Potential Operational Capability for S2S Prediction

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Staffs of EMC and ESRL

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28 Feb. – 2 Mar. 2018
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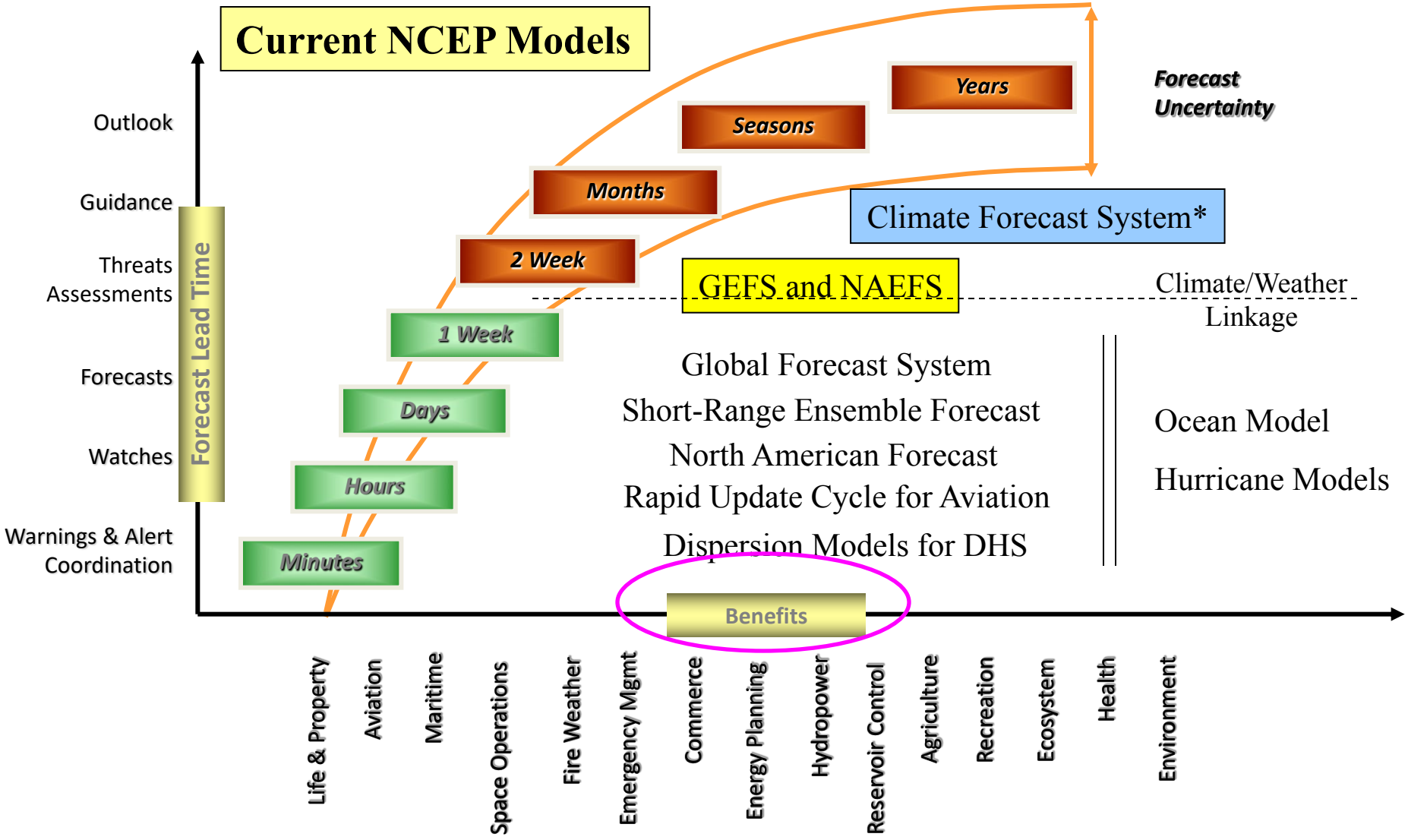
NWS Seamless Suite of Forecast Products Spanning Weather and Climate



