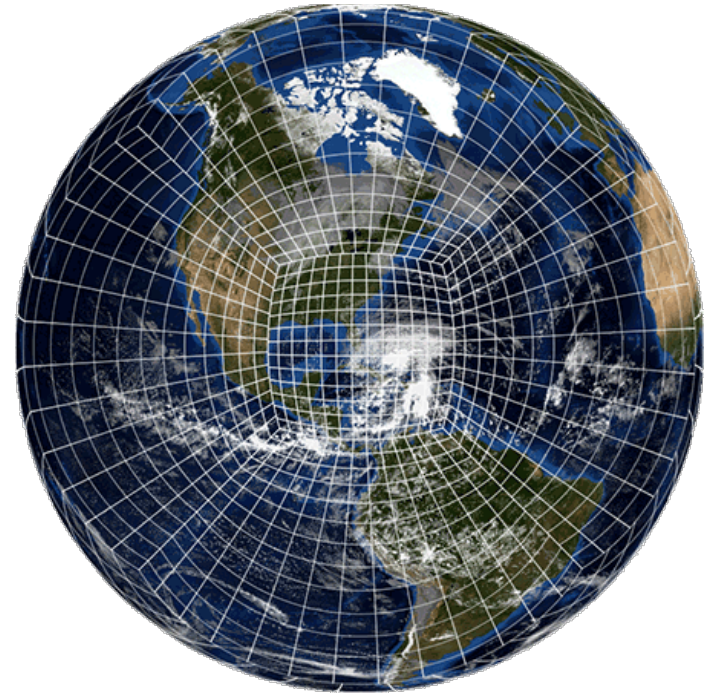




# **NOAA's NWS Next Generation Global Prediction System (NGGPS) and Strategic Implementation Plan (SIP)**



Ming Ji and Fred Toepfer  
31 January 2018



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



- Design/Develop/Implement NGGPS global atmospheric prediction model
  - Non-hydrostatic scalable dynamics
- Improve data assimilation and physics
- Position NWS for next generation high performance computing
- Engage community in model/components development
- Reduce implementation time
- Increase effectiveness of product distribution
  - Post-processing, assessments, and display

**World's Best Global Forecast Guidance**

<sup>1</sup>From NWS Budget Initiative proposal to OMB



# NGGPS Status Highlights



- Integrating and testing new atmospheric dynamical core for upcoming release
  - Beta Release – Q3 FY18
  - Final Release – Q2 FY19
- Completed Common Community Physics Package (CCPP) Requirements and Design documentation and progressing toward initial release
- Broadening community participation
  - Ongoing funded and newly initiated FY2018 FFOs
  - Global Model Test Bed
  - Community Engagement/Governance for Unified Modeling
  - Initiated Joint Effort for Data assimilation Integration (JEDI) project
- Coupled modeling development ongoing
- Strategic Implementation Plan (SIP) published, November 2017
- UFS Governance established/UFS Steering Committee established



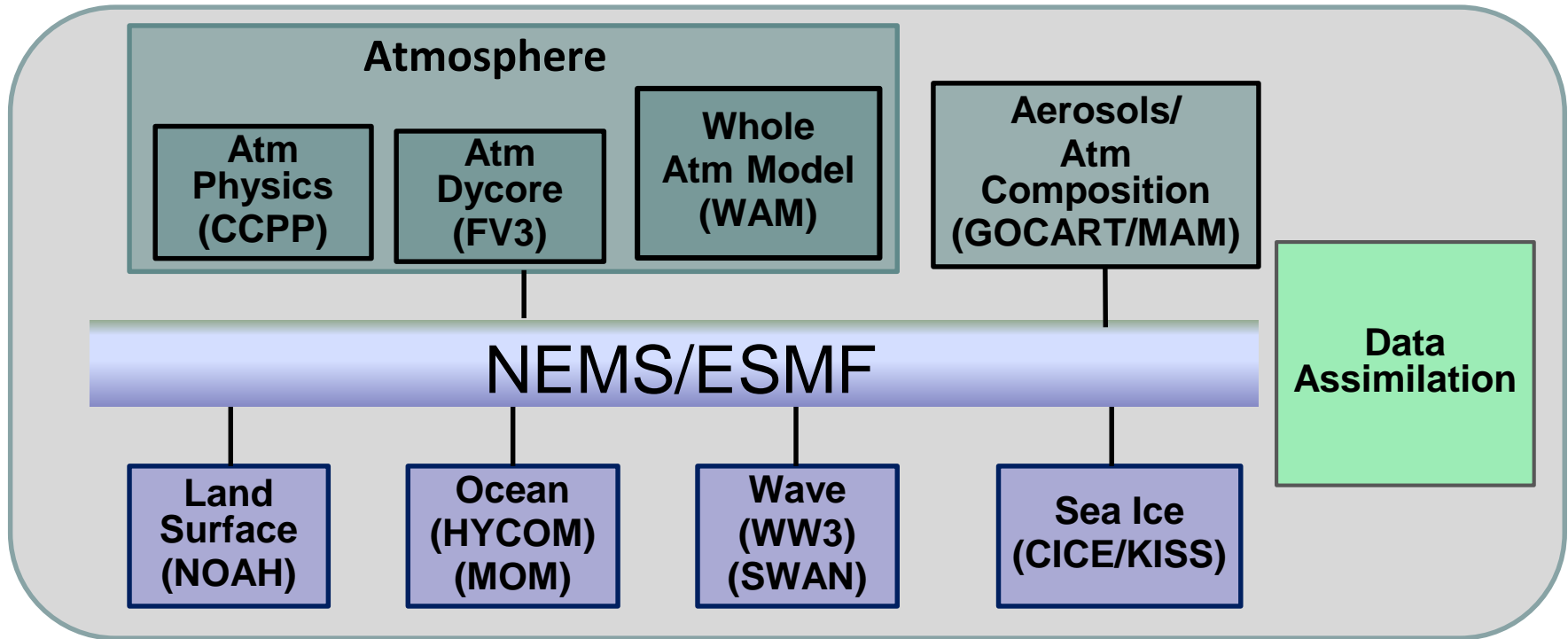
# NGGPS Next Steps



- Continue integration and implement FV3 dynamical core
- Accelerate evolution of model physics
- Implement improved data assimilation (adapt to the new model with FV3 dynamical core and add data sets)
- Develop enhanced post-processing, ensemble methods; verification and validation; visualization tools and techniques
- Foster a community model environment, with GMTB, JCSDA, and community involved governance
- Conduct robust and ongoing testing and evaluation of components and systems, with community involvement
- ***Community involvement in planning and development through SIP*** and FFO grants



# NGGPS Prediction Model Components (2015)



- NGGPS prediction model will consist of fully coupled components representing different parts of the Earth system.
- All components will be based on community codes.

