The NCEP Production Suite

Science presentation

Strategic

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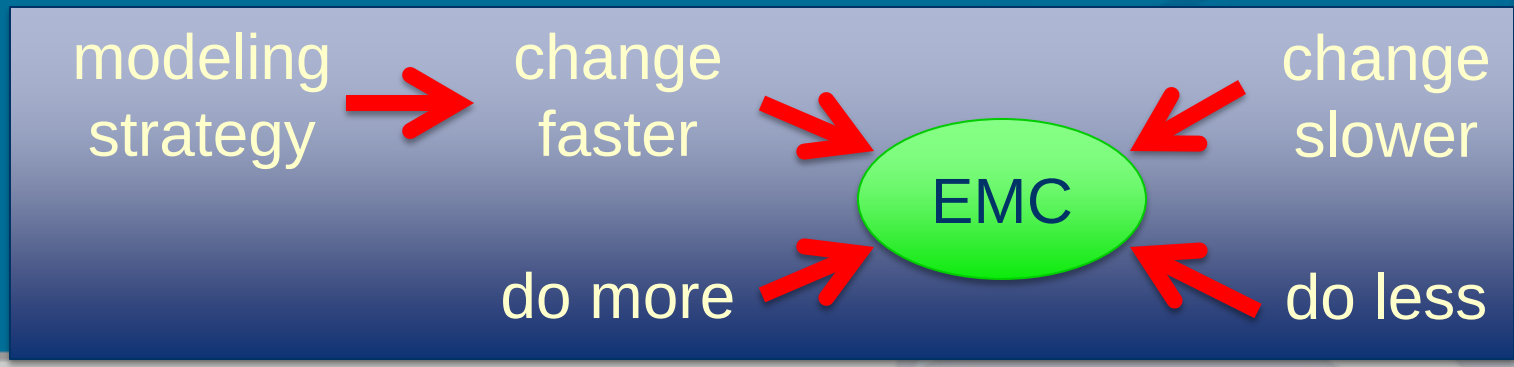
UCACN report and NCEP Strategic plan

- EMC modeling directions:
  - Toward unified modeling:
    - Simplify Production Suite (up to 30 major systems).
  - But ….. also add more:
    - New elements in the environmental modeling suite.
    - Reforecast for postprocessing of model results.
  - Be more nimble, faster model improvements.
  - But …… changes require much work on post-processing side, so change less often …..



Simplify NPS, unified modeling

- First deal with global and regional separately.
  - To disruptive for operations to unify all at once.

- Unified modeling approach promoted by UCAN.
  - NOAA Environmental Modeling System (NEMS, ESMF).
  - From GFS / GEFS / CFS models to coupled model with GFS / GEFS / CFS applications.
  - Reduce number of mesoscale models
    - RSM ✗, ETA ✗, NMM ✓, HWRF ✓, GFDL ✓, NMM-B, WRF-ARW.
  - Global – meso unification ?
    - Keep in mind in planning phases.
    - Actual unification later.

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:
  - Atmosphere, land, ice, ocean, waves, aerosols, (ecosystems).
  - Individual products versus coupled modeling.
  - Water cycle, NWC.

Guiding factors:

- Community modeling
  - Concepts proven with HWRF, WW3, CRTM, ….
  - Communicate operational business model to academia.
    - Town hall meetings at AGU and AMS.
- New opportunities
  - Sandy Supplemental, R2O funding (NGGPS).
  - Has to be integrated R&O approach, not building of new stovepipes.
- Modeling strategy:
  - We need a well articulated and documented strategy.
  - Now only bits and pieces in place.
    - Following slides 10-12 …

Changing slower versus developer- user engagement in implementation process.

- Use HWRF paradigm for more implementations.
  - To be discussed later today.
- Increased MDL, NCEP Centers, (OHD, NWC) involvement in implementation process.
  - Operationally sustainable “downstream” processing.
  - Articulate needs for retrospective data (including reanalysis and reforecasts).
  - Clear expectation on time lines for implementations.
  - Business cases for
    - Up front available retrospective data.
    - Real-time available retrospective data.
    - ~~Sunsetting of old model versions~~.

