Climate Modeling

The NCEP / EMC perspective

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Overview

Modeling at EMC

- Present
- Future

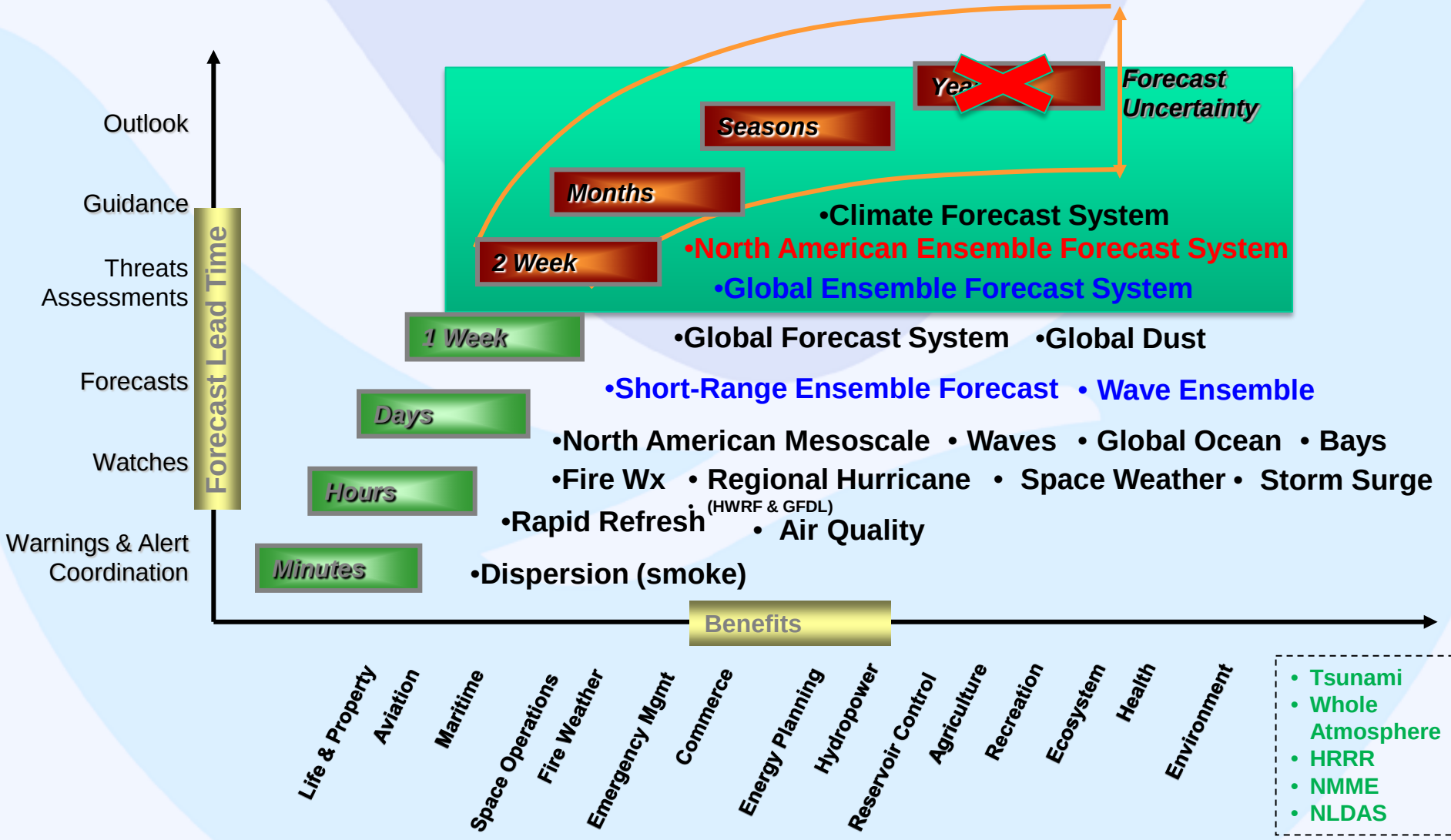
CFS v2

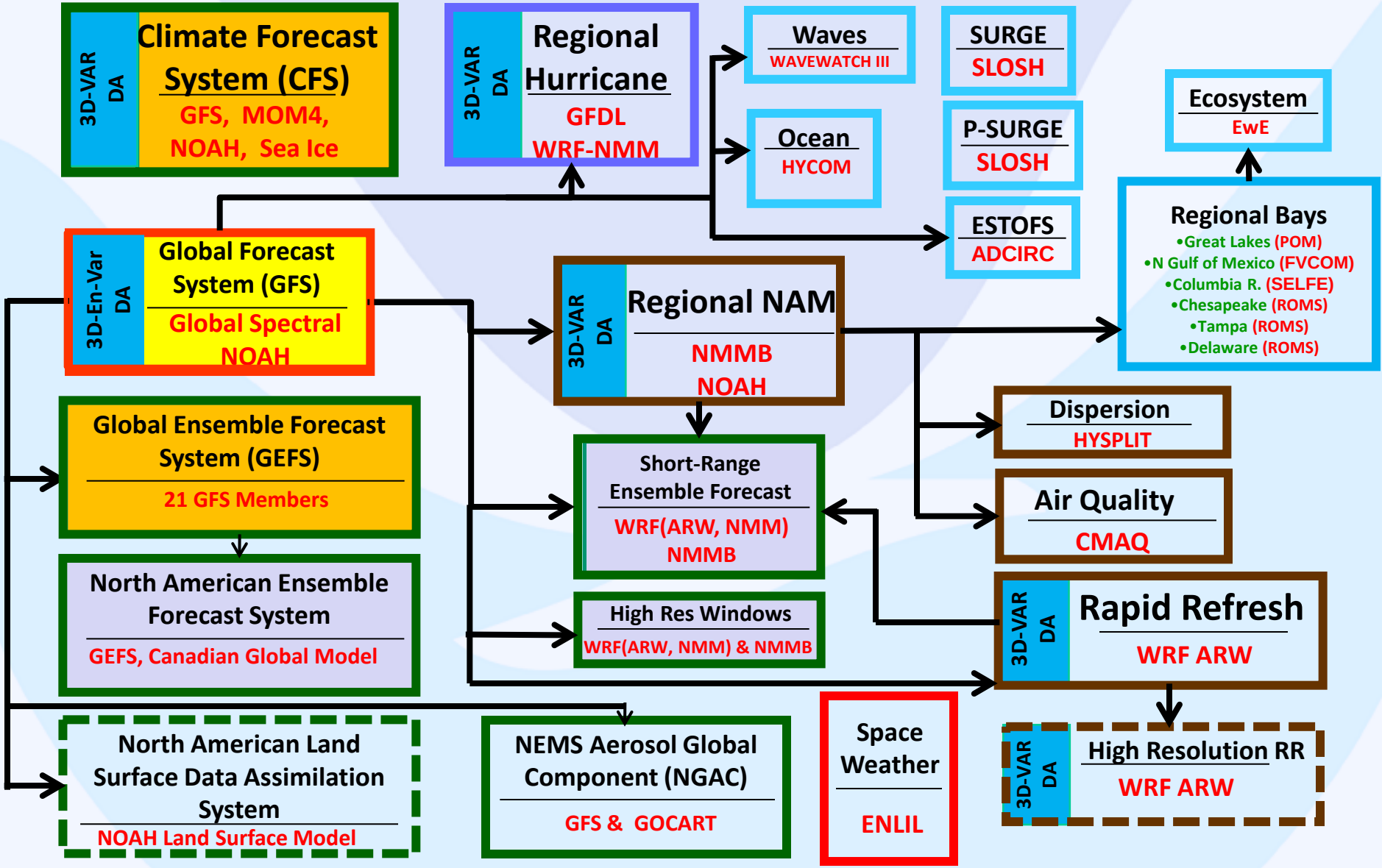
- Layout of CFSRR and CFS-v2
- Selected results

