GAME and Pan-WCRP monsoon studies

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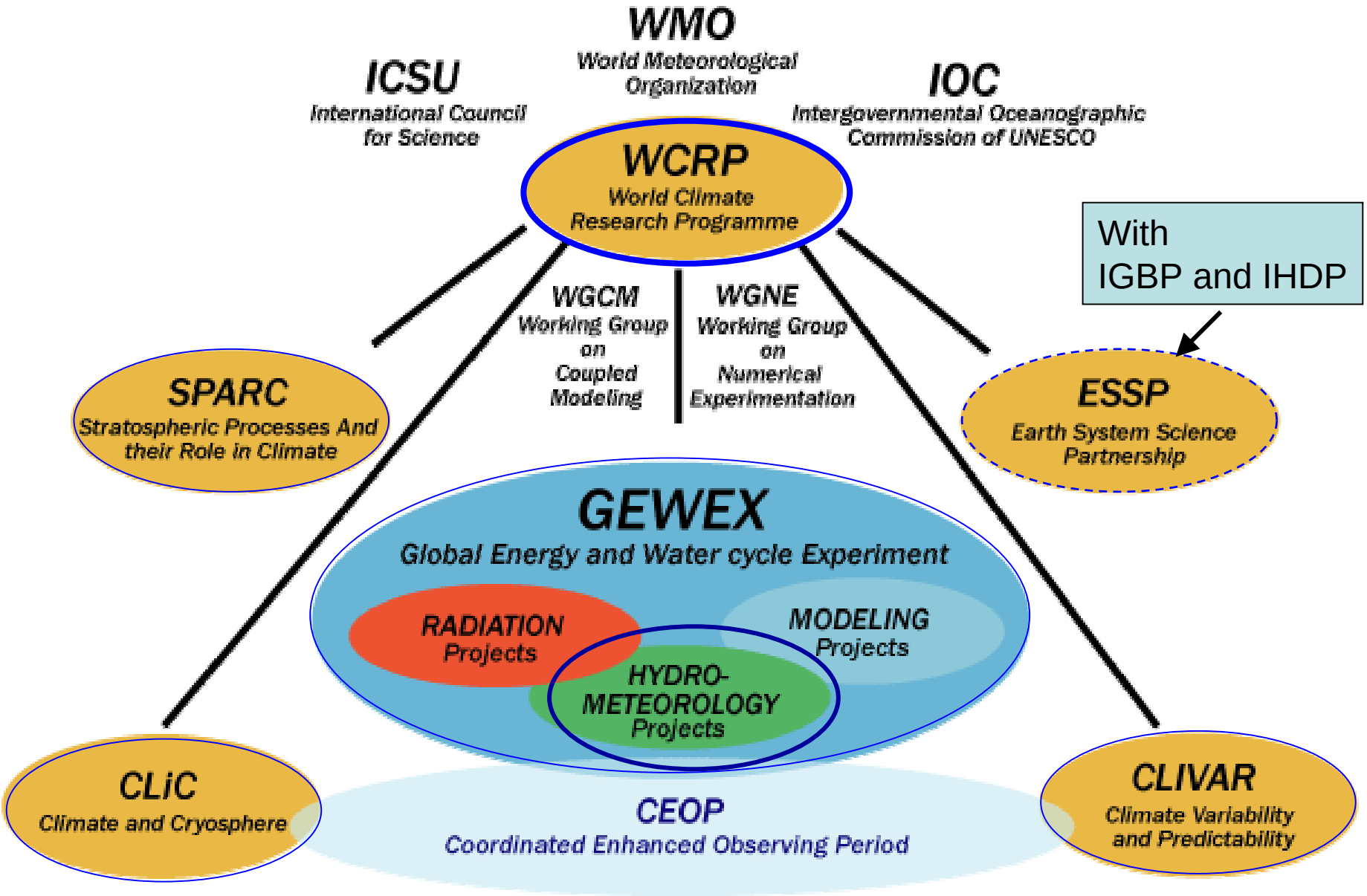
Important tasks of WCRP

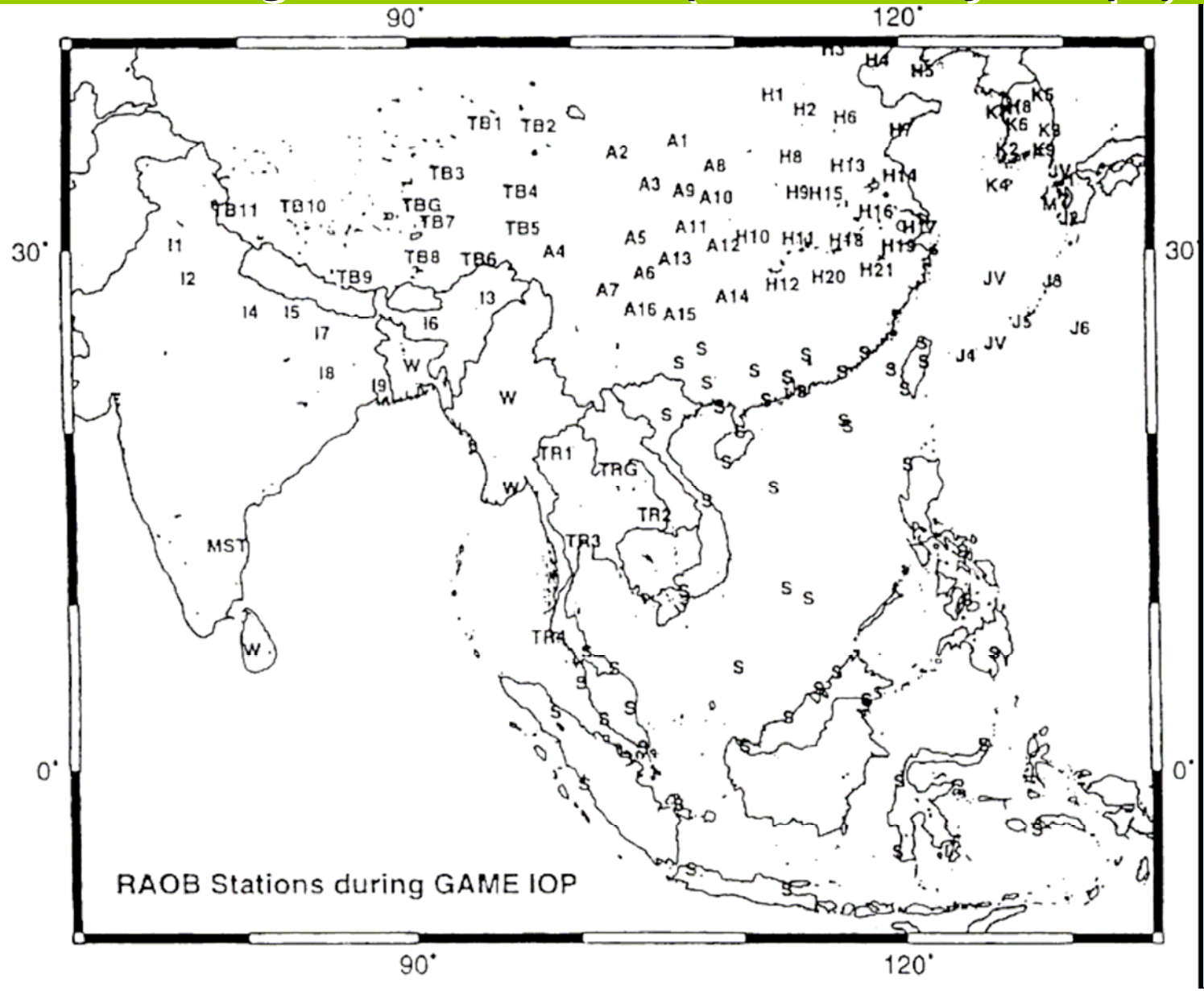
- To promote new research observation projects
- To promote development of new climate/earth system models
- To produce and release new data sets for climate studies with free & unrestricted exchange bases (for scientific communities)
- To contribute to international societies through prediction & application projects

GEWEX Organization Within WCRP



GEWEX Continental-Scale Experiments
focusing on land-atmosphere interactions

Enhanced Radiosonde Network during GAME-IOP (1998 May-Sep.)



