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SDSM — a decision support tool for the assessment of regional climate change impacts

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Introduction:

Develop a tool which is low-cost, rapid assessment of highly localized climate change impacts.

Software availability
Name of the product: SDSM (version 2.1)
Developed by: Robert L. Wilby and Christian W. Dawson
Contact address: Robert L. Wilby, Department of Geography, King's College London, Strand, London WC2R 2LS, UK. Tel.: +44-20-7848-2865; fax: +44-20-7848-2287. E-mail: rob.wilby@kcl.ac.uk.
Available since: 2000
Coding language: Visual Basic 6.0
Hardware requirement: PC Windows 95 or above
Program size: 3 MB RAM, 3 MB ROM
Availability: C.W.Dawson1@lboro.ac.uk
Cost: Freeware

Table 1
Comparison of the main strengths and weakness of statistical and dynamical downscaling

	Statistical downscaling	Dynamical downscaling
Strengths	●Station-scale climate information from GCM-scale output	●10–50 km resolution climate information from GCM-scale output
	●Cheap, computationally undemanding and readily transferable	●Respond in physically consistent ways to different external forcings
	●Ensembles of climate scenarios permit risk/uncertainty analyses	●Resolve atmospheric processes such as orographic precipitation
	●Flexibility	●Consistency with GCM
Weaknesses	●Dependent on the realism of GCM boundary forcing	●Dependent on the realism of GCM boundary forcing
	●Choice of domain size and location affects results	●Choice of domain size and location affects results
	●Requires high quality data for model calibration	●Requires significant computing resources
	●Predictor–predictand relationships are often non-stationary	●Ensembles of climate scenarios seldom produced
	●Choice of predictor variables affects results	●Initial boundary conditions affect results
	●Choice of empirical transfer scheme affects results	●Choice of cloud/convection scheme affects (precipitation) results
	●Low-frequency climate variability problematic	●Not readily transferred to new regions

Methods:

Table 3
Candidate predictor variable definitions

Abbreviation	Description
Lag-1	Predictand value from previous day
Wet	Precipitation occurrence ('1'=wet, '0'=dry)
T_{mean}	2 m daily mean temperature (°C)
SH	Near surface specific humidity (gm/kg)
RH	Near surface relative humidity (%)
Mslp	Mean sea level pressure (hPa)
U[a]	Zonal component of geostrophic airflow (hPa)
V[a]	Meridional component of geostrophic airflow (hPa)
F[a]	Geostrophic airflow (hPa)
Z[a]	Vorticity (hPa)
z500	500 hPa geopotential height (m)

[a] Secondary variable derived from Mslp following the method of Jones et al. (1993).

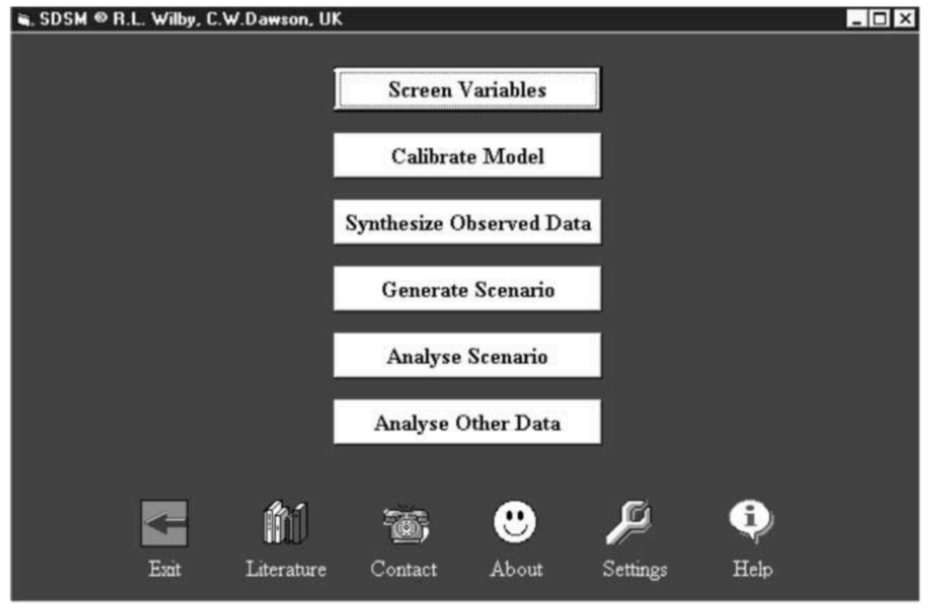


Fig. 1. Main menu of SDSM version 2.1.

computes multiple linear regression equations

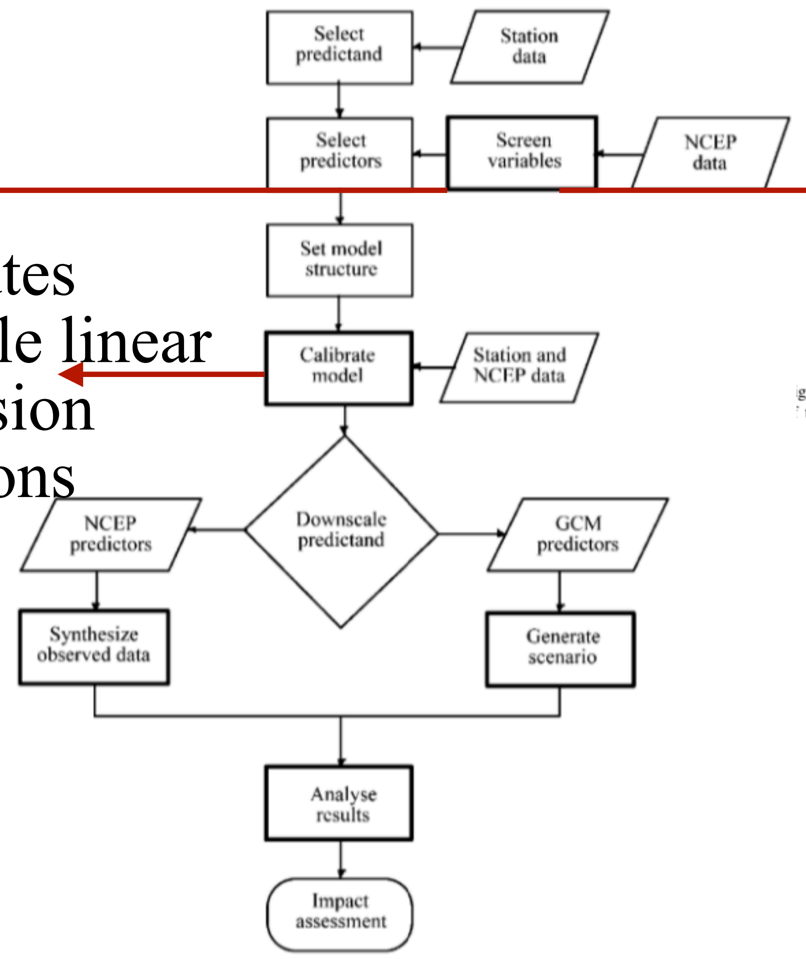


Fig. 2. SDSM climate scenario generation process.

