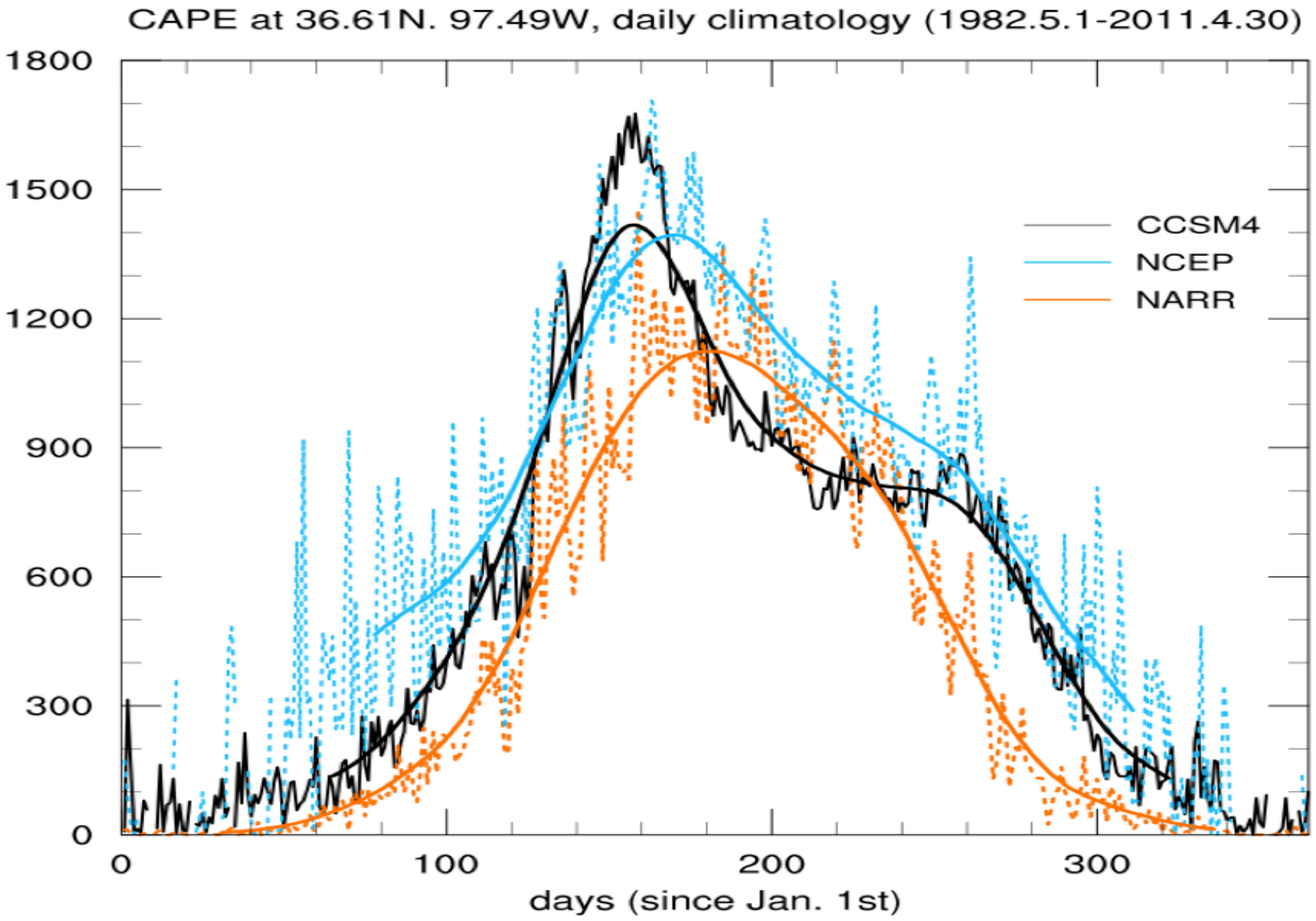
CCSM3 vs. CCSM4: In the Context of the NMME Experiment



North American Multi-Model Ensemble: Goals

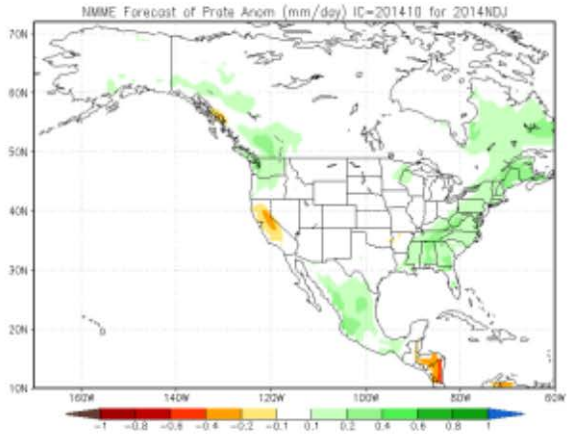
- **Continued Real-Time Forecasts**
  - **Model Updates (FLOR, CCSM4, CESM, CMC)**
- **Coordinated Predictability Research**
  - **Benefits of MM, Model Combinations, Inform Model Development and Applications**
- **Developing and Evaluating an Intraseasonal protocol**
  - **Research/Testing Mode**
- **Continued and Enhanced data distribution**
  - **Supporting Prediction/Predictability Research**
  - **Supporting Forecast Applications**

NMME Seasonal Prediction Science

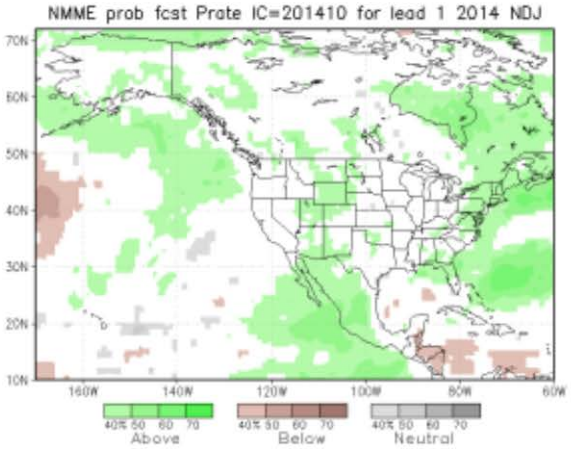
- **Real-Time Effort – Model Upgrades**
  - **CMC1, CMC2, FLOR, CCSM4, CESM1**
- **Quantifying the NMME Benefit**
  - **Model Diversity**
- **Prediction and Predictability Research**

NMME Precipitation Forecast Issued October 15th, 2014 Valid for November-December-January

