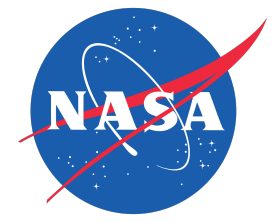


# The Subseasonal Experiment (SubX)

*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

## Navy-ESM

Neil Barton  
Joe Metzger

## NCEP-GEFS

Yuejian Zhu  
Wei Li

## NCAR-CCSM4

Ben Kirtman  
Duguong Min  
Kathy Pegion  
Rong Fu

## NASA-GEOS5

Deepthi Achuthavarier  
Randy Koster  
Len Marshak

## ESRL-FIM

Shan Sun  
Stan Benjamin  
Ben Green

## ECCC-GEM

Hai Lin  
Bertrand Denis



# 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
<b>SubX Models</b>									
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 forward processing analysis	MOM5 ½ degree horizontal resolution, 40 vertical layers  Hindcast ICs: GMAO's ocean analysis  RT ICs: GEOS-5 realtime forward processing analysis	CICE Los Alamos Sea Ice Model  Hindcast ICs: GMAO's Ocean Analysis  RT ICs: GEOS-5 realtime forward processing analysis	Catchment land surface model  Hindcast ICs: MERRA-2 precipitation corrected fields  RT ICs: GEOS-5 realtime forward processing analysis	Atmosphere: (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)
<b>Partner Models</b>									
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

Data Library  
Models SubX

Description Expert Mode

SOURCES Models SubX

### Models SubX

Models SubX: Subseasonal Experiment (SubX).

#### Documents

[overview](#) an outline showing sub-datasets of this dataset  
[CTB](#) NOAA Climate Test Bed Website  
[SubX Project](#) SubX Project Website

#### Datasets and Variables

[ECCC](#) Models SubX ECCC[GEM ]  
[EMC](#) Models SubX EMC[GEFS ]  
[ESRL](#) Models SubX ESRL[FIMr1p1 ]  
[GMAO](#) Models SubX GMAO[GEOS\_V2p1 ]  
[NRL](#) Models SubX NRL[NESM ]  
[RSMAS](#) Models SubX RSMAS[CCSM4 ]

Last updated: Mon, 14 Aug 2017 20:01:46 GMT

*Codes to help you download on github*

GitHub, Inc. [US] https://github.com/kpegion/SubX

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Codes for Accessing SubX Data from the IRI Data Library (Matlab, GrADS, NCL, Python, bash) Edit

Add topics

51 commits 2 branches 0 releases 1 contributor MIT

Branch: master New pull request Create new file Upload files Find file Clone or download

File/Folder	Commit Message	Time Ago
GrADS	Update README for GrADS	2 months ago
Matlab	Modified to also read forecasts	2 months ago
NCL	Delete README.md	2 months ago
Python	Delete test	2 months ago
bash	Create test	2 months ago
LICENSE	Create LICENSE	2 months ago
README.md	Update README	2 months ago
website	Create website	2 months ago

README.md

<http://iridl.ideo.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	<a href="#">Average of Instantaneous values at 0,6,12,18Z</a>

On 850 and 200 hPa levels

Variable	CF Standard Name	Abbrev	Unit	Frequency
Zonal Velocity	eastward_wind	ua	ms-1	<a href="#">Average of Instantaneous values at 0,6,12,18Z</a>
Meridional Velocity	northward_wind	va	ms-1	<a href="#">Average of Instantaneous values at 0,6,12,18Z</a>

On a single level

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

## 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	<input checked="" type="checkbox"/>		1995-2015								<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			
EMC-GEFS	11	7-days	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1999-2016						<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
ESRL-FIM	4	7-days	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1999-2016		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
GMAO-GEOS	4	5-days	<input checked="" type="checkbox"/>		1999-2015							<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
NRL-NESM	1	4 inits every 7-days	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1999-2015							<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
RSMAS-CCSM4	3	7-days	<input checked="" type="checkbox"/>		1999-2016	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

- 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

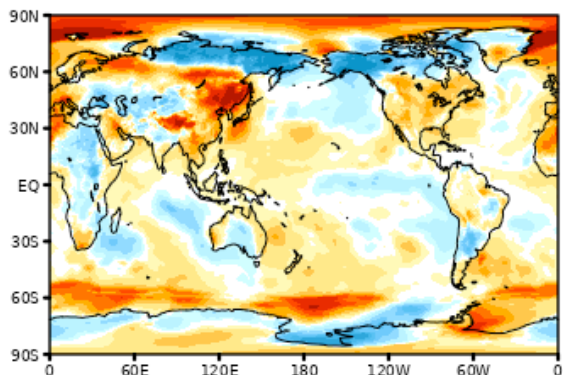
# Real-time Forecasts

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

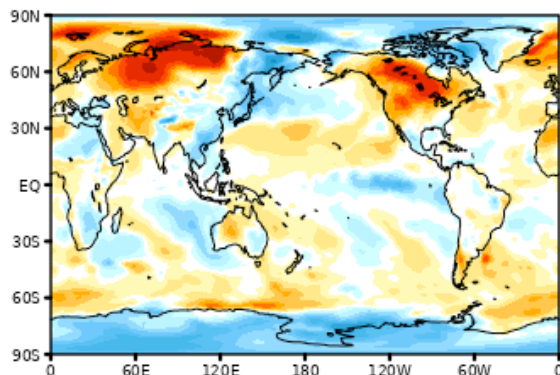
# SubX Week 3-4 2m Temperature Anomalies (deg C)

Valid Nov 11-24

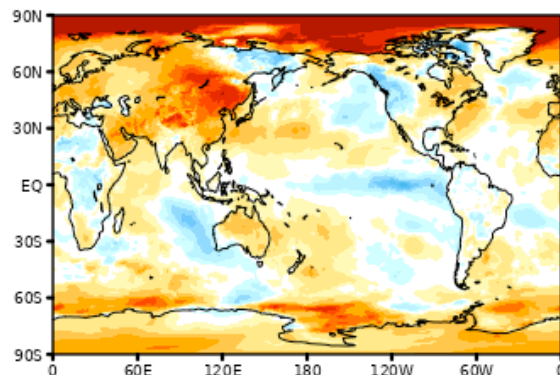
ESRL-FIM (IC: Oct 18; 4 Ens)



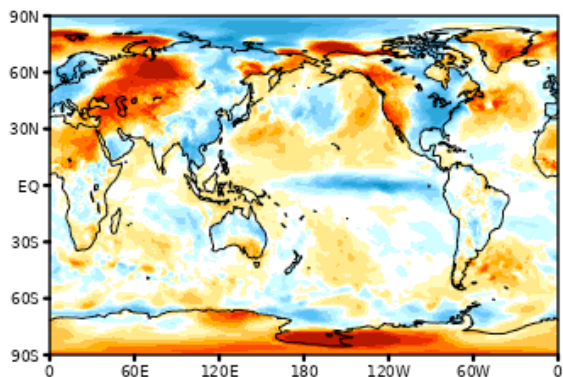
RSMAS-CCSM4 (IC: Oct 15; 9 Ens)



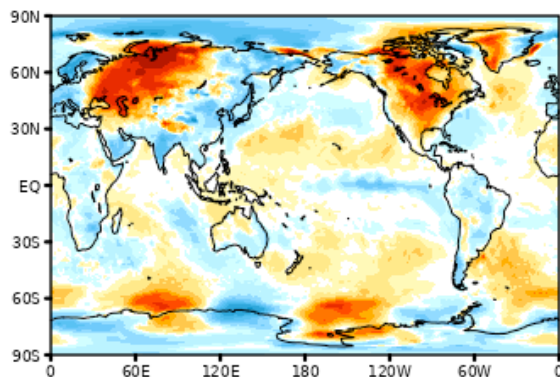
EMC-GEFS (IC: Oct 18; 21 Ens)



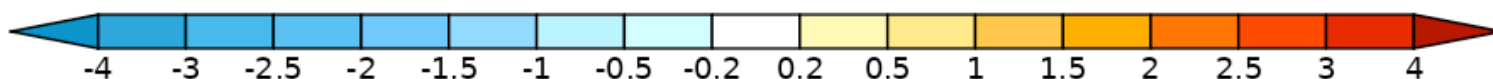
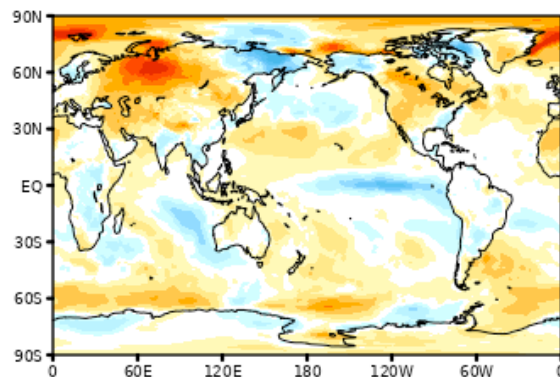
GMAO-GEOS (IC: Oct 13; 4 Ens)



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



MME (42 Ensemble Members)