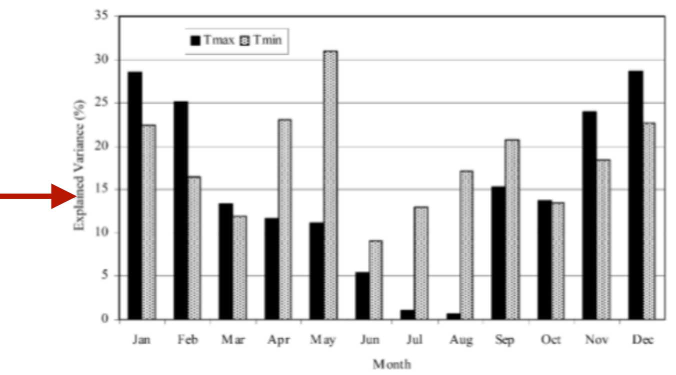


Fig. 3. Monthly variations in the percentage of variance explained in maximum and minimum daily temperatures by the meridional flow component of the surface geostrophic wind at Toronto, during the model calibration period 1981–1985.

Table 4
Partial correlation coefficients for predictor variables at Toronto 1981–1985. The **bold** values denote predictor variables selected for model calibration. The average percentage of explained variance (E%), and standard error (SE) for monthly models are also shown

Predictor	Predictand		
	T_{max} (°C)	T_{min} (°C)	Prec (mm)
Lag-1	0.15	**0.42**	0.03
Wet	−0.13	0.07	n/a
T_{mean}	**0.45**	**0.35**	−0.04
SH	0.14	0.03	**0.06**
RH	−0.20	0.02	−0.01
Mslp	−0.08	−0.03	−0.08
U	0.20	0.10	−0.04
V	−0.02	0.13	**0.40**
F	−0.01	0.12	0.04
Z	**−0.34**	−0.19	**0.20**
z500	0.11	0.07	−0.05
E (%)	73	72	28
SE	2.8	2.6	3.9

Data and study site:

研究地区：Toronto, Canada.

研究变量：Tmax, Tmin, DTR, CLD.

研究时间：1981-1985 (calibration), 1986 - 1990 (validation), 2040-2069 (future);

数据：

·*Observed data*

·*Models:* NCEP reanalysis gridded datasets.

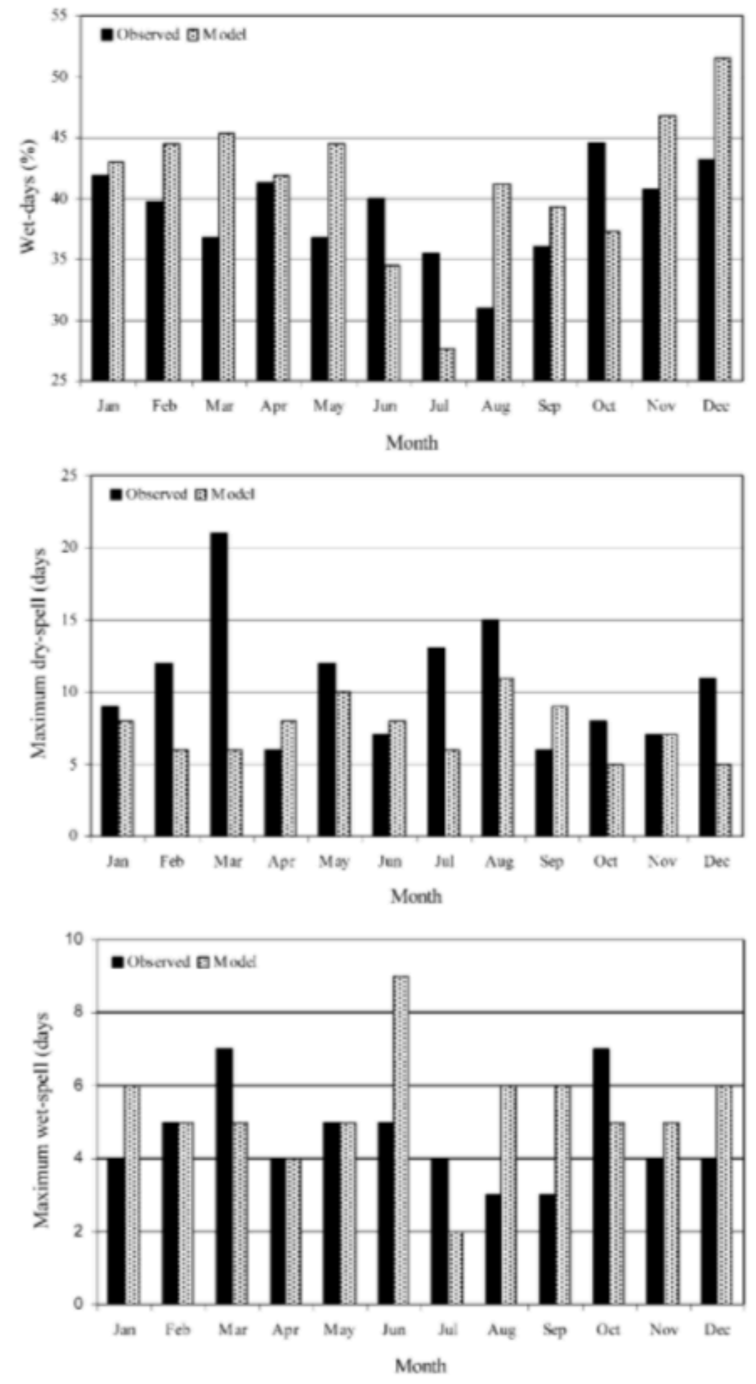


Fig. 4. Validation of downscaled monthly mean wet-day frequencies (% days), maximum dry-spell, and maximum wet-spell lengths (days) at Toronto, 1986–1990.

