NWS – Agency Partner Overview

2019 JCSDA Technical Review Meeting and Science Workshop

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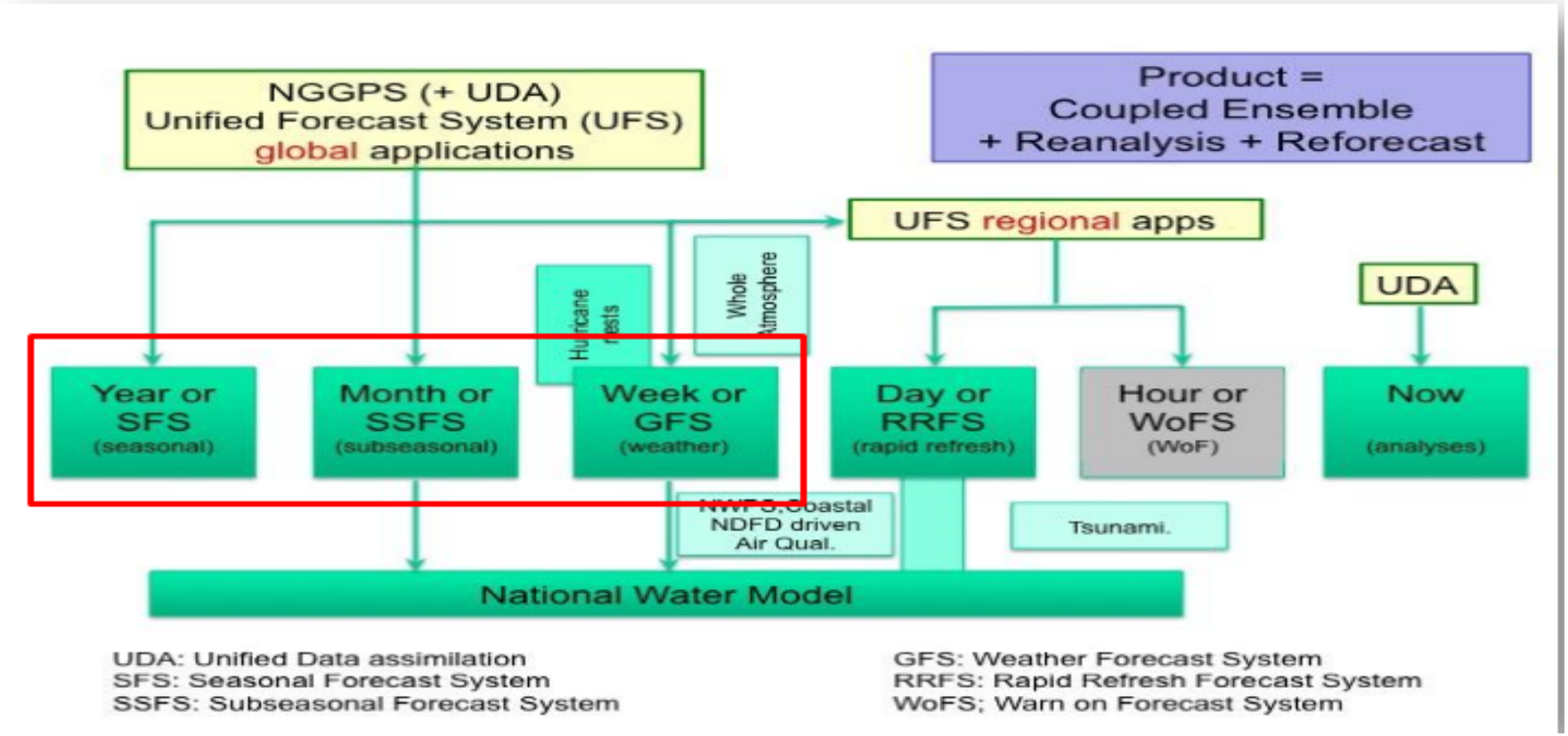
On behalf of the entire EMC Data Assimilation Team