A basic question for GAME

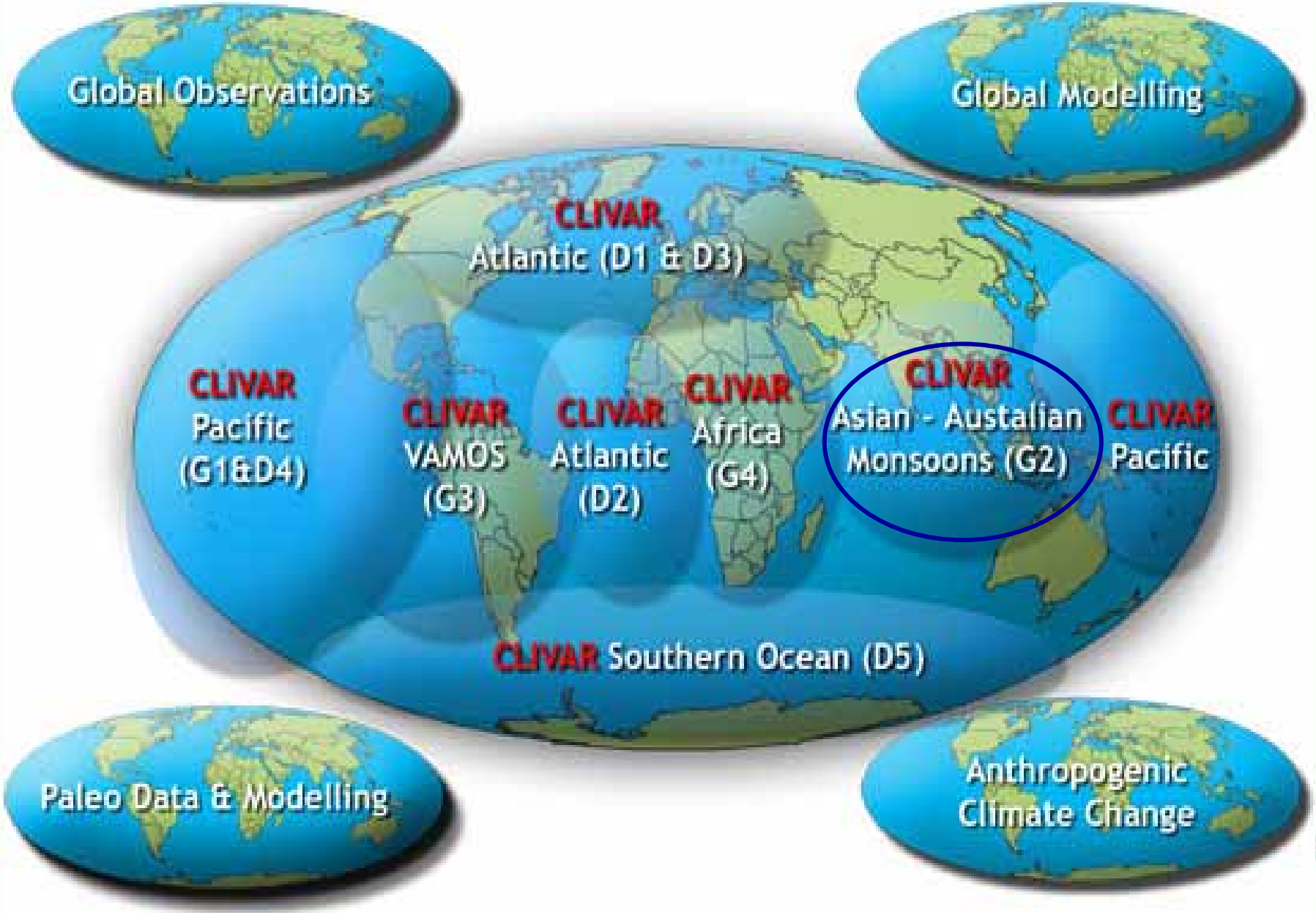
- What is the role of "LAND" in forcing the Asian monsoon system?

- Fundamental land surface processes for formation and variability of Asian monsoon system
  - Orography?
  - Vegetation?
  - Others?

Major achievements in response to this question

- **Role of complex topography and geography** in development of convective systems and through diurnal cycle
- **Role of vegetation** in controlling energy and water fluxes and related monsoon circulation systems
- **Large-scale water cycling processes** using transport models, isotope GCMs and PCE analyses by GAME data sets

CLIVAR - global view



A new strategic framework of WCRP

Coordinated Observation and Prediction of the Earth System (COPES)

WCRP has defined a new strategic framework for the next ten years under the title "Coordinated Observation and Prediction of the Earth System" (COPES). It will capitalize on past progress with the aim *to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society.*

COPES will provide the unifying context and agenda for the wide range of climate science coordinated by, and performed through, WCRP core projects and other activities, and for demonstrating their relevance to society.

Period: 2005-2015

COPES Monsoon System Study Project (tentative) will be launched.

Predicting monsoon rains

Over half the world's population lives within the influence of the Asian monsoon and a further large fraction lives within the monsoon areas of Africa and the Americas. Forecasting monsoon characteristics, including their onsets, breaks and duration, remains a challenging (but critically important) scientific problem because of the complexities of the interactions involved. Advances in simulation of clouds and radiation, progress in assimilating humidity and temperature data to produce better atmospheric analyses, and use of new ocean observations have set the stage for WCRP to improve monsoon prediction capabilities.

Photo: FAO/G. Bizzarri

1st Pan-WCRP Monsoon Workshop

Jun.15-17, 2005, UC Irvine, CA, USA

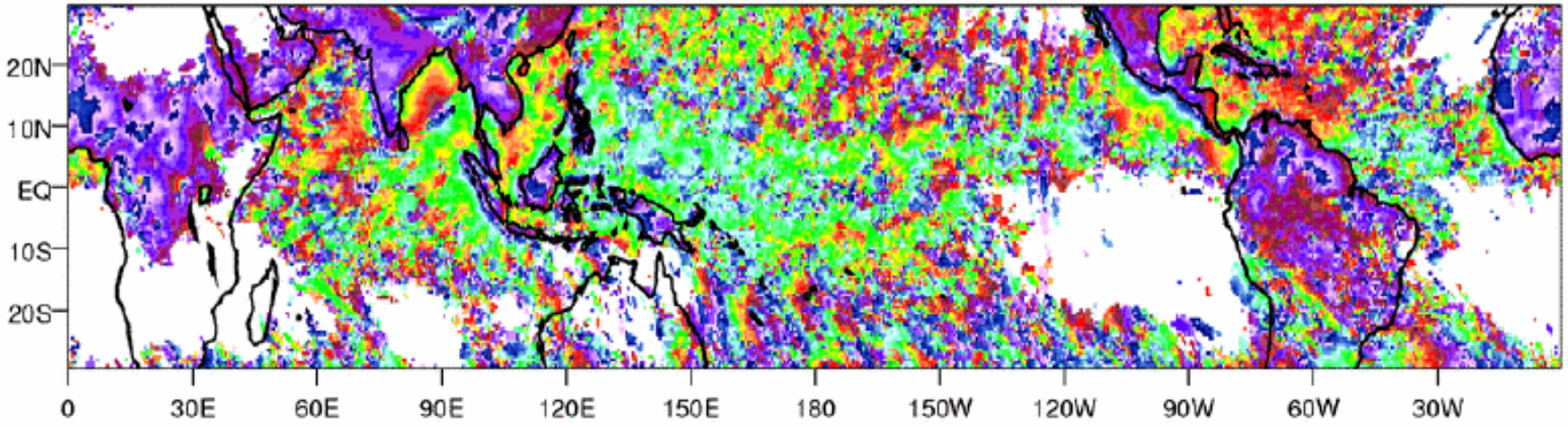
- More than 50 distinguished monsoon scientists participated.
- **Objective 1:** To integrate our current understanding of fundamental physical processes that govern the various monsoon climate systems, and to promote better predictions using a hierarchy of models.
- **Objective 2:** To provide a unique and timely opportunity to promote a new initiative of the pan-WCRP monsoon system prediction studies, which should be an essential part of the forthcoming COPES (Coordinated Observation and Prediction of the Earth System) as a new WCRP strategy.

