# Moving to a simpler NCEP production suite

## *Unified coupled global modeling*

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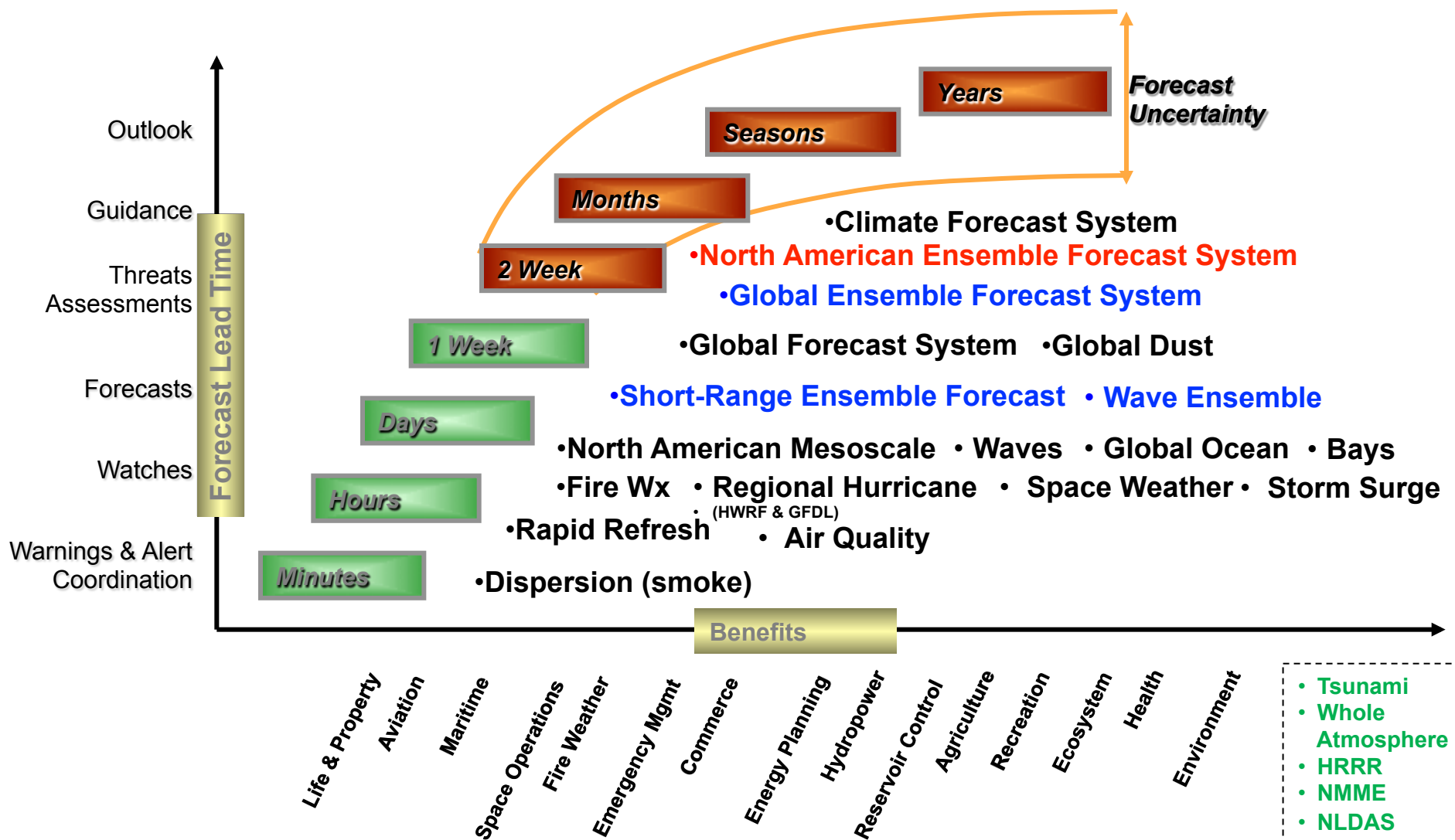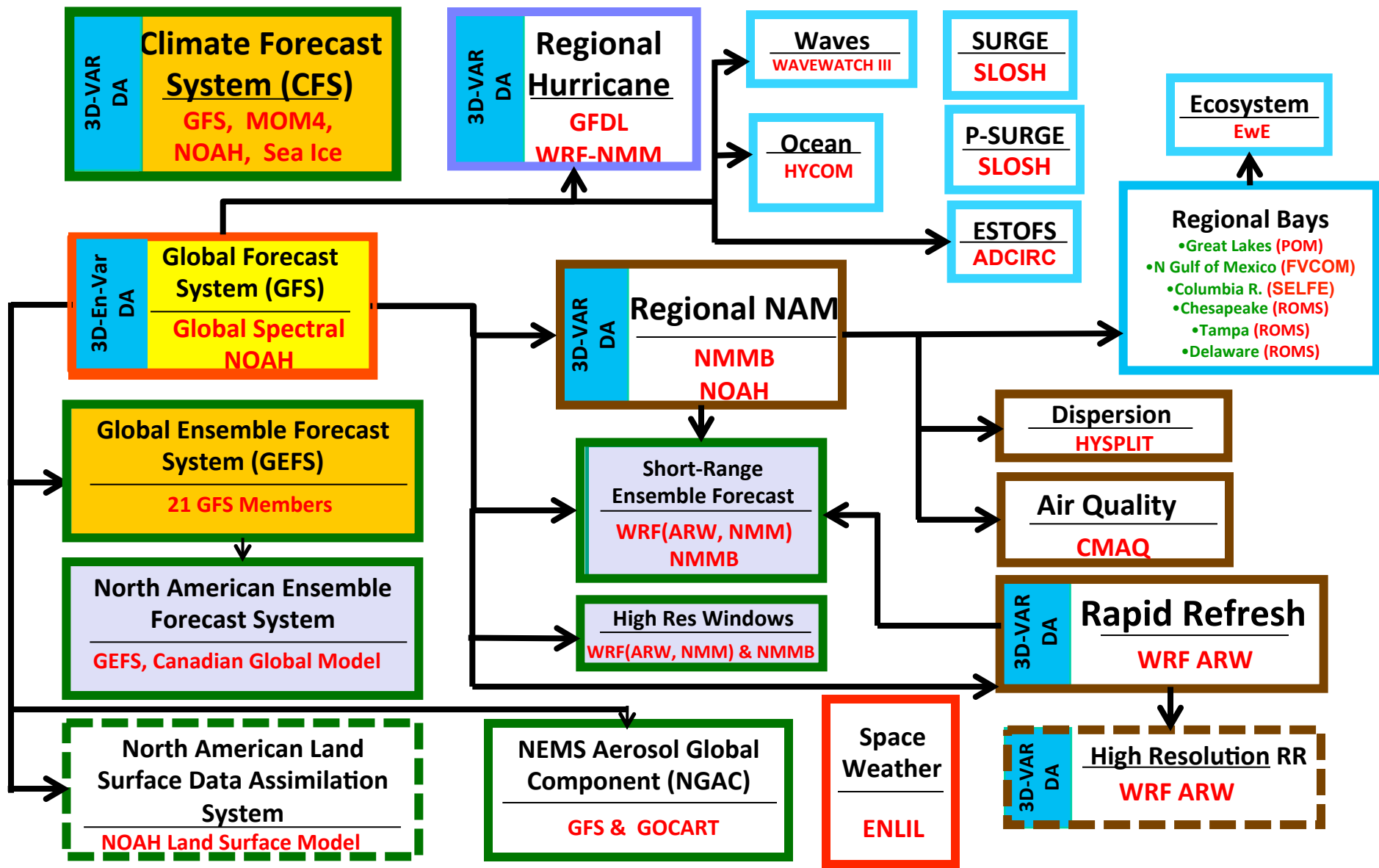*NOAA / NWS / NCEP*