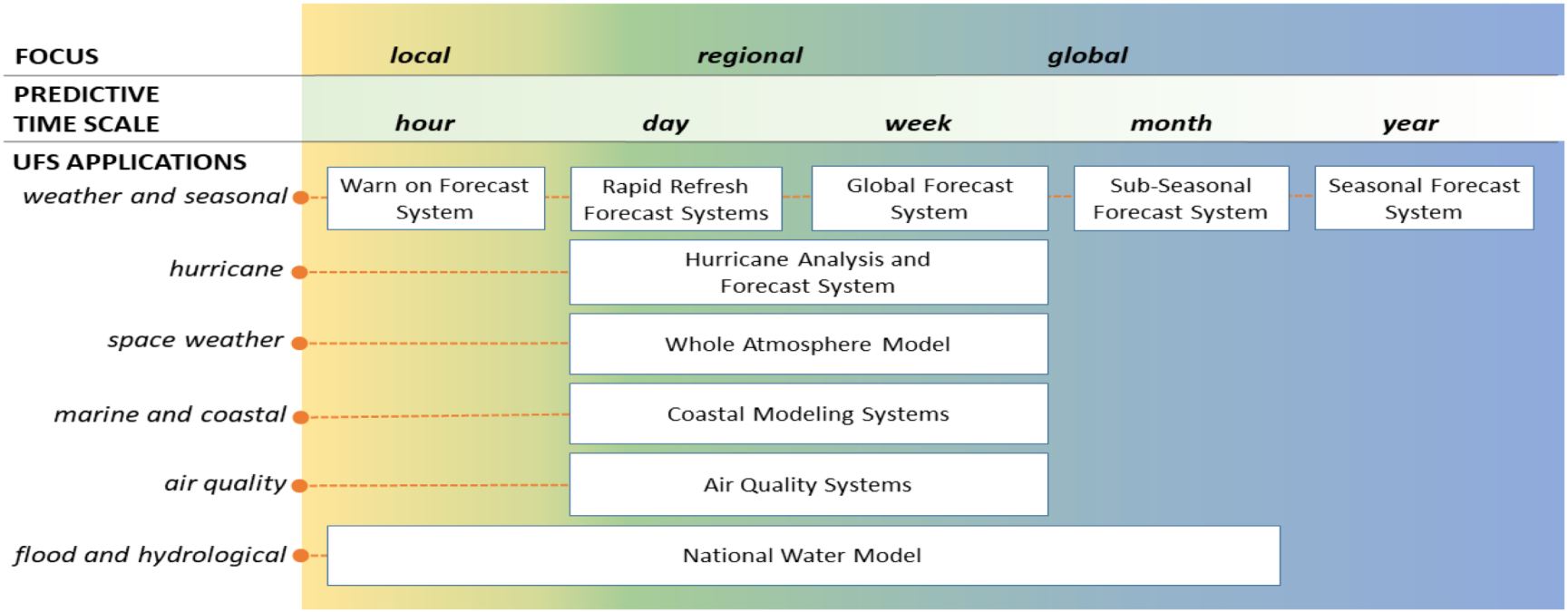
NOAA

National Weather Service

Moving Toward Unified Forecast System for NWS Operational Applications



Unified Forecast System Scope



UFS applications span predictive timescales (less than an hour to more than a year) and focus on multiple spatial scales (local to global).

