Climatic and Hydrologic Modeling and Prediction in the Yellow River Basin in China

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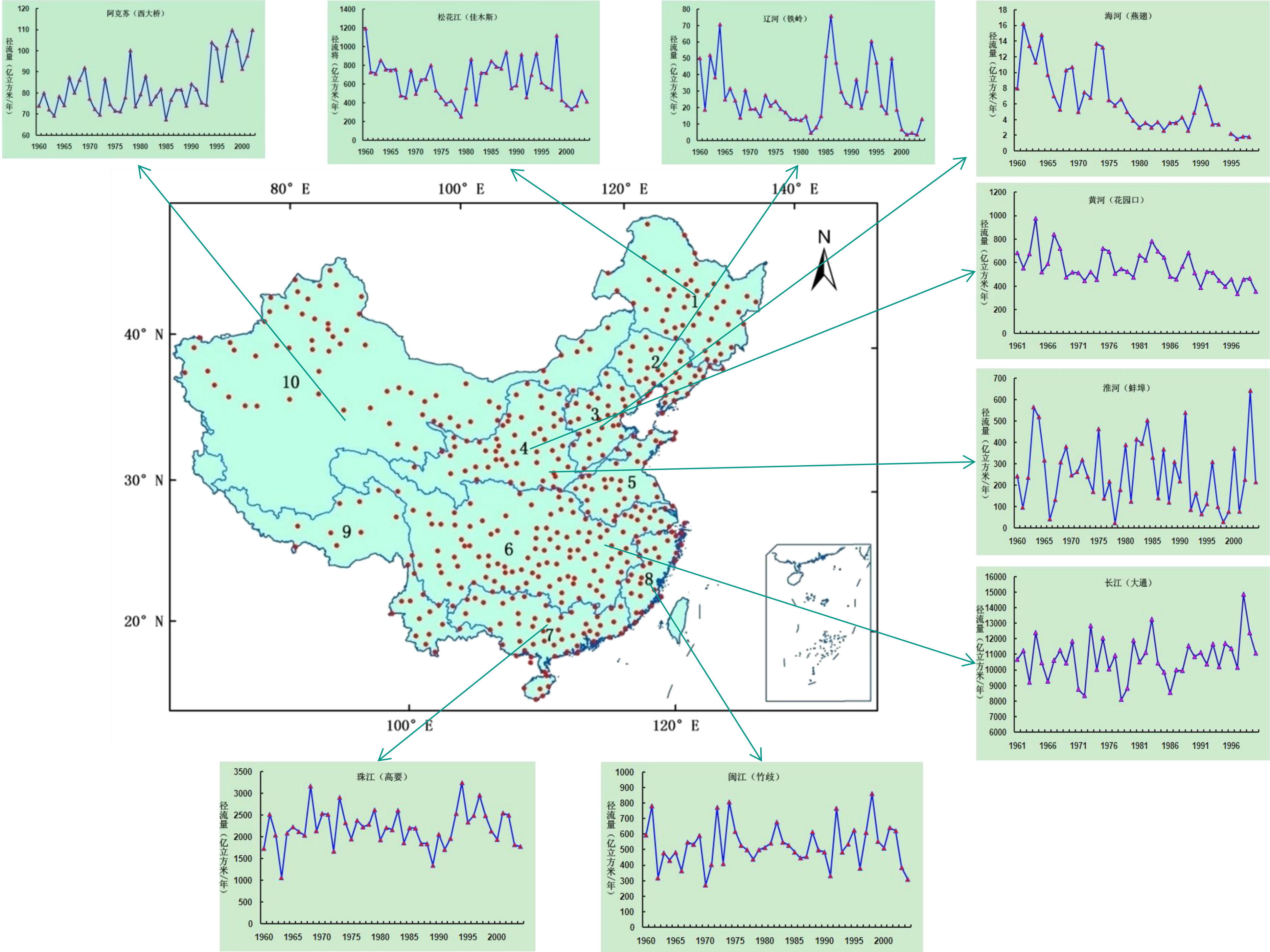
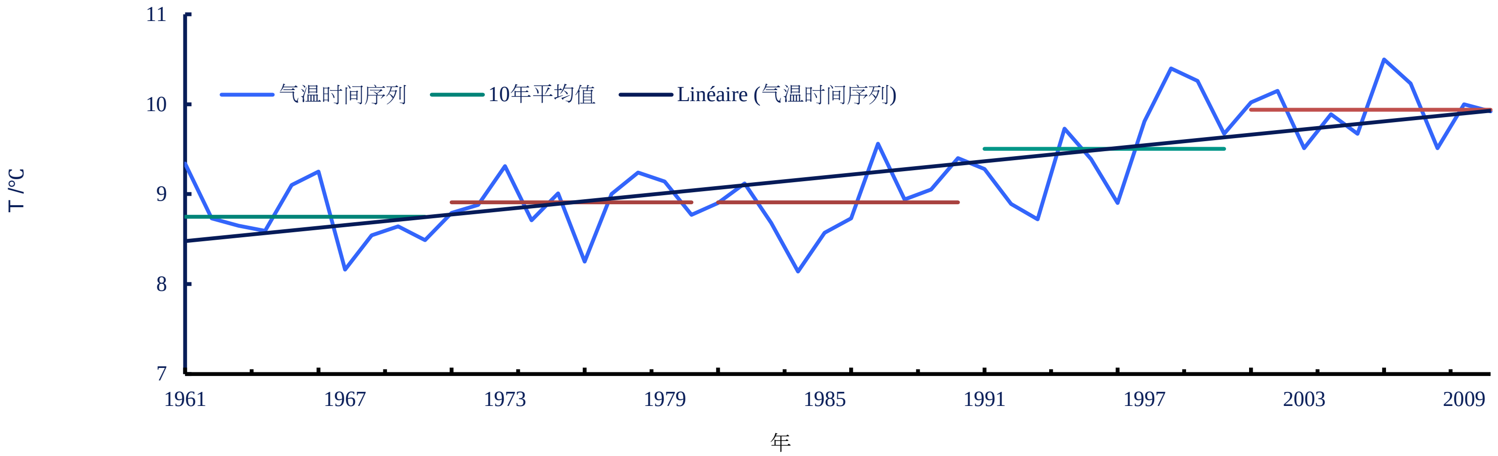
1 Research Background
2 Multi GCMs Downscaling
and Ensemble Prediction
3 Seasonal Climatic & Hydrologic Modeling
4 Climate Change & Hydrologic Modeling
5 Conclusions & Discussions

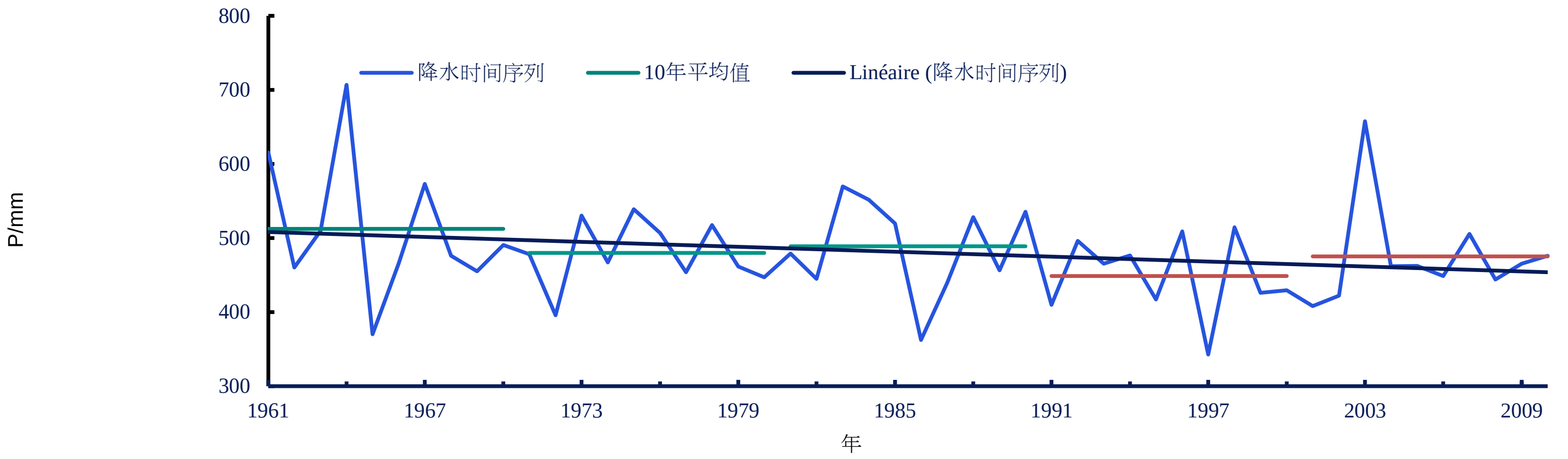
Omsk
Novosibirsk
Krasnoyarsk
Bratsk
Lake Baikal
Chita
Irkutsk
Khabarovsk
Harbin
Changchun
Shenyang
Karaganda
Semipalatinsk
Lake Balkhash
Alma-Ata
Bishkek (Frunze)
KYRGYZSTAN
Ulaanbaatar
MONGOLIA
NORTH KOREA
P'yongyang
Ürümqi
Beijing
Tianjin
Dalian
Demarcation Line
Yellow River
Kashi
Yinchuan
Jinan
Huang He
Zhengzhou
Golmud
Lanzhou
Xi'an
Shanghai
Nanjing
Hangzhou
Indian claim
Chinese line of control
Wuhan
CHINA
Chang Jiang
Chengdu
Nanchang
Chongqing
Changsha
Fuzhou
Lhasa
NEPAL
Kathmandu
BHUTAN
Thimphu
Guiyang
Ganges
Brahmaputra
Kunming
Guangzhou
Hong Kong (U.K.)
Macau (PORT.)
Pratas Island
Vārānasi
Dhaka
Nanning
Irrawaddy
BANGLADESH
Calcutta
Hanoi
Haiphong
Mandalay
Nāgpur
BURMA
Hainan Dao