The future CFS

Modeling at EMC

Seamless Suite, spanning weather and climate



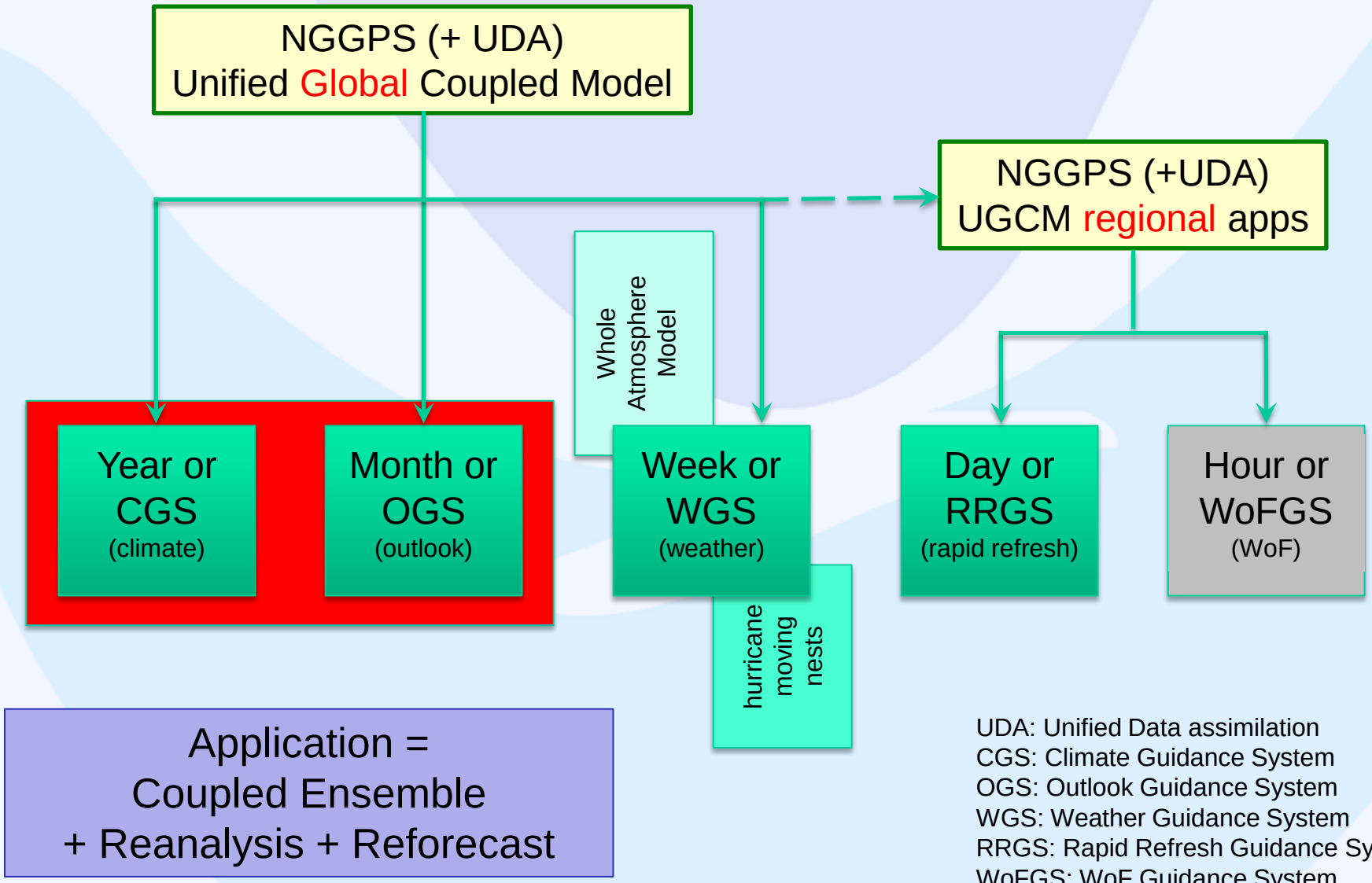


Production suite ca. January 2014

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.
    - Forecast uncertainty.
    - Calibration of outlook products.
- Range of products beyond weather:
  - Land, ice, ocean, waves, aerosols, (ecosystems, space weather).
  - Water cycle, National Water Center (NWC).

Unified design (high level goal)



UDA: Unified Data assimilation
CGS: Climate Guidance System
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WoFGS; WoF Guidance System

The Climate Forecast System

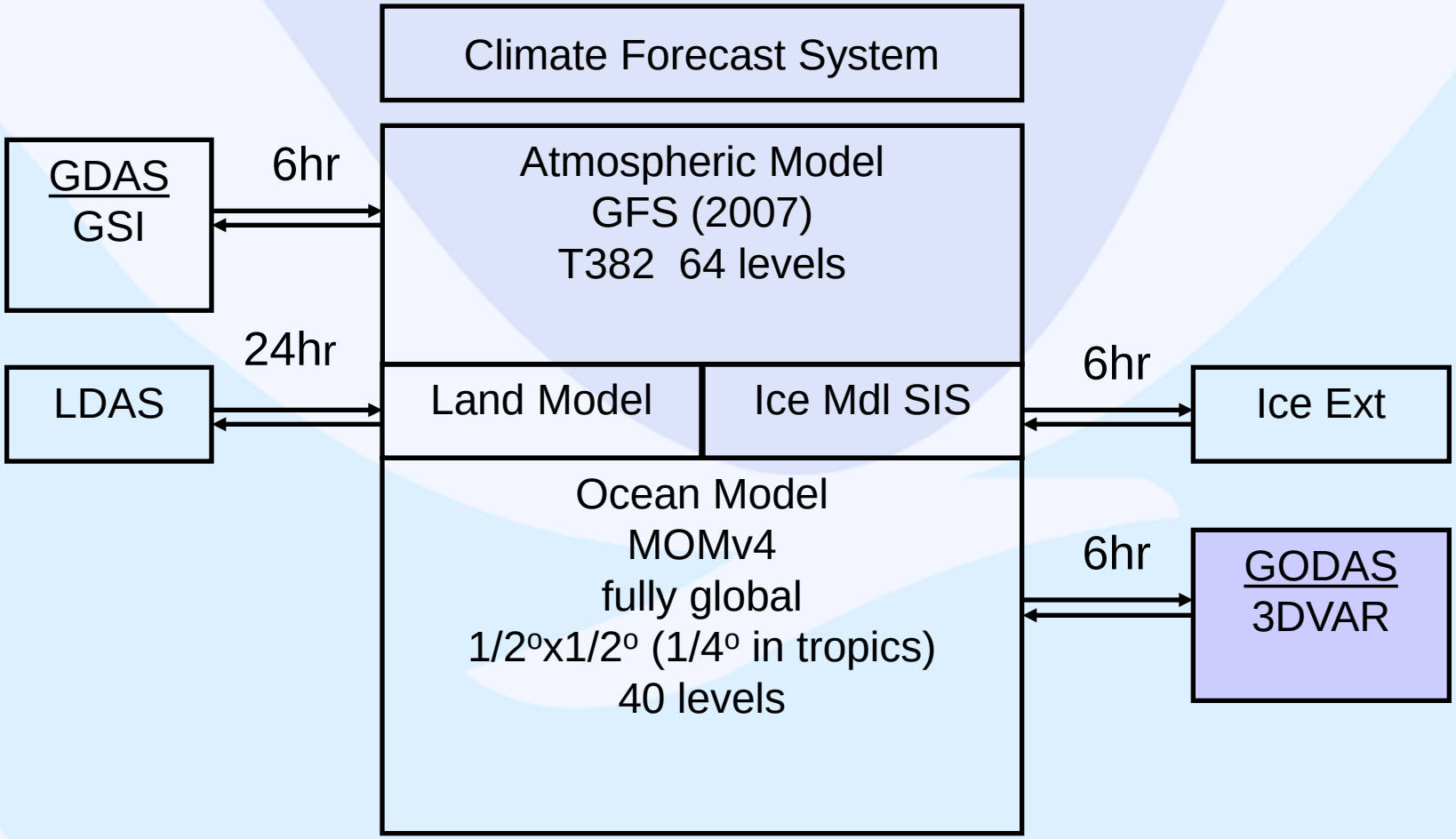
Focus on CFSRR / CFS v2

Saha et al, 2010: The NCEP Climate Forecast System Reanalysis.
Bull. Amer. Meteor. Soc., 91, 1015.1057. doi: 10.1175/2010BAMS3001.1
Saha et al, 2014: The NCEP Climate Forecast System Version 2.
Journal of Climate J. Climate, 27, 2185–2208. doi: http://dx.doi.org/10.1175/JCLI-D-12-00823.1

Essential elements of CFS v2 / RR

- Development and testing of an upgraded data assimilation and forecast model for the new system.
- Making a new Reanalysis of the atmosphere, ocean, sea ice and land over the 32-year period (1979-2010), which is required to provide consistent initial conditions for:
- Making a complete Reforecast of the new CFS over the 29-year period (1982-2010), in order to provide stable calibration and skill estimates of the new system, for operational sub-seasonal and seasonal prediction at NCEP
- Operational Implementation of the new system

