

Why Multi-Model?

- Multi-Model Methodologies Are a Practical Approach to Quantifying Forecast Uncertainty Due to Uncertainty in Model Formulation
 - And, Apparently Improve Forecast Quality
- Larger Ensembles Yield Better Resolved Uncertainty Due to Initial Condition Uncertainty
- Multi-Model is also Multi-Institutional Bringing More Resources to the Effort
 - And, More Frequent Prediction System Updates

Phase 1 NMME

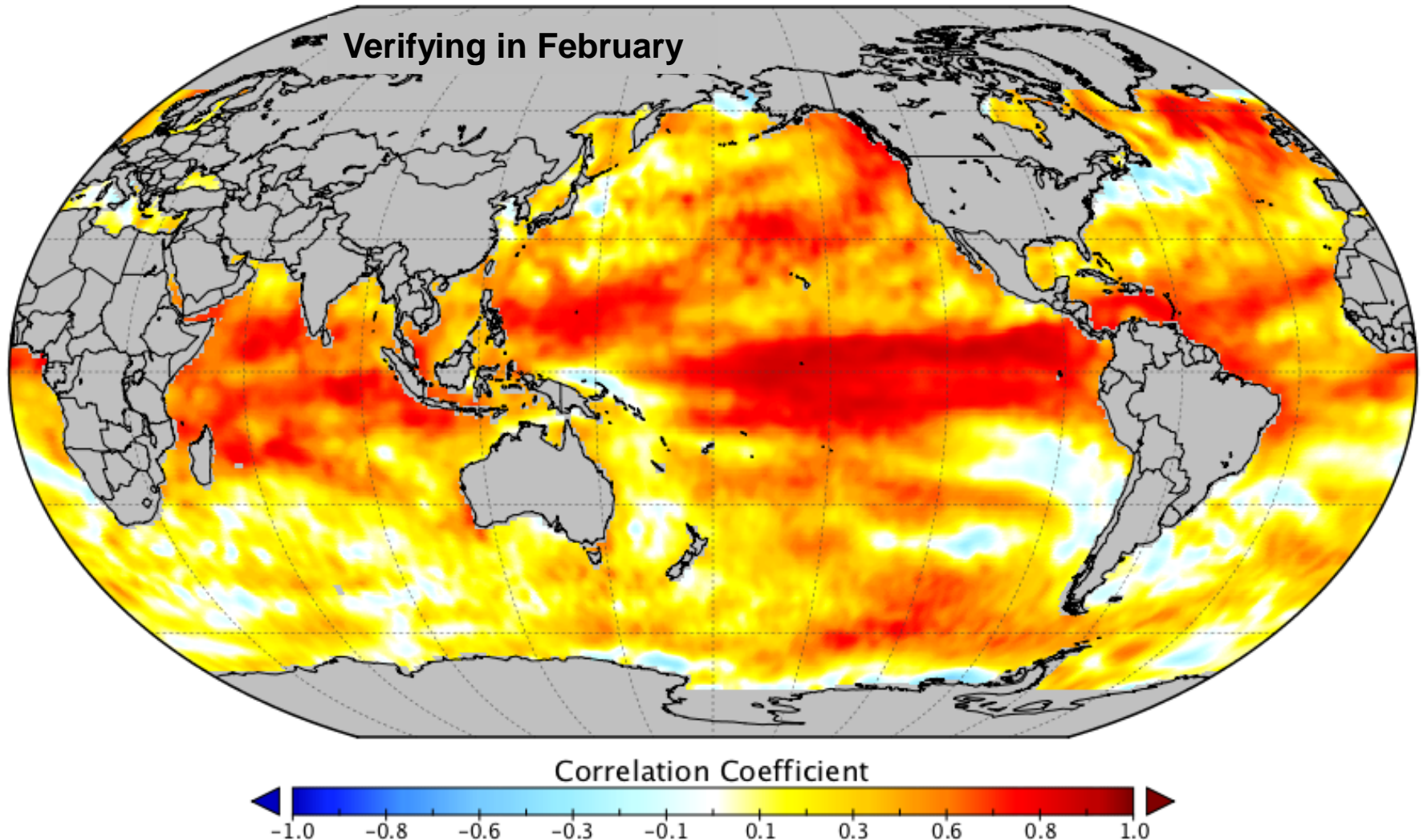
- **CTB NMME Workshops February 18, April 8, 2011**
 - Establish Collaboration and Protocol for Experimental Real-time Multi-Model Prediction
- **Protocol Developed**
- **Distributing Hindcast Data to CPC**
 - Public Dissemination via IRI Data Library
- **Became Real-Time in August 2011**
 - Adhering to CPC Operational Schedule

NMME Partners

- **University of Miami – RSMAS**
- **Nation Center for Atmospheric Research (NCAR)**
- **Center for Ocean-Land-Atmosphere Studies (COLA)**
- **International Research Institute for Climate and Society (IRI)**
- **University of Colorado – CIRES**
- **NASA – GMAO**
- **NOAA/NCEP/EMC/CPC**
- **NOAA/GFDL**
- **Canadian Meteorological Centre (Soon)**
- **Princeton University**

(Preliminary) Hindcast Quality Assessment

US NMME SSTA Correlation Coefficient
6 Month Lead August Initial Conditions (1982-2010)

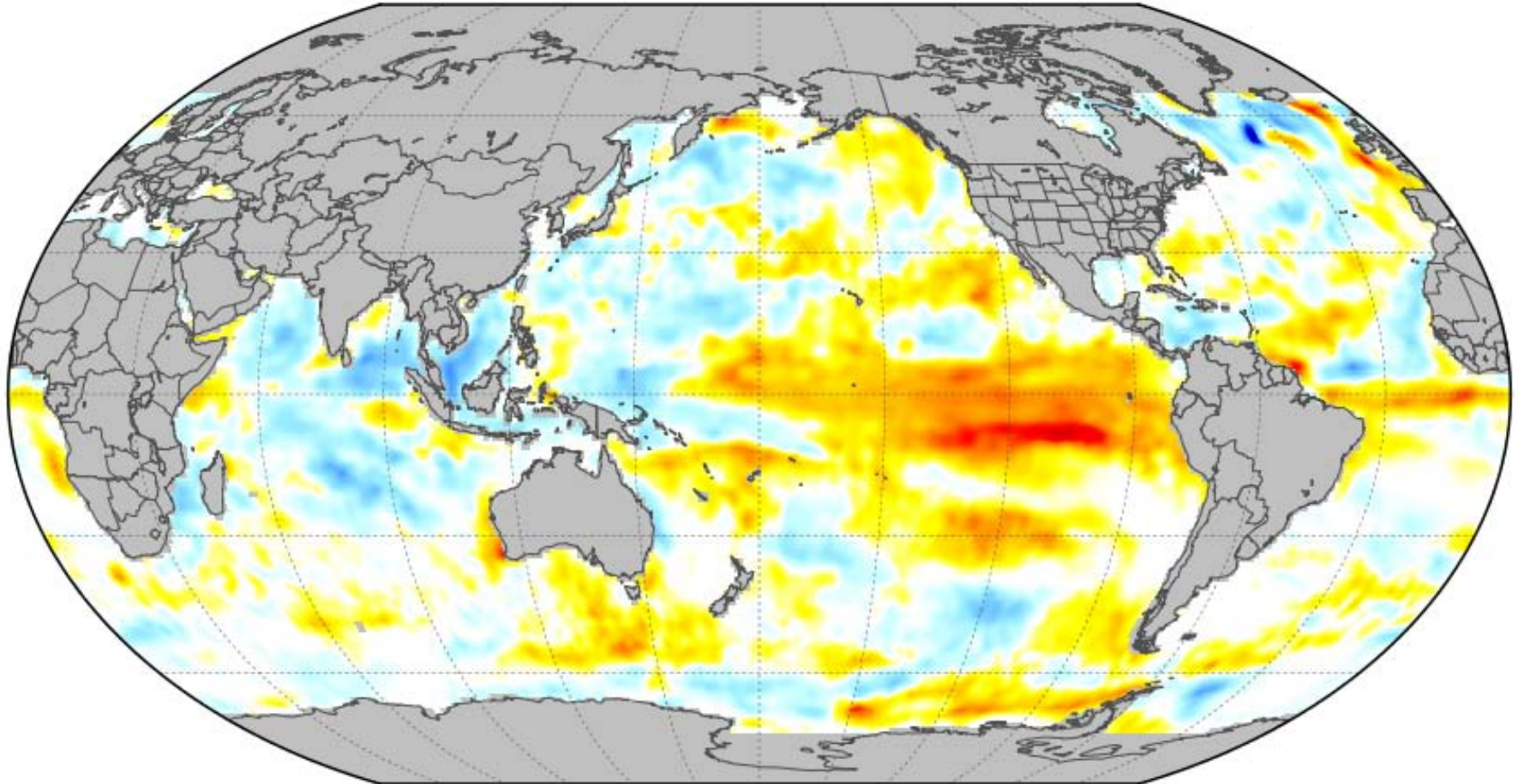


Each Ensemble Member from Each Model Weighted Equally – 83 Ensemble Members

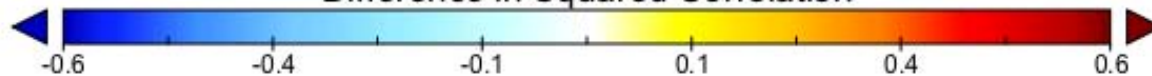
Complementary Correlation

CFSv2 vs. All Others (24 Member Ensembles)

Lead Time 6 Months (August Initial Conditions)



