UNIVERSITY
OF MIAMI
ROSENSTIEL
SCHOOL of MARINE &
ATMOSPHERIC SCIENCE

SubX Multi-Model Predictability and Prediction Experiment

SubX Team
(Ben Kirtman)

UNIVERSITY OF MIAMI
COOPERATIVE INSTITUTE for
MARINE & ATMOSPHERIC STUDIES

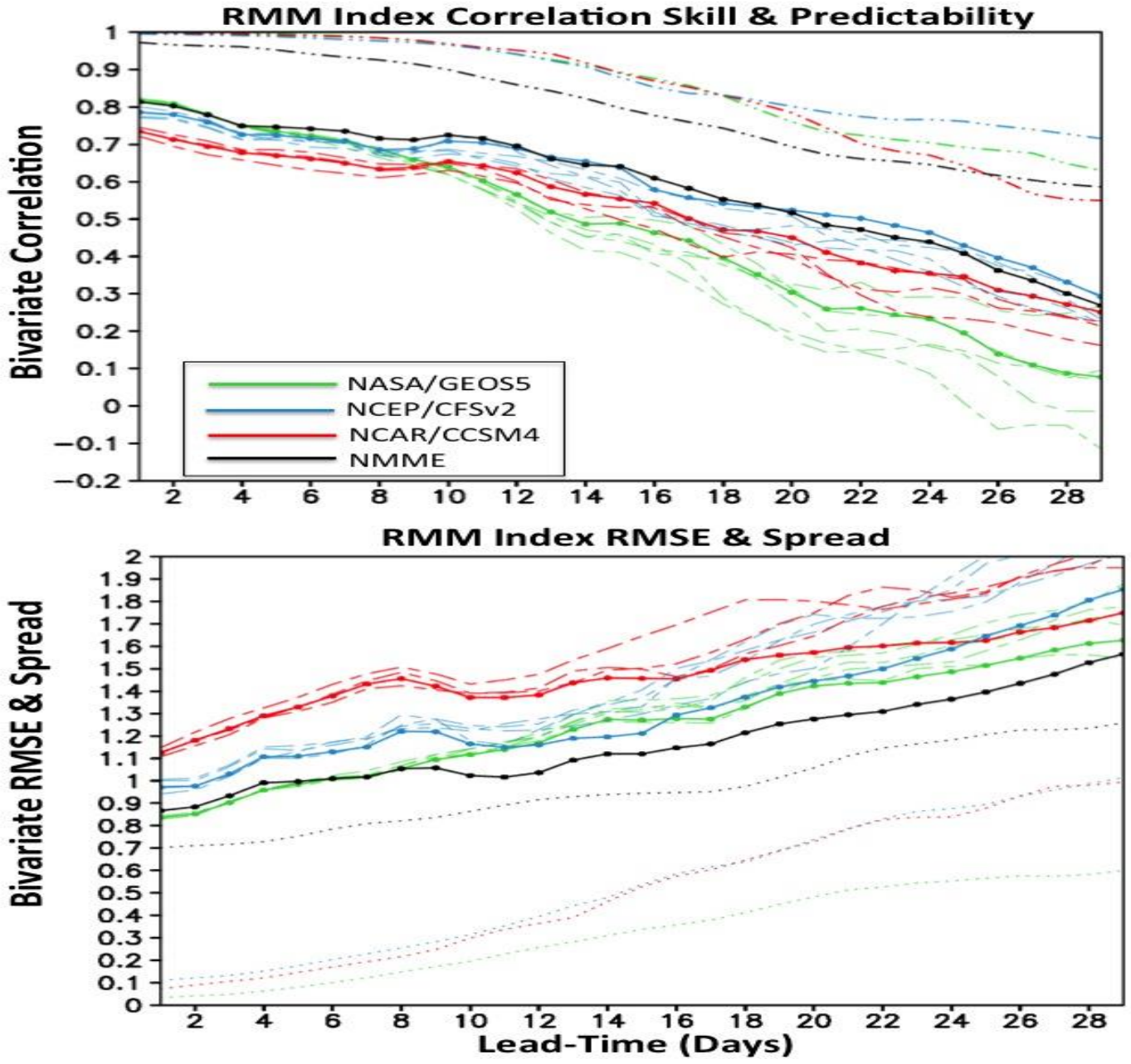
UNIVERSITY OF MIAMI
CENTER for
COMPUTATIONAL
SCIENCE

SubX≠NMME

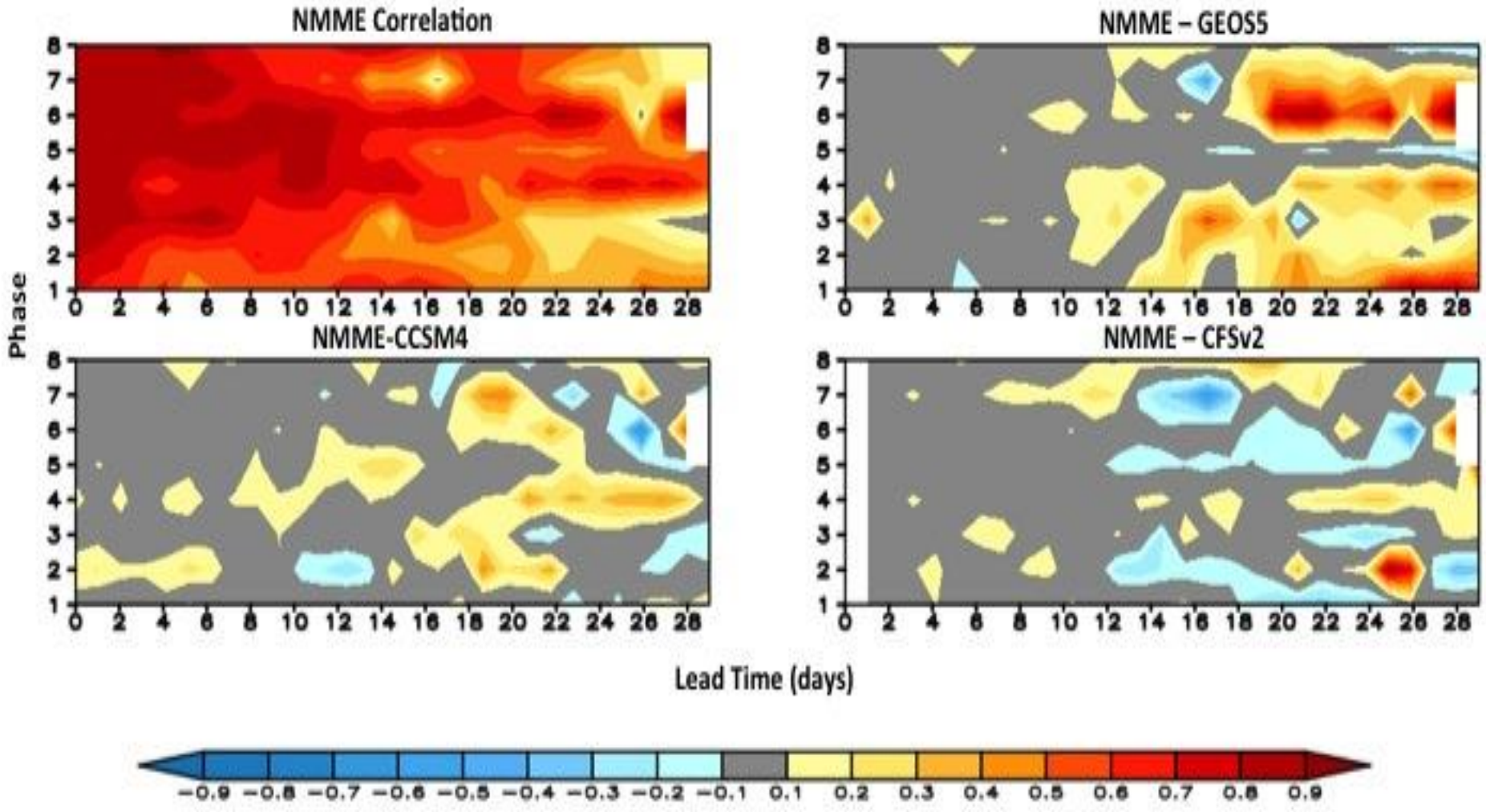
- **NMME Sub-Seasonal Experiment**
  - **High Frequency NMME Output**
- **NMME Sub-Seasonal Forecast System Exploratory Workshop**
  - **Recommendations/Experimental Protocol**
- **SubX Protocol – Real-Time July 7, 2017**
  - **Re-Forecast and Forecast Data Available Mid-August 2017**
  - **Real-Time Forecast Results**
- **Sub-Seasonal Predictability with Ocean Eddy Resolving Coupled Model**

