Application of the *Bias Correction and Spatial Downscaling* Algorithm on the Temperature Extremes From CMIP5 Multimodel Ensembles in China

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Introduction:

·The BCSD technique was used in NEX-GDDP to downscale simulations from 21 GCMs in CMIP5 project.

·The 2015 Paris Agreement: holding the increase in global mean temperature to well below 2°C above preindustrial levels.

·Therefore, it's necessary to investigate future climate change by using more accurate and refiner data sets under the RCP2.6 scenario.

·However, the NEX-GDDP data set does not include RCP2.6 projections.

Method:

·Bias Correction and Spatial Downscaling(BCSD) algotithm —>data preprocessing(detrend), bias correction(BC, quantile-mapping), spatial disaggregation(SD, interpolation)

Data:

·gridded station-based DMT(daily maximum temperature) data at a horizontal resolution of 0.25°Cx0.25°C(CN05.1) as observations(Wu & Gao, 2013).

·13 GCMs in CMIP5 projects

Table 1
List of the 13 General Circulation Models (GCMs) From the CMIP5 Archive

Model name	Horizontal resolution in degree	Modeling center
BNU-ESM	2.8° 2.8°	Beijing Normal University
CanESM2	2.8° × 2.8°	Canadian Centre for Climate Modelling and Analysis
CNRM-CM5	1.4° × 1.4°	Centre National de Recherches Meteorologiques/Centre Europeen de Recherche et Formation Avancee en Calcul Scientifique
CSIRO-Mk3.6.0	1.875° × 1.875°	Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence
GFDL-CM3	2° × 2.5°	NOAA Geophysical Fluid Dynamics Laboratory
GFDL-ESM 2G	2° × 2.5°	
GFDL-ESM 2 M	2° × 2.5°	
IPSL-CM5A-MR	1.5° × 1.27°	Institut Pierre Simon Laplace
MIROC5	1.4° × 1.4°	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies
MIROC-ESM	2.8° × 2.8°	
MPI-ESM-LR	1.875° × 1.875°	Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology)
MPI-ESM-MR	1.875° × 1.875°	
MRI-CGCM3	1.121° × 1.125°	Meteorological Research Institute

Results:

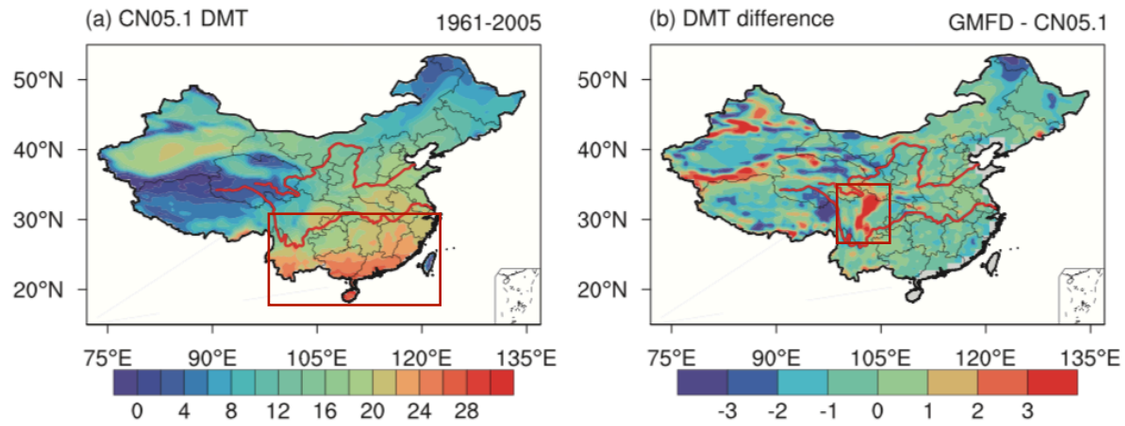


Figure 2. (a) Spatial distribution of DMT during 1961–2005 based on the CN05.1 data set. (b) Spatial distribution of DMT difference between CN05.1 and GMFD for 1961–2005. Unit: °C.