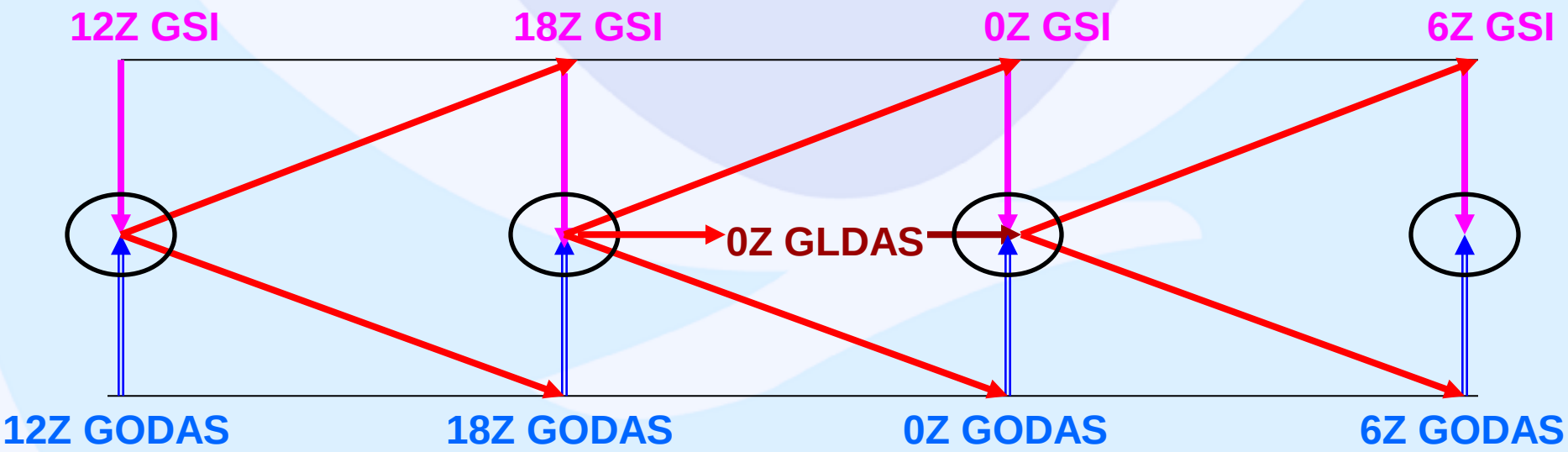
CFS at NCEP (RR – v2)



http://cfs.ncep.noaa.gov/cfsr

Data Assimilation (CDASv2)

CFSv2 is the dynamical model used in the CFS Reanalysis
The CFSR is an ocean, land, atmosphere, and sea-ice analysis, which covers the period from 1979 to present.

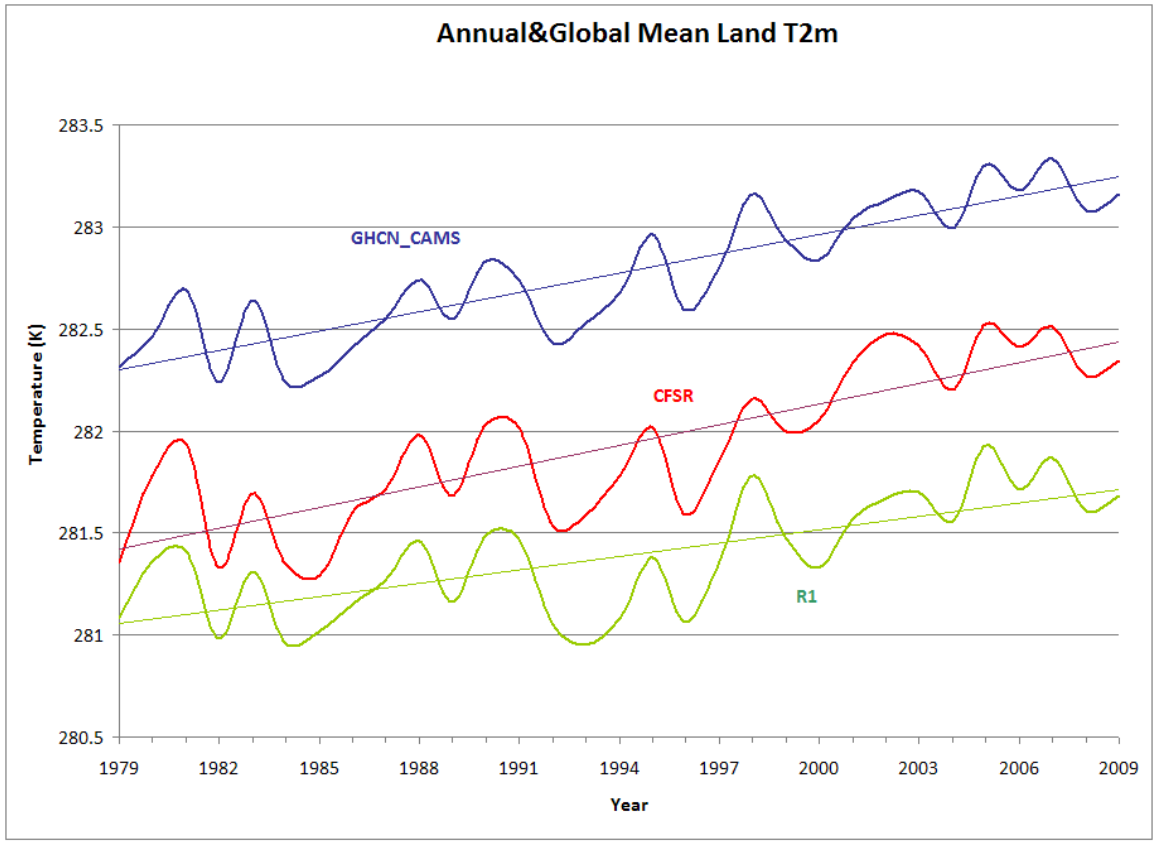


9-hr coupled T574L64 forecast guess (GFS + MOM4 + Noah)

GSI is the atmospheric component
GODAS is the ocean component (includes sea ice)
GLDAS is the land component

Using historical carbon data

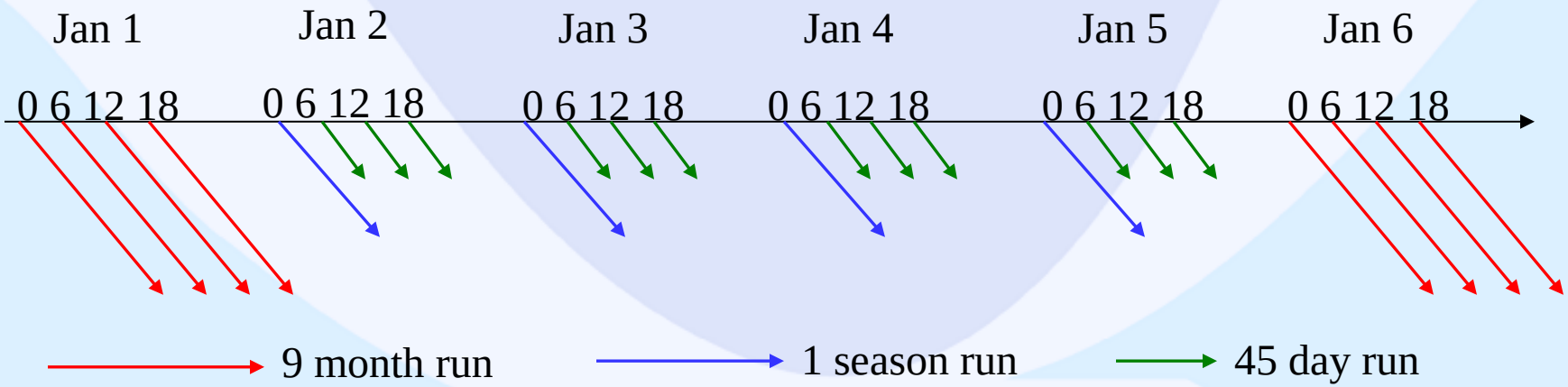
Satellite Platform	Mission Mean (ppmv)b
TIROS-N	337.10
NOAA-6	340.02
NOAA-7	342.96
NOAA-8	343.67
NOAA-9	355.01
NOAA-10	351.99
NOAA-11	363.03
NOAA-12	365.15
GEOS-8	367.54
GEOS-0	362.90
GEOS-10	370.27
NOAA-14 to NOAA-18	380.00
IASI METOP-A	389.00
NOAA-19	391.00



