Statistical downscaling of temperature using three techniques in the Tons River basin in Central India
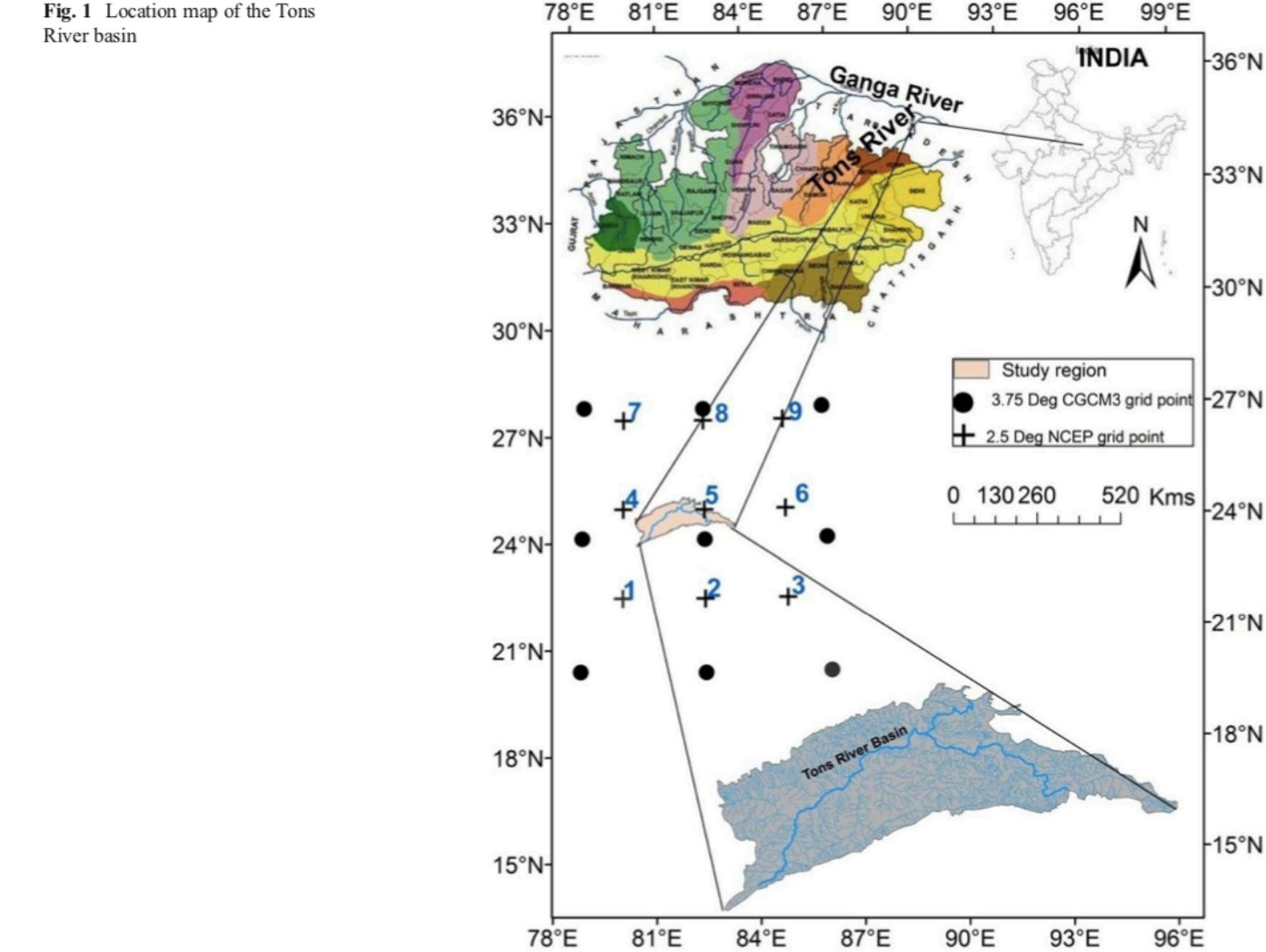
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Introduction:

· Statistical Downscaling (comparatively cheap and computationally efficient):

- Multiple linear regression (MLR),
- Artificial neural network (ANN),
- least square support vector machine (LS-SVM).

