Changing Ocean Signatures, and relevance for climate prediction

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Current projects

- climate prediction and monitoring operations and development of monthly outlook.
- R & D projects

- Experimental Coupled MME 6-12 month seasonal prediction

- Development of the APCC coupled model development

- MME-based Experimental Drought prediction

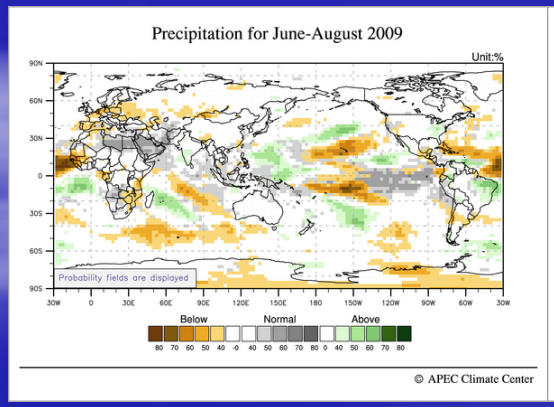
-An international collaborative project on statistical downscaling for Japanese stations.

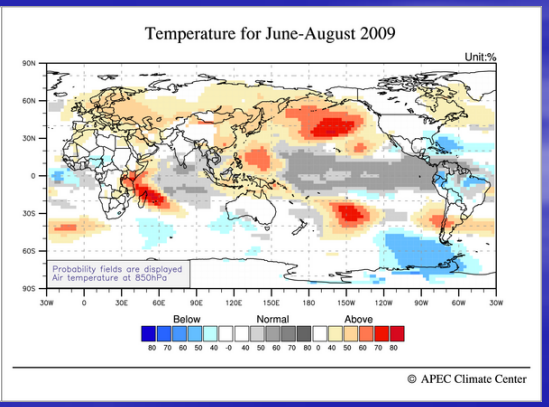
-Feedback Diagnostics of the model performance –intercomparison of prediction skills.

-Predictability of northwest Pacific storm tracks in a coupled prediction model

The APCC Operational Monthly 3-Month Forecasts

- 4-deterministic and one probabilistic MME forecasts carried out each month. Best deterministic forecast for that month selected on hindcast verification.
- Forecast outlooks sent out by 25th of each month to 21 NMHSs and to larger climate prediction community.
- Review of outlook by Working Group and SAC members prior to public release





The APEC CLIMATE CENTER
Climate Outlook for June-August2009

BUSAN, 24 June, 2009 - Synthesis of the latest computer model forecasts for December 2008-February 2009 at the APEC Climate Center (APCC), located in Busan, Korea, predicts colder than normal conditions in northwest North America, and the opposite signal in the southern part as well as in some parts of the eastern seaboard. The anomalously warm and dry conditions may continue in the Middle East.

Current Climate Conditions

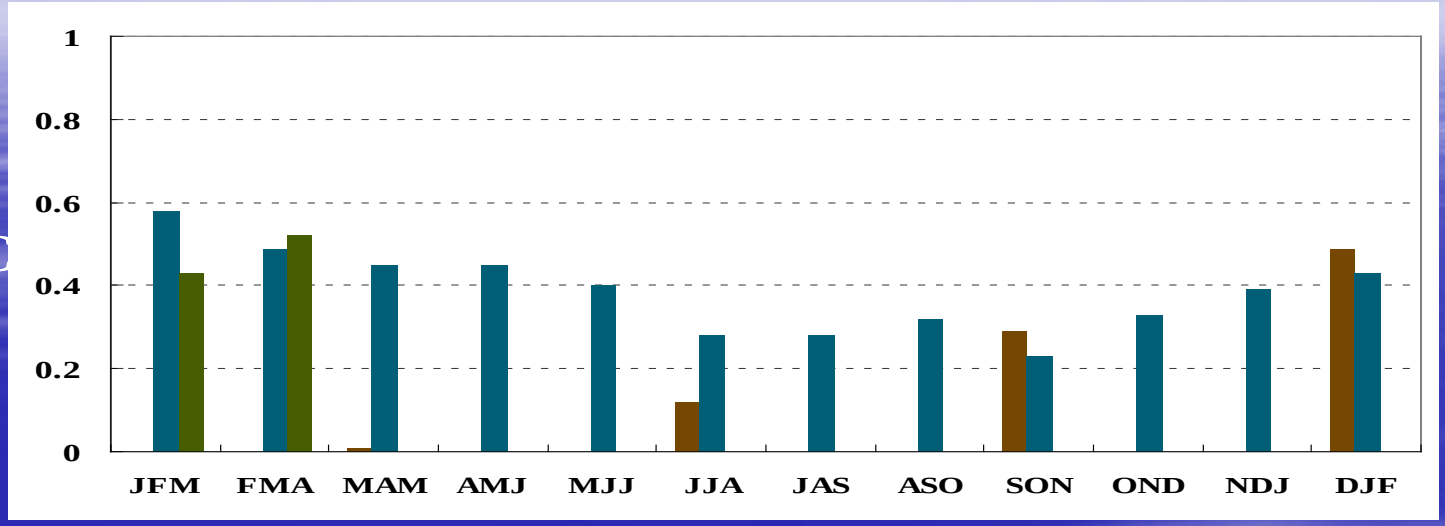
During the period from September through the second week of November, anomalously warm or near-normal temperature conditions persisted in most of land regions around the globe except in the following few during the specified sub-periods: mid-latitude west Asia in September, Alaskan region during October, and the Middle East, northwest portions of Africa, central Russia, and west Australia in November. It is to be also noted that most of the tropical through midlatitude western South America also experienced anomalously cold temperatures during different months, with the most dominant signal in Venezuela. Most of the nations in South America also received near-normal to below normal rainfall except Equador and Equatorial Brazil. In general, near-normal to below normal conditions of rainfall were observed around the globe, except in most of Indochina, parts of the Philippines, eastern Indonesia and adjoining Papua New Guinea, and equatorial North America. Australia and Japan seem to move from a deficit rainfall condition to surplus.

Forecast

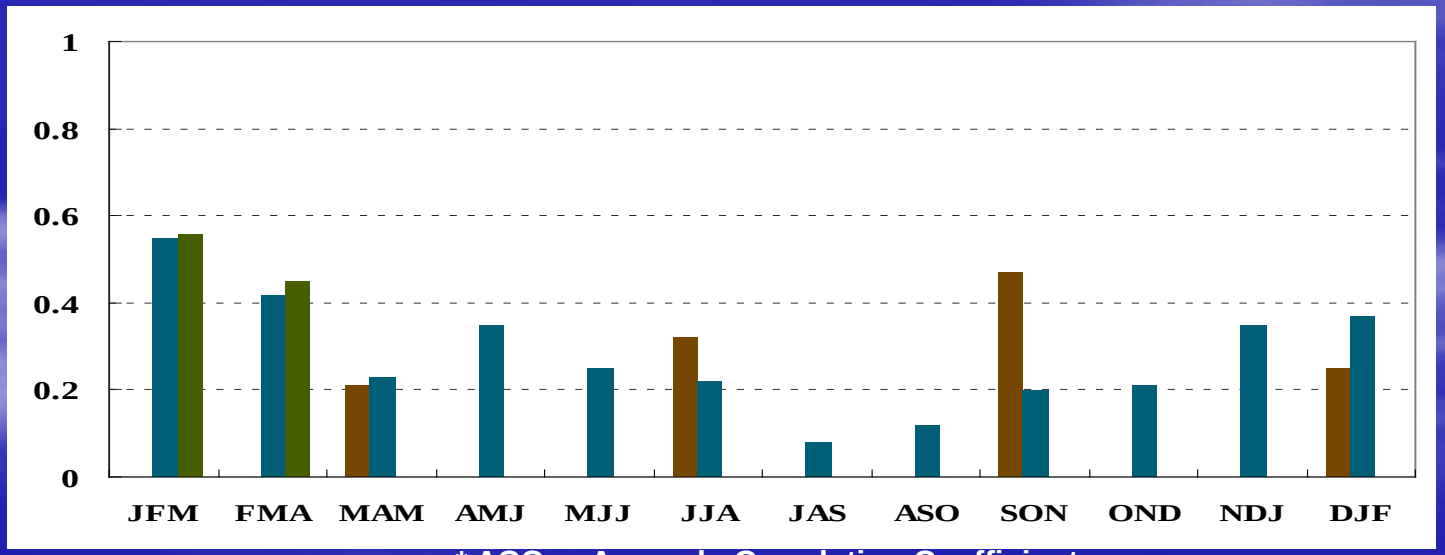
The APCC forecast for December 2008-February 2009 indicates continuing near neutral conditions in the tropical Pacific. A horse-shoe shaped structure, centered in tropical western Pacific can be seen in the anomalies of temperature as well as rainfall, extending from the Northeast Pacific through Philippines, Indochina, most of Indonesia and Malaysia, Papua New Guinea and adjoining Polynesian islands; the Indonesian region off the coast of the Indian Ocean may, on the other hand, suffer from less than normal rainfall. There is a chance that the northeast Australian continent may receive more than normal rainfall ……

Recent Performance (global ACC)

PREC



T850

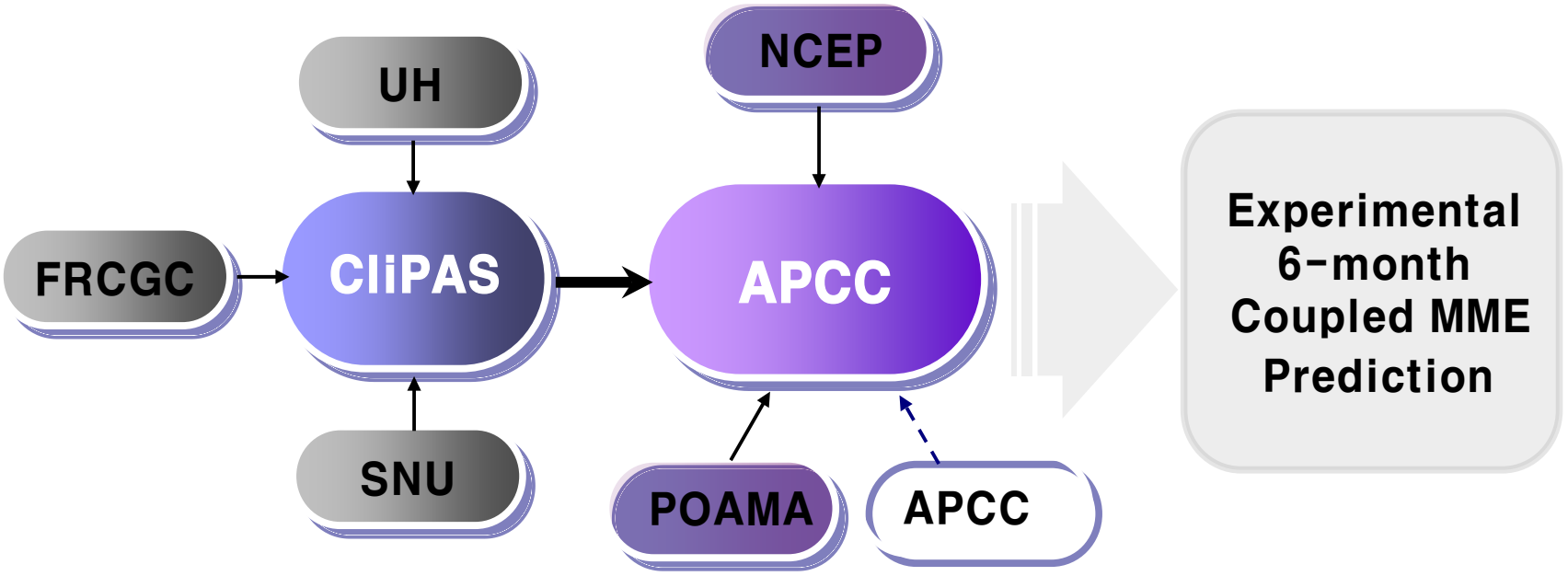


2007
2008
2009

* ACC : Anomaly Correlation Coefficient

Possible solution: Coupled Models may provide better monsoon prediction (Wang et al., 2008).

Experimental 6-month 1-tier MME Forecast



- Coupled Models may provide better monsoon prediction (Wang et al., 2008).

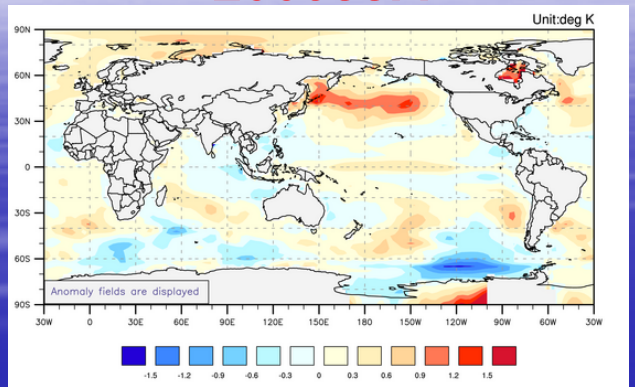
- Forecasts and hindcast verification carried out every season since the fall of 2008.
- Completed for SONDJF2008-09 (with IC of Aug., 2008), DJFMAM2008-09,MAMJJA2009, and JJASON2009
- Experimental 1-7 month lead climate bulletin launched since spring 2009.
- Will introduce the 1-7 month lead EMSO, ENSO Modoki and IOD prediction in December.

