pronged approach
  - Strategic Plan: Broad, high-level strategic vision
  - Roadmap: More detailed evolution over 5-10 year time frame
  - Strategic Implementation Plan (SIP): Short-term (2-3 years) to move toward vision
    - Detailed planning broken down into Working Groups, now underway
- Community workshop (April 2017) to begin building approach and draft SIP v1.0
- NOAA already moving to replace legacy models (e.g., Global Spectral Model) with new FV3-based NGGPS modeling system; migration underway!
- NCEP/EMC taking concrete steps to evolve to unified modeling paradigm
  - *PM discipline; Reorg around unified system; freeze legacy models, working on FV3*

***NOAA and partners are working with broad community to build towards a National unified modeling system across time/space scales...join us!***



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# Backup/Background Slides



# NGGPS Goals and Objectives<sup>1</sup>



## Next Generation Global Prediction System (NGGPS)

- Design/Develop/Implement the Next Generation Global Atmospheric Prediction Model
  - Non-hydrostatic Scalable Dynamics
  - Accelerated Physics Improvement Profile
- Improve Data Assimilation
- Position NWS for Next Generation High Performance Computing (HPC)

***Ultimate Goal: World's Best Global Forecast Guidance!***

1 – From NWS Budget Initiative proposal to OMB



# NGGPS Model Strategy



- Model architecture to separate dynamic core and physics
  - Reduces risk and implementation time
- Identify/Implement optimal core for global weather forecast applications
  - Highly scalable; Non-hydrostatic
- Accelerate evolution of physics (evolve to “scale aware”)
  - Develop/Implement Common Community Physics Package
    - Begin with scheme based on current GFS physics package
    - Integration of best of other existing physics packages
  - Implement Global Modeling Test Bed to integrate community interaction

***Opportunity: use NGGPS global modeling framework as basis to unify modeling across spatial and temporal scales***



# NGGPS Model Timeline



- Phase I – Identify qualified Dynamic Cores
  - Evaluate technical performance (**complete**)
    - Scalability; Integration of Scheme Stability and Characteristics
- Phase II – Select Candidate Dynamic Core (**complete**)
  - Integrate with operational GFS Physics
  - Evaluate Meteorological Performance
  - *Selection: NOAA/GFDL Finite Volume v3 (FV3)*
- Phase III – Implementation (**underway**)
  - Implement Candidate Dynamic Core Operationally
  - Implement Common Community Physics Package
  - Upgrade Data Assimilation (4DEnVar)



# UCACN Modeling Advisory Committee (UMAC): Background and Motivation



- UCAR Community Advisory Committee for NCEP (UCACN)
  - Established by Univ. Corp. of Atmos. Res. (UCAR) in March 2011
  - The UCACN is as permanent external advisory committee to provide guidance to the National Centers for Environmental Prediction (NCEP) on improvement of products and services based on the latest advances in science and technology
- UMAC established in March 2015 as a UCACN subcommittee
  - Advise NCEP Director on strategy, science and tech
  - Provide a comprehensive, technical review of the NCEP Prediction Suite (NPS) strategy for development
  - 12–14 members who are established subject matter experts in numerical modeling; drawn from academia, non-governmental organizations, the private sector and Federal and state agencies





# UMAC 2015 meeting

## *Major Recommendations*



- Unified, collaborative strategy for model development across NOAA is needed
- NOAA must develop a comprehensive and detailed vision document and strategic plan that maps out future development of national environmental prediction capabilities
- Execute strategic & implementation plans based on stakeholder requirements
- Reduce the complexity of the NCEP Production Suite
- The NOAA environmental modeling community requires a rational, evidence-driven approach towards decision-making and modeling system development
- NOAA needs to better leverage the capabilities of the external community
- NOAA must continue to enhance High Performance Computing (HPC) capabilities
- Essential to effective planning and execution is the creation of a Chief Scientist position at NOAA level for Numerical Environmental and Weather Prediction
  - *Note: New position not supported, so in lieu of this, NWS/NCEP/EMC taking lead to form coalition of NOAA and external partners to build a integrated short-term plan*



