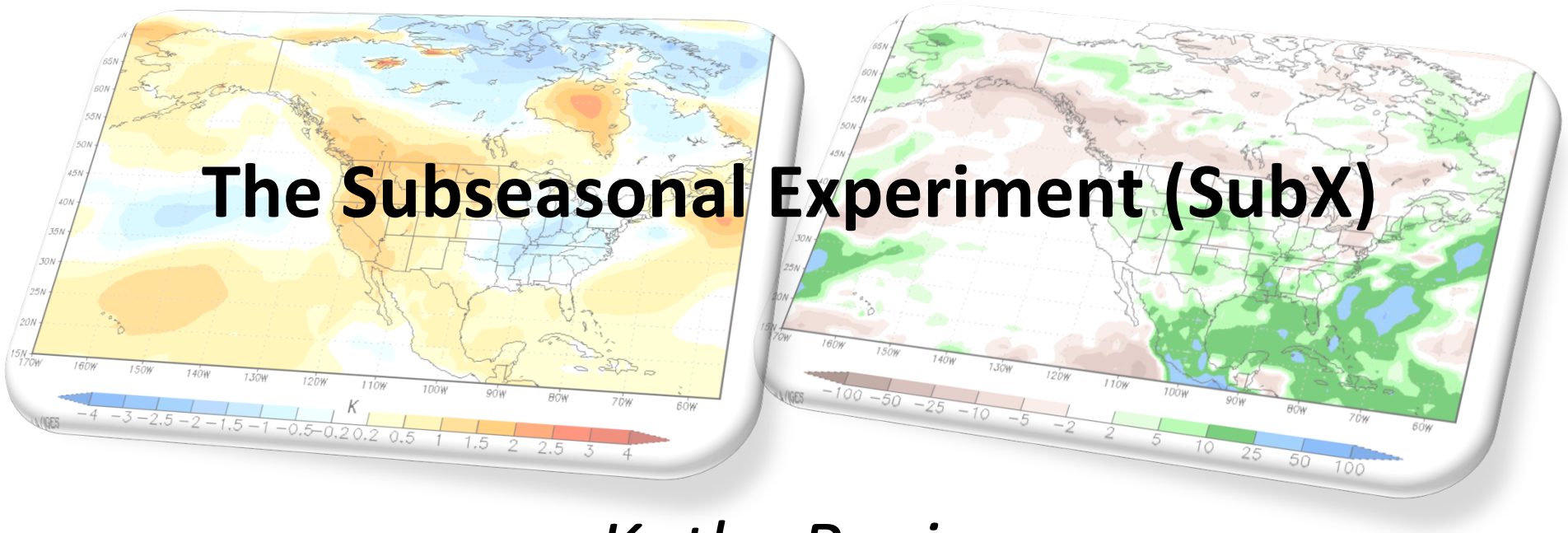


The Subseasonal Experiment (SubX)

Kathy Pegion

SubX Team

MAPP
Modeling, Analysis, Predictions, and Projections

SubX BY THE NUMBERS

7 Global Models

1 Year of *Real-time* Forecasts

17 Years of *Retrospective* Forecasts

3-4 week guidance for Climate Prediction Center Outlooks

What is SubX?

NOAA/Climate Testbed project focused
on subseasonal predictability and predictions

Objectives

- 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
- Evaluating the skill of individual model systems
- Investigating multi-model 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
- Participation in the NOAA/MAPP S2S Task Force

Who is the SubX Team?

CORE TEAM

Ben Kirtman
Kathy Pegion
Tim DelSole
Michael Tippett
Andy Robertson
Michael Bell
Robert Burgman
Jon Gottschalck
Dan Collins
Emerson LaJoie
Hai Lin

NCEP-CFSv2
Dan Collins
Jon Gottschalck
Emerson Lajoie
Emily Becker

NCEP-GEFS
Yuejian Zhu
Wei LI

NASA-GEOS5
Deepthi Achuthavarier
Randy Koster
Len Marshak

ECCC-GEM
Hai Lin
Bertrand Denis

Navy-ESM
Neil Barton
Joe Metzger

NCAR-CCSM4
Ben Kirtman
Duguong Min
Kathy Pegion
Rong Fu

ESRL-FIM
Shan Sun
Stan Benjamin
Ben Green

SubX Protocol

- Prediction System Details up to Provider
- Real-time and Retrospective Systems Identical
  - Ensemble Generation Issues
- Reforecast Period: 1999-2014
- At Least 3 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

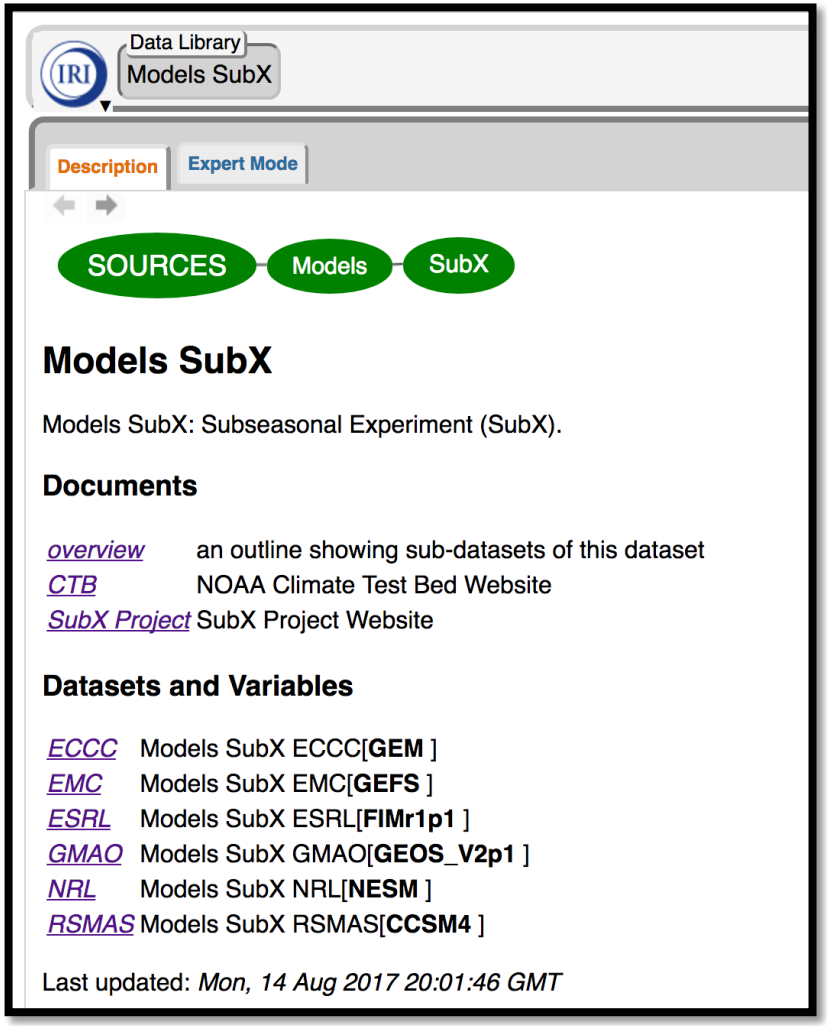
Model	Hindcast Period	# of Members	Perturbation Methodology	Lead (days)	Model Resolution & init (Atmos)	Model Resolution & init (Ocean)	Model Resolution and Init (Sea Ice)	Model Resolution & Init (Land)	Reference
SubX Models									
Navy Earth System Model	1999-2015	4	Time-lagged ensemble	45	T0359L50 (~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)

SubX Current Status

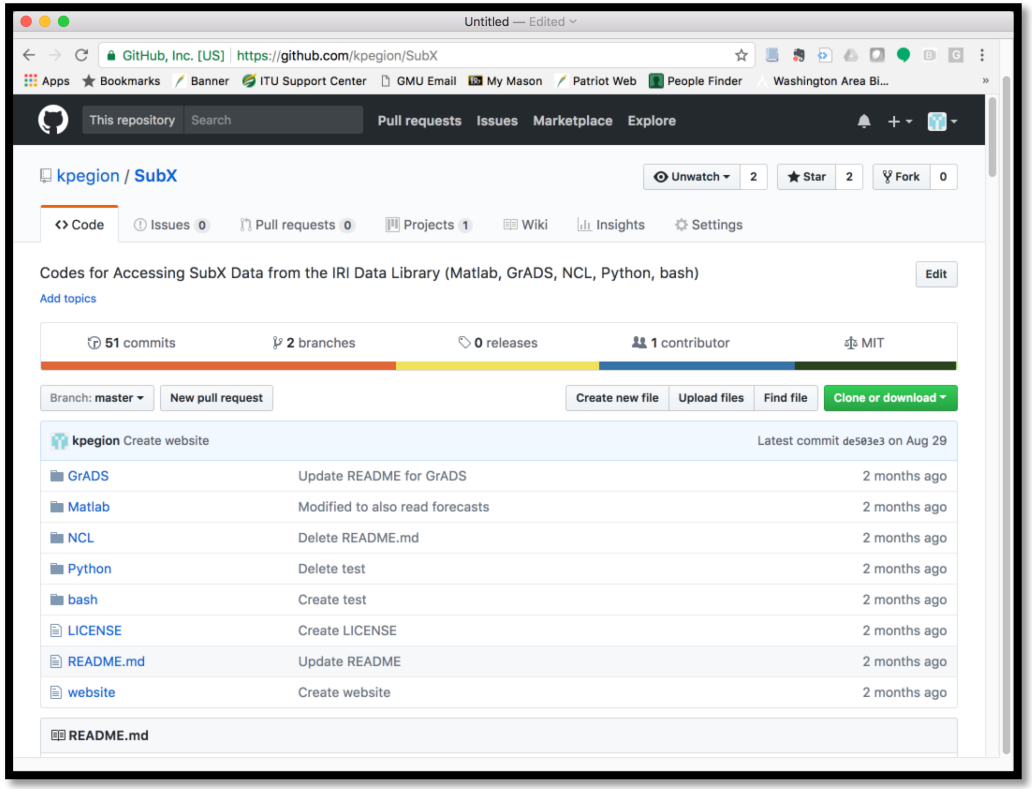
- ✓ Re-forecast & real-time forecast database
- ✓ Real-time forecast maps
- ✓ Forecast Evaluation (tropical cyclones)
- ✓ Re-forecast Evaluation: skill