NMME Sub-Seasonal Effort

- **Re-Forecast experiments for Years 1999-2012**
  - **November Only, Minimum of 45-days, Initialized Every 5-days on the 2nd, 7th, 12th, 17th, 22th, 27th of November.**
- **Ocean and Atmosphere Initialized; Land Initialized**
  - **Three Ensemble Members**
- **Daily means: SST, U200, U850, OLR, Precip, MSLP, Z200**


RMM Index Correlation Skill & Predictability
Bivariate Correlation
NASA/GEOS5
NCEP/CFSv2
NCAR/CCSM4
NMME
RMM Index RMSE & Spread
Bivariate RMSE & Spread
Lead-Time (Days)

RMM Bivariate Correlation by Phase



NMME Sub-Seasonal Forecast System Exploratory Workshop

- **March 30-31 2015**
- **Assessment of Scientific Opportunity**
- **Assessment of Operational Need**
- **Extension of NMME?**
  - **Needs to be a Separate Effort (SubX ≠ NMME)**
  - **Overlap Opportunities**
- **Sub-seasonal Prediction Experiment (SubX)**
- **Coordination with Research Efforts and International S2S**

SubX Protocol

- Prediction System Details up to Provider
- Real-time and Retrospective Systems Identical
  - Ensemble Generation Issues
- Reforecast Forecast Period: 1999-2017
- At Least 4 Ensemble Members
- Minimum Length 32 Days
- Real-time Forecast Made Available to CPC Through NCO Every Wednesday by 5pm of Every week
- Data on Uniform 1x1 Grid

Model	Hindcast Period	# of Members	Perturbation Methodology	Lead (days)	Model Resolution & init (Atmos)	Model Resolution & init (Ocean)	Model Resolution and Init (Sea Ice)	Model Resolution & Init (Land)	Reference
SubX Models									
Navy Earth System Model	1999-2015	4	Time-lagged ensemble	45	T0359L50 (~37 km resolution and 50 vertical levels) Initial conditions from atmosphere data assimilation system	0.08 deg 41 vertical layers Initial conditions from an ocean reanalysis at the same resolution		T0359 (~37 km) Initialized from the Agricultural Meteorological Modeling System (AGRMET)	Hogan et al. (2014) for atmos Metzger et al. (2014) for ocean/ice
NCEP GEFS	1999-2015	20	EnKF and ETR	35	T574(~33km)L64 for 0-8 day and T382 (~55km) for 8-35 day; Initial conditions from atmosphere data assimilation system	N/A	N/A	T574(~33km), initial condition come from global data assimilation system (GDAS)	Zhou et al. (2016a,b); Hou et al. (2012)
NASA/ GEOS5	1981-2015	10	simple scaled difference of two consecutive days of analysis	45	GOES5 ½ degree horizontal resolution, 72 vertical layers Hindcast ICs: MERRA2 RT ICs: GEOS-5 realtime foreward processing analysis	MOM5 ½ degree horizontal resolution, 40 vertical layers Hindcast ICs: GMAO's ocean analysis RT ICs: GEOS-5 realtime foreward processing analysis	CICE Los Alamos Sea Ice Model Hindcast ICs: GMAO's Ocean Analysis RT ICs: GEOS-5 realtime foreward processing analysis	Catchment land surface model Hindcast ICs: MERRA-2 precipitation corrected fields RT ICs: GEOS-5 realtime foreward processing analysis	Amosphere: (Rienecker et al. 2008; Molod et al. 2012) Ocean: Griffies 2012 Land (Koster et al. 2000) Sea Ice (Hunke and Lipscomp 2008) MERRA-2 precipitation corrected fields (Reichle et al. 2014)
NCAR/ CCSM4	1999-2015	3 or 4 per day	time-lagged	45	0.9x1.25degL26	POPL60 1 degree global with 0.25 latitude res in deep tropics	Same as ocean	Same as atmosphere	Infanti, J. M., and B. P. Kirtman (2016)
NCEP/ CFSv2	1999-2010	4 per day	Time-lagged 0,6,12,18Z each day	45	T126L64	MOM4L40 0.25deg Eq 0.5deg global ICs CFSR	Same as ocean	NOAH ICs GLDAS	Saha et al. (2014); Saha et al. (2010)
ECCC/ GEM	1995-2014	4	Random isotropic perturbation	32	0.45x0.45 deg 40 levels Initial condition from ERA-Interim	N/A	N/A	Offline SPS forced by ERA-Interim	Lin et al. (2016)
Partner Models									
FIM- HYCOM (NOAA/ ESRL)	1999-2014	4/week	Time-lagged: 12Z & 18Z Tues.; 00Z & 06Z Wed.	32	~30 km ("G8") with 64 vertical layers Hindcast ICs from CFSR. (Hindcast test also with 60km)	Same as atmos., but with 32 vertical layers; Hindcast ICs from CFSR	GFS ice treatment; Hindcast ICs from CFSR	GFS Noah land surface model; Hindcast ICs from CFSR	FIM: Bleck et al. (2015) HYCOM: Bleck (2002)

