The Abdus Salam
International Centre for Theoretical Physics

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1934-10

Fourth ICTP Workshop on the Theory and Use of Regional Climate Models: Applying RCMs to Developing Nations in Support of Climate Change Assessment and Extended-Range Prediction

3 - 14 March 2008

Reduction of Future Monsoon Precipitation over China: Comparison between a high resolution RCM simulation and the driving GCM.

GAO Xuejie

National Climate Center
Chinese Meteorological Administration
46 Zhongguancun Nandajie 100081 Beijing
PEOPLE'S REPUBLIC OF CHINA

Reduction of Future Monsoon Precipitation over China: Comparison between a high resolution RCM simulation and the driving GCM

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The Abdus Salam ICTP, Trieste, Italy

4th ICTP Workshop on the Theory & Use of REGional Climate Models
March 3-14, 2008, Trieste, Italy

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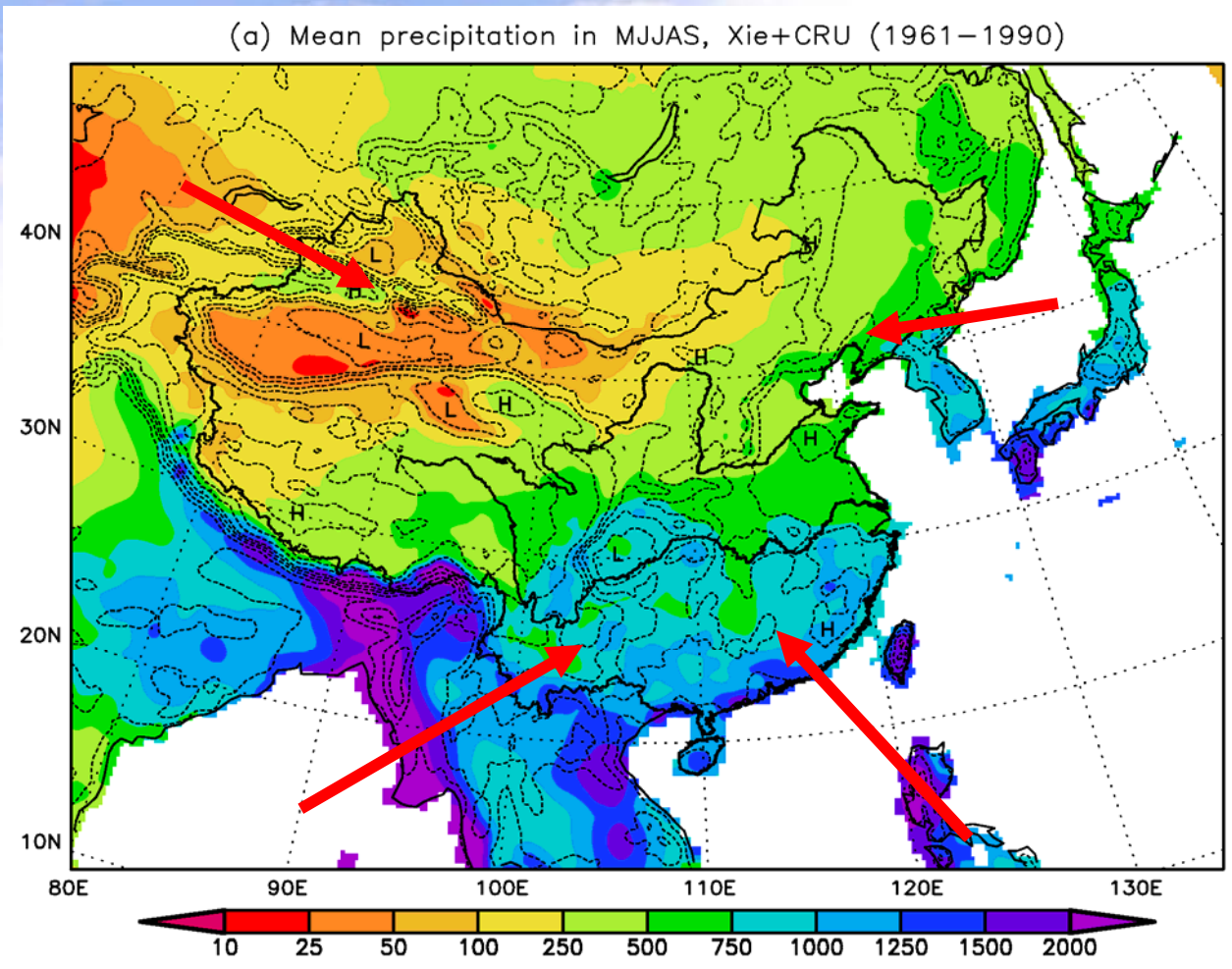
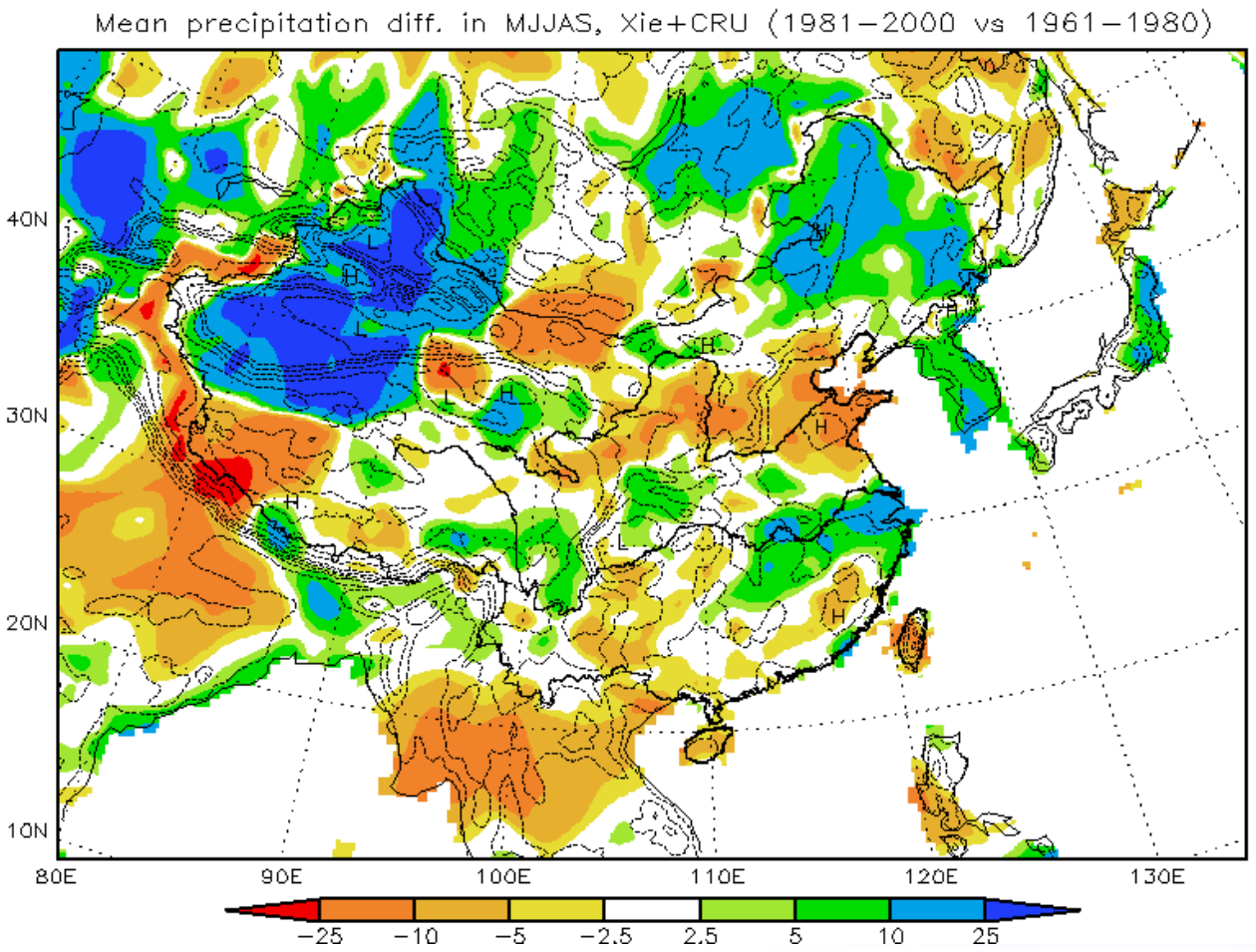
Motivation

- *Reduction of precipitation is found in Northern China in the late decades*
- *Most AOGCMs project an general increase of precipitation over China*
- *AOGCMs show poor performance in simulating monsoon precipitation over China*
- *What about the simulation by a high resolution RCM?*

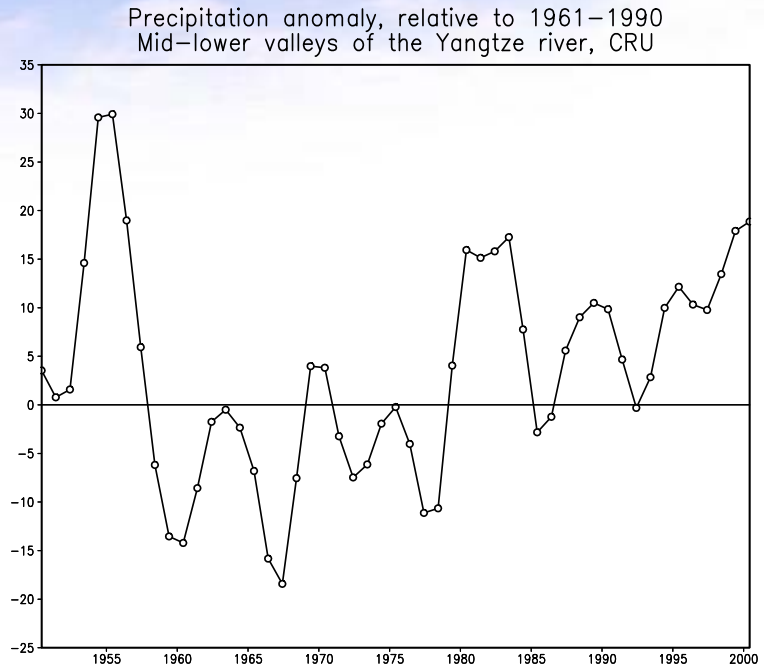


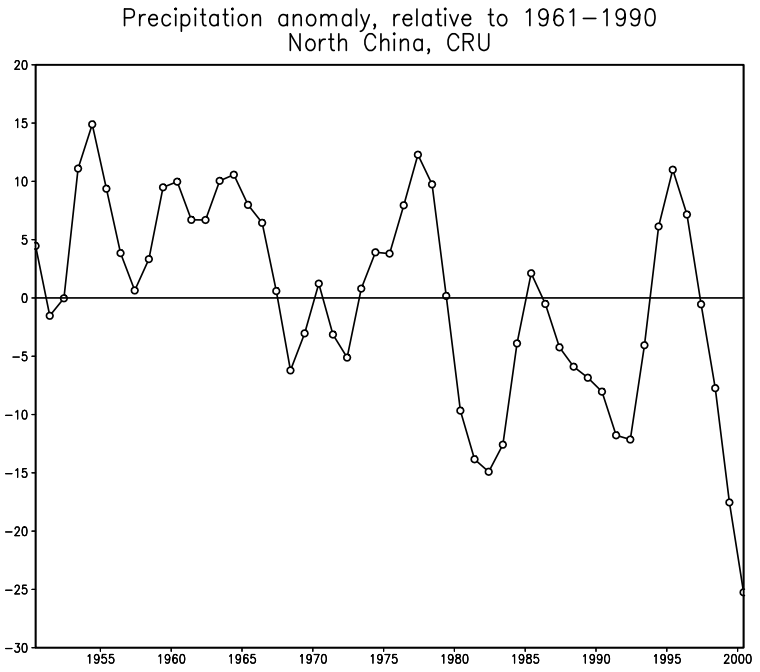
Multi-year mean precipitation in East Asia in the monsoon seasons (MJJAS, mm)



Difference between the observed MJJAS mean precipitation in 1981-2000 and 1961-1980 (%).