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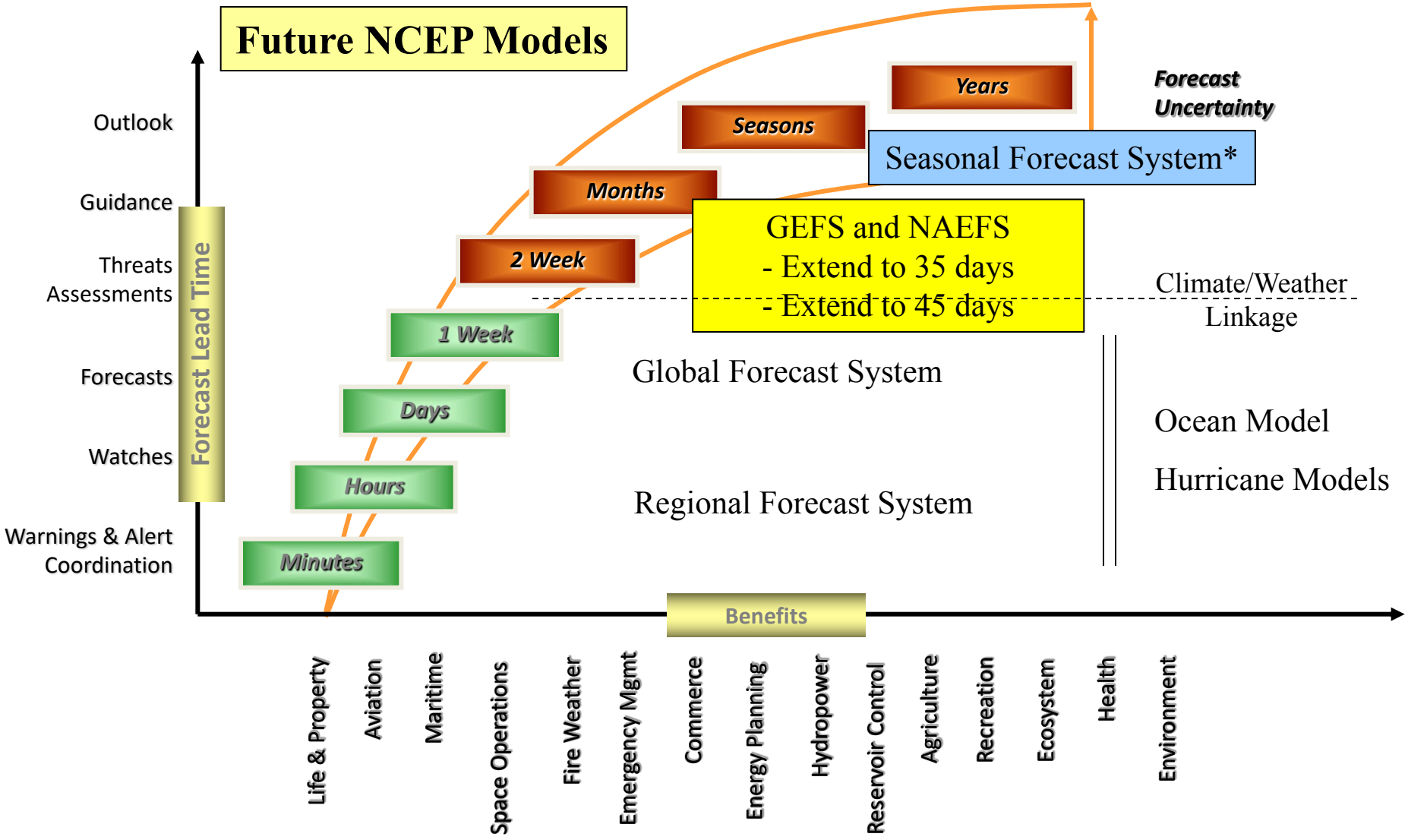
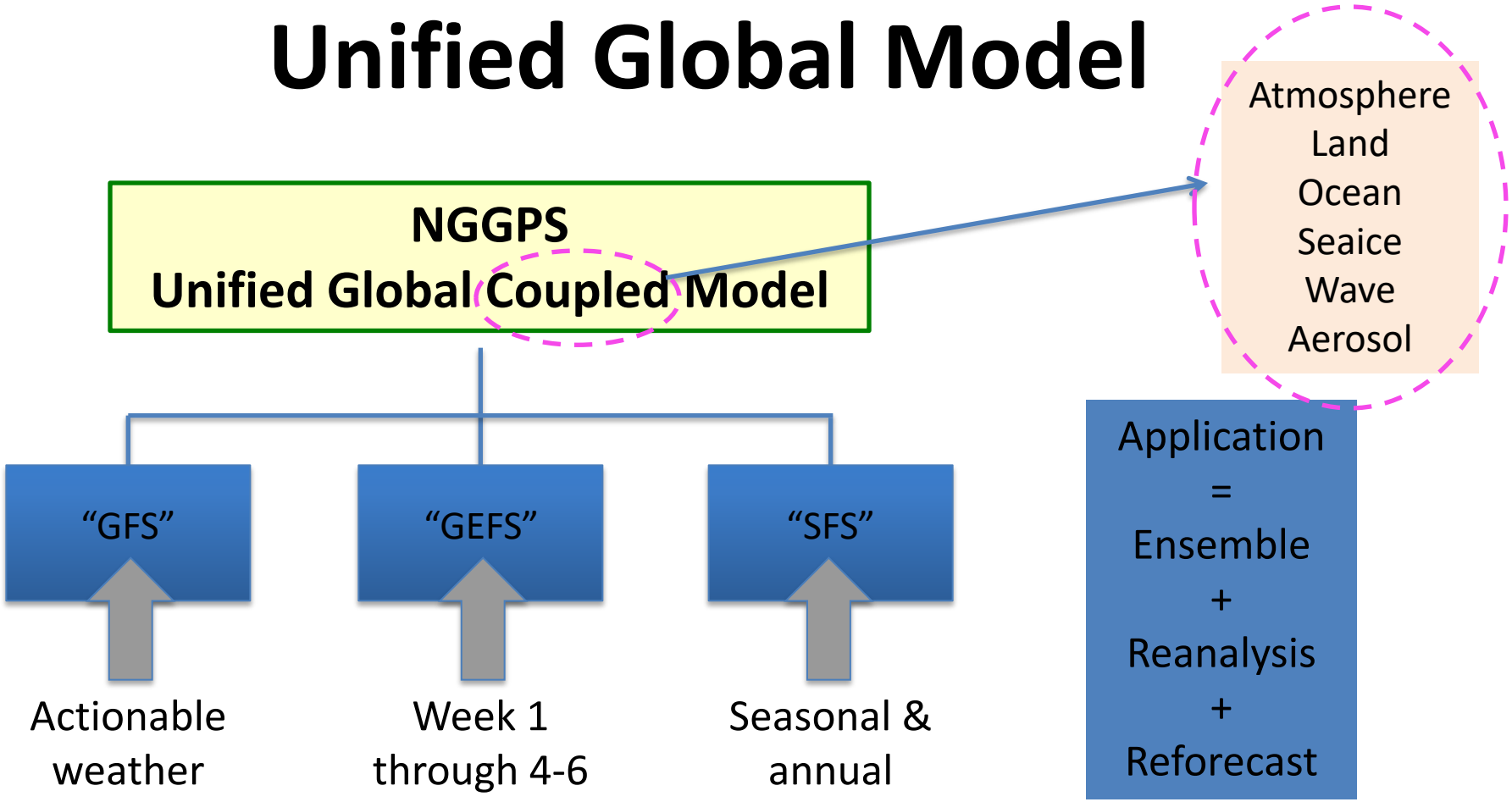


Unified Global Model



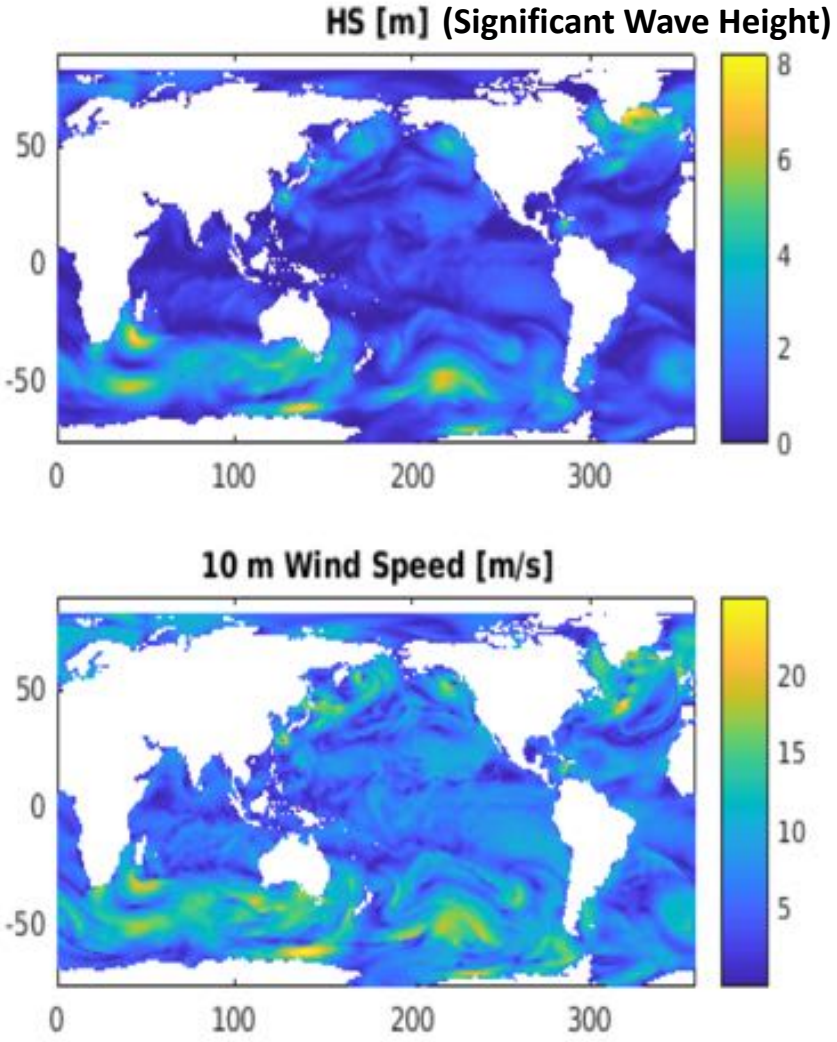
1 y	2 y	4 y	**Update cycle**
3 y	20-25 y	1979 - present	**Reanalysis**
6h	6-24h	???	**cycling**
WCOSS	WCOSS	WCOSS ?	**where**