Shared Community Infrastructure

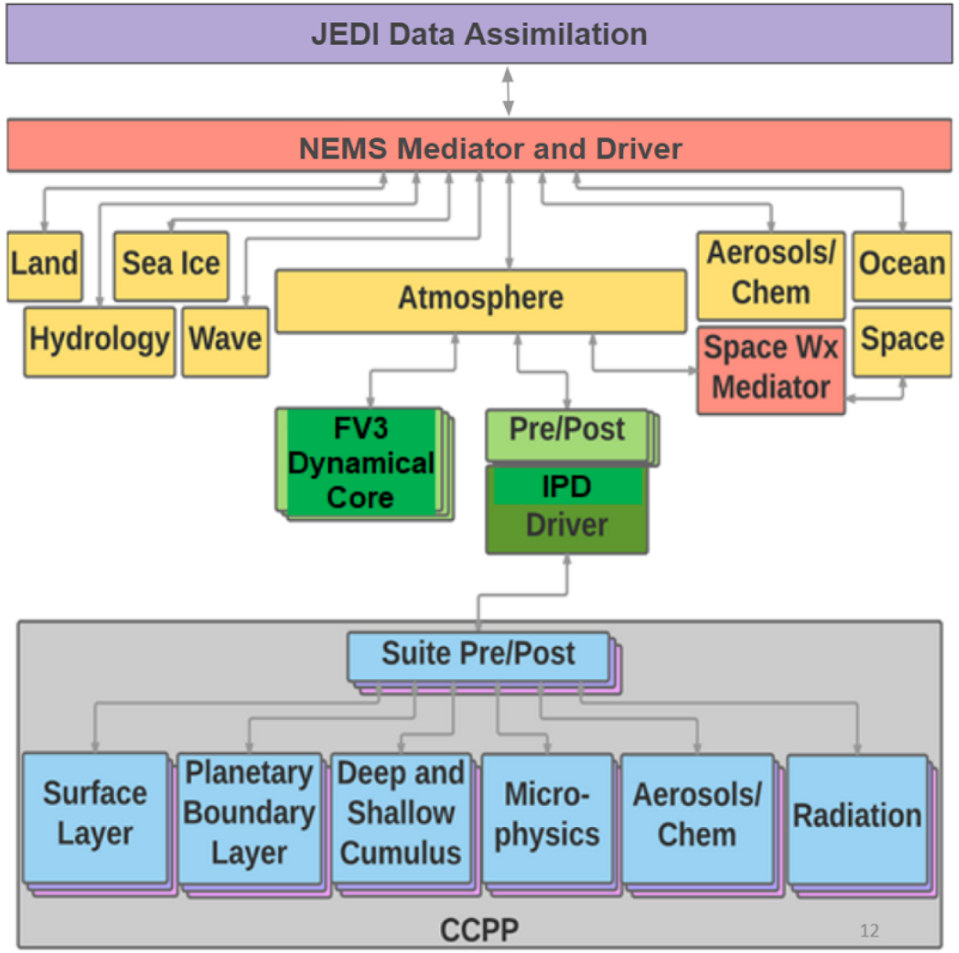
*Infrastructure for data assimilation: Joint Effort for Data assimilation Integration (**JEDI**)*

Infrastructure for coupling models together:

- NOAA Environmental Modeling System (**NEMS**) coupler
- based on the Earth System Modeling Framework (**ESMF**)
- using National Unified Operational Prediction Capability (**NUOPC**) conventions

Infrastructure for interoperable physics:

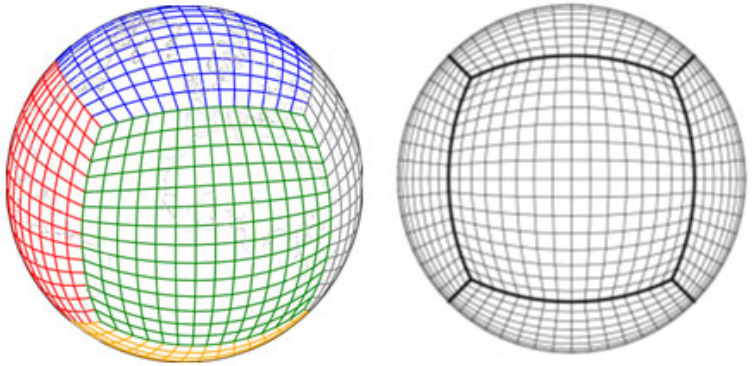
- Common Community Physics Package (**CCPP**) framework