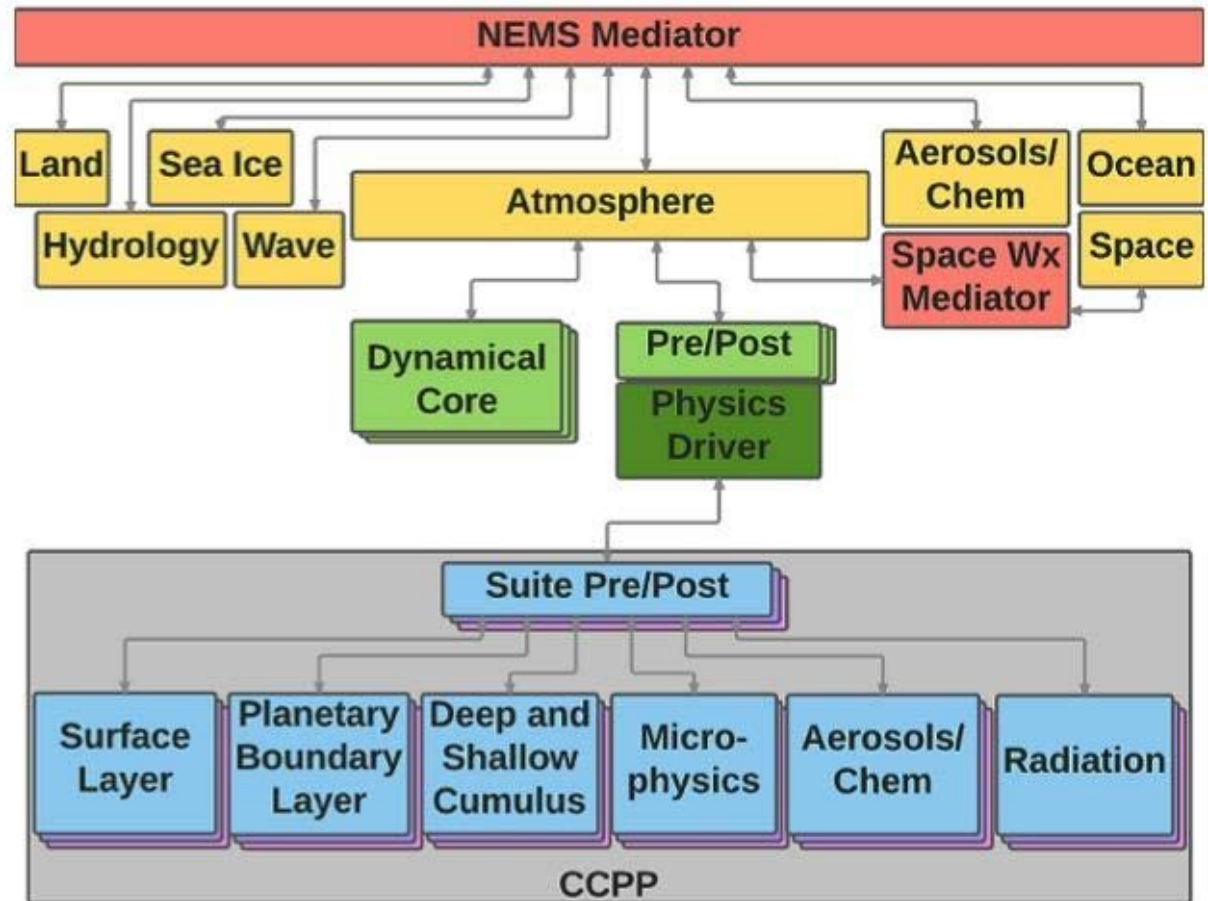


# Unified Forecast System for Operational Earth System Prediction (2018)



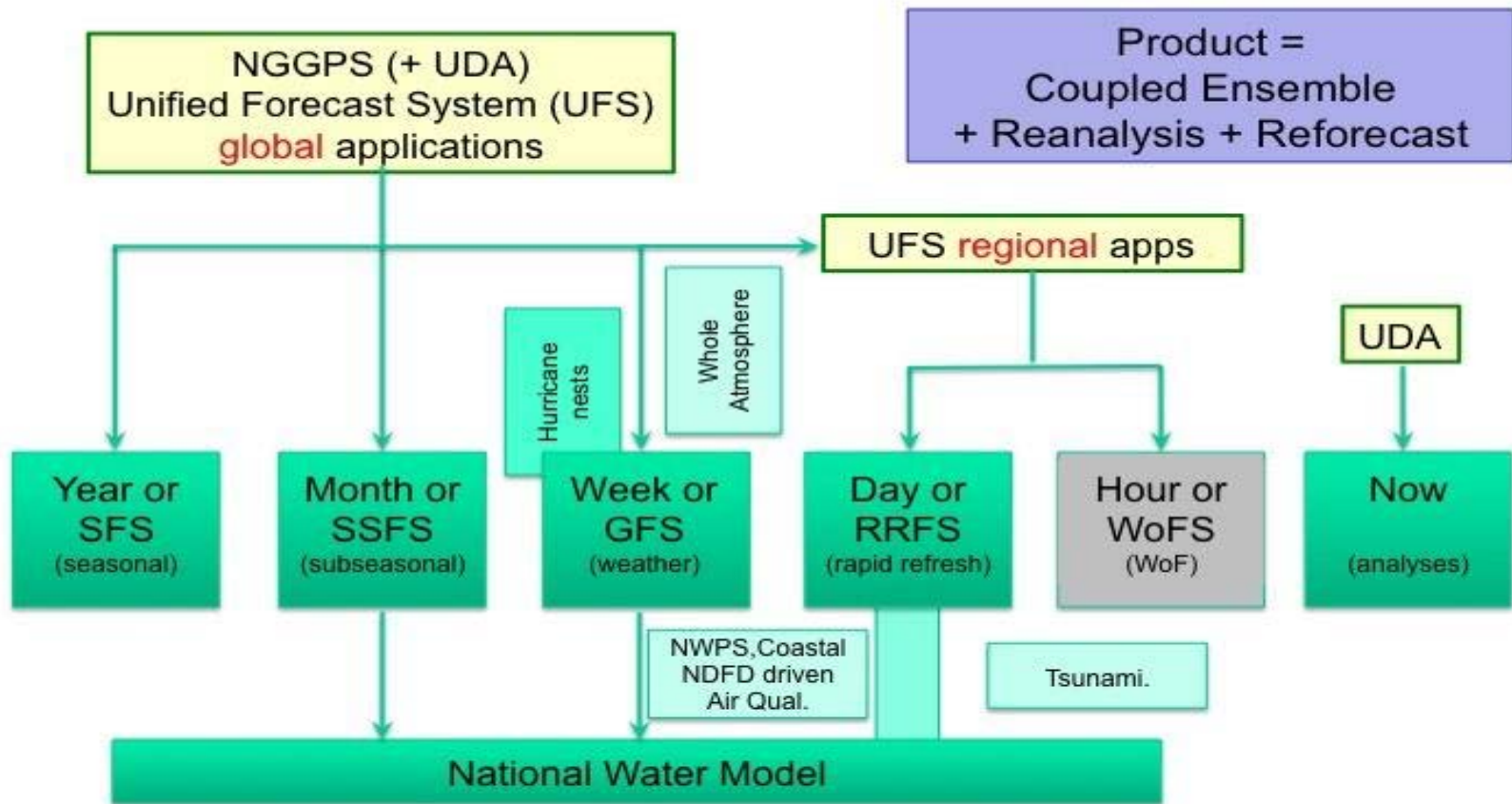
*ESMF/NUOPC/NEMS architecture enables unified global and regional coupled modeling and DA*