South flood and north drought





Observed changes of precipitation in the mid-lower reaches of the Yangtze River and in North China

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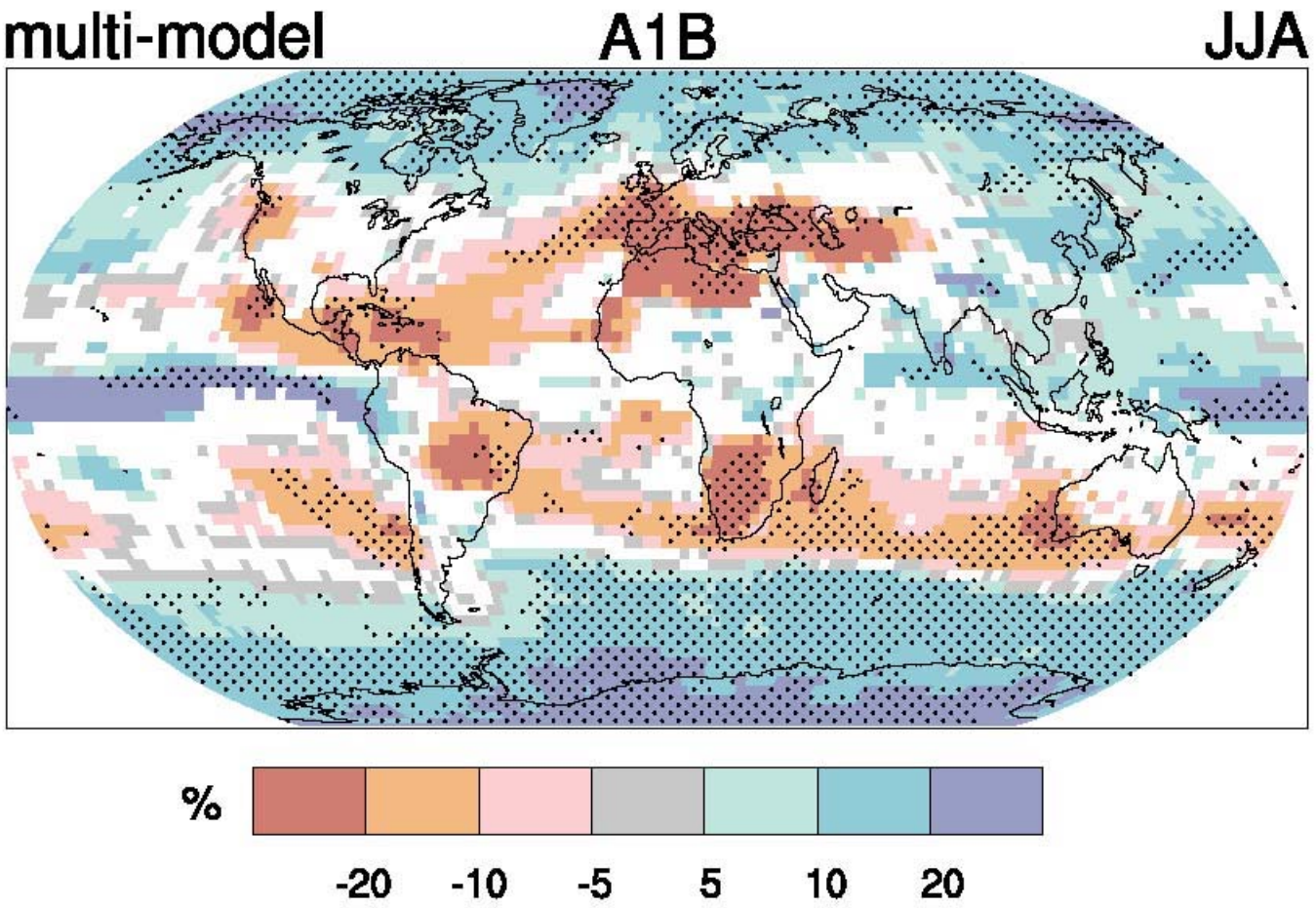
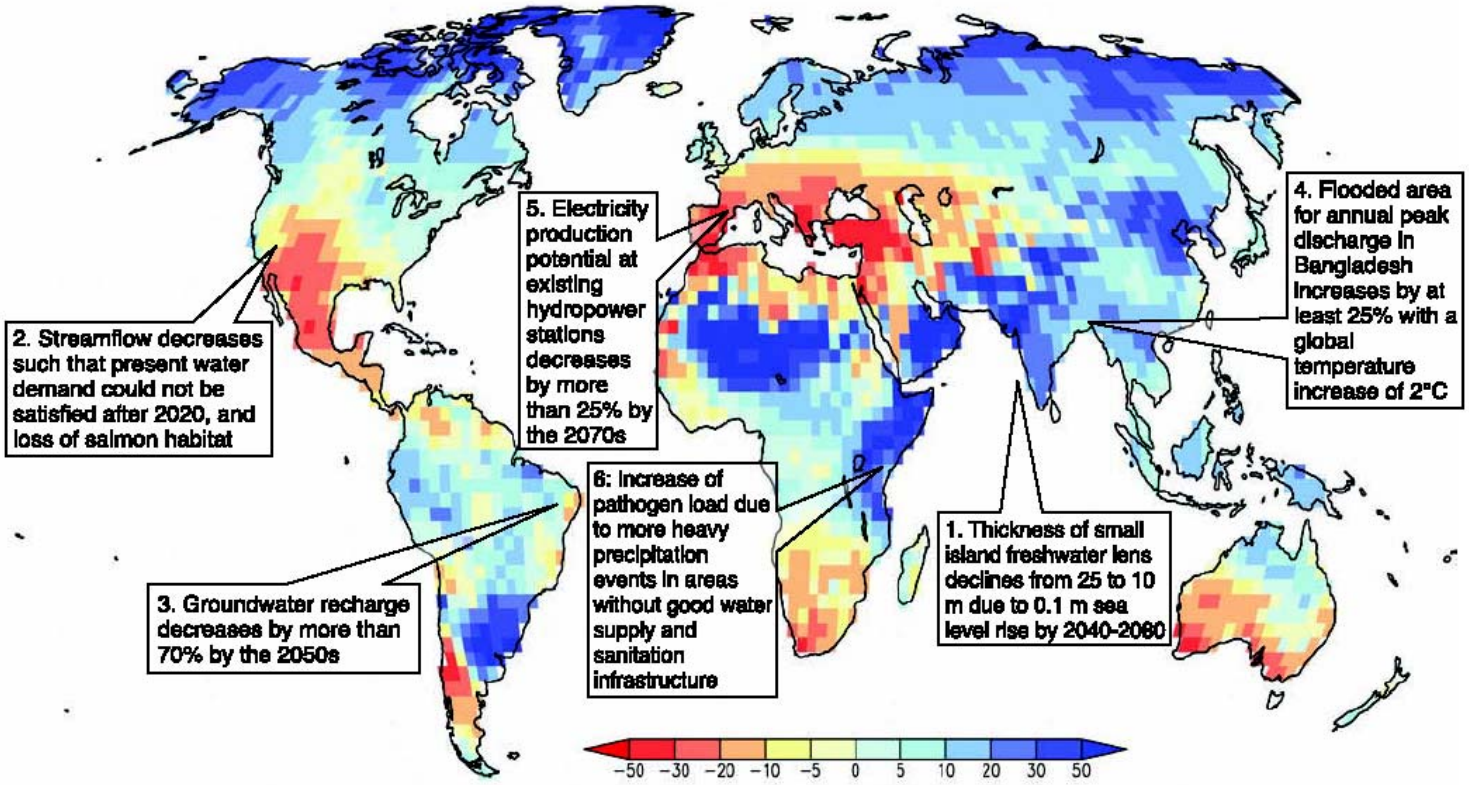
AOGCMs are the primary tool used for climate change projections.

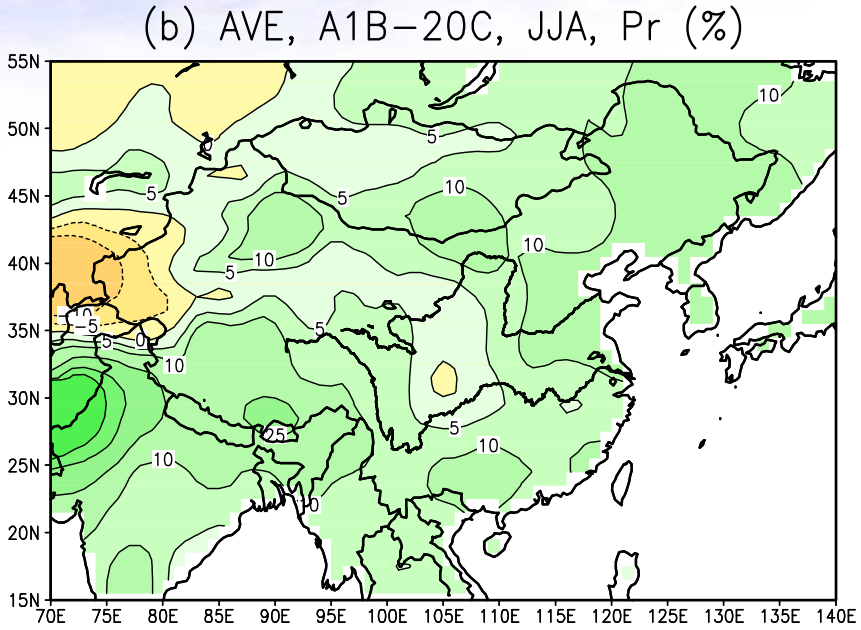


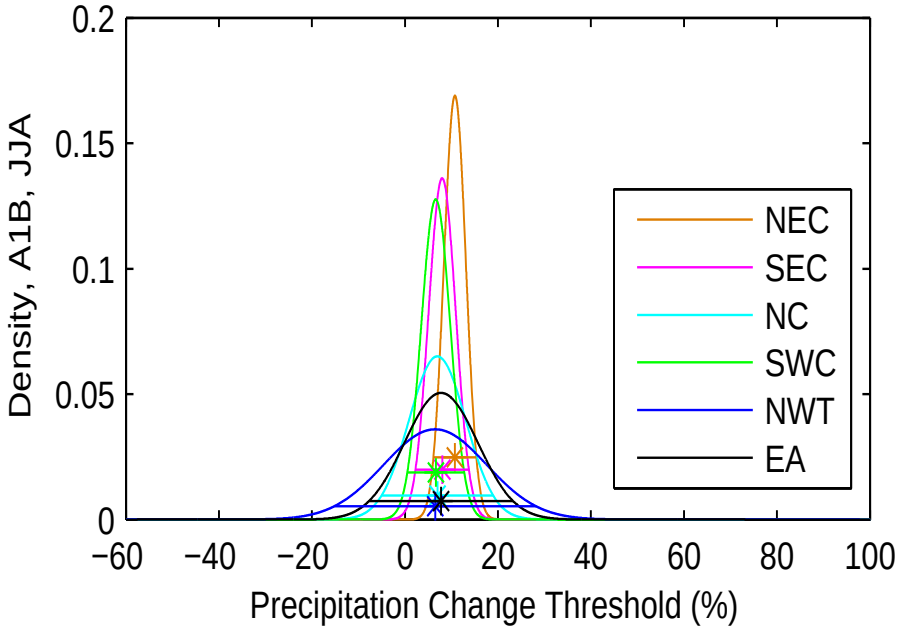
Ensemble mean change of precipitation in the end of the century (IPCC, 2007)