Huug van den Dool, CPC

Model configurations

Reforecast on “5 day cycle” = 9,447 years of model runs



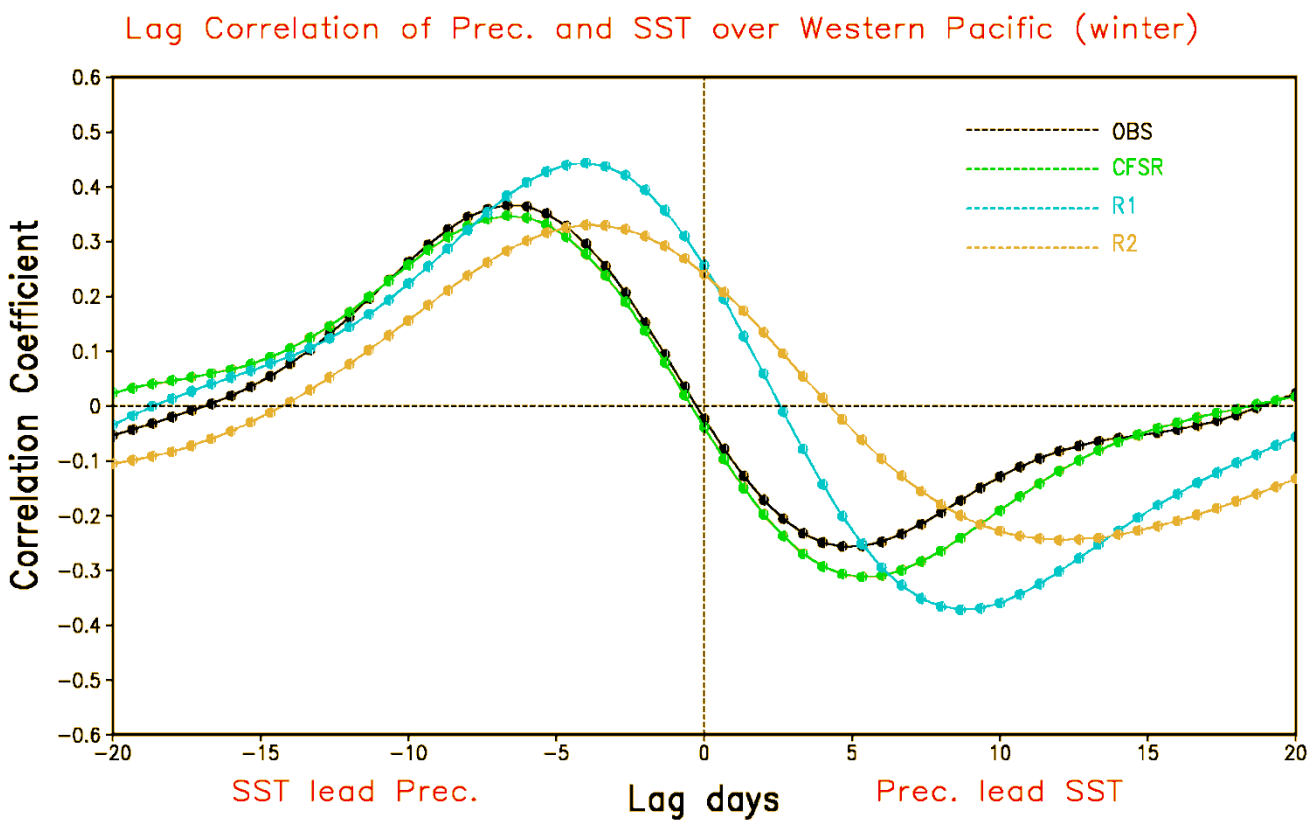
Real-time CFS runs on “daily cycle”

Designed to satisfy CPC requirements

The Climate Forecast System

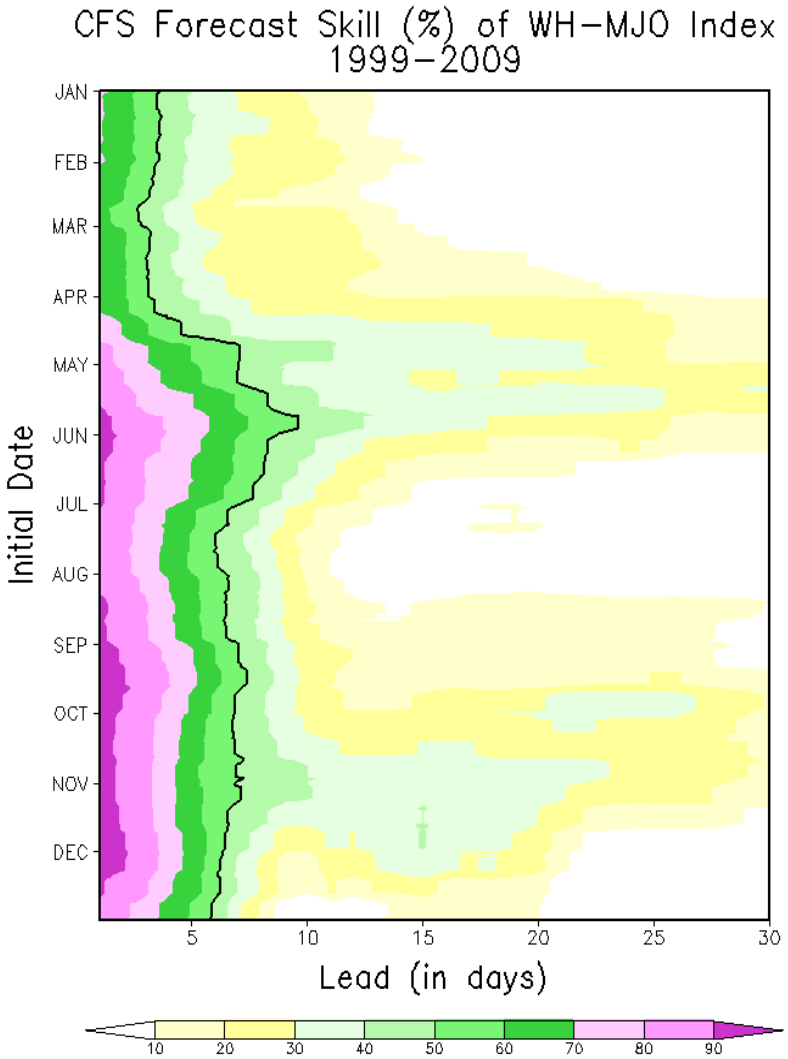
Results of v2 (versus older models)

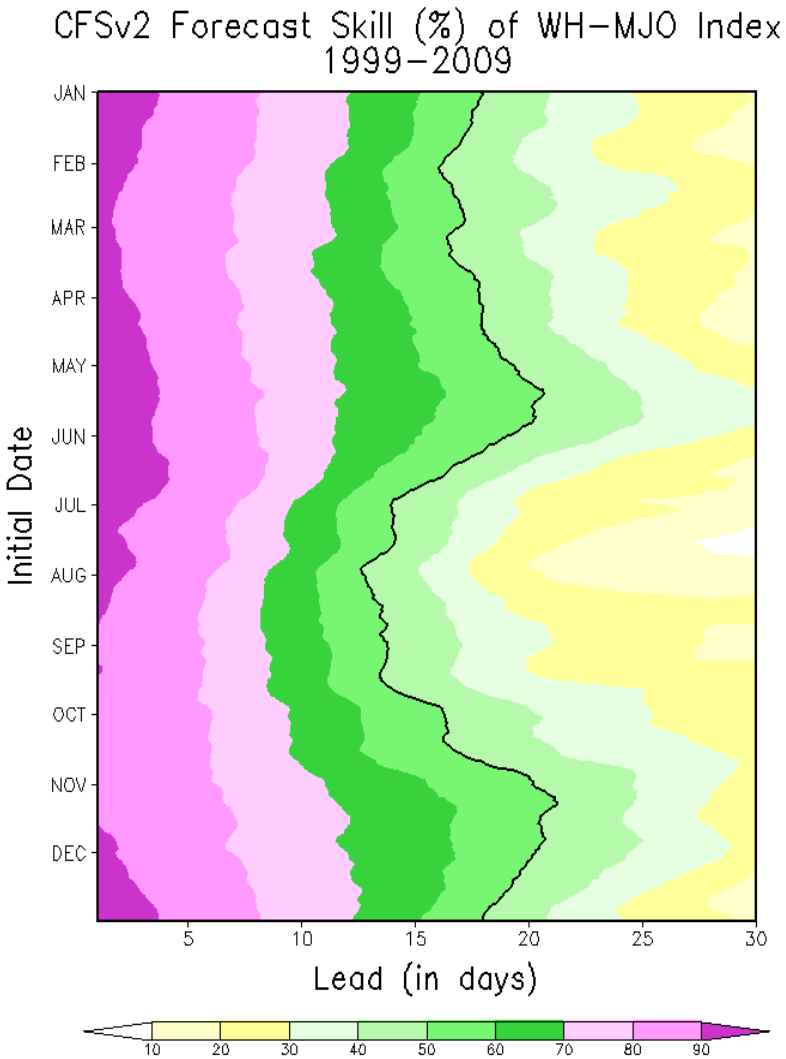
SST-Precipitation Relationship in CFSR



Jiande Wang, EMC

Forecast Skill of WH-MJO index (45 day forecasts)