Data and study site:

研究地区：the Ton River (ranges from 23° 57'N to 25° 20'N latitudes, 80° 20′ E to 83° 25′ E longitudes).

- Satna station
- Rewa station
- Allahabad station

Fig. 1 Location map of the Tons River basin

研究变量：Tmax and Tmin

研究时间：2001 - 2100;

数据：

·*Observed data:* India Meteorological Department (IMD);

·*Models:* CGCM3, NCEP.

Method:

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Results:

Table 9 Result of performance statistics during calibration for minimum and maximum temperature at different stations using multiple linear regression (MLP), least square support vector machine (LS-SVM), and artificial neural network (ANN)

	Station name	Variable name	ANN model type	CC			RMSE			NMSE			NASH		
				MLR	ANN	LS-SVM	MLR	ANN	LS-SVM	MLR	ANN	LS-SVM	MLR	ANN	LS-SVM
Calibration	Allahabad	Tmax	4-5-1	0.963	0.970	0.973	1.579	1.440	1.359	0.072	0.060	0.053	0.928	0.940	0.947
		Tmin	5-5-1	0.974	0.984	0.985	1.579	1.242	1.211	0.051	0.031	0.030	0.949	0.969	0.970
	Satna	Tmax	5-5-1	0.983	0.988	0.989	1.012	0.840	0.809	0.034	0.020	0.022	0.966	0.980	0.978
		Tmin	5-5-1	0.980	0.990	0.991	1.344	0.953	0.917	0.040	0.020	0.019	0.960	0.980	0.981
	Rewa	Tmax	4-4-1	0.977	0.983	0.983	1.174	0.997	1.010	0.045	0.033	0.034	0.955	0.967	0.966
		Tmin	4-5-1	0.954	0.970	0.968	2.061	1.664	1.708	0.090	0.059	0.062	0.910	0.941	0.938
Validation	Allahabad	Tmax	4-5-1	0.966	0.971	0.980	1.492	1.382	1.160	0.188	0.026	0.040	0.928	0.938	0.950
		Tmin	5-5-1	0.960	0.974	0.982	2.060	1.891	1.289	0.128	0.034	0.037	0.906	0.923	0.963
	Satna	Tmax	5-5-1	0.979	0.981	0.988	1.092	1.036	0.780	0.090	0.017	0.020	0.955	0.960	0.980
		Tmin	5-5-1	0.970	0.979	0.986	1.764	1.442	1.126	0.090	0.019	0.027	0.933	0.955	0.973
	Rewa	Tmax	4-4-1	0.976	0.975	0.984	1.162	1.215	0.935	0.123	0.021	0.030	0.951	0.946	0.968
		Tmin	4-5-1	0.971	0.978	0.988	1.970	1.899	1.034	0.230	0.031	0.023	0.915	0.923	0.977

