Preliminary Results from CliPAS/APCC Multi-Model Ensemble Hindcast Experiments

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Current CliPAS/APCC MME Hindcast Experiments

Two-Tier systems

Statistical-Dynamical SST prediction (SNU) → AGCM

- FSU
- GFDL
- SNU/KMA
- CAM2 (UH)
- ECHAM(UH)

One-Tier systems

CGCM

- NASA
- CFS (NCEP)
- SNU
- SINTEX-F (FRCGC)
- UH Hybrid CM

Experiment design

- 1981 – 2004 summer (MJJAS)and winter (NDJFM) seasons for 24 years,
- 6-15 Member ensemble for each model
- 4-9 months Duration

SCIENTIFIC BASIS for climate prediction

Two –tier system

Bengtsson, L. et al. (1993), Graham and Barnett 1995.

Charney and Shukla (1981), Shukla (1998)

Atmospheric climate variation arises from slowly varying lower boundary forcing

One –tier system

Palmer (2000): "Prediction of seasonal climate fluctuations is essentially an initial value problem. Unlike the weather prediction, predictability arises from a memory of initial conditions in the ocean (as well as land surface)."

DEMETER/ ECMWF (Tier 1 Prediction System)

- **Development of European Multimodel Ensemble system for seasonal-to-interannual prediction**
- **One-tier prediction system using CGCM**
- **9 ensemble members of 7 models**
- **1980-1999 forecast**

Institute	AGCM	Resolution	OGCM	Resolution	Atmosphere initial conditions	Ensemble generation
FSU	ARPEGE	T63 31 Levels	OPA 8.2	2.0x2.0 31 Levels	ERA-40	Windstress and SST perturbations
ECMWF	IFS	T95 40 Levels	HOPE-E	1.4x0.3-1.4 29 Levels	ERA-40	Windstress and SST perturbations
INGV	ECHAM-4	T42 19 Levels	OPA 8.1	2.0x0.5-1.5 31 Levels	Coupled AMIP-type experiment	Windstress and SST perturbations
LODYC	IFS	T95 40 Levels	OPA 8.2	2.0x2.0 31 Levels	ERA-40	Windstress and SST perturbations
Meteo-France	ARPEGE	T63 31 Levels	OPA 8.0	182GPx152 GP 31 Levels	ERA-40	Windstress and SST perturbations
MPI	ECHAM-5	T42 19 Levels	MPI-OM1	2.5x0.5-2.5 23 Levels	Coupled run relaxed to observed SSTs	Atmospheric conditions from the coupled initialization run (lagged method)
UK Met Office	HadAM3	2.5x3.75 19 Levels	GloSea OGCM based on HadCM3	1.25x0.3-125 40 Levels	ERA-40	Windstress and SST perturbations

Preliminary Results

MME Hindcast Skills (temperature/ precipitation)
: JJA and DJF, APCC and DEMETER

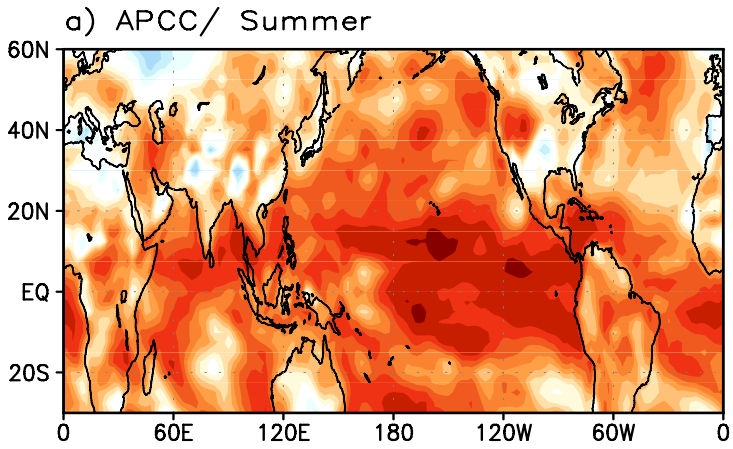
- **Global correlation skill score**
- **ENSO and A-AM**
  - Taylor diagram (PCC, NSD, RMSE)
  - MME effectiveness index
  - Probabilistic skill (BS, ROC)
- **Tier 1 vs Tier 2 (Remote vs local forcing)**
- **Asian summer monsoon rainfall**
- **Simple potential economic value assessment**
  - Deterministic and probabilistic forecast
- **Issues**

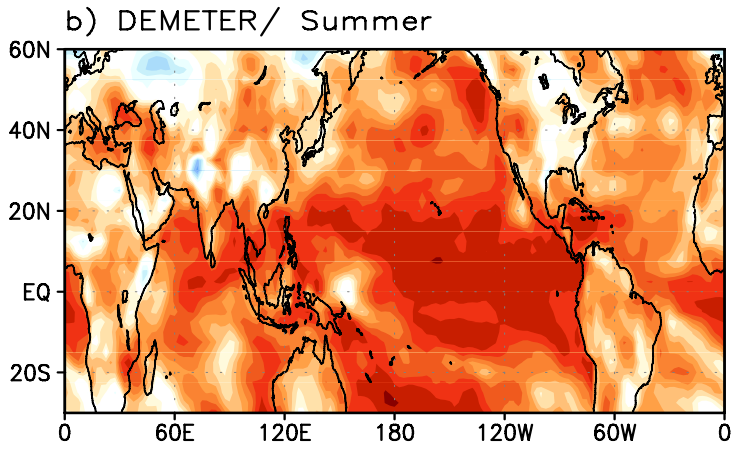
MME Hindcast Skill: Temporal Correlation/ 1981-2001

2m Air Temperature

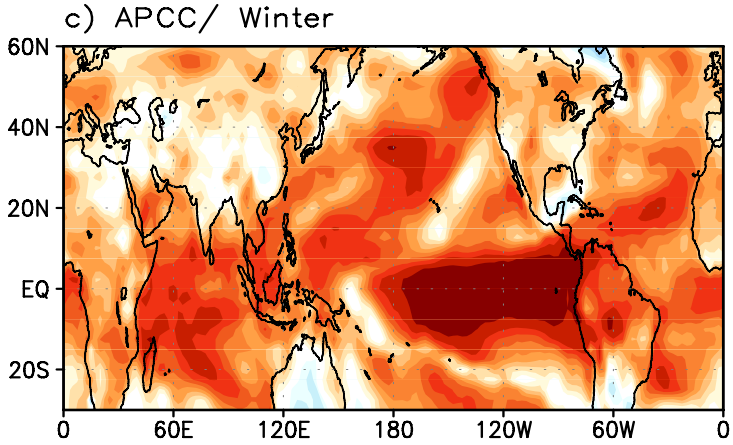
APCC MMEP | **DEMETER MMEP**

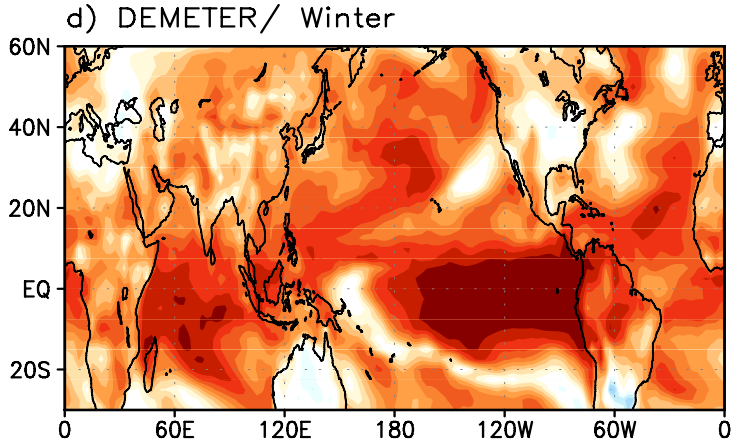
JJA

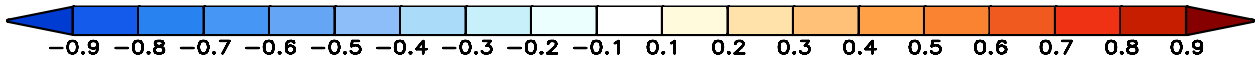




DJF





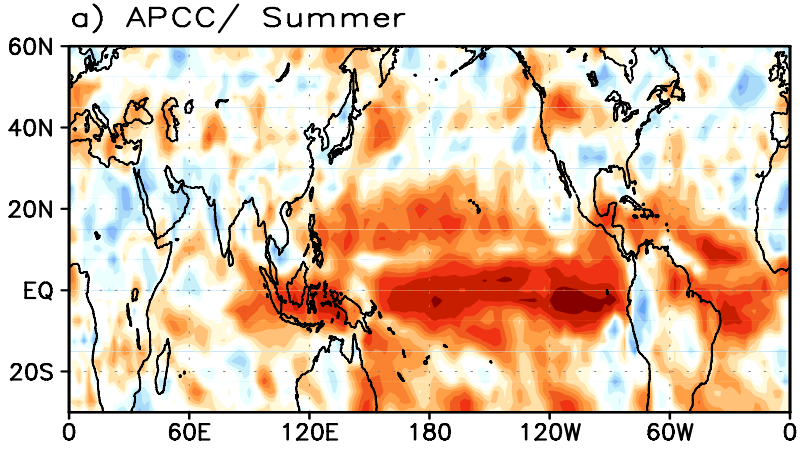


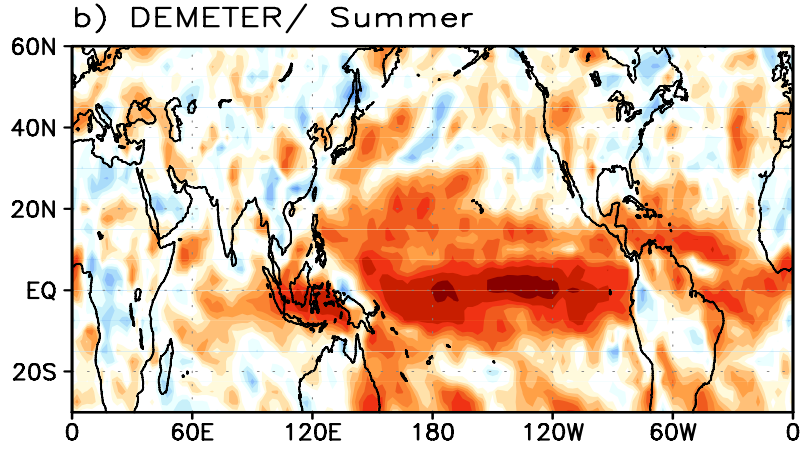
MME Hindcast Skill: Temporal Correlation/ 1981-2001