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# Content

- The suite in 2 minutes

- Emerging requirements

- Forces driving unification of the model suite
  - UMAC              (UCACN model advisory committee)
  - NGGPS            (Next Generation Global Prediction System)

- Focus on global part of unified modeling approach
  - Unified Global Coupled Model
  - Dynamic cores
  - Physics
  - Data Assimilation

# Seamless Suite, spanning weather and climate

**Climate Forecast System (CFS)**
3D-VAR DA
GFS, MOM4, NOAH, Sea Ice

**Regional Hurricane**
3D-VAR DA
GFDL WRF-NMM

**Waves**
WAVEWATCH III

**Ocean**
HYCOM

**SURGE**
SLOSH

**P-SURGE**
SLOSH

**ESTOFS**
ADCIRC

**Ecosystem**
EwE

**Regional Bays**
• Great Lakes (POM)
• N Gulf of Mexico (FVCOM)
• Columbia R. (SELFE)
• Chesapeake (ROMS)
• Tampa (ROMS)
• Delaware (ROMS)

**Global Forecast System (GFS)**
3D-En-Var DA
Global Spectral NOAH

**Regional NAM**
3D-VAR DA
NMMB NOAH

**Global Ensemble Forecast System (GEFS)**
21 GFS Members

**Short-Range Ensemble Forecast**
WRF(ARW, NMM) NMMB

**Dispersion**
HYSPLIT

**Air Quality**
CMAQ

**North American Ensemble Forecast System**
GEFS, Canadian Global Model

**High Res Windows**
WRF(ARW, NMM) & NMMB

**Rapid Refresh**
3D-VAR DA
WRF ARW

**North American Land Surface Data Assimilation System**
NOAH Land Surface Model

**NEMS Aerosol Global Component (NGAC)**
GFS & GOCART

**Space Weather**
ENLIL

**High Resolution RR**
3D-VAR DA
WRF ARW

Production suite ca. January 2014

# Emerging requirements

- Weather Ready Nation.
  - Products.
  - Social science.
- High impact events.
- Weather to climate—seamless suite of guidance and products.
  - Week 3-4.
  - Systematic reforecast need.
- Range of products beyond weather:
  - Space weather, land, ice, ocean, waves, aerosols, (ecosystems).
  - Individual products versus coupled modeling.
  - Water cycle, National Water Center (NWC).

# UMAC

- UCACN Model Advisory Board
  - Review production suite (August 2015)
    - Strategic level.
    - Team from academia, stakeholders / contributors heard, but not on the panel itself.

- Some key findings:
  - Simplify / unify model suite.
  - Lack of requirements process.
  - Better process to identify development paths.
    - "end-to-end" management of implementations.
  - Evidence driven decision.
    - No more "jigsaw puzzle".

# NGGPS

## (Next Generation Global Prediction System)

- NWS R2O funding and NGGPS projects.
  - For first time NWS is funding agency.
    - Fund gaps in operations.
    - Project based funding for strategic development.
      - Within US government.
      - Academia, with NWS partners / champions.
    - Test beds for R2O.