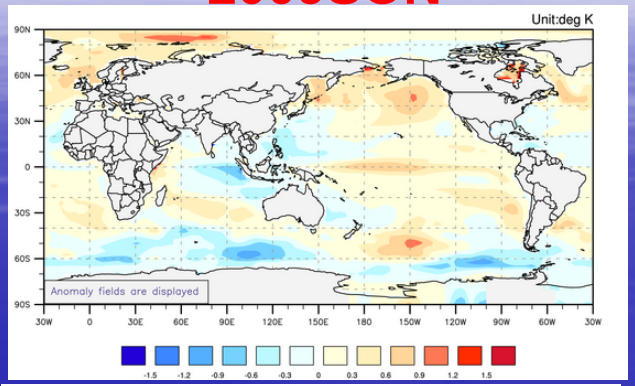
APCC 1-tier MME Forecast for JJASON

2009JJA

2009SON

SST





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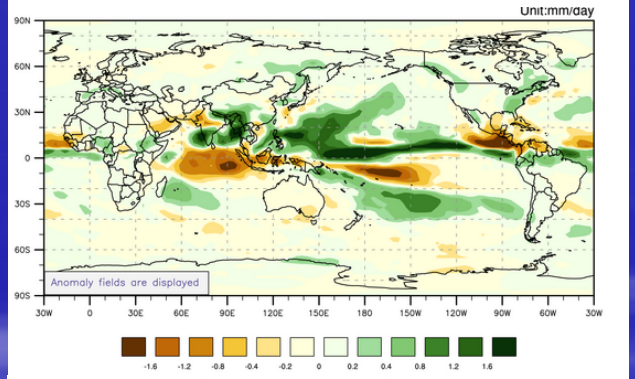

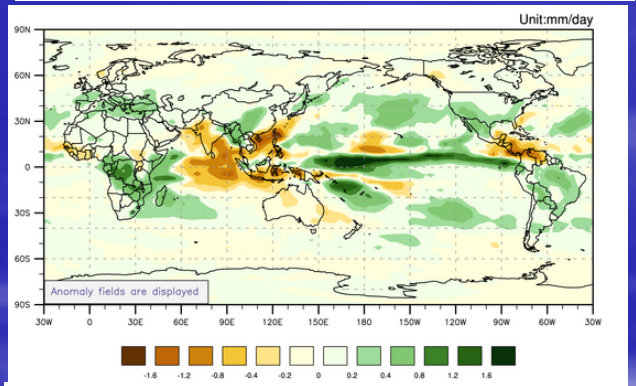

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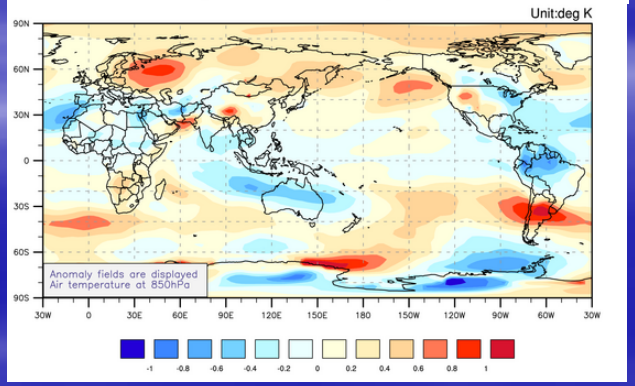
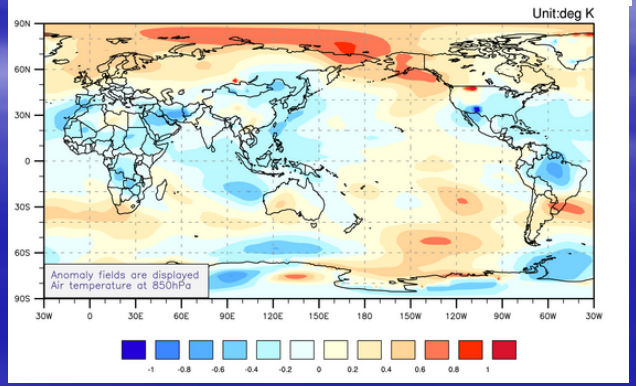
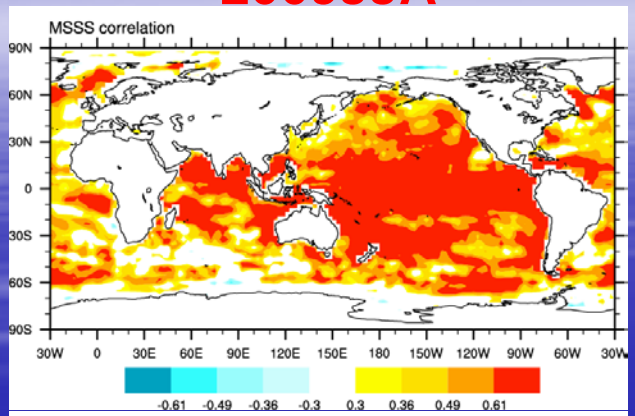
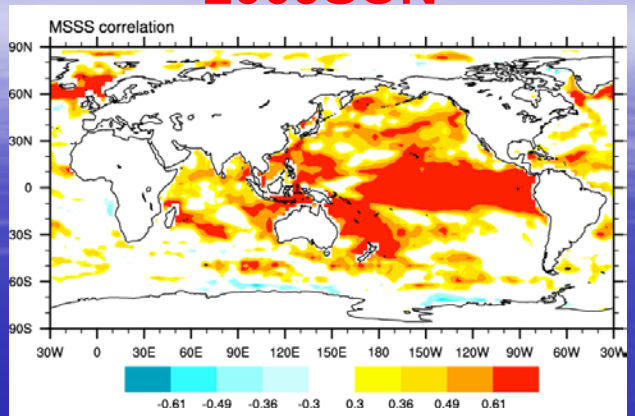
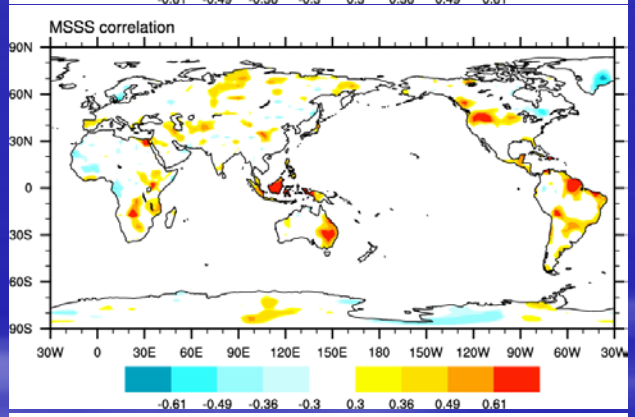
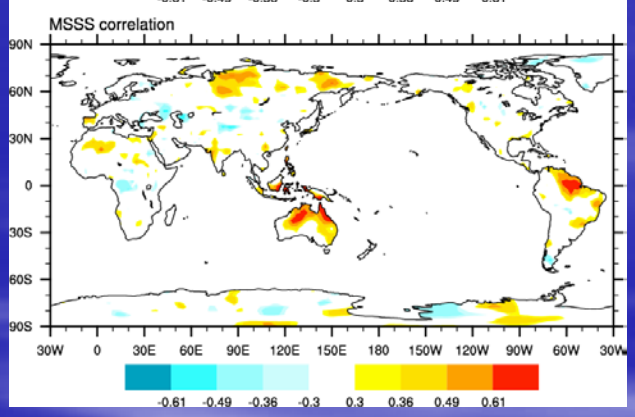
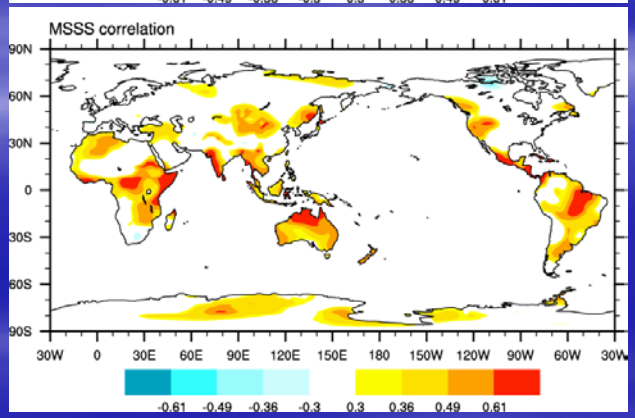
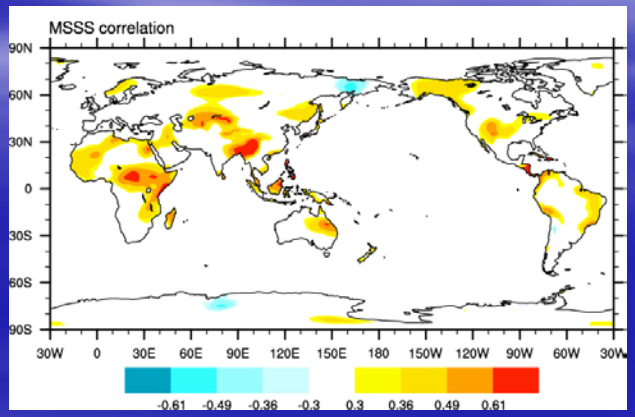




