国际气候与环境科学中心

International Center for Climate and Environment Sciences

Annual Report of ICCES

Center of excellence on
Climate and Environment Sciences

(2012.5-2013.4)

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Chinese Academy of Sciences

Contents

I. ICCES Introduction

- **Founded in 1991 with support from both CAS and Ministry of Science and Technology of China (MOST) ;**
- **Secretariat of CAS-TWAS-WMO Forum (CTWF) on climate science since 2000**

ICCES currently has **46** staffs in total, with **40** research scientists, and **6** supporting staff . Besides, there are **7** Adjunct professors. As for 2012, there are **1** Postdoc, and **33** graduate students studying in ICCES

I. ICCES updated

- In March of 2013, ICCES was newly selected as the CAS-TWAS center of excellence on Climate and Environment Sciences through evaluation, one of the 5 CAS-TWAS CoEs.
- Video meeting between CAS-TWAS CoEs and TWAS have been organized on April 26, 2013, with Romain Murenzi, executive director of TWAS, and Officials from BIC, CAS and Directors of CoEs participating in the meeting
- In April, 2013, the Project on “Establishment of CAS-TWAS center of excellence on Climate and Environment Sciences” was approved by the Chinese Academy of Sciences, with total financial support of 8.8 Million CNY during 2013-2015.

I. Vision

The goal of *ICCES* is to become an international renowned research center on global climate and environmental sciences, as well as a cooperative base providing technology support, capacity building and talent training for developing countries, to take the lead in initiating, organizing, coordinating and implementing major international scientific cooperation between CAS and other developing countries.

I. Missions

- To conduct research on the key scientific problems in global climate and environmental changes, such as theories, simulation and prediction of global change, disaster detection and assessment
- To promote the capability of monitoring and forecasting of climatic and environmental disaster
- To provide consultancy for the national and international requirements on sustainable developments, and scientific policies in the negotiation of global climate change
- To provide services to the developing countries with scientific support and advisory, capacity building.

Measures for strengthening the collaboration with developing countries

- In order to provide services to the developing countries with scientific support and advisory, capacity building. The following measures will be taken:

  - ✓ Organizing the CTWF(CAS-TWAS-WMO Forum on climate science) international symposiums/workshops
  - ✓ Organizing international training workshops, with most participants from developing countries
  - ✓ Providing exchange programs for international visiting scholars and students from developing countries
  - ✓ Fostering key international cooperative projects with developing countries on the area of climate and environmental sciences, to enhance the research capability for developing countries

II. Major Research Fields

- 地球系统动力学模式研制和数值模拟

  Development of Dynamical Earth System Model and Numerical Simulation

- 气象与环境预测及灾害评估理论和方法

  Meteorological and Environmental Forecast and Related Disaster Assessment Theory and Technique

- 资料同化理论和方法

  Data Assimilation Theory and Methodology

- 地球系统科学理论与自然控制论研究

  Earth System Theories and Natural Cybernetics

II. On-going Projects

- **On-going Projects**

  • ***54*** **on-going research porjects in total, including demestic research projects as well as international collabrative projects;**

  • **Within the 54 projects, *14* are newly established in 2012;**
    - **6 funded by MOST/MOF**
    - **5 funded by National Natural Science Foundation of China**
    - **1 funded by Chinese Academy of Sciences**
    - **2 for international collaboration projects from MOST**

III. Current Research Progress

- Development of Dynamical Earth System Model and Its Applications
- Seasonal climate and hydrological forecast

Brief History of CAS-ESM development

- **1980s:** IAP AGCM (2L) + IAP 4L OGCM
- **1990s:** IAP AGCM (9L) + IAP 20L OGCM + IAP94 LSM
- **2000s:** IAP AGCM (26L) + LICOM1.0 + CoLM1.0
- **2010s:** IAP AGCM with Chemical Module + LICOM2.0 with Sea Ice model + CoLM2.0 (CLM) with UCM+ IAP DGVM1.0 + Biogeochemical Model

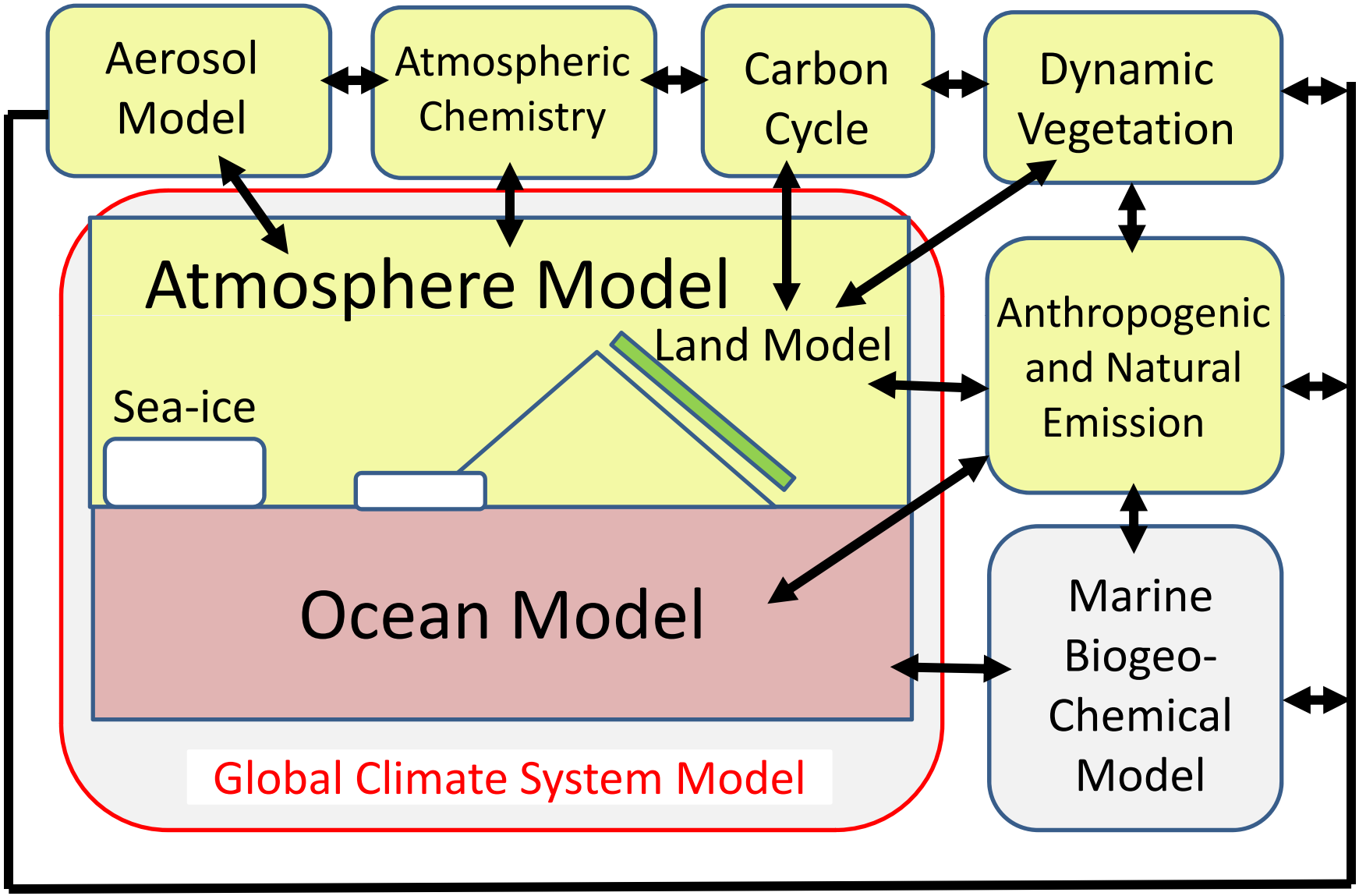
Participates in AMIP, SMIP, CMIP, PILPS, IPCC AR1-AR5; Widely applied in Seasonal forecast and climate studies