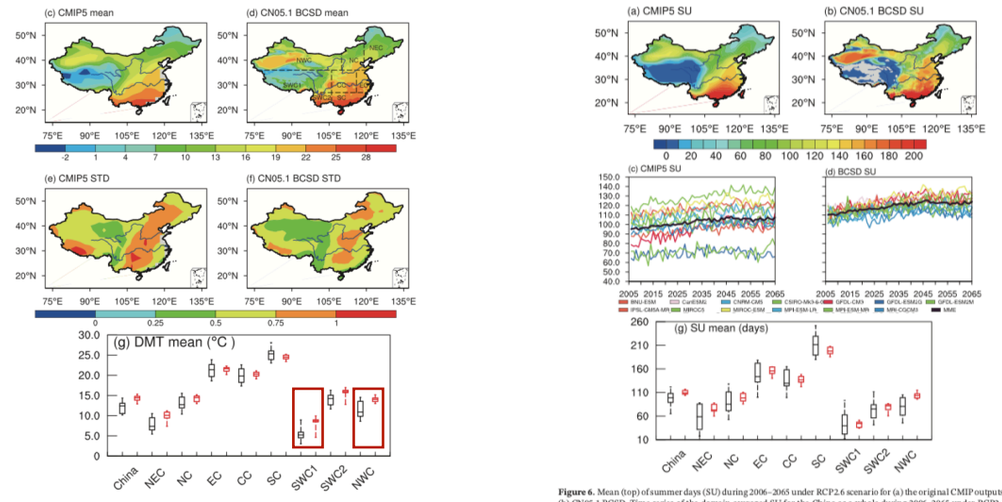


Figure 5. Annual cycle of DMT during 2006–2065 under RCP2.6 scenario derived from (a) the raw CMIP5 simulations and (b) CN05.1 BCSD. Mean (middle) and standard deviation (bottom) of DMT during 2006–2065 under RCP2.6 scenario. (c and e) For the raw CMIP5 outputs. (d and f) For CN05.1 BCSD. (g) Box-and-whisker plots for the mean value of DMT for the whole China and eight subregions. The black boxes indicate the original CMIP5 outputs. The red boxes show the downscaled outputs.

Figure 6. Mean (top) of summer days (SU) during 2006–2065 under RCP2.6 scenario for (a) the original CMIP outputs and (b) CN05.1 BCSD. Time series of the domain-averaged SU for the China as a whole during 2006–2065 under RCP2.6 scenario for (c) the raw CMIP5 outputs and (d) CN05.1 BCSD. The SU anomaly during 2006–2065 derived from (e) the raw CMIP5 simulations and (f) CN05.1 BCSD with respect to 1961–2005. (g) Box-and-whisker plots for the mean value of SU for the whole China and eight subregions. The black boxes indicate the original CMIP5 outputs. The red boxes show the downscaled outputs.

Conclusions:

·BCSD方法是可靠的，可用于降尺度中以得到更为精确的变量；

·CN05.1 BCSD可以得到和观测相同的特征，因此选择它作为BCSD方法中的观测数据而非GMFD；

·通过CMIP5的13个GCMs得到的将尺度后的数据对于中国地区极端温度的表现更优。

2020/3/24

Report

2020.3.31

張慕琪

Methods

实验设计：

1. 使用新的求alpha[std(GMFD) / std(ANN Raw)]公式；
2. 画Beijing单点Tmax和Tmin的1/7月time series；
3. 画全国所有点Tmax和Tmin的1/7月time series.

时间： Train & validation (=historical)

数据： CCSM, GMFD, ANN(before BC) , ANN(after BC)

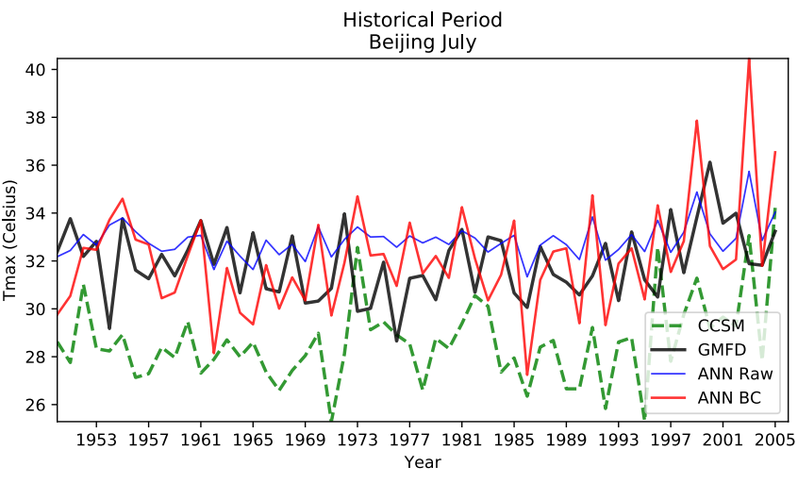
变量：

·Temperature:

