



# Overarching System Team

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# Objectives



- Provide a portable, high performance, **unified software infrastructure** for use in operational prediction models at NCEP.
- Coordinate and provide to NCEP a document on **code, [data, and documentation] management** for NEMS-based modeling applications and suites.
- **Promote communication** and coordinated software development across the NGGPS teams and related efforts in the community.

# Unified Software Infrastructure



**CHARGE:** Deliver multiple coupled system configurations following the NGGPS Implementation Plan and CPO MAPP awards, all running *under a unified software framework*, with EMC, broader NOAA, and community engagement.

## **ACHIEVEMENTS:**

1. **Delivered initial global, regional, space weather, and land/hydrology coupled system milestones running under the NEMS framework:**
  - Delivered development version (0.2) of the Unified Global Coupled System – Seasonal (UGCS-Seasonal) running under NUOPC/NEMS, with fully coupled GSM, MOM5, and CICE components, initialized for a cold start and optimized for comparable performance with CFSv2.

# Unified Software Infrastructure



## ACHIEVEMENTS (cont):

- Delivered development version (0.1) of a single domain regional configuration running under NUOPC/NEMS, with two-way coupled NMMB and HYCOM components.
- Delivered development version (0.4) of WAM and the Ionosphere-Plasmasphere Electrodynamics (IPE) models validated under NUOPC/NEMS, with a one-way (WAM>IPE) 3D coupling exchange.
- Delivered development version (0.2) of WRF-Hydro and LIS/Noah land validated running with GSM, MOM5, and CICE under NUOPC/NEMS, showing correct technical exchanges implemented among components, not yet scientifically viable.
- Implemented WAVEWATCHIII coupled one-way to GSM (GSM>WWIII), including nesting, running under NUOPC/NEMS.

# Unified Software Infrastructure



## ACHIEVEMENTS (cont):

2. Delivered high performance modeling coupling tools capable of supporting a variety of coupled applications in a flexible and systematic manner, based on community standards ESMF/NUOPC, with options for 2D and 3D grid remapping.

- Coordinated a merge of the NEMS development branch back to the NEMS trunk, which resulted in all development codes at EMC now running through a NUOPC/NEMS driver.
- Established a way to systematically describe and test many new coupled configurations using “compsets”, a concise nomenclature, e.g.:

`cfsr%20150401_1day_leapfrog_gsm%eul%T126_ww3%T188`

`cfsr%20150401_30day_nems_gsm%eul%T126_cice%0.5_mom5%0.5`

- Provided ESMF/NUOPC/NEMS training for about 60 EMC staff, during multiple sessions.

# Unified Software Infrastructure



## ACHIEVEMENTS (cont):

3. Initiated a NGGPS-funded pilot project with the Community Earth System Model (CESM) in which the main NEMS coupler/mediator will become a community component. The proposal is to distribute a version of it through a shared repository created by NCAR called Common Infrastructure for Modeling Earth (CIME).

NCAR has started building its next CESM implementation on coupler code shared with NEMS.

# Unified Software Infrastructure



## DOCUMENTATION:

All coupled model deliveries are documented here:

[https://docs.google.com/spreadsheets/d/1RS-ftBYnfSIWrJYfalD2IAI-bUOGM0frNPEMIO\\_ND28/edit#gid=0](https://docs.google.com/spreadsheets/d/1RS-ftBYnfSIWrJYfalD2IAI-bUOGM0frNPEMIO_ND28/edit#gid=0)

New NEMS User's Guide:

[https://docs.google.com/document/d/1-kFhPBf7GBTUd5SaB5D\\_3OUGX\\_93pWKP21QgTh4y6ok/edit#](https://docs.google.com/document/d/1-kFhPBf7GBTUd5SaB5D_3OUGX_93pWKP21QgTh4y6ok/edit#)

