Statistical downscaling and dynamical downscaling of regional climate in China: Present climate evaluations and future climate projections

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Introduction:

· Dynamical downscaling refers to the use of regional climate models (RCMs) driven by GCM output or reanalysis data to produce regionalized climate information.

· The resolution in most RCMs ranges from 20km to 60km.

· The regression approach is the most widely used in statistical downscaling due to its relatively easy realization and its relatively small computer resource requirement.

· But statistical downscaling requires long-term, high-quality surface observation to establish a robust statistical relationship between large-scale variables and local variables.

Data:

· OBS: National Meteorological Information Center of China.

· GCMs: 1. ECHAM5/MPI-OM model (ECHAM5)

2. IPSL-CM5A-LR model (CM5A)

· SDSM vs. WRF (Weather Research and Forecasting)

Table 1. The 13 Used NCEP Predictor Variables

Abbreviation	Description	Unit
Slp	Mean sea level pressure	Pa
p5_p	500 hPa geopotential height	m
p5_t	500 hPa temperature	K
p5_u	500 hPa zonal velocity	m/s
p5_v	500 hPa meridional velocity	m/s
p5_z	500 hPa vorticity	1/s
p7_t	700 hPa temperature	K
p7_u	700 hPa zonal velocity	m/s
p7_v	700 hPa meridional velocity	m/s
P8_t	850 hPa temperature	K
P8_u	850 hPa zonal velocity	m/s
P8_v	850 hPa meridional velocity	m/s
shum	700 hPa specific humidity	kg/kg

Methods:

· time period: 1961-2000 (1961-1980 and 1981-2000),

2041-2060

Metrics: RMSEs

MAEs,

CORRs

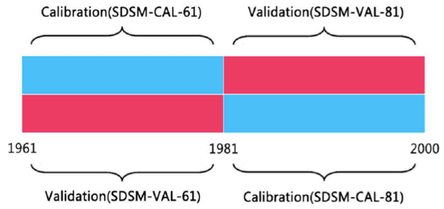

Figure 2. Sketch map of the cross validation for the SDSM. SDSM-CAL-61: SDSM during calibration period 1961–1980; SDSM-CAL-81: SDSM during calibration period 1981-2000; SDSM-VAL-61: SDSM during validation period 1961–1980; SDSM-VAL-81: SDSM during validation period 1981–2000.

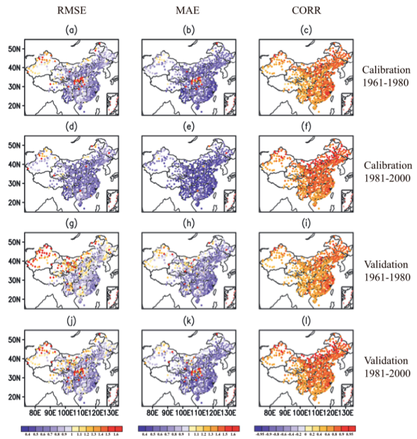

Figure 3. The root-mean-square errors (RMSEs), mean absolute errors (MAEs), and correlation coefficients (CORRs) between the SDSM-downscaled monthly surface temperature and observations for the calibration and validation periods (correlation coefficients exceeding 0.15 are significant at the 0.05 level).

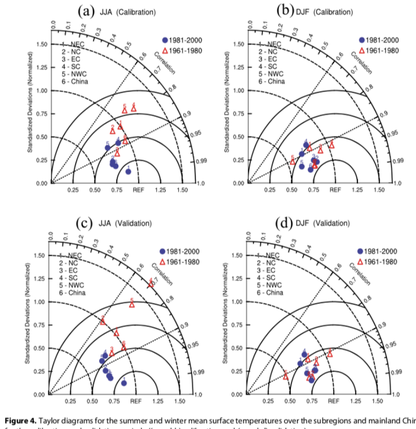

Figure 4. Taylor diagrams for the summer and winter mean surface temperatures over the subregions and mainland China for the calibration and validation periods ((a and b) calibration and (c and d) validation).

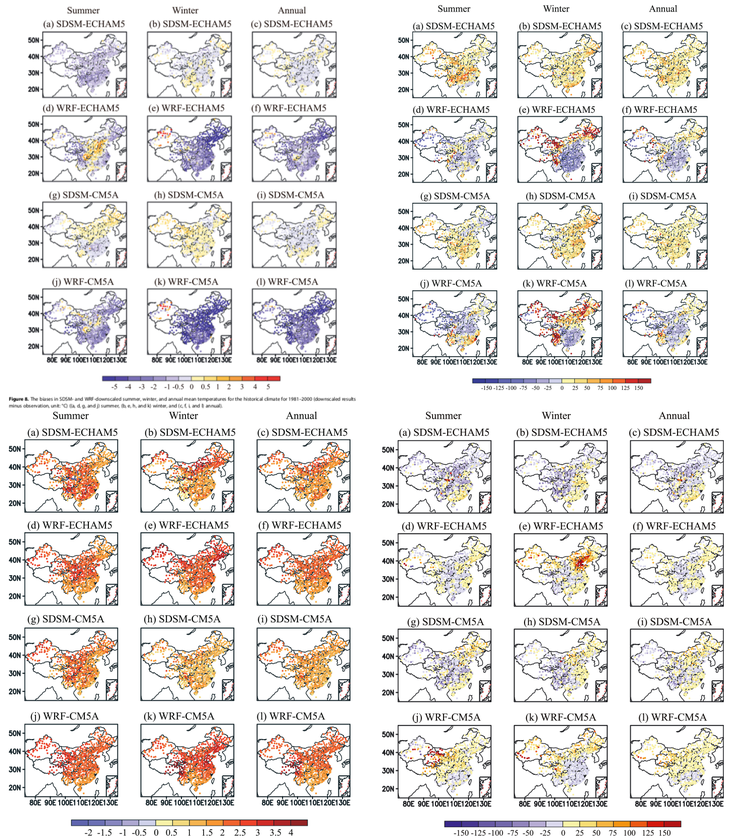

Figure 5. The biases in SDSM- and WRF-downscaled summer, winter, and annual mean temperatures for the historical climate for 1981–2000 (downscaled results minus observation; unit: °C (a, d, g, and j) summer, (b, e, h, and k) winter, and (c, f, i, and l) annual).

