NGGPS deliverables

Timelines & workshop goals

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Outline

More than NGGPS, need some background …

- The present production suite in two slides
- Basic UMAC findings

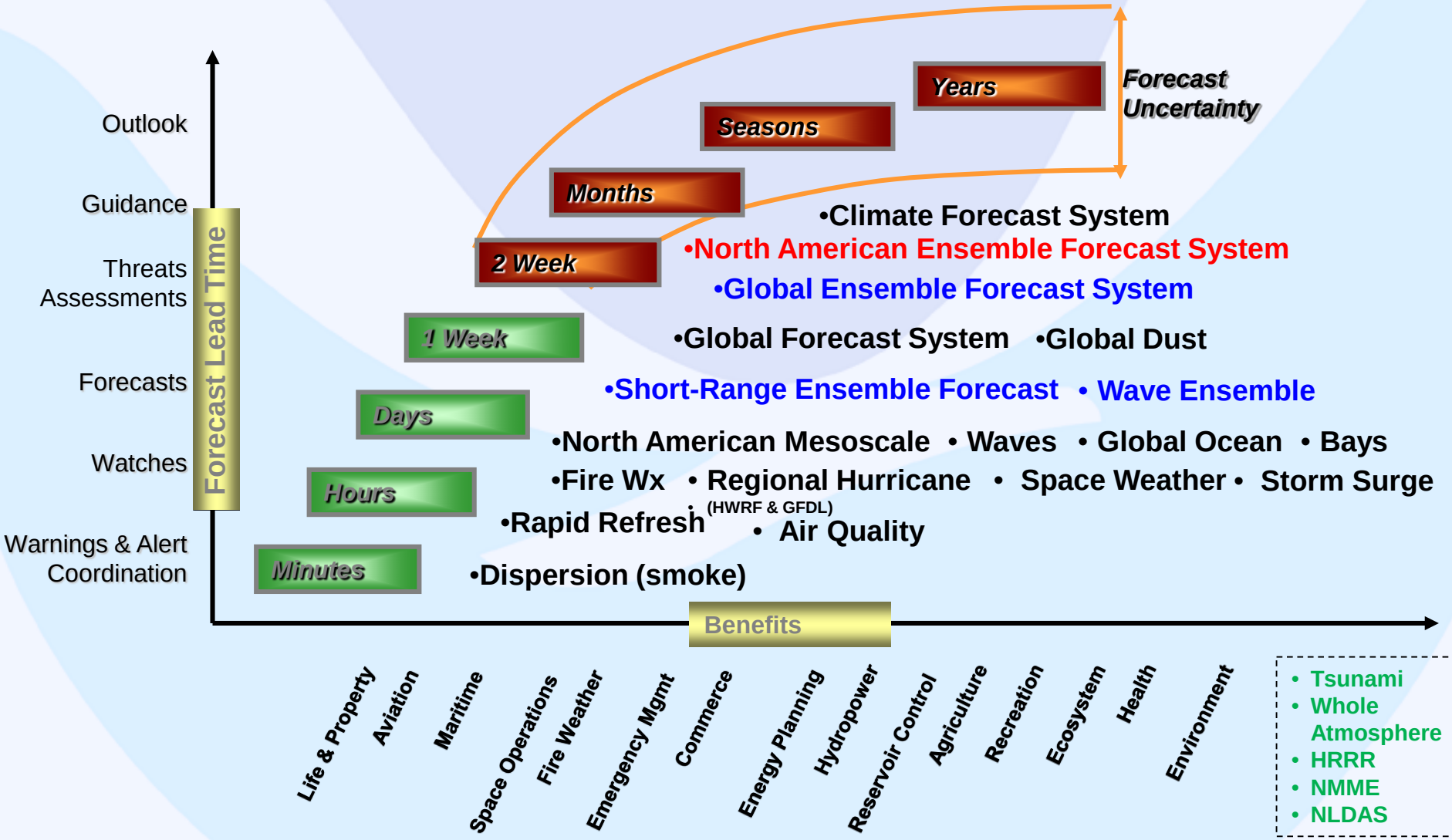
NGGPS: part of the new R2O approach of NWS