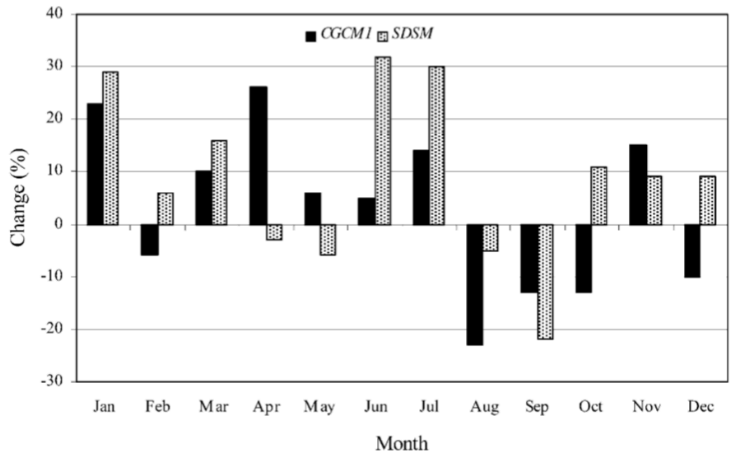


Fig. 7. Changes (%) in monthly mean wet-day amounts at Toronto between 1961–1990 and 2040–2069.

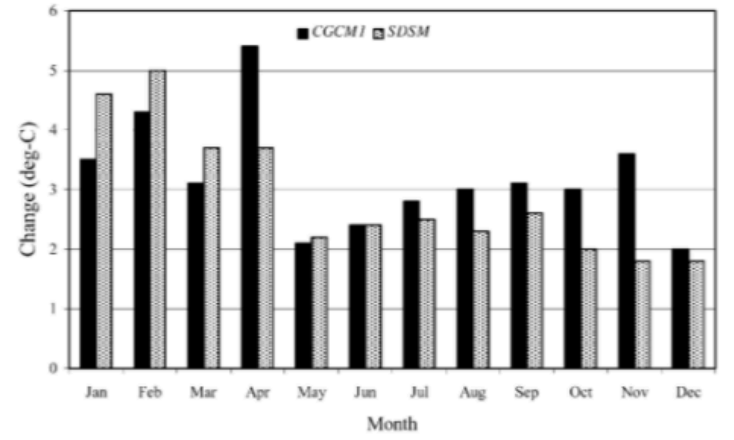


Fig. 8. Changes (°C) in monthly mean maximum daily temperatures at Toronto between 1961–1990 and 2040–2069.

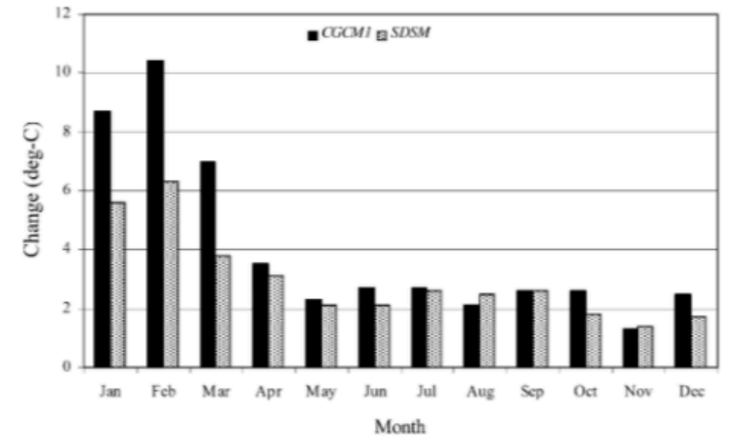


Fig. 9. Changes (°C) in monthly mean minimum daily temperatures at Toronto between 1961–1990 and 2040–2069.

Results:

Conclusions:

1. SDSM软件的开发较为成功；
2. 日降水量的问题一直是降尺度研究的难点，SDSM方法关于日降水的降尺度仍需要进一步改善。

Report

2020.06.01

張慕琪

Methods

实验设计:

ANN在train、vali、future的 $\delta_{O,REF}$ → 56×31 (7月)的std.

已经完成

改会法3 → forth method的 产生扰动

$T_{BC}(t) = (T_{RAW}) - (\overline{T}$

Fifth method:

third method:

$$T_{BC}(t) = \overline{T}_{RAW} - (\overline{T}_{REF} - \overline{O}_{REF}) + \frac{\delta_{O,REF}}{\delta_{T,REF}}(T_{RAW} - \overline{T}_{RAW})$$

①REF: 56yr 计算参数

②hist 用56yr做BC参数 ⇐ 不按一年一年算，按56y一起输入: 56×31 (7月eg.)

