Prospectus for CLIVAR

Asian-Australian Monsoon Panel

The Asian-Australian Monsoon affect more than one half od the world population.
Monsoon prediction remains a major challenge for the scientific community for the 21st centuary

Panel:
Cobin Fu, Harry Hendon (Co- Chair), In-Sik Kang, Jay McCreary, Holger Meinke, Gary Meyers, Rajeevan, Takehiko Satomura, Andrews Schiller, Julia Slingo, Ken Sperber, Bin Wang (Co-Chair), Peter Webster

Key questions AAMP is addressing

--Defining AAMP activity

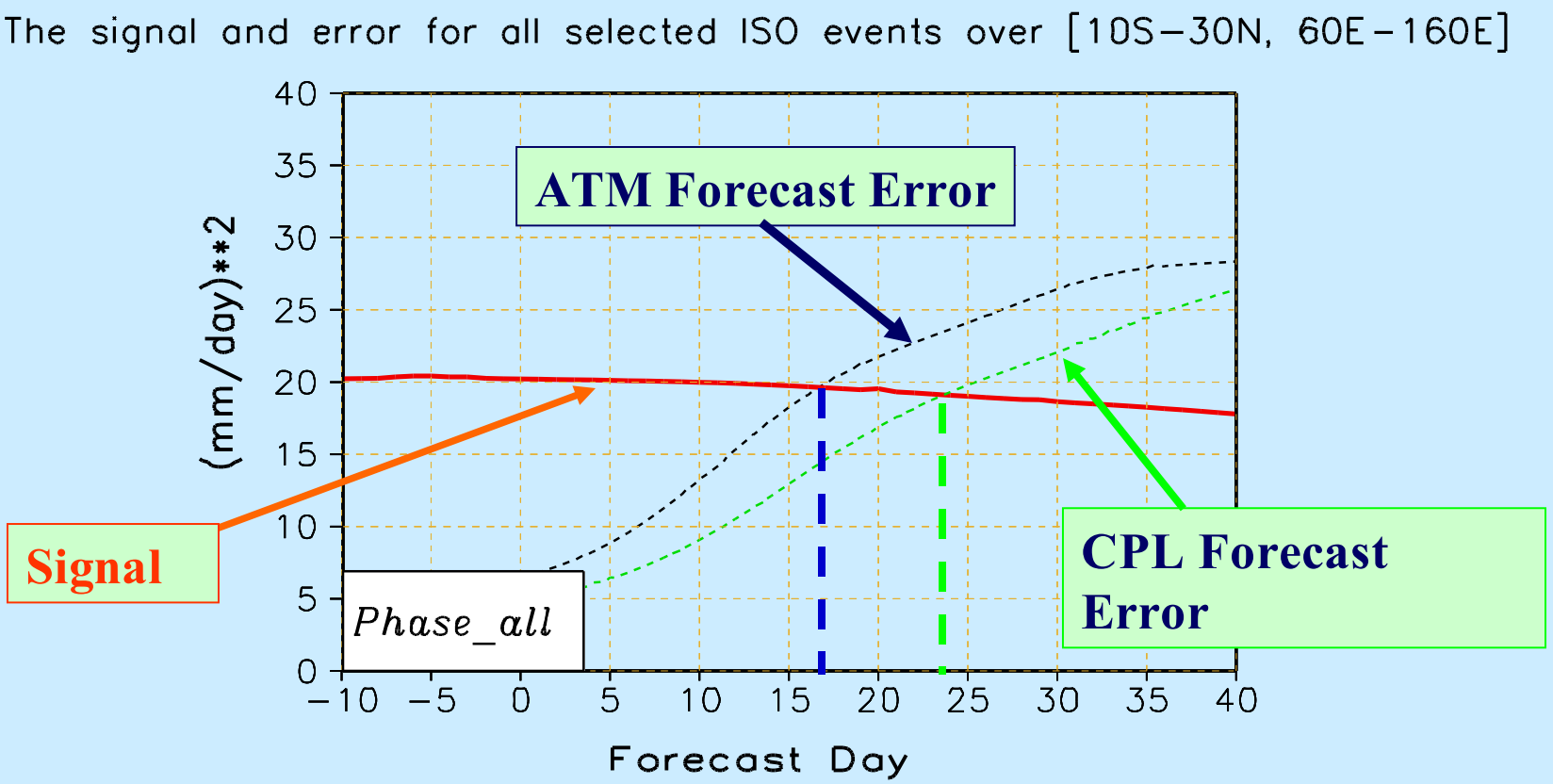
- What are the critical processes causing monsoon Intraseasonal Variability? What are the major challenges to modeling and predict MJO and monsoon ISV? To what extend the monsoon ISV is predictable?
- What is the current state of knowledge and predictive skill of AAM IAV? How predictable is the IAV and how to advance monsoon seasonal predictions?
- Does AAM system have a coherent structure of interdecadal variation? How does the decadal variability couple to ocean?
- How will AA-M system change in a global warming environment? What are sub-seasonal to interannual factors that influence extreme events? What is the sensitivity of the monsoon to external and anthropogenic climate forcing?
- What are the structure and dynamics of the annual cycle of the coupled atmosphere-ocean-land system? What are the major weaknesses of the climate models in simulation of the annual cycle?Do models getting diurnal cycle right will improve the modeling of the annual cycle and low-frequency variability?

1. ISV and Predictability

What are the critical processes causing monsoon Intraseasonal Variability? What are the major challenges to modeling and predict MJO and monsoon ISV? To what extend the monsoon ISV is predictable?

- The panel promoted **THORPEX/WCRP/ICTP Workshop Organisation and Maintenance of Tropical Convection and the Madden Julian Oscillation**.
- The panel has asked CLIVAR SSG endorsement on Sieg Shubert's proposal on an **coordinated experiment on high resolution climate model simulation of hurricane/Typhoon activity**.
- The panel is also encouraging study of strategies, such as **slow manifold** approach, for improving dynamical model's capacity of MJO prediction.

Air-Sea Coupling Extends the Predictability of Monsoon Intraseasonal Oscillation



ATM: 17 days, CPL: 24 days

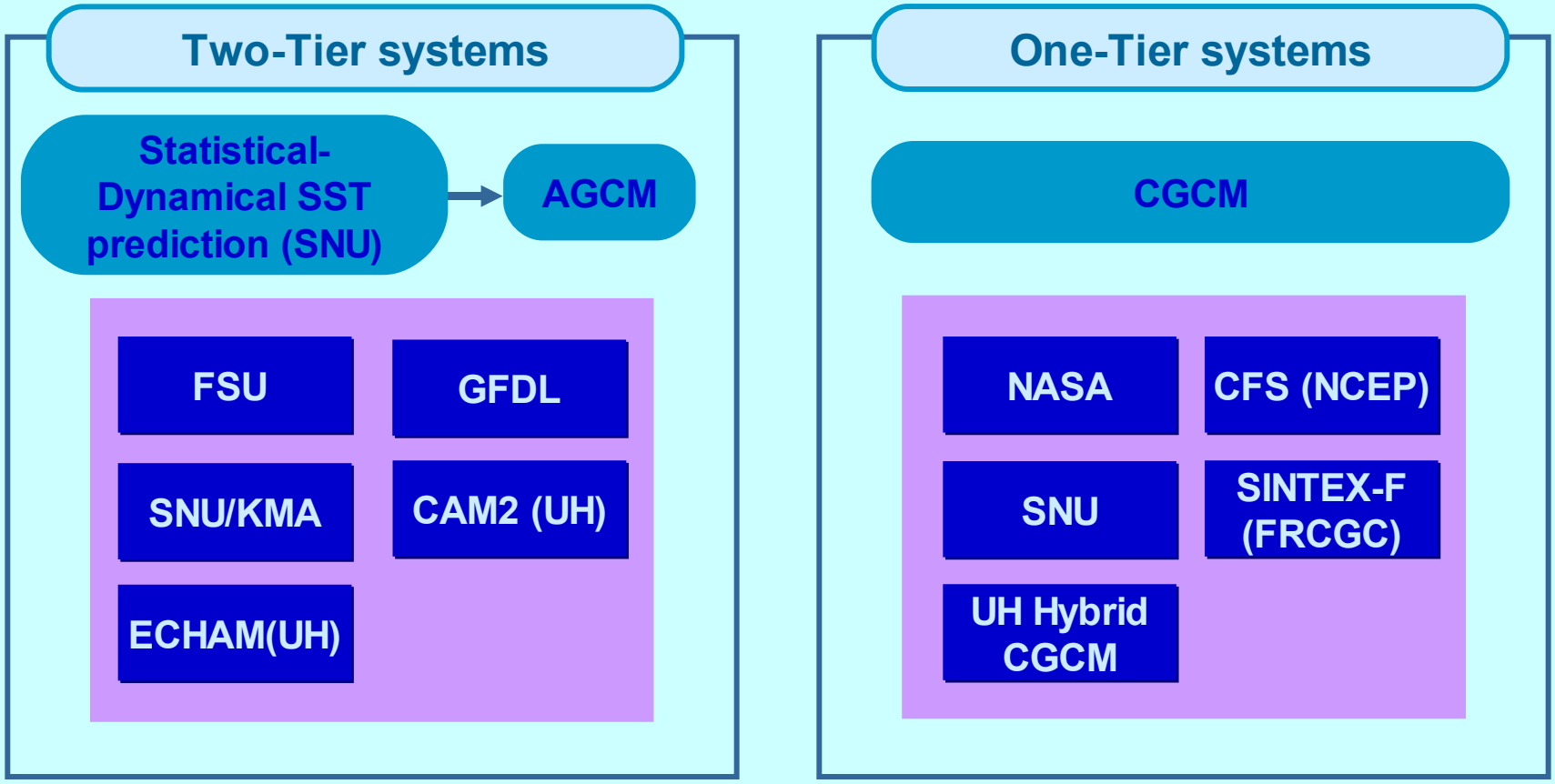
Fu and Wang 2005

2. IAV and predictability

What give rise to the leading modes of interannual variability? What is the current state of knowledge and predictive skill of AAM IAV? How predictable is the IAV and how to advance monsoon seasonal predictions?

- the panel is promoting Asian-Pacific Economic Cooperation Climate Center (**APCC) Climate Prediction and its Societal Application** (**CliPAS**) project.