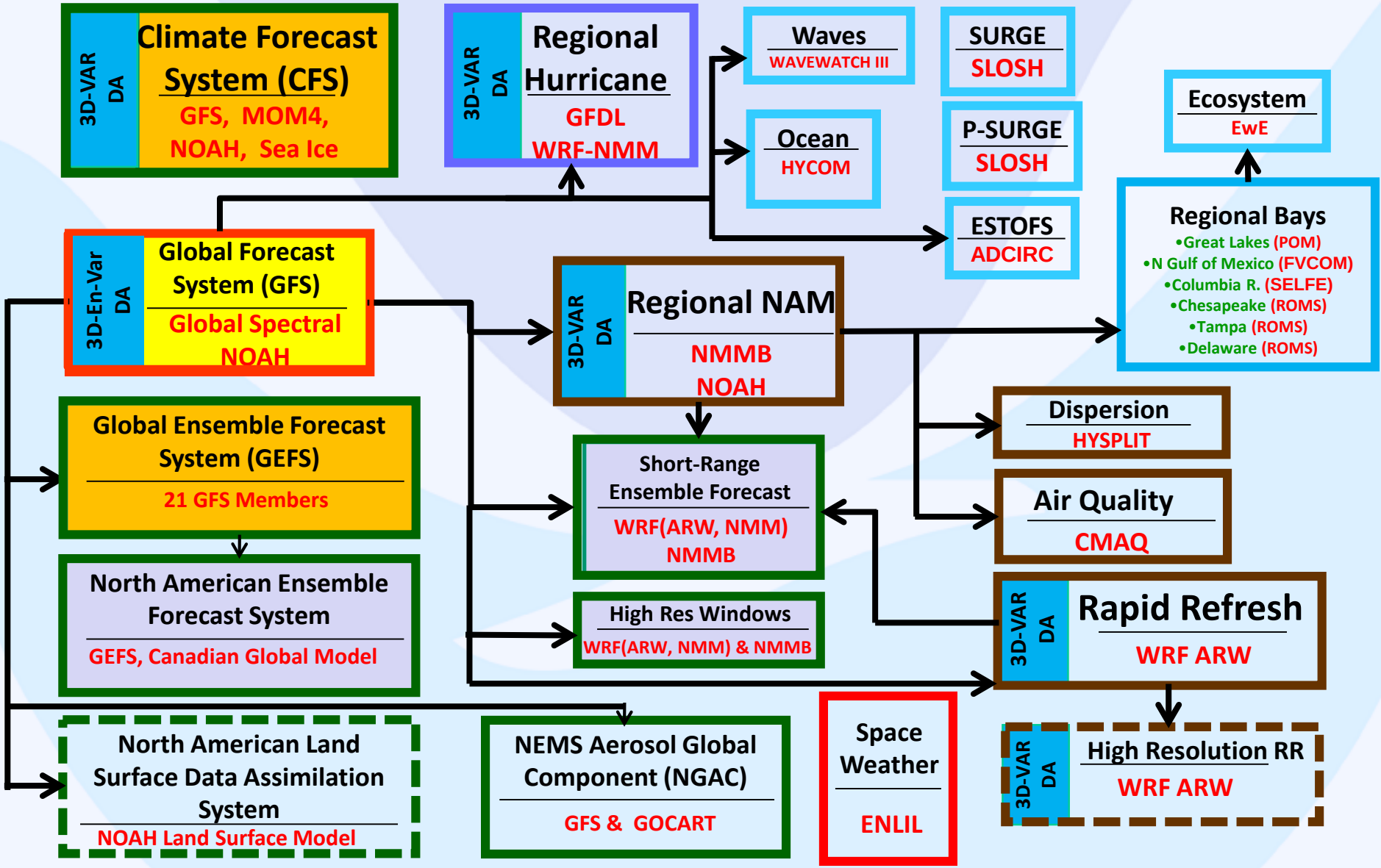
- Overview.
- Dycore project
- Physics approach
- Unifying the production suite

Finally ice !

- Global project
- Arctic project
- This workshop

Seamless Suite, spanning weather and climate





Production suite ca. January 2014

Basic issues / UMAC

Some key findings of UMAC* :

- 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 predetermined (relative) compute resources for individual applications (our previous “jigsaw puzzle”)

The production suite has evolved as a set of solutions for (ill-defined) requirements, instead of a set of products serving well defined requirements.