Precipitation

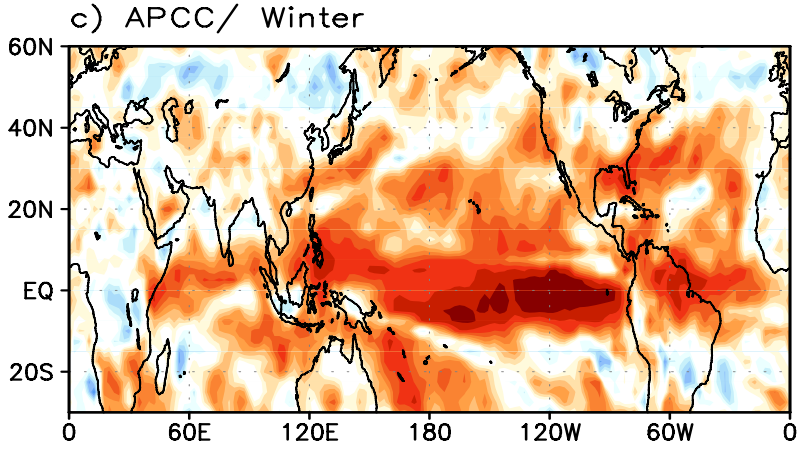
APCC MMEP | **DEMETER MMEP**

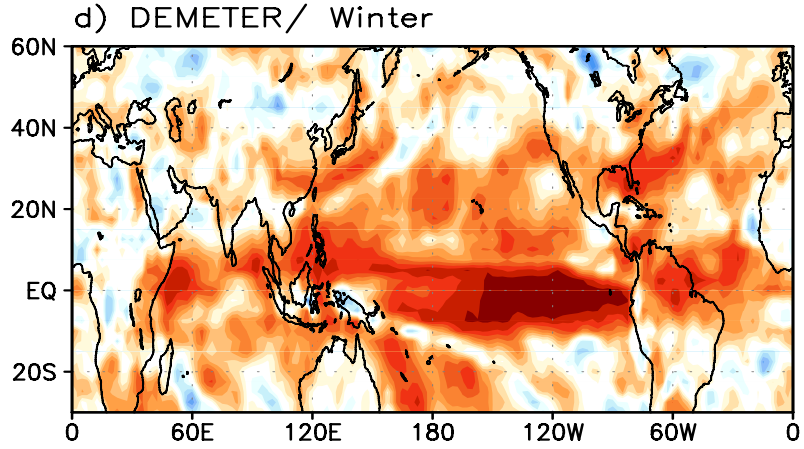
JJA

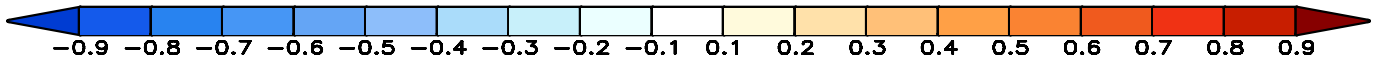




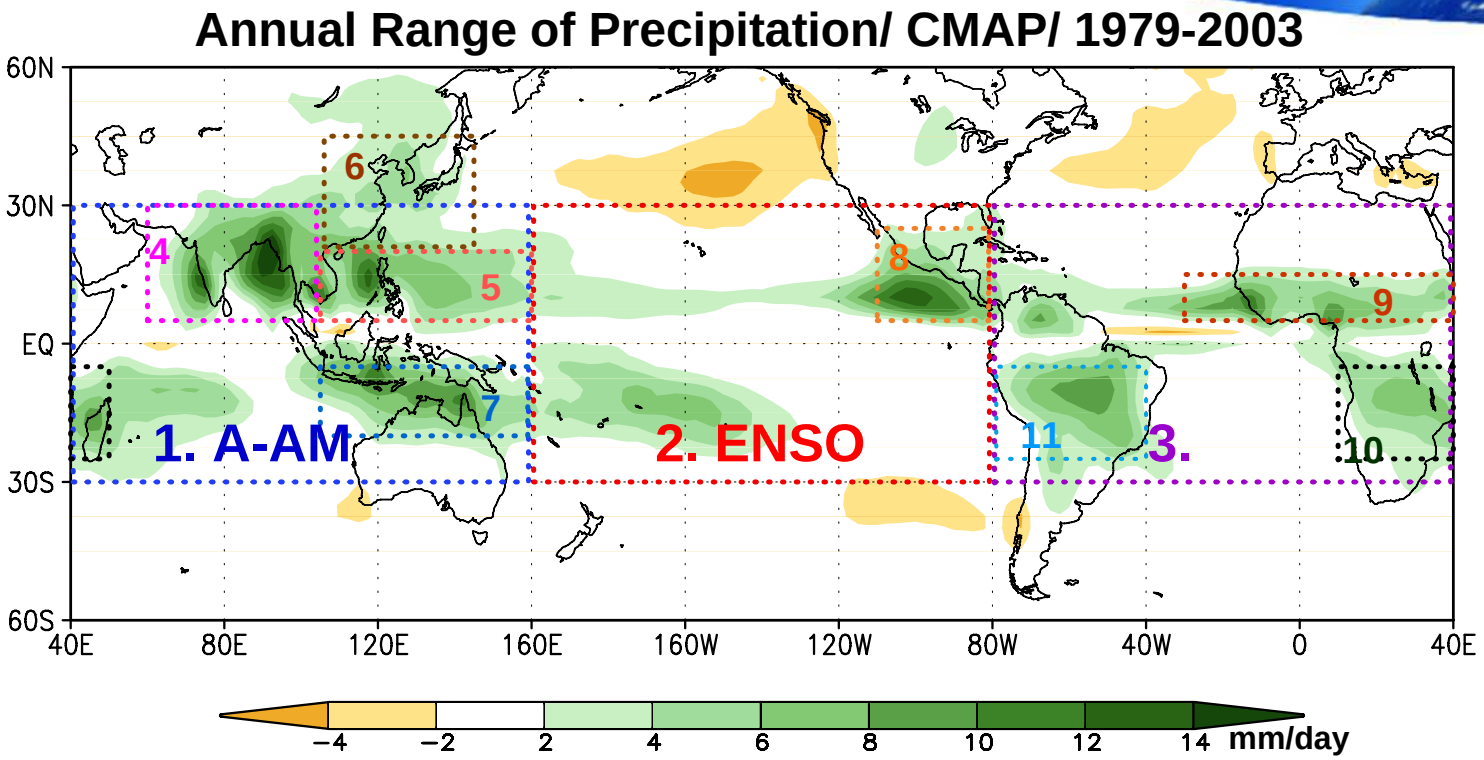
DJF







Definition of Domains



1. Asian-Australian Monsoon (A-AM) Region : 40E-160E, 30S-30N

4. Indian or South Asian (IM): 60E-105E, 5N-30N, 6. East Asian (EA) : 105E-145E, 20N-45N

5. Western North Pacific (WNP): 105E-160E, 5N-30N, 7. Australian (AUS): 105E-160E, 20S-5S

2. ENSO Region : 160E-80W, 30S-30N

8. Eastern North Pacific-Mexico (ENP-MEXICO) : 110W-80W, 5N-25N

3. Tropical Atlantic-SA-A Region : 80W-40E, 30S-30N

9. North African (NAF) : 30W-40E, 5N-15N, 11. South American (SAM) : 80W-40W, 25S-5S

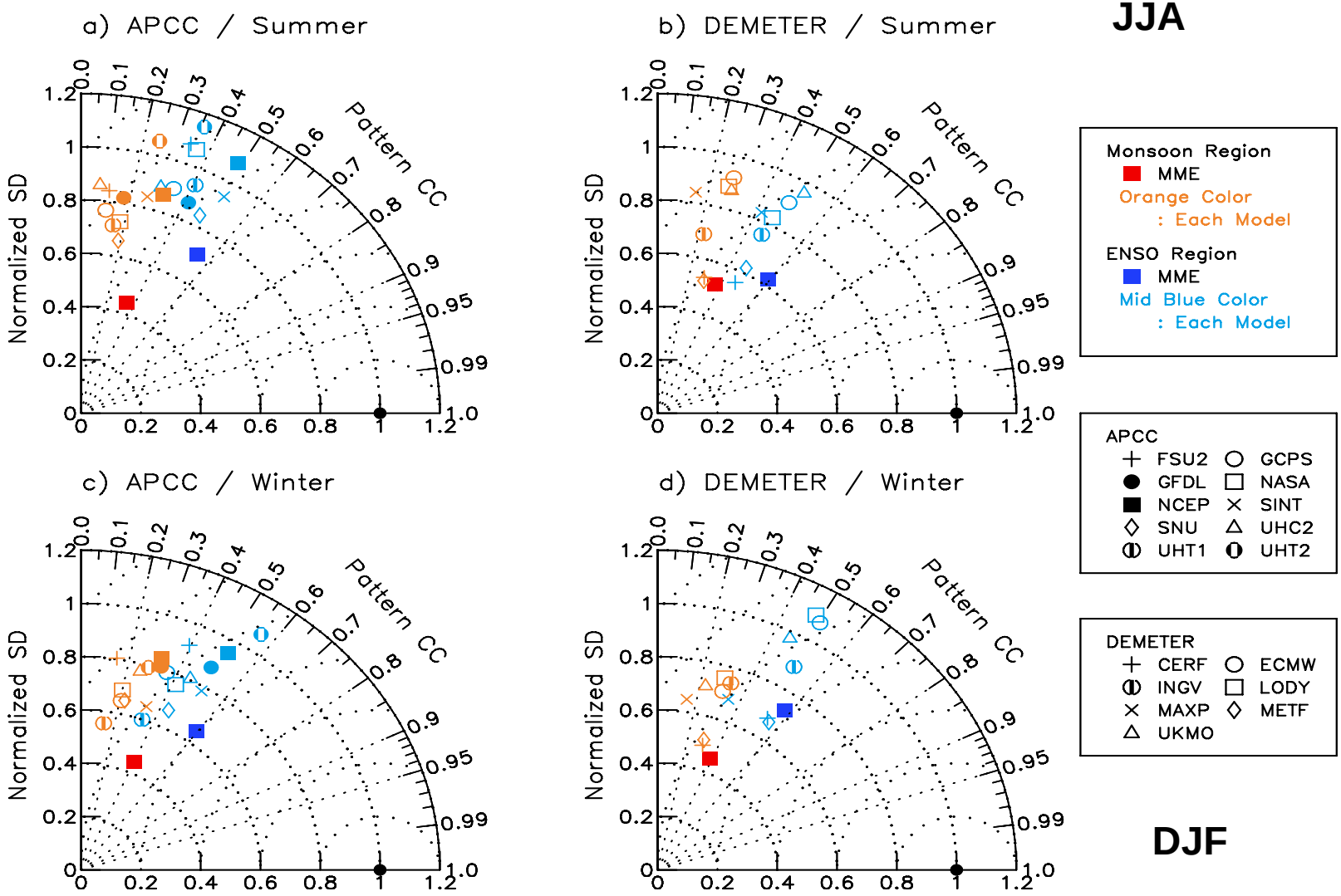
10. South African (SAF) : 10E-50E, 25S-5S