Scientifc issues in Asian monsoon systems

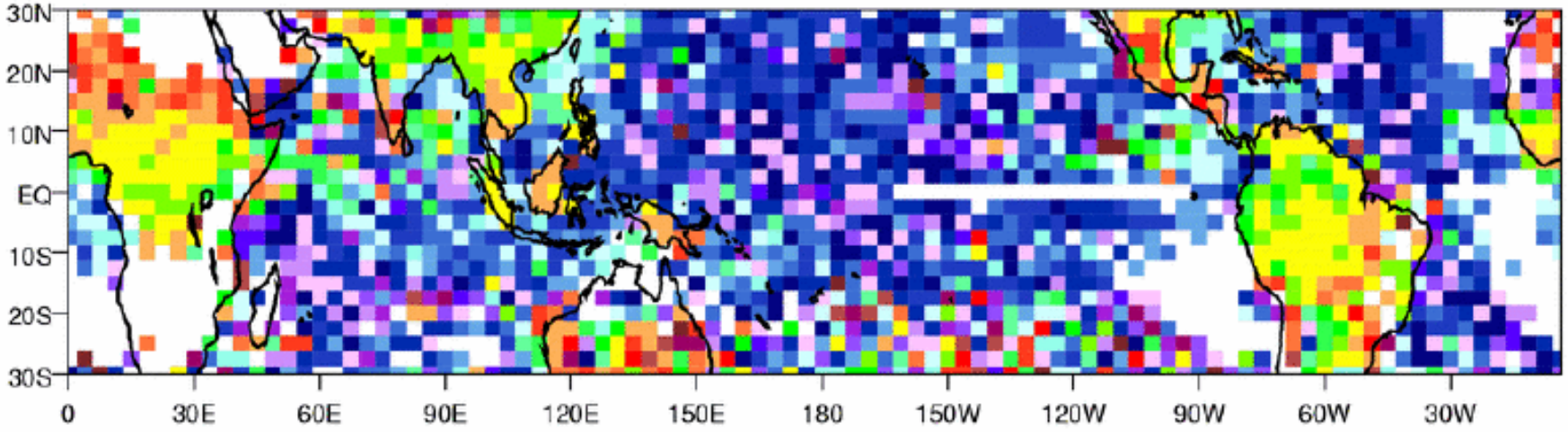
- Multi-scale interactions between land/ocean surface, PBL and cloud/precipitation system
- **Role of diurnal cycle** on cloud/precipitation systems
- Dynamics of intraseasonal variations (ISV)
- Role of the Maritime continent on ISV and disturbances in southeast Asian monsoon
- Role of vegetation and land surface changes on Asian monsoon hydro-climate
- Role of aerosols on Asian monsoon variability
- Teleconnections between heating/cooling over Eurasian continent and the atmosphere/ocean processes in the IO and WP warm pools.
- Others…….