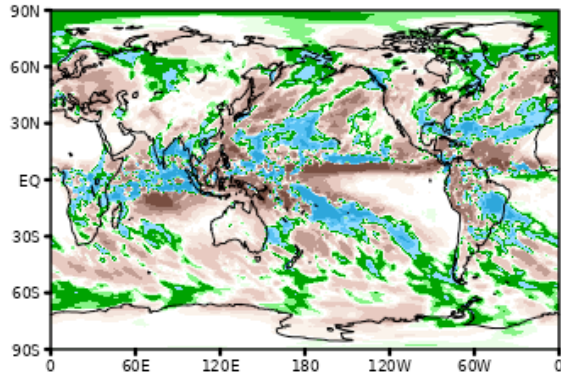




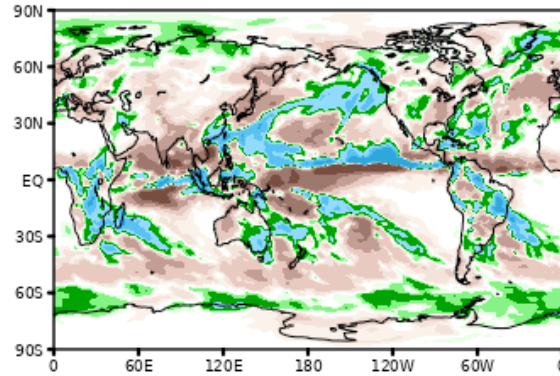
# SubX Week 3-4 Total Precipitation Anomalies (mm)

Valid Nov 11-14

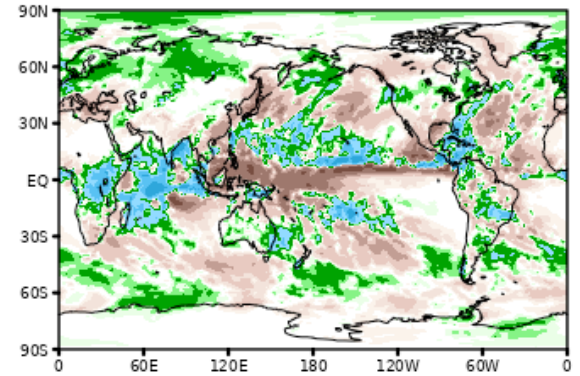
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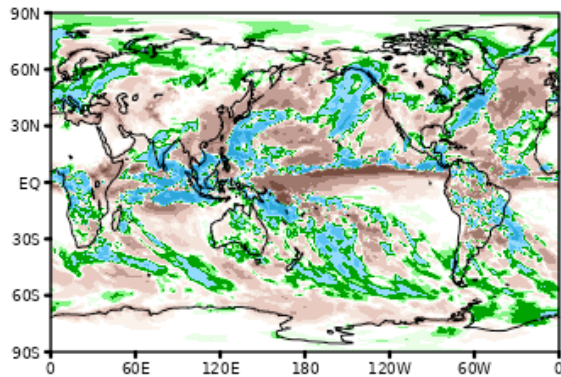
RSMAS-CCSM4 (IC: Oct 15; 9 Ens)



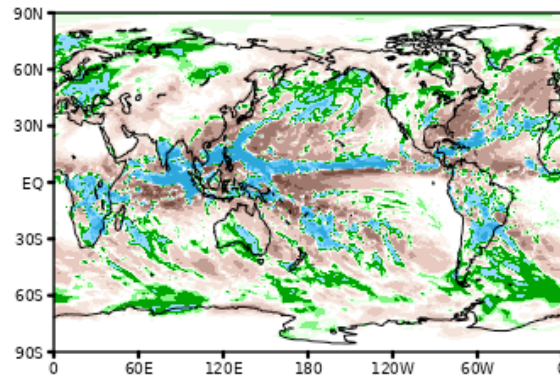
EMC-GEFS (IC: Oct 18; 21 Ens)



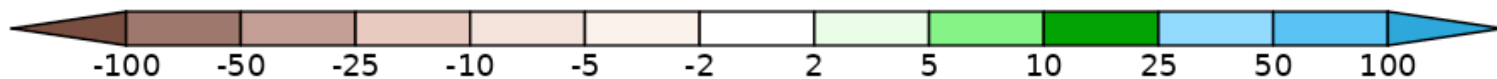
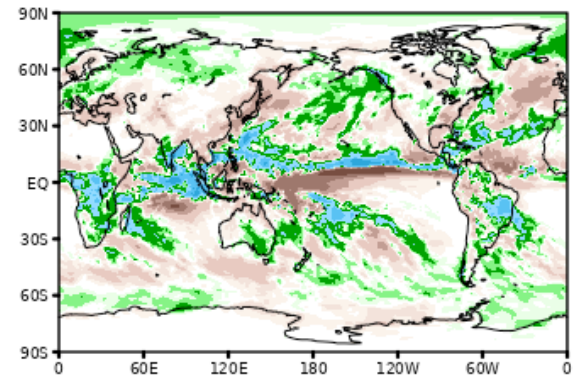
GMAO-GEOS (IC: Oct 13; 4 Ens)



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



MME (42 Ensemble Members)



## ~ 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](#).

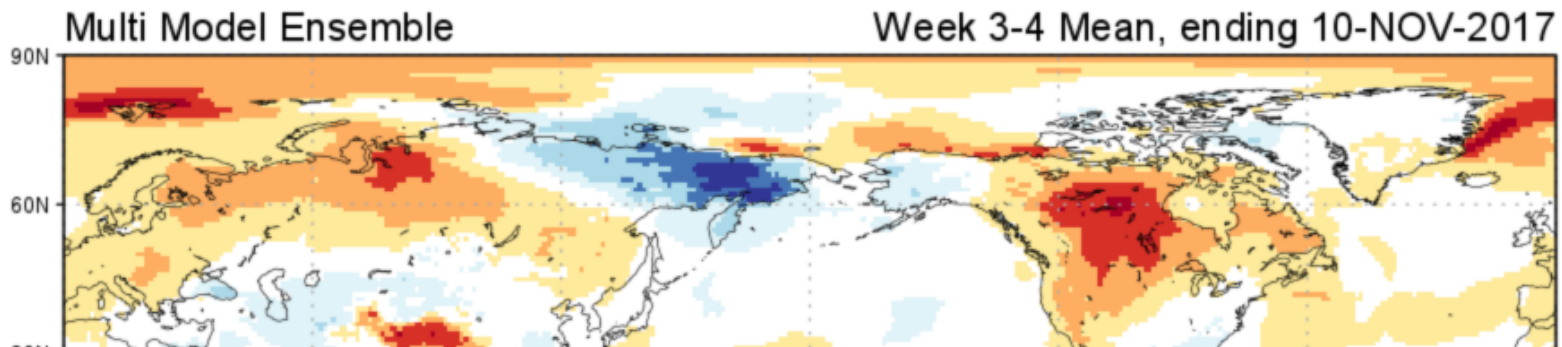
Select a SubX model and variable, choose a forecast period, specify the Longitude and Latitude ranges, then click on the **SUBMIT** button.

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

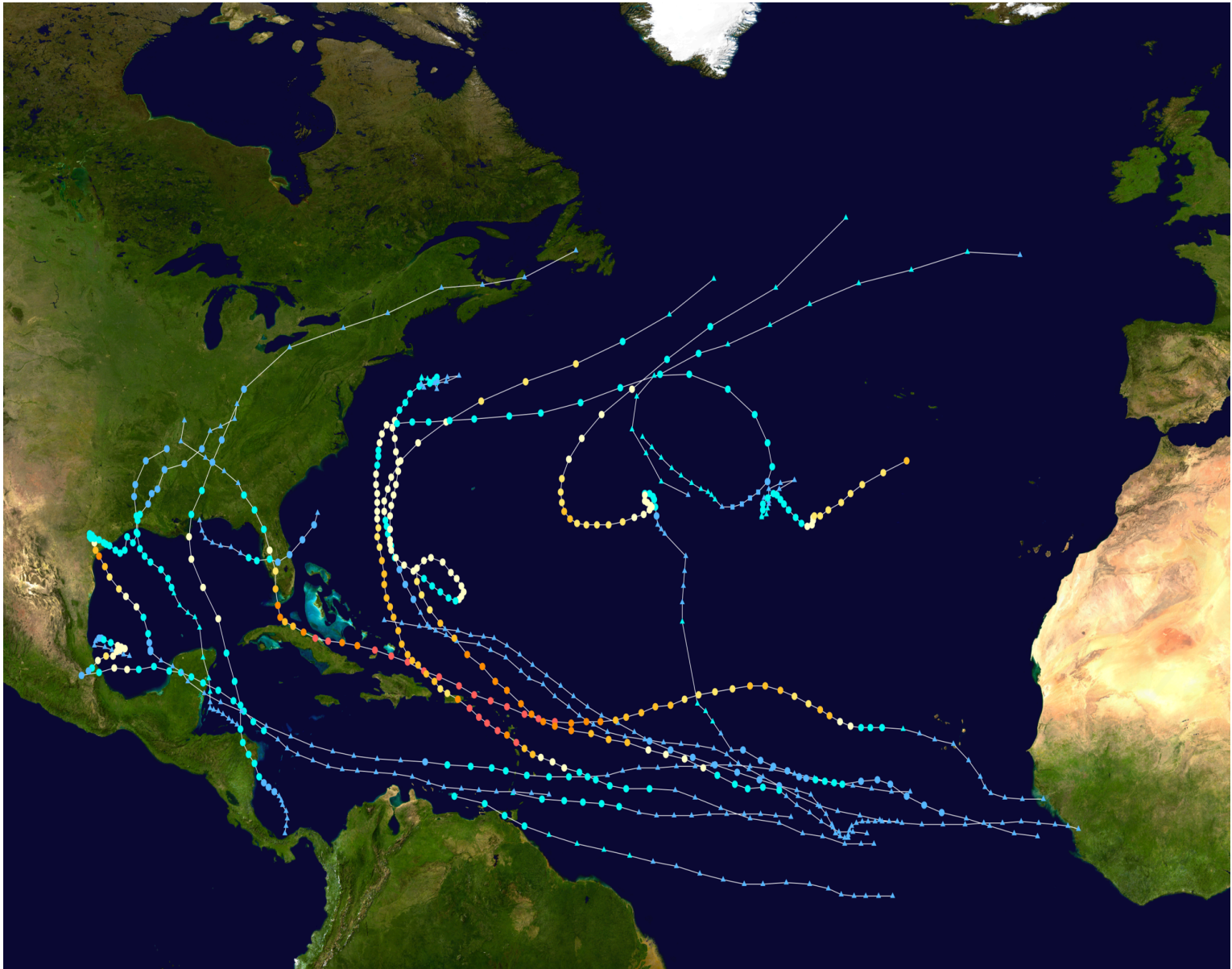
**Longitude:** 0 to 360  Average over this range **Latitude:** -90 to 90  Average over this range