NGGPS/FV3-GFS (June 2019 Implementation)

NOAA GFDL FV3 selected for dynamic core component of NGGPS

- Using Non-hydrostatic option
- Initial prototyping with (mostly) GFS physics (new: GFDL MP)
- Same vertical levels and model top (~55km)



Courtesy : GFDL

Data Assimilation

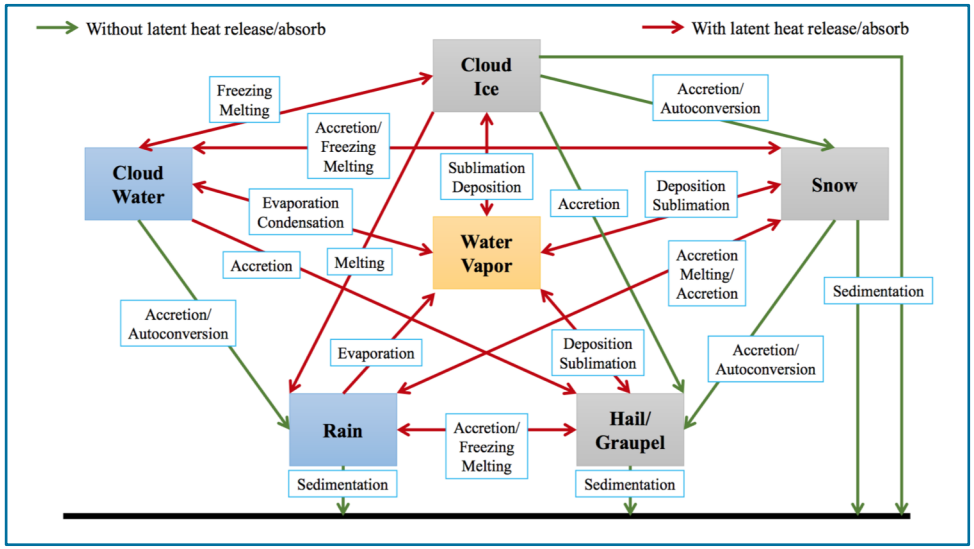
- ***Adaptation of current GSI hybrid 4DEnVar scheme (with 80 member EnSRF-updated ensemble)***
- ***Re-gridding to accommodate current DA infrastructure***

FV3GFS
Key Difference from Current Operations

- Ensemble and analysis increment resolution
  - ***While control remains ~13km, ensemble and increment resolution have been increased to ~25 km (currently ~39km)***
- Initialization
  - Current GFS uses digital filter, ***NEMS-FV3GFS not yet using initialization***
    - Both use Tangent Linear Normal Mode Constraint
  - No TC Relocation. Still assimilation single central SLP observation
- Treatment of system error
  - GFS uses SKEB+SPPT+SHUM, ***FV3GFS utilizes SPPT+SHUM only***

FV3GFS
Key Difference from Current Operations

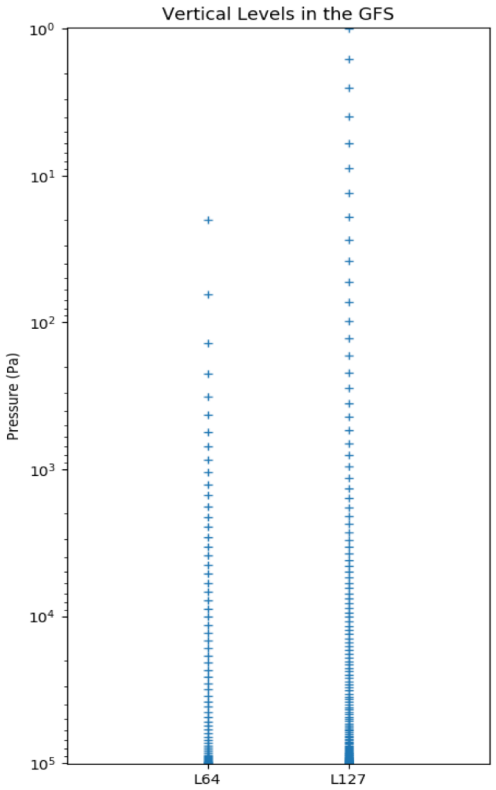
- New microphysics
  - GFS analysis total cloud increment and passes back to model
  - FV3GFS engineered to make this work with new MP scheme (5 species), ***but does not pass cloud increment back to model***



