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Fifth ICTP Workshop on the Theory and Use of Regional Climate Models

31 May - 11 June, 2010

Recent climate change studies with RegCM in NCC

GAO Xuejie

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

Recent Climate Change Studies with RegCM in NCC

Gao Xuejie, Shi Ying, Zhang Dongfeng, Wu Jia, Ji Zhenmin,
Xu Chonghai, Xu Ying, ESP/ICTP

National Climate Center, CMA, Beijing, China
The Abdus Salam International Centre for Theoretical Physics,, Italy

Fifth ICTP Workshop on the Theory and Use of Regional Climate Models
Trieste - Italy, 31 May 2010 - 11 June 2010

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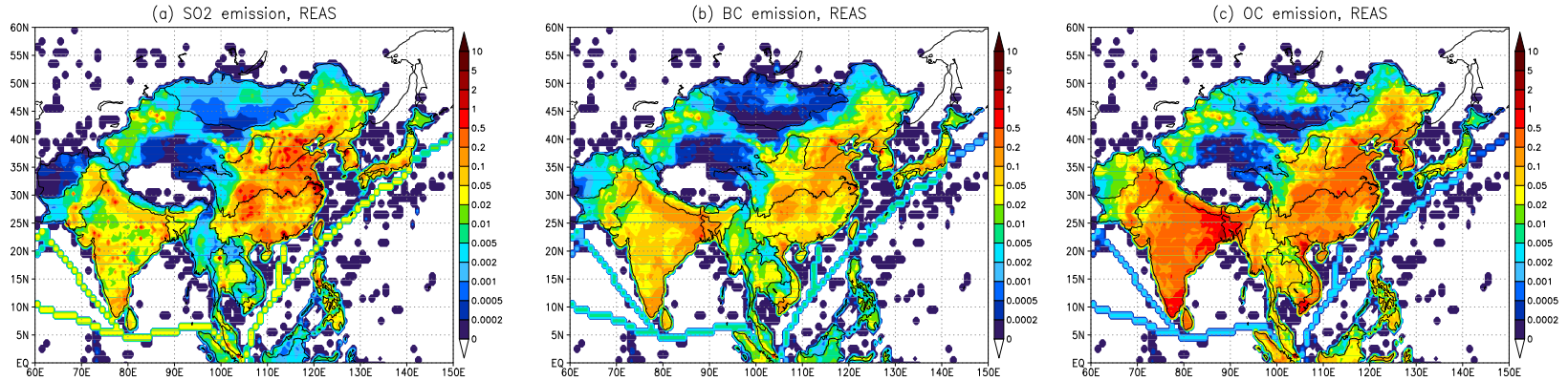
Outline:

1. The aerosol effects on climate over China
2. Climate change and dust events in China
3. Three-Gorge Dam and climate
4. Comparison of 2 high resolution climate change simulations over East Asia - monsoon precipitation
5. Gridding the daily data - CN05
6. Interpolation of the climate and climate change scenario to 1 km
7. CORDEX - East Asia
8. Discussions and future work plan

1. The aerosol effects on climate over China

2×15 years (1987-2002, +1 year spin-up) simulations, driven by NCEP re-analysis, resolution 50 km L16, Direct effects.



Anthropogenic aerosol emission of sulfate, BC and OC over Asia (units are 10^{-9}, 10^{-10} and 10^{-10} kg/m^2/s), REAS from Japan

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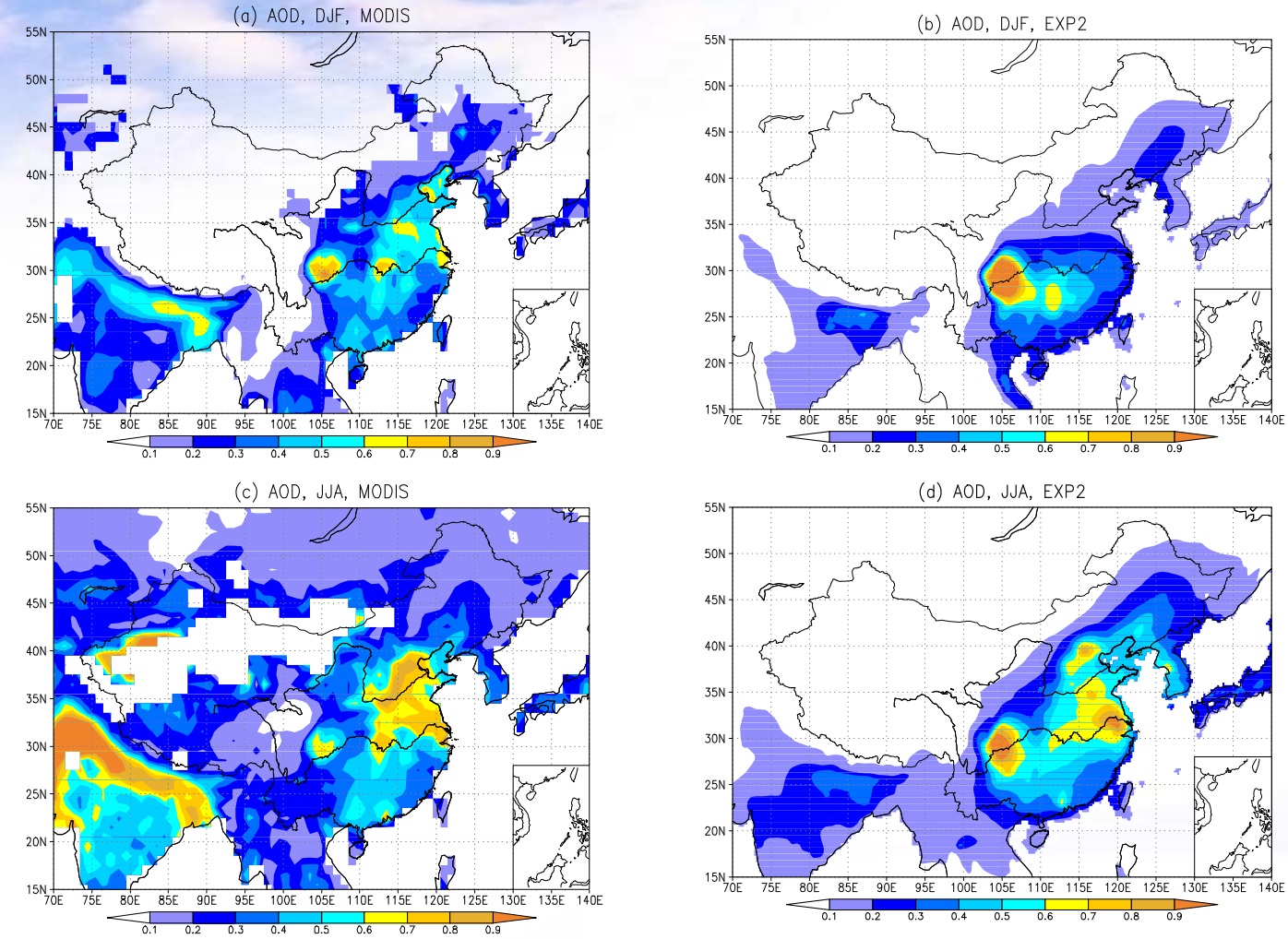
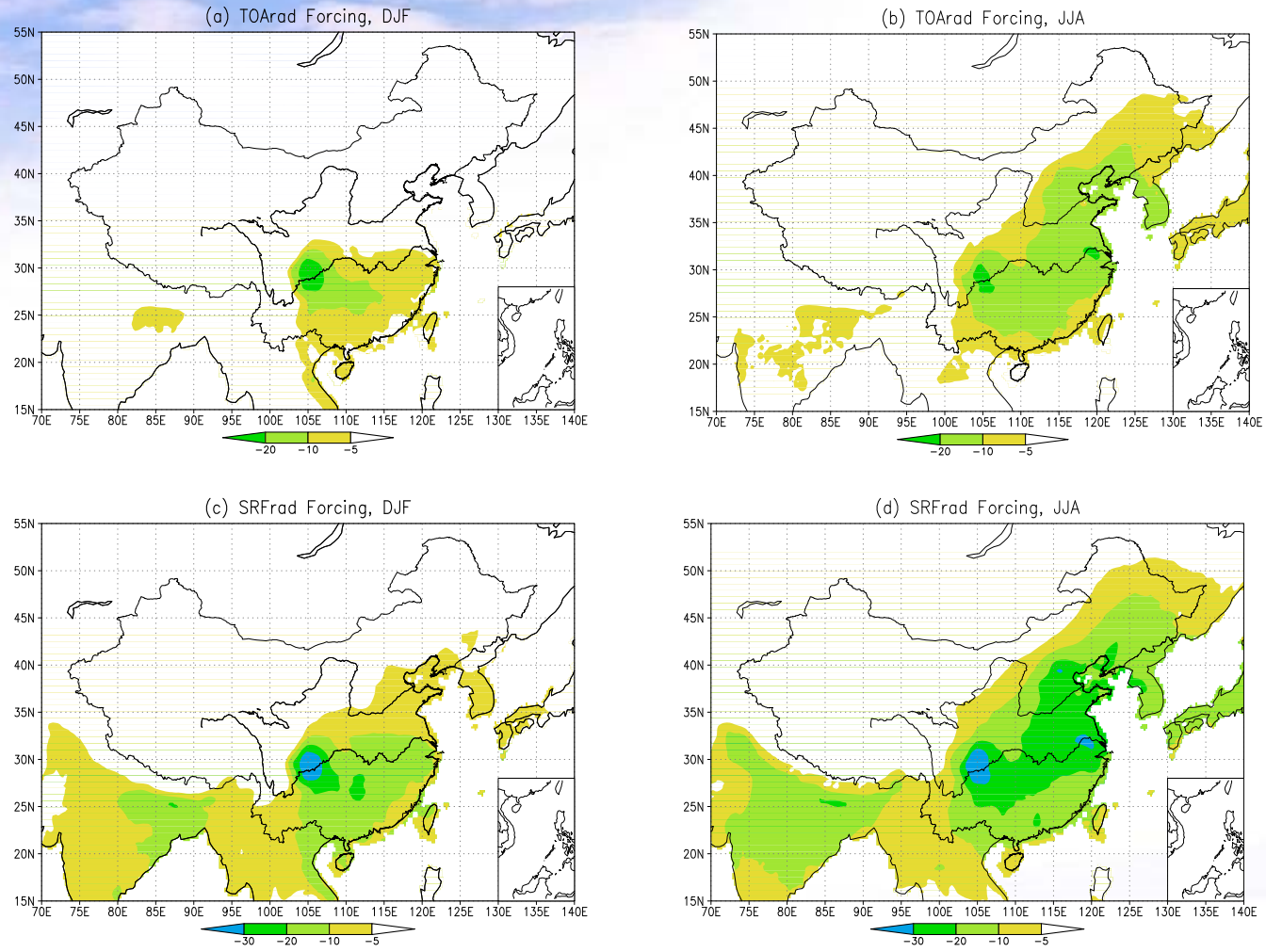


The observed and simulated AOD in DJF and JJA



TOA and SRF radiative forcing in DJF and JJA (W/m²)