  - Key element: Next Generation Global Prediction System.
    - Next generation Dycore Selection.
    - Unified physics interface, focus on physics.
    - Model Coupling
      - Started with Climate Forecast System
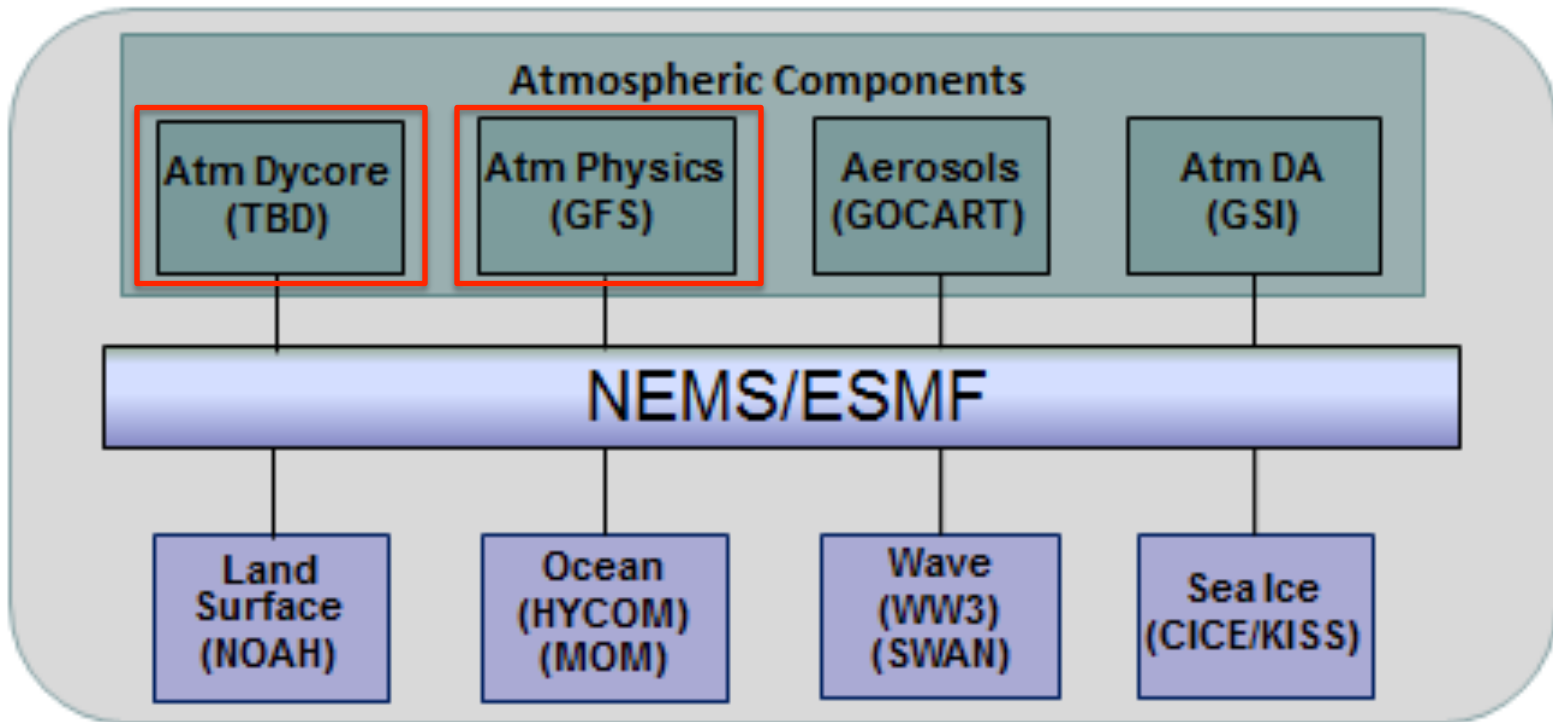      - Arctic modeling

