Modeling study of aerosol direct radiative forcing over East Asia with a coupled Regional Climate/Chemistry model

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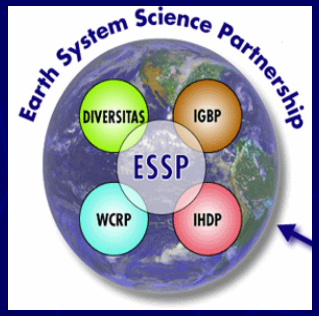
Background

- **Monsoon Asia** - *plays a crucial role in the social and economic development of the region*
- **Human activities** -*in the Monsoon Asia region have had, and will continue to have, significant environmental impacts, not only regionally but also globally*
- *But can the Asian monsoon climate be significantly altered by the human activities?*
- **Evidence** *indicates that increasing greenhouse gases concentrations in the atmosphere are increasing the amount and variability of summer monsoon rainfall in South Asia, weakening the winter monsoon over continental Asia and causing an early onset of the Indian summer monsoon.*
  Anthropogenic aerosols and large scale human-induced land cover change have also been shown to be affecting the Asian monsoon climate.

  Large uncertainties in quantifing the extent

A Monsoon Asia Integrated Regional Study (MAIRS)



The ESSP is a joint initiative of four global environmental change programmes

- Concept proposed by Fu & Huang (1996)
- Feb 2003 acceptted by ESSP as the first IRS, Set up MAIRS International Project Office
- In 2004, CAS and MOST began to support IPO
- MAIRS Science Steering Committee is made up of 13 members from China, India, Japan, Thailand, Australia, USA and EU
  Chairman: Prof Congbin Fu from China