Fig. 2 Comparison of monthly observed and simulated maximum temperature using LS-SVM model at **a** Allahabad station, **b** Satna station, and **c** Rewa station
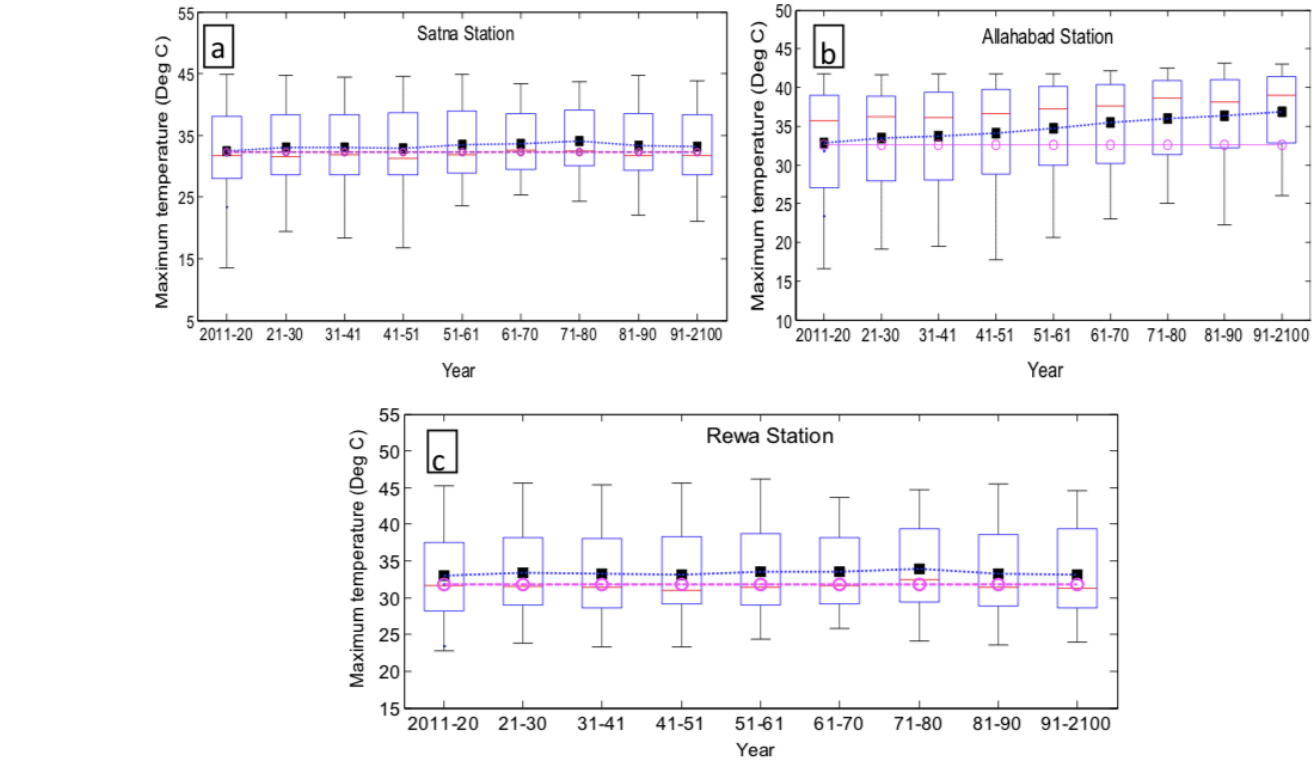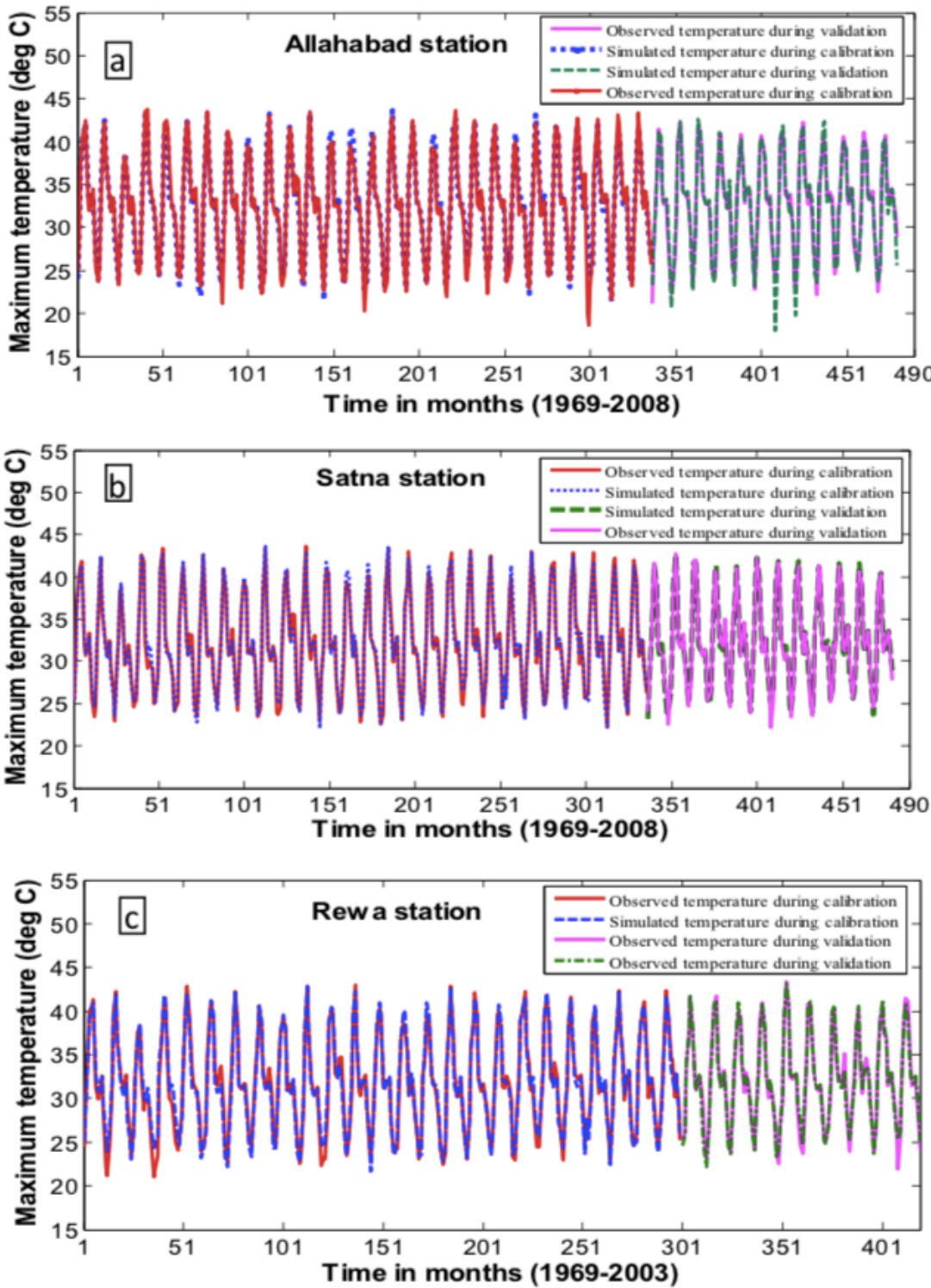