# UMAC 2016 meeting

## *Summary Remarks*



- Strategic Plan: Need for Strategic Plan that connects NOAA modeling internally and with greater R&D community
- Community: Need to develop next-gen models through effectively working with private sector, federal, and academic communities
  - Evolution of NGGPS, NOAA Env. Modeling System (NEMS); testing/eval; governance
- Global Modeling and Global Model Unification: NGGPS, NEMS collaborations need to be part of NCEP/NOAA culture; integrate global/regional modeling
- High Performance Computing and WCOSS: Continue multi-year plan to procure greater HPC; balance CPU vs. storage, ops vs. R&D; more efficient use of capacity
- Convection-Allowing Models (CAMs) and Ensembles:
  - Institute 3-km CONUS ensemble; operationalize Storm Scale Ensemble of Opp. (SSEO)
  - Need for parallel R&D effort for new/improved Ensemble Forecast System (EFS)
  - Need to develop Strategic Plan for CAMs at NCEP and associated EFS
- Salt water (coastal) and fresh water (riverine) modeling issues:
  - NOAA storm-surge/inundation modeling fragmented; better NWS-NOS integration
  - Recommend workshop, then develop strategy for integrated water modeling



# UMAC 2016 Report

## *Strategic Plan*



- UMAC: Need for Strategic Plan that connects NOAA modeling internally and with greater R&D community. Notable specifics include:
  - The need to consider an individual's incentive structure
  - Linking computational, scientific, workforce capacity, and cost
  - Proper description and management of requirements
  - Special attention is needed to Meso-Unification / Regional modeling
- NWS/NCEP response: We agree and are moving out on this now
  - Long-term Strategic Plan being led by NWS/OSTI (Hendrik Tolman)
    - Being developed in concert with Unified Modeling Task Force
    - High-level Strategic Plan + accompanying detailed Roadmap document
  - Short-term (0 to ~2-3 years) Strategic Implementation Plan (SIP) combines implementation activities with strategic actions absent final Strategic Plan
    - Led by NWS/NCEP/EMC (Mike Farrar) with NOAA and external partners
    - New WG being formed to tackle Meso-Unification spotlighted by UMAC



# UMAC 2016 Report

## *Community*



- UMAC: Need to develop next-gen models through effectively working with private sector, federal, and academic communities
  - Build on progress noted on NGGPS and NOAA Env. Modeling System (NEMS)
  - How to ensure NGGPS built as community model? Suggest trusted super-users, early testing of CAMs with community participation
  - Evolve beneficial set of rules, definition of effective, balanced governance practices
- NWS/NCEP response: We agree, and are already moving forward
  - Community structure envisioned on four fundamental levels;
    - (a) Broad R&D community; (b) Trusted Super-users
    - (c) Core Development partners; (d) Operations
  - NWS organizing a “visioning exercise” on NOAA Operational Global Weather Model Development Community on Jan 9, 2017 (facilitated with Social Scientists)
  - Tackling issues within SIP Working Groups, to include:
    - Governance WG will review existing community efforts and their governance
    - System Arch. WG will explore evolution of NEMS for both ops and R&D
    - Infrastructure WG will explore collaboration and sandbox options



# UMAC 2016 Report

## *Global Modeling and Unification*



- UMAC: The UMAC noted progress in global modeling and the efforts towards unifying the suite of products that use the global model
  - NEMS & NGGPS project needs to become part of NCEP internal org. culture
  - NEMS represents a strategic asset (e.g., coupling) and is elemental for global model unification, and, ultimately, integrating global and regional modeling
- NWS/NCEP response: We agree; now expanding our NEMS, arch. capabilities
  - EMC and GFDL work under NGGPS (e.g., new prototype FV3-GFS with NEMS)
  - Teamed with ESRL/GSD, who built NEMS into their new org structure
  - Greater focus on NEMS as part of new EMC reorg structure
  - System Arch. WG (under SIP) will explore evolution of NEMS for both ops and R&D
  - NCAR/CGD exploring use of NEMS as starting point for CESM coupling architecture
  - EMC, NOAA consolidating modeling (ocean, sea ice) + fewer NOAA global models
  - Scale-aware/advanced physics options developed, tested and implemented via Community Common Physics Package (CCPP) at Global Modeling Test Bed (GMTB)
  - Development of advanced Joint Effort for DA Integration (JEDI) in collaboration with Joint Center for Satellite DA (JCSDA) and other core partners (e.g., NASA and Navy)