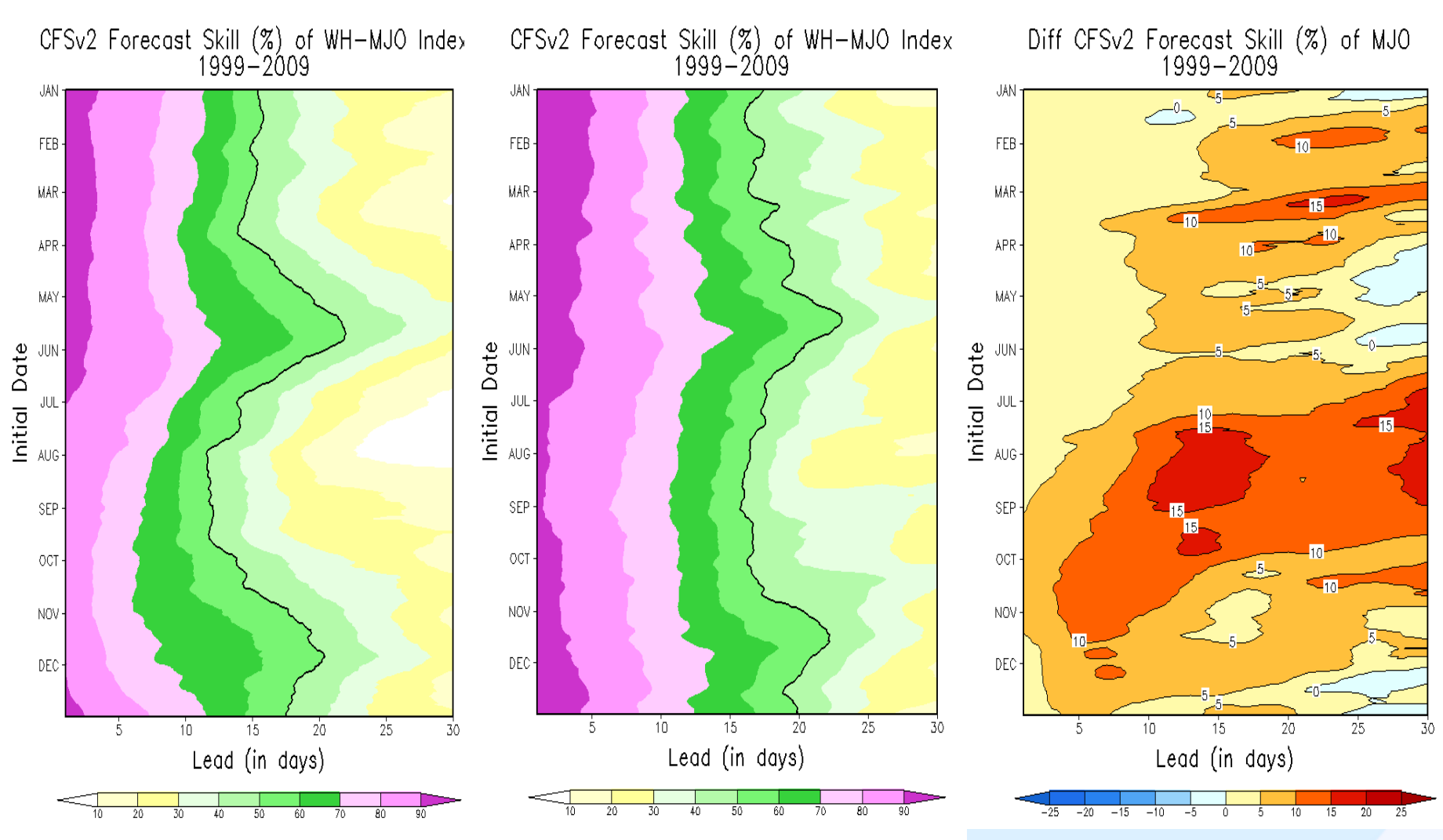




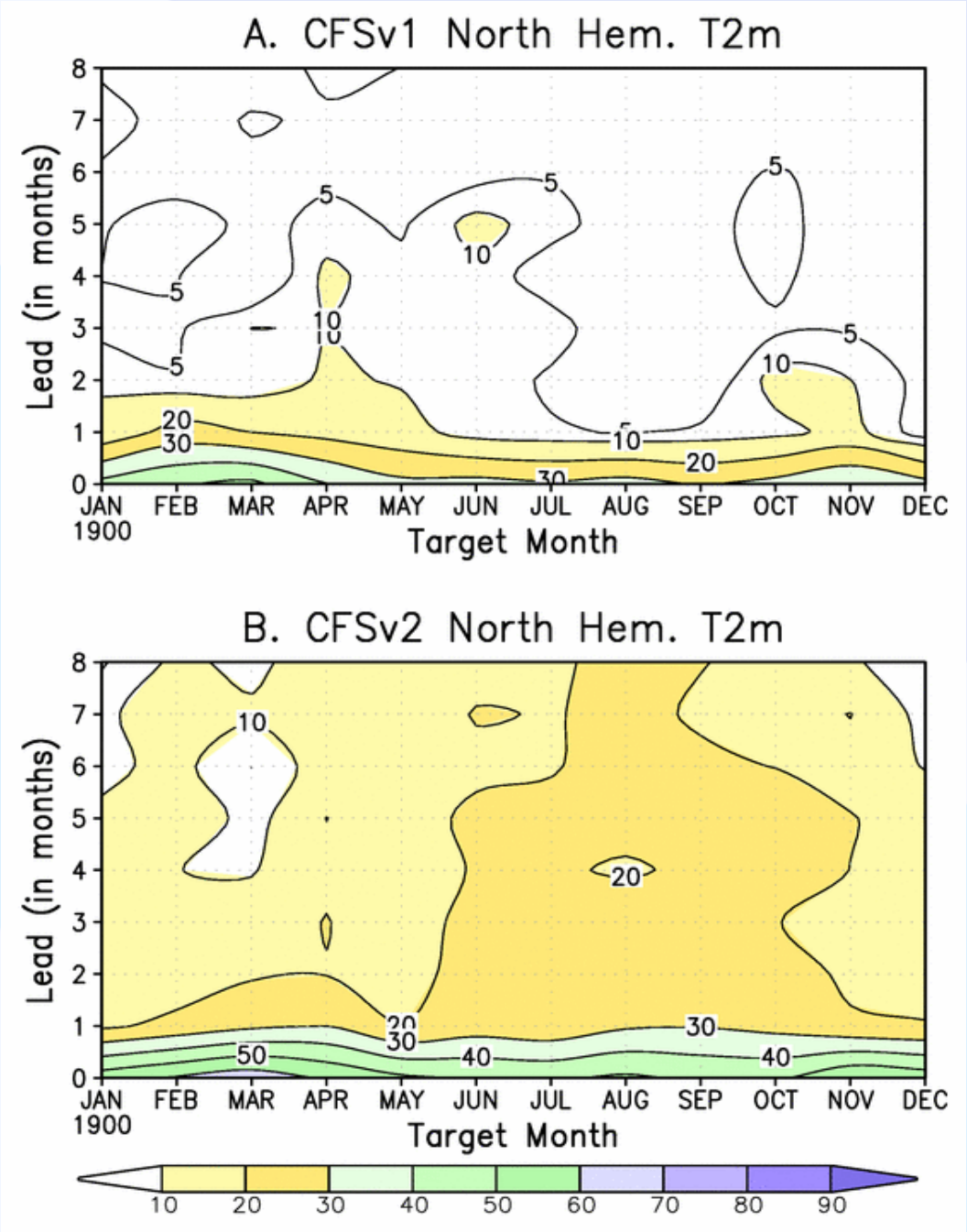
Qin Zhang and Huug van den Dool, CPC

Forecast Skill of WH-MJO index (45 day forecasts)

Before Model Bias Correction | After Model Bias Correction | Difference (After - Before)



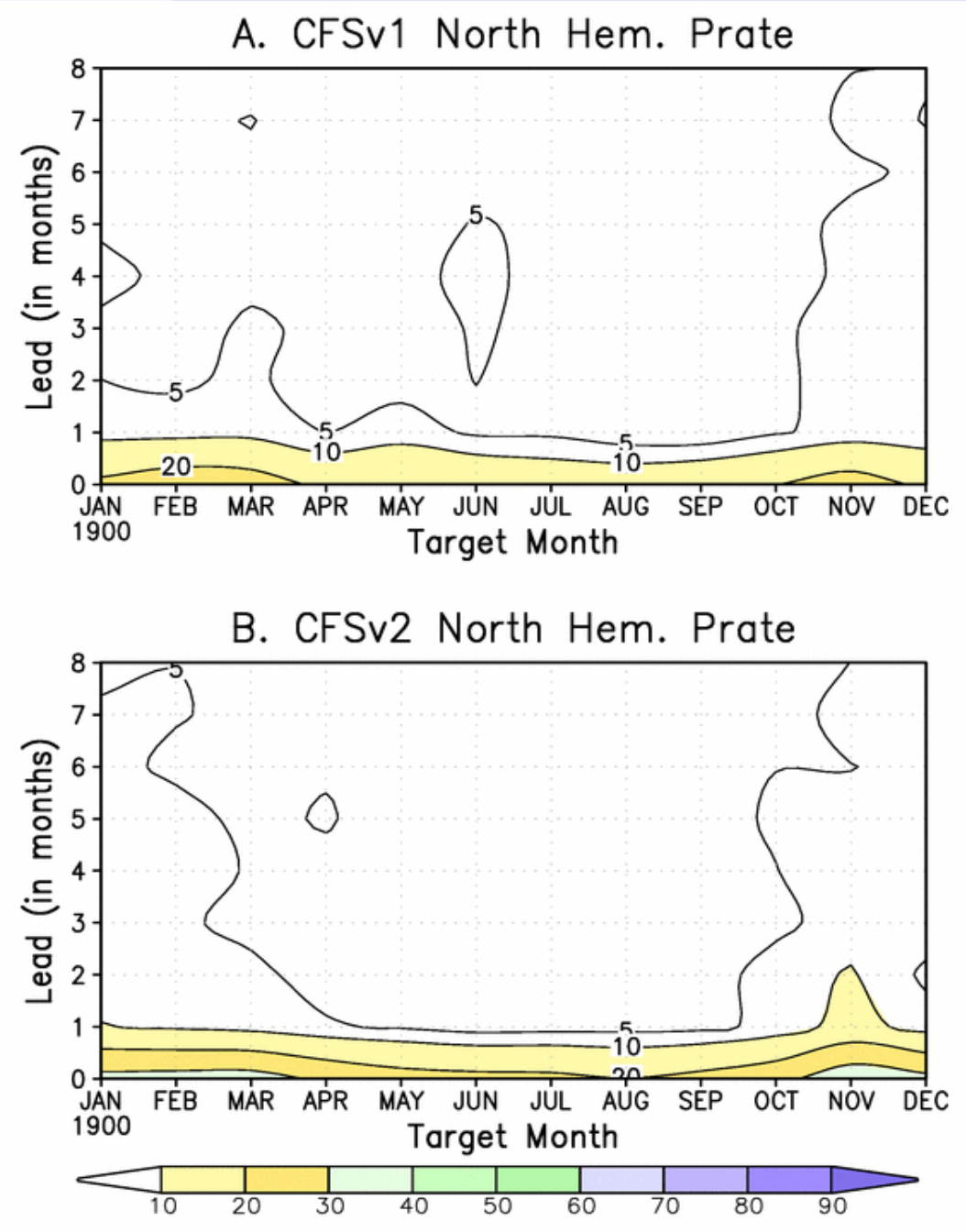
Qin Zhang and Huug van den Dool, CPC



2-meter Temperature Ensemble skill of Northern Hemisphere (all land north of 20°N)