1. Time series

Results ts Beijing

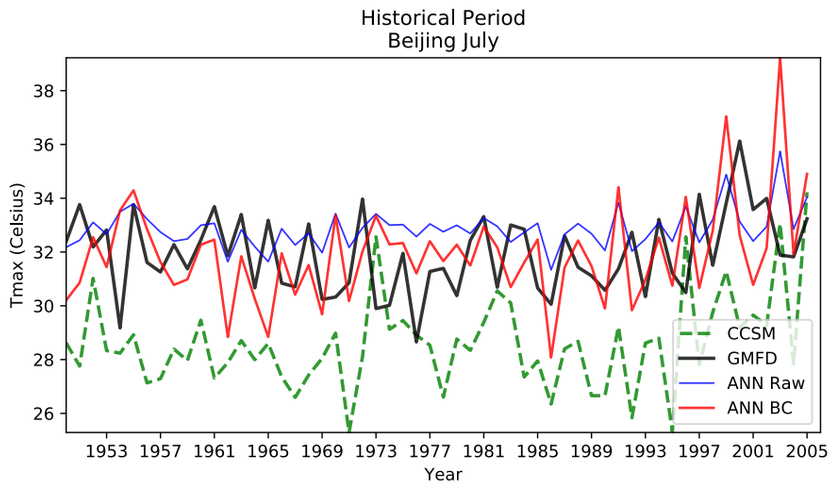
Tmax (old method, 42yr)



mean_ccsm = 28.612423
mean_ground = 31.921953
mean_ann_raw = 32.856594
mean_ann_bc = 32.10389

std_ccsm = 1.7578304
std_ground = 1.4520789
std_ann_raw = 0.7223801
std_ann_bc = 2.1987932

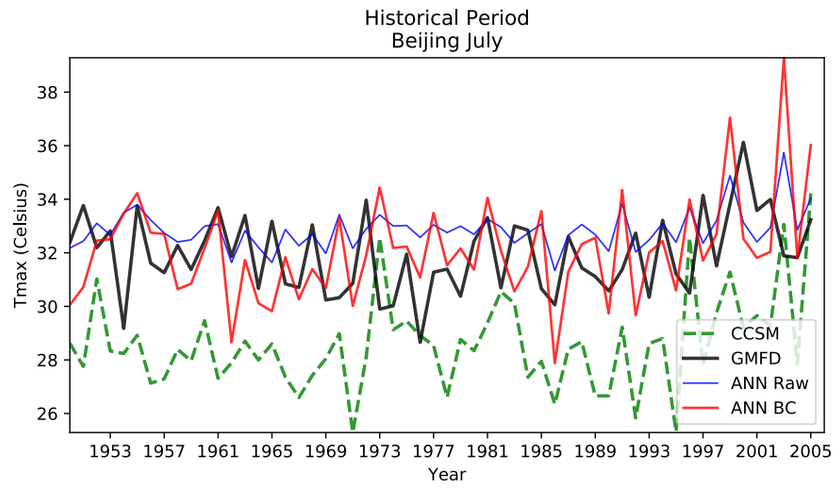
Tmax (new method, 56yr)



mean_ccsm = 28.612423
mean_ground = 31.921953
mean_ann_raw = 32.856594
mean_ann_bc = 31.921877

std_ccsm = 1.7578304
std_ground = 1.4520789
std_ann_raw = 0.7223801
std_ann_bc = 1.8286802

Tmax (new method, 42yr)