Diurnal Cycle: Local time of maximum precipitation

Satellite Observation

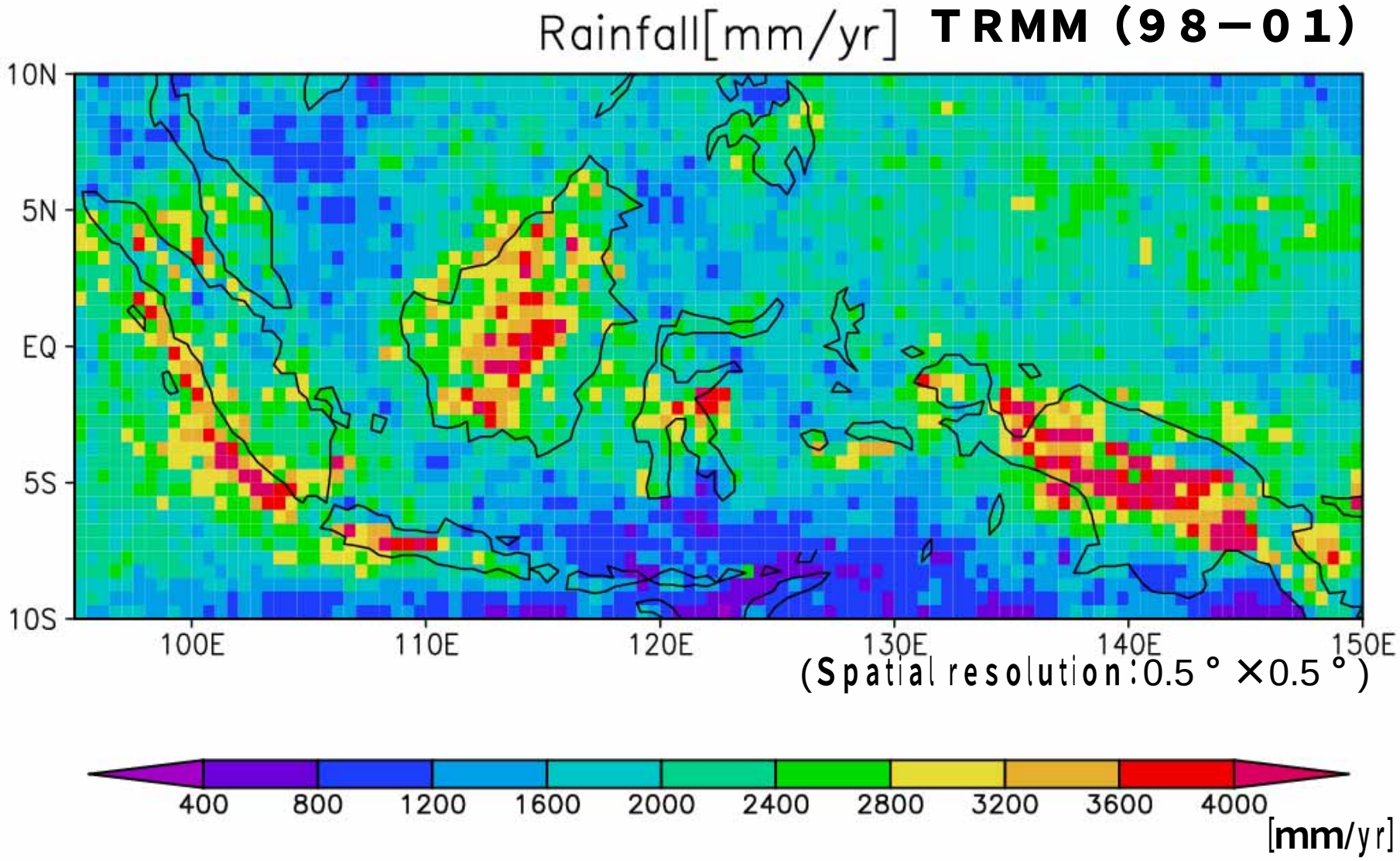


Model Simulation

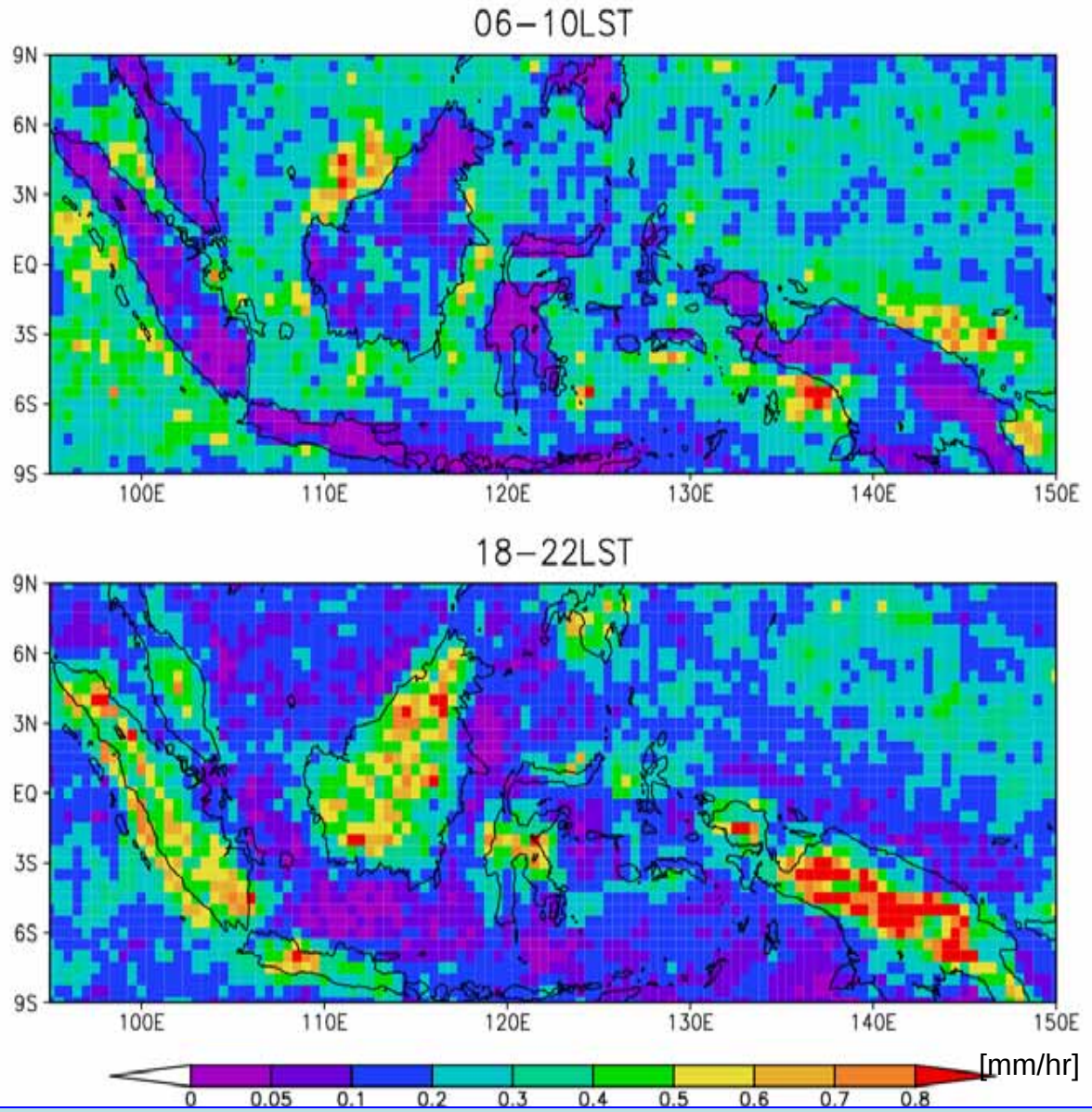


(Slingo et al., 2005)

TRMM has proved that most of rainfall is concentrated In land (island) region in the maritime continent