*Consistent with broader community (CESM) and US National ESPC*





# Unified Forecast System NWS Operational Applications

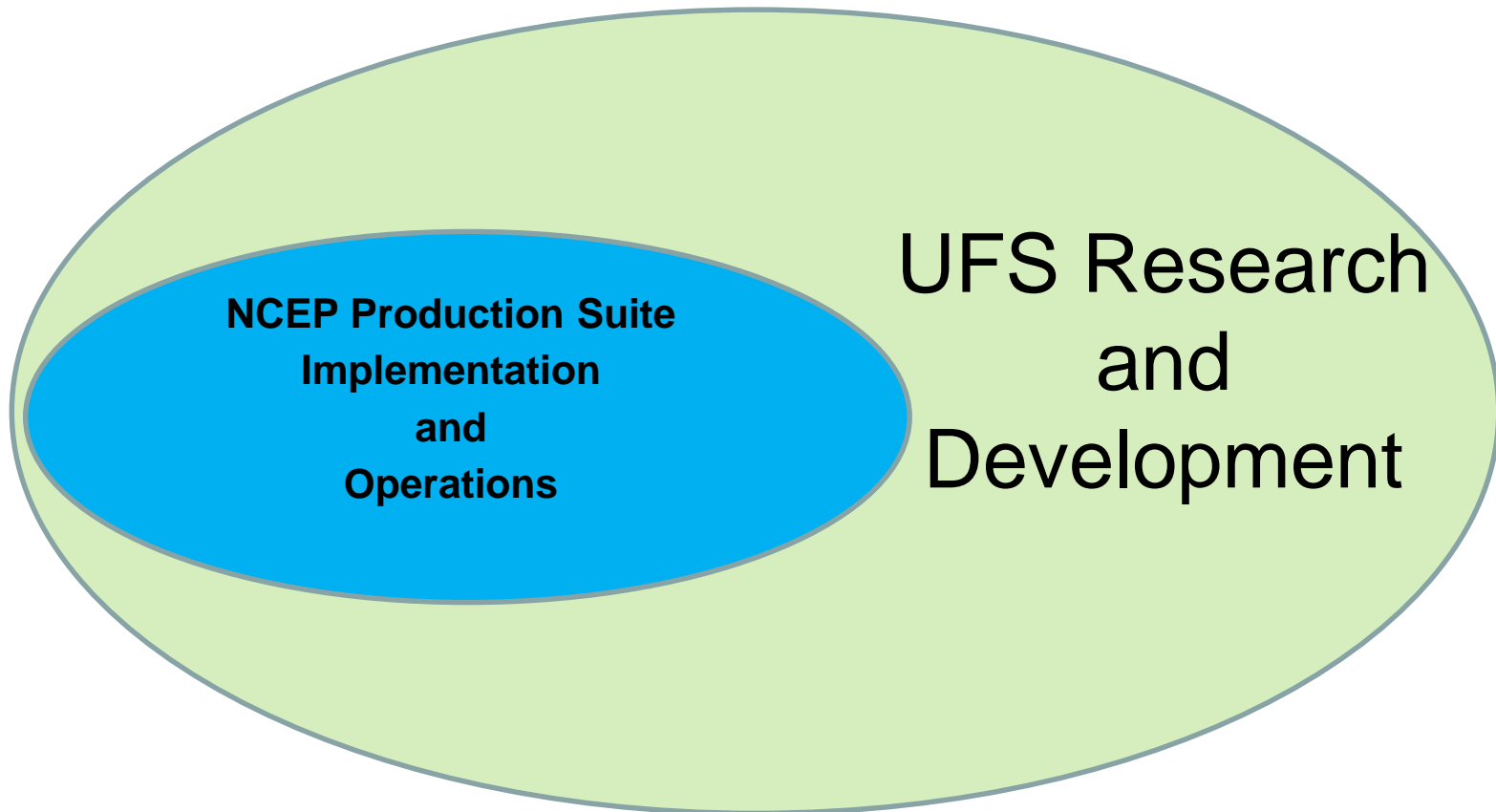


UDA: Unified Data assimilation  
SFS: Seasonal Forecast System  
SSFS: Subseasonal Forecast System

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



# Unified Forecast System Governance



Governance functions at the interface of the NCEP Production Suite, the broader UFS and the broader research and development community. What is being governed is: a community-based, unified, coupled modeling system suitable for application in NCEP's Production Suite (UFS).