Difference in Squared Correlation

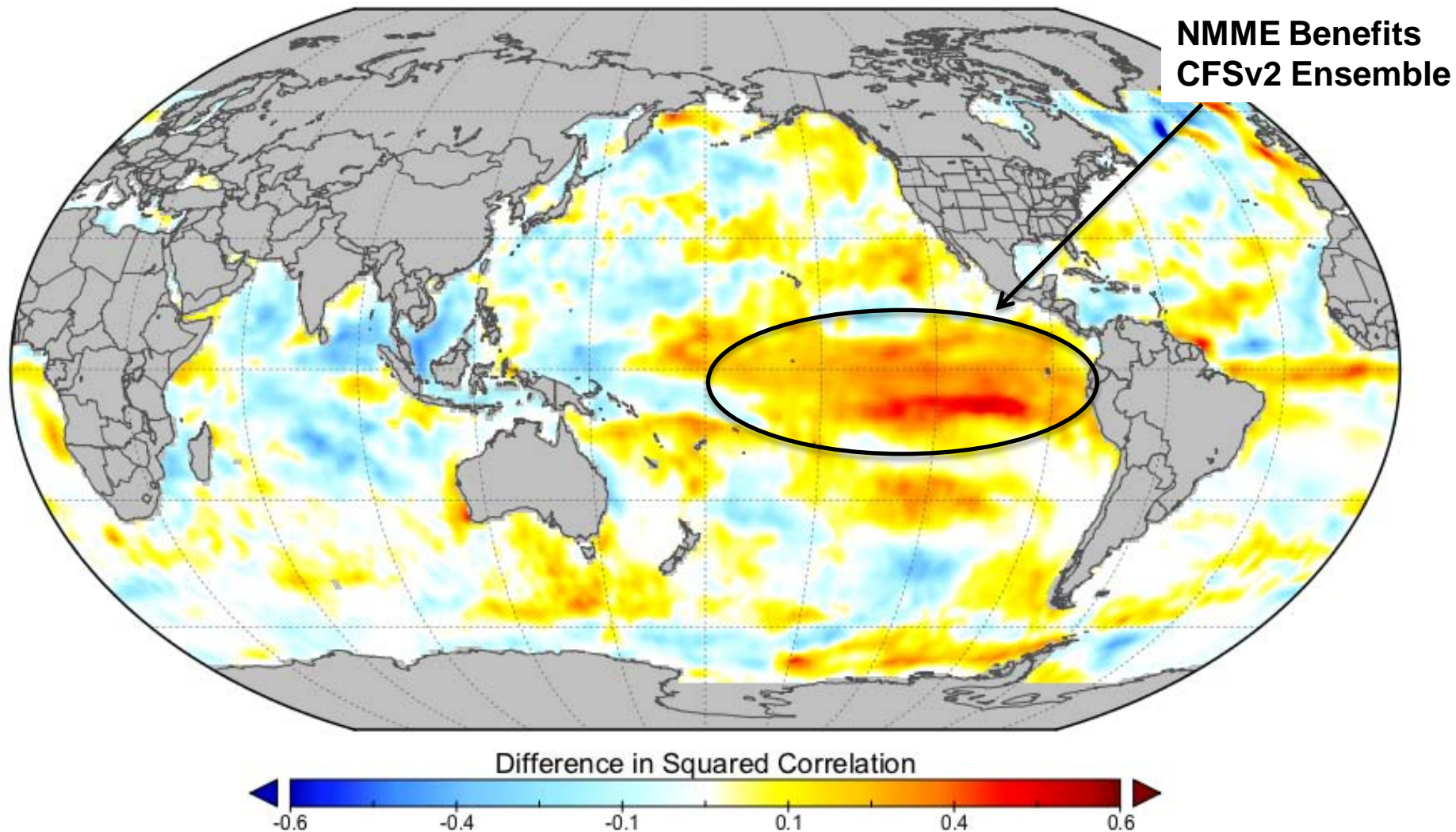


CFSv2(24) vs. CCSM3(4)+IRIa(4)+IRId(4)+CM2.1(4)+GEOS5(4)+CFSv1(4)

Complementary Correlation

CFSv2 vs. All Others (24 Member Ensembles)

Lead Time 6 Months (August Initial Conditions)

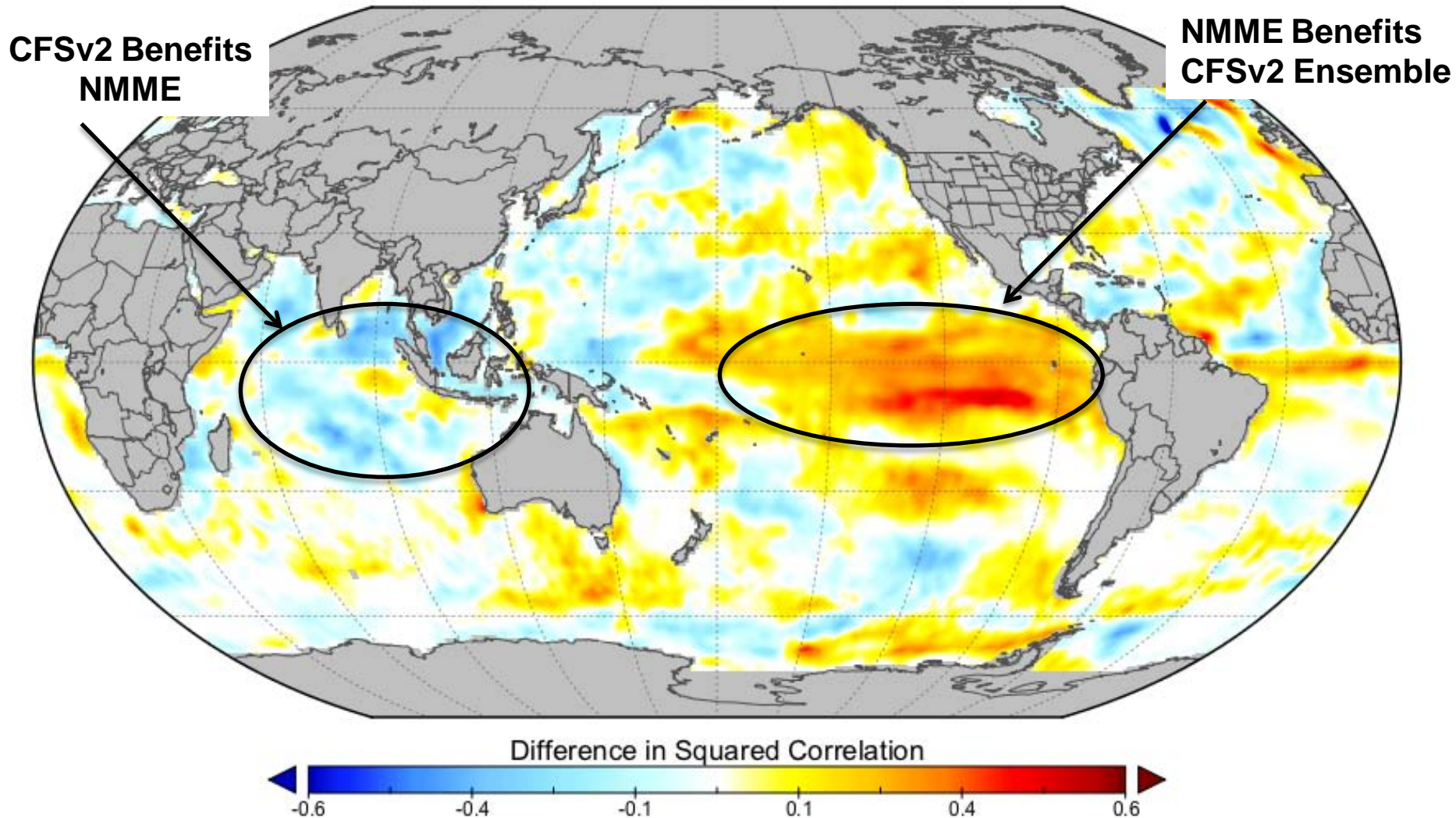


CFSv2(24) vs. CCSM3(4)+IRIa(4)+IRId(4)+CM2.1(4)+GEOS5(4)+CFSv1(4)