Coupled modeling with FV3

- FV3 model is being coupled with other earth system components using the NEMS / NUOPC Framework
- Current coupled modeling efforts with FV3
  - A coupled FV3-MOM6-CICE5 modeling system targeting sub seasonal to seasonal time scales with OAR partners (initial testing in progress)
  - A coupled FV3-WW3 modeling system for weather time scales
- NUOPC caps developed in partnership with NESII Group for coupling GSM,FV3, MOM6, HyCOM, WW3 and CICE5
- Exchanging fields between the other earth system components and atmospheric physics via a physics driver are in their final stages of development

Wave (WW3) - Atmosphere (FV3) coupling

Example



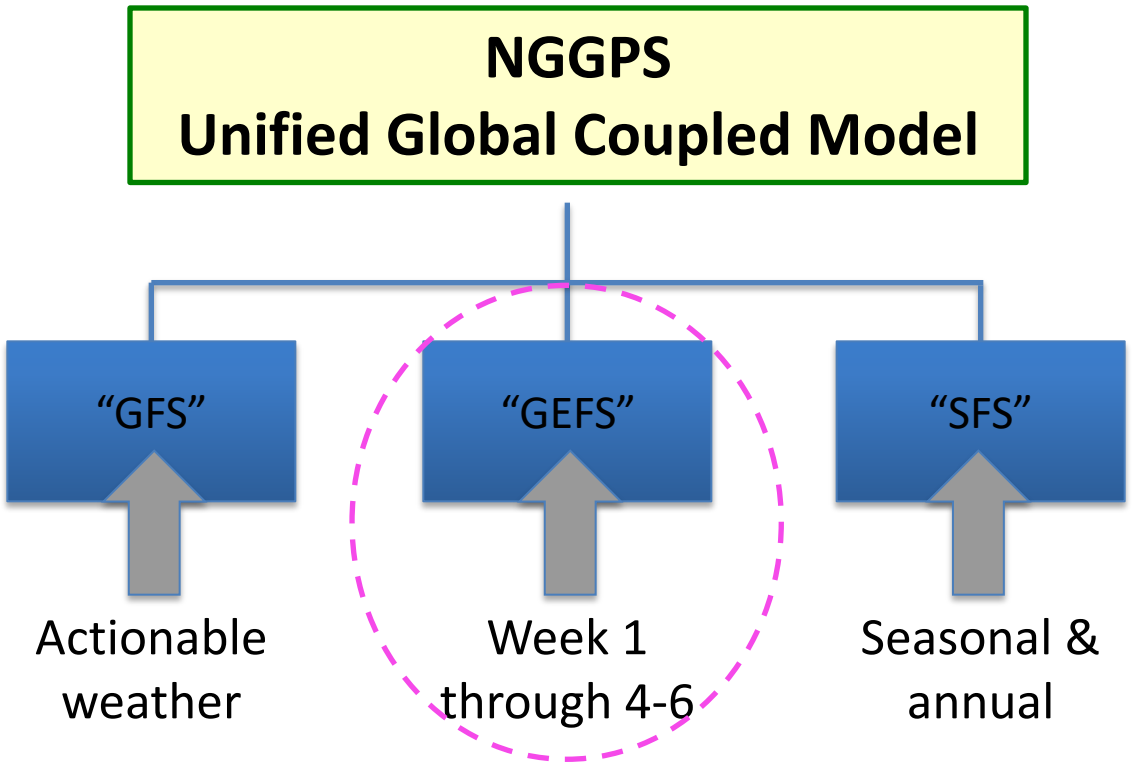
FV3-GFS near-term plans

- **Q2 FY2018**: Begin releasing real-time parallel FV3-GFS forecasts to the field
- **Q3 FY2018**: Begin releasing retrospective runs for Community evaluation
- **Q3 FY2018**: FV3-GFS Experimental begins running Operationally
- **Q2 FY 2019**: FV3-GFS Operational

FV3-GEFS near-term plans

- **Q3 FY2018**: Begin FV3-Hybrid reanalysis for 20 years (1999-2018)
- **Q4 FY2018**: Begin FV3GEFS reforecast (30 years; 1989-2008) extend to 35 days
  - Challenge for inconsistent initial analyses
  - NWC (request) is aware this challenge
- **Q2 FY2019**: Begin to evaluate FV3GEFS forecast performance out to 35 days.
- **Q3 FY2019:** FV3GEFS begin running real-time
- **Q4 FY2019**: FV3GEFS Operational

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**
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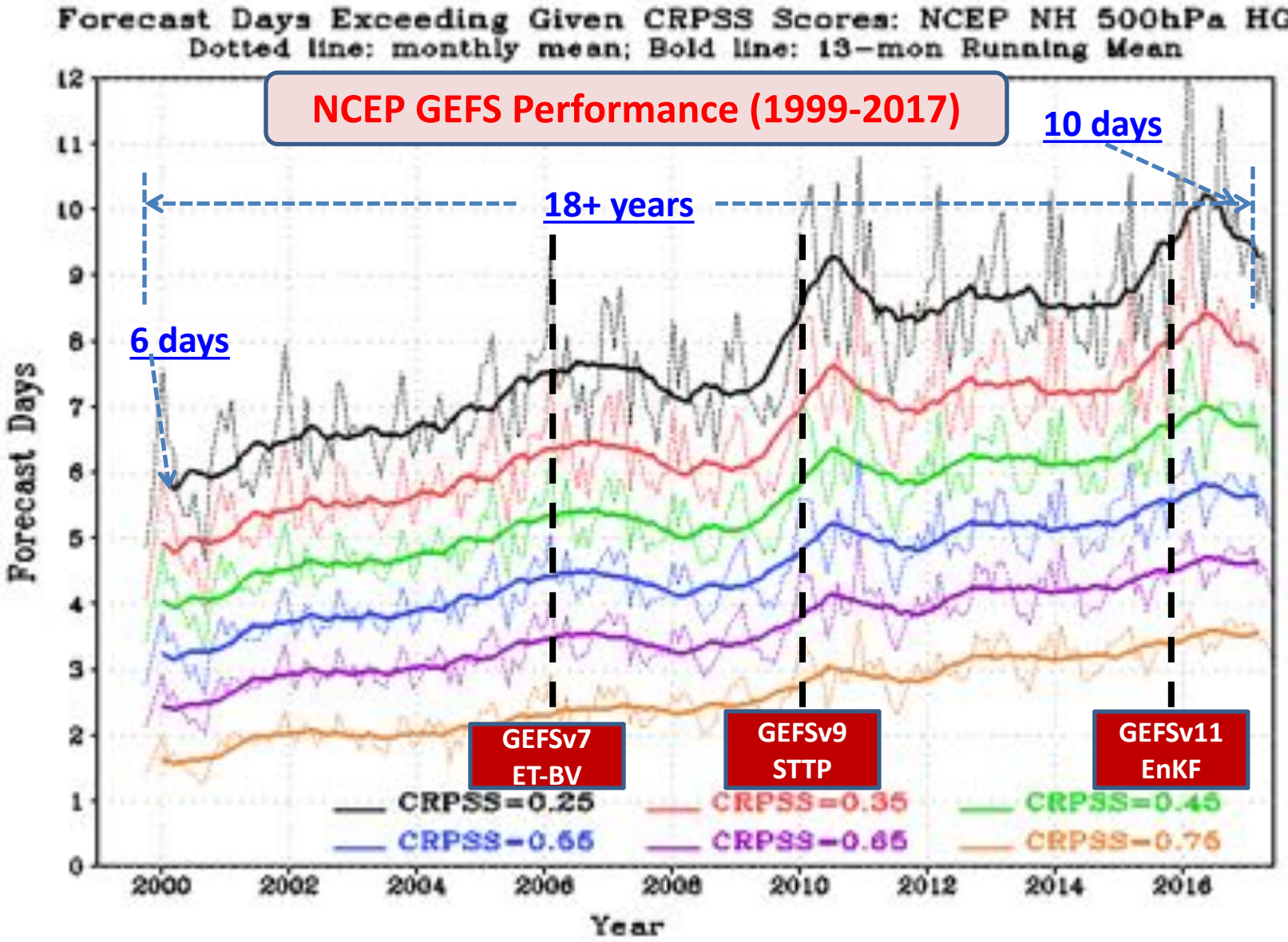
CRPSS for NH 500hPa geopotential height