Table 2. List of the WRF Runs

Runs	GCM	Domain and Resolution	Emission Scenario	Nudging
WRF-ECHAM5-20C	ECHAM5/MPI-OM	233 × 197 50 km	CMIP3 20C3M	No
WRF-ECHAM5-A1B	ECHAM5/MPI-OM	233 × 197 50 km	CMIP3 A1B	No
WRF-CM5A-HIST	IPSL-CM5A-LR	117 × 103 50 km	CMIP5 HIST	No
WRF-CM5A-RCP45	IPSL-CM5A-LR	117 × 103 50 km	CMIP5 RCP4.5	No

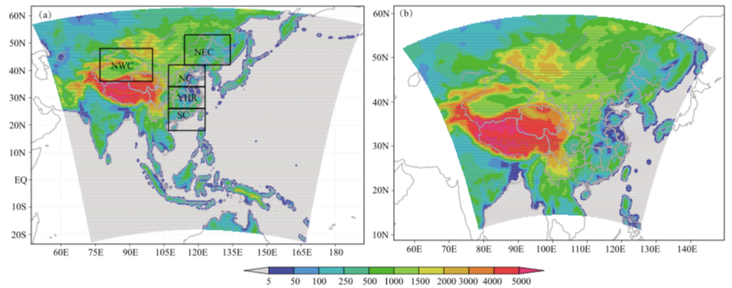

Figure 1. (a) WRF-ECHAM5 and (b) WRF-CM5A simulation domains (light shadowed area, unit: meters above sea level) and the Five Subregions in China (NEC: Northeast China; NC: North China; YHR: Yangtze-Huai He River basin; SC: South China and NWC: Northwest China).

Conclusions:

· The spatial distribution of surface temperature produced by the SDSM is generally within approximately 1°C of the observations. In contrast, the WRF produces large negative biases that are especially strong during the colder seasons.

· For the future period 2041–2060, the SDSM and WRF produce nontrivial warming when either ECHAM5 or CM5A is used as input. Compared to the WRF temperature changes, the SDSM predicts weaker warming.

· For the precipitation changes, less consistency is found in the projected precipitation changes between the two downscaling methods.