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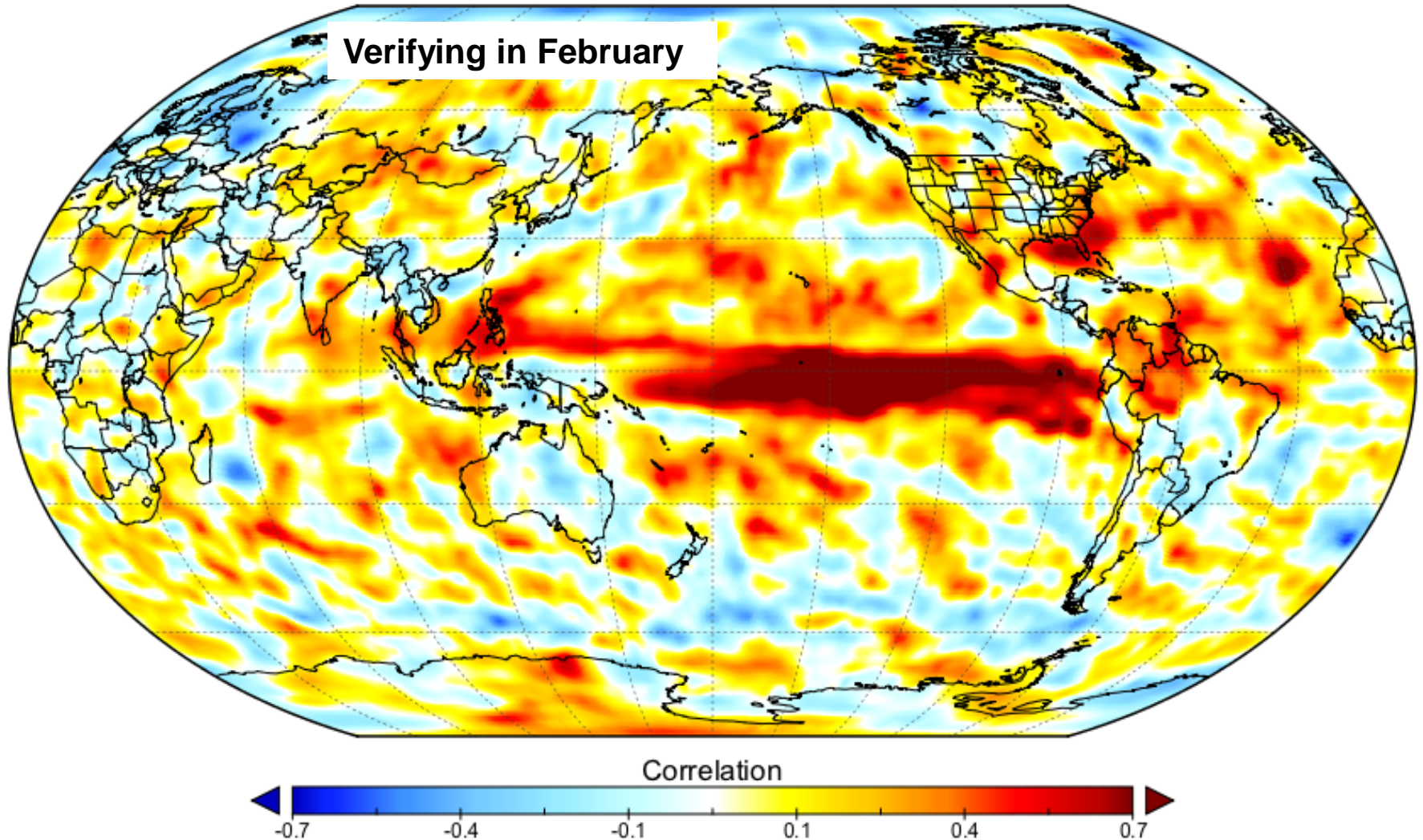


CFSv2(24) vs. CCSM3(4)+IRIa(4)+IRId(4)+CM2.1(4)+GEOS5(4)+CFSv1(4)

(Preliminary) Hindcast Quality Assessment

NMME Precipitation Correlation 6 Month Lead (August IC)

Each ensemble member weighted equally

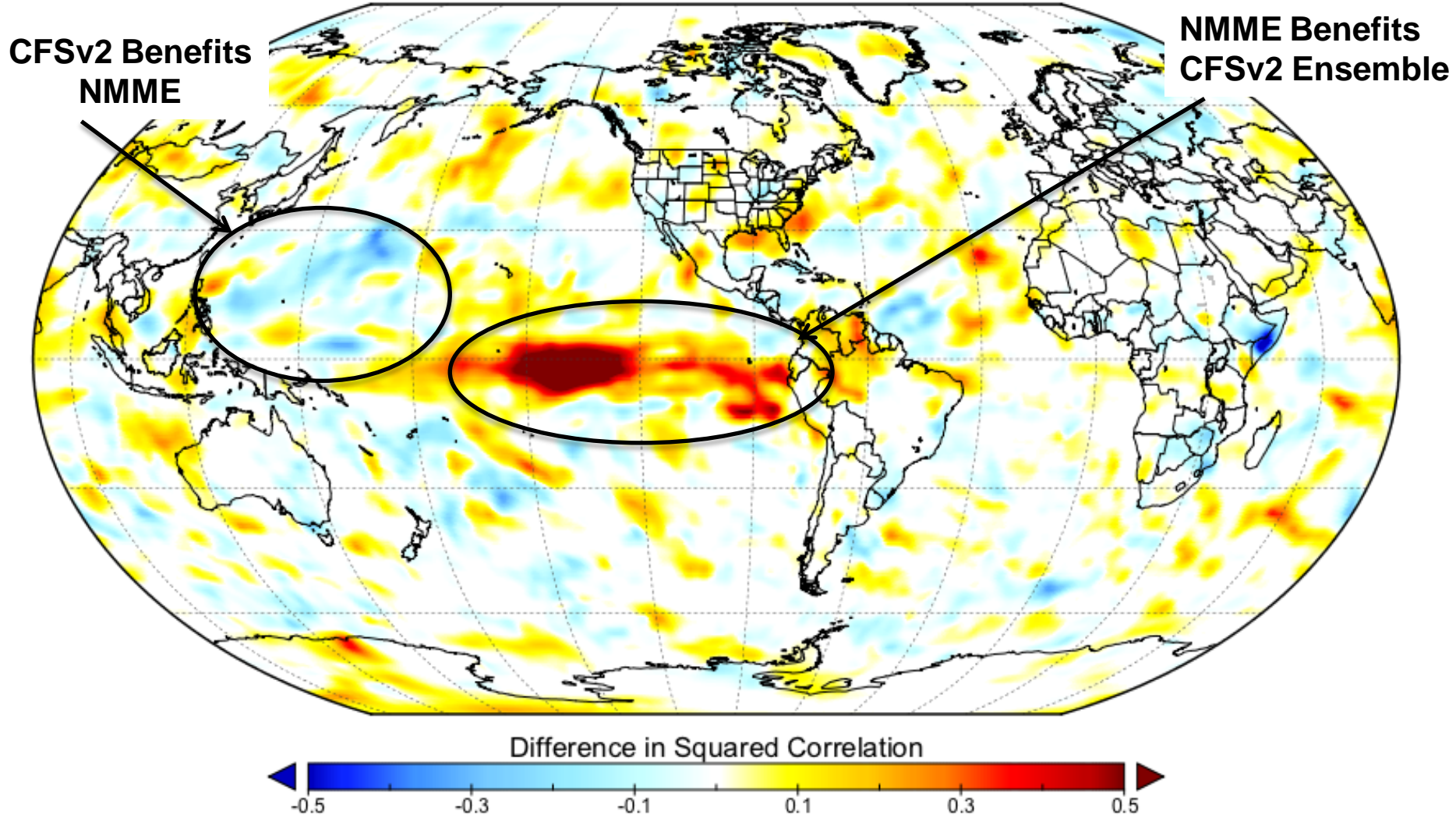


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Complementary Correlation

CFSv2 vs. All Others (24 Member Ensembles)

Lead Time 6 Months

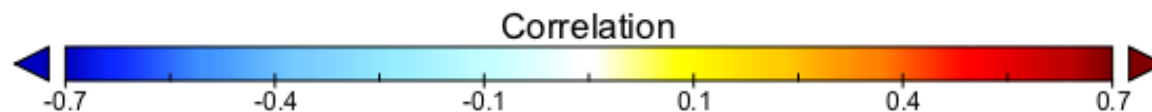
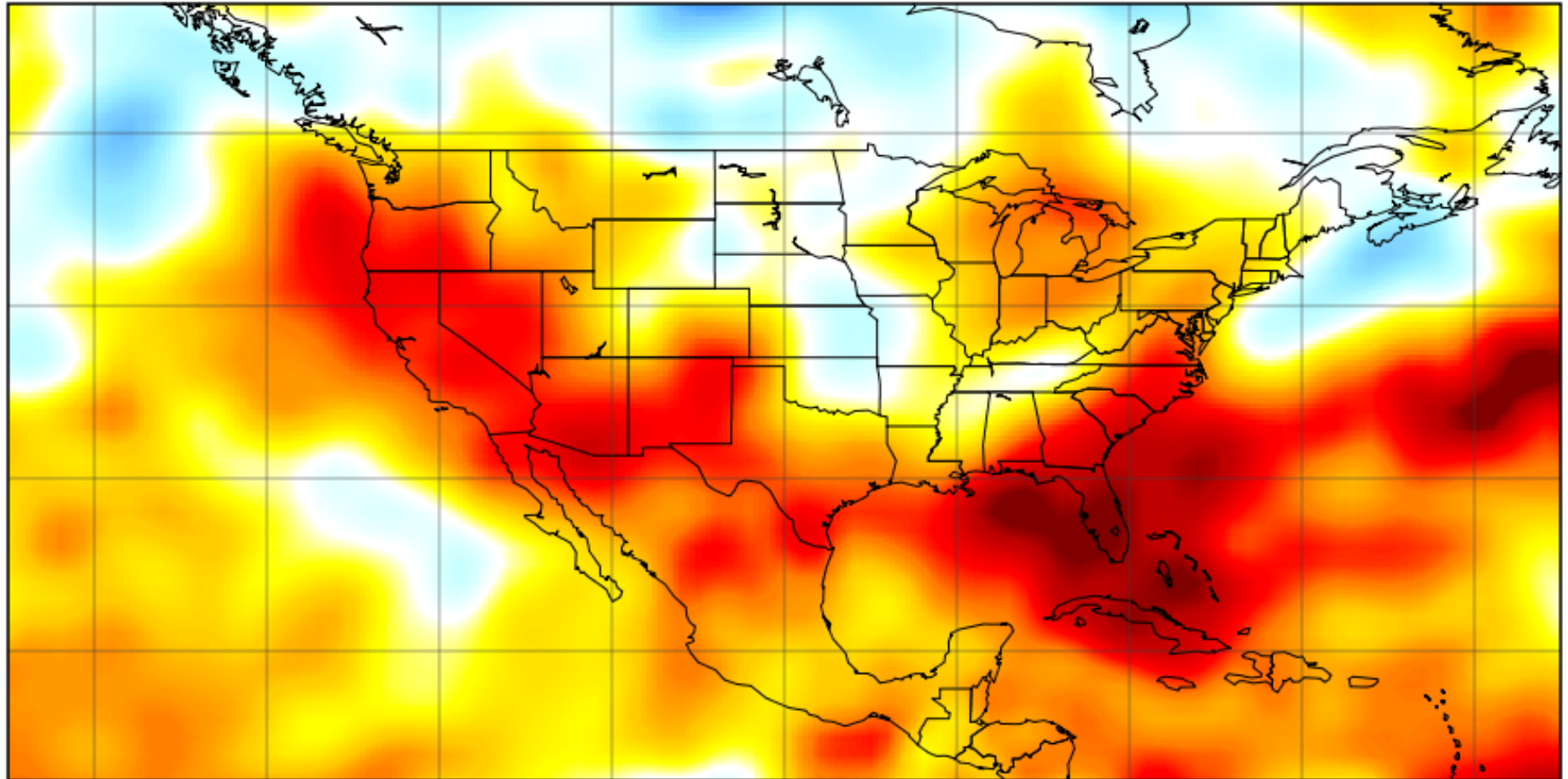