阿克苏（西大桥）
松花江（佳木斯）
辽河（铁岭）
海河（燕翅）
黄河（花园口）
淮河（蚌埠）
长江（大通）
珠江（高要）
闽江（竹岐）
径流量（亿立方米/年）
径流将（亿立方米/年）
80° E
100° E
120° E
140° E
40° N
30° N
20° N
N
1
2
3
4
5
6
7
8
9
10

Annual mean temperature (top) and precipitation (bottom) during 1961-2009 in the Yellow River Basin





Studies on Integrated Climatic and Hydrologic Prediction Methods in the Yellow Basin

- Analyses of Climate and hydrology changing trend
- Diagnosis and simulations of strong signals affecting climate change
- Seasonal climate simulations and predictions
- Climate change simulations and projections
- Climatic-hydrologic modeling

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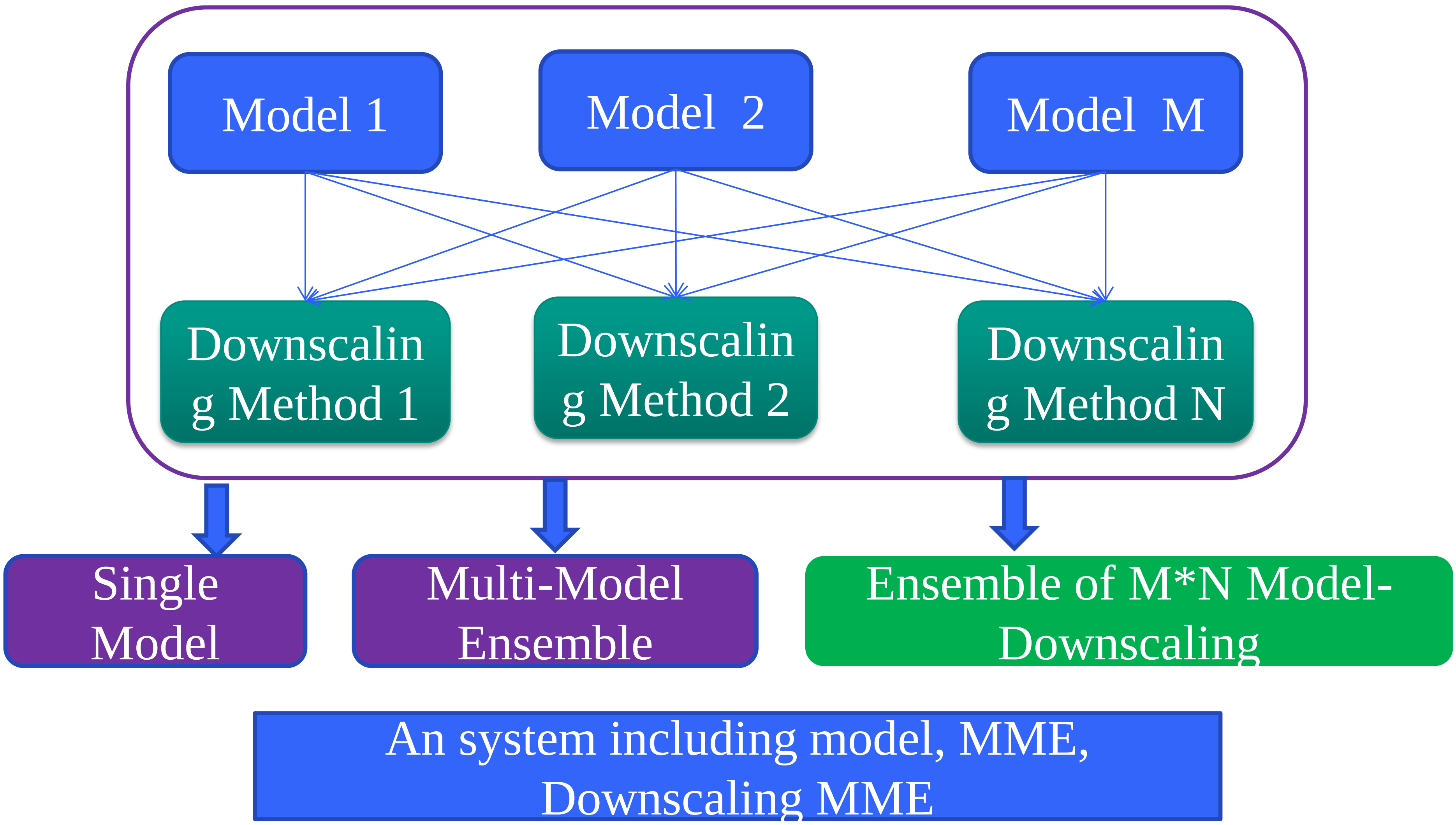
Multi-Model&Downscaling Ensemble Prediction System for Yellow River Basin



Models and observation data

WMO-GPC	Model Name	Predicted Months	Operational Application	Resolution	Hindcast Time
ECMWF	System 4	7	2011	1.5*1.5	1981-2010
NCEP	CFS v2	9	2011	1* 1 /t126 Gauss	1982-2010
TCC	MRI-CGCM	3-7	2009	2.5*2.5	1979-2008
NCC	CGCM v1	11	2005	2.5*2.5	1983-2003

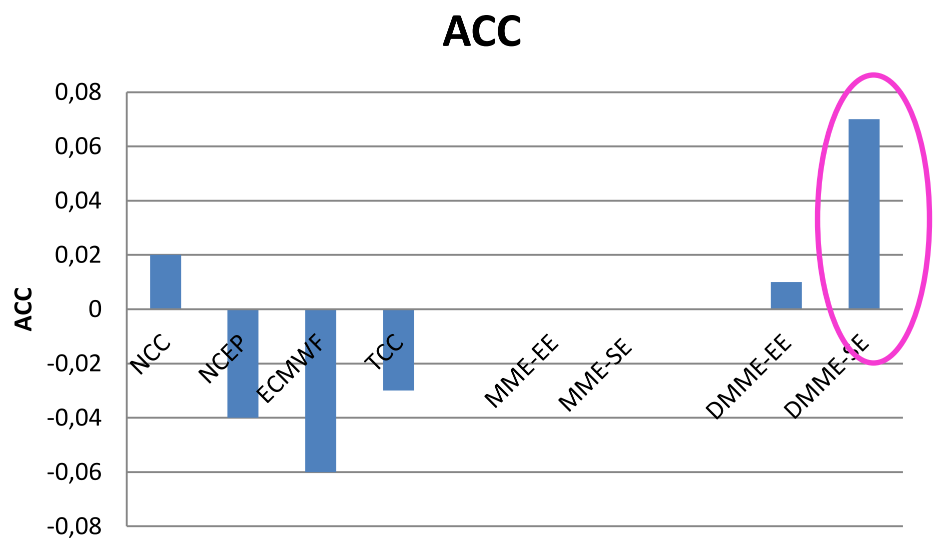
Observation data: monthly 134 stations over Yellow River Basin