APCC 1-tier MME Verification for JJASON

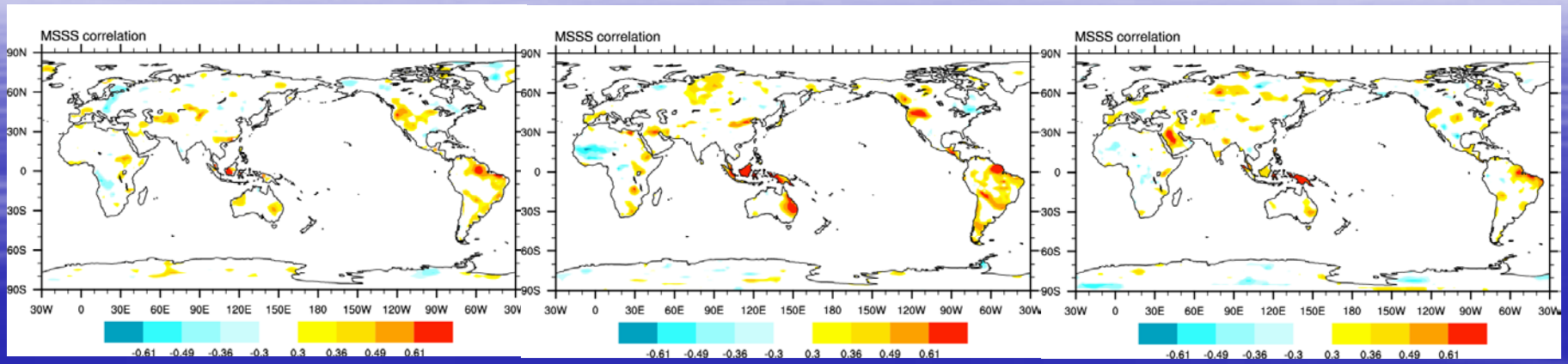
	2009JJA	2009SON
SST		
PREC		
T850		

MSSS_correlation JJA

Tier-2 JJA 1-month

Tier-1 JJA 1-3 month

Tier-1 JJA 4-6 month

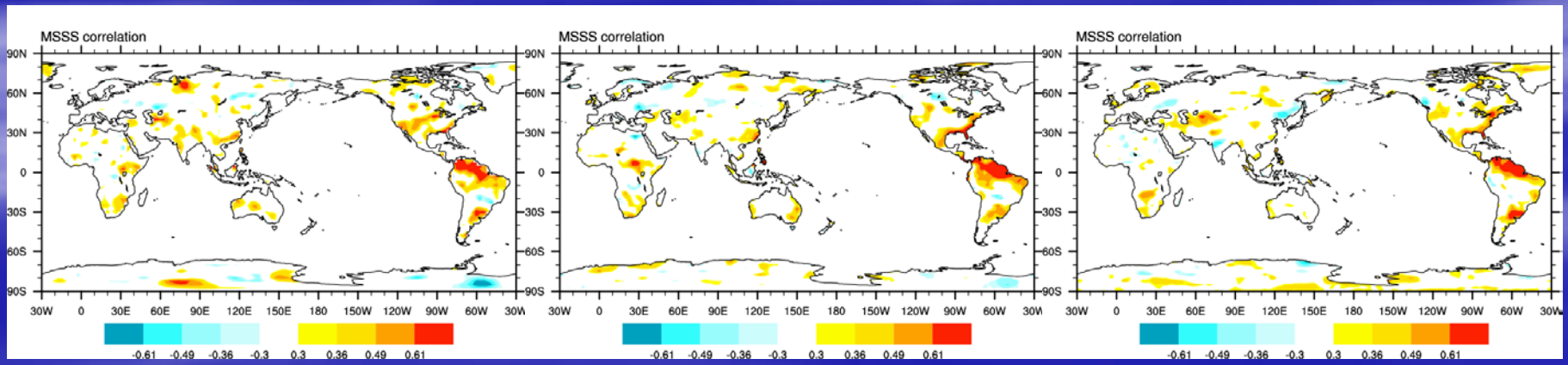


MSSS_correlation DJF

Tier-2 JJA 1-month

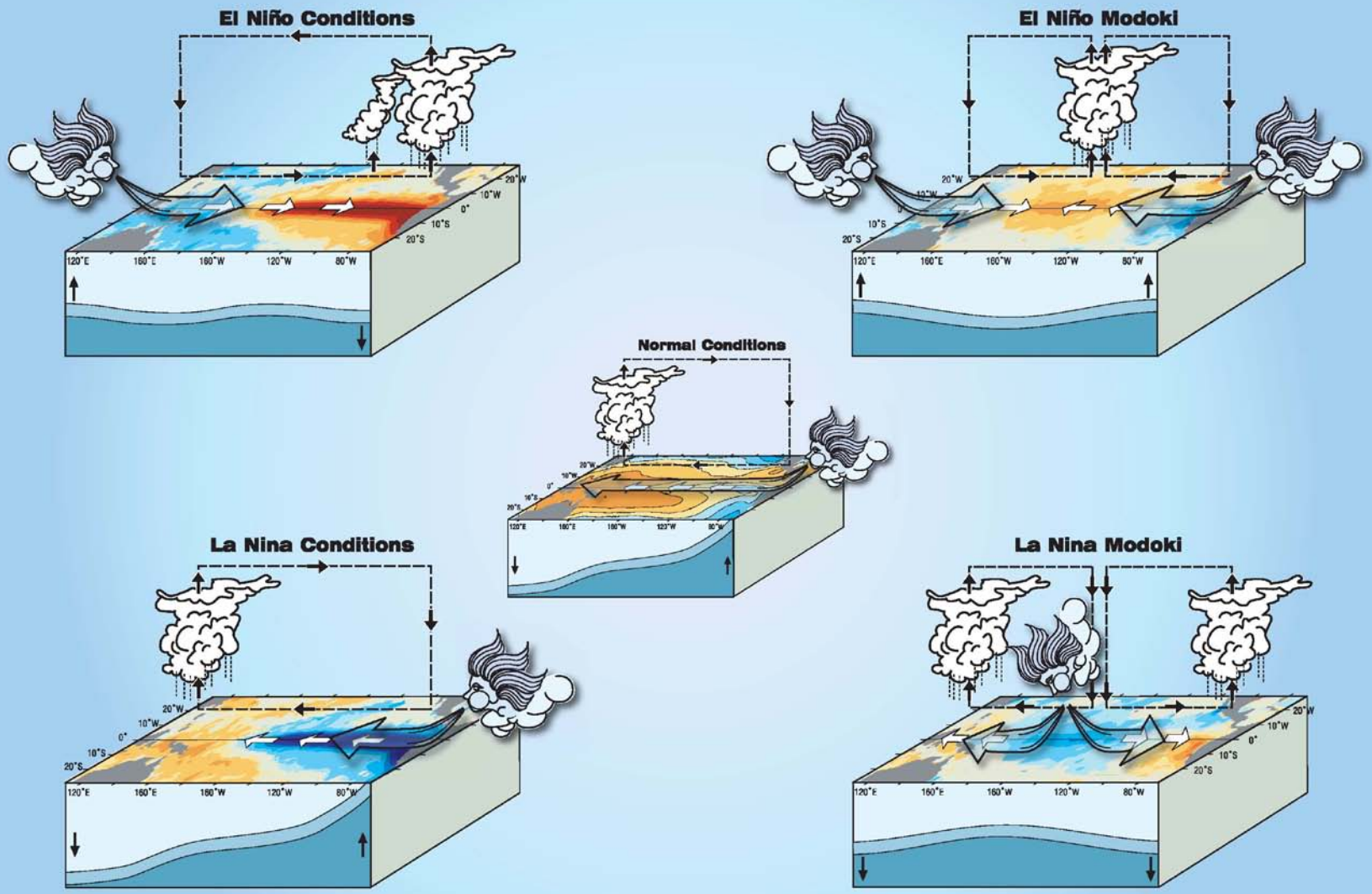
Tier-1 JJA 1-3 month

Tier-1 JJA 4-6 month

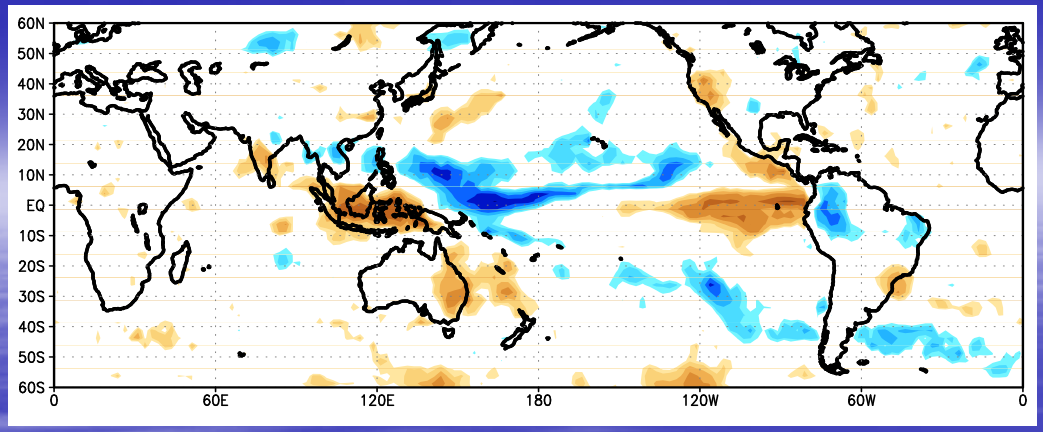


Changing Climate Conditions - Challenges

- The predictability basically comes from ENSO, as seen by the better predictive skills in tropical Pacific.
- But variability signatures are changing in tropical Pacific
- Associated with this is the changing frequency of the IODs.
- A manifestation of the climate change is the frequent occurrence of the so called “ENSO Modoki” a phenomena with tripolar SSTA in tropical Pacific lasting from boreal summer through following winter (Ashok et al., 2007a).



The El Niño Modoki events, distinguished by a tripolar SSTA pattern in tropical Pacific. These are occurring with increased frequency since late 1970s, and are distinctly different from canonical ENSO in terms of evolution and impacts (Ashok et al., 2007). The El Niño Modoki, such as seen in 2004, is associated with anomalous twin Walker cells with common ascending limb in the anomalously warm central tropical Pacific from boreal summer through winter resulting in impacts (Ashok et al., 2007, 2009; Weng et al, 2007, 2008; Taschetto et al., 2009) distinct from those of the canonical El Niño, such as that in 1997.

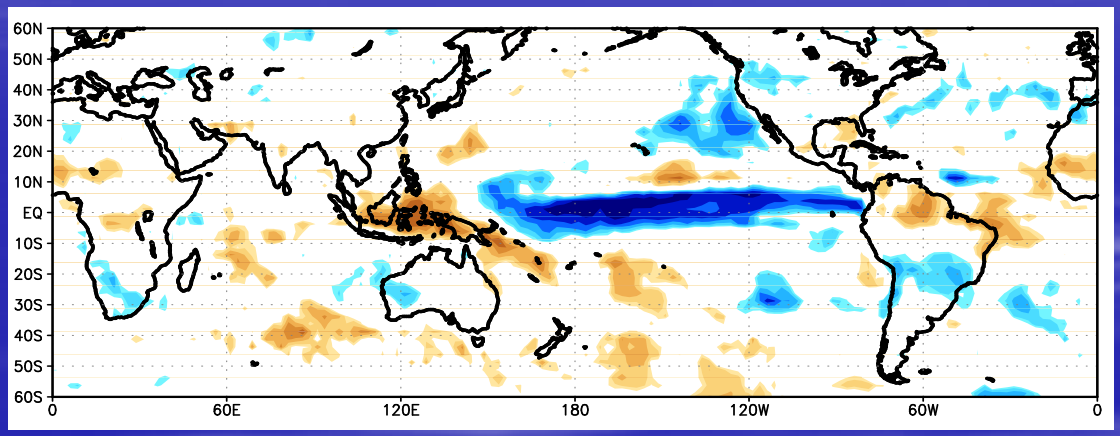


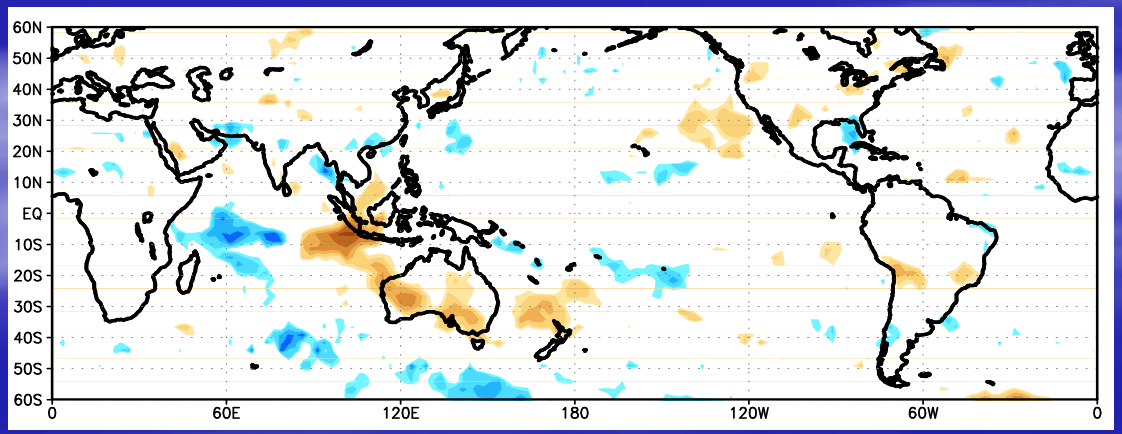
JJAS Partial Corr. of GPCP rainfall With

EMI

NINO3

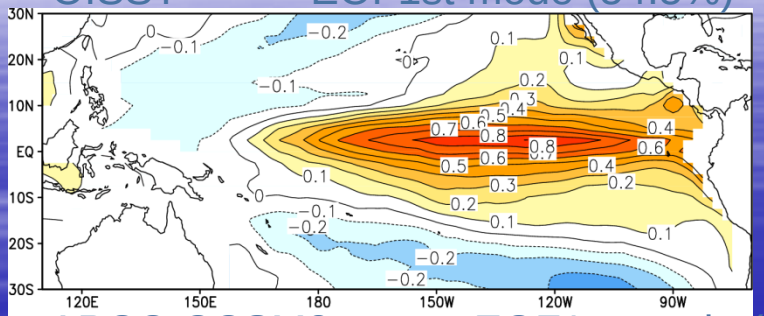
IODMI



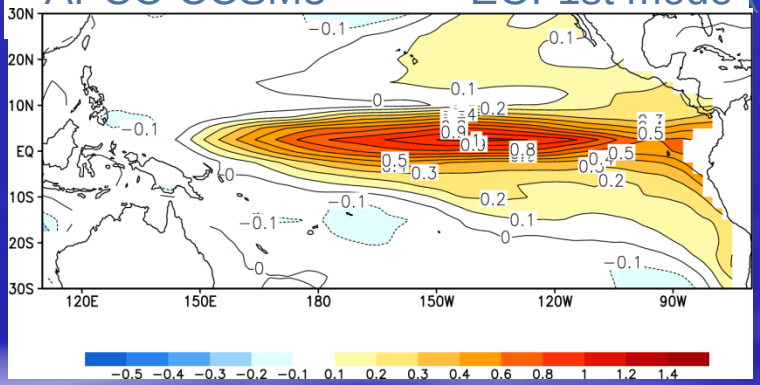


So, models at least need to predict the two top Modes

OISST EOF1st mode (54.5%)

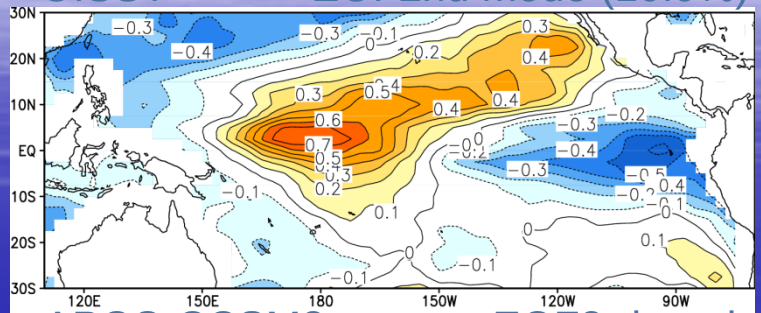


APCC-CCSM3 EOF1st mode (58.4%)

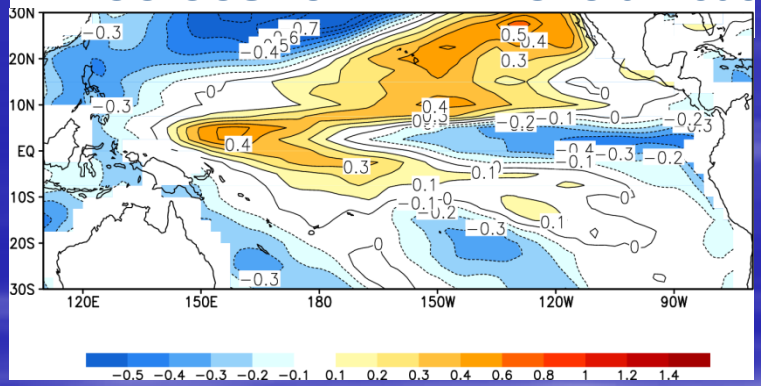


Corr. Between PC time Series : 0.93

OISST EOF2nd mode (10.9%)



APCC-CCSM3 EOF3rd mode



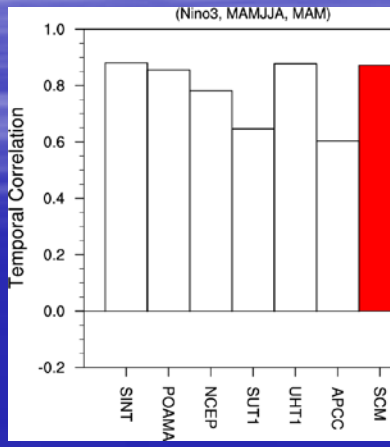
Corr. Between PC time Series : 0.78

- Successful prediction of the boreal winter ENSO and ENSO Modoki evolution, including their phase
- The distinct “Flavors of ENSO” need to be understood better and predicted as a first order for better predictive skills.

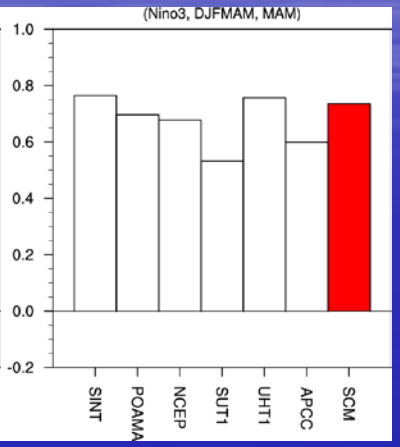
The APCC 6-month coupled MME Prediction: Corr. Coef. between OBS Nino3 and Model Nino3