CFSv2(24) vs. CCSM3(4)+IRIa(4)+IRId(4)+CM2.1(4)+GEOS5(4)+CFSv1(4)

(Preliminary) Hindcast Quality Assessment

NMME Precipitation Correlation 2 Month Lead (December IC)

Each ensemble member weighted equally



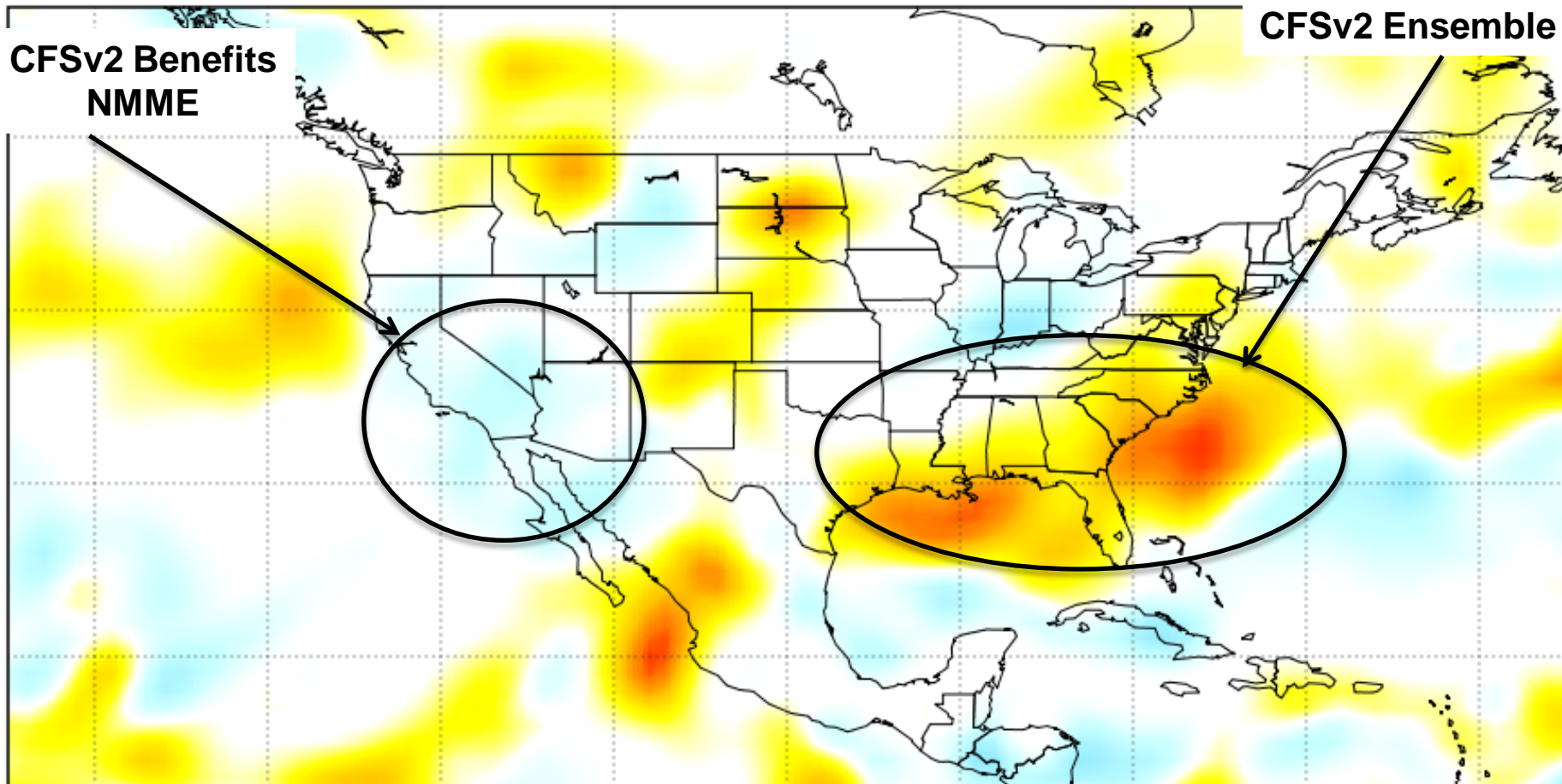
Each Ensemble Member from Each Model Weighted Equally – 83 Ensemble Members

CFSv2 vs. All Others (24 Member Ensembles)

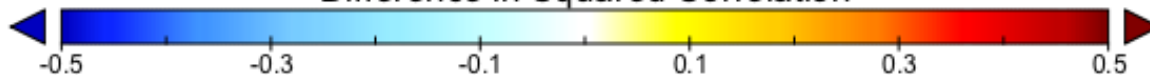
Lead Time 6 Months (August Initial Conditions)

**NMME Benefits
CFSv2 Ensemble**

**CFSv2 Benefits
NMME**



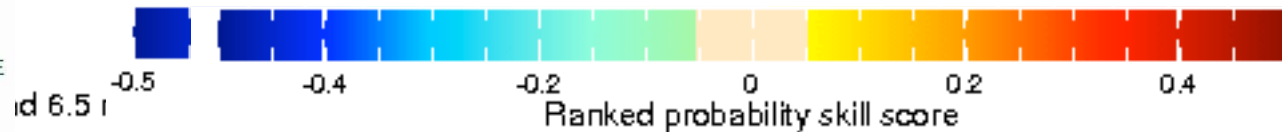
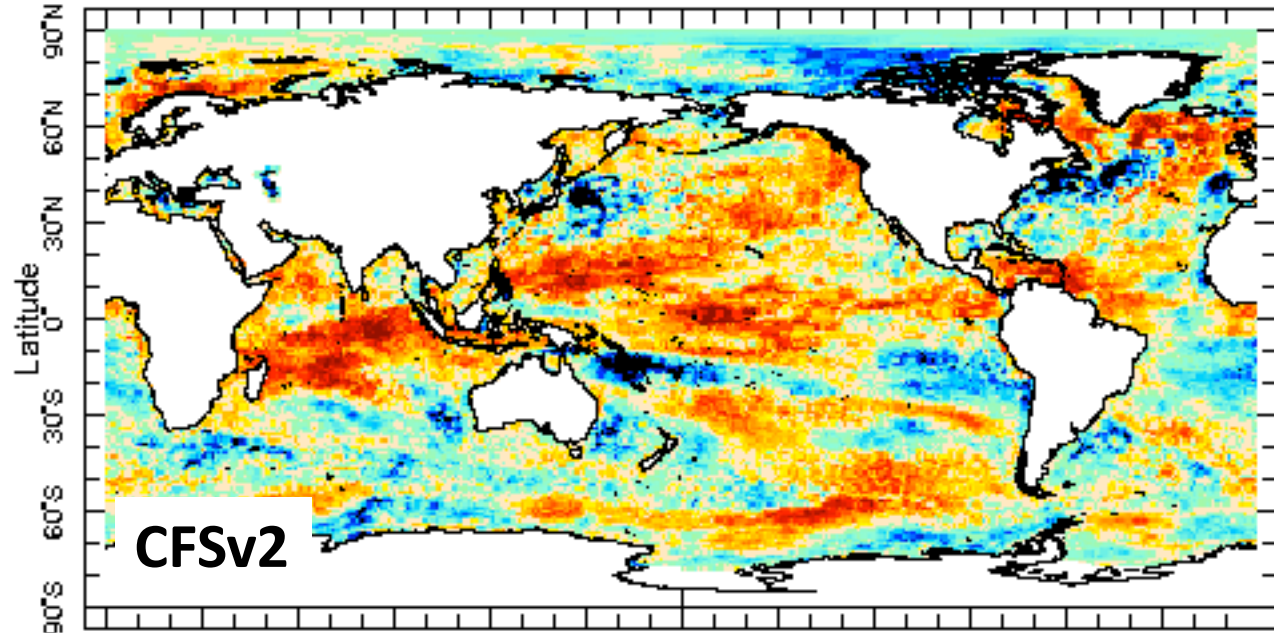
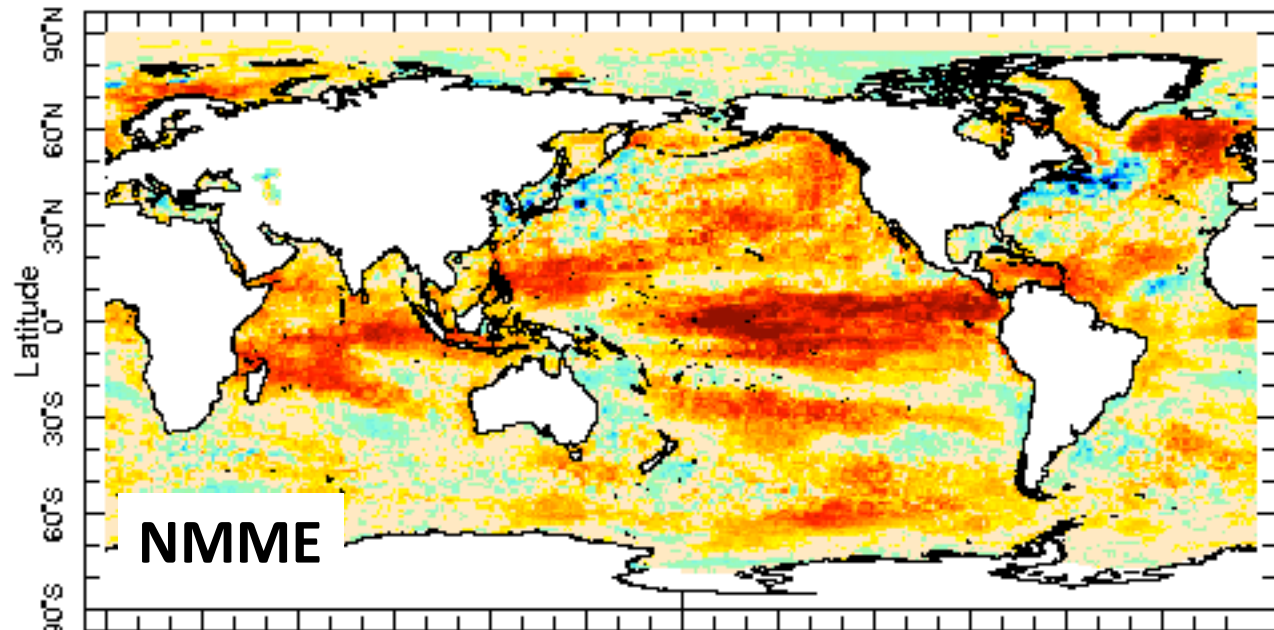
Difference in Squared Correlation