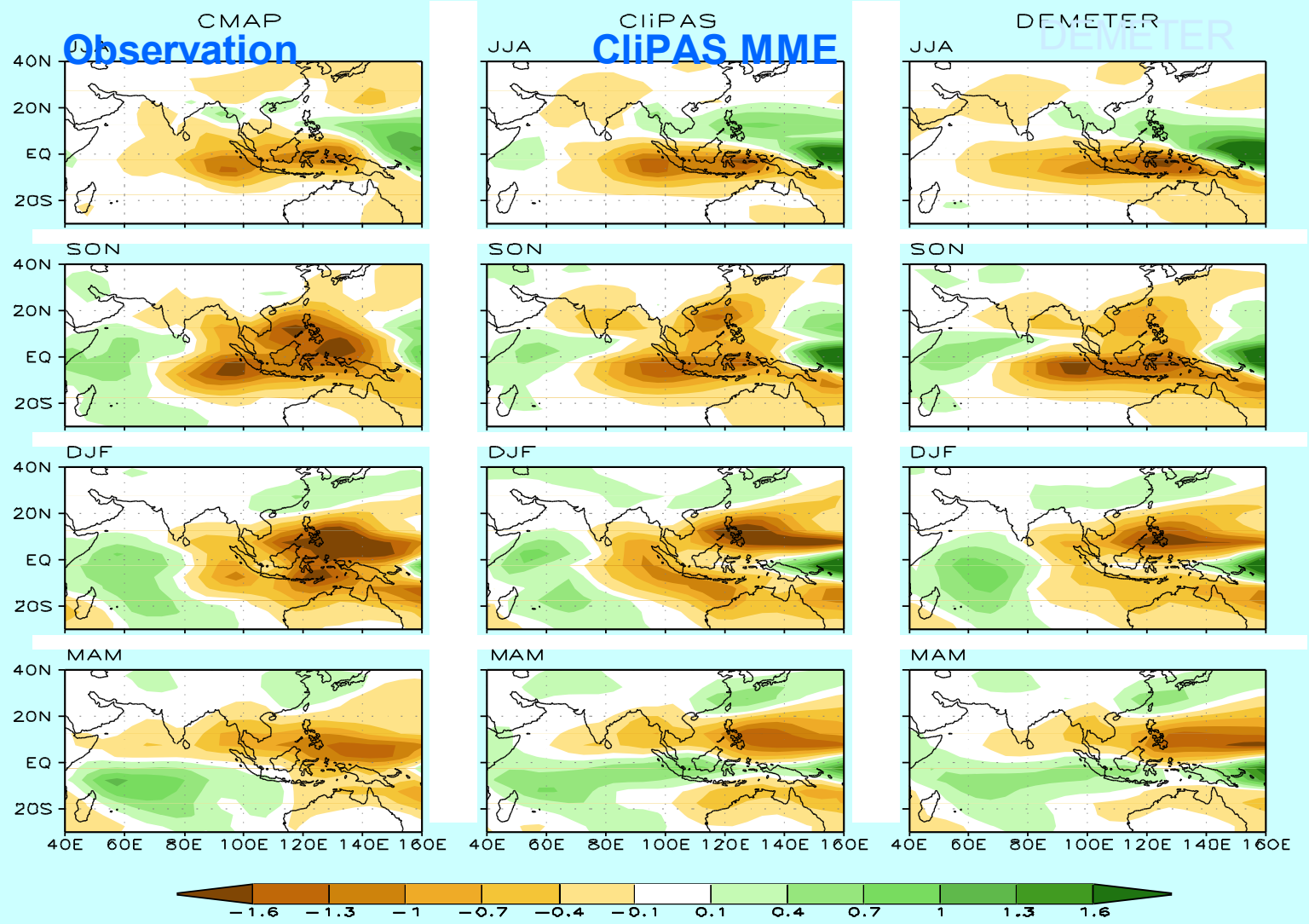
Current CliPAS/APCC MME Hindcast Experiments



Experiment design

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

Multi-Model Ensemble Historical Prediction (1981-2001) Faithfully Replicate the 3 leading modes of A-AM Interannual Variability



Shown is the First leading mode, which accounts for 30% of the total variance

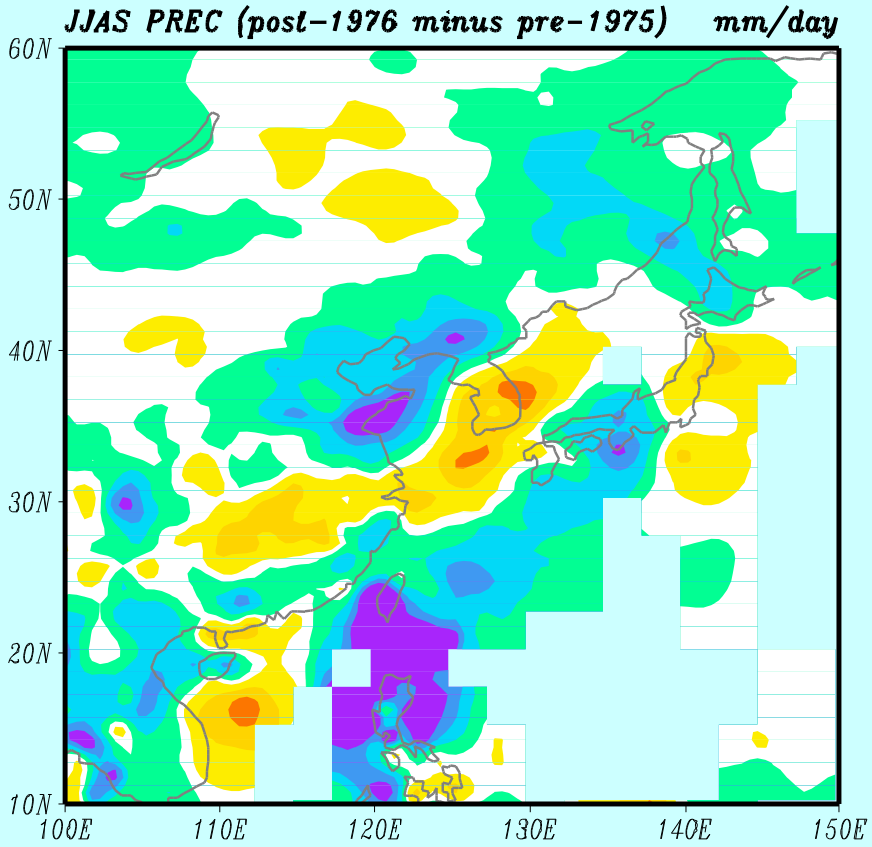
Pattern Correlation Coefficients for the first 3 modes are about 0.8, 0.7, and 0.6

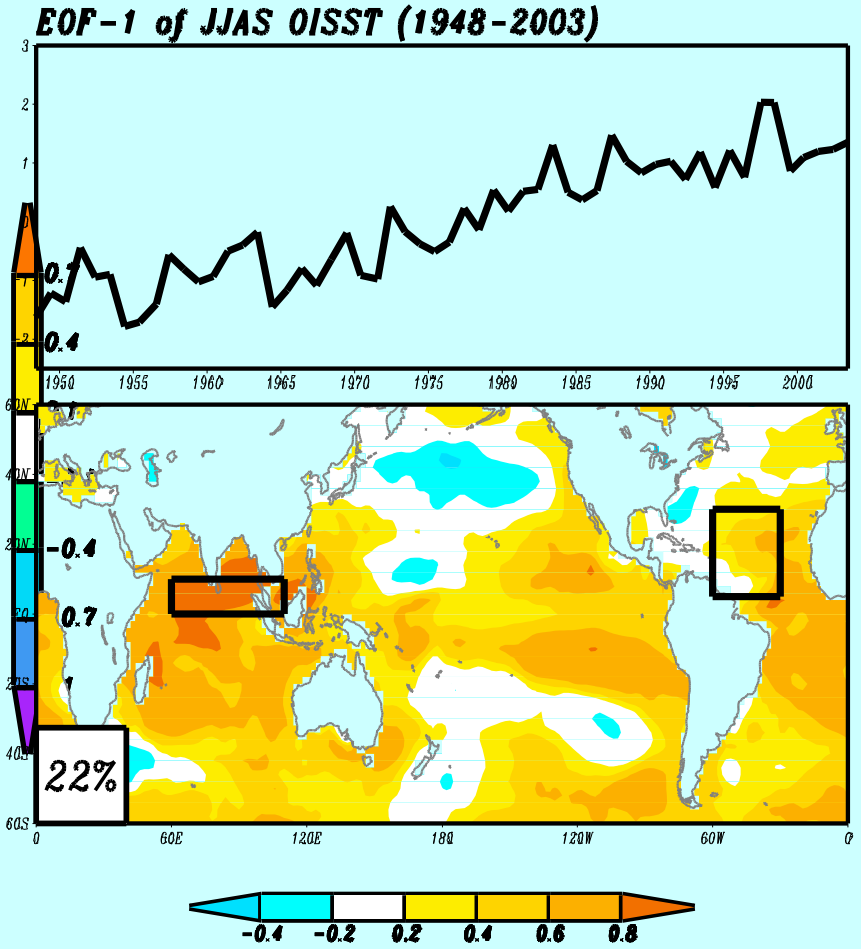
Temporal correlation coefficients for the first three PCs are 0.95, 0.9, and 0.8

3. IDV and Coupling to Ocean

Does AAM system have a coherent structure of interdecadal variation? How does the decadal variability couple to ocean?

- Organized Jointly with WCRP China Committee Decadal-to-Centennial Variability of East Asian monsoon workshp, July 7-9 2006, Qingdao, China.
- Analysis of long-term past changes





The increasing trend in Seoul JJAS precipitation reflect a trend in large scale East Asian monsoon rain belt, which appears to be related to strong trends in northern Indian ocean SST. The pattern correlation with reference to Seoul JJAS precipitation was calculated using NCEP PREC/L land and island rain gage data.

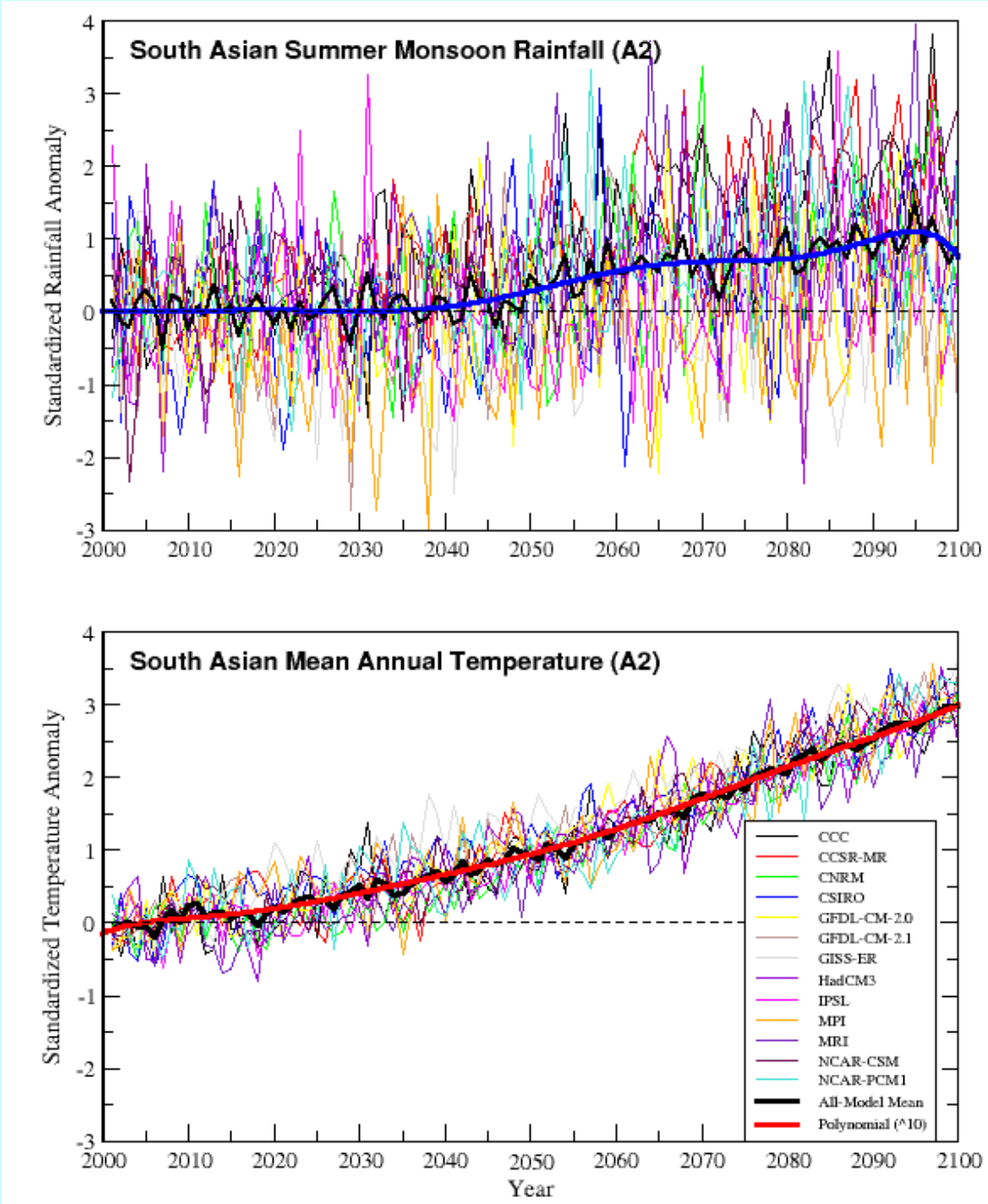
4. Cliamte Changes

How will AA-M system change in a global warming environment? What are sub-seasonal to interannual factors that influence extreme events? What is the sensitivity of the monsoon to external and anthropogenic climate forcing?