* UCACN Model Advisory Committee

https://www.earthsystemcog.org/projects/umac_model_advisory

Basic issues / UMAC

Moving away from implementing solutions:

- Need better NWS requirements process.
- Map requirements to products (not models).
- Target model development to better serve requirements.
- Business case is integral part of decisions:
  - ➤ Unified model with concentrated effort, versus
  - ➤ models tailored to selected requirements.

Additional considerations

- Coupled modeling needs to be considered in this context.
- Focus on predictability and outlook products requires systematic ensemble / reanalysis (retrospective) / reforecast approach.

Basic approach : atmosphere

Start with weather side:

- We are NWS !

Starting with products:

- What forecast time ranges,
- which reasonably imply
  - ➤ Run cadences.
  - ➤ Update cycles.
- Not so clear:
  - ➤ Resolutions.
  - ➤ Data Assimilation.
  - ➤ Reforecast / reanalysis / retrospectives
- Need to map requirements to forecast ranges.

Possible Approach			
Range	Target	Cadence	Means
year	Seasonal	?	9-15mo
month	S2S	6-24h	35-45d
week	Actionable weather	6h	3-16d
day	Convection resolving	1h	18-36h
hour	Warn On Forecast *	5-15 ‘	3-6h
now	Analyses **	?	now

* FACETs
** Separating from DA for models

Basic approach : coupling

This is not just a science problem

- Requirements for additional, traditionally downstream products.
- '"One-way" model coupling versus downstream model:
  - Increases forcing resolution of downstream models while reducing I/O needed to force models.
  - Creates a better integrated test environment for holistic evaluation of model upgrades.
  - Less implementations.
  - Creates environment for investigating benefits of two-way coupling. Enables two-way coupling if science proves benefit.

Negative aspects of coupling:

- More complex implementations.
- Less flexibility to tailor products.
- Produce "too much" compared to tailored products (forecast range).

Basic approach : coupling

Many potentially coupled model components already have products in the production suite :

- Where no products exists, science suggests benefit of coupling.
- For the hourly forecast range, all still TBD.
- DA is also moving (internationally) to coupling.
- Space weather making its way into operations.
- Ecosystems (marine) being considered (not in table).

Subsystem	Year	Month	Week	Day	Hour
Land / hydro	Y	Y	Y	S	?
Ocean / coast	Y	Y	Y	S/R	?
Ice	Y	Y	S	?	?
Waves	S	Y	Y	Y	?
Aerosols	S	S	Y	Y	?
Space weather	?	?	Y	?	?

Y: present product
S: science benefit
R: unmet requirement
?: TBD

Basic approach : DA

DA is critical !

Unifying on GSI and ensemble hybrid 4DVAR.

Global focus:

- Is a single DA system for all global models feasible?
  - ➤ Freeze or update DA for climate applications.
- Where do we go with coupling.

Regional focus:

- We do want to unify, but how feasible is this?
- Great progress with convection resolving, but
- not yet at the science level achieved at global scales.
  - ➤ Ensemble based convection resolving DA ….
  - ➤ WoF, many efforts, no real link to production suite yet.

NGGPS

(Next Generation Global Prediction System)