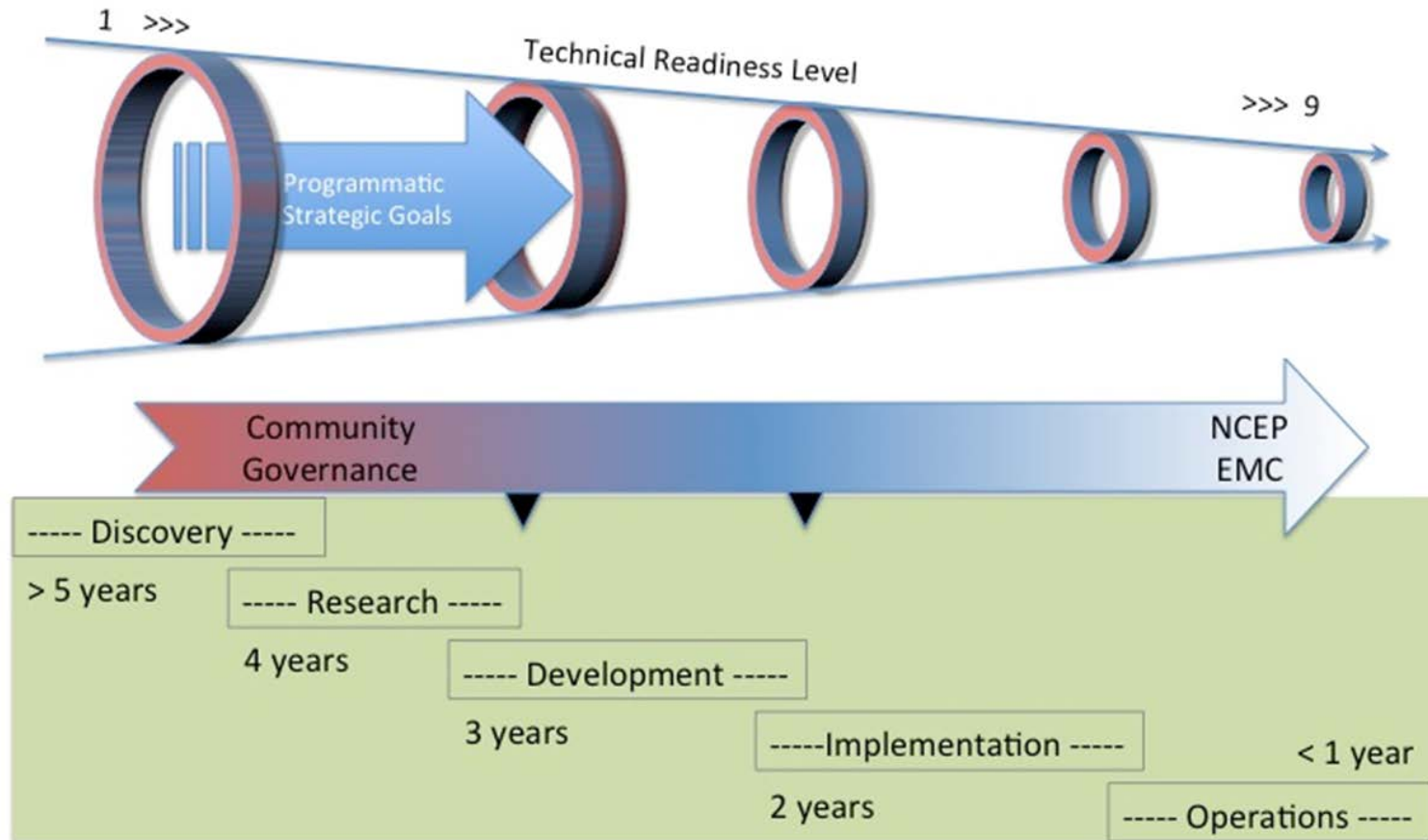




# Community Governance Unified Forecast System

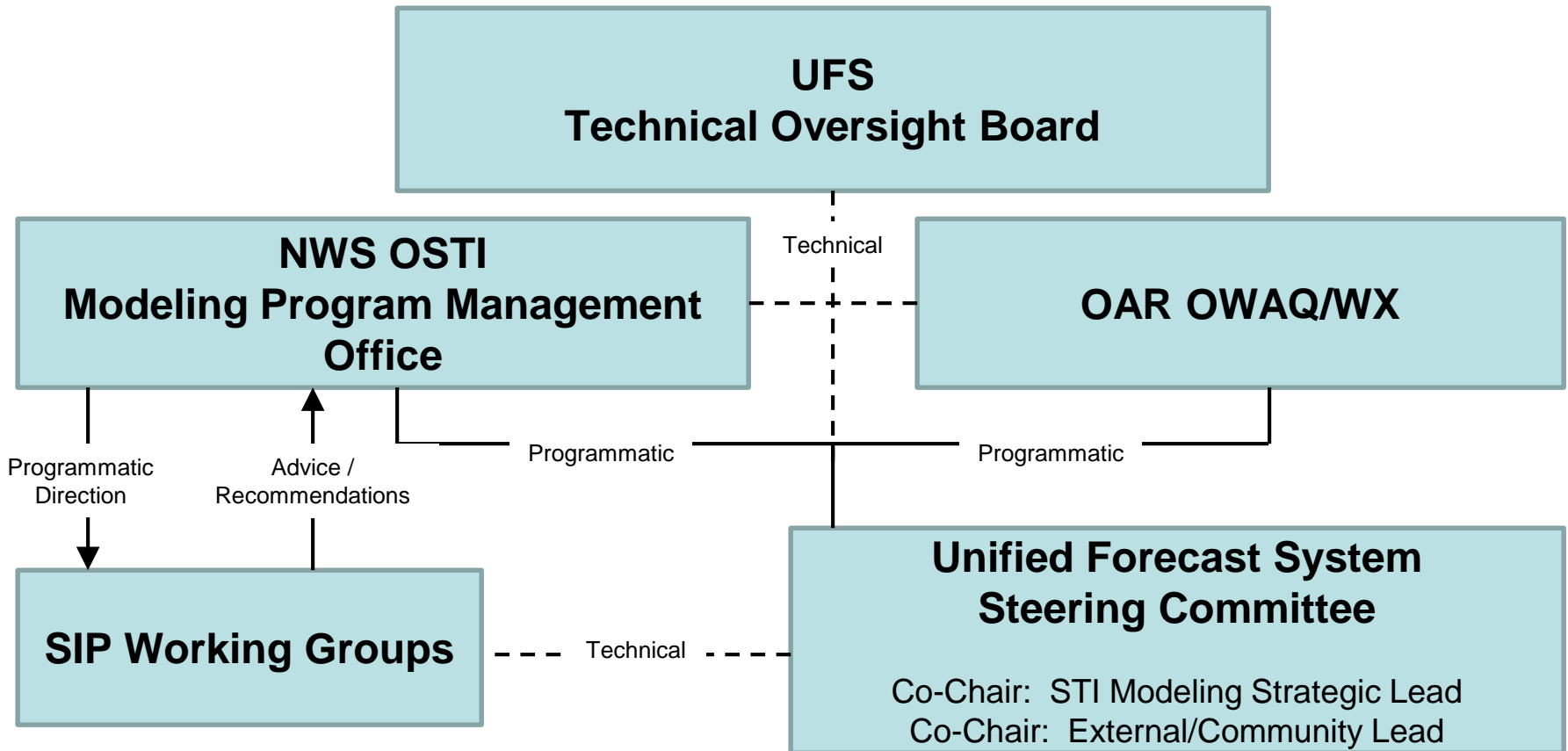


## Community Governance: Unified Forecast System



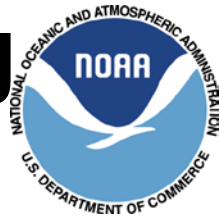


# Unified Forecast System Management and Executive Oversight





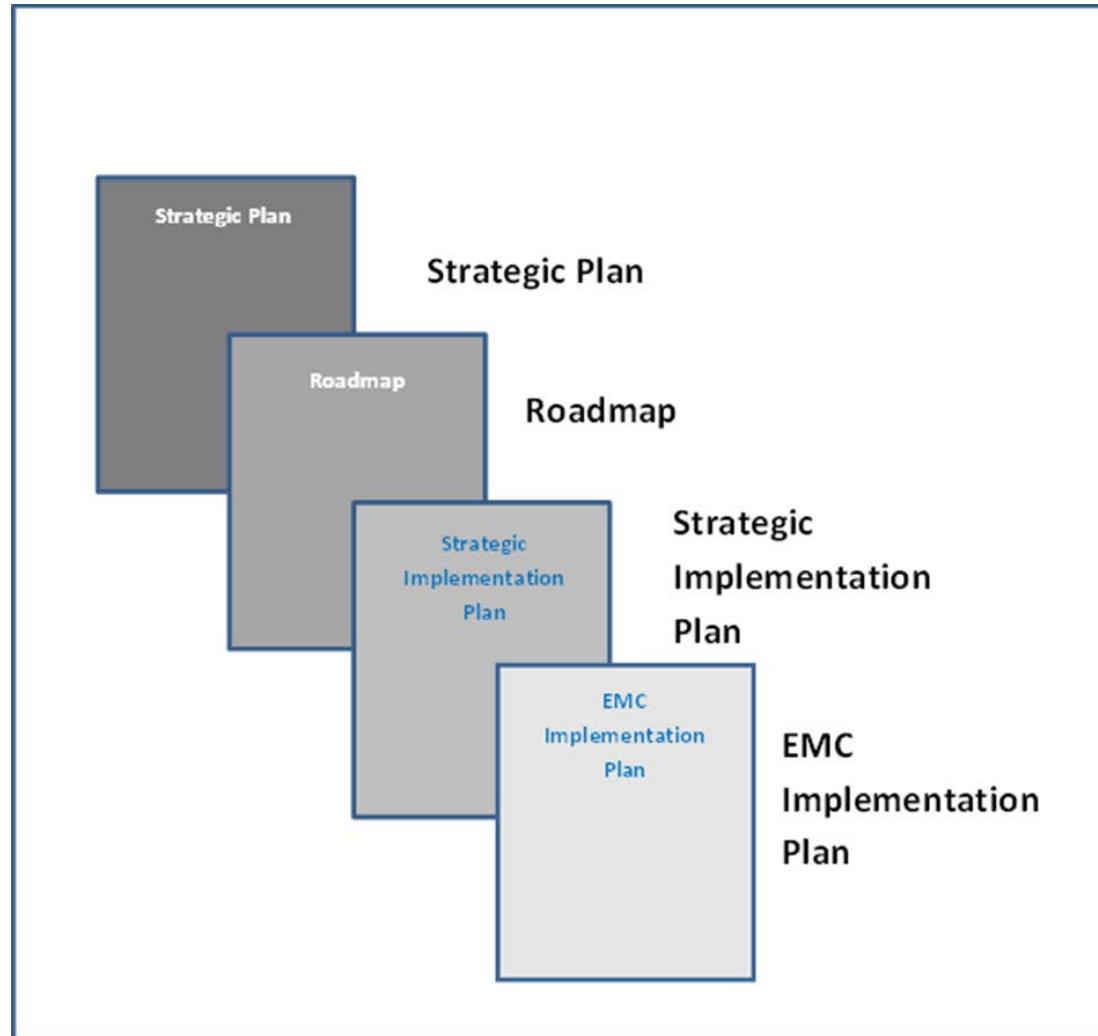
# Approach for Unified Modeling Planning



- 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 with NOAA and external partners



# NOAA – UFS Planning Documents Hierarchy





# SIP Goals and Objectives for Unified Model



- 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