Target : MAM

1-3 month Lead

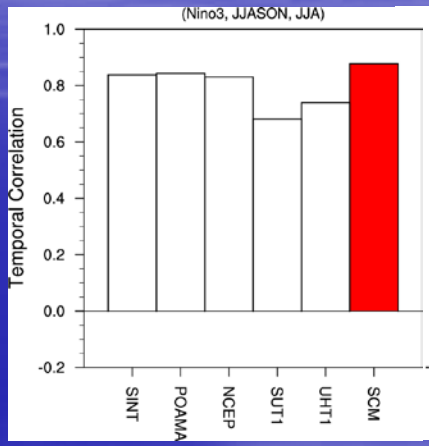


4-6 month Lead

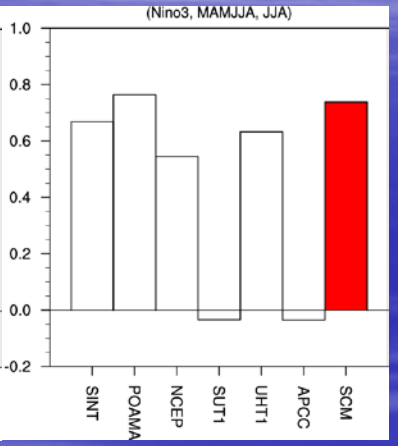


Target : JJA

1-3 month Lead

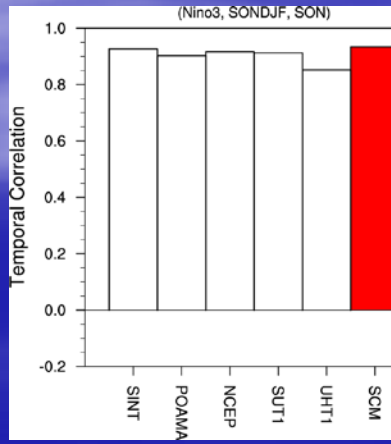


4-6 month Lead

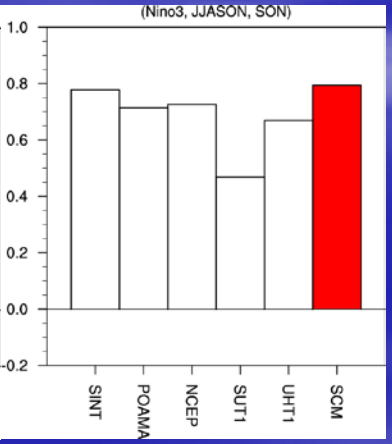


Target : SON

1-3 month Lead

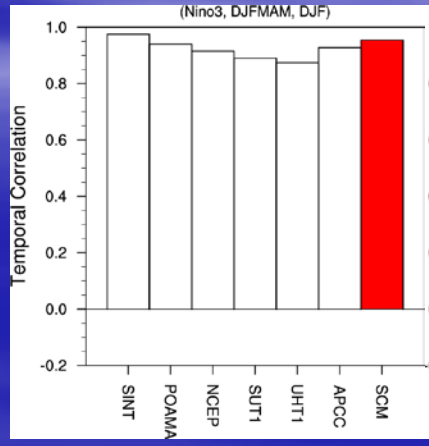


4-6 month Lead

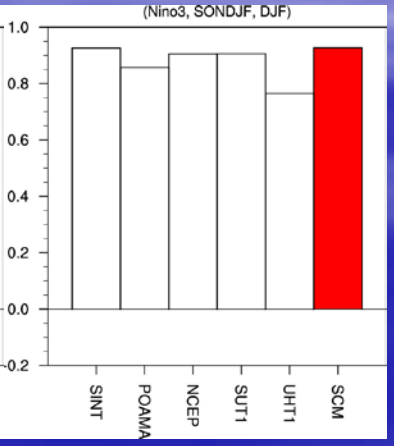


Target : DJF

1-3 month Lead



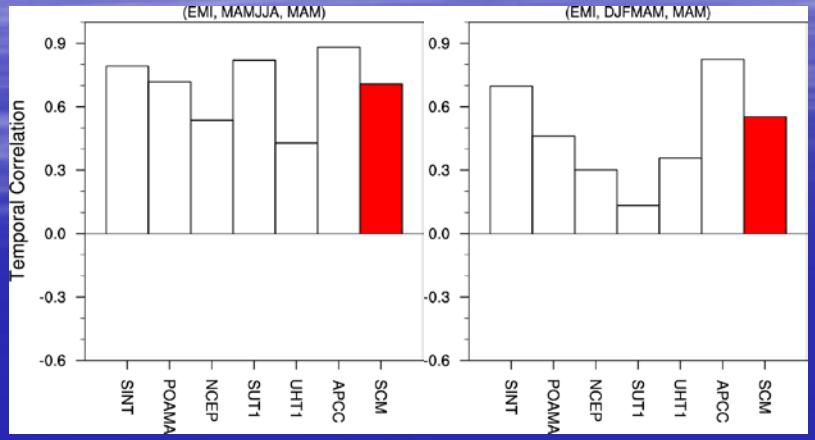
4-6 month Lead



The APCC 6-month coupled MME Prediction: Corr. Coef. between OBS and Model EMI

Target : MAM

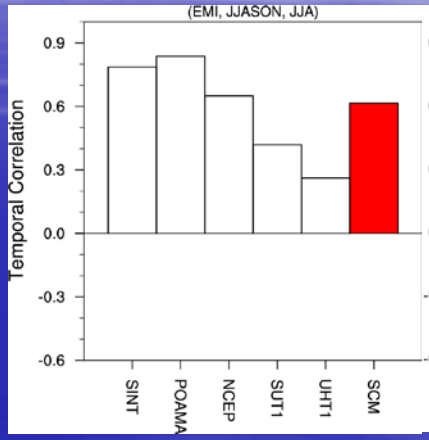
1-3 month Lead



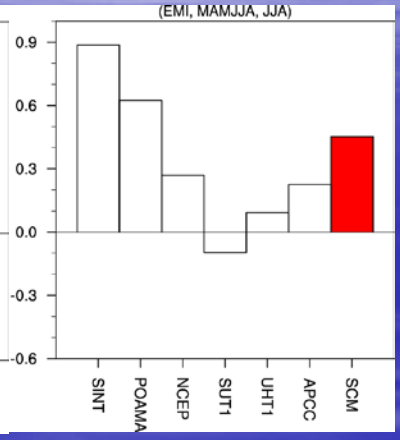
4-6 month Lead

Target : JJA

1-3 month Lead

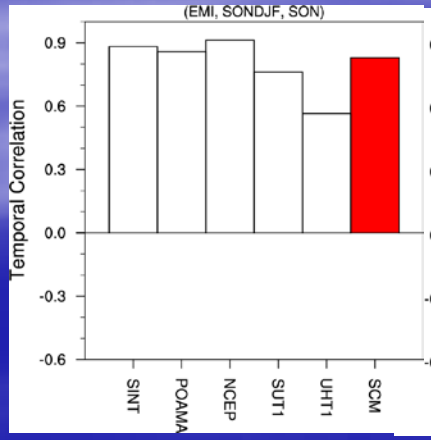


4-6 month Lead

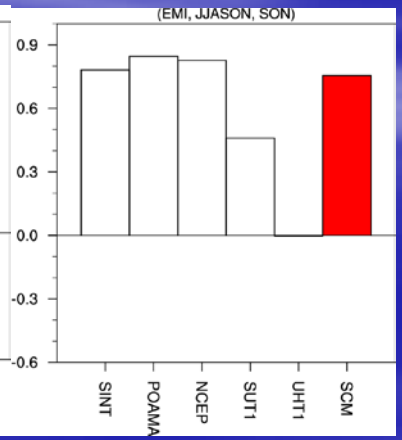


Target : SON

1-3 month Lead

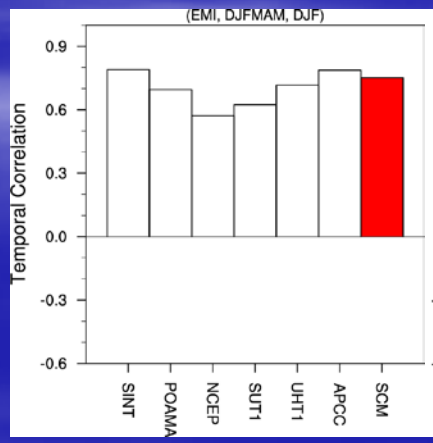


4-6 month Lead

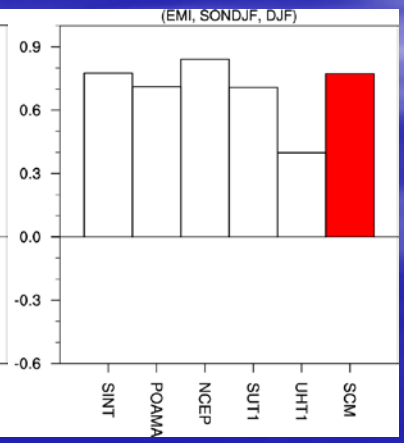


Target : DJF

1-3 month Lead



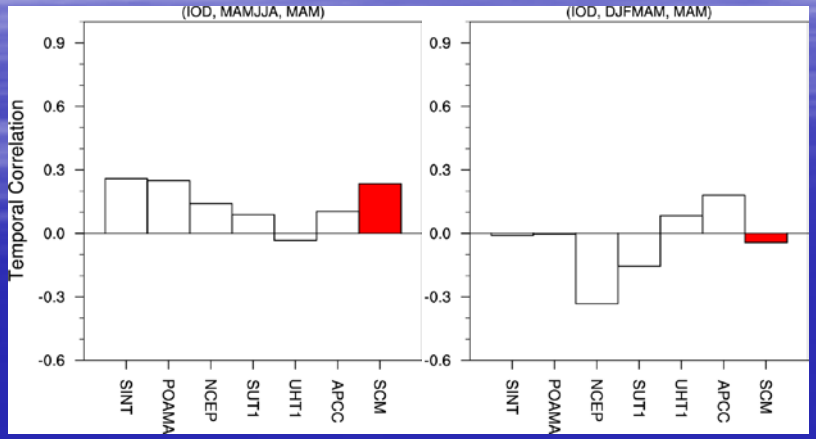
4-6 month Lead



The APCC 6-month coupled MME Prediction: Corr. Coef. between OBS and Model IODMI

Target : MAM

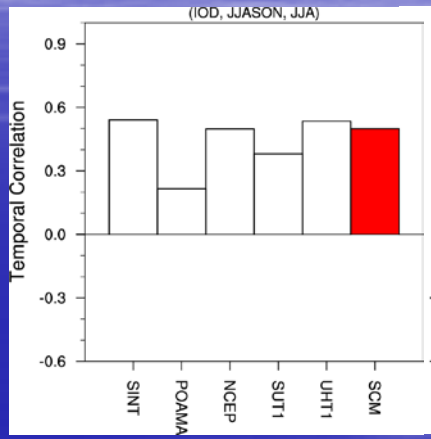
1-3 month Lead



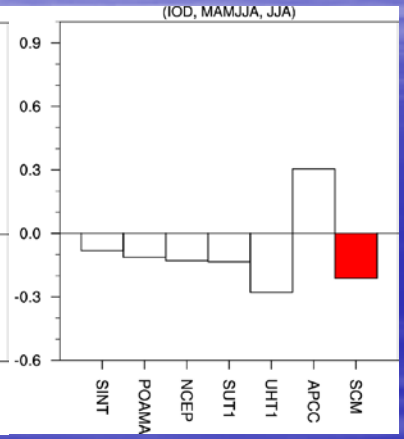