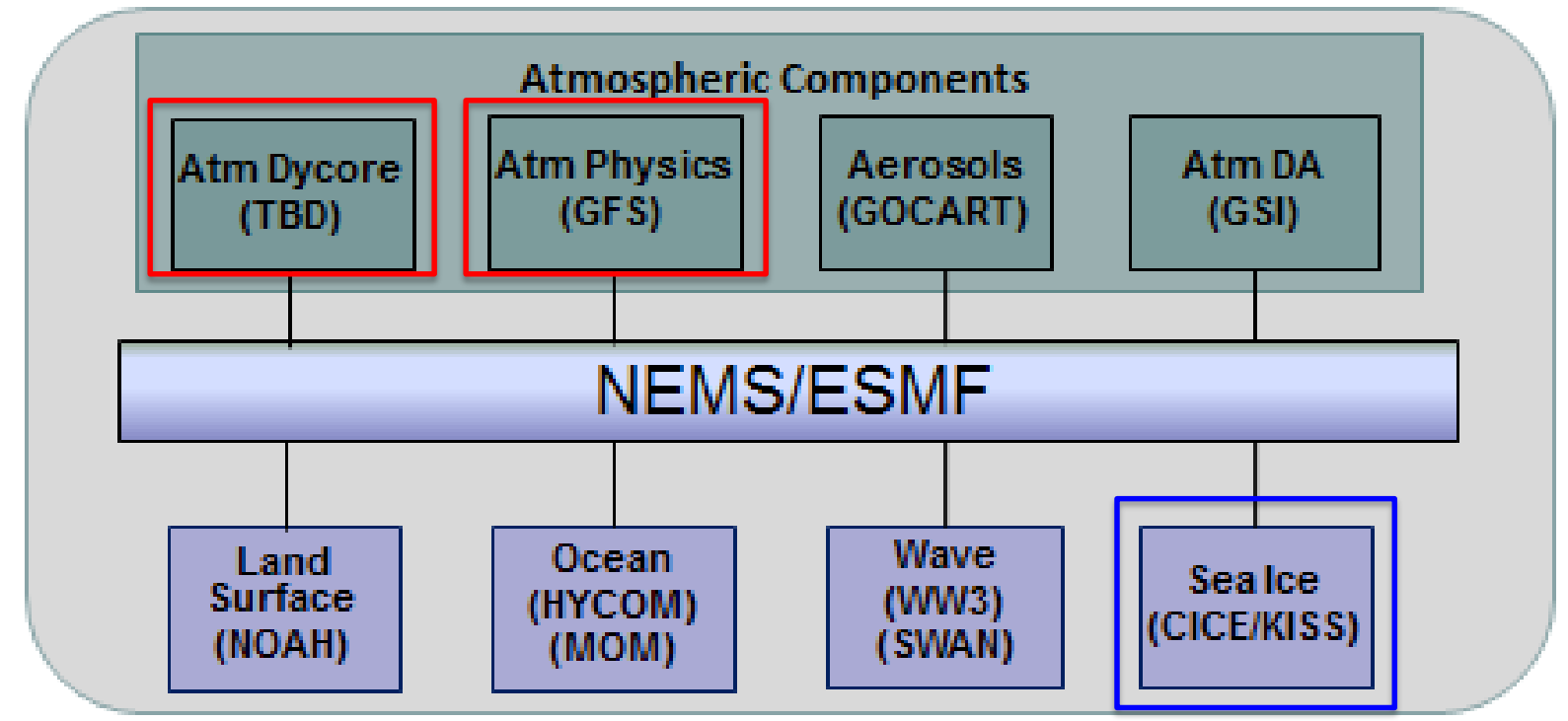
NWS R2O funding and NGGPS projects

- 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

See grants.gov for recent AO !

- Key element: Next Generation Global Prediction System
  - Next generation Dycore Selection
  - Unified physics interface, focus on physics
  - 11 more NGGPS teams ….
  - Model Coupling
    - Unified Coupled Global model (building on CFS-v2)
    - Arctic modeling