  - NGGPS: foundation to build upon
  - Activities include R&D, testing/eval, V&V, R2O, shared infrastructure, etc.
- 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
  - SIP Version 1.0, a 3-year plan (FY 2018-2020) is posted at [https://www.weather.gov/sti/stimodeling\\_nggps\\_implementation](https://www.weather.gov/sti/stimodeling_nggps_implementation)
  - SIP will be rolling 3-year plan updated annually



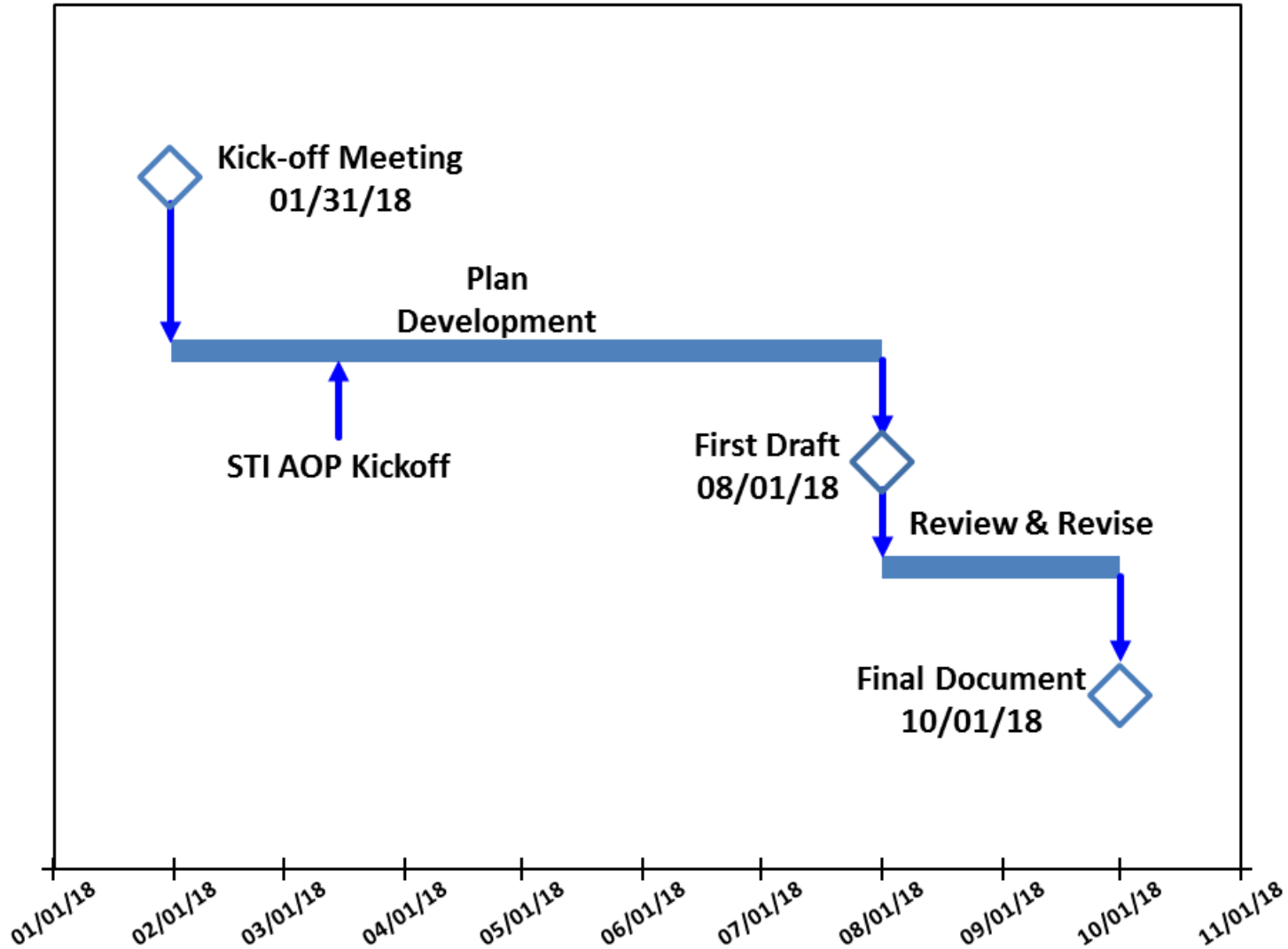
# Unified Forecast System SIP Planning Cycle