CFSv2 clearly has more skill

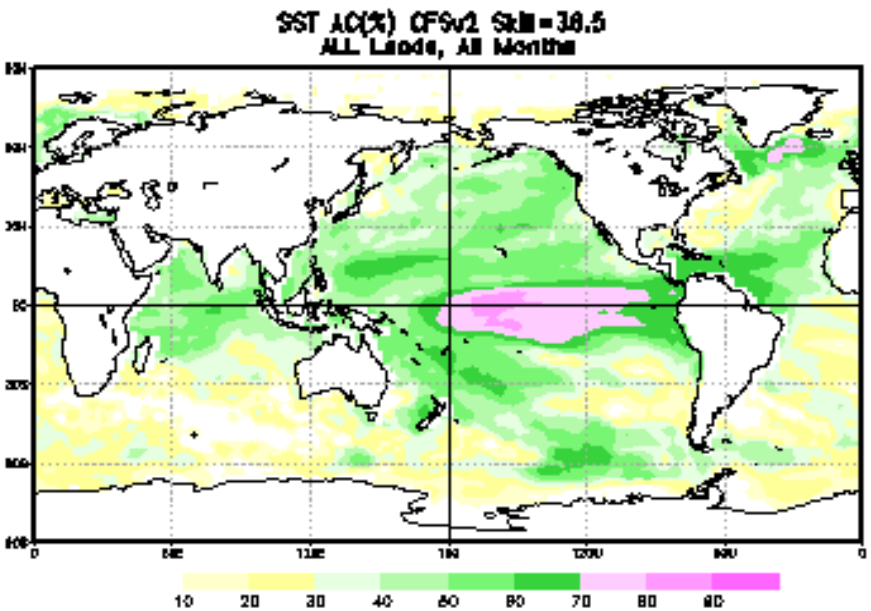
Huug van den Dool & Emily Becker, CPC

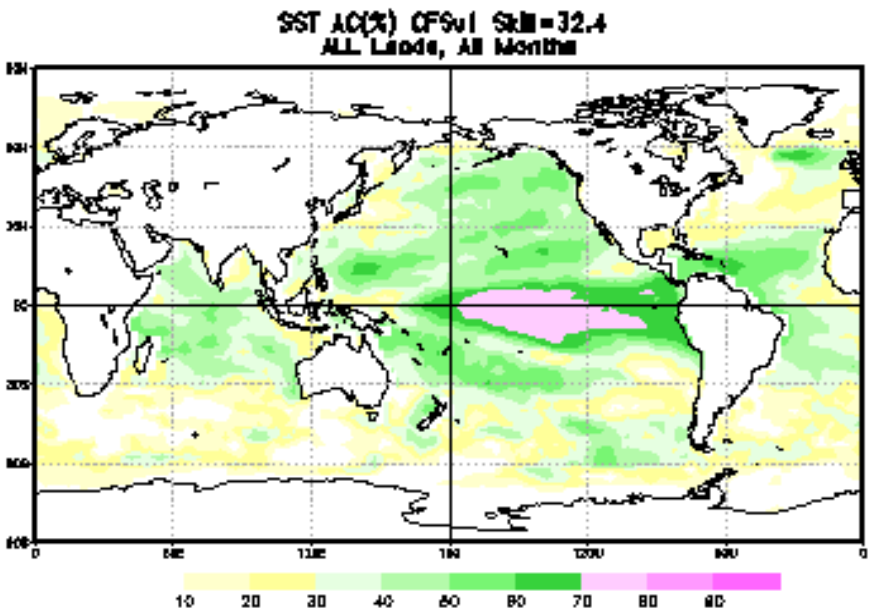


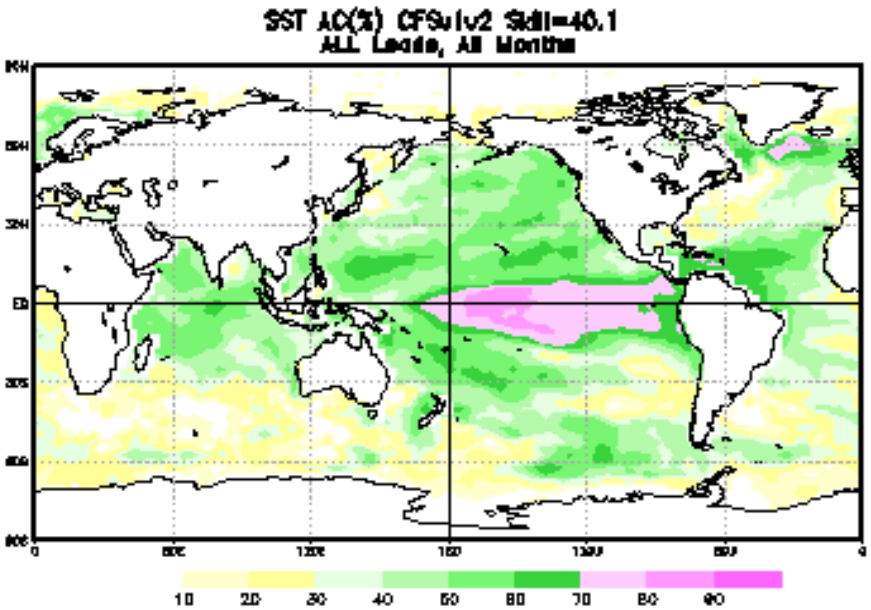
Precipitation Ensemble skill of Northern Hemisphere (all land north of 20°N)

Both systems have very little skill for precipitation

Huug van den Dool & Emily Becker, CPC







HUUG VAN DEN DOOL, CPC/NCEP/NWS/NOAA

Sea Surface Temp AC

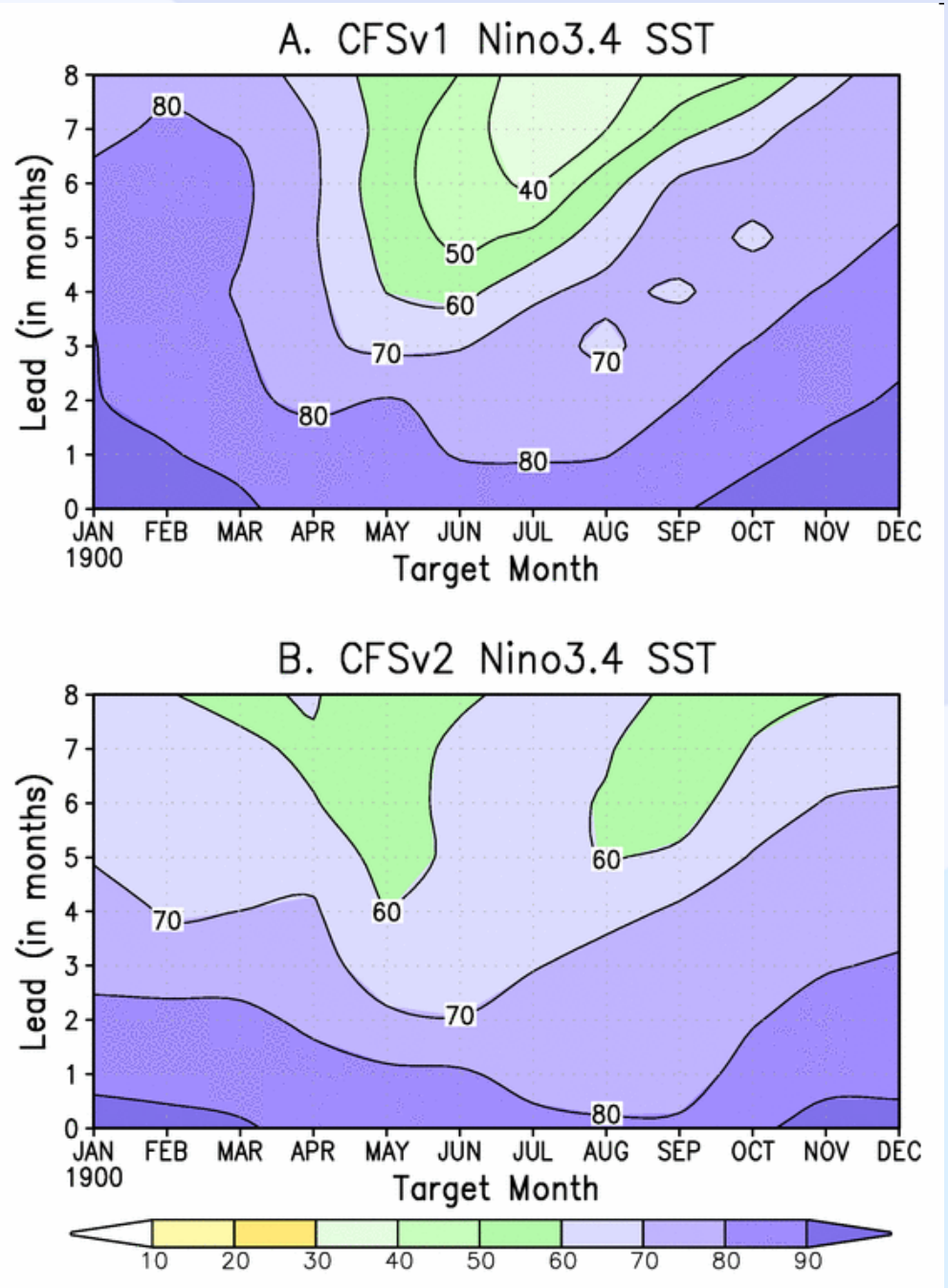
(All Leads, All Months)