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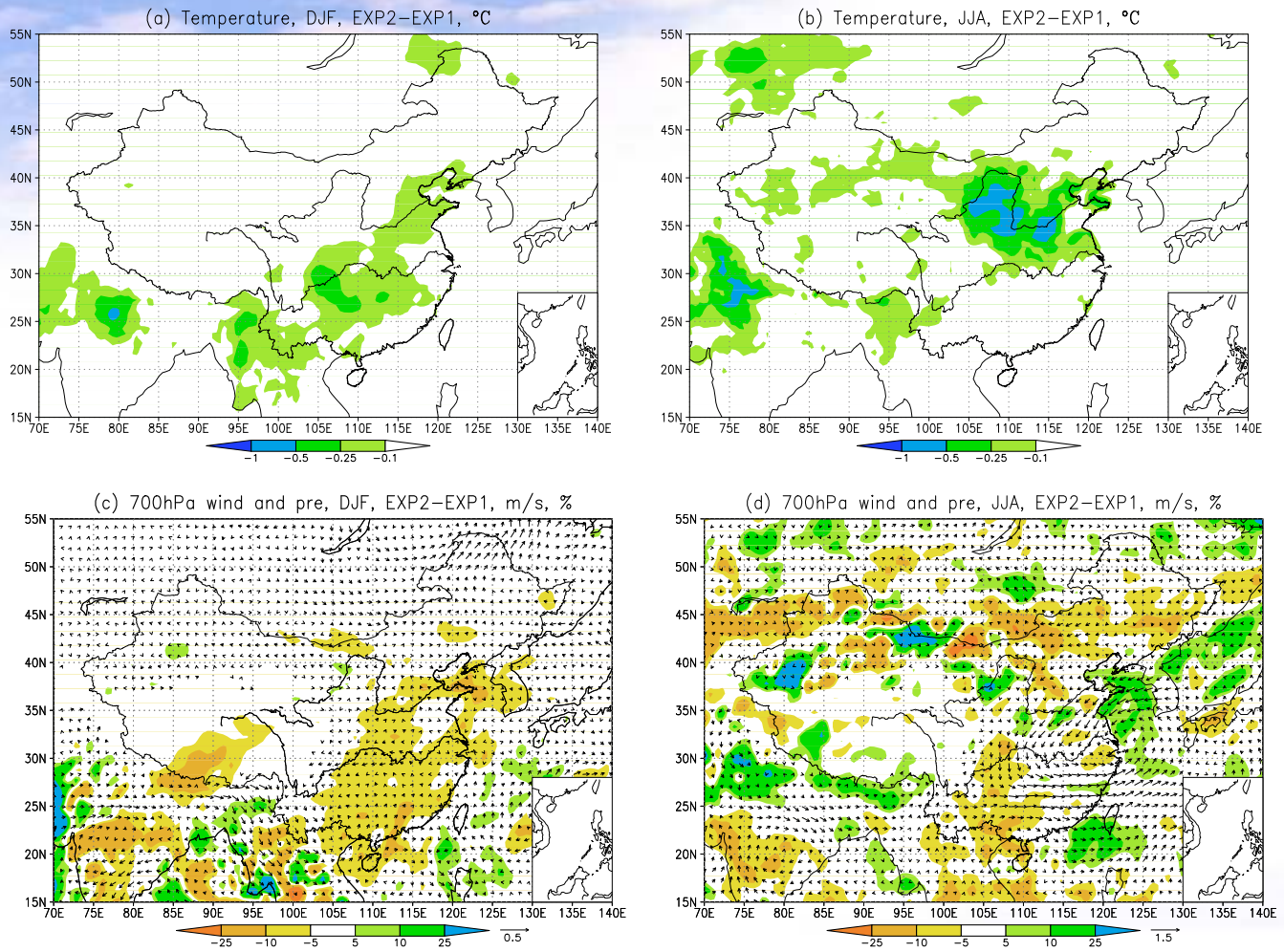

Effects on temperature: DJF (a) and JJA (b) (ºC)

precipitation: DJF (c) and JJA (d) (%)

2. Climate change and dust events in China

Driven by a AOGCM (CCSR/NIES/FRCGC MIROC3.2_hires), changes in dust events under global warming are simulated by 50km RegCM3

4 simulations: 1991-2000 with and without feedback,
2091-2100 with and without feedback (A1B).

Play

Case study: simulation of April, 2006 (burden, mg/m^2)

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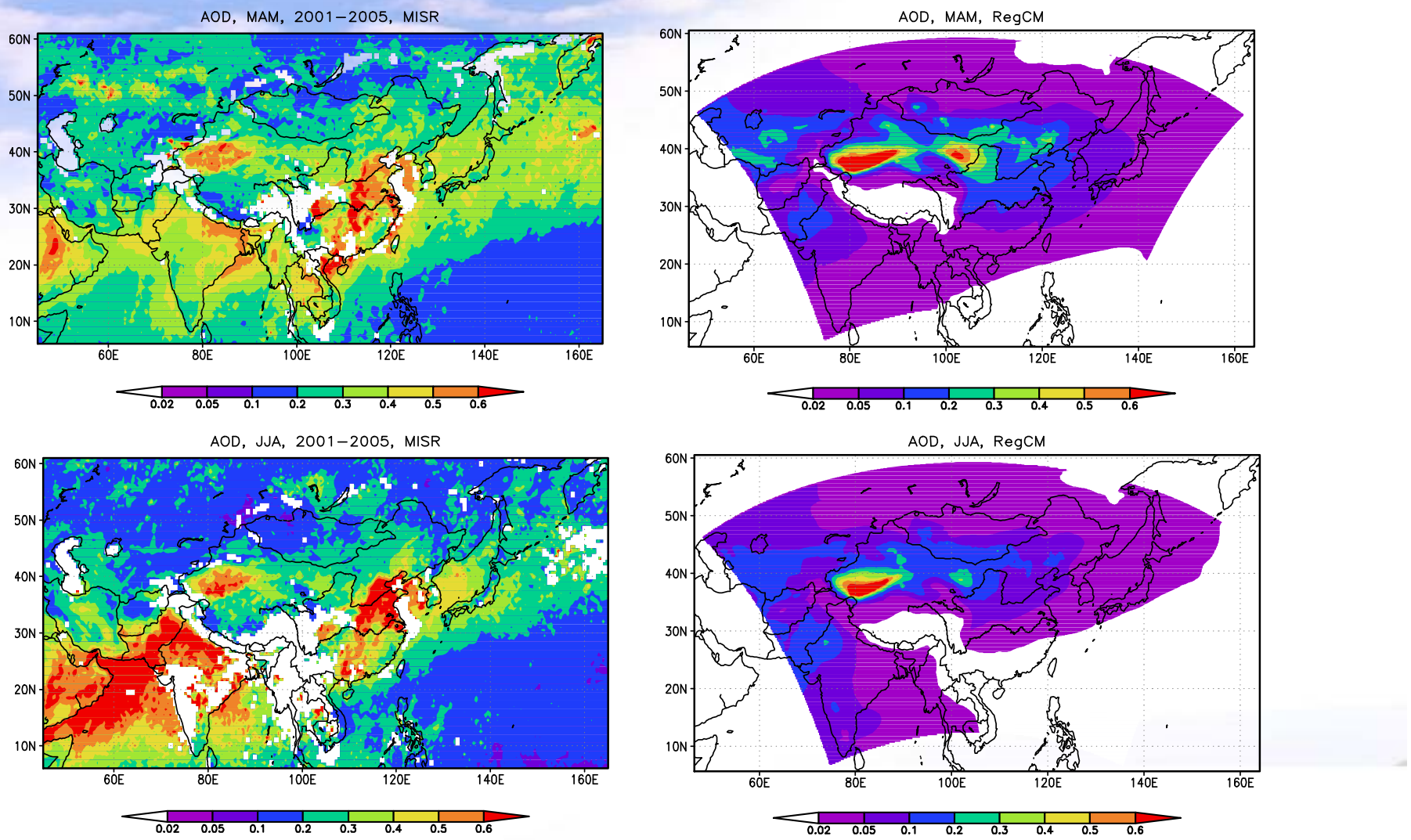

The observed (MISR) and simulated AOD in MAM and JJA

Zhang et al., 2009

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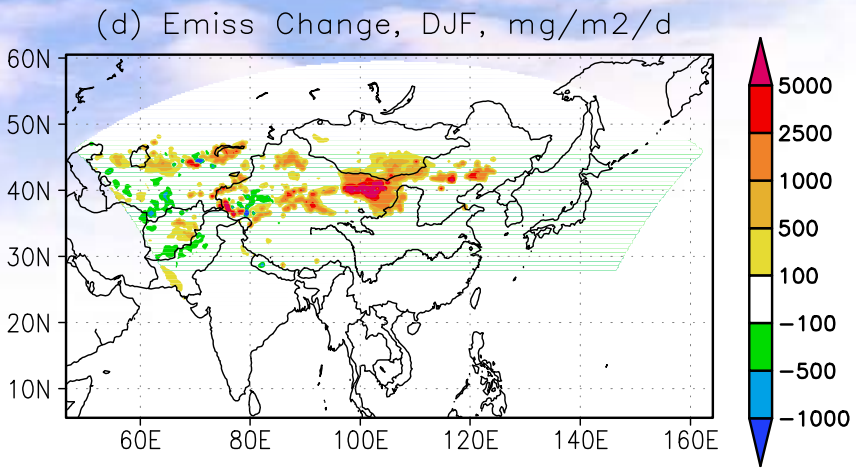
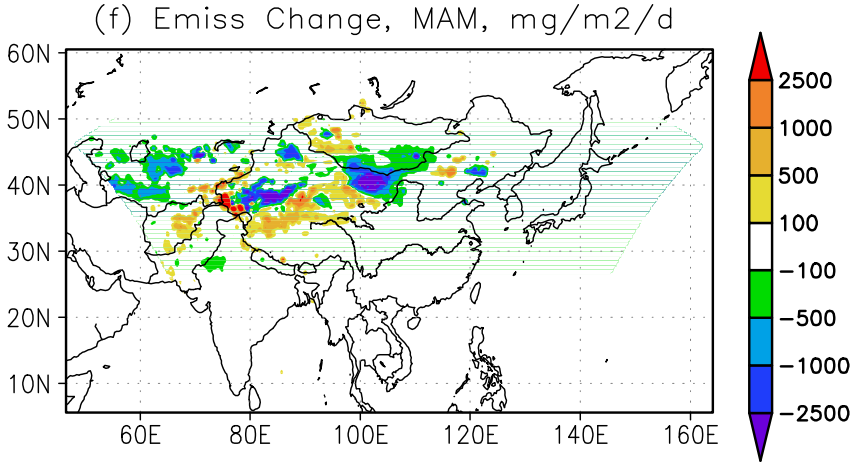
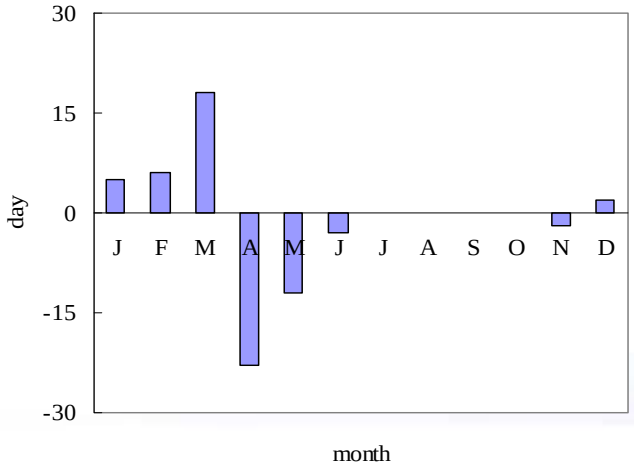
Future changes





Change of dust emission in DJF and MAM



Change of the frequencies

Zhang et al. 2009b

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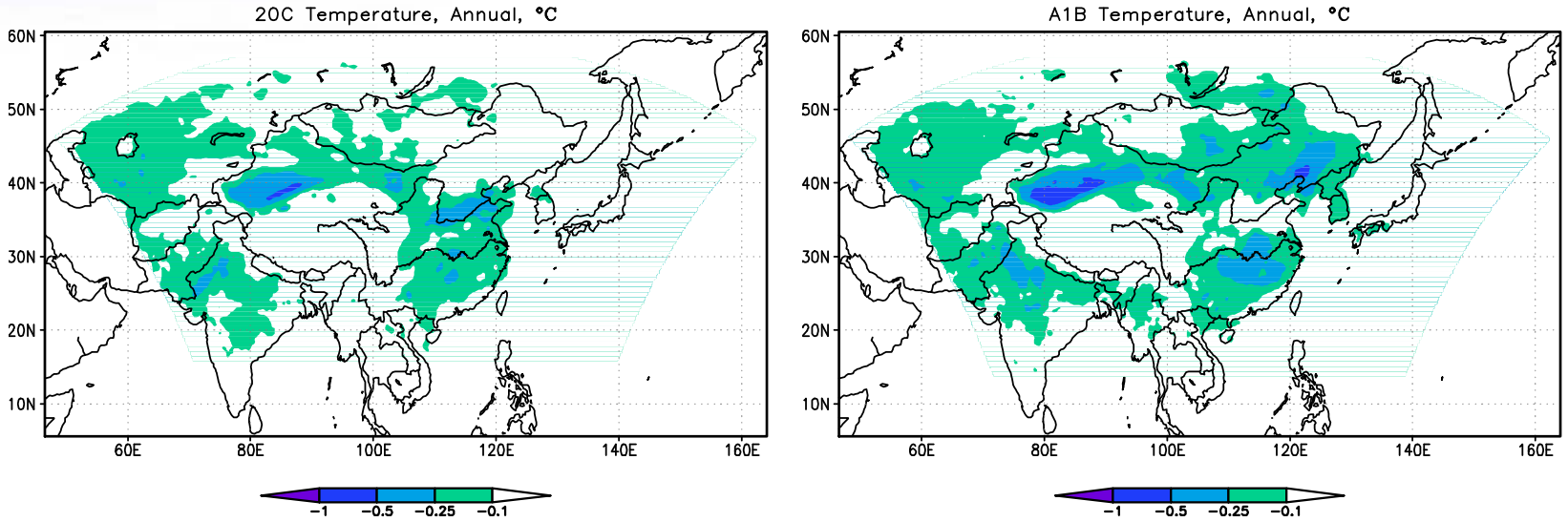

Climate effects-temperature: present and future

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3. Three-Gorge Dam and climate

The TGD is the largest hydroelectric project and the TGR the largest artificial water body in the world. The designed final water level is of 175 m.