**SUBMIT**

### SubX Forecast of 2-Meter Temperature Anomaly [degC]



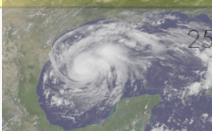
# Forecast Evaluations: Tropical Cyclones





# Hurricane Harvey

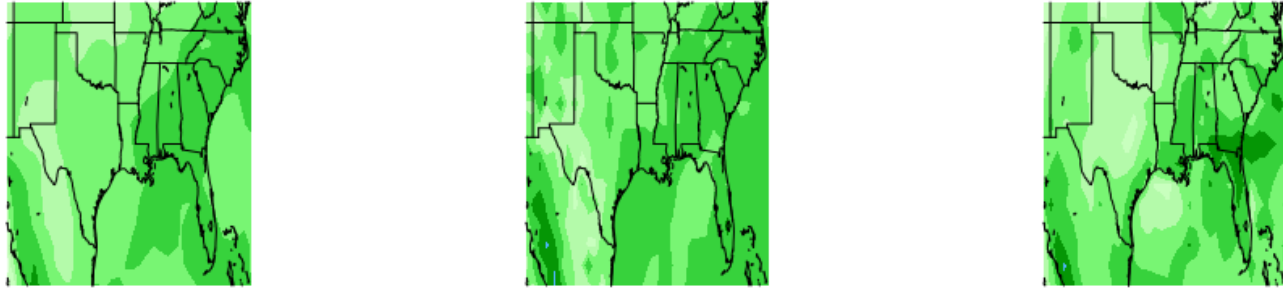
## August 2017

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)			

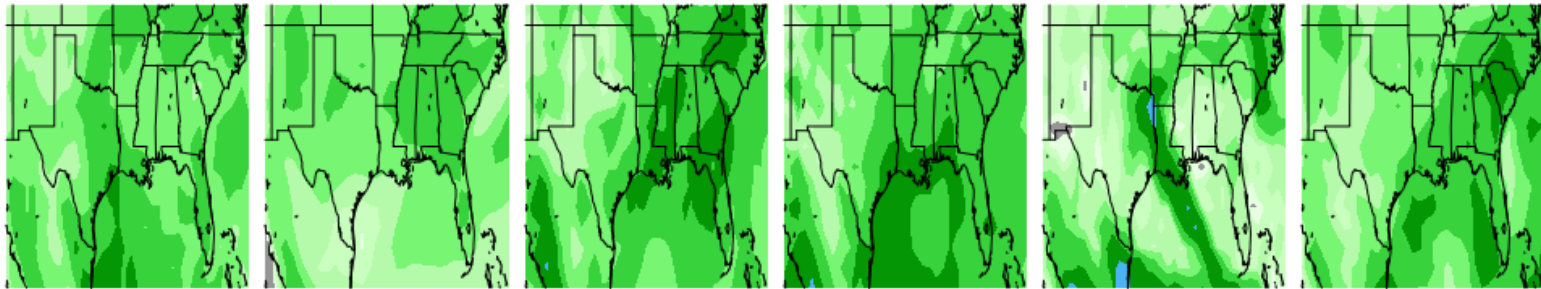
Harvey

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

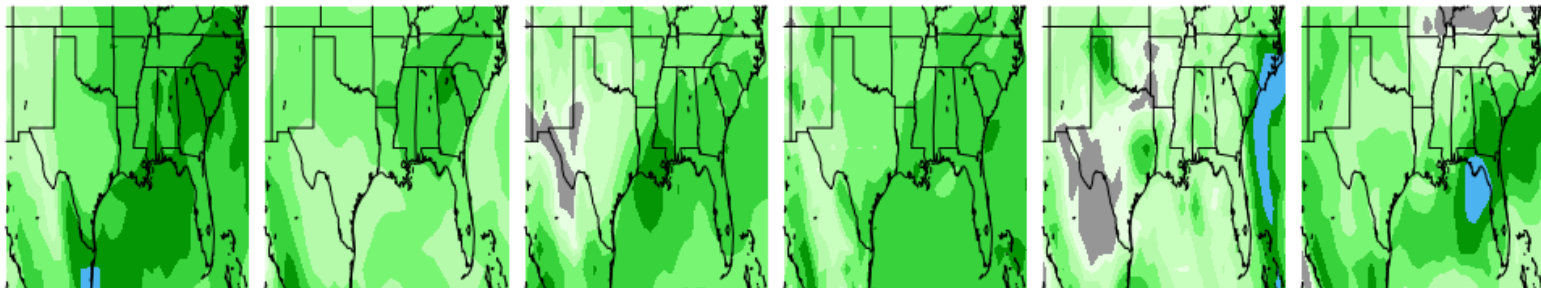
Week 4  
Init: Jul 30-Aug 3



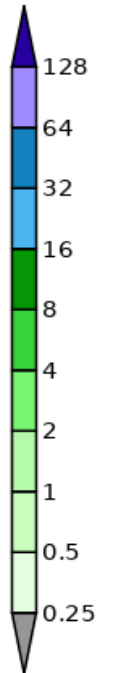
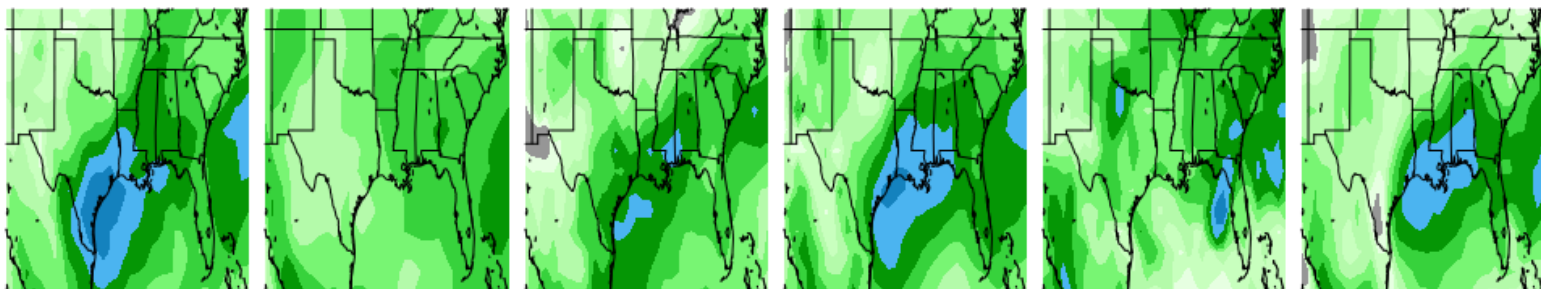
Week 3  
Init: Aug 4-10