CFSv2(24) vs. CCSM3(4)+IRIa(4)+IRId(4)+CM2.1(4)+GEOS5(4)+CFSv1(4)

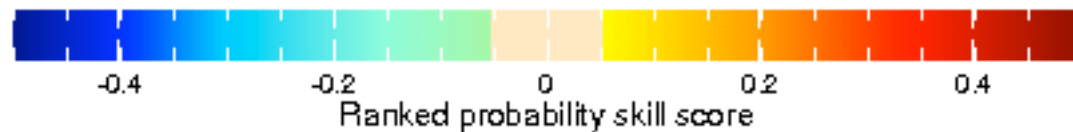
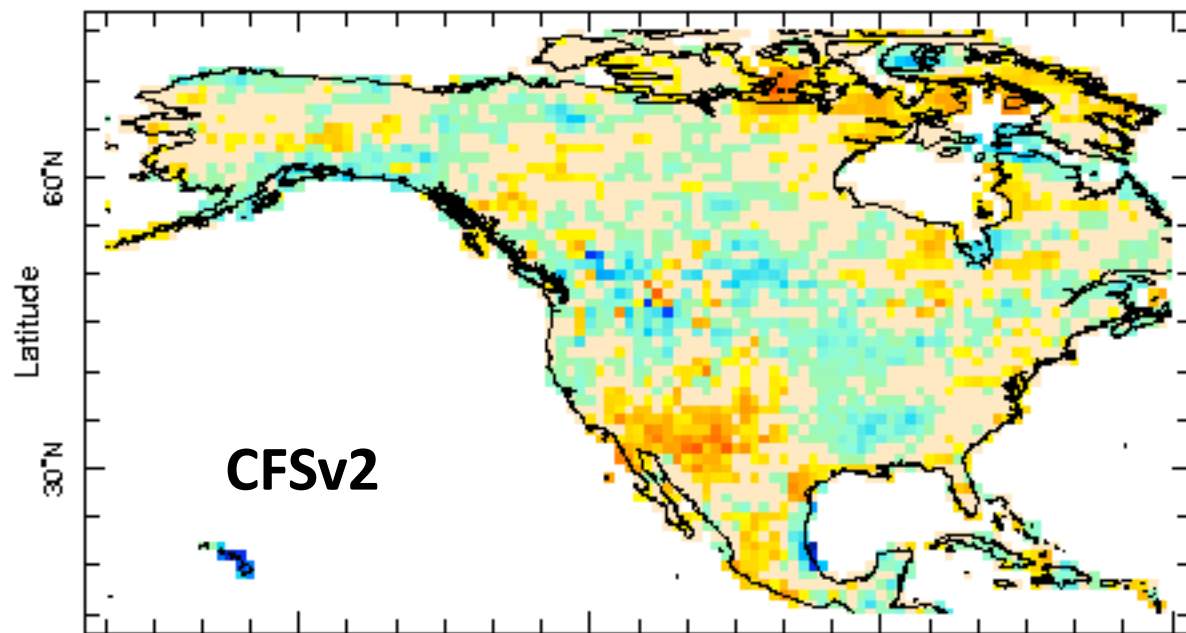
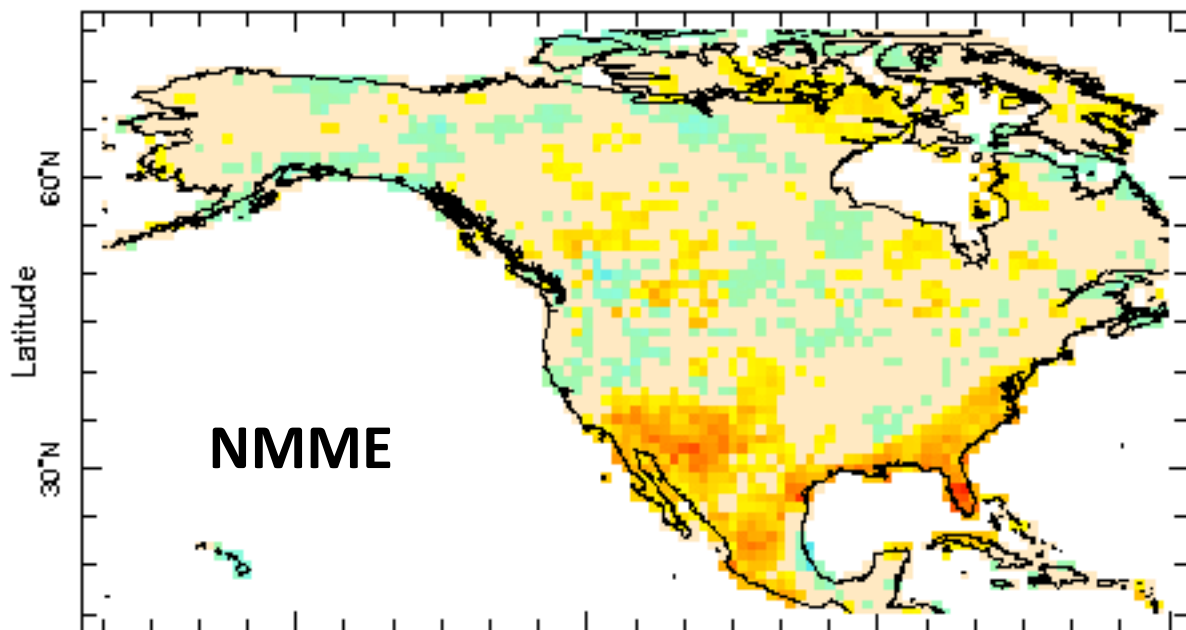