It extends for ***660 km*** along the waterway of the Yangtze River. Being a typical river-type reservoir, the TGR is narrow, having a width of ***~1.1 km***.

Climate effects of TGD?

Experimental design:

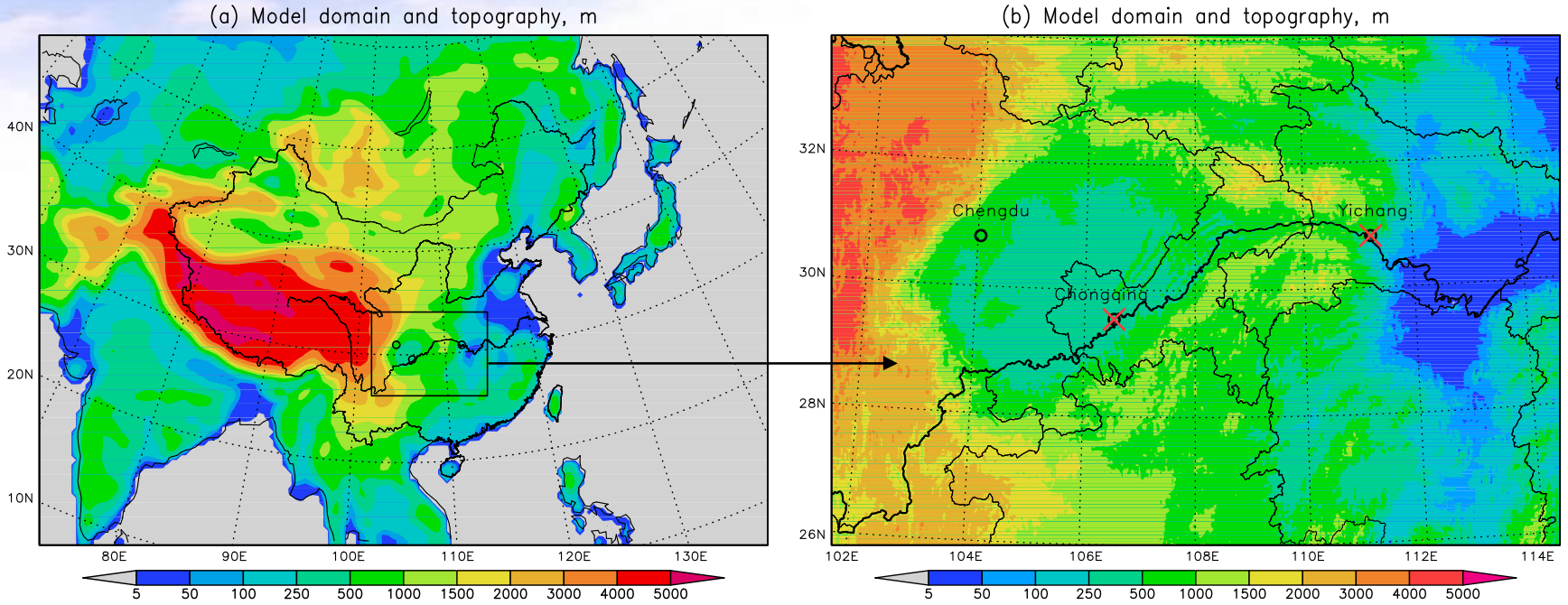
The physics are using the default configuration

Integration period 01/01/1995 to 01/01/2007, the first year is the spin-up

Exp 50: 50 km over East Asia, driven by NCEP

Exp 10-2: 10 km over TGD region (128×90), 5×5 sub-bats is used to reach 2×2 km resolution for land surface. ICBC from Exp 50.

Exp TGR: same as Exp 10-2, with water surface along TGR, and climatology of daily WST is used



Domains and topography (m) for the 50km and 10-2km simulations

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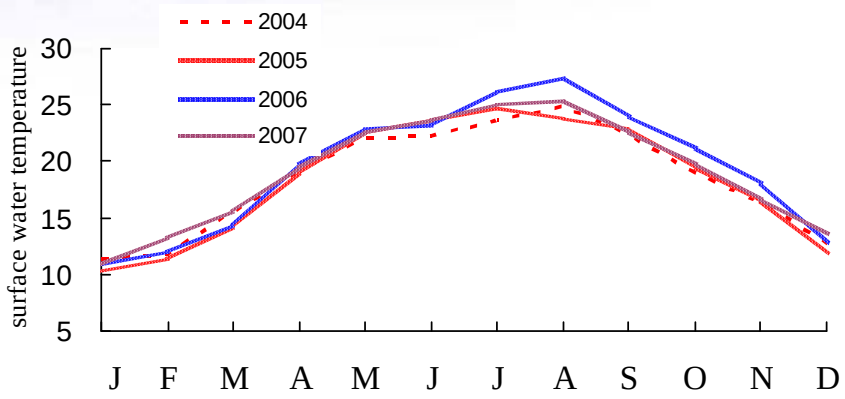

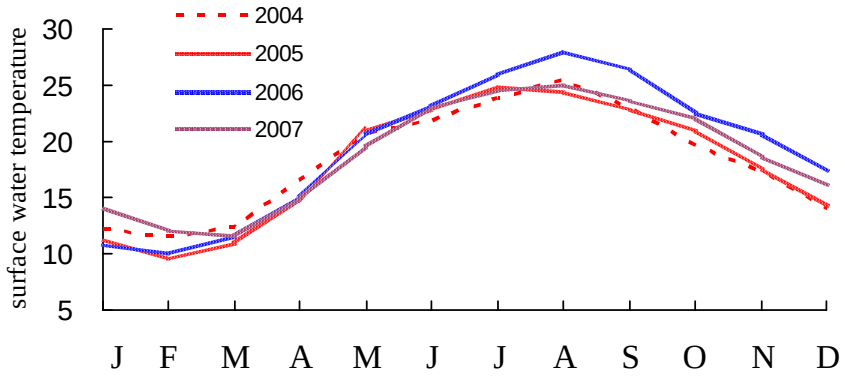

Climatology of WST in two stations in the top and end of TGR is calculated based on the mean of the 4 years daily observation data. Then SSW is interpolated bilaterally to each of the 2 km grids along TGR

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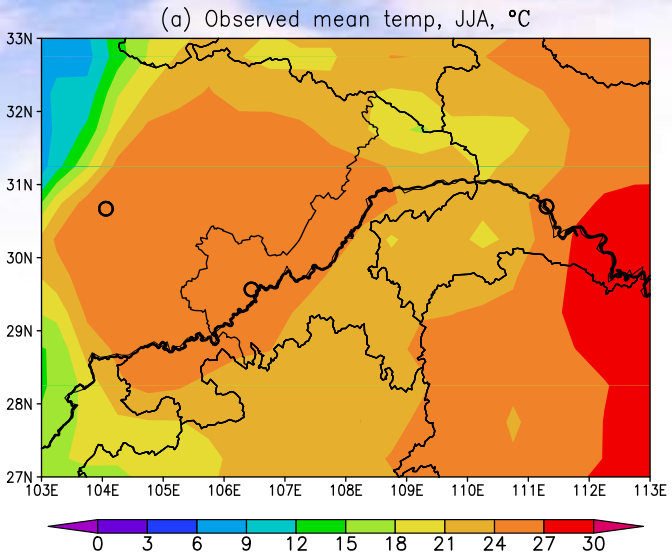

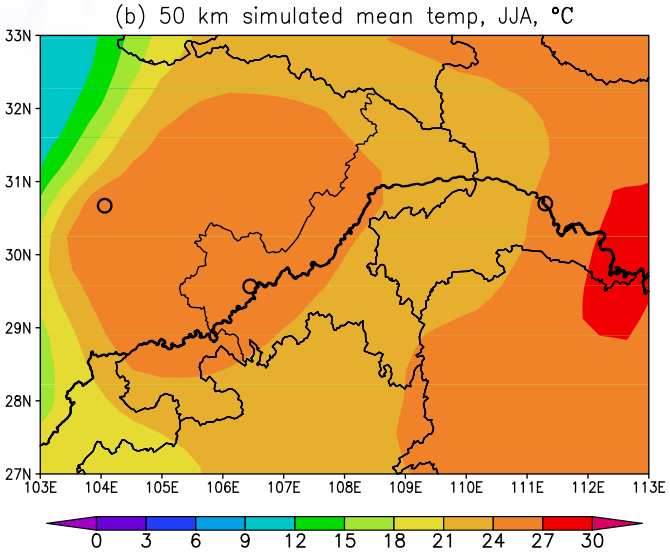

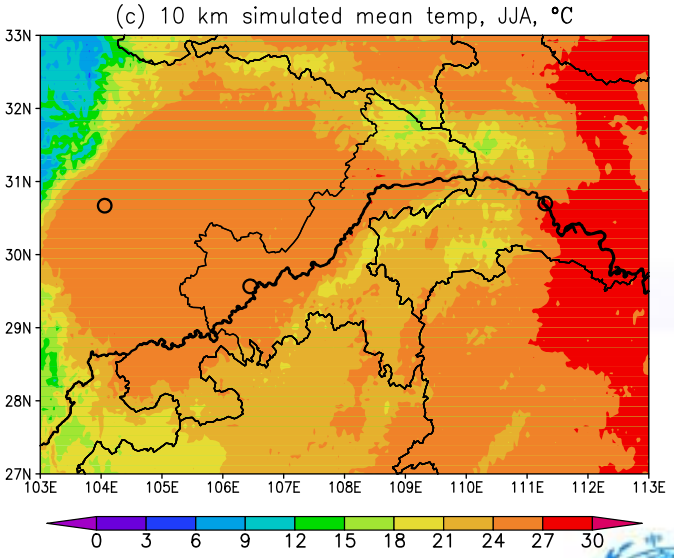

Temperature in JJA:

Observation and simulation by the 50km and 10-2km (ºC)

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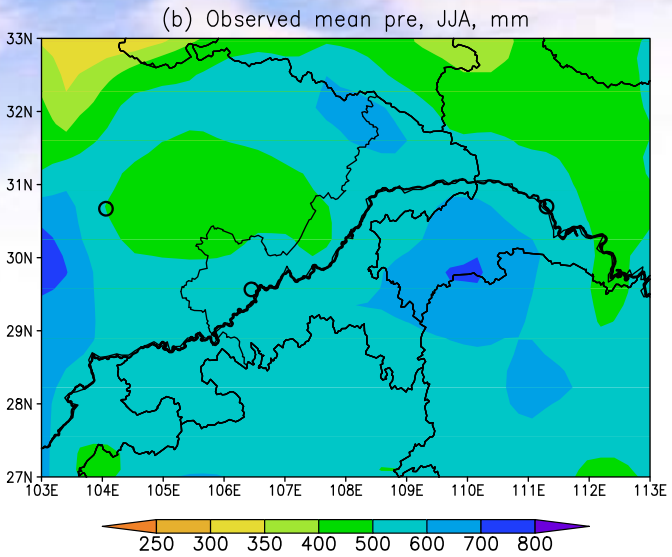