End of 2017

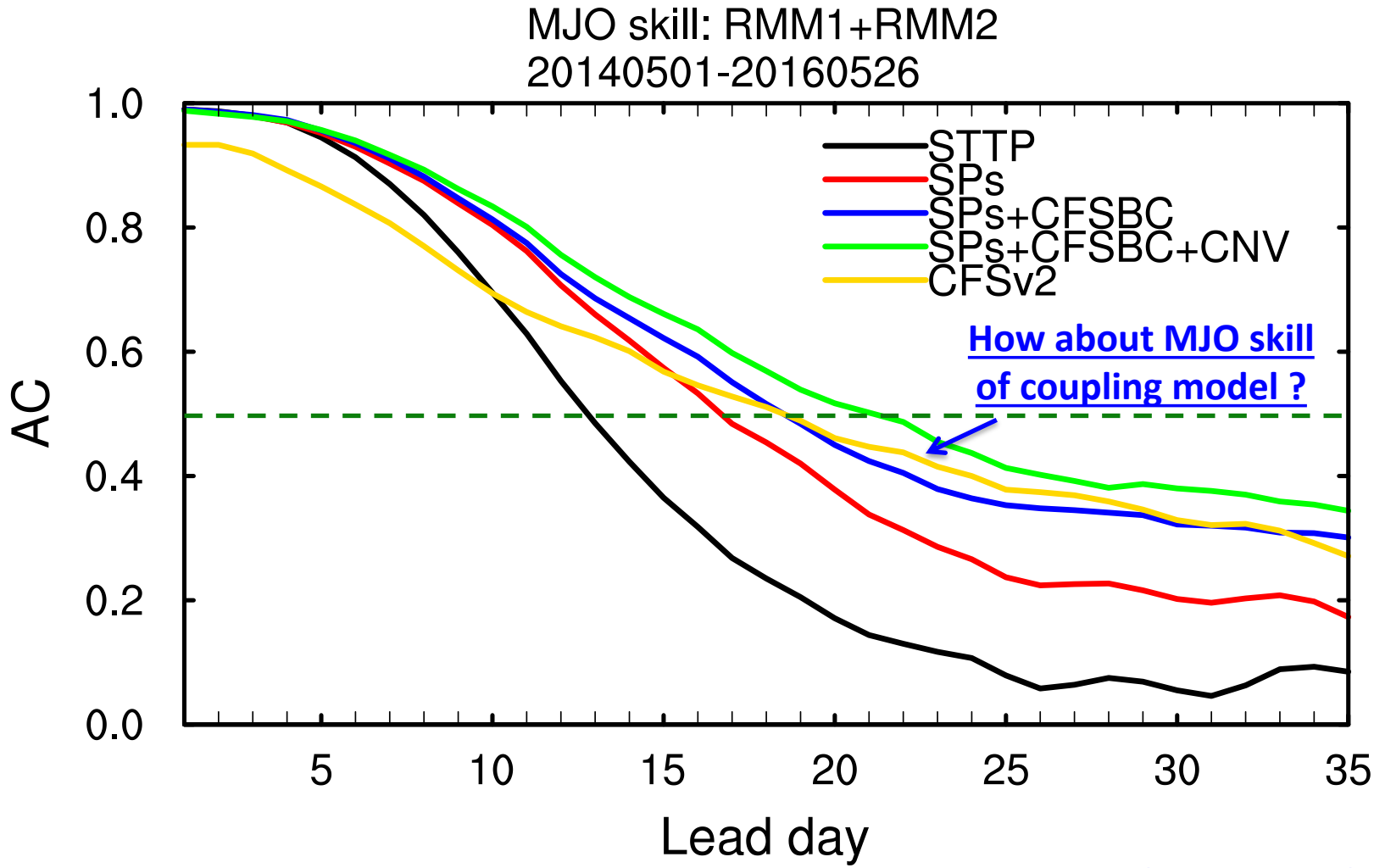
“SubX” 35d forecast Set Up

The period of experiments are from **May 1st 2014 to May 26 2016**, and forecasts are initiated for every 7 days at 00UTC. The main difference of four experiments can be found in table

Experiments	Stochastic Schemes	Boundary (SST)	Convection
CTL	STTP	Default	Default
SPs	SKEB+SPPT+SHUM	Default	Default
SPs+SST_bc	SKEB+SPPT+SHUM	2-Tiered SST	Default
SPs+SST_bc+SA_CV	**SKEB+SPPT+SHUM**	**2-Tiered SST**	**Scale Aware Convection**