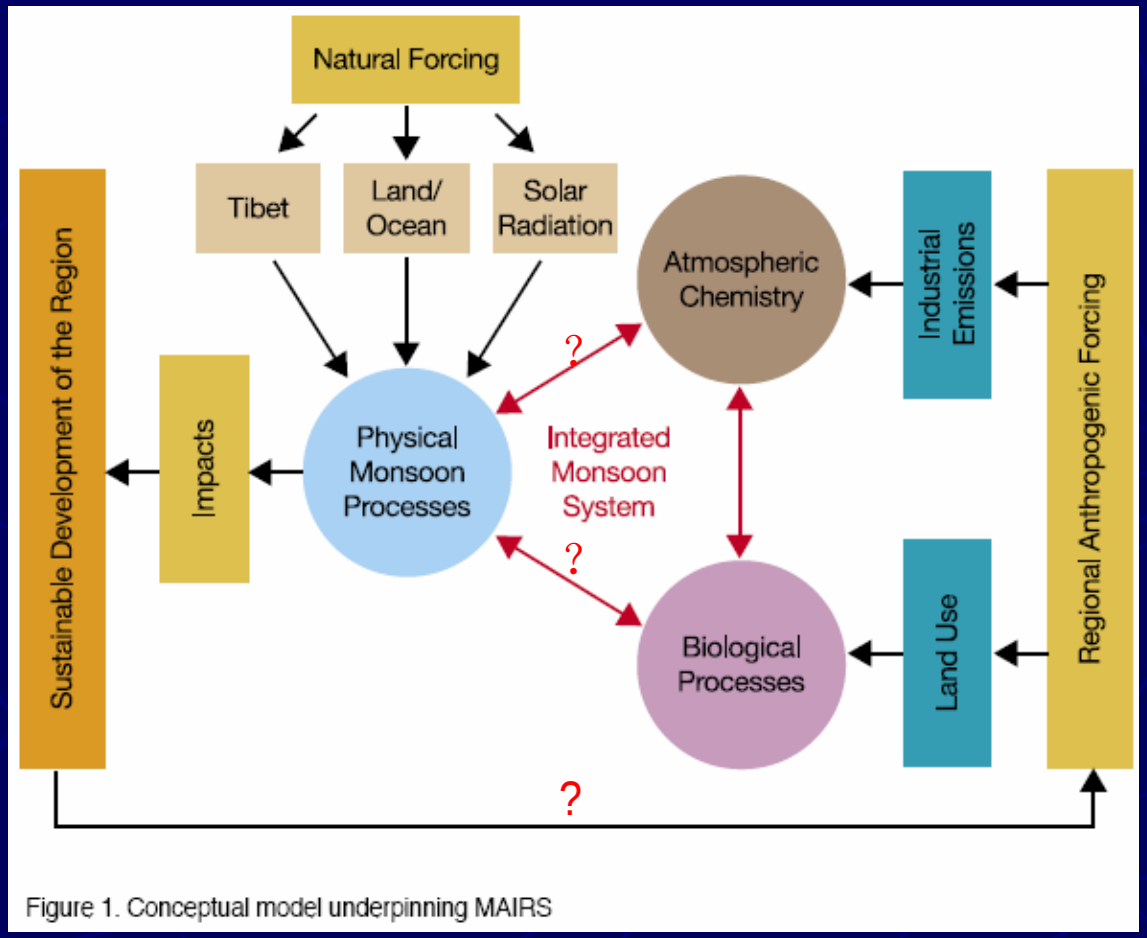


Figure 1. Conceptual model underpinning MAIRS

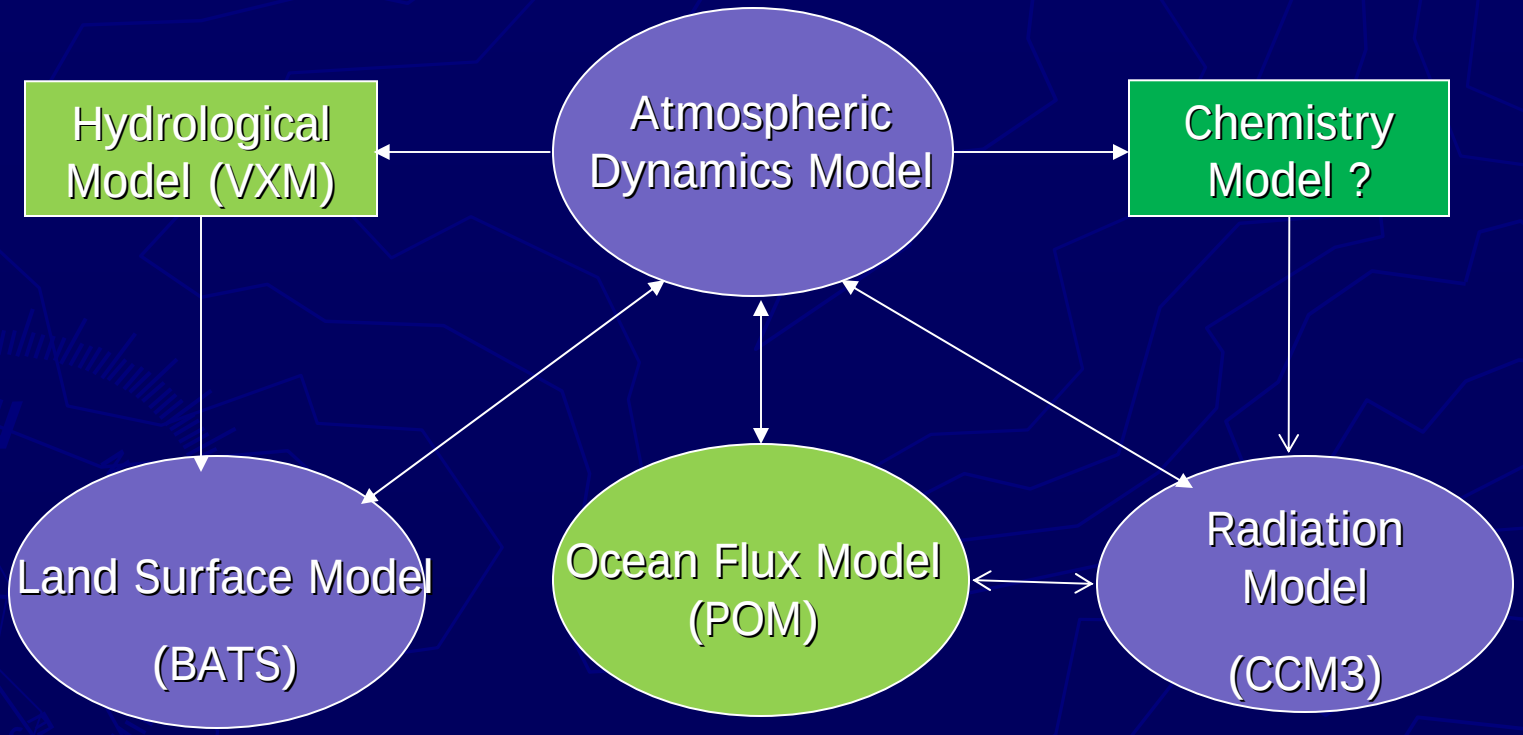
Fu (2005) *Global Change Newsletter*

Modeling

- An essential element of MAIRS

Regional Integrated Environmental Model System (RIEMS)

---Developed in RCE-TEA based on dynamic component of MM5



Fu et al. 2005. Regional Climate Model Intercomparison Project for Asia, *Bulletin of the American Meteorological Society,* 257-266

Coupling of chemistry processes with RIEMS

Double way coupling – interaction among dynamics, radiation and chemistry

Gas phase chemistry: CB-IV

Aerosol chemistry: ISSOROPIA (Inorganic)

Gas dry deposition (Wesely, 1989)

Gas wet scavenging (RADM, Chang et al., 1987)

Aerosol dry and wet deposition (Han et al., 2004)

Soil dust deflation (Han et al., 2004)

Organic aerosols: POA, SOA (Odum ,1997; Griffin et al.,1999; Henze and Seinfeld,2006)