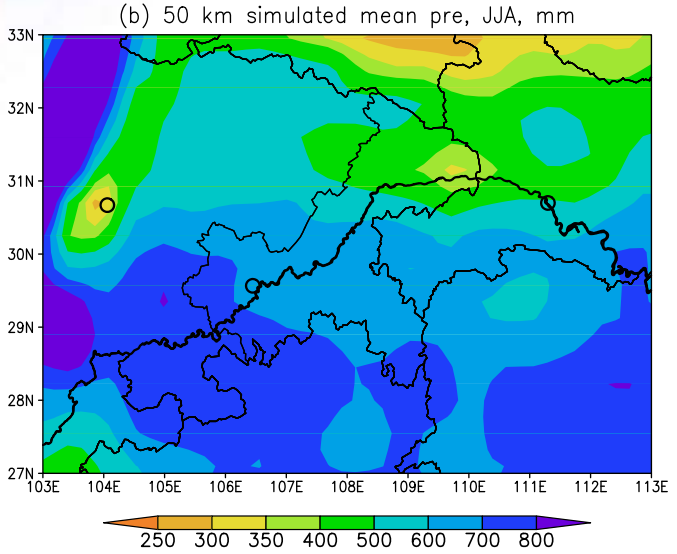

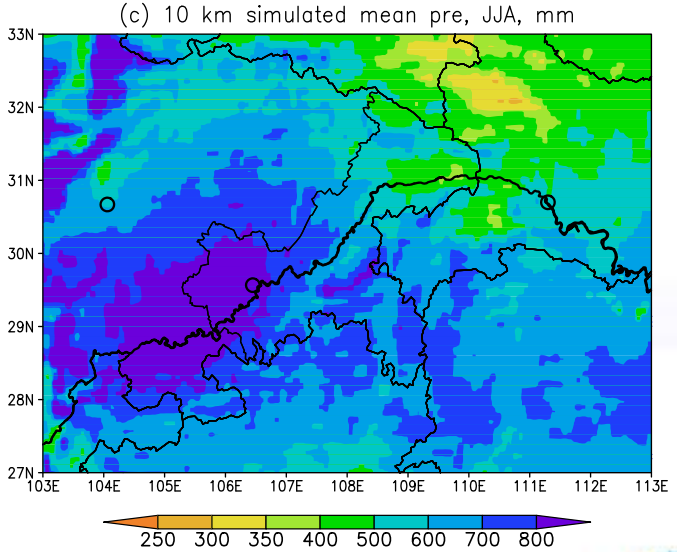

Precipitation in JJA:

Observation and simulation by the 50km and 10-2km (ºC)

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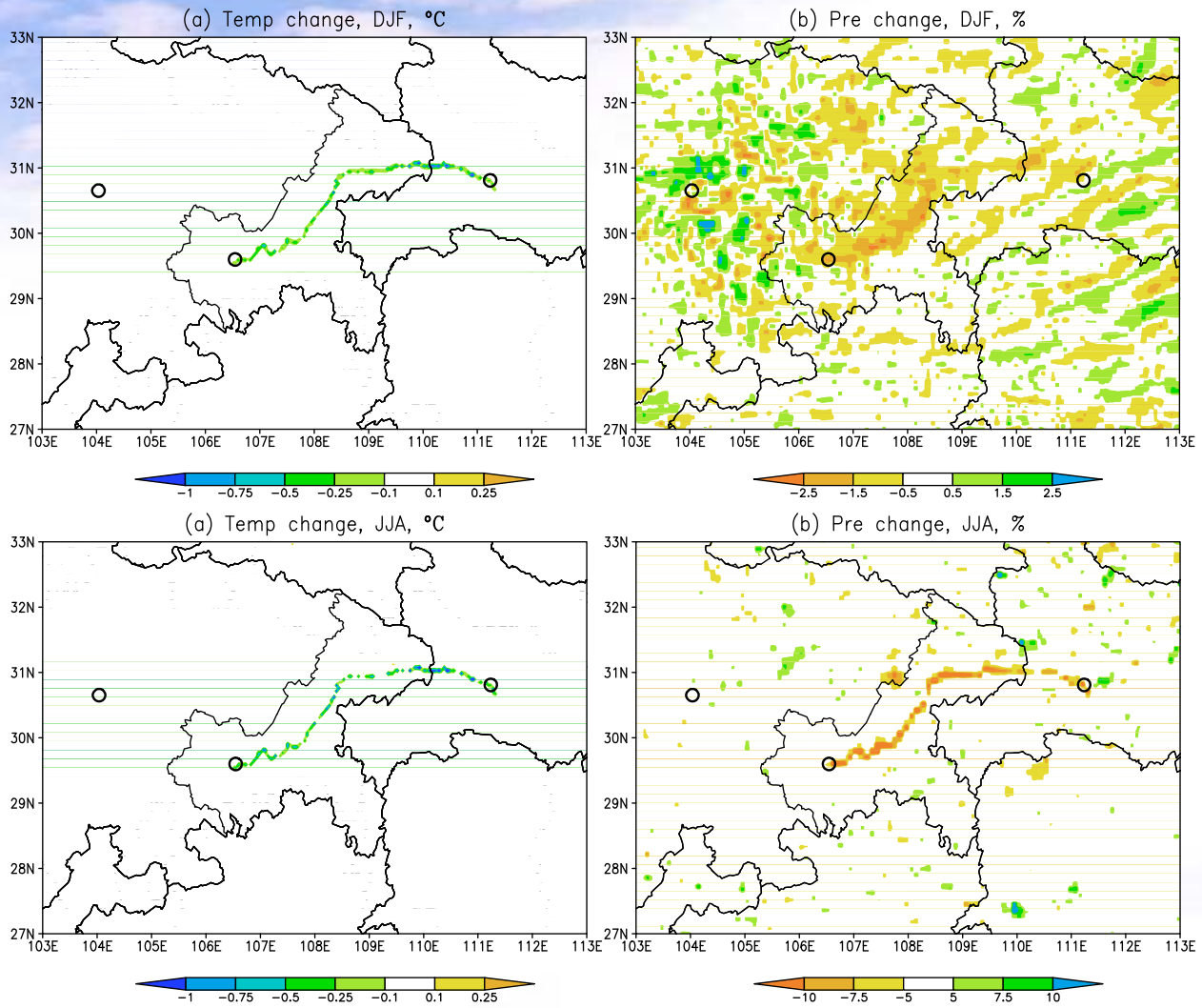

Changes in temperature (ºC) and precipitation (%) in DJF and JJA

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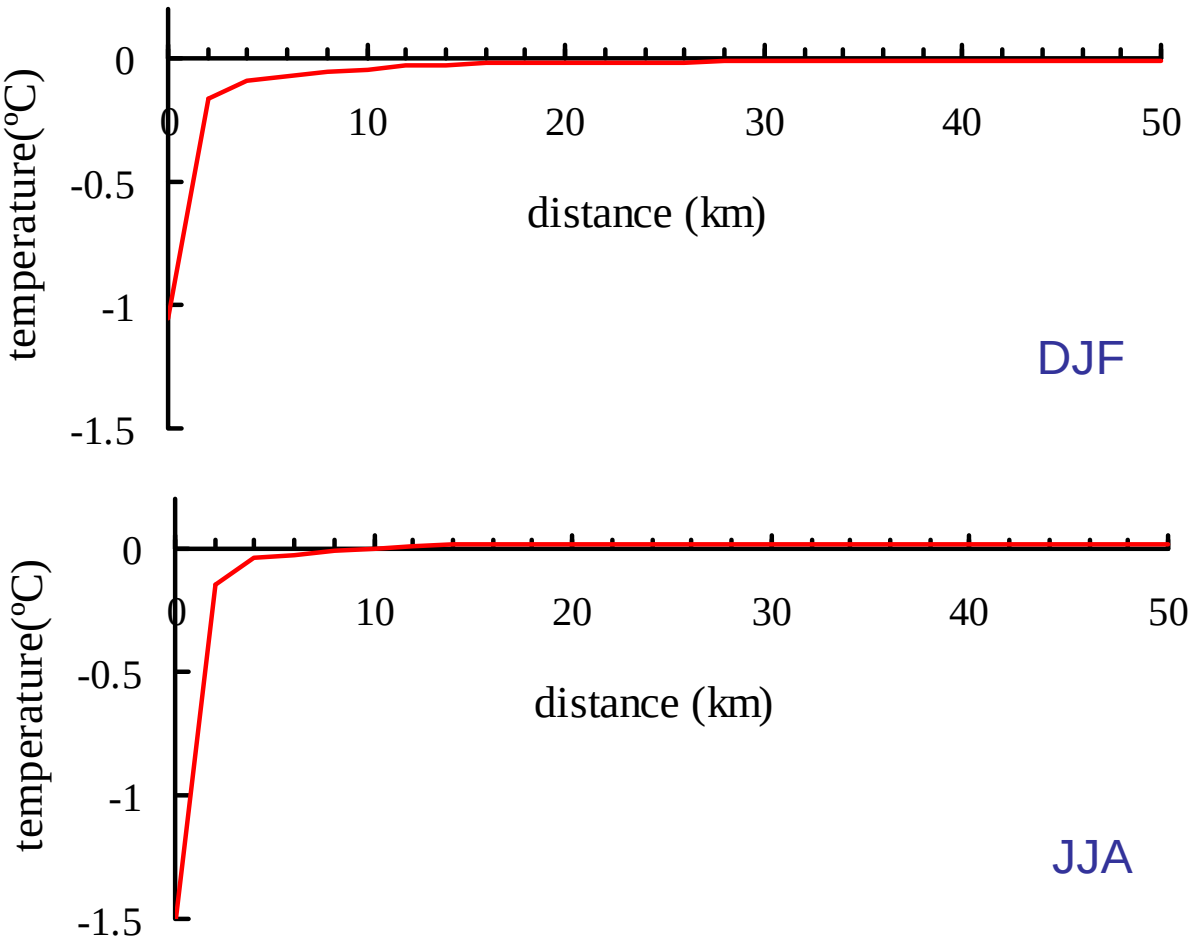
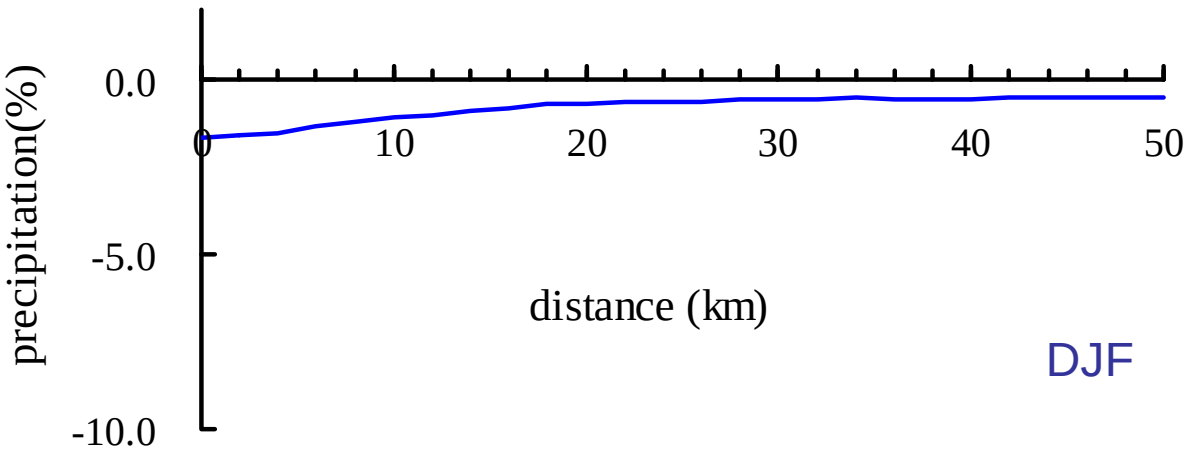
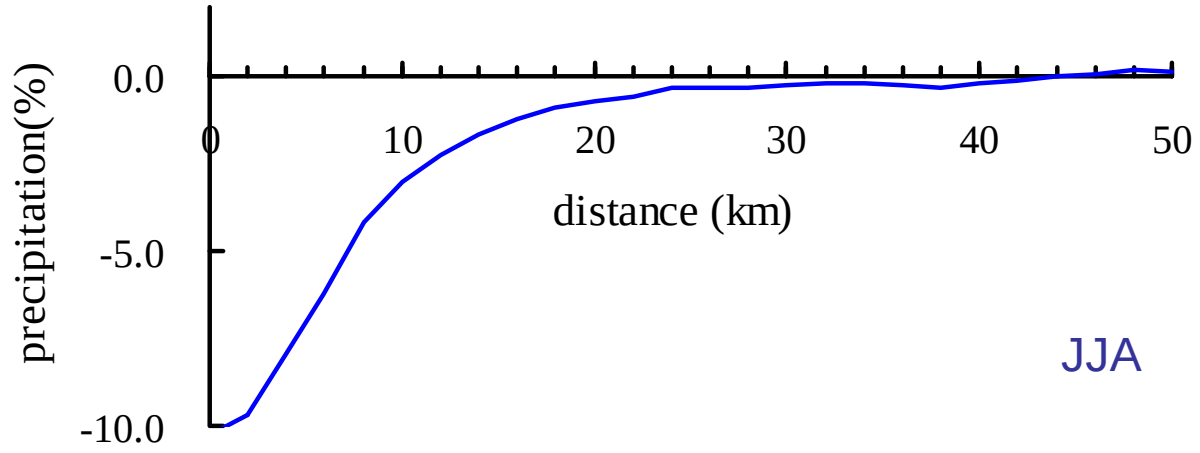