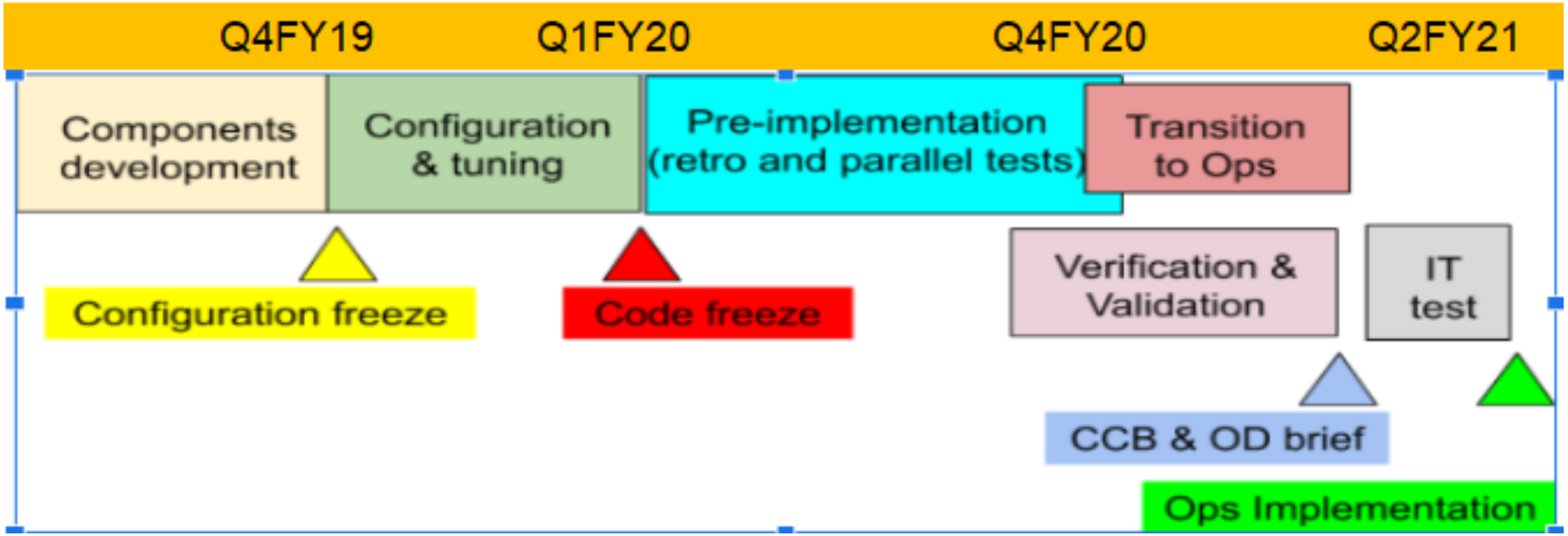
- Observations
  - Operational GFS and to-be operational FV3GFS evolving with new observing system (GOES16 AMVs, NOAA 20 CrIS and ATMS, OMPS-N, Meteosat-11 SEVIRI)
  - ***FV3GFS will implement all-sky radiance assimilation for ATMS and additional water vapor channels from IASI***
- Inline NSST
  - Background error has been recalibrated