Week 2  
Init: Aug 12-17

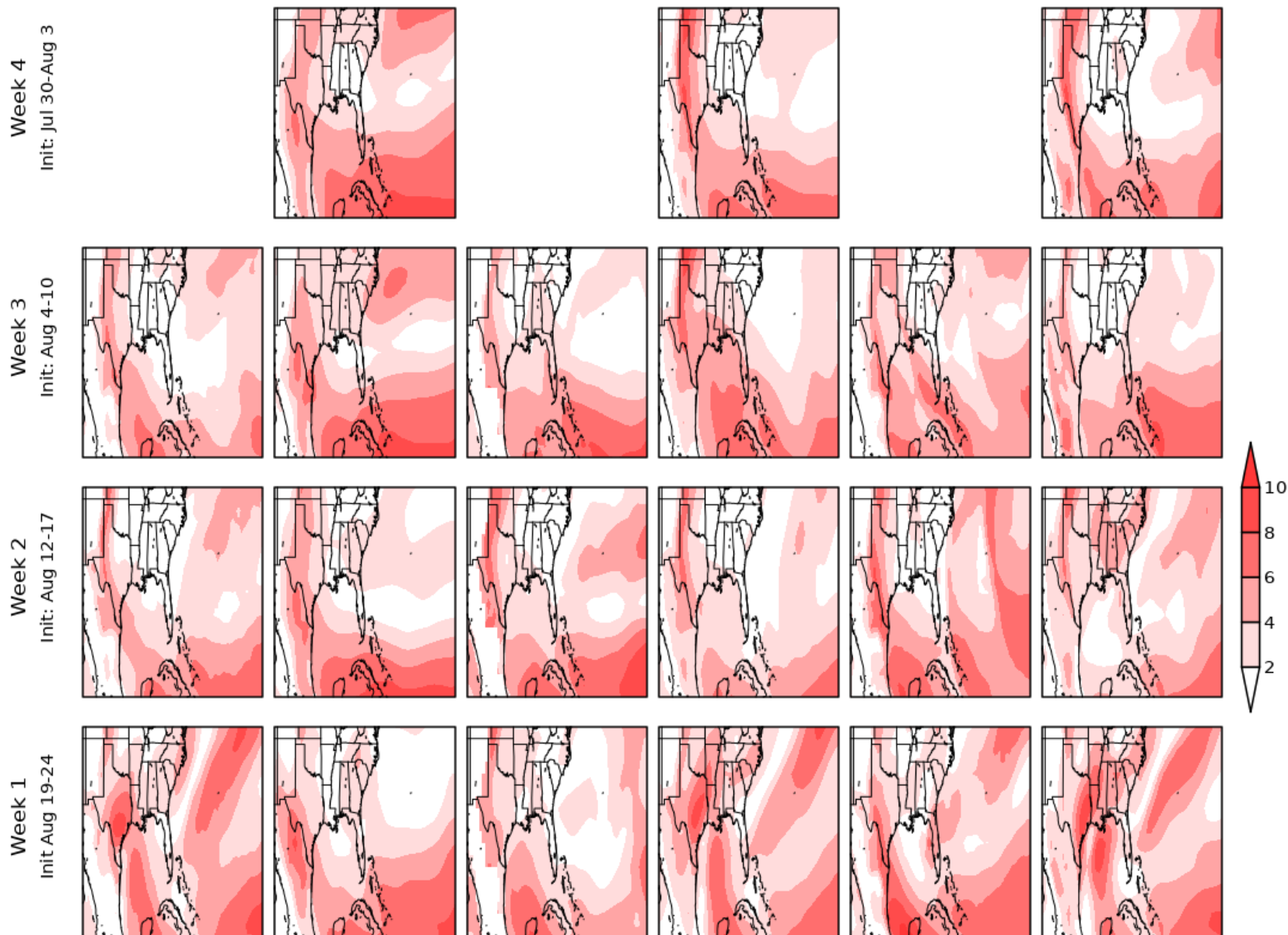


Week 1  
Init: Aug 19-24



Harvey

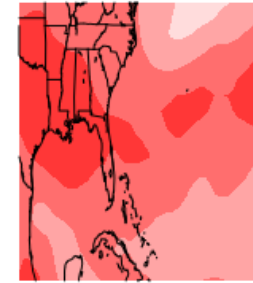
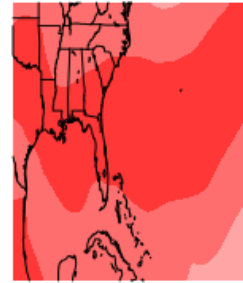
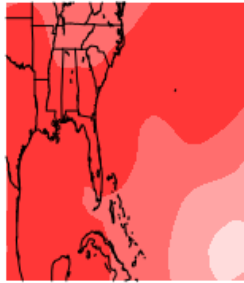
# Weekly averaged wind speed (m/s) for Week of Aug 26- Sep 1 Ensemble Mean



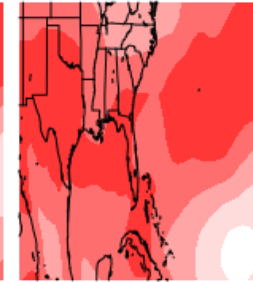
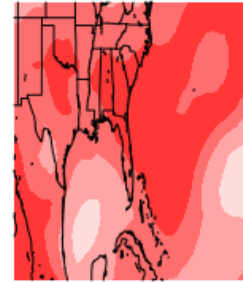
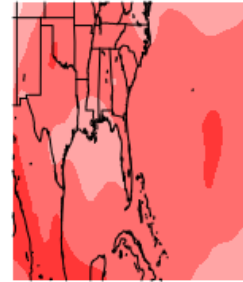
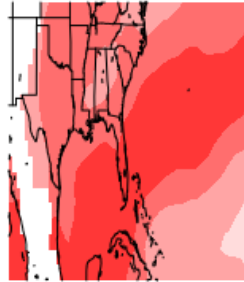
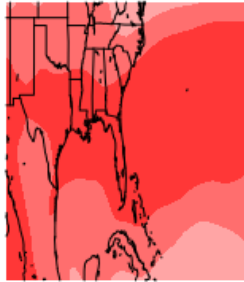
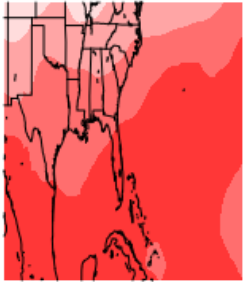
Harvey

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

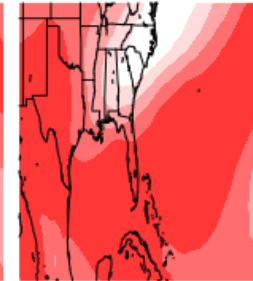
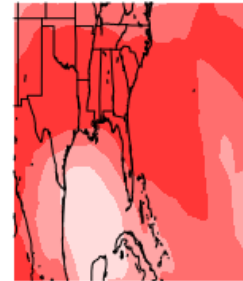
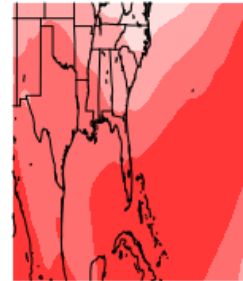
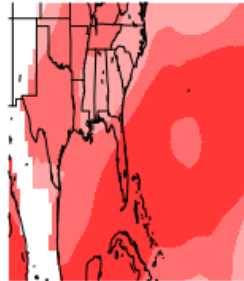
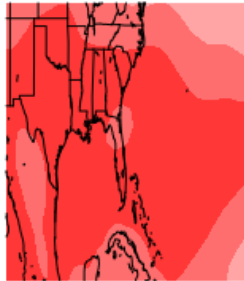
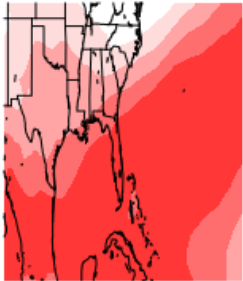
Week 4  
Init: Jul 30-Aug 3



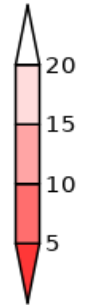
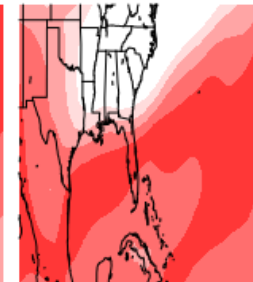
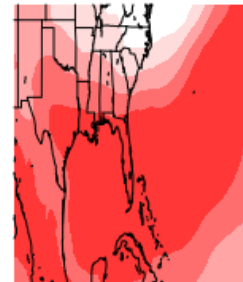
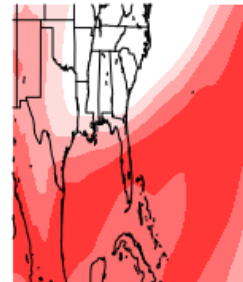
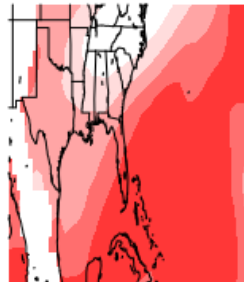
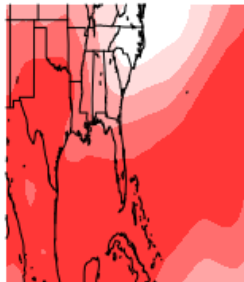
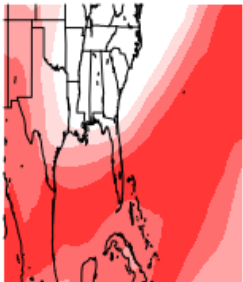
Week 3  
Init: Aug 4-10