4-6 month Lead

Target : JJA

1-3 month Lead

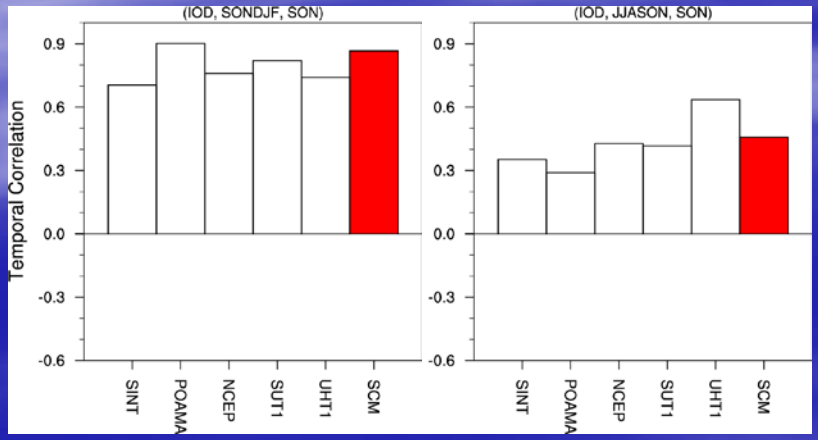


4-6 month Lead



Target : SON

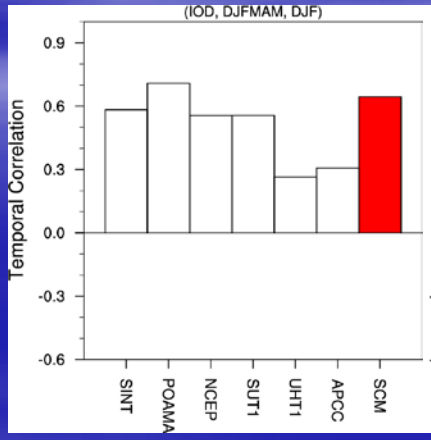
1-3 month Lead



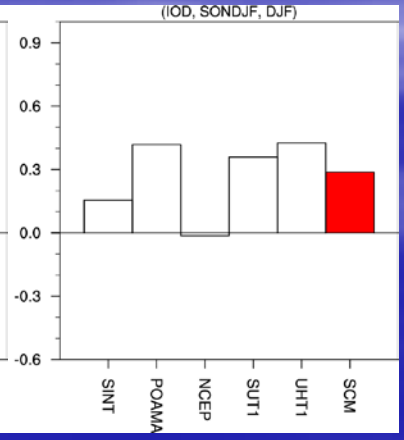
4-6 month Lead

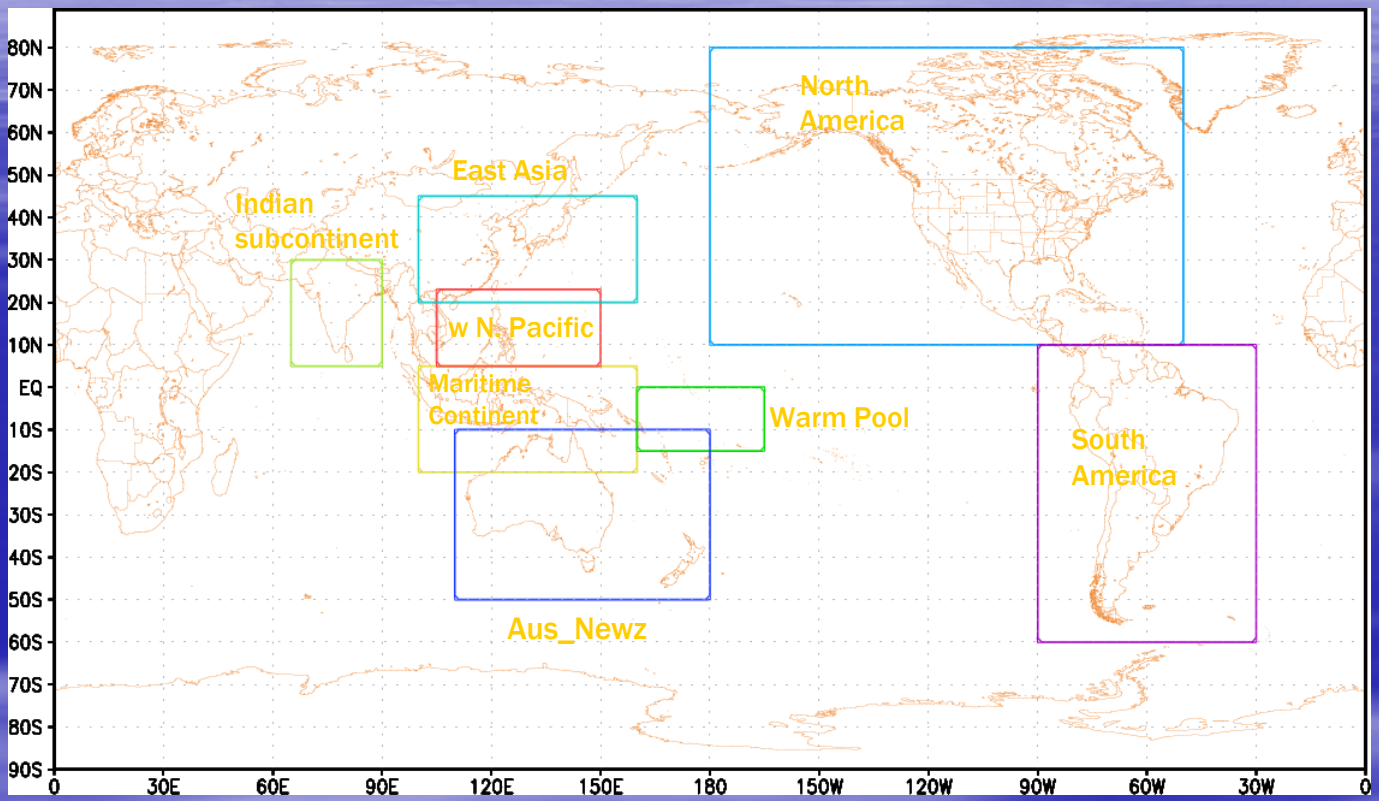
Target : DJF

1-3 month Lead



4-6 month Lead




80N
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90E
120E
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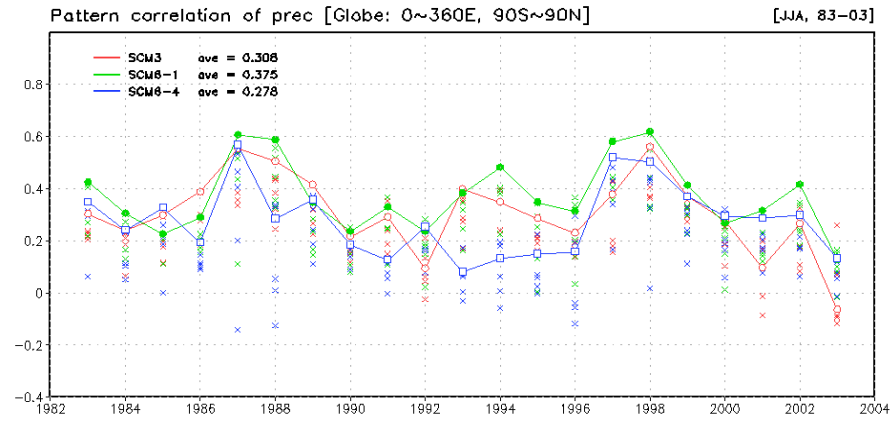
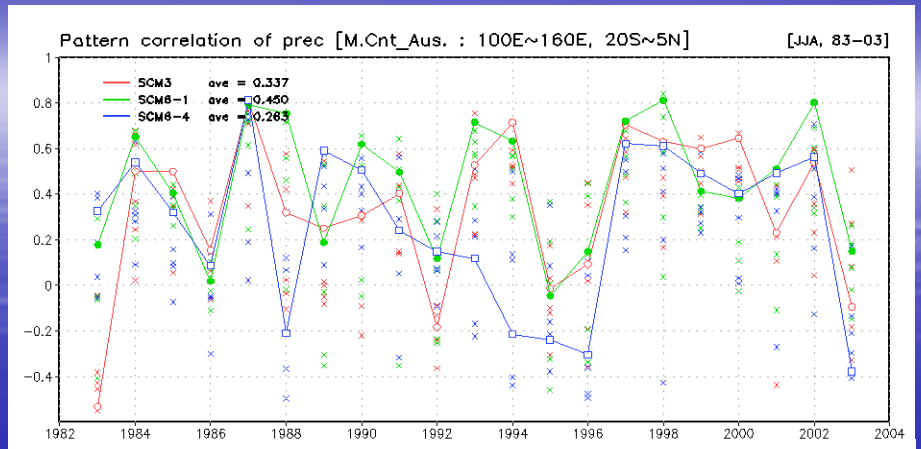
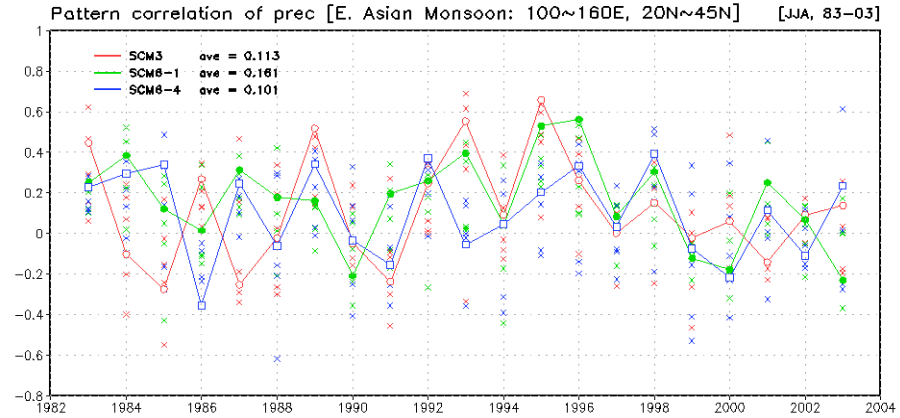
180
150W
120W
90W
60W
30W
0
North America
East Asia
Indian subcontinent
w N. Pacific
Maritime Continent
Warm Pool
South America
Aus_Newz

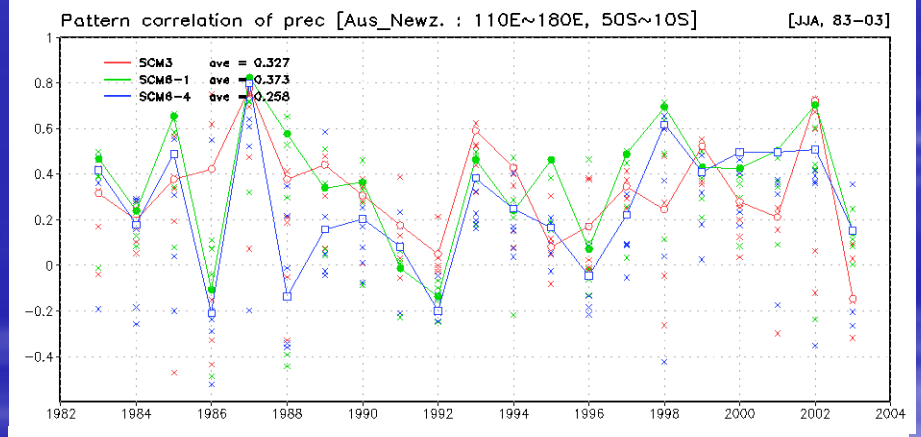
1. Interanuual variance of precipitation

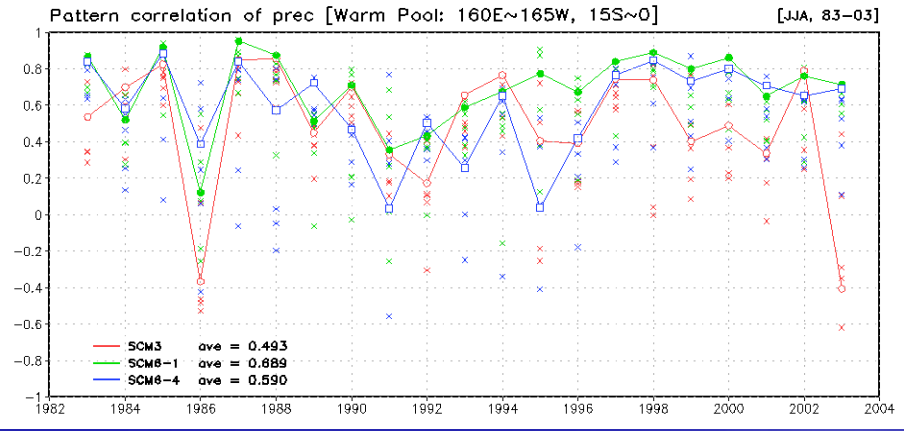
Pattern correlation between observation and models

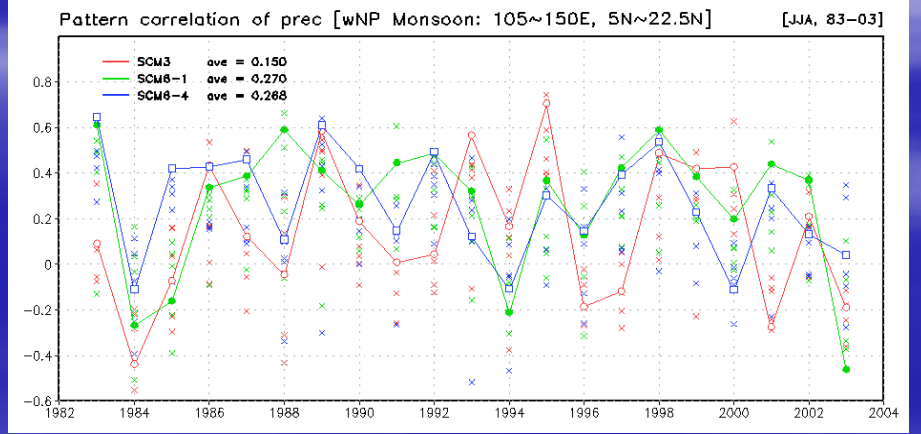






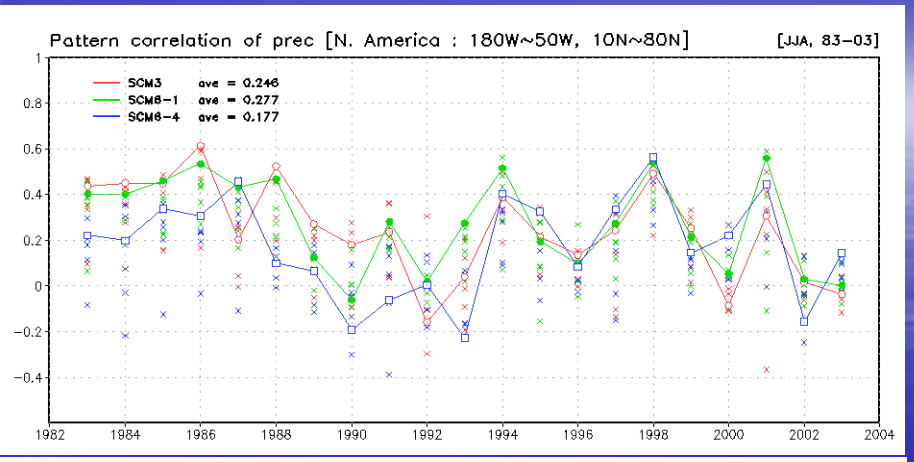


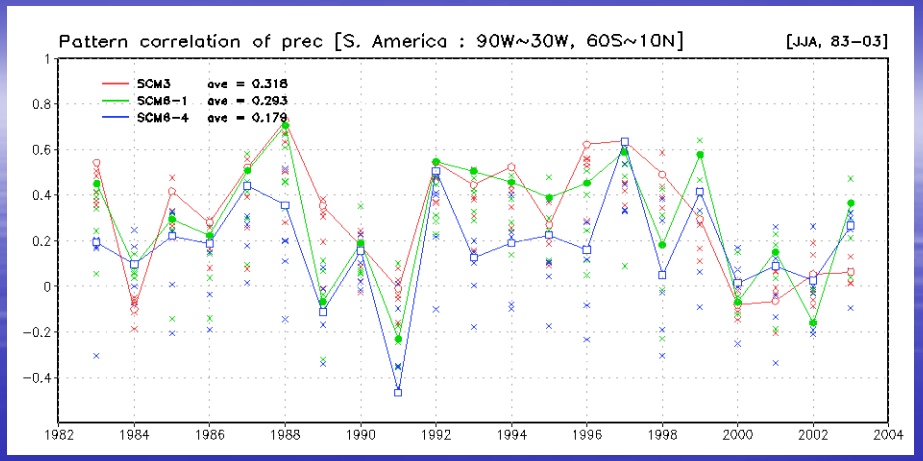


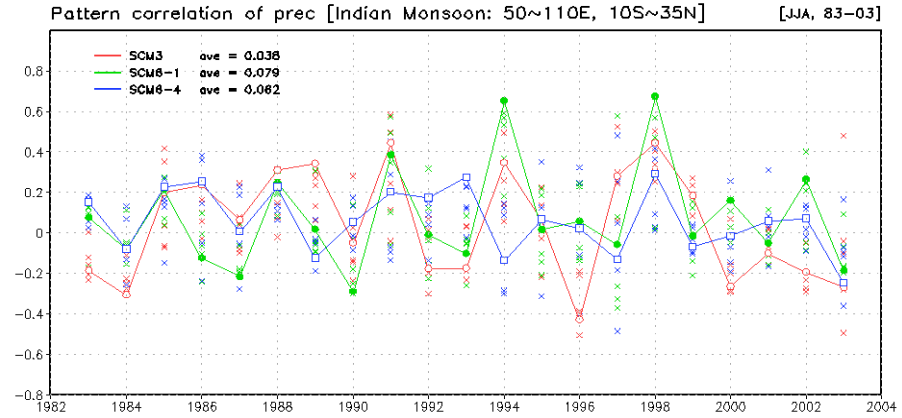


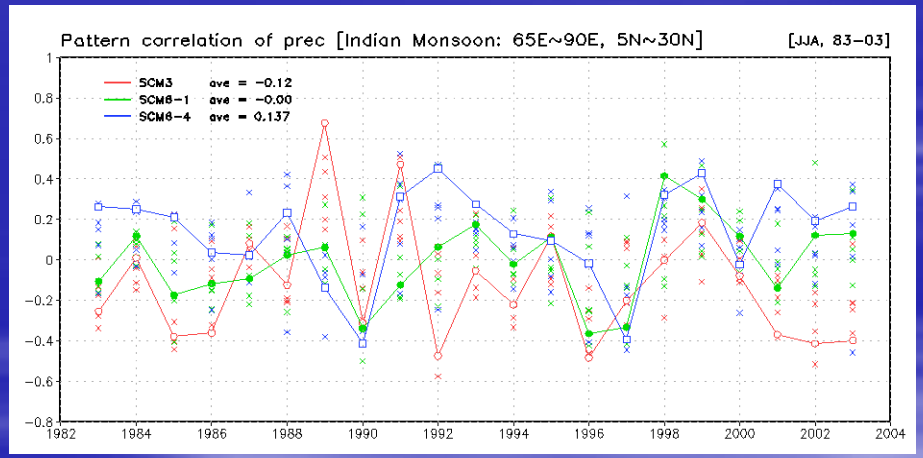
2. Interanuual variance of precipitation

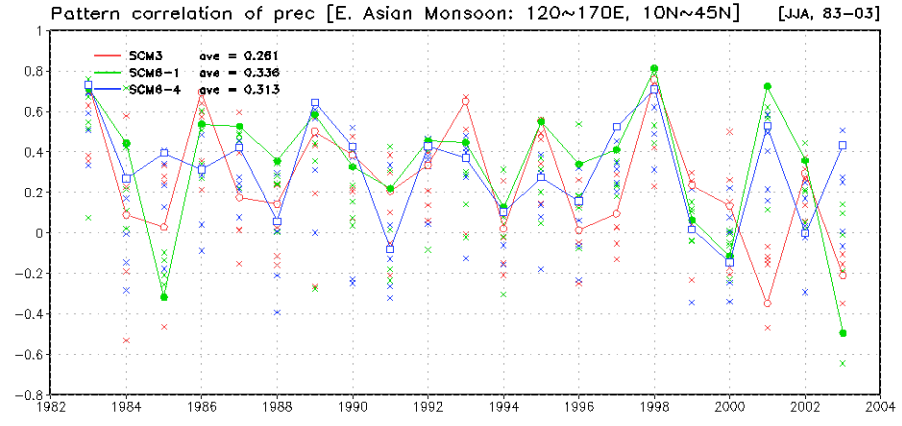
Pattern correlation between observation and models