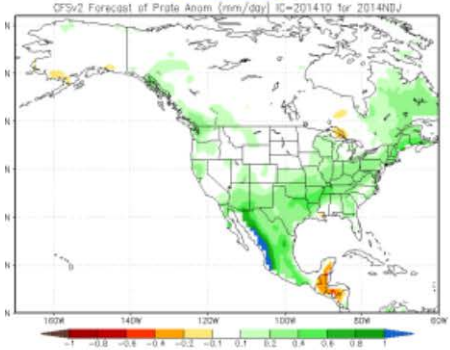
NMME



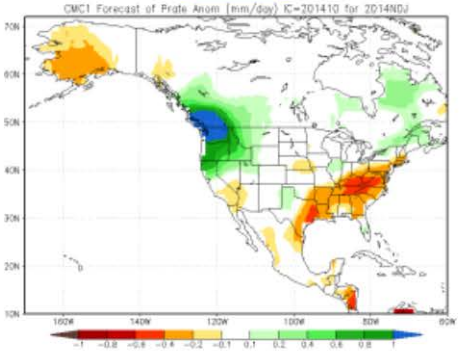
Prob fcst



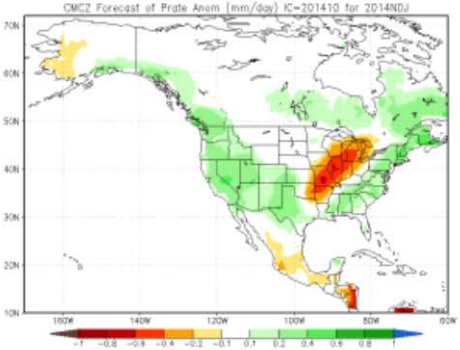
CFSv2



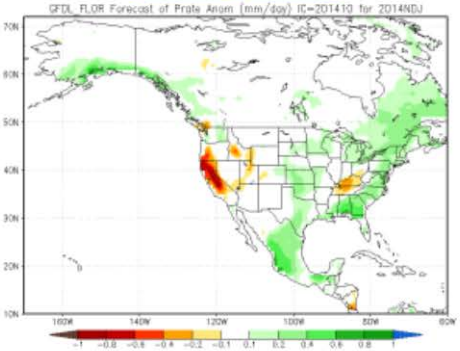
CMC1



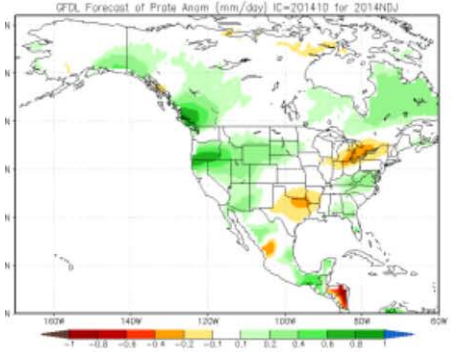
CMC2



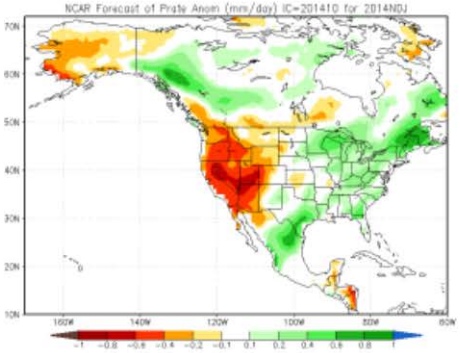
GFDL_FLOR



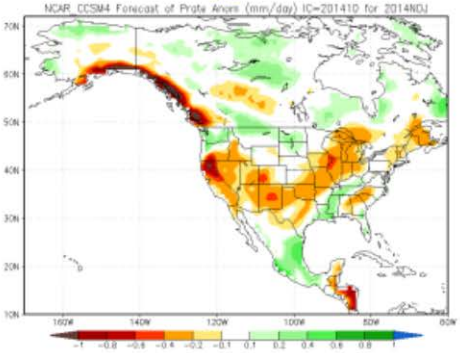
GFDL



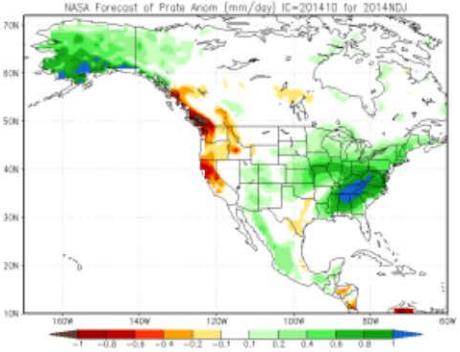
NCAR



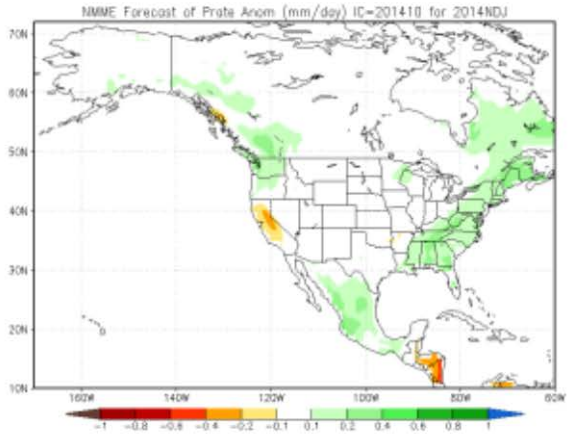
NCAR_CCSM4



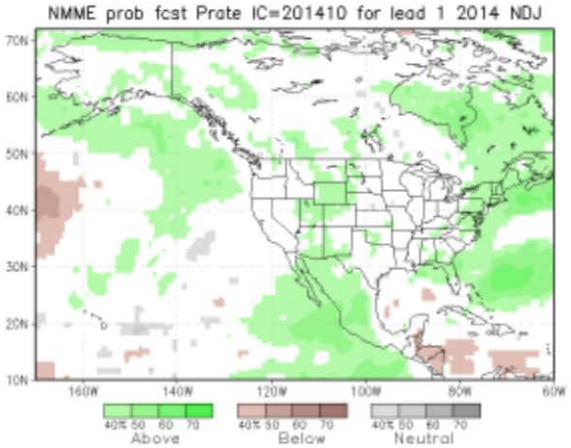
NASA

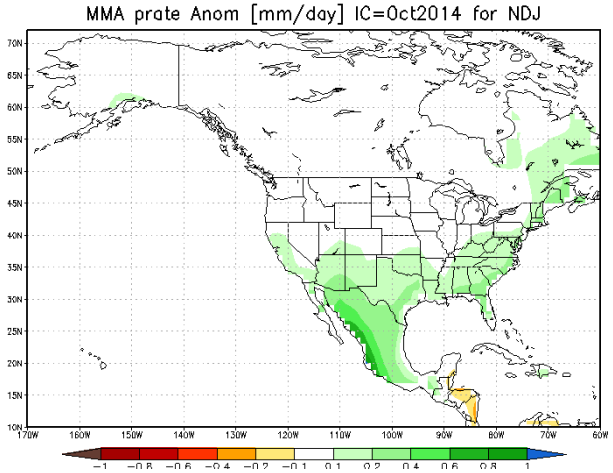


NMME

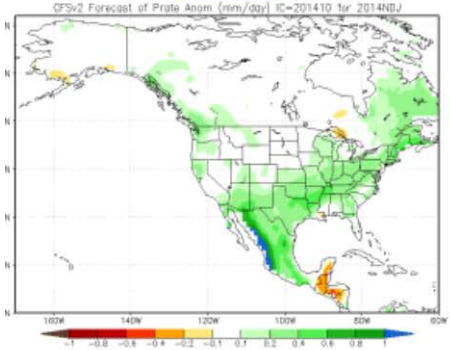


Prob fcst

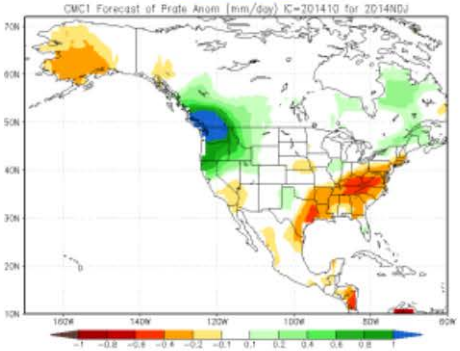




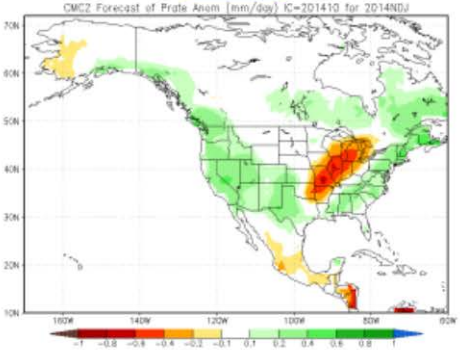
CFSv2



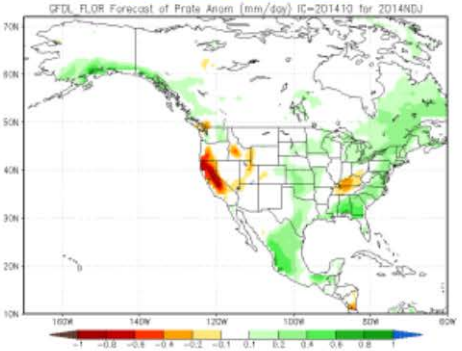
CMC1



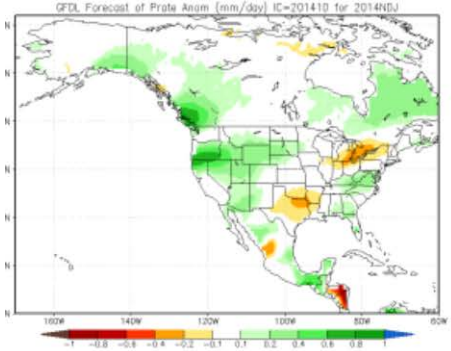
CMC2



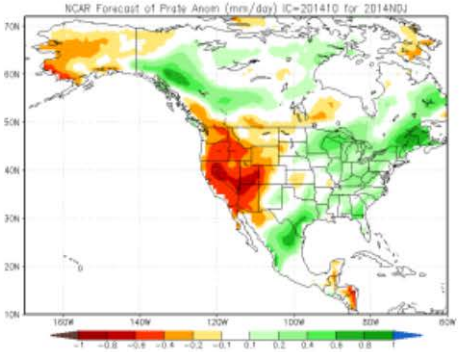
GFDL_FLOR



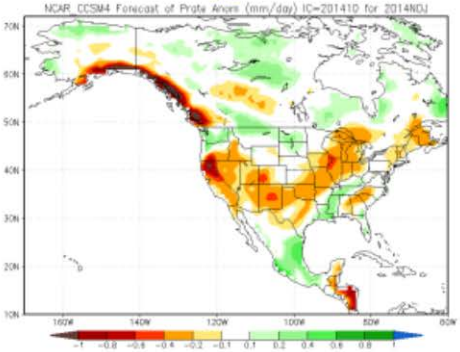
GFDL



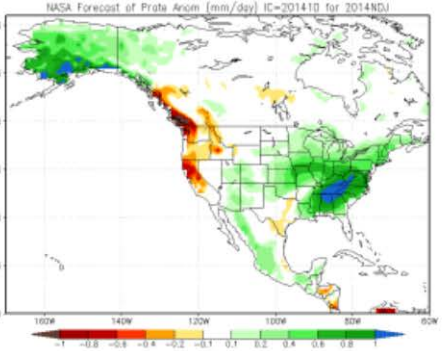
NCAR



NCAR_CCSM4

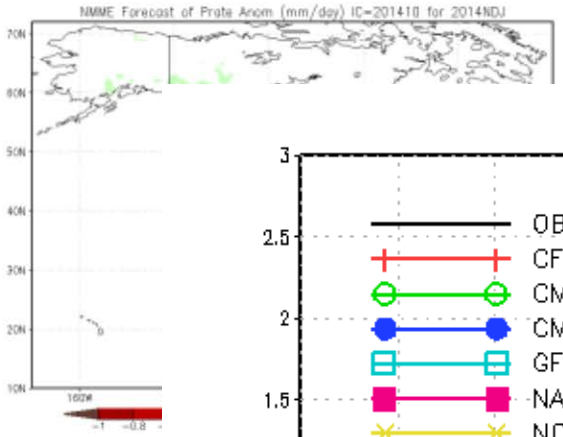


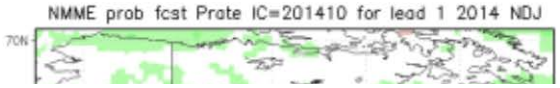
NASA

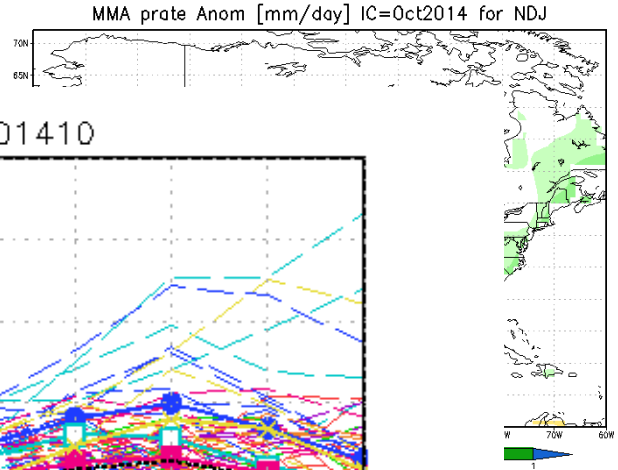


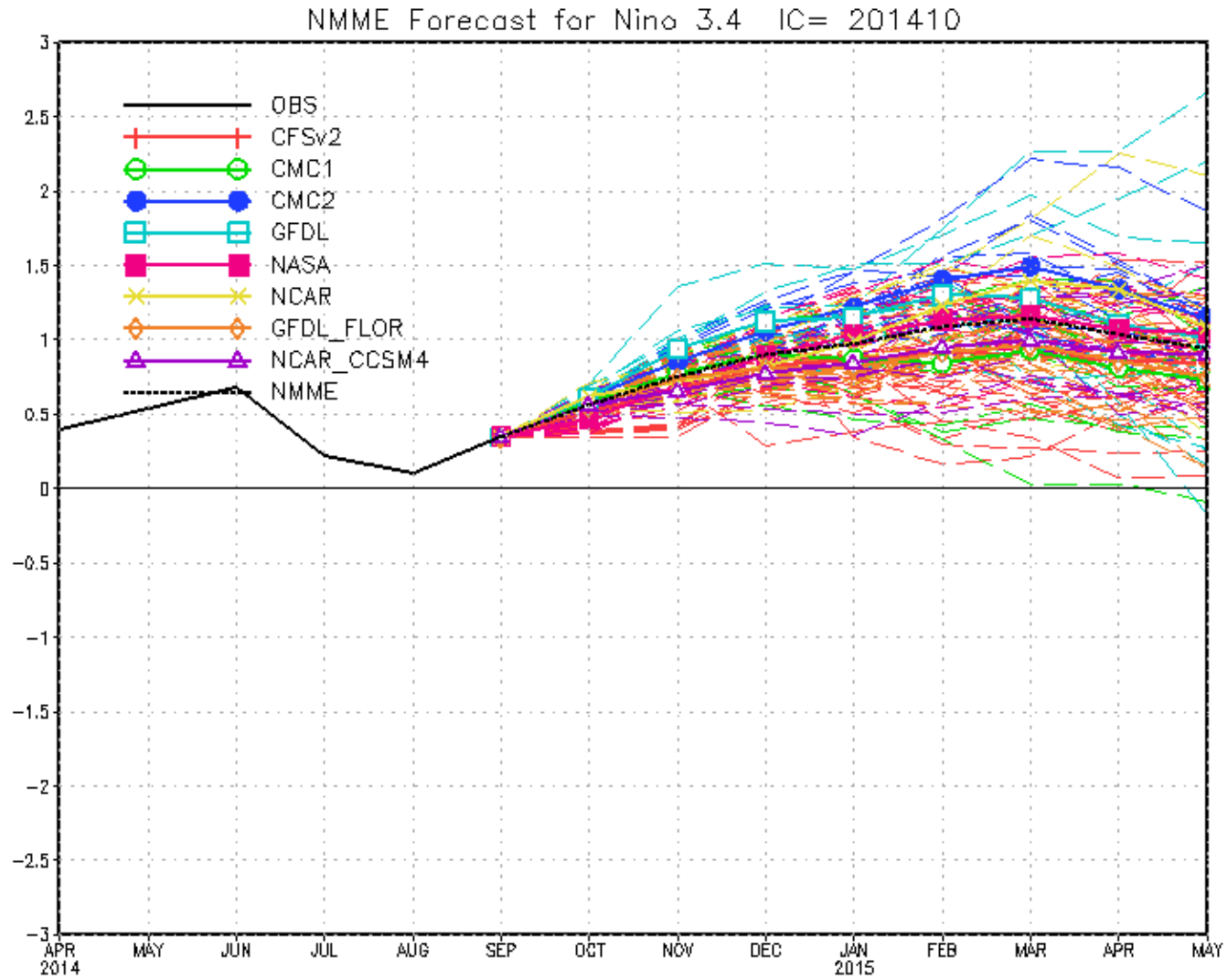
NMME

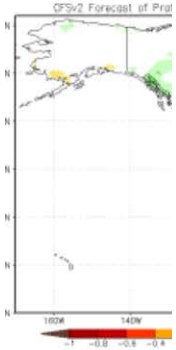
Prob fcst

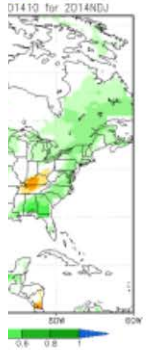


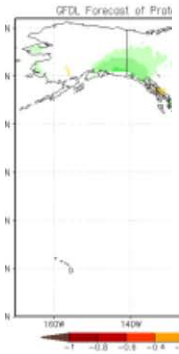


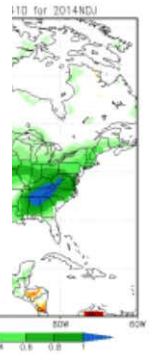








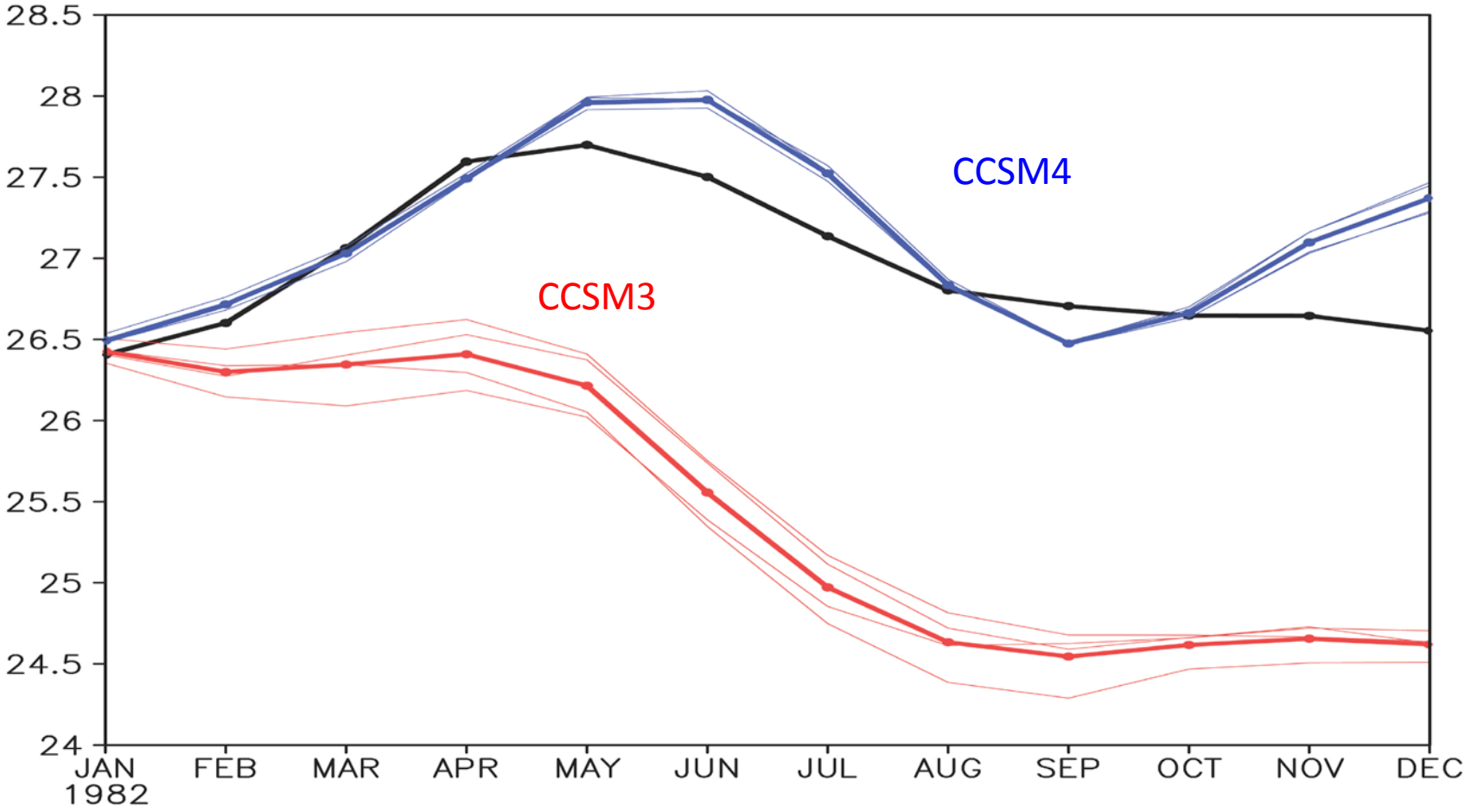




CCSM3 vs. CCSM4

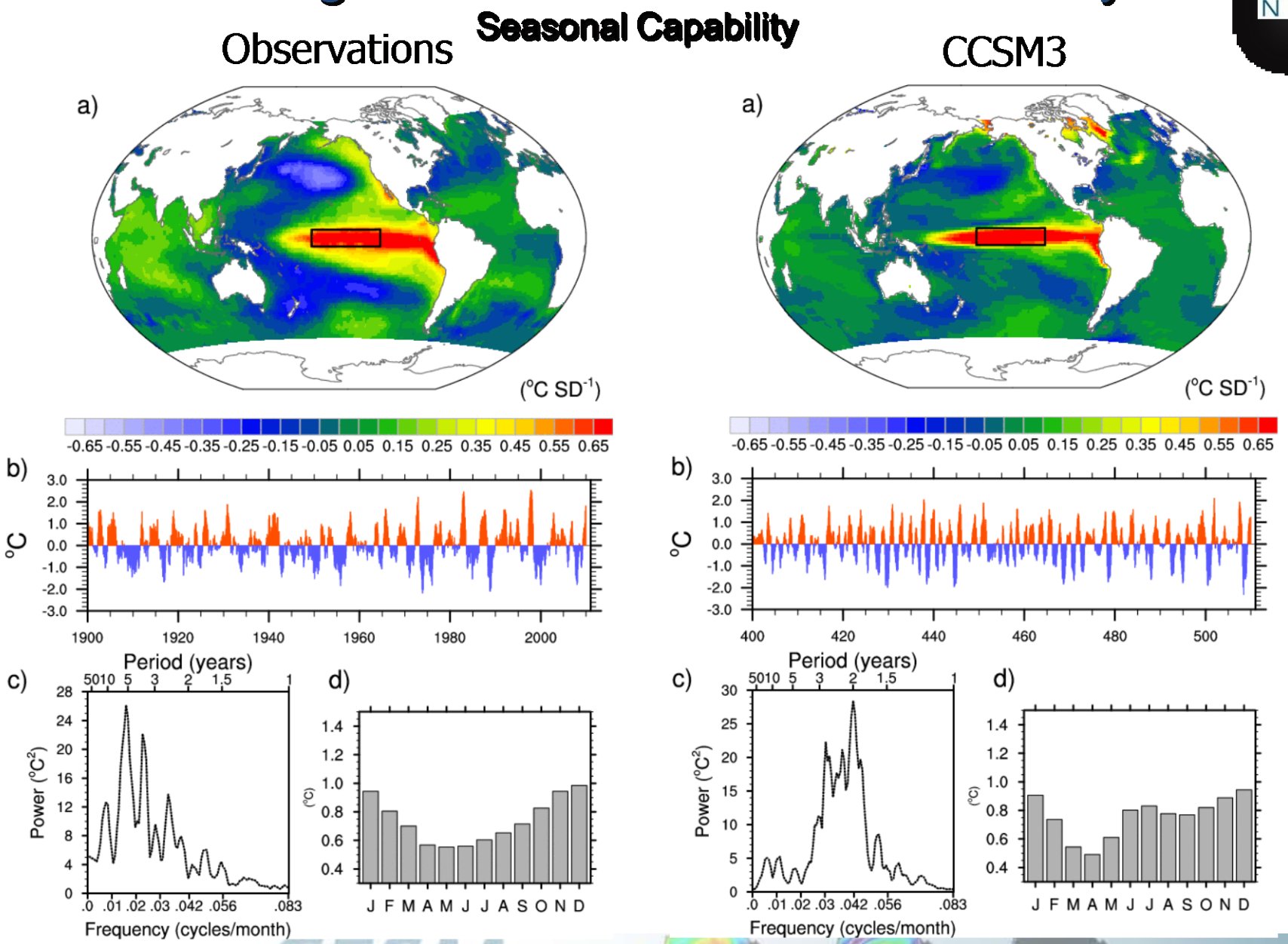
- **Resolution Nearly Comparable (1º)**
  - **Ocean 40 Levels to 60 Levels**
- **Atmospheric Physics Changes**
  - **Convective Parameterization**
    - **Cumulus Friction,**
  - **PBL**
- **Initialization:**
  - **CCSM3 – Ocean Only: GFDL OI**
  - **CCSM4 – O-L-A: CFSR**
    - **Some Experiments to Isolate O-L-A**
- **Retrospective Forecast: 1981-2010**