Projects related with ESM development

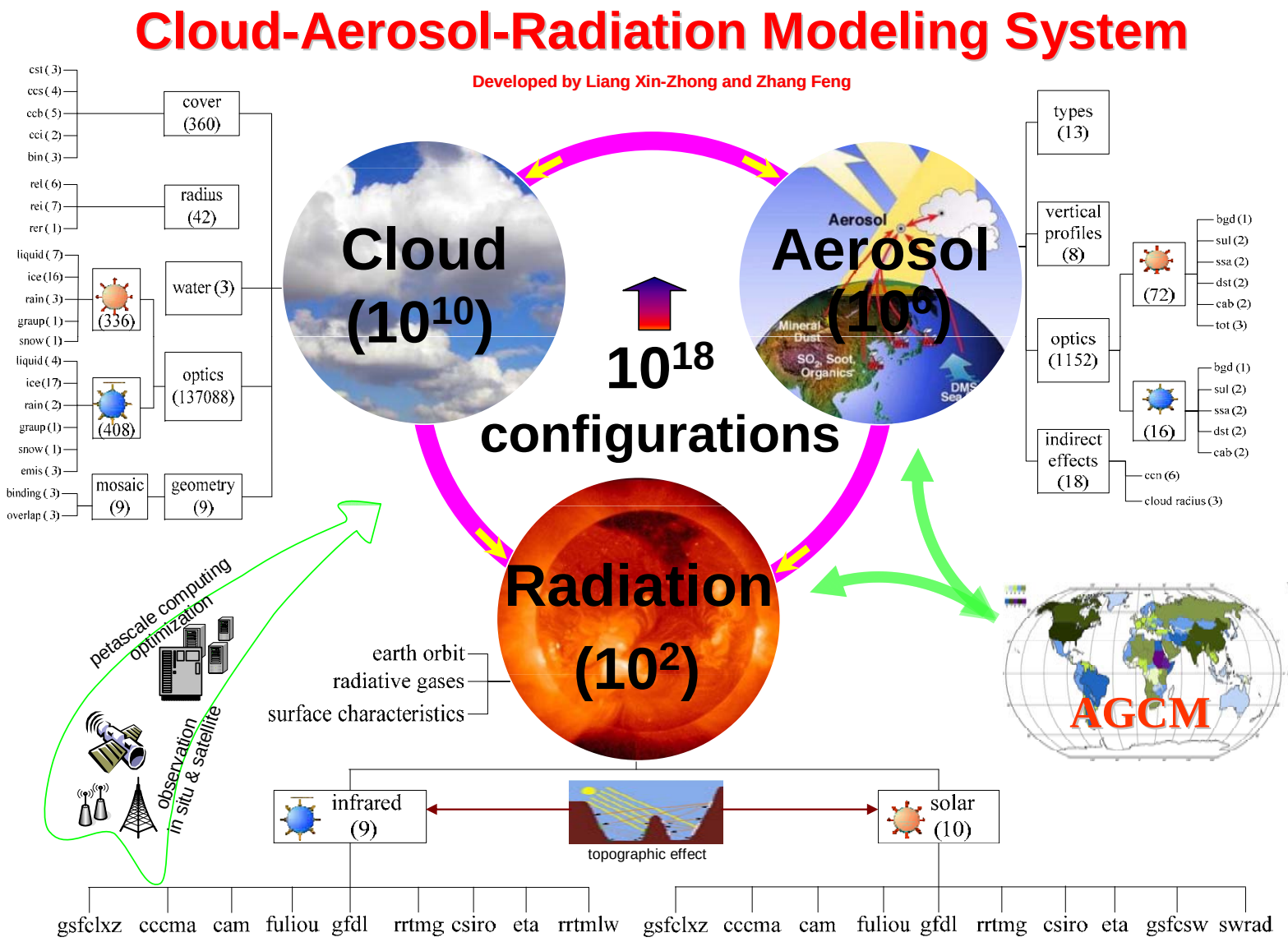
- **2007:** CAS Key project on Development of CAS Earth System Model launched (2007-2010) (Budget: 10 Million RMB ≙ 1.2 million Euro)
- **2009:** NSFC first key project on the ESM framework launched (2009-2012)
- **2010:** MOST 973 key basic research program launched two projects
  a) Development and improvement of Ecosystem and Environment Model
  b) Development of High resolution climate system model and its evaluation
  (2010-2014; 30 million RMB for each project)
- **2011:** Sub-project of CAS strategic priority projects launched:
  "Uncertainties on the climate simulation and projection using CAS climate system model" (2011-2015; 30 million RMB)

- **Development of CAS ESM is one of the three key goals of IAP for the CAS "Innovation 2020 Project" (2011-2020)**