- Diagnostic studies focusing on the observed long-term changes of the monsoon precipitation and circulation in the past and
- Diagnosis of IPCC AR4 model projection for future change of AA-monsoon. In particular, how will the leading modes of AAM system change and Monsoon-ENSO relationship changes?
- Need coordinated effort to look at specific issues though some of our colleagues are involved in the climate change projections for the AAM region.

Future Scenarios for Summer Monsoon Rainfall and Annual Temperature over South Asia under A2 Scenario

- The general conclusion that emerges of the diagnostics of the IPCC AR4 simulations: Asian summer monsoon rainfall is likely to be enhanced.



5. Modeling of AAM

What are the structure and dynamics of the annual cycle of the coupled atmosphere-ocean-land system? What are the major weaknesses of the climate models in simulation of the annual cycle? Do models getting diurnal cycle right will improve the modeling of the annual cycle and low-frequency variability?

- Endorsed the approach identified at the 1st pan--WCRP Monsoon Modelling Workshop (Irvine California, 15-17 June 2005) for key studies of the diurnal cycle over both land and ocean. Develops monsoon metrics
- Support the Model systematic Error Workshop, Feb 2007 by focusing on AAM region.
- Designed a Monsoon Metrics for validation of the model (in collaboration with WGSIP)

Performance metrics for AAM Assessments

- Objective, verifiable, and quantitative measures of essential characteristics of diurnal, intraseasonal, annual cycle, and interannual variability.
- Evaluating both models simulation and hindcast skills
- Application to assessing DEMETER and CliPAS MME hindcast skill in terms of leading modes of variability

Collaborated Activities

CLIVAR/WGSIP: Develop Monsoon Metrics and

Pan-WCRP Monsoon/ GEWEX: Assessed systematic errors of CGCMs in Diurnal cycle and MJO, Systematic error workshop San Francisco Feb 12-16, 2007

THORPEX/WCRP workshop on Tropical Convection/MJO, Trieste March 2006.

CLIVAR/IOP: MJO (MISMO and IOD studies

MAHASRI: Supported Endorsement, Planned collaboration in regional modeling of coupled atmosphere-land-ocean system and regional season prediction (proposal)

MAIRS/START: Training workshop, Februaru 2007, Honolulu (proposal)

CLIVAR/POP: MJO-ENSO, Monsoon-ENSO Interaction (Proposal)

APCC/CliPAS MME development

WMO: Monsoon Panel: WMONEX 25+, Kuala Lumpur, April 2006

IPCC AR4: Climate change assessments

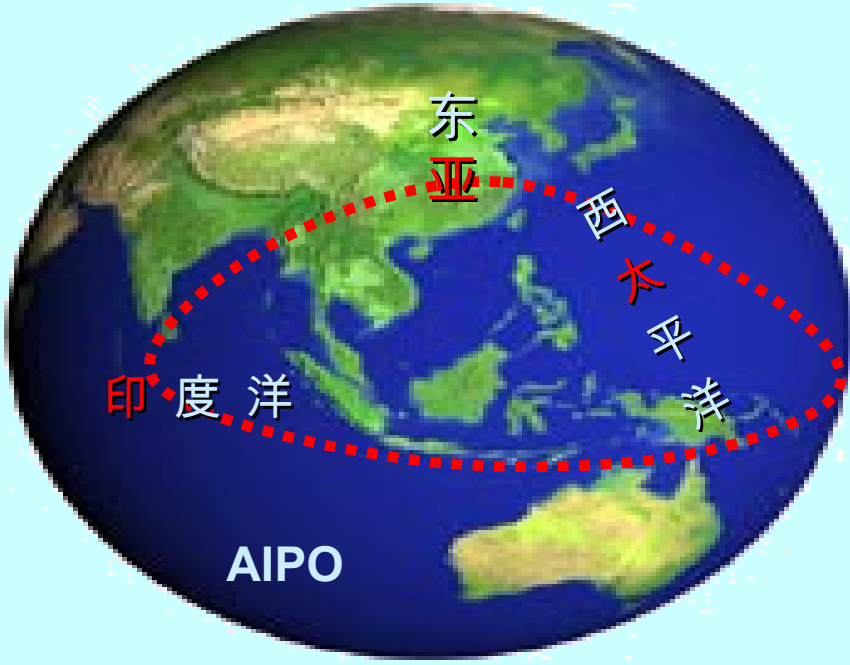
Activity in Planning

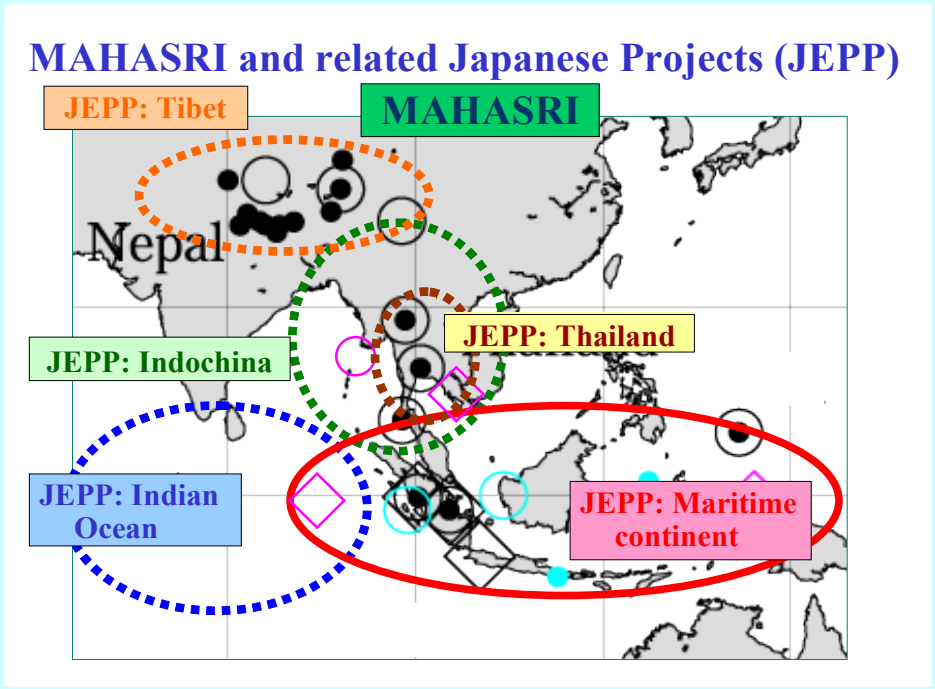
- Coordinate Asian Monsoon Year 2008 (AMY'08)
- Promote and Coordinate AMY'08 with "
- Plan a joint workshop on dynamical prediction of MJO/MISO with US CliVAR Sub-seasonal WG. (Simmer 2007?)
- Organize special sessions for IPCC AR4 assessment of AAM changes.
- Coordinate regional monsoon climate modeling with MAHASRI, APCC regional prediction, EA GCM modeling group, Regional Climate Modeling groups, START/MAIRS, ...
- NASA/GMAO Proposal: Typhoon, MJO modeling

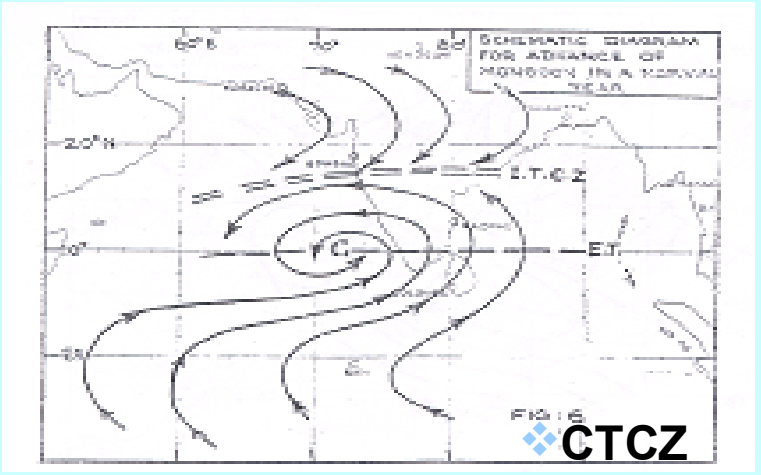
Asian Monsoon Year in 2008--AMY08

Coordination of A-O-L Interaction study

- China- AIPO
- India- CTCZ
- MAHASRI
- CEOP/Tibet
- AAMP/CLIVAR--

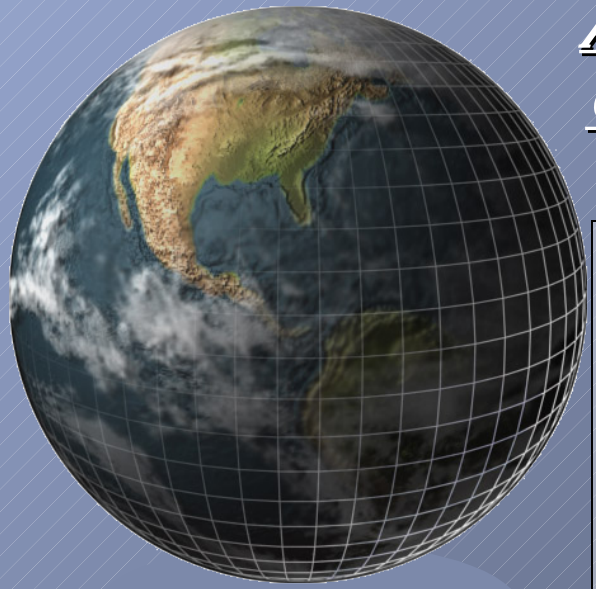






Year of coordinated Observing, modeling and Forecasting:

Addressing the Challenge of Organized Tropical Convection



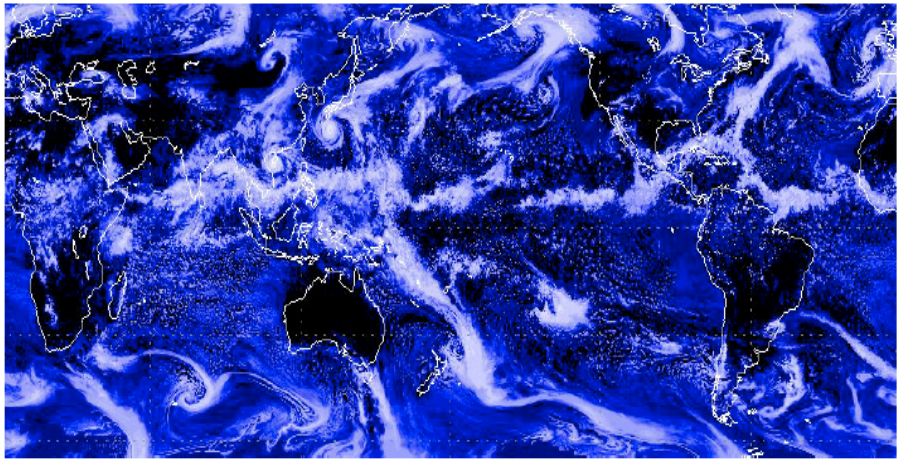
This proposed activity arose out of a recommendation by the THORPEX/WCRP/ICTP Workshop on Organisation and Maintenance of Tropical Convection and the MJO, held in Trieste in March 2006. It was presented at the WCRP/CLIVAR SSG Meeting in Buenos Aires in April 2006.