MME Hindcast Skill: Taylor Diagram /1981-2001

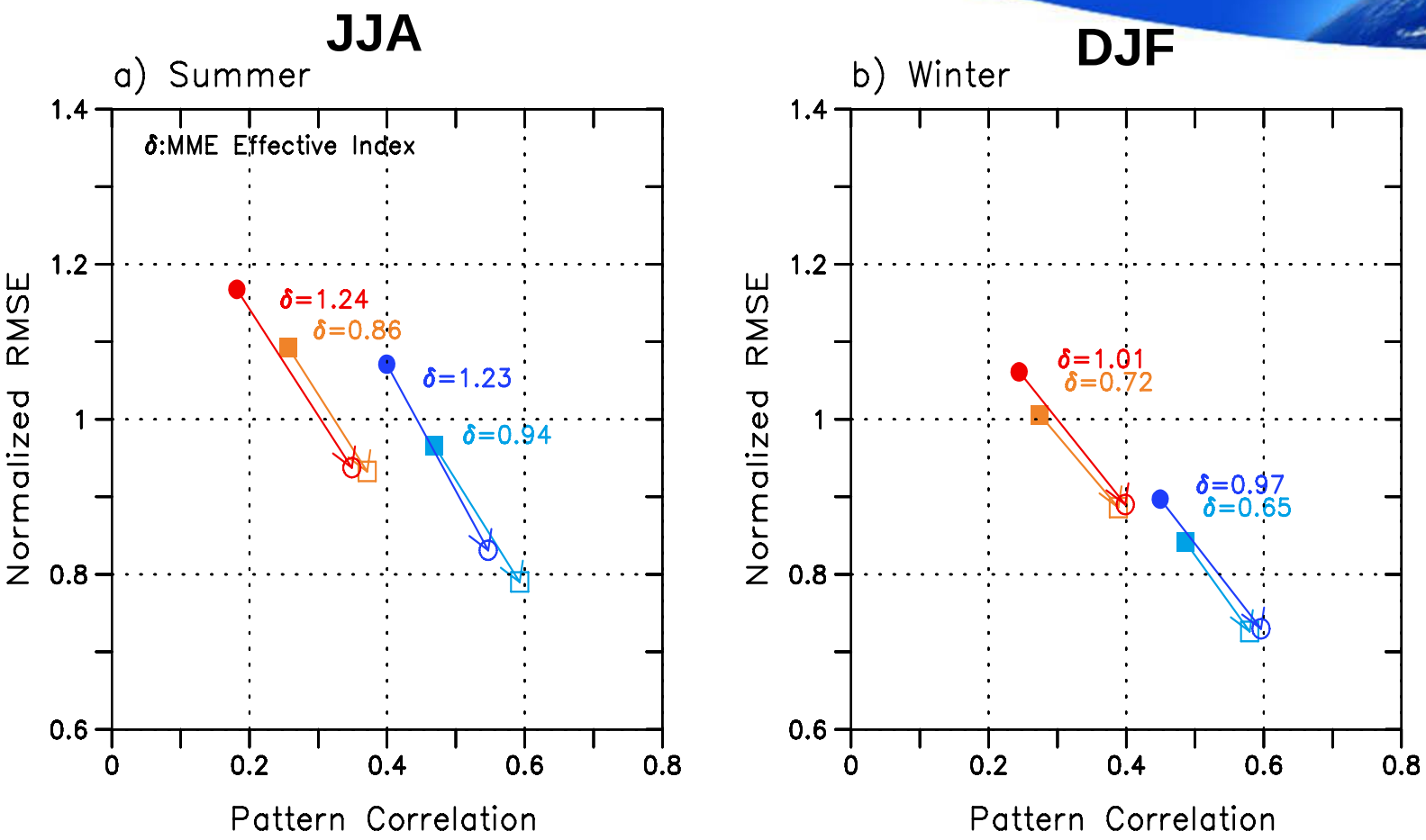
Precipitation

APCC MME

DEMETER MME



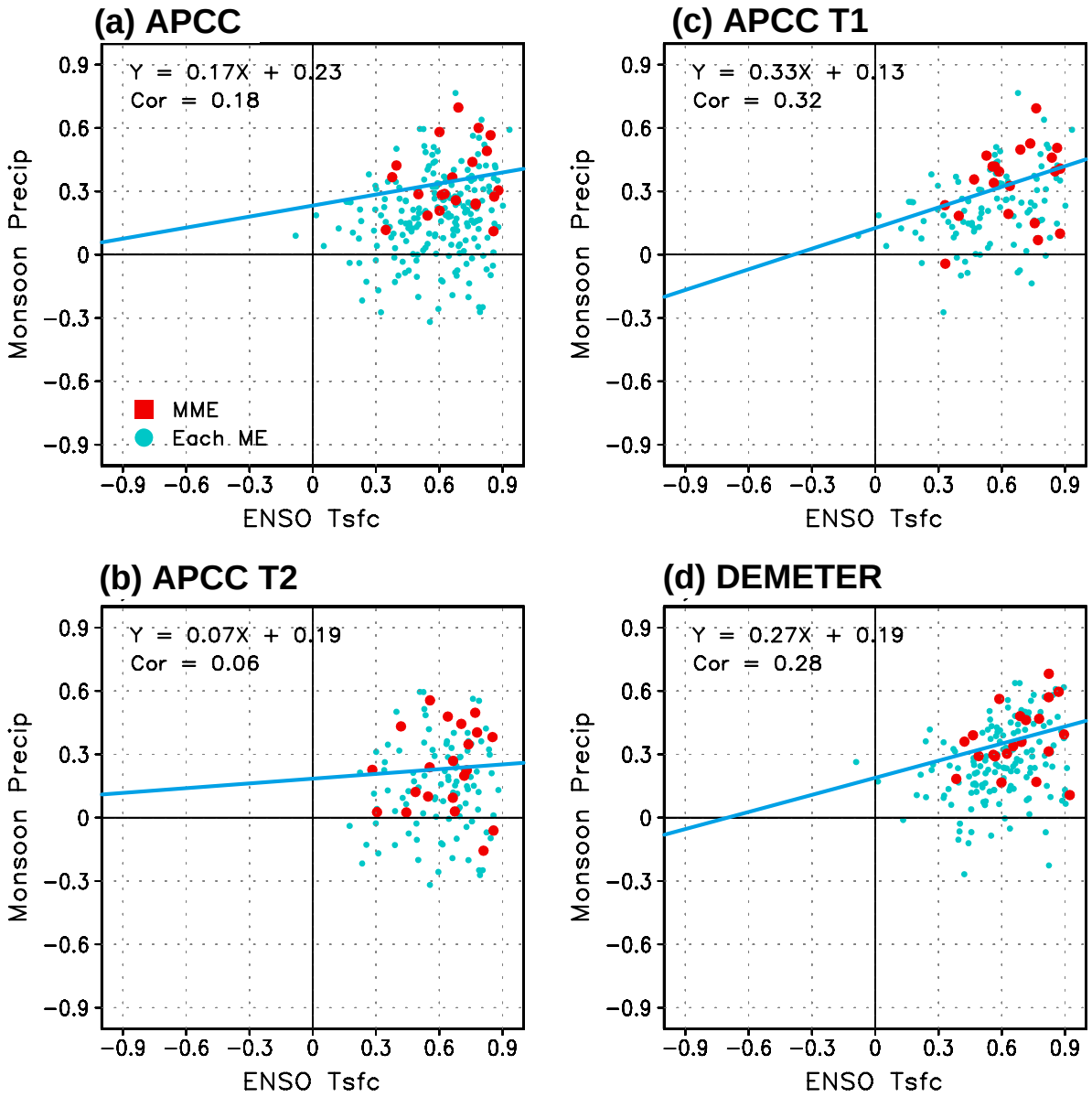
MME Effective Index/ Precipitation



	Monsoon Region		ENSO Region	
	APCC	DEMETER	APCC	DEMETER
Averaged Skill of Models	●	■	●	■
MME Skill	○	□	○	□

