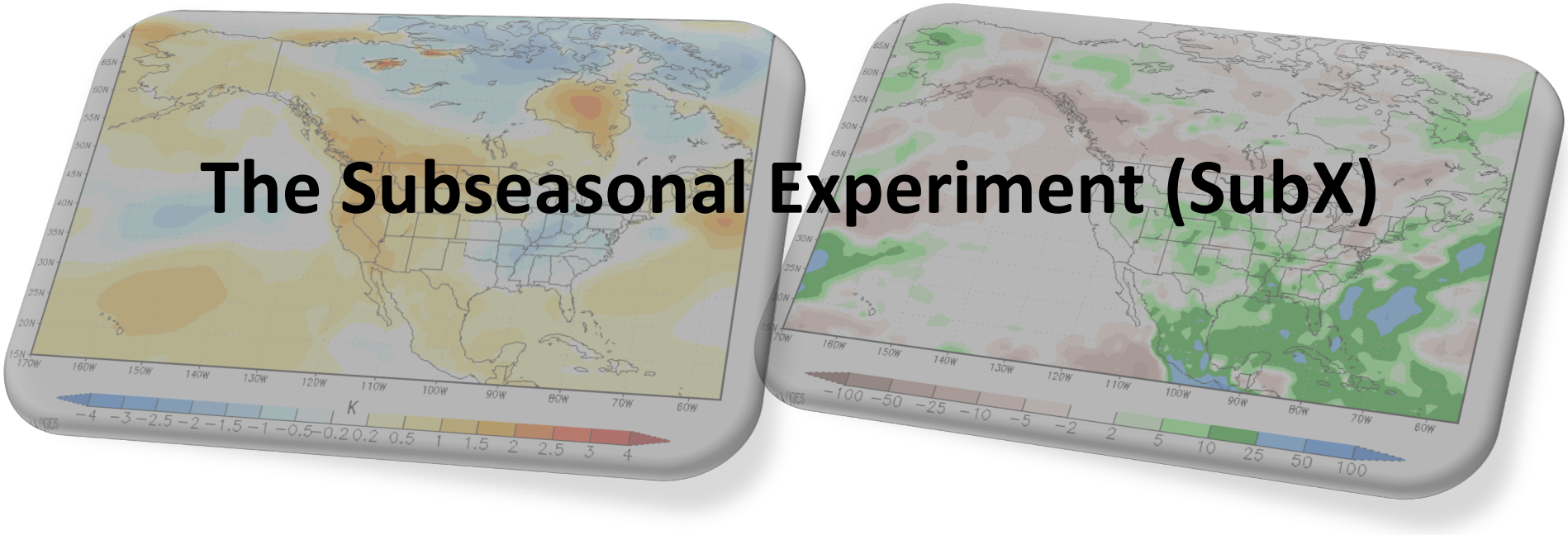


The Subseasonal Experiment (SubX)

Kathy Pegion

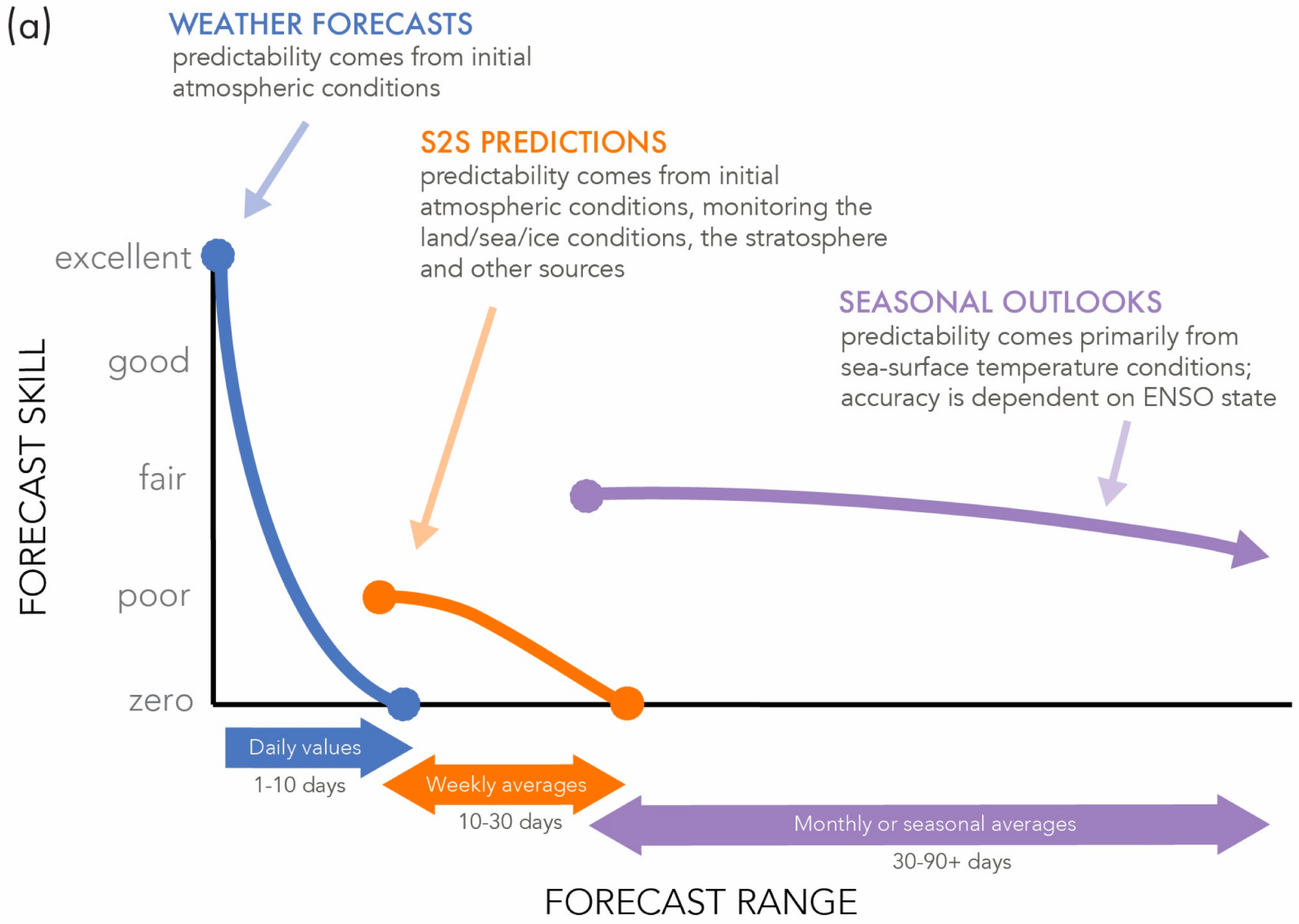
George Mason University, Dept of Atmospheric, Oceanic, and Earth Sciences

Center for Ocean-Land-Atmopshere Studies

Pegion, K. and Co-authors, 2018: The Subseasonal Experiment (SubX): A multi-model subseasonal prediction experiment, submitted to BAMS

OFFICE OF WEATHER AND AIR QUALITY

MAPP
Modeling, Analysis, Predictions, and Projections



https://iri.columbia.edu/news/qa-subseasonal-prediction-project/

- Multi-model
- Monthly
- Re-forecasts & Forecasts
- Research & Predictions (R2O)

- International project
- Operational models
- Re-forecasts & Forecasts (delayed)
- Research

- Multi-model
- Subseasonal (weekly)
- Re-forecasts & Forecasts
- Research & Predictions (R2O)

- Collection of NOAA MAPP PIs
- Collaboration to understand S2S predictability & prediction
- Uses data from other S2S Projects

What is Unique about SubX?