Real-time and Re-forecast Database

Data publicly available from the IRI Data Library



Codes to help you download on github



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

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

Re-forecasts Data Holdings

Model	Ens Members	Init Interval	P1	P2	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ECCC-GEM	4	7-days	☑		1995-2015								☑	☑			
EMC-GEFS	11	7-days	☑	☑	1999-2016						☑	☑	☑	☑	☑	☑	
ESRL-FIM	4	7-days	☑	☑	1999-2016		☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
GMAO-GEOS	4	5-days	☑		1999-2015							☑	☑	☑	☑	☑	
NRL-NESM	1	4 inits every 7-days	☑	☑	1999-2015							☑	☑	☑	☑	☑	☑
RSMAS-CCSM4	3	7-days	☑		1999-2016	☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	☑

- Some groups producing re-forecasts “on the fly”
- Some groups have provided both P1 & P2 data, others only P1
- Database constantly updated as new data comes available

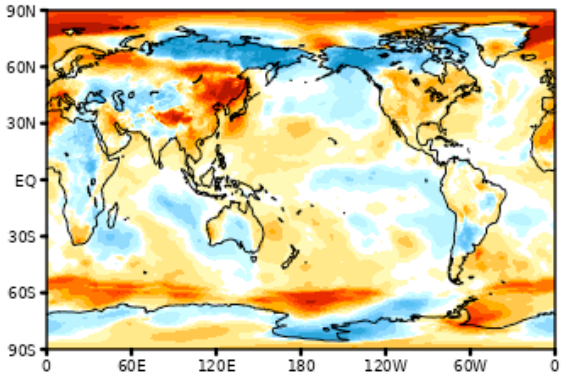
Real-time Forecasts

- Begin first week of July with 3 models participating
- Additional models joined by Aug (total of 5 models)
- ECCC was added last week (up to 6)
- CFSv2 will be included once it has been formatted to SubX data requirements (7th model)
- See latest forecasts….

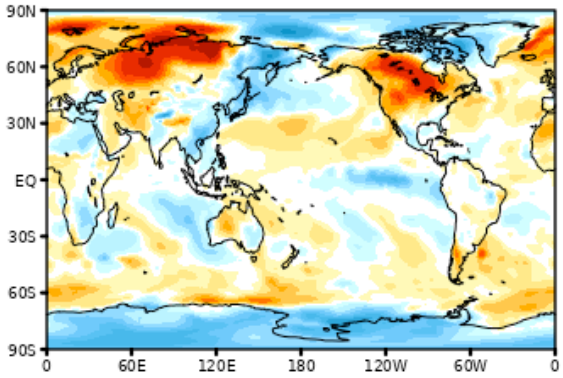
SubX Week 3-4 2m Temperature Anomalies (deg C)

Valid Nov 11-24

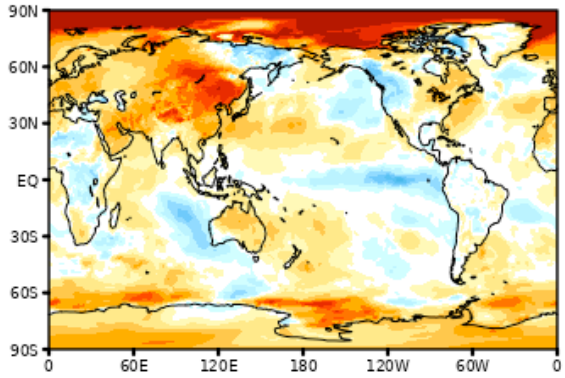
ESRL-FIM (IC: Oct 18; 4 Ens)



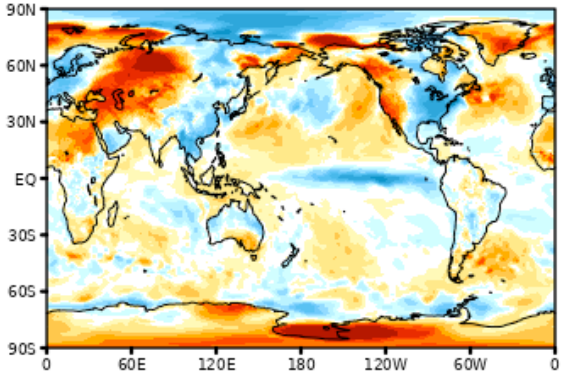
RSMAS-CCSM4 (IC: Oct 15; 9 Ens)



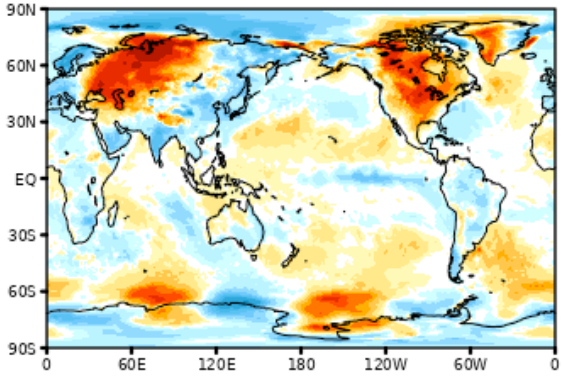
EMC-GEFS (IC: Oct 18; 21 Ens)



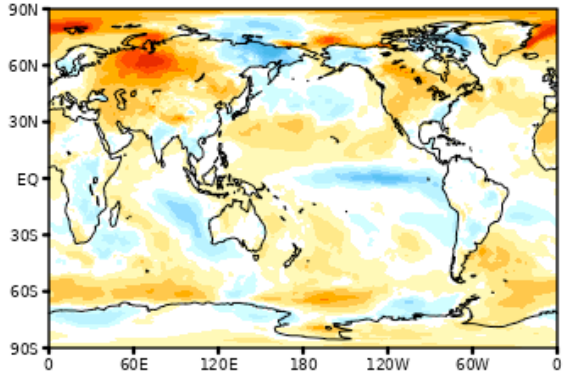
GMAO-GEOS (IC: Oct 13; 4 Ens)

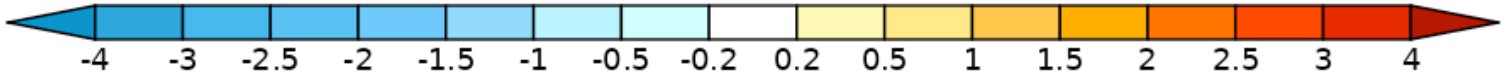


NRL-NESM (IC: Oct 14-Oct 17; 4 Ens)