Mean change in temperature in DJF and JJA





Mean change in precipitation in DJF

4. Comparison of 2 high resolution climate change simulations over East Asia - monsoon precipitation

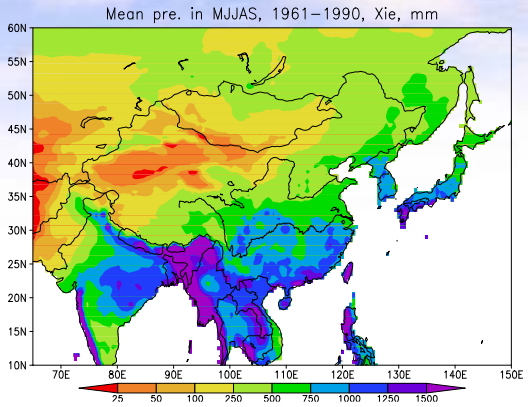
Two simulations conducted:

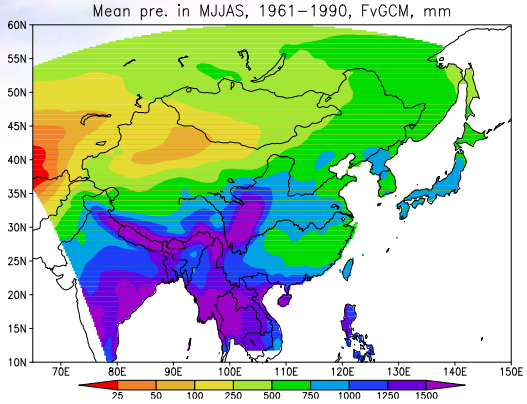
FvGCM - RegCM, 1961-1990, 2071-2100 (A2), 20km

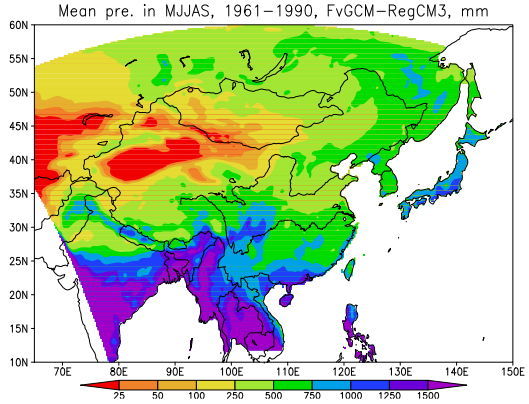
MIROC_hires - RegCM, 1951-2100, A1B, 25km

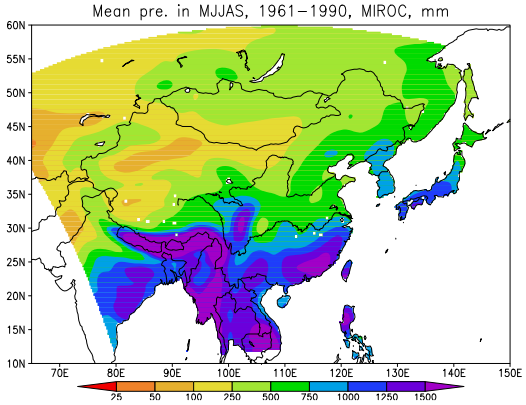
Inter-comparison of the monsoon precipitation (MJJAS) in two runs, 1961-1990; 2071-2100

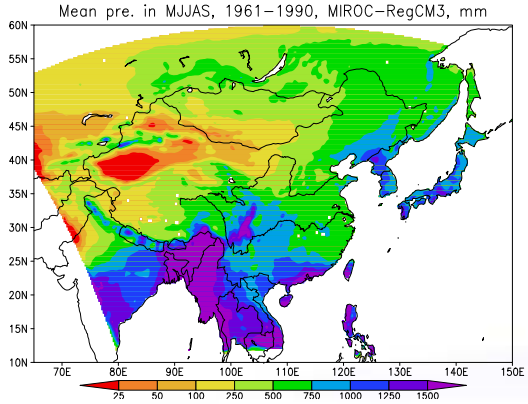
MIROC3.2_hires: CCSR (Center for Climate System Research, University of Tokyo) */NIES* (National Institute for Environmental Studies) */FRCGC* (Frontier Research Center for Global Change)











Mean precipitation in MJJAS in 1961-1990 (mm)

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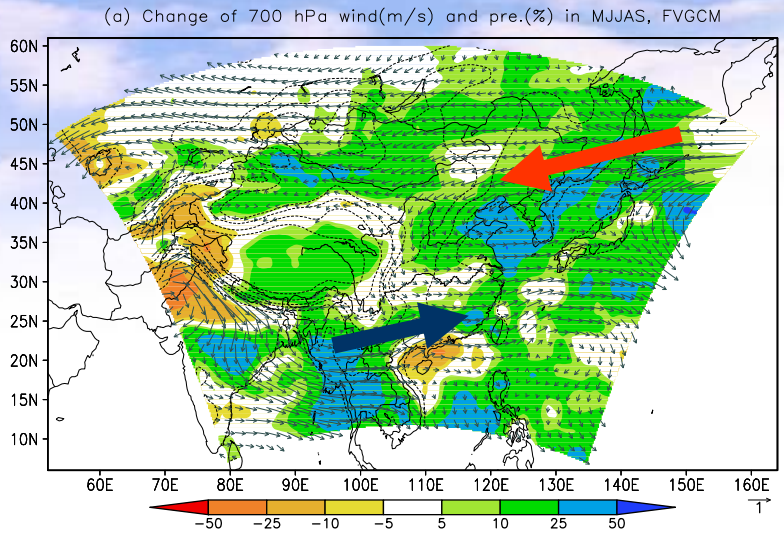

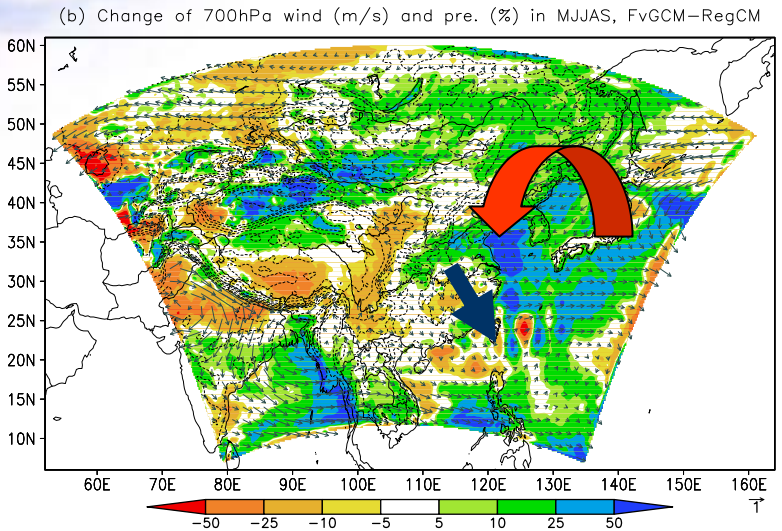

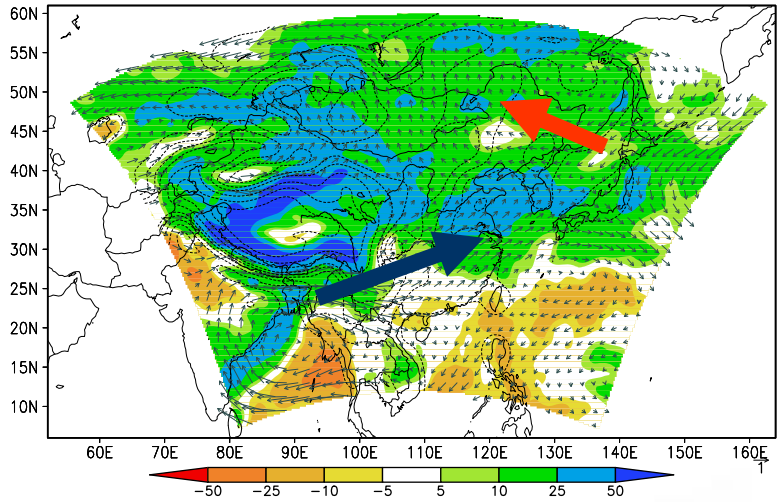

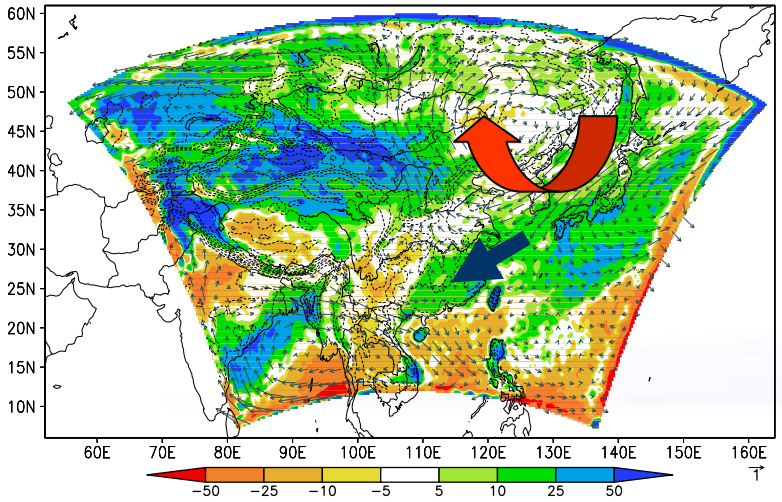

Changes in precipitation and 700 hpa wind circulation in MJJAS

2071-2100 vs 1961-1990

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5. Gridding the daily data - CN05

Motivation: the need for gridded daily temperature data in validating high resolution RCM simulations.

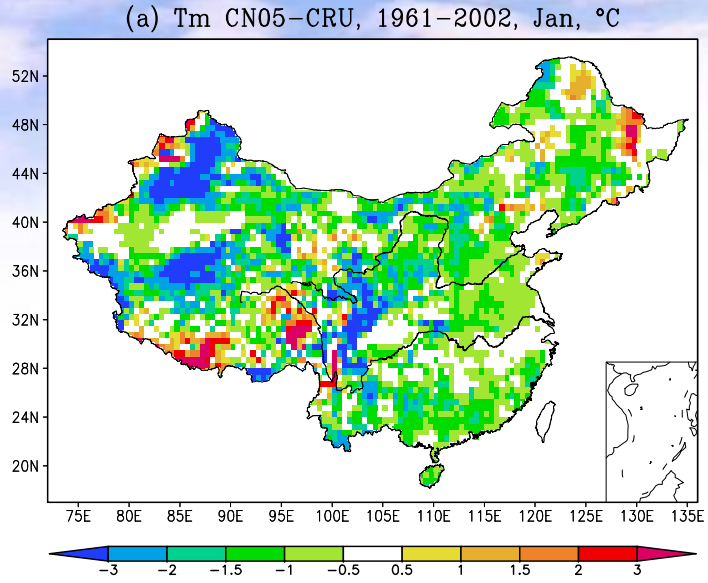
The dataset is based on the interpolation from 751 (CRU: ~200) observing stations over China, comprises 3 variables: Tm, Tmin, and Tmax. Period: 1961–2008. Resolution: 0.5º×0.5º.