CCSM3 vs. CCSM4
Systematic Error - January Starts



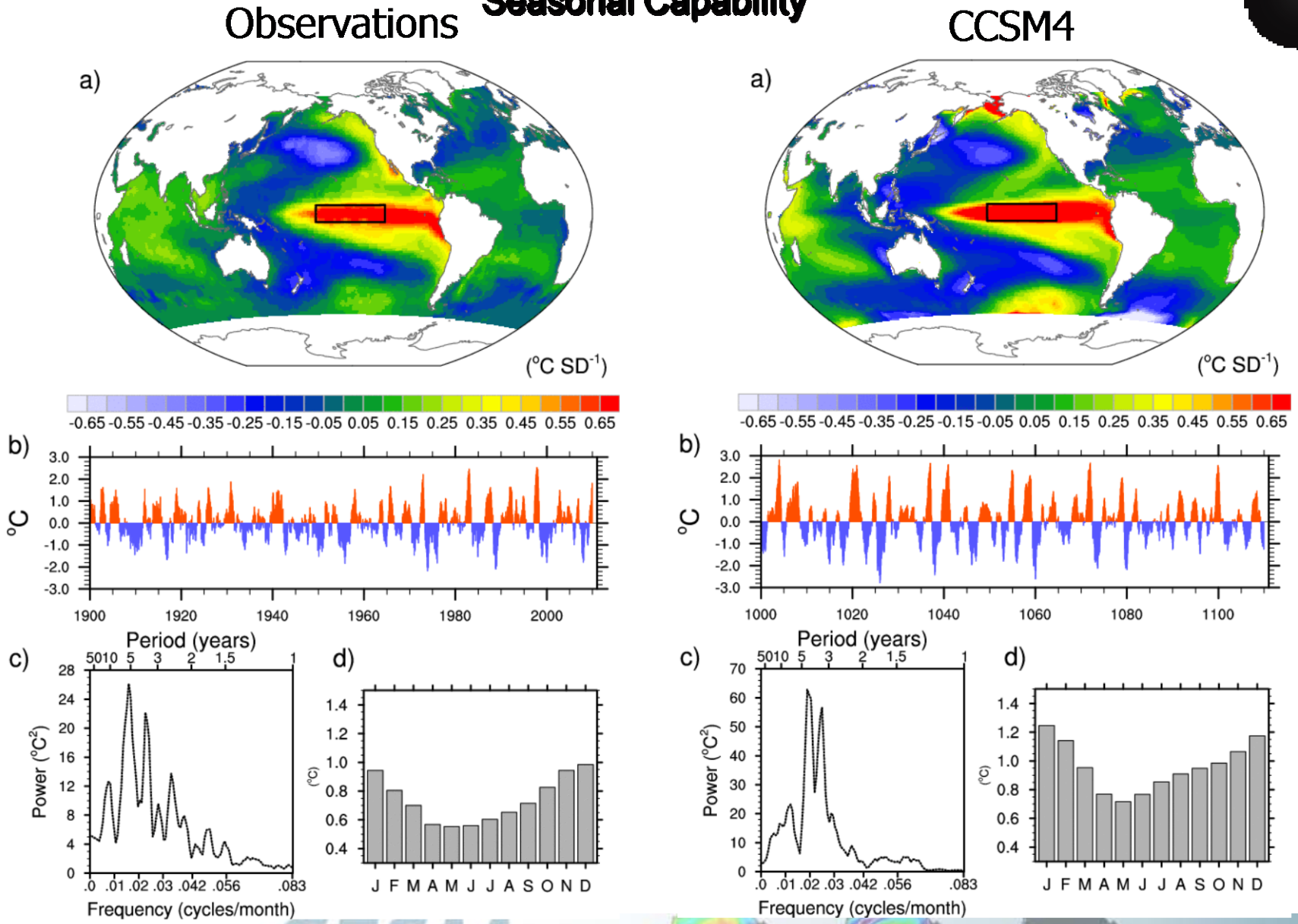
Leading Mode of Global SST Variability

Seasonal Capability

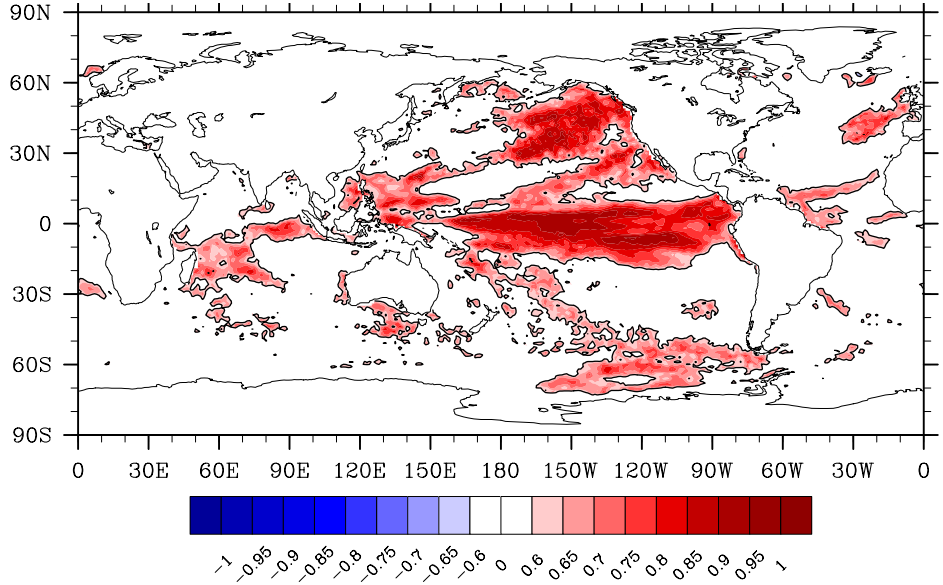


Leading Mode of Global SST Variability

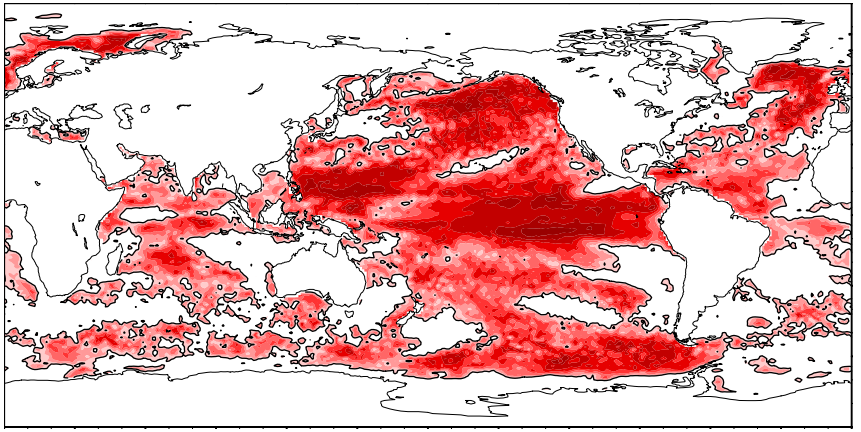
Seasonal Capability



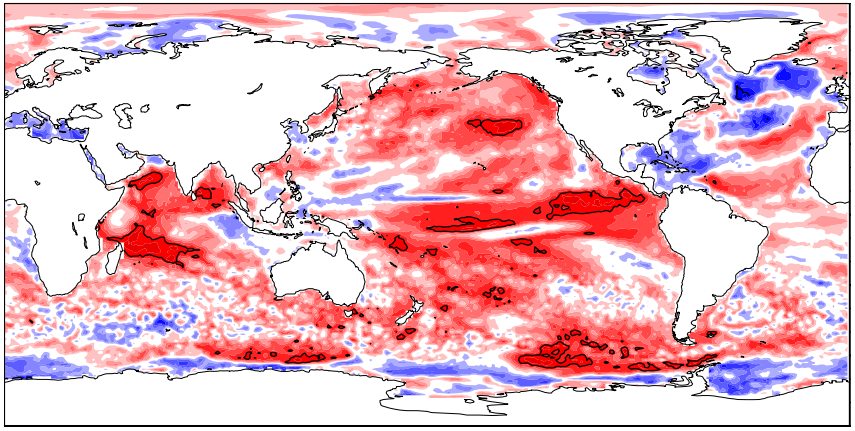
CCSM3 SST Anomaly Correlation
Jan Start, Verifying JFM



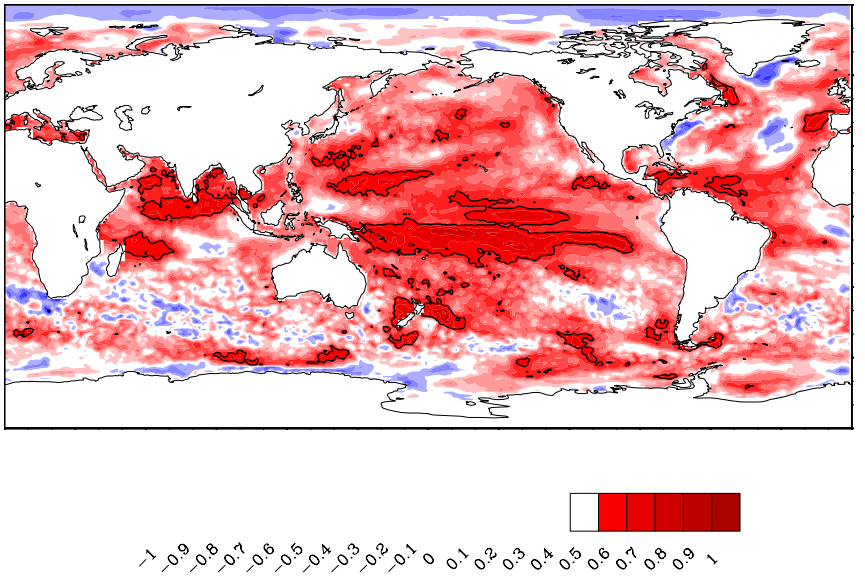
CCSM4 SST Anomaly Correlation
Jan Start, Verifying JFM



CCSM3 SST Anomaly Correlation
Jan Start, Verifying JJA

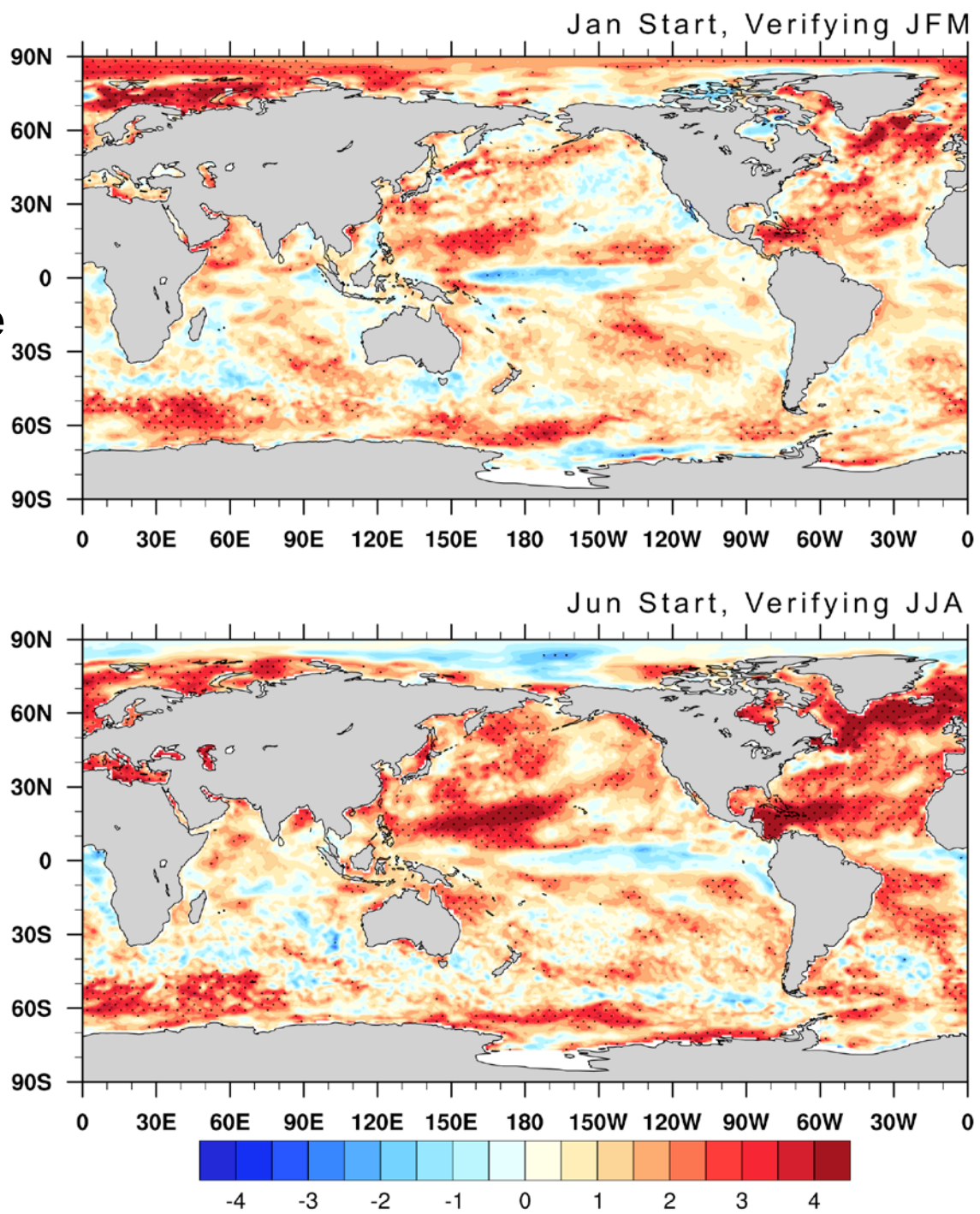


CCSM4 SST Anomaly Correlation
Jan Start, Verifying JJA

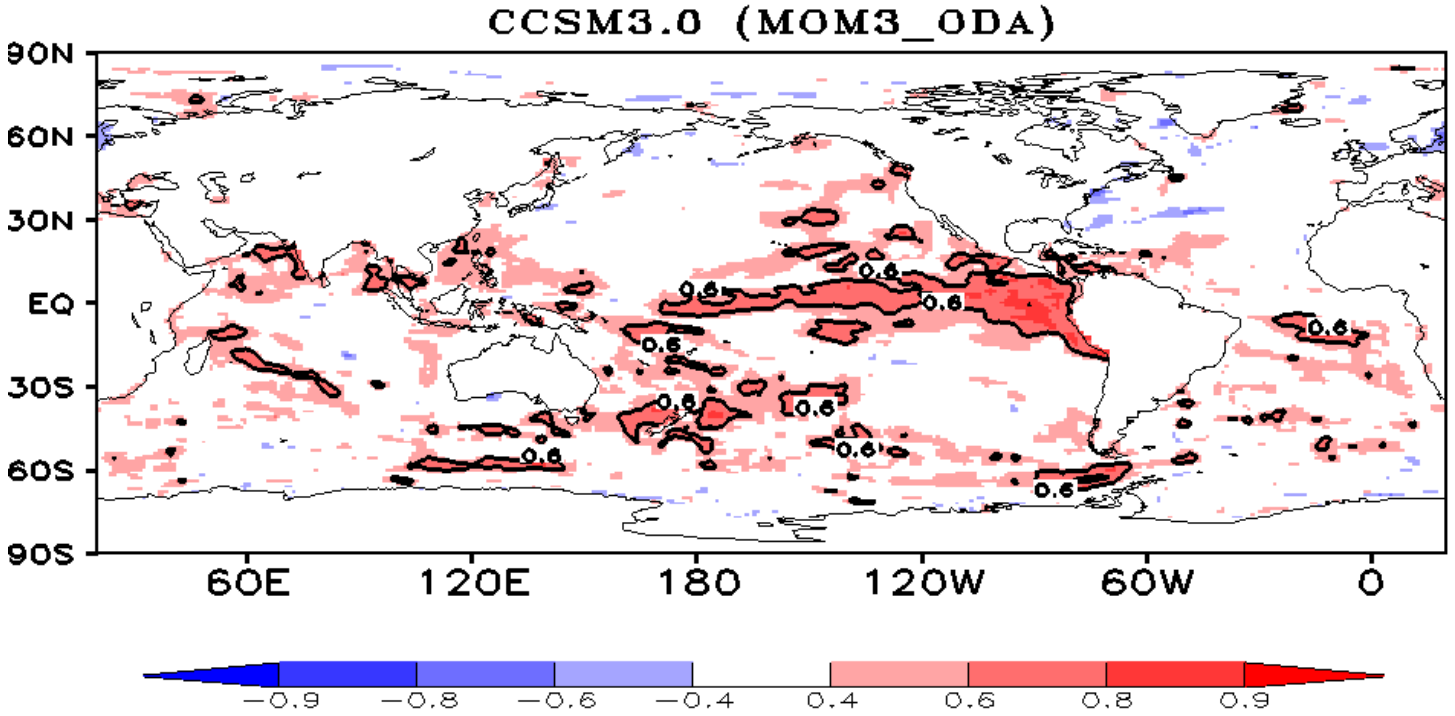


Are The Differences in the Correlation Significant?