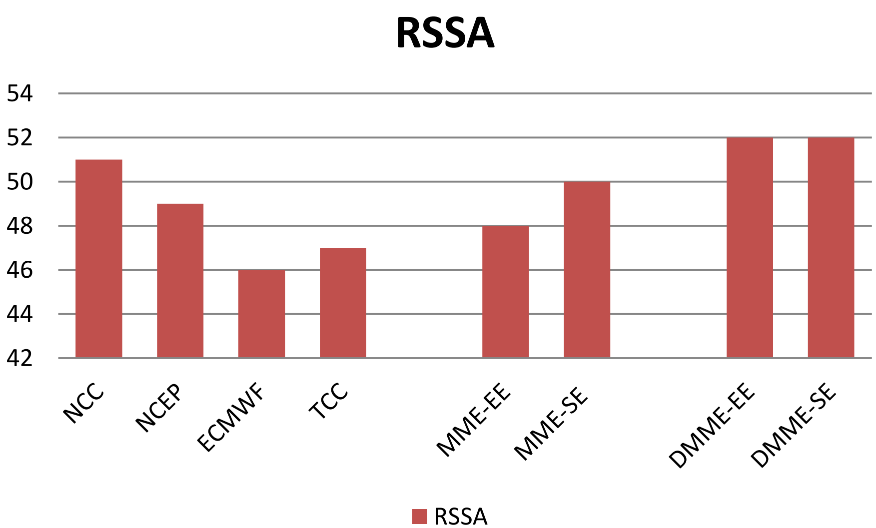
Downscaling and Ensemble Methods

- BP-CCA
- EOF-ITE
- Regress Ensemble of High Correlation Factors
- Optical Subset Regression

- ✓ Equal-weighted Average Ensemble
- ✓ Super-Ensemble

Skill of Model, MME and Downscaling MME

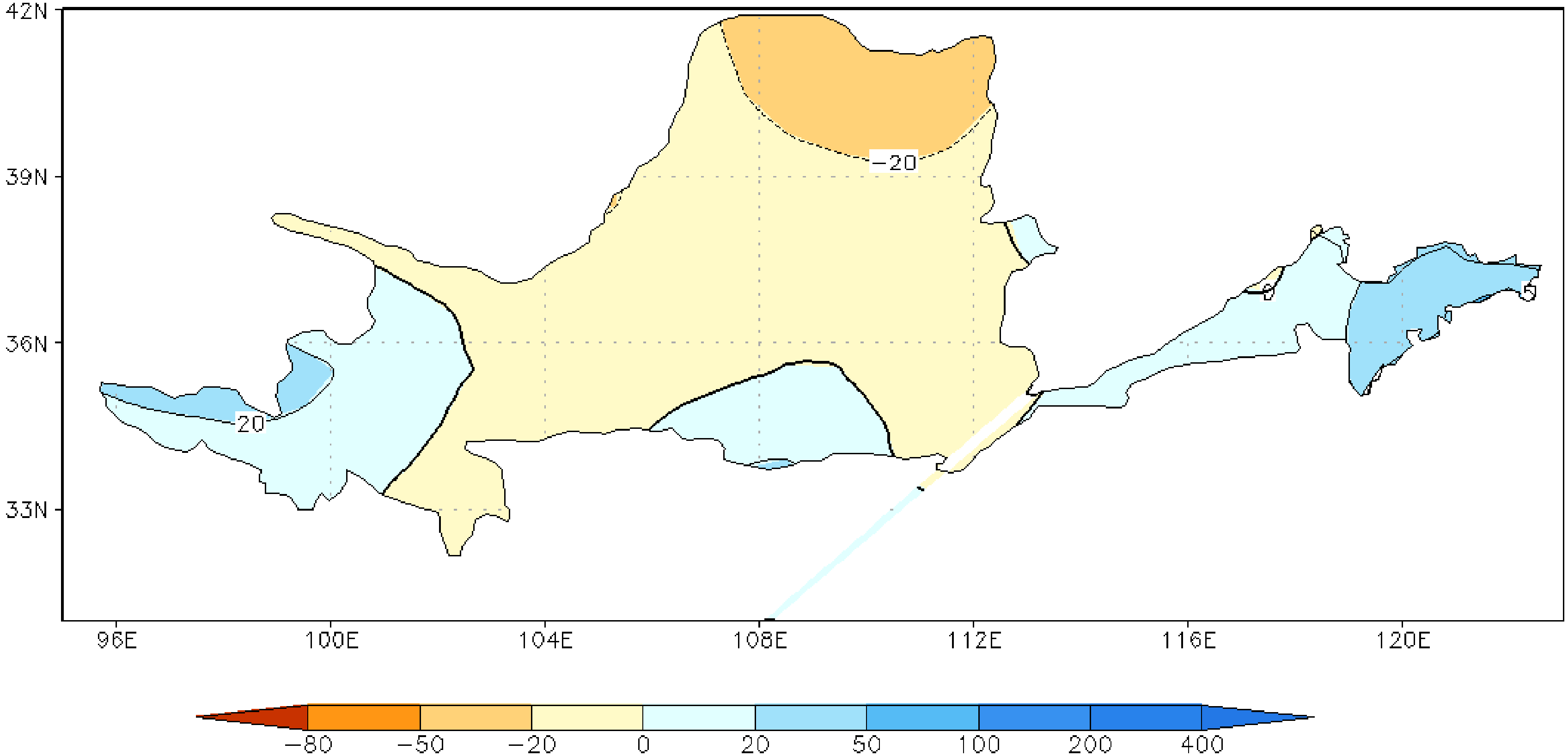




- Single Model is no predicting skill
- MME can’t improve predicting ability

- Downscaling MME looks better
- Super-ensemble is better than Equal-Weight Average ensemble

Prediction for precipitation anomaly Percent over the Yellow River Basins for the 2013 summer



It is predicted that there will be less precipitation over most of the basins based on our Multi-Model&Downscaling Ensemble Prediction Method.