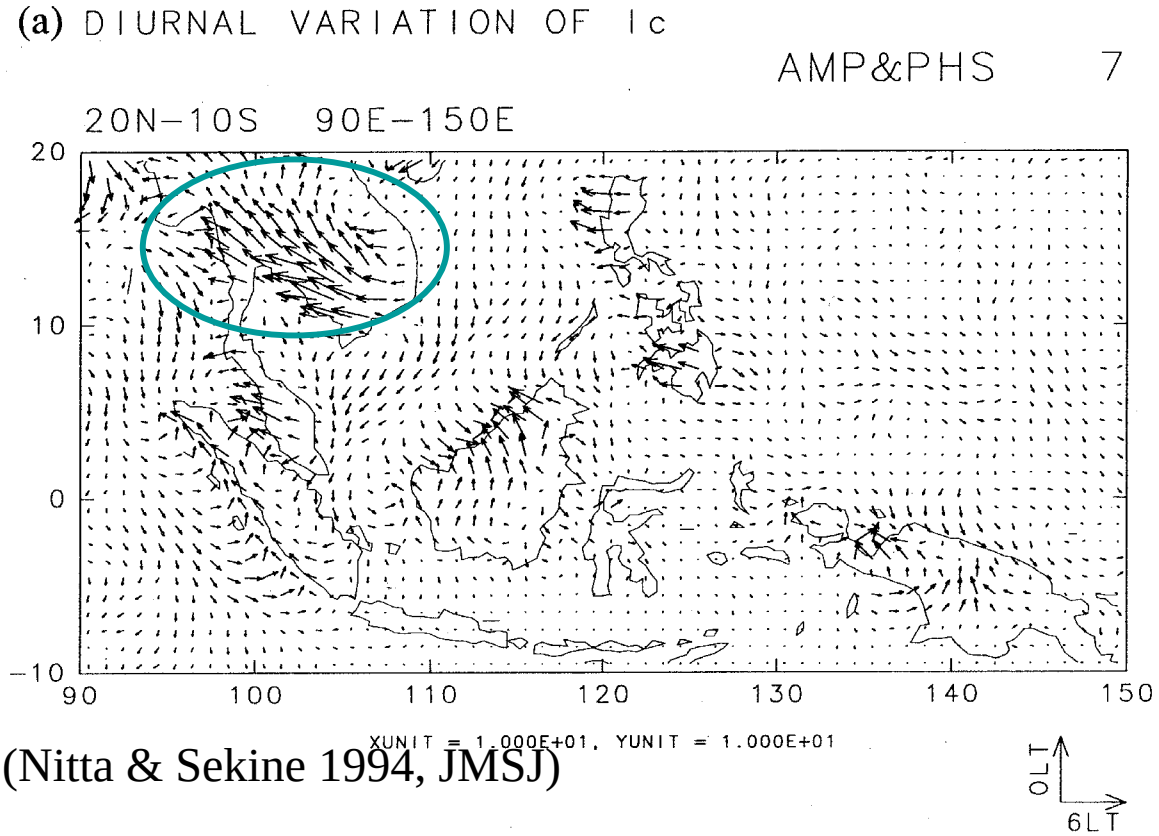
TRMMによる降水量分布の日変化



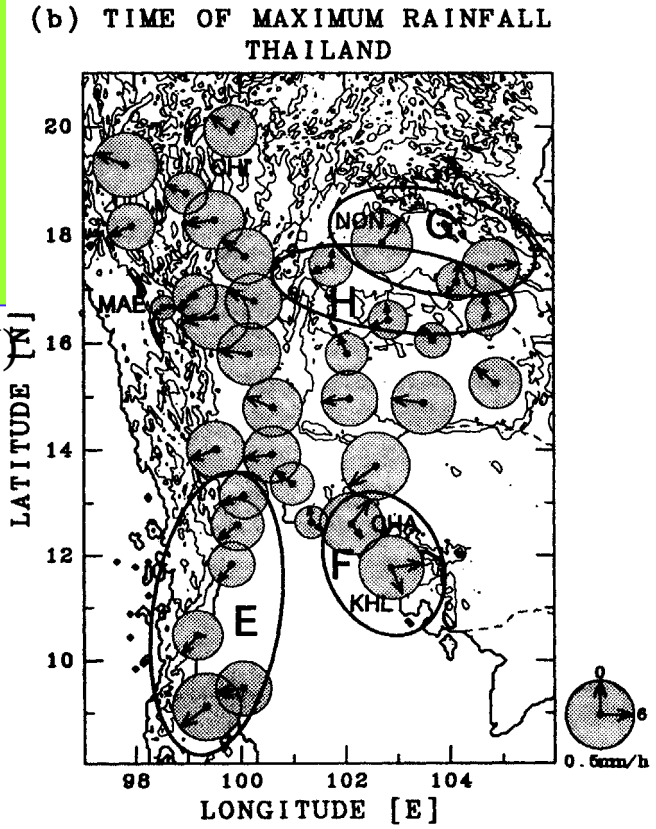
海大陸・熱帯雨林結合系で、降水域は海・陸間で大きく日変化している

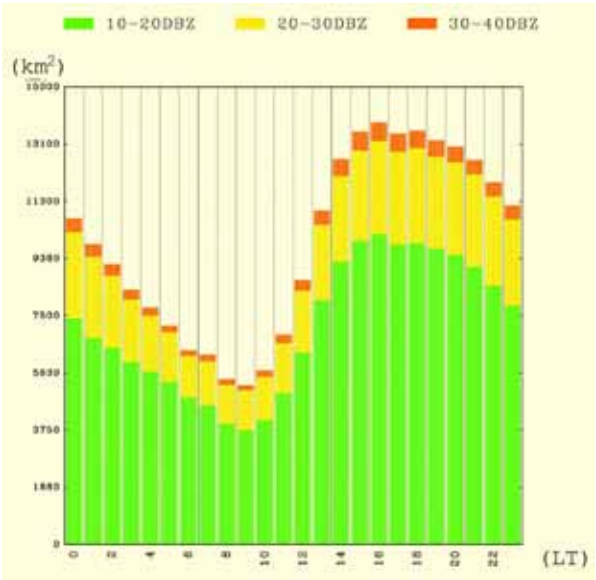
Diurnal cycle is a fundamental characteristic of convection and rainfall in monsoon system

(Ohsawa et al. 2001, JMSJ)

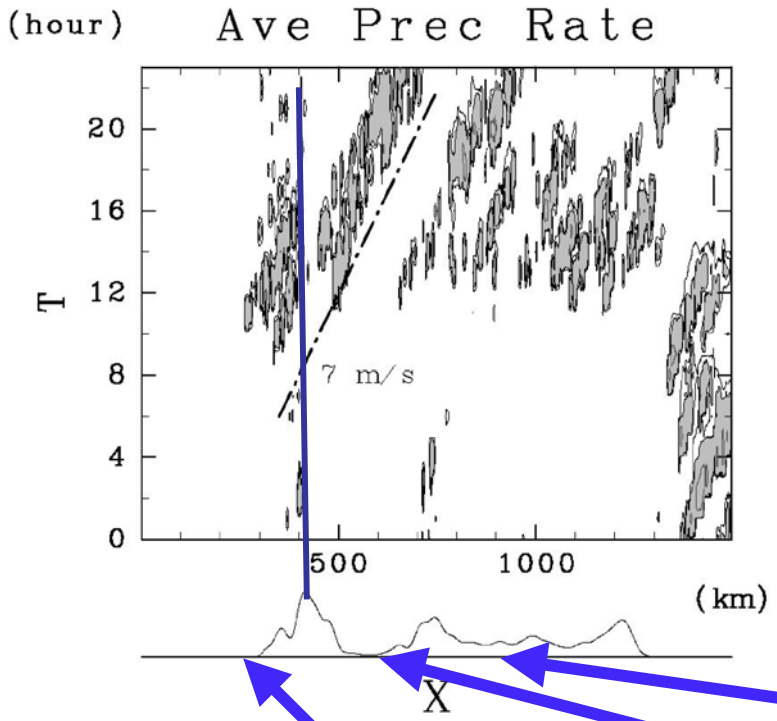


(Nitta & Sekine 1994, JMSJ)



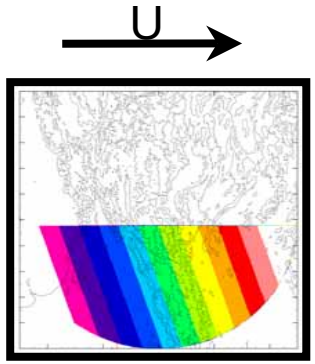


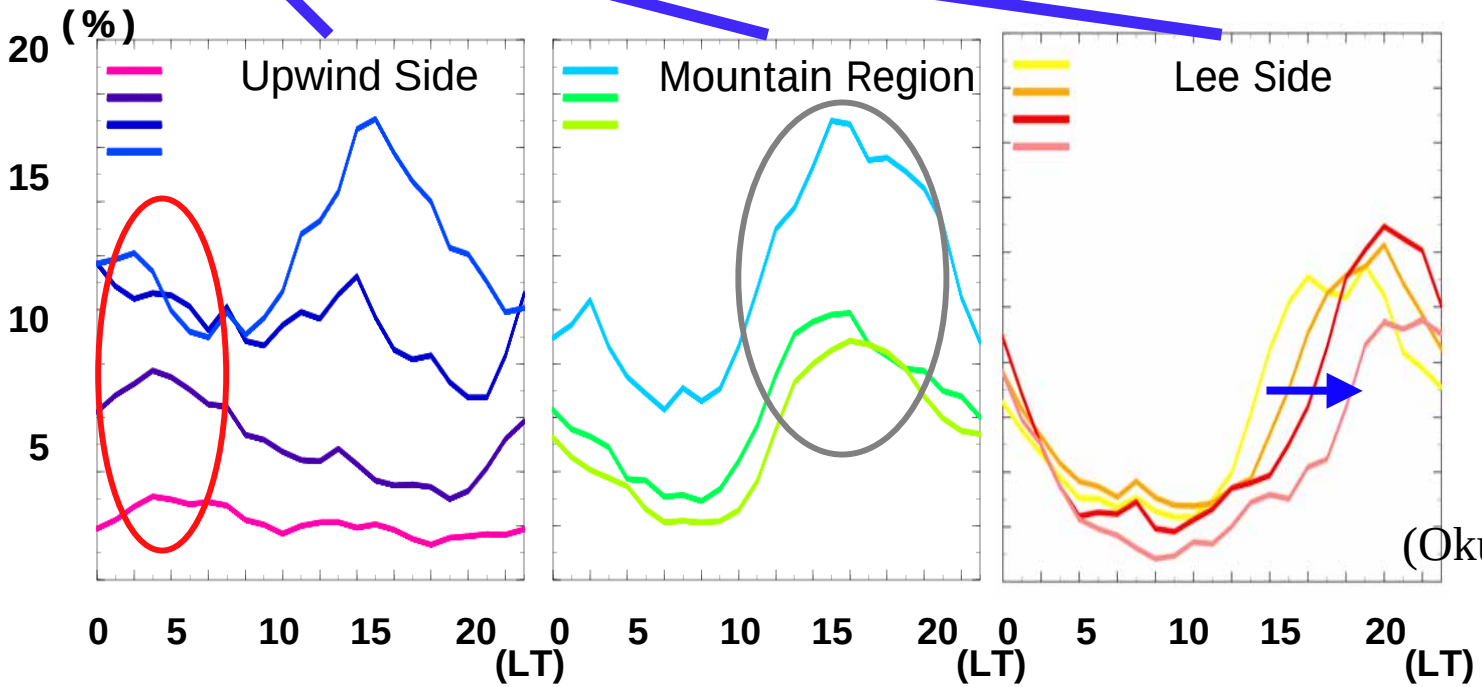
(Okumura 2002, M Th)