- UFS Strategic Implementation Plan - a rolling 3-year plan, updated annually
  - FY18 – 20 (initial cycle) published in November 2017
  - FY19 – 21 to be published October 2018
    - Initial kick-off January/February 2018
    - Update development Spring and Summer 2018
    - Draft developed at semi-annual meeting (August 2018)
    - Final Draft published - October 2018



# Annual SIP Process





# SIP Working Groups



- ~~*Governance*~~ ( → *UFS-SC/TOB*)
  - 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





# SIP Working Group Near-Term Priorities



- System Architecture
  - Continuing support for FV3-GFS Coupling Projects and assessment of system architecture framework and infrastructure requirements, capabilities, and gaps with respect to possible development paths
- Infrastructure
  - Community coordination of unified workflow (Community Research and Operations Workflow (CROW))
- Dynamics/Nesting
  - Broadened community testing/evaluation of FV3-GFS upon broad release; multiple moving nests for hurricanes



# SIP Working Group Near-Term Priorities



- Atmospheric Physics
  - Provide recommendations for new parameterization testing/evaluation priorities (advanced scale-aware physics)
- Data Assimilation
  - Advance JEDI; focus on improved techniques for incorporating new data streams; develop a longer-term (5-10 year) plan for DA improvement to guide near-term (1-3 year) priorities; 4D-Var?
- Ensemble Development
  - Conduct retrospective and real-time experiments, testing and evaluation, and transition to operations
- Post Processing
  - Recommend path forward for coordinating and ensuring unification of MDL post-processing activities/plans (including the NBM) with the Strategic Implementation Plan



# SIP Working Group Near-Term Priorities



- Verification/Validation
  - Unification of verification methods under MET; develop end-to-end system test plan
- Marine
  - ALE related activities? MOM follow-on?
- Land/Hydrology
  - Upgrade of the current operational GLDAS?
- Aerosols/Atmospheric Composition
  - Unification of development using NUOPC coupling with FV3-GFS; data assimilation



# SIP Working Group Near-Term Priorities



- Mesoscale/CAM
  - Prioritizing activities to expedite FV3-based CAM; development/implementation in multiple applications (hurricane, RAP/HRRR, HRRRE)
- Communications/Outreach
  - Establish a foundation for communication, by forming a communication organization (Communications Focus Team), defining an identity for the UFS enterprise, and establishing a common vocabulary



# How STI and OWAQ Use SIP



- Funding Priorities
- Funding Determinations
- Hurricane Supplemental Planning
  - Begin with SIP Modeling Research and Development Activities
  - Accelerate as appropriate!
  - Augment as appropriate!



# Meeting Objective/Goal



- Objective: To present the status of SIP activities and facilitate coordination among SIP working groups in preparation for an annual update of the SIP for FY19-21
- Groups will present progress and successes, and address issues and dependencies requiring resolution
- Updates on special topics (Unified Forecast System Governance, Community Engagement) and focused sessions in specific areas (DA, CAM, and Verification and Validation) will be included
- Goal: SIP working group co-leads will obtain direction and information needed to return to their working groups and coordinate updates to their respective SIP Annexes for the annual update of the SIP
  - Anticipate reconvening to develop the final draft of SIPv2 in August 2018



# Potential Hurricane Supplemental



- Lay Foundation for UFS upgrades/improvements addressing potential supplemental objectives
  - Data Assimilation
  - Hurricane Intensity Research and Development
  - Coupled System Development
  - CAM Development
  - Storm Surge



**STI Modeling Program Website:**

**<http://www.weather.gov/sti/stimodeling>**

**Information NGGPS:**

**[http://www.weather.gov/sti/stimodeling\\_nggps](http://www.weather.gov/sti/stimodeling_nggps)**

**Strategic Implementation Plan**

**[https://www.weather.gov/sti/stimodeling\\_nggps\\_implementation](https://www.weather.gov/sti/stimodeling_nggps_implementation)**

**Information on Grants:**

**<http://www.weather.gov/sti/stigrants>**





# Back-Up



# FV3-GFS near-term plans



Version 1.1 January 2018		Implementation Plan for FV3-GFS (FY2017-2020)																% complete
FV3GFS		FY17				FY18				FY19				FY20				
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
FV3 Documentation	Evaluate, prepare and document FV3 dycore for GFS																	80%
FV3 Dycore in NEMS	Implement FV3 dycore in NEMS@																	100%
FV3 Dycore with GFS Physics	Couple FV3 to GFS physics (NUOPC physics driver) perform forecast-only experiments, tuning and testing																	90%
Preliminary GSI/EnKF DA for FV3	Develop DA techniques and use new data																	90%
Cycled FV3GFS* experiments (real-time parallels)	Cycled experiments, benchmarking, efficiency and optimization																	20%
	Real-time parallel FV3GFS forecasts to the field																	0%
Advanced Physics&	Couple FV3 to Advanced physics (NUOPC physics driver) perform forecast-only experiments, tuning and testing&																	30%
Post Processing	Adapt post-processing & downstream to FV3 Dycore																	50%
Verification	Test & evaluate using Global MET transition to Operation																	0%
Pre-implementation T&E for FV3GFS@&%	3-year retrospective + real-time parallels, EMC and Community Evaluation																	0%
Transition to semi-operation*	FV3GFS Experimental*																	0%
Transition to operation@&%	NCO Parallel FV3GFS in Operation @&%																	0%
Advancement of FV3GFS	Further advancements of FV3GFS with inputs from NGGPS and community contributions & Global-Meso unification (Unified Model Development)																	0%

\* Q3FY18 FV3GFS will be very similar to operational GFS being implemented in May 2017

@ Q3FY19 FV3GFS target resolution is ~10km grid with 127 layers, extends up to 80 km.