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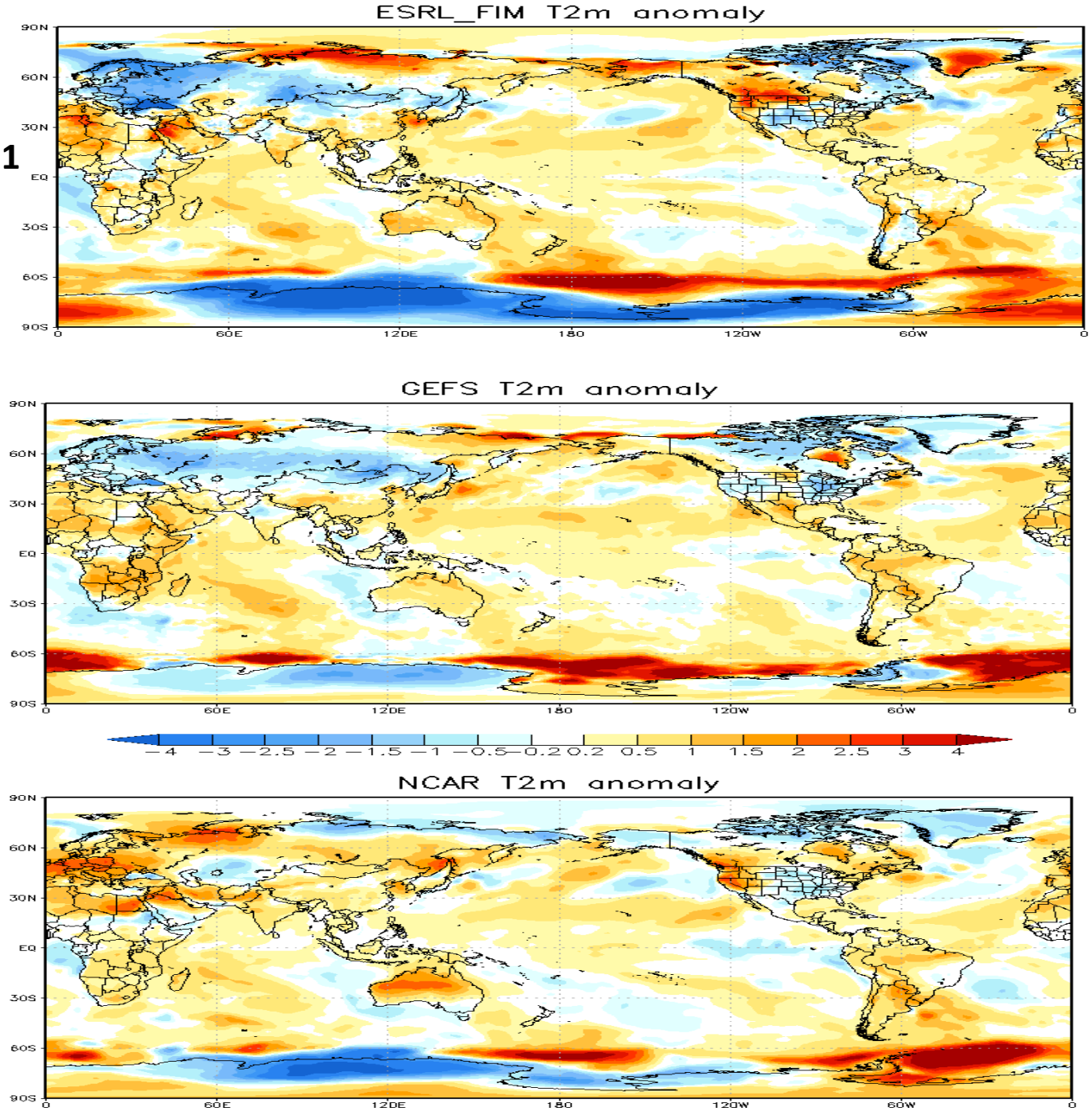
Navy Earth System Model
NCEP GEFS
NASA GEOS5
NCAR CCSM4
NCEP CFSv2
ECCC GEM
ESRL FIM-HYCOM

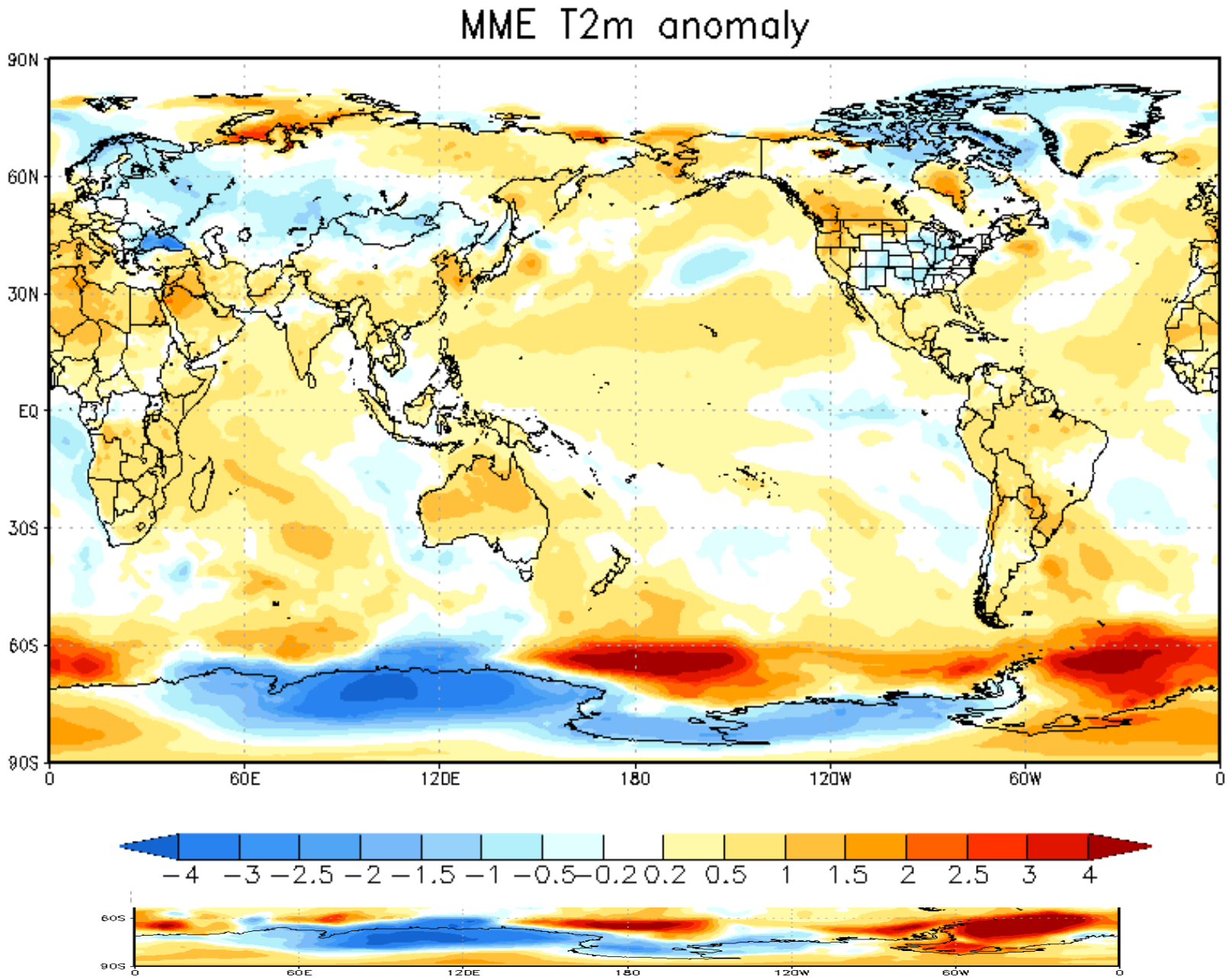
Subseasonal Experiment (SubX)
week 3/4 forecasts
(07/12/2017)