July 1 start
DJF SST
forecast
RPSS





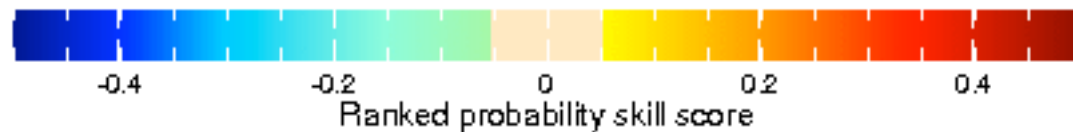
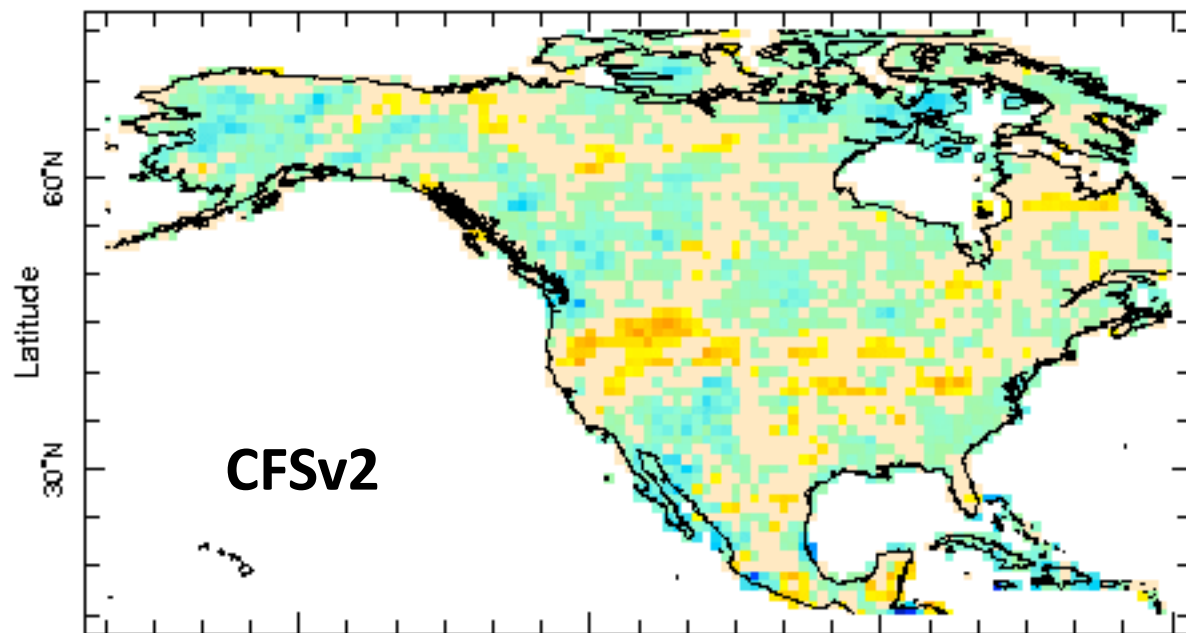
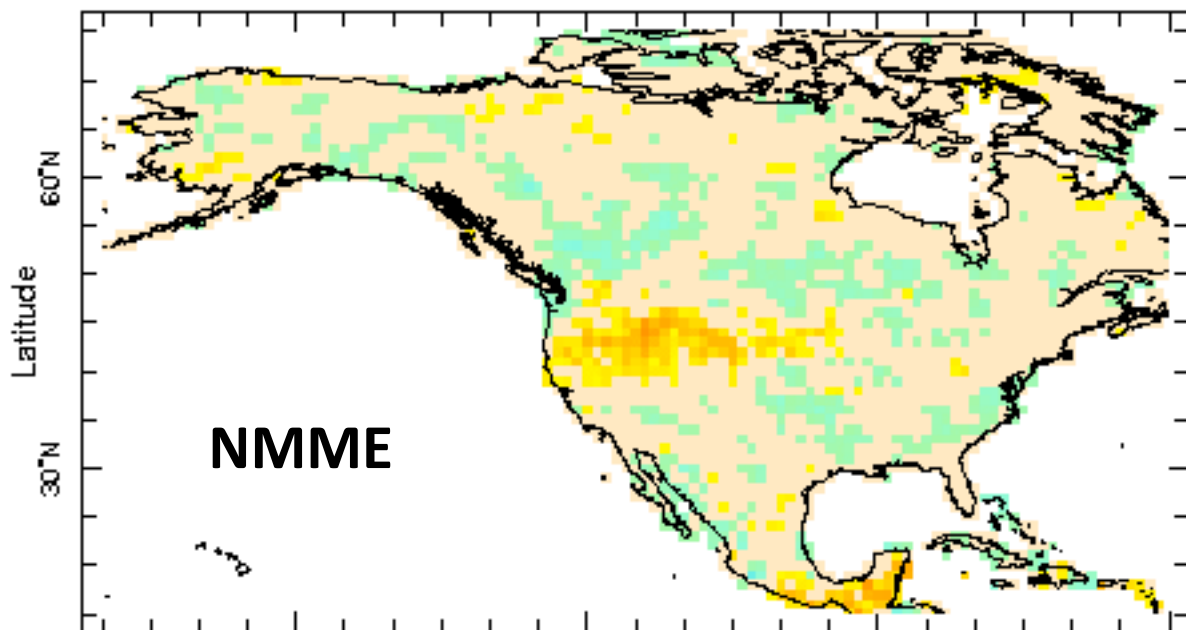
July 1 start
DJF prec
forecast
RPSS



lead 6.5 |



Jan 1 start
JJA prec
forecast
RPSS

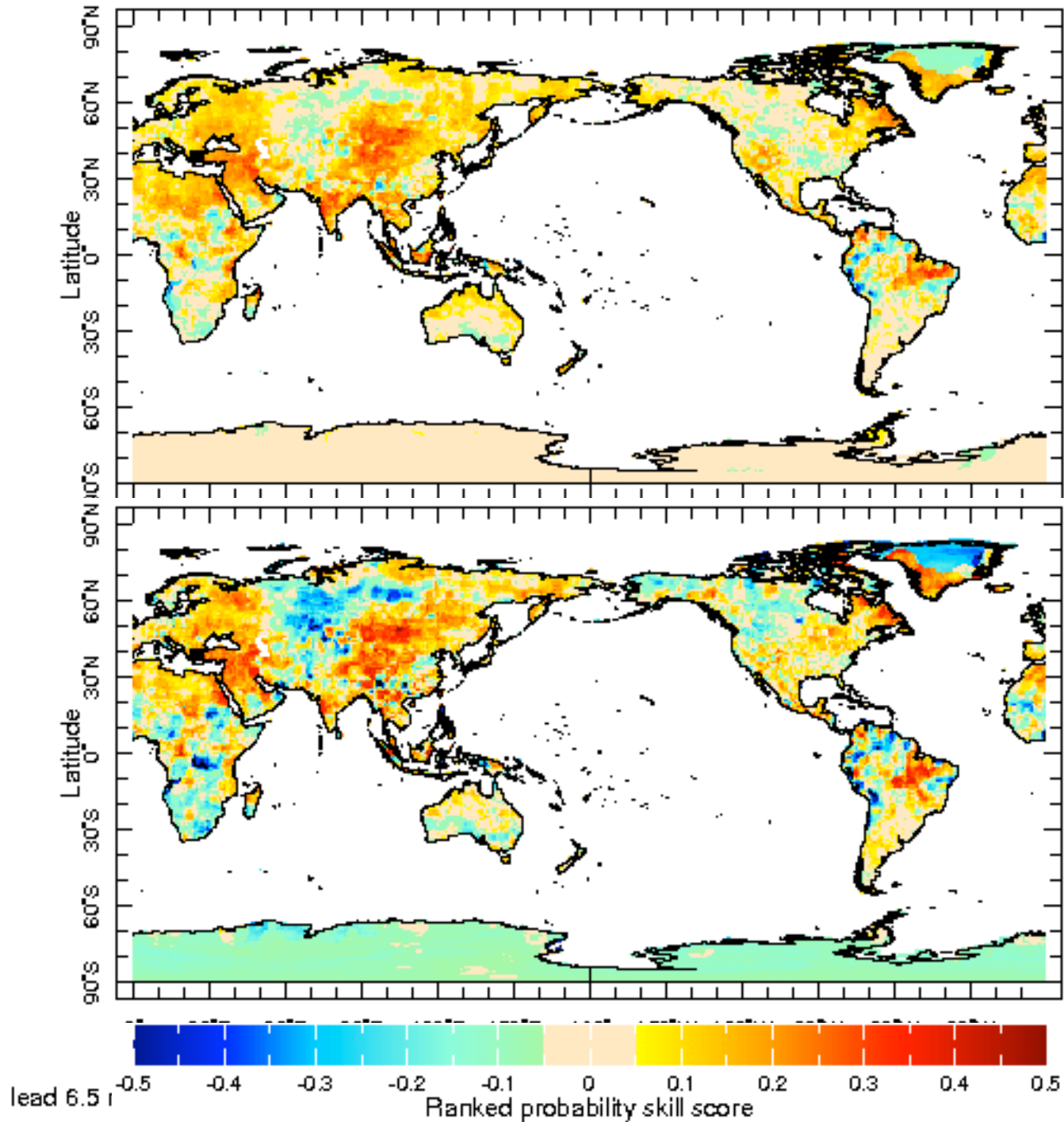


lead 6.5 |

Jan 1 start
JJA tref forecast
RPSS

NMME

CFSv2



Verification maproom

- <http://iri.columbia.edu/~tippett/NMME/>



The National Multimodel Ensemble

There is ample evidence of the need for a US national multi-model seasonal-to-interannual prediction system. It is in the Nation's interest to have a multi-model seasonal-to-interannual prediction capability independent of information that may be available from outside sources. The advantage of a MME prediction system is that it, in addition to providing additional forecast information for the surface air temperature and precipitation outlooks that are currently products of the Climate Prediction Center (CPC), the MME can also provide information about fields and phenomena that the US has specific interest in predicting: ENSO cycle, monsoons, intraseasonal variability and the Madden-Julian Oscillation. (Ben P. Kirtman and Dughong Min)

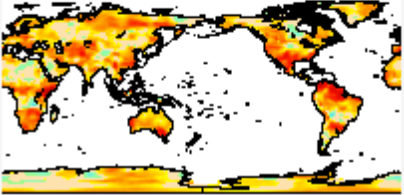
Verification

Precipitation
Near-surface temperature
SST

Precipitation

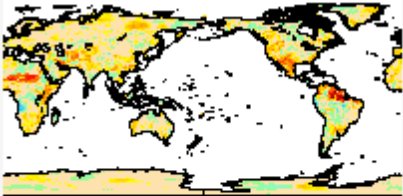
Anomaly correlation

This map shows the anomaly correlation between NMME forecast precipitation and observations as a function of start and lead.



RPSS

This map shows the RPSS for NMME forecast precipitation as a function of start and lead.