Based on positive feedback from the WCRP Director and the SSG, the SSG asked that the proposal be developed in cooperation with THORPEX, GEWEX, CEOP, AAMP, WOAP, WMP, etc.

If implemented in 2008, this initiative could be a WCRP contribution to the UN Year of Planet Earth* and compliment IPY.

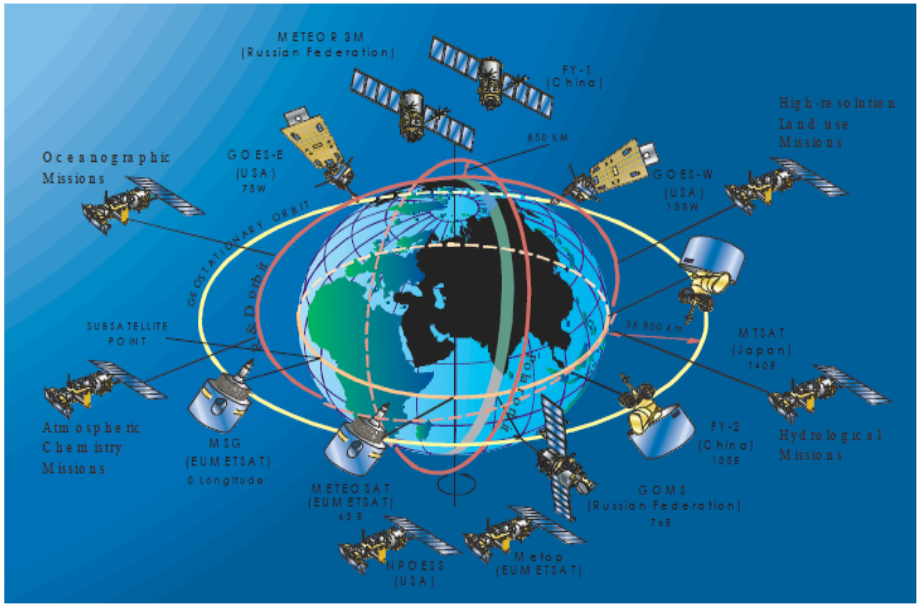
*January 5, 2006: The U.N. General Assembly, meeting in New York, proclaimed the year 2008 to be the U.N. International Year of Planet Earth. The Year's activities will span the three years 2007-2009 **(www.yearofplanetearth.org/proclamation.htm)**.

New Opportunities

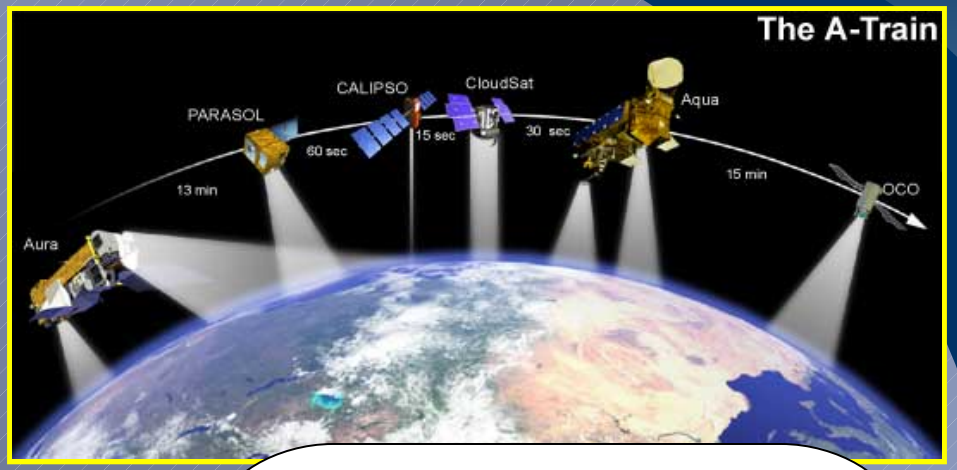


Explicit representation of convective organization, scale interaction and convectively-coupled waves is now possible with major increases in computational power

New observations, especially satellite borne (e.g. A-Train) and surface remote sensing (e.g. ARM), are providing new insights into multi-scale cloud structures.



Arrival of the EOS-era of Satellite Observations



Merely a sample, consider where we were 10-15 years ago…

TOPEX: sea surface height
QuickScat: ocean surface winds
TRMM: precipitation
TMI: sea surface temperature w/clouds
AIRS: temperature and water vapor profiles
CloudSat: cloud profiles
Calipso: aerosol/thin-cloud profiles
AMSRE: ocean precip, water vapor, liquid water
MLS: upper tropospheric water vapor, cloud ice, temperature
CERES: TOA and surface radiative fluxes
MODIS: cloud characteristics, ocean color, land characteristics
AURA platform: atmospheric composition/chemistry
MISR: aerosol and cloud structure

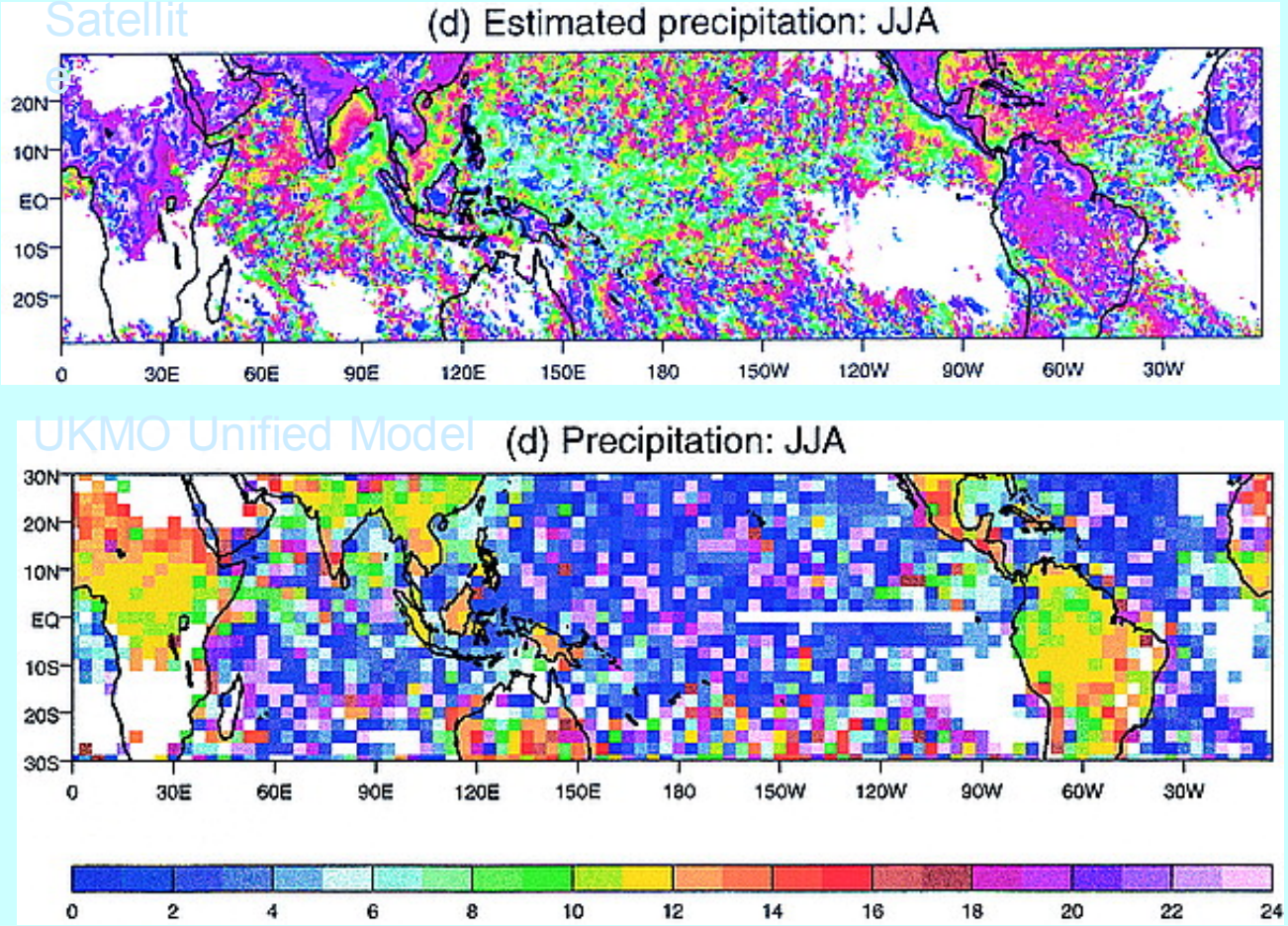
COARE: 120-day IOP
~6000 soundings

Tropical Soundings:
AIRS: ~100,000/day
CloudSat: ~90,000/day

Collaboration with GEWEX/MAHASRI

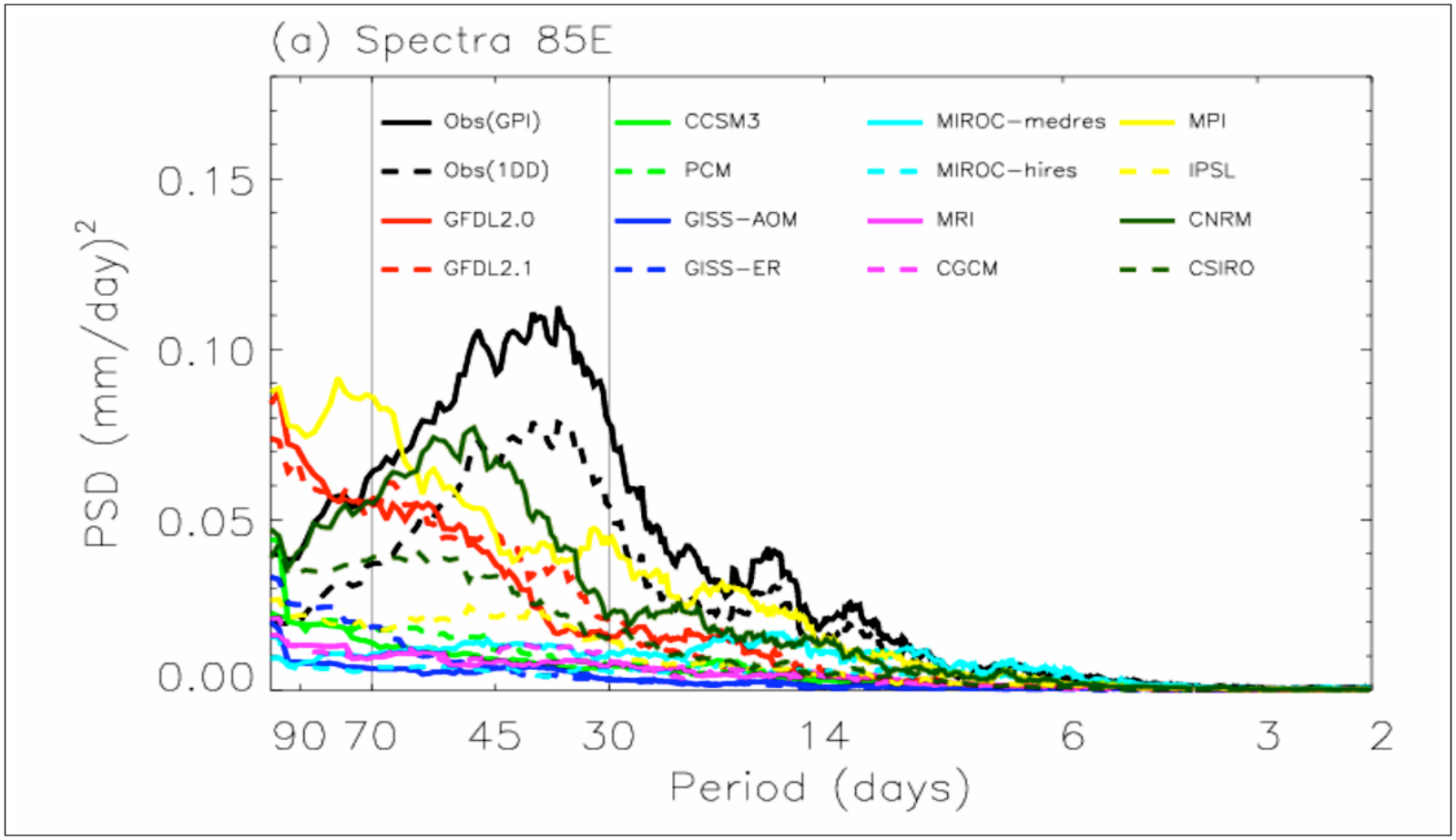
- 1st pan--WCRP Monsoon Modelling Workshop for key studies of the diurnal cycle over both land and ocean.
- Seek to organise a study of monsoon onset and monsoon ISO of SEASM.
- Develop Multi-model ensemble Regional Climate Prediction (Downscaling System) In collaboration with APCC.
- Develop land surface data nase for hindcast