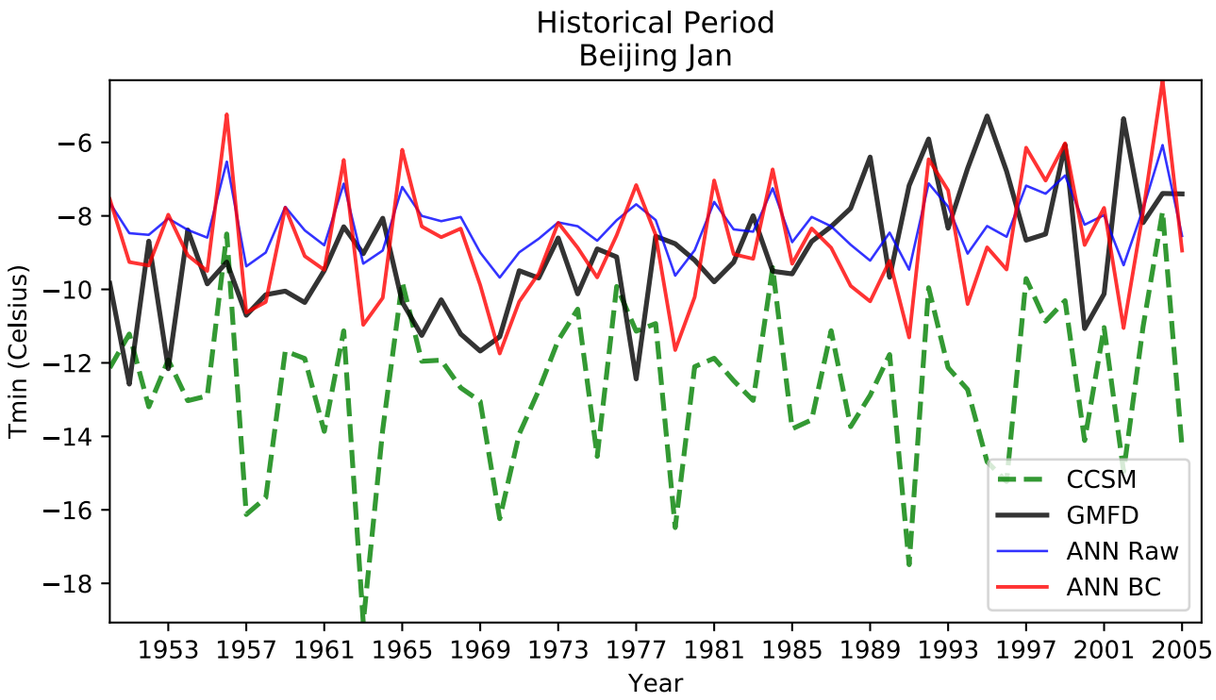


mean_ccsm = 28.612423
mean_ground = 31.921953
mean_ann_raw = 32.856594
mean_ann_bc = 32.103893

std_ccsm = 1.7578304
std_ground = 1.4520789
std_ann_raw = 0.7223801
std_ann_bc = 1.9083097

Results ts Beijing

Tmin

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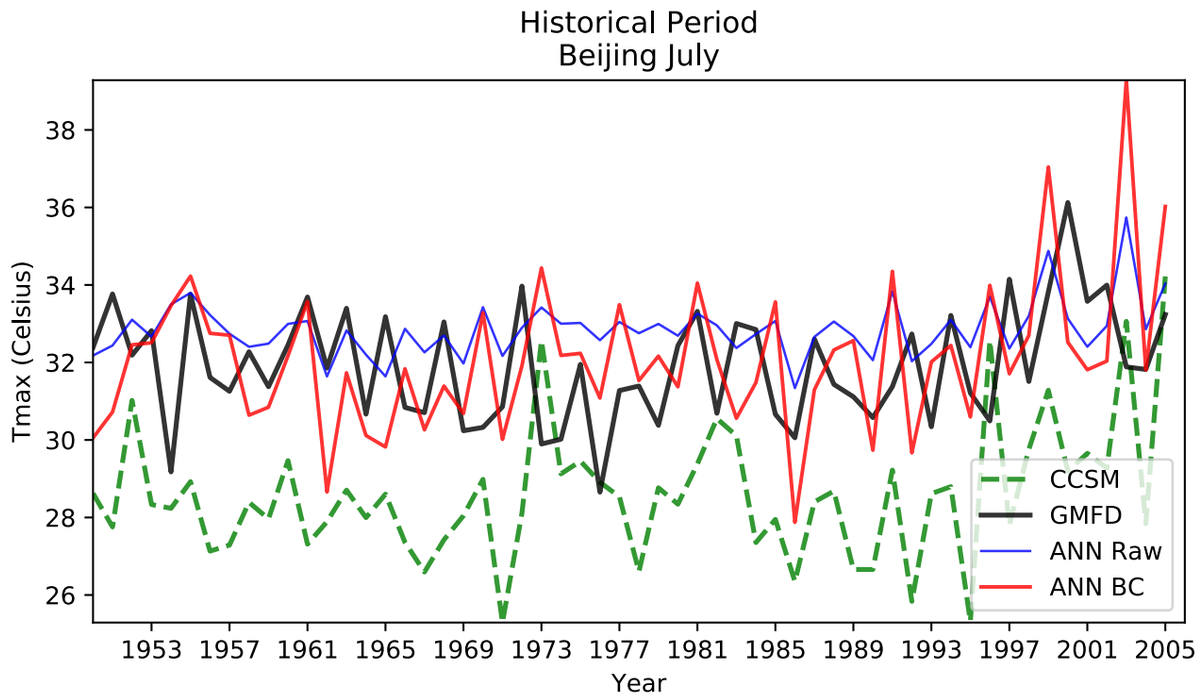
mean_ccsm =  -12.599457
mean_ground =  -9.066935
mean_ann_raw =  -8.267509
mean_ann_bc =  -8.720985