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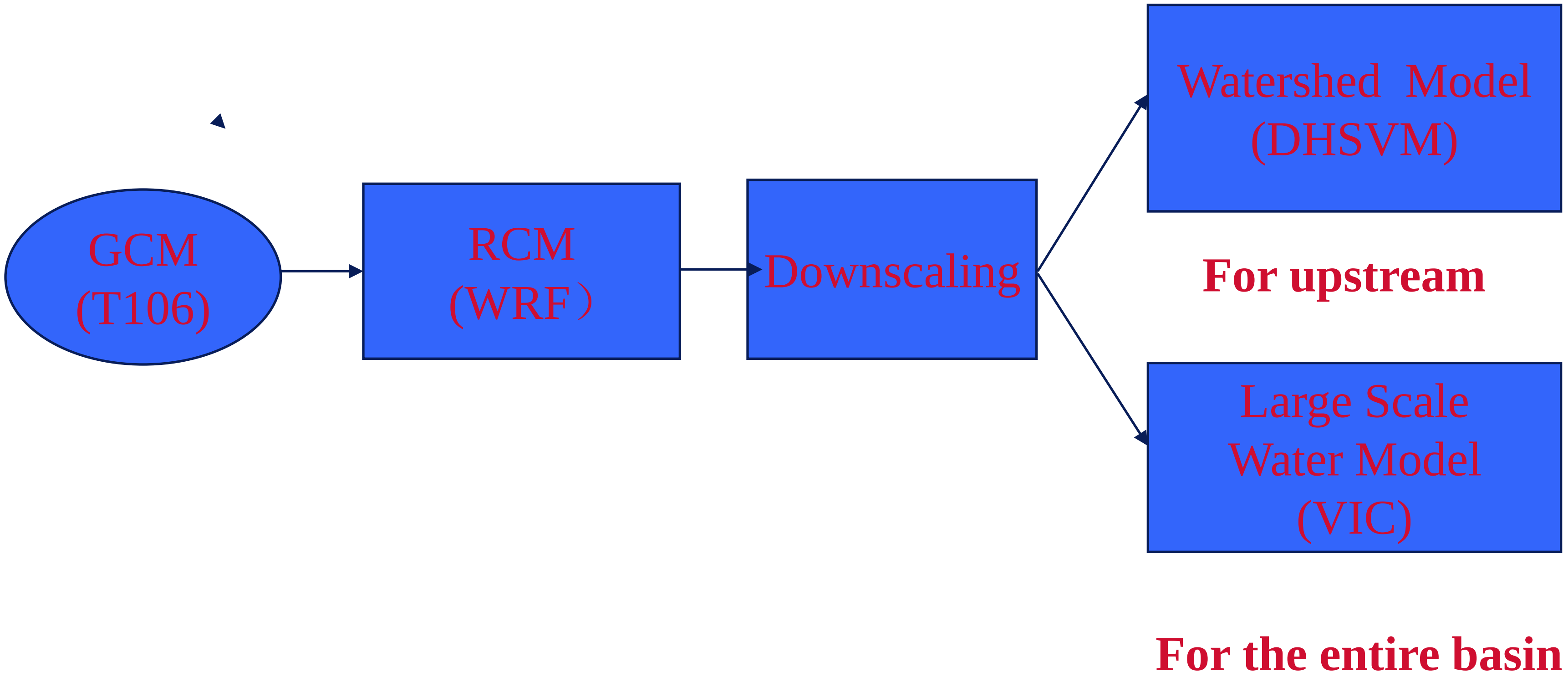
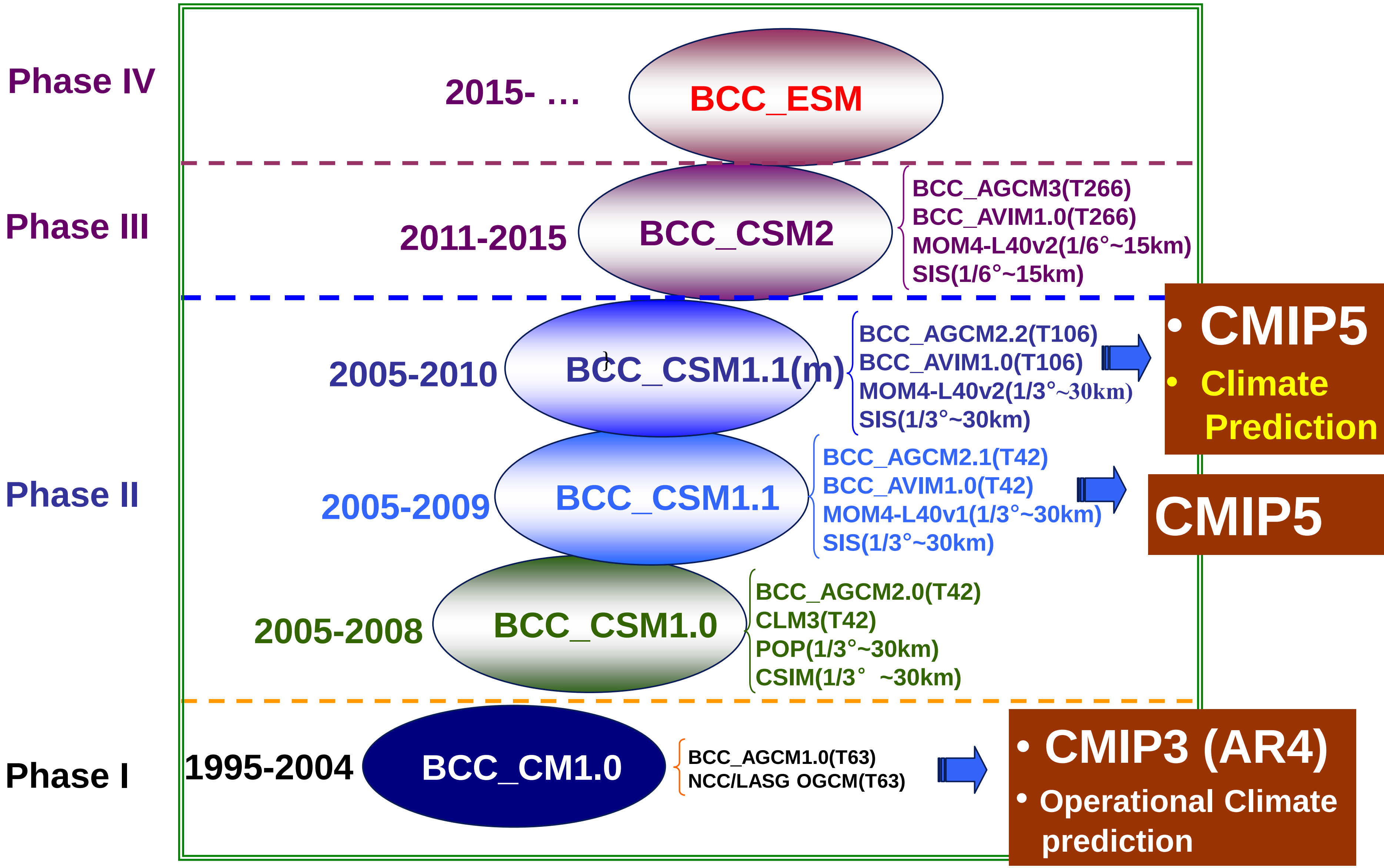
Seasonal Climatic & Hydrologic Modeling Diagram



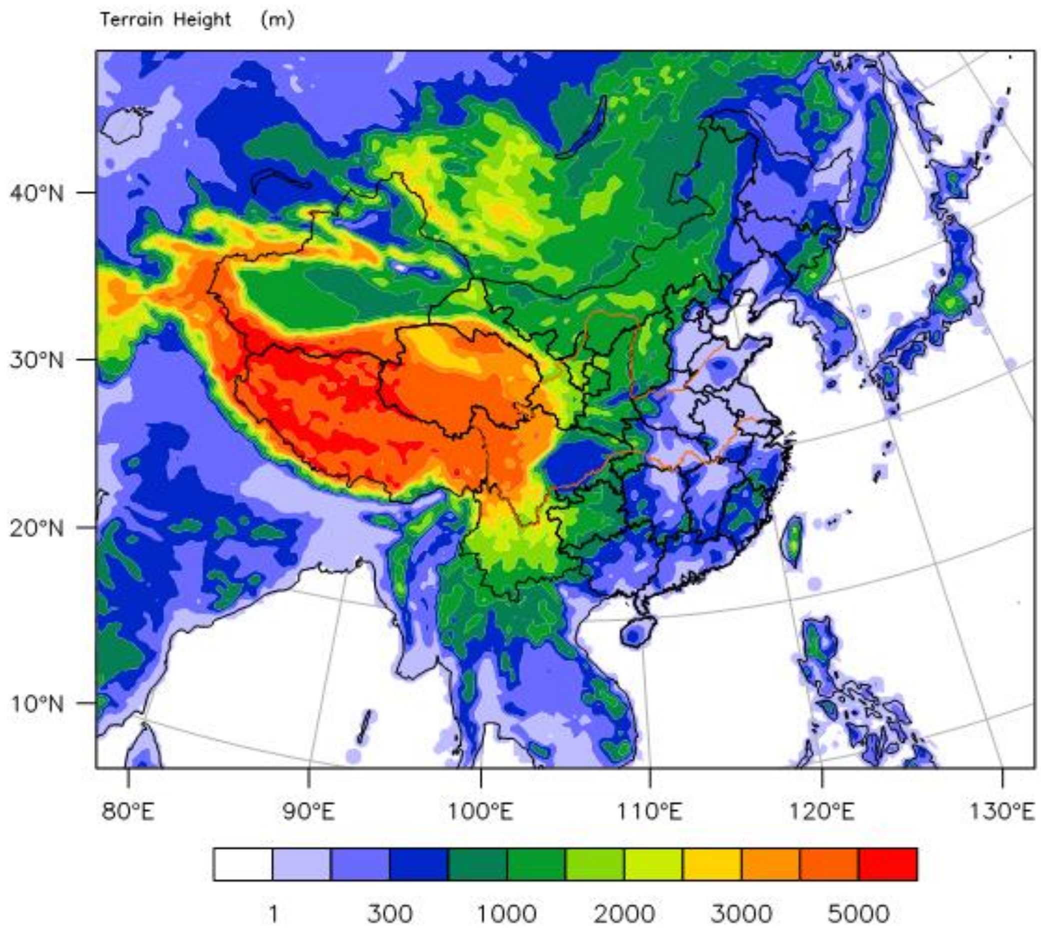
Climate System Model (BCC_CSM)



WRF3.3.1

Horizontal Resolution :30km

Domain: East Asia including whole China

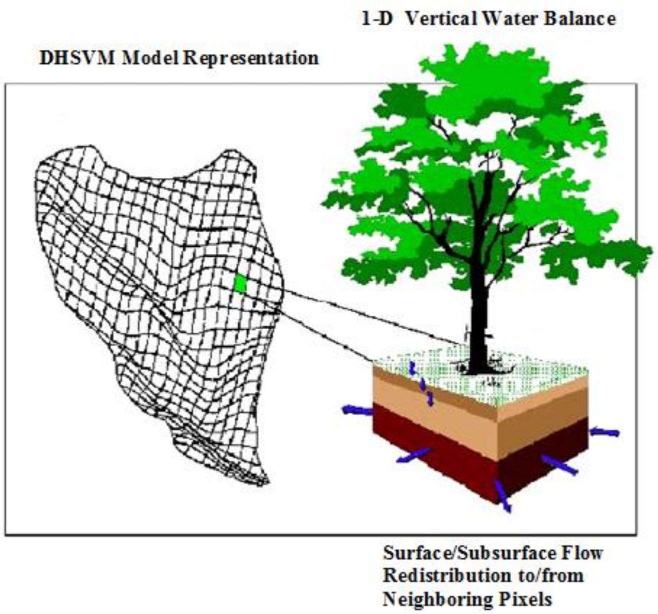


4 groups of microphysics and cumulus schemes

	microphysics schemes	cumulus schemes
Test1	Kain-Fritsch scheme	Morrison 2-moment scheme
Test2	Grell 3D ensemble scheme	Morrison 2-moment scheme
Test3	Kain-Fritsch scheme	Ferrier scheme
Test4	Grell 3D ensemble scheme	Ferrier scheme