Forecasts from 3 models and the equally weighted MME

- ESRL FIM
- NCAR CCSM4 (U. Miami)
- NCEP GEFS (SubX version)

July 28-Aug. 11 Average

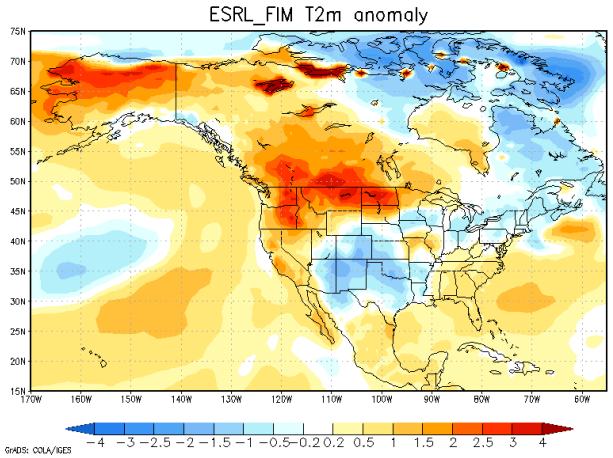



MME T2m anomaly
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
−4 −3 −2.5 −2 −1.5 −1 −0.5 −0.2 0.2 0.5 1 1.5 2 2.5 3 4
60S
90S
0
60E
120E
180
120W
60W
0

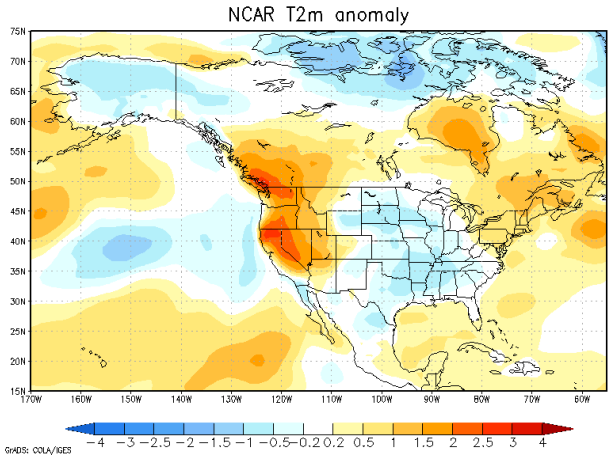
July 28-Aug. 11 Average

Temperature Anomaly (C)