Share



- http://iri.columbia.edu/~shuhua/mis-html/Reliability_nmme.html



The International Research Institute
for Climate and Society

NMME Reliability Diagrams

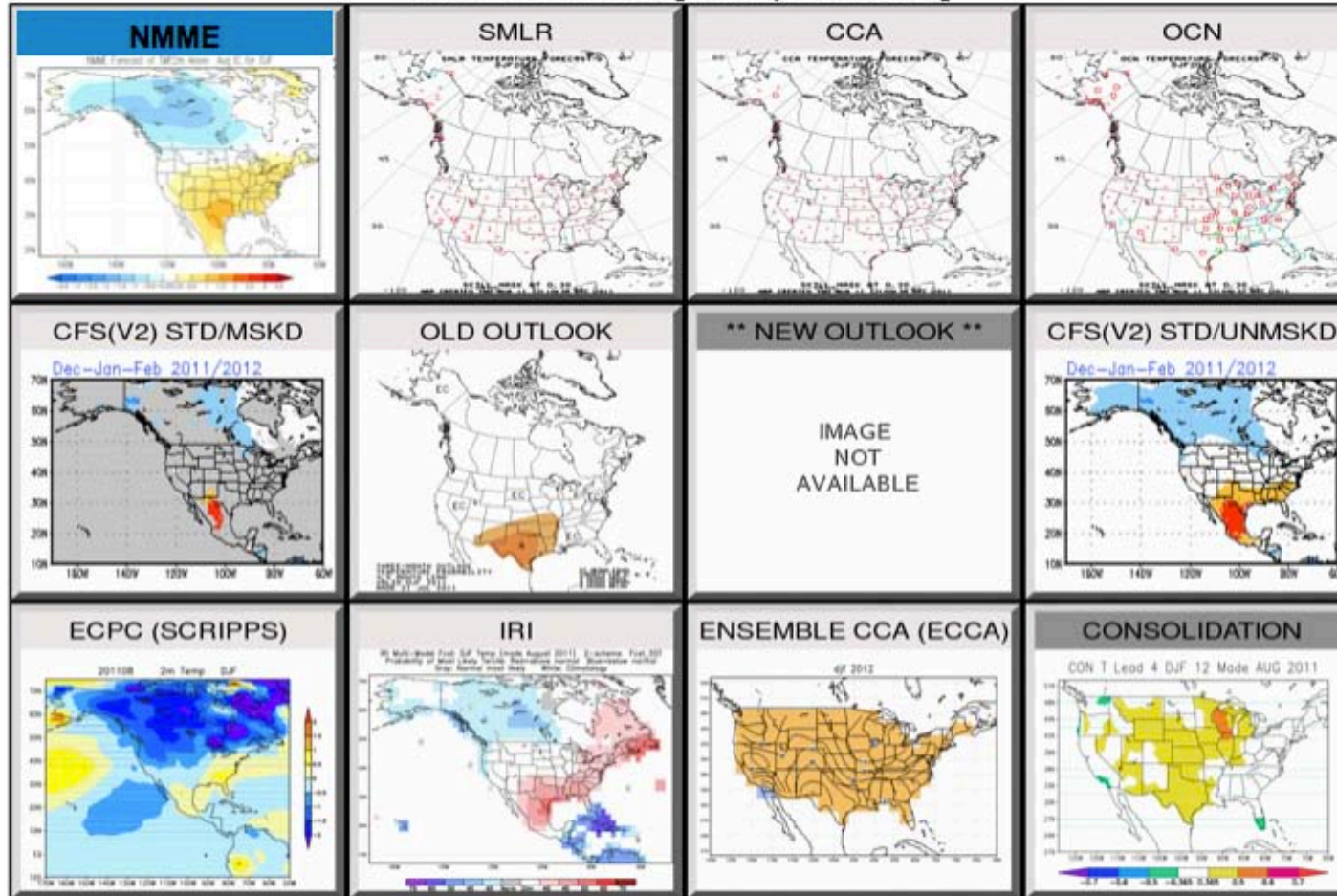
Period: 1982-2010

Lead: <ul style="list-style-type: none"><input checked="" type="radio"/> Lead-1<input type="radio"/> Lead-2<input type="radio"/> Lead-3<input type="radio"/> Lead-4<input type="radio"/> Lead-5<input type="radio"/> Lead-6	Season: <ul style="list-style-type: none"><input checked="" type="radio"/> DJF<input type="radio"/> JFM<input type="radio"/> FMA<input type="radio"/> MAM<input type="radio"/> AMJ<input type="radio"/> MJJ<input type="radio"/> JJA<input type="radio"/> JAS<input type="radio"/> ASO<input type="radio"/> SON<input type="radio"/> OND<input type="radio"/> NDJ
Variable: <ul style="list-style-type: none"><input checked="" type="radio"/> Precipitation<input type="radio"/> 2m Air Temperature<input type="radio"/> Sea Surface Temperature	Region: <ul style="list-style-type: none"><input checked="" type="radio"/> Globe<input type="radio"/> Tropics (25S-25N)
<input type="button" value="Reset"/> <input type="button" value="Submit"/>	Note: For the tropics, the reliability diagrams are only available for precipitation.

Area Averaged Correlation (R^2) Over North America: Model Ranks

	Mod A	Mod B	Mod C	Mod D	Mod E	Mod F	Mod G	NMME
JFM P (August IC)	4	6	5	8	7	3	2	1
JFM T2m (August IC)	3	1	5	6	7	4	8	2
MJJ P (December IC)	5	7	1	2	8	6	3	4
MJJ T2m (December IC)	6	1	3	4	8	7	5	2
Mean Rank	4.5	3.75	3.5	5.0	7.5	5.0	4.5	2.2

DJF Season [Temperature]



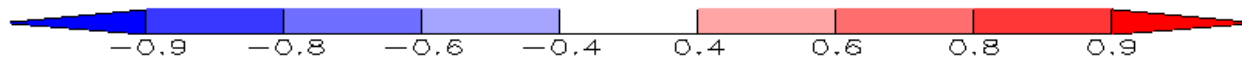
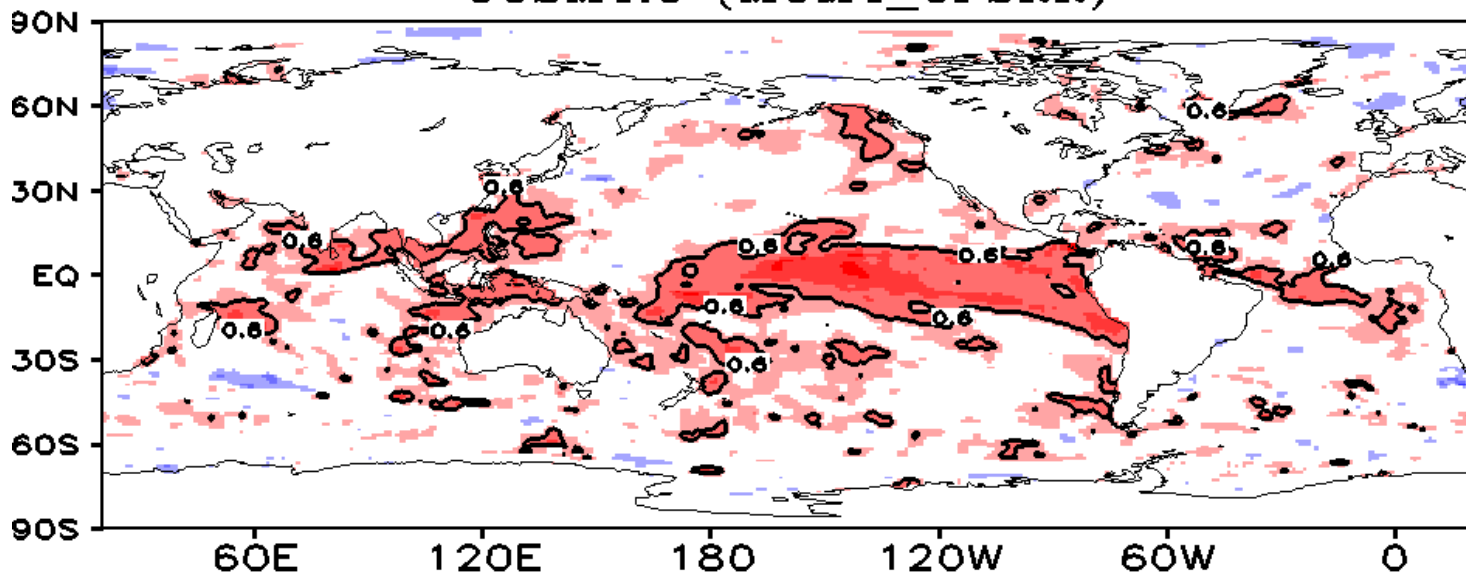
CPC Seasonal Prognostic Map Discussion (PMD):

“PROGNOSTIC TOOLS USED FOR U.S. TEMPERATURE AND PRECIPITATION OUTLOOKS OUTLOOKS FOR JFM THROUGH AMJ 2012 WERE PRIMARILY BASED ON THE NEW NATIONAL MULTI-MODEL ENSEMBLE MEAN FORECAST (NMME). THE FORECASTS STRONGLY AGREE WITH ...”

Phase 2 NMME

- **Continue Experimental Real-Time Predictions**
- **Enhancing Current NMME Capability**
 - Model Updates: GFDL-CM2.5 (20 km AGCM), IRI (T106), CCSM4, CESM1
- **Assess Forecast Quality**
 - MME Combinations, Model Independence
 - Drought Assessment
 - Include: soil moisture, runoff, evaporation
- **Sub-Seasonal Assessment**
 - Forecast Protocol
- **Initial Condition Sensitivity Experiments**
 - Ocean, Land
- **Improved Data Distribution**
 - NCAR To Host