std_ccsm =  2.1791046
std_ground =  1.6685536
std_ann_raw =  0.76728755
std_ann_bc =  1.5988857
```

Tmax

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mean_ccsm =  28.612423
mean_ground =  31.921953
mean_ann_raw =  32.856594
mean_ann_bc =  32.103893

std_ccsm =  1.7578304
std_ground =  1.4520789
std_ann_raw =  0.7223801
std_ann_bc =  1.9083097
```
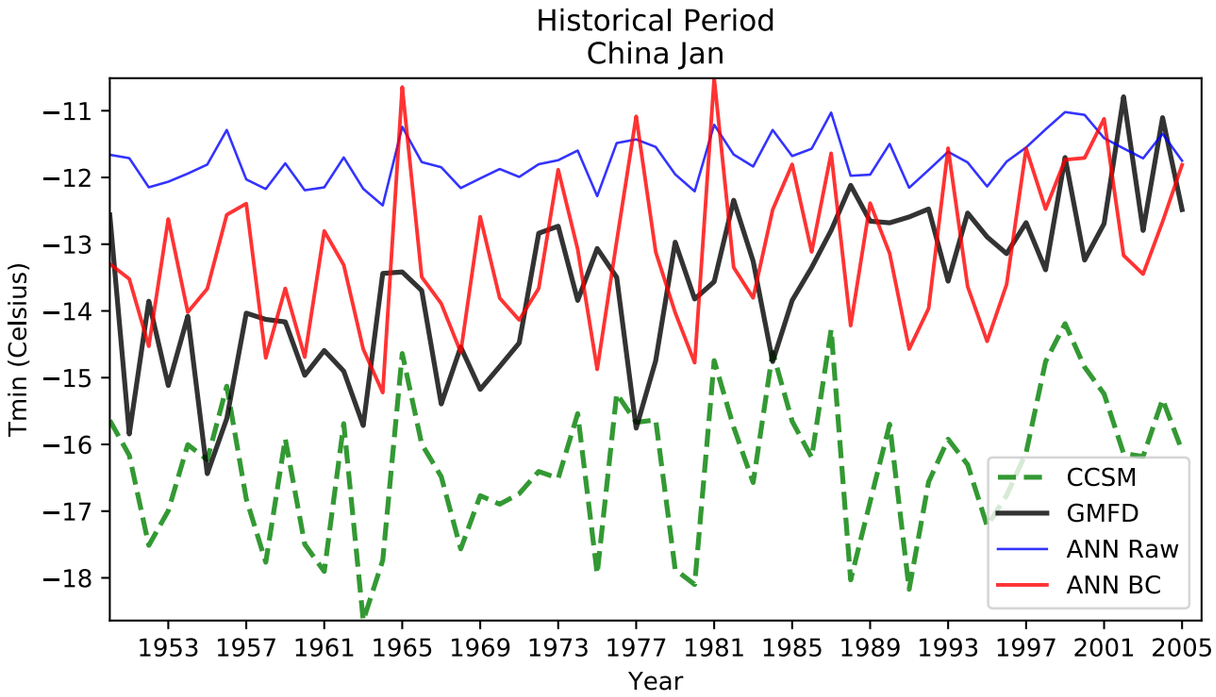