Fig. 4 *Box plot* depicts the decadal changes in downscaled maximum temperature using LS-SVM model from 2011 to 2100 at **a** Satna, **b** Allahabad, and **c** Rewa stations. The *horizontal red line in the box* denotes median. The *black square* represents the mean value of simulated maximum temperature, while the *pink line with circle* depicts the mean value of observed maximum temperature
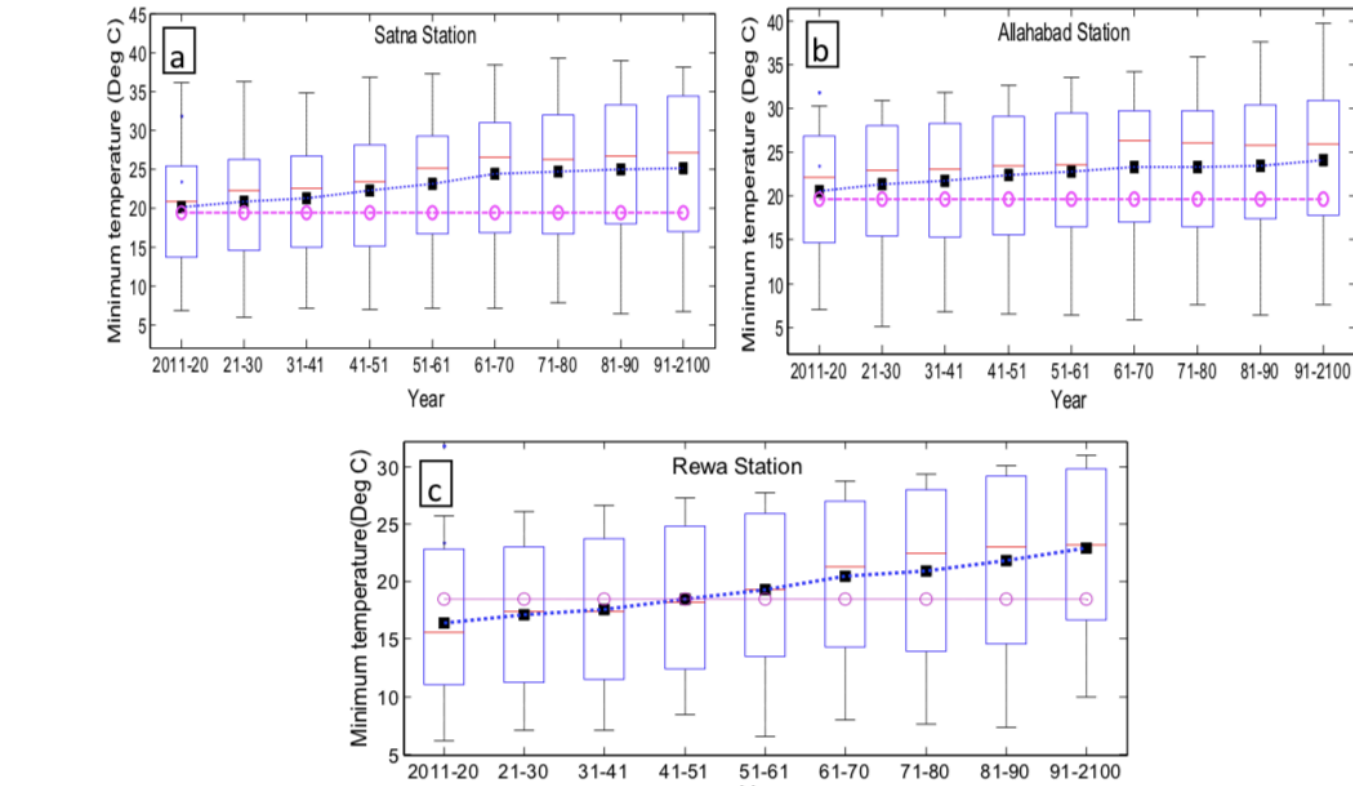