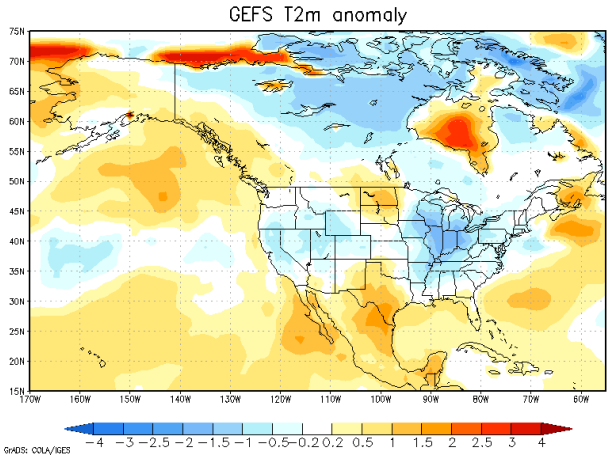
ESRL

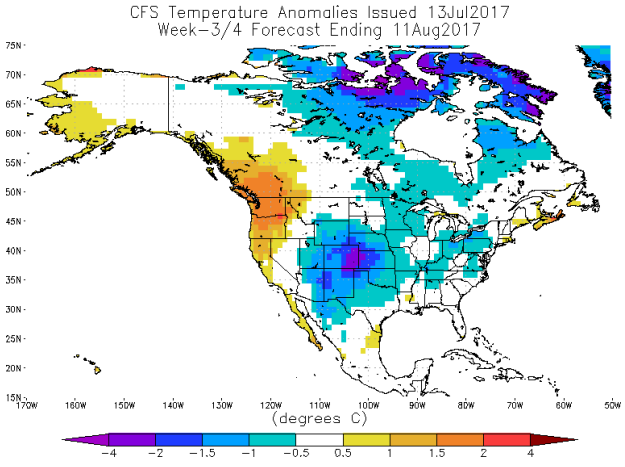


CCSM

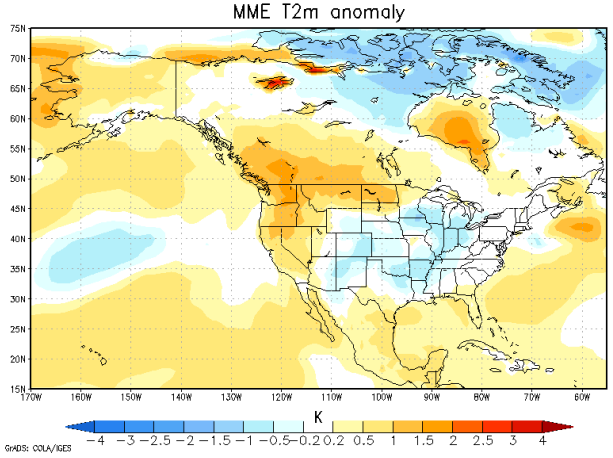


GEFS

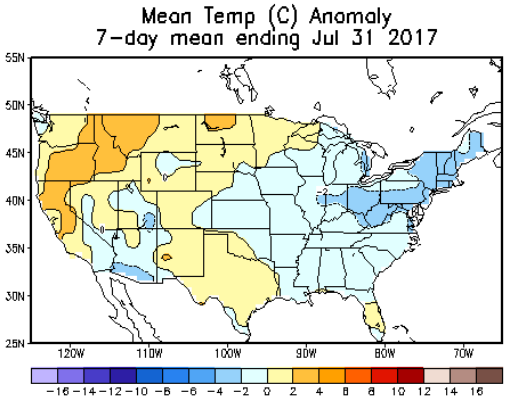




CFS



MME

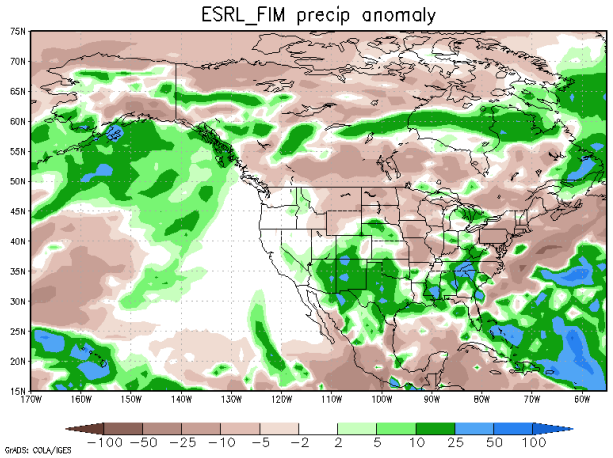


Observational Estimate

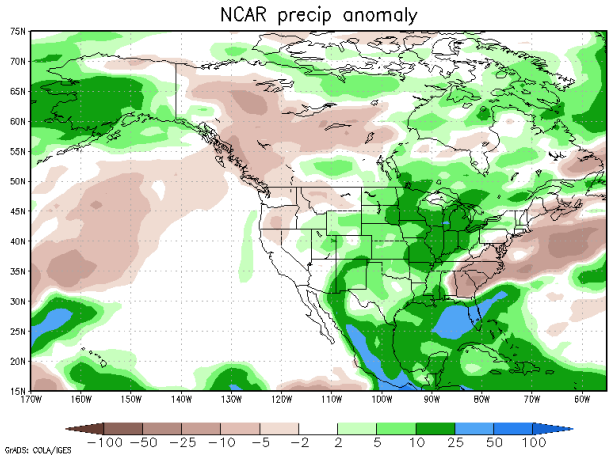
July 28-Aug. 11 Average

Precipitation Anomaly (mm)