## TEAM:

***Weekly communication with distribution of about 80***, including:

ESRL/CU NESII team (Fei Liu, Gerhard Theurich, Anthony Craig, Cecelia DeLuca, others), EMC (Xingren Wu, Jiande Wang, Bin Li, Mark Iredell, Suru Saha, Patrick Tripp, Jun Wang, Jack Woollen, Jiarui Dong, others), NCAR (David Bailey), COLA (Larry Marx, Jim Kinter), GFDL (Niki Zadeh), AOML (Steve Diaz, Gopal), others

# Unified Software Infrastructure



## GAPS:

- EMC has not yet addressed several key system architecture questions.<sup>1</sup> Developers would benefit from the input of researchers with deep knowledge of and proven skill in the science of building coupled systems with many model components on questions including how best to seamlessly address a broad range of time and space scales.
- EMC would benefit from the formalization of a science team that spans its applications, and is authorized to make decisions about topics like the system architecture (similar to the CESM Scientific Steering Committee).
- EMC would benefit from research community experimentation and contribution to coupled model configurations. Currently GMTB's expertise and focus is the atmosphere, so that could be augmented and benefit from partnerships (like the CIME pilot) that bring additional expertise.

<sup>1</sup>[https://docs.google.com/document/d/1ySqAUtJiw2PrsfW\\_8cC4pypwiNv1wQ4EFolv2jeBL3w/edit#heading=h.gor6vgpzooko](https://docs.google.com/document/d/1ySqAUtJiw2PrsfW_8cC4pypwiNv1wQ4EFolv2jeBL3w/edit#heading=h.gor6vgpzooko)