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

% DA system with higher resolution consistent with the model and using 4d-Hybrid EnVAR



# FV3-GFS Release Schedule



## FV3-GFS Release v0

- released in **May 2017**
- Access by request (core developers and trusted users)
- Limited capability: forecast only experiment on WCOSS, Theia and Jet

## FV3-GFS Release v1

- planned for **March 2018**
- Core developers and trusted users to get access through **Vlab/Git**
- Public release through **github.com**
- Full capability; including Data Assimilation and Post-Processing
- Instructions and documentation at NCEP Vlab FV3-GFS community page

**VIRTUAL LAB**  
WHERE GREAT IDEAS BECOME OPERATIONAL REALITY

FV3GFS Home

FV3GFS Version 0 Release

**Announcing the Version 0 Release of the FV3GFS!**  
NOAA users and external partners with NWS Virtual Lab access can view the release information, as well as other developmental details, in the FV3GFS Community.

**NGGPS and FV3 Dynamic Core:**  
NOAA GFDL's Finite Volume Cubed Sphere (FV3) dynamical core was selected for the new NGGPS atmospheric model. FV3 dynamical core implementation includes incorporating FV3 into NEMS, and developing advanced physics and data assimilation techniques to match or exceed the skill of operational Global Forecast System (GFS). In addition, NWS is working with federal partners, universities, and the community to create a fully accessible community model.

NGGPS FV3-based Unified Modeling System will be a community guided system. Additional information can be found on the [Community Participation](#) page.

[Click here to view a 2016 FV3 Workshop presentation by the GFDL FV3 team.](#)

Documentation of FV3 Dynamic Core is available through various documents listed below.

FV3	A brief overview of the FV3 dynamical core	General description that is part of FV3 Documentation.
FV3	A class of the van Leer-type Transport Schemes and its Application to the Moisture Transport in a General Circulation Model	Scientific Journal Article that is part of FV3 Documentation.
FV3	A Control-Volume Model of the Compressible Euler Equations with a Vertical Lagrangian Coordinate	Scientific Journal Article that is part of FV3 Documentation.
FV3	A finite-volume integration method for computing pressure gradient force in general vertical coordinates	Scientific Journal Article that is part of FV3 Documentation.
FV3	An explicit flux-form semi-Lagrangian shallow-water model on the sphere	Scientific Journal Article that is part of FV3 Documentation.
FV3	A Two-Way Nested Global-Regional Dynamical Core on the Cubed-Sphere Grid	Scientific Journal Article that is part of FV3 Documentation.

**How to access the FV3GFS Version 0 Release**

**NON-NOAA USERS**  
Users outside of NOAA will need to obtain a VLab External Partner Account. To get an external partner account please fill out the [FV3GFS External Partner Request Form](#).

**NOAA USERS AND EXTERNAL PARTNERS**  
[FV3GFS VLab community.](#)  
NOAA users and external partners with VLab access: 1) click "Sign In" on top right of this page, 2) once signed in click on "All Available Communities" in the "My Communities" portlet on the left side, 3) scroll down the list to find the "FV3GFS" community and 4) click "Join" next to the community. Then navigate to the community home page through your "My Communities" list at the top by this link:  
<https://vlab.ncep.noaa.gov/group/fv3gfs/>

**FV3GFS Redmine & Git repository:**  
(access requested through form in FV3GFS VLab community)  
<https://vlab.ncep.noaa.gov/redmine/projects/comfv3>

**EMC SVN repository:**  
(users with pre-established access to EMC SVN server)  
<https://svn.ncep.noaa.gov/trac/nems/>

Documents and Media Display

Release Version 0 Documents

Last Updated 5/15/17 5:22 PM | Subfolders | Documents

- Access FV3-GFS Project on VLab <https://vlab.ncep.noaa.gov/web/fv3gfs>
- Code repositories set up on VLab GIT
- Community Wiki page, Forums and Developers Pages on VLab

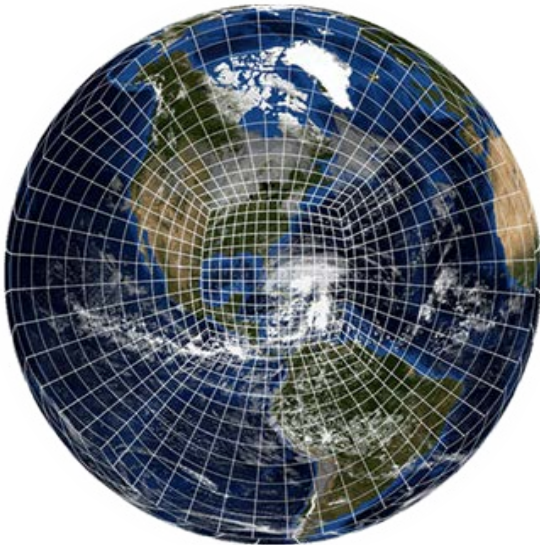


# FV3 for Convection Allowing Models



## Completed

- Q3FY17: Initial concept ensemble test case with FV3 nesting on a stretched cube (manually run)



## Near-term Milestones

- Q1FY18: More testing with global FV3 with a 3 km CONUS nest on a stretched cube including ensemble display tools
- Q1FY18: Develop a standalone regional FV3 capability
- Q3FY18: Static nests running in standalone regional FV3
- Q4FY18: Integration/testing of advanced physics in nested FV3
- Q2FY19: Compare pure FV3-based HREF with multi-model HREF

- CAPS was funded by NGGPS to enhance/evaluate FV3 at CAM (~3km) resolution during the HWT Spring Experiment
  - Enhancement included implementation of Thompson microphysics and several PBL schemes
- Evaluation demonstrated results comparable to WRF



# GMTB

## CCPP schedule



- **CCPP v1 release (Mar 2018):** FY17 GFS Suite in CCPP + SCM. Target audience: public release.
- **CCPP Demo capability (Apr 2018):** FY17 GFS Suite in CCPP + latest FV3-GFS at top of trunk (with modifications to build system, run scripts etc. to work with CCPP). Target audience: developers and trusted collaborators.
- **CCPP v2 release (Q3 FY18):** FY17 GFS Suite in CCPP + FV3 v1. Target audience public. Use FV3-GFS Beta Physics configuration (replace Zhao-Carr with GFDL MP; and other changes to GFS physics as needed).