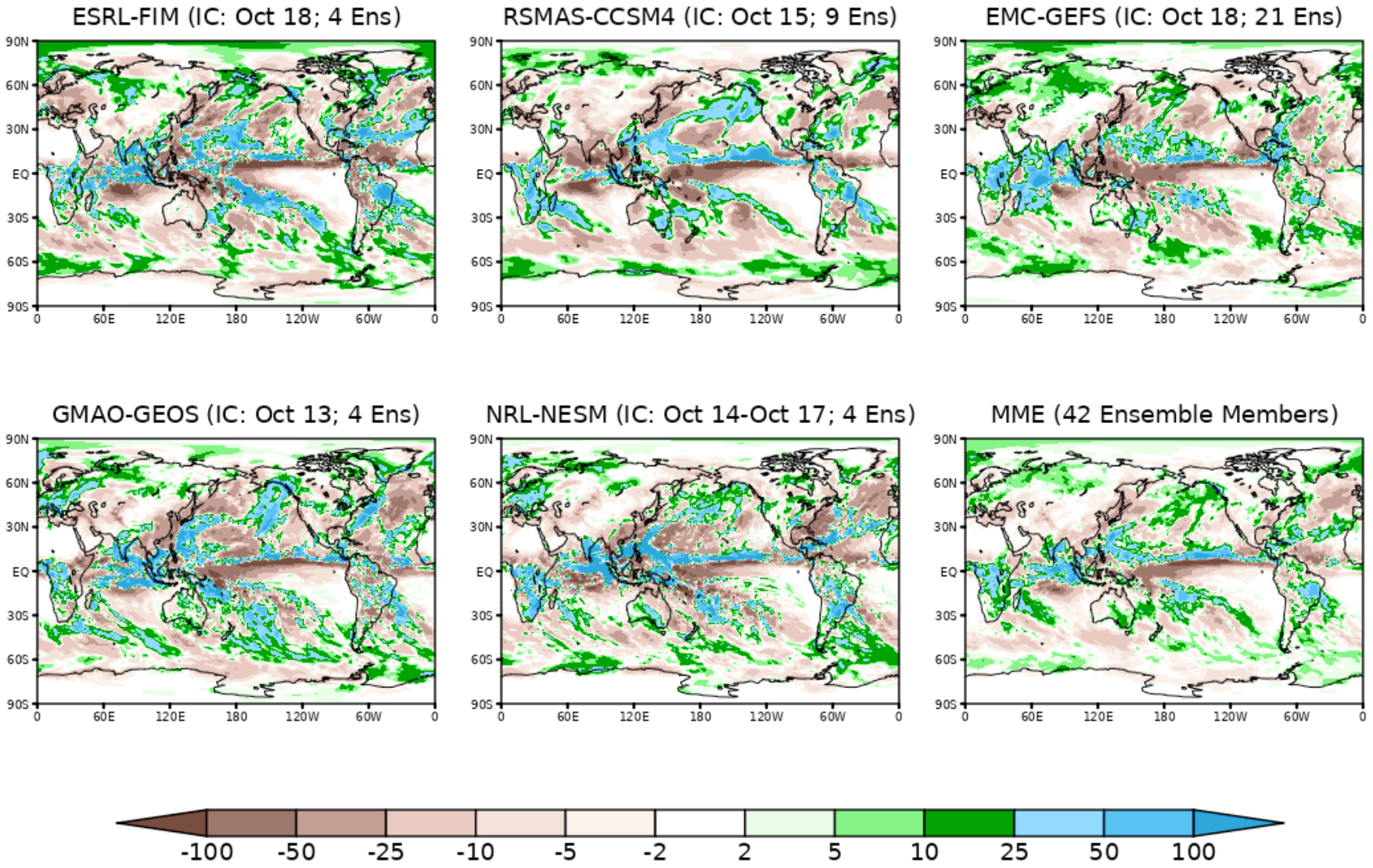
MME (42 Ensemble Members)





SubX Week 3-4 Total Precipitation Anomalies (mm)

Valid Nov 11-14



dataset: Models SubX | SubX Forecasts | Kathy

wxmaps.org/subx_custom.php

Apps | Bookmarks | Banner | ITU Support Center | GMU Email | My Mason | Patriot Web | People Finder | Washington Area Bi...

~ Customized SubX Forecast Plots ~

Very Important Disclaimer: These experimental anomaly forecasts, produced by the SubX project for research purposes, are not official forecasts and are not guaranteed to be timely or accurate. For official subseasonal climate outlooks, please visit the NOAA/NWS Climate Prediction Center.

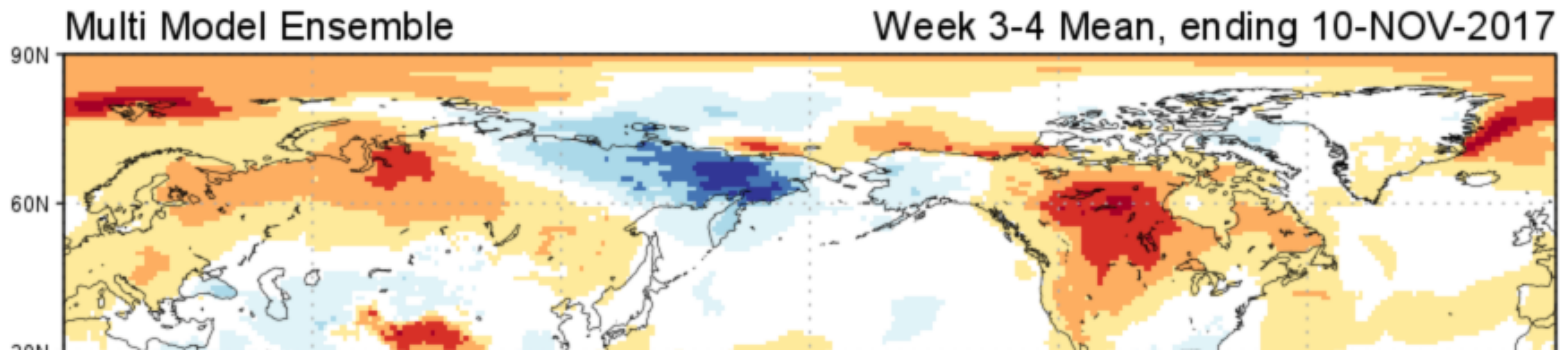
Select a SubX model and variable, choose a forecast period, specify the Longitude and Latitude ranges, then click on the SUBMIT button.

SubX Model: Multi Model Ensemble **Variable:** Air Temperature at 2 meters **Forecast Week:** 3-4 Mean

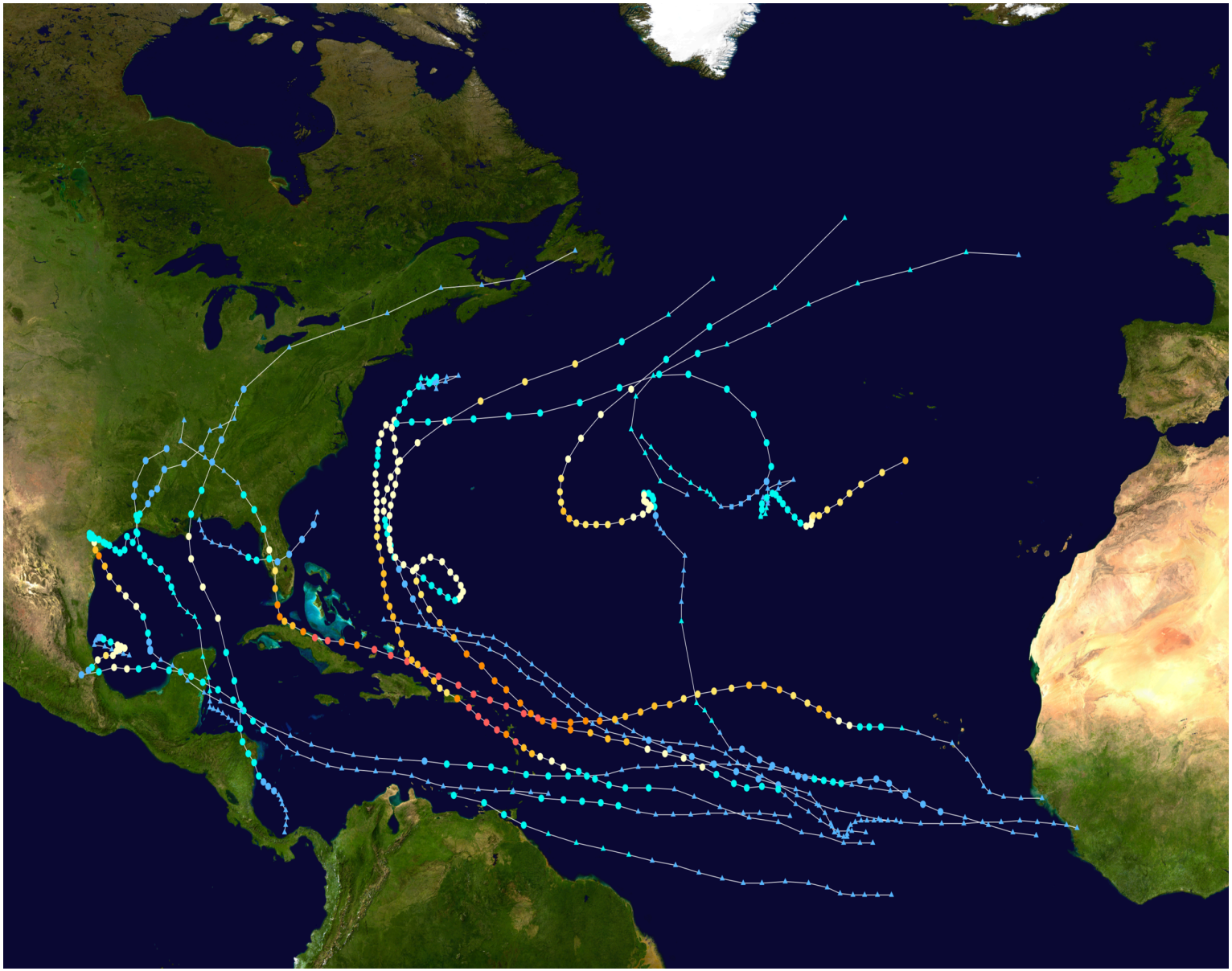
Longitude: 0 **to** 360 Average over this range **Latitude:** -90 **to** 90 Average over this range

SUBMIT

SubX Forecast of 2-Meter Temperature Anomaly [degC]