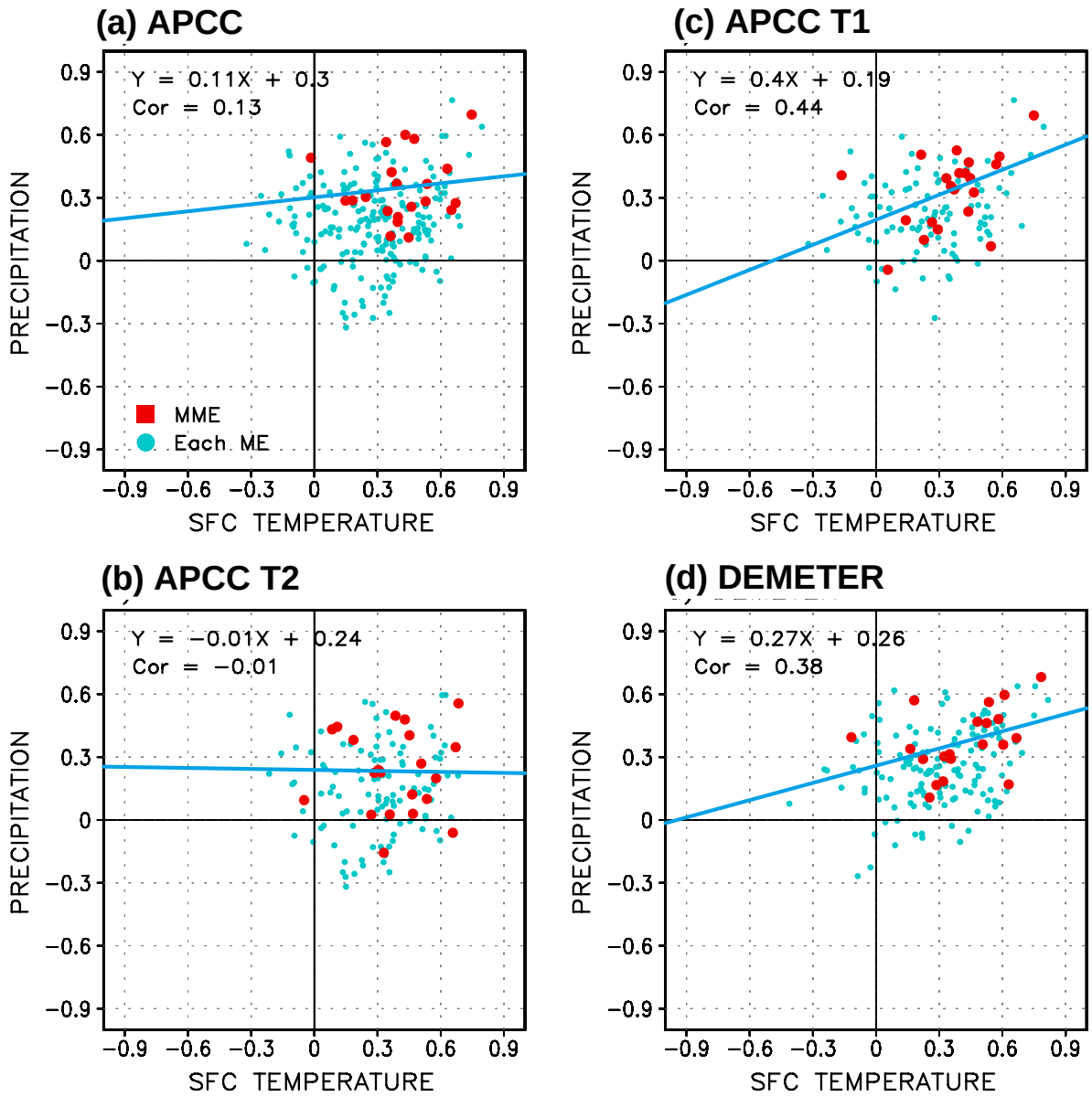
One-Tier 1 vs Two-Tier Anomaly PCC over AAM (JJA)

ENSO SST vs Monsoon Precipitation

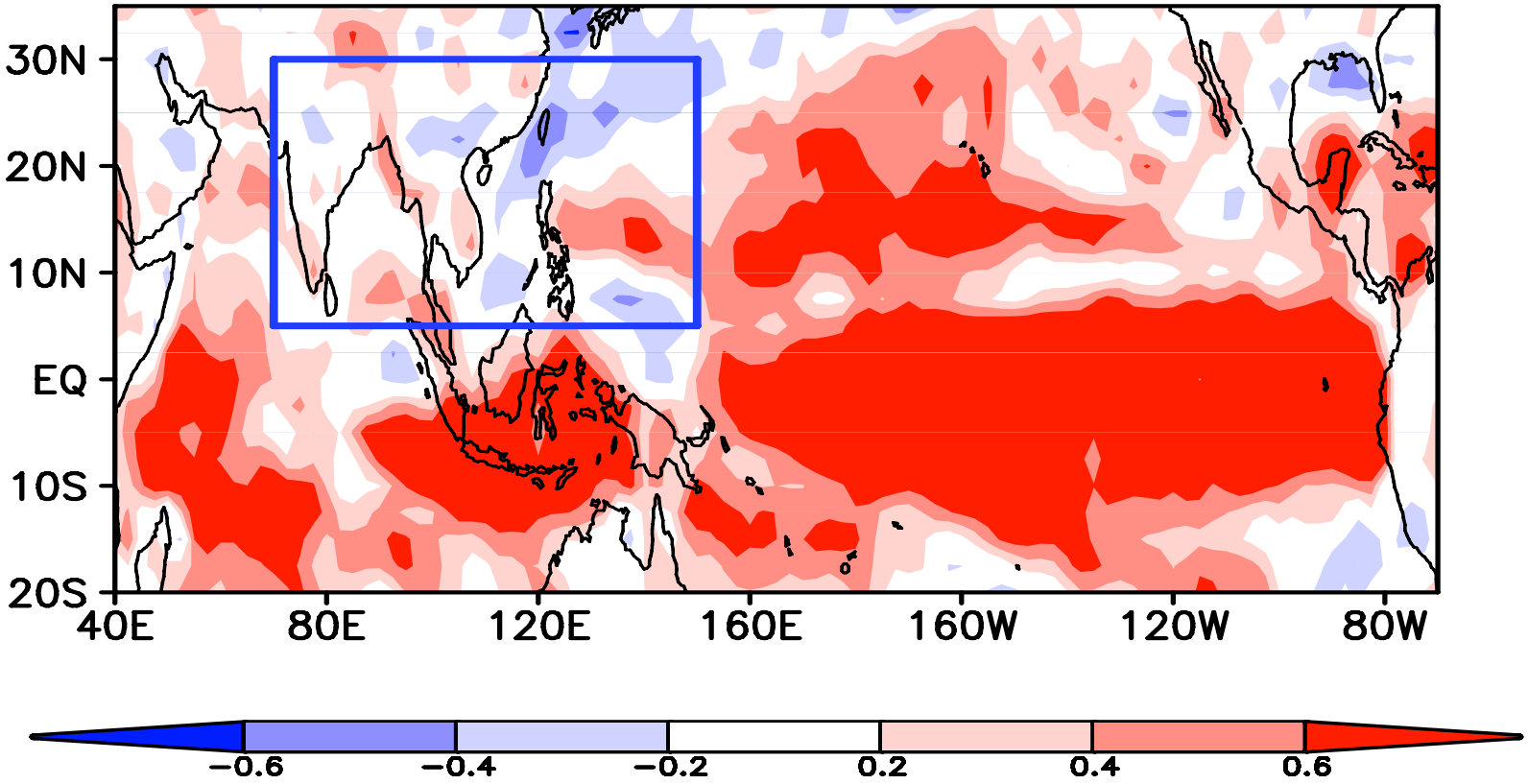


One-Tier 1 vs Two-Tier Anomaly PCC over AAM (JJA)

Local SST vs Precipitation over Monsoon Region



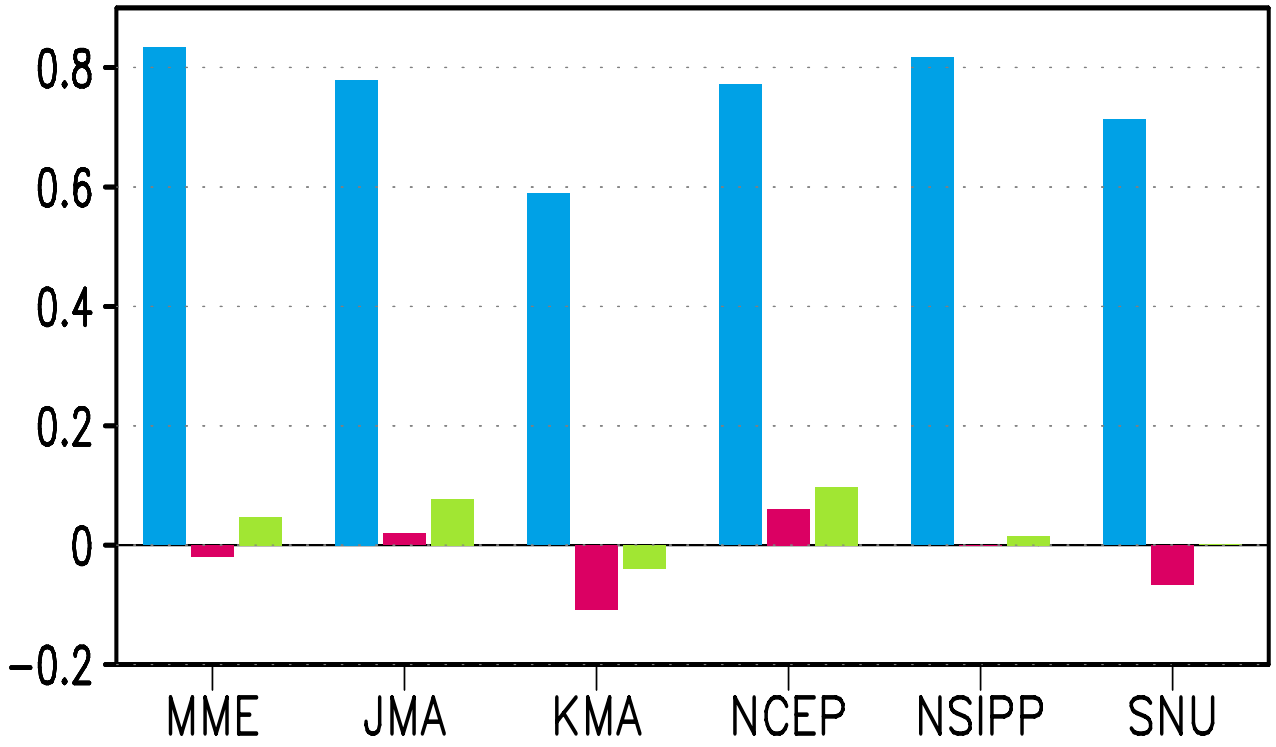
Correlation Coefficients between the observed and 5 AGCM MME hindcast June-August precipitations (1979-1999)