Ensemble mean change of annual runoff in the end of the century
(IPCC, 2007)

Projection of JJA precipitation in the end of the Century：Multi-model mean (left) and the PDF distribution (right)





General increase and good agreement among the models of precipitation is found over China (Xu et al., 2007)

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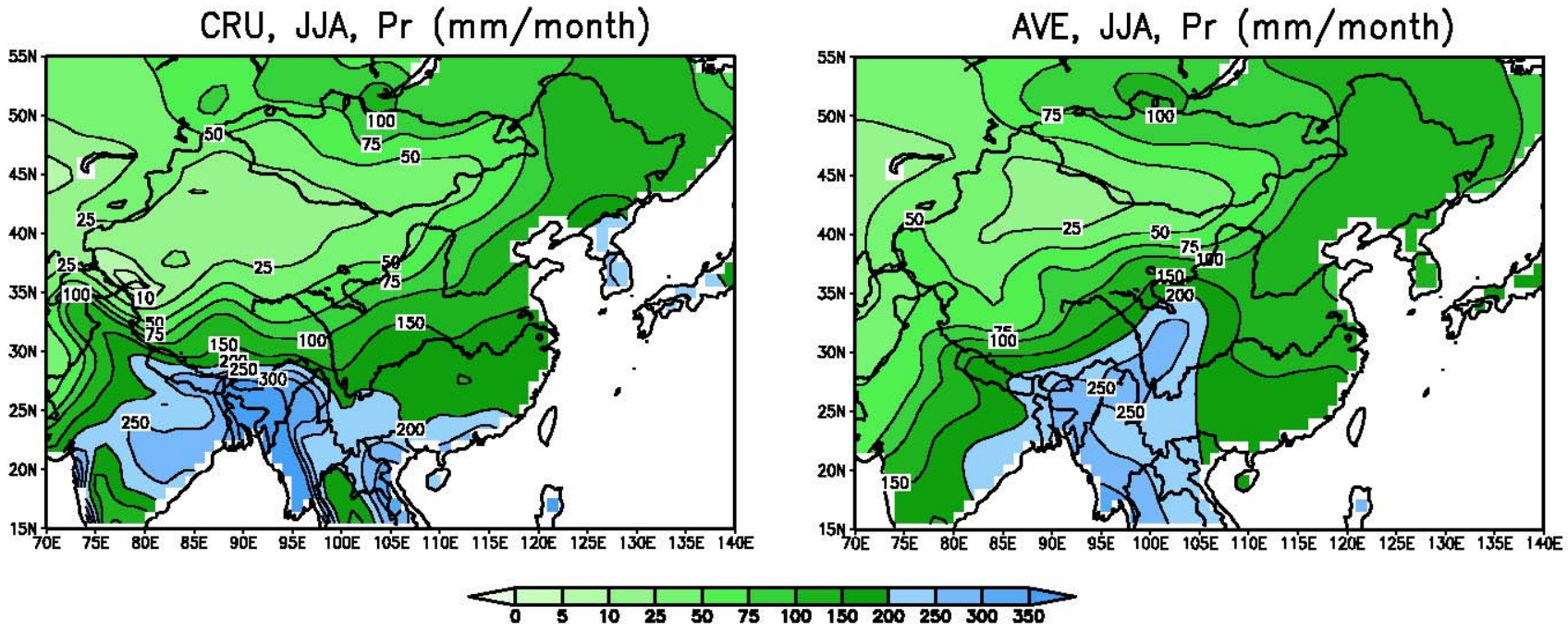
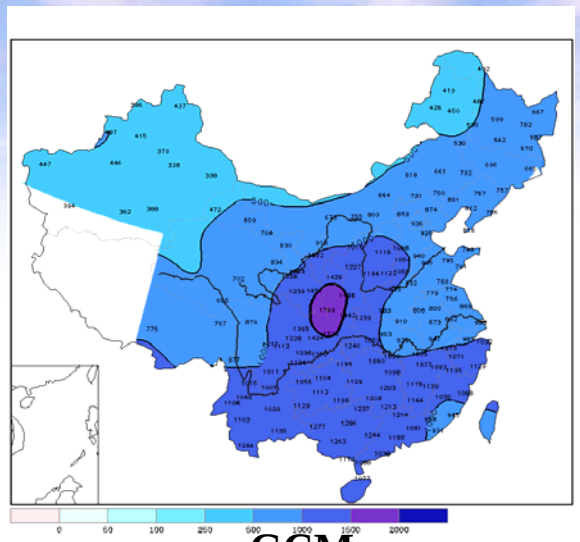
Observed and simulated JJA precipitation by multi-models (Xu et al., 2007)

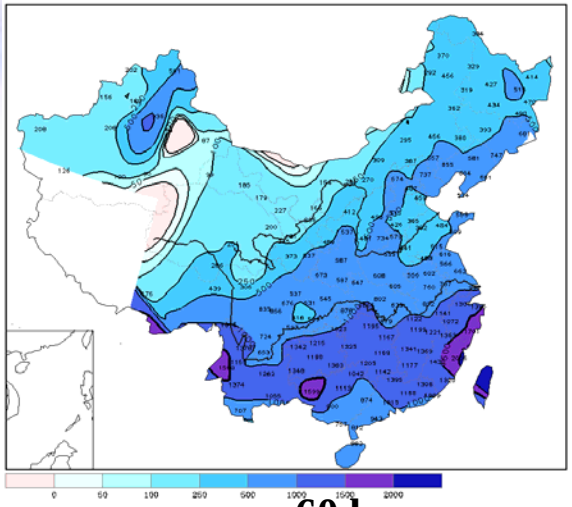


Traditionally, AOGCMs have shown a poor performance in simulating East Asia monsoon precipitation patterns.

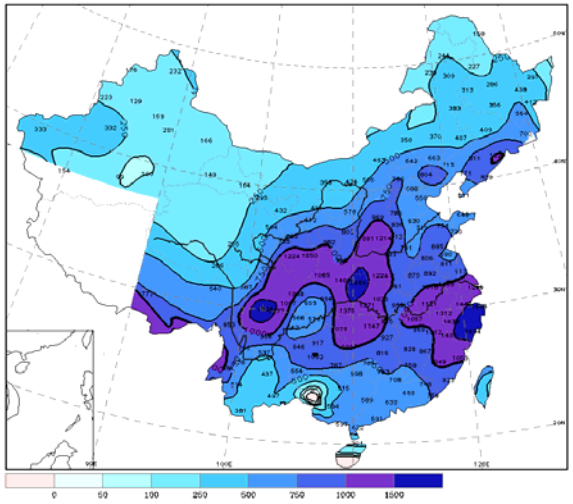
Model resolution and precipitation simulation