Science and Technology Advances

- Observing systems
- High performance computing
- Data dissemination
- Numerical Guidance Systems
  - Data assimilation (methodology)
  - Modeling (physics, coupling & dynamics)
  - Ensembles (constr.—initialization, membership, etc.)
  - Intelligent post processing
- Predictability
  - convective systems
  - Seasonal to interannual

The NOAA Modeling Strategy…

High Level Perspective

- Moving away from the “model of the day”.
- Priorities for deterministic development are clear:
  - Data assimilation (methodology and observations).
  - Model physics
    - Why do we continue to underplay this important part of the enterprise?
    - Clouds, microphysics, radiation, land, ocean, waves, ice, aerosols….includes coupling.
  - Resolution—horizontal and vertical.
  - Dynamic core.
  - Must consider advanced HPC technologies.
  - Regional systems shift to convection permitting applications.

The NOAA Modeling Strategy…

- Focus on probabilistic modeling (ensembles).
  - Continue to pursue multi-model approach to ensembles.
    - Limited within NCEP.
    - National or international approach.
  - Don’t forget: ensemble systems only as good as the modeling system it is built from.
  - Presentation / use of probabilistic information.
  - Push to products for week 3-4.
- Unified modeling approach promoted by UCAN.

NOAA Chief Scientist (Dr. Rick Spinrad) tasked to develop NOAA wide modeling strategy (R2O).

UCACN Model Advisory Board

- Review production suite
  - Strategic level.
  - Team from academia.
  - Stakeholders (including contributors) to be heard, but not on the panel itself.
- Global unification ?
  - Folowing slides on global are tentative ….
- High Resolution Rapid Refresh and ensembles.
- Everything in between

Essential point of reference for NCEP

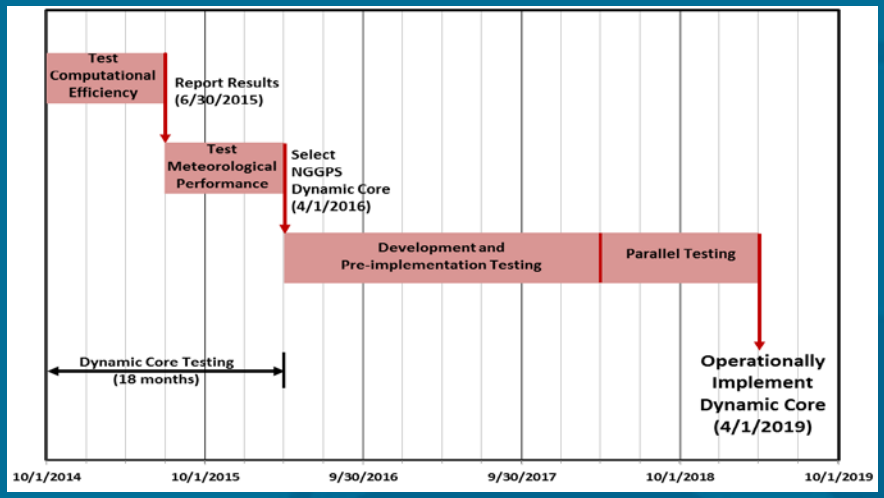
NWS R2O and NGGPS funding.

- 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
    - Climate Forecast System
    - Arctic modeling.