Wang et al. (2005)

Fig. 1

Area averaged correlation coefficients (skills)



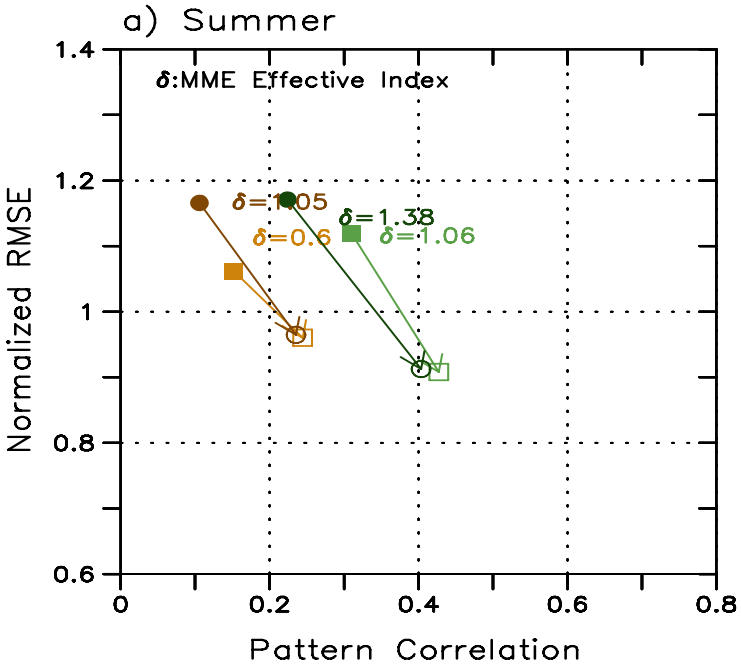
El Nino region (10°S-5°N, 80°W-180°W)

WNP (5-30°N, 110-150°E)

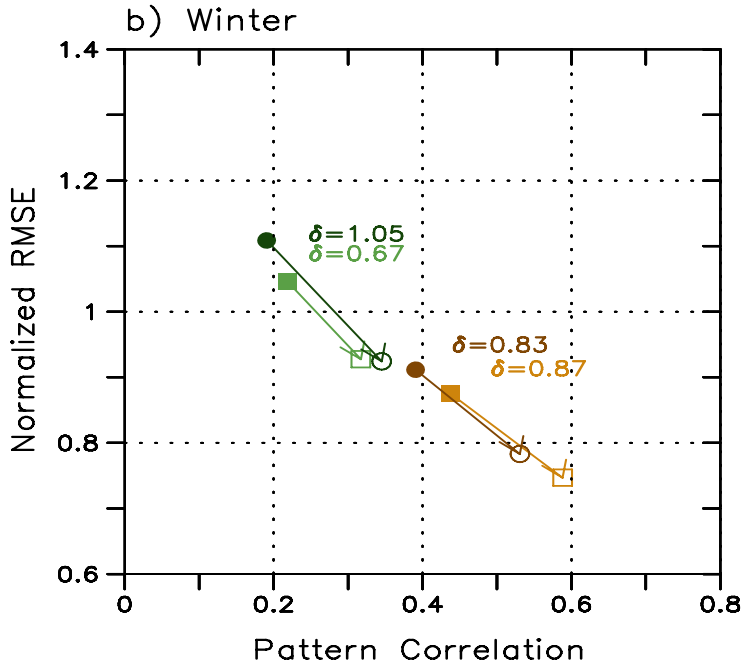
Asian-Pacific MNS (5-30°N, 70-150°E)

MME Effective Index/ Precipitation

JJA



DJF



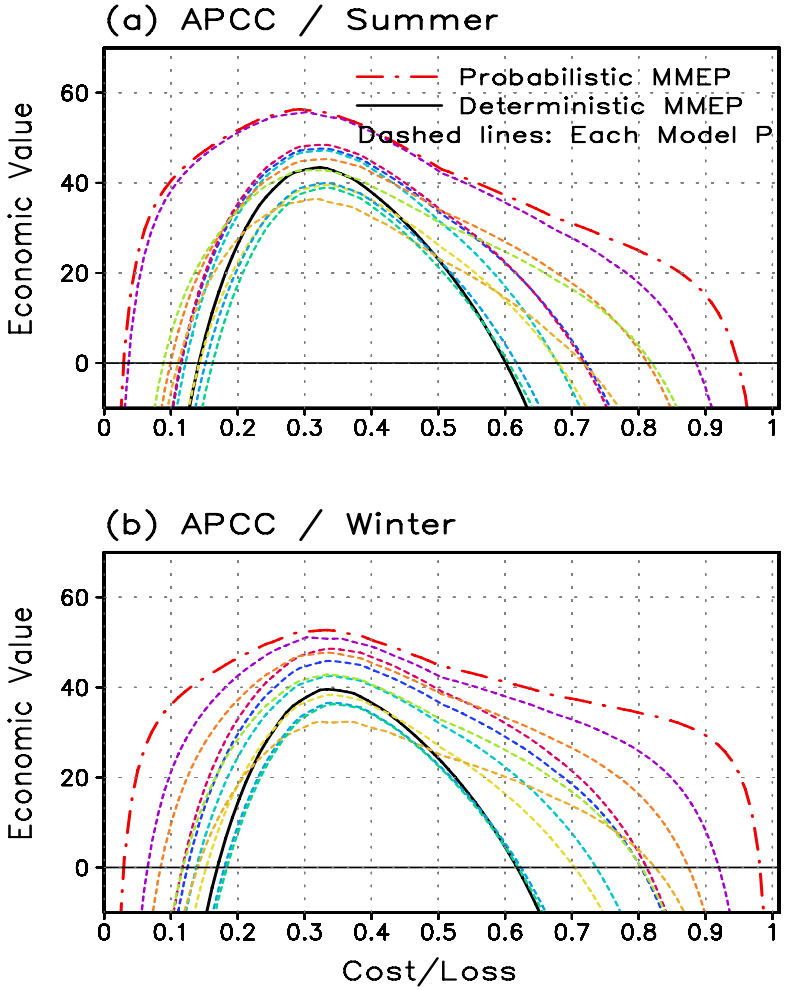
	SA&WNP		Rest of AAM	
	APCC	DEMETER	APCC	DEMETER
Averaged Skill of Models	●	■	●	■
MME Skill	○	□	○	□

Southeast Asian and WNP region: 80-150E, 5-30N

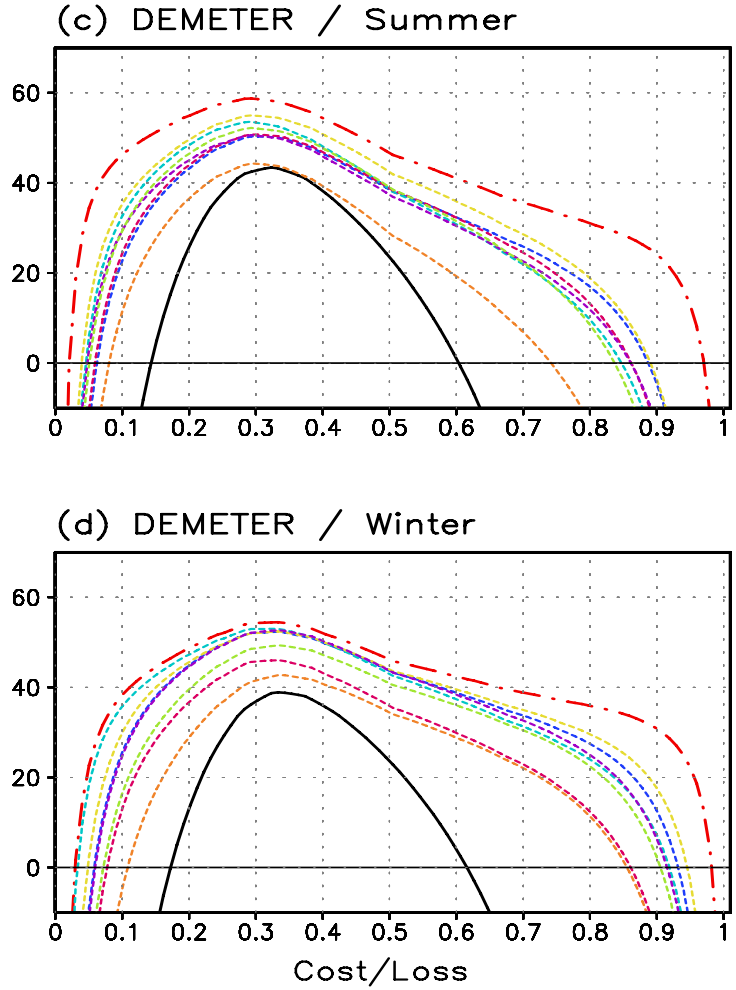
Deterministic and Probabilistic MMEP/ 2m Air Temperature

Potential Economic Value Assessment

APCC



DEMETER



Probabilistic forecast for above normal 2m air temperature greater than 0.5 standard deviation over ENSO Region

Summary of the Preliminary Results

1. The CliPAS blended one- and two-tier MME hindcasts have skills comparable to DEMETER in precipitation and surface temperature prediction, although their averaged individual models' performance is lower than that of DEMETERs.

2. The CliPAS MME is more effective due to their larger mutual independence among individual models as evidenced from their larger range of their skills.

3. The MME is more effective when and where individual models have moderate performances while potential predictability is large. MME is more applicable to the summer monsoon regions.

4. In A-A summer monsoon heavy precipitation regions, one-tier maybe superior over two-tier system due to increased feedback from the local surface SST and improved ENSO teleconnections.