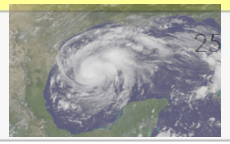


Forecast Evaluations: Tropical Cyclones



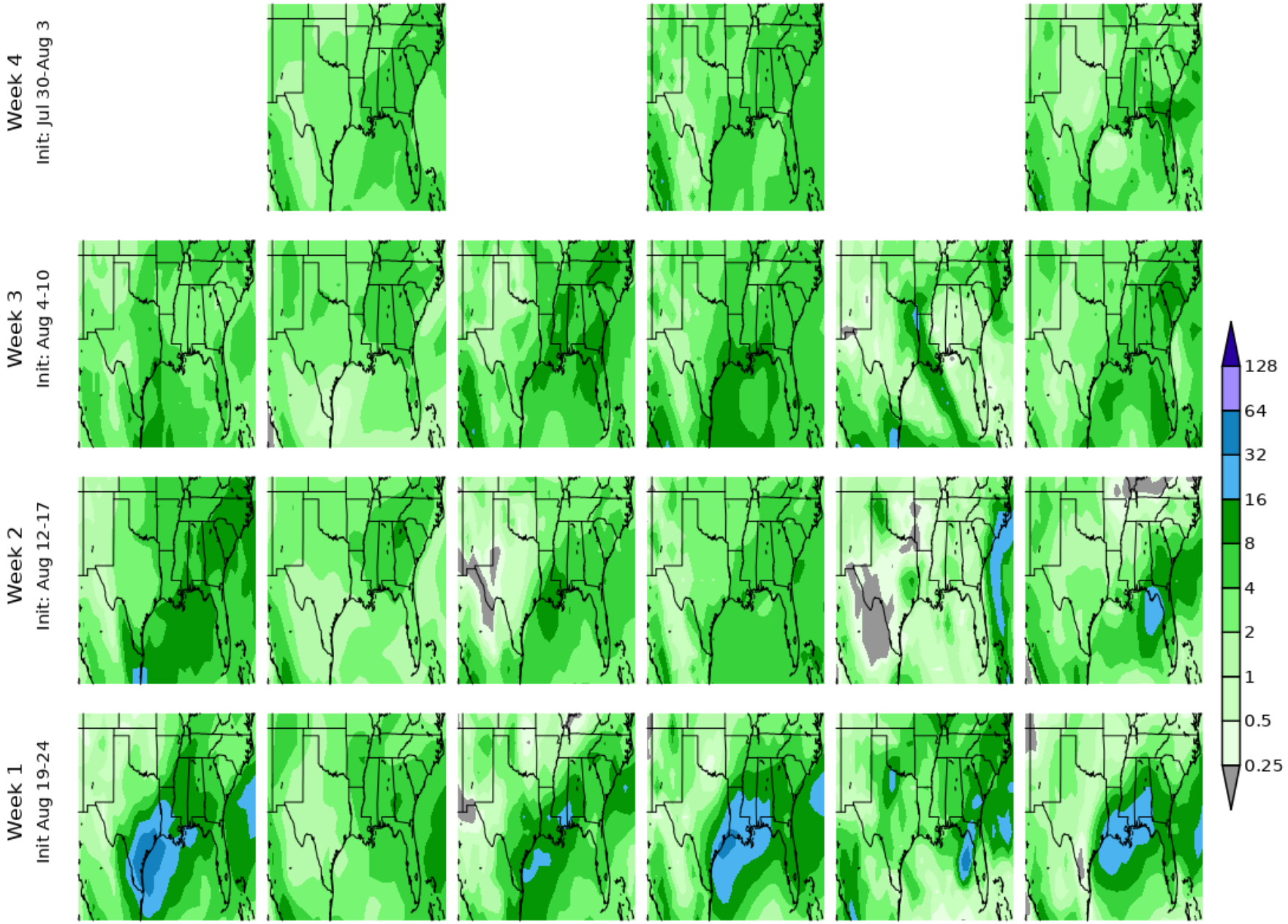
Hurricane Harvey

August 2017

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	1 EMC-GEFS(21)	2 EMC-GEFS(21) ESRL-FIM(4)	3 ECCC-GEM(21)	4 GMAO-GEOS5(4)	5 NRL-NESM(1)	6 RSMAS-CCSM4(9) NRL-NESM(1)
7 NRL-NESM(1)	8 EMC-GEFS(2) NRL-NESM(1)	9 EMC-GEFS(21) ESRL-FIM(4) GMAO-GEOS5	10 ECCC-GEM(21)	11	12 NRL-NESM(1)	13 RSMAS-CCSM4(9) NRL-NESM(1)
14 NRL-NESM(1) GMAO-GEOS5(4)	15 EMC-GEFS(21) NRL-NESM(1)	16 EMC-GEFS(21) ESRL-FIM(4)	17 ECCC-GEM(21)	18	19 **NRL-NESM(1)** **GMAO-GEOS5(4)**	20 **RSMAS-CCSM4(9)** **NRL-NESM(1)**
21 **NRL-NESM(1)**	22 **EMC-GEFS(21)** **NRL-NESM(1)**	23 **EMC-GEFS(21)** **ESRL-FIM(4)**	24 **ECCC-GEM(21)** GMAO-GEOS5(4)	25 	26 NRL-NESM(1)	27 RSMAS-CCSM4(9) NRL-NESM(1)
28 NRL-NESM(1)	29 EMC-GEFS(2) NRL-NESM(1) GMAO-GEOS5	30 EMC-GEFS(2) ESRL-FIM(4)	31 ECCC-GEM(21)			