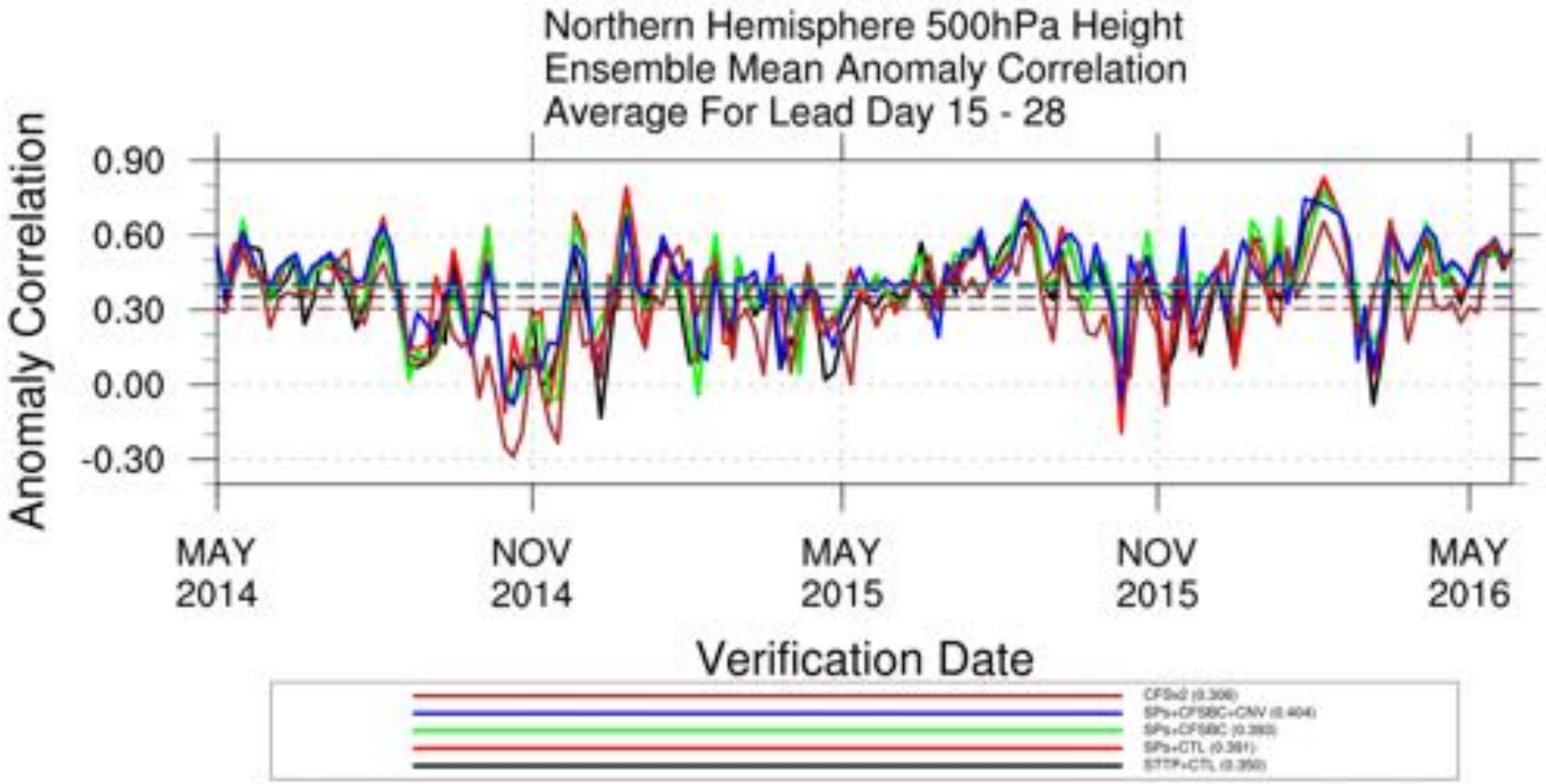
***Table**: Configuration differences for four experiments*

GEFS week 3&4 forecasts (May 2014-May 2016)



CFSv2 is NCEP operational climate forecast system (coupling) implemented on 2011 – 16 members leg (24 hours) ensemble

GEFS week 3&4 forecasts (May 2014-May 2016)

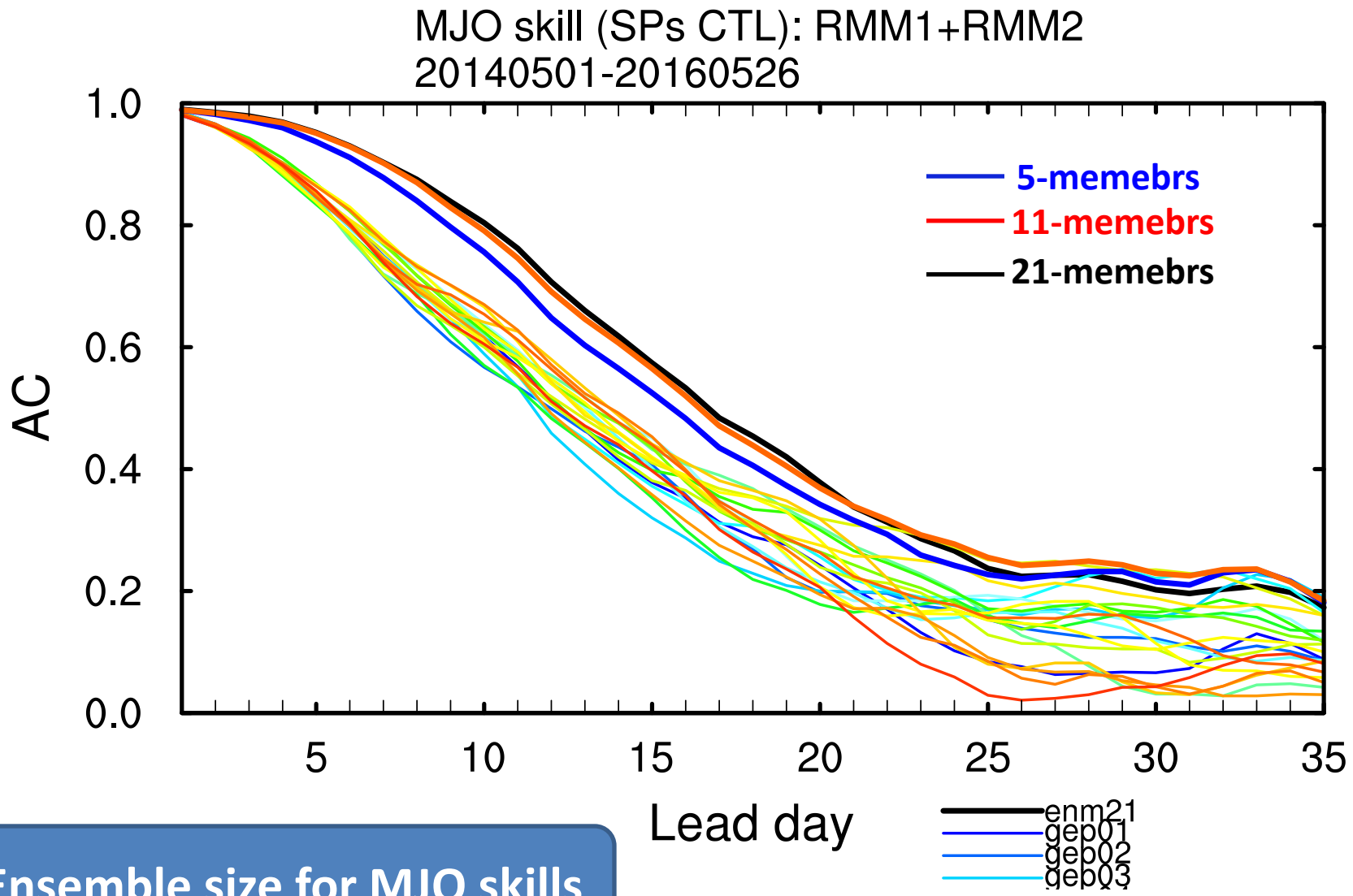


SPs+SST_bc+SA-CV (0.404) **CFSv2 (0.306)**

Weeks 3&4 forecast discussion:

Ensemble size
T2m calibration

WH-MJO Forecast Skills: Ensemble mean vs each member



Ensemble size for MJO skills

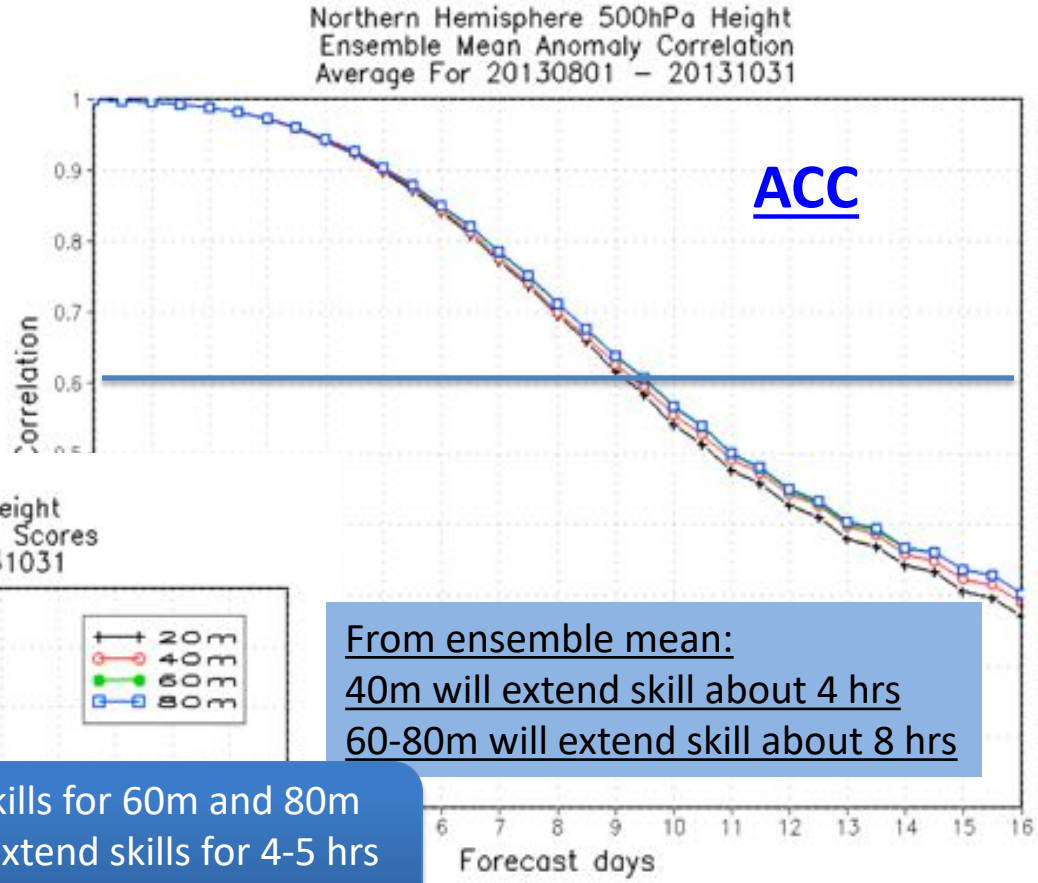
Comparison of Ensemble Size

PAC Scores	Domains	Variables	21 Members	11 Members	5 Members	1 Member
Day 8-14	NH	z500	0.628	0.619	**0.586**	**0.463**
	SH	z500	0.620	0.609	0.582	**0.458**
	TR	u850	0.686	0.673	**0.646**	**0.501**
		u250	0.641	0.630	**0.605**	**0.490**
Day 15-28	NH	z500	0.410	0.405	**0.372**	**0.257**
	SH	z500	0.380	0.363	0.323	**0.194**
	TR	u850	0.583	0.571	**0.544**	**0.400**
		u250	0.430	0.420	0.409	**0.300**

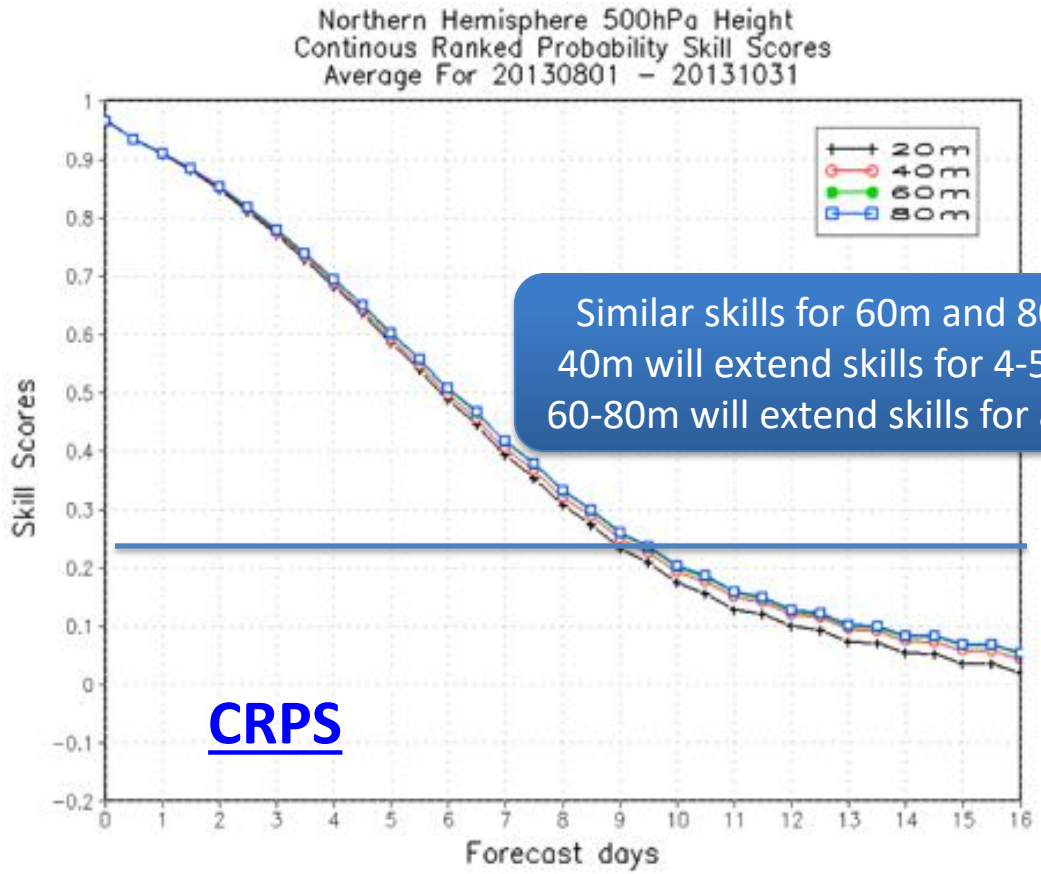
Anomaly Correlation for different ensemble sizes from SPs+SST_bc+SA_CV averaged over 25 months for lead days 8-14 (week 2) and lead days 15-28 (weeks 3 & 4). The bolded values represent results that are significantly degraded from the 21-member ensemble experiment at the 95% confidence level.