Forecasts available in real-time

Supports potential use in real-time applications

Research models included

Facilitates model development & improvements

SubX BY THE NUMBERS

7 Global Models

1+ Years of *Real-time* Forecasts

17 Years of *Retrospective* Forecasts

3-4 week guidance for Climate Prediction Center Outlooks

The SubX Team

CORE TEAM

Ben Kirtman
Kathy Pegion
Tim DelSole
Michael Tippett
Andy Robertson
Michael Bell
Robert Burgman
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Hai Lin

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Normand Gagnon

Navy-ESM
Neil Barton
Joe Metzger

NCAR-CCSM4
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Dughong Min
Kathy Pegion
Ray Bell

ESRL-FIM
Shan Sun
Stan Benjamin
Ben Green

SubX Protocol

- Prediction System Details up to Provider
- Real-time and Retrospective Systems Identical
- Reforecast Period: 1999-2015
- At Least 3 Ensemble Members
- Minimum Length: 32 Days
- Real-time Forecast Made Available to CPC *Every Thurs* by 6am of *Every week*
- Data on Uniform 1x1 Grid

Priority 1 Variables – Required to Support Operations

On 500 and 200 hPa levels

Variable	CF Standard Name	Abbrev	Unit	Frequency
Geopotential Height	geopotential_height	zg	m	Average of Instantaneous values at 0,6,12,18Z

On 850 and 200 hPa levels

Variable	CF Standard Name	Abbrev	Unit	Frequency
Zonal Velocity	eastward_wind	ua	ms-1	Average of Instantaneous values at 0,6,12,18Z
Meridional Velocity	northward_wind	va	ms-1	Average of Instantaneous values at 0,6,12,18Z

On a single level

Variable	CF Standard Name	Abbrev	Unit	Frequency
2m Temperature	air_temperature	tas	K	Daily Average
Precipitation	precipitation_flux	pr	kgm-2s-1	Accumulated every 24hrs
Surface Temperature (SST+Land)	surface_temperature	ts	K	Daily Average
Outgoing Longwave Radiation at top of Atm	toa_outgoing_longwave_flux	rlut	Wm-2	Accumulated every 24hrs

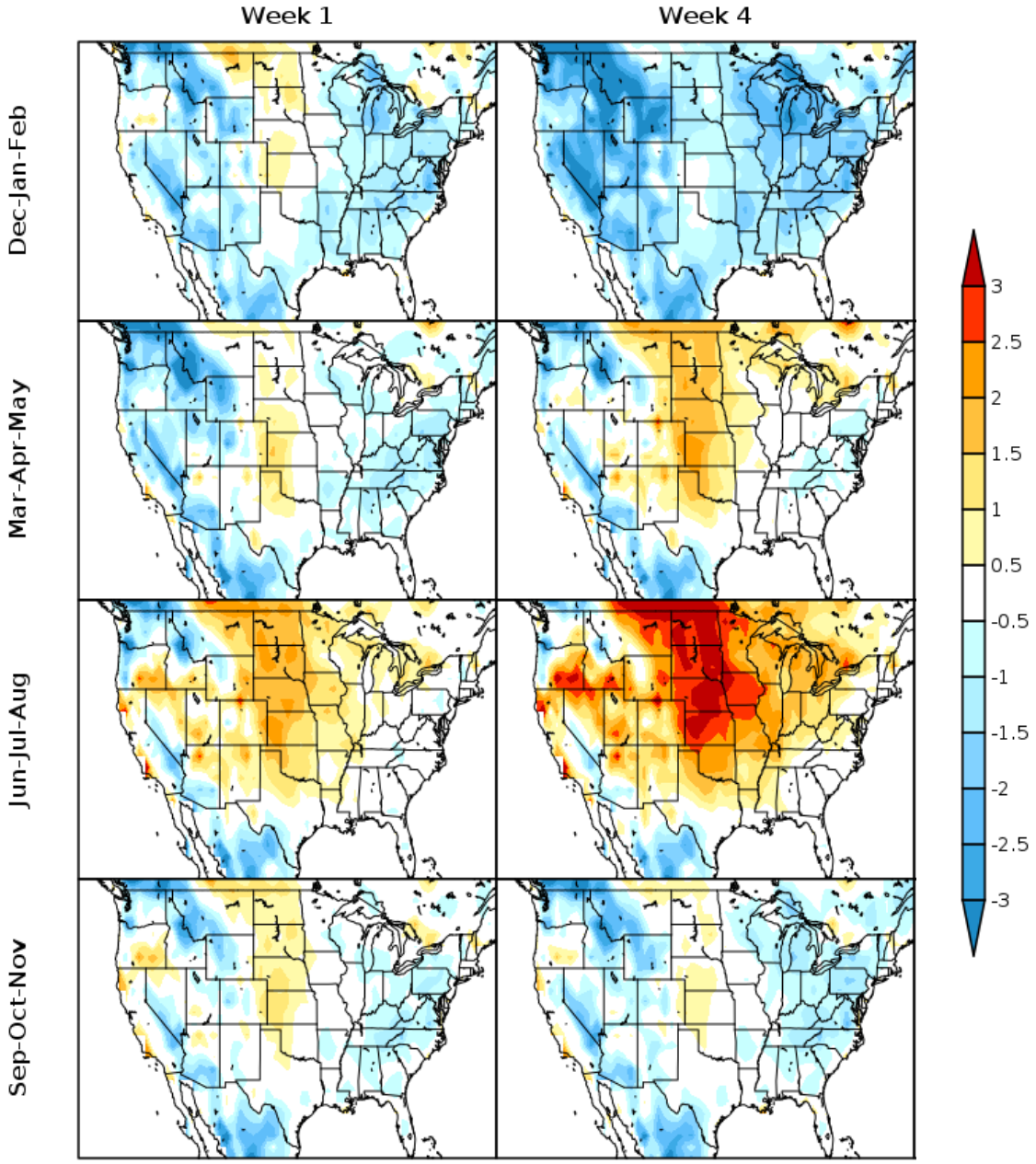
SubX Models

Model	Components	Ensemble Members	Length (Days)
NCEP-CFSv2	A,O,I,L	4	45
EMC-GEFS	A,L	11 [21]	35
ECCC-GEM	A,L	4 [21]	32
GMAO-GEOS5	A,O,I,L	4	45
NRL-NESM	A,O,I,L	4	45
RSMAS-CCSM4	A,O,I,L	3 [9]	45
ESRL-FIM	A,O,I,L	4	32