Diurnal cycle biases (Yang and Slingo 2001)



- Satellite shows early evening peak over land, early morning peak over ocean ITCZ.
- Models show late morning peak over land, midnight peak over ocean.

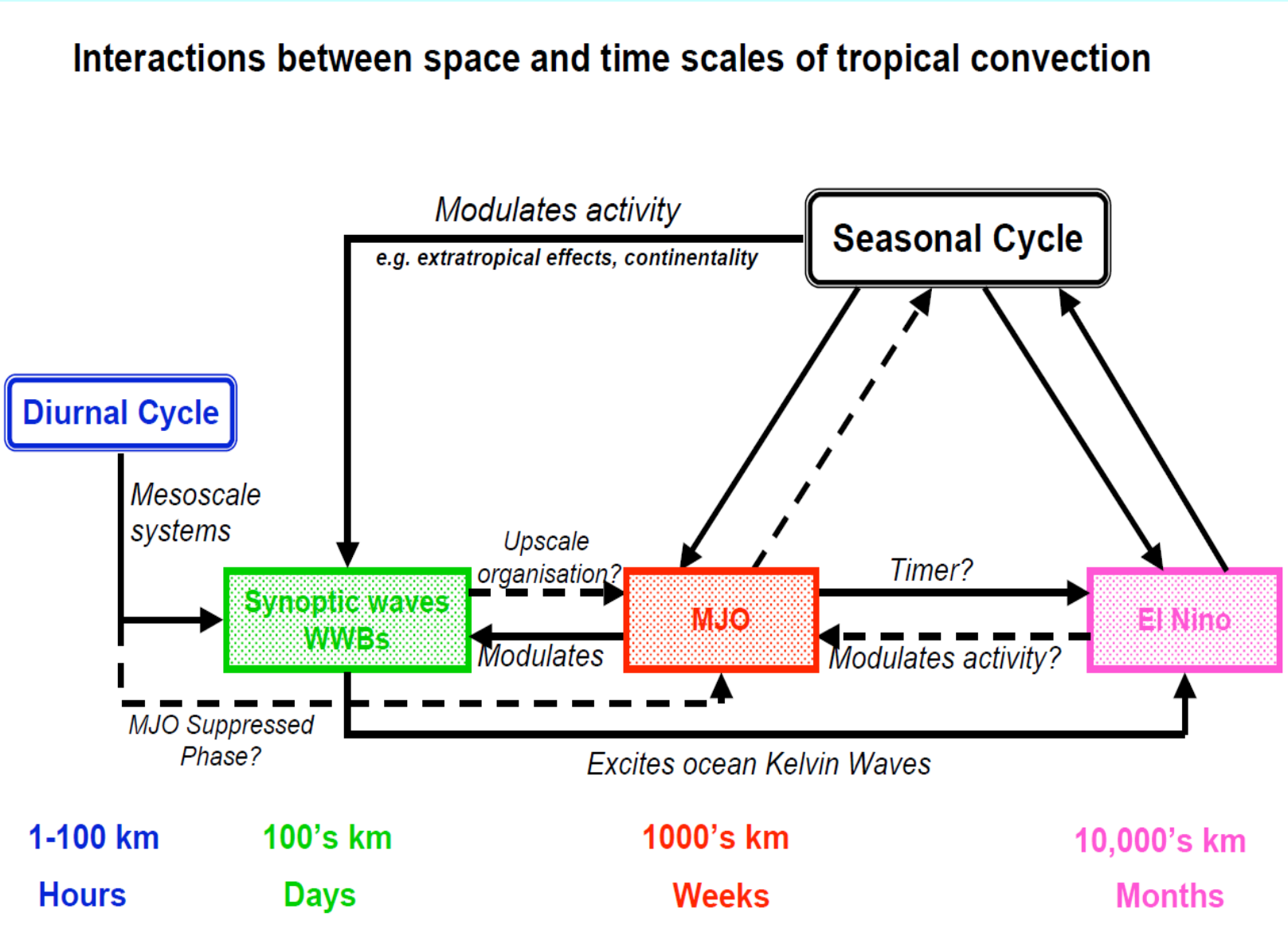
IPCC AR4 Models: Spectrum of the eastward wavenumber 1-6 component of equatorial precipitation (5N-5S) at 85E



Lin et al., J. Clim.

- ISV Variance is too small
- MJO variance does not come from pronounced spectral peak but from over reddened spectrum: too strong persistence of equatorial precipitation (13/14)

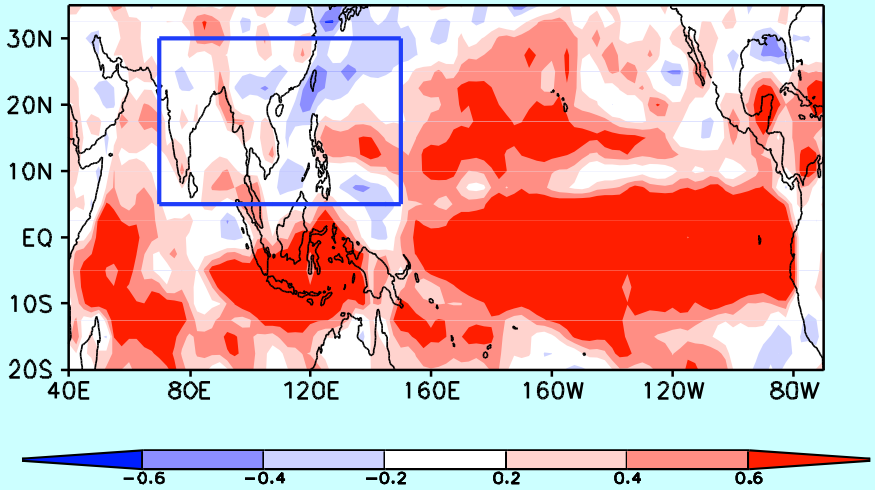
THORPEX/WCRP Workshop report



Physical Basis for Monsoon Prediction:

A challenge to Two-tier approach

a. 5-AGCM ensemble hindcast skill



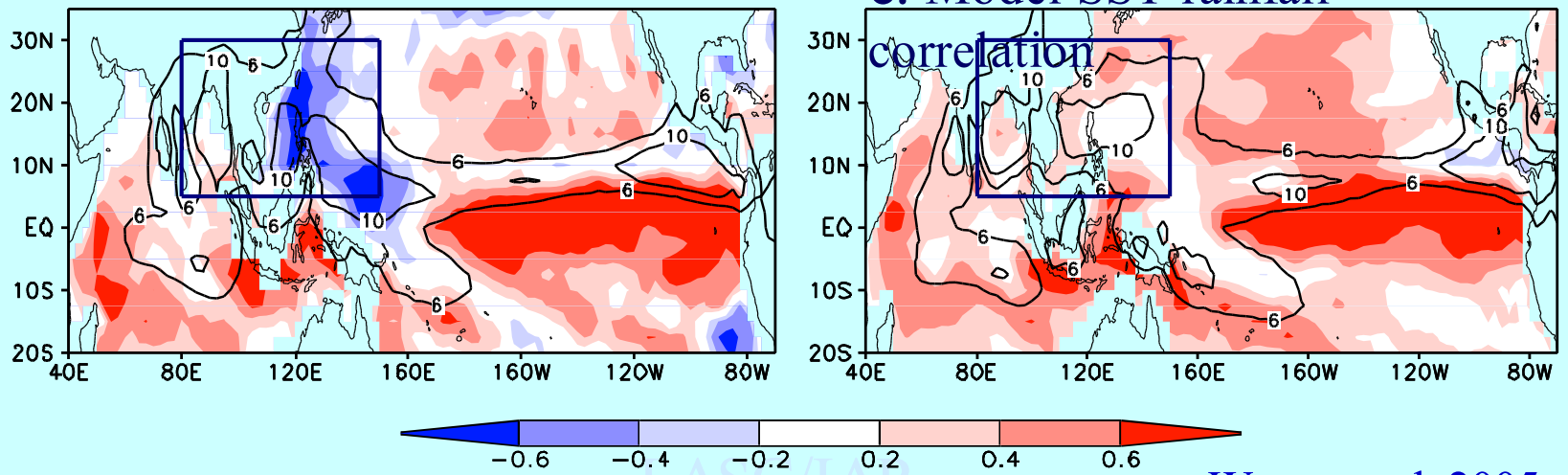
State-of-the-art AGCMs, when forced by observed SST, are unable to simulate Asian-Pacific summer monsoon rainfall (Fig. a).

The models tend to yield positive SST-rainfall correlations in the summer monsoon region (Fig. c) that are at odds with observation (Fig.b).