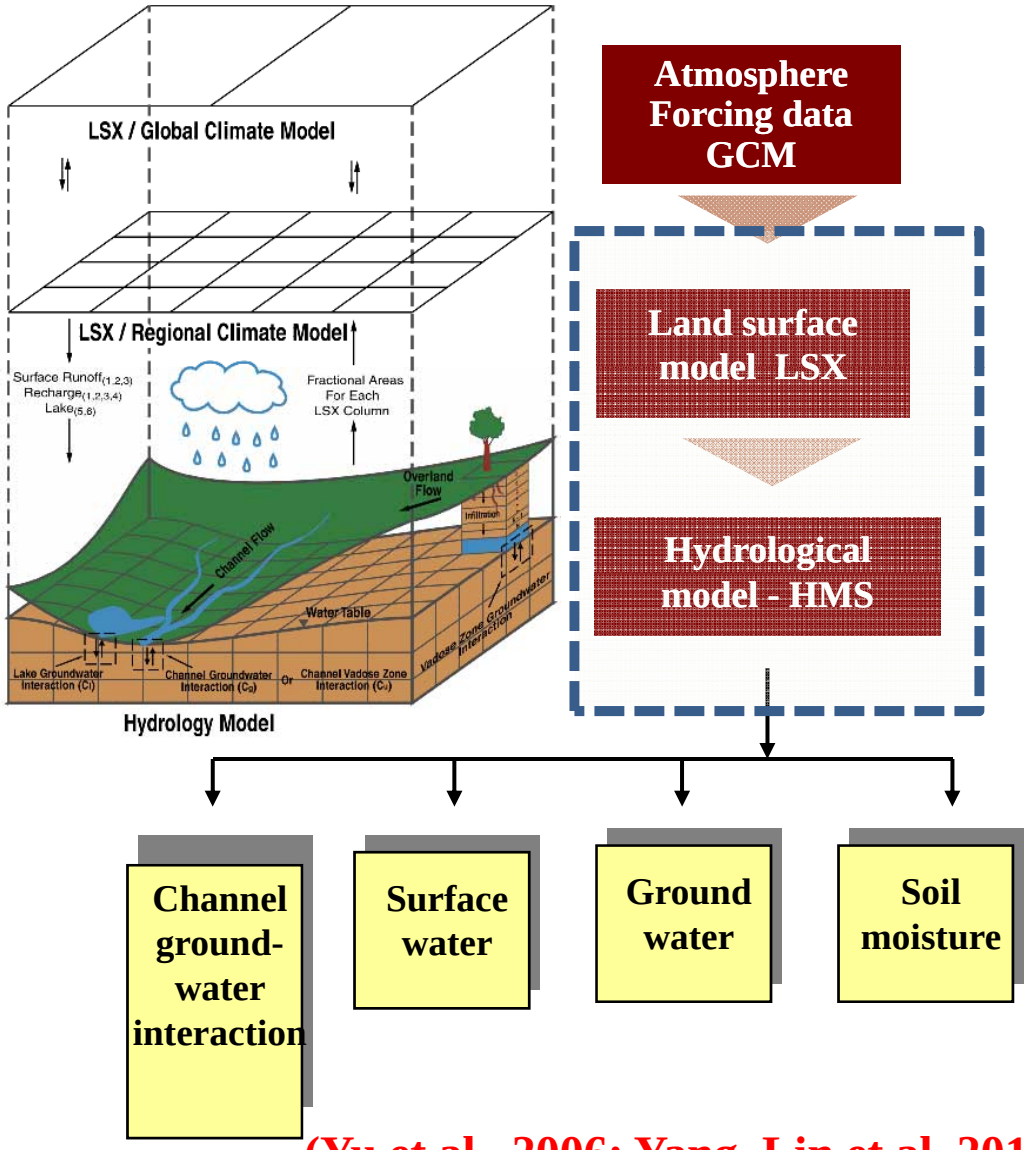
CAS Earth System Model



Research progress on AGCM − CAR System



Land-Hydrological Model System

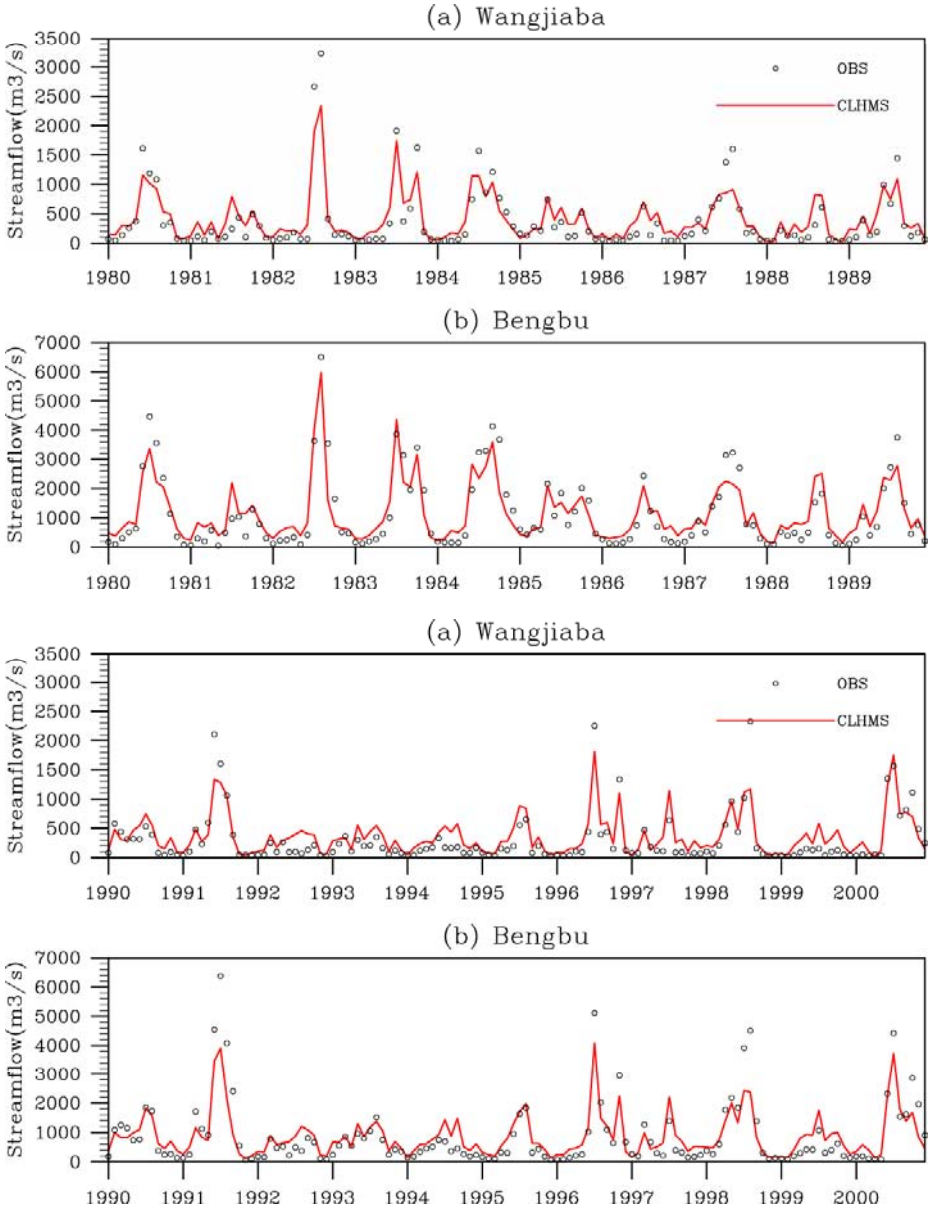


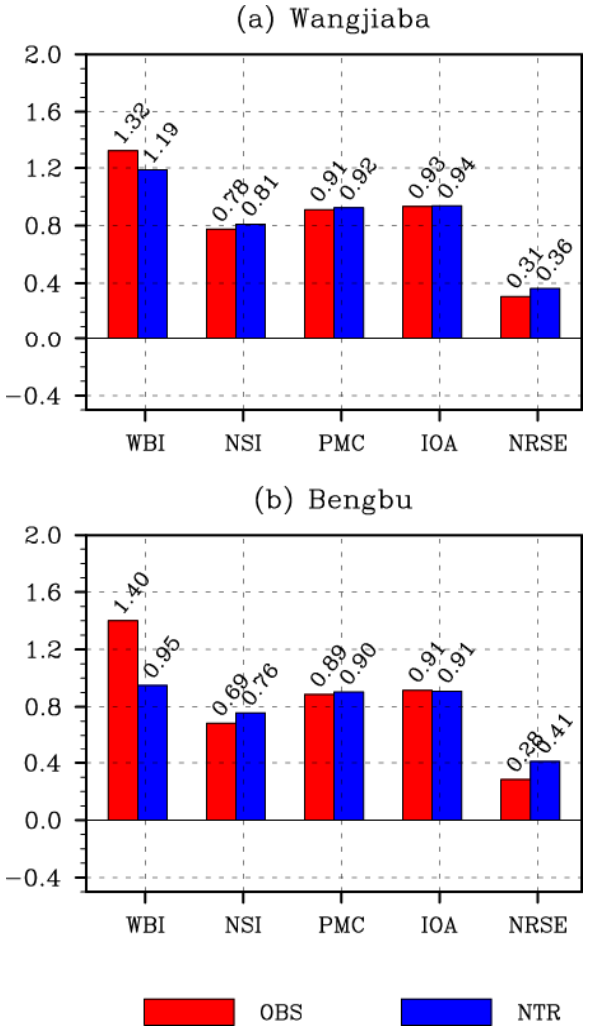
(Yu et al., 2006; Yang, Lin et al, 2010)

Forcing Data

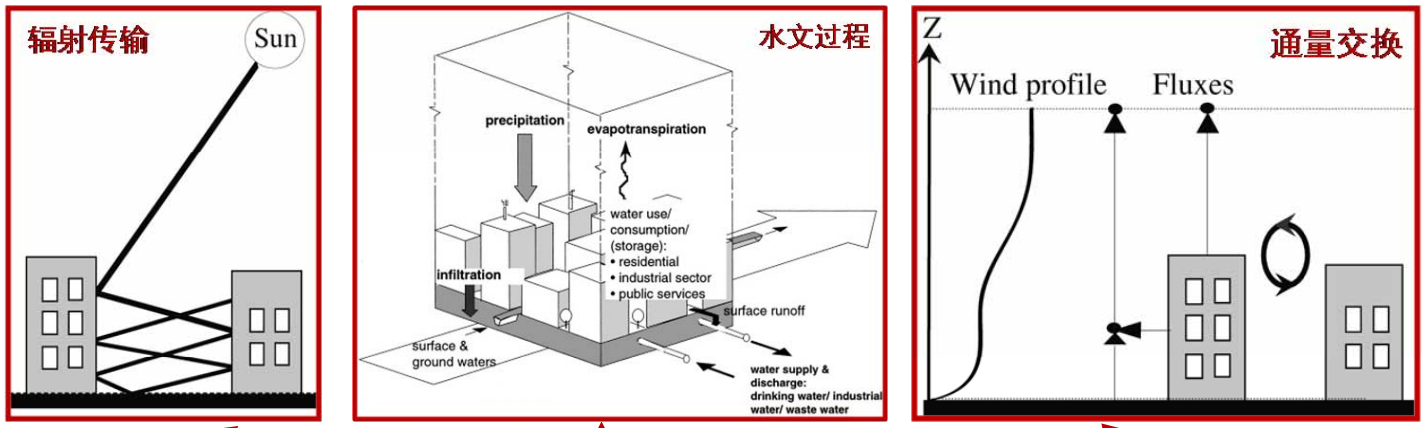
Variables	UNIT
2m temperature	K
2m humidity	Kg/Kg
Surface pressure	N/m^2（Pa）
Zonal wind	m/s
Meridional wind	m/s
Precipitation rate	Kg/（m^2s）
cloud	-
Downward longwave radiative flux	W/m^2
Visible beam downward solar flux	W/m^2
Near IR beam downward solar flux	W/m^2
Visible diffuse downward solar flux	W/m^2
Near IR diffuse downward solar flux	W/m^2

Validated with Natural streamflow





Introducing the Urban Canopy Model (UCM) in LSM

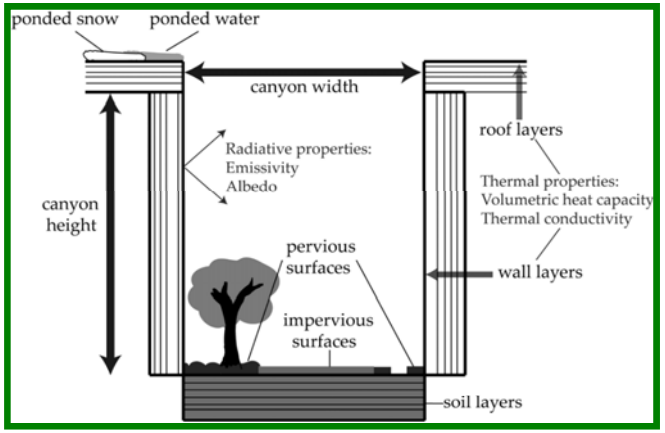


Urban

Columns/PFTs

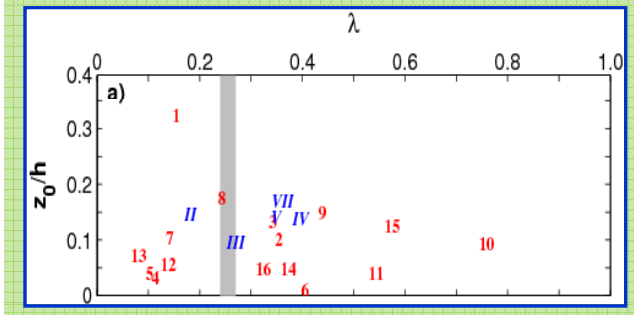
Roof | Sunlit Wall | Shaded Wall | Pervious | Impervious

Canyon Floor

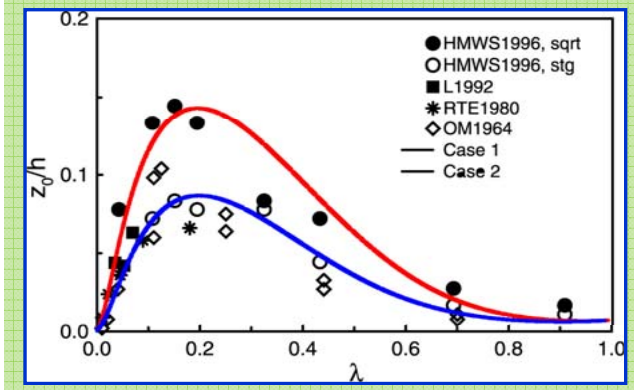


UCM development: A morphology-based roughness length parameterization for urban weather and climate modeling