Report

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張慕琪

讨论

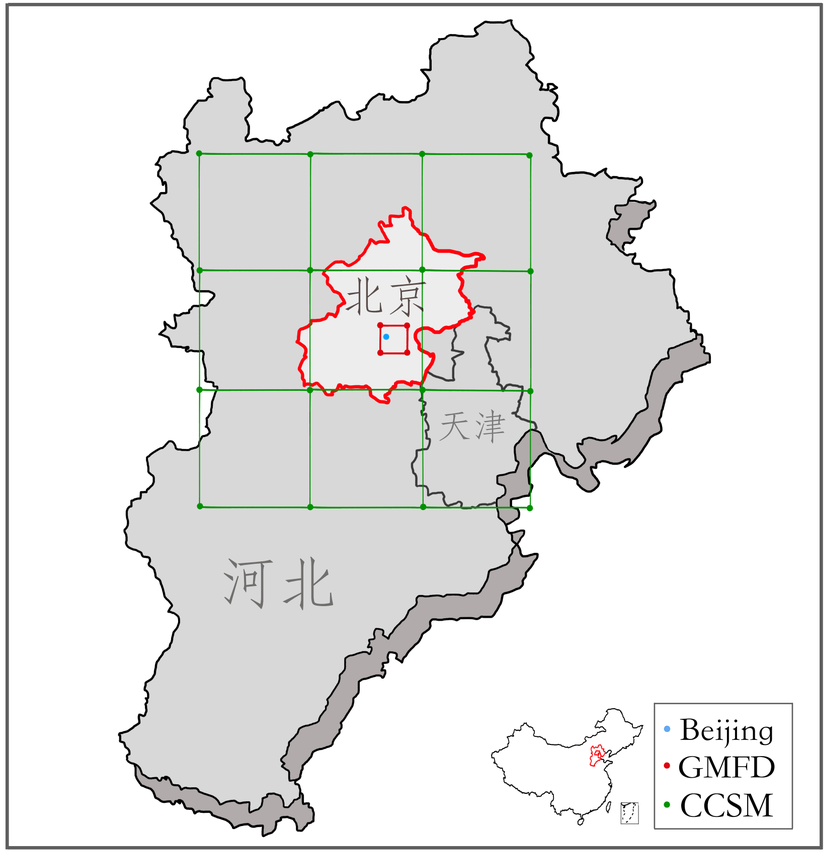

北京
天津
河北
Beijing
GMFD
CCSM

图1

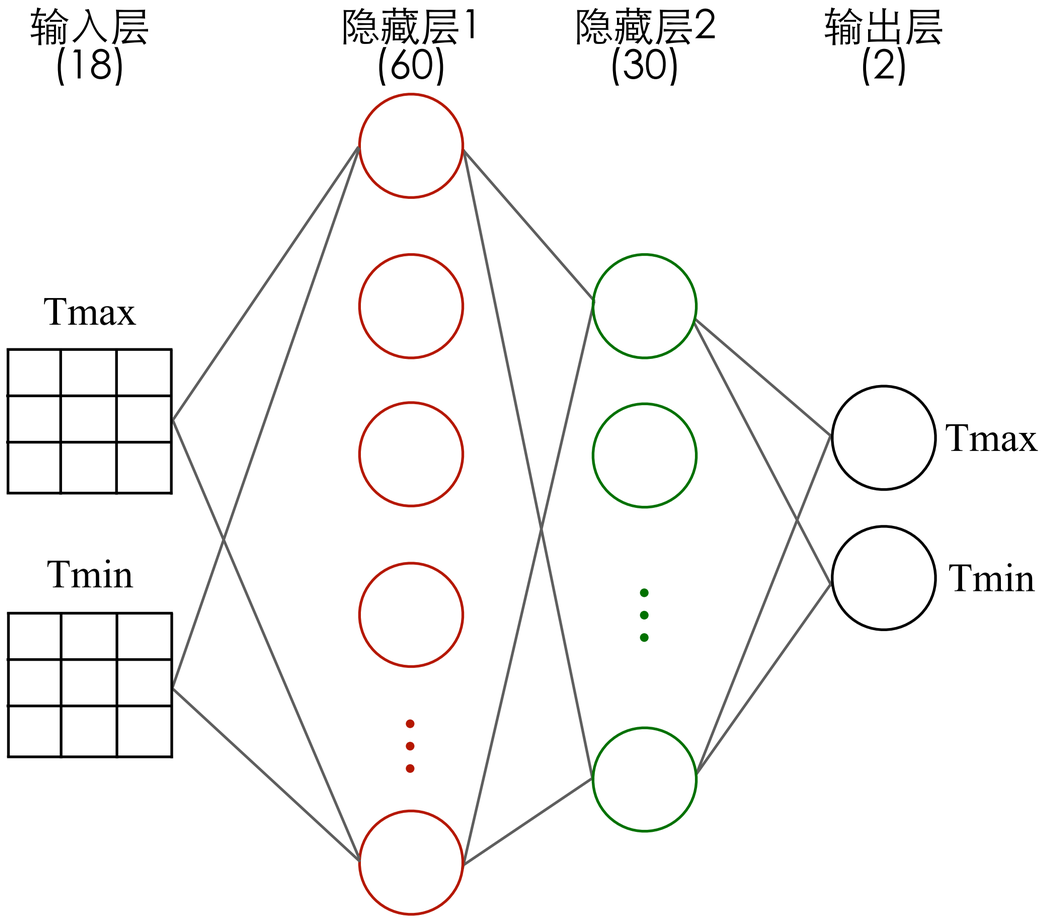
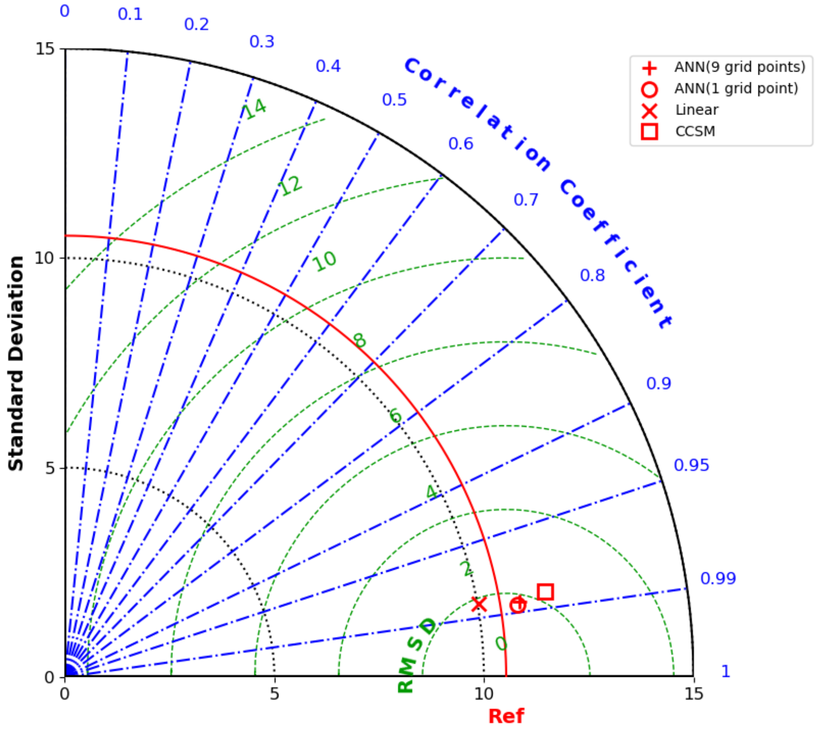
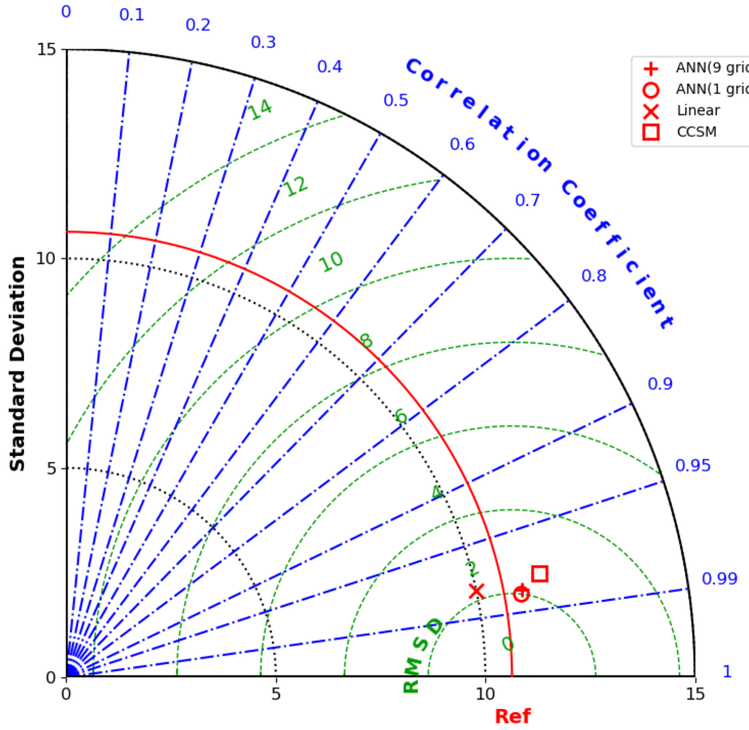

输入层
(18)
隐藏层1
(60)
隐藏层2
(30)
输出层
(2)
Tmax
Tmin
Tmax
Tmin

图2

讨论


Correlation Coefficient
Standard Deviation
RMSD
Ref
ANN(9 grid points)
ANN(1 grid point)
Linear
CCSM


Correlation Coefficient
Standard Deviation
RMSD
Ref
ANN(9 grid points)
ANN(1 grid point)
Linear
CCSM