Treating monsoon as a slave to prescribed SST results in the models' failure, which suggests inadequacy of the tier-2 climate prediction system for summer monsoon prediction.

b. OBS SST-rainfall correlation

c. Model SST-rainfall correlation

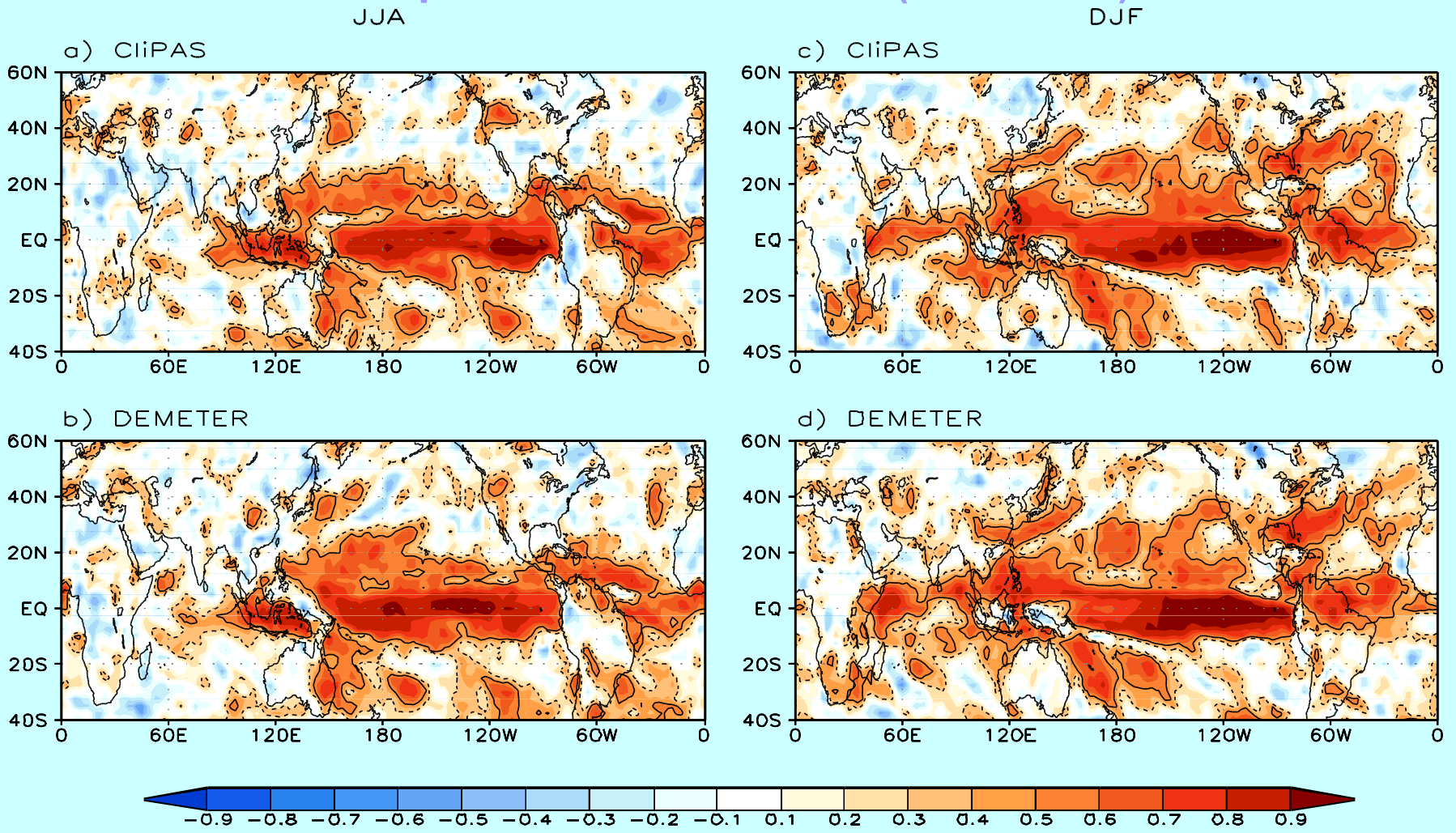


LASG/IAP

Wang, et al. 2005

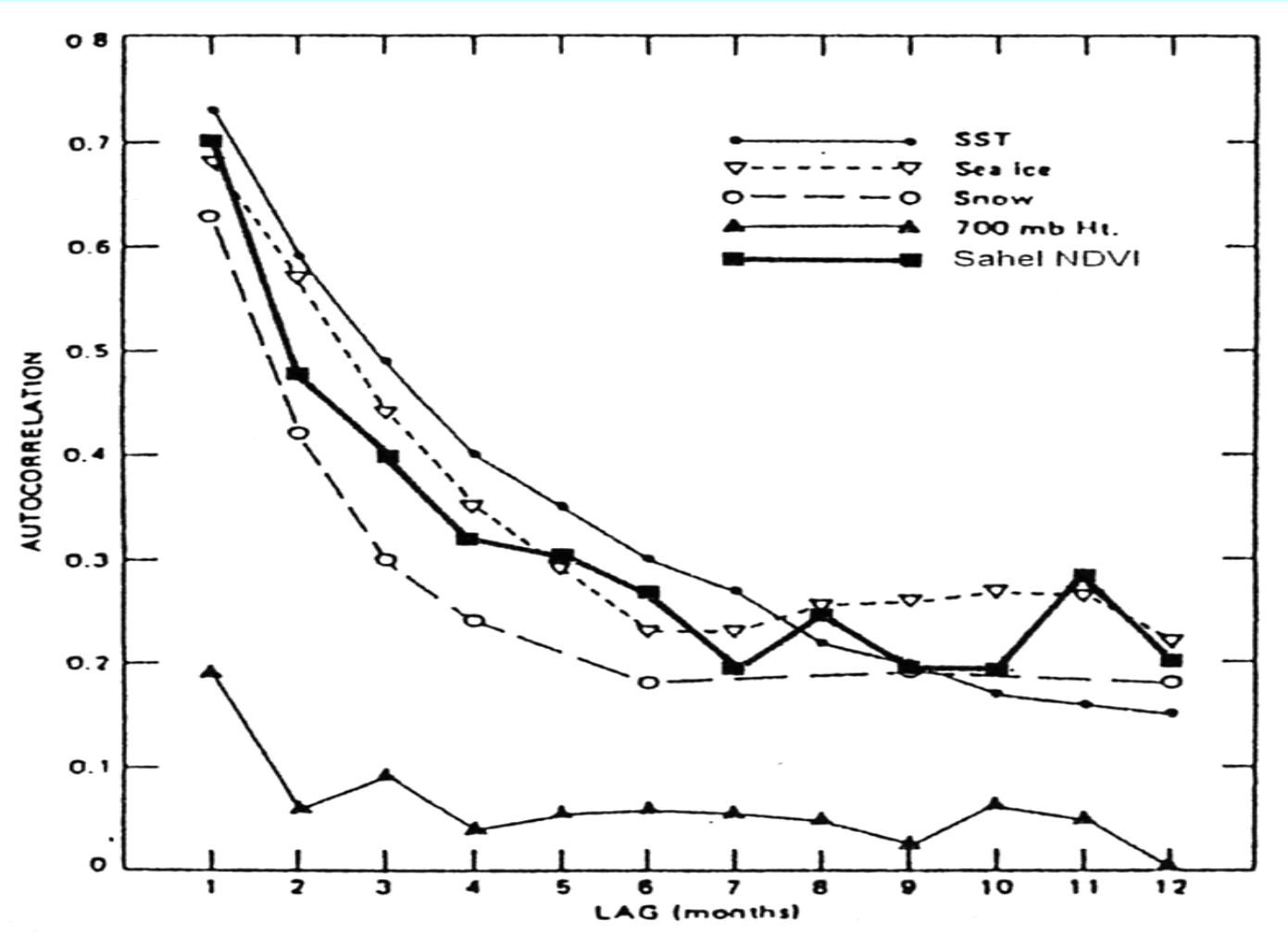
Current status of seasonal prediction of precipitation:

Temporal Correlation skill (1981-2001)



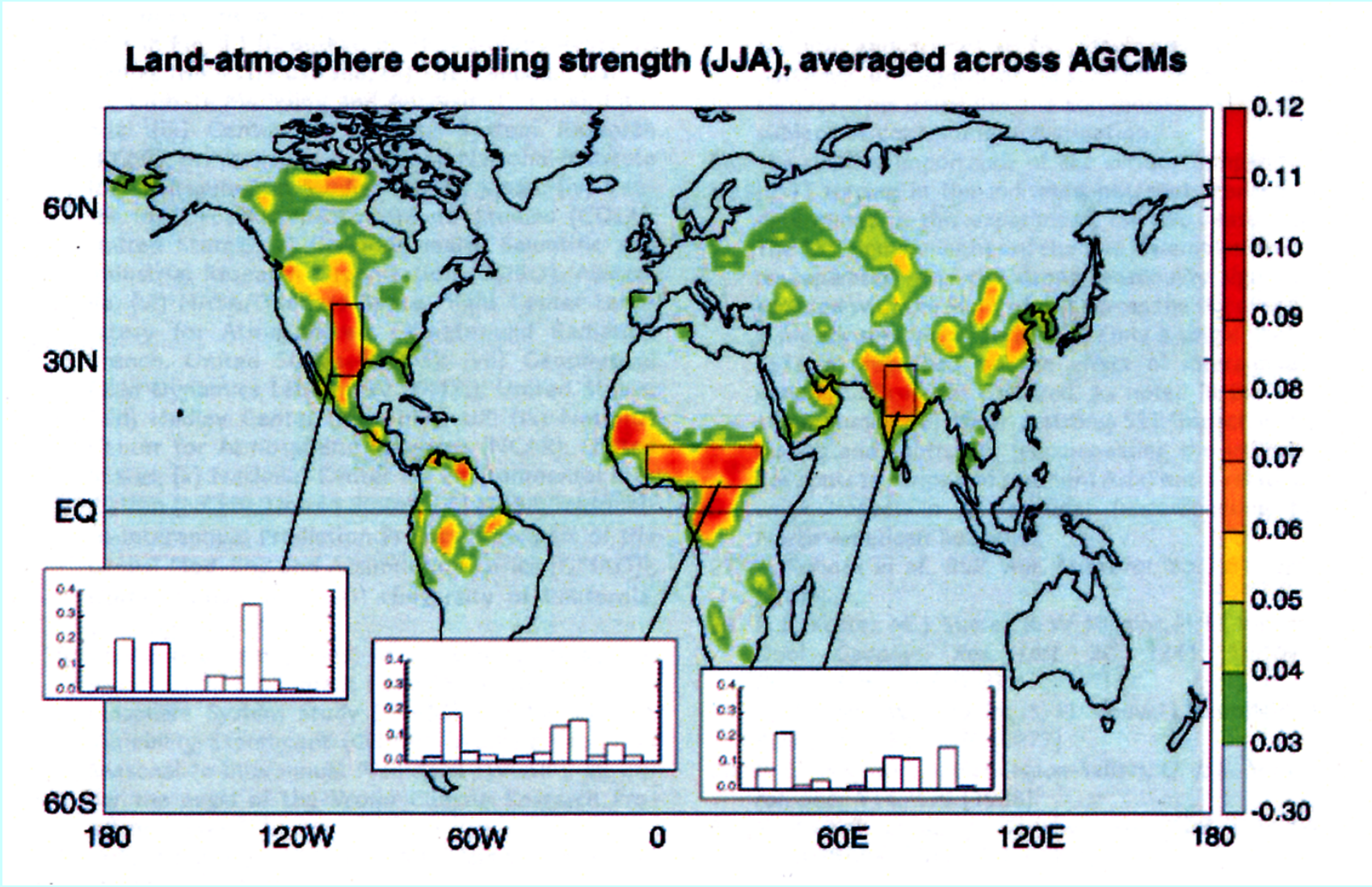
- Two MMEs correlation skill are comparable.(DEMETER 7 one-tier models, CliPAS 5 one-tier and 5 two-tier models)
- The high skills : the tropical Pacific between 10S and 20N, MC, and the northeast Brazil and the equatorial Atlantic Ocean
- Western Hemisphere tropics is better. A hoarse shoe like low-skill region is found in the EH.
- Land regions are lacking skills. During DJF ENSO impacts extends to Land..
- JJA: midlatitude wavelike patterns of moderate skill is found.

Land surface process provide memories up to a season?



Shinoda et al. 2003

Hot places of land surface feedback



Koster et al. 2004

LASG/IAP

Thanks

Climate Prediction and Its Application to Society (CliPAS) In Support of APCC

Mission: CliPAS project supports the Asia-Pacific Economic Cooperation (APEC) Climate Center (APCC), which serve as a hub of regional climate research and prediction and provide core facility to fulfill WCRP vision.