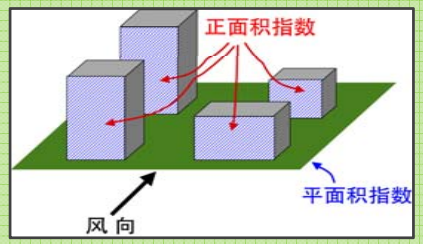
Observational basis

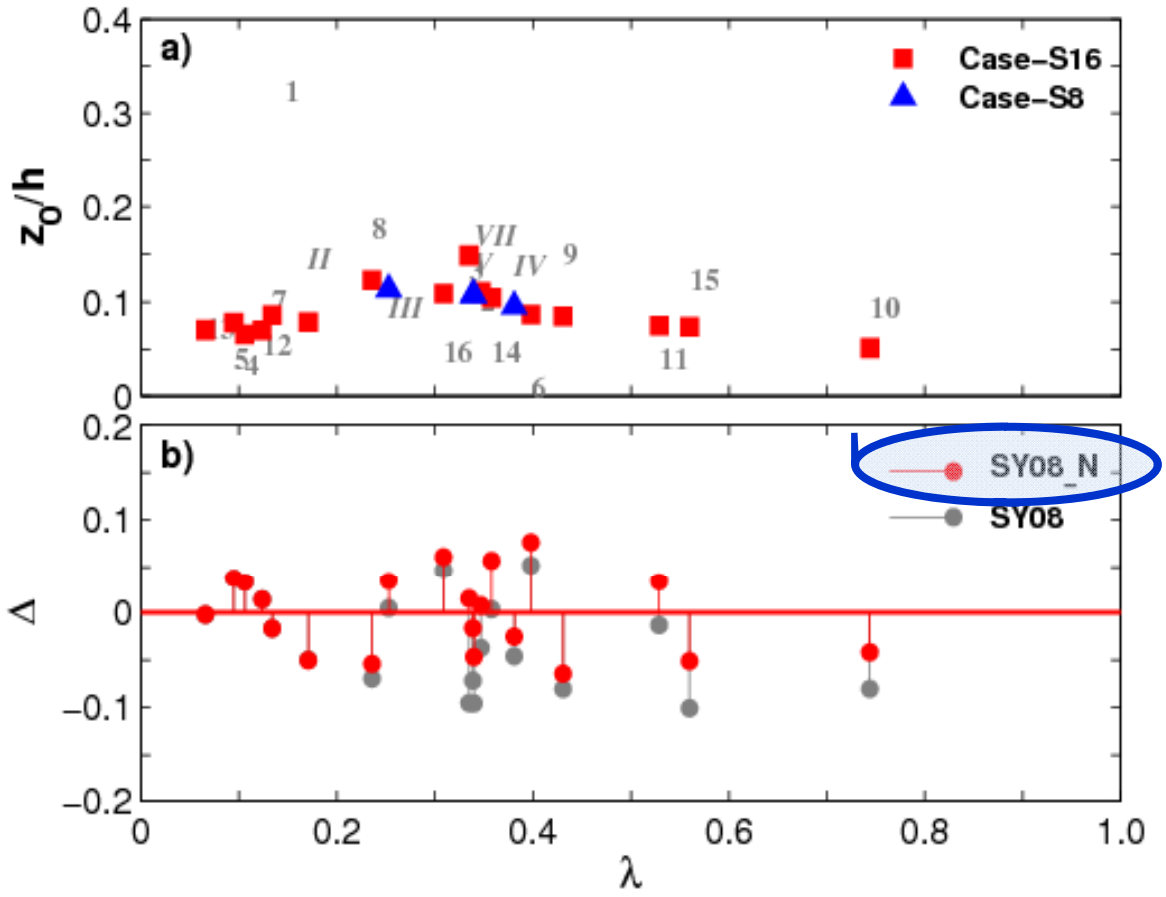


Theoretical scheme



Geometric parameters





$$z_0 = f(h, \lambda, \eta, \sigma_H)$$

高度 密度 覆盖度 高度变率

Development of IAP DGVM1.0

CLM-DGVM （Levis et al. 2004)

+Shrub Submodel

（Zeng et al. 2008; Zeng 2010)

+Fire Parameterization

（Li et al. 2012a; 2012b)

+Establishment Module

（Song 2012）

(Zeng et al. 2012, in prep; Li et al. 2012c, in prep)

Development of IAP DGVM1.0 – Establishment Module 1

Original Establishment Schemes (for woody vegetation)

Increment in Population density

$$\Delta P_i = [\Delta P_{\max}\underbrace{(1-e^{-5(1-FPC_{woody})})}_{\text{shading effect}}\underbrace{(1-\mathrm{FC}_{woody})}_{\text{available area}}] \cdot \frac{g_i}{\sum_{k=1}^{n_{est,woody}} g_k}$$

Total Number of Saplings

Partitioning of Saplings

$$g_i = 1$$

Same establishment for all PFTs

Major problems:

- **Does not consider the different in establishment among PFTs**
  - ✓ Saplings independent of PFT's current status（e.g., fractional coverage, productivity）
  - ✓ No difference in the relative establishment capability (competition-colonization trade-off)

Development of IAP DGVM1.0 – Establishment Module 2

New Scheme

- ✓ Number of saplings in proportion to PFT's fractional coverage
- ✓ Background establishment
- ✓ Mortality rates of saplings

shade tolerance

$$\Delta P_i = [\Delta P_{\max}(1-e^{-5(1-FC_{woody})})(1-FC_{woody})\cdot e^{-\gamma\cdot FC_{woody}}]\cdot\frac{g_i}{\sum_{k=1}^{n_{est,woody}} g_k}\cdot(1-mortality)$$