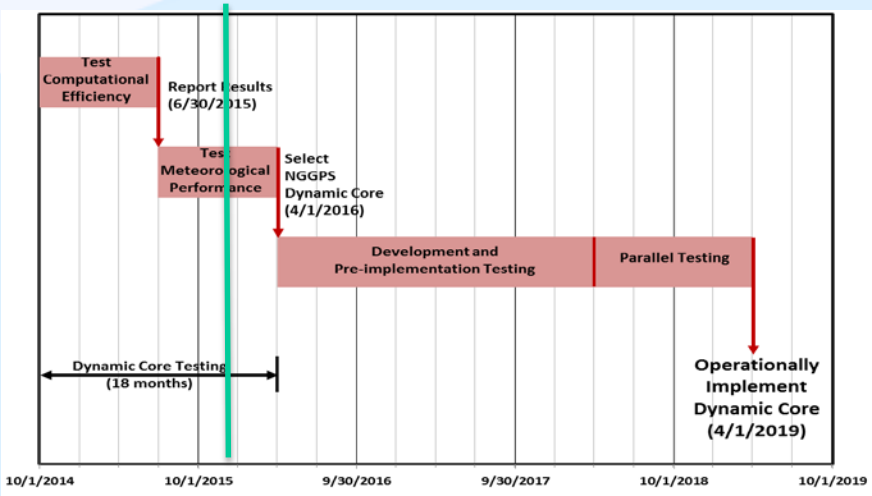
NGGPS and NEMS / ESMF



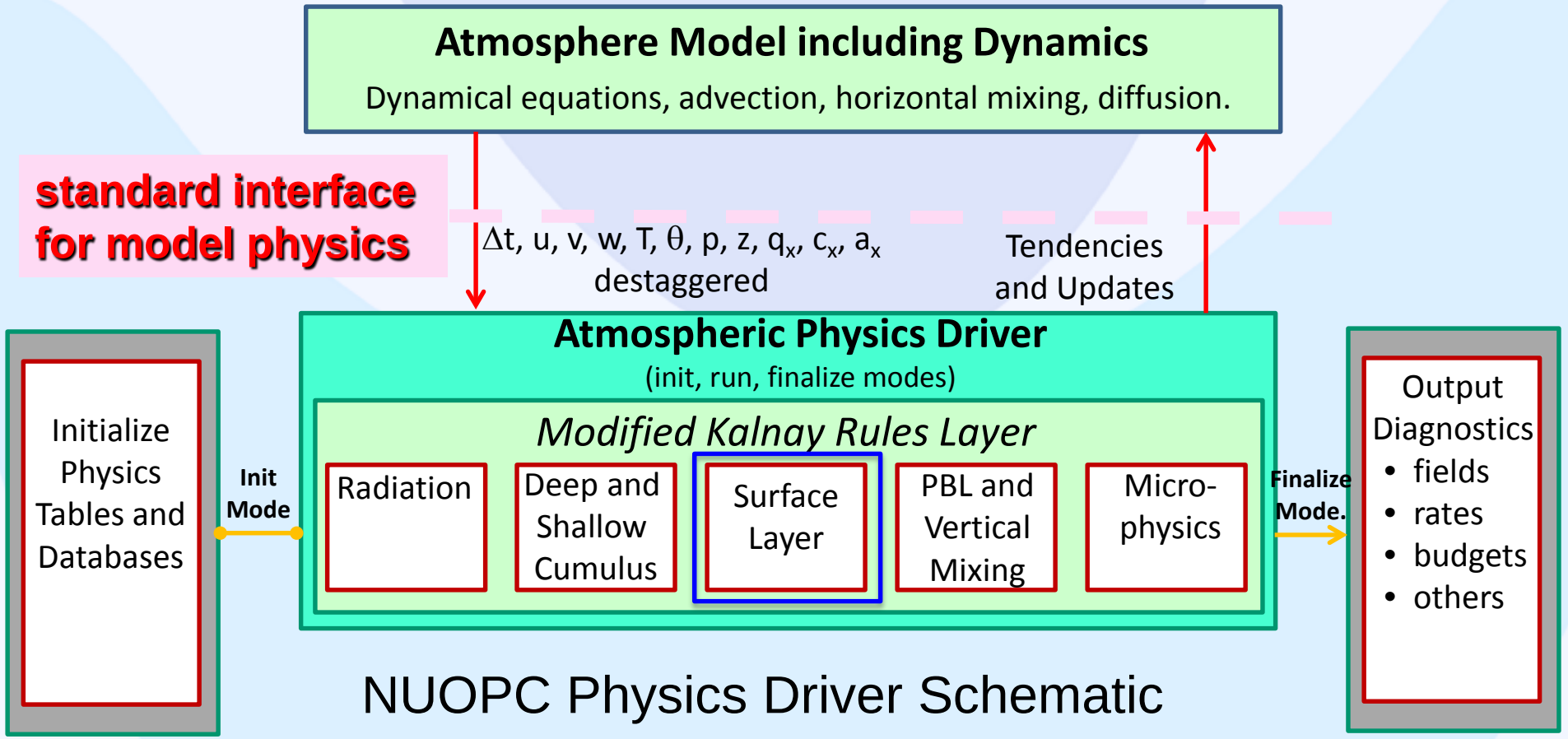
Modular modeling, using ESMF to modularize elements
in fully coupled unified global model
(+ *ionosphere , ecosystems , ……*)