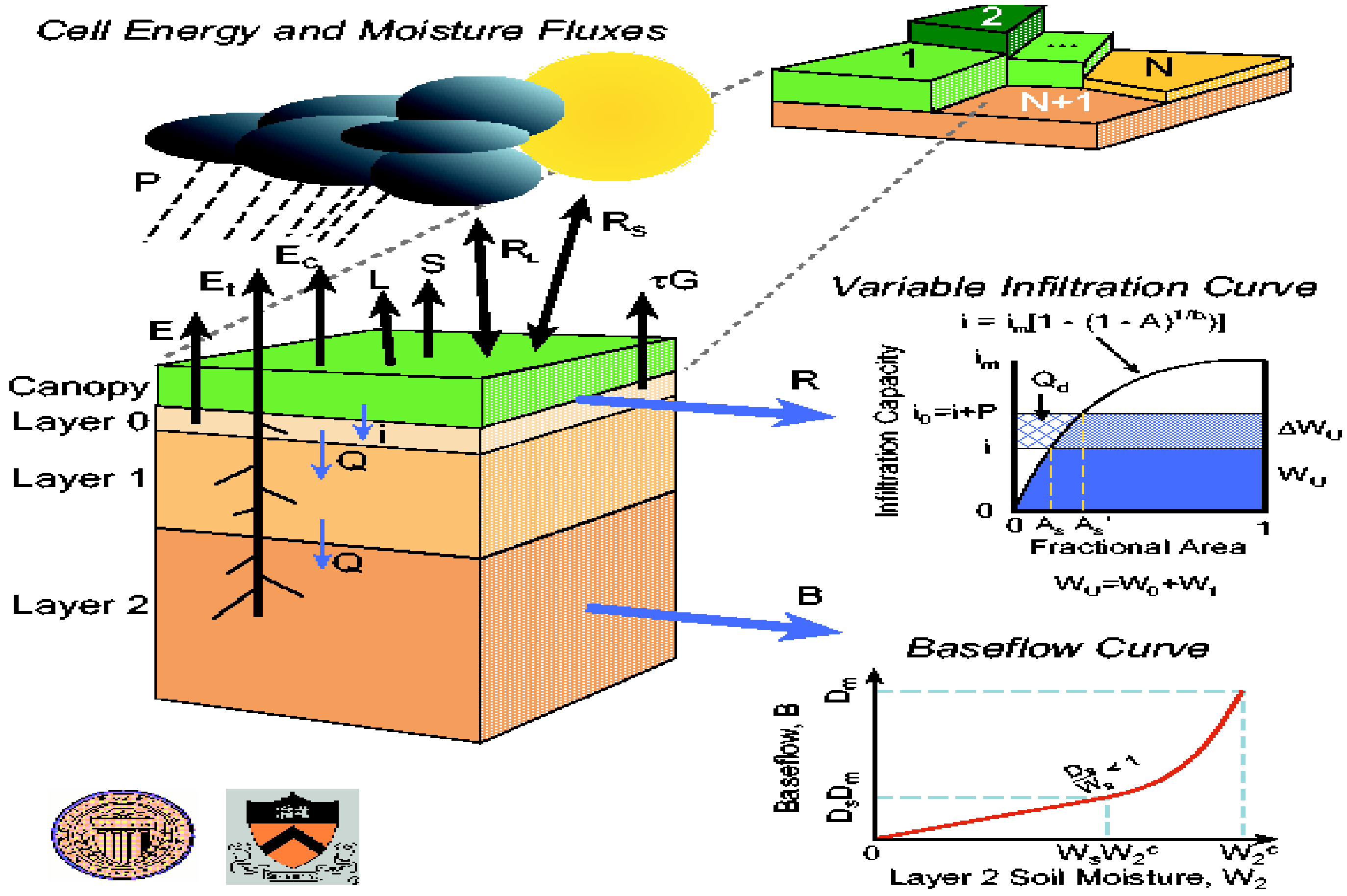
DHSVM 3.0

Distributed hydrology-soil-vegetation model (DHSVM)



- Physically based hydrologic model that represents the effects of
  - Topography
  - Soil
  - Vegetation
- Solves the energy and water balance at each grid cell at each timestep

VIC（Variable Infiltration Capacity）



Schematic of the VIC-3L model with mosaic representation of vegetation coverage.

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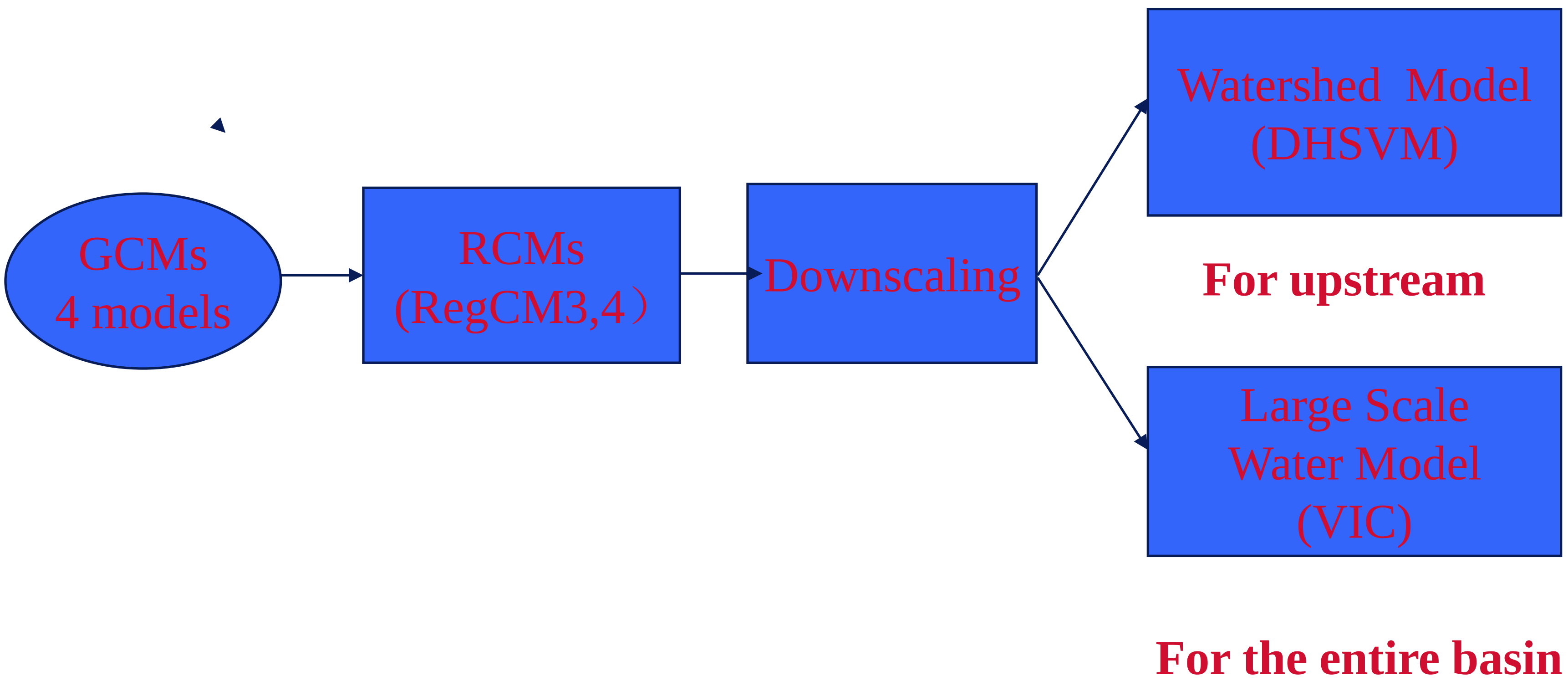
Climate Change & Hydrology Modeling Diagram