# Unified Global Model
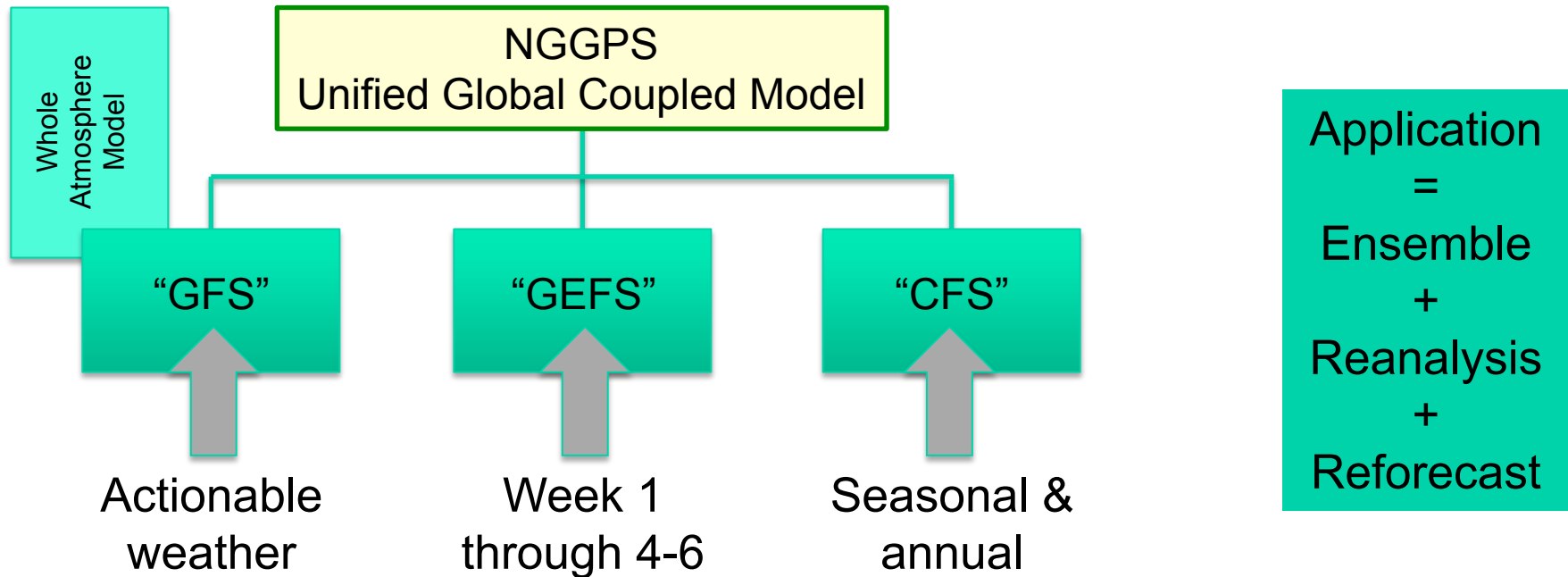


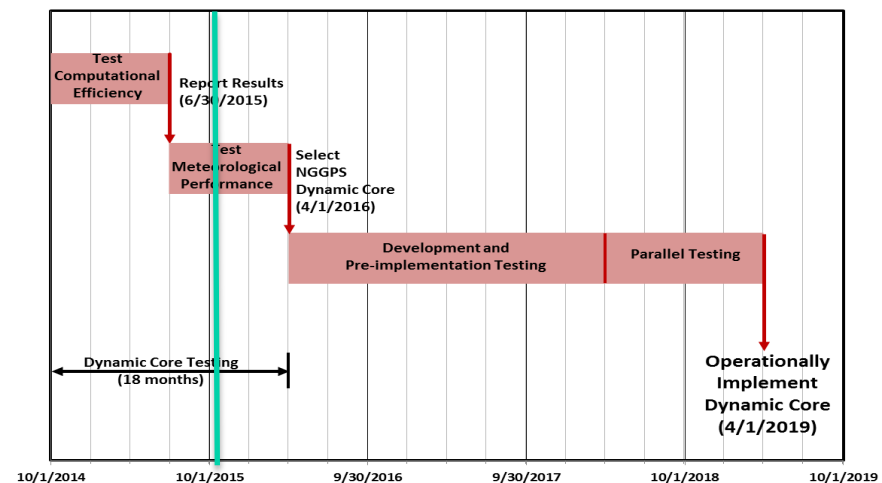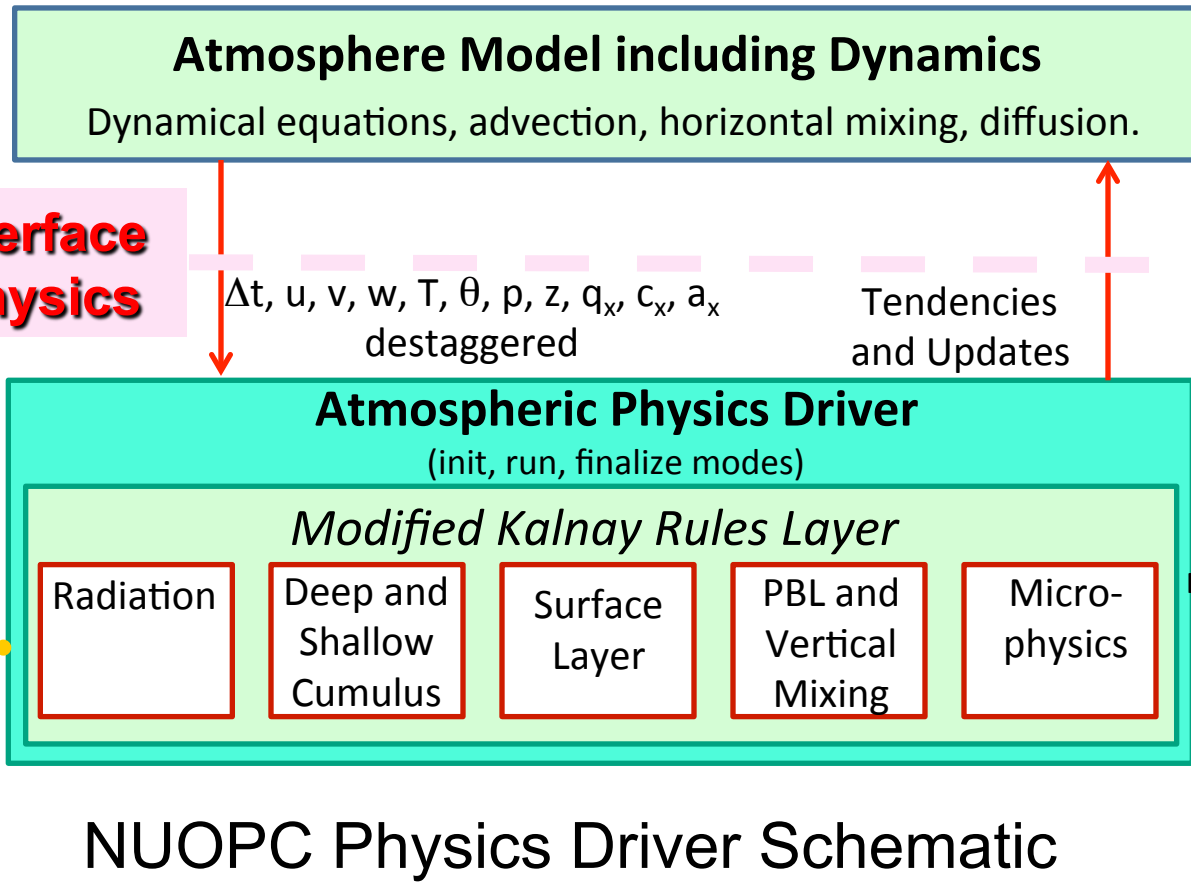| 1 y | 2 y | 4 y | **Update cycle** |
|-----|-----|-----|------------------|
| 3 y | 20-25 y | 1979 - present | **Reanalysis** |
| 6h | 6-24h | ??? | **cycling** |
| WCOSS | WCOSS | WCOSS ? | **where** |