Competition among PFTs

Mortality rates of saplings

$$g_i = g_{i0}[\varepsilon_0 + (1-\varepsilon_0)FC_i^{\frac{1}{2}}]$$

$$mortality = e^{-(\alpha\cdot mort_{greff}+\beta\cdot mort_{heat})}$$

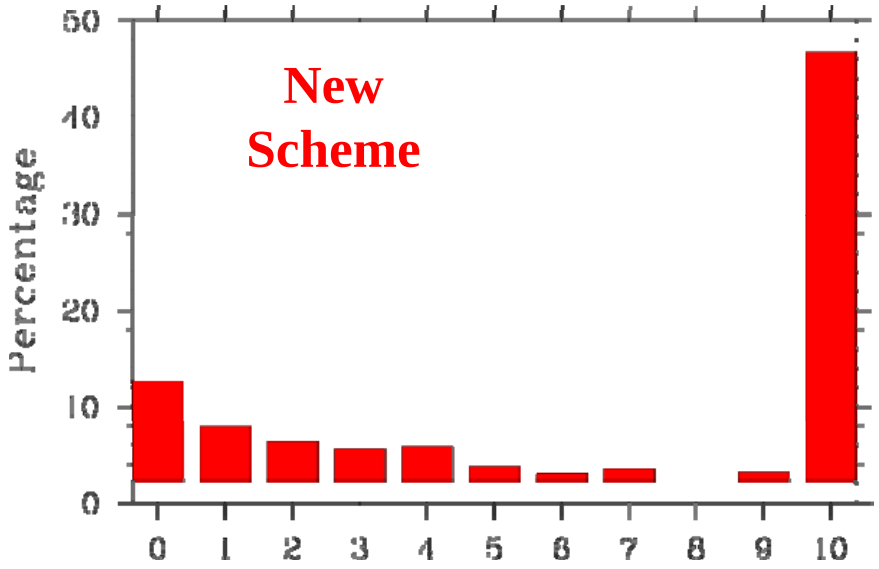
Relative establishment potential

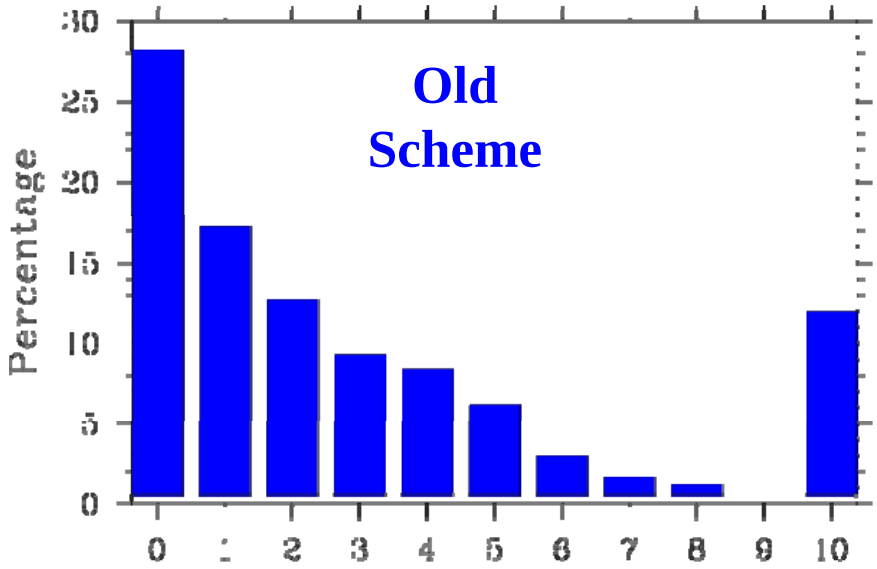
Background establishment

background and heat stress mortality of mature individuals

Development of IAP DGVM1.0 – Establishment Module 3

Density distribution of tree crown area simulated by DGVM

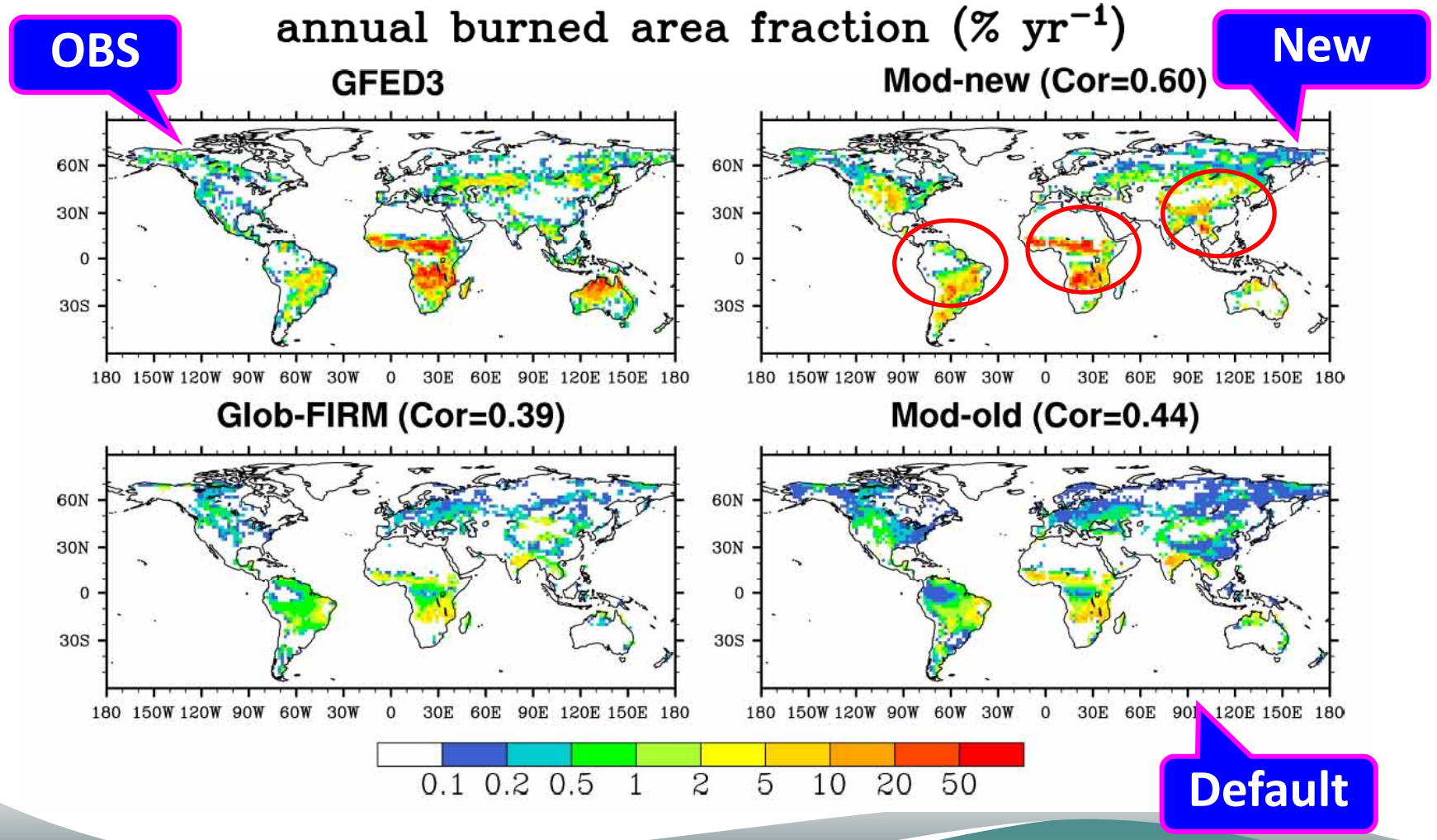




The old scheme underestimates tree crown areas, e.g., more than 80% of forest area grow trees with crown area less than $5m^2$;

This is significantly improved in the new Scheme.

Development of IAP DGVM1.0 – **Fire Parameterization**



Role of natural aerosols in climate system – sea salt and mineral dust aerosols

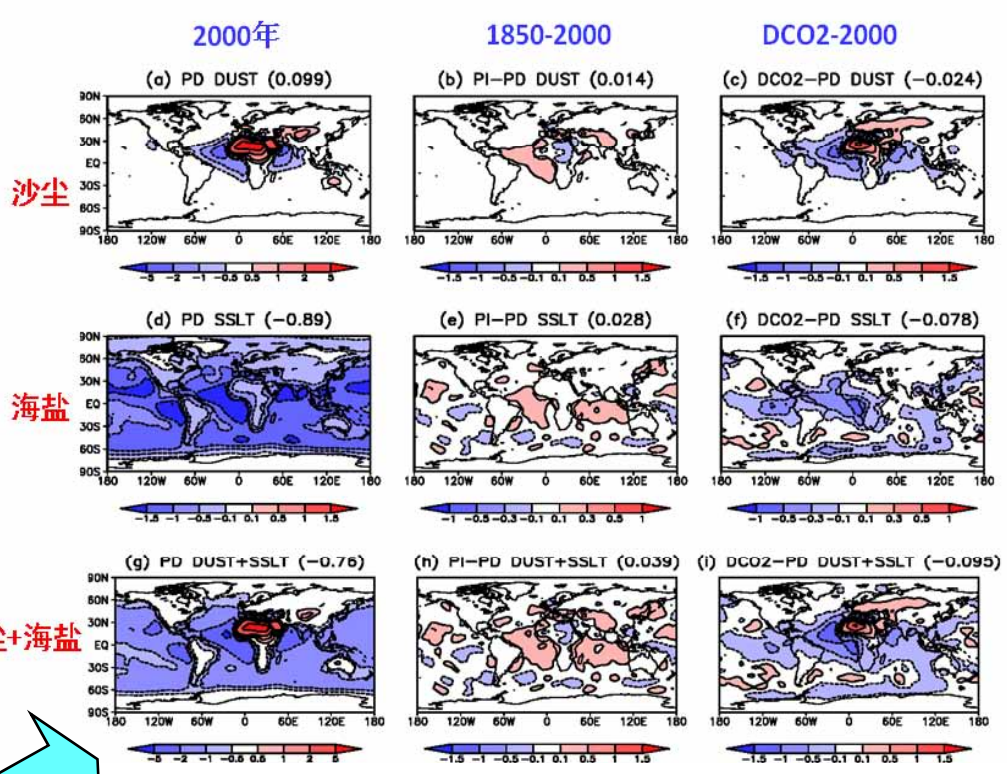
- Implemented a sea salt scheme in IAP mode, considering aerosol particles with diameter ≤ 10 μm; simulated present-day global sea salt emission is 4253 Tg;

- Examined the climatic effect (longwave plus shortwave) of sea salt in present day and LGM.

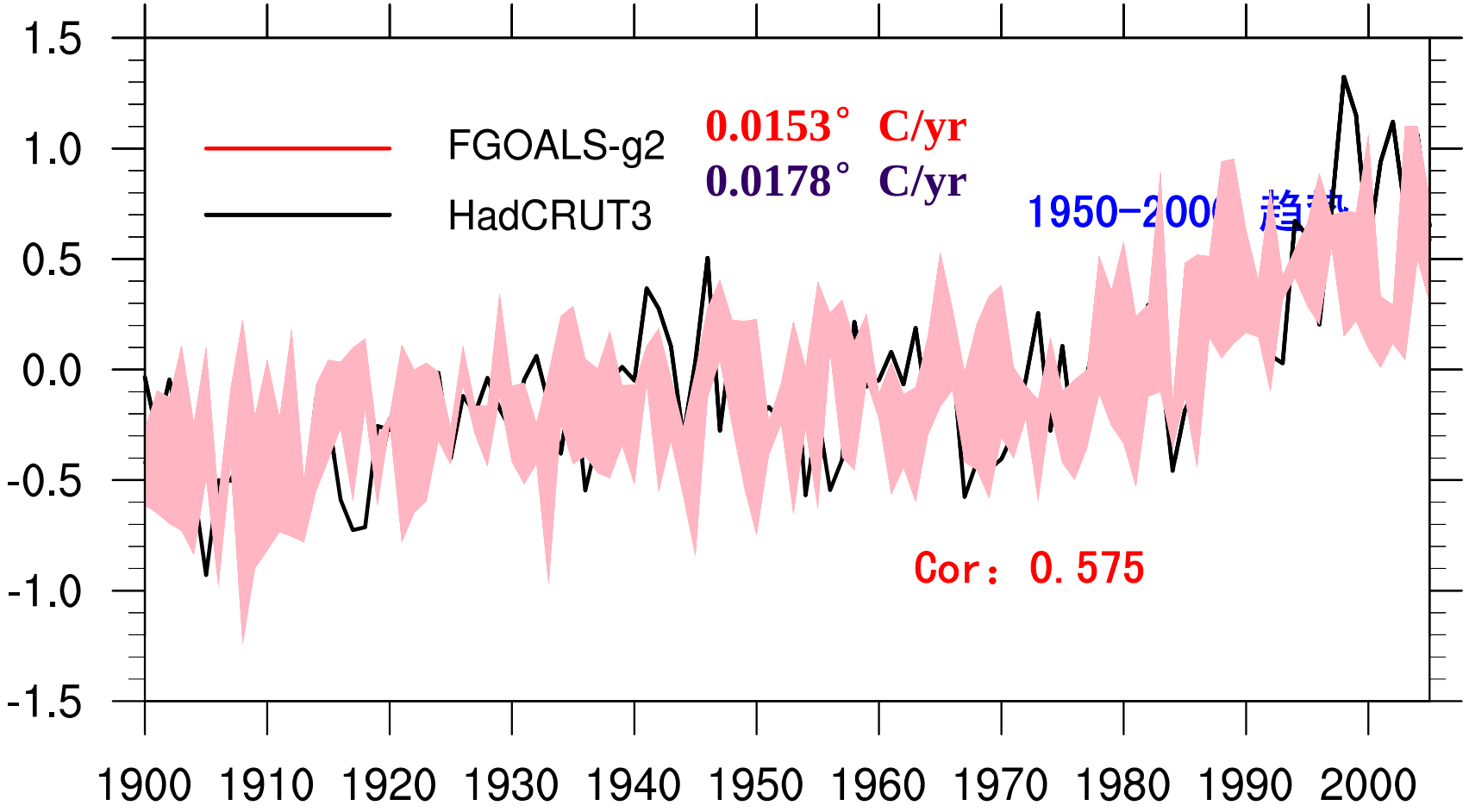
--(Yue and Liao, Climate Dynamics, 2012)

- From 1850 to the doubled CO_2 future atmosphere, changes in radiative forcing by sea salt and dust is estimated to be -0.13 W m^{-2}, which is smaller than the radiative forcing by anthropogenic aerosols.