Eastward moving diurnal rainfall disturbances are well simulated by a cloud-resolving model

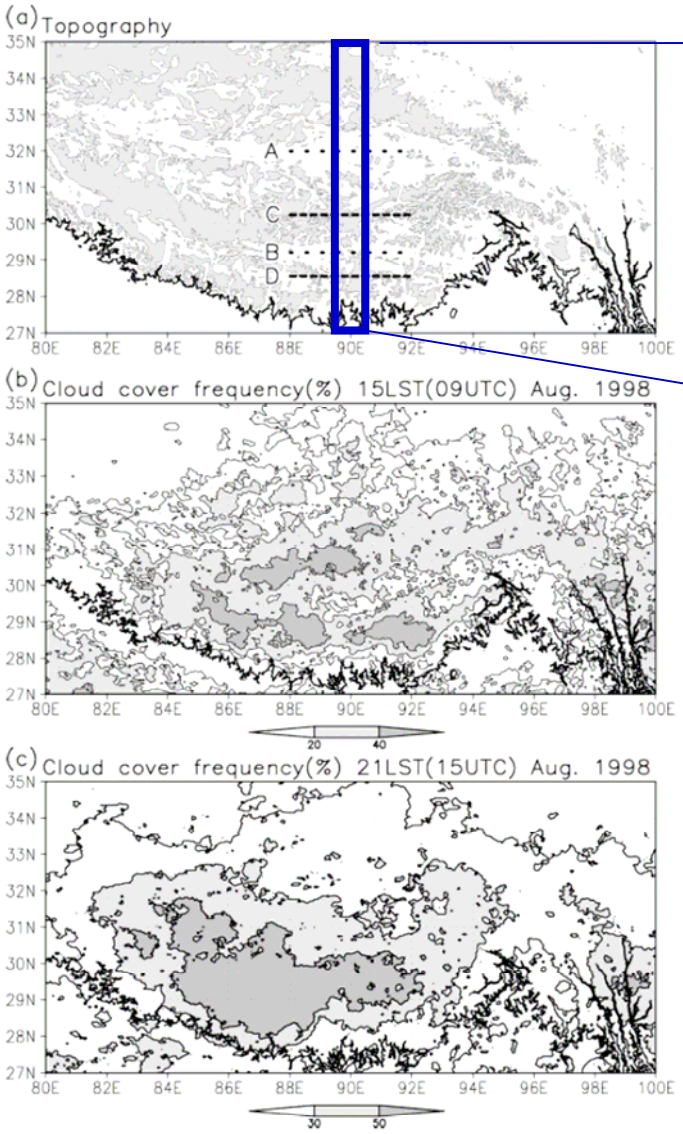
(Satomura, 2000, JMSJ)

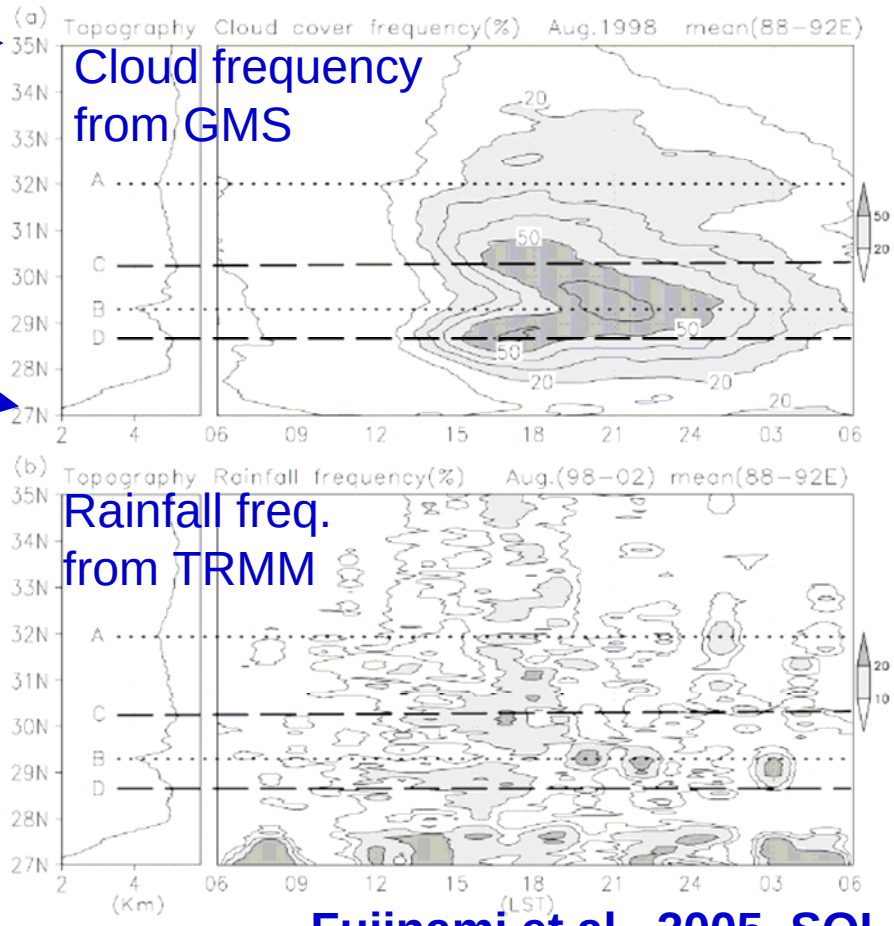




(Okumura 2002, M Th.)

Topography-induced convection develops to meso-scale systems in the diurnal cycle over the Tibetan Plateau