2006–2100

③future 用每10yr的31个数做BC! (15+10+10+…) ← 年际和季节做BC

年代际不BC

⇒ Expectation: ①hist 阶段应该和左上角相同

②future 如何未知

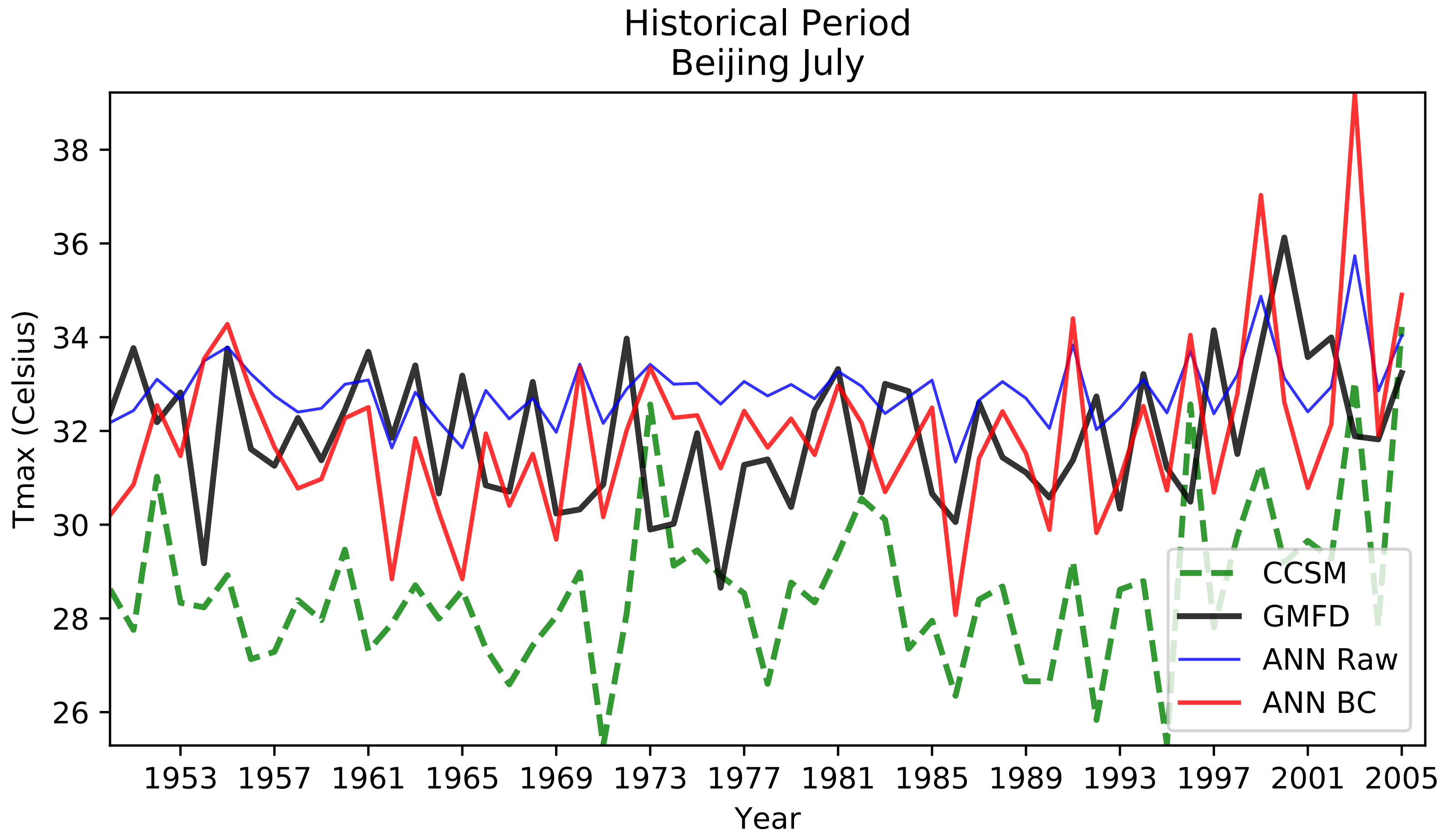
hist和future的颜色统一

Results

Time series

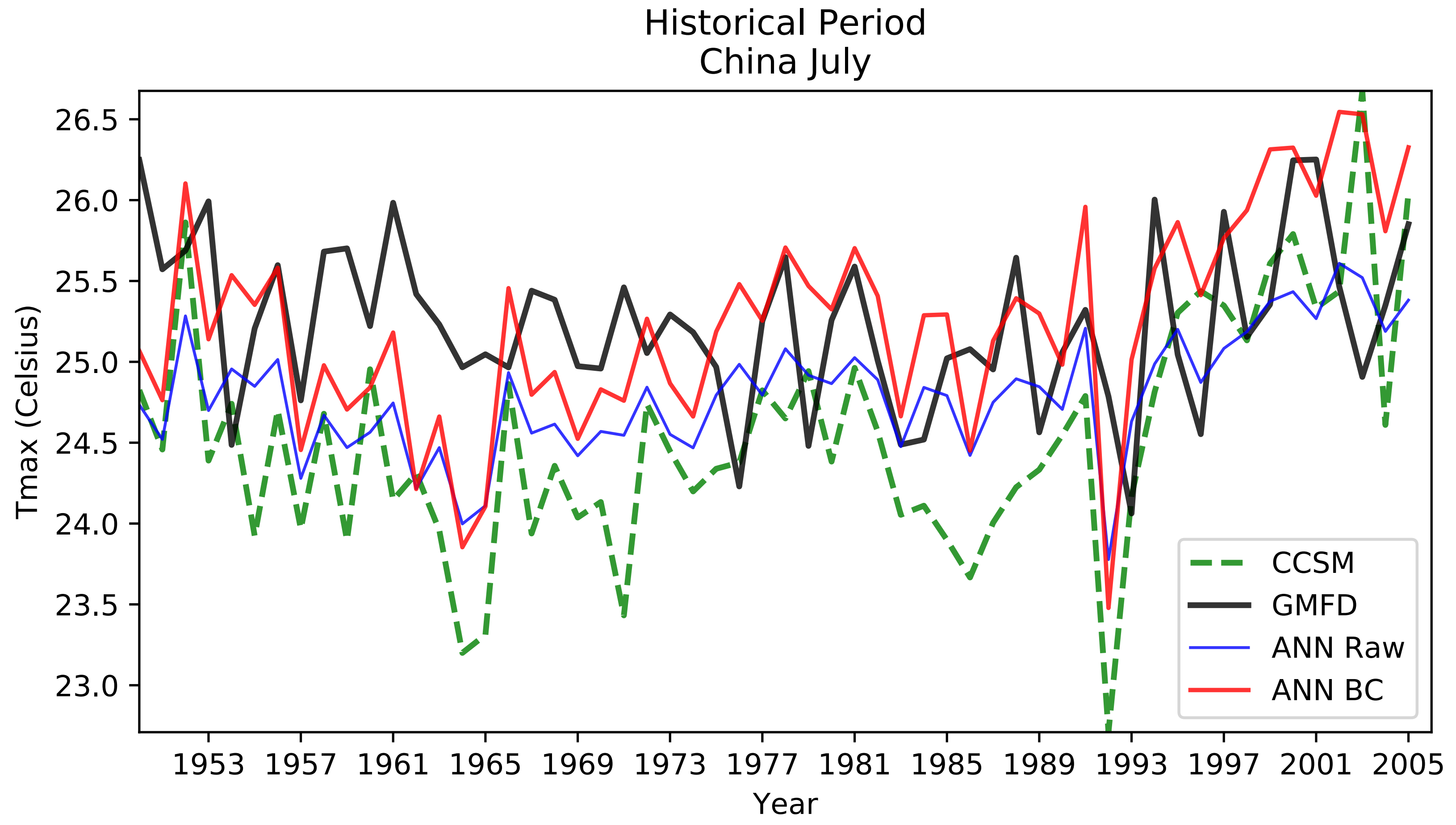
Historical Tmax (third method, 56yr)