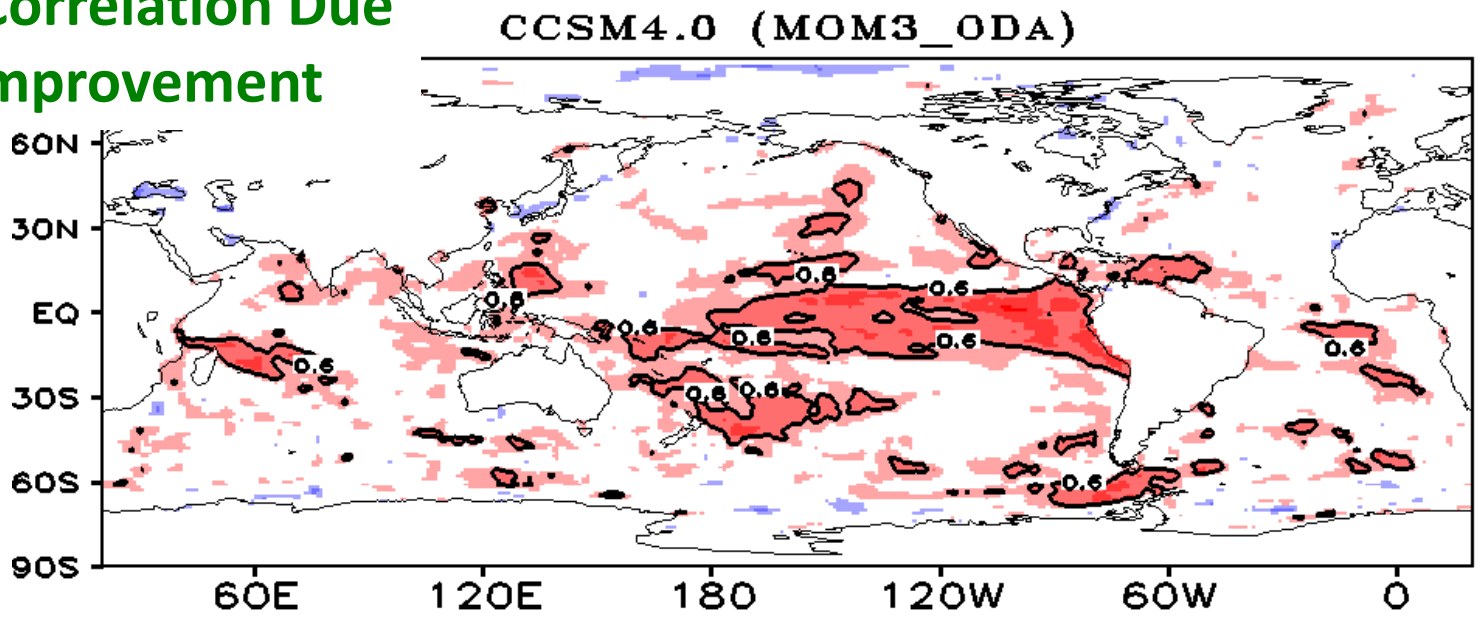
Z-Statistic



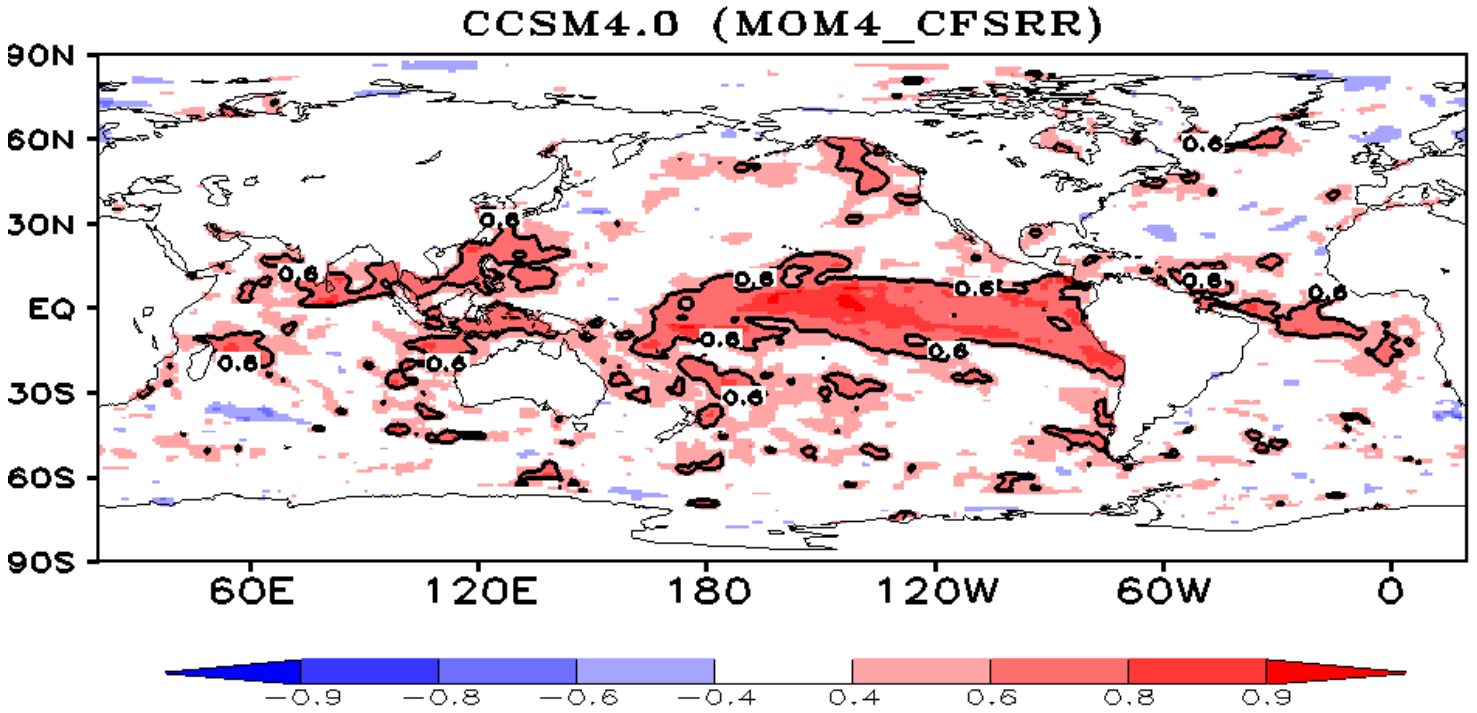
May Initial Conditions 3-Months Lead



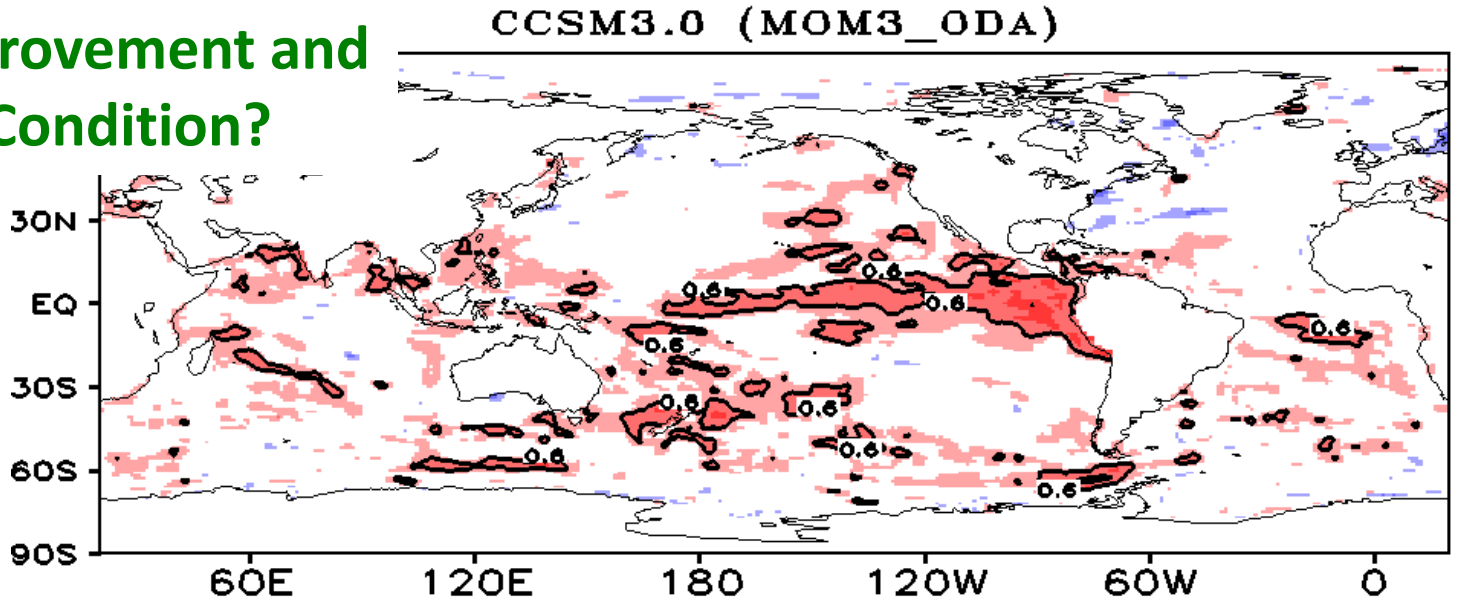
Improved Correlation Due to Model Improvement



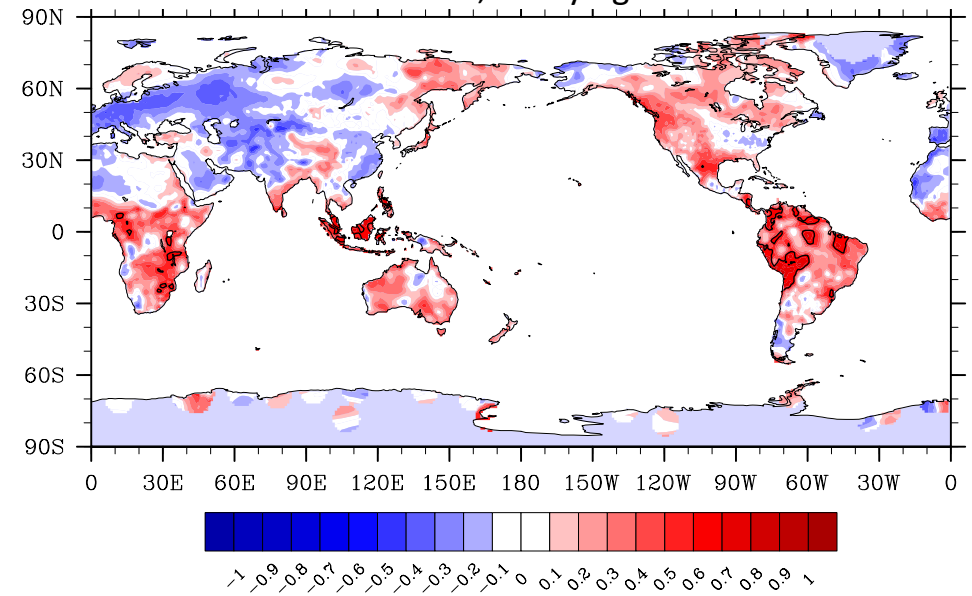
May Initial Conditions 3-Months Lead



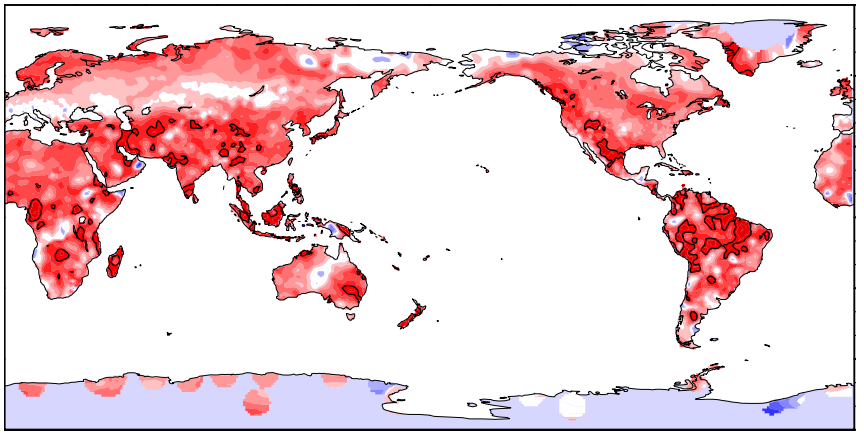
Improved Correlation Due to Model Improvement and Better Initial Condition?