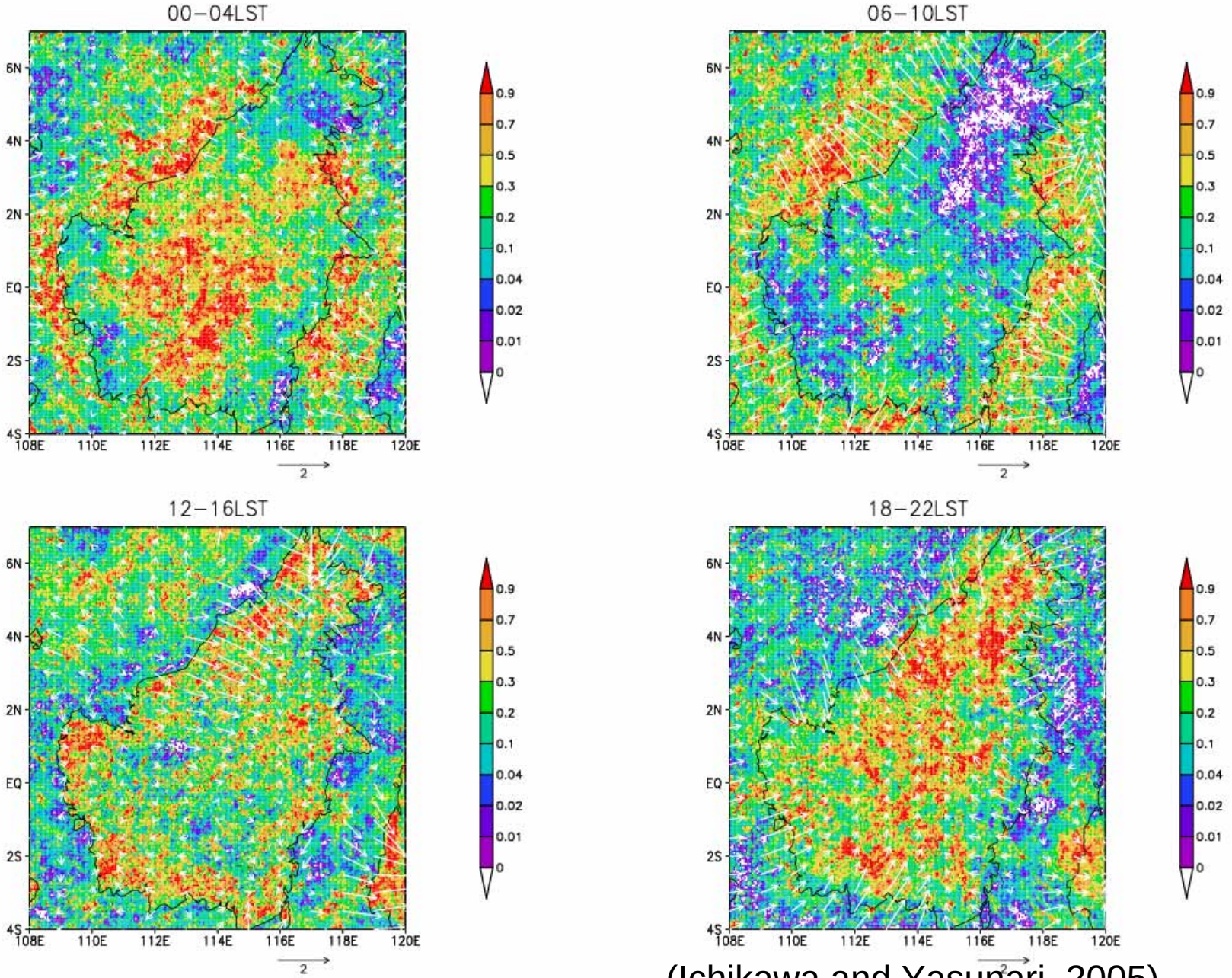
Cloud frequency from GMS

Rainfall freq. from TRMM

Fujinami et al., 2005, SOLA

Fig. 2 (a) Latitude-LST section of cloud-cover frequency averaged between 88° and 92° E for August 1998. Contour interval is 10%. The left-hand figure shows topography averaged over the same longitudes. (b) As in (a) but for rainfall frequency averaged for five Augusts (1998–2002).

Diurnal Change of Surface Rainfall [mm/h] & Wind



(Ichikawa and Yasunari, 2005)

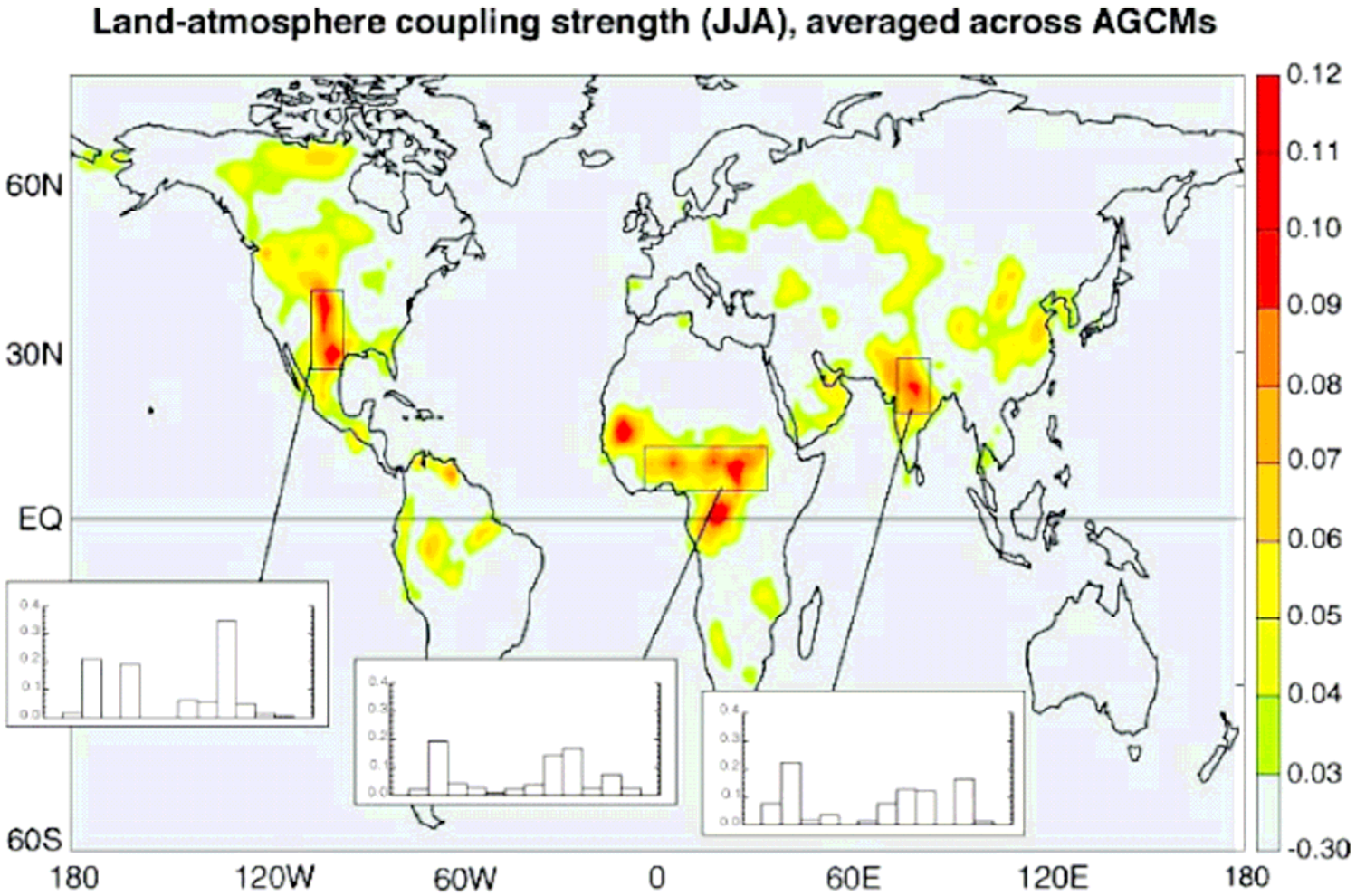
Diurnal cycle of rainfall is a fundamental process of water cycle

- Need for resolving diurnal cycle both in time and spatial structures in climat system
- Need for simulating diurnal cycle of rainfall in climate models
- Need for archiving data sets for resolving diurnal cycle (both from satellites and in-situ observations)
- The 1st target of CLIVAR-GEWEX coordinated monsoon studies is to resolve, understand and simulate diurnal cycles of rainfall in the climate system.

Rainfall anomalies depend deeply on characteristic nature of DCs in convection and rainfall in monsoon regions

displays the uncertainty in model outputs

(Koster et al., Science, August 2004).