Changes in radiative forcing by sea salt and mineral dust from 1850 to the doubled CO_2 future atmosphere

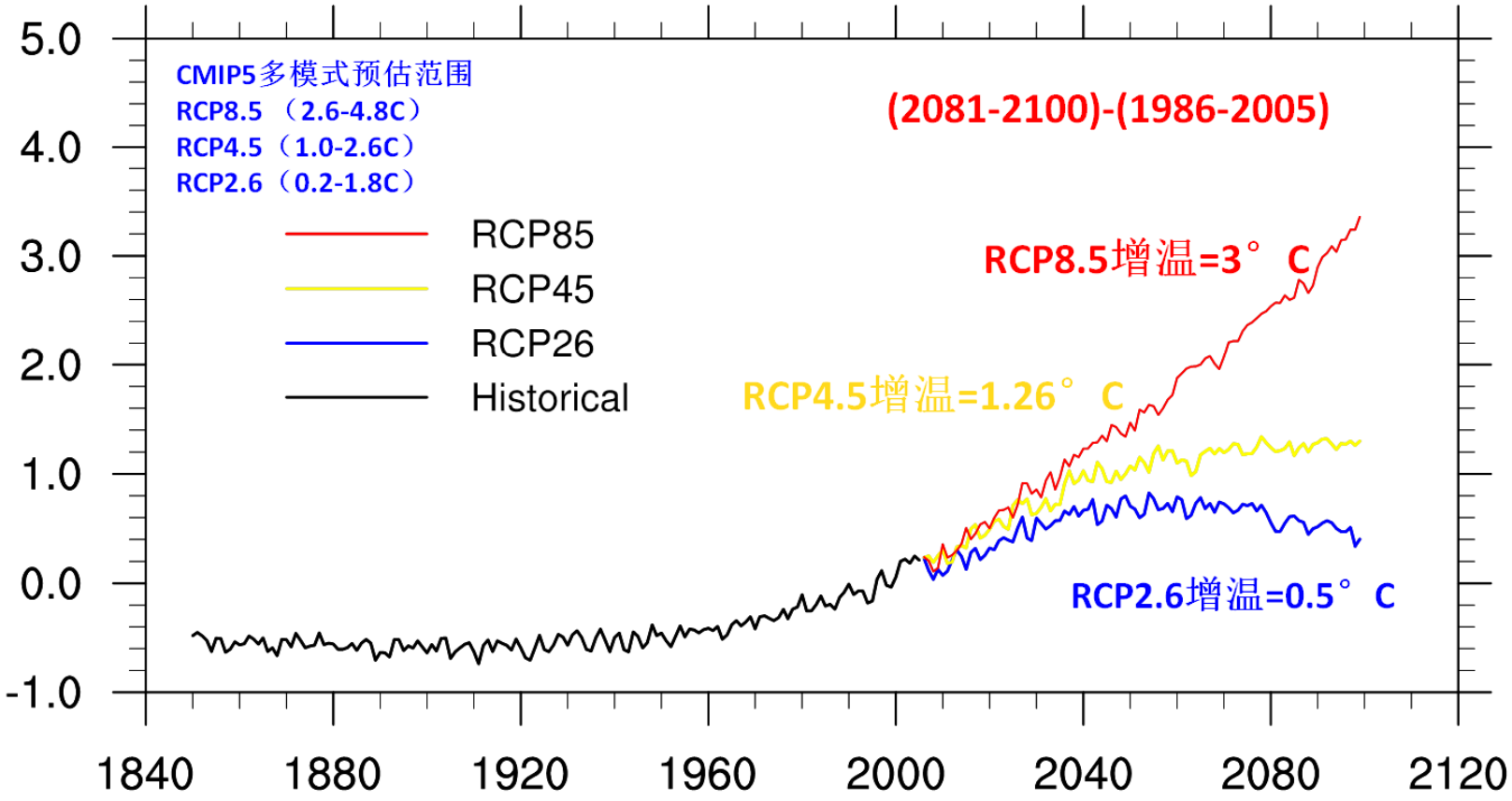


Model Applications: 20 Century simulation



Model Applications: Future climate change projection

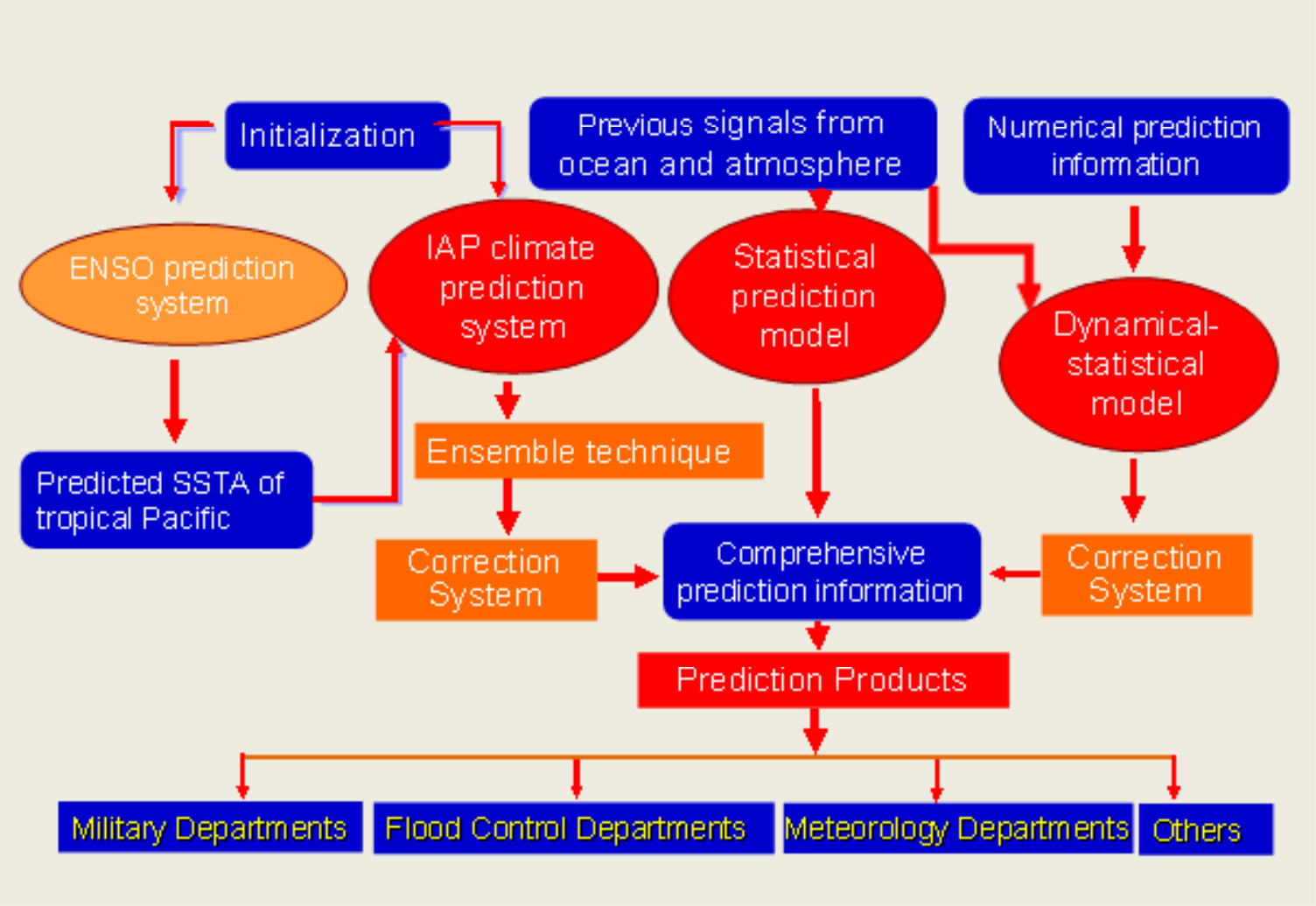
Projection of future TAS change （RCP8.5、RCP4.5、RCP2.6）



III. Current Research Progress

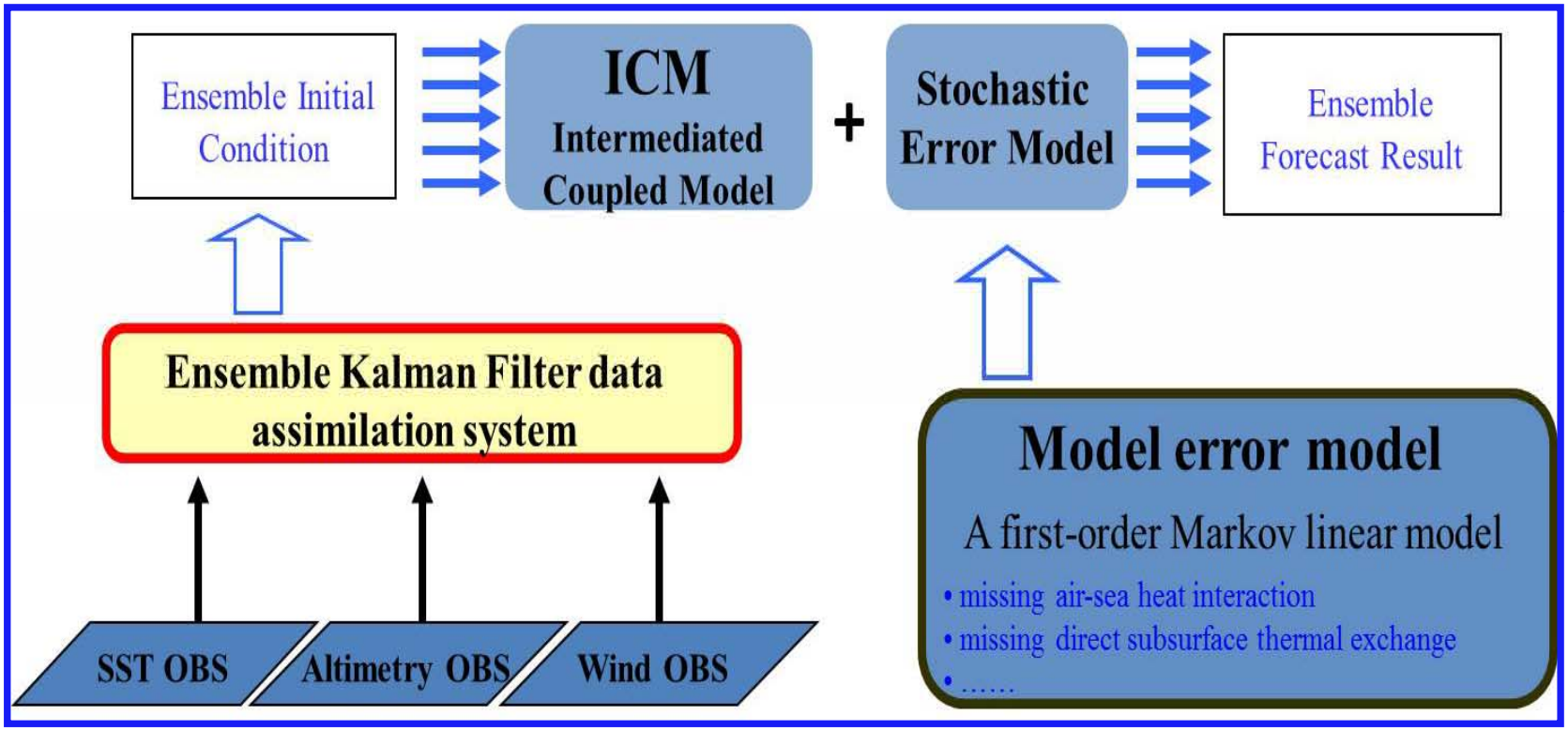
- Development of Dynamical Earth System Model and Its Applications
- Seasonal climate and hydrological forecast