SubX Current Status & On-going Activities

- ✓ Re-forecast & real-time forecast database
- ✓ Real-time forecast maps
- ✓ Real-time forecast data to NCEP/CPC
- ✓ Re-forecast Evaluation: probabilistic and deterministic skill, bias
- ✓ Sources of predictability/phenomena: MJO, NAO

SubX Multi-model Biases 2m Temperature

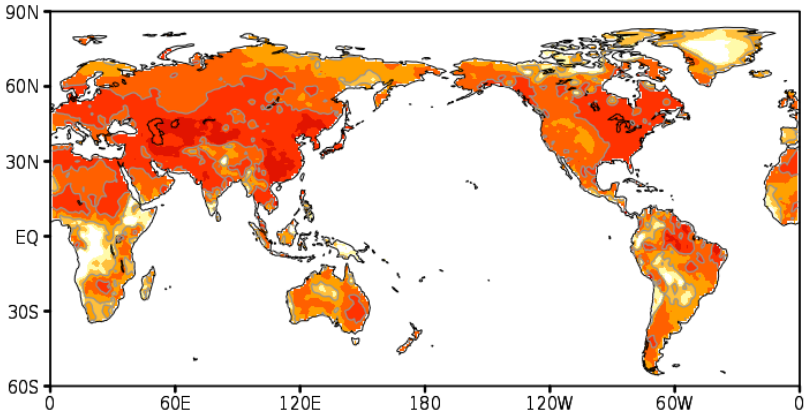


- Bias patterns established in week 1, grow into week 4
- Summer warm/dry bias

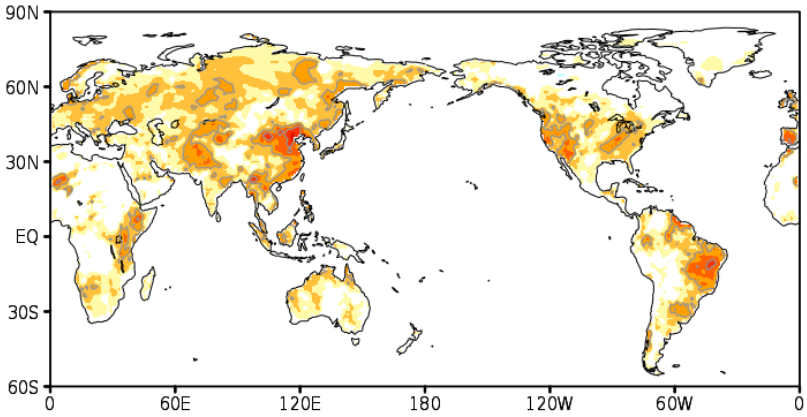
SubX Multi-model Week 2 Skill Dec-Jan-Feb

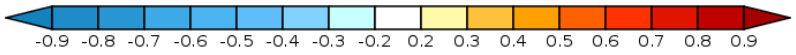
Anomaly Correlation

2m Temperature



Precipitation





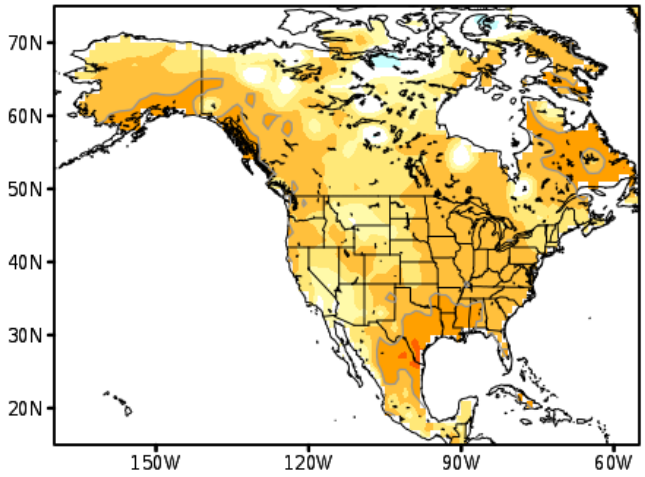
SubX Multi-model Anomaly Correlation Week 3-4