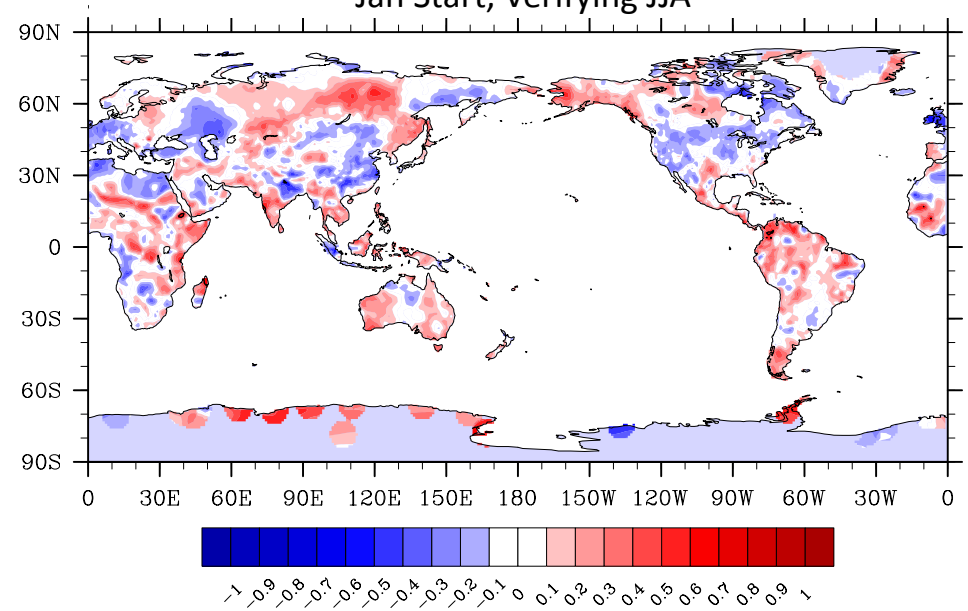
CCSM3 T2m Anomaly Correlation
Jan Start, Verifying JFM



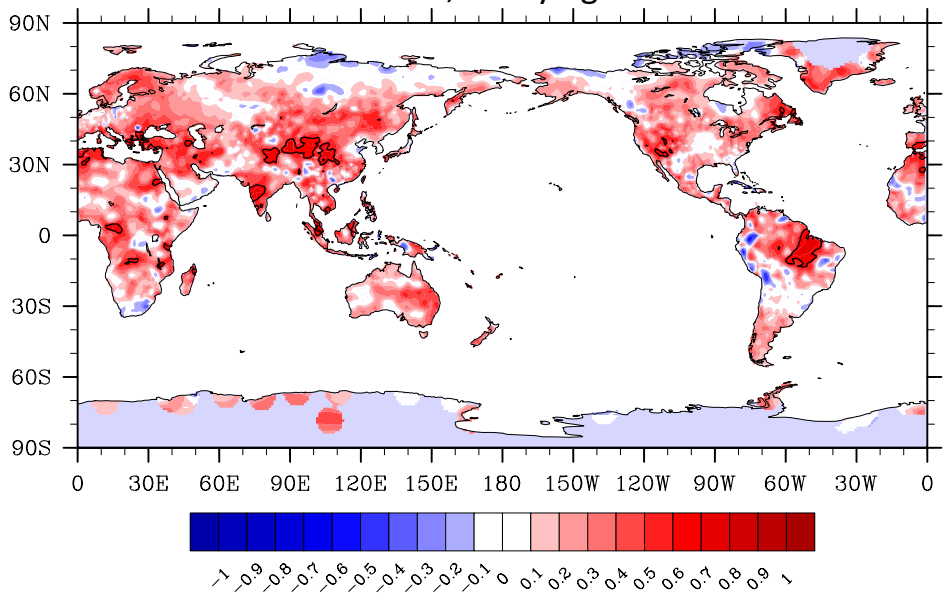
CCSM4 T2m Anomaly Correlation
Jan Start, Verifying JFM



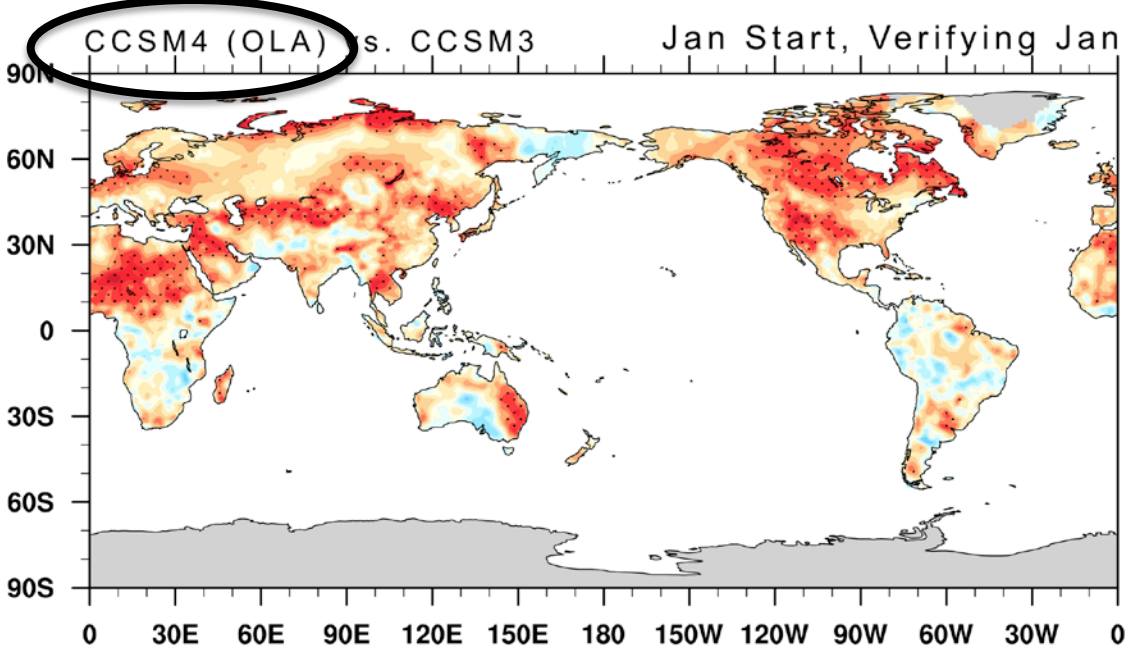
CCSM3 T2m Anomaly Correlation
Jan Start, Verifying JJA

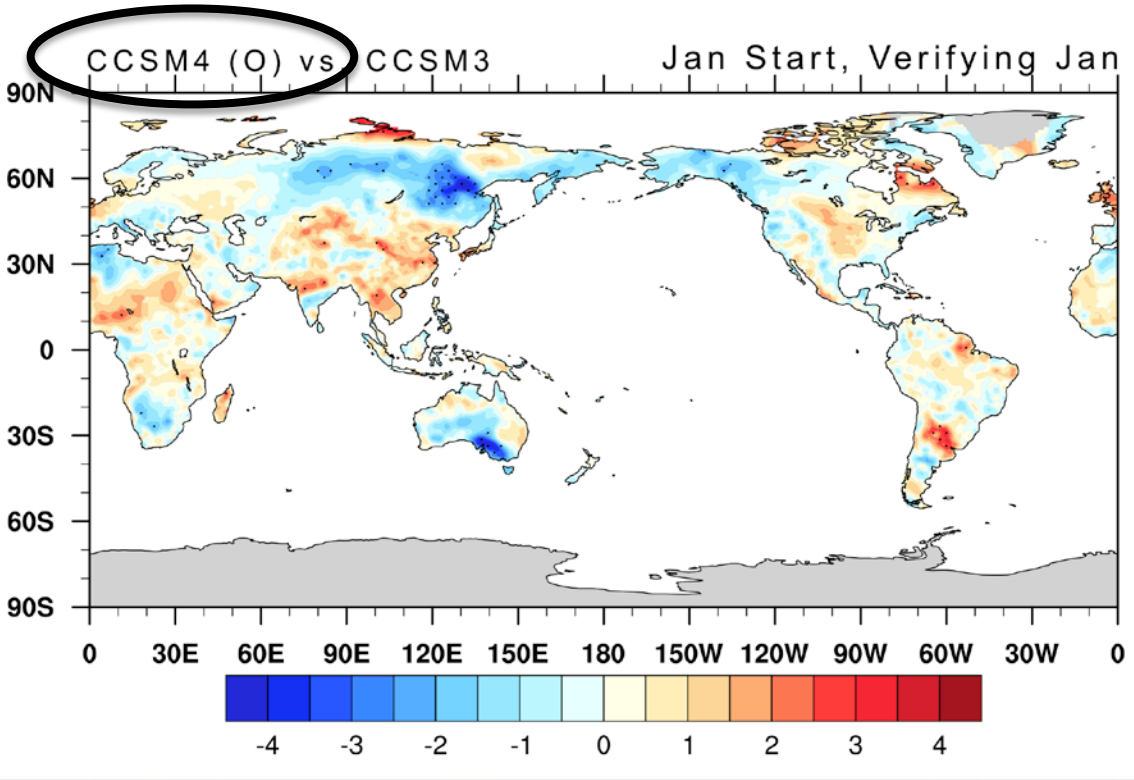


CCSM4 T2m Anomaly Correlation
Jan Start, Verifying JJA

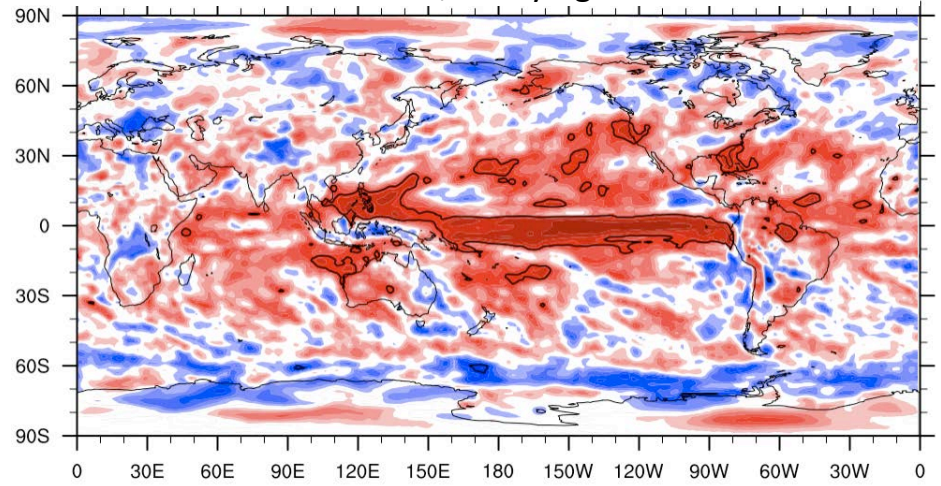


Better Model vs. Better L/A Initial Condition

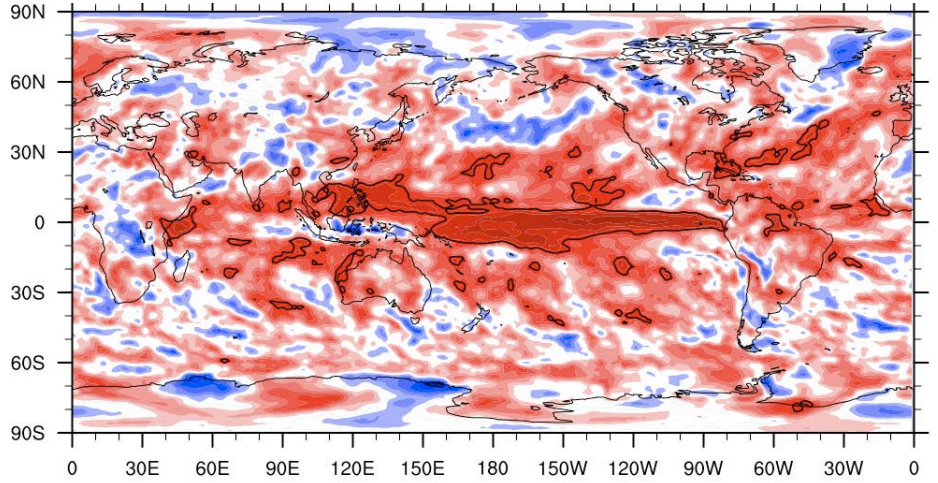




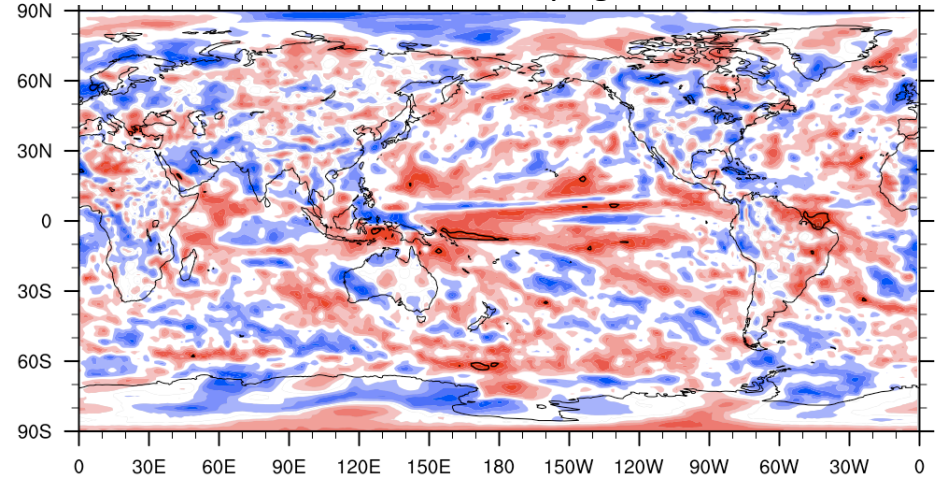
CCSM3 Precip Anomaly Correlation
Jan Start, Verifying JFM



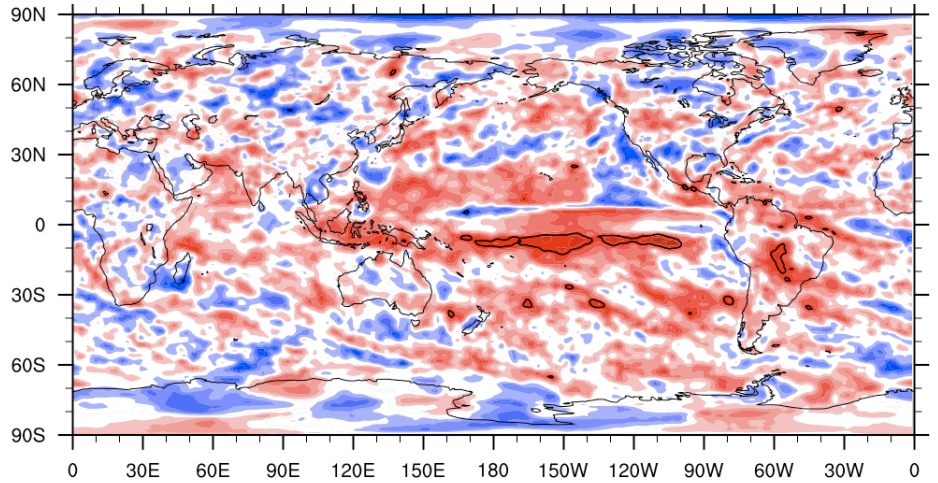
CCSM4 Precip Anomaly Correlation
Jan Start, Verifying JFM



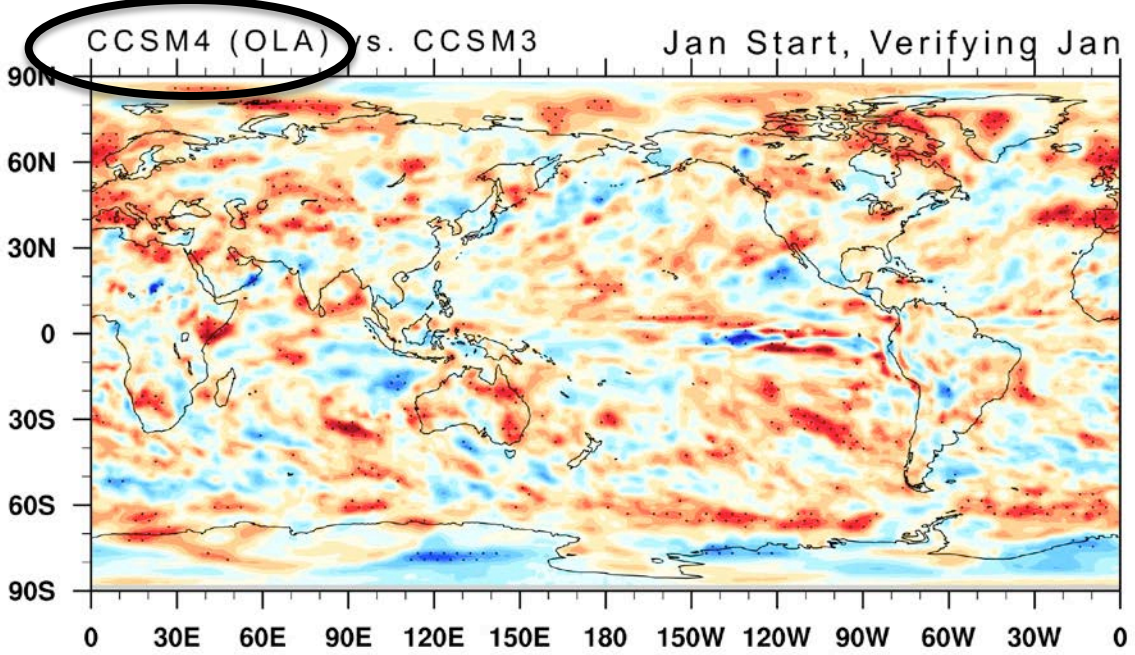
CCSM3 Precip Anomaly Correlation
Jan Start, Verifying JJA