CFSv2: 36.5

CFSv1: 32.4

CFSv1v2: 40.1

More skill west of the dateline and over the Atlantic for CFSv2

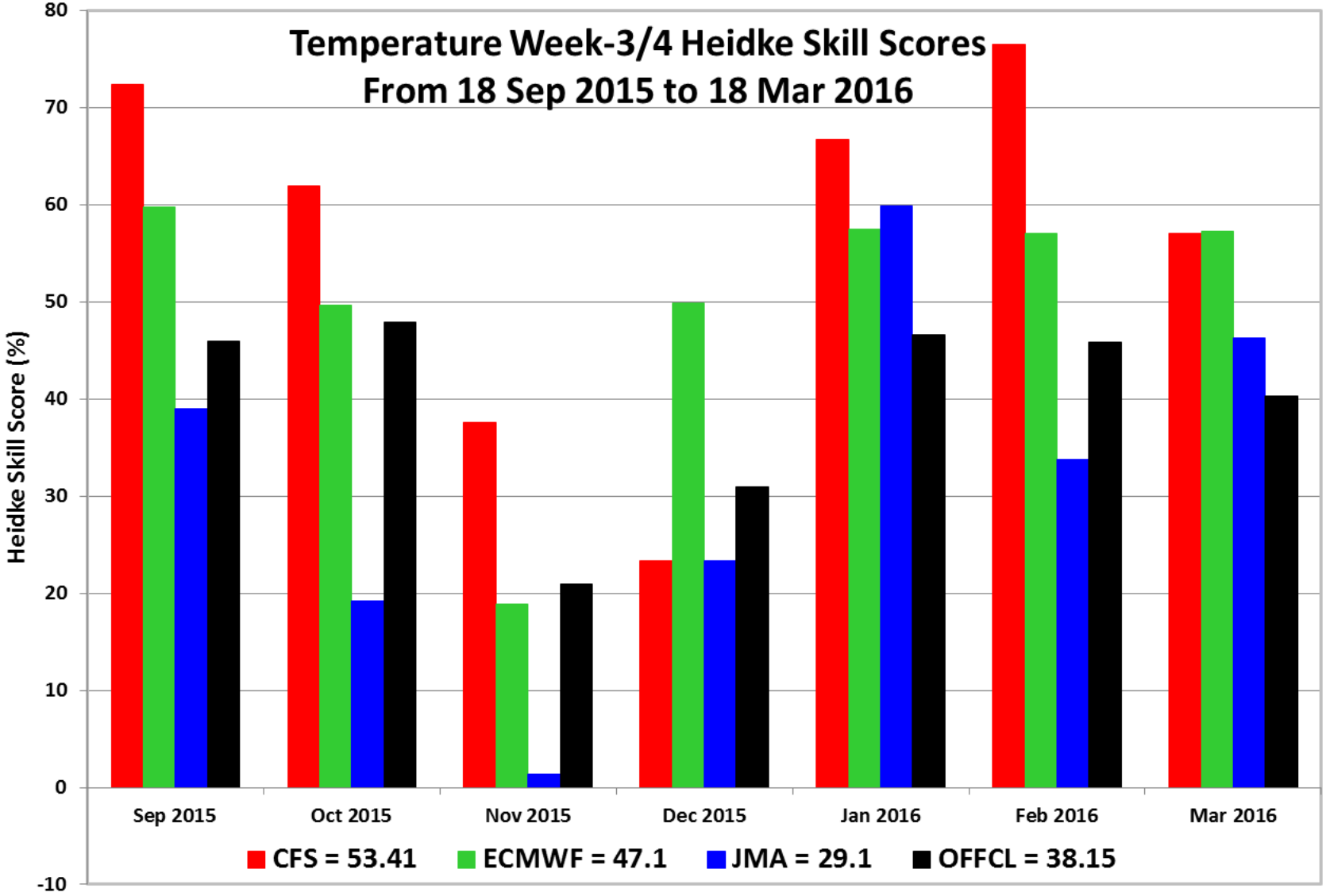


Sea Surface Temperature
Ensemble skill of Nino 3.4

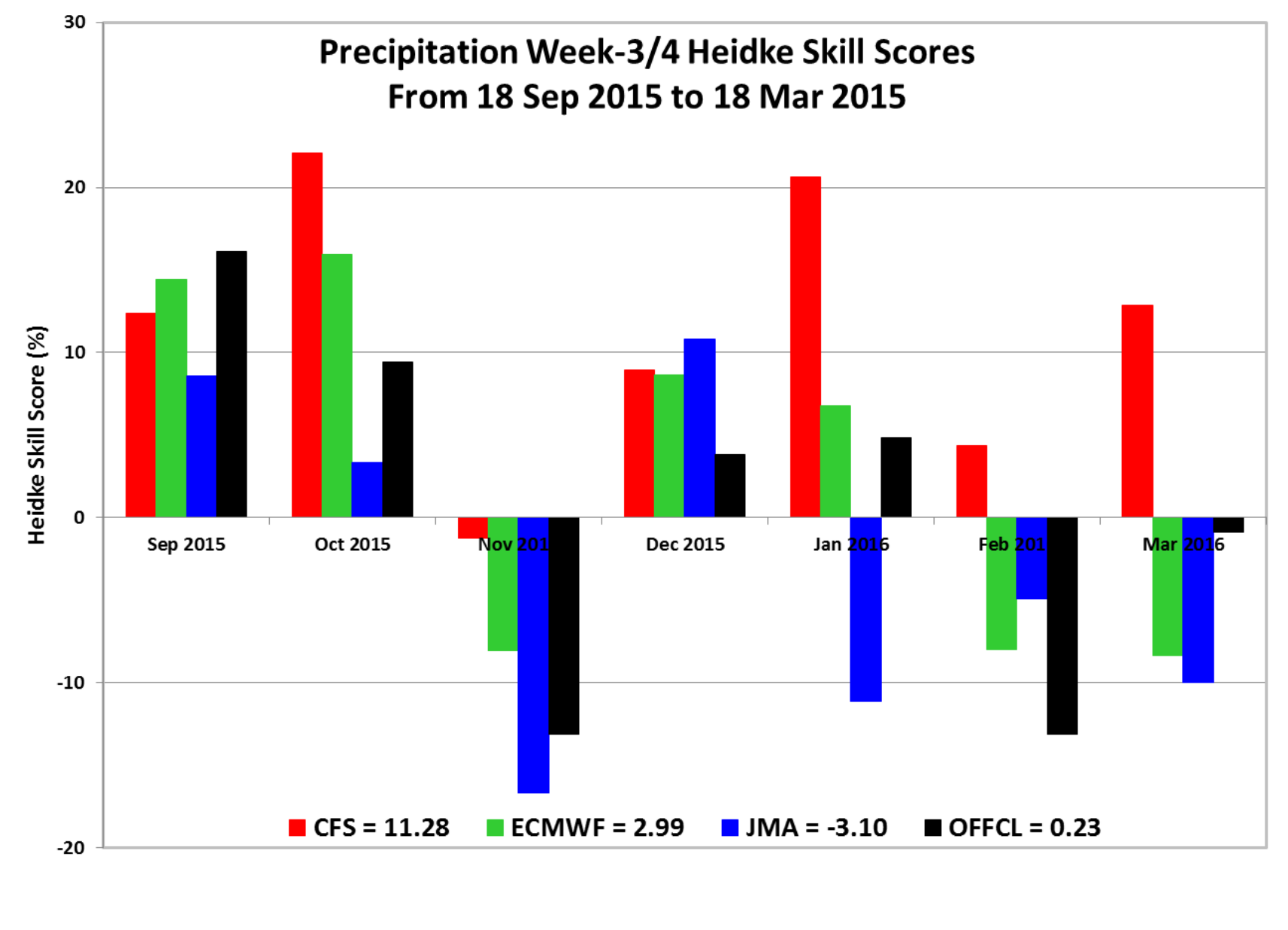
CFSv1 has a problem in that it persists large winter anomalies into the spring (a critical ENSO season) and is reluctant to go to neutral, let alone to go from La Nina to El Nino or vice versa (as is common in spring).