2m Temperature

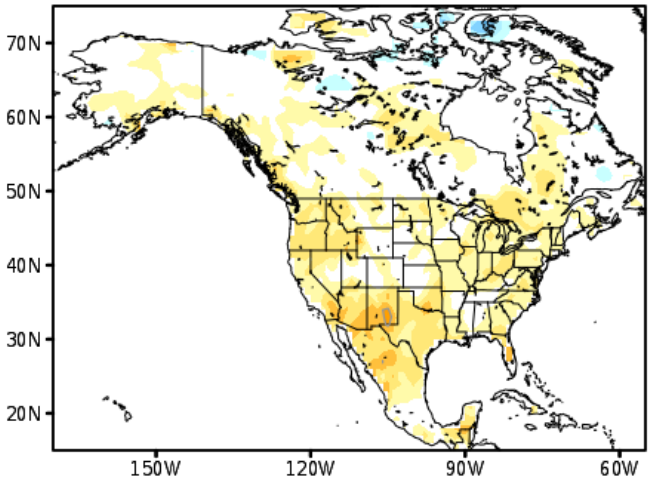
Precipitation

Winter

a) 2m Temperature Dec-Jan-Feb

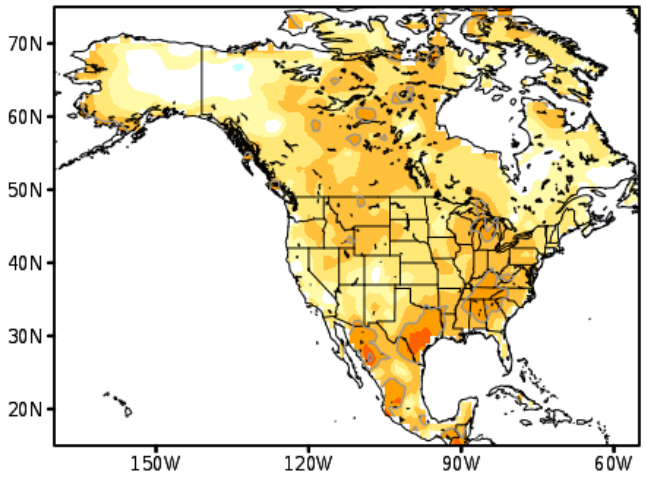


a) Precipitation Dec-Jan-Feb

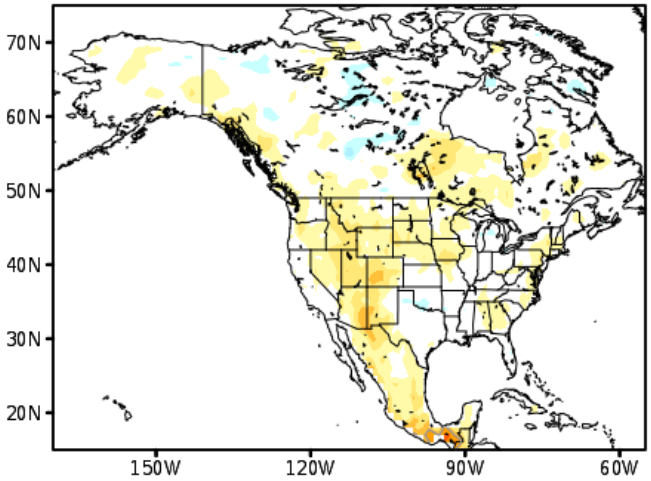


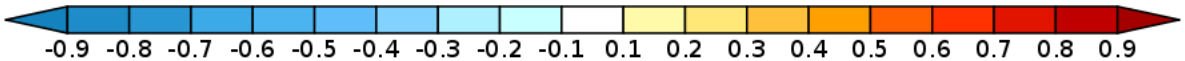
Summer

c) 2m Temperature Jun-Jul-Aug



c) Precipitation Jun-Jul-Aug

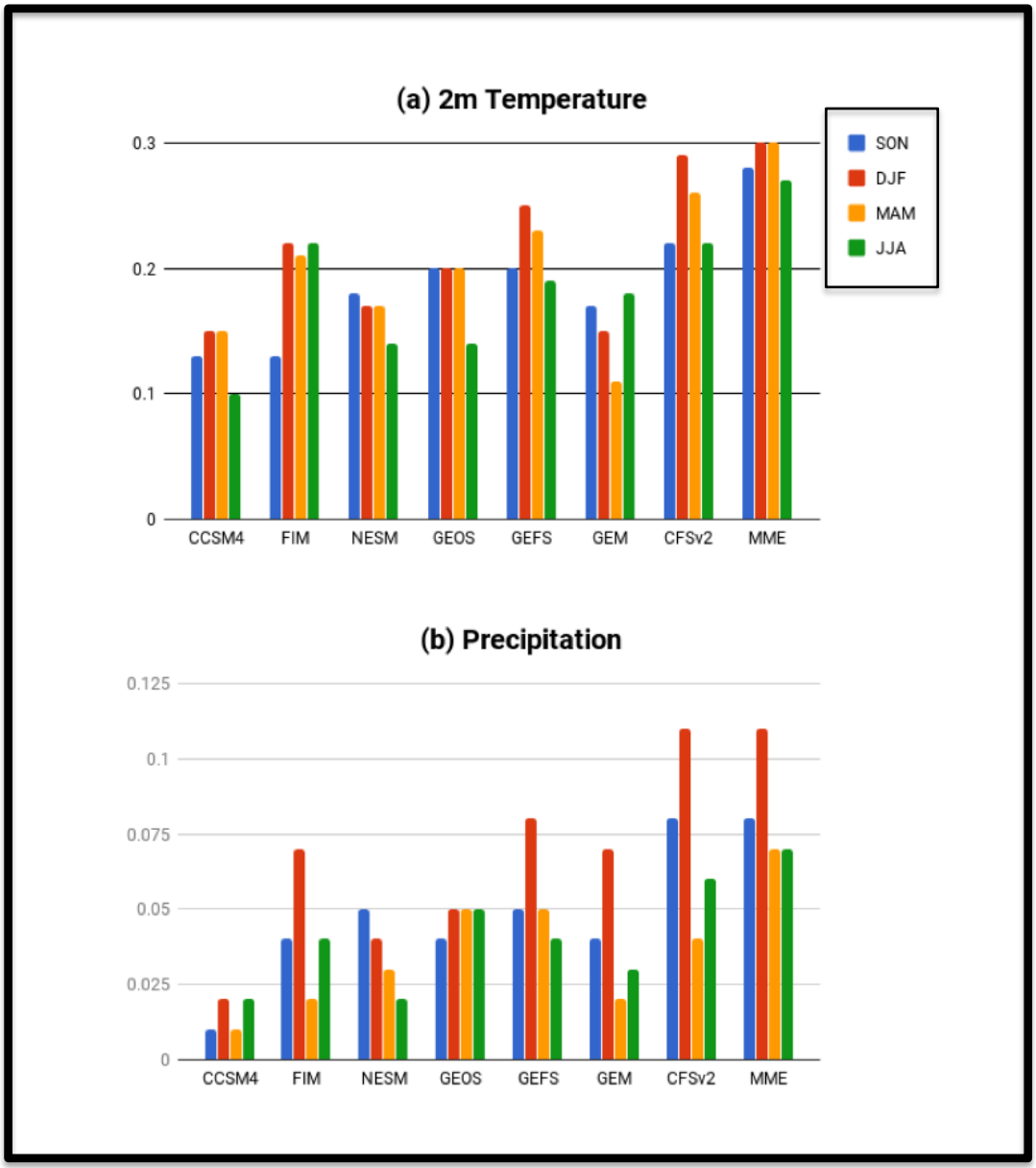




- Skill is positive
- There is "useful" skill for some regions and seasons

SubX Average Anomaly Correlation
North America Week 3-4

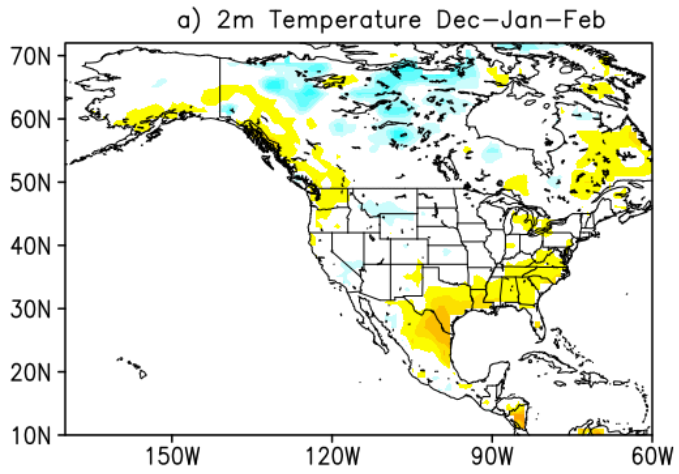
- MME more skillful than individual models in all seasons
- No stratification of skill by model configuration