Fig. 5 *Box plot* depicts the decadal changes in downscaled minimum temperature using LS-SVM model from 2011 to 2100 at **a** Satna, **b** Allahabad, and **c** Rewa stations. The *horizontal red line in the box* denotes the median value. The *black square* represents the mean value of simulated minimum temperature, while *the pink line with circle* depicts the mean value of observed minimum temperature

Conclusions:

1. 三种方法中LS-SVM的统计降尺度效果最好；
2. 未来，最高温并没有显著的升高而最低温升高走势明显；
3. Allahabad站点的最低温度升高最为明显。

Report

2020.06.25

張慕琪

讨论

· 关于Tmax&Tmin:

MLPRegressor:

```
hidden_layer_sizes=(10, 5),
solver='adam',
activation='tanh',
alpha=1e-2,
learning_rate_init=1e-2
```

```
Now: j=119, i=227 | ANN: Traning score: 0.889 Testing score: 0.881
Now: j=119, i=228 | ANN: Traning score: 0.890 Testing score: 0.871
Now: j=119, i=229 | ANN: Traning score: 0.802 Testing score: 0.819
Now: j=119, i=230 | ANN: Traning score: 0.895 Testing score: 0.876
Now: j=119, i=231 | ANN: Traning score: 0.897 Testing score: 0.871
Now: j=119, i=232 | ANN: Traning score: 0.892 Testing score: 0.897
Now: j=119, i=233 | ANN: Traning score: 0.892 Testing score: 0.874
Now: j=119, i=234 | ANN: Traning score: 0.886 Testing score: 0.871
Now: j=119, i=235 | ANN: Traning score: 0.889 Testing score: 0.857
Now: j=119, i=236 | ANN: Traning score: 0.895 Testing score: 0.887
Now: j=119, i=237 | ANN: Traning score: 0.884 Testing score: 0.862
Now: j=119, i=238 | ANN: Traning score: 0.893 Testing score: 0.891
Now: j=119, i=239 | ANN: Traning score: 0.893 Testing score: 0.887
Now: j=119, i=240 | ANN: Traning score: 0.892 Testing score: 0.889
Now: j=119, i=241 | ANN: Traning score: 0.888 Testing score: 0.879
Now: j=119, i=242 | ANN: Traning score: 0.890 Testing score: 0.880
Now: j=119, i=243 | ANN: Traning score: 0.886 Testing score: 0.876
Now: j=119, i=249 | ANN: Traning score: 0.893 Testing score: 0.881
Now: j=119, i=250 | ANN: Traning score: 0.057 Testing score: 0.038
End of main thread...
```
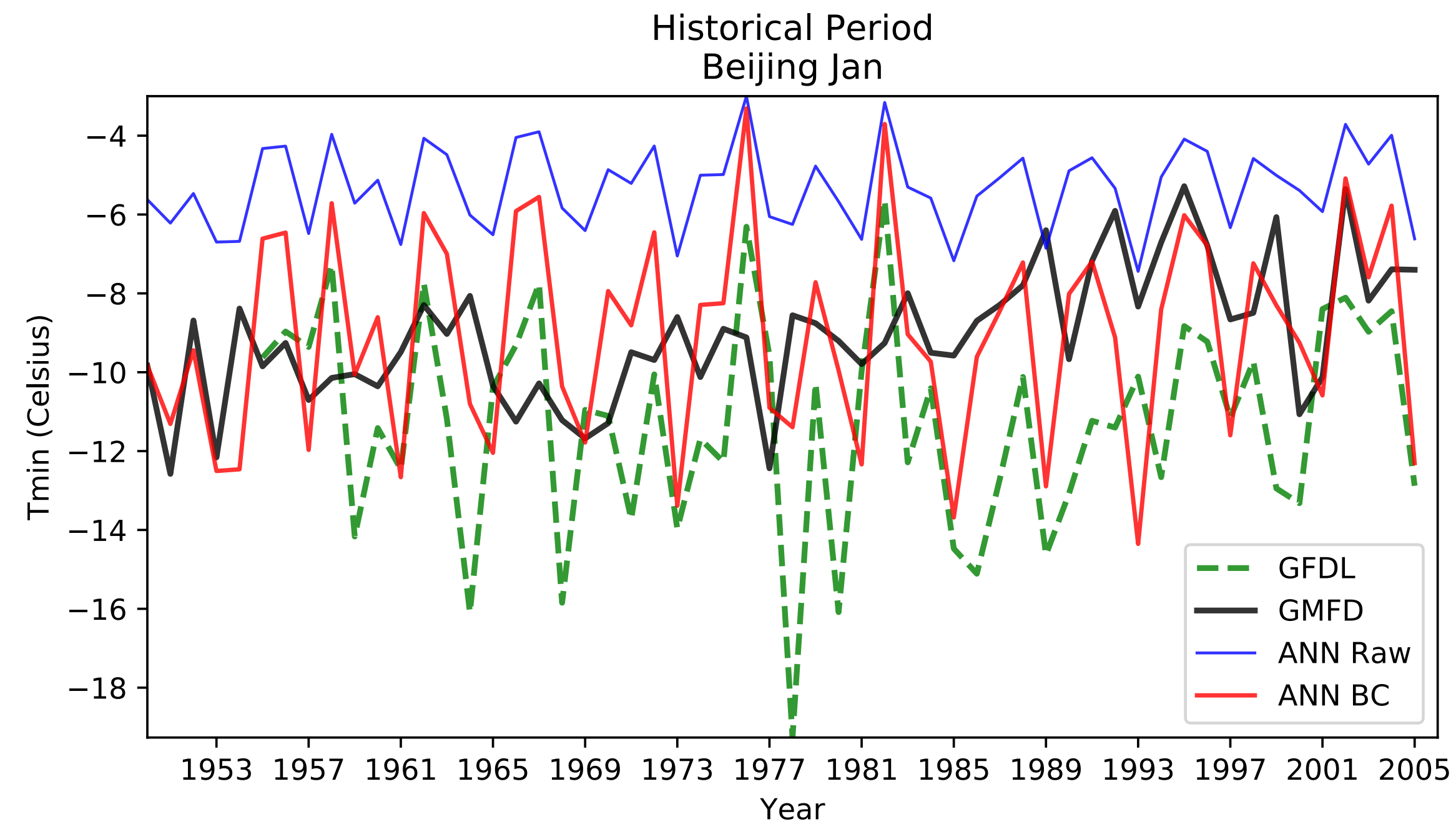
讨论