Week 2  
Init: Aug 12-17



Week 1  
Init Aug 19-24



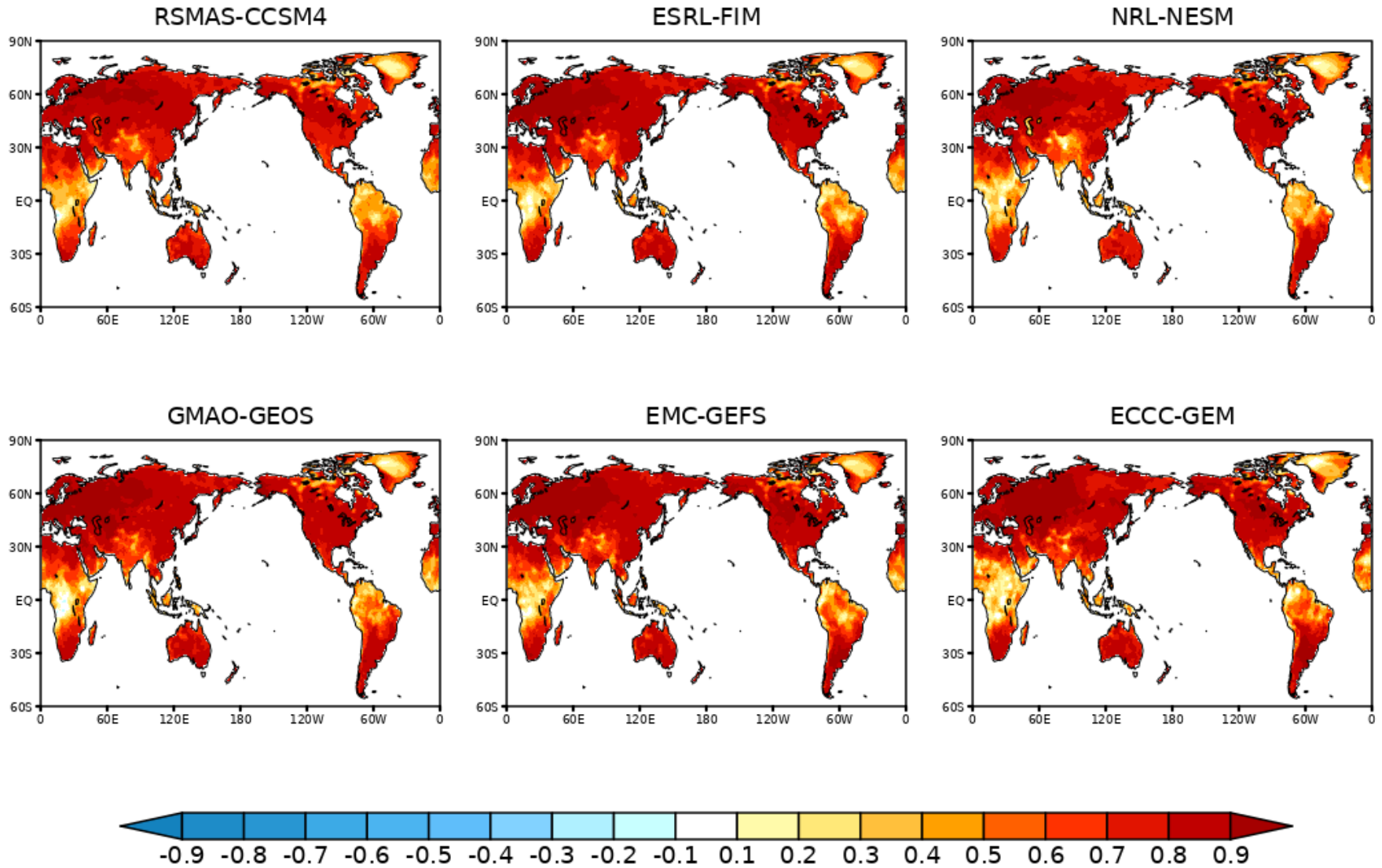
- SubX models were able to predict increased precipitation at week 3-4 associated with an “event”, but not the details of that event.
- Some SubX models appear to predict tropical cyclone related precipitation at 2 to 3-weeks, but tracks and land fall locations are not well predicted this far out.
- SubX models predicted low shear environment at 3-4 weeks



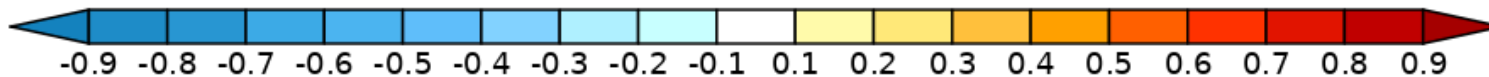
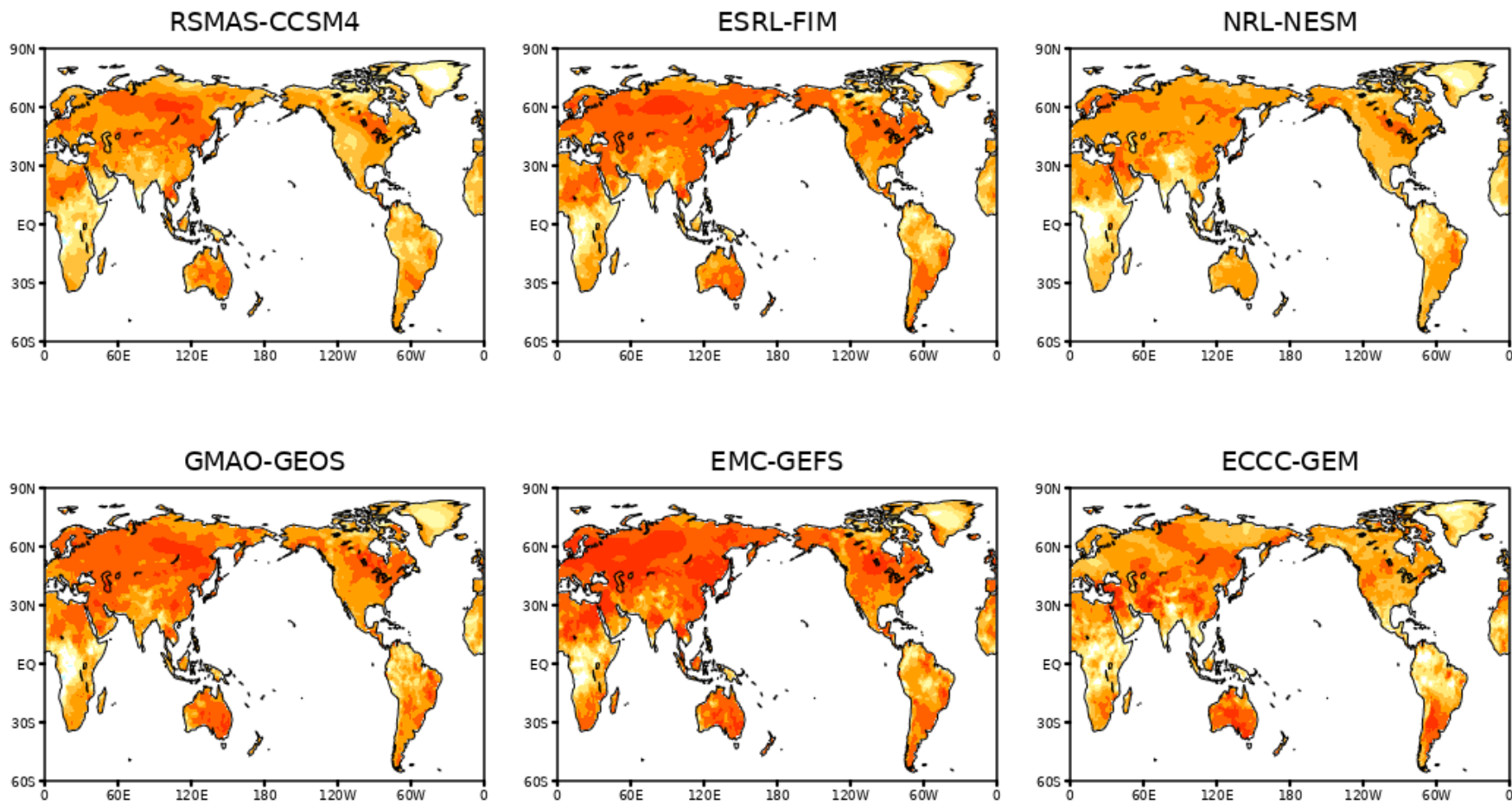
# Re-forecast Skill

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

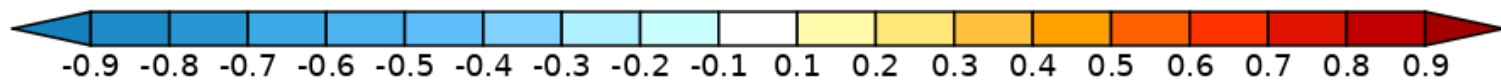
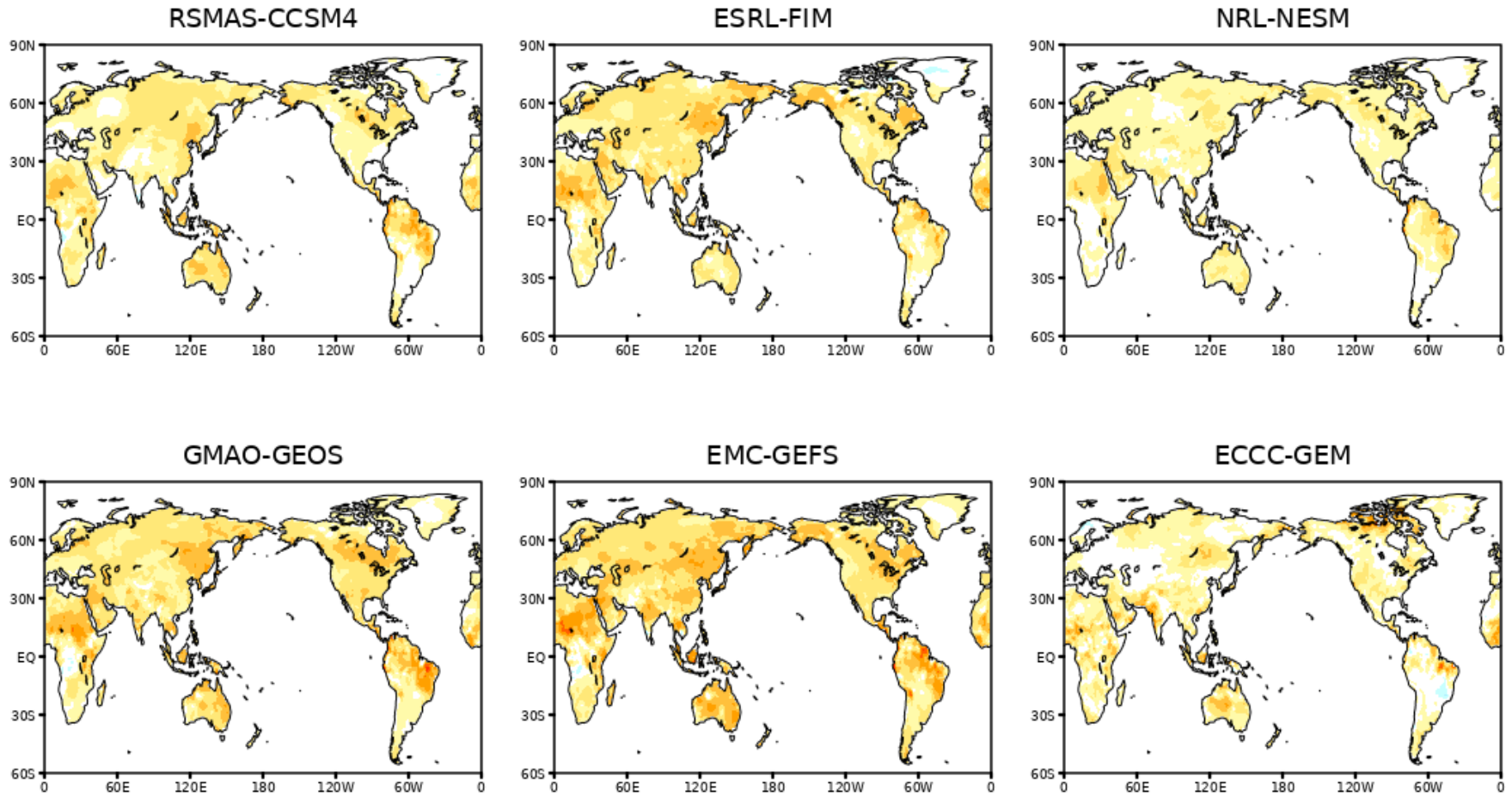
# SubX Week 1 Anomaly Correlation 2m Temperature [Jun-Nov 1999-2015]