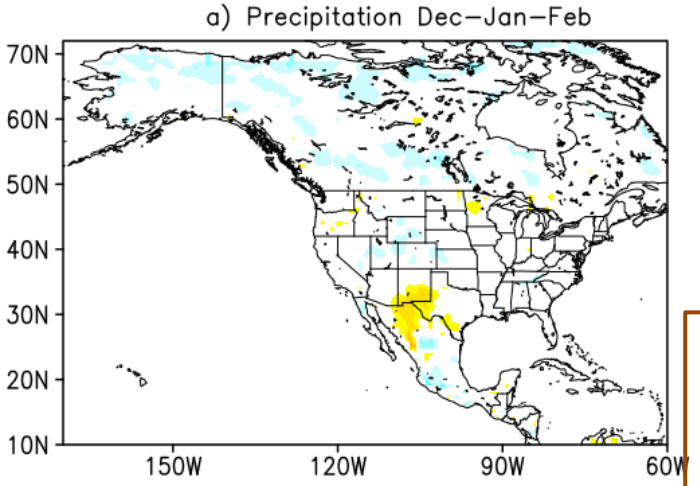


SubX Multi-model RPSS Week 3-4

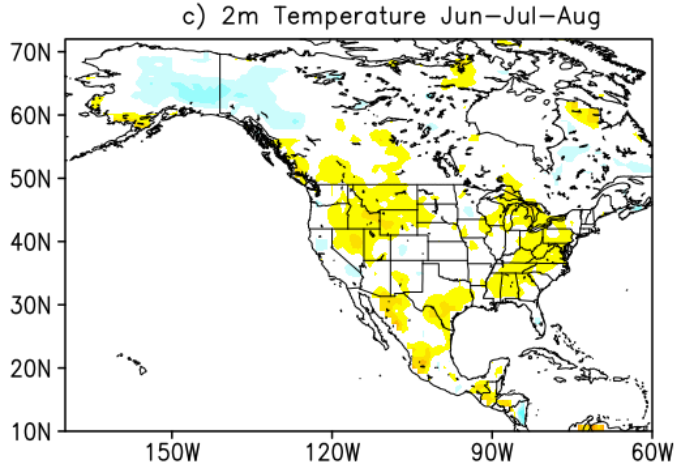
2m Temperature | **Precipitation**

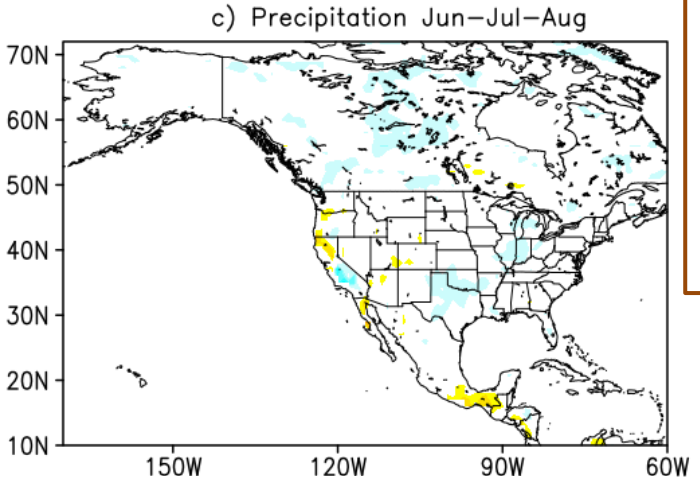
Winter

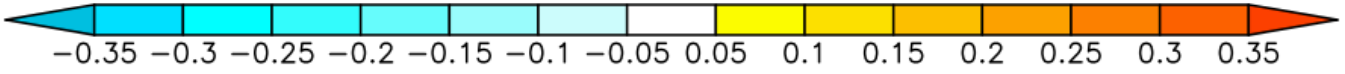




Summer



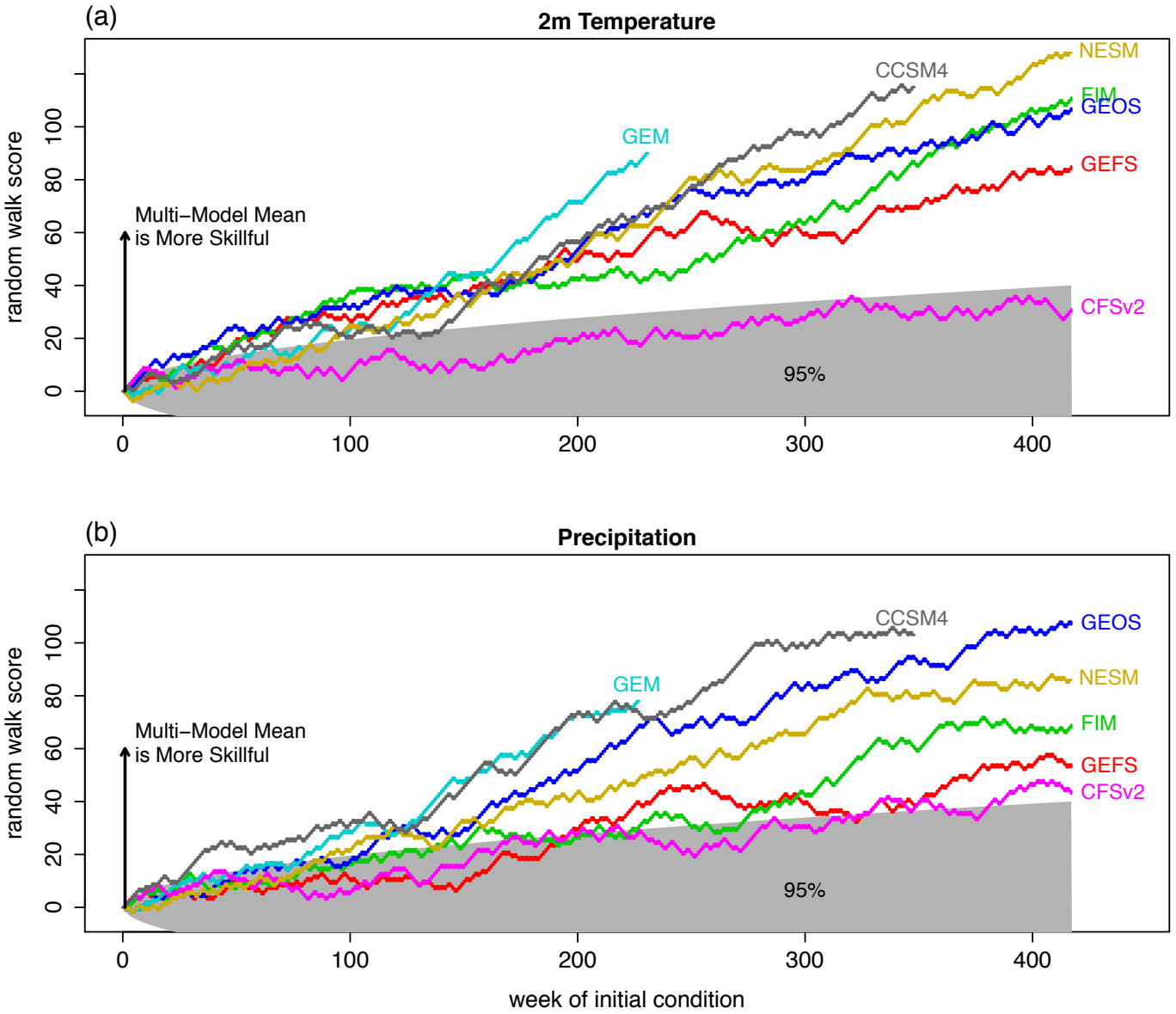




- Consistent with ACC
- There is skill for T2M
- Little skill for precip

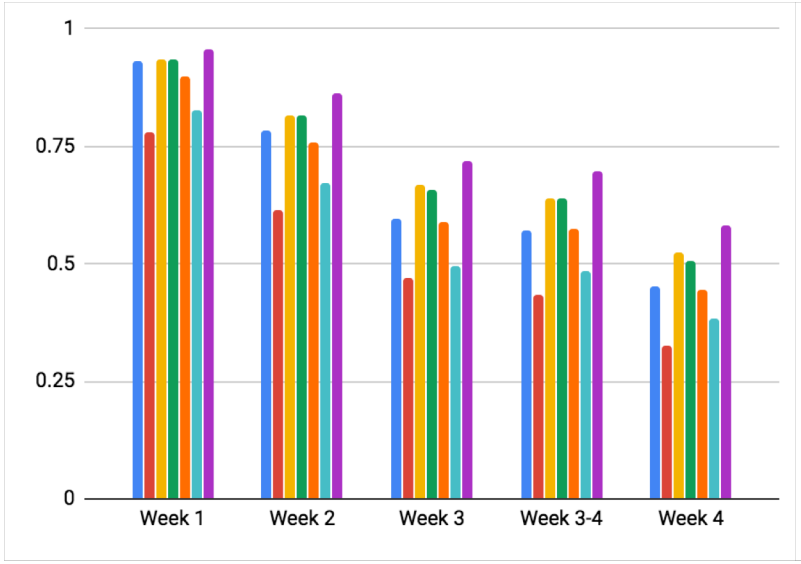
Benefit of SubX MME

Random Walk Test for Comparing Multi–Model Mean to SubX Models
Week 3–4 Hindcasts; Pattern Correlation; US and Canada