Results ts China

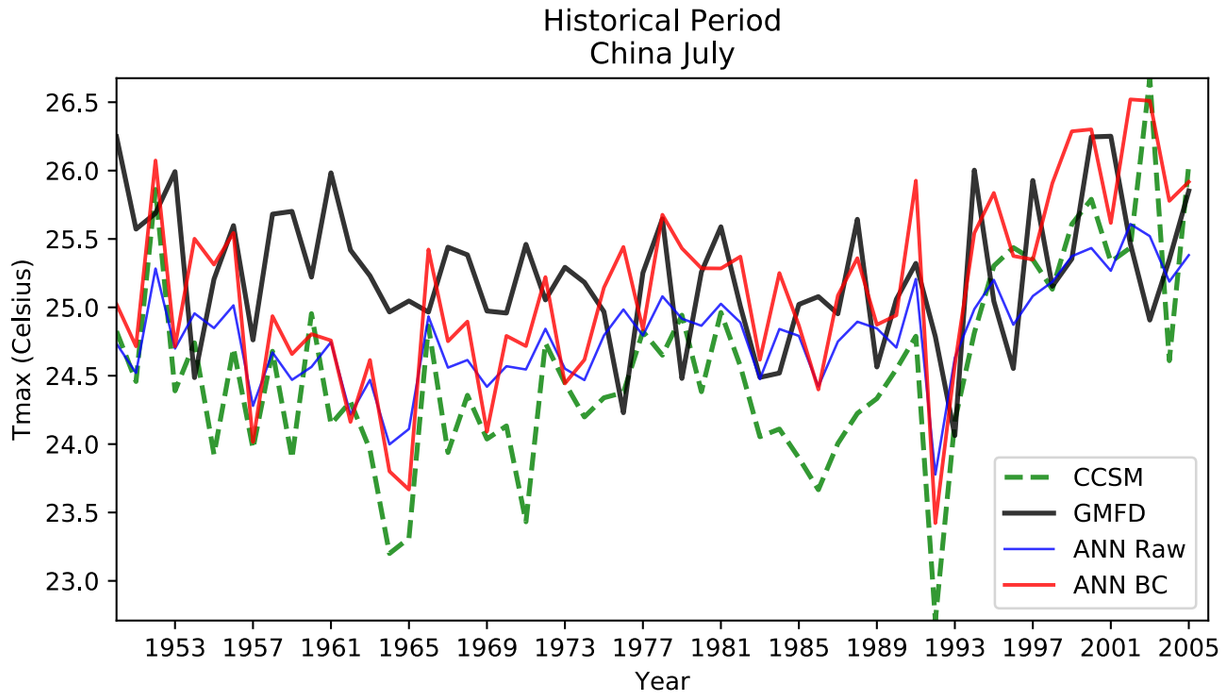
Tmin



mean_ccsm = −16.318928
mean_ground = −13.636529
mean_ann_raw = −11.74804
mean_ann_bc = −13.145223

std_ccsm = 1.072079
std_ground = 1.2027843
std_ann_raw = 0.334979
std_ann_bc = 1.1460037

Tmax



mean_ccsm = 24.545729
mean_ground = 25.242002
mean_ann_raw = 24.801483
mean_ann_bc = 25.107103

std_ccsm = 0.7186829
std_ground = 0.4995916
std_ann_raw = 0.37120652
std_ann_bc = 0.676033