# NEMS Component Schematic

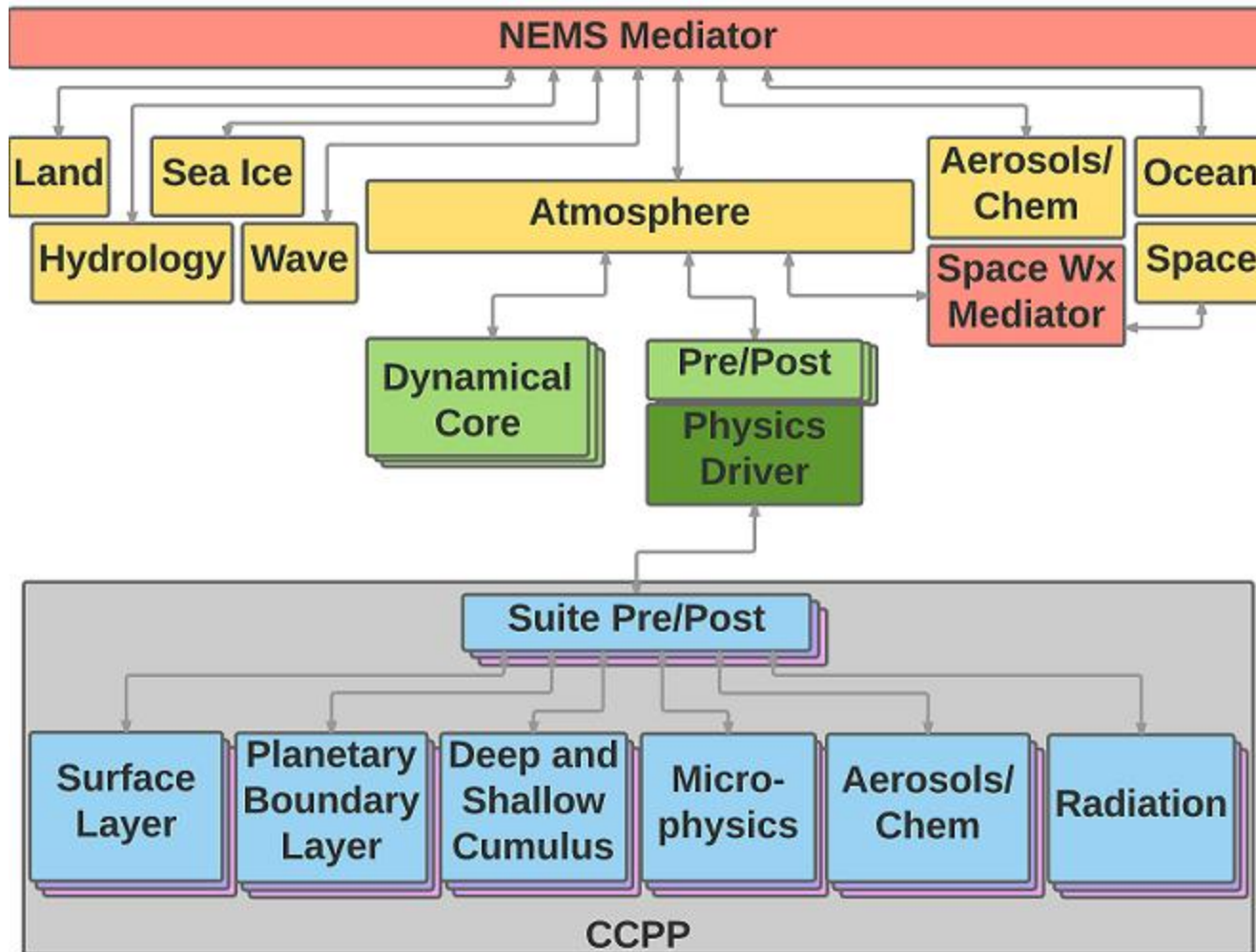


Image courtesy of DTC.

# Model Components in NEMS

(at least in progress as of Aug 5, 2016)



## **Atmosphere**

- NMM-B
- GSM
- FIM
- FV3 (soon)

## **Chemistry**

- GOCART
- CMAQ

## **Ocean**

- MOM
- HYCOM
- POM

## **Sea Ice**

- CICE
- KISS

## **Wave**

- WaveWatch3

## **Land/Hydro**

- LIS
- WRF-Hydro

## **Ionosphere**

- IPE

## **Coupling mediators**

- Ensemble mediator
- Atmosphere-Ocean-Ice mediator
- Physics-Chemistry mediator
- Space Weather mediator

# Coupled Compsets in NEMS (at least in progress as of Aug 5, 2016)



- noyear\_spaceweather\_datawam\_dataipe
- noyear\_spaceweather\_datawam\_ipe
- noyear\_sbys\_hycom
- noyear\_sbys\_hycom%core2
- noyear\_sbys\_hycom%core2%1.6
- 2009\_blocked\_gsm\_ww3
- 2009\_leapfrog\_gsm\_ww3
- 20150401short\_nems\_gsm\_cice\_hycom
- 20150401short\_nems\_gsm\_cice\_mom5
- 20150401short\_nems\_gsm\_cice\_mom5\_ww3
- 20150401short\_nems\_gsm\_cice\_mom5\_slg
- 20150401short\_nems\_gsm\_eulerian
- 20150401short\_nems\_gsm\_slg
- 20150401short%prof\_nems\_gsm\_cice\_mom5
- 20150401short\_nemscold\_gsm\_cice\_mom5
- 20150401short%prof\_nemscold\_gsm\_cice\_mom5
- 2009\_sbys\_gsm\_ww3
- 2009\_sbys\_ww3
- 20150401long\_nems\_gsm\_cice\_mom5
- 20150401long\_nems\_gsm\_cice\_mom5\_slg
- 20150401\_nems\_gsm\_cice\_mom5
- 20150401\_nems\_gsm\_cice\_mom5\_slg
- 2009\_nems\_gsm\_cice\_mom5\_sbys\_lis\_wrfhydro
- 2009\_nems\_gsm\_cice\_mom5\_wrfhydro\_sbys\_lis
- 2009\_nems\_gsm\_lis\_cice\_mom5\_sbys\_wrfhydro
- 2009\_nems\_gsm\_lis\_cice\_mom5\_wrfhydro
- 2013\_sbys\_nmmb%glob20150401short\_nems\_nmm\_cice\_mom5

# Code, Data, and Documentation Management



**CHARGE:** Deliver a document that outlines issues, requirements, and plans related to code, data and documentation management, with EMC, broader NOAA, and community engagement.