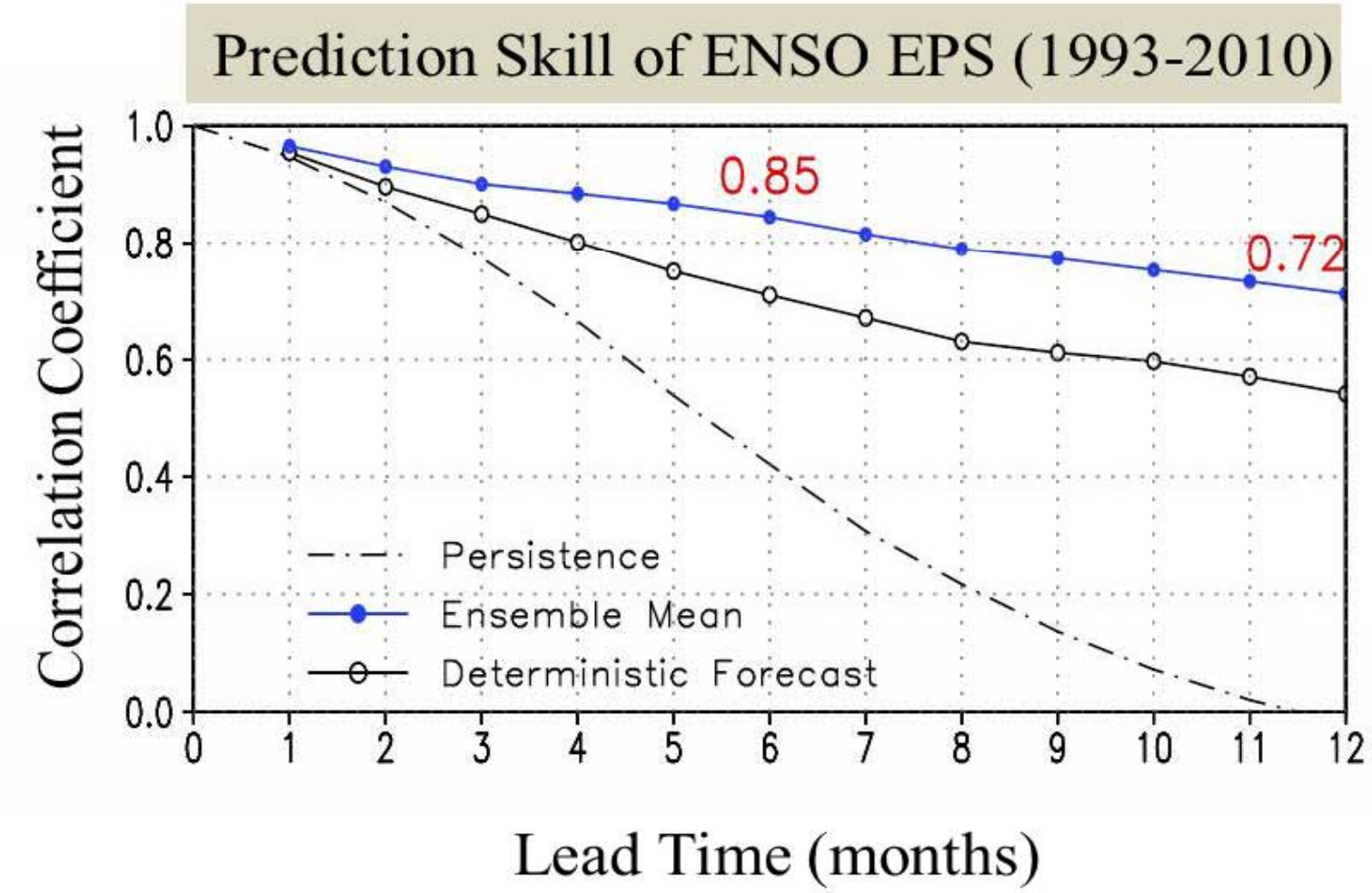
IAP Seasonal climate and hydrological Prediction System



Framework of IAP Seasonal to inter-annual Prediction System

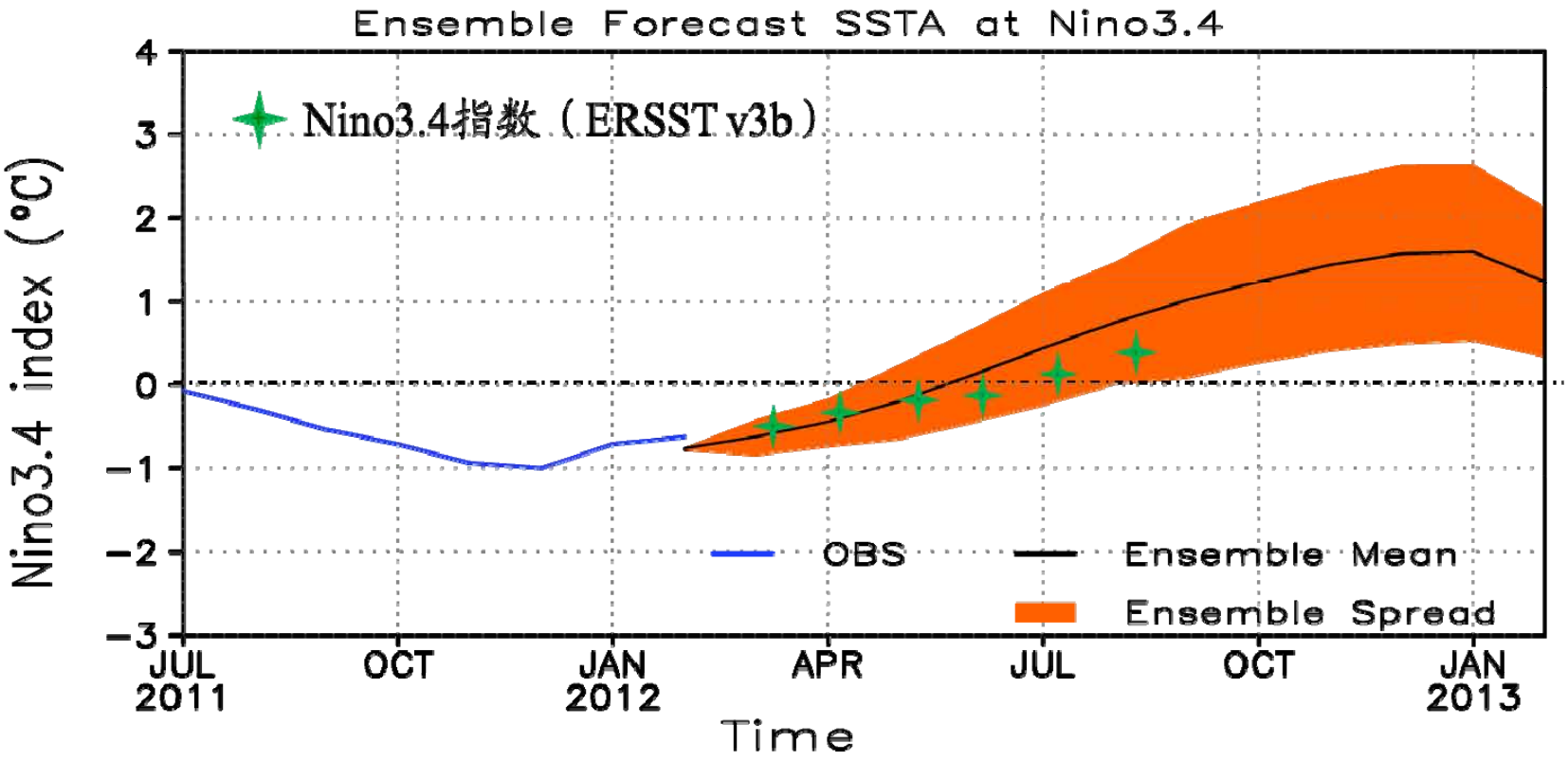
IAP ENSO Ensemble Prediction System





Prediction skills (anomaly correlation) of the Niño3.4 index for the ensemble-mean forecast, the deterministic forecast, and the persistence forecast as functions of lead time. Results are obtained from the ensemble/deterministic predictions made during the period from 1993 to 2010 regardless of starting month.

