

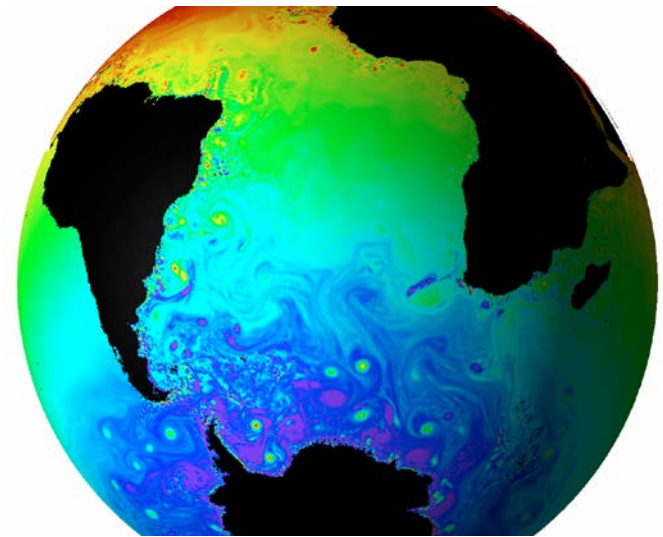


Next Generation Global Prediction System (NGGPS)

CICS-MD Science Meeting

24 November 2015

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(NWS/OSTI)





NGGPS Objectives



- Re-establish US as the world leader in global weather prediction
 - Extend forecast skill beyond 8 to 10 days
 - Improve hurricane track and intensity forecast
- Extend weather forecast to 30 days
 - Implement a weather-scale, fully-coupled numerical weather prediction system
 - Support development of products for weeks 3 and 4
- Support unification of the NWS numerical weather prediction suite
- Multi-year community effort
- Position NWS to take advantage of advanced high performance computing architectures



NGGPS Over-Arching Strategy



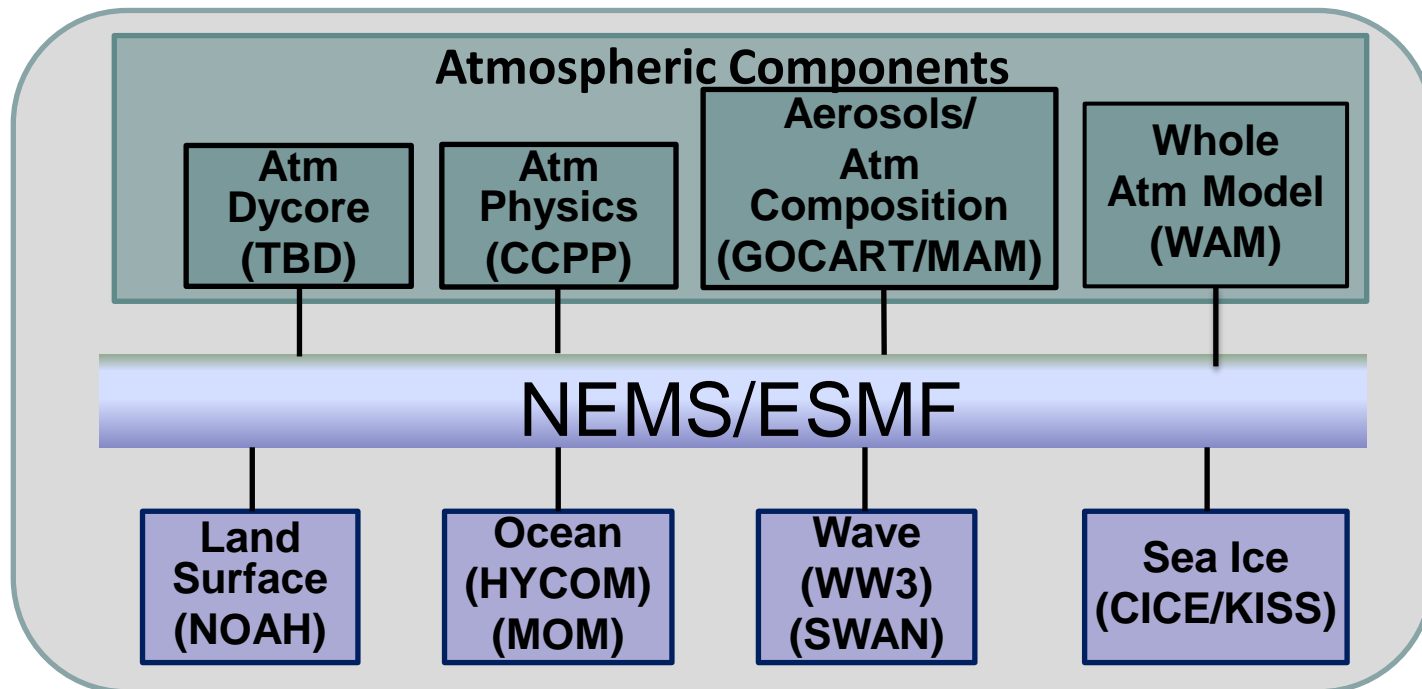
- Multi-year NWS-led community effort to build and implement
 - Future global weather prediction system supporting multiple forecast applications at NCEP
 - Availability of community codes
- Enhance forecast performance improvement through accelerated research to operations
 - Funds supporting both R&D and operations
 - Implement a Global Modeling Test Bed
- Overall system designed (re-architected) to take advantage of evolving HPC architectures (CPU/GPU Hybrid or Massively Integrated Cores (MIC))
 - Highly scalable
 - Adapt to continued evolution of HPC
 - Support modeling suite migration to fine grain computing