Issues

1. What are advantages and potential limitations of Two-tier vs. One-tier system?

2. Why does all models perform poorly in prediction of the A-A-A continental monsoon precipitation?

3. ENSO prediction: La Nina barrier

4. Ensemble prediction: Impacts of Initialization

5. Optimization of MME

6. Extreme events: Typhoon/Hurricane

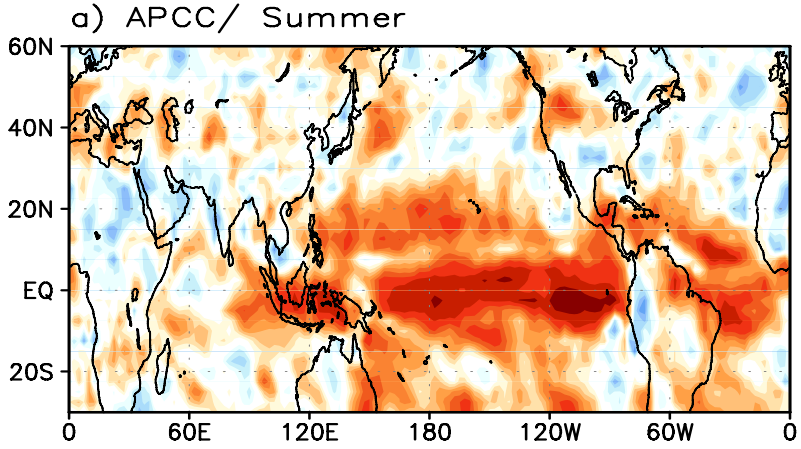
7. Explore new sources of predictability for extratropics

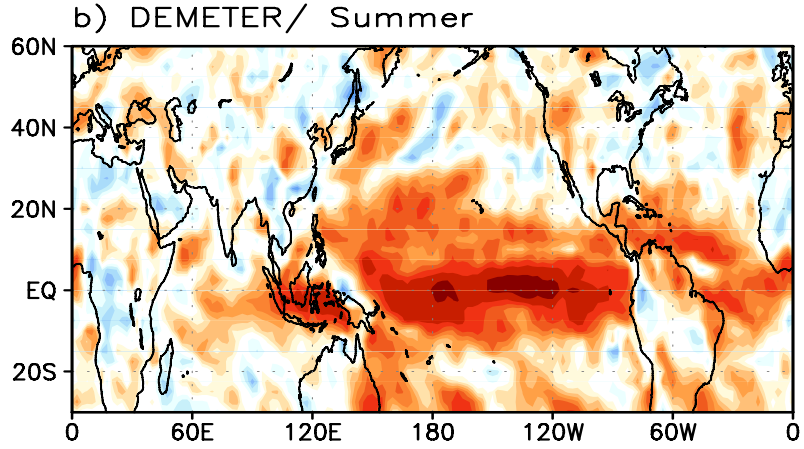
MME Hindcast Skill: Temporal Correlation/ 1981-2001

Precipitation

APCC MMEP | **DEMETER MMEP**

JJA





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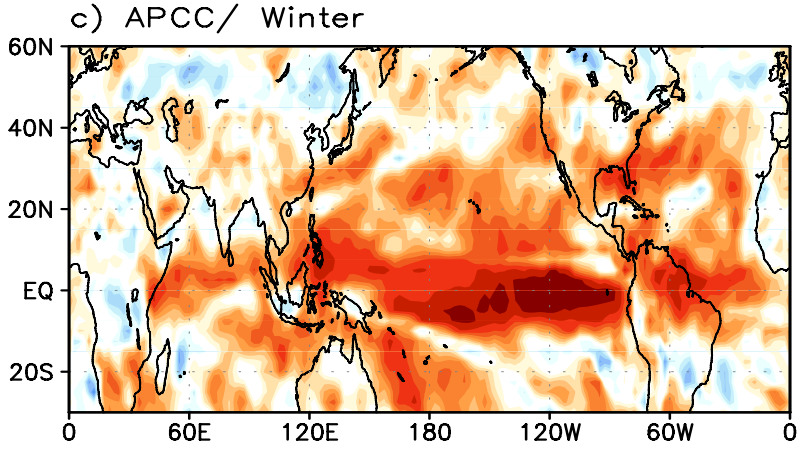
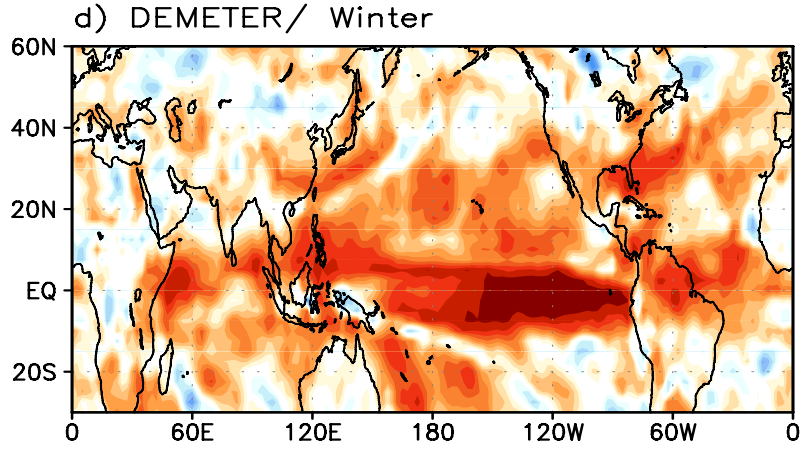
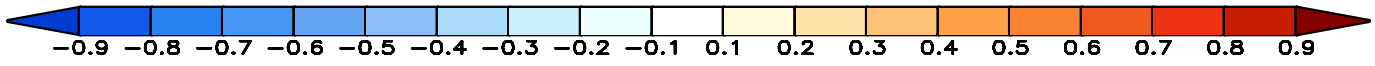
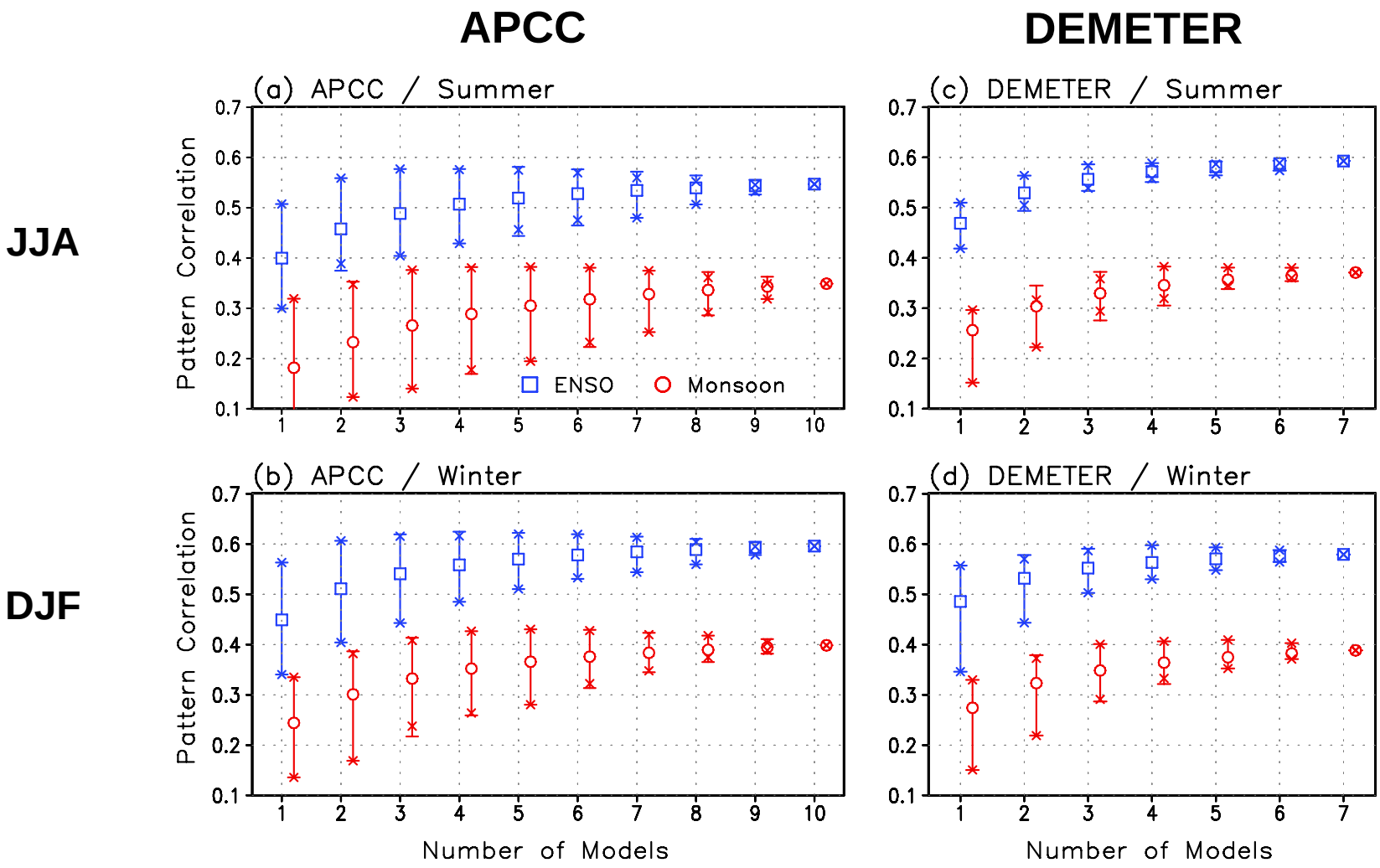