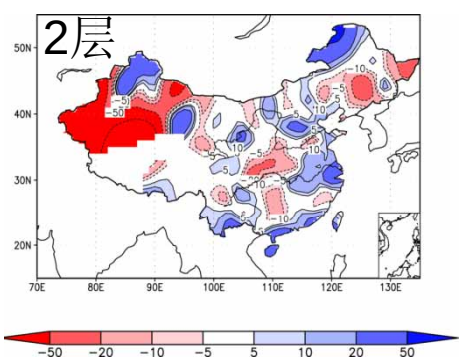
Updated prediction for 2012 – *Nino3.4 index*

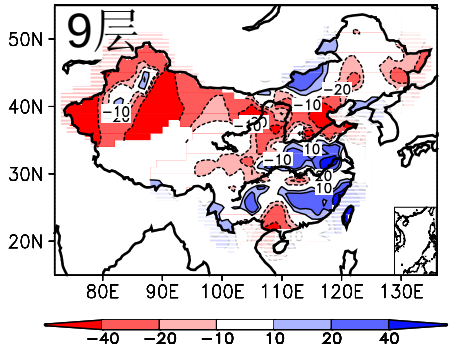


The decay of La Nina event during 2011-2012 has been well predicted by the IAP ENSO prediction system, along with the ending time of the La Nina event.

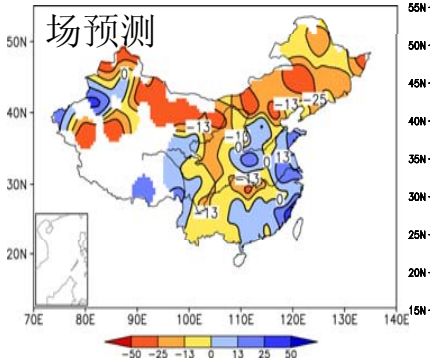
Real-time prediction of Summer rainfall anomalies over China (2012)

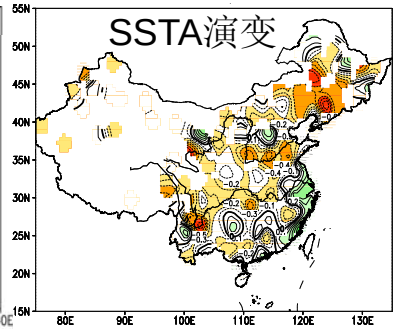
Model Forecast

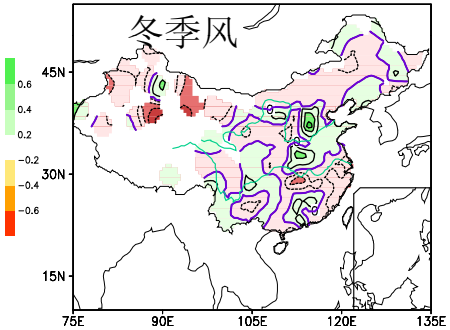


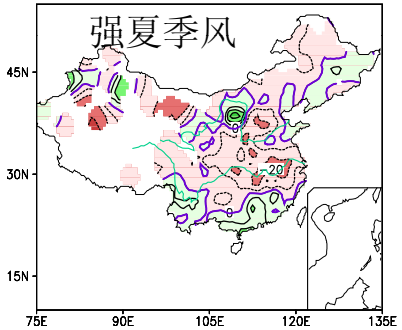


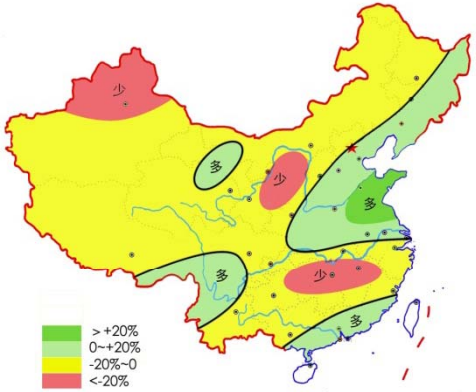
Statistical Forecast

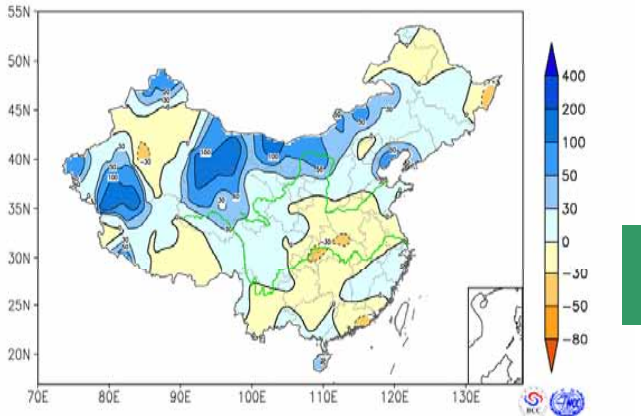












Issued at March, 2012

Research Outcome Distribution

- **Series of News Letter of Climate Prediction**

IV. International Cooperation

Statistics:

- More than *30* foreign experts visited ICCES in 2011.
- Research scientists from ICCES attended more than *20* international conferences.
- More than *70* experts from over *10* countries, mostly from developing countries attended 2012 CTWF workshop in Beijing.

2012 CTWF International Workshop

Theme: "Terrestrial Ecosystems under the Changing Climate"

More than **70** participants attended the 2012 CTWF, including **19** representatives from **10** oversea institutions and government departments.

Time: September 2-5, 2012
Venue: Beijing, China.

2012 CTWF International Workshop

12th CTWF Workshop on operational oceanography for developing countries,

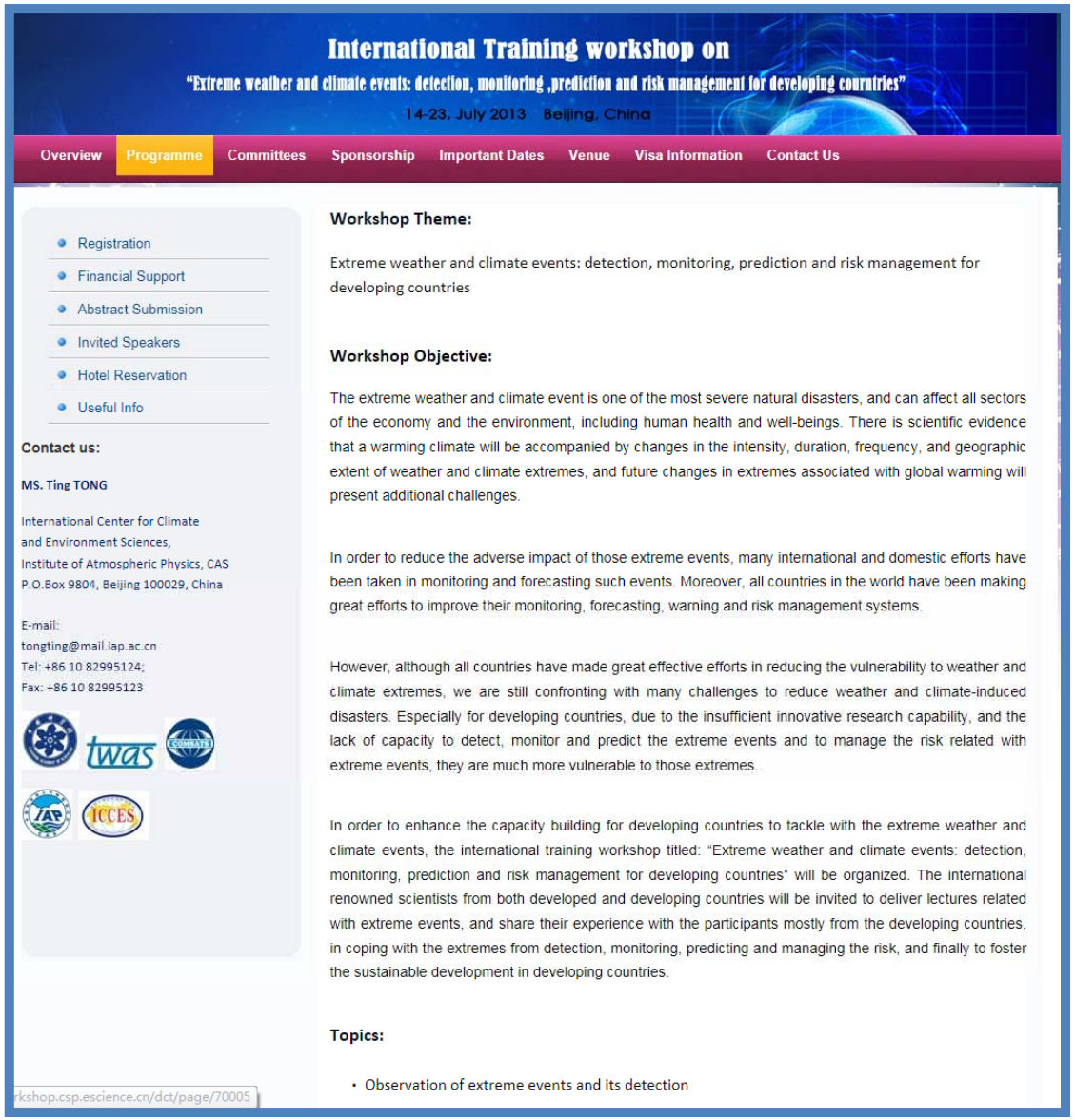
Time: Sep 9-12., 2013

Venue: Beijing

http://2013ctwf-icces.csp.escience.cn

More scientists from developing countries are welcome to attend the workshop

International Training Workshop on Extreme Events



Topics:

- Observation of extreme events and its detection
- Monitoring and prediction of extreme events
- Risk management of extreme events

Time: July 14-23., 2013

Visit our website: ***http://icces-trainingworkshop.csp.escience.cn***

More young scientists from developing countries are welcome to attend the training workshop

THANK YOU !

Prof. Dr. Zhaohui Lin

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