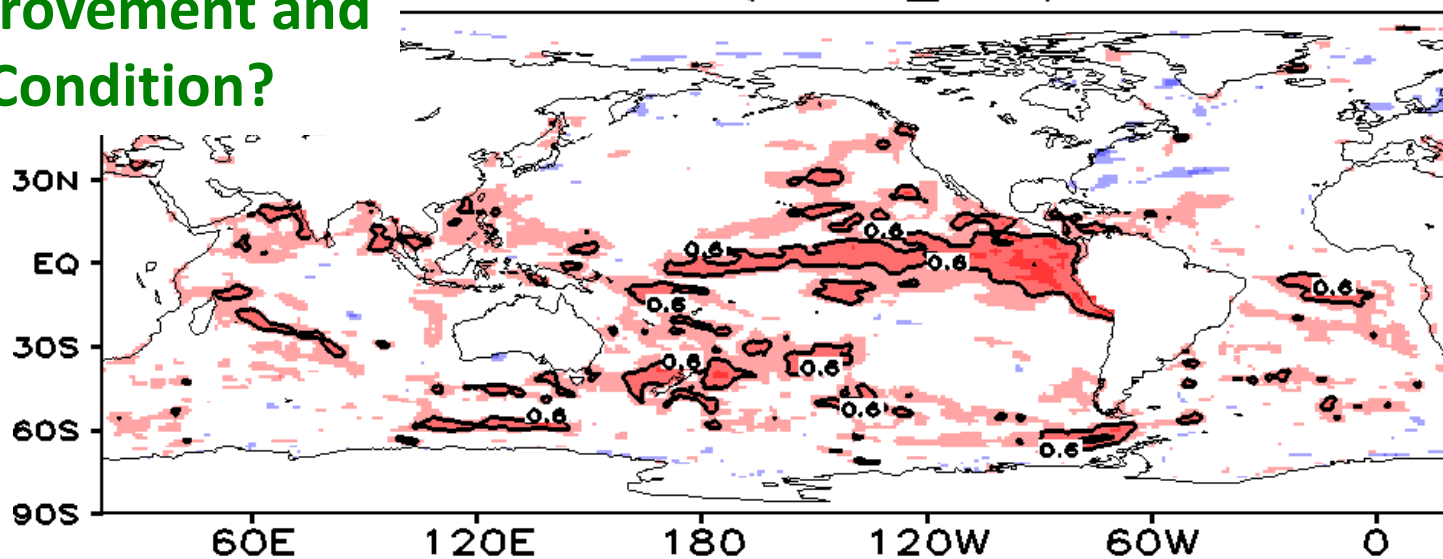
CCSM4.0 (MOM4_CFSRR)



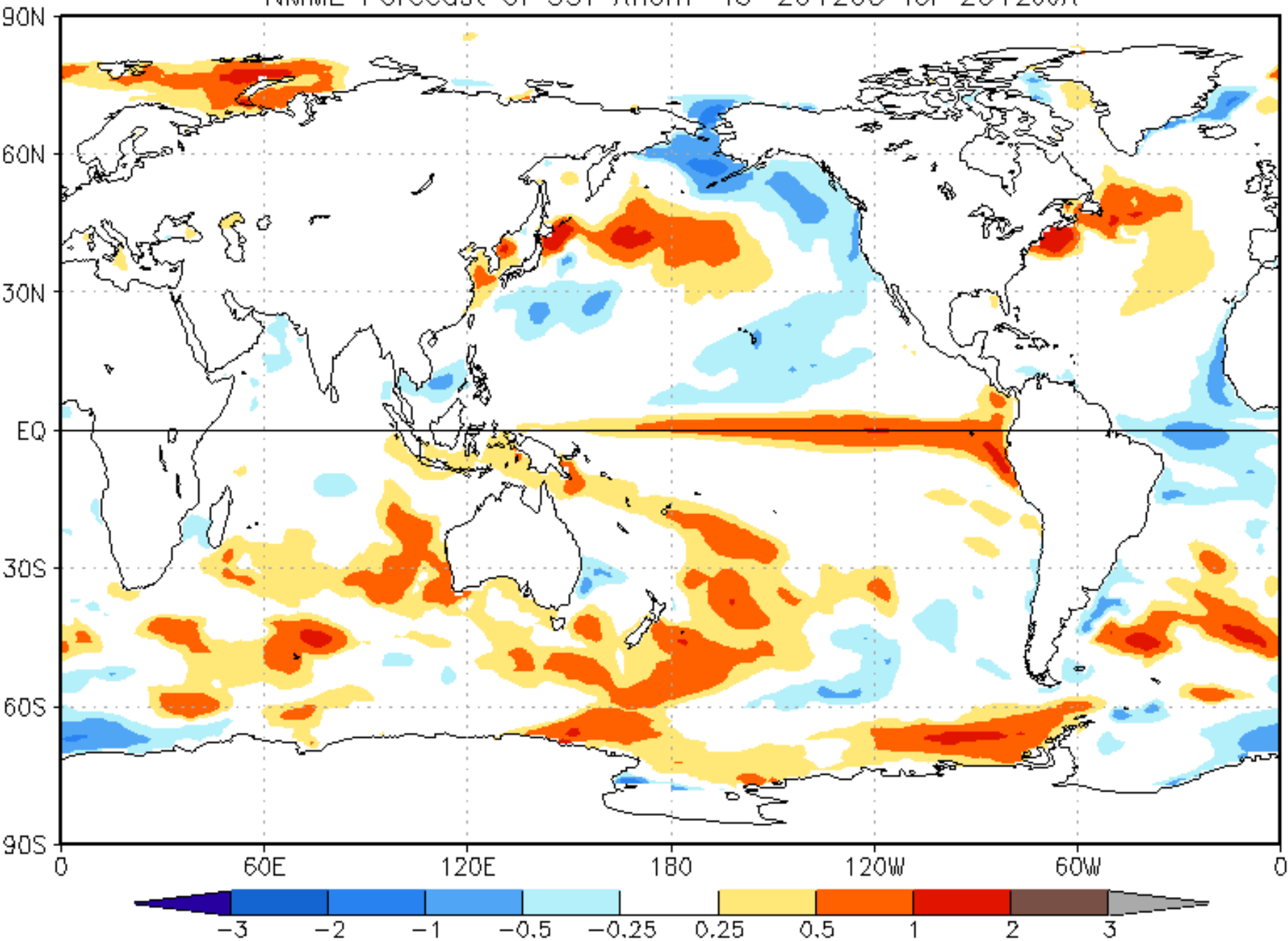
May Initial
Conditions
3-Months Lead

Improved Correlation Due
to Model Improvement and
Better Initial Condition?

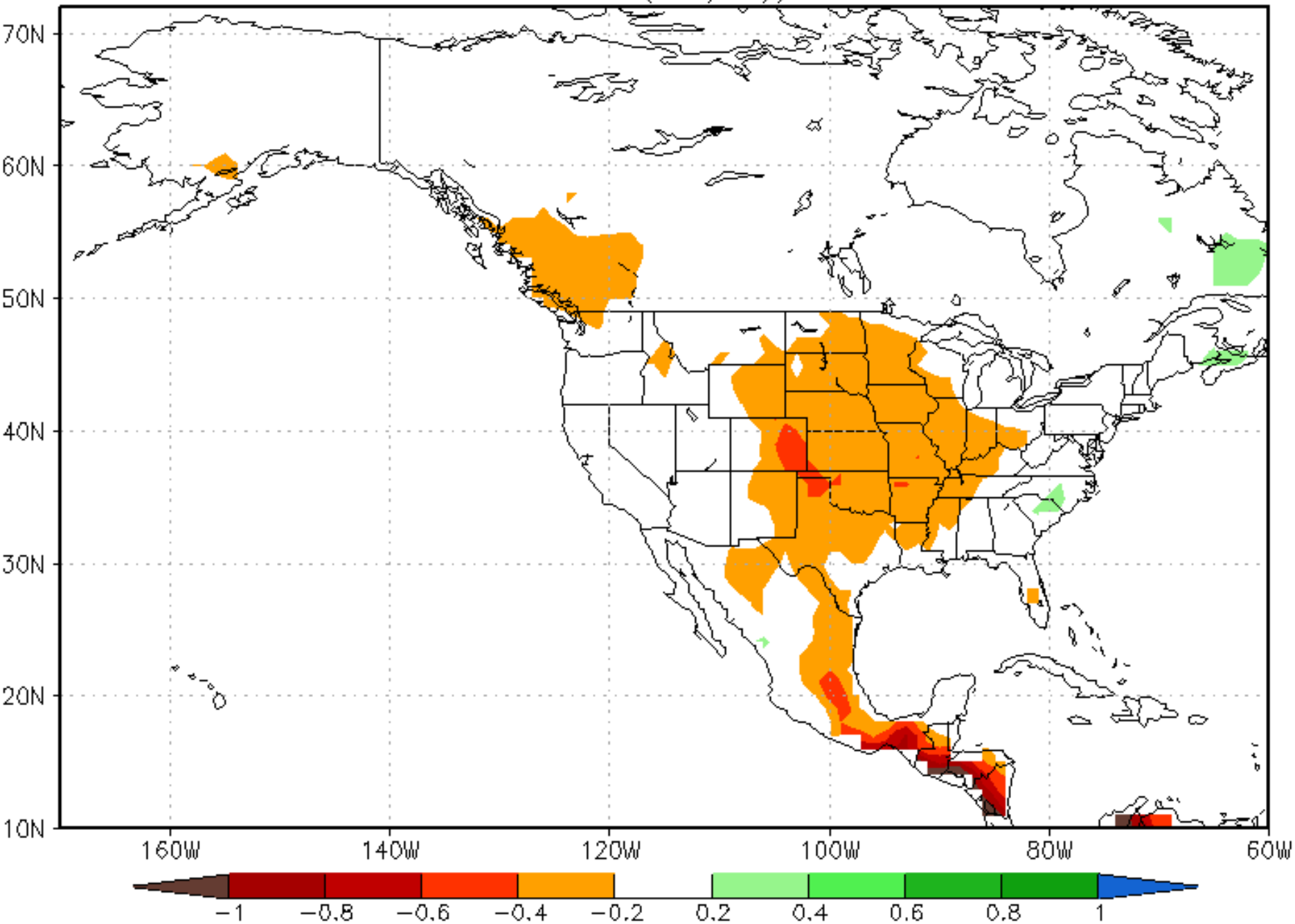
CCSM3.0 (MOM3_ODA)



NMME Forecast of SST Anom IC=201205 for 2012JJA



NMME Forecast of Prate Anom (mm/day) IC=201205 for 2012JJA



NMME

Data <http://iridl.ldeo.columbia.edu/home/.tippett/.NMME>

Skill maps

<http://iri.columbia.edu/~tippett/NMME/>

Reliability http://iri.columbia.edu/~shuhua/mis-html/Reliability_nmme.html

- Varying NMMEs
- Additional metrics
- ENSO