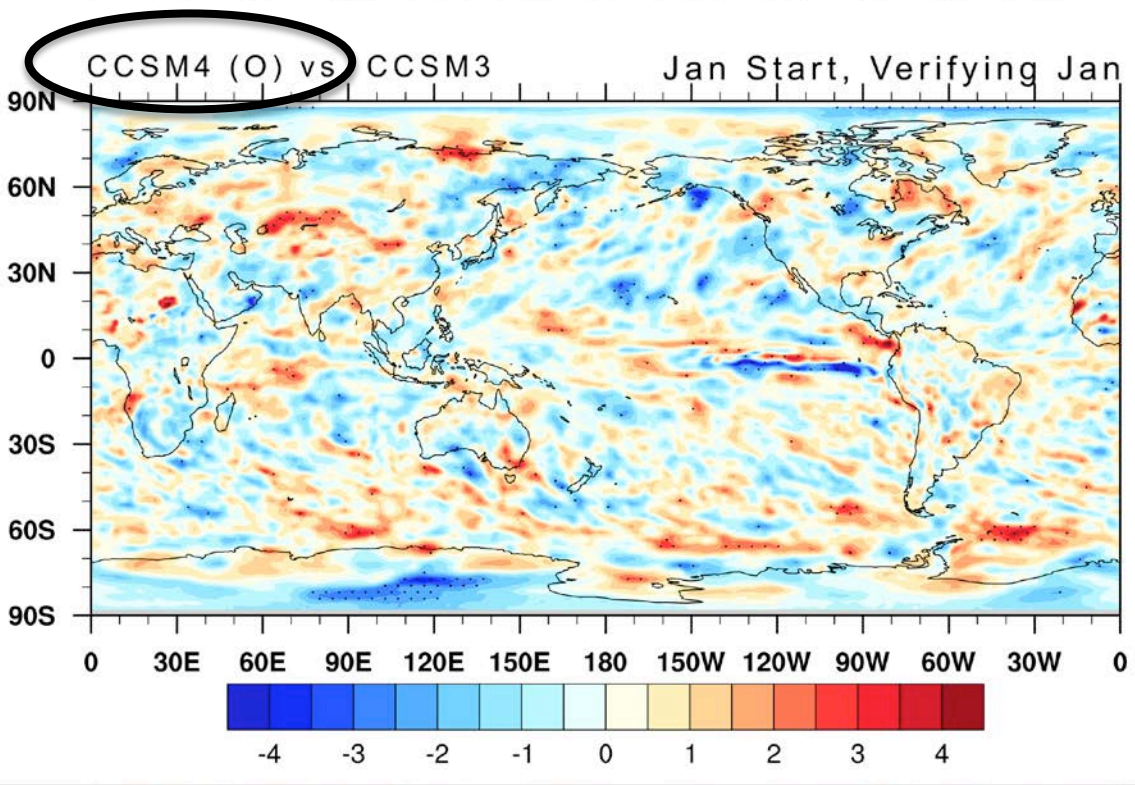


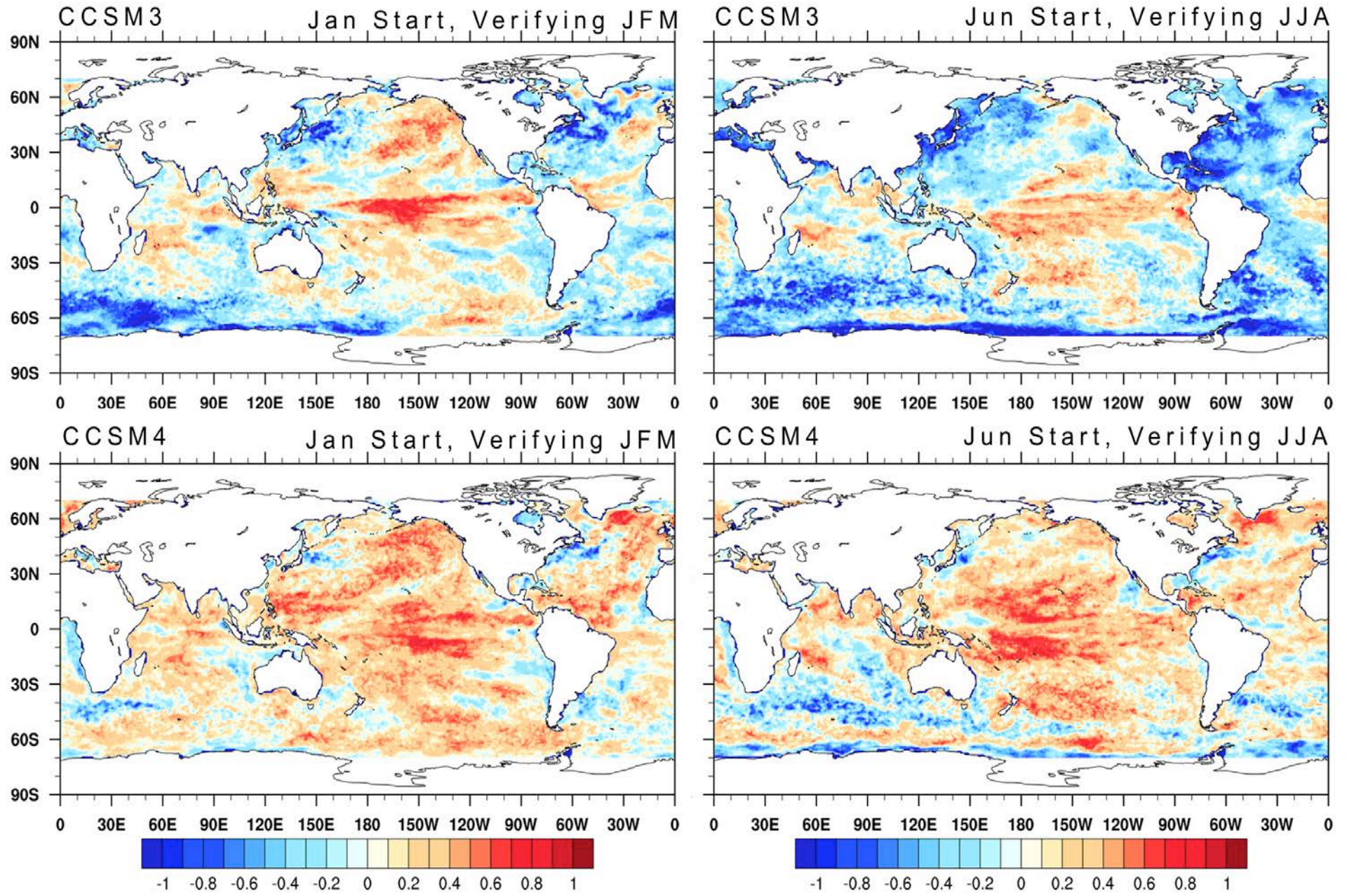
CCSM4 Precip Anomaly Correlation
Jan Start, Verifying JJA



Better Model vs. Better L/A Initial Condition



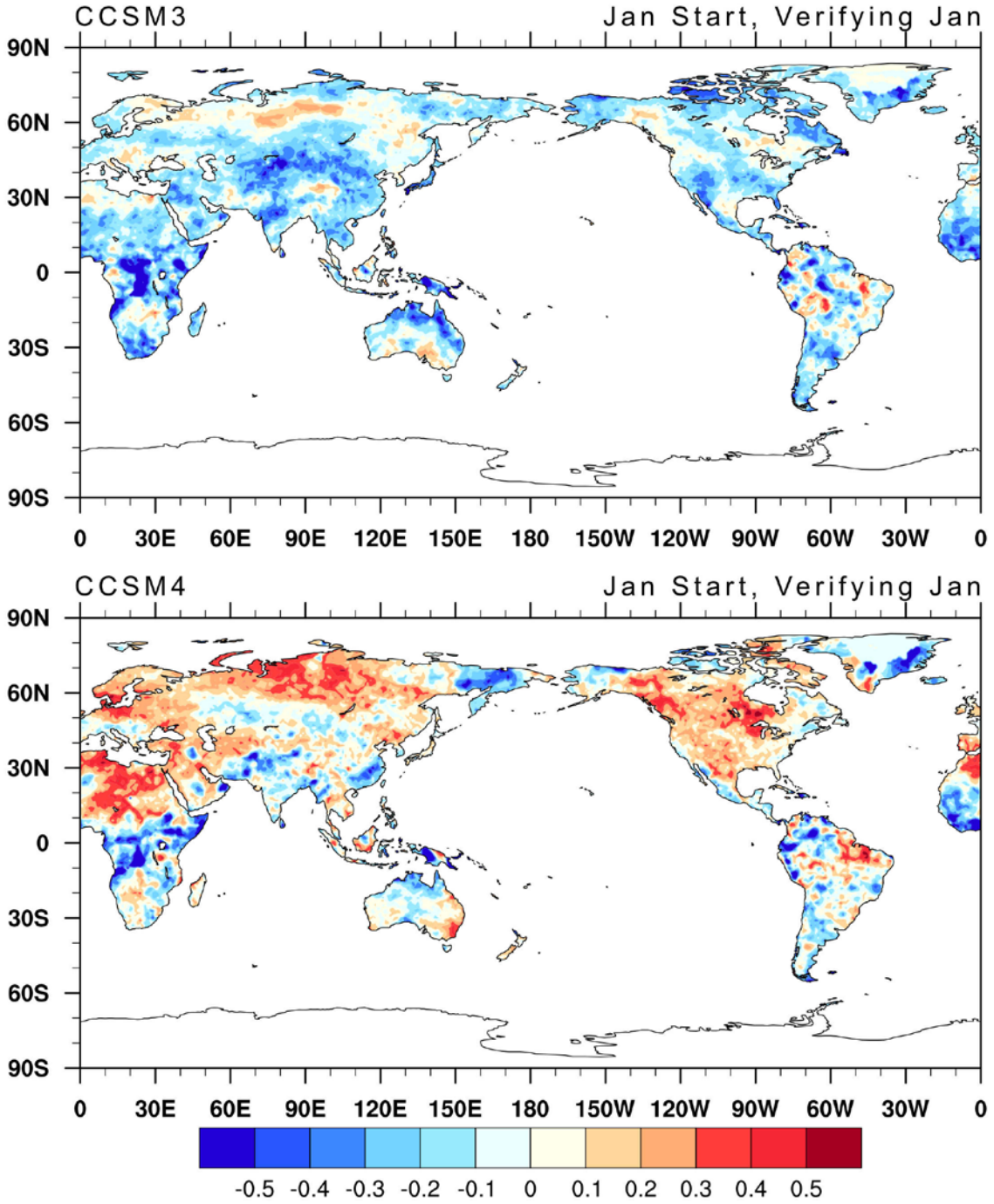



CCSM3
Jan Start, Verifying JFM
CCSM3
Jun Start, Verifying JJA
CCSM4
Jan Start, Verifying JFM
CCSM4
Jun Start, Verifying JJA
90N
60N
30N
0
30S
60S
90S
0 30E 60E 90E 120E 150E 180 150W 120W 90W 60W 30W 0
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1