Beijing




```
mean_ccsm =  28.61
mean_ground =  31.92
mean_ann_raw =  32.86
mean_ann_bc =  31.92

std_ccsm =  1.76
std_ground =  1.45
std_ann_raw =  0.72
std_ann_bc =  1.83
```

China



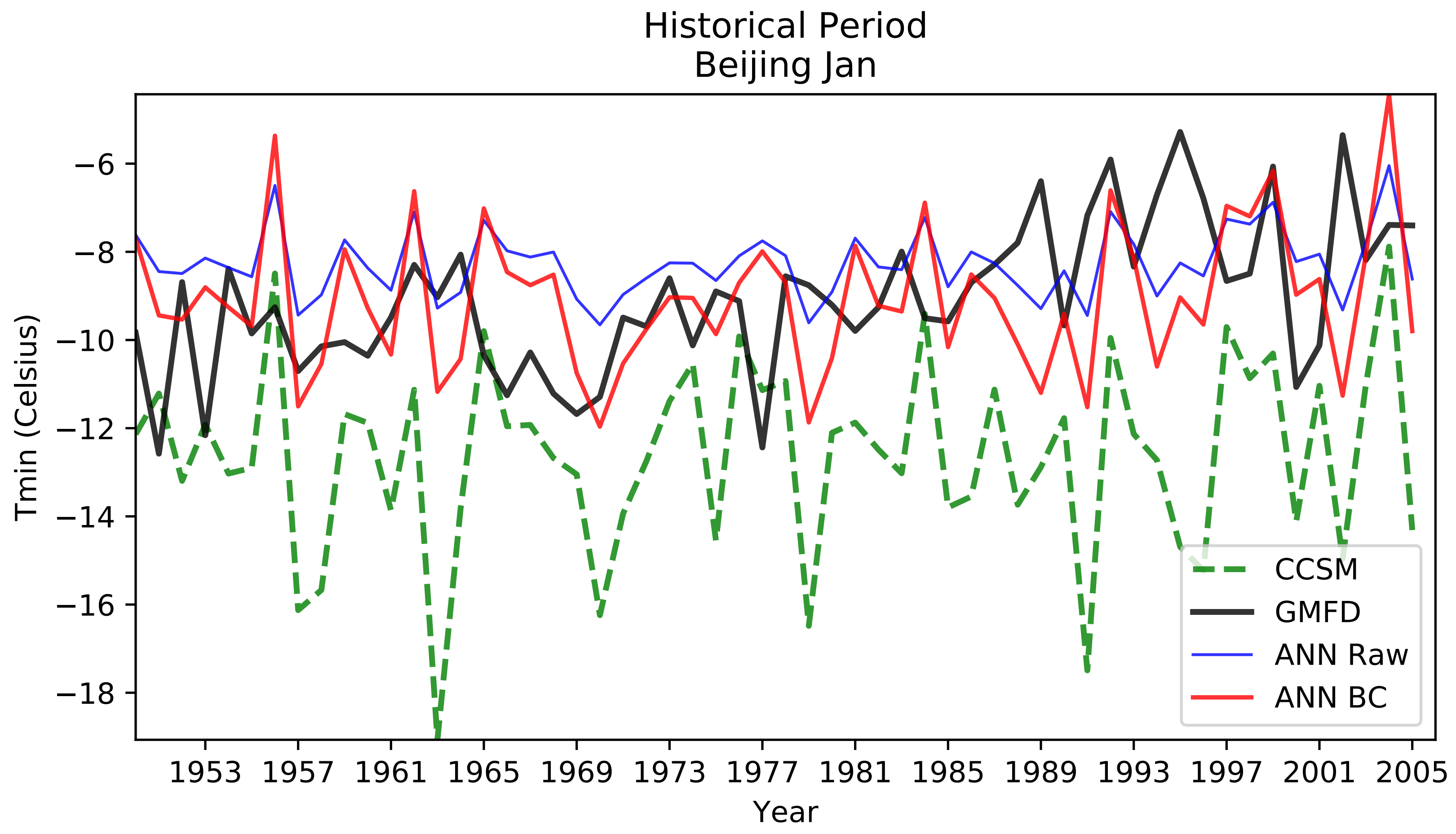

```
mean_ccsm =  24.55
mean_ground =  25.24
mean_ann_raw =  24.80
mean_ann_bc =  25.24

std_ccsm =  0.72
std_ground =  0.50
std_ann_raw =  0.37
std_ann_bc =  0.64
```