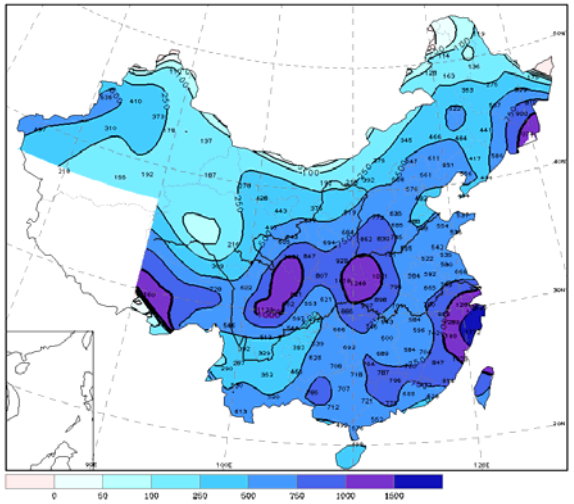
GCM



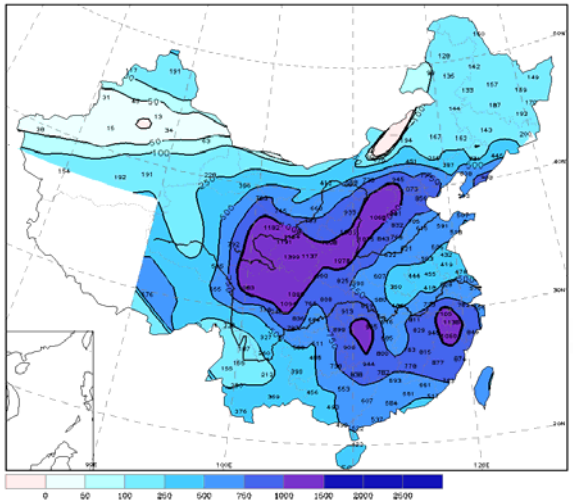
60 km



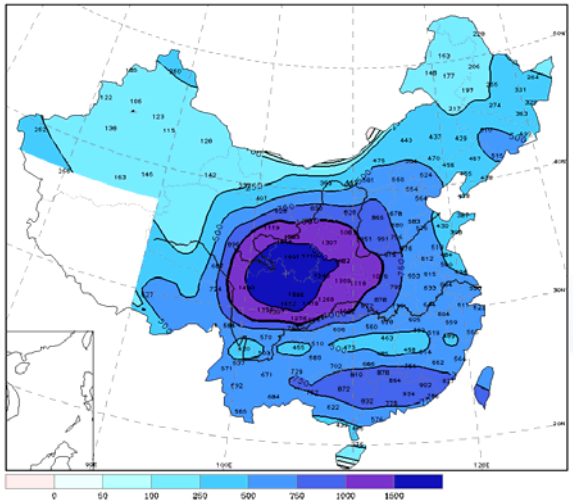
120 km



180 km



240 km



360km

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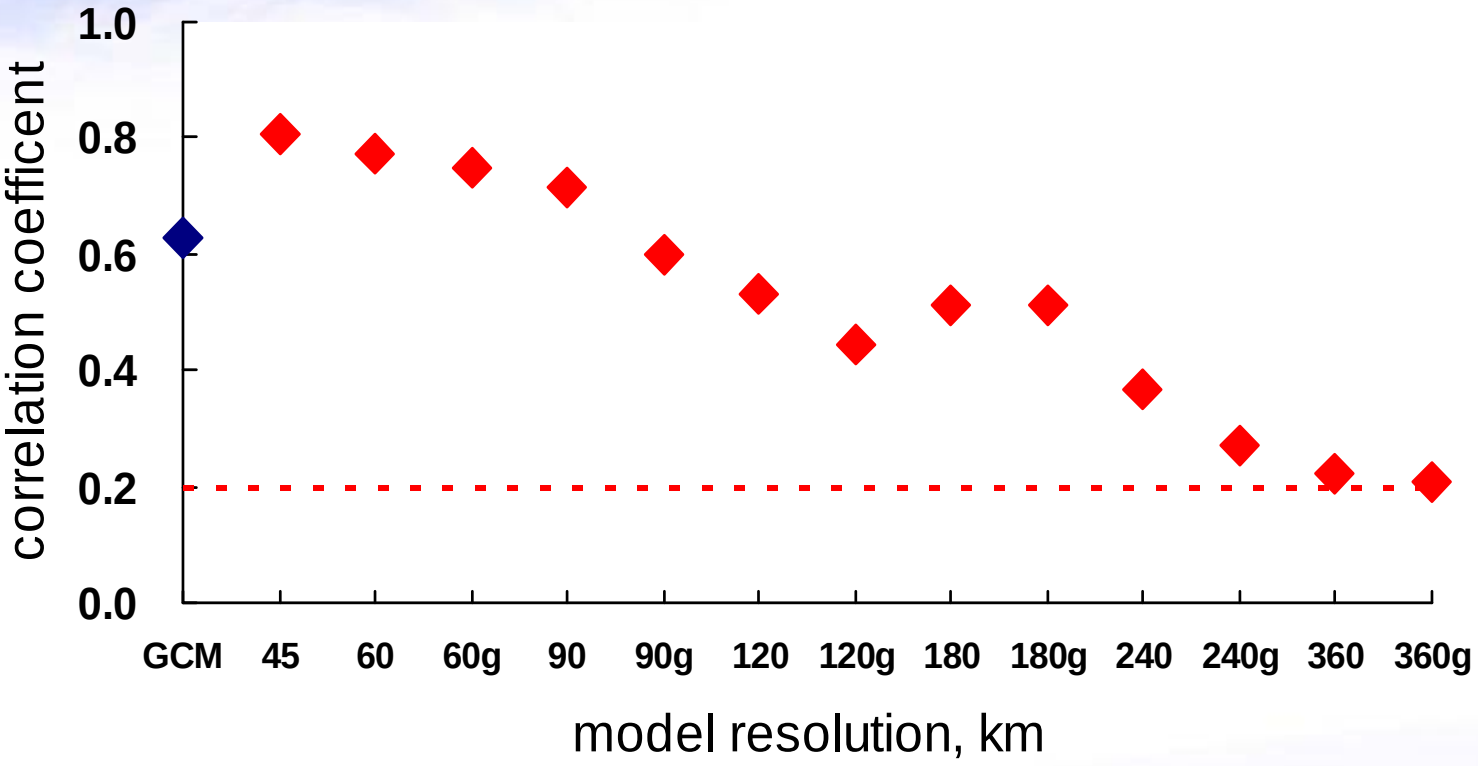
annual mean total precipitation (mm)

Model resolution and simulation of precipitation over China



The simulated East Asia large-scale precipitation patterns are significantly affected by resolution. (Gao et al, 2006)

RCM employed: The ICTP RegCM

Driving field: NCAR/NASA FvGCM/CCM3 (1×1.25°)

Scenario: SRES A2

Model resolution: 20-km grid point spacing

Periods: Reference (1961-1990)
A2 scenario (2071-2100)

Analysis focused on: precipitation during May-September, the monsoon season

Model configuration:

- CCM3 Radiation package (Kiehl et al. 1996)
- SUBEX Large-scale precipitation scheme (Pal et al. 2000)
- Grell convection, Fritsch & Chappell closure
- Land surface: BATS1e
- Planetary boundary layer scheme: Holtslag et al. (1990)
- Ocean Flux Model , Zeng et al. (1998)

Observed SST for present, and anomalies from HadCM3 for future

The Driving GCM (FvGCM/CCM3):

- Mass-conserving finite-volume element dynamical core
- Radiation: Kiehl et al. (1996)
- Planetary boundary layer scheme, Holtslag et al. (1990)
- Land surface: Bonan (1996)
- Cloud and radiation physics: McRAS

SST and sea ice:

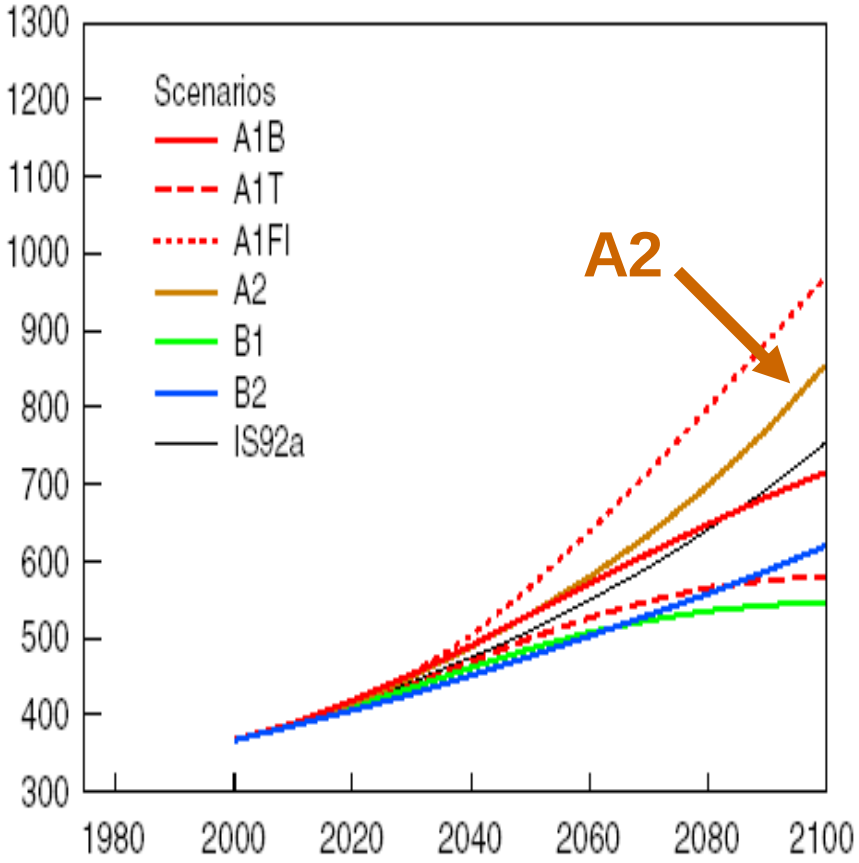
observed for RF and HadCM3 anomalies for A2

FvGCM-RegCM: North America, South Asia, Australia

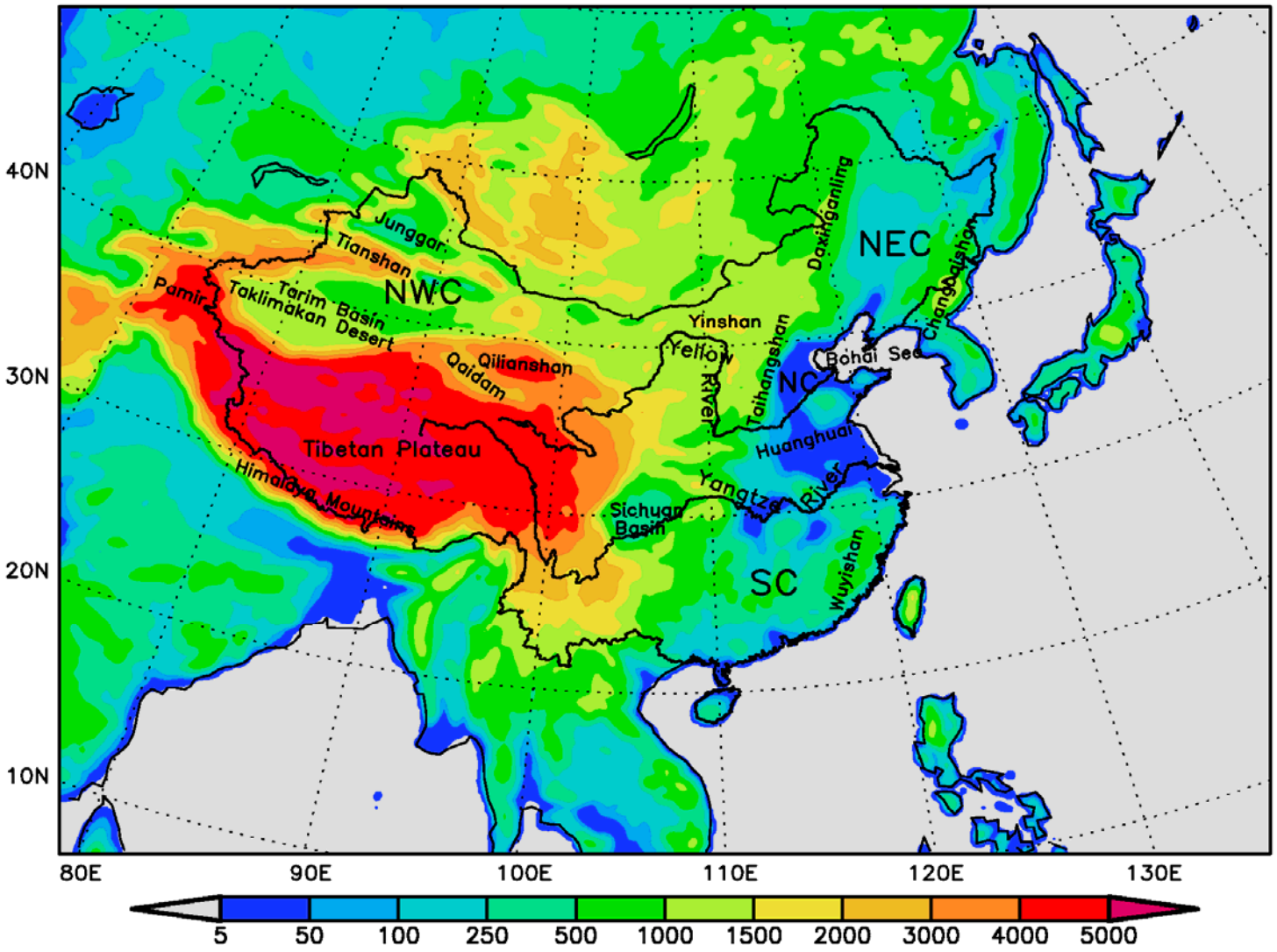
History of GHG emission scenarios:

- $2\times CO_2$
- 1%/yr
- IS92a
- SRES
- RCPs (BESs)