NGGPS Description



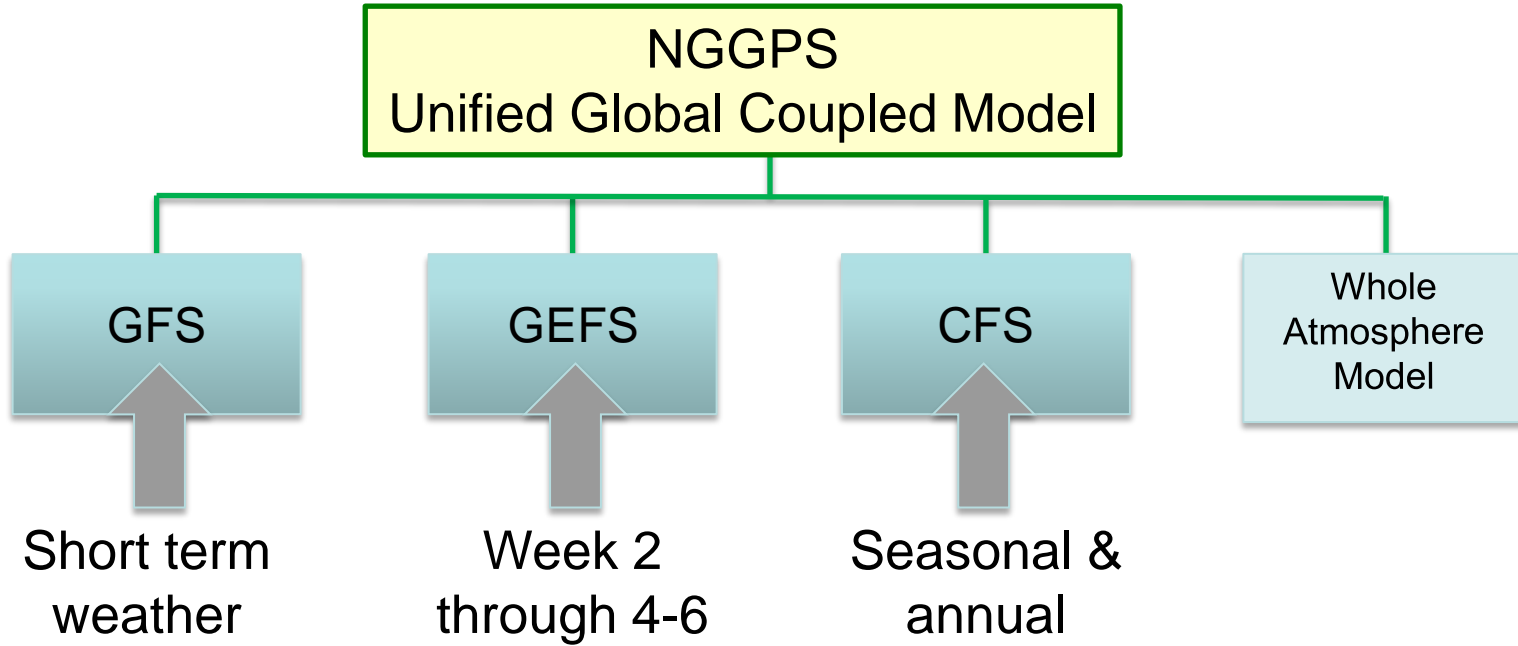
- Fully-coupled system with ocean, waves, sea ice, land surface, atmosphere, aerosols and atmospheric composition model components
- Built using NEMS/Earth System Modeling Framework
- Each component model will be community code