# NGGPS and NEMS / ESMF



Modular modeling, using ESMF to modularize elements
in fully coupled unified global model
( + *ionosphere , ecosystems , ……* )

# NGGPS dycore

- – Selecting a new dynamic core for global model to serve the NWS for the coming decades.
  - • Architecture suitable for future compute environments.
  - • Non-hydrostatic to allow for future convection-resolving global models.
- – 18 month process to down-select candidate cores.
- – 5 year plan to replace operations.
- – Core → NEMS → applications.
  - • ~~GSM-NH (EMC)~~
  - • MPAS (NCAR)
  - • FV3 (GFDL)
  - • ~~NIM (ESRL)~~
  - • ~~NEPTUNE (NRL)~~
  - • ~~NMMB-UJ (EMC)~~

**Atmosphere Model including Dynamics**

Dynamical equations, advection, horizontal mixing, diffusion.

**standard interface for model physics**

$\Delta t$, u, v, w, T, $\theta$, p, z, $q_x$, $c_x$, $a_x$ destaggered

Tendencies and Updates

**Atmospheric Physics Driver**

(init, run, finalize modes)

*Modified Kalnay Rules Layer*

| Radiation | Deep and Shallow Cumulus | Surface Layer | PBL and Vertical Mixing | Micro-physics |
|---|---|---|---|---|