SRES scenario



Model Domain and Topography, RegCM3, m



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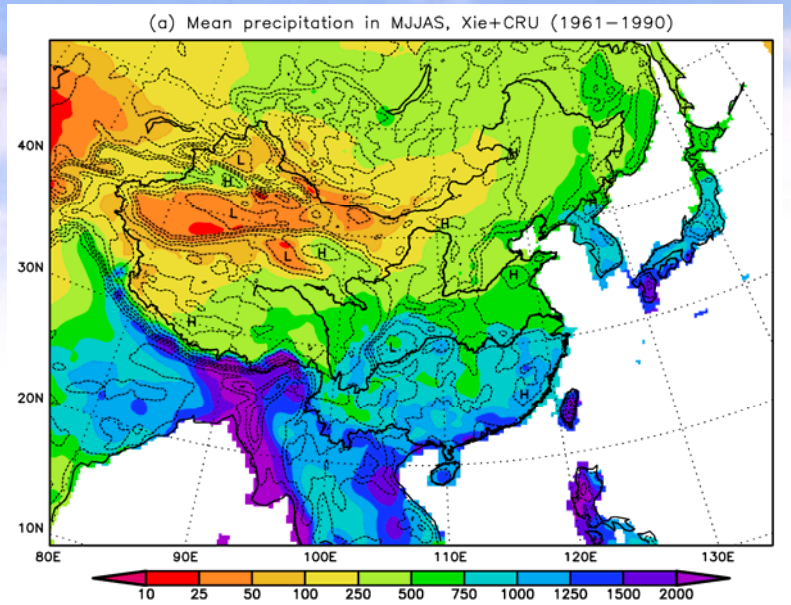
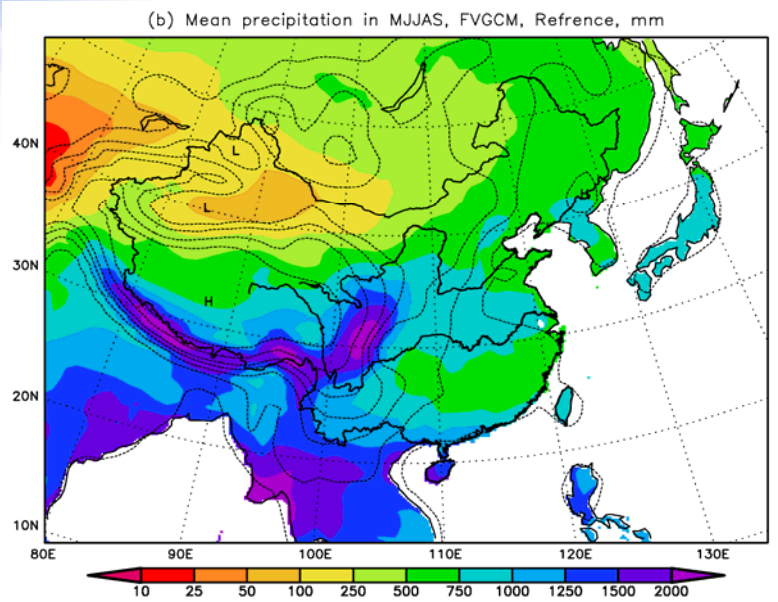
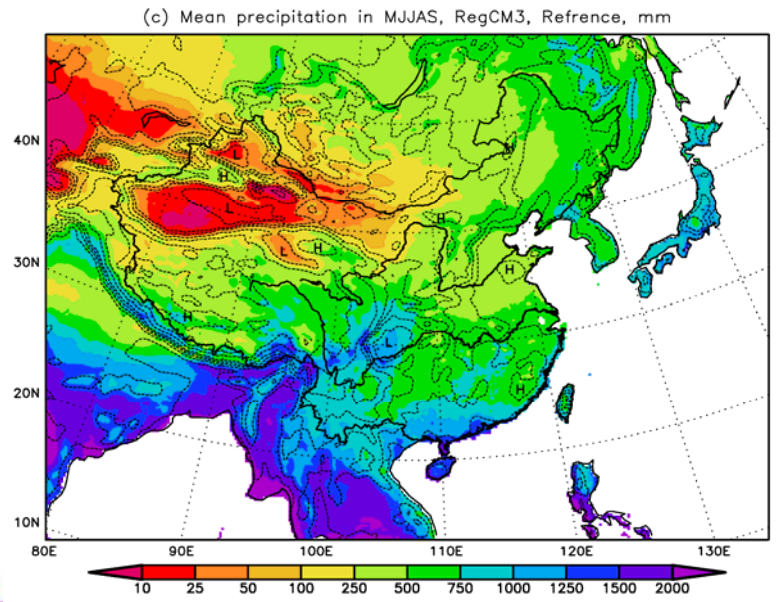




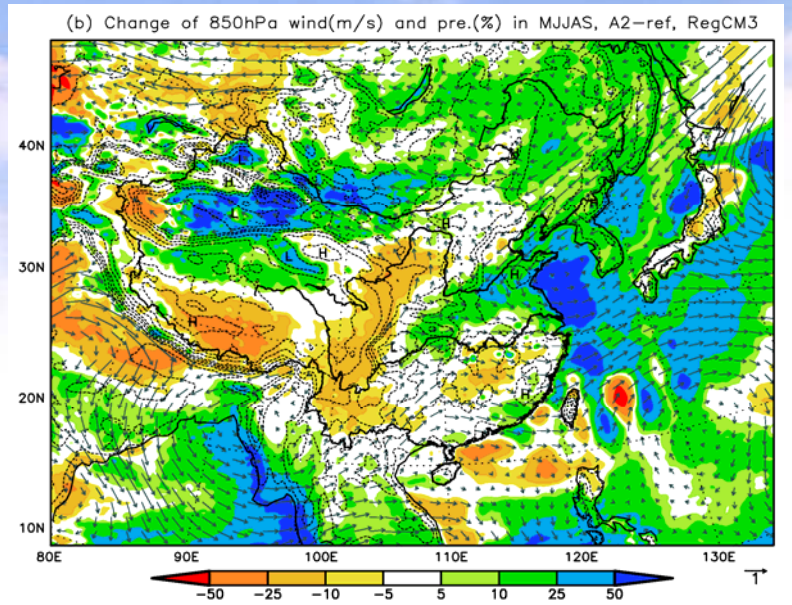


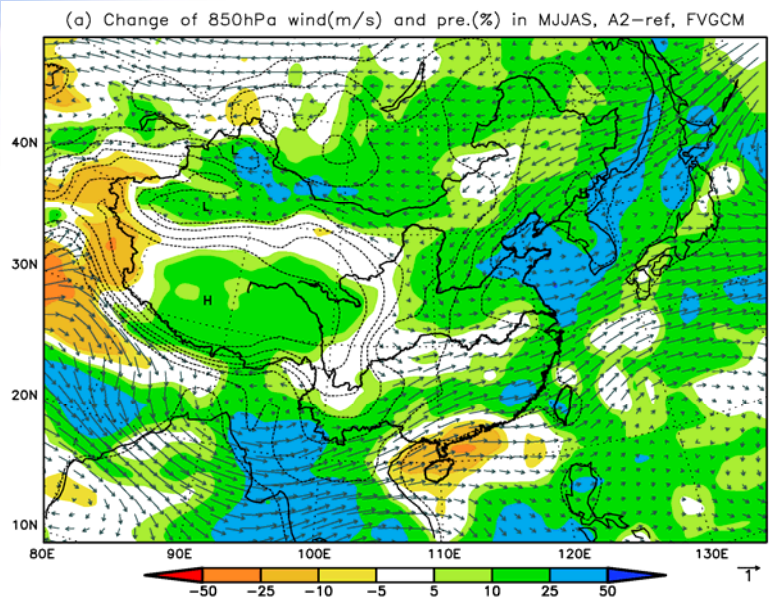
Validation of the present day monsoon precipitation (MJJAS) simulation

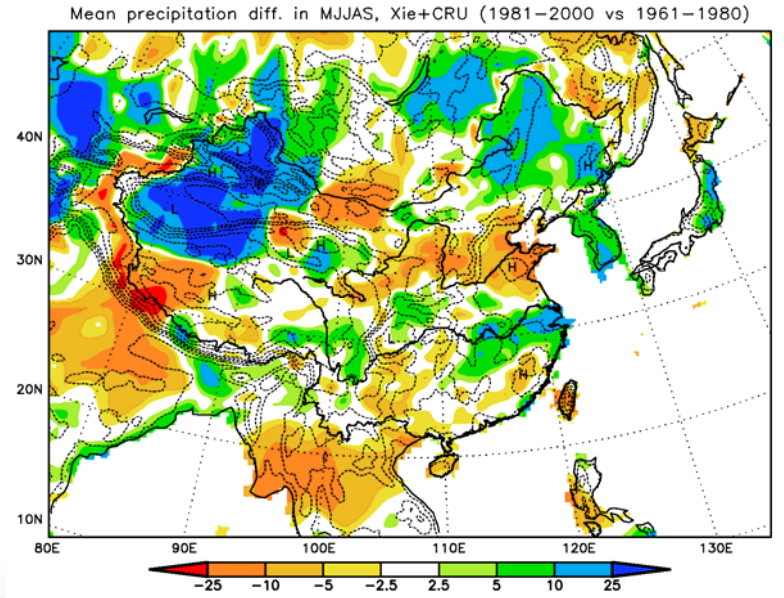
OBS **FvGCM**

RegCM3

Corr.: 0.585 and 0.702



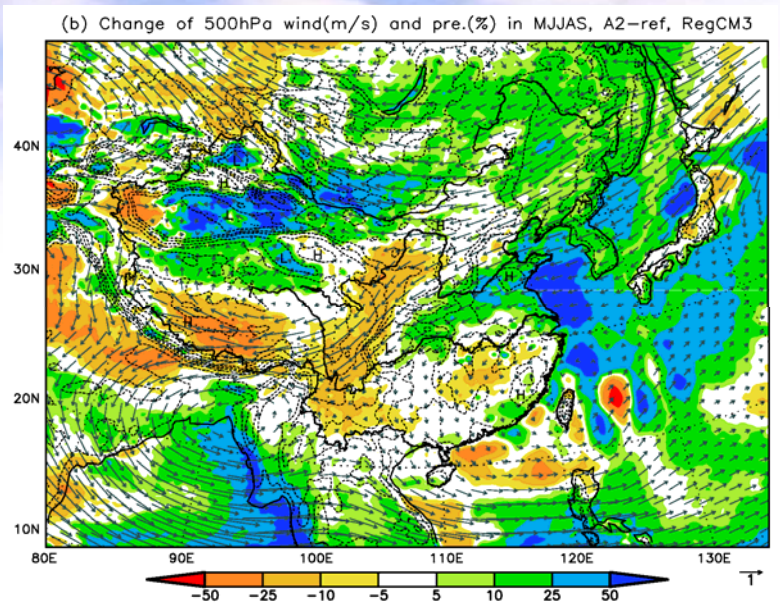


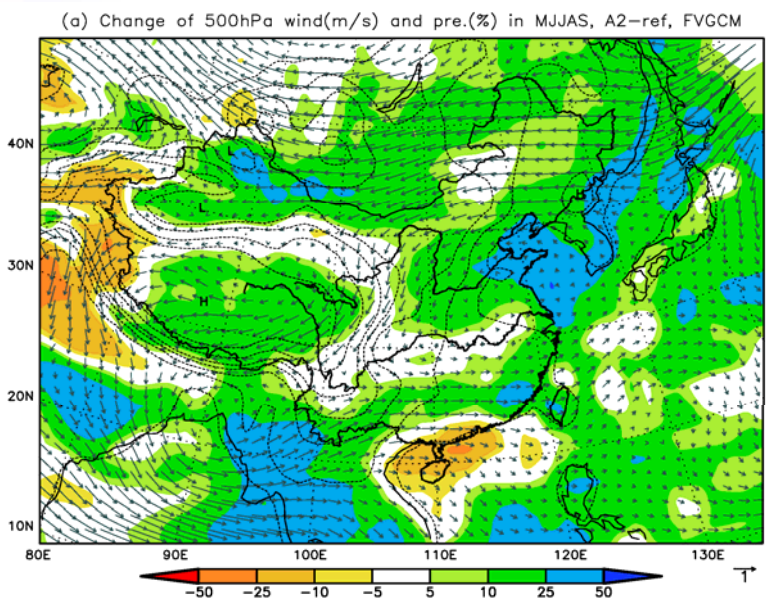


Simulated future changes by the FvGCM and RegCM+850hPa wind, and observed changes in the late decades