NGGPS dy-core project

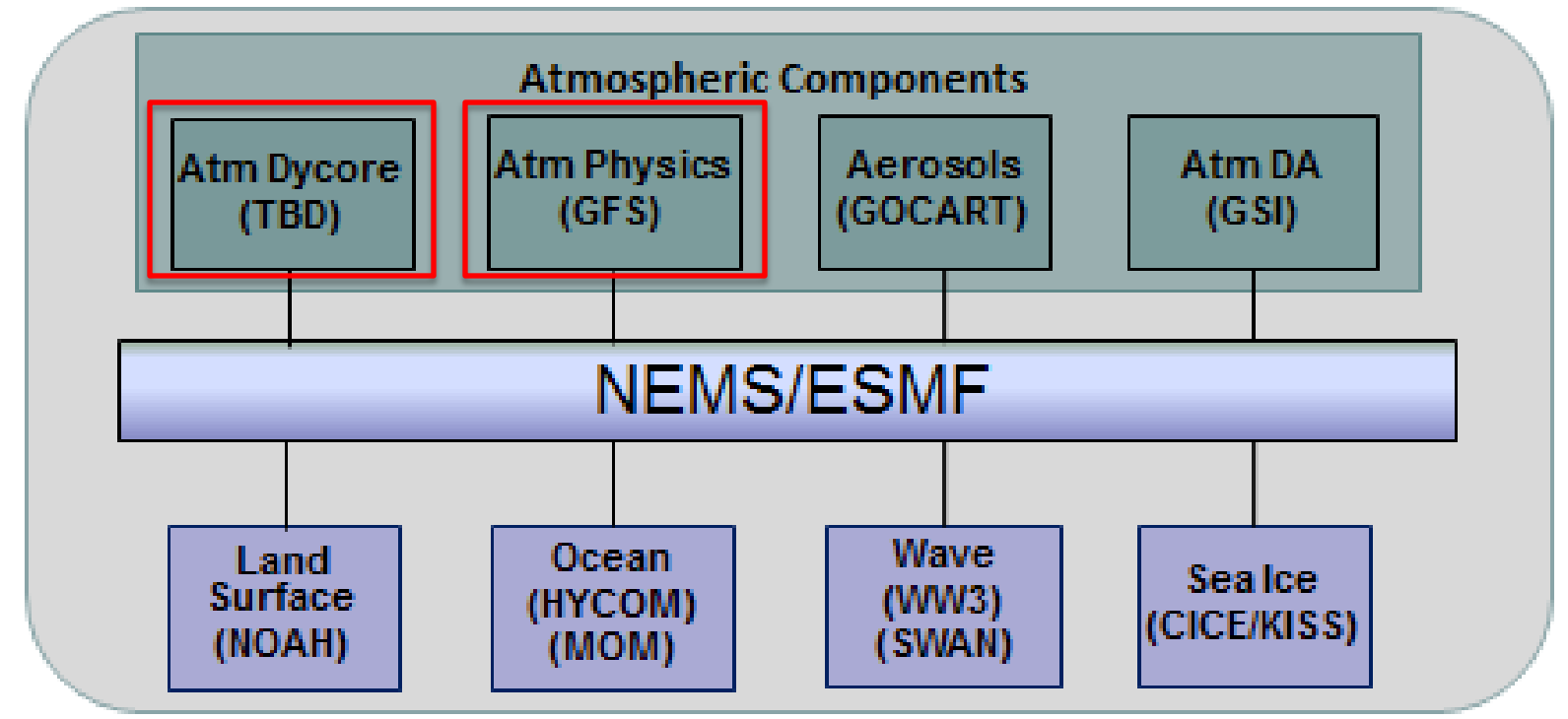
- Selecting a new dynamic core for global model to serve the NWS for the coming decades.
  - Architecture suitable for future compute environments.
  - Non-hydrostatic to allow for future convection-resolving global models.
- 18 month process to down-select candidate cores.
- 5 year plan to replace operations.
- Core → NEMS → applications.



Starting from existing cores:

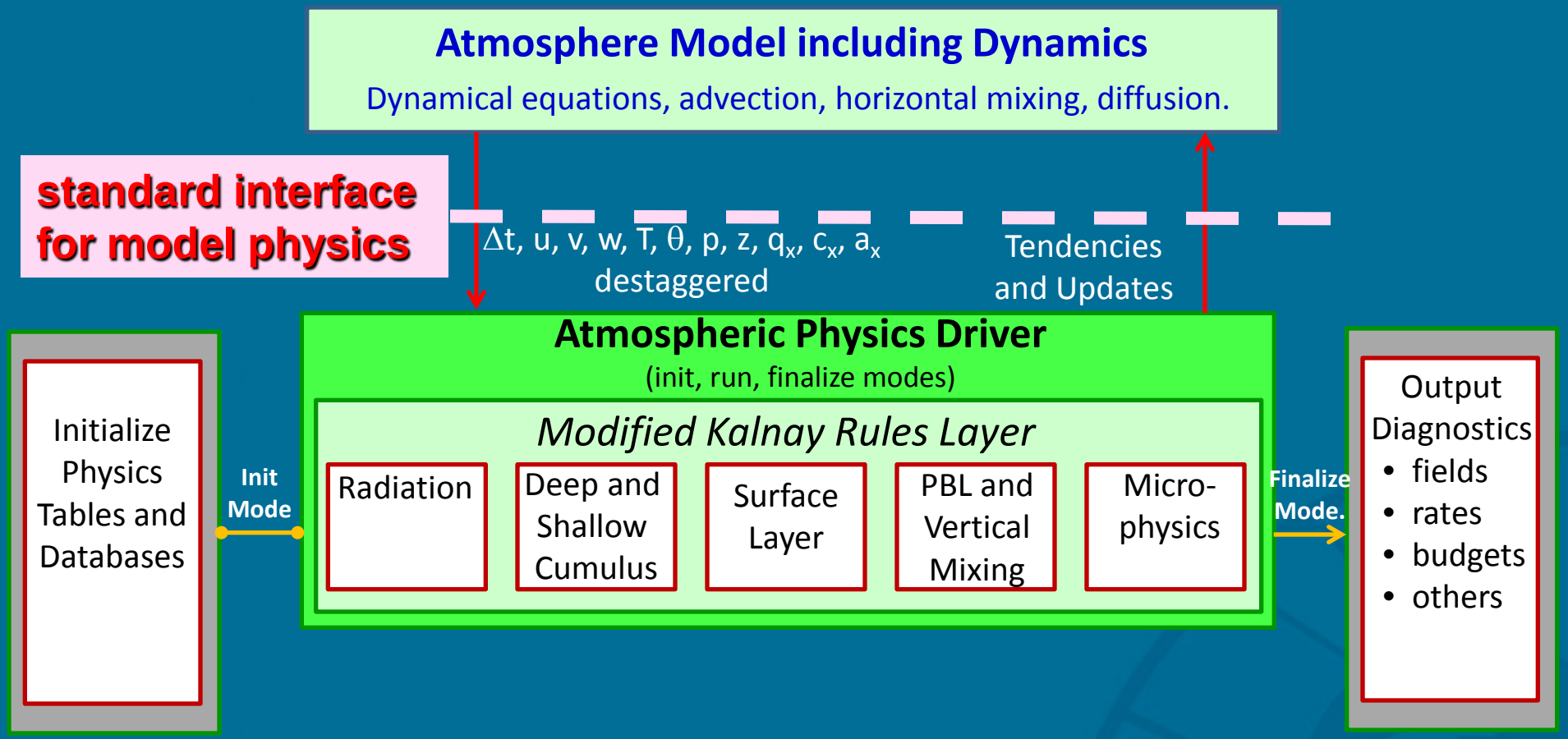
- GFS-NH: “baseline”
- FV-3 (GFDL, cubed sphere, finite volume)
- MPAS (NCAR, unstructured c-grid)
- NIM (ESRL, icosahedral)
- NEPTUNE (Navy, DG+)
- NMM-B UJ (cubed sphere)

NGGPS and NEMS / ESMF



Modular modeling, using ESMF to modularize elements in fully coupled unified global model

