



NGGPS

Software Architecture and Engineering

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Overview

This will be short, much in other presentations

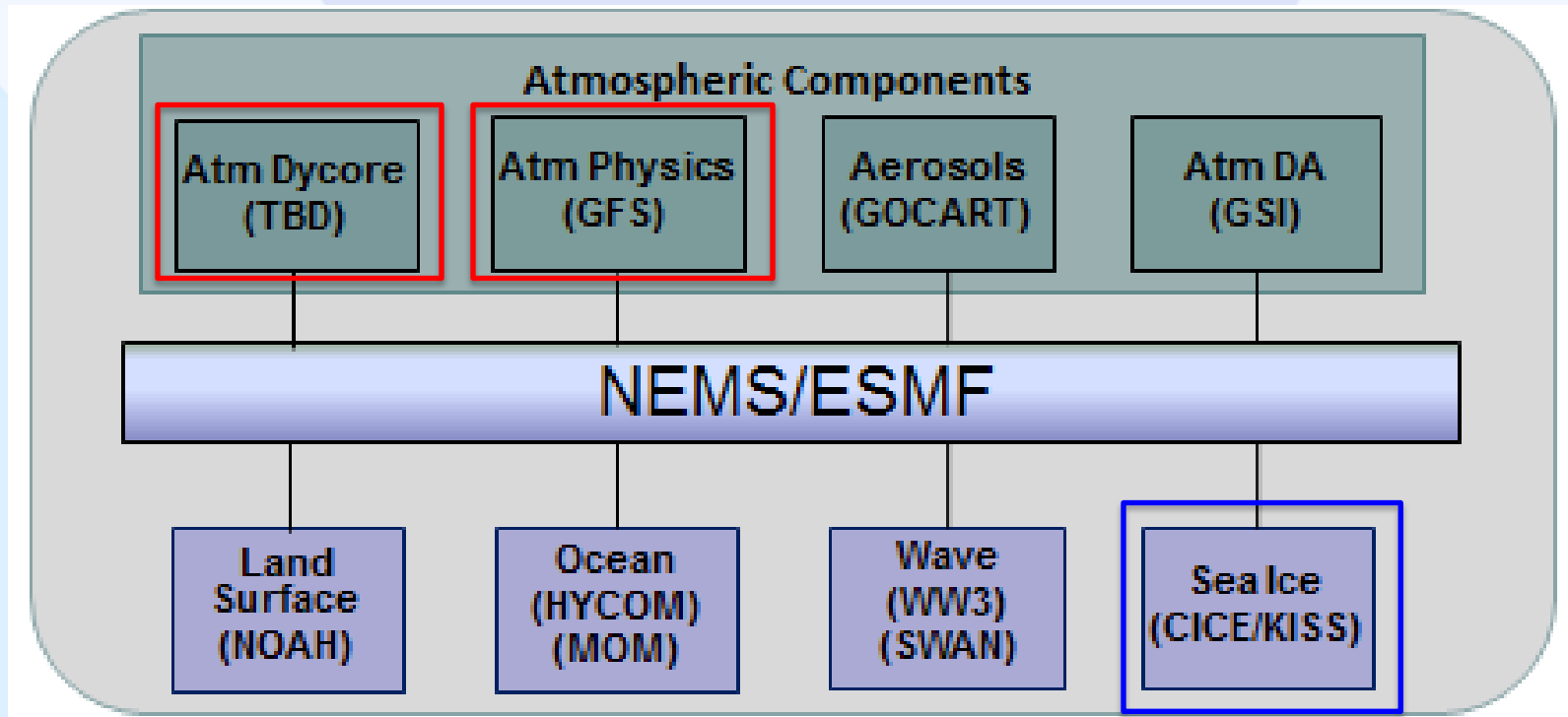
Base effort:

- NEMS: software architecture
- Unification: suite architecture

Bigger picture:

- NITE
- Validation and Verification

NGGPS and NEMS / ESMF



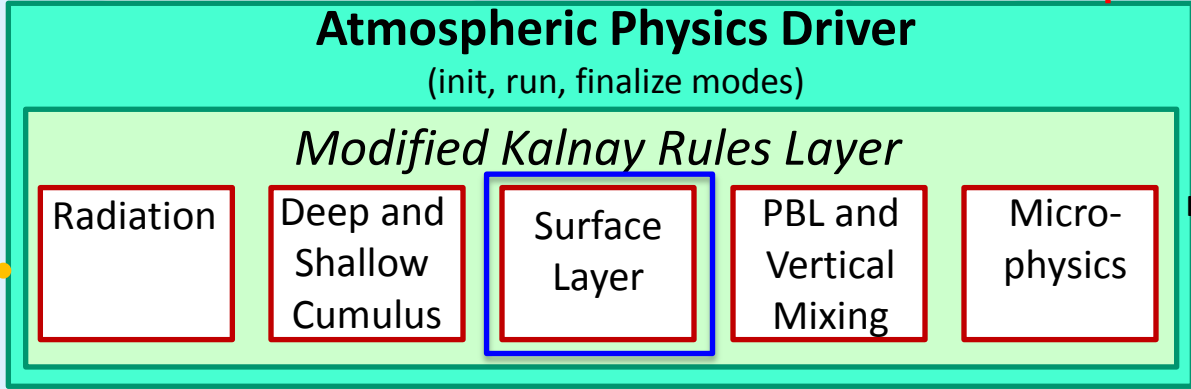
Modular modeling, using ESMF to modularize elements
in fully coupled unified global model
(+ *ionosphere* , *ecosystems* ,)