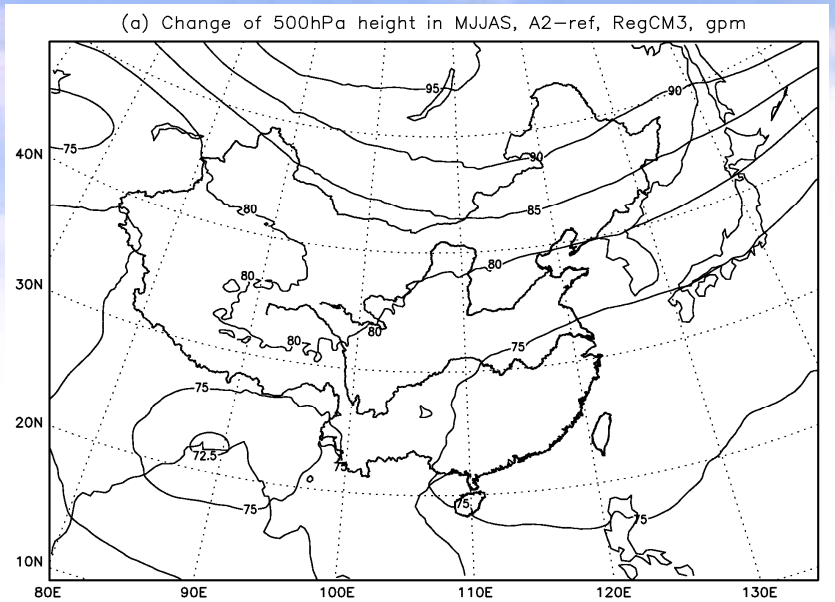
FvGCM **RegCM3**

Observation (1981-2000 vs 1961-80)





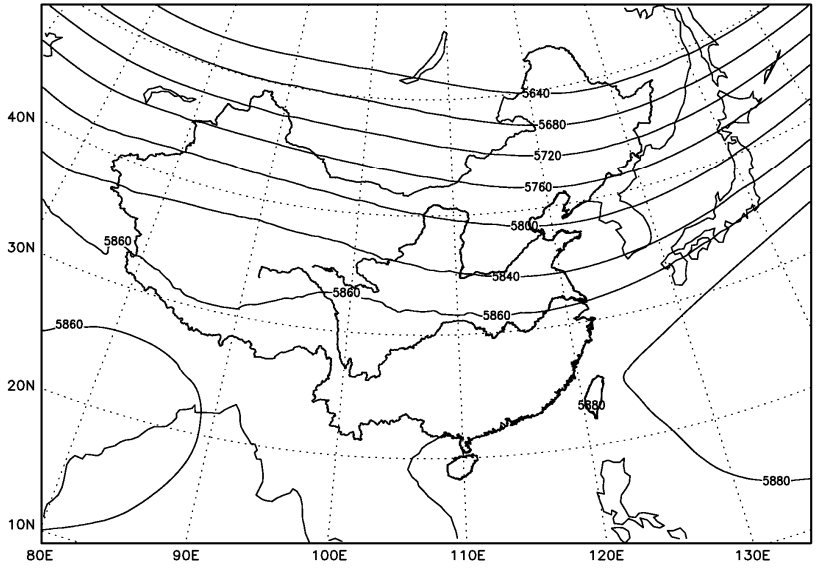
Simulated future changes by the FvGCM and RegCM + 500hPa wind

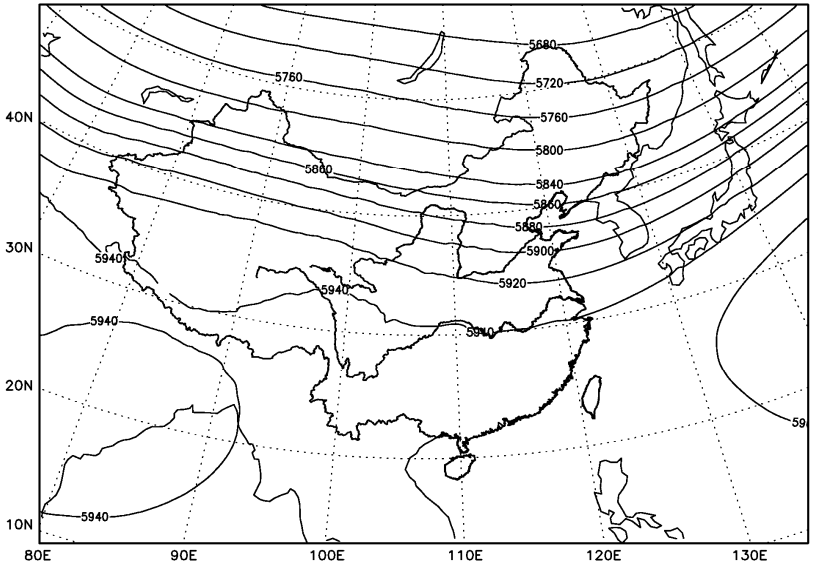


The western Pacific subtropical high in MJJAS

Change

RF A2





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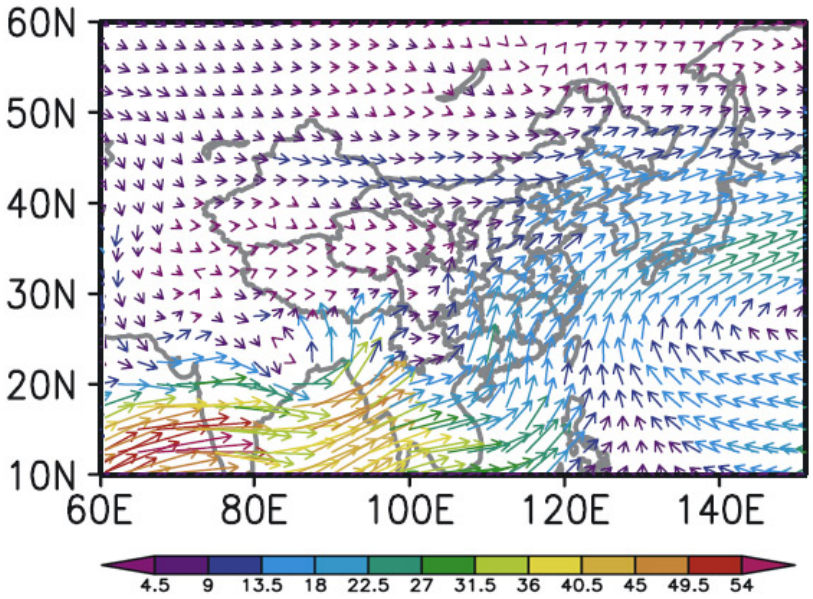

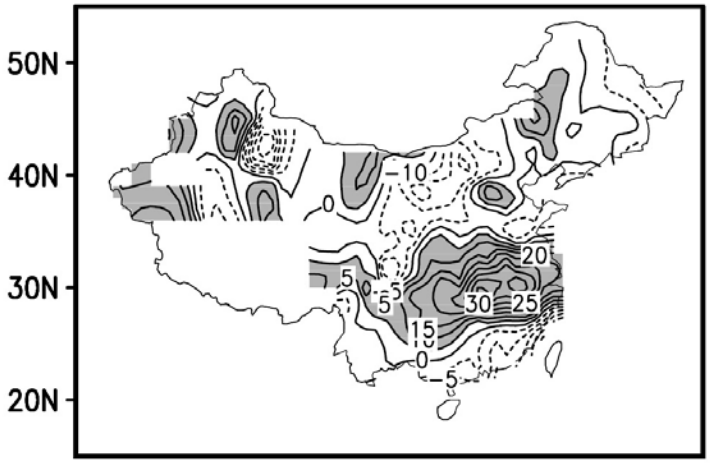

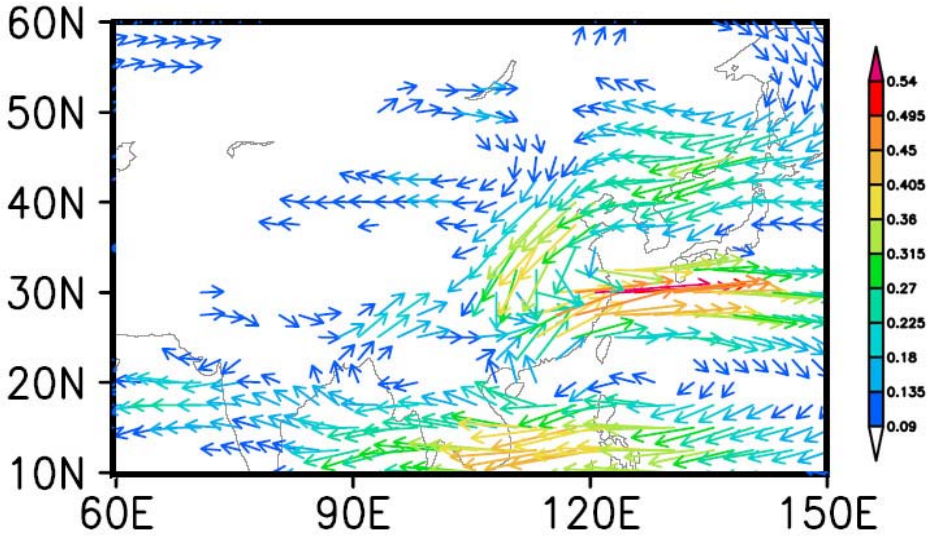

Climatology of moist flux over China in JJA;

EOF1 of the observed precipitation anomaly and its MF

(Zhou and Yu, 2004)