The standard deviation for MAM is clearly improved in CFSv2. There appears to be much less of a "spring barrier" in CFSv2.

Week 3-4 skills

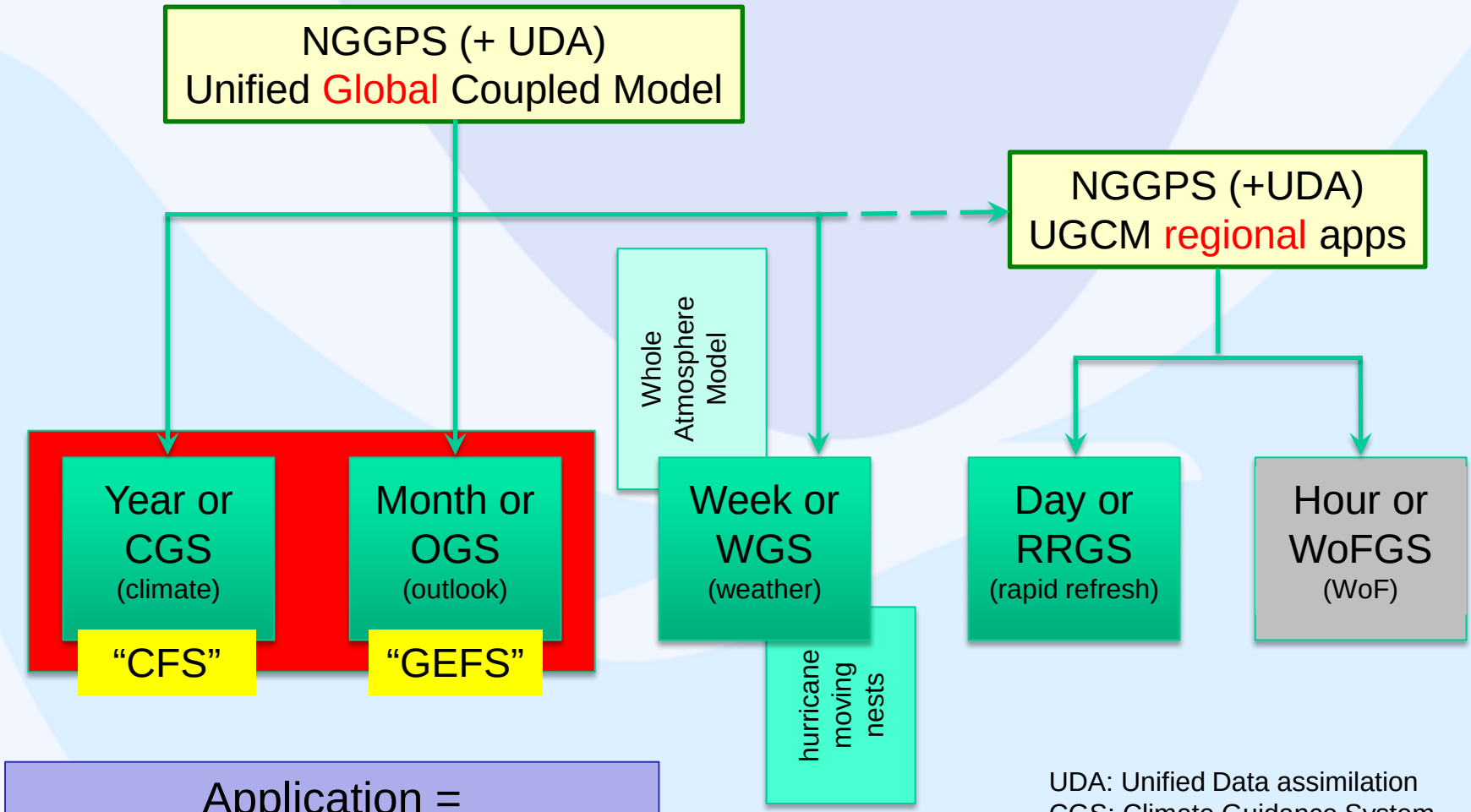


Week 3-4 skills



Modeling plans

Unified design (high level goal)



Application =
Coupled Ensemble
+ Reanalysis + Reforecast

UDA: Unified Data assimilation
CGS: Climate Guidance System
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Future climate models

CFS and GEFS to move to same code base

- Unified coupled system
- 9-12 month and 45 day runs at different resolutions
- Timing of transition still TBD
  - Next GEFS coupled?
  - CFS v2.5 and CFS v3

Deal with known issues in CFS v2.5

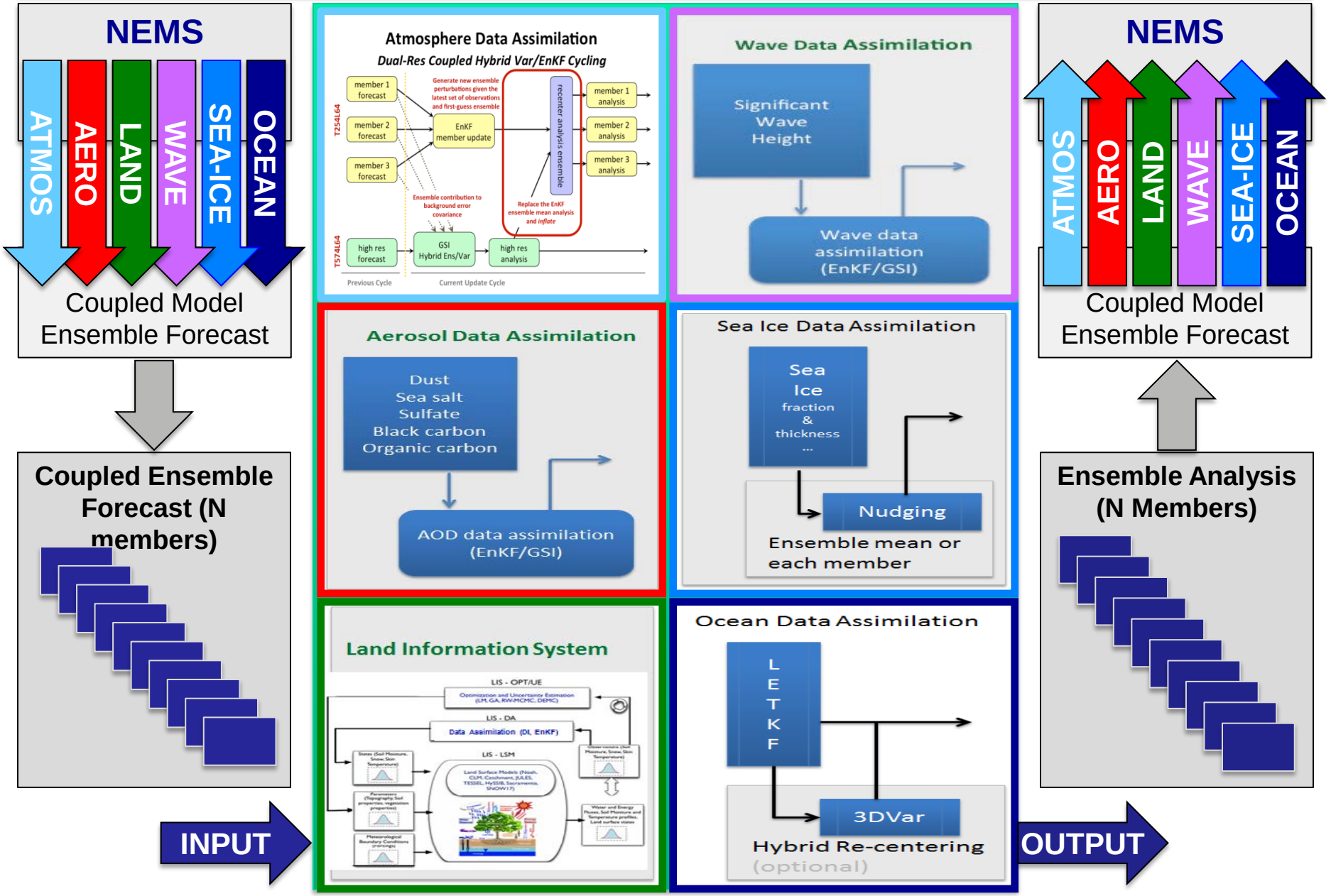
- Discontinuities in CFSRR in ocean, land, ice
- Ice initialization issues
- Better atmosphere

Focus on coupling (DA) in CFS v3

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.

NCEP Coupled Hybrid Data Assimilation and Forecast System



Thank You!