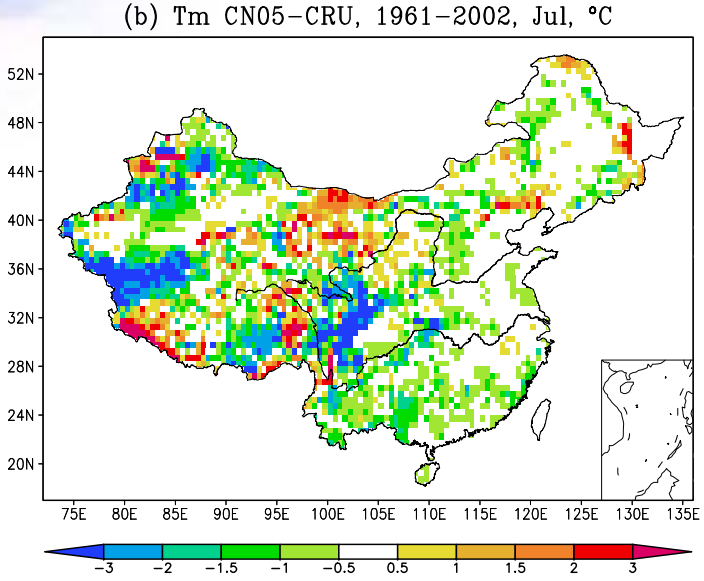
Method: “anomaly approach” as CRU data.

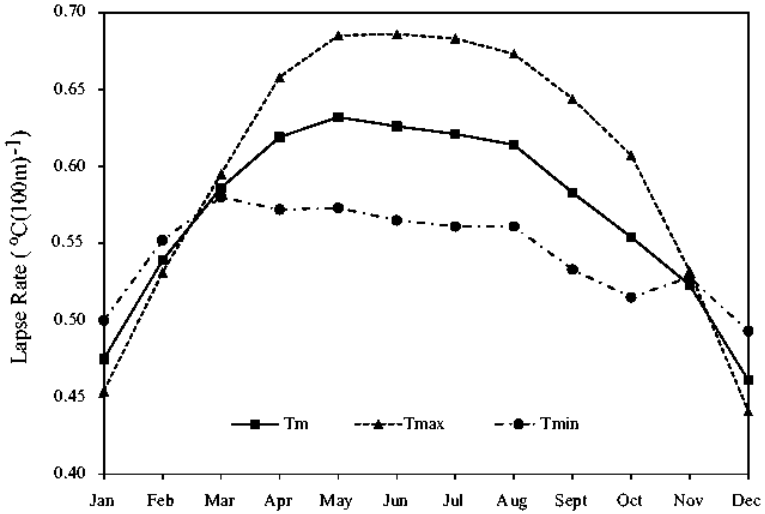
Mean: 1971–2000, by thin-plate smoothing splines (ANUSPLIN).

Anomaly: 1961–2005, by angular distance weighting (ADW).

Xu et al., 2009



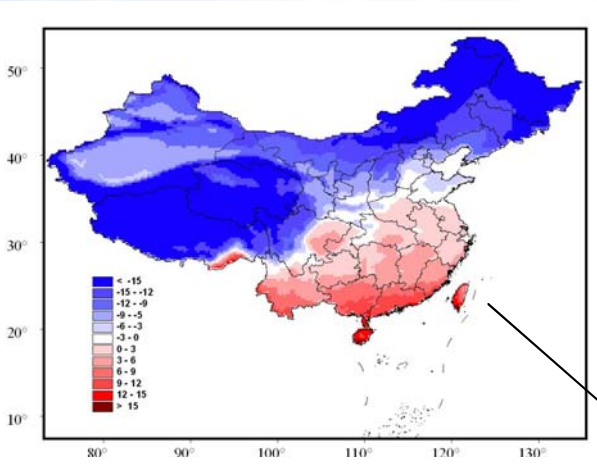


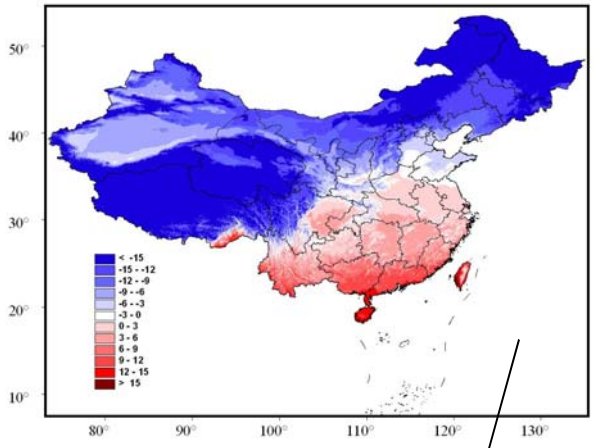


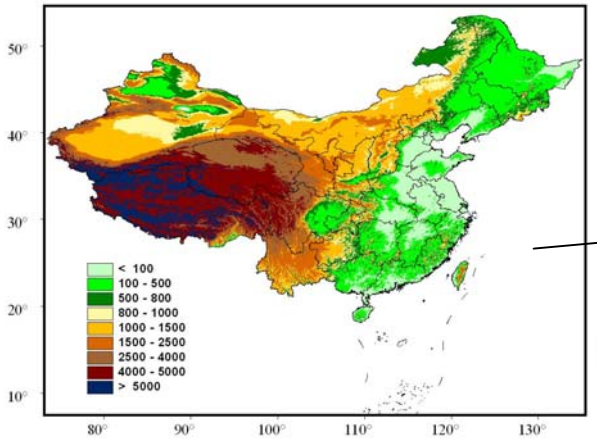
Upper panel: Difference with CRU, Tm in January and July

Lower panel: Elapse rate derived and used in the interpolation

6. Interpolation the climate and climate change scenario to 1 km





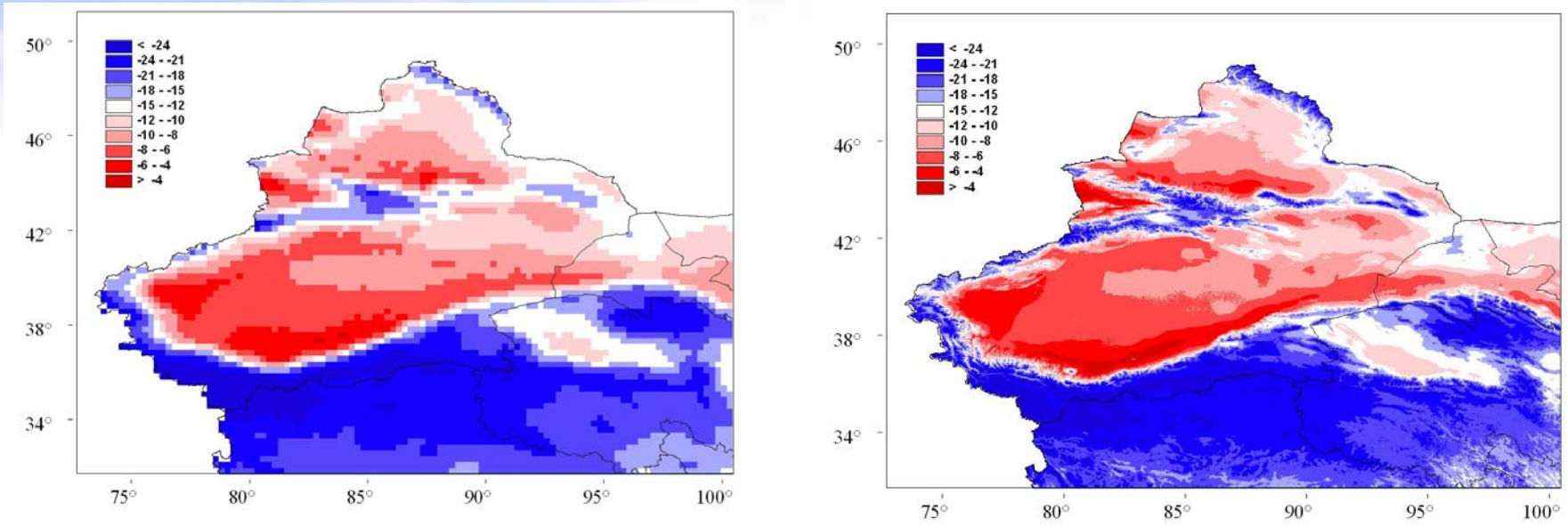


25 km model

1 km interpolated

Topography (m, DEM)

Temperature in January



Temperature in January over Northwest China (Xinjiang)

25 km model (left), 1km interpolation (right)

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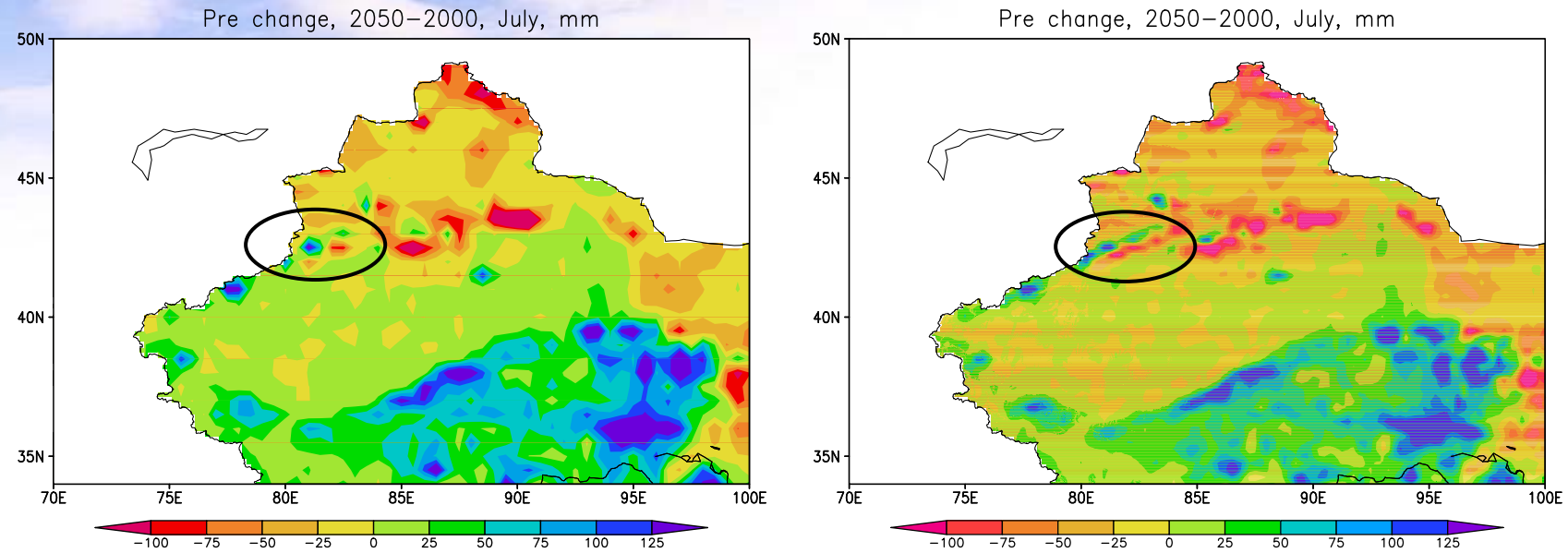

Climate change signal: precipitation in July, 2050-2000

25 km model (left), 1km interpolation (right)