RCMs nesting with GCMs

- **MdR: RegCM3.0 nesting with MIROC3.2_hires**

  Domain: East Asia area

  Horizontal Resolution: 25km

  Period: 1981-2100

  Scenario: IPCC SRES A1B

- **EdR: RegCM4.0 nesting with ECHAM5**

  Domain: CORDEX-East Asia area

  Horizontal Resolution: 50km

  Period: 1981-2100

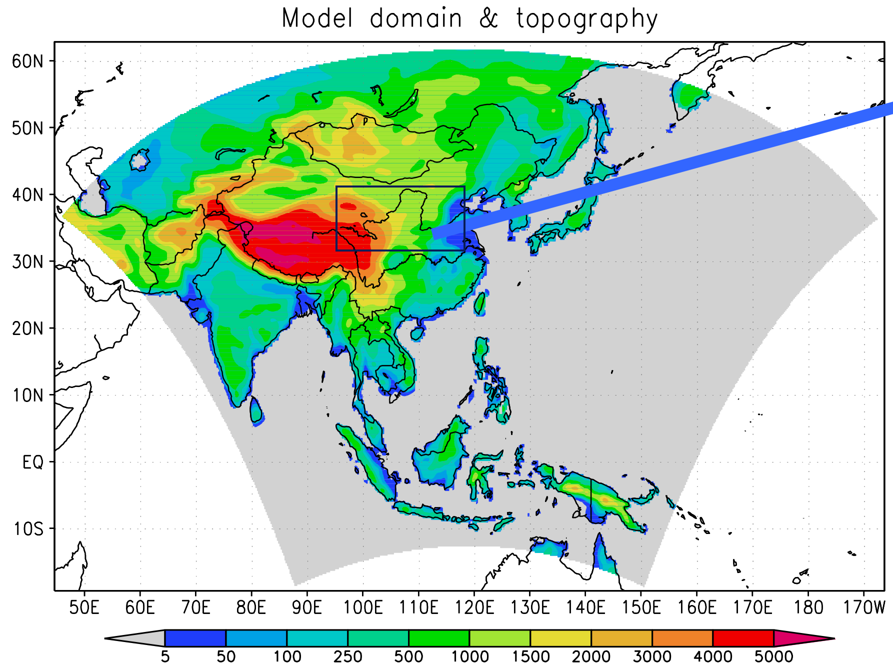
  Scenario:IPCC SRES A1B

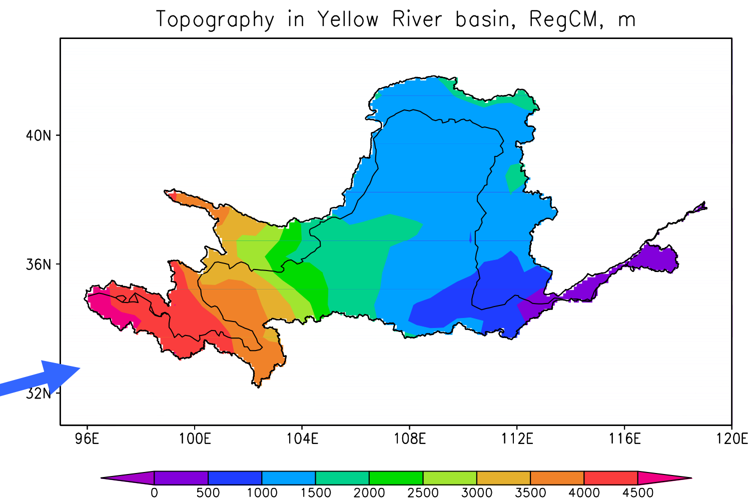
RCMs nesting with GCMs

- **HdR: RegCM4.0 nesting with HadCM3**
  Domain: CORDEX-East Asia area
  Horizontal Resolution: 50km
  Period: 1981-2100
  Scenario: IPCC SRES A1B

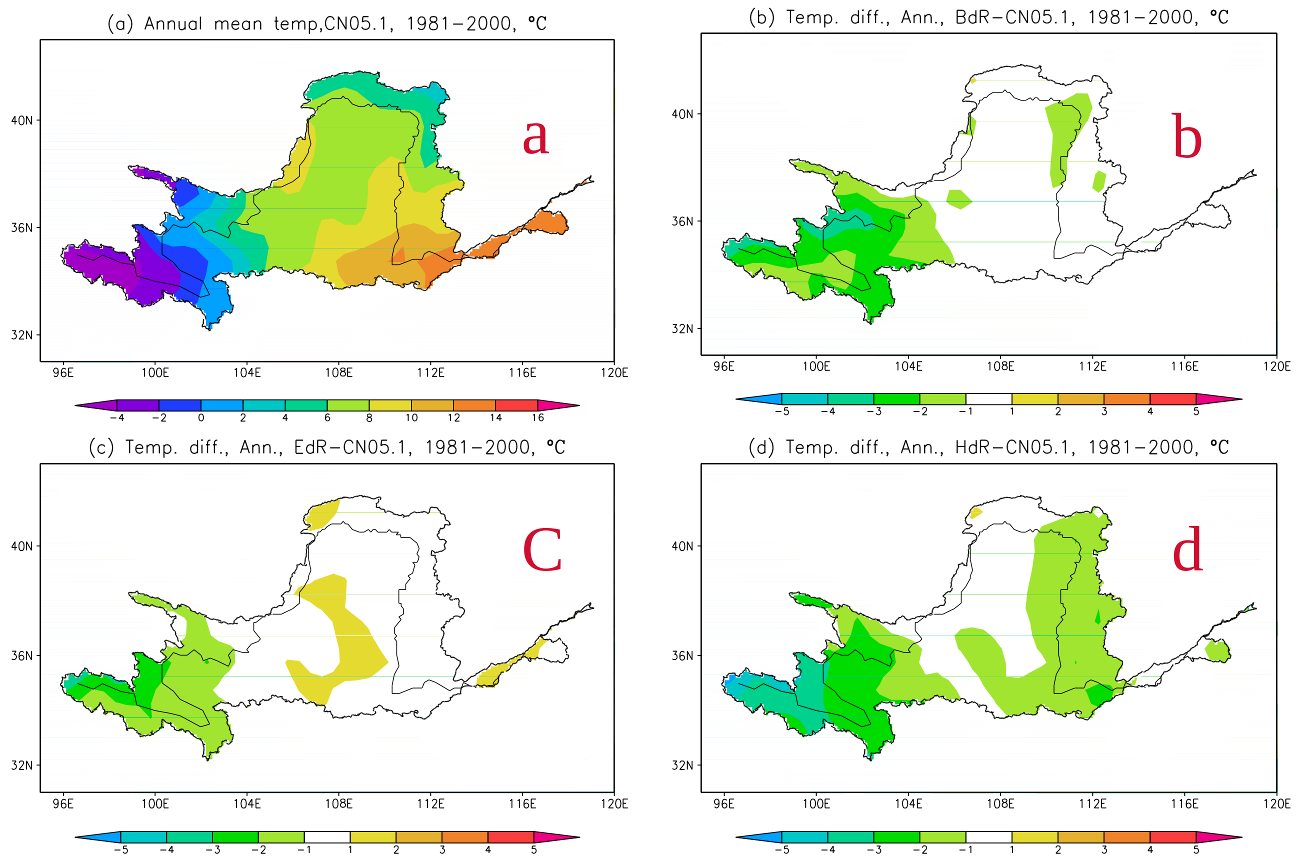
- **BdR: RegCM4.0 nesting with BCC-CSM1.0**
  Domain: CORDEX-East Asia area
  Horizontal Resolution: 50km
  Period: 1981-2100
  Scenario: RCP8.5, RCP4.5