Dynamic biogenic VOC and NOx model

Aerosol optical properties (d'Almeida et al. 1991)
(Extinction coefficient, Single-scattering albedo, asymmetry factor)

A Case Study

Time period: 1-15 March, 2006

Study domain: 85-145ºE, 15-55ºN

IC/BC: NCEP data $1^{o} \times 1^{o}$

Horizontal: 60 km

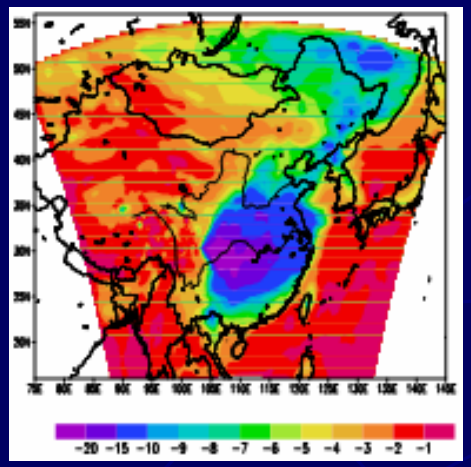
Vertical: 16 levels, surface to 100 mb

Emissions: Streets et al. (2003)

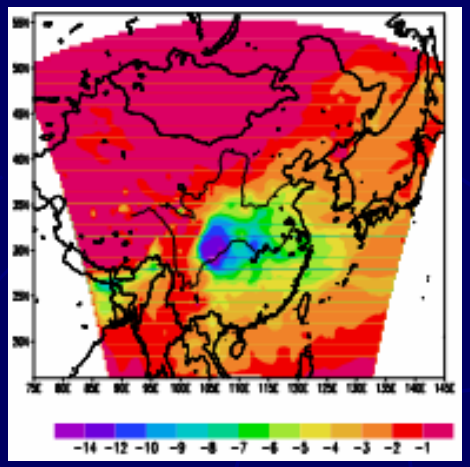
Aerosols: Sulfate, BC, OC(primary), Soildust

Mixture: external mixing of aerosols

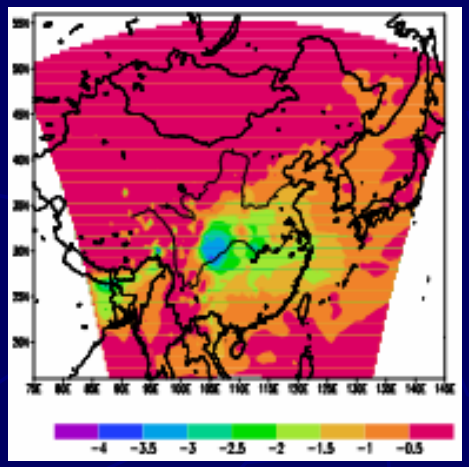
Results (Direct radiative forcing by aerosols at the surface)



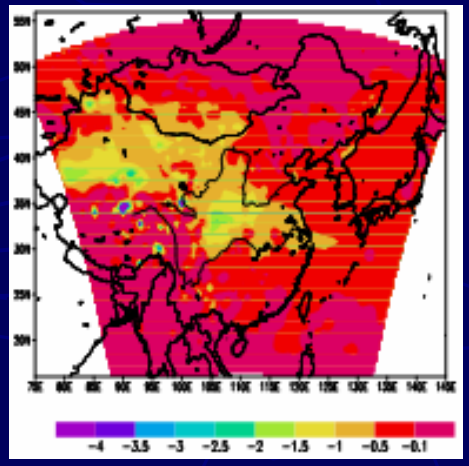
Sulfate



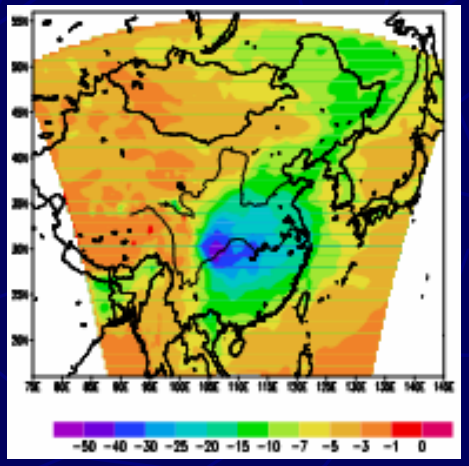
BC



OC



Soildust



All

Ongoing works

Comparision with data from AERONET, MODIS … for AOD and optical properties

More aerosol components (seasalt, nitrate,SOA)

Heterogeneous reactions on aerosol surface

Optical properties (Internal/external, hygroscopic growth, …)

Indirect radiative forcing

Impacts on regional climate and monsoon (wind, temperature, stability, Precipitation, circulation …)

Suggestions to the MICS-Asia phase III

- To Include indicators of radiative impact for intercomparison, such as AOD

Thank you !