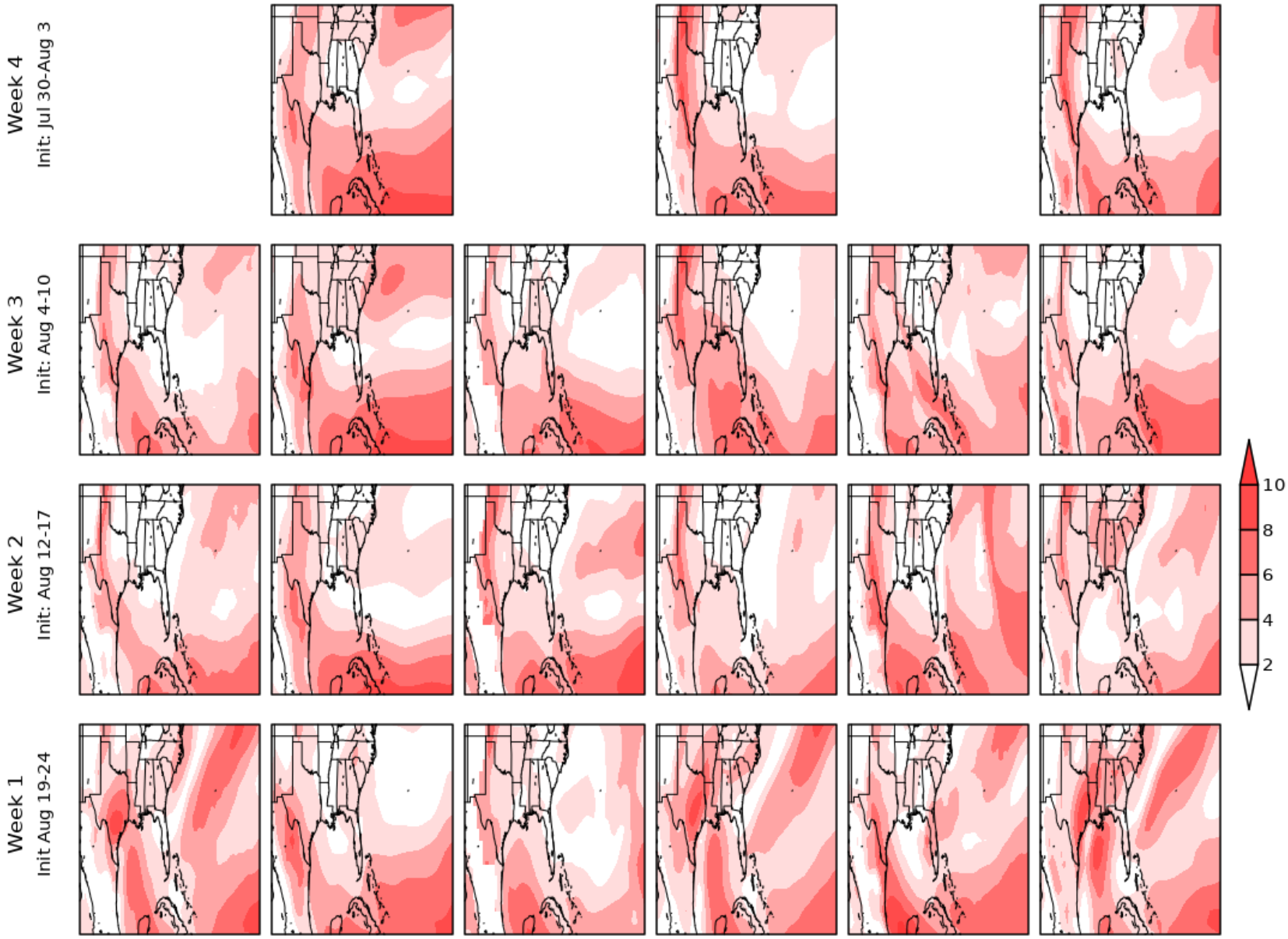
Harvey

Weekly total rainfall (mm) for Week of Aug 26- Sep 1
Ensemble Mean



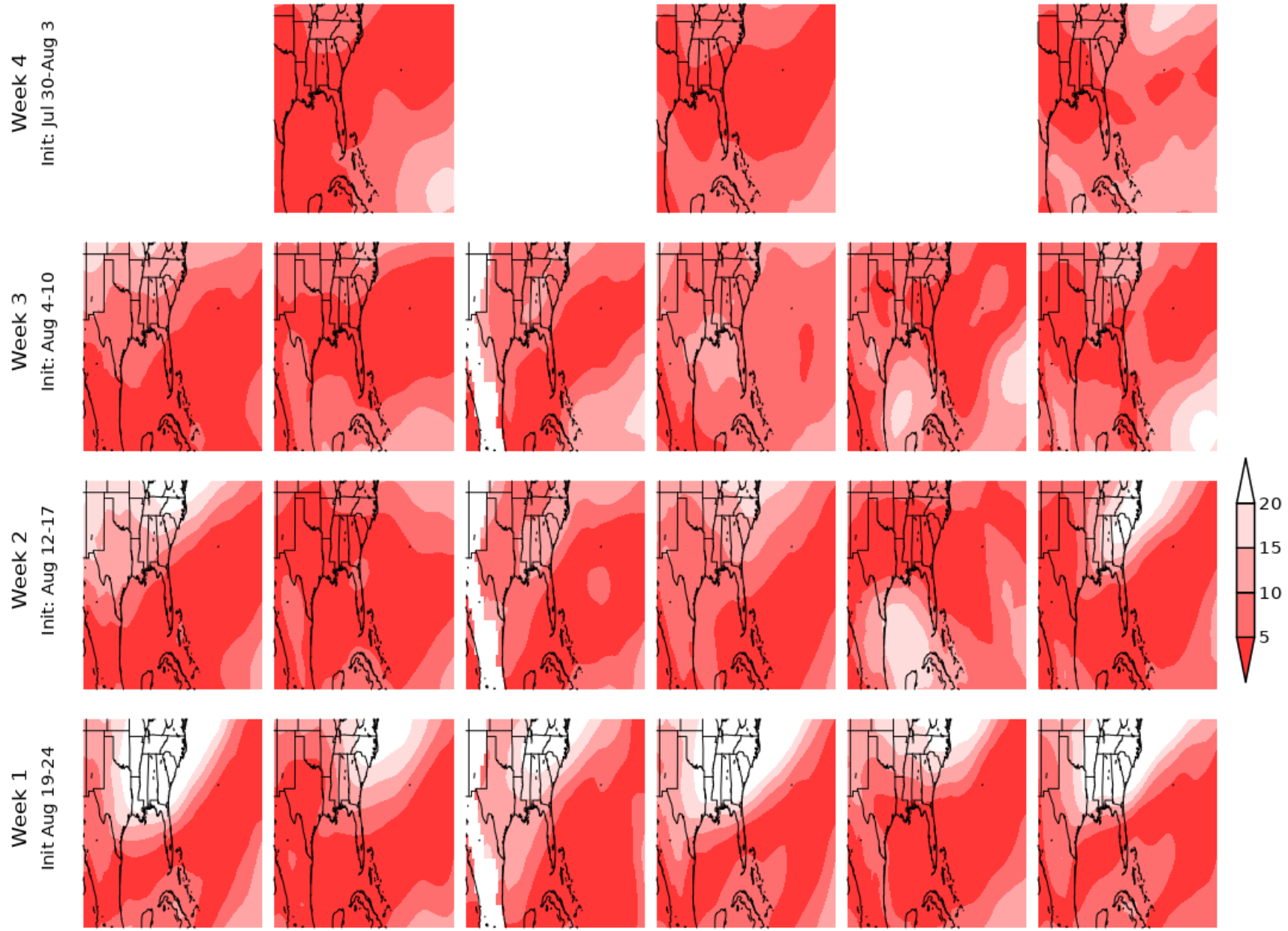
Harvey

Weekly averaged wind speed (m/s) for Week of Aug 26- Sep 1
Ensemble Mean



Harvey

Weekly Averaged Zonal Shear for Week of Aug 26- Sep 1
Ensemble Mean



- SubX models were able to predict increased precipitation at week 3-4 associated with an “event”, but not the details of that event.

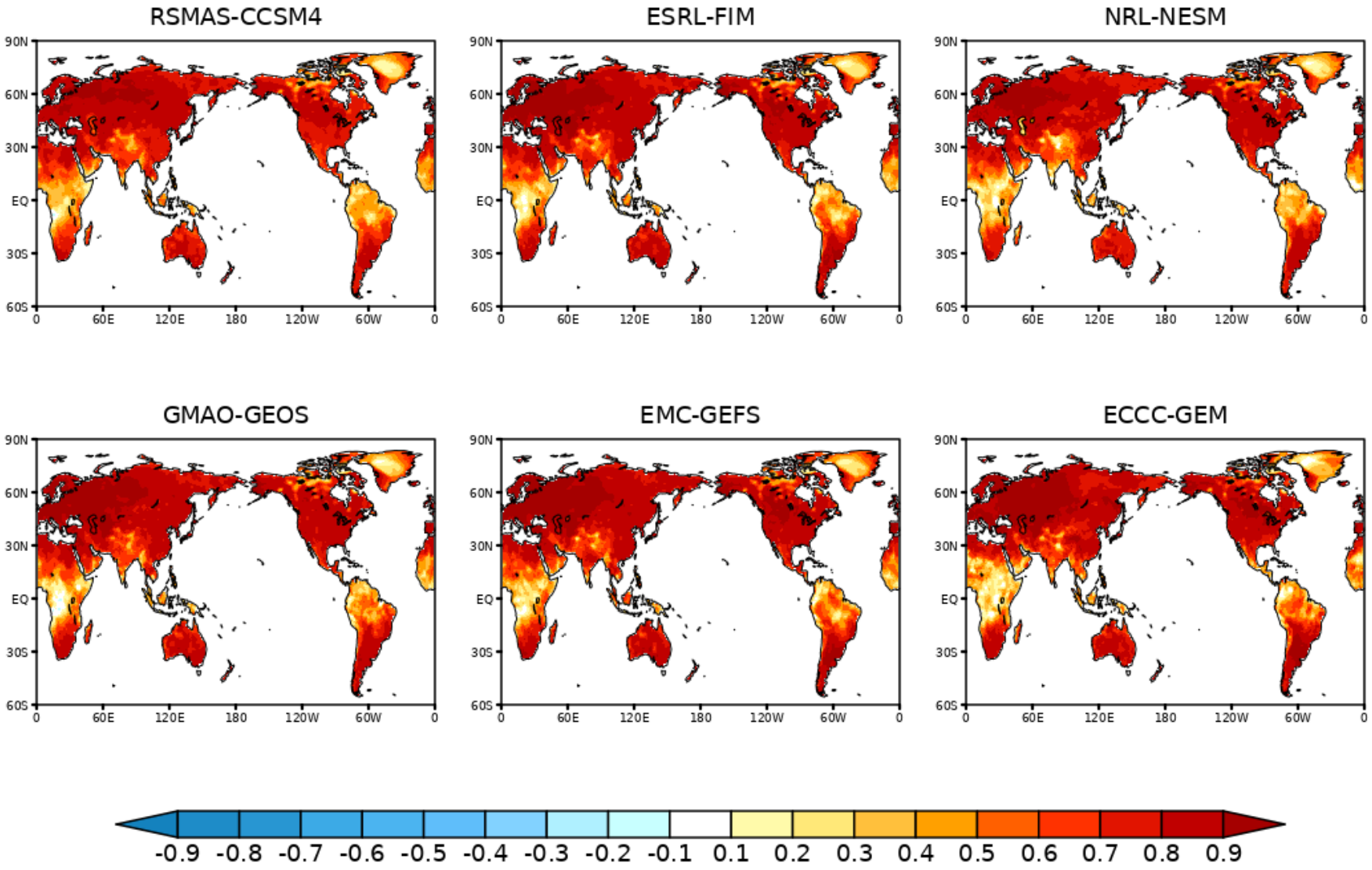
- Some SubX models appear to predict tropical cyclone related precipitation at 2 to 3-weeks, but tracks and land fall locations are not well predicted this far out.