NGGPS

Planned Operational Applications

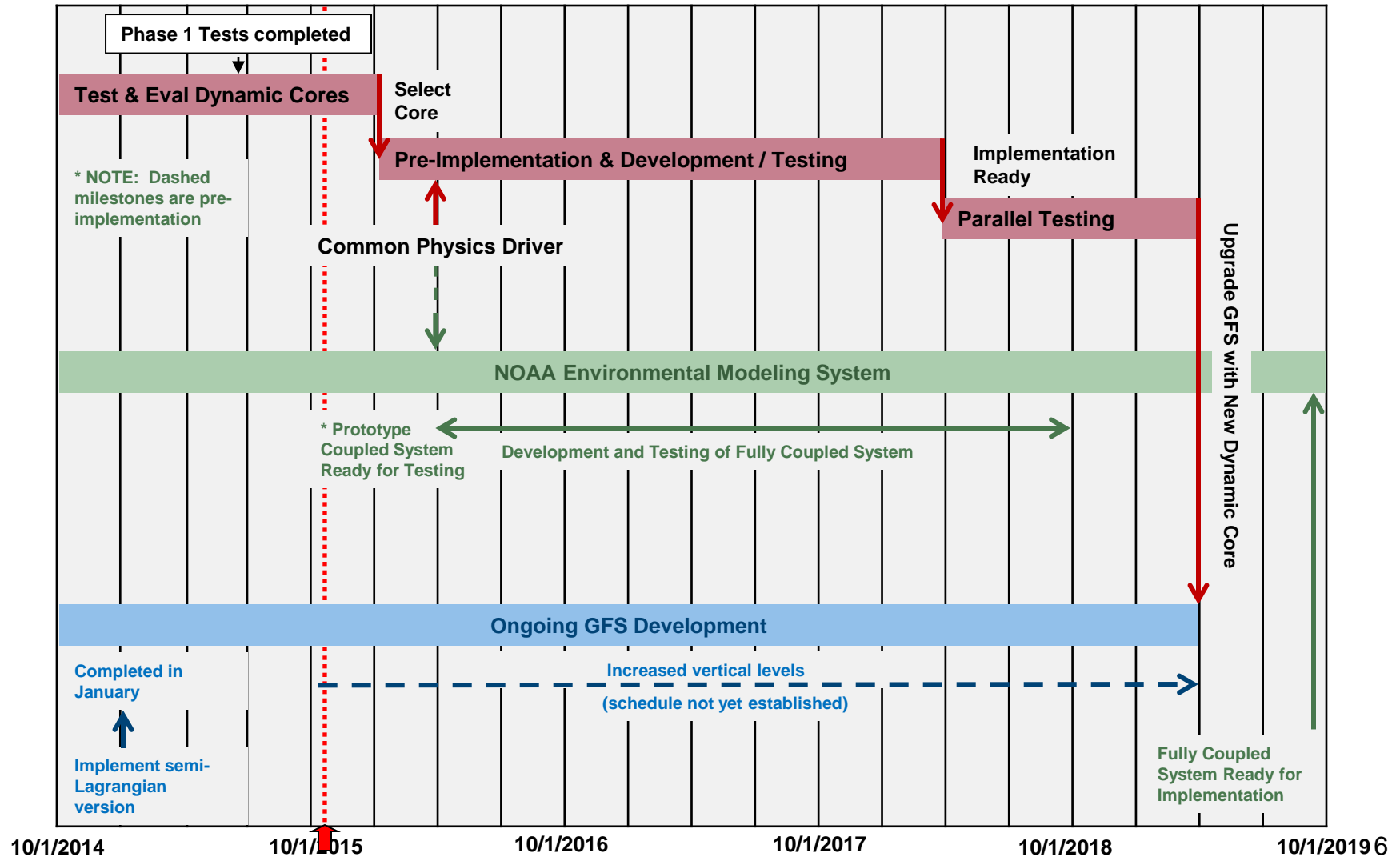


Application = Ensemble + Reanalysis + Reforecast

Research needs to fit into strategy



NGGPS Implementation





Current Major Activities



- Conduct atmospheric model dynamic core evaluation
- Improve physics packages
- Accelerate model development, upgrade operational data assimilation, advance ensemble systems
- Initiate NGGPS Test Bed activities / Global Modeling Test Bed
- Accelerate NEMS - Develop prototype coupled system
- Improve software engineering
- Upgrade EMC infrastructure to support community participation
- Broaden community participation