RPSS

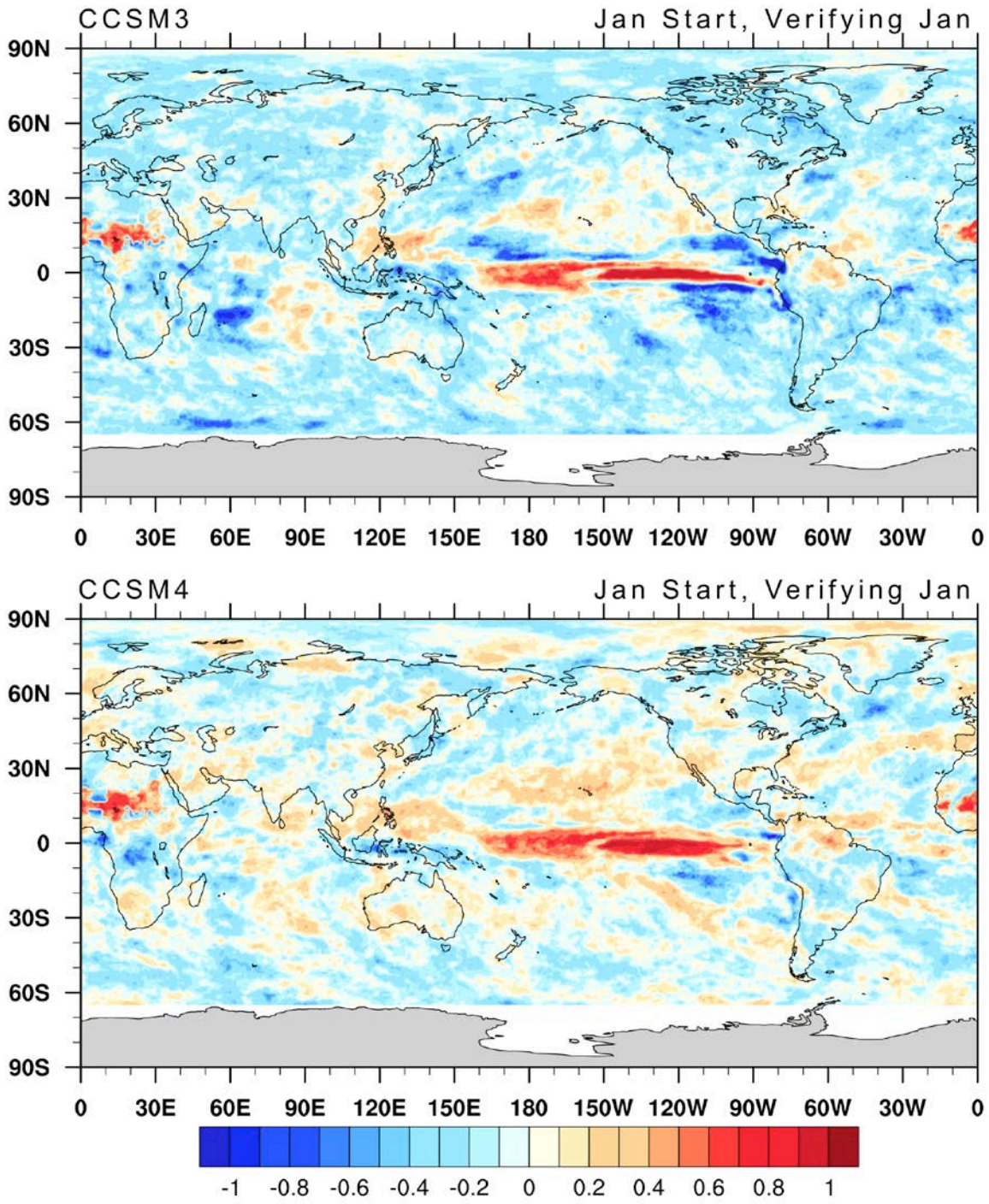
CCSM4 vs. CCSM3
T2m RPSS

T2m Forecast:
Initialized in January –
Verifying in January
1982-2010

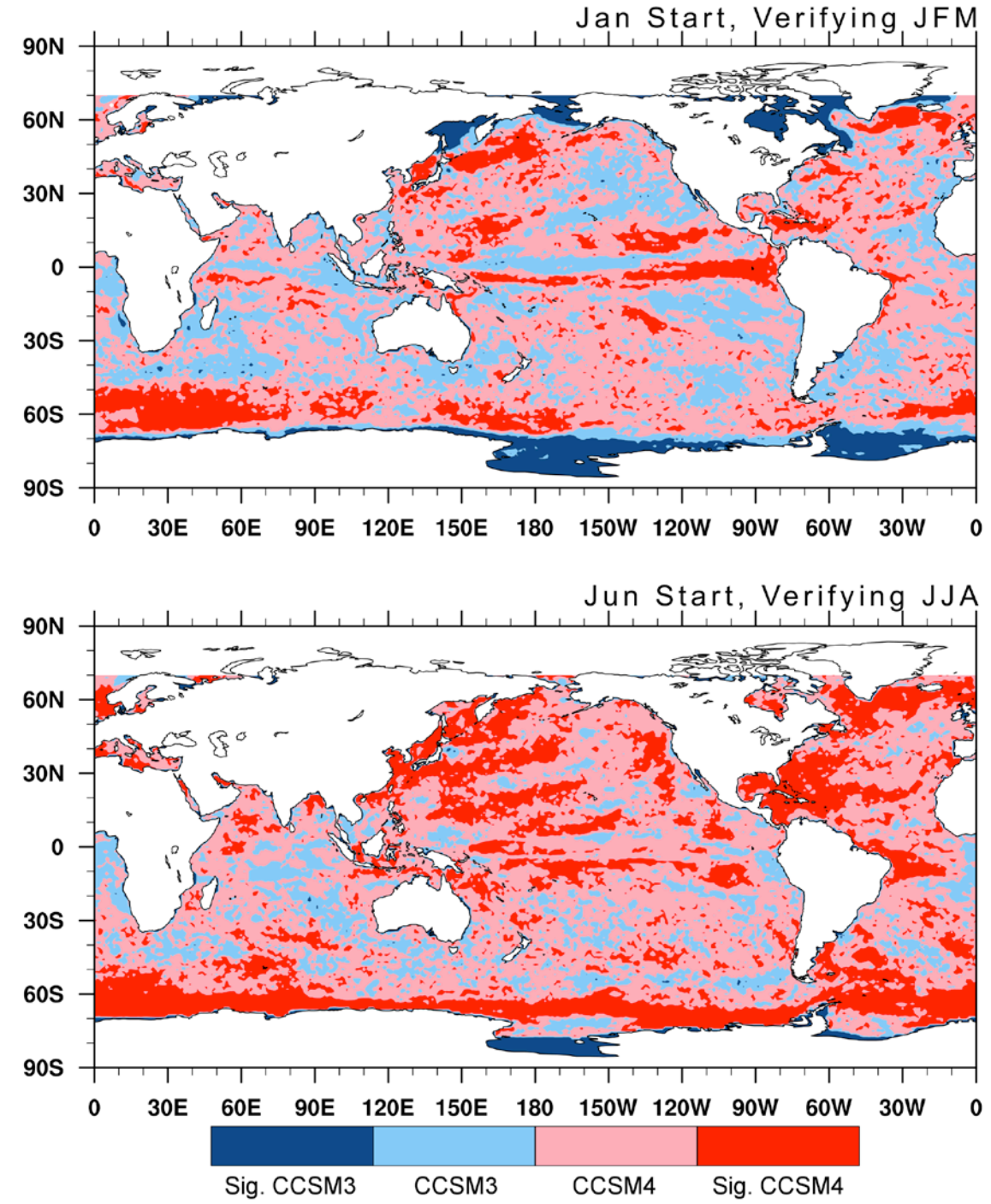


CCSM4 vs. CCSM3
Precip RPSS

Precip Forecast:
Initialized in January –
Verifying in January
1982-2010



CCSM4 vs. CCSM3 SST Verification: Mean Squared Error Sign Test

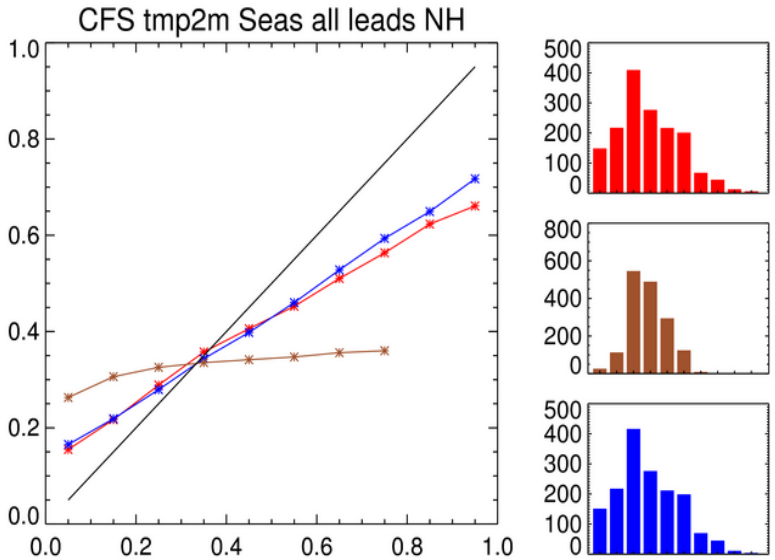


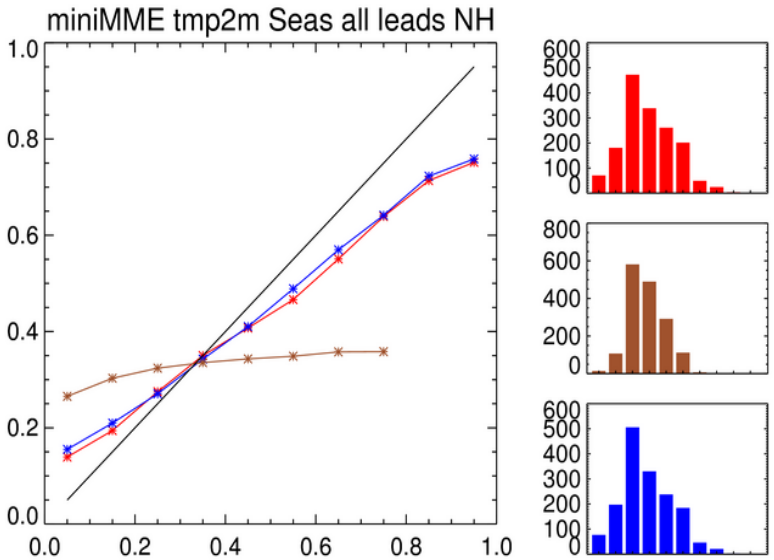
Should We Remove CCSM3 from NMME?

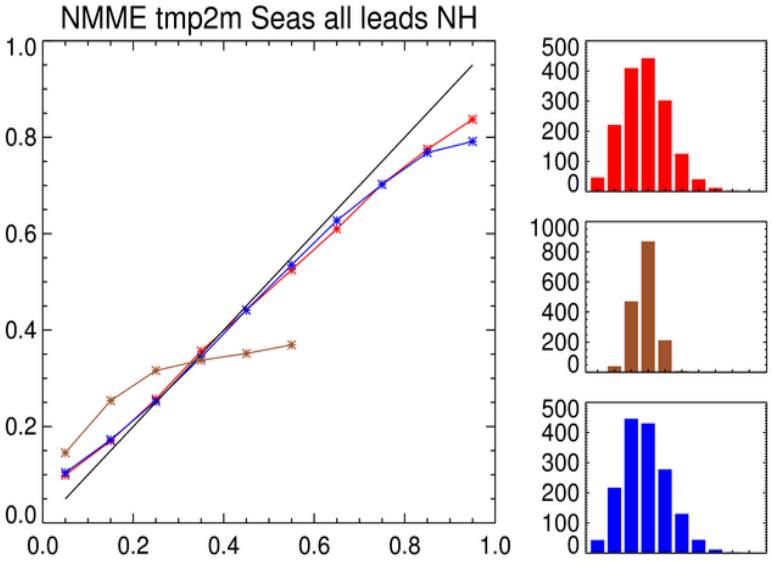
NMME Team Needs to Develop a Protocol for Removing and Adopting Models

Model Diversity

- **Comparing CFSv2 with NMME**
  - **Skill Comparison: Model Diversity or Ensemble Size**
  - **Mini-NMME vs. CFSv2**


CFS tmp2m Seas all leads NH
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
500
400
300
200
100
0
800
600
400
200
0
500
400
300
200
100
0


miniMME tmp2m Seas all leads NH
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
600
500
400
300
200
100
0
800
600
400
200
0
600
500
400
300
200
100
0


NMME tmp2m Seas all leads NH
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
500
400
300
200
100
0
1000
800
600
400
200
0
500
400
300
200
100
0

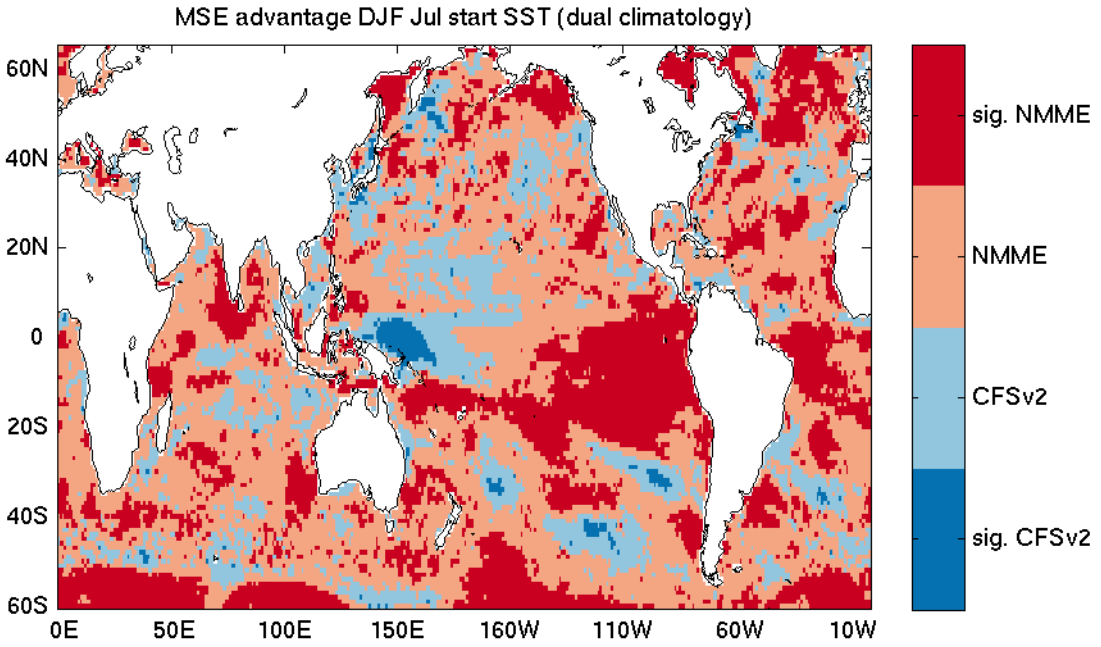
Brier Skill Score for T2m Northern Hemisphere Extra-tropics Land (23N-75N)

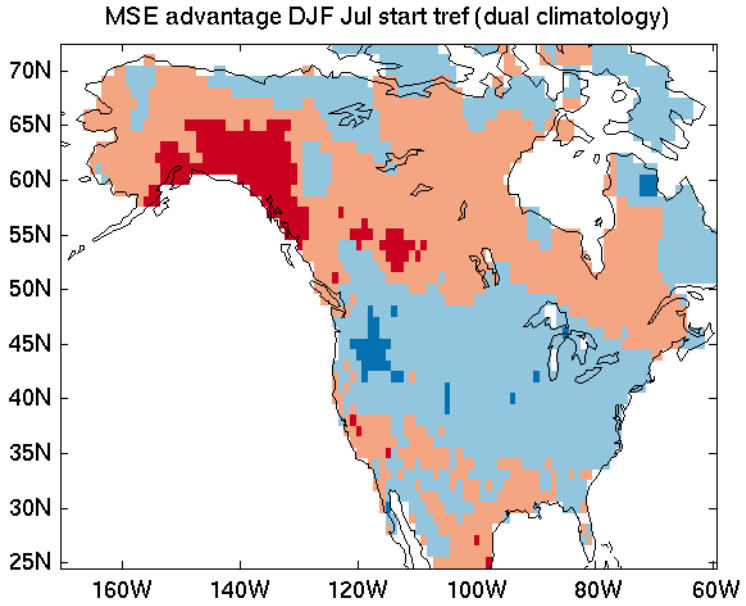
	A/N/B	Lead 0	Lead 1	Lead 2	Lead 3	Lead 4	Lead 5
CFS (24 Members)	Above	0.10	0.03	0.01	0.01	0.01	0.01
	Normal	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04
	Below	0.10	0.04	0.03	0.02	0.02	0.02
Mini-NMME (24 Members)	Above	0.12	0.05	0.03	0.03	0.02	0.02
	Normal	-0.02	-0.04	-0.04	-0.04	-0.04	-0.04
	Below	0.11	0.05	0.04	0.03	0.03	0.03
Full NMME	Above	0.14	0.07	0.06	0.06	0.05	0.05
	Normal	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
	Below	0.14	0.08	0.06	0.06	0.06	0.05

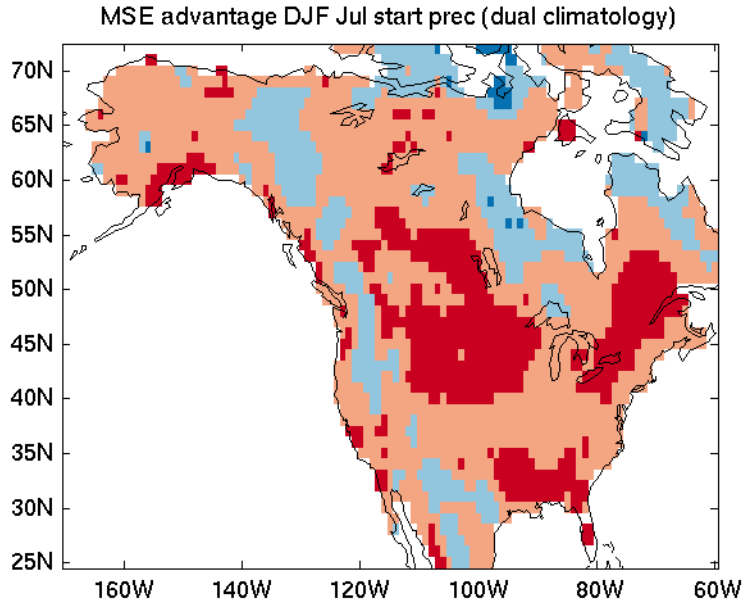
Brier Skill Score for Nino3.4

	A/N/B	Lead 0	Lead 1	Lead 2	Lead 3	Lead 4	Lead 5
CFS (24 Members)	Above	0.54	0.45	0.39	0.33	0.28	0.25
	Normal	0.10	0.05	0.03	0.03	0.03	0.02
	Below	0.49	0.43	0.40	0.38	0.36	0.35
Mini-NMME (24 Members)	Above	0.68	0.60	0.55	0.48	0.42	0.37
	Normal	0.34	0.24	0.18	0.15	0.13	0.09
	Below	0.66	0.59	0.56	0.53	0.49	0.45
Full NMME	Above	0.68	0.61	0.55	0.49	0.43	0.38
	Normal	0.35	0.25	0.19	0.16	0.14	0.11
	Below	0.65	0.58	0.54	0.52	0.49	0.46