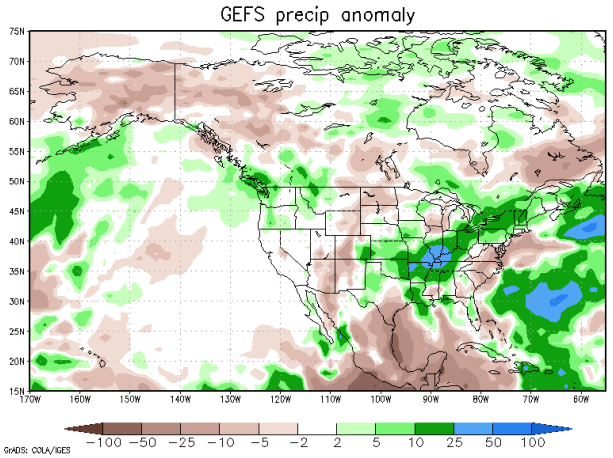
ESRL



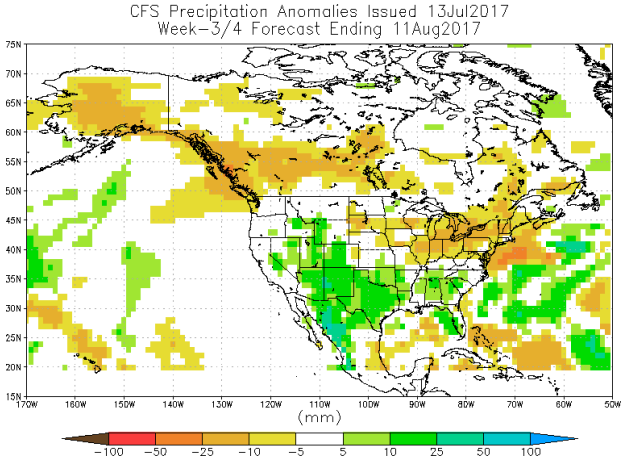
CCSM4



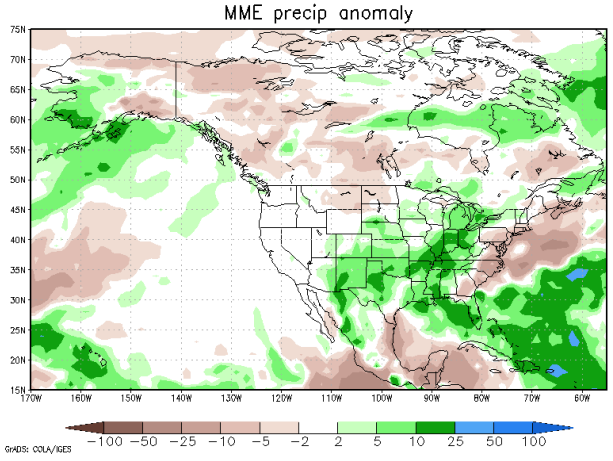
GEFS



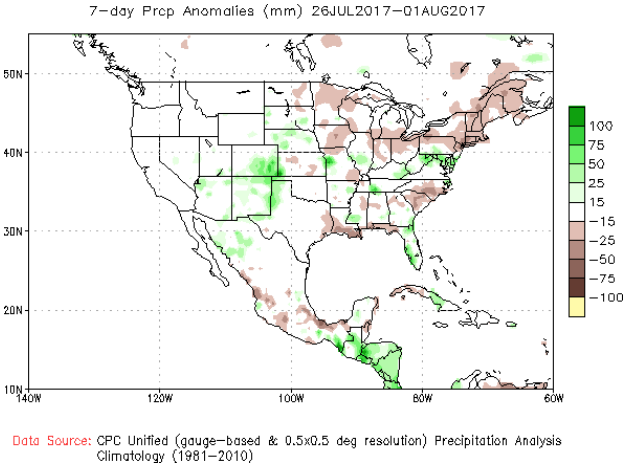
CFS



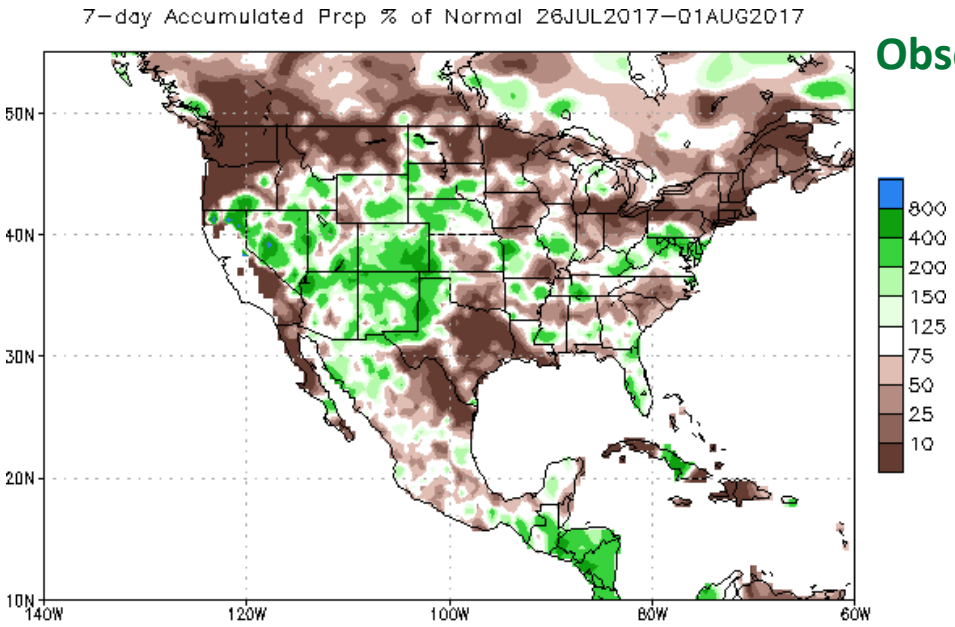
MME



Observational Estimate



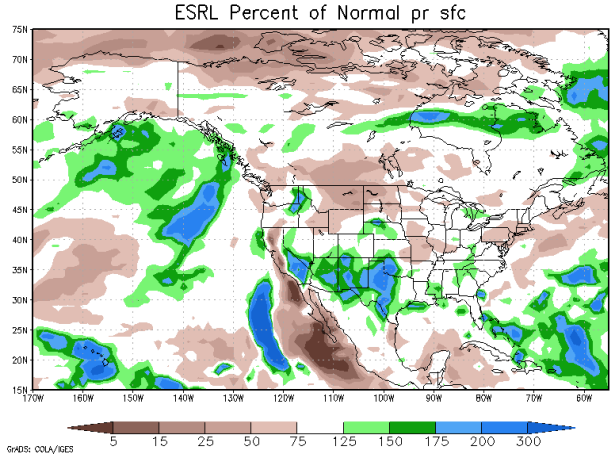
July 28-Aug. 11 Average



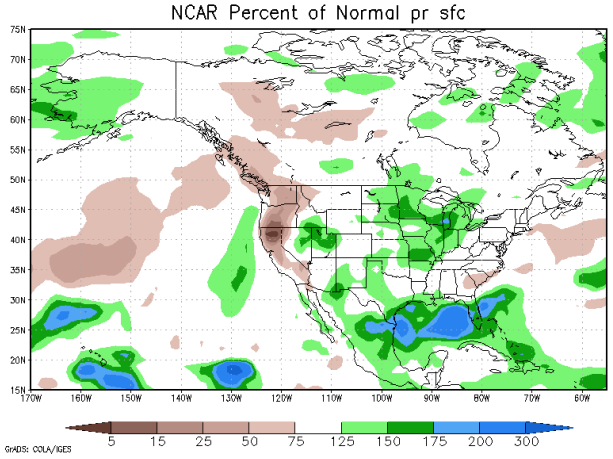
Observational Estimate

Precipitation Percent of Normal