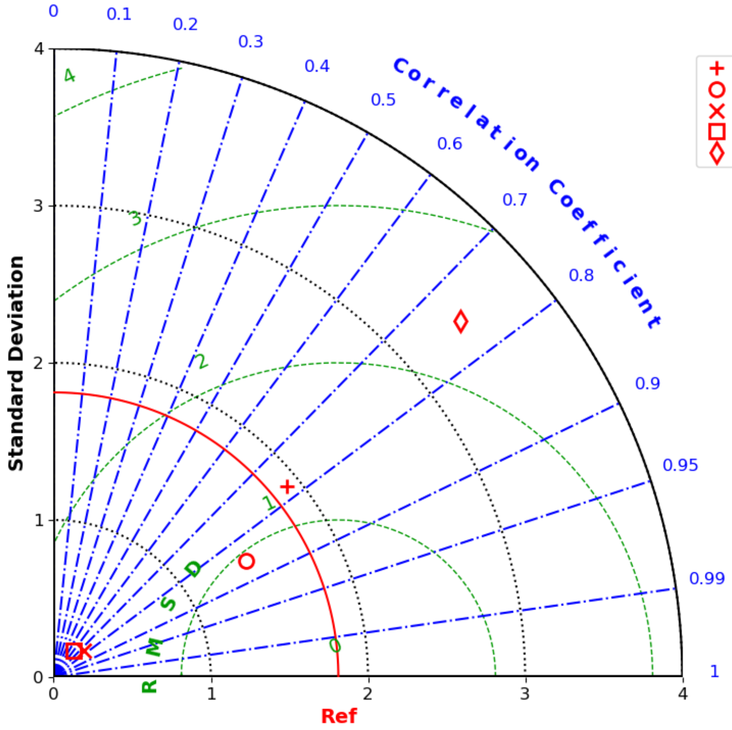

Correlation Coefficient
Standard Deviation
RMSD
Ref
BC
ANN
Linear
Poisson
CCSM

图3

表1

Train

	Tmax			Tmin			Pr		
	obs	CCSM	ANN	obs	CCSM	ANN	obs	CCSM	BC
mean	25.05	24.56	25.25	-13.79	-16.38	-13.62	3.66	4.64	3.67
std	0.43	0.73	0.66	1.10	1.12	0.86	0.33	0.47	0.42
RMSE		0.91	0.73		2.98	1.28		1.17	0.59

表2

Validation

	Tmax			Tmin			Pr		
	obs	CCSM	ANN	obs	CCSM	ANN	obs	CCSM	BC
mean	25.17	24.52	25.21	-13.89	-16.17	-13.70	3.69	4.68	3.74
std	0.56	0.69	0.59	0.85	0.88	0.71	0.22	0.40	0.34
RMSE		0.89	0.55		2.49	1.01		1.09	0.44