Mean Squared Error Sign Test



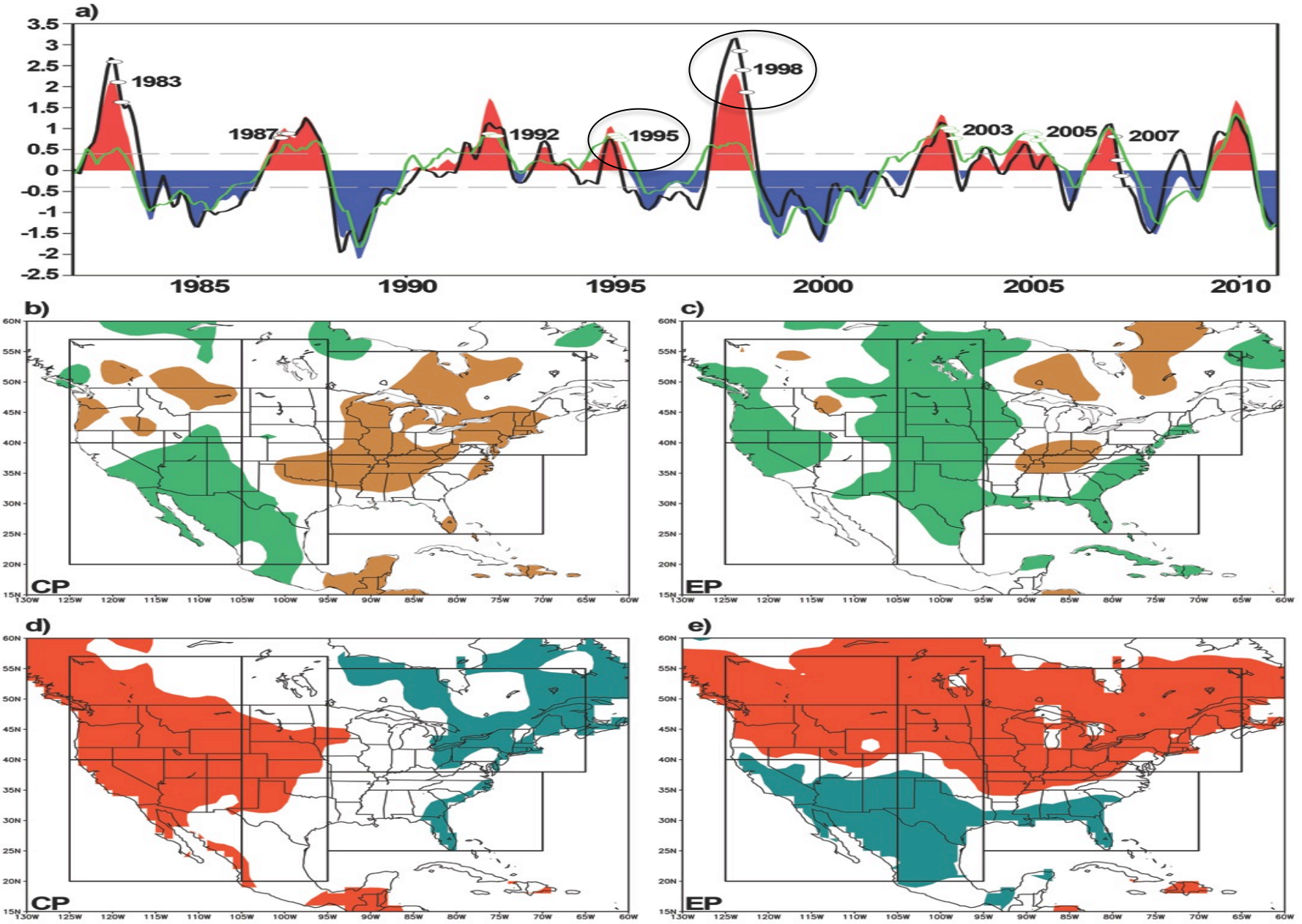




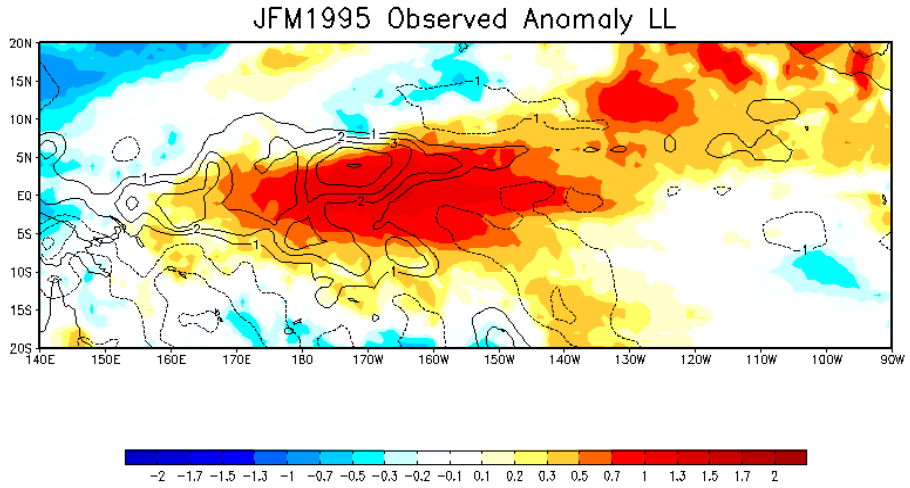
NMME Seasonal Prediction Science

- **Real-Time Effort – Model Upgrades**
  - **CMC1, CMC2, FLOR, CCSM4, CESM1**
- **Quantifying the NMME Benefit**
  - **Model Diversity**
- **Prediction and Predictability Research**

Central Pacific vs. East Pacific Warm Events



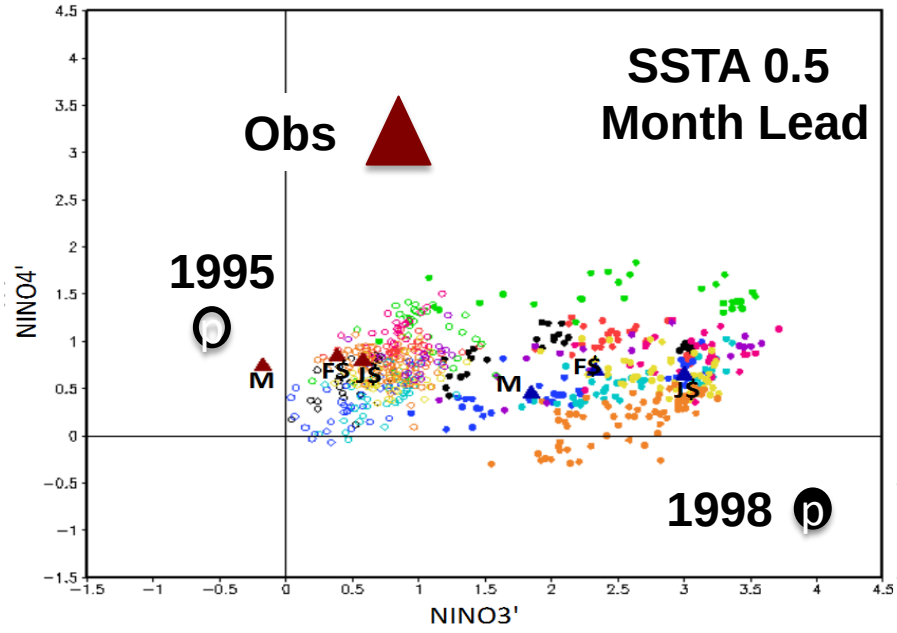
Infanti and Kirtman 2014, JClim

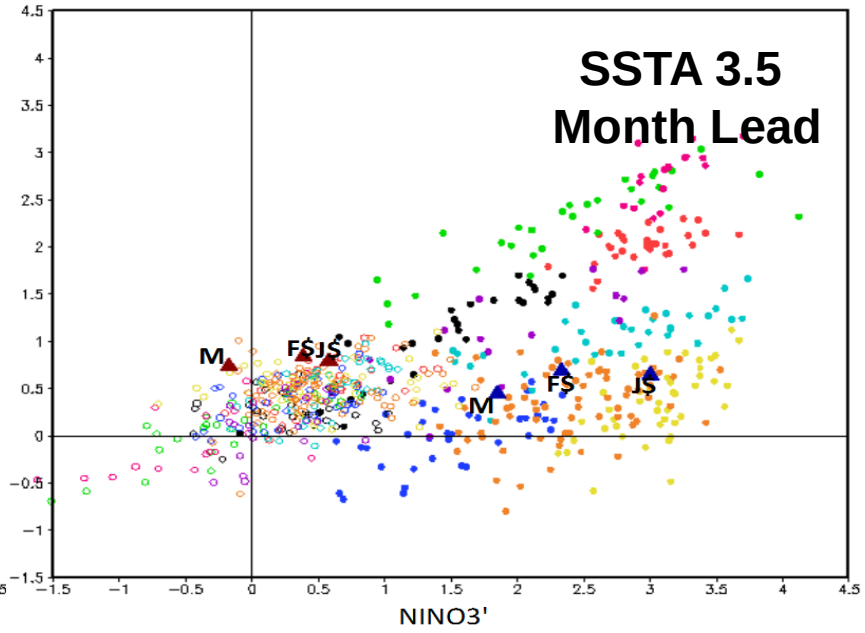


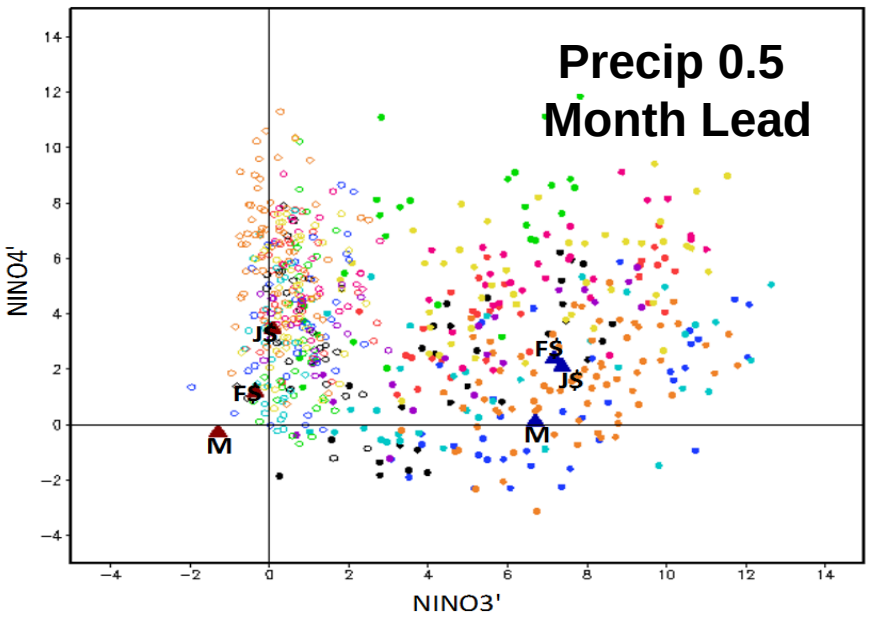
) – Long Lead

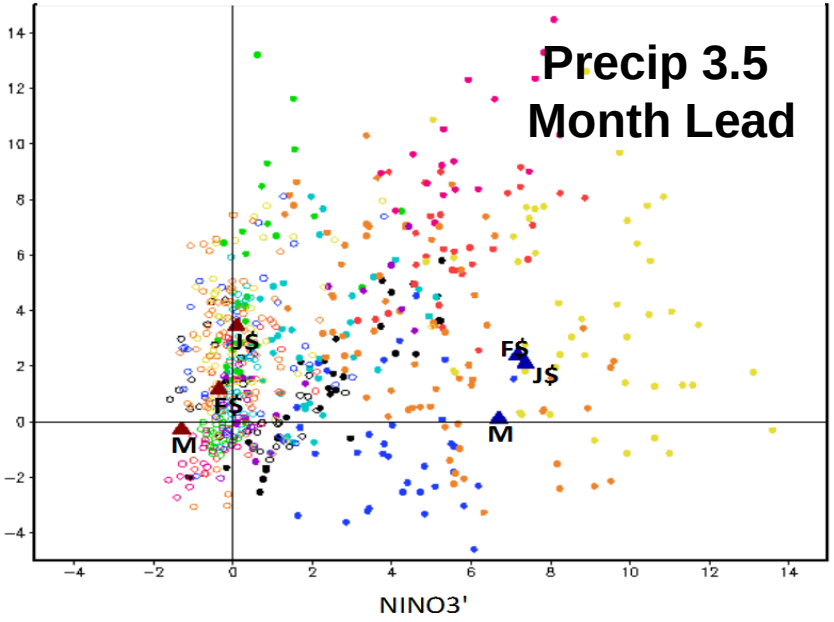
NMME JFM1998 (EP) – Short Lead

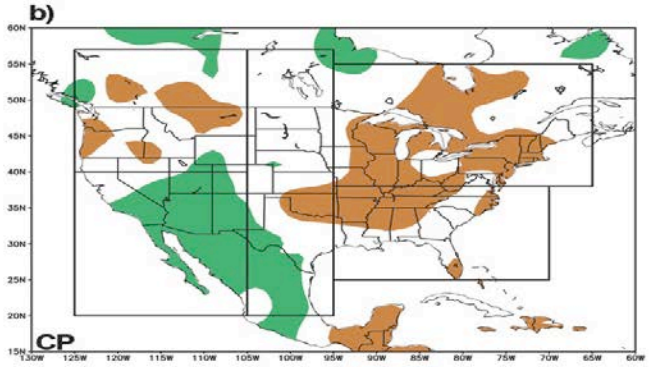
NMME JFM1998 (EP) – Long Lead

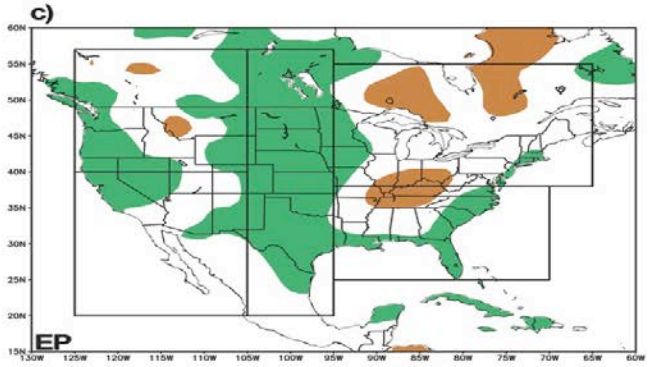

SSTA 0.5
Month Lead
Obs
1995
1998
M
FS
JS
NINO4'
NINO3'


SSTA 3.5
Month Lead
M
FS
JS
NINO3'


Precip 0.5
Month Lead
M
FS
JS
NINO4'
NINO3'

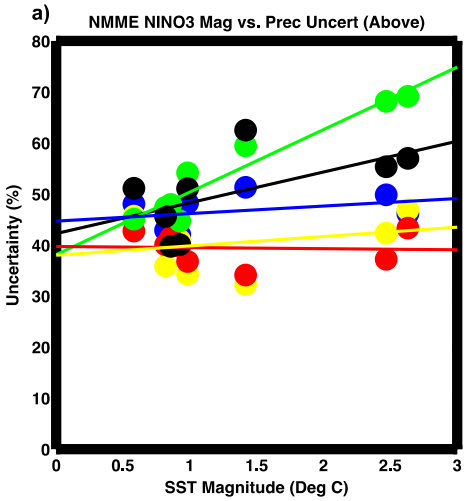

Precip 3.5
Month Lead
M
FS
JS
NINO3'



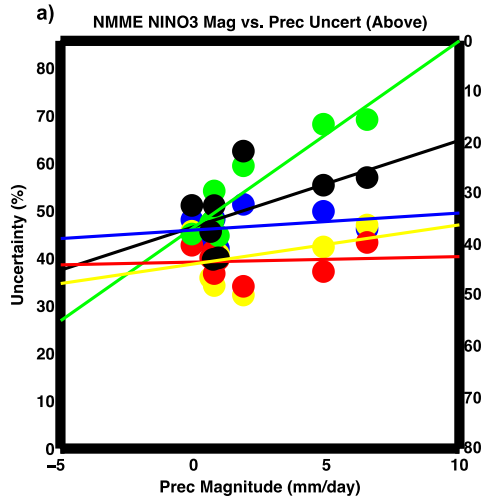


Observed Rainfall Composites

Tropical "SSTA" Forcing



Tropical "Precip" Forcing



Infanti and Kirtman 2014, JClim

NMME: Accomplishments

- **Introduced Four New Modeling Systems**
  - **Ensemble over 100 members**
- **Increased Real-Time Monthly Data to 8 Variables**
- **Provide Real-Time Bias Corrected Monthly Forecast Data**
  - **Over 2500 Figures Each Month**
- **Produced (October 2014) Most Comprehensive Seasonal Prediction Data set (1.5 PB)**
  - **Freely Available to the Entire Community**
- **Demonstrated that the Diversity of Models is Enhancing the Forecast Skill**
- **Testing a Sub-Seasonal Multi-Model Prediction Protocol**
- **New Prediction and Predictability Research**