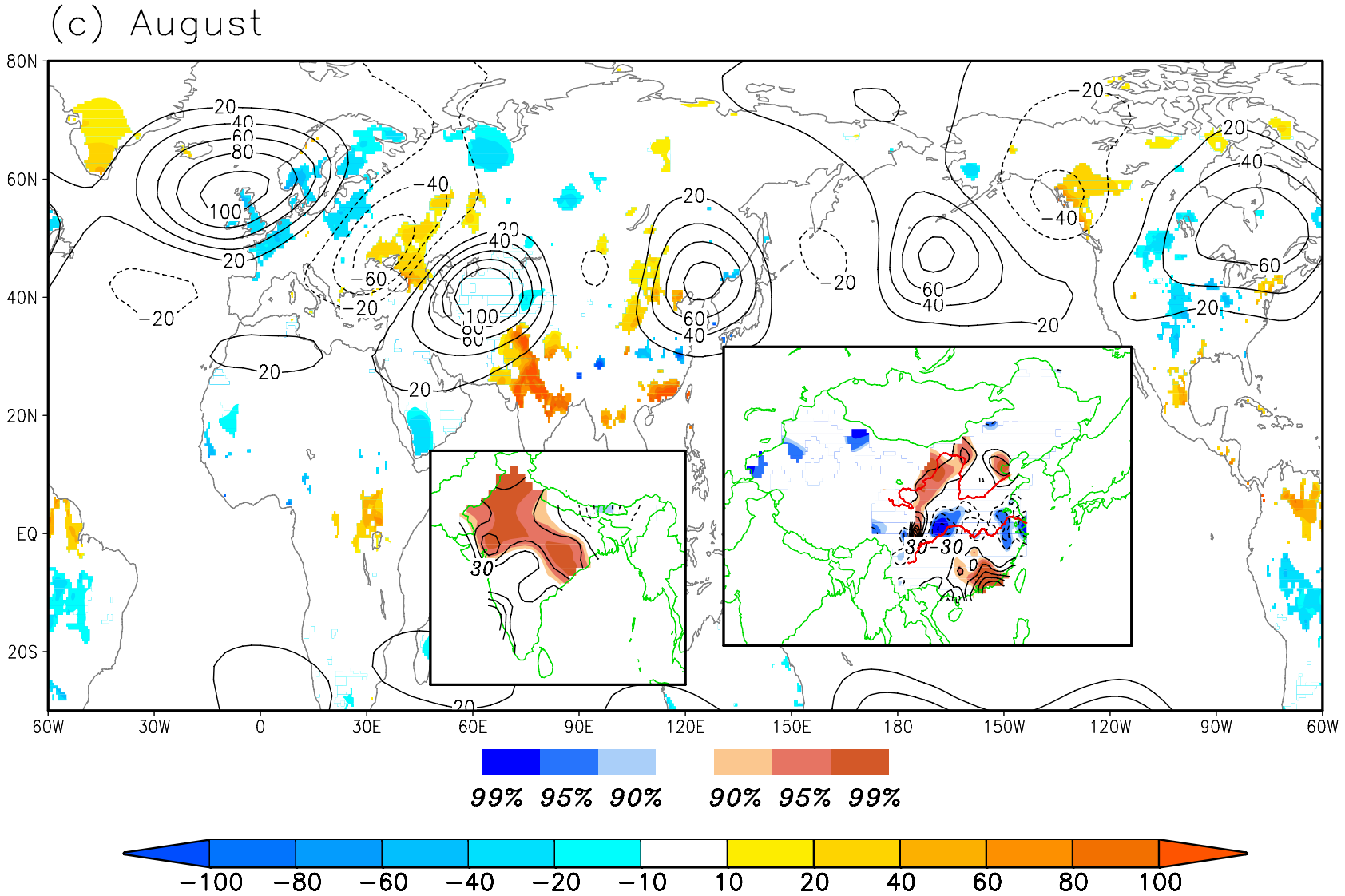


Deterministic MMEP

Range of Pattern Correlation/ Precipitation



NH Summer Circumglobal Teleconnection (CGT



Ding and Wang'05

Composite differential surface air temperature

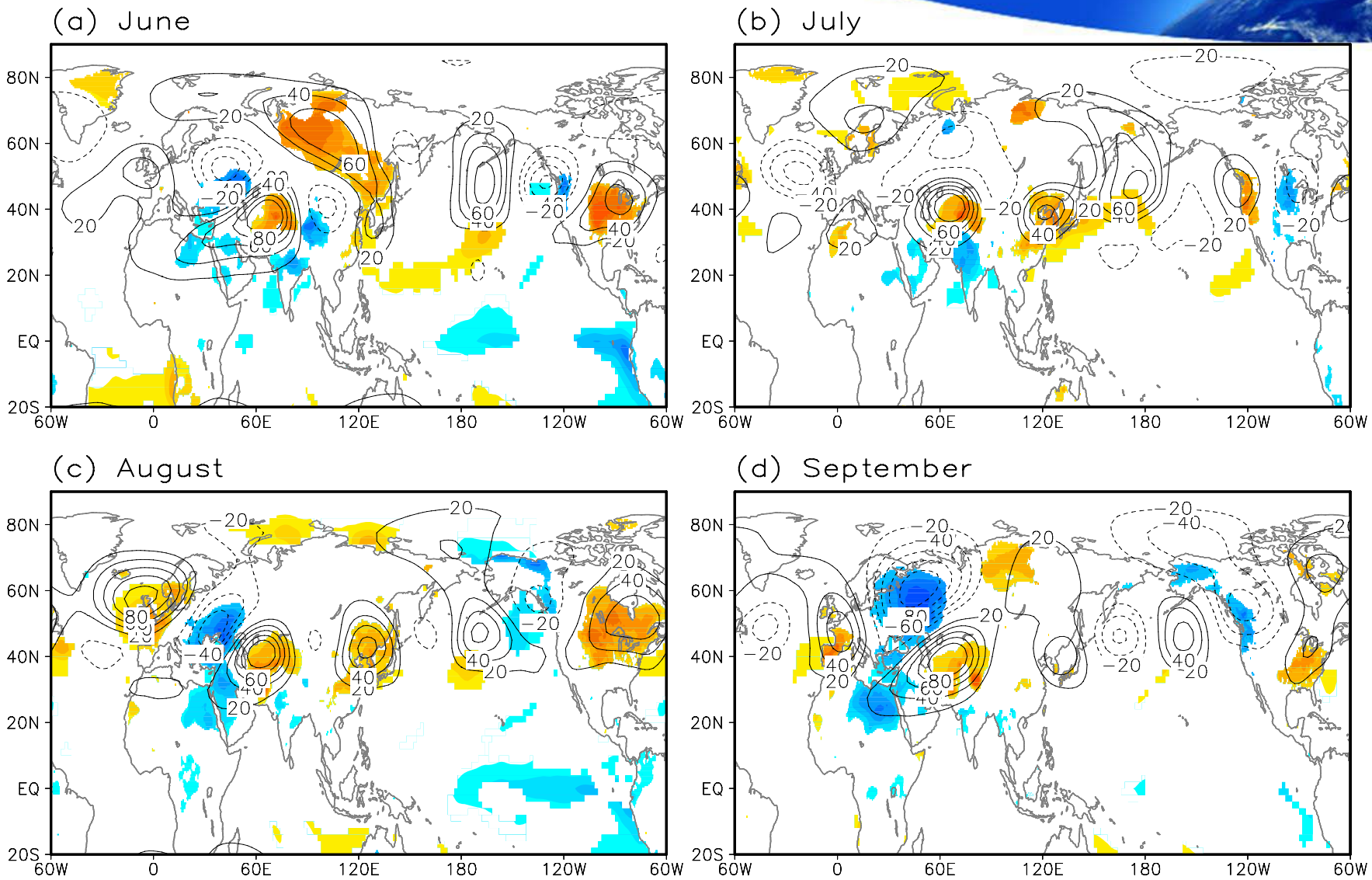


Fig.8

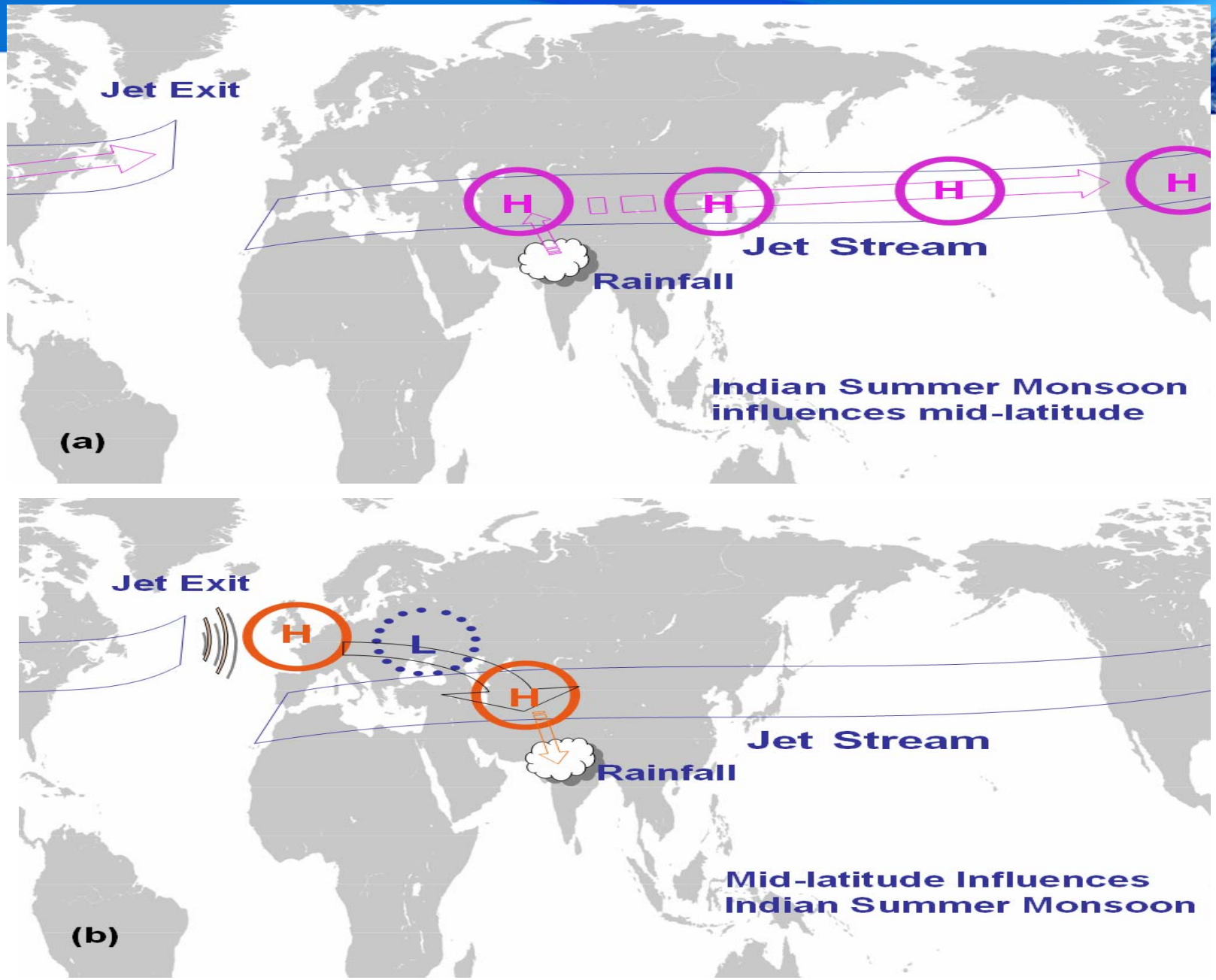