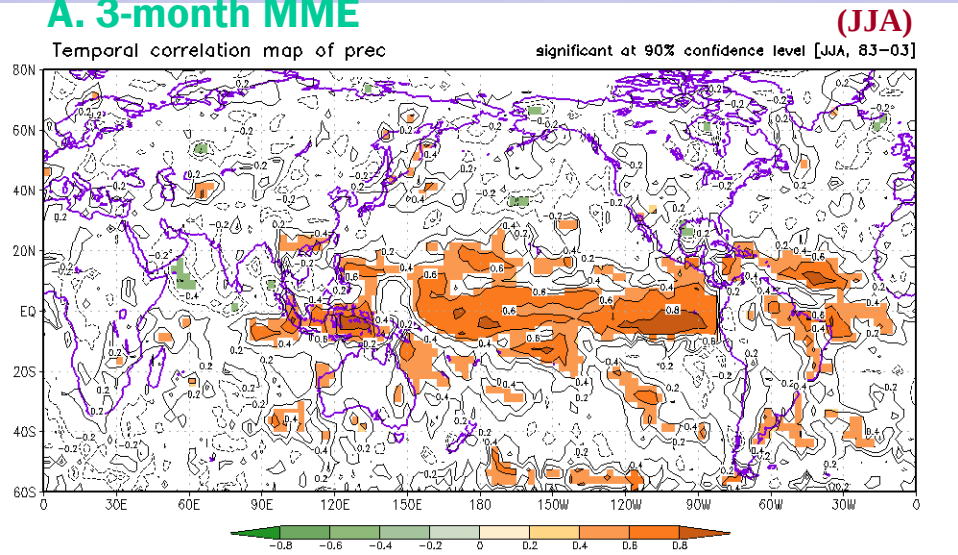


Temporal correlation – Precipitation (83-03)

significant at 90 % confidence level from a two-tailed Student's *t* test

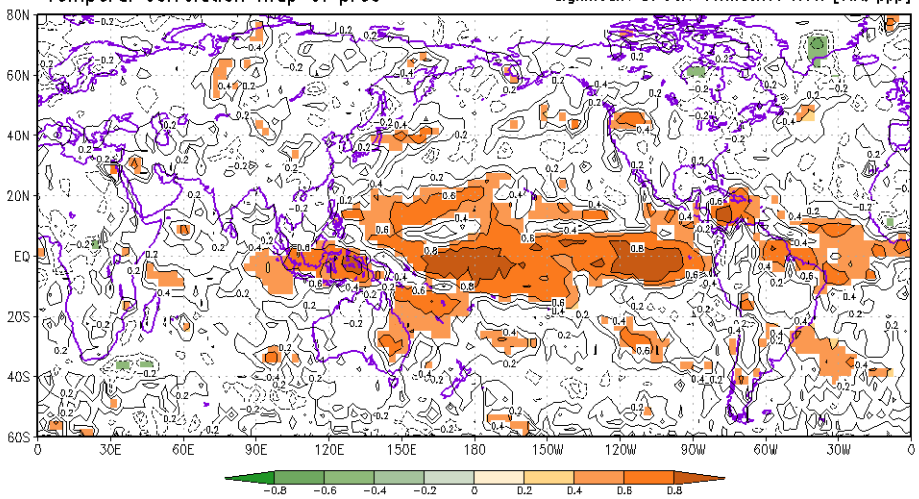
A. 3-month MME

(JJA)



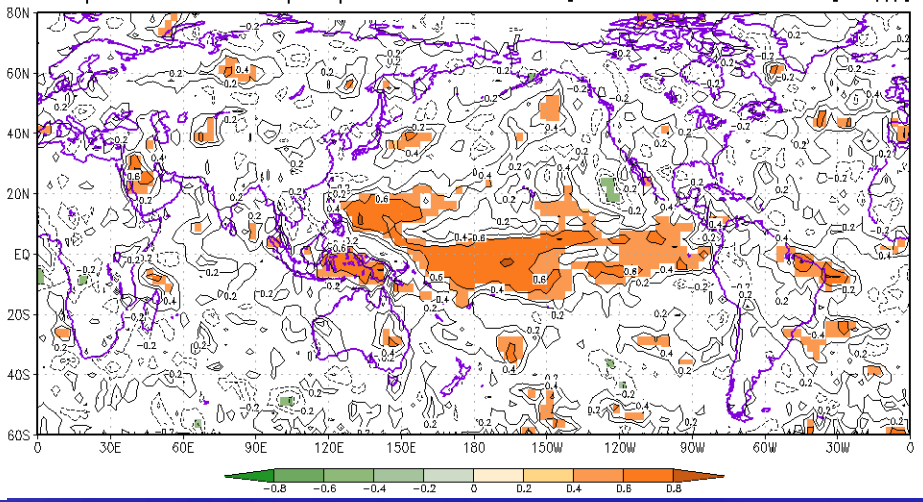
B. 6-month MME

JJA



C. 6-month MME

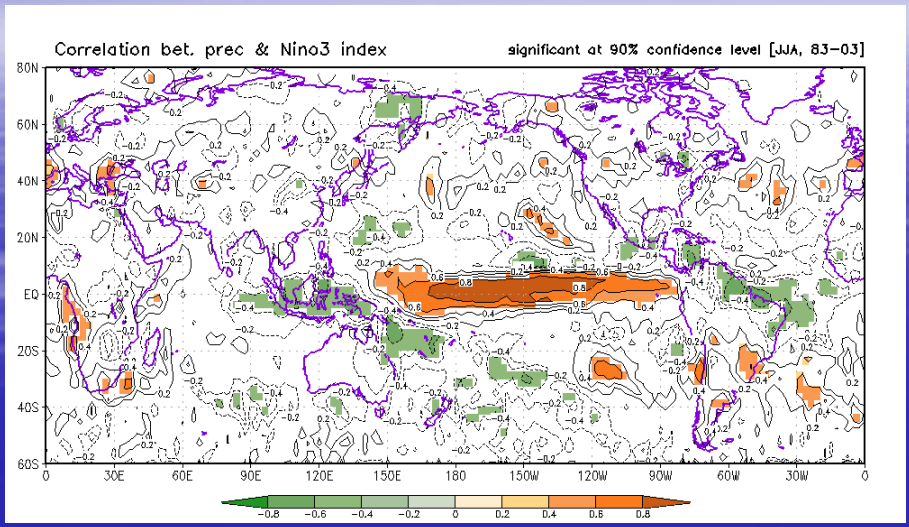
JJA



Temporal correlation – Prec & Nino3 (83-03)

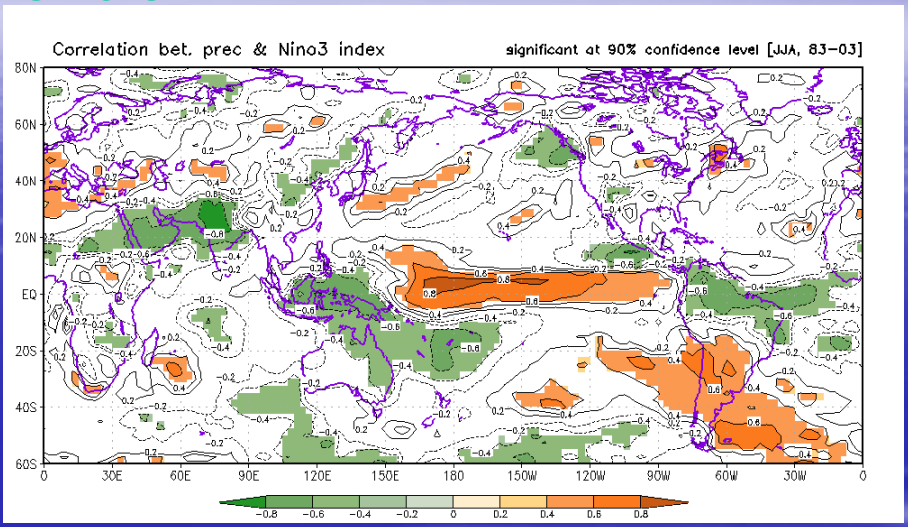
significant at 90 % confidence level from a two-tailed Student's *t* test

A. OBS



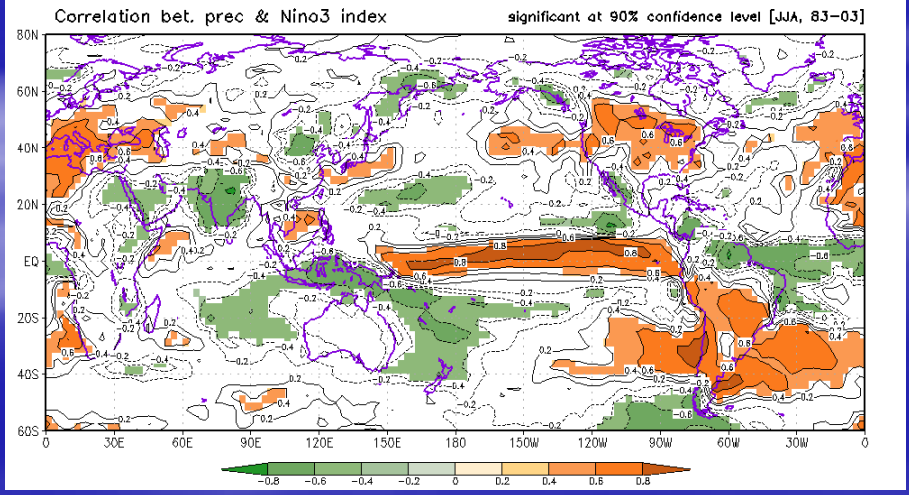
B. 3-month MME

1-month lead (JJA)



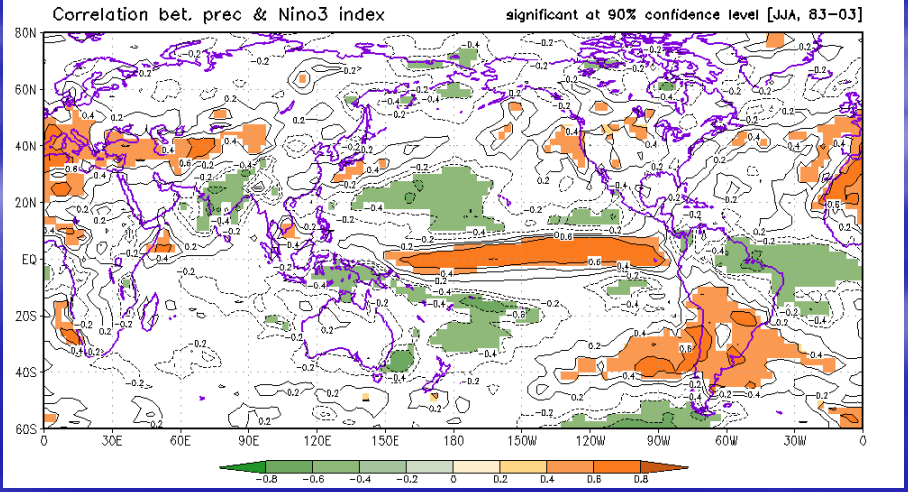
C. 6-month MME

1-month lead (JJASON)



D. 6-month MME

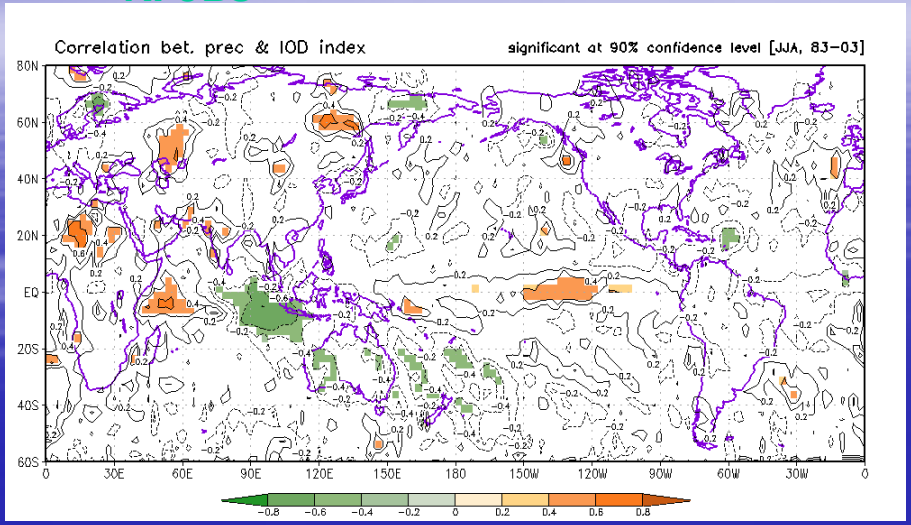
4-month lead (MAMJJA)



Temporal correlation – Prec & IOD (83-03)

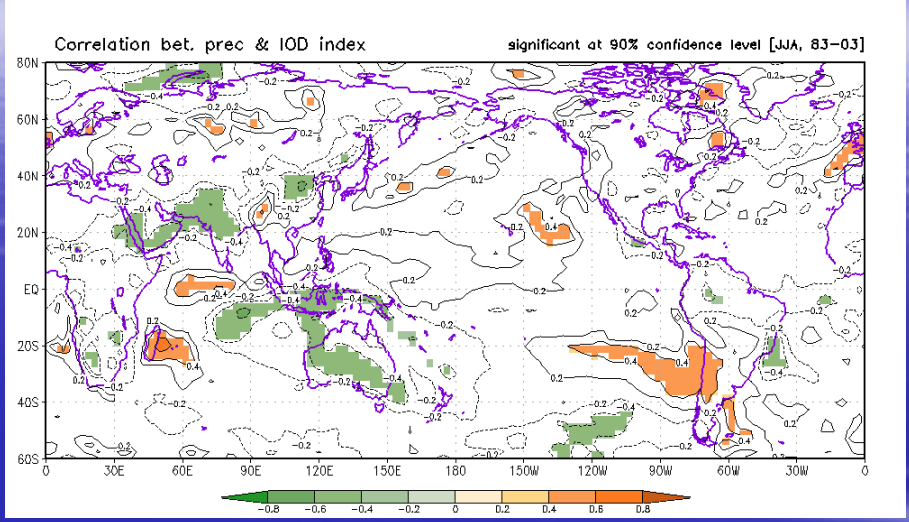
significant at 90 % confidence level from a two-tailed Student's *t* test

A. OBS



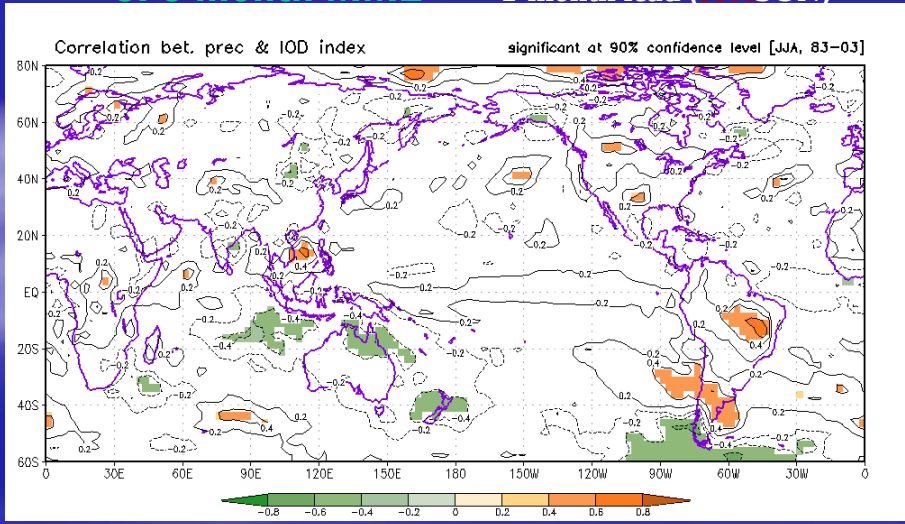
B. 3-month MME

1-month lead (JJA)