图4

Tmax

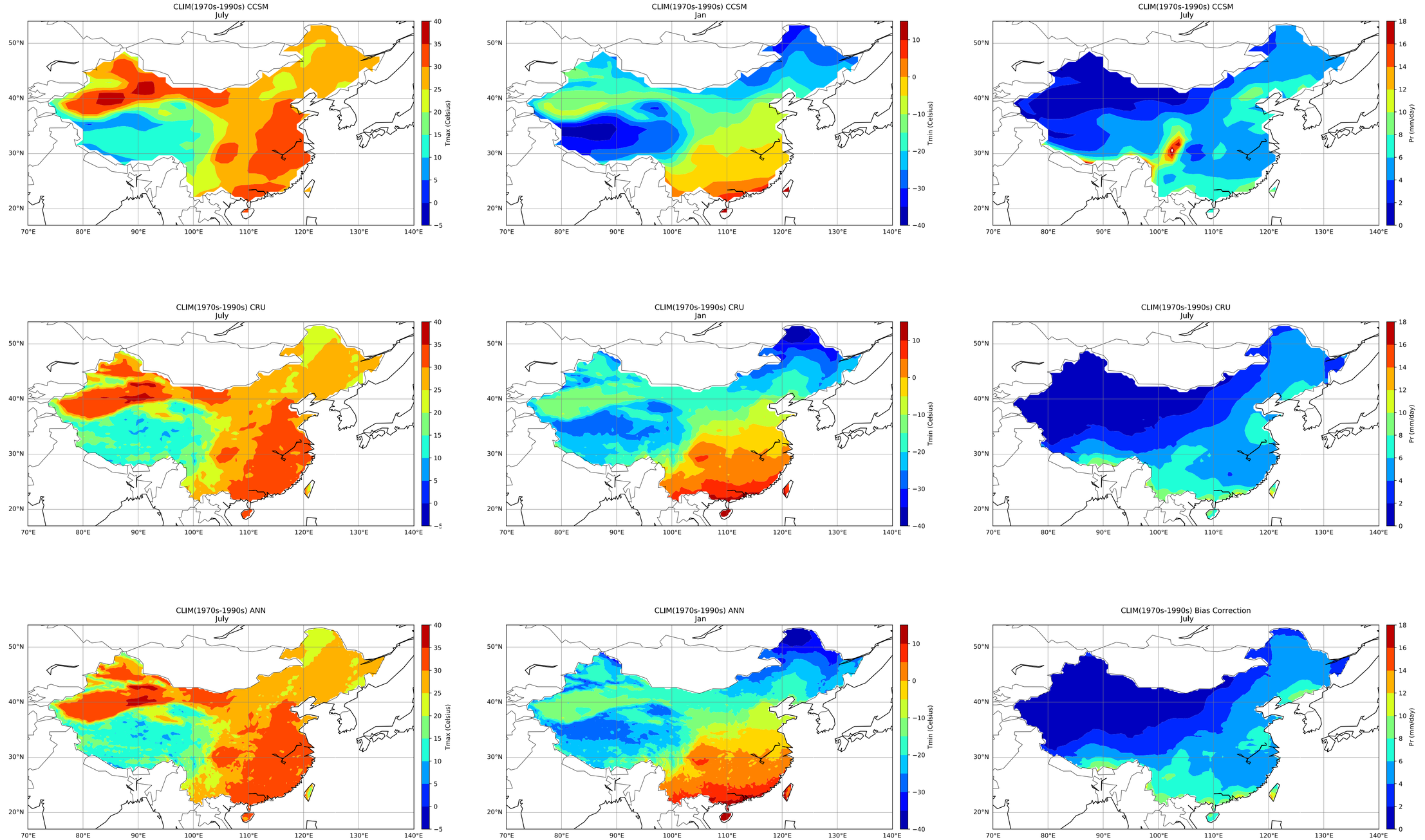
Tmin

Pr

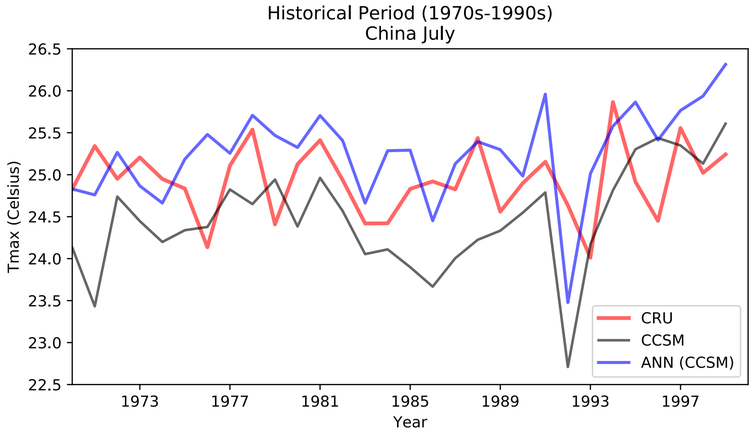
CCSM

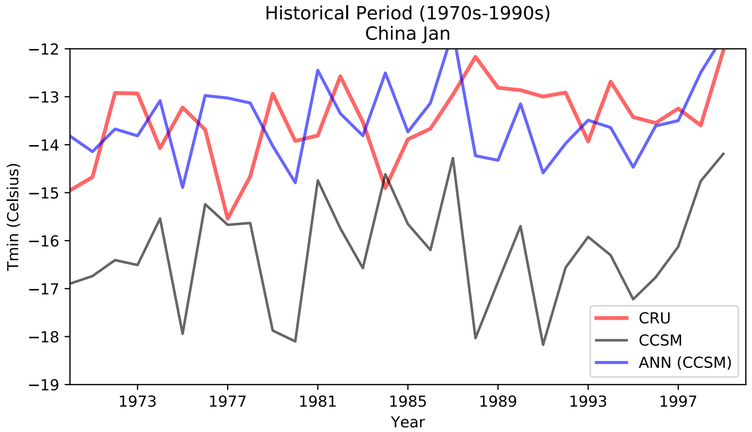
CRU

ANN/BC



讨论


Historical Period (1970s-1990s)
China July
Tmax (Celsius)
Year
CRU
CCSM
ANN (CCSM)


Historical Period (1970s-1990s)
China Jan
Tmin (Celsius)
Year
CRU
CCSM
ANN (CCSM)