DA Plans for GFSv16

- Vertical Resolution: **127L with 80km top** (Currently **64L with 50km top**) with modified physics
- Ensemble Perturbation Update: LETKF (replace EnSRF), Early Cycle (instead of late, GDAS cycle)
- 4D Incremental Analysis Update
- Inter-channel correlated ob error
- NSST Improvements
- Upgrade to CRTM 2.3
- GOES-16 and Himawari clear-sky radiances
- Global “LDAS”



GFSv16 Schedule



JEDI Transition (of capabilities) for Global NWP

(1) JEDI-UFO for EnKF (Sept. 2019)
Replace use of GFS for computation of O-F for EnKF only

(2) JEDI-EnKF Solver (Sept. 2020)
Replace GSI-based EnKF with JEDI-EnKF

(3) JEDI-UFO connected to GSI Solver (Sept. 2021)
Connect JEDI observer to current solver using diag/netcdf files

(4) JEDI-Solver / Full scale replacement of GSI (Sept. 2022)
Full-scale replacement of GSI

***** Note: These are benchmarks for deliveries of capabilities; not "implementations into operations"***

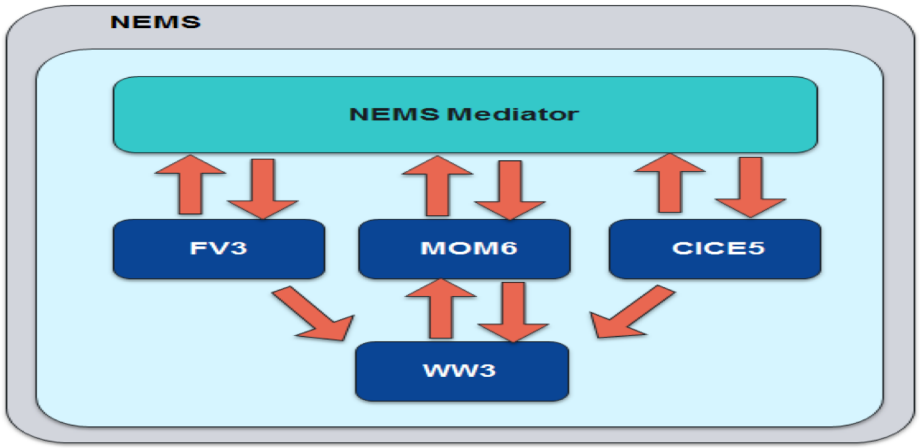
Planned Coupled UFS Applications for S2S

GEFS (Ensemble) v13: First coupled system for sub-seasonal predictions

- FV3+MOM6+CICE5+WWW3+GOCART Coupled Model
- Advanced Physics
- FY22: Implement GEFS v13.0

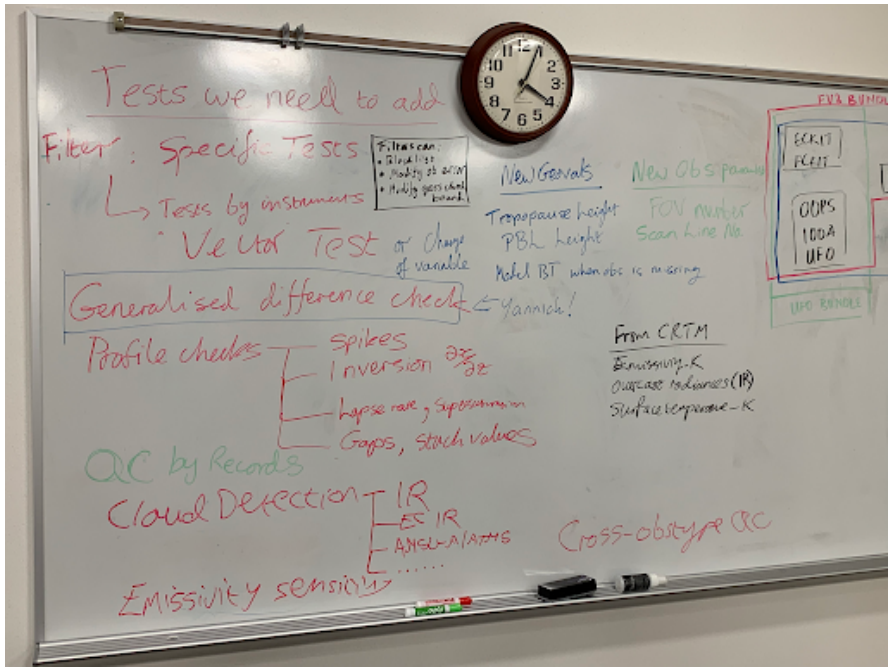
Seasonal Forecast System (SFS v1.0/CFS v3)