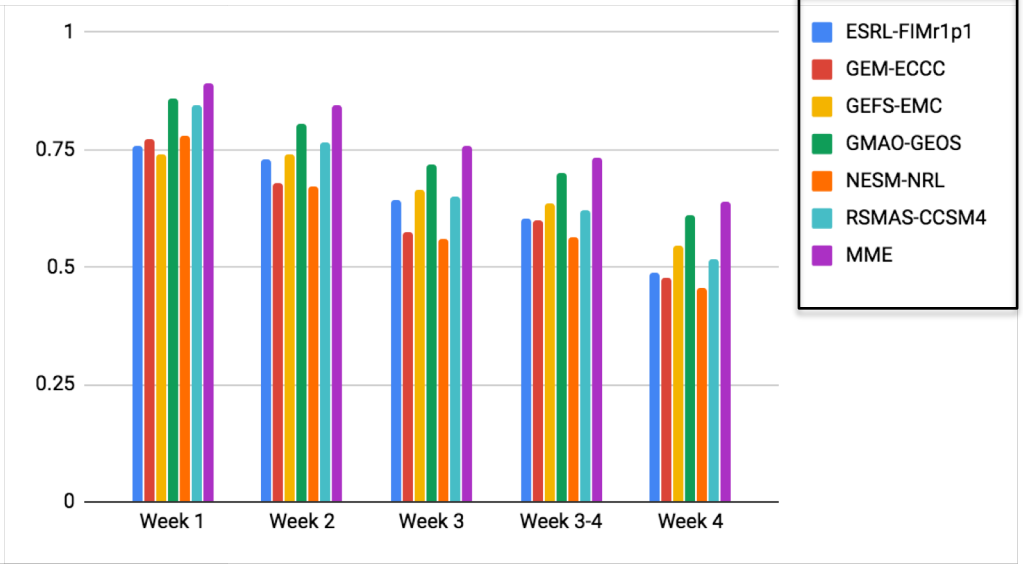


MJO Skill: Anomaly Correlation

RMM Index



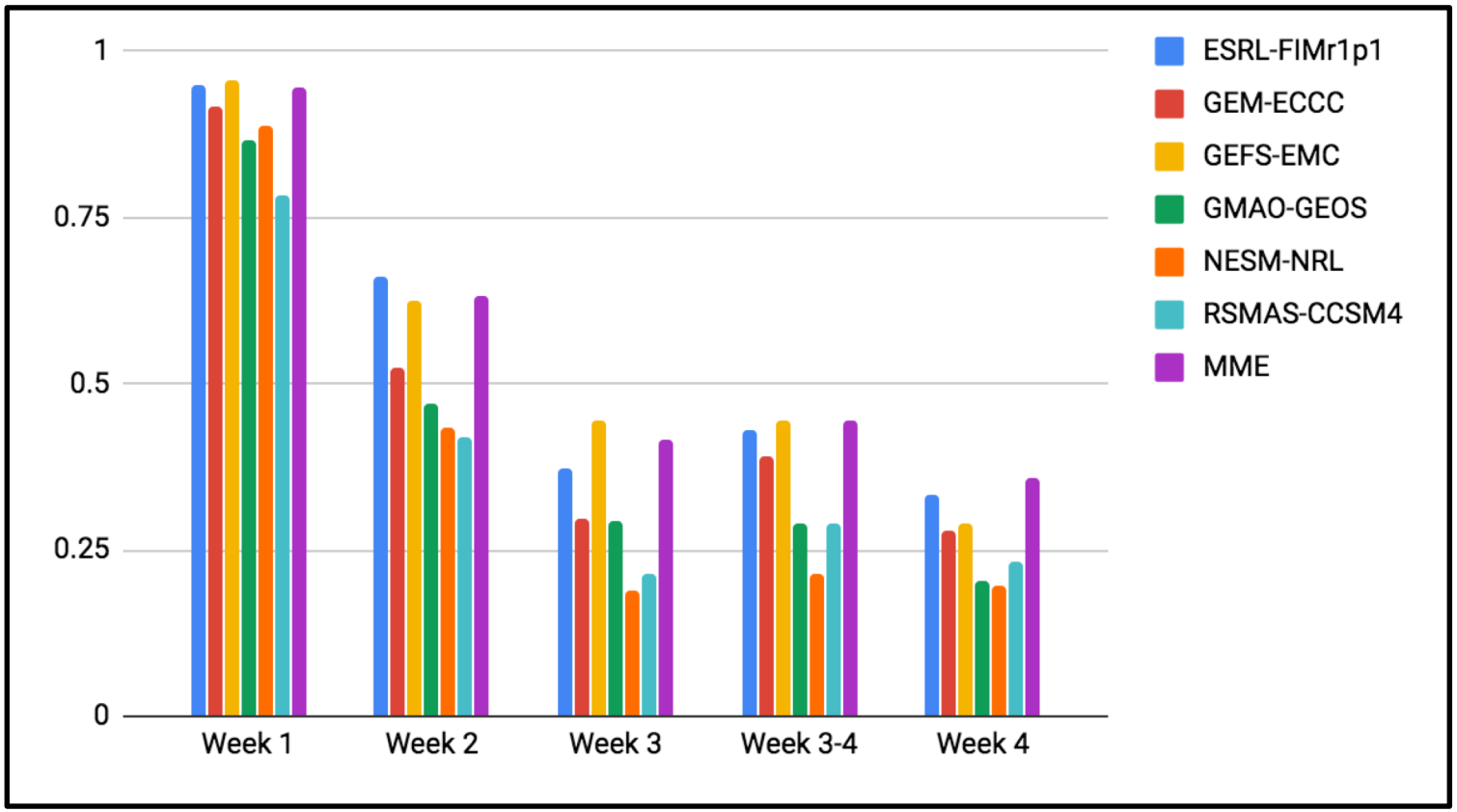
ROMI Index



- Skill >0.5 at week 3-4
- Skill is similar to WWRP/WCRP S2S Models
- Two most skillful models have very different configurations
- MME has higher skill than individual models