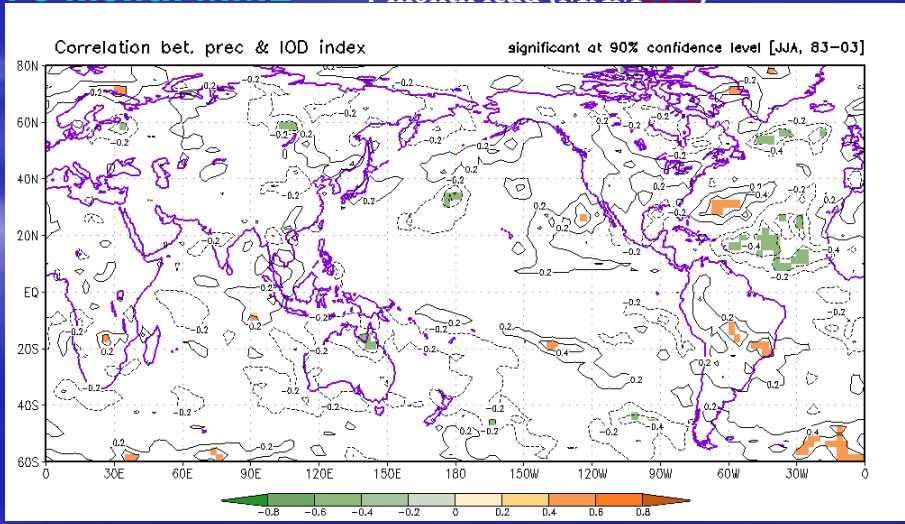
C. 6-month MME

1-month lead (JJASON)



D. 6-month MME

4-month lead (MAMJJA)

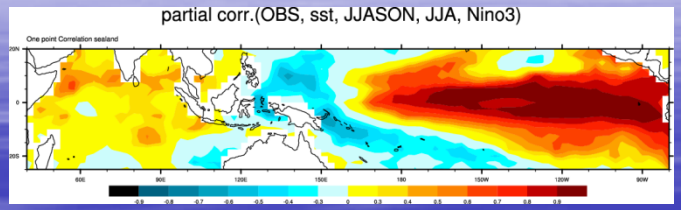


Target season: JJA

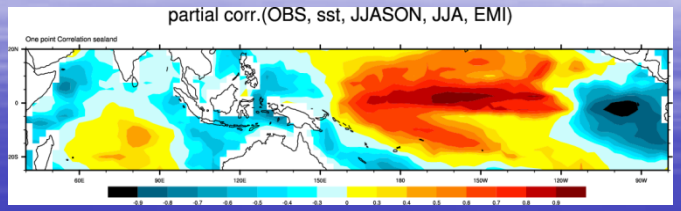
P Corr between Nino3 and SSTA

P Corr between EMI and SSTA

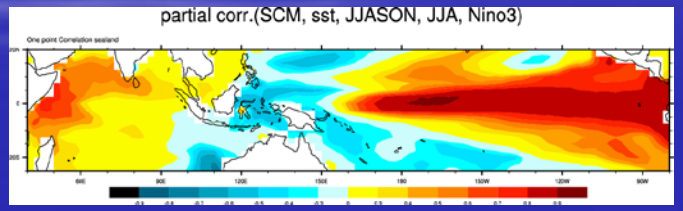
OBS



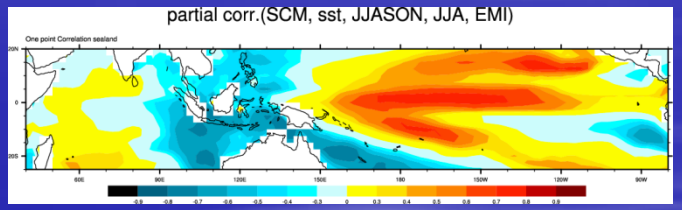
0.08



1-3month SCM



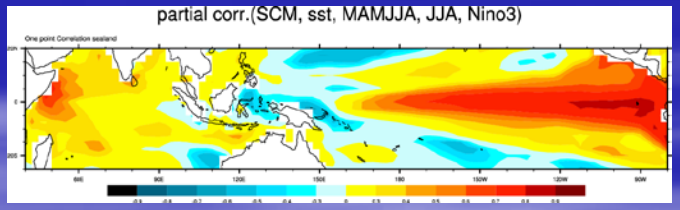
0.39



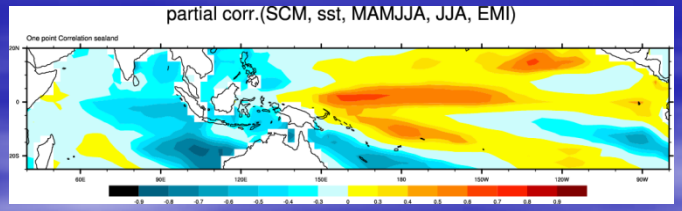
r (obs,SCM) = 0.92

r (obs,SCM) = 0.72

4-6month SCM



0.01



r (obs,SCM) = 0.87

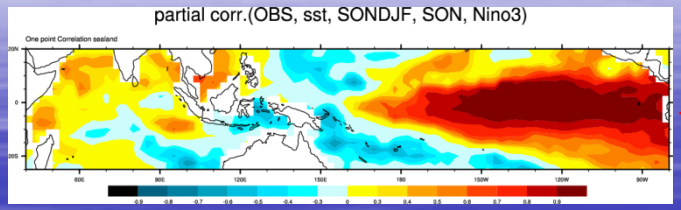
r (obs,SCM) = 0.60

Target season: SON

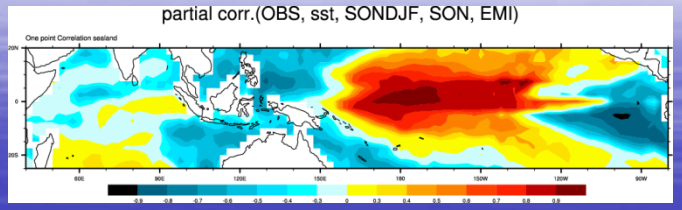
P Corr between Nino3 and SSTA

P Corr between EMI and SSTA

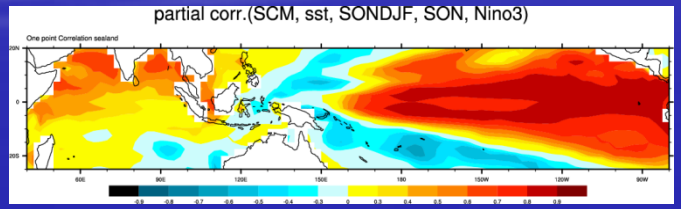
OBS



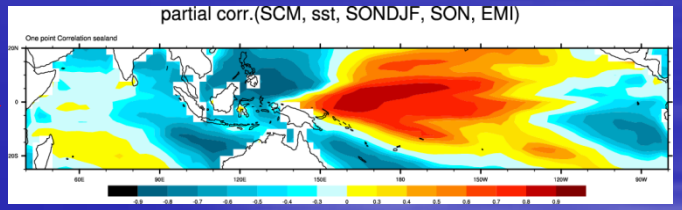
0.13



1-3month SCM



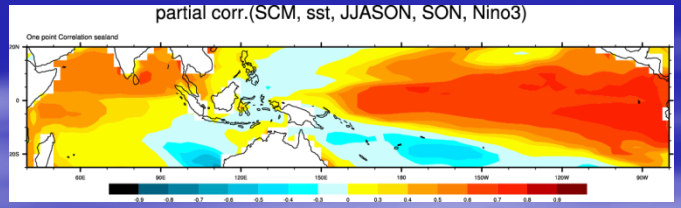
0.08



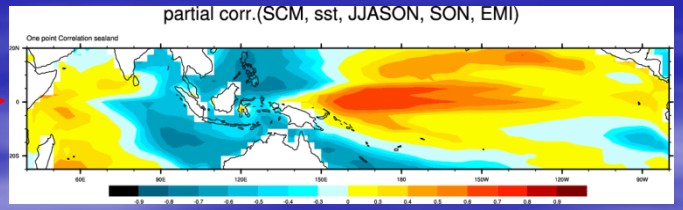
r (obs,SCM) = 0.89

r (obs,SCM) = 0.87

4-6month SCM



0.34



r (obs,SCM) = 0.87

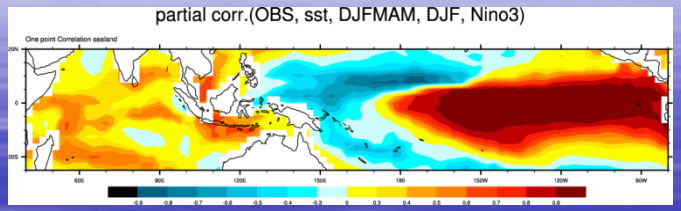
r (obs,SCM) = 0.67

Target season: DJF

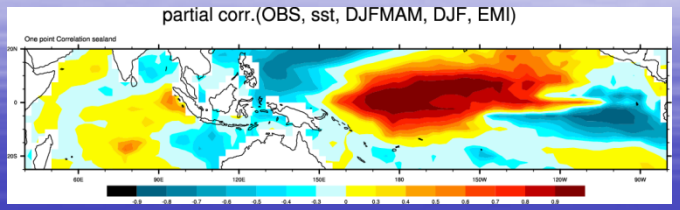
P Corr between Nino3 and SSTA

P Corr between EMI and SSTA

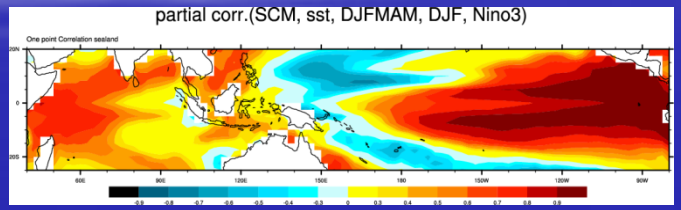
OBS



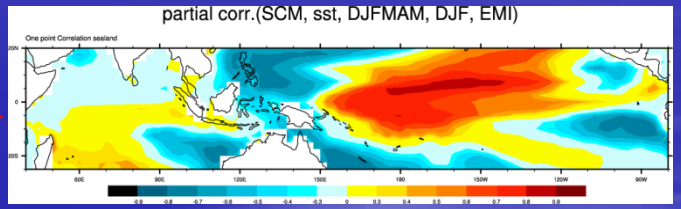
0.05



1-3month SCM



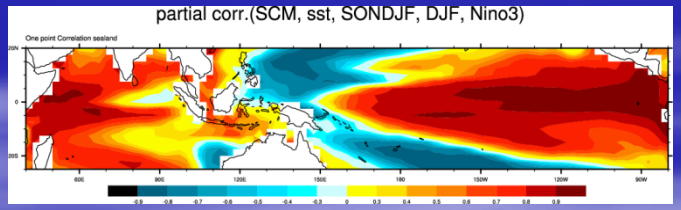
0.10



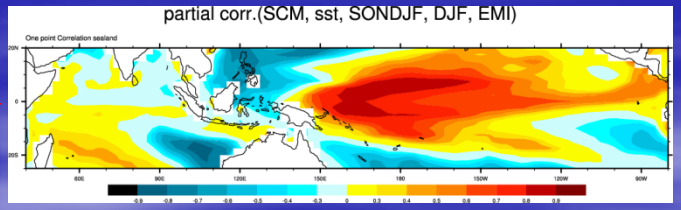
r (obs,SCM) = 0.86

r (obs,SCM) = 0.83

4-6month SCM



0.47



r (obs,SCM) = 0.80

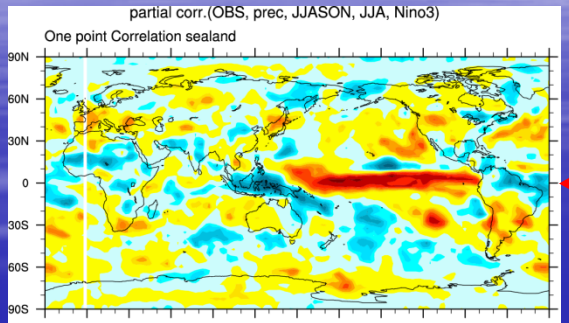
r (obs,SCM) = 0.68

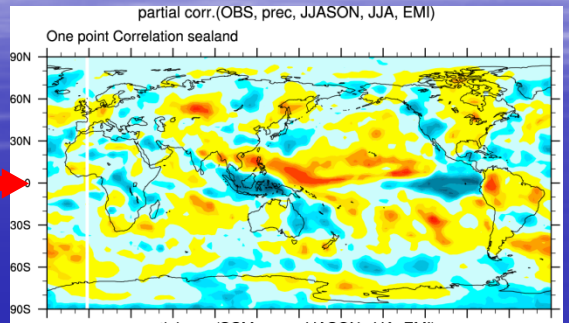
Target season: JJA

P Corr between Nino3 and Prec Ano.

P Corr between EMI and Prec Ano.