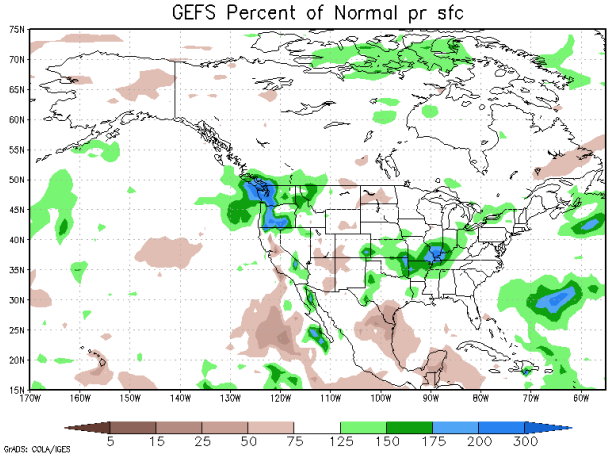
ESRL



NCAR



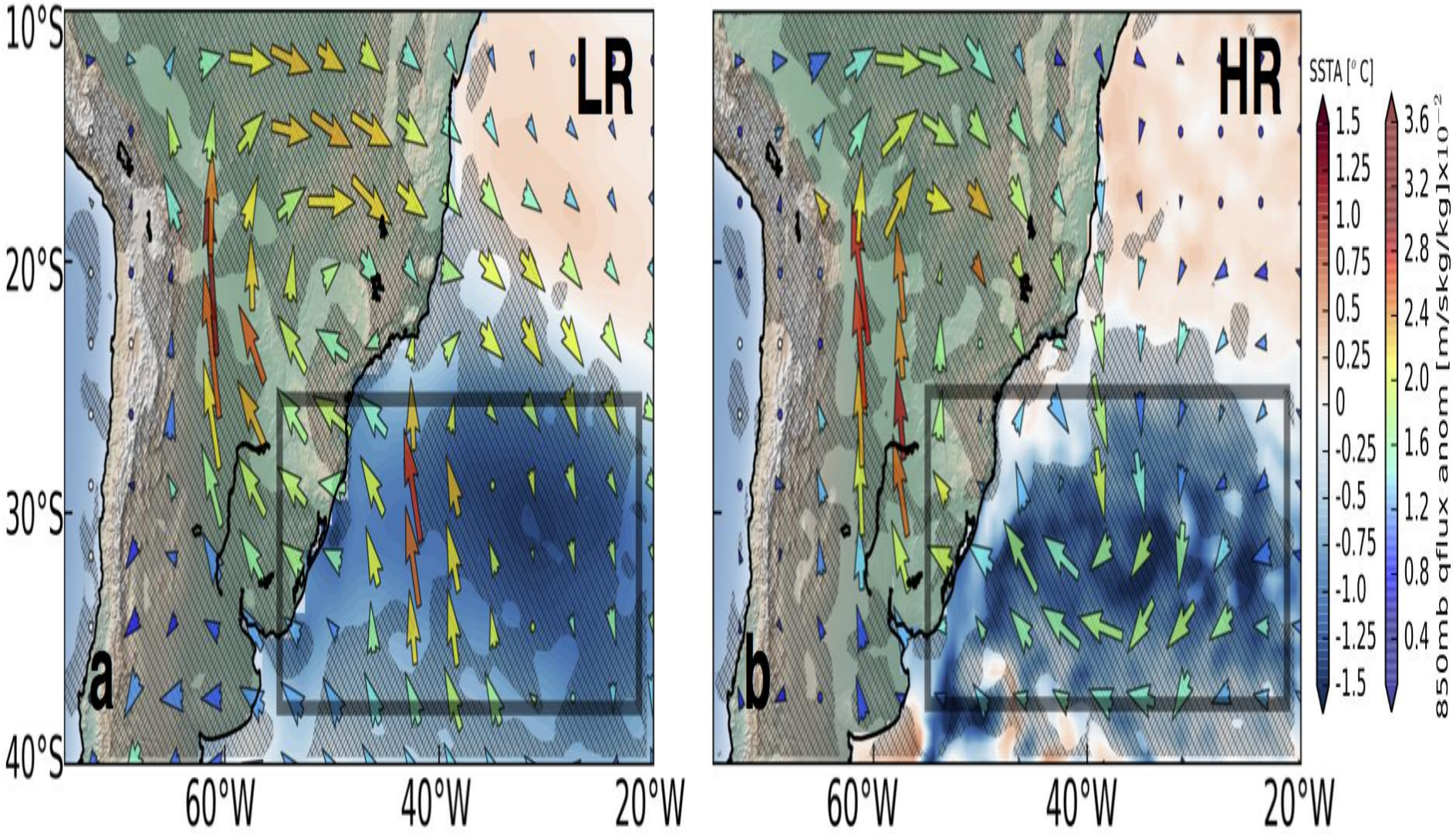
GEFS



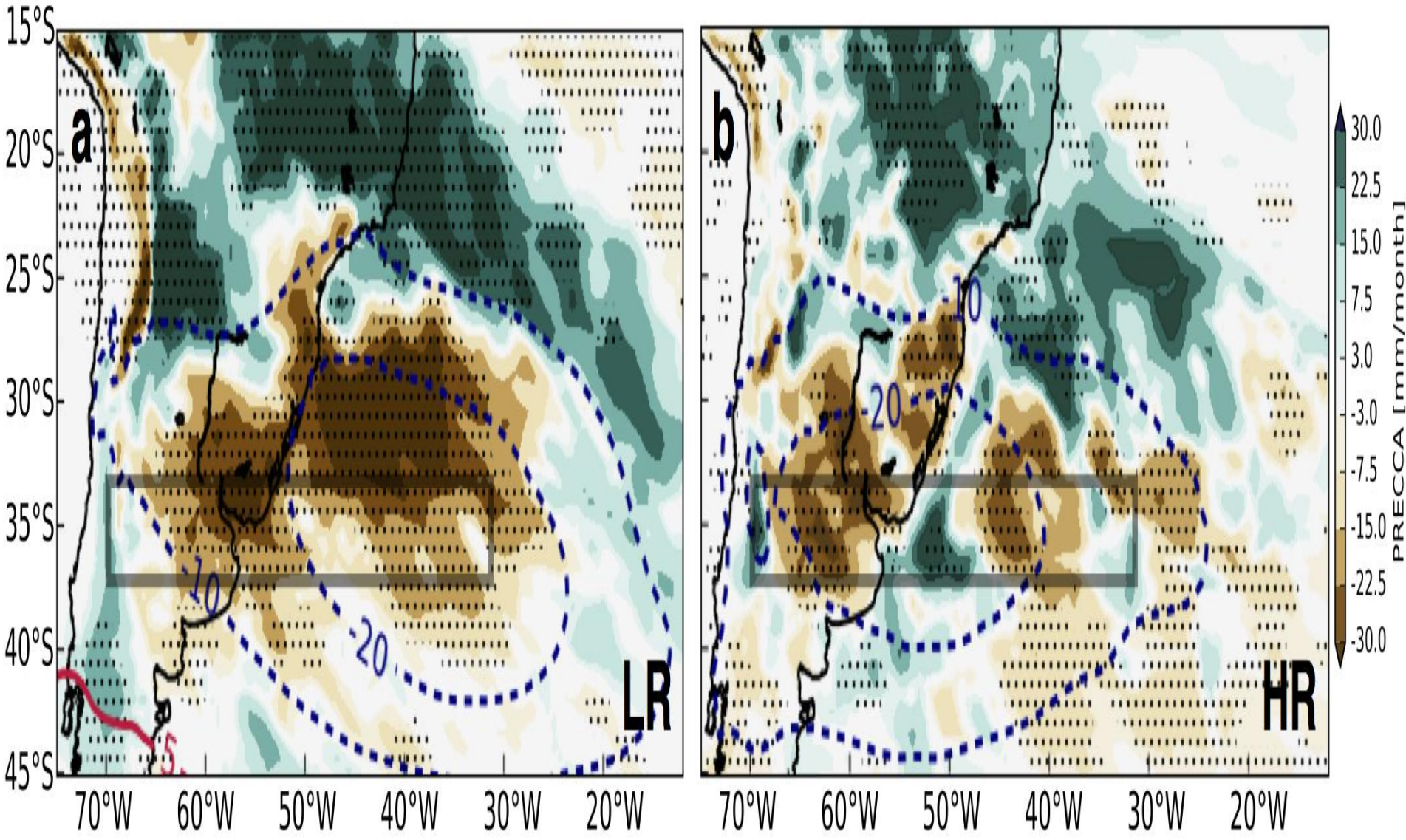
Ocean Eddy Resolving Coupled Predictability

- **CESM**
  - **Atmosphere: 0.5x0.5**
  - **Ocean: 0.1x0.1 [HRC] vs. 1x1 [LRC]**
- **“New” Sub-Seasonal to Seasonal Variability**
  - **Means, Fronts vs. Eddies (or Both)?**
  - **Regional Representation of Large Scale Drivers**