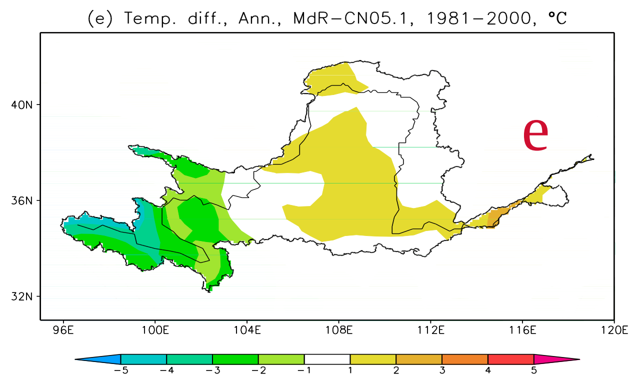
Downscaling





Comparison of the modeling results with observations: T





a CN05.1

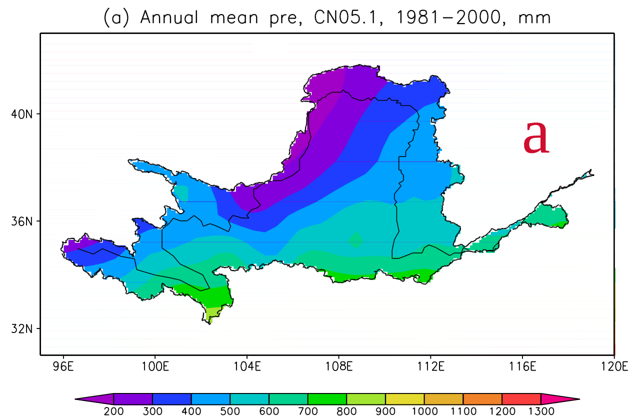
b BdR looks better

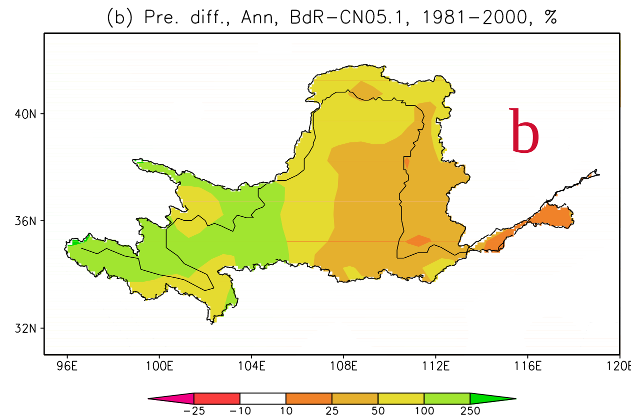
c EdR

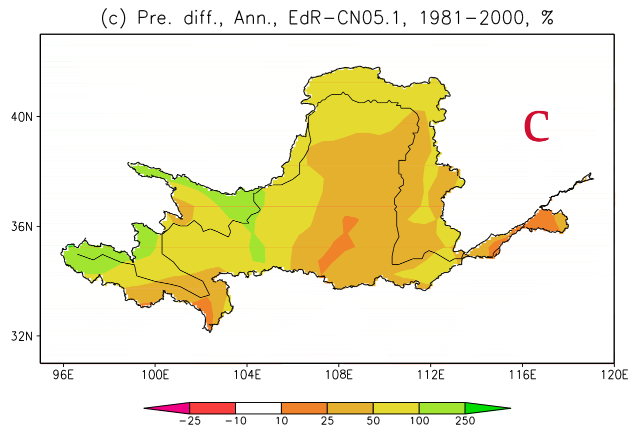
d HdR

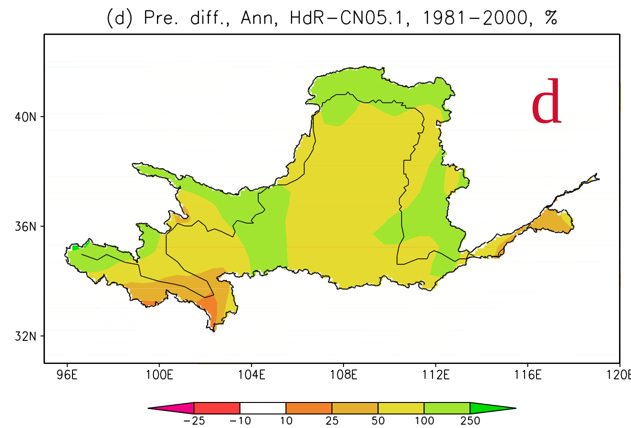
e MdR

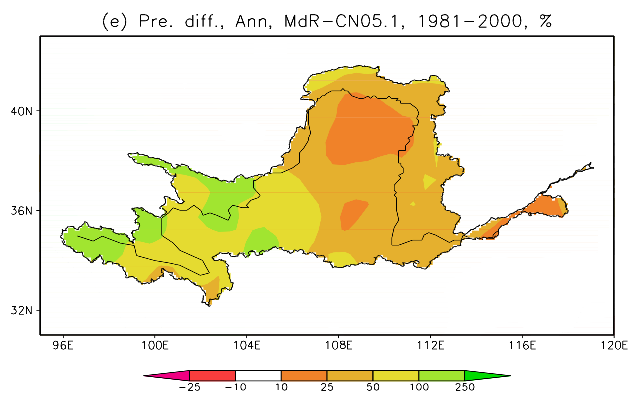
Comparison of the modeling results with observations: P











a CN05.1

b BdR looks better

c EdR

d HdR

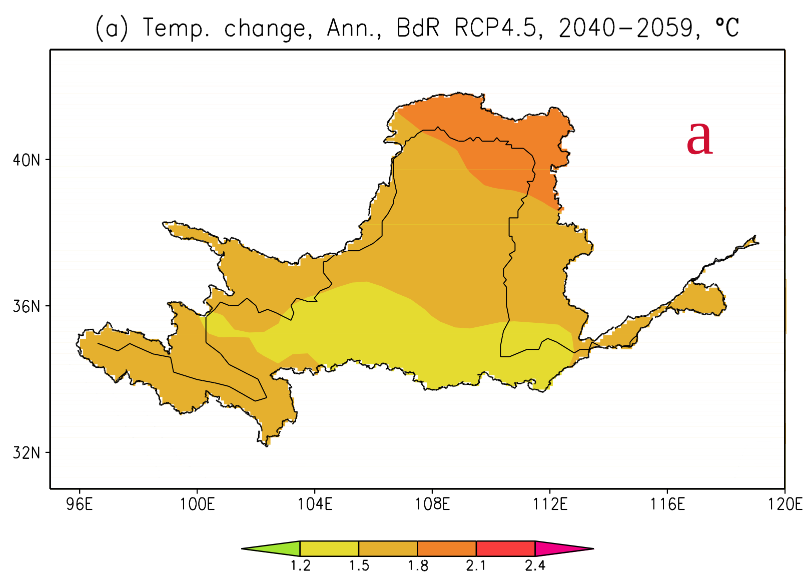
e MdR

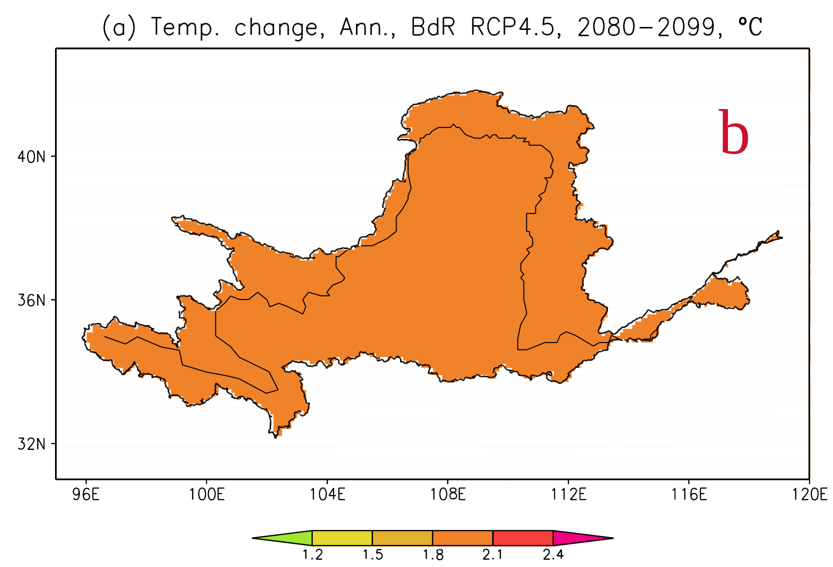
Future T projections under RCP 4.5 scenario