Historical Period
Beijing July
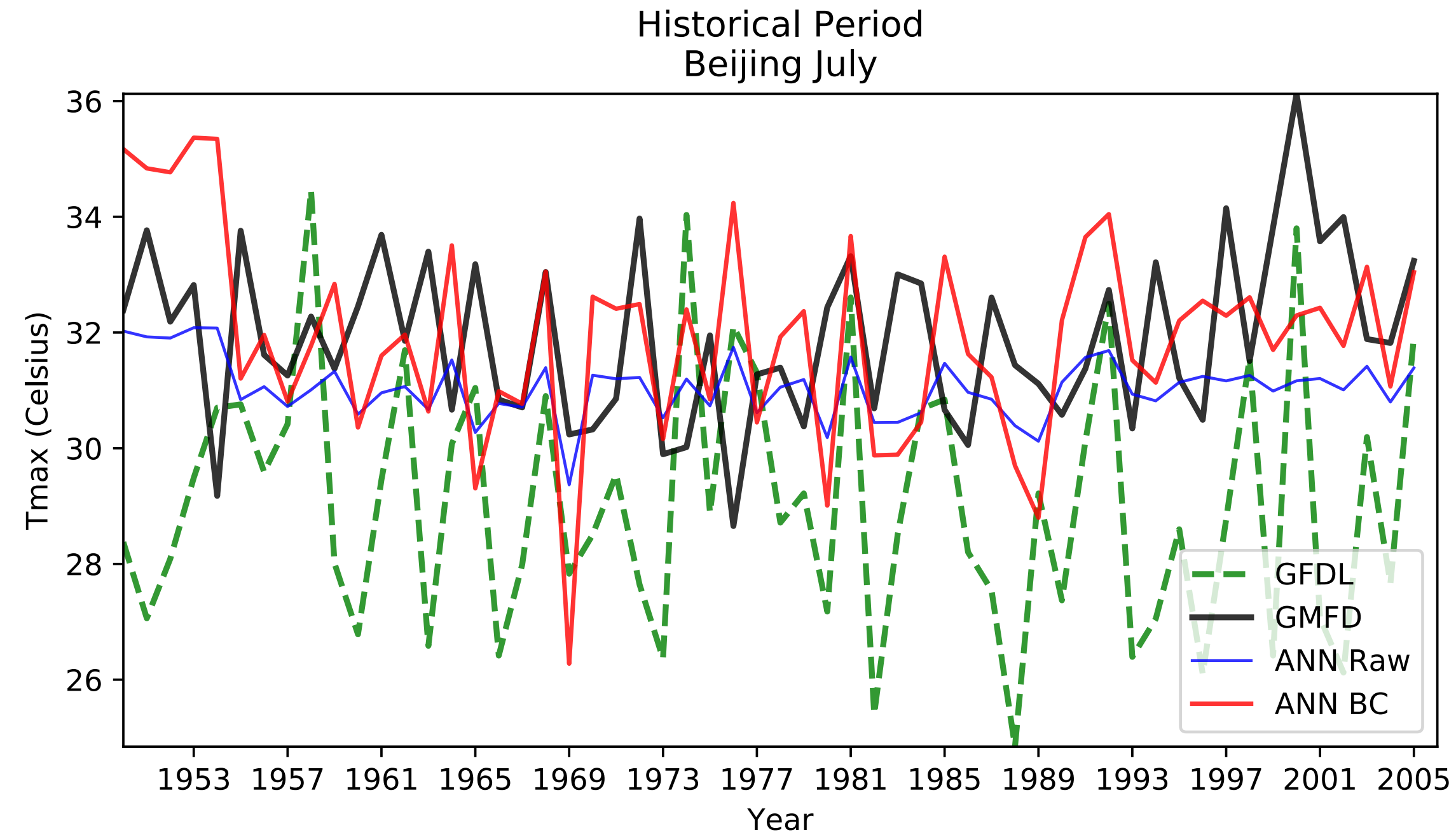
mean_gfdl = 29.084316
mean_ground = 31.921953
mean_ann_raw = 31.053915
mean_ann_bc = 31.92196

std_gfdl = 2.2402873
std_ground = 1.4520789
std_ann_raw = 0.5174515
std_ann_bc = 1.7327423

讨论

Historical Period
Beijing Jan

mean_gfdl = /
mean_ground = −9.066935
mean_ann_raw = −5.315023
mean_ann_bc = −9.066932

std_gfdl = /
std_ground = 1.6685536
std_ann_raw = 1.0551983
std_ann_bc = 2.6220672

谢谢