- SubX models predicted low shear environment at 3-4 weeks

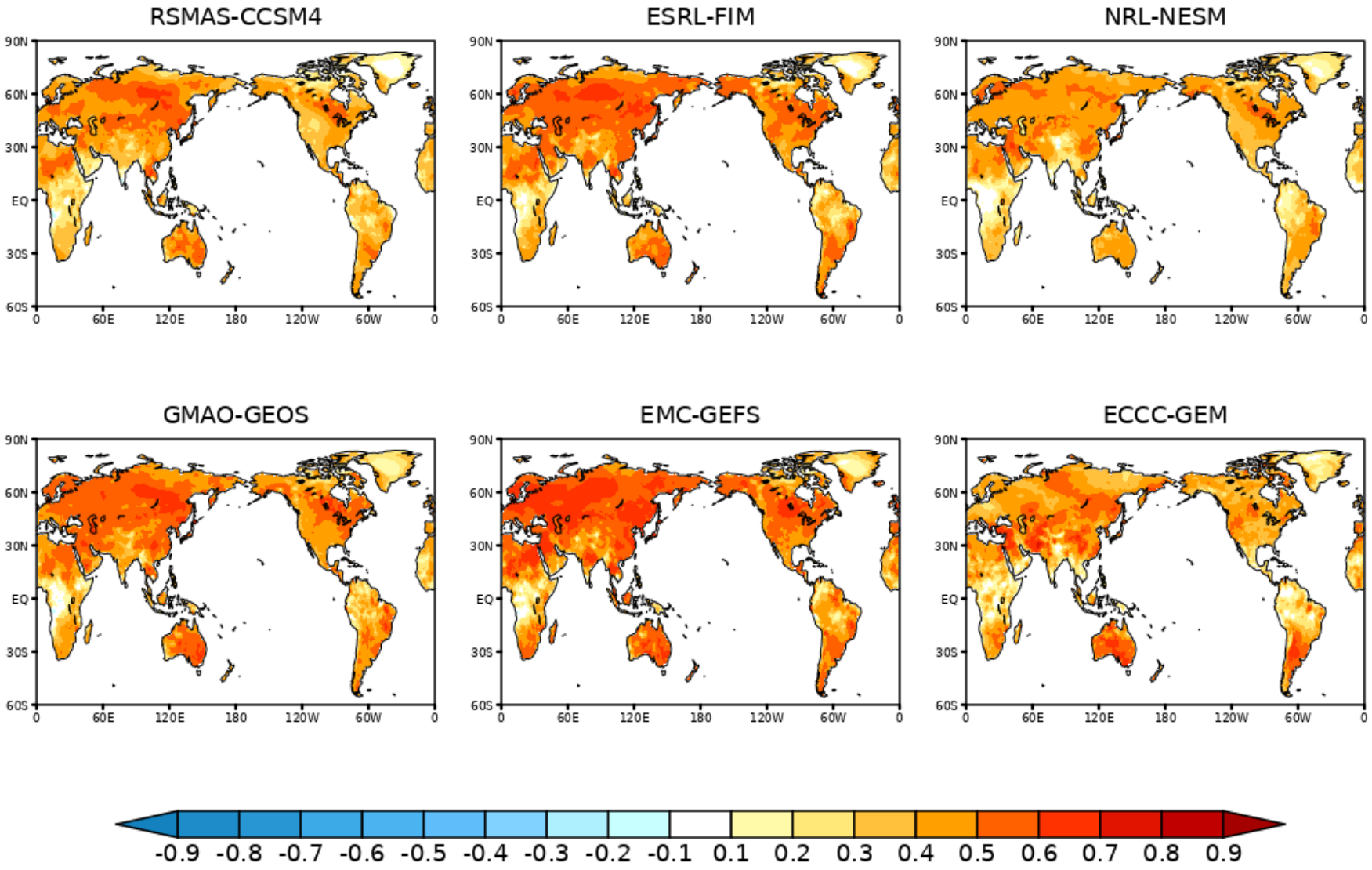
Re-forecast Skill

- Currently focused on 2m Temp and Precipitation for CPC's products
- Anomaly correlation over available months

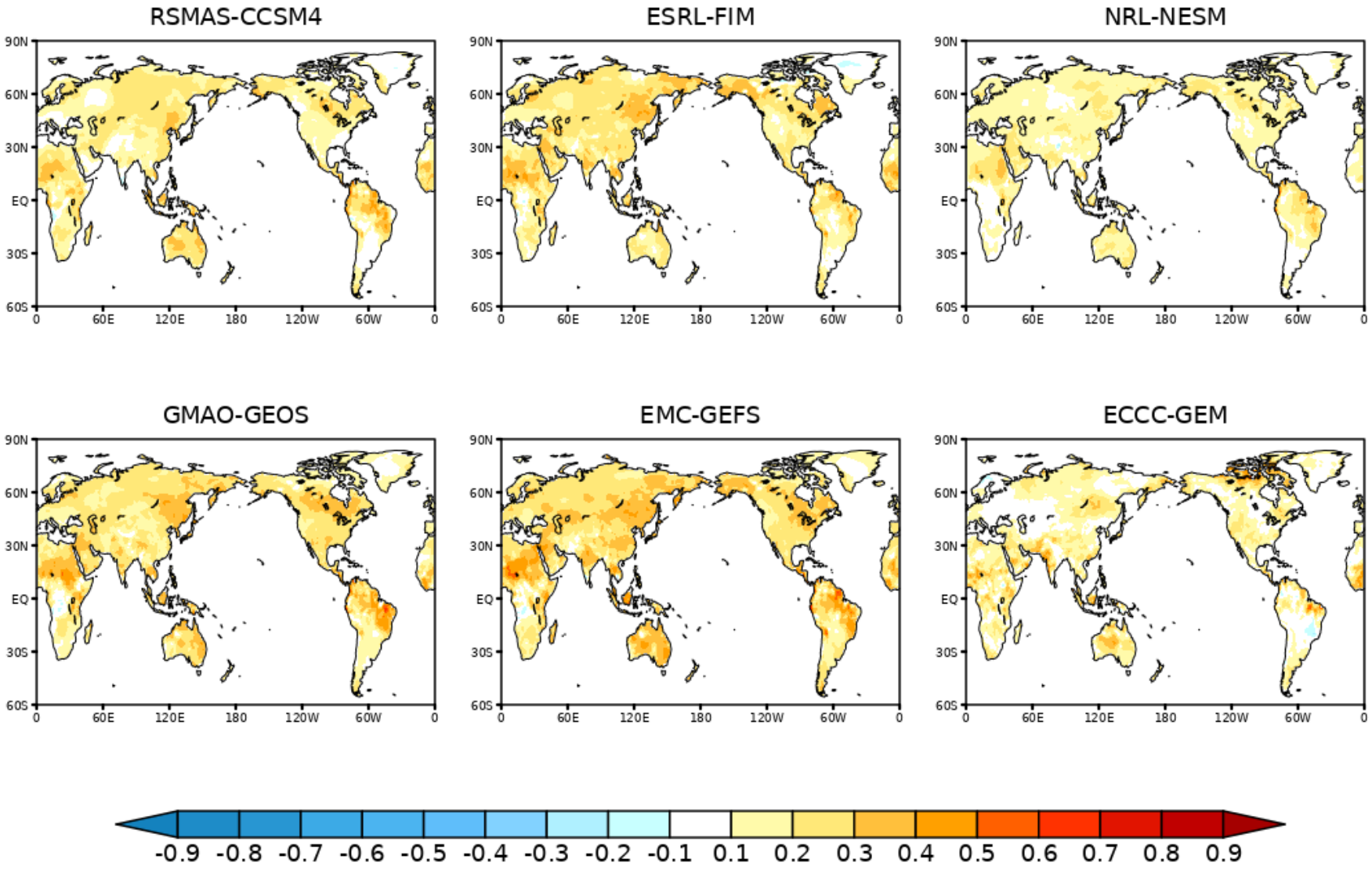
SubX Week 1 Anomaly Correlation
2m Temperature [Jun-Nov 1999-2015]