- Fully coupled Unified Forecast System
- Seasonal ensemble forecasts with reanalysis and reforecasts
- Fully coupled DA
- FY23: Implement SFS v1.0



NWS In-Kinds (~5FTE)

- Andrew Collard
- Stylianos Flampouris
- Iliana Genkova
- Louis Kouvaris
- Daryl Kleist
- Hyun-Chul Lee
- Haixia Liu
- Emily Liu
- Cory Martin
- Shastri Paturi
- Mark Potts
- Miodrag Rancic
- Todd Spindler
- Jun Wang
- Denise Worthen
- Jim Yoe
- Yanqiu Zhu



Science Updates will be provided by Yanqiu Zhu, Andrew Collard, Cory Martin, & Haixia Liu

Small group has been especially active in UFO development to reproduce GSI observation operators

Particular areas of interest in coming year

- Marine-JEDI (toward coupled DA)
- More emphasis on land/hydrology
- Observations (COSMIC-2, all-sky radiances)
- Aerosols/constituents
- Continued CRTM improvements
- FSOI/monitoring, link to “poor skill project”
- JEDI-enabling science such as 4DVar comparison study

Thank you!

Status of radiance data assimilation in the FV3GFS

Microwave:

- AMSU-A: NOAA-15, 18, 19, MetOp-A, MetOp-B, Aqua
- ATMS: NPP, NOAA-20
- MHS: NOAA-18, 19, MetOp-A, MetOp-B
- SSMIS: DSMP-F17
- SAPHIR: Megha-Tropiques

Infrared:

- AIRS: Aqua
- GOES-15 Sounder
- IASI: MetOp-A, MetOp-B
- CrIS: NPP, NOAA-20
- SEVIRI: MeteoSat-8, 11
- AVHRR: MetOp-A, NOAA-18

- ❑ Both clear-sky and cloudy radiances from AMSU-A and ATMS over ocean FOVs are assimilated in the **all-sky** approach (Zhu et al. 2016; Zhu et al. 2019)
- ❑ Only clear-sky radiances are assimilated from other sensors

DA Plans for Global NWP

Given results from UKMO, **draft test plan for inter-comparison between Hybrid 4DEnVar and Hybrid 4DVar (with FV3 TL/AD)**

- Continue to invest in improvements to 4DEnVar as it is operational system (time evolving full rank B, time evolving localization)
- Forward thinking, HPC considerations
- Consider implication of choices on coupled data assimilation (Is TL/AD available for coupled model, etc.?)
- Further exploitation of information from ensembles
- Scale dependent hybrids (weights, localization), shifting/lagging, multi-resolution
- Can we close the gap between Hybrid 4DEnVar and Hybrid 4DVar?
- ***Choice of algorithms may be application dependent***

Supplemental-funded global hourly updating system

- Recent proposal for "Continuous DA" from ECMWF as alternative?
- Additional/alternate cadence strategies

Better/more monitoring, online tools

- Includes EFSOI, PQC testing, etc.