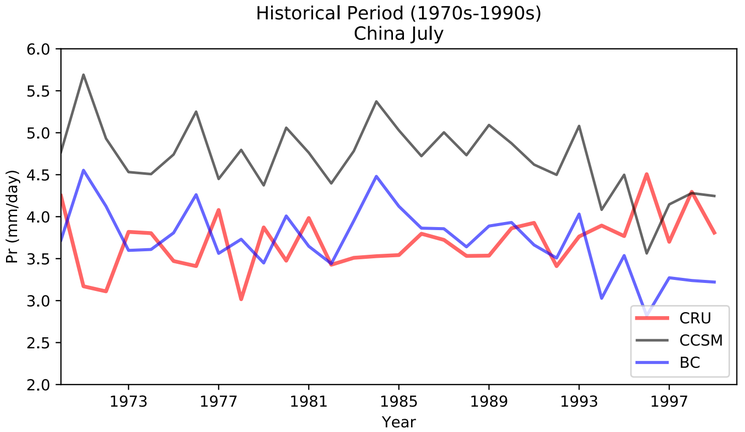

Historical Period (1970s-1990s)
China July
Pr (mm/day)
Year
CRU
CCSM
BC

图5

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讨论

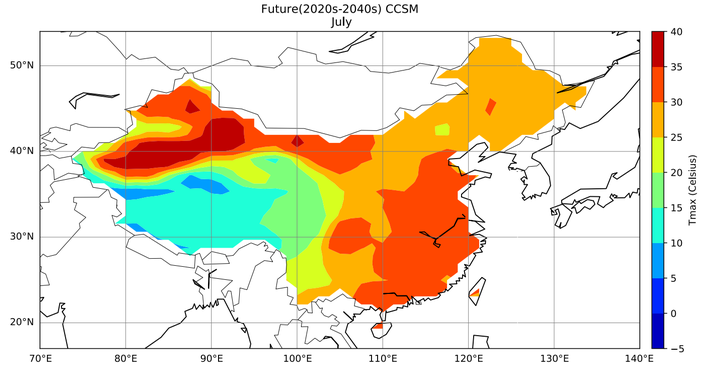
Near-term, RCP2.6

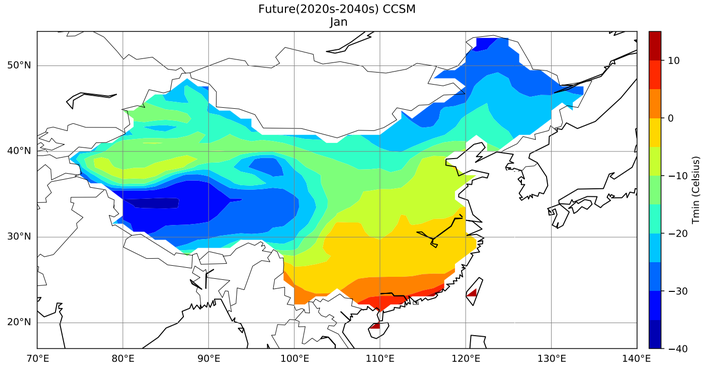
Tmax

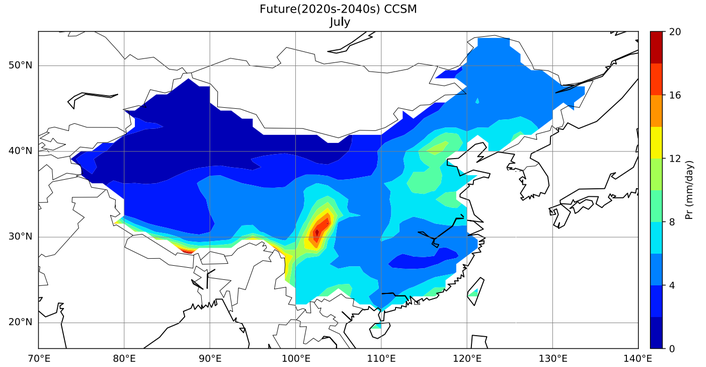
Tmin

Pr

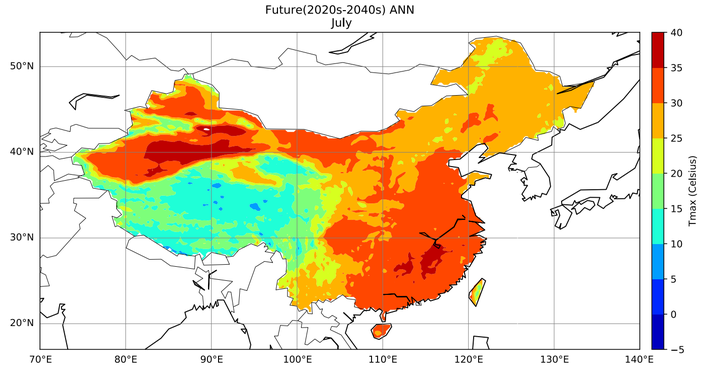
CCSM

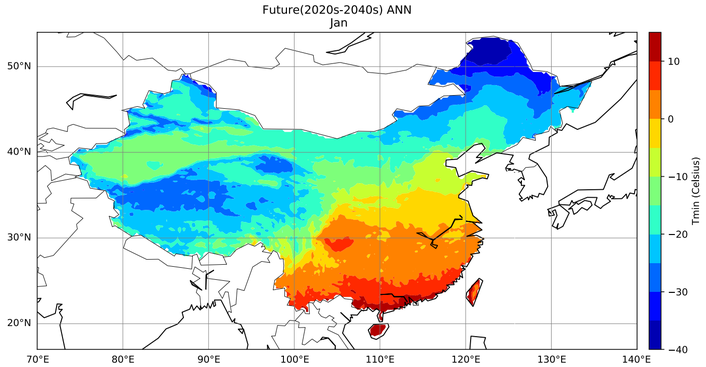






ANN/BC





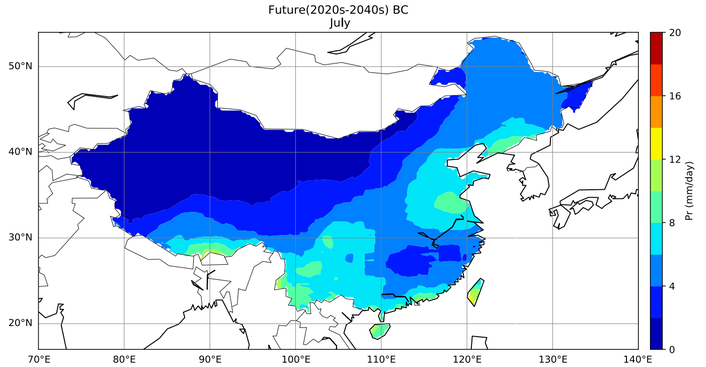


图6

讨论

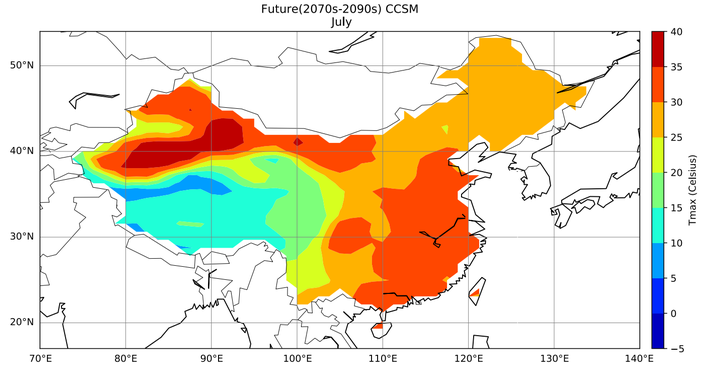
Long-term, RCP2.6