Objective: CliPAS aim: establishing well-validated multi-model ensemble (MME) prediction systems for climate prediction and developing economic and societal applications.

Participating Institutions from US, Korea and Japan: NCEP, GFDL, NASA/GMAO, COLA, FSU, UH/IPRC/ICCS, SNU, FRCGC, APCC.

MAHASRI

OBJECTIVE:

"To establish hydro-meteorological prediction system, particularly up to seasonal time-scale, through better scientific understanding of Asian monsoon variability".

Key Issues

- Atmosphere-ocean-land interactions in the Asian monsoon system
- Scale-interactions among diurnal, synoptic, intraseasonal and seasonal variability of Asian monsoon
- Effect of various-scale orography on monsoon rainfall
- Interactions of surface and boundary layer processes with convective cloud system

Broad Objectives of CTCZ (continental tropical convergence zone)

- Improving the observational understanding of the representative monsoon processes with the aim to improve rainfall forecasts and applications to climate, water resources and agriculture.
- Study monsoon energy budget and water cycle to assess the contribution of the coupled land-atmosphere-ocean regional monsoon system.
- Assess the skill of current atmospheric and coupled system models in simulating and forecasting monsoon rainfall and enhance the capabilities of operational IMD/NCMRWF system to provide realistic estimate of surface water budget.
- Assimilation of water related variables in dynamical forecast models on short and medium-range scales.

A Proposed APCC and CLIVAR Project to Conduct High Resolution Climate Model Simulations of Recent Hurricane and Typhoon Activity: The Impact of SSTs and the Madden Julian Oscillation

Sieg Schubert

Project Overview

- Description: A coordinated international project to carry out and analyze high-resolution simulations of tropical storm activity with a number of state-of-the-art global climate models
- Issues to be addressed: the mechanisms by which SSTs control tropical storm activity on inter-annual and longer time scales, the modulation of that activity by the Madden Julian Oscillation on sub-seasonal time scales, and the sensitivity to model physics and resolution.
- Approach: case studies of selected years with highly unusual tropical storm activity, including model runs with specified SST, an anomaly mixed layer ocean, and fully coupled models.
- Resource/sponsorship requests: sponsorship from APCC and U.S. and international CLIVAR; funding for a workshop in the fall of 2007 ($50K), and for maintaining a central data repository (estimated at about $100K)

Approach

- Focus on extreme seasons/events
  - high resolution is expensive - limits ability to do long runs
  - these tend to have major societal impact
  - much interest in community

- Community involvement (multi-model& analysis)
  - runs with different models made at home institutions
    - spreads computational burden
    - increases the ensemble size
    - allows assessing model dependency/errors/resolution

Expected Outcomes

- Improved understanding of the physical mechanisms controlling major changes in tropical storm activity on subseasonal, seasonal and longer time scales (role of SST, role of MJO/ISO)
- An assessment of the ability of current climate models, when run at high resolution, to simulate hurricanes and changes in hurricane activity, including an assessment of sensitivity to model resolution and physics

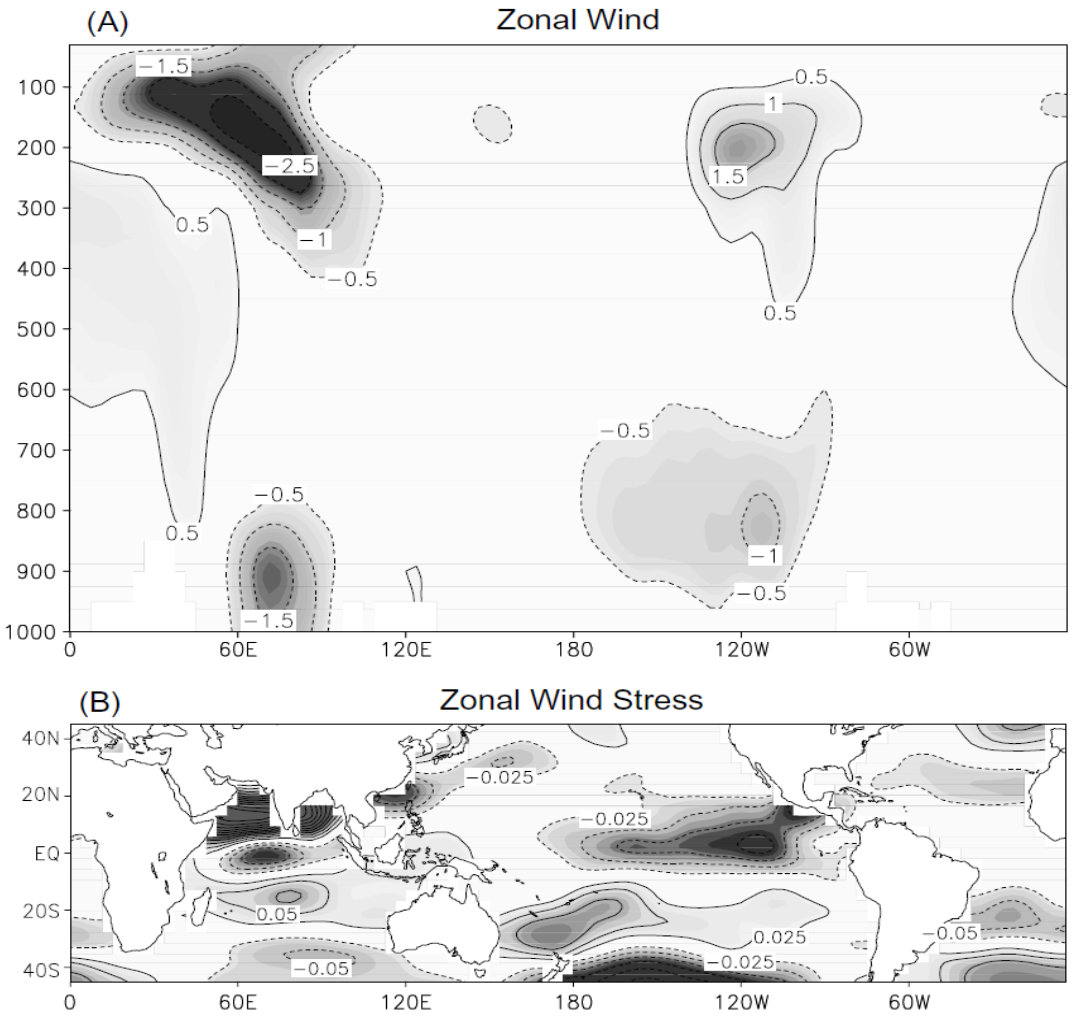
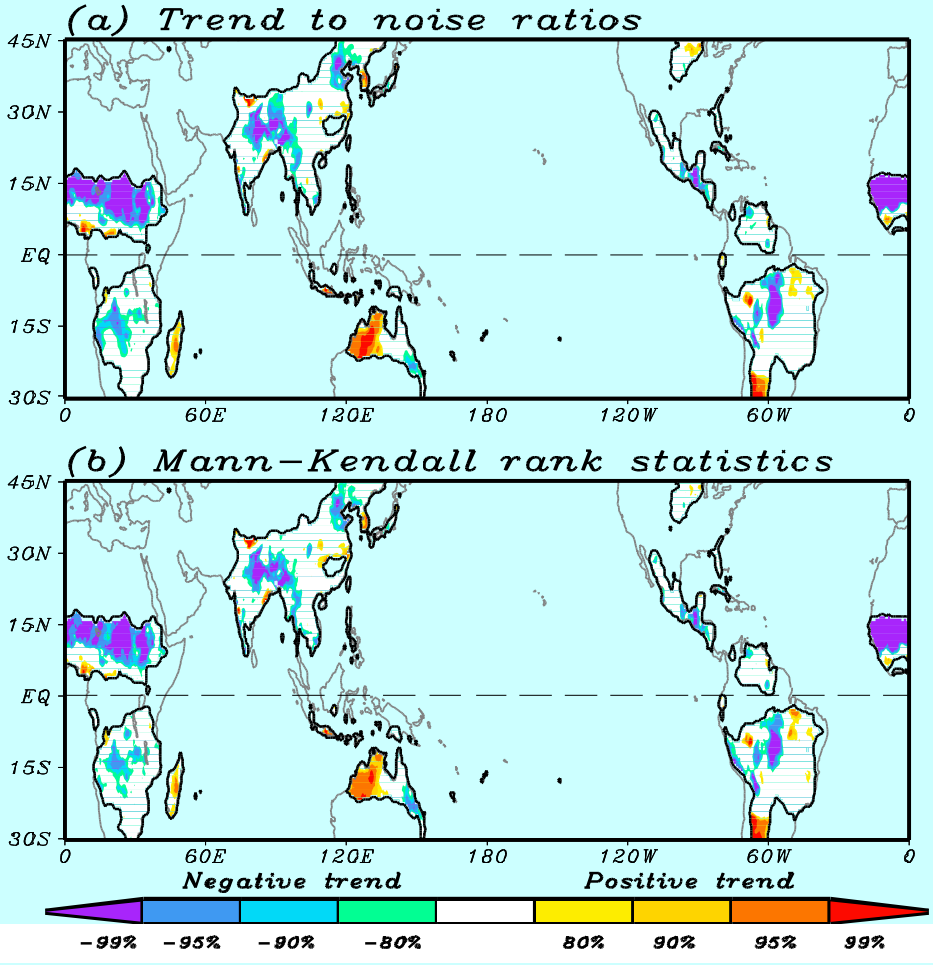
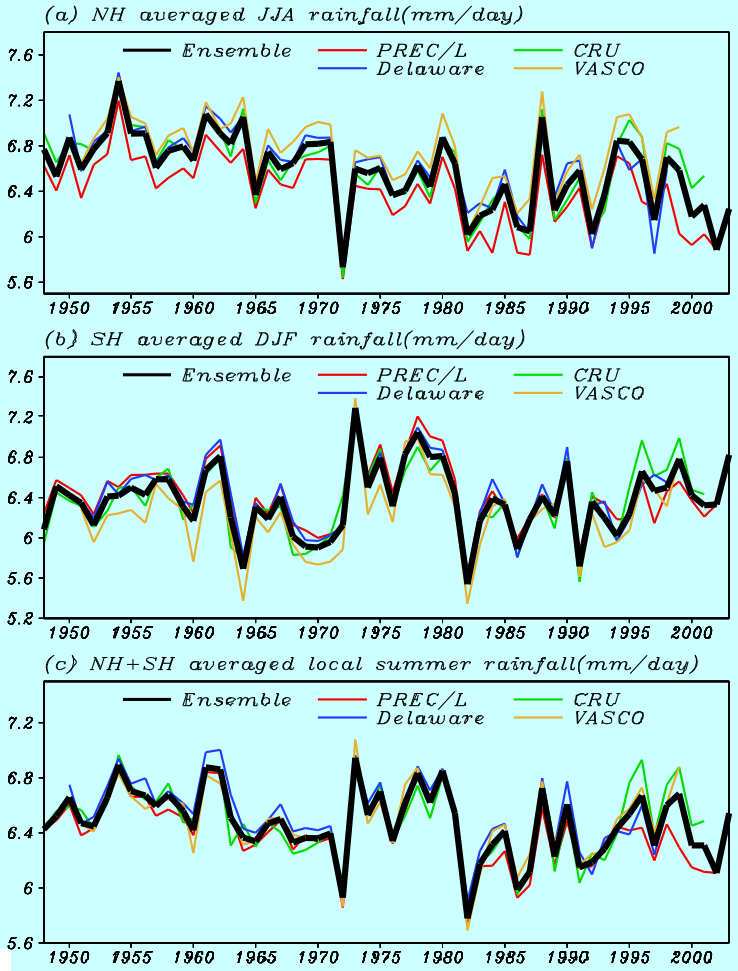


Figure 12.13. Distributions of the linear regression coefficients vs. the south Asian monsoon rainfall index of (a) zonal wind along the equatorial zonal plane (contour interval: 0.5 m s^{-1}) and (b) zonal wind stress (contour interval: 0.025 dynes cm^{-2}). The amplitude of the pattern corresponds to a rainfall anomaly of 2 mm d^{-1}. Results are based on output from the COLA atmospheric GCM.
From Kirtman and Shukla (2000).

