Strategic Implementation Plan (SIP) for a Community-based Unified Modeling System: Overview and Introduction

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Outline

• Three-pronged Planning approach to enable change
  – 1) Strategic plan/vision, 2) Roadmap, 3) Strategic Implementation Plan

• Strategic Implementation Plan (SIP)
  – Basic Approach
  – Vision for Community
  – Working Group structure
  – Schedule

• NOAA/NWS evolutionary changes
  – Upcoming NWS/NCEP global model transitions towards unified system
  – Environmental Model Center (EMC) strategic changes

• 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** co-led by NWS/OSTI & OAR/OWAQ
    - High-level **Strategic Plan** + accompanying detailed **Roadmap** document
  - **Short-term (0-3 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
  - Flexible architecture and infrastructure to meet needs of Ops and R&D
- **Evidence-driven** decisions
- Consistent **standards** for all who contribute
- Transparent and robust **governance**
Strategic Vision
Temporal Domains

Unified Coupled Model

Unified Data Assimilation

Year+
(decadal-
centennial)

Year
(seasonal)

Month
(outlook/
sub-seas.)

Week
(weather)

Day
(rapid
refresh)

Hour
(Warn on
Forecast)

Now
( analyses)

Global  Global  Global  Global  Global

Regional refinement  Regional refinement

Down-scaling  Down-scaling  Regional  Regional  Regional
Starting from the quilt of models and products created by the implementing solutions rather than addressing requirements ....
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
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*
  - 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
  - Bring together *broader community*, first as invited WG members, followed by *public workshop* (College Park, MD; April 2017)
    - Second workshop/planning meeting targeted for late summer 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
Engage community on several layers for varying roles:

- **Researchers, Users, Stakeholders**: Conducts research and testing on publicly available model baseline; long-term science contributions; builds next-generation 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-generation 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.
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)*

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- **New WG or addition**
- Augmentation of existing NGGPS group
Strategic Implementation Plan (SIP) Schedule

- Nov 2016: First SIP Planning Meeting (Boulder, CO)
- Dec 2016: Establish Working Group membership and co-chairs
- Jan 2017: Brief approach at AMS Town Hall Meeting (Seattle, WA)
- Apr 2017: Community Workshop (College Park, MD)
  - WGs brief initial findings; solicit community input
- ~ Late summer 2017: Meeting to draft SIP v1.0 (location TBD)
  - Incorporate Community and SIP WG inputs into SIP v 1.0 (FY 2018-2020)
  - SIP v 1.0 will be initial, “living” document; once mature, update annually
- 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/NWS Evolutionary Changes

- Evolution of current operational modeling systems
  - Global Forecast System (GFS) >> weather
  - **NGGPS: Transition legacy GFS/GSM to GFS/Fv3**
    - Global Ensemble Forecast System (GEFS) >> Sub-seasonal system
    - Climate Forecast System (CFS) >> Seasonal system
- Evolution of the Environmental Modeling Center (EMC)
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
## Implementation Plan of FV3GFS (FY17-FY19)

<table>
<thead>
<tr>
<th>FY17</th>
<th>FY18</th>
<th>FY19</th>
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<tbody>
<tr>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
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<tr>
<td>Evaluate FV3 structure and document FV3 modeling system</td>
<td>Implement FV3 dycore in NEMS@</td>
<td>Couple FV3 to GFS physics (NUOPC physics driver) perform forecast-only experiments, tuning and testing</td>
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<td>Develop DA techniques % (native grid vs physics grid; New data)</td>
<td>Cycled experiments, New physics options, benchmarking, computational efficiency &amp; optimization</td>
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<td>Preprocessing and post-processing, up &amp; downstream dependencies</td>
<td>Test and Implement NGGPS Verification tools</td>
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<td>Code delivery, NCO Parallel &amp; operations</td>
<td>NEMS/ FV3GFS in operations</td>
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@ 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

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Q3FY19 FV3GFS Configuration

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Early experimental implementation of FV3GFS (~13km L64) w/cycled DA
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.
Proposed Plan for FV3-based GEFS v12 (*sub-seasonal ensemble system*)

**Development testing**

FY2017

- Help develop and test the FV3 configuration used in reanalysis and real-time DA (ESRL)

FY2018

- Receive FV3 GFS codes and configure it for GEFS application (EMC)

FY2019

- NEMS/FV3GFS Available for reforecasts
- Reanalysis production using FV3GFS (ESRL)
- NEMS/FV3GEFSv12 reforecasts (EMC)

**Integration testing**

Implementation testing

**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.
CFS Development Plans
Status quo vs. alternative

- 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?)
- Several areas of overlap exist between future GFDL climate models and NCEP/EMC’s seasonal model
  - GFDL’s current HiFLOR climate model runs with old version of FV3 and MOM4 ocean model
  - CM4, next-gen 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?

- Incorporate Project Management (PM) principles into model development
  - 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 development
  - GFDL and EMC working early prototype parallel runs for FV3-GFS: already underway!
  - EMC model developers shifting focus to development in FV3 framework
- 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 SIP strategy/approach
- 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 principles; 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!