Results

Time series

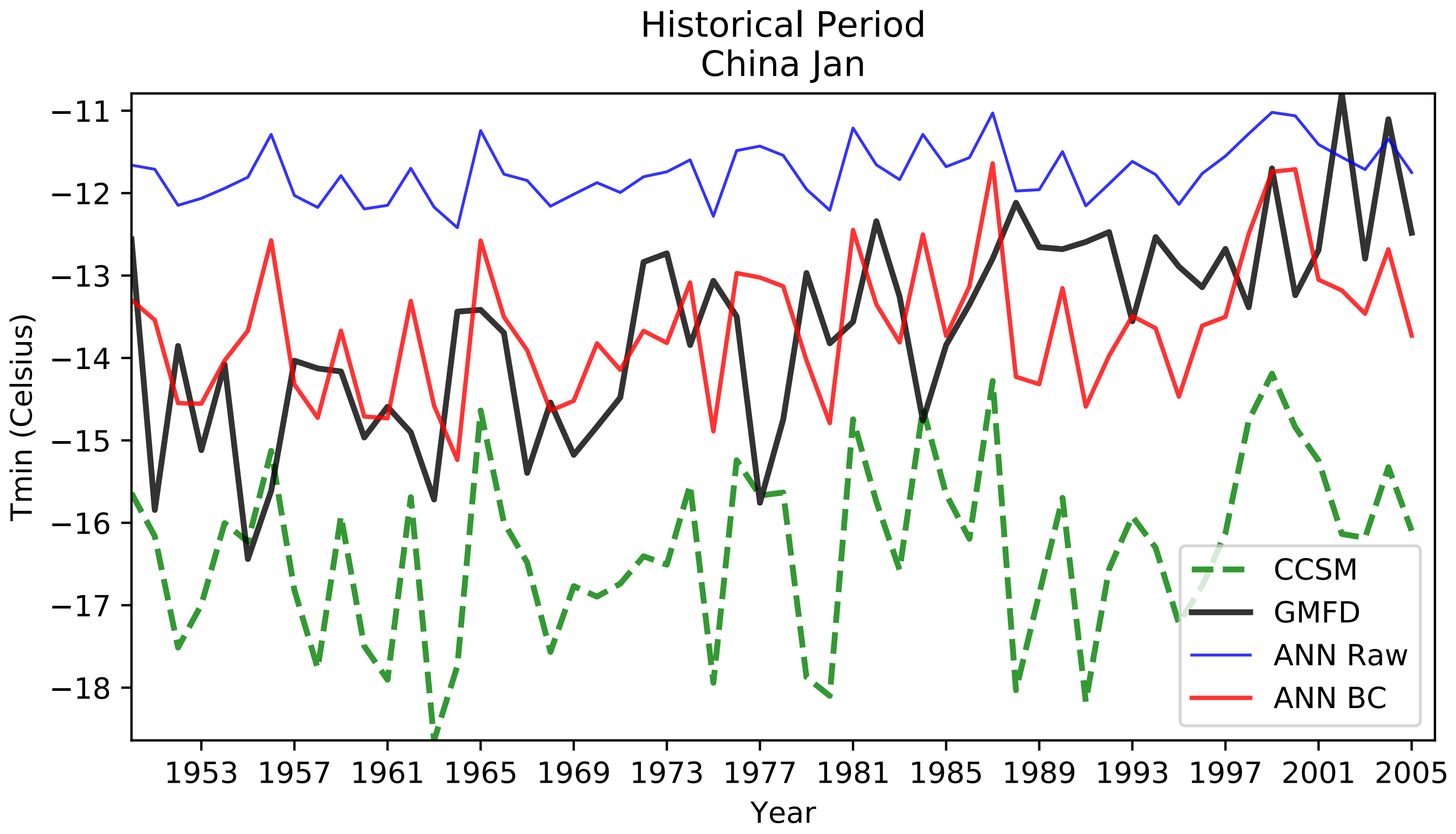
Historical Tmin (third method, 56yr)

Beijing




```
mean_ccsm =  −12.60
mean_ground =  −9.07
mean_ann_raw =  −8.27
mean_ann_bc =  −9.07

std_ccsm =  2.18
std_ground =  1.67
std_ann_raw =  0.77
std_ann_bc =  1.60
```

China




```
mean_ccsm =  −16.32
mean_ground =  −13.64
mean_ann_raw =  −11.75
mean_ann_bc =  −13.64

std_ccsm =  1.07
std_ground =  1.20
std_ann_raw =  0.33
std_ann_bc =  0.83
```