Announcement of 2016 Federal Funding Opportunity



- Soliciting proposals for two-year projects involving data assimilation, prediction, ensemble development, post-processing, advances in verification methods, and weeks 3-4 products
- Eligibility – Institutions of higher education, federally funded educational institution
- *Letters of Intent will be due January 19, 2016*
- *Applications will be due February 29, 2016*
- Anticipated total announcement funding is \$3.2M annually
 - \$2.6M is restricted to non-governmental only – max award \$200K/yr
 - \$600K is for testbed related activities for public and private sector/university partnership encouraged

Announcement will be posted on <http://www.grants.gov>



NGGPS Modeling Priorities



- **Data Assimilation:** Advance techniques for remotely sensed observations, coupled ocean forecasts, position errors of cyclones/hurricanes, and improved forward observation models (4d-Var)
- **Prediction:** Improve the representation of atmospheric model dynamics, and the representation of atmospheric model physical processes through coupling with land surface, ocean, waves, sea ice, and aerosols, atmospheric components
- **Ensemble Development:** Further methods for ensemble initiation and the treatment of model uncertainty in ensembles
- **Post-Processing:** Extend techniques and the development of methods suited to the 15-30 day time range
- **Verification Methods:** Advance model forecast verification methods by identifying the uncertainties in methods comparing analyses and observational data sets
- **Weeks 3 and 4 Products:** Improve forecasts of precipitation, and near-surface air temperature over the US



HFIP Priorities



- **Data Assimilation:** Advance techniques specific to hurricane numerical weather prediction
- **Hurricane Intensity Errors:** Develop new and/or enhance techniques for high resolution model physics, vortex initialization, and downstream applications for landfalling storms to reduce hurricane intensity errors
- **High Resolution Ensembles:** Demonstrate the value of high resolution single model or multi-model ensemble approaches to improve hurricane forecast guidance
- **Post-Processing:** Increase hurricane forecaster utility of tropical cyclone forecast guidance for genesis, track, and intensity



NGGPS Testbed Priorities



- Advance forecasts for days 6-10, in collaboration with the Hydrometeorology Testbed (HMT)
- Develop forecast tools and applications to reduce hurricane intensity errors, and provide improvements of observation data assimilation in the hurricane and tropical storm prediction subsystem, leveraging the Joint Hurricane Testbed (JHT)
- Support advances in forecasts for weeks 3-4, partnering with the Climate Test Bed (CTB)
- Develop advances in forecasts for high-impact weather focusing on days 0-3, in cooperation with Hazardous Weather Testbed (HWT) and Aviation Weather Testbed (AWT)



2015 Federal Funding Opportunity NGGPS Proposals Selected



University	Principal Investigator	Proposal Title	Research Subject Area
George Mason University	James Kinter	Accelerating Development of NOAA's Next-Generation Global couple System for Week-3 and Week-4 Weather Prediction	Ensemble Development 3-4 Week Model Improvement
SUNY Stony Brook	Ping Liu	Calibration and Evaluation of GEFS Ensemble Forecasts at Weeks 2-4	Ensemble Development
Columbia University in the City of NY	Andrew Robertson	Development and testing of a multi-model ensemble prediction system for sub-monthly forecasts	Ensemble Development
University of Illinois	Zhuo Wang	Developing Physics-oriented Diagnostic Tools for Model Evaluation and Improvement	Data Assimilation - Model Evaluation Tools
University of Wisconsin	James Jung	Development of Advanced Data Assimilation Techniques for Improved use of Satellite-Derived Atmospheric Motion Vectors	Data Assimilation
University of Oklahoma	Xuguang Wang	Improving Global and Hurricane Prediction by Using Minimum-Cost Large Ensemble in GFS 4DVar Hybrid Data Assimilation System	Data Assimilation
University of Maryland	Christopher Hain	Enhancing NCEP GFS Forecasts via Assimilating Satellite Soil Moisture and Snow Observations	Land Data Assimilation
	Daryl Kleist	Improved tropical cyclone initialization for NCEP operations through direct assimilation of storm information	Data Assimilation
	Steve Penny	An Operational Hybrid 3DVar/EnKF Ocean Assimilation System-NCEP	Ocean Data Assimilation
	Zhanqing Li	Evaluating the Impact of Cloud-Aerosol-Precipitation Interaction (CAPI) Schemes on Rainfall Forecast in the NGGPS	Impact of aerosols on clouds and precipitation
SUNY Albany	Sarah Lu	Investigation of Aerosol Effects on Weather Forecast using NCEP Global Forecast System	Aerosol and Radiation Interaction
University of Washington	Clifford Mass	Subseasonal Prediction over the Western US	Post-Processing/Down Scaling
University of Colorado	Timothy Fuller-Rowell	Integrating Unified Gravity Wave Physics into the Next Generation Global Prediction System	Gravity Wave Physics
Pennsylvania State University	David Stensrud	Advancing Storm-Scale Forecasts over Nested Domains for High-Impact Weather	Convective Modeling 12