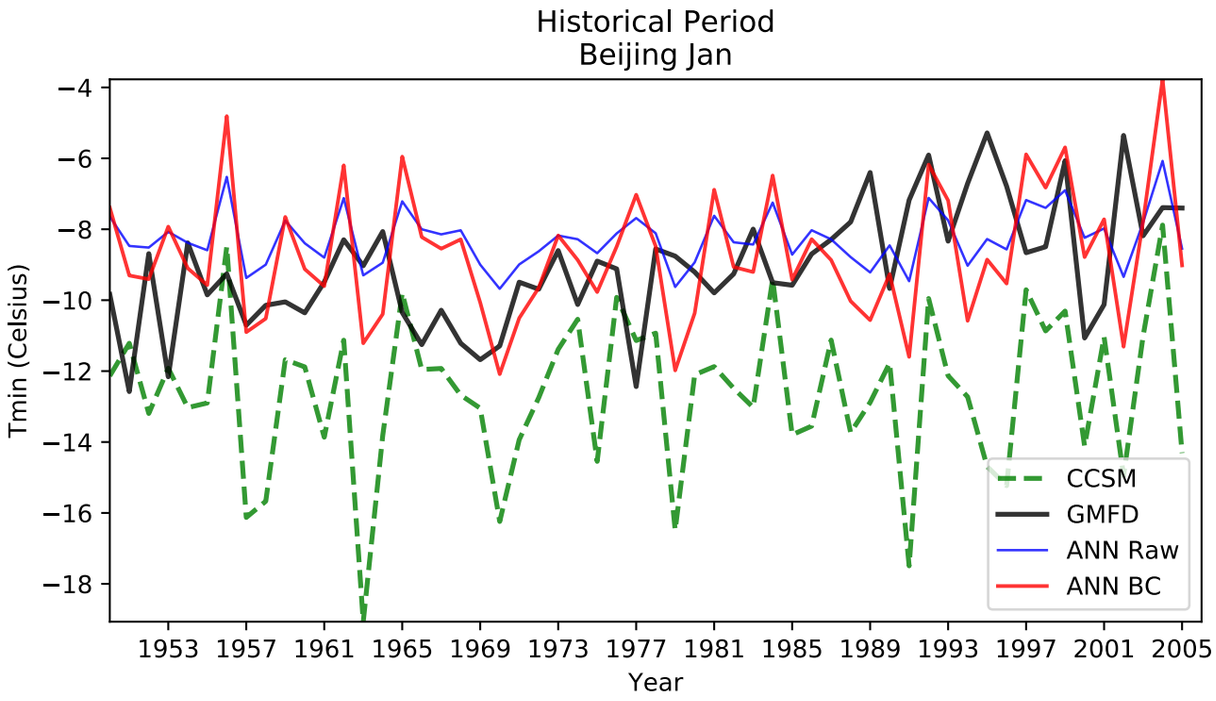
谢谢

附录

ts

Beijing

Tmin

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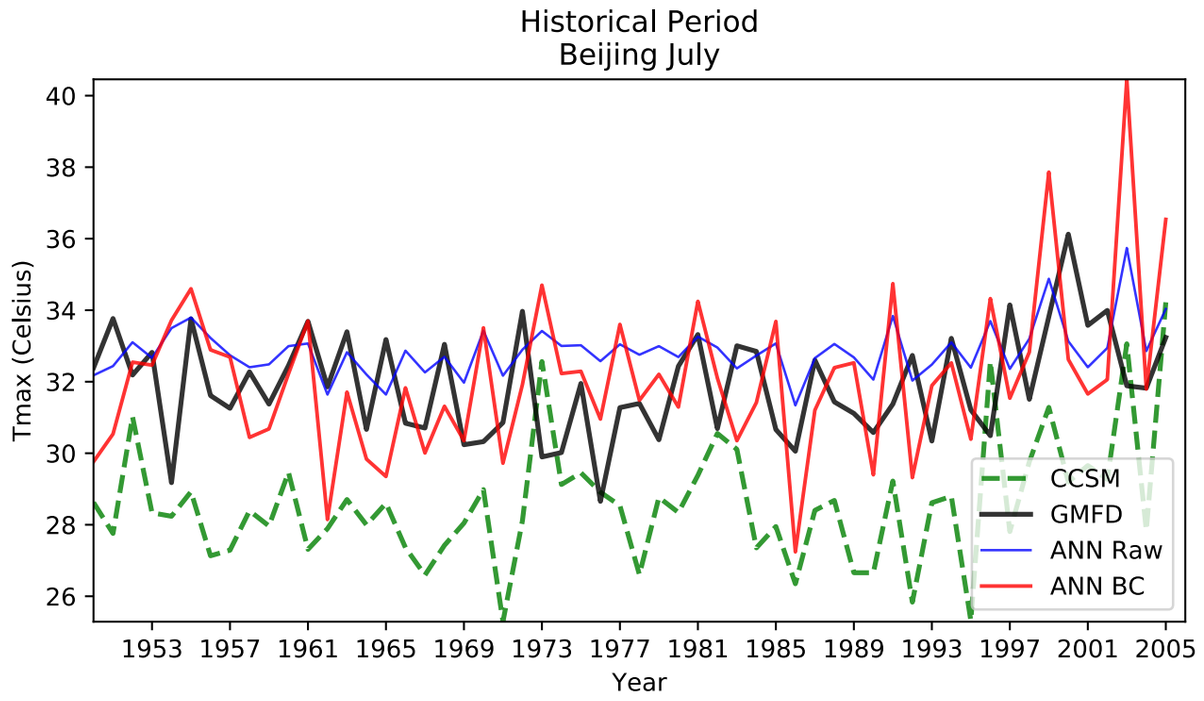
mean_ccsm =  -12.599457
mean_ground =  -9.066935
mean_ann_raw =  -8.267509
mean_ann_bc =  -8.720985