（Representative Concentration Pathways，RCPs）

To middle of 2100 (a): increase1.2~2.1°C

To the end of 2100 (b): increase1.8~2.1°C

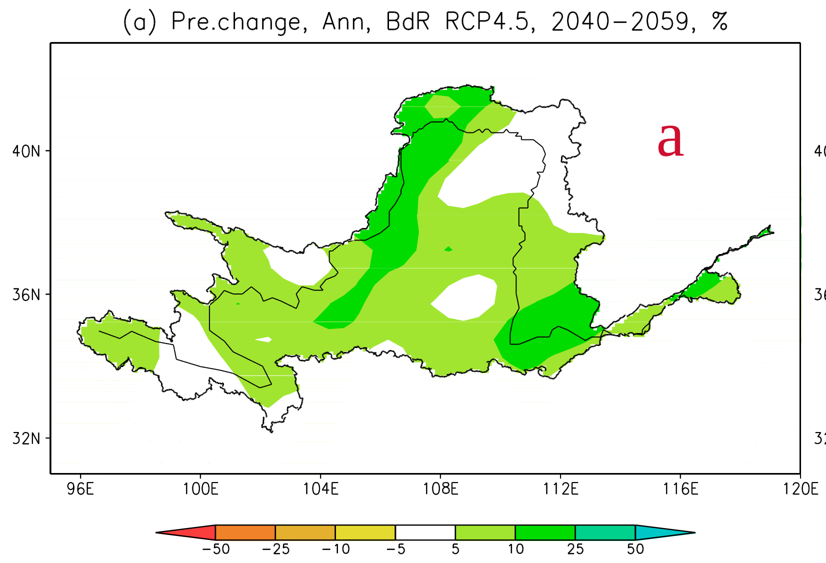


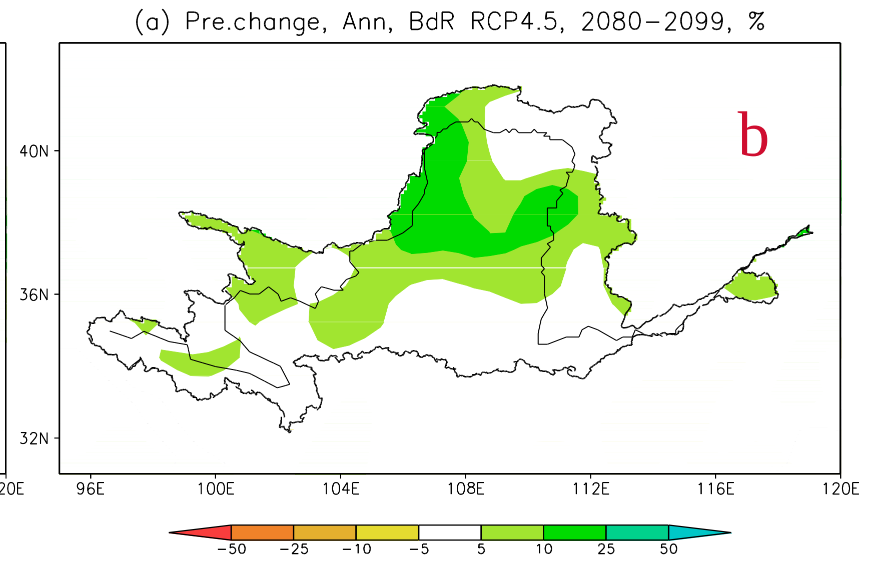


Future P projections under RCP 4.5 scenario

To middle of 2100 (a): increase 5%~25%

To the end of 2100 (b): increase10%~25%

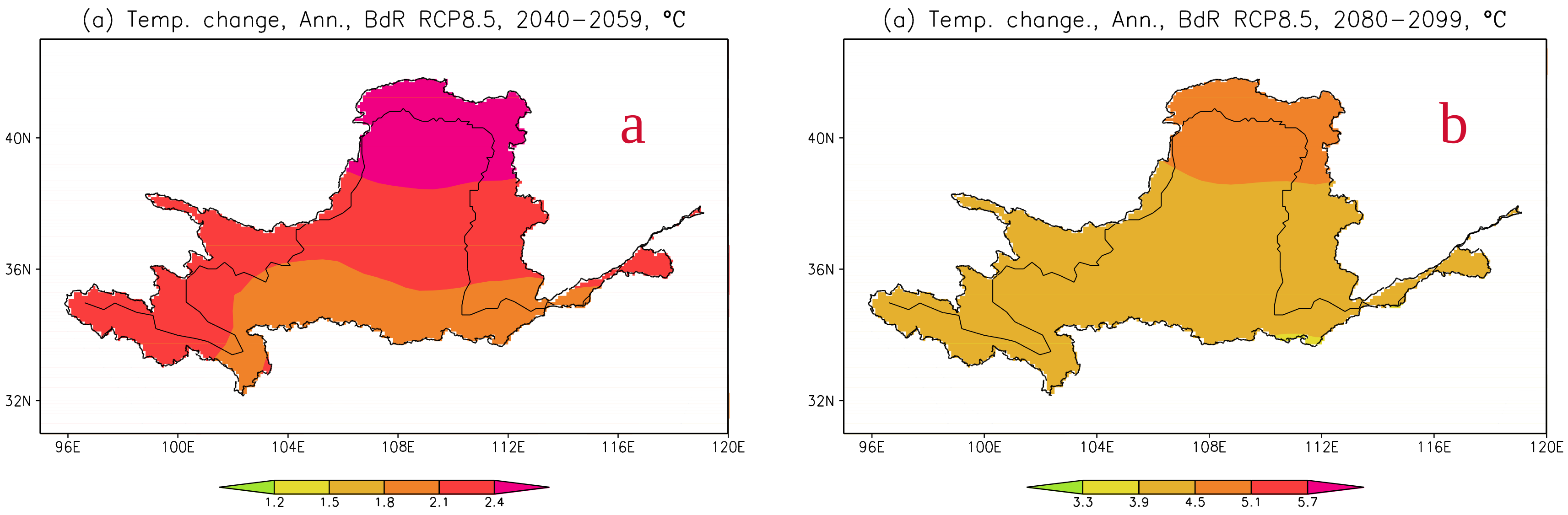




Future T projections under RCP 8.5 scenario

To middle of 2100 (a): increase more than 1.8°C

To the end of 2100 (b): increase 3.9~5.1°C



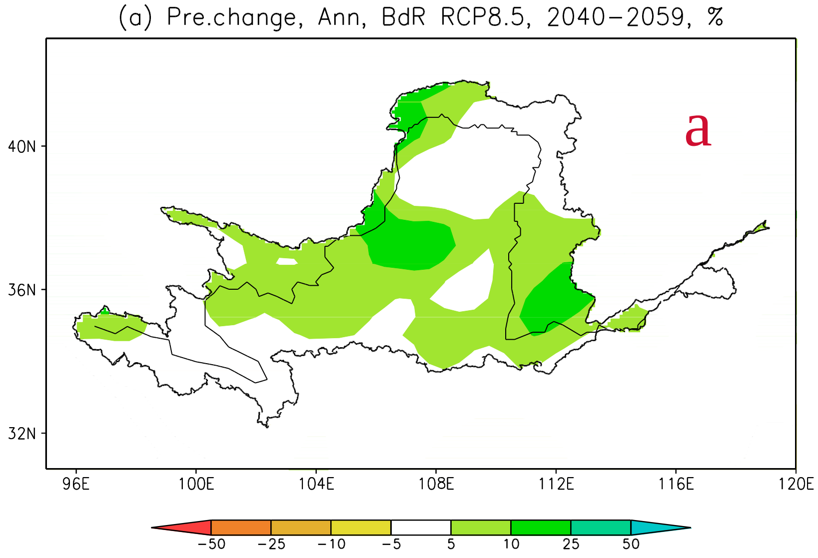
Future P projections under RCP 8.5 scenario

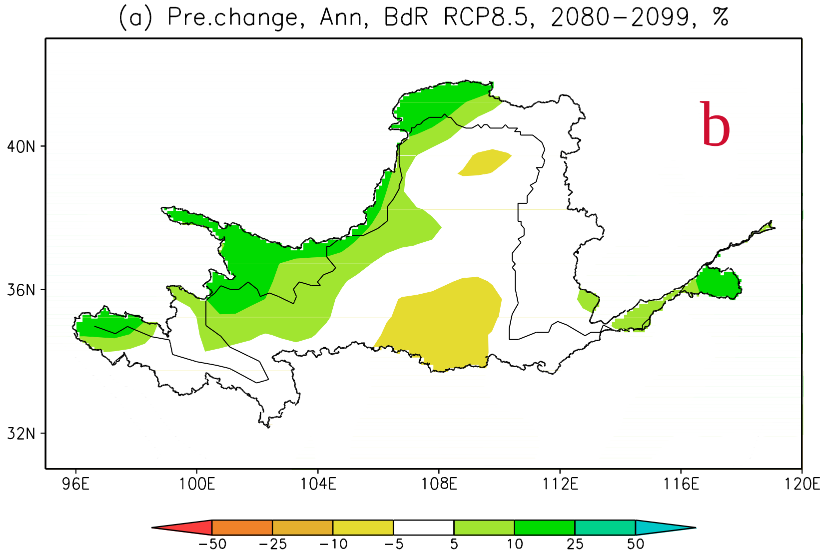
To middle of 2100 (a): most areas ±5%

some areas increase 5%~25%

To the end of 2100 (b): most areas ±5%

some areas increase -5%~10%





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Conclusions & Discussions

•In order to enhance climatic and hydrologic prediction and assessment ability in the Yellow River Basin, the climatic and hydrologic modeling system was developed based on a joint international research.

•Multi GCMs downscaling and ensemble prediction system for the Yellow River Basin was established. In terms of the modeling results, less precipitation will occur this summer over the middle reach of the Yellow River Basin.

•The regional climate model WRF3.3.1 was nested with BCC_CSM (T106, T266) for seasonal climate modeling, and the downscaling results were used for driving the large scale hydrologic mode VIC and watershed model DHSVM for hydrologic modeling.

Conclusions & Discussions

- RegCM3 and RegCM4 were nested with 4 GCMs (MIROC3.2, ECHAM5, HadCM3 and BCC-CSM1.0) for climate change modeling . According to comparison between modeling results and observations, the BdR approach (RegCM4 nested with BCC-CSM1.0) looks better than others. Then the BdR was driven by RCP4.5 and RCP8.5 for climate change simulations. The modeling results indicate that in future, temperature will continually increase, while precipitation in general will also increase, but not as obvious as temperature.
- There are many uncertainties and challenges for climate modeling and predictions. The modeling system should be improved through predictiing practices and broad international collaborations.

Thank you very much