Federal Funding Opportunity Testbeds Proposals Selected



University/ Organization	Year 1 Total by org	Year 1 Funding \$1,679,452	PI	Testbed	Proposal Title
NOAA/NESDIS STAR	\$170,502	\$170,502	Csizar	JCSDA	Incorporation of near-real-time Suomi NPP Green Vegetation Fraction and Land Surface Temperature data into NCEP Land modeling suite
NOAA/NWS/NCEP	\$128,500	\$128,500	Schemm	CTB	Application of a Hybrid Dynamical-Statistical Model for Week 3 to 4 Forecast of Atlantic/Pacific Tropical Storm and Hurricane Activities
University of North Dakota	\$248,258	\$248,258	Dong	HWT	Improvement of Convective/Severe Weather Prediction through an Integrative Analysis of WRF Simulations and NEXRAD/GOES Observations over the CONUS
University of Oklahoma	\$506,907	\$175,827	Correia	HWT	Data Mining of High-Resolution Storm-Scale Datasets
		\$206,205	Jirak	HWT	Information Extraction and Verification of Numerical Weather Prediction for Severe Weather Forecasting
		\$124,875	Smith	HWT	Data Mining of High-Resolution Storm-Scale Datasets
SUNY Albany	\$421,887	\$196,888	Thorncroft	JHT	Exploitation of Ensemble Prediction System Information in support of Atlantic Tropical Cyclogenesis Prediction
		\$224,999	Bosart	HMT	An Investigation of the Skill of Week Two Extreme Temperature and Precipitation Forecasts at the NCEP-WPC
SUNY Stony Brook	\$203,398	\$203,398	Colle	DTC	Validation of Significant Weather Features and Processes in Operational Models Using a Cyclone Relative Approach



Questions?

NGGPS Website:

<http://www.nws.noaa.gov/ost/nggps>

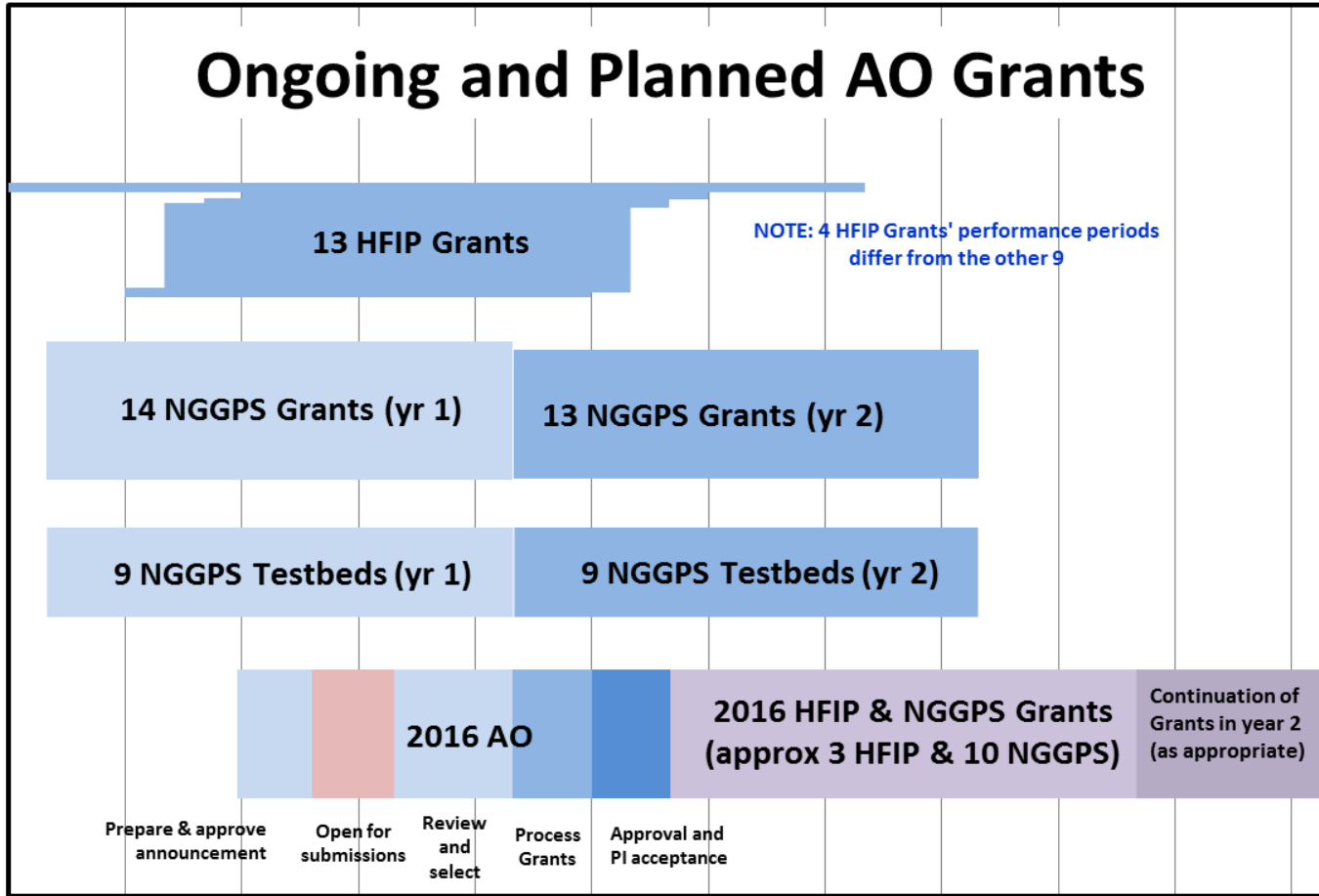


Back-up





Grants



NOTE: 4 HFIP Grants' performance periods differ from the other 9

May need to shift 2016 AO dates

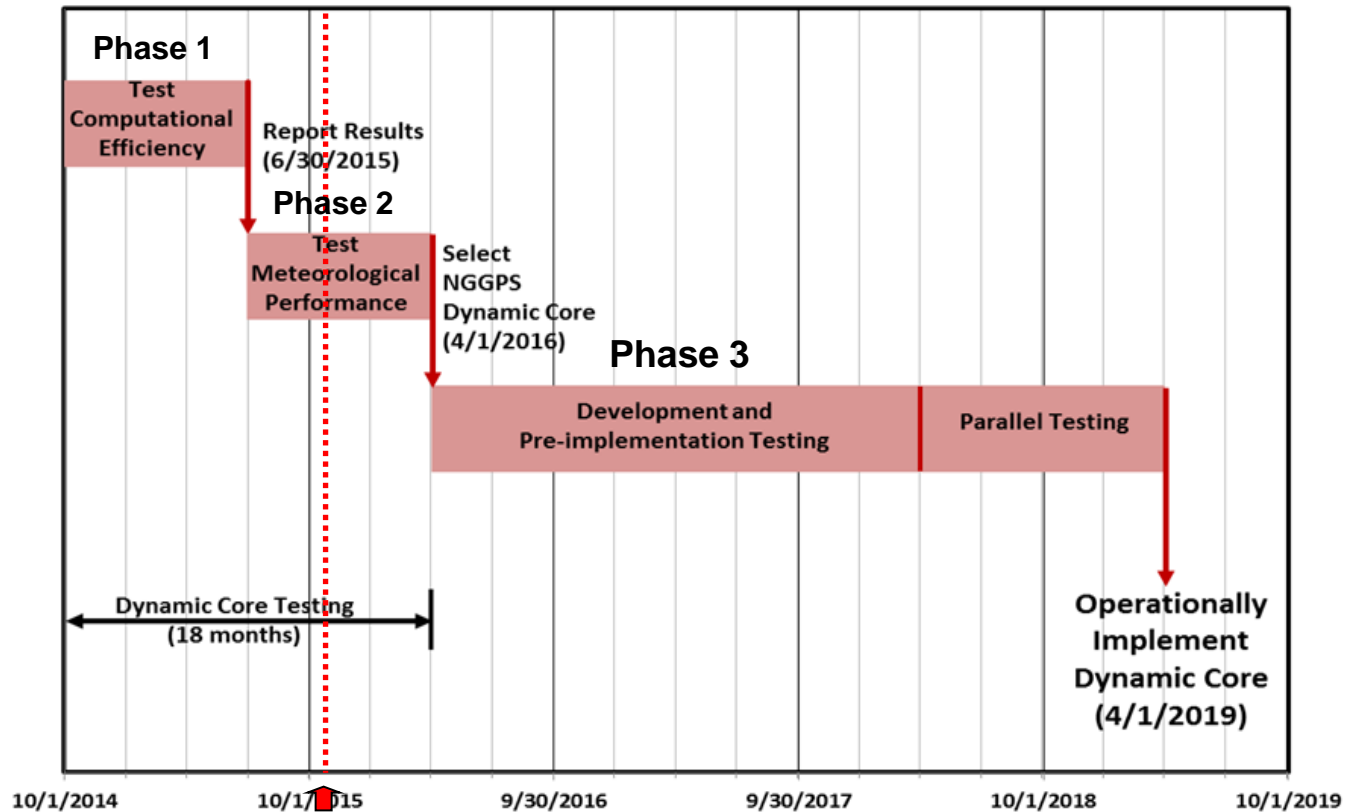
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Atmospheric Dynamic Core