std_ccsm =  2.1791046
std_ground =  1.6685536
std_ann_raw =  0.76728755
std_ann_bc =  1.7830557
```

Tmax

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mean_ann_bc =  32.10389

std_ccsm =  1.7578304
std_ground =  1.4520789
std_ann_raw =  0.7223801
std_ann_bc =  2.1987932
```
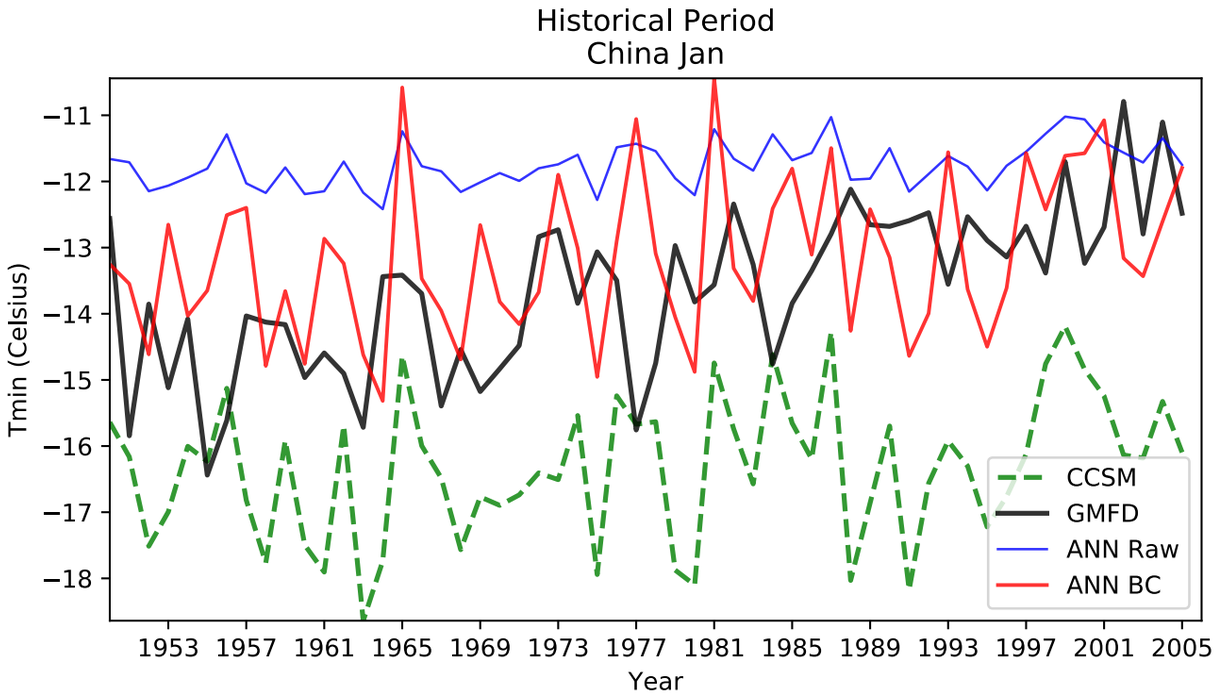
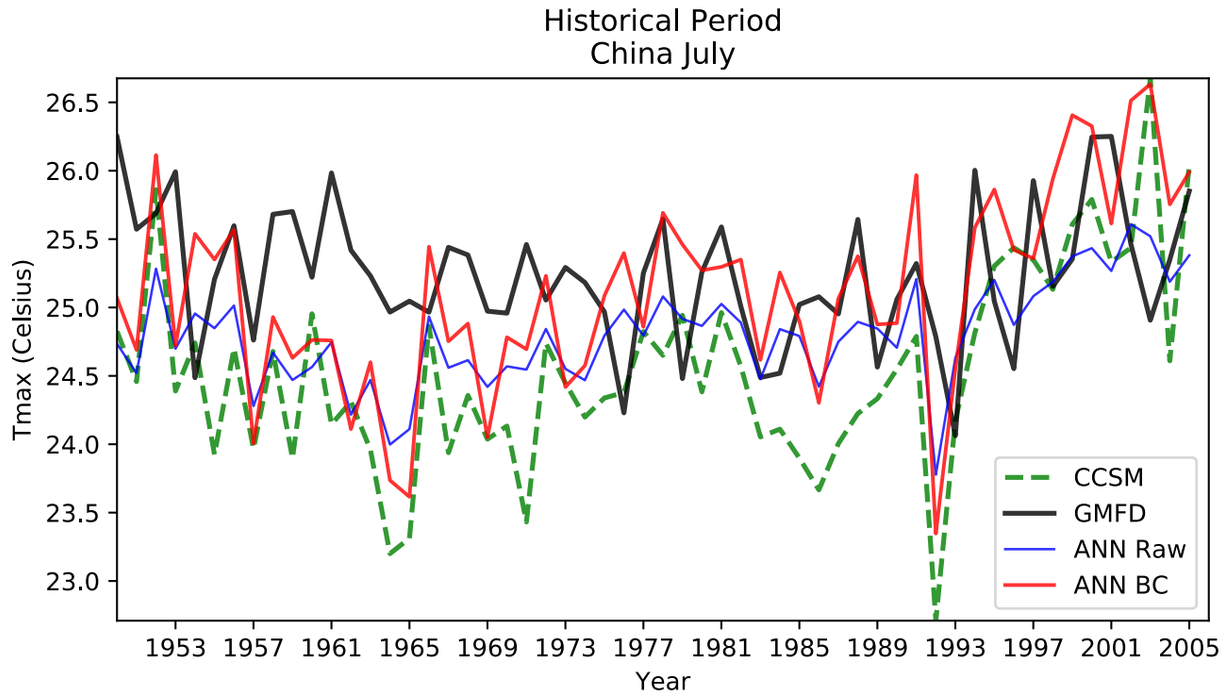

附录 ts China

Tmin




```
mean_ccsm =  -16.318928
mean_ground =  -13.636529
mean_ann_raw =  -11.74804
mean_ann_bc =  -13.145223

std_ccsm =  1.072079
std_ground =  1.2027843
std_ann_raw =  0.334979
std_ann_bc =  1.1847649
```

Tmax




```
mean_ccsm =  24.545729
mean_ground =  25.242002
mean_ann_raw =  24.801483
mean_ann_bc =  25.107101

std_ccsm =  0.7186829
std_ground =  0.4995916
std_ann_raw =  0.37120652
std_ann_bc =  0.7060385
```