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7. CORDEX - East Asia

Simulation period: 1989.1 - 2002.1, first 12 months for spin-up

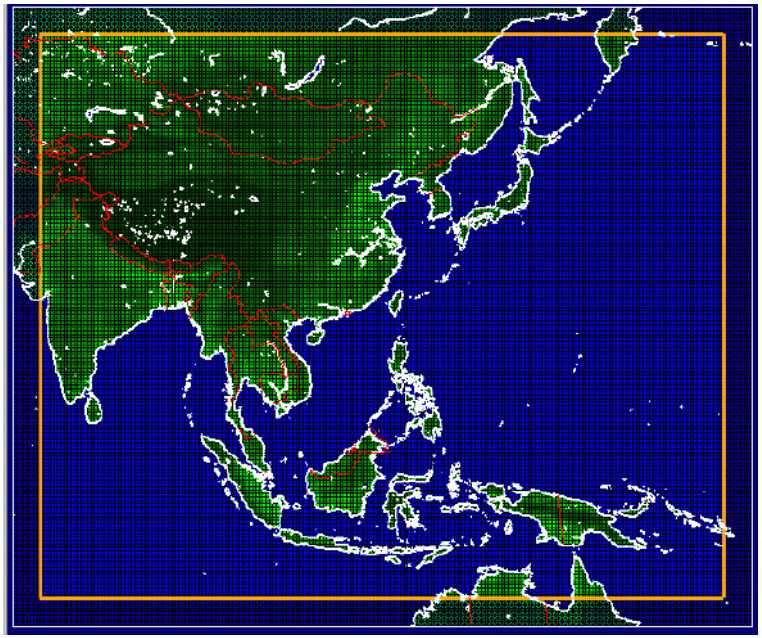
ICBC: ERA-Interim

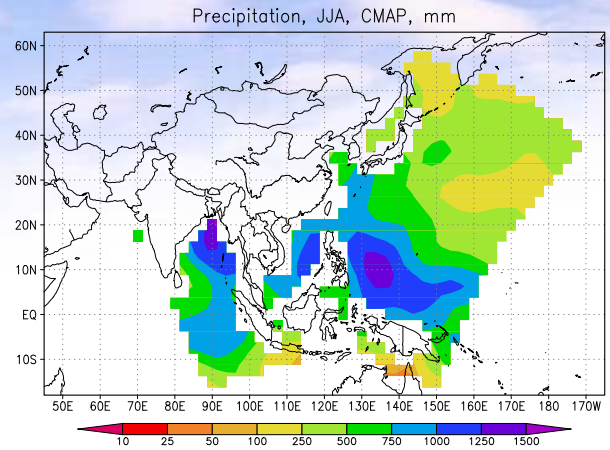
Resolution: 50km

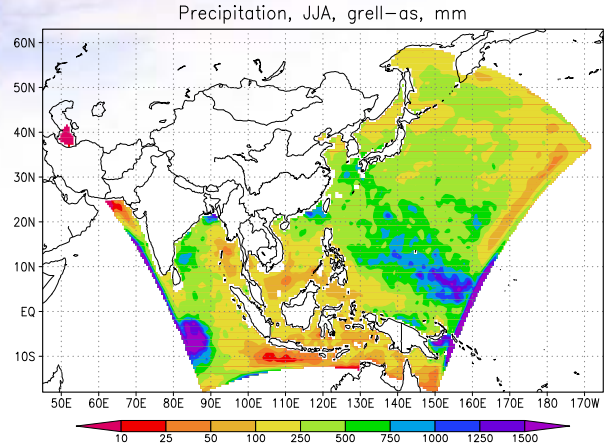
Grids: jx=225, iy=186

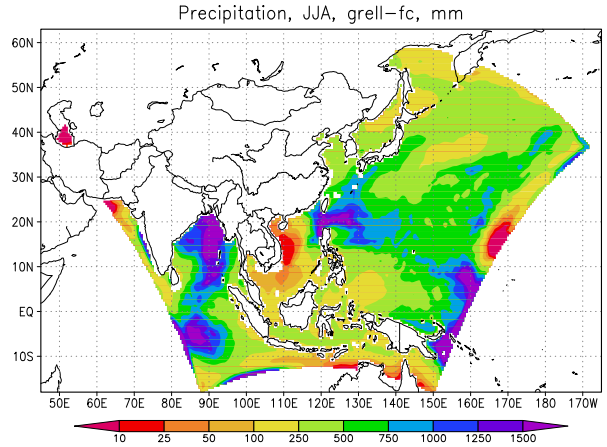
Observation: Xie (2007), CRU

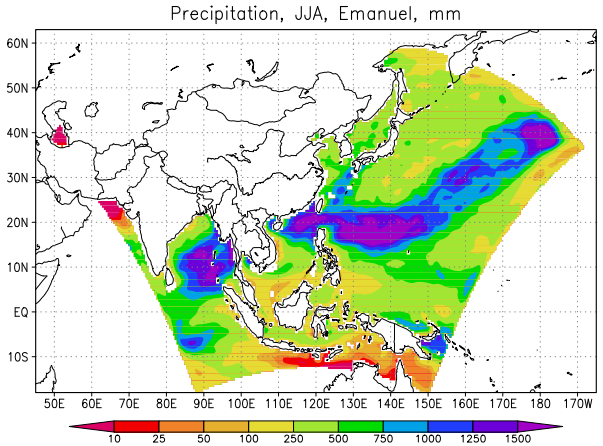
Convection: Grell-AS

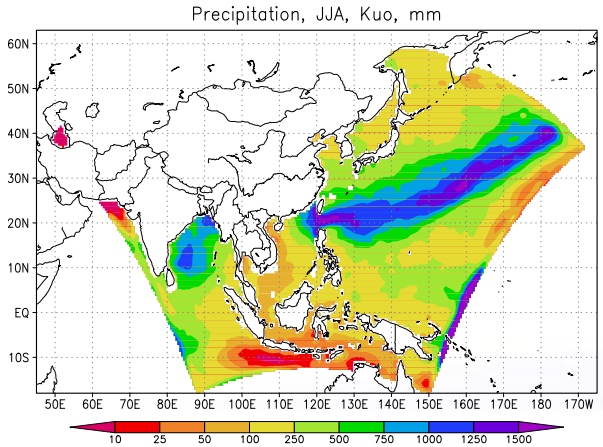












Model set-up, 2 years simulation: precipitation over the ocean, JJA

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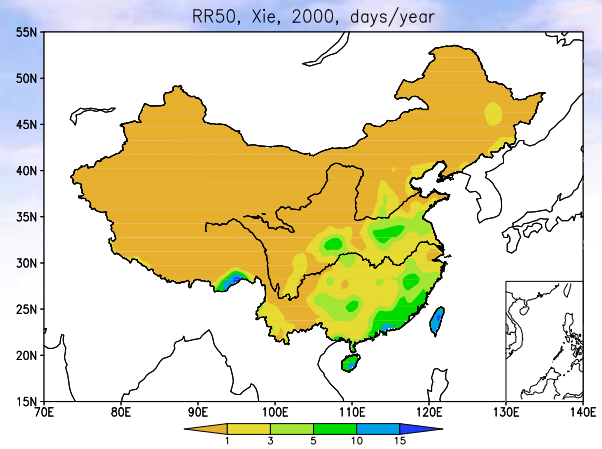

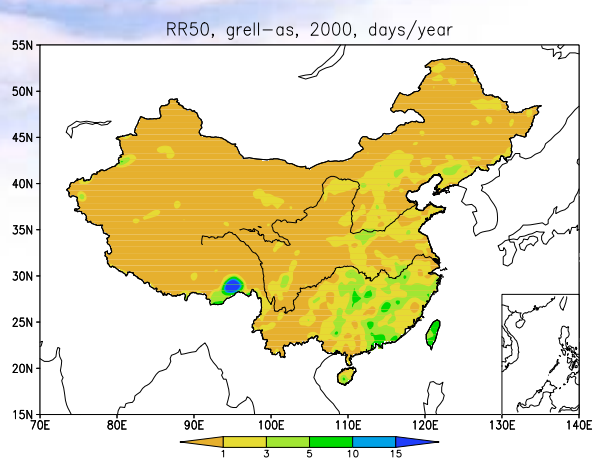

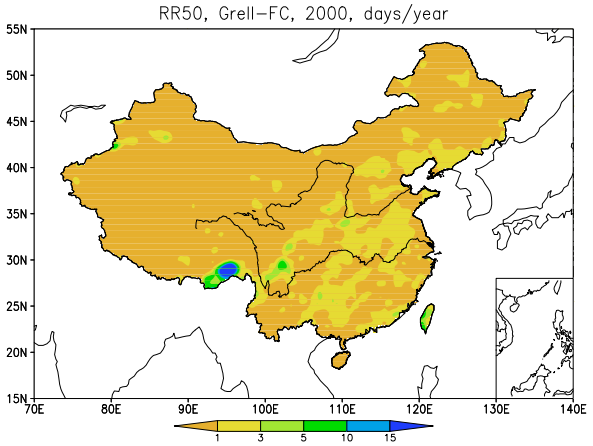

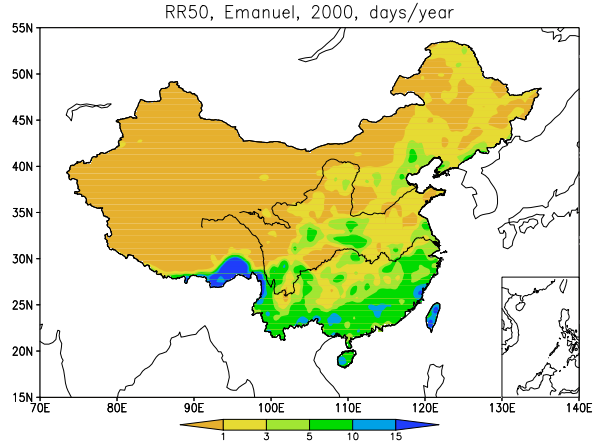

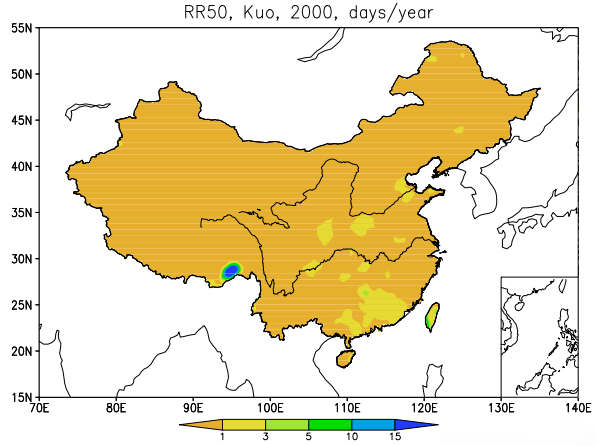

Model set-up, 2 years simulation: extreme precipitation over China

RR50: annual number of days with precipitation >50 mm/day

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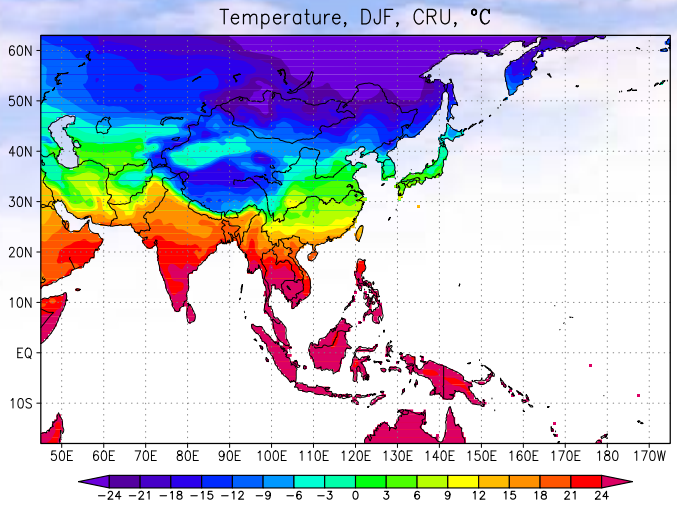