LR and HR Simulated COLD WSSA Events



LR and HR Simulated COLD WSSA Events



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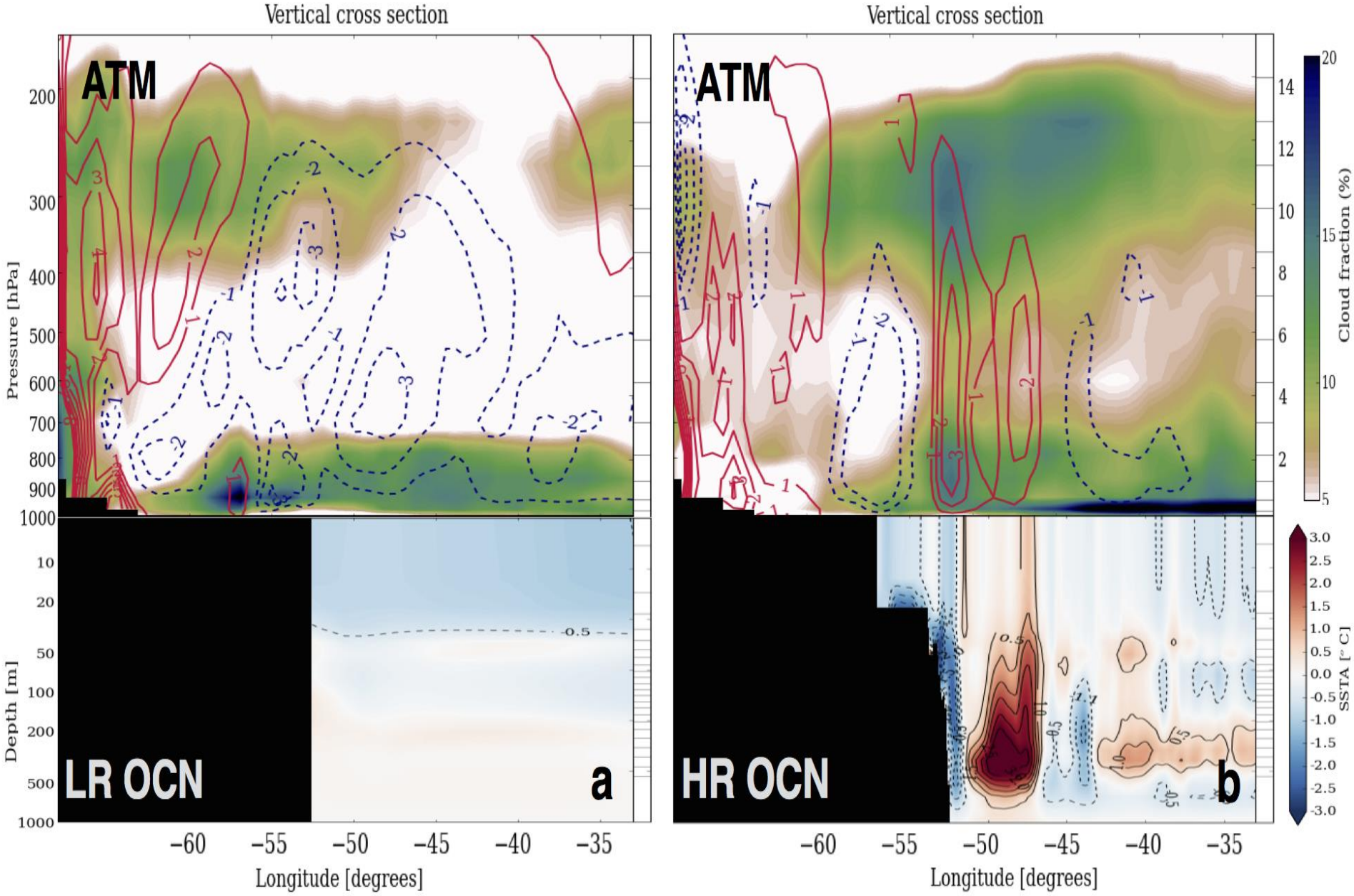
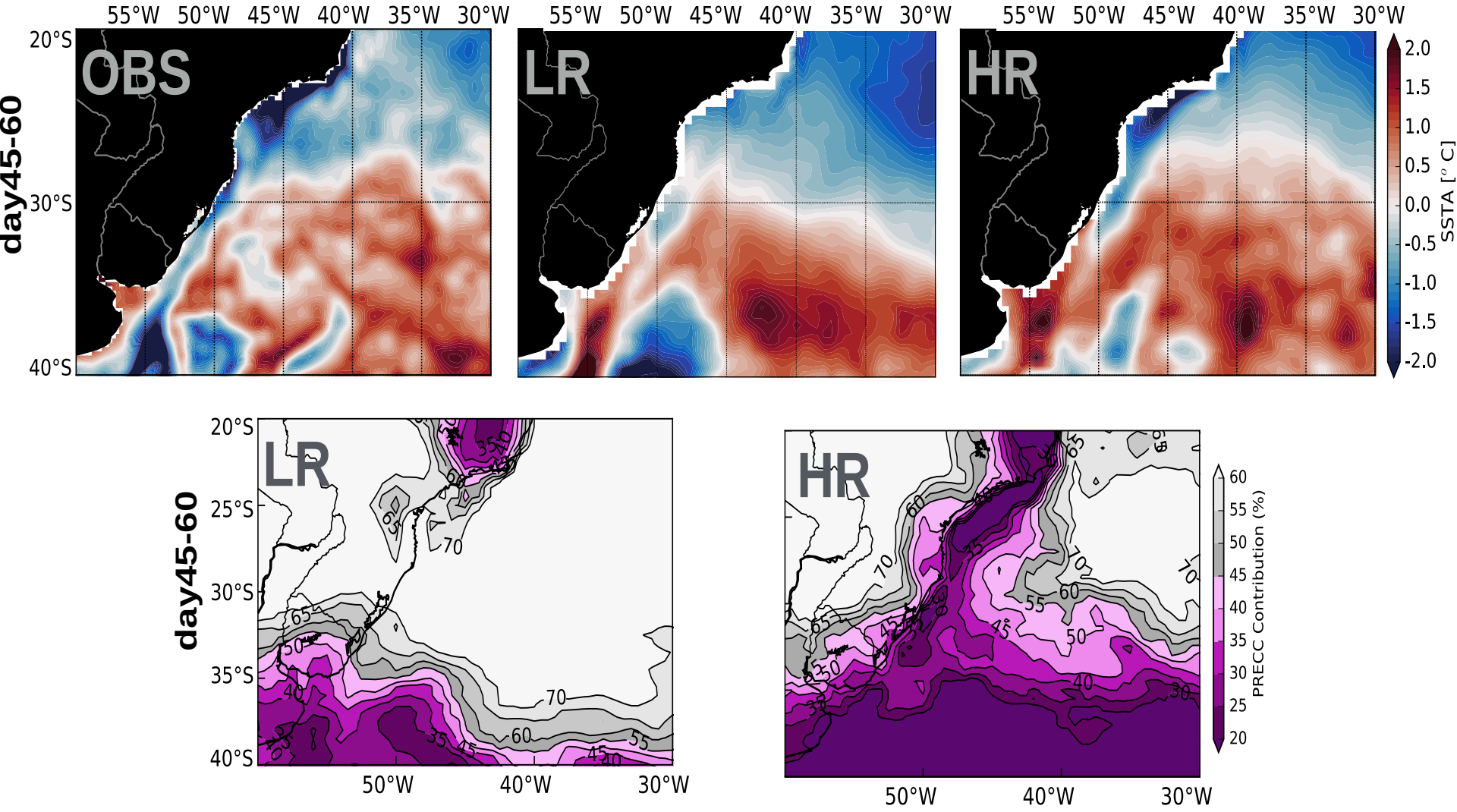


1997 Extreme WSSA: Jan-Feb 60days Forecast !
Ensemble Average (3 members)



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

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What is SubX?

The Subseasonal Experiment (SubX) is a project producing retrospective and real-time predictions on subseasonal timescales. Six global models are producing seventeen years of ensemble retrospecive forecasts initialized weekly with daily output to investigate subseasonal prediction and predictability. Additionally, one-year of real-time predictions will be produced and provided to the NOAA/NWS Climate Prediction Center as additional guidance for their week-3/4 outlooks.

The Objectives of the SubX Project are:

- Collecting and serving data both internally at CPC for use by operational forecasters and for the external community via the IRI data library
- Providing a baseline verification particularly for the weeks 3-4 temperature and precipitation probability forecasts
- Multi-model evaluations and combinations including selecting suitable models, optimizing the design of the system, and evaluation of the prediction products
- Enhancing communications between operational forecasts and the model forecast producers

MAPP Modeling, Analysis, Predictions, and Projections — Modeling, Analysis, Predictions and Projections Program

The Office of Naval Research

MAP Program

Office of Science and Technology Integration