# UMAC 2016 Report

## *HPC and WCOSS*



- UMAC: Strongly encourage continuation of a multi-year procurement plan for High-Performance Computing (HPC); note other centers moving forward fast
  - Need to balance R&D vs. ops; also balance CPU with storage and I/O
  - Use HPC to progress on CAM ensembles, improved physics and DA
  - Recommend shifting HPC used for CFS to run CAM ensembles
  - Team with other HPC centers and vendors to test methods for HPC efficient use
- NWS/NCEP response: Agree with all but point on CFS; all still resource limited
  - HPC for CFS small compared HPC needed for CAM ensemble; not a viable trade-off
  - Bottom line: need **major** infusion of ops + R&D HPC to achieve desired end state
  - NWS (OSTI/Tolman), NWS/OCP, NOAA/CIO partnered to document HPC needed to meet end state requirements: estimated ~100x compute increase needed to support ensembles for climate/S2S, long-range weather, Warn on Forecast, etc.
    - ~10x needed for ops (not including WoF); ~100x needed for R&D
  - Working with NOAA/OCIO on Software Engineering for Novel Architectures (SENA) project, as well as with other external partners (e.g., Navy with ocean models)



# UMAC 2016 Report

## *CAMs and Ensembles (1 of 2)*



UMAC made several recommendations grouped into 3 major areas:

- UMAC (1): Immediately institute 3-km ensemble forecast system over CONUS
  - As an initial step, it would make sense to operationalize the SSEO
  - Guidance for construction of this ensemble can be found from the results of recent HMT/HWT Spring experiments, although some additional studies may be needed.
- NWS/NCEP response: We agree on basic approach but differ on some details
  - EMC implementing HREF (operational version of SSEO) by Q4FY17
    - Normalizing domains with 3-km horiz. res. and 48-hr forecast length
    - CONUS HREF available 2-3 hours earlier than SSEO + new HREF for Alaska
  - Now working comprehensive test plan to evaluate FV3 at CAM scales (~Mar 2017)
    - Prototype FV3 convective forecasts planned to be part of next HWT spring expt
  - We note that Community Leveraged Unified Ensemble (CLUE) tested at 2016 HWT spring experiment showed that SSEO was the top performer
    - As such, this new HREF will serve as the new baseline for comparison for the next Ensemble Forecast System (EFS)





# UMAC 2016 Report

## *CAMs and Ensembles (2 of 2)*



- UMAC (2): Proceed in parallel on subsequent ensemble forecast system (EFS)
  - Some in UMAC advocate moving rapidly to HRRRE without usual evaluations, while others advocate consistent application of evidence-based approach
  - Most UMAC members endorse HRRRE with stochastic physics
- NWS/NCEP response:
  - NCEP supports evidence-based decision making for all issues, including this one
  - HREF will be baseline; next EFS must provide greater value within available HPC
- UMAC (3): Develop strategic plan at NCEP for CAMs and its associated EFS
  - Near future: move to dual core system of HRRR/ARW and FV3
  - Long term (3-5 years): goal of unified system under FV3 if suitable
- NWS/NCEP response:
  - Agree with overall proposed direction to continue with multi-model ensemble and move to single core-unified system once verification and validation supports it
  - SIP WG on CAMs will work short-term plan; expect initial recommendation by April
  - Long-term plans will be part of overall Strategic Plan and Roadmap





# UMAC 2016 Report

## *Salt & Fresh Water Modeling Issues*



- UMAC: Coastal “salt water” modeling and associated forecasts from the NWS and NOS have been fragmented and disjointed
  - NWS and NOS should meet at least twice per year to discuss plans for coastal and storm-surge/inundation modeling, identify/strengthen strategic partnerships
  - Bring CONUS (freshwater) and coastal (salt water) experts into a unified structure.
    - Community-based workshop + development of strategy to integrate water modeling
    - NWS and NOS should all be using the same models to address their missions
- NWS/NCEP response: Efforts ongoing to improve NOAA integration of water
  - NOAA coord: NWS and NOS meet regularly via multiple strategic partnerships:
    - Partnerships include NOAA Storm Surge Roadmap team, COASTAL Act, “ETSS and Total Water Level” CaRDS initiative, and bi-weekly inundation modeling meetings
    - Examples of collaboration include implementation of HSOFS in NWS operations (FY16), coupling of WW3 and ADCIRC models (FY17) for Coastal Act (post-storm assessments)
  - Planning underway for “Total Water Level and Inundation Summit: Integrating Product and Services Across Multiple NOAA Programs”; Implementation Plan next
    - OWP FY17 milestone to identify and document strategy for coupling of ocean/coastal model with NWM hydraulic modeling (Q4)
  - NWS and NOS already use the same models for like/similar applications
    - ADCIRC, FVCOM for coastal; HYCOM for global; WW3, SWAN for waves