Kirman and Shukla(2000)

Changes in Global Monsoon Precipitation over the Past 56 Years

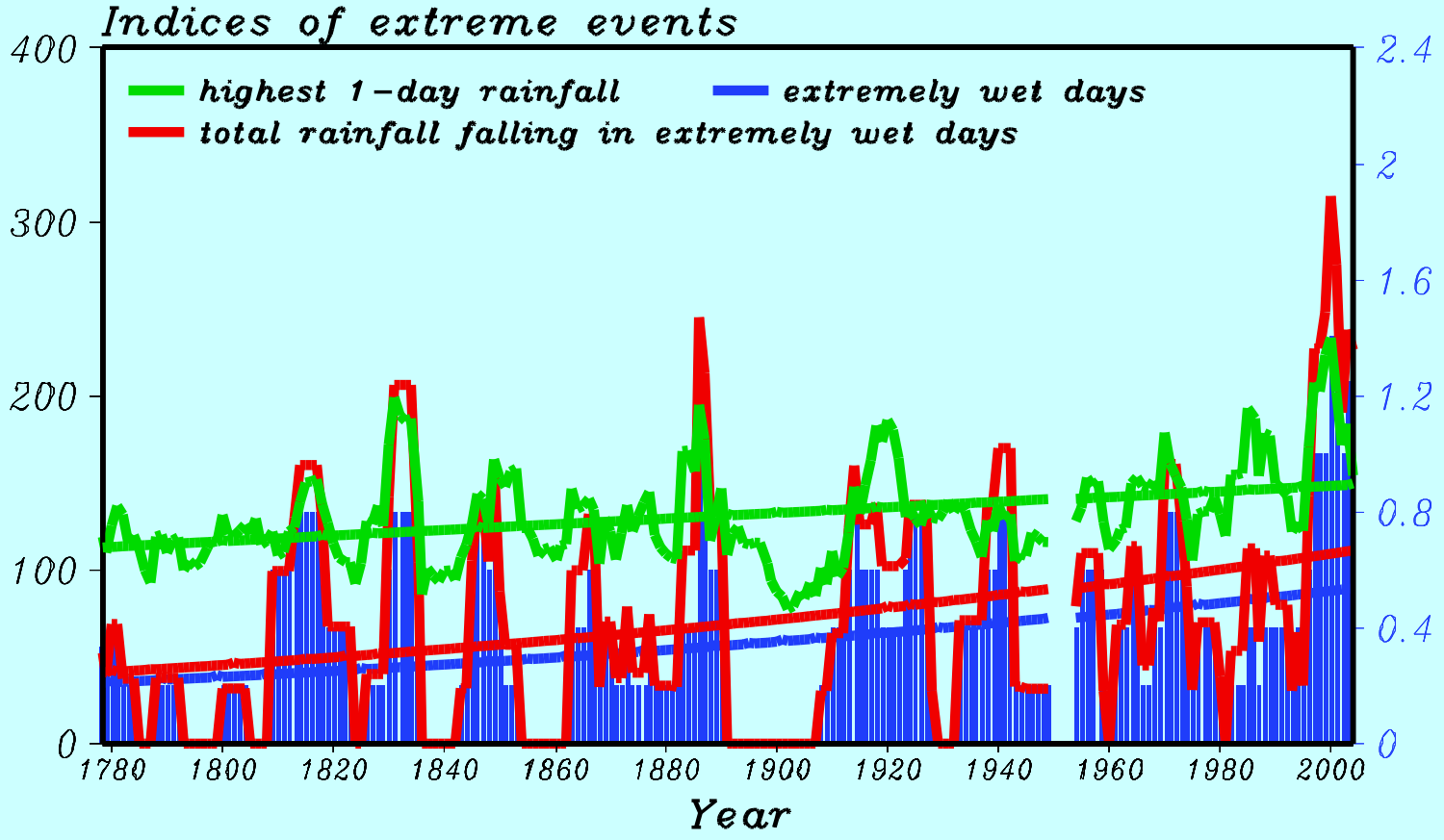




Statistical significance of of the linear trends: (a) Trend to noise ratio and (b) Mann-Kendal rank statistics. Four sets of rain-gauge precipitation datasets compiled for the period of 1948-2003 by climate diagnostic groups around the world were used: CRU, PREC/L, Delware, VASCO.

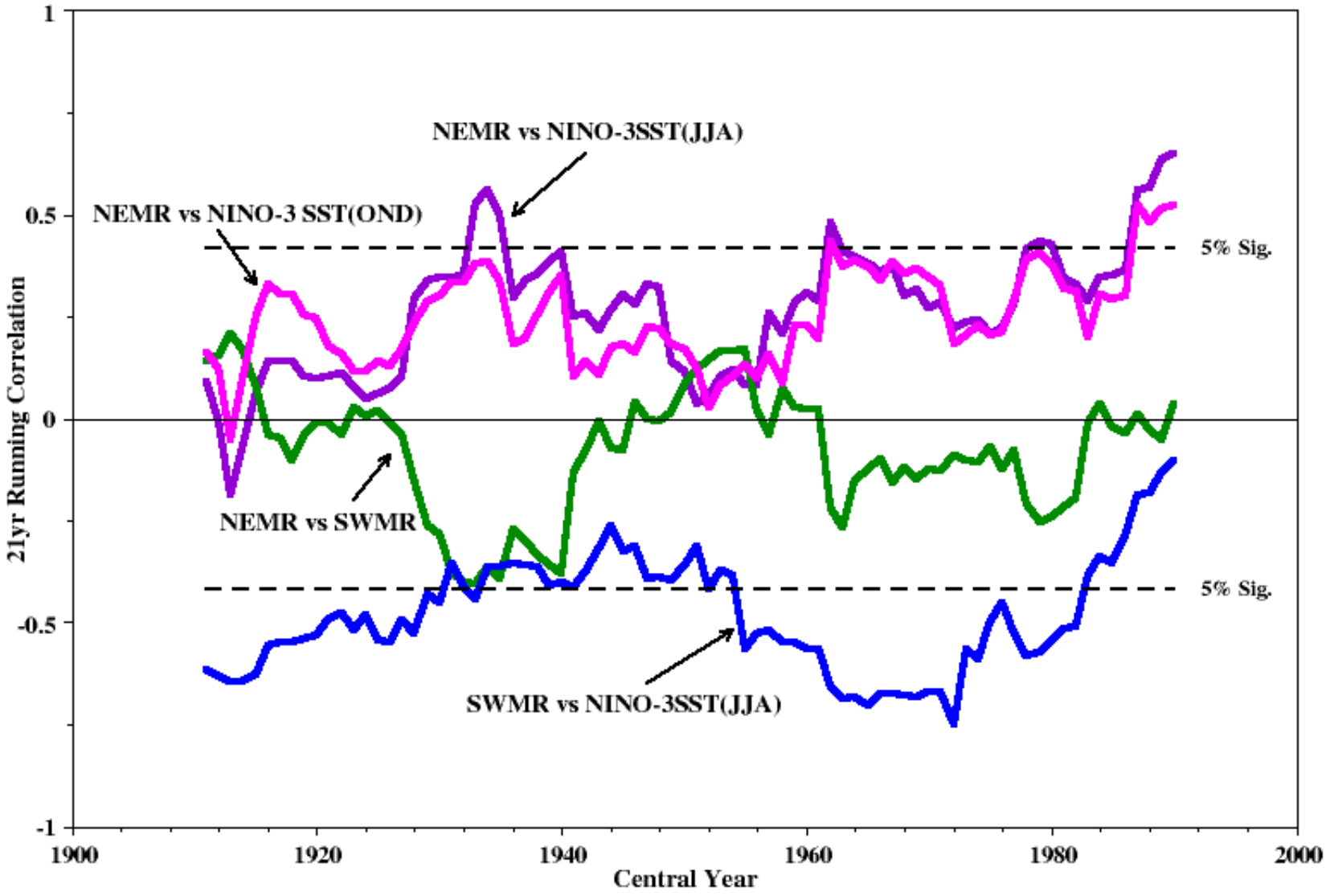
The results suggest an overall weakening of the global land monsoon precipitation in the last 56 years, primarily due to weakening of the summer monsoon rainfall in the Northern Hemisphere. However, since 1980, the global land monsoon rainfall has seen no significant trend, which contrasts with the rapid intensification of global warming during the same period.

DecCen variability



Seoul has probably the world longest **instrumental** record for **daily precipitation** from 1778 to present. The above figure shows running five-year means for the number of heavy precipitation days. Also shown are the corresponding trends obtained by logistic regression. (Adapted from Wang et al. 2006)

Recent strengthening of ENSO-Northeast Monsoon relationship



Metrics for Interannual variability (IAV) of AAM:

2-D maps of seasonal mean anomalies of Pr, OLR, SST, Ts, 850 hPa zonal wind or the leading modes of these fields.

Objective measure: Spatial averaged SD, Anomaly Pattern Correlation Coefficients (PCC), RMSE; Taylor diagram

Precipitation indices:

ISM, WNP, AUS, EA (regional mean precipitation)

All Indian Summer Rainfall (Pathasarathy and Carpenter, 1992)

Circulation indices:

Westerly vertical shear: u850 (0-20N, 40-110E) minus u200 (0-20N, 40-110E) ISM: Southerly vertical shear index (Goswami et al. 1999); Westerly meridional shear index (Wang et al. 2001); Cross-equatorial flowindex (Joseph 2005)

WNPM: Westerly meridional shear index u850 (5-15N, 100-130E) minus u850 20-30N,110-140E) (Wang and Fan 1999)

EASM: Westerly meridional shear at 200 hPa: Lau et al. (2001)

AUSM: Zonal wind u850 (10S-0, 120E-150E) (Webster 1983 and McBride 1987)

Collaboration with IOP: ISO focus

- Focus on issues related to the role of air-sea interaction over the Indian Ocean in modulating the ISV of the Indian summer monsoon and its representation in models
- Plan a joint IOP/AAMP science meeting on understanding the ocean's role in MJO/MISO, perhaps one year after MISMO and CIRENE process studies and after pilot moorings produce longer

IPCC AR4 Assessment

- AA Monsoons are given due importance in IPCC Fourth Assessment Report under preparation.
- In Working Group 1 Report on Physical Basis, AA Monsoons are adequately covered in observed change, global projections as well as regional projections.
- Kumar is involved as one of the Lead Authors in the chapter on Regional Projections.
- GCOS organized a workshop at IITM to analyze observed changes in extreme precipitation and temperature over South and Central Asia

Collaboration Areas with Pacific Ocean Panel and Other Panels

- ENSO-monsoon relation

  What roles does El Nino play in TBO?

  Does A-AM play a role in ENSO prediction? How?

  How variable is the ENSO-AAM relationship? And why?

- Interdecadal variability

  What are major modes of AAM interdecadal variability and what roles does ocean play? ---This also fits in major CLIVAR themes.

- Global teleconnection

  How do variability of AA, African, and American monsoons related to each other?

  Do AAM variability contribute to midlatitude climate prediction?