NH 500hPa height

GEFS ensemble membership size testing from GEFSv11 configuration for 3-months. Random selected 20-, 40- and 60-members from 80-members pool



From ensemble mean:
40m will extend skill about 4 hrs
60-80m will extend skill about 8 hrs

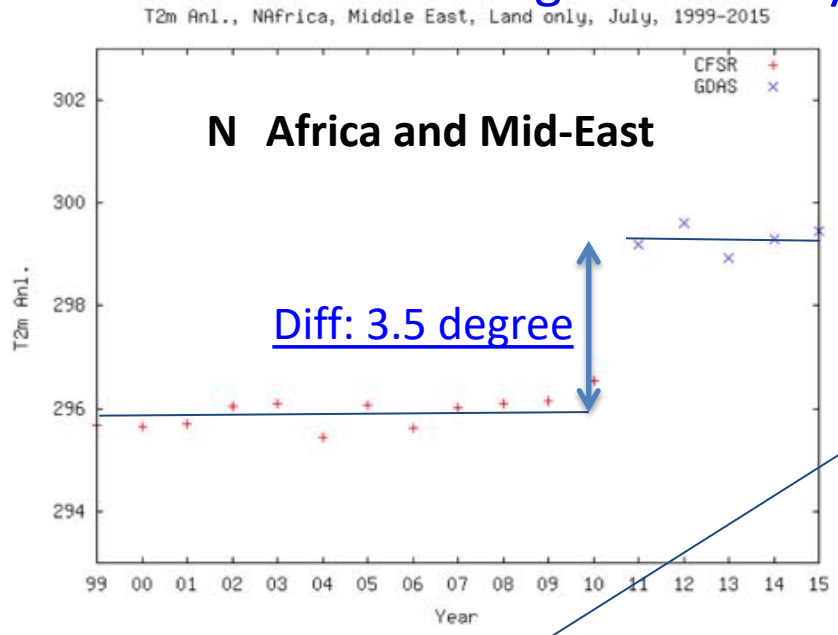


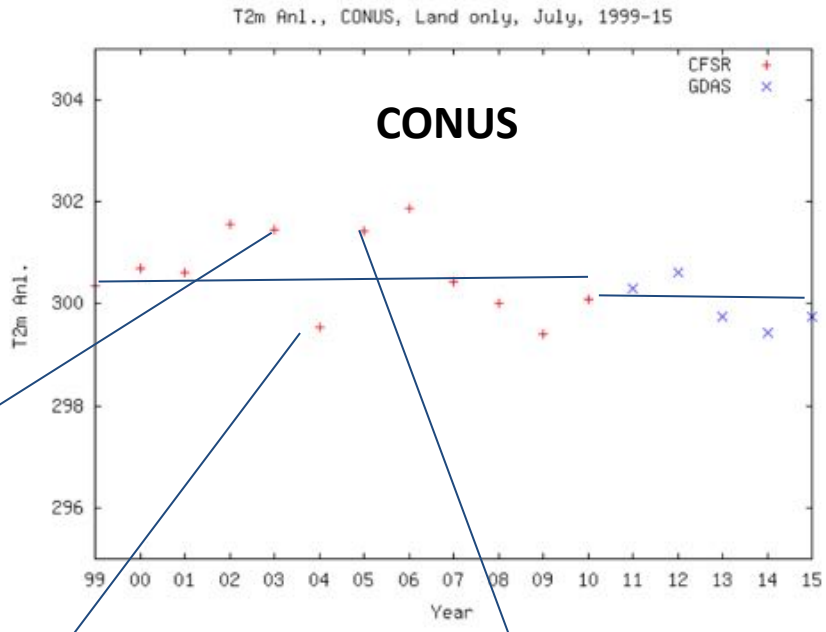
Similar skills for 60m and 80m
40m will extend skills for 4-5 hrs
60-80m will extend skills for 8 hrs

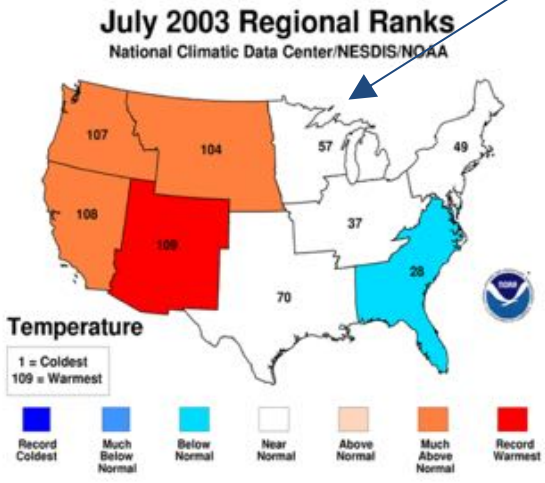
Summary:
Based on weather forecast skill analysis (ensemble mean and ensemble distribution) – 60 members could be optimum approach for weather configuration

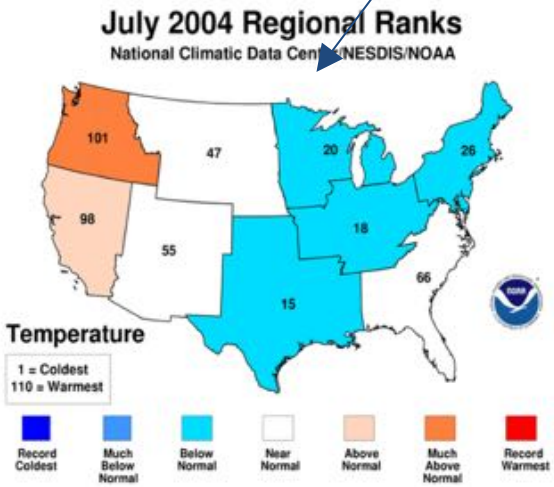
Inconsistent Analysis

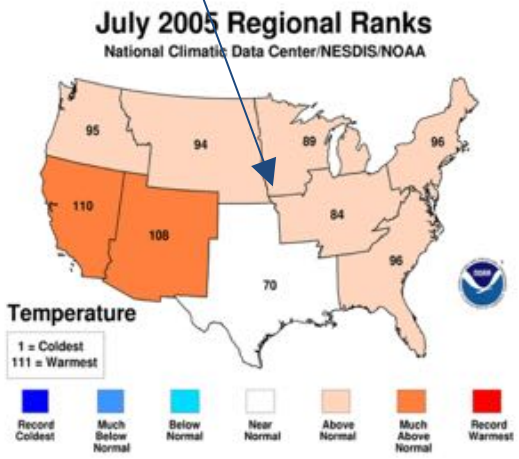
Domain average T2m analysis for July of past 17 years