NGGPS physics

Atmosphere Model including Dynamics
Dynamical equations, advection, horizontal mixing, diffusion.

**standard interface
for model physics**

$\Delta t, u, v, w, T, \theta, p, z, q_x, c_x, a_x$ Tendencencies and Updates



Initialize Physics Tables and Databases

Init Mode

Output Diagnostics

- fields
- rates
- budgets
- others

Finalize Mode.

NUOPC Physics Driver Schematic

Version 1.0 delivered June 2015

NEMS / progress

Deliveries by Cecilia

- Training at EMC
- Starting to run models / debug

Issues:

- How to get off dual development paths
- Revisit path of NEMS development

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

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.

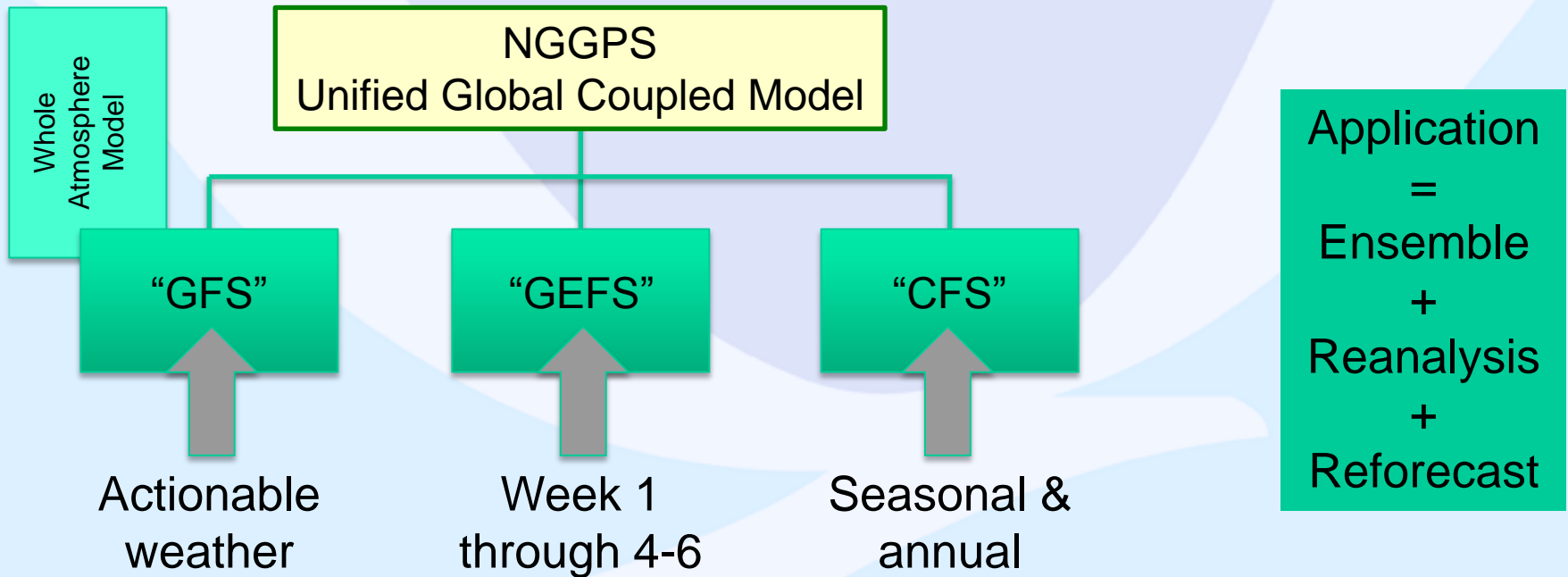
Unification, the atmosphere

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



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

Unified Mesoscale ?

Not quite part of NGGPS yet, but:

× EMS / ESRL / NSSL discussion on going forward with mesoscale models:

× Discussion not yet mature but,

- Need to do mesoscale core comparison, as soon as the NGGPS global dycore has been selected

Other

NITE: create common run time environment:

- Design by DTC
- Work on development starting at EMC

Validation and verification:

- Key to have community package for efficient community modeling and R2O.
- Focus on MET.

Thank You