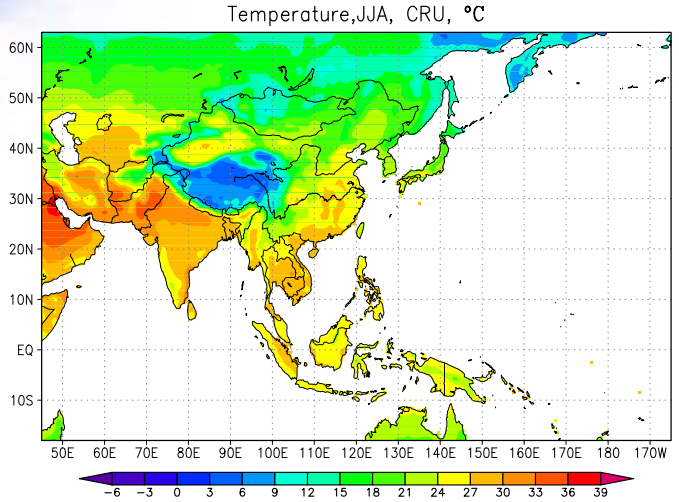

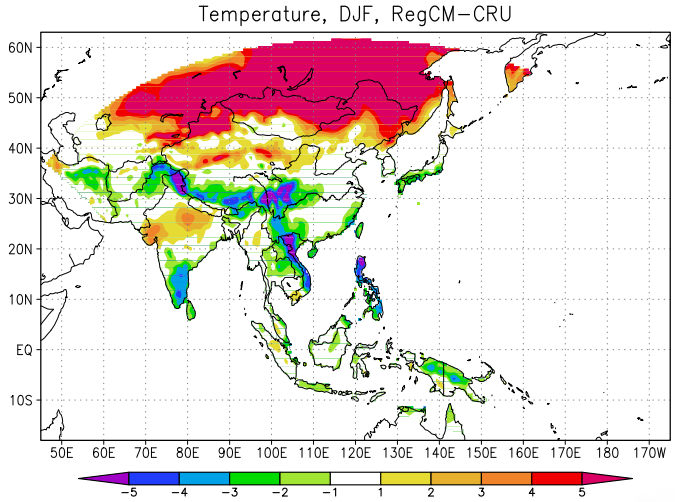

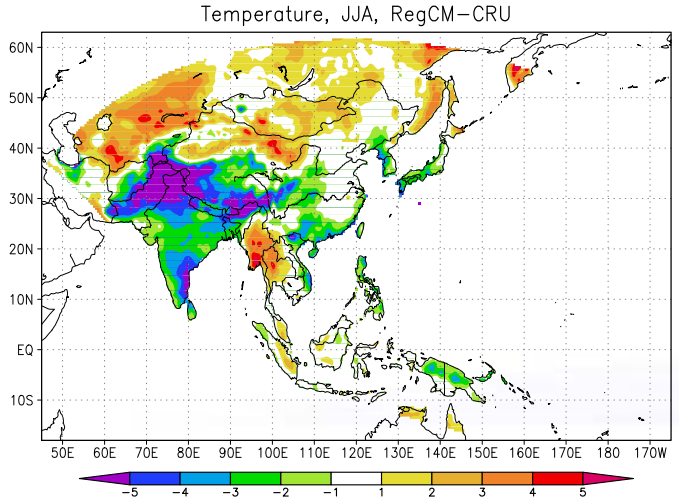

Results: temperature, observation and bias (ºC)

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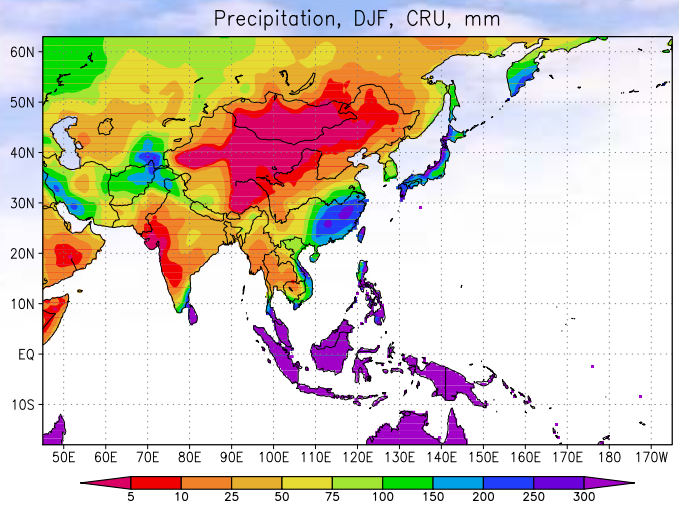

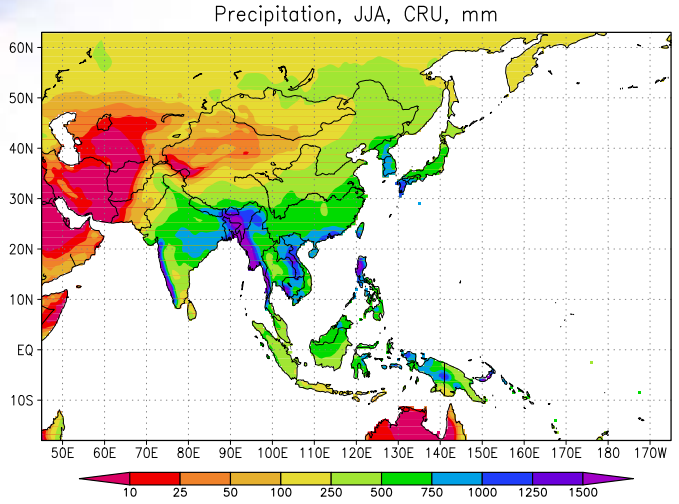

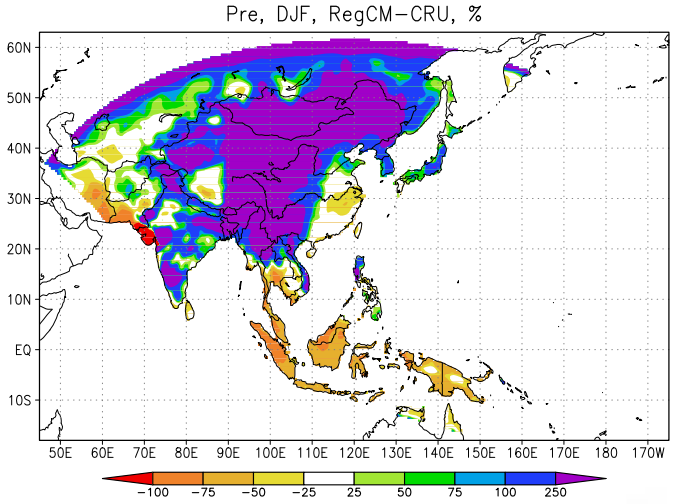

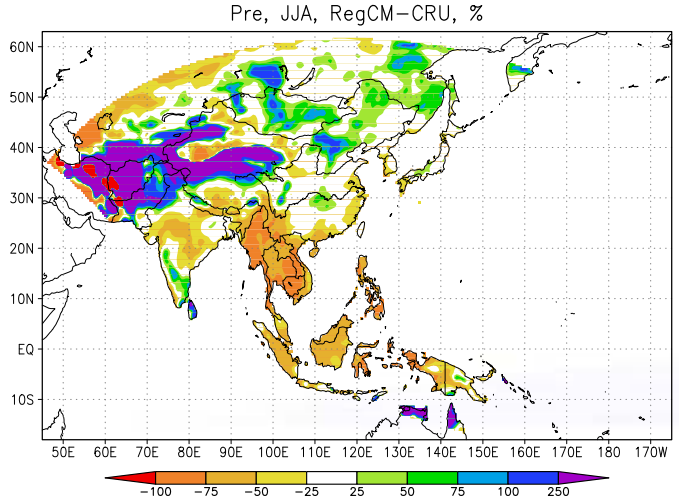

Results: precipitation, observation (mm) and bias (%)

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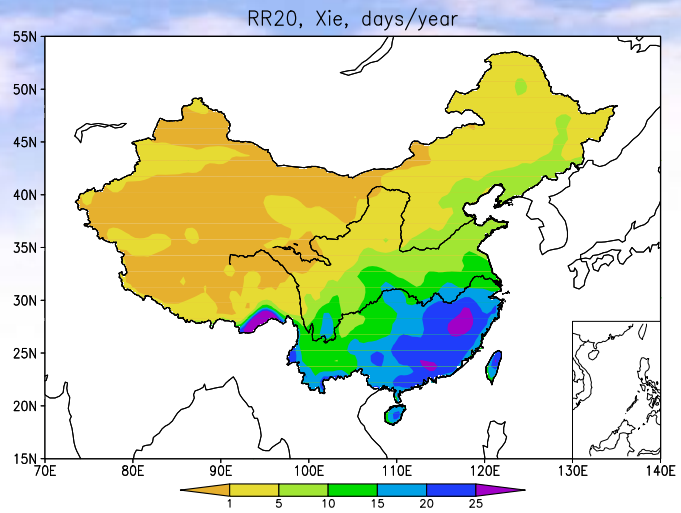

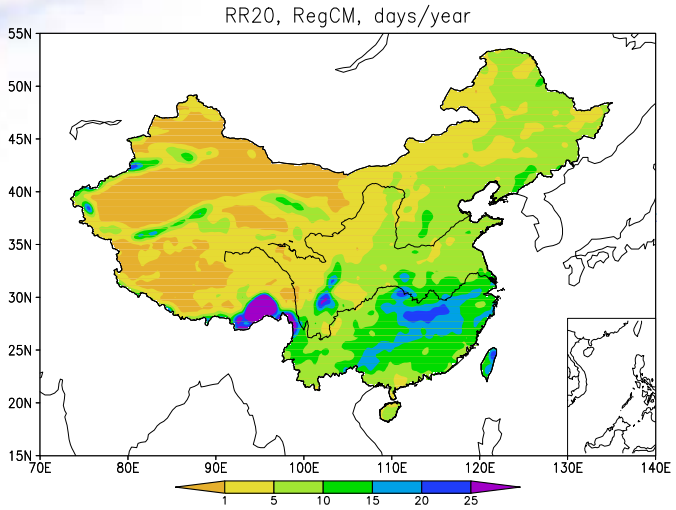

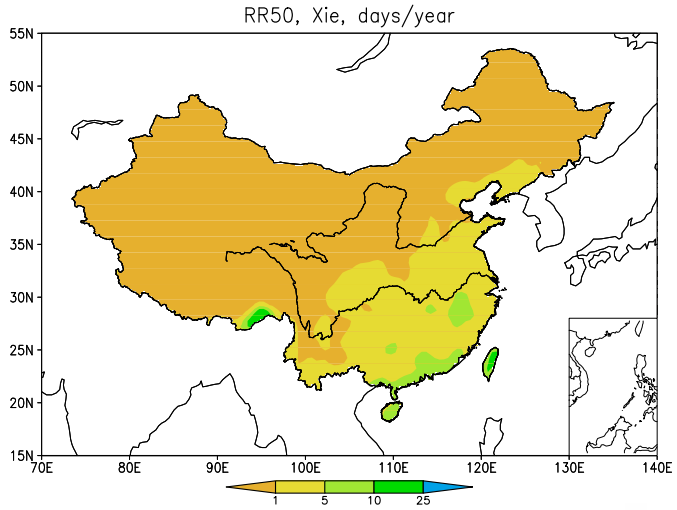

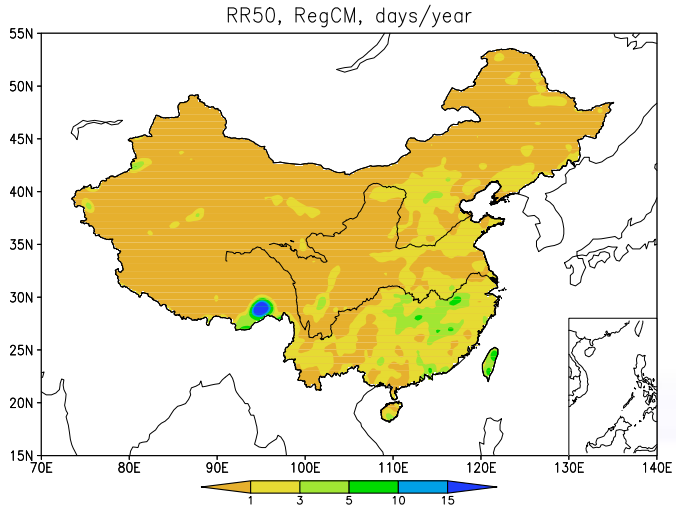

Results: extremes in precipitation, observation and simulation

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8. Discussions and future work plan

- **Further collection and interpolation of daily data:**

  More stations (~2000), more variables, higher resolution (~0.25º)

- **Improvements of the RegCM performances over China:**

  warm bias over the high latitudes in DJF, cold bias in general;

  underestimation of precipitation over southern China, DJF

- **Inter-comparison with other RCM(s)**

  ACCC project of the Sino-UK collaboration: RegCM and PRECIS, ERA-interim, ECHAM5, HadCM3-Qump, and RCP runs, over the CORDEX domain

- **Further analysis of the existed runs**

- **Communication with impact society**

  Interpretation of model results, data processing and distribution (user-friendly, web-site: http://www.climatechange-data.cn)


THANK YOU
GRAZIE
谢 谢！