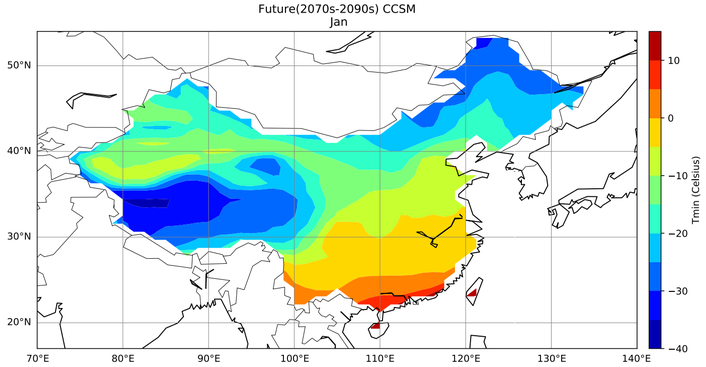
Tmax

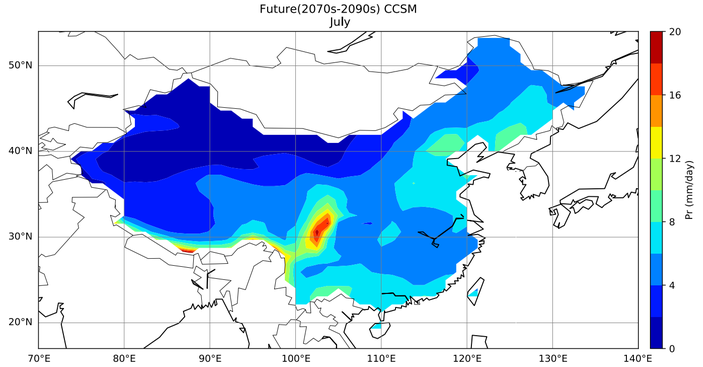
Tmin

Pr

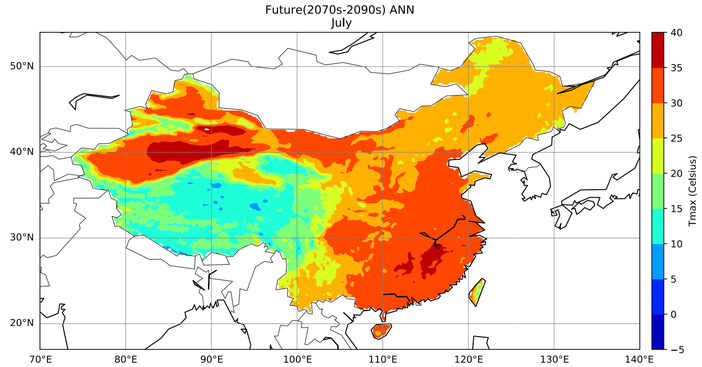
CCSM

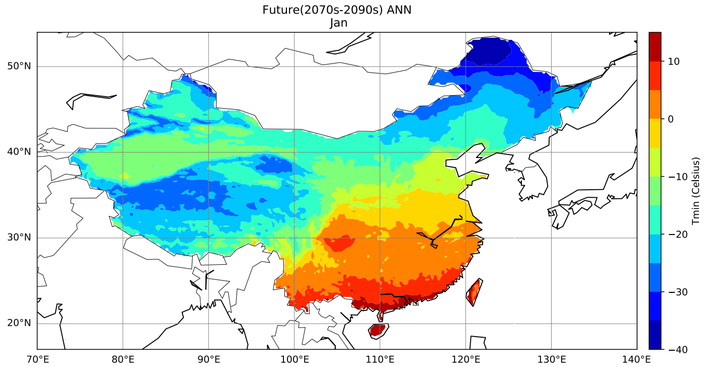






ANN/BC





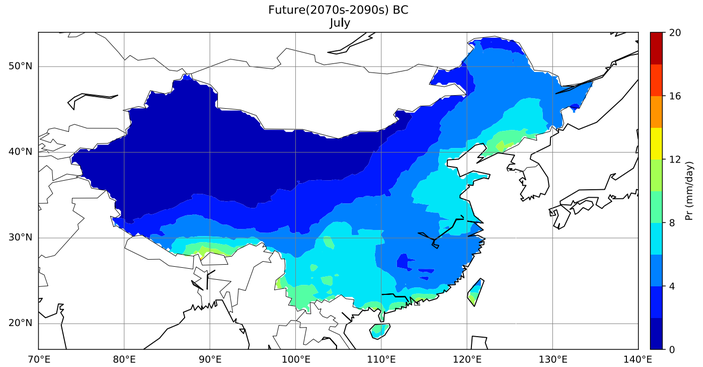


图7

讨论

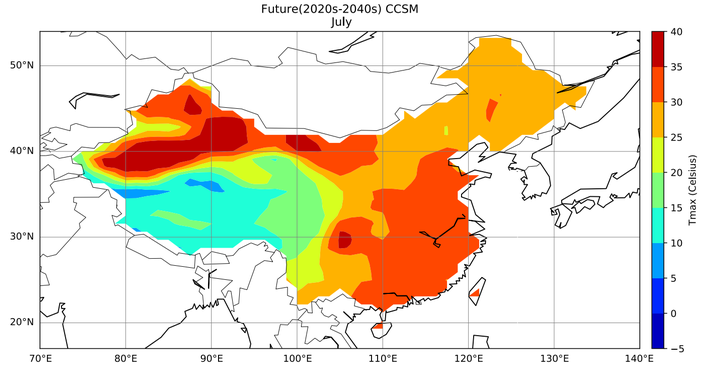
Near-term, RCP8.5

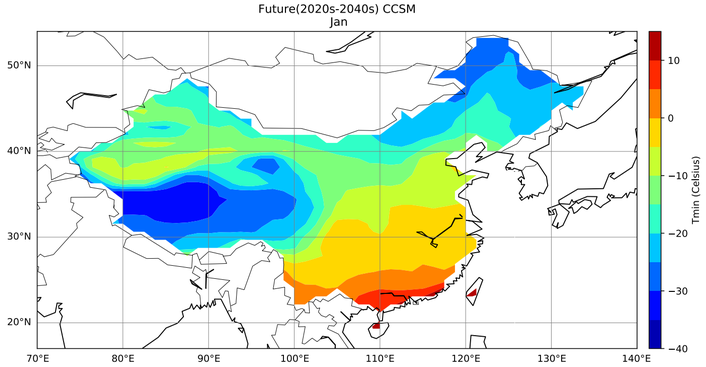
Tmax

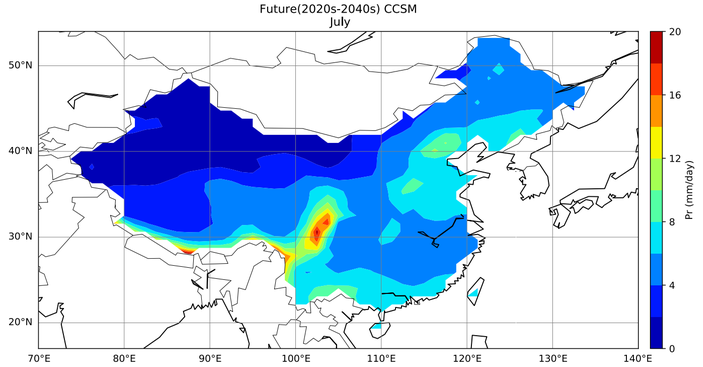
Tmin

Pr

CCSM







ANN/BC

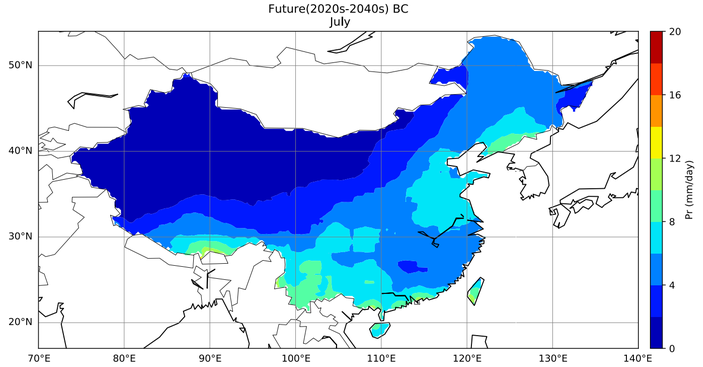


图8

讨论

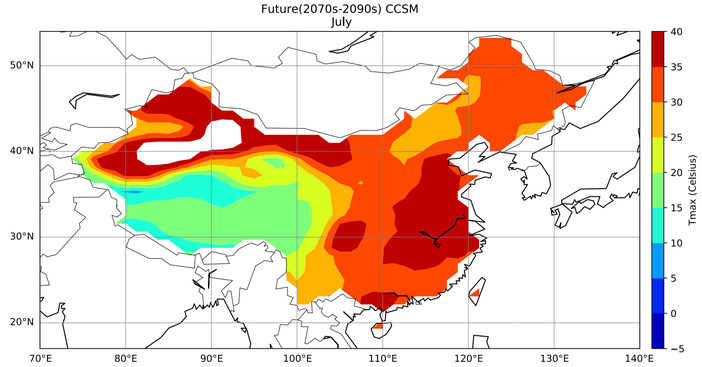
Long-term, RCP8.5

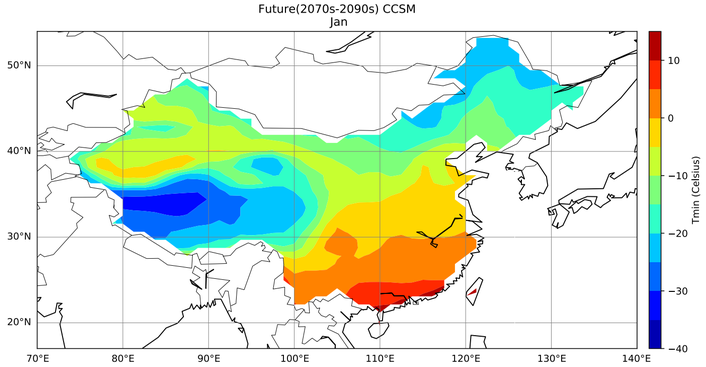