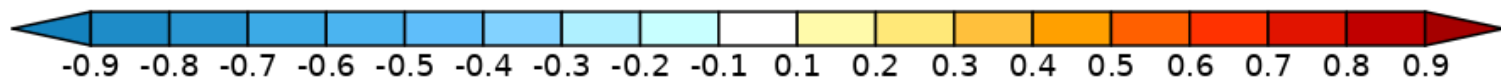
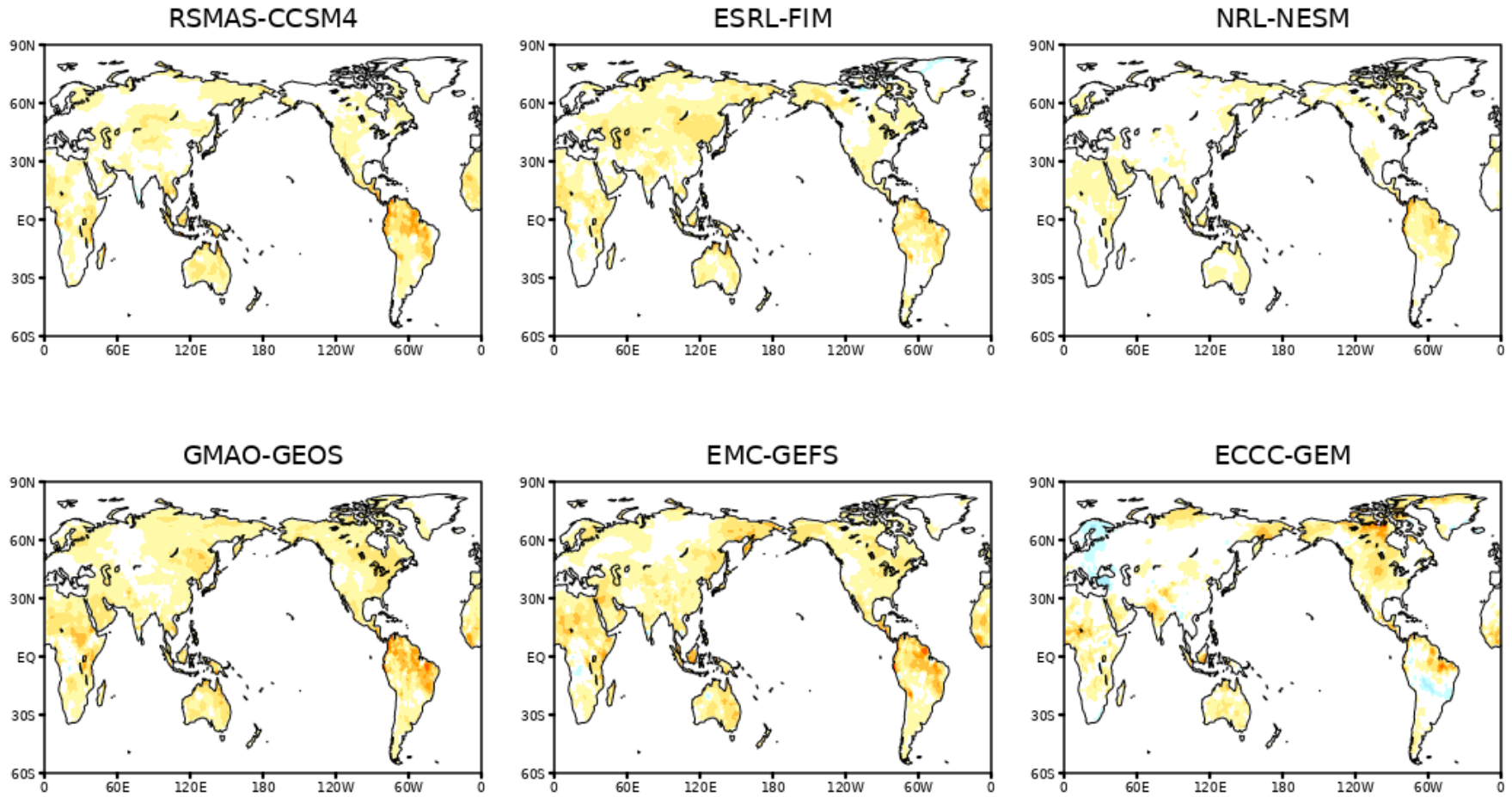
# SubX Week 2 Anomaly Correlation 2m Temperature [Jun-Nov 1999-2015]



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



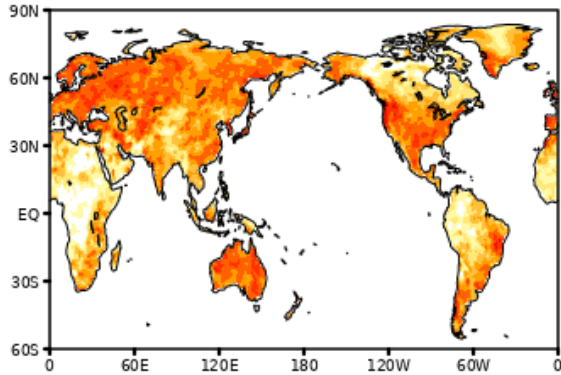
# SubX Week 4 Anomaly Correlation 2m Temperature [Jun-Nov 1999-2015]