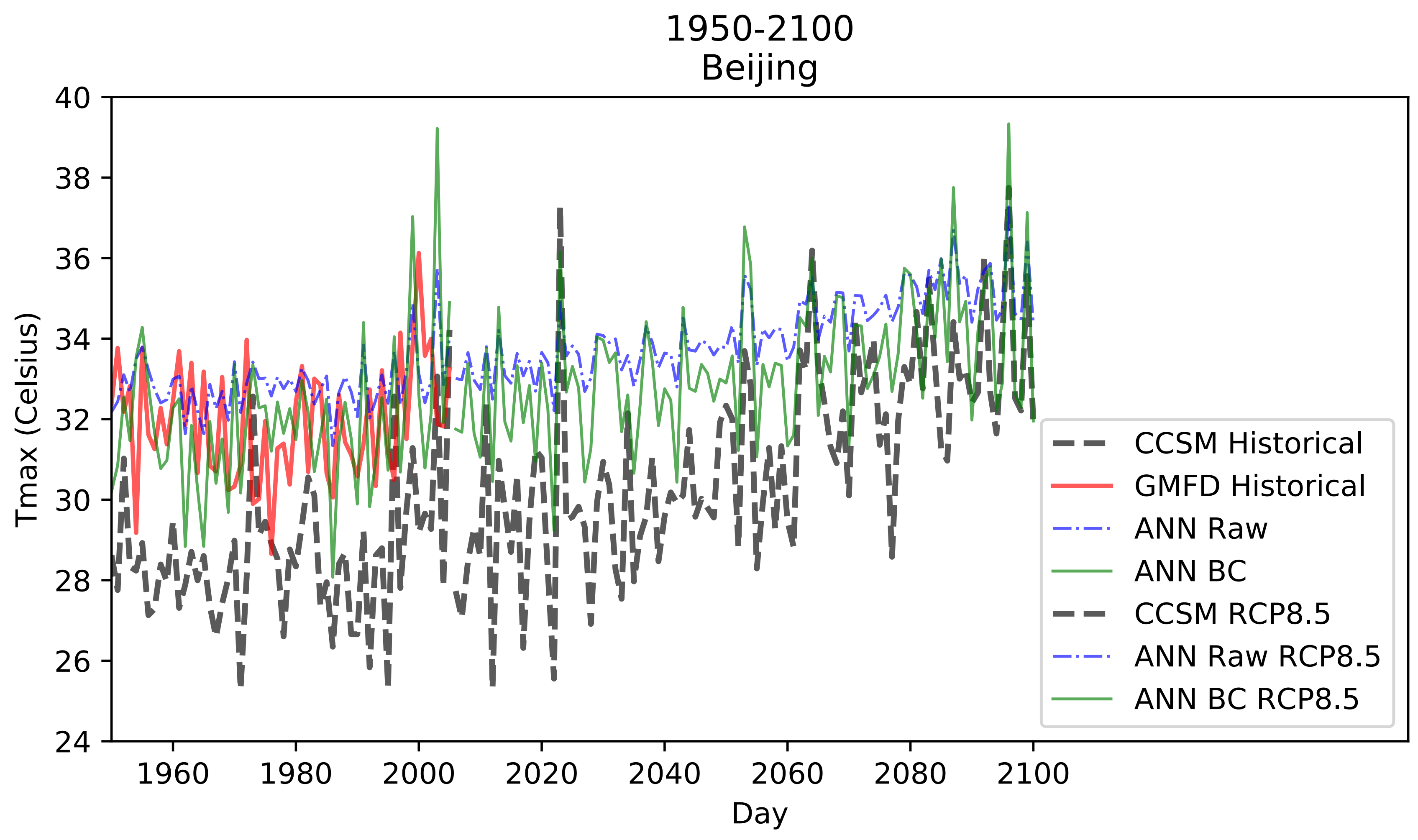
Results

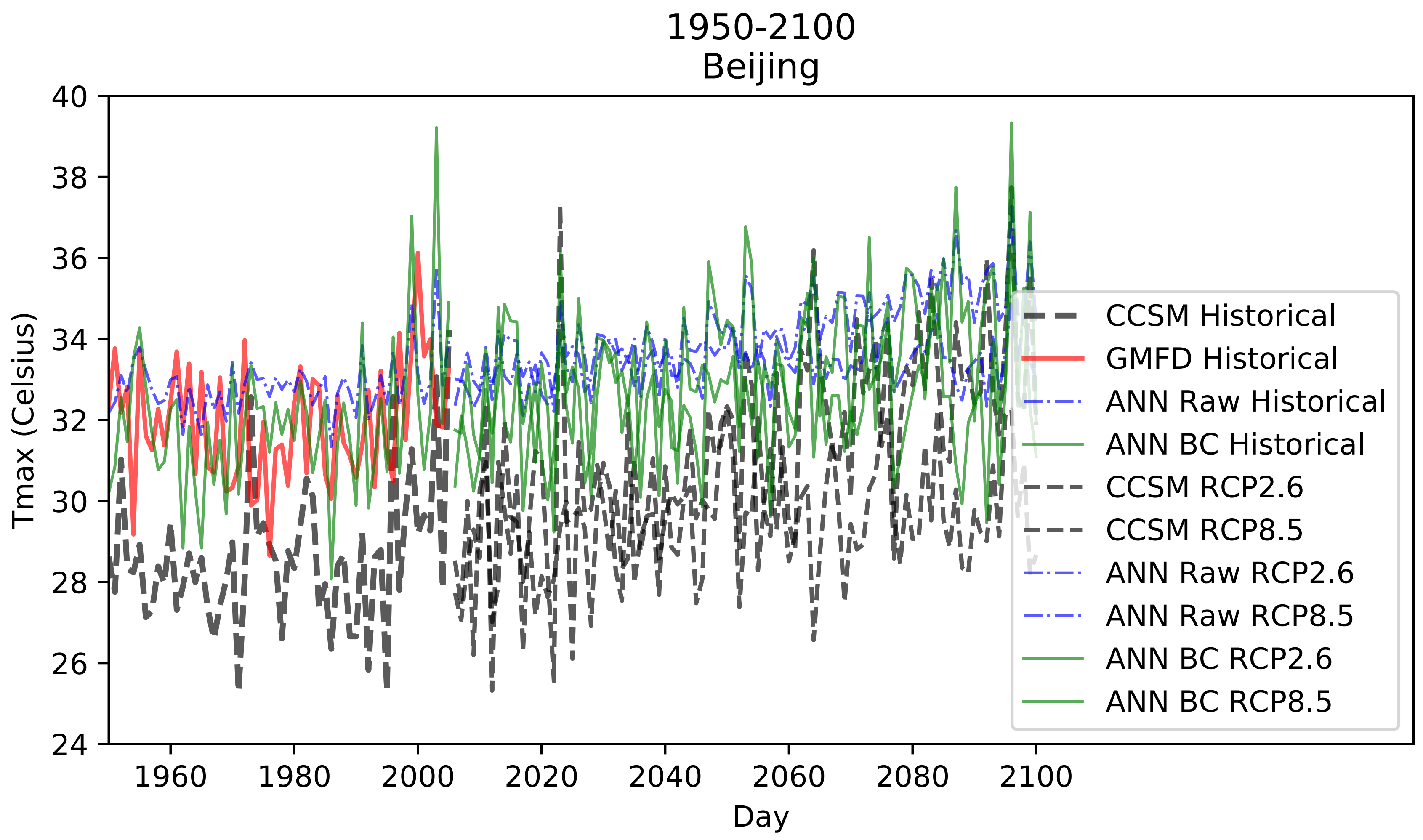
Time series

Beijing

Historical Tmax

(third method, 56yr, 每十年)