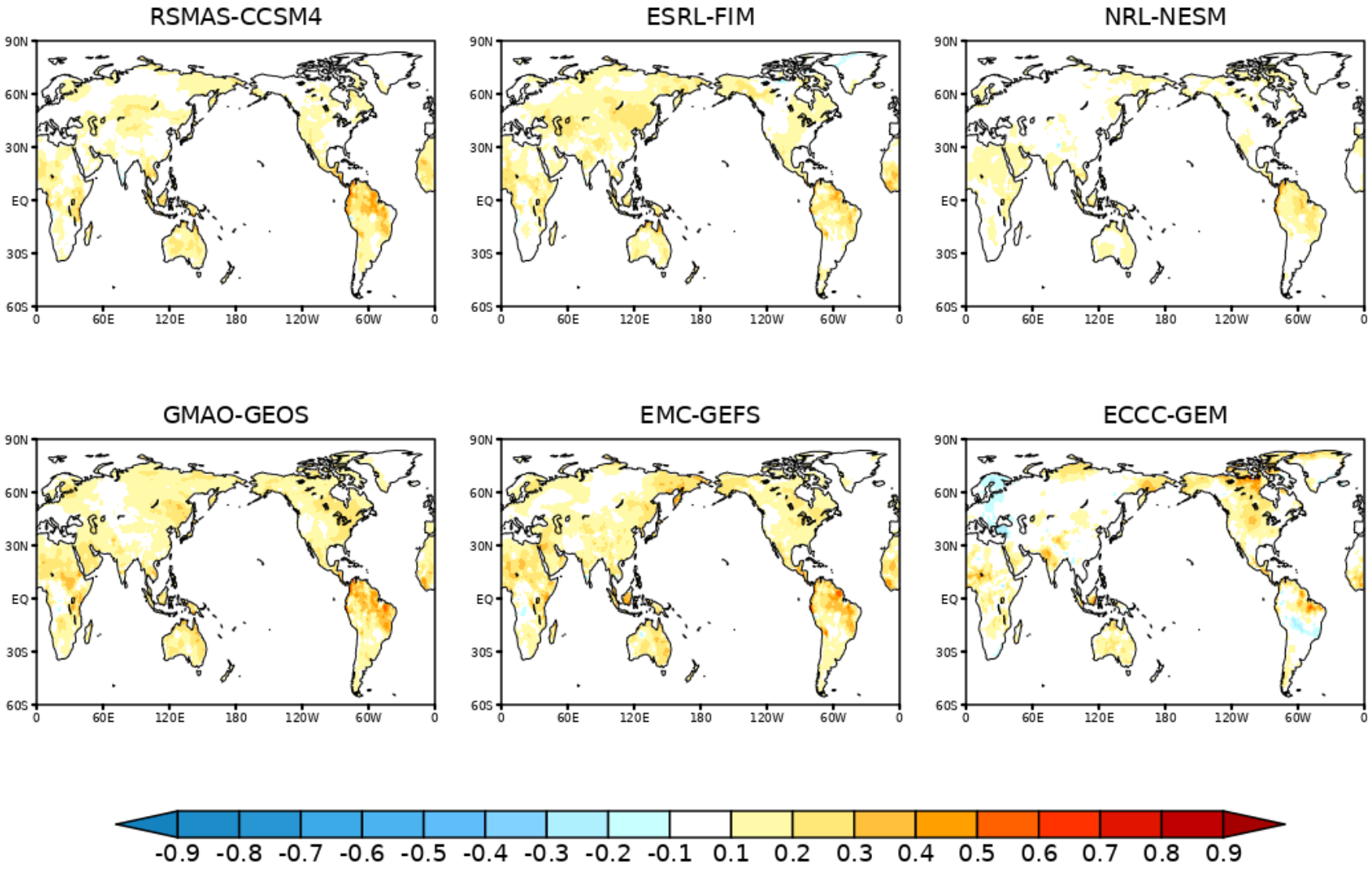
SubX Week 2 Anomaly Correlation
2m Temperature [Jun-Nov 1999-2015]



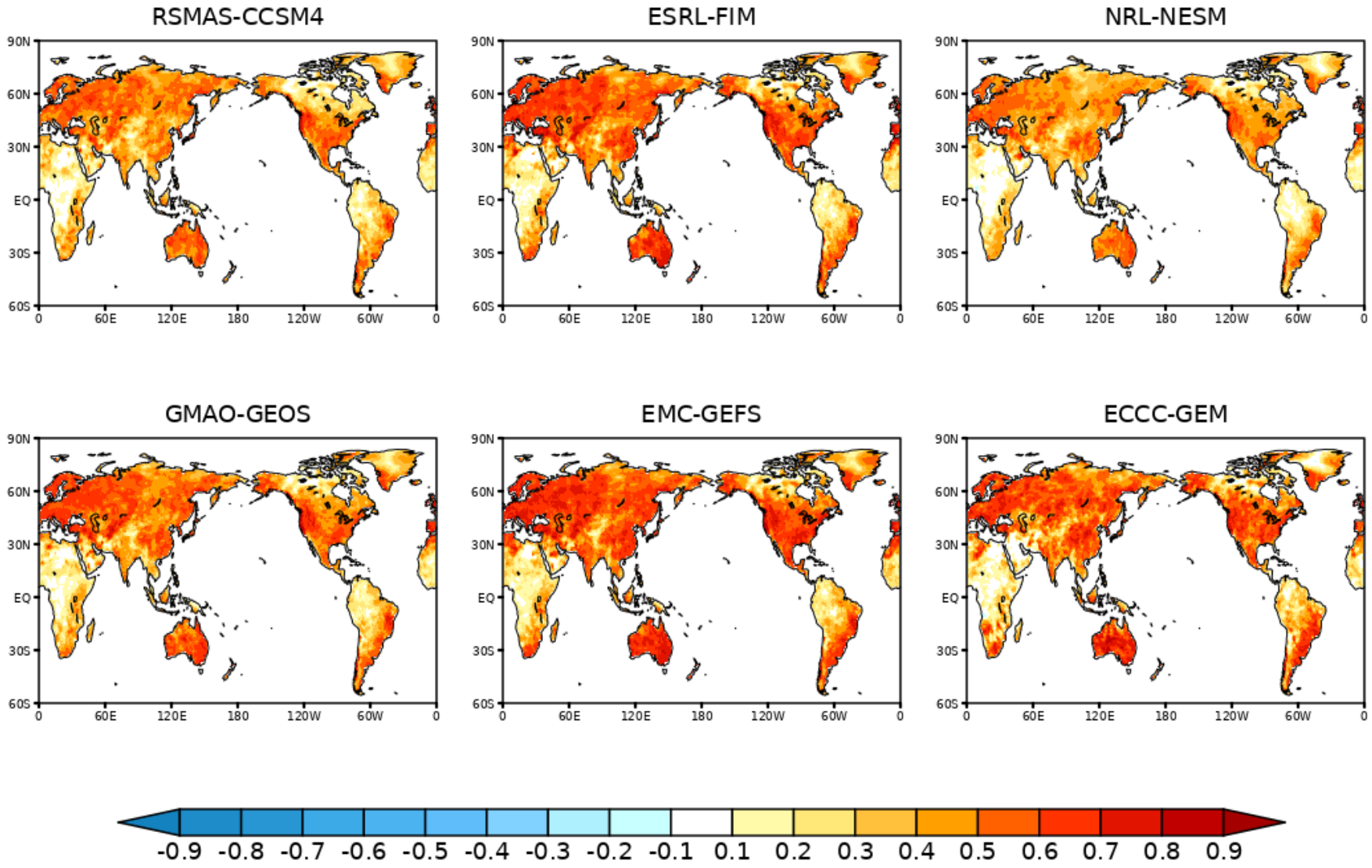
SubX Week 3 Anomaly Correlation
2m Temperature [Jun-Nov 1999-2015]



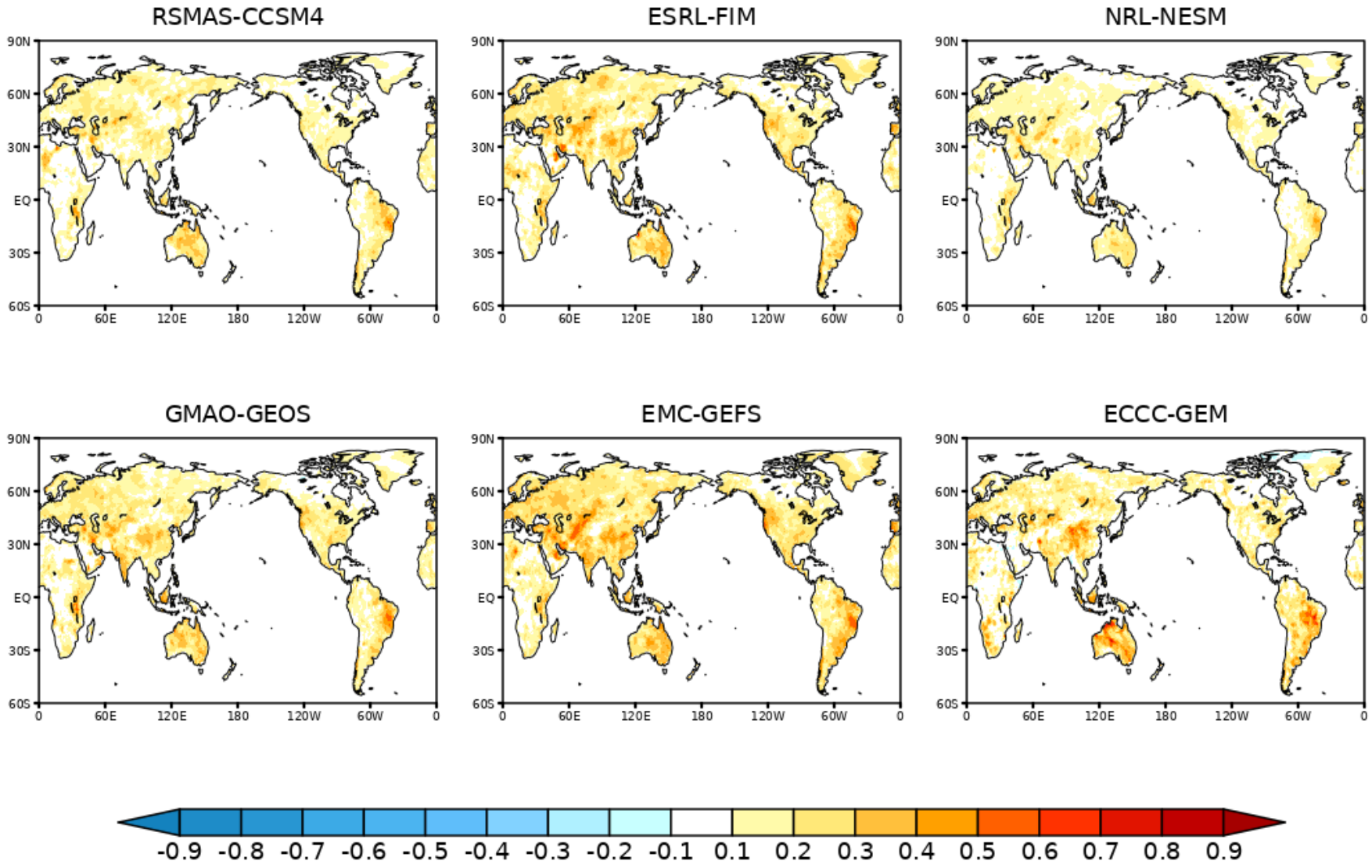
SubX Week 4 Anomaly Correlation
2m Temperature [Jun-Nov 1999-2015]