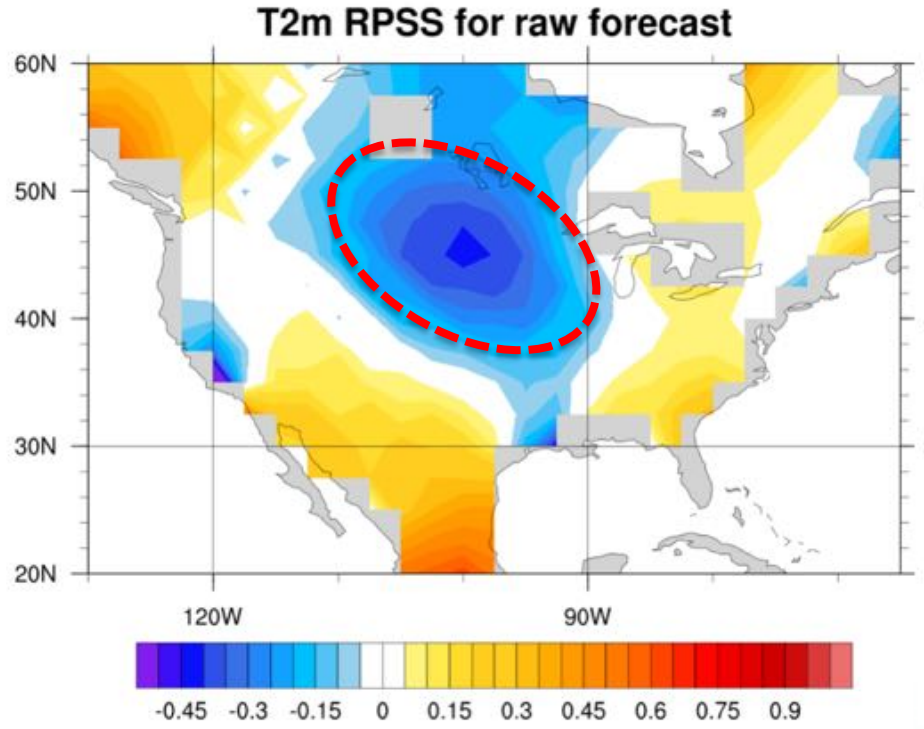


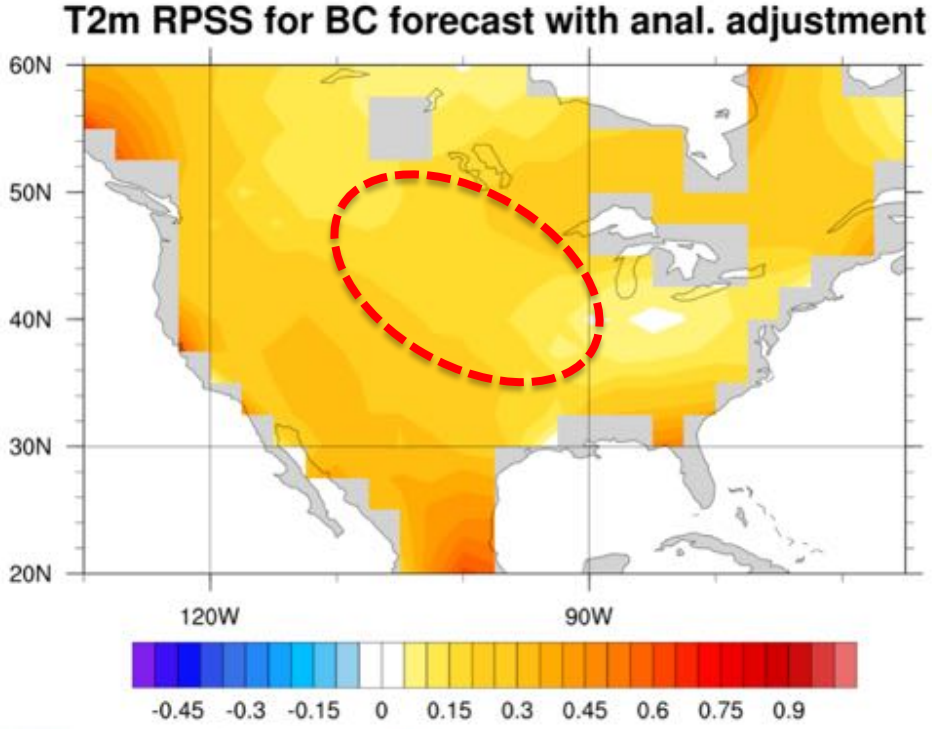




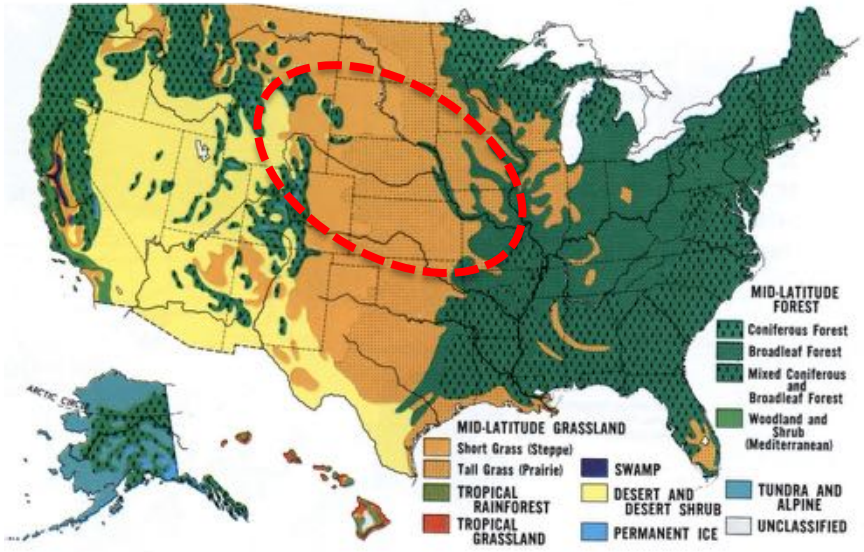
https://www.ncdc.noaa.gov/temp-and-precip/

Bias correction improves Wks 3&4 forecast skill (2016)





Using adjusted bias (1999-2015) to correct 2016 forecast



Weeks 3&4 surface temperature skills have been improved significantly for CONUS (north/south) plain areas

Background !!!

Implementation Plan for FV3-GEFS (FY2017-2020)

FV3GEFS	FY17				FY18				FY19				FY20			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
FV3GEFS Reanalysis Development			Develop and test low resolution FV3GFS with FV3GDAS, configure it for reanalysis (ESRL)													
FV3GEFS Ensemble Configuration		Configure FV3GFS ensemble resolution, members, physics, coupling to ocean and sea-ice, and extend forecasts to week 3&4 (EMC)														
FV3GEFS Reanalysis Production							Produce ~20-year reanalysis datasets using FV3GFS/GDAS (ESRL)									
FV3GEFS Reforecasts								Finalize FV3GEFS V12 configuration* & produce ~20-year reforecasts (extended to 35 days)								
FV3GEFS V12 Evaluation										Evaluate FV3GEFS V12 forecast performance out to week 3&4						
FV3GEFS V12 Implementation											Transition FV3GEFS V12 into operations					
Advancement of FV3GEFS													Further advancements of FV3GEFS (GFS/GEFS unification, ensemble based coupled modeling for 35-day weather outlook guidance)			

* Proposed changes for GEFS V12: 1) Produce FV3 based reanalysis in FY18 using the same configuration as Q2FY18 FV3GFS (ESRL); 2) Reforecasts will be based on FV3GEFS configured with either coupled to Ocean and Sea-Ice models or use 2-Tier SST approach; and 3) FV3GEFS Reforecasts extended to 35 days to include week 3&4 guidance.

FV3-GEFS implementation (plan)

- Version 12 – **Q4 2019**
- Adapt FV3GFS "beta" version
  - 25km resolution (C384)
  - 64 hybrid vertical levels
  - 31 ensemble members
  - 4 cycles per day, out to 16 days
  - 1-2 extend forecast per week, out to 35 days
- Reforecast – **Q3 2019**
  - Based on new reanalysis (1999-2018)
    - **Challenges – Reanalysis will not be the same analysis as GEFSv12 implementation**
  - 20-30 years
    - **Challenges - No consistent initial conditions for 30 years, but NWC requires**
    - Configuration is in discussion
    - CPC requires – 20 years, every 5-7 days
    - OWP requires – 30 years, every day
    - Membership – 11 members?
    - Variables to be saved – 3 tiers
      - Common variables for calibration (priority) – **could exchange between agencies**
      - Extend variables for downstream application (save on tape)
      - Initial conditions saved on tape for re-run