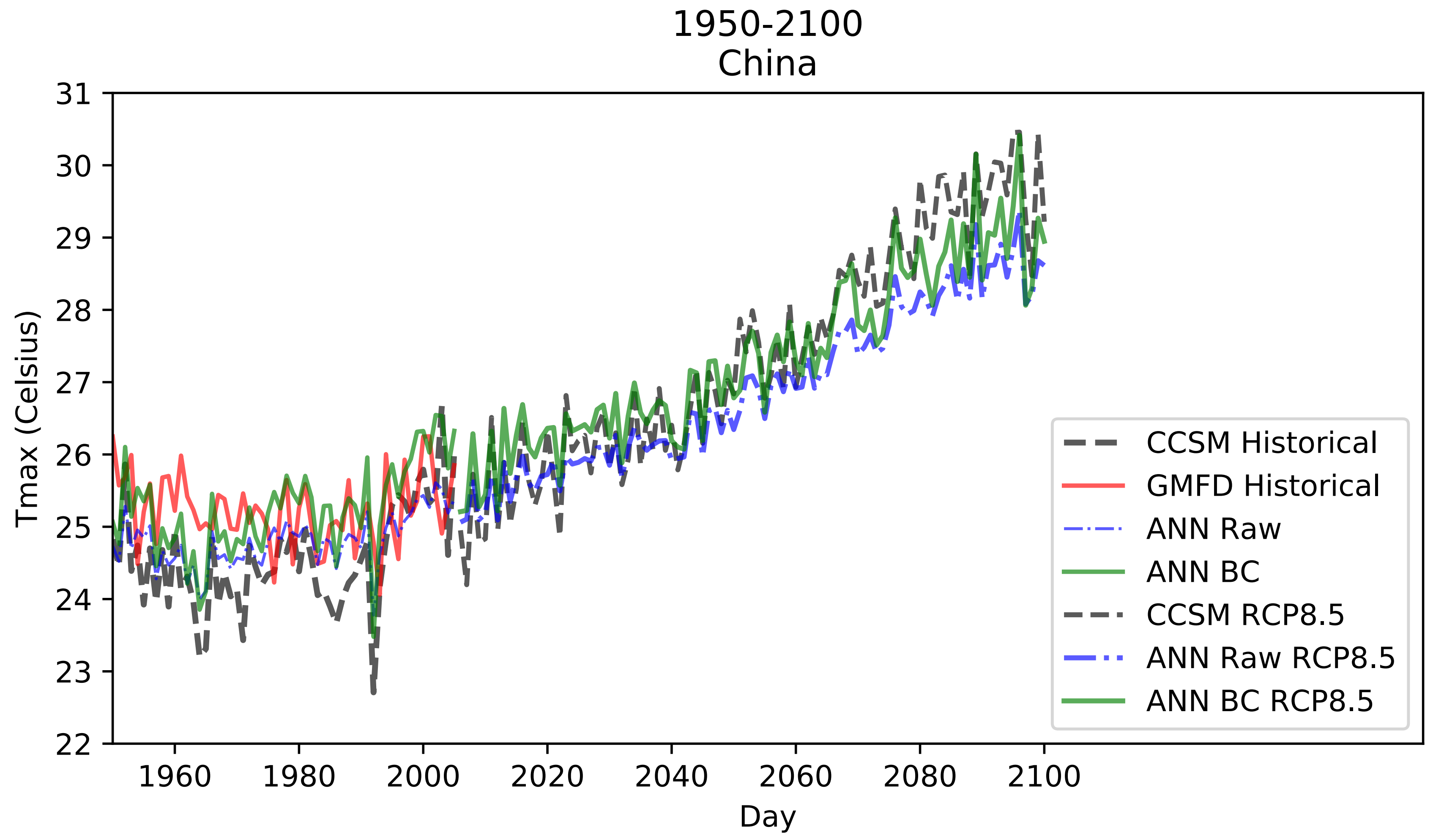
Results

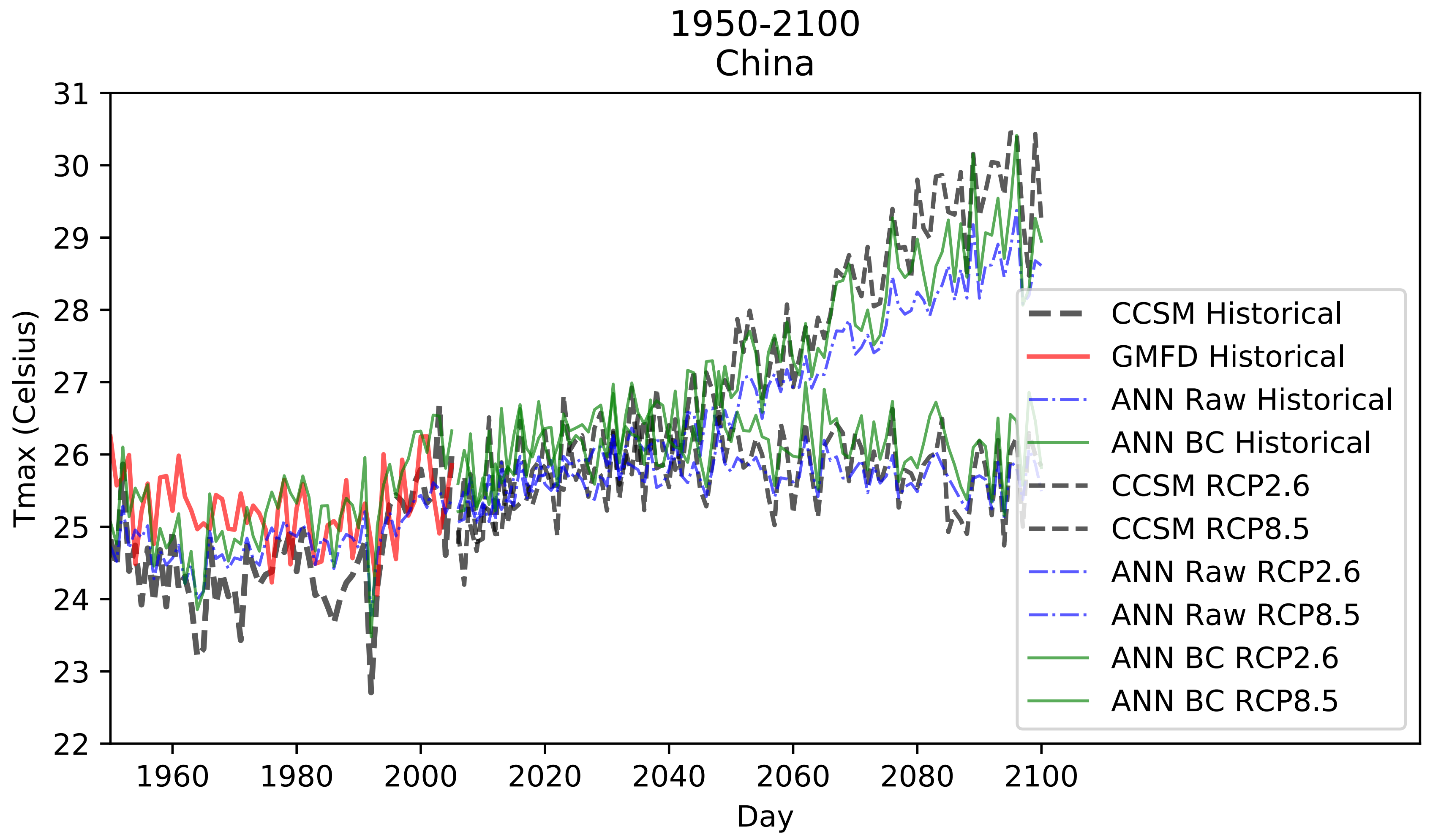
Time series

China

Historical Tmax

(third method, 56yr, 每十年)





谢谢