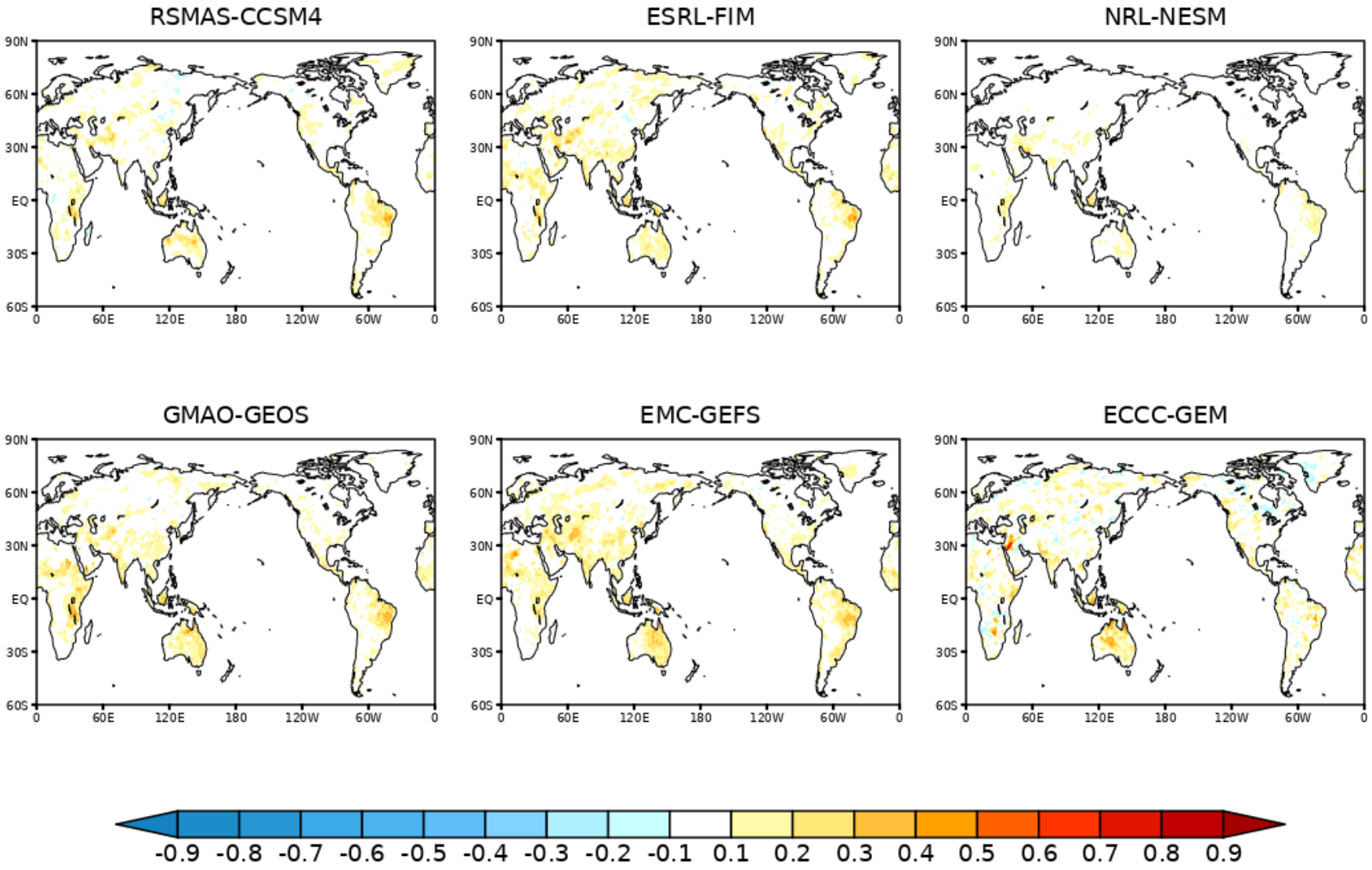
SubX Week 1 Anomaly Correlation
Precipitation [Jun-Nov 1999-2015]



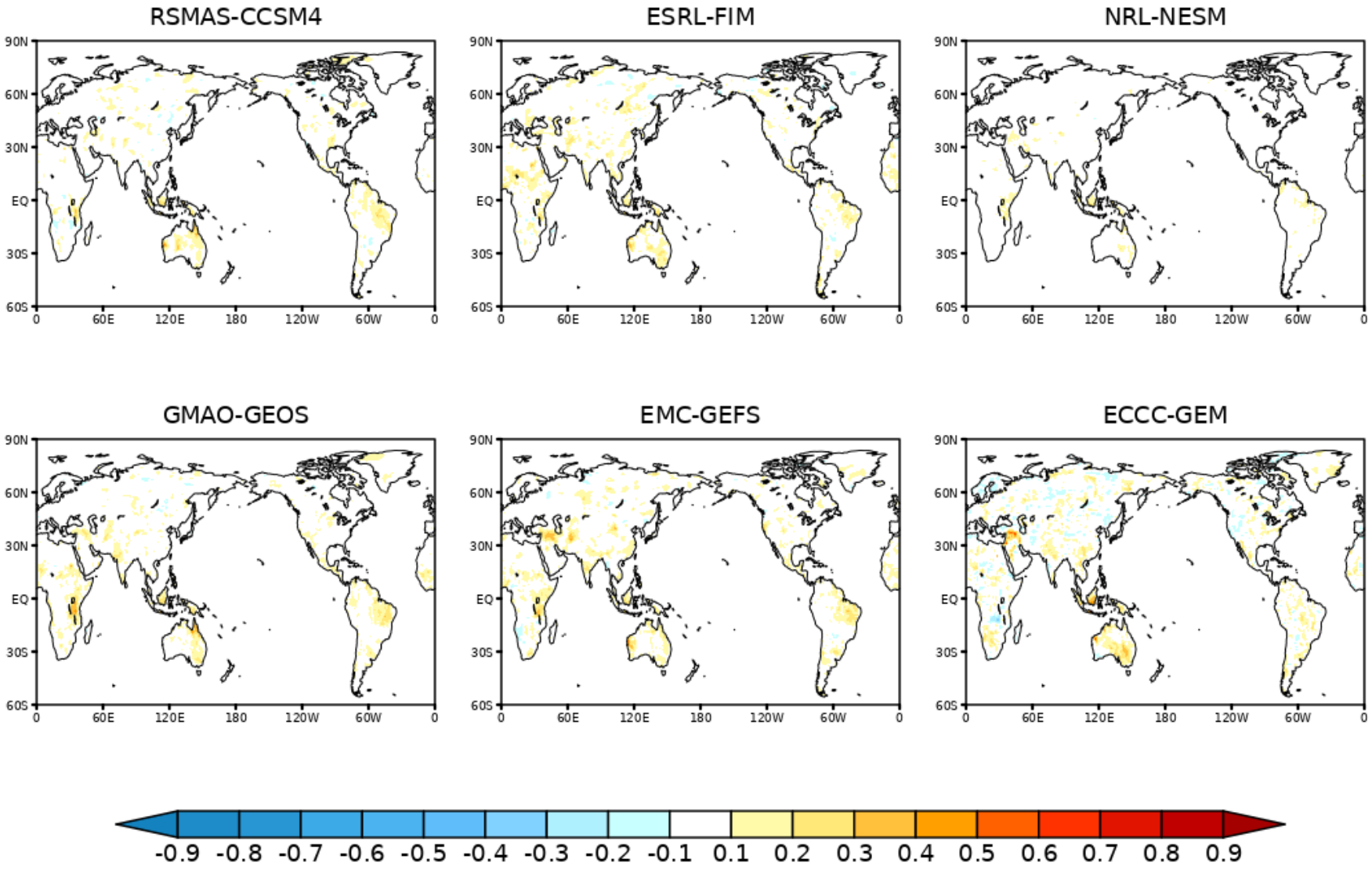
SubX Week 2 Anomaly Correlation
Precipitation [Jun-Nov 1999-2015]



SubX Week 3 Anomaly Correlation
Precipitation [Jun-Nov 1999-2015]



SubX Week 4 Anomaly Correlation
Precipitation [Jun-Nov 1999-2015]



Future Plans

1. Probabilistic skill evaluation
2. Model systematic errors at weeks 1-4
3. Sources of S2S Predictability: MJO, NAO, TC environmental factors, etc.
4. Representation of Uncertainty
5. Multi-model combinations
6. Climatology & bias correction
7. Case Studies
8. Prediction of Extremes

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