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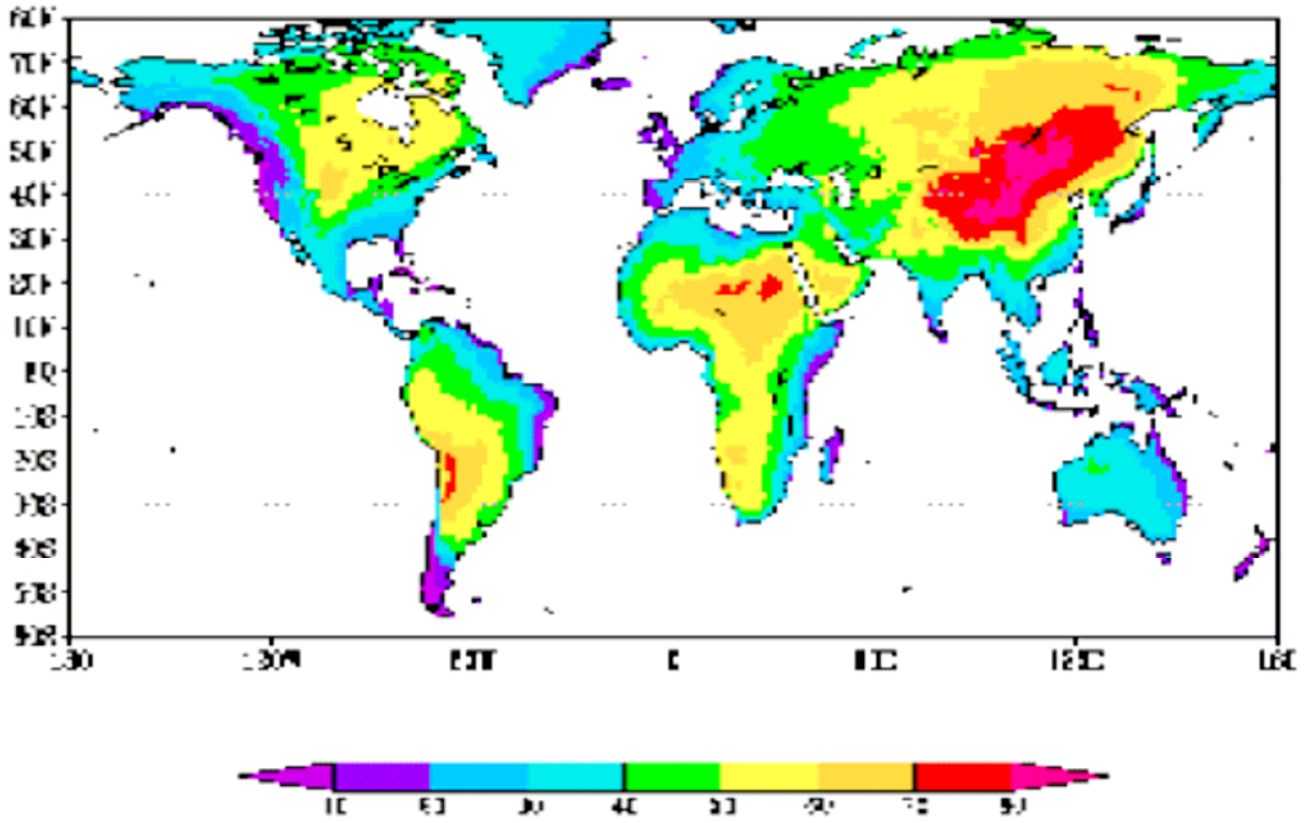
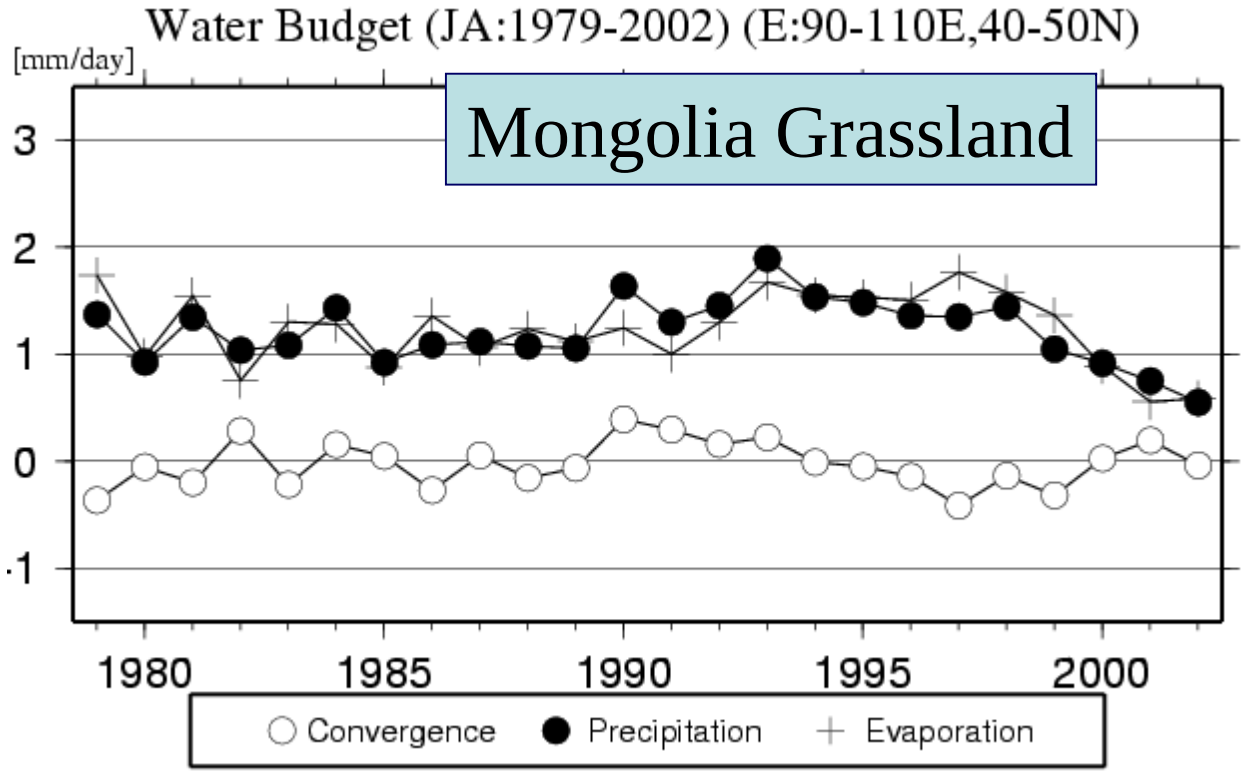
ANALYZING THE REGIONAL HYDROLOGICAL CYCLE



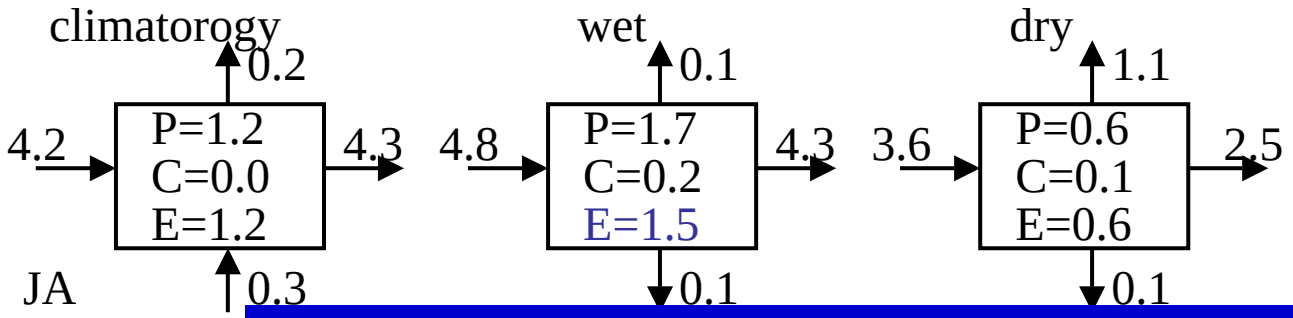
Percentage of precipitation over land that originated as continental evaporation, annually averaged over 15 years of simulation.



July-Aug.

P ~ E

⊿P ~ ⊿E



植生が気候･水循環に果たす役割

Wet：90,93,94

Dry：01,02