Thanks to Shuguang Wang, Columbia University, ROMI Indices

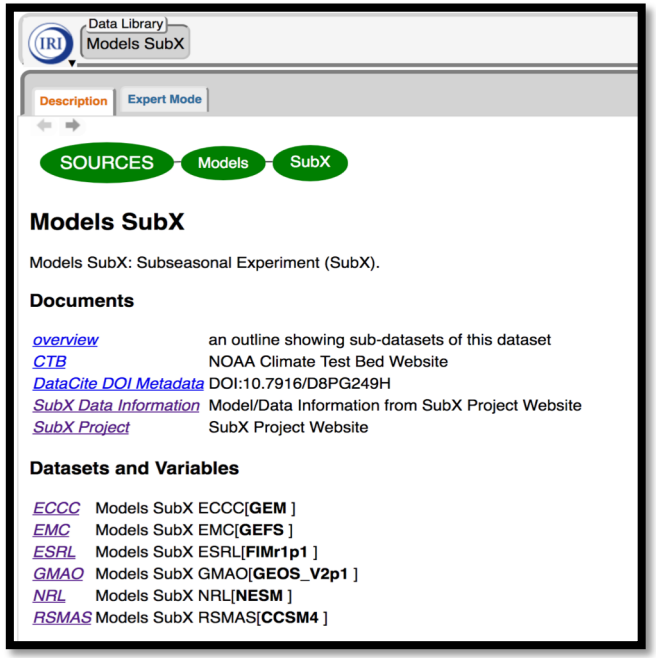
NAO Skill: Anomaly Correlation



- Skill below 0.5 after week 2
- MME has similar skill to best models
- Two best models have similar configurations

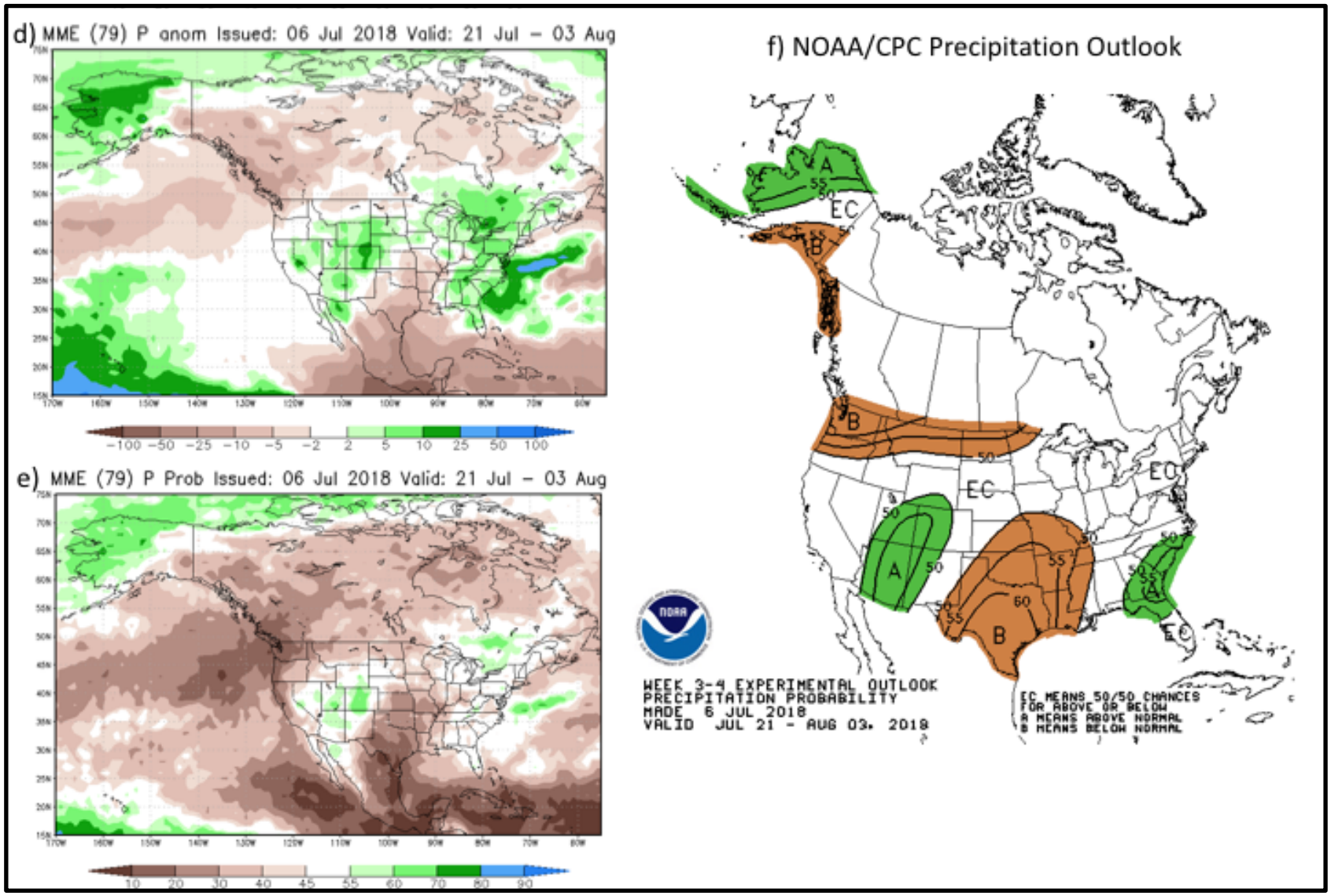
Real-time Forecasts

- CPC processes for their week 3-4 outlooks
- SubX Team processes for publicly available forecast plots
- All data are publicly available