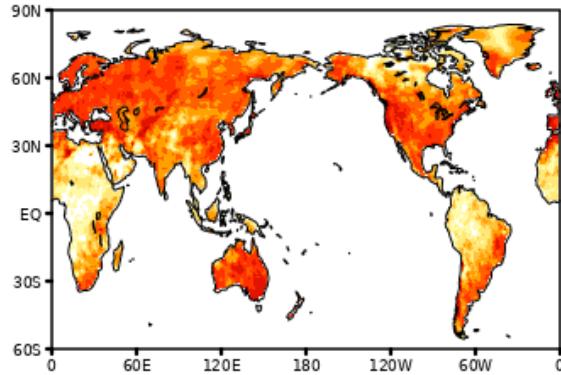


# SubX Week 1 Anomaly Correlation Precipitation [Jun-Nov 1999-2015]

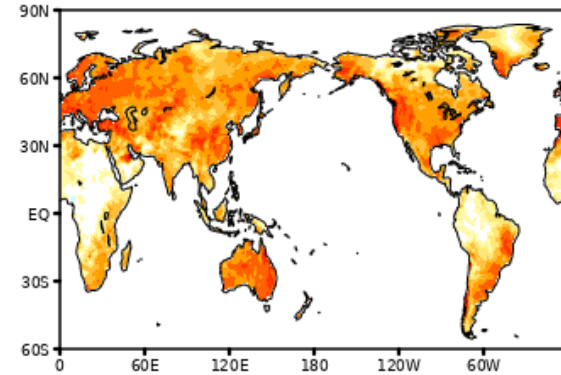
RSMAS-CCSM4



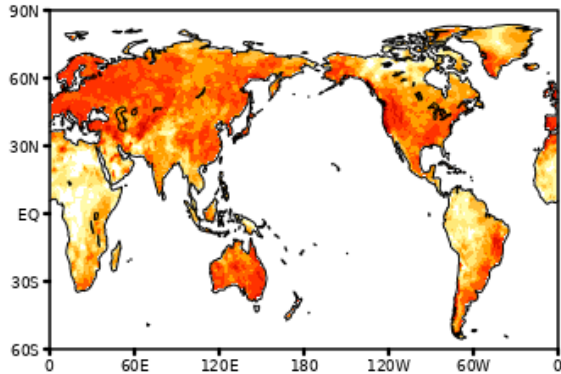
ESRL-FIM



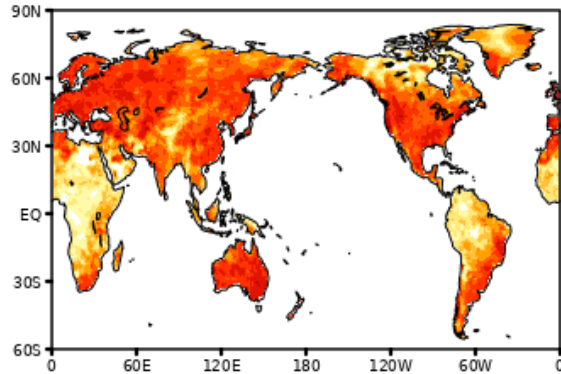
NRL-NESM



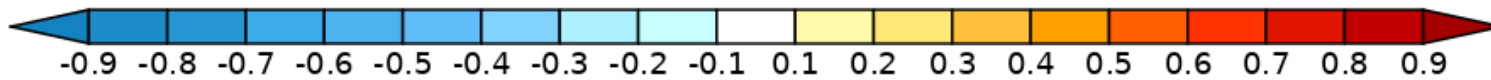
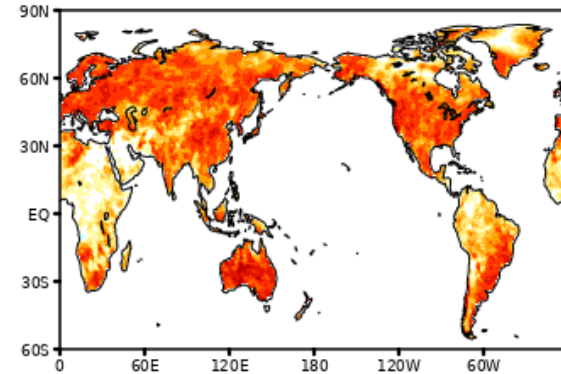
GMAO-GEOS



EMC-GEFS

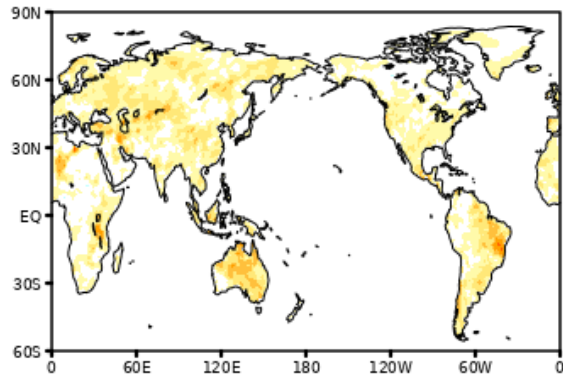


ECCC-GEM

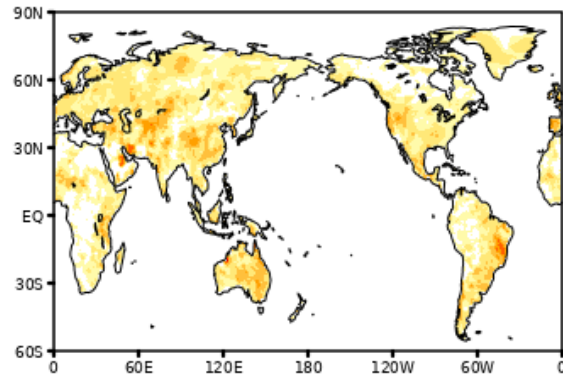


# SubX Week 2 Anomaly Correlation Precipitation [Jun-Nov 1999-2015]

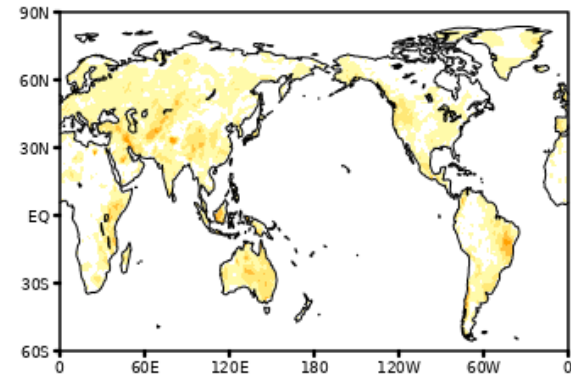
RSMAS-CCSM4



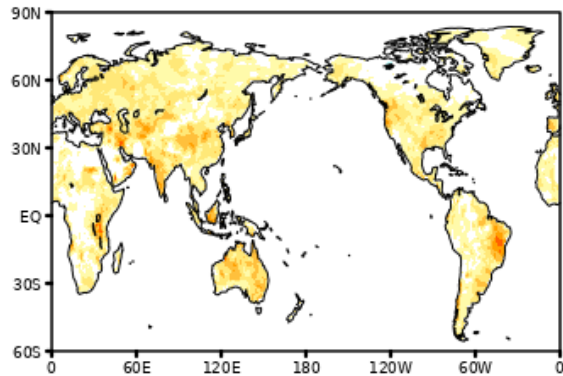
ESRL-FIM



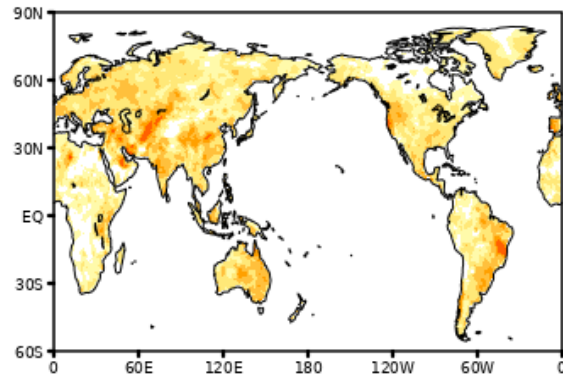
NRL-NESM



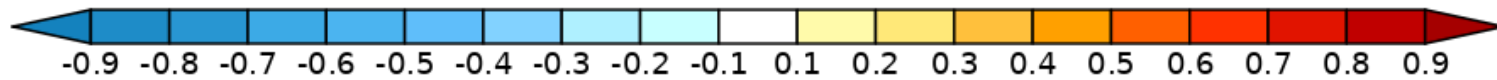
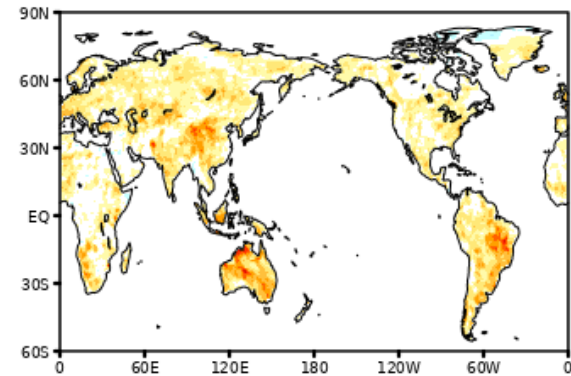
GMAO-GEOS