Tmax

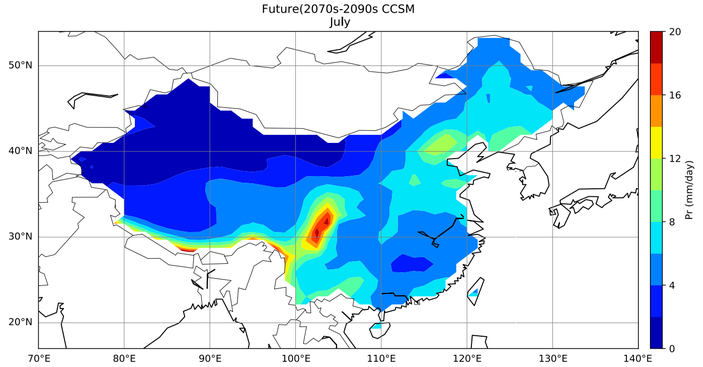
Tmin

Pr

CCSM







ANN/BC

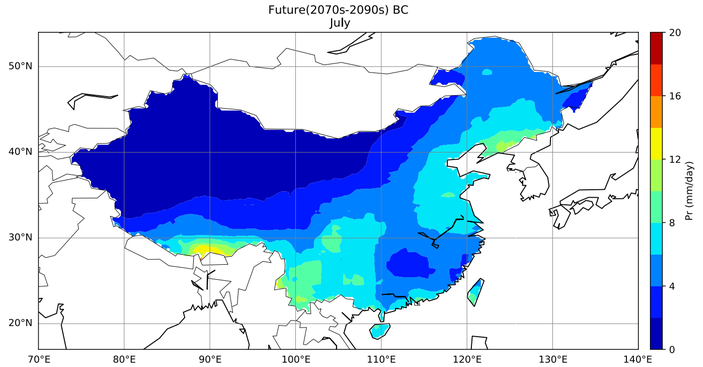


图9

讨论

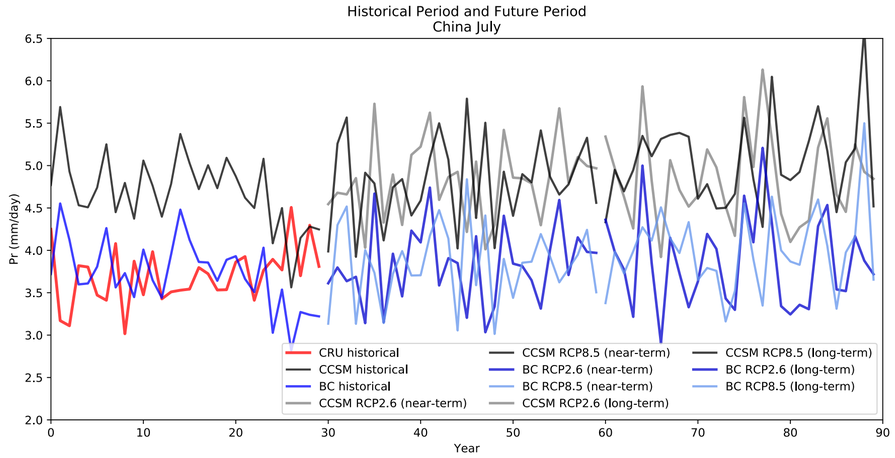

Historical Period and Future Period
China July
Pr (mm/day)
Year
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0
10
20
30
40
50
60
70
80
90
CRU historical
CCSM historical
BC historical
CCSM RCP2.6 (near-term)
CCSM RCP8.5 (near-term)
BC RCP2.6 (near-term)
BC RCP8.5 (near-term)
CCSM RCP2.6 (long-term)
CCSM RCP8.5 (long-term)
BC RCP2.6 (long-term)
BC RCP8.5 (long-term)

图10

谢谢