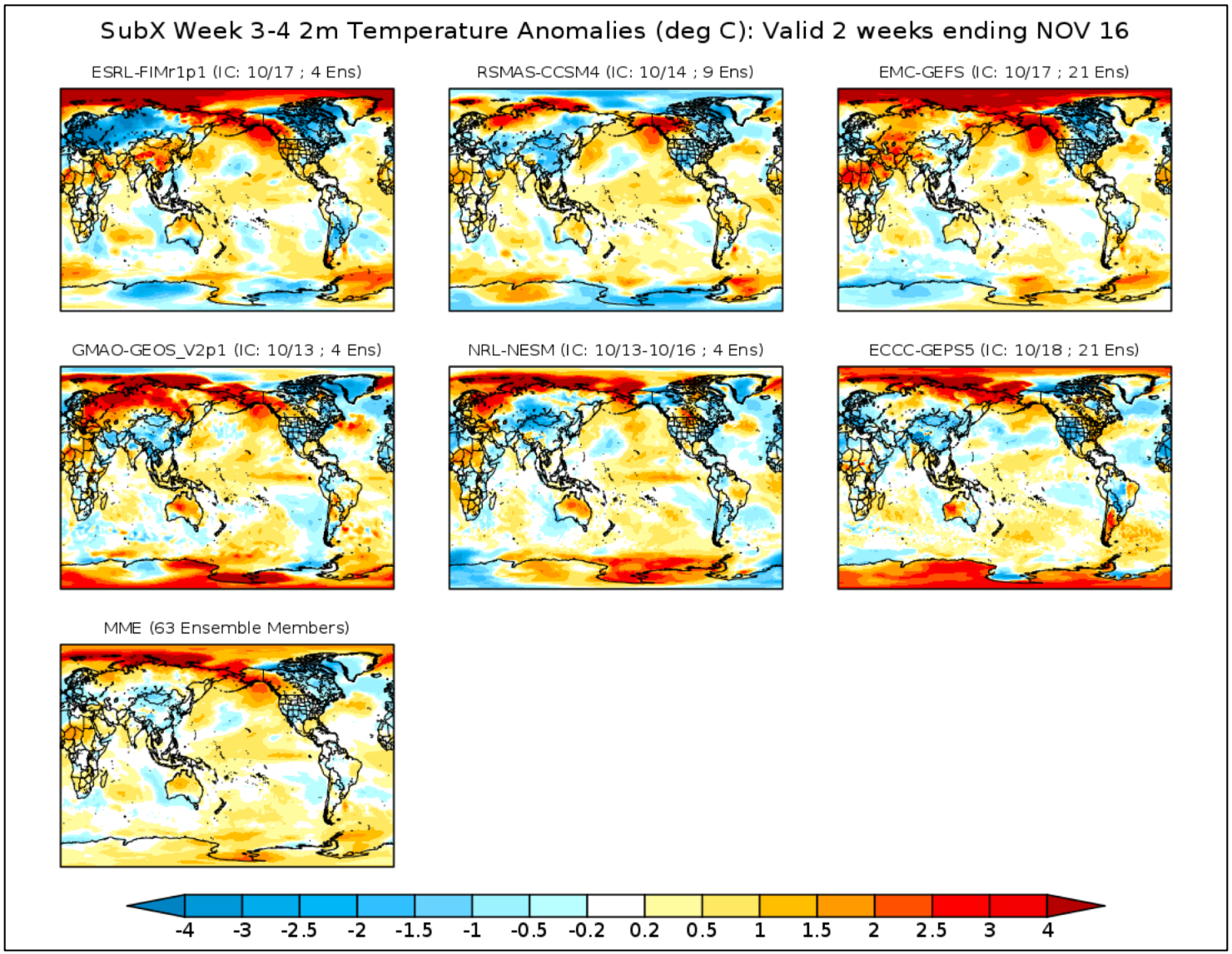


http://iridl.ldeo.columbia.edu/SOURCES/.Models/.SubX/

Example SubX Forecast Guidance & CPC Outlook



Example: Real-time forecast maps on SubX Website



http://cola.gmu.edu/kpegion/subx/forecasts/forecasts.html

Summary

- **SubX provides a publicly available re-forecast and real-time forecast database for S2S research, operations, and applications.**

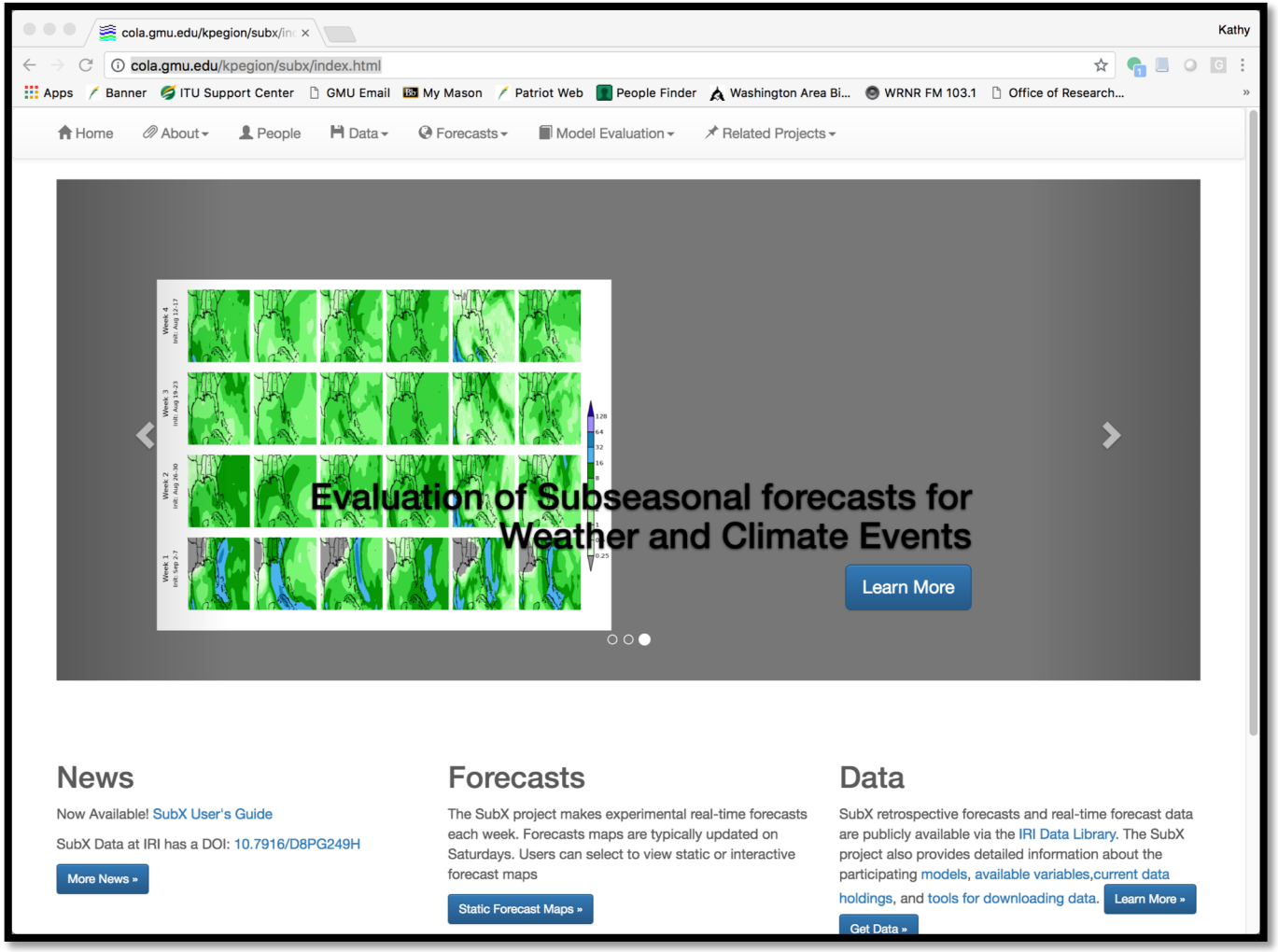
- **SubX Complimentary to other S2S efforts:**
  - real-time forecasts
  - research models

- **Evaluation of model biases, skill, sources of predictability demonstrate skill at subseasonal timescales in specific regions and seasons and benefit of MME**
  - Much more to be done

- **SubX provides useful contributions to operational week 3-4 forecast guidance**
  - What can we do to provide more useful information?
  - Emerson Lajoie's Talk this afternoon

- **SubX is an ideal framework for testing model improvements/new models**
  - E.g. CESM, UFS

Where to find more information:
http://cola.gmu.edu/kpegion/subx/



- Submitted BAMS Paper
- SubX Data Users Guide
- Codes for Downloading and processing data
- Model Evaluation Plots
- Real-time Forecast Plots