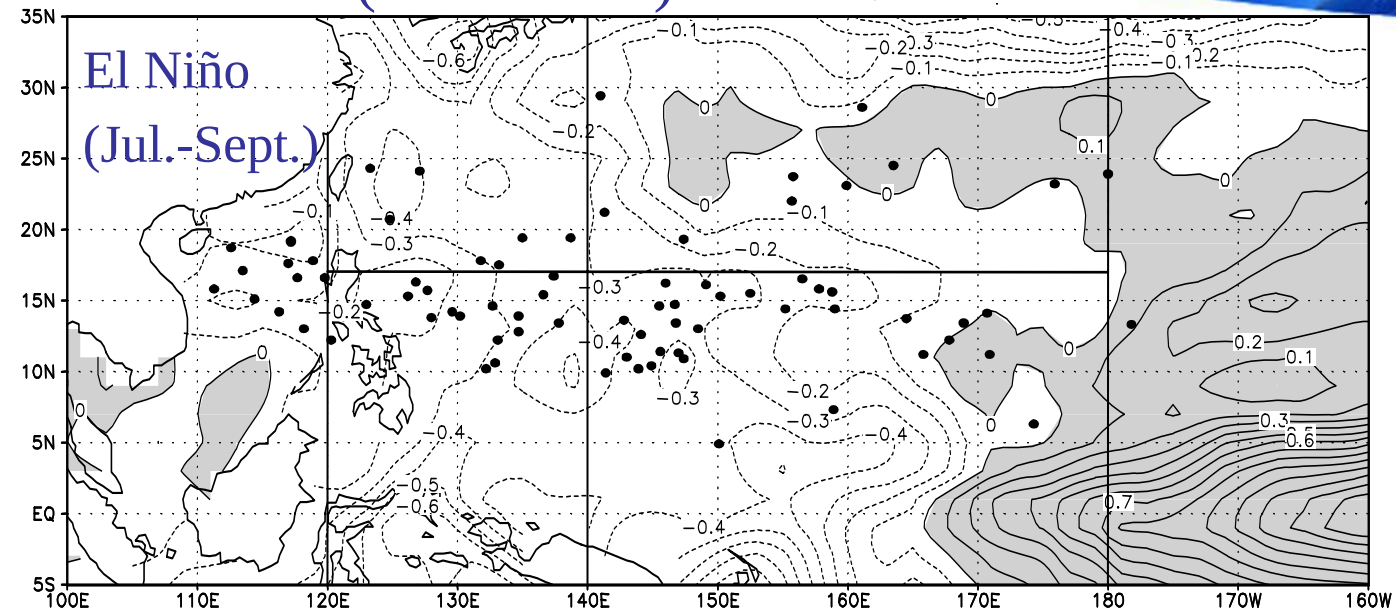
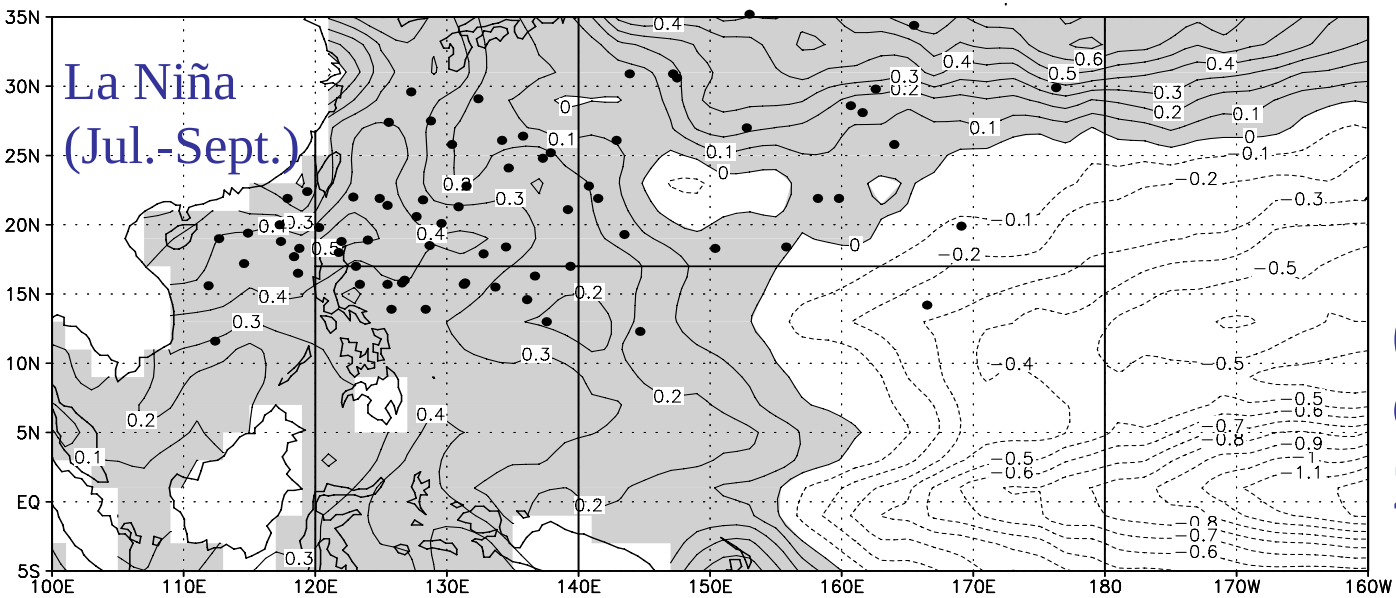


Fig.13 Relay mechanism: ISM_extratropical interaction

ENSO impacts on WNP storm

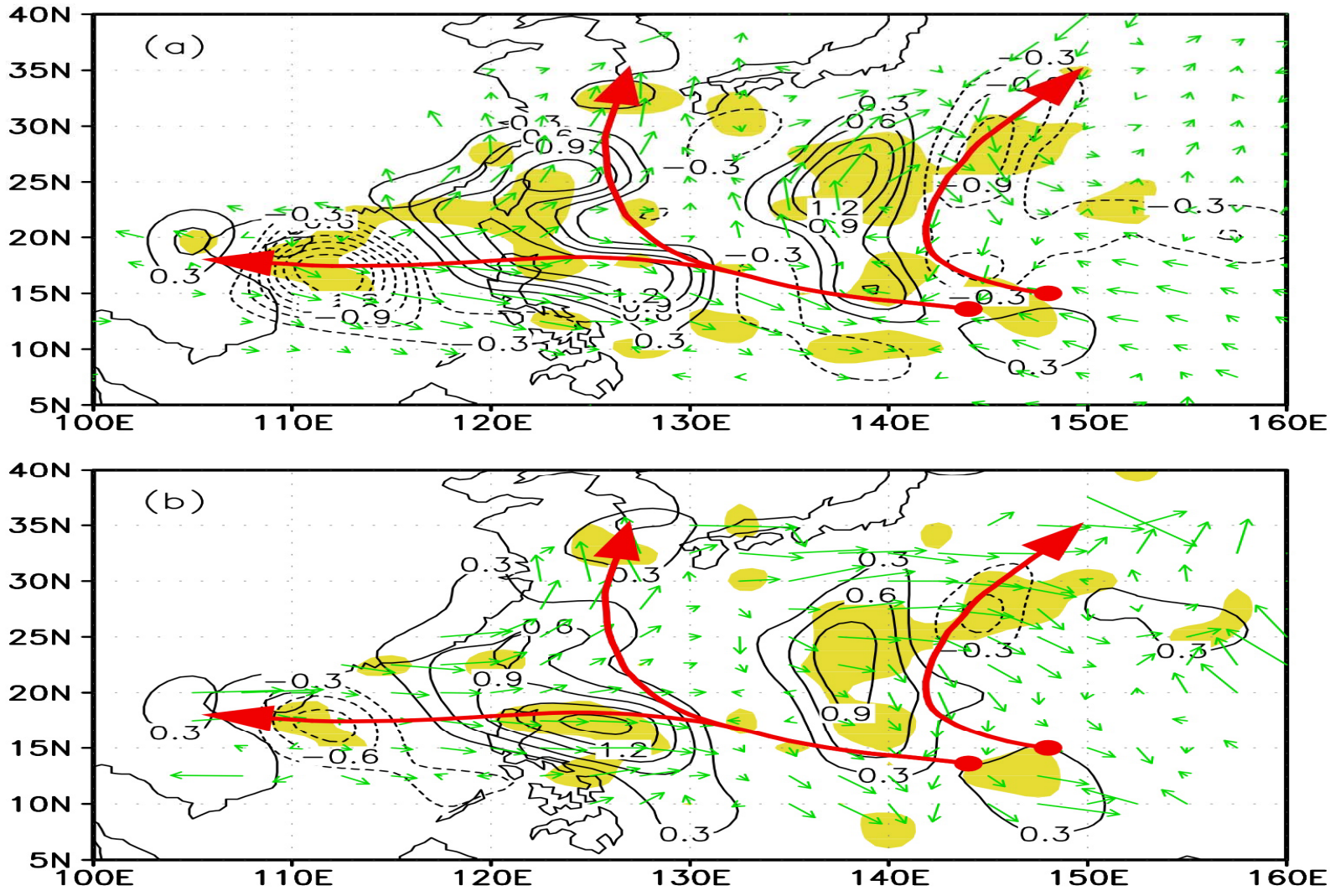
(1965-2001) Nino 3.4 SSTA





(Wang & Chan 2002)

Typhoon Track Changes in the last 40 years



Wu and Wang 2005