- Select an atmospheric dynamic core from existing research and operational models





Atmospheric Dynamic Core Selection



- Phase 1
 - Utilized High Impact Weather Prediction Project (HIWPP) idealized tests
 - Computational performance and scalability tests, and software evaluation
- Proceeded to Phase 2 testing on schedule with two dynamic cores: FV3 and MPAS
- Phase 2 currently underway
 - Phase 3
 - Potential upgrades needed for initial implementation
 - Elements of compatibility including standards specified by NCEP Central Operations for software structure, coding, scripting, workflow and production utilities



Atmospheric Model Dynamic Core Phase 2 Testing Criteria



Phase 2 Eval #	Evaluation Criteria
1	Plan for relaxing shallow atmosphere approximation (deep atmosphere dynamics)
2	Accurate conservation of mass, tracers, entropy, and energy.
3	Robust model solutions under a wide range of realistic atmospheric initial conditions using a common (GFS) physics package
4	Computational performance with GFS physics
5	Demonstration of variable resolution and/or nesting capabilities, including physically realistic simulations of convection in the high-resolution region
6	Stable, conservative long integrations with realistic climate statistics
7	Code adaptable to NEMS/ESMF
8	Detailed dycore documentation, including documentation of vertical grid, numerical filters, time-integration scheme and variable resolution and/or nesting capabilities
9	Evaluation of performance in cycle data assimilation
10	Implementation Plan (including costs)