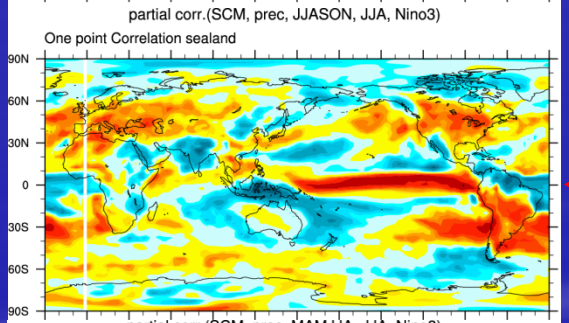
OBS

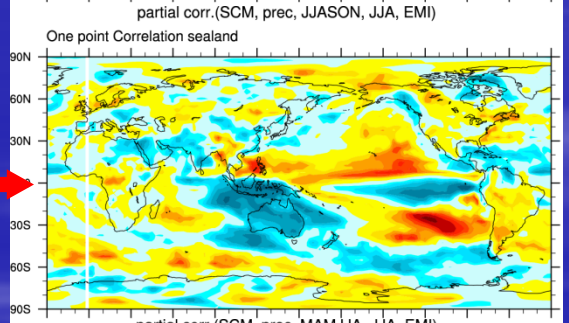




0.17

1-3month SCM



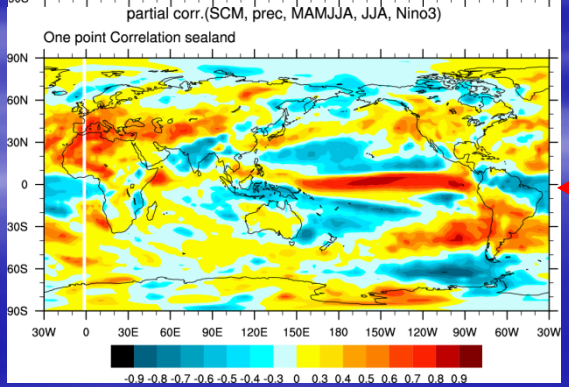


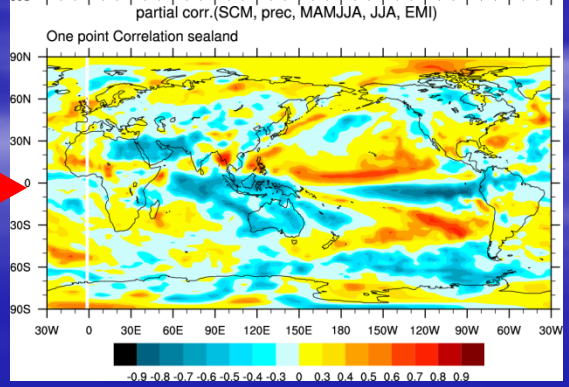
0.34

r (obs,SCM) = 0.49

r (obs,SCM) = 0.45

4-6month SCM





0.18

r (obs,SCM) = 0.38

r (obs,SCM) = 0.40

Target season: SON

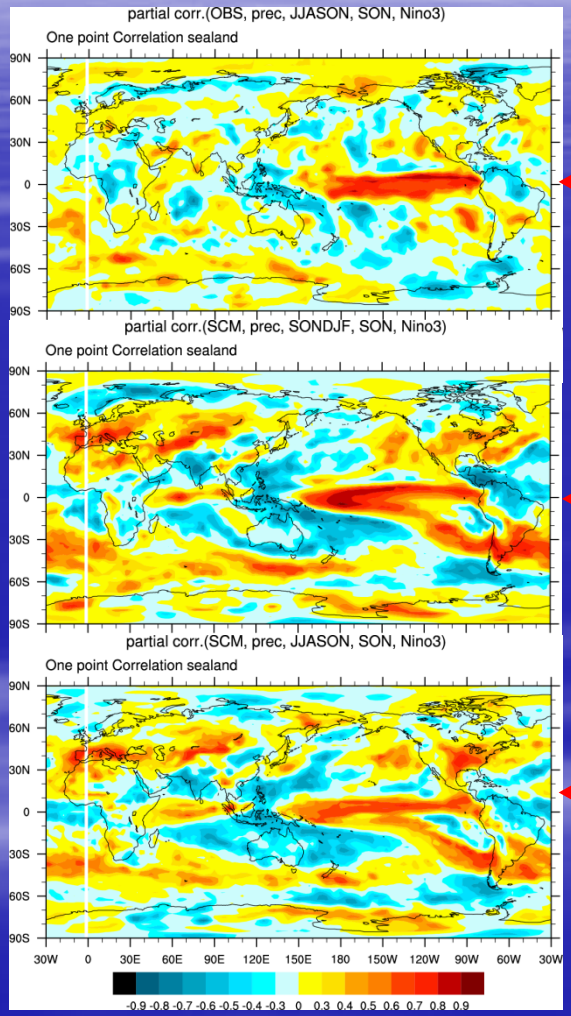
P Corr between Nino3 and Prec Ano.

P Corr between EMI and Prec Ano.

OBS

1-3month SCM

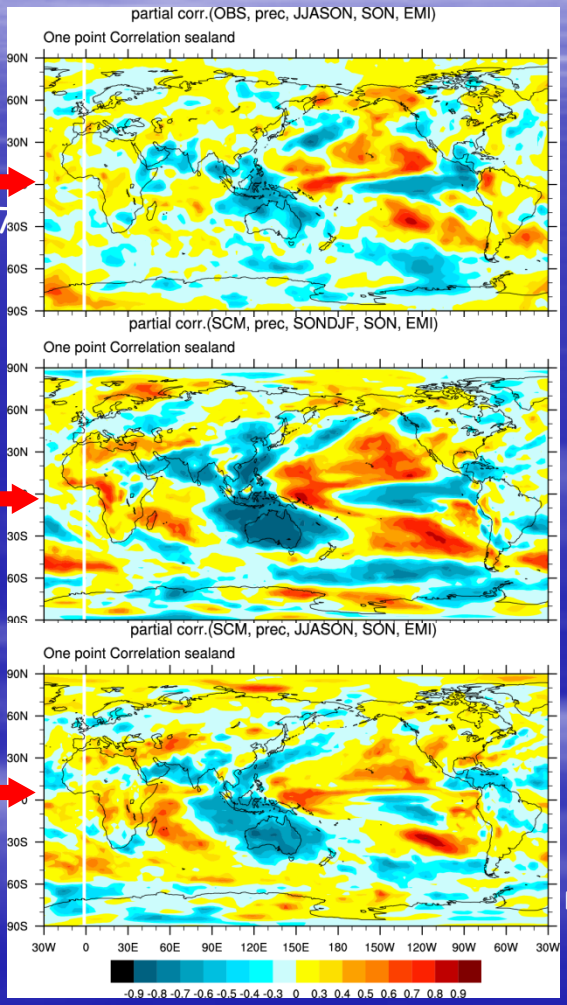
4-6month SCM



-0.07

0.15

0.27



r (obs,SCM) = 0.38

r (obs,SCM) = 0.53

r (obs,SCM) = 0.28

r (obs,SCM) = 0.40

Target season: DJF

P Corr between Nino3 and Prec Ano.

P Corr between EMI and Prec Ano.

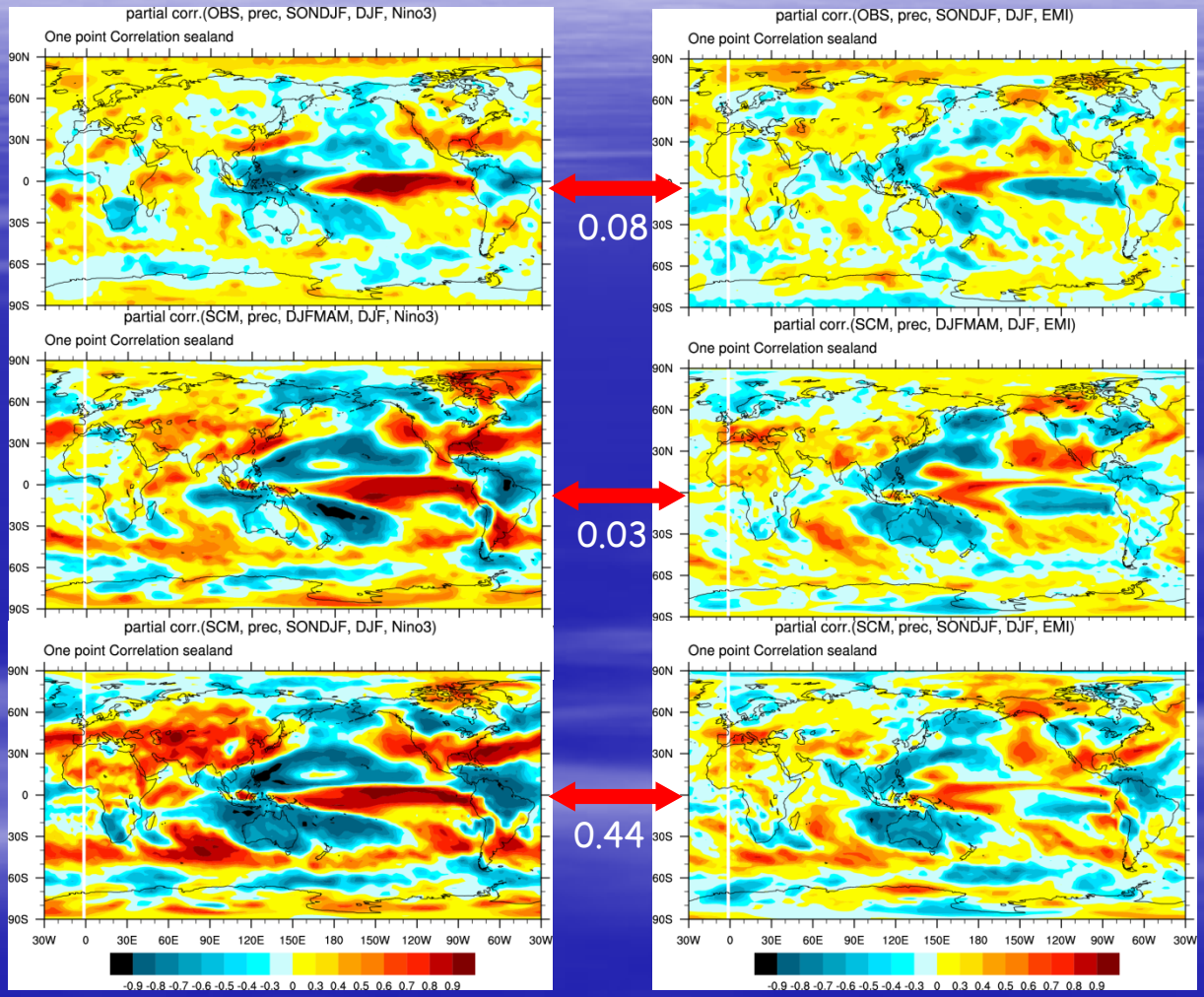
OBS

1-3month SCM

r (obs,SCM) = 0.59

4-6month SCM

r (obs,SCM) = 0.60



0.08

0.03

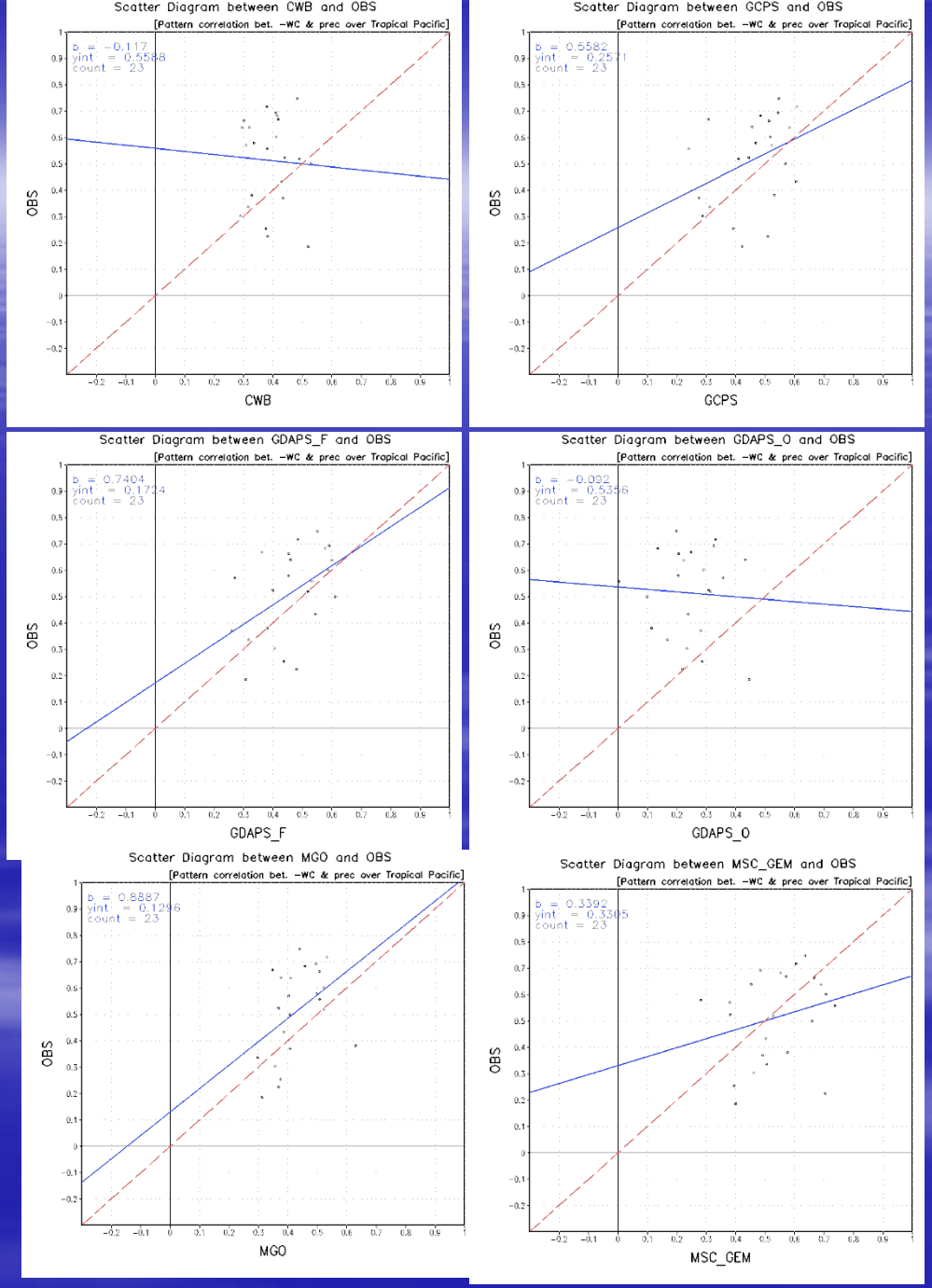
0.44

r (obs,SCM) = 0.43

r (obs,SCM) = 0.36

Intercomparision of model prediction performance

- **To evaluate the model skills in reproducing tropical teleconnections, realistic ENSO response in tropics is vital.**
- **Designed an ENSO-related Walker circulation index.**
- **A bulletin comparing the forecast performance for specific season as well as the historical performance has been also launched.**
- **The right hand side figure shows the a scatter diagram between the ACC between observed and Walker circulation index, with those of the individual models, for DJF seasons from 1983-2002. This proves that for good tropical performance, we need at least good ENSO circulation. Interestingly, many models still fail to do this.**



Scatter Diagram (**DJF**)

Pattern correlation bet.WC & Prec

Tropical Pacific (100E~300E, 15S~20N) region (TR1)

Summary

- The coupled models have prediction skills in regions adjacent to the tropical Pacific at lead times of 4-6 months.
- Increasing the participant models (& ensembles), with better physics, may be the solution to improve the performance.
- Longer hindcast data will provide avenues for better statistical downscaling.
- The issue of non-stationarity may be needed to be addressed with longer hindcasts. But non-linear methods (and MMEs) may provide the solution.