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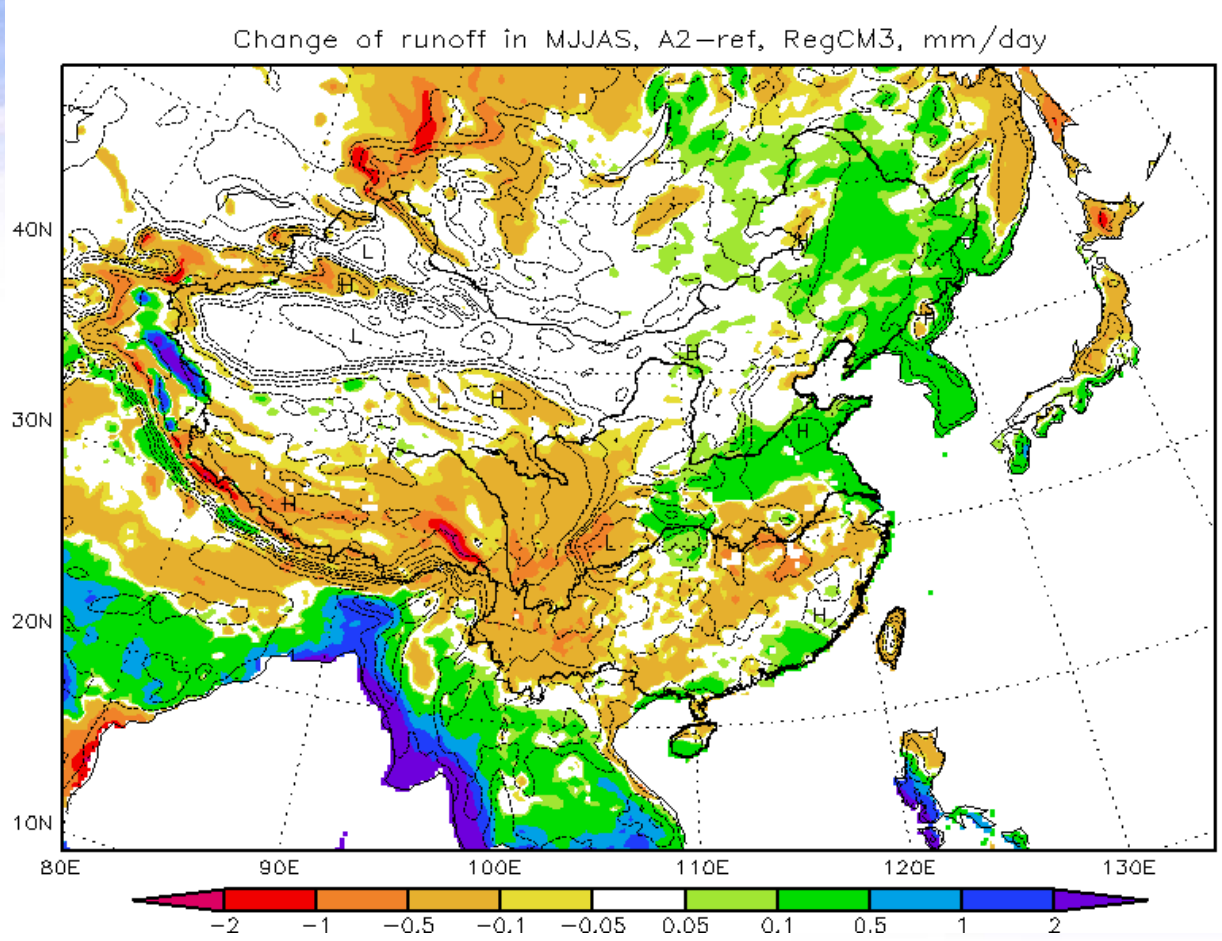
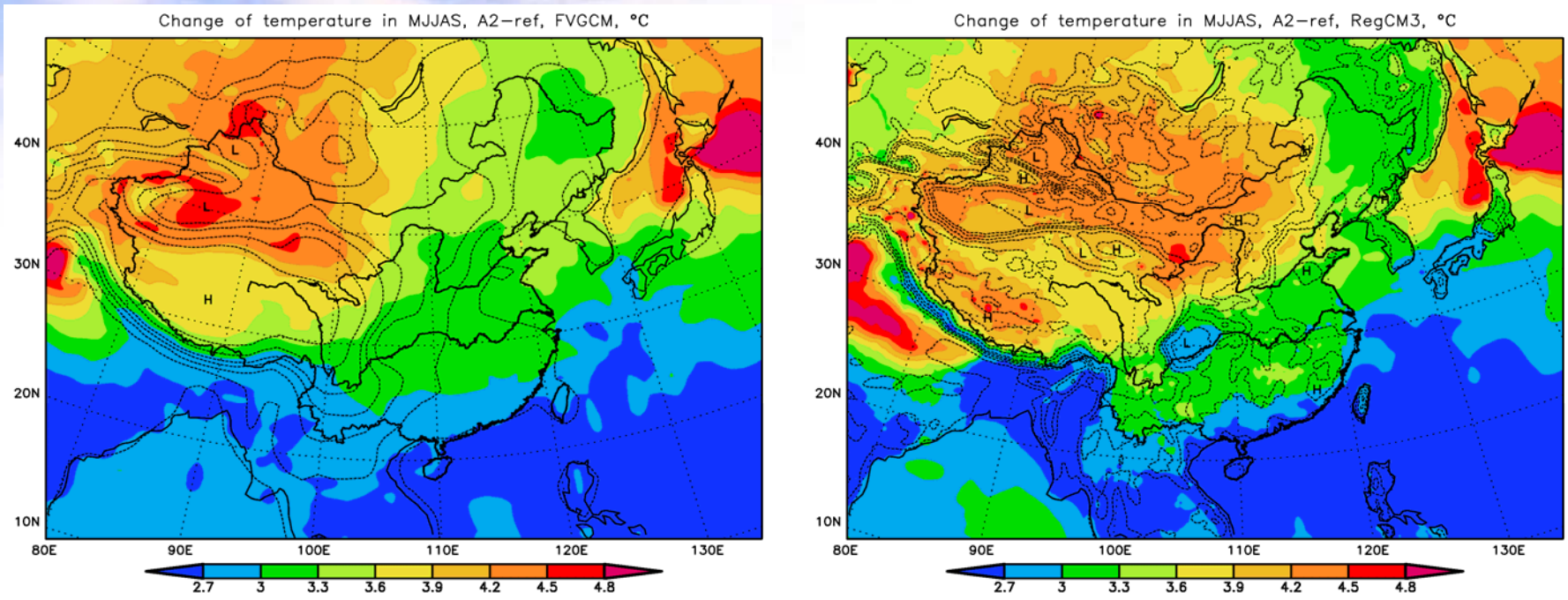


Future changes in runoff in MJJAS over China



Simulated changes in temperature by the FvGCM and RegCM

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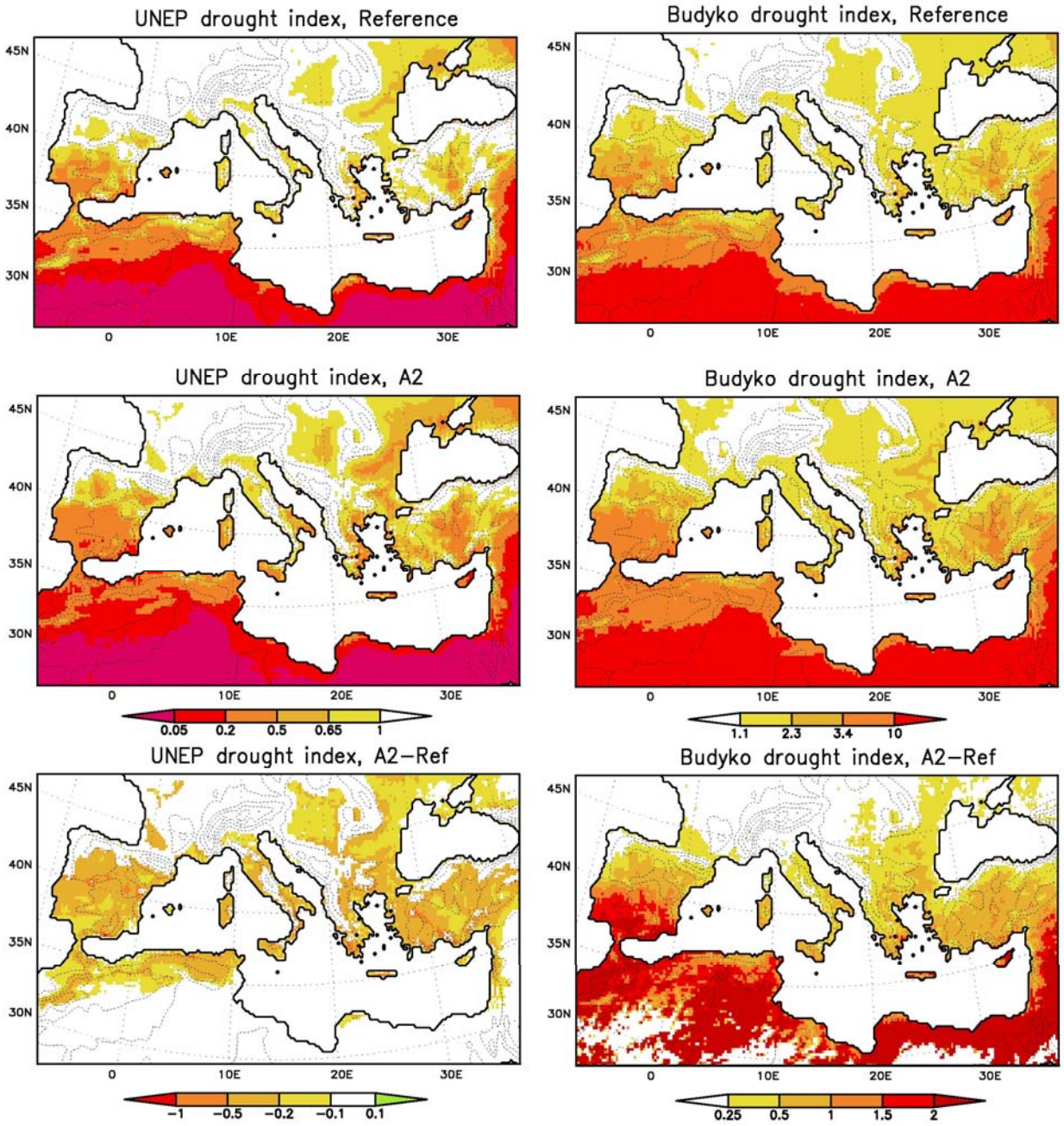
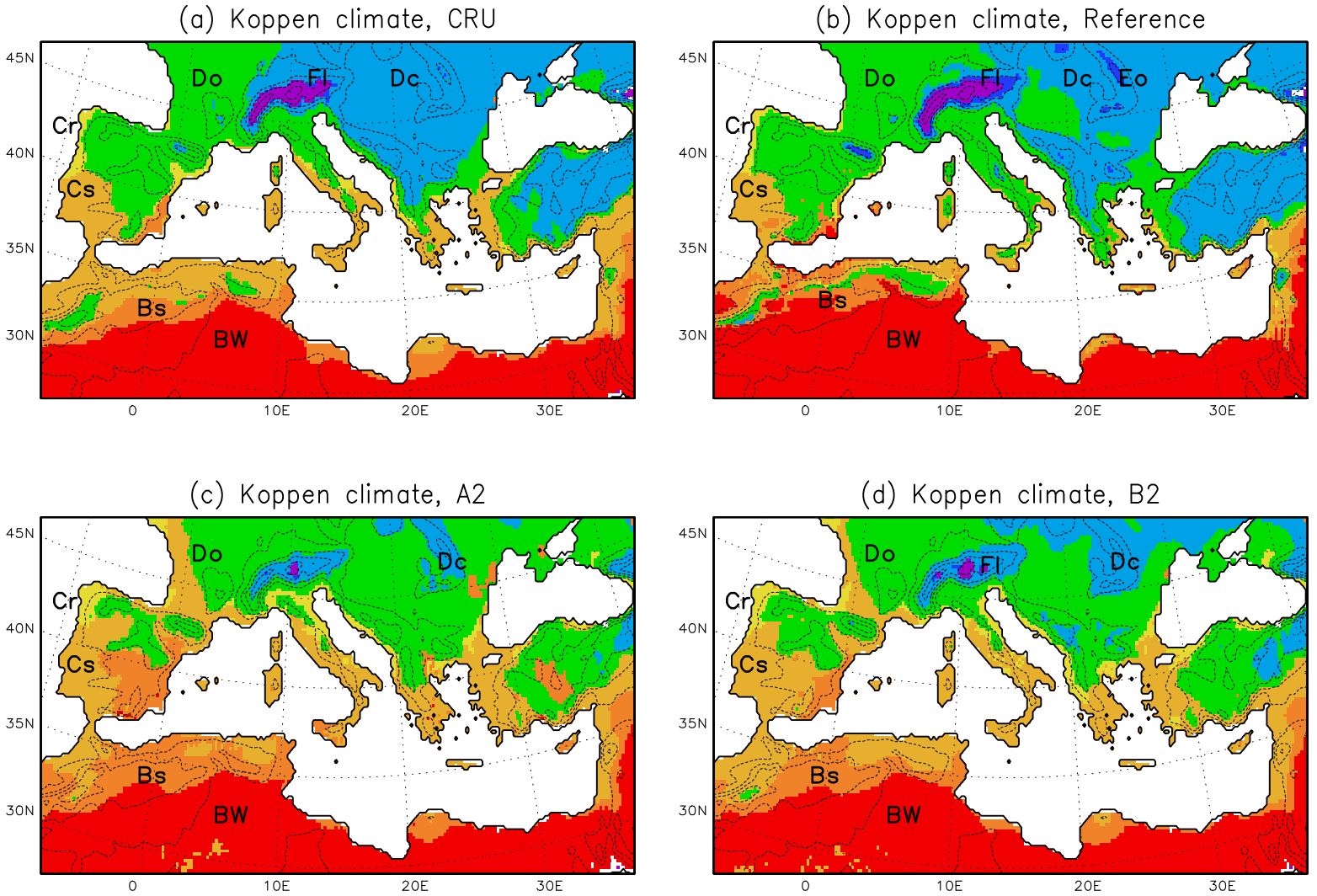