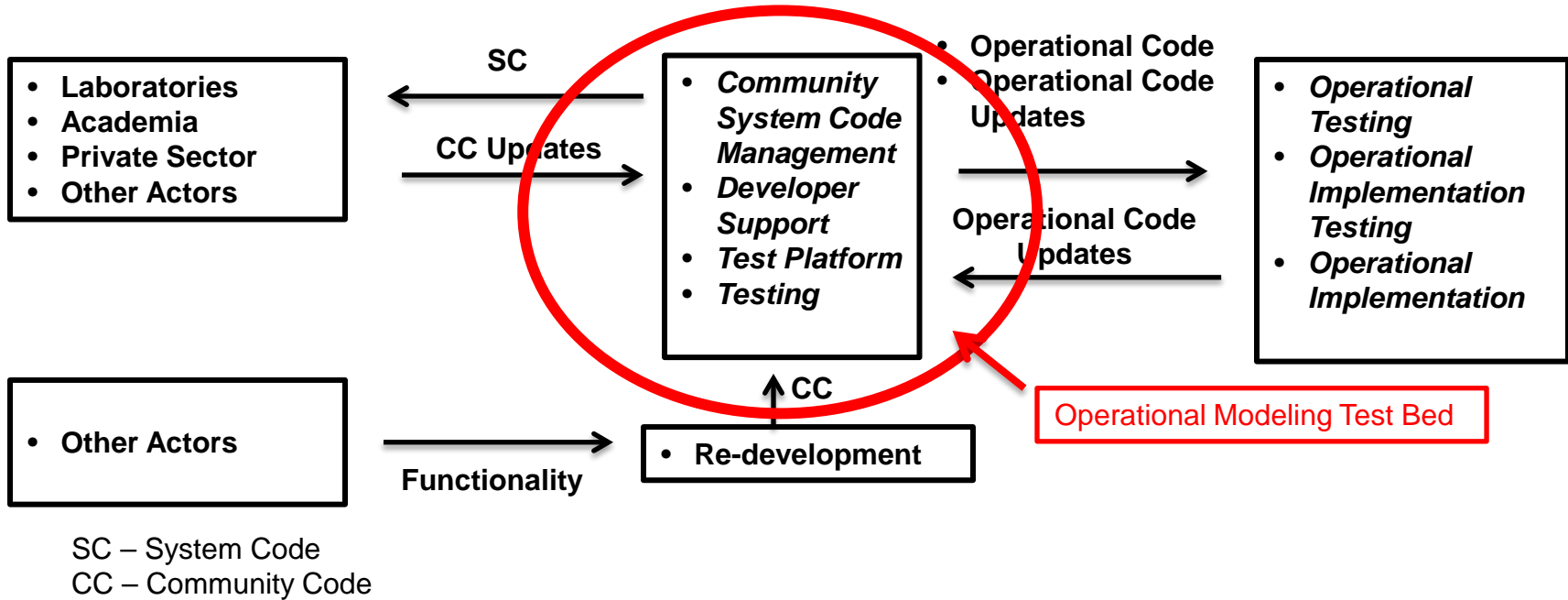
Common Physics Package/Driver



- Snapshot of GFS physics will be used in dynamic core Phase 2 testing
 - GFS physics and prototype driver interface delivered
 - NUOPC Physics Interoperability leading design effort for driver interface
- Environmental Modeling Center (EMC)/National Unified Operational Prediction Capability (NUOPC) Physics Interoperability group are coordinating requirements
- EMC/NGGPS Physics Team to work specifications for common community physics package
 - Scale-aware physics parameterizations
 - Suitable for variable-resolution grids



Global Modeling Test Bed (GMTB) Concept



- Implements concept of *Community Development*
- System Code based on Operational Code (O to R)
- Community System Code supports both Operations and Research
- Proposal for first year activities in development
 - Common community physics package
 - Ice modeling package



Global Modeling Test Bed



- Extension of current DTC (NCAR and GSD partnership)
- Pre-implementation testing of new functionality
- Fosters community involvement in ongoing development of operational modeling systems
 - Community code management
 - Test platform management
 - Provides necessary infrastructure for community to interact with code system
 - Supports code system to external developers
 - Independent test and evaluation of proposed upgrades to operational system from external community



NGGPS Implementation Plan



- Team plan briefings conducted for NGGPS and EMC management to support FY16 spend plan development
- EMC support task (SCITECH contract) awarded 16 July (funds approx 20 positions)
- EMC providing lead recommendations for Science Working Groups and Test and Evaluation Group to support Physics Team planning
 - Convection and Boundary Layer
 - Cloud Microphysics
 - Gravity Wave and Large-scale Orographic (& non-Orographic) Drag
 - Radiation
 - Earth System Surface Fluxes and State
- Physics and Post-Processing Teams planning workshops early 2016
- Team plans to be posted as individual links on website – allows for tailored/responsive updates



Project Activities and Status



- Develop Implementation Plan
 - Plan drafted
 - Revising team plans
 - Team component leads established/approved
 - Incorporated proposal work into team plans
- Broaden community participation
 - Federal Funding Opportunity: \$3.9M awarded to University PI's
 - Internal Announcement: \$2.4M awarded to federal labs
 - Use of community codes/components
- Conduct Atmospheric Model Dynamic Core Evaluation
 - Phase 1 testing completed and results assessed
 - Final report and public release being prepared
 - Phase 2 testing began in FY15Q3
 - GFS Physics driver delivered for dycore testing



Project Activities and Status cont.



- Initiate NGGPS Test Bed activities/ Propose Global Modeling Test Bed
 - Test bed activities defined and funded through FFO
 - Global Modeling Test Bed Proposal approved
 - Includes code management support for common physics package and interoperable physics driver
- Accelerate NEMS - Develop Prototype Coupled System
 - Components (including MOM5, HYCOM, WW3, CICE, NOAH and GFS) to be coupled in a test-ready system by FY16Q2
- Upgrade EMC infrastructure to support community participation
 - Software and Scientific Development at EMC (SciTech Task) being awarded
 - Technical support for NEMS development
 - Software engineering, technical support for infrastructure upgrades
 - R&D for upgrade of global modeling components



2015 Federal Funding Opportunity



- Received 62 proposals for one and two-year projects involving applied science, modeling, DA, and NOAA testbed activities
 - 14 NGGPS proposals selected
 - 9 Testbed Proving Ground proposals selected
- All documentation for proposal selection is finalized and submitted to Grants Management Division.
- Notification and funding distribution expected to take place March 2015



Planning and Development Teams



- Atmospheric Prediction – Dynamics (including Nesting)
- Atmospheric Prediction – Physics
- Aerosols and Atmospheric Composition
- Atmospheric Data Assimilation
- Ocean Prediction (includes waves, sea ice, and data assimilation)
- Land Prediction
- Post-Processing
- Ensemble Design
- Overarching System (architecture and integration including NEMS/ESMF)
- Software Architecture and Engineering
- Infrastructure
- Verification and Validation
- Testbeds

Team participation across NOAA line offices/laboratories, Navy, NASA, UCAR and coordination with the High Impact Weather Prediction Project and the National Earth System Prediction Capability program