Initialize Physics Tables and Databases

**Init Mode**

**Finalize Mode.**

Output Diagnostics
- fields
- rates
- budgets
- others

NUOPC Physics Driver Schematic

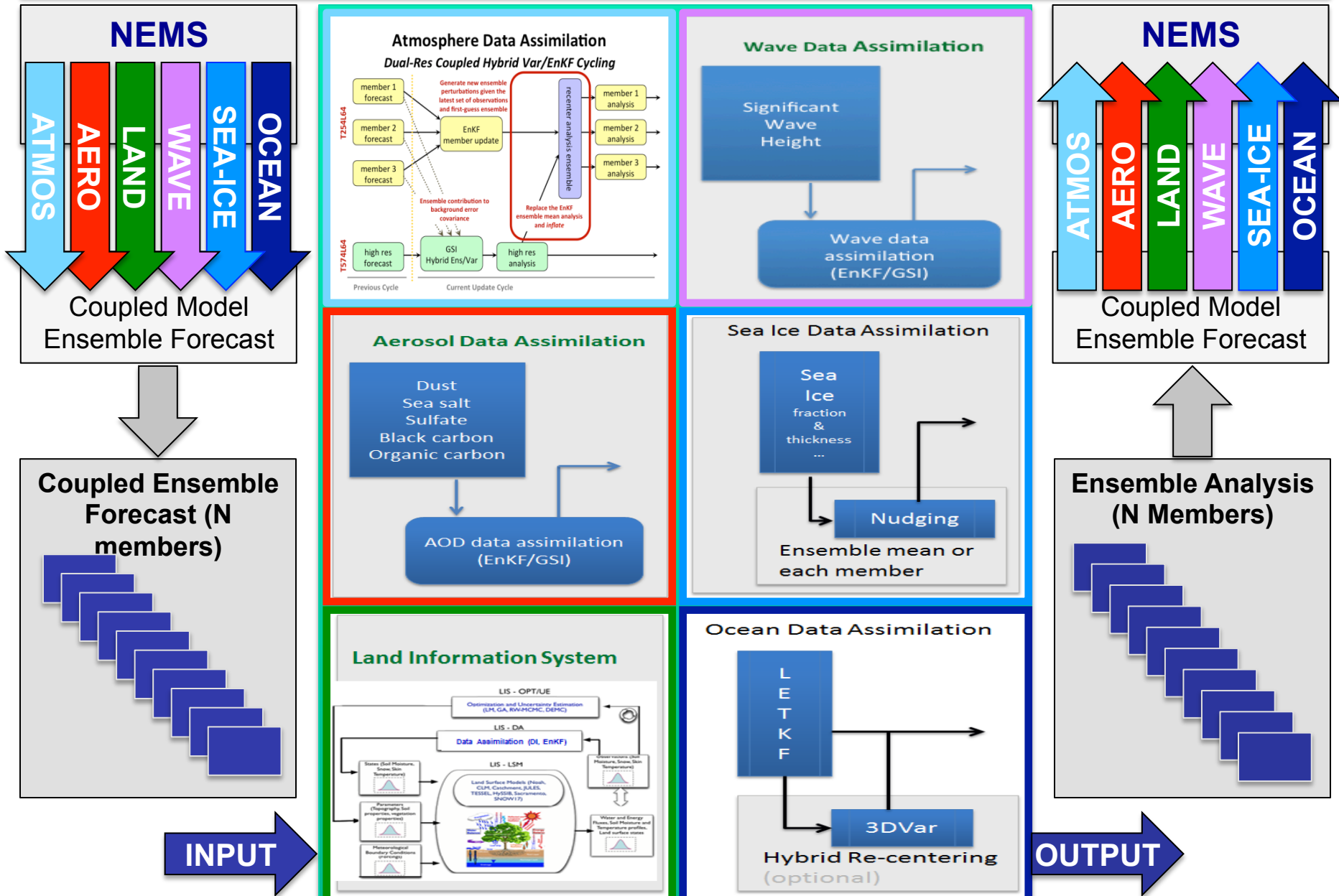Version 1.0 delivered June 2015

# COUPLED DA PROOF OF CONCEPT

- Atmosphere: Hybrid 4D-EnVAR approach using a 80-member coupled forecast and analysis ensemble, with Semi-lagrangian dynamics, and 128 levels in the vertical hybrid sigma/pressure coordinates.

- Ocean/Seaice: GFDL MOM5.1/MOM6-SIS and/or HYCOM-CICE for the ocean and sea-ice coupling, using the NEMS coupler.

- Aerosols: Inline GOCART for aerosol coupling.

- Waves: Inline WAVEWATCH III for wave coupling.

- Land: Inline Noah Land Model for land coupling.