NUOPC Physics Driver Schematic



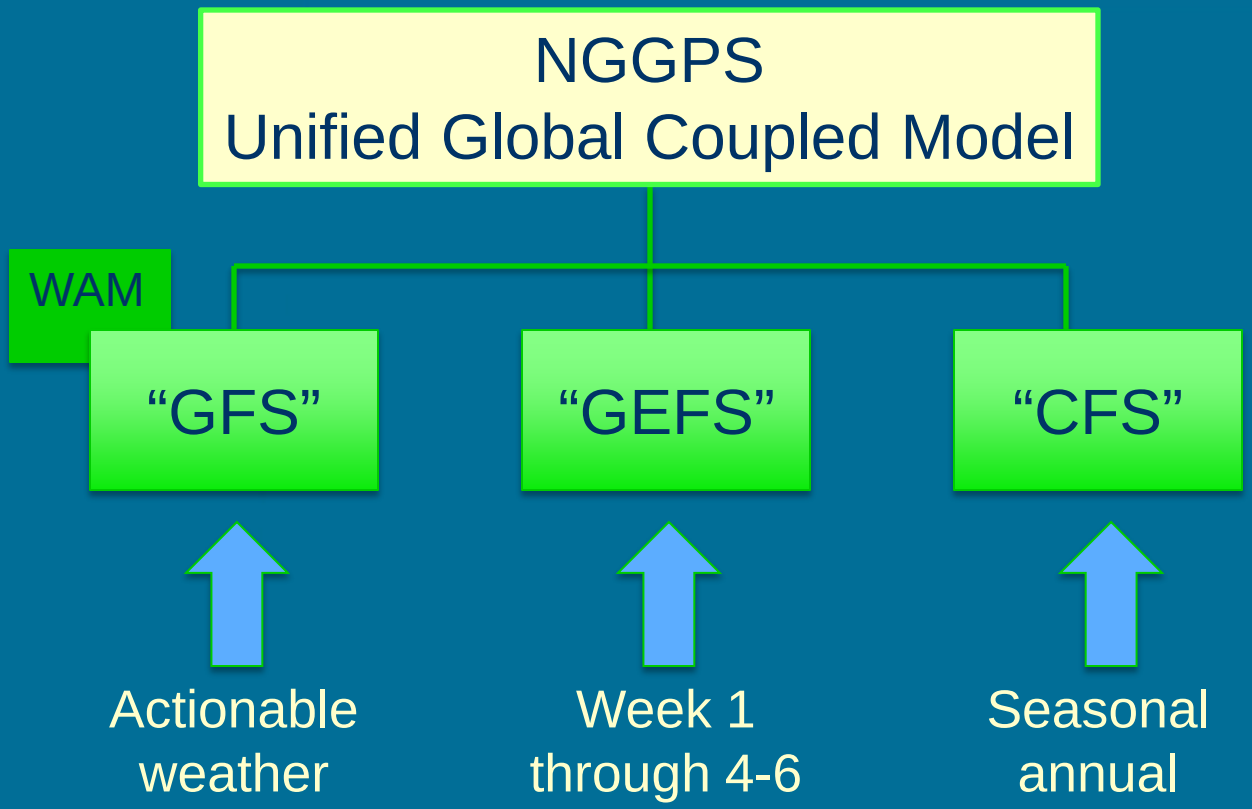
Key elements for ice modeling / predictability:

- Coupled problem ocean-ice-atmosphere.
  - See Canadian experience for Gulf of St. Lawrence.
- Need to control flux biases in coupled system.
  - 10 W/m2 bias grows/thaws 1m ice per year!
- Ensemble should improve predictability, as random flux errors are averaged out.
- Metrics need to be developed to make validation relevant to real-world users.

Tentative NGGPS funding for two year project.

- EMC to build model with above features (regional → global).
- Partnering with GFDL (ice models, validation).

Unified Global Model



Modeling system

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Application
=
Ensemble
+
Reanalysis
+
Reforecast

Prototype model plan

<table>
<tr><th>Months</th><th colspan="3">Activities</th></tr>
<tr><td>1-2</td><td rowspan="2">Set up NMMB, HYCOM, static ice “solo” in NEMS.</td><td rowspan="2">archive based flux biases</td><td rowspan="3">Ice in ESMF</td></tr>
<tr><td>3-4</td></tr>
<tr><td>5-6</td><td rowspan="4">Build and validate deterministic coupled system with flux bias correction for 5-7 day forecast</td><td rowspan="3">Validation metrics</td></tr>
<tr><td>7-8</td><td rowspan="3">KISS v2</td></tr>
<tr><td>9-10</td></tr>
<tr><td>11-12</td><td></td></tr>
<tr><td>13-14</td><td colspan="3" rowspan="2">Setup ensemble system</td></tr>
<tr><td>15-16</td></tr>
<tr><td>17-18</td><td colspan="3" rowspan="3">Test, validate and calibrate ensemble system</td></tr>
<tr><td>19-20</td></tr>
<tr><td>21-22</td></tr>
<tr><td>23-24</td><td colspan="3">Coupled demonstration system, (→ day 10+ ?)</td></tr>
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History

- EMC Model Evaluation Group (MEG) started in spring 2012
- Inspired by similar efforts at ECMWF
- Comprehensive real-time evaluation of models.
- Started with part-time contributions of Manikin and White.
  - Added Corey Guastini mid 2014.
- Focus
  - NAM, SREF, RAP, HRRR, HIRESW, HWRF
  - GFS, ECMWF, GEFS, +
  - Mostly CONUS

Identified model issues

- GFS cold/wet biases
- SREF initialization
- Ice / snow cover issues in various models.

Post-mortems

- Sandy, Derecho, Recent east coast storms

Better communications with centers and the field.

Expand MEG

- Alaska
- Marine models
- NARRE, HRRRE

Increase staffing

- 5-7 FTE, including focus on physics validation and verification.
- Skill set: modelers versus forecasters.

Many ideas floated …


Questions?