Increased aridity in the Mediterranean region : Application of two aridity indexes (UNEP, Budyko):

AI_U=P/PET

AI_B=R/LP

(Gao and Giorgi, 2008)



Change in climate regimes in the Mediterranean region : Köppen Climate **(Gao and Giorgi, 2008)**

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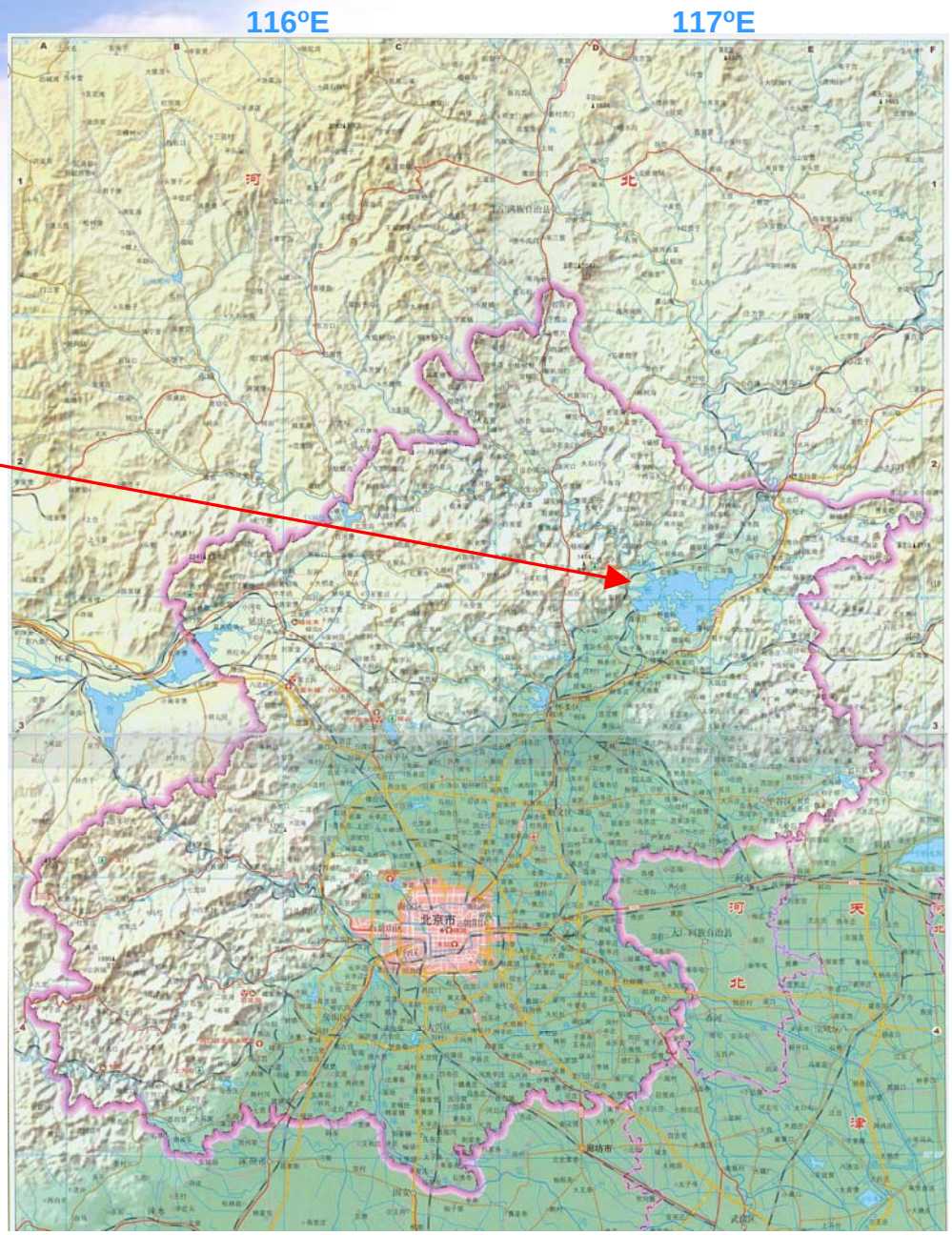
Possible study in climate change and changes of water resources:

Miyun Reservoir,

The major water supplier for Beijing, watershed < 150 km*100 km (1.5°*1°)

Beijing suffered from water shortage in the late decades



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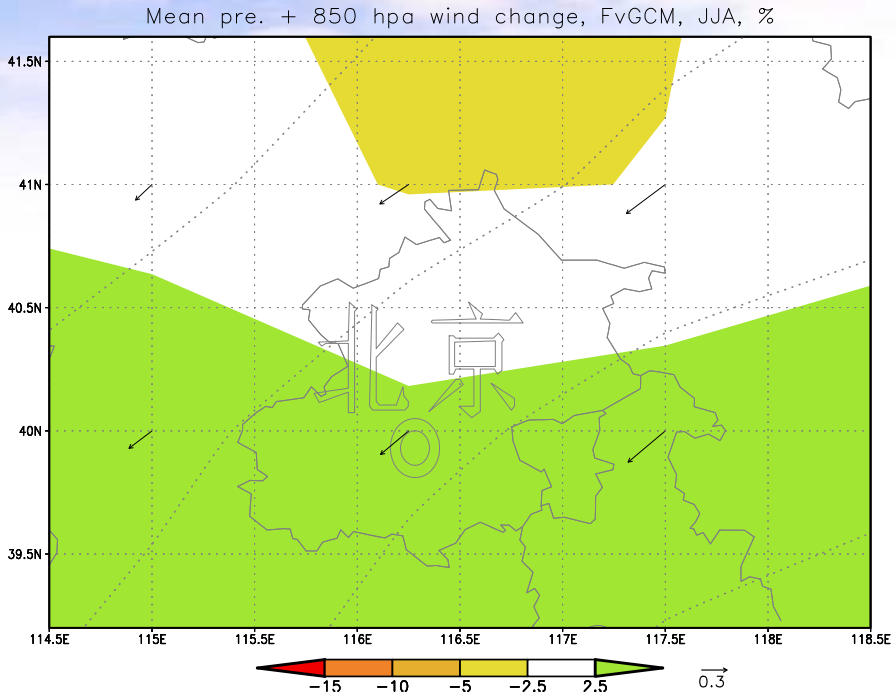

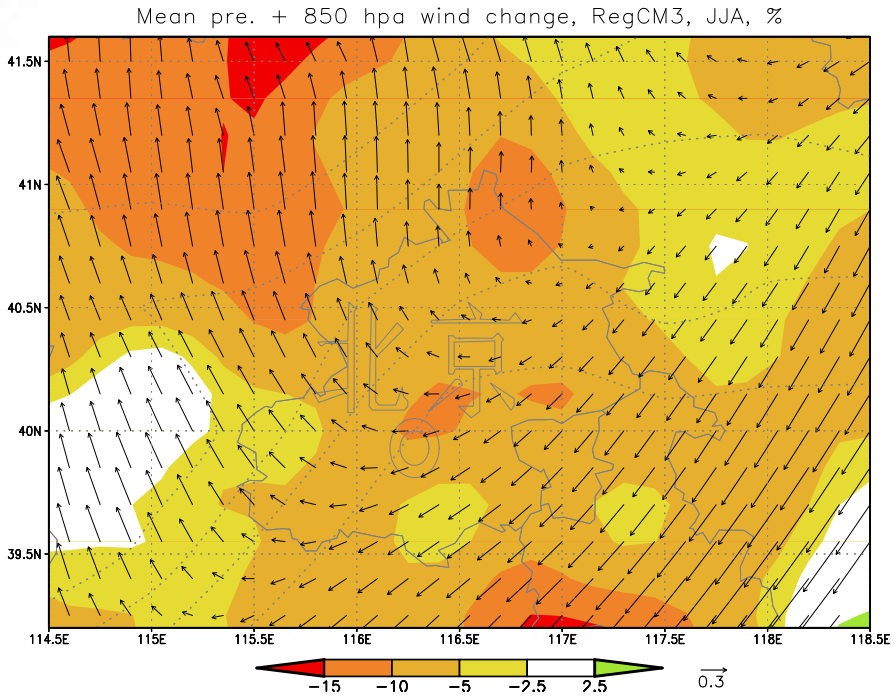

Precipitation change in JJA in Beijing by FvGCM and RegCM, %

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Conclusions and discussions

1. Resolution plays a very important role in the simulation of East Asia monsoon precipitation.

2. RegCM simulates some significantly different change patterns compared to the driving FvGCM.

3. The FvGCM projected a prevailing increase of monsoon precipitation, while the RegCM projected extended areas of decreased precipitation.

4. Importance of resolution in climate change and impact studies

Future studies:

Further analysis of the FvGCM-RegCM:

- drought indexes
- extremes

Climate change and dust;

Comparison with other model simulations;

ENSEMBLEs like simulation over ESA:

- ECHAM5-RegCM, 20km, 1950-2000

Ensemble projection by:

- different RCMs driven by different AOGCMs

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Seasonal forecast

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THANK YOU
GRAZIE
谢 谢！