## **ACHIEVEMENTS:**

1. Delivered updated Code, Data, and Documentation Management document:

[https://docs.google.com/document/d/1bjnyJpJ7T3XeW3zCnhRLTL5a3m4\\_3XIAUeThUPWD9Tg/edit#heading=h.ku78qulk21xh](https://docs.google.com/document/d/1bjnyJpJ7T3XeW3zCnhRLTL5a3m4_3XIAUeThUPWD9Tg/edit#heading=h.ku78qulk21xh)

Organized a meeting for September 1-2, 2016 at NCWCP, focused on EMC review and evolution of the document. Workshop prospectus:

<http://cog-esgf.esrl.noaa.gov/projects/nems-workshop/>

2. The draft code/data/documentation management document includes proposed operating principles, a proposed standard requirements format, and initial requirements for software, documentation, and input and output data.

Technical requirements were also initiated for land surface and ensembles.

# Code, Data, and Documentation Management



## ACHIEVEMENTS (cont)

3. Initiated a Change Review Board (CRB) process for prioritizing NEMS-related work and allocating shared technical resources. First meeting was March 8, 2016.

## TEAM:

Contributors/reviewers include DTC (Bernardet, Carson), ESRL (DeLuca, Theurich, Liu), EMC (Iredell, Tolman, Saha, Trahan), NCAR CESM (Large, Vertenstein), VLab (Sperow), COLA (Kinter, Marx), others.

## GAPS:

- Broader community review of the code/data/doc management document will be needed after the September 1-2 meeting at EMC.
- EMC needs to establish a regular schedule for NEMS CRB meetings (at least twice a year).

# Communication and Coordination



**CHARGE:** Communication and coordination across NGGPS teams and related efforts in the community.

## ACHIEVEMENTS:

1. Initiated documentation survey and gap analysis across NEMS components, model applications, and end-to-end suites. Contacted participants NGGPS-wide for input. Included **general, scientific, technical, and user** documentation categories per entry:

[https://docs.google.com/spreadsheets/d/1CLT66uzJrjrsY-um0jB5hU-Gfeh3\\_VCIJDA4-lbmu5s/edit#gid=0](https://docs.google.com/spreadsheets/d/1CLT66uzJrjrsY-um0jB5hU-Gfeh3_VCIJDA4-lbmu5s/edit#gid=0)

Recently added **requirements** and **tutorial** categories.

2. Began migrating all *developer* documentation to an EMC Community Workspace on VLab.

The screenshot shows the homepage of the Environmental Modeling Center (EMC) on the Virtual Lab platform. The page features a navigation bar with links for Home, Information, Data & Products, Software & Code, and Our History. The main content area includes a welcome message, a list of models (Prediction Suites, Modeling Applications, Components, Infrastructure), and sections for About EMC, Mission, and Vision. The footer contains information about the NEMS infrastructure and contact details for the EMC.

<https://vlab.ncep.noaa.gov/web/environmental-modeling-center/home>

# Communication and Coordination



## **ACHIEVEMENTS (cont):**

3. Agreed to a preferred technical documentation format (in a repository with code, set up so that it is automatically updated with code updates), and implemented physical parameterization, physics driver documentation, and other documentation in this format.

## **TEAM:**

Organized by DTC (Bernardet), NESII (DeLuca, Liu), and EMC (Howard, Kunkel, Iredell); others have been contributing ideas and information.

## **GAPS:**

Several components do not appear to have documentation, or are missing specific kinds of documentation. Much of the technical documentation is not in the preferred format, and it needs to be reviewed for clarity and correctness.

EMC would benefit from redesign of their primary website (<http://www.emc.ncep.noaa.gov/>) and dedicated resources to maintain it. This process will be easier if developer documentation is moved off the primary website to a VLab community workspace.

# OAS Role and Leadership



## **OVERALL GAPS:**

Topics the OAS has tried to address (including system-wide architecture, organizational coordination, and communication) would normally be aspects of organizational management. The leadership and membership of OAS is primarily technical. It would benefit from working more closely with EMC management and science leadership.



# Acknowledgements



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