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)~~



NGGPS physics



NUOPC Physics Driver Schematic

Version 1.0 delivered June 2015

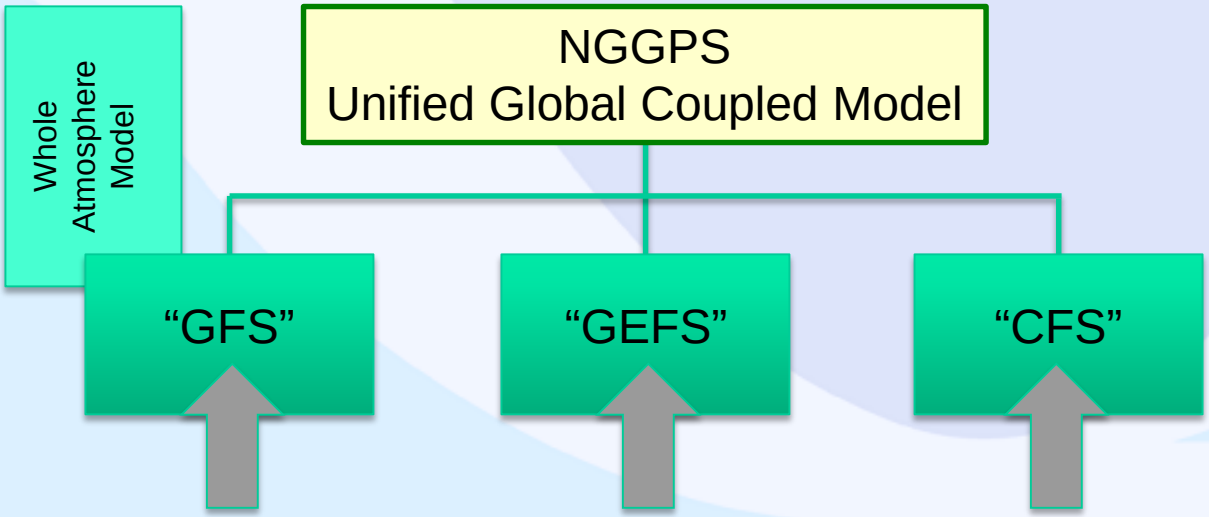
Back to unification, the atmosphere

Range	Year	Month	Week	Day	Hour	Now
Target	Seasonal outlook	S2S outlook	Actionable weather	Convection resolving	Warn On Forecast	Analyses / nowcast
Present models	CFS	CFS (GEFS extension)	GFS, GEFS, NAM, SREF, RAP, hurricane	HRRR, NAM nest, HiresW		RTMA, URMA, blend
Cadence	? (is 6h)	24h (is 6h)	6h	1h	5-15’	?
Range	9-15mo global	35-45d global	3-16d global (?)	18-36h regional (?)	3-6h ? regional	0 regional (?)
Updates	4y	2y	1y	1y	1y	6 mo
Reanal.	1979-now	20-25y	3y	?	?	
Where	?	WCOSS	WCOSS	WCOSS	?	WCOSS

- Ensemble based DA for all ranges (day and hour TBD), except possibly for the now range.
- All global applications from single unified modeling system.
- Global / regional unification ?

- Present NPS elements not fitting well in this layout:
  - Space weather (WAM-IPE / Geospace).
  - Hurricane models (GFDL / HWRF).

Unified Global Model



Application
=
Ensemble
+
Reanalysis
+
Reforecast

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

On to ice …

NGGPS project #1: global

- Demonstration coupled global model and DA.
- See previous slide.
- Ice integral part.
- Deliverable by end of FY16
  - Move into CFV-v3
  - Core for GFS and GEFS further development

NGGPS polar #2: Arctic demonstration project

- See next slides
- Following NRL ACFNS strategy
  - Start with regional model to limit development costs.
  - Development FY16-17, contribution to YOPP.
  - FY18: decide on operations / merging with unified model(s).

Arctic model development

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.

STI-R2O funding for two year project.

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

Arctic 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>
</table>

This workshop

Community input in our ice modeling.

- Input in setting directions
  - Models
  - Validation
- Buy in of community
- Alignment of community

Time line

- Global demonstration end of FY16
- Arctic
  - FY16 regional deterministic coupled model
  - FY17 extend to regional ensemble
  - FY18 YOPP experimental products, transition to or merging with operations.


Thank You!