# Currently Funded Academic Community Projects



- NWS/STI supports collaborative development by the external/academic community through these programs:
  - NGGPS: Next Generation Global Prediction System
  - S2S: Seasonal to Sub-seasonal (Weeks 3-4) forecasting improvements
  - HFIP: Hurricane Forecast Improvement Project
  - CSTAR: Collaborative Science, Technology, and Applied Research
  - Full list of STI grants (<http://www.weather.gov/sti/stigrants>) and also in the NOAA VLab CSTAR community
- Total funding in FY17: ~ \$5.4M for 35 projects



# NWS Funding Opportunities



- **2 companion Federal Funding Opportunities (FFO)**
- The first FFO has two separate competitions: **NGGPS and HFIP**
  - NGGPS: Collaborative projects with EMC or CPC researchers, including S2S projects
  - HFIP: Collaborative projects with EMC or NHC researchers
- Open only to non-federal applications in the academic community (no funding for feds or contractors)
- Estimated funding available: \$2.5M for NGGPS, \$1M for HFIP
- 2-year projects, maximum funding \$200K/year
- LOIs: not required, due date was December 8, 2017
- **Full applications due: February 7, 2018**
- Expected project start date: September 1, 2018



# NWS Funding Opportunities

## NOAA Testbeds

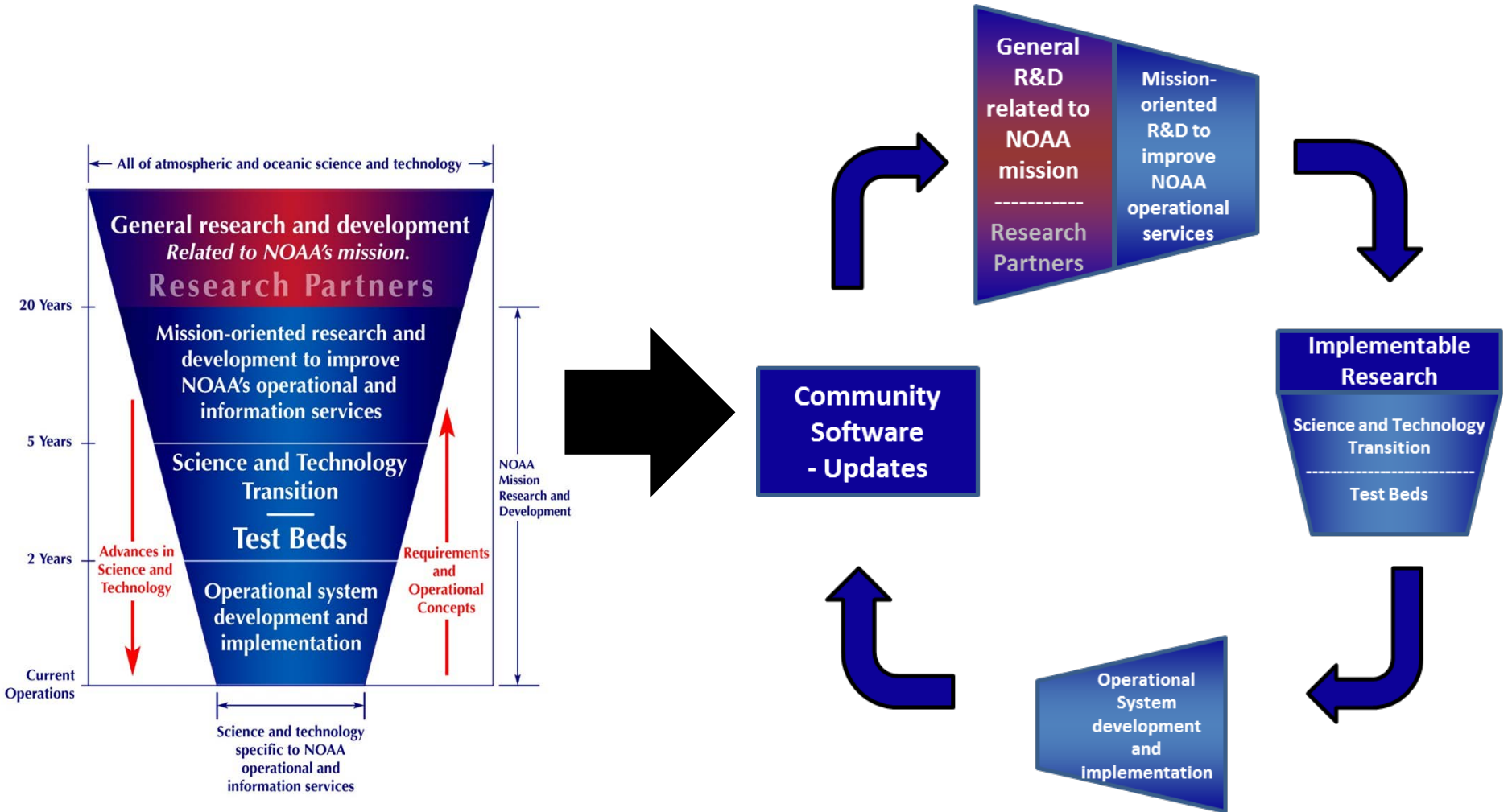


- The second FFO will have 1 competition: **NOAA Testbeds**
- These are NNGPS modeling projects which have a collaborative partnership with 1 or more NOAA Testbeds
- Open to federal and non-federal applications
- Estimated funds available: up to \$1M
- 2-year projects, maximum funding \$200K/year
- LOIs were **required** and due December 13, 2017
- Full applications due: February 7, 2018
- Expected project start date: September 1, 2018



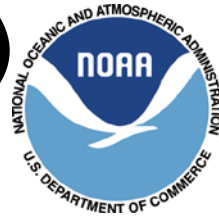


# Rethinking the R2O Funnel





# 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)
- Aug 2017: Meeting to draft SIP v1.0 (College Park, MD)
  - Incorporate Community inputs; SIP v 1.0 will be initial, “living” document
- October 2017: Formal comment period
- December 2017: SIP published
- January 31 – February 1, 2018: NGGPS/SIP Community Meeting
  - Update WG input and extend plans
- Forums at upcoming major conferences
  - AGU (Dec 11-15, 2017; New Orleans)
  - AMS (Jan 7-11, 2018; Austin TX)
  - AGU Ocean Sciences (Feb 11-16; Portland, OR)
  - *Any others? Seeking additional ideas from the community...*



# Unified Forecast System Technical Oversight Board



ORGANIZATION / POSITION	PRIMARY	ALTERNATE
Board Members		
NWS/STI	Ming Ji ( <b>Co-Chair</b> )	Hendrik Tolman
OAR/OWAQ/WX	John Cortinas ( <b>Co-Chair</b> )	
NWS/NCEP	Bill Lapenta	
NWS/EMC	Brian Gross	Vijay Tallapragada
NWS/SWPC	Brent Gordon	
OAR/ESRL	Kevin Kelleher/Robin Webb	
OAR/GFDL	V. Ramaswamy	Whit Anderson
OAR/AOML	Robert Atlas	
OAR/ARL	Ariel Stein	
OAR/GLERL	Deborah Lee	
OAR/NSSL	Stephen Koch	
OAR/CPO	Wayne Higgins	
NOS/CSDL	Richard Edwing?	
NASA	Steven Pawson/Tsengdar Lee	
NCAR/RAL	Scott Swerdlin/Louisa Nance	
NCAR/MMM	Chris Davis	
NCAR/CGD	Bill Large	
OWP	Tom Graziano	
NAVY/NRL Stennis	Ruth Preller	