EMC-GEFS

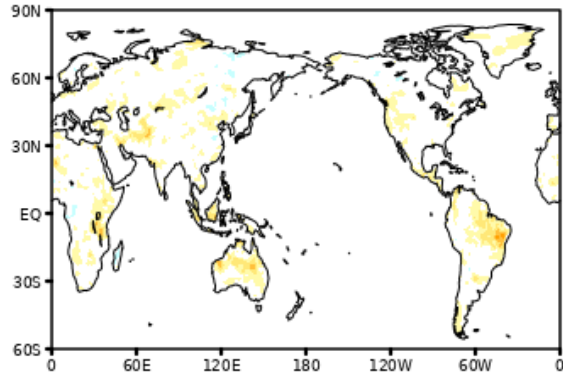


ECCC-GEM

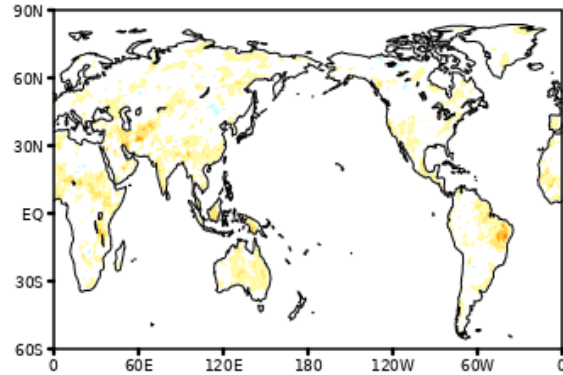


# SubX Week 3 Anomaly Correlation Precipitation [Jun-Nov 1999-2015]

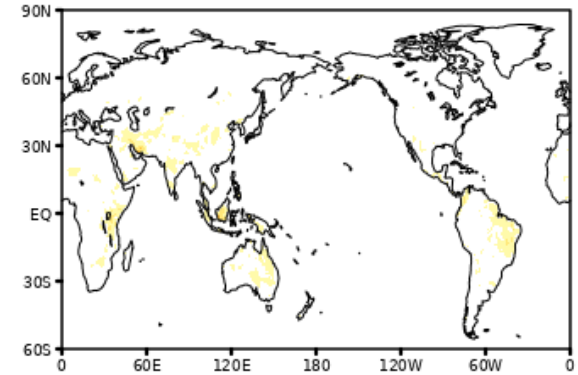
RSMAS-CCSM4



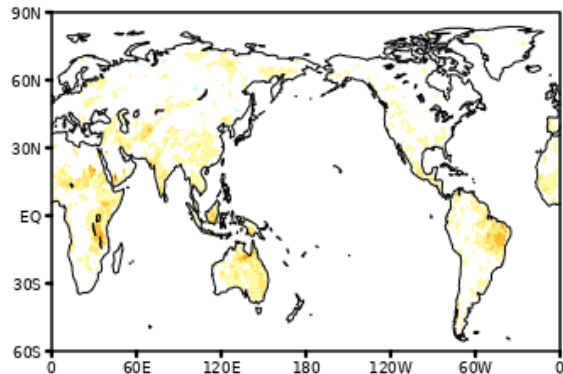
ESRL-FIM



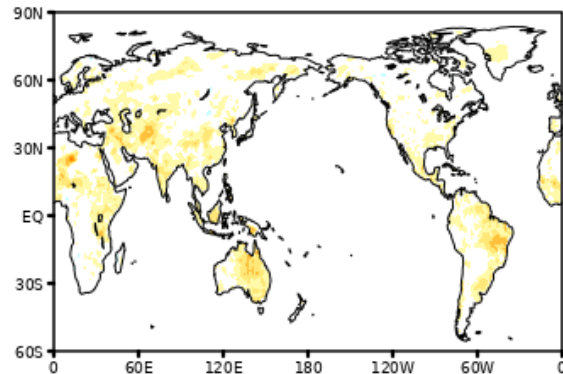
NRL-NESM



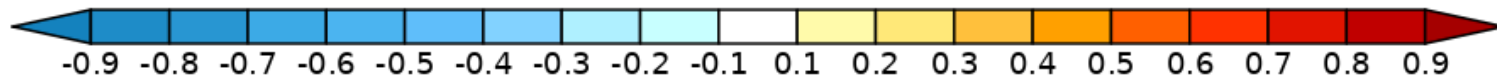
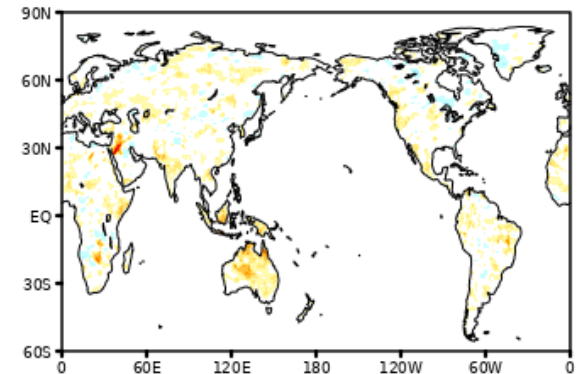
GMAO-GEOS



EMC-GEFS



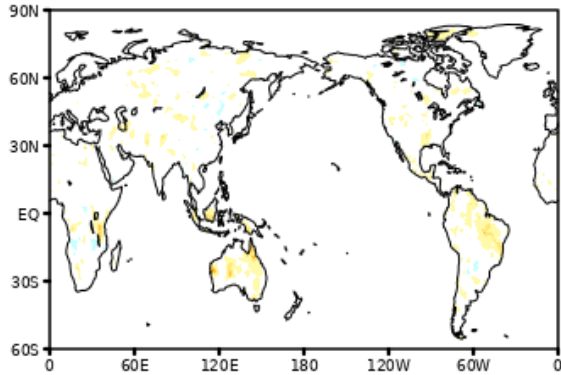
ECCC-GEM



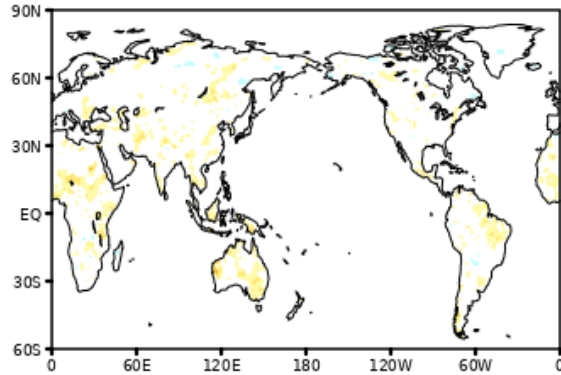


# SubX Week 4 Anomaly Correlation Precipitation [Jun-Nov 1999-2015]

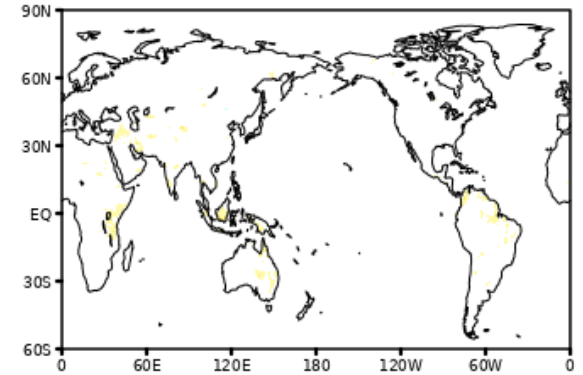
RSMAS-CCSM4



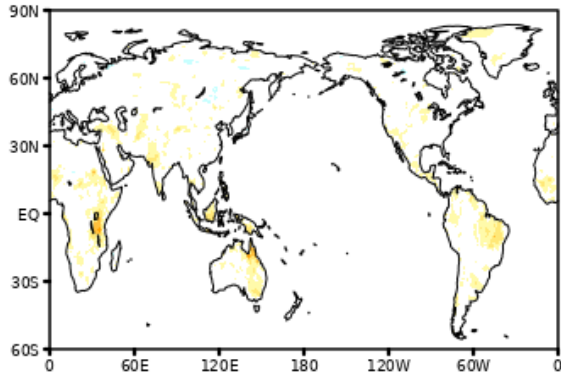
ESRL-FIM



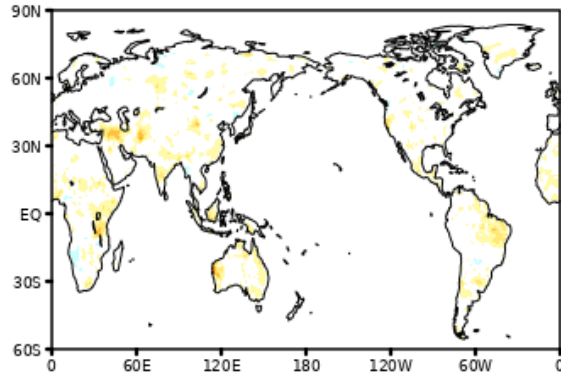
NRL-NESM



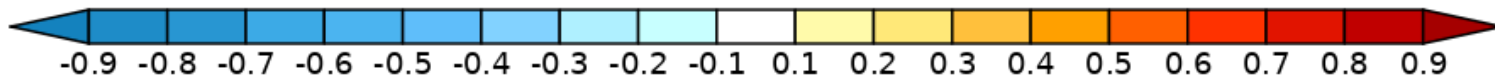
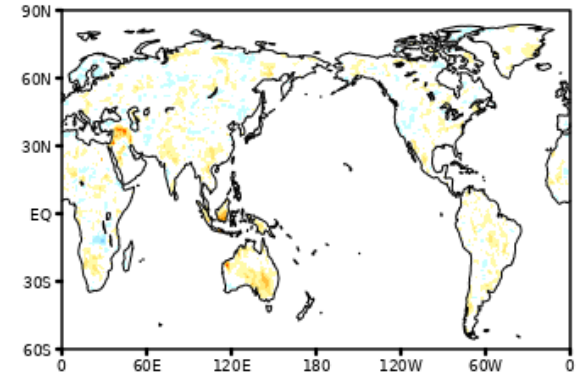
GMAO-GEOS



EMC-GEFS



ECCC-GEM



# 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/kpegon/subx/>

The screenshot shows a web browser window with the URL [cola.gmu.edu/kpegon/subx/](http://cola.gmu.edu/kpegon/subx/). The browser's address bar and navigation tools are visible. Below the browser window, a navigation menu includes links for Home, About, People, Data, Forecasts, and Related Projects. The main content area features a carousel of six maps titled "SubX Week 3-4 2m Temperature Anomalies (deg C) Valid Oct 14-27". The maps are arranged in two rows of three. The top row includes ESRL-FIM (IC: Sep 27; 4 Ens), RSMAS-CCSM4 (IC: Sep 24; 9 Ens), and EMC-OEFS (IC: Sep 27; 21 Ens). The bottom row includes GMAO-GEOS5 (IC: Sep 23; 4 Ens), NRL-NESL (IC: Sep 23-26; 4 Ens), and MME (42 Ensemble Members). A color scale legend at the bottom of the maps ranges from -4 to 4 degrees Celsius. A blue button labeled "Learn more" is positioned to the right of the maps. Below the carousel, there are three navigation dots, with the middle one being active. At the bottom of the page, there are three main sections: "News" with a link to "Oct 2: SubX Real-time Forecast Maps Now", "Forecasts" with the text "The SubX project makes experimental real-", and "Data" with the text "SubX retrospective forecasts and real-time".