

Detection of Urbanization Influence on Temperature Observations over Mainland China

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Abstract: Climate change and global warming are noted as mixable terminology to indicate the anthropogenic influence on climate variation, and it seems that such influence may result in mostly irreversible negative impacts on our societies. Meanwhile, the urban heat island effects (or partly regarded as urbanization influence) on local climate have been evident by a large number of studies through analyzing urban and associated rural weather observations. However, intuitively, it is a question whether the urbanization has influenced our estimation of global warming. This study uses the observed temperature data and land use data over Mainland China to evaluate urbanization influence on temperature data. The Moderate Resolution Imaging Spectroradiometer (MODIS) land cover product (MCD12Q1) of 2008 are used to extract the urban area percentage (UAP) within the circles centered at each weather station for the radii of 2 km, 4 km, 6 km, 8 km and 10 km. Then 578 weather stations over Mainland China are categorized into different groups. Those groups include four Large City groups, four Medium City groups and four Small City Groups. Then, the urbanization effects are explored by analyzing annual maximum (Tmax) and minimum (Tmin) temperature series of the station group datasets. The results reveal that there is no considerable difference among those station groups for the Tmax trends for the period from 1984 to 2009. For the Tmin data, the trends are about 0.7 °C/decade for the Large City groups and only 0.5 °C/decade for Small City groups. This study proves that in a certain extent the urbanization has resulted in over-estimation of Tmin (and associated daily temperature) trend. Therefore, the global warming might be over-estimated.



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Motivation & Objective

✓ **Motivation:**

- Has the urbanization influenced our estimation of global warming?

✓ **Objective:**

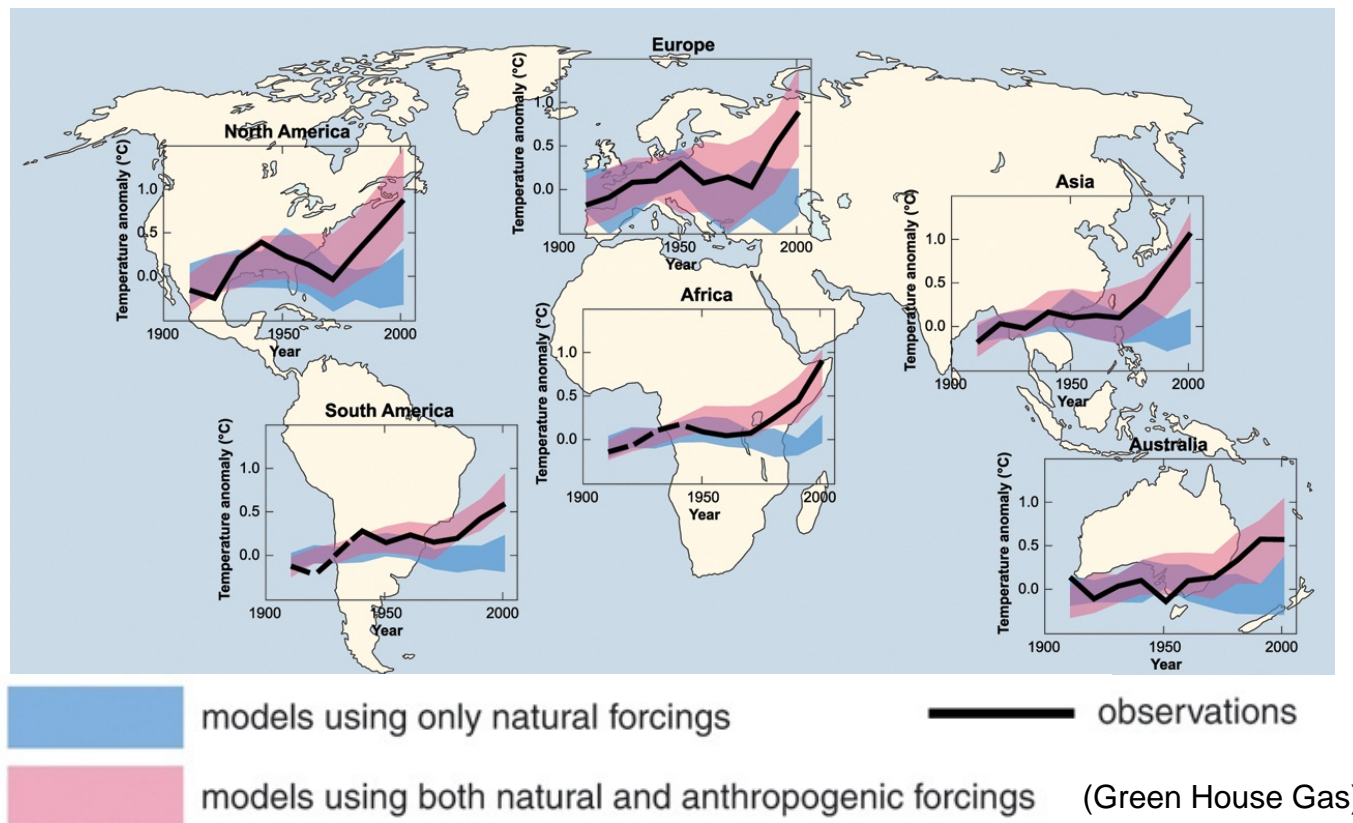
- To evaluate the relationship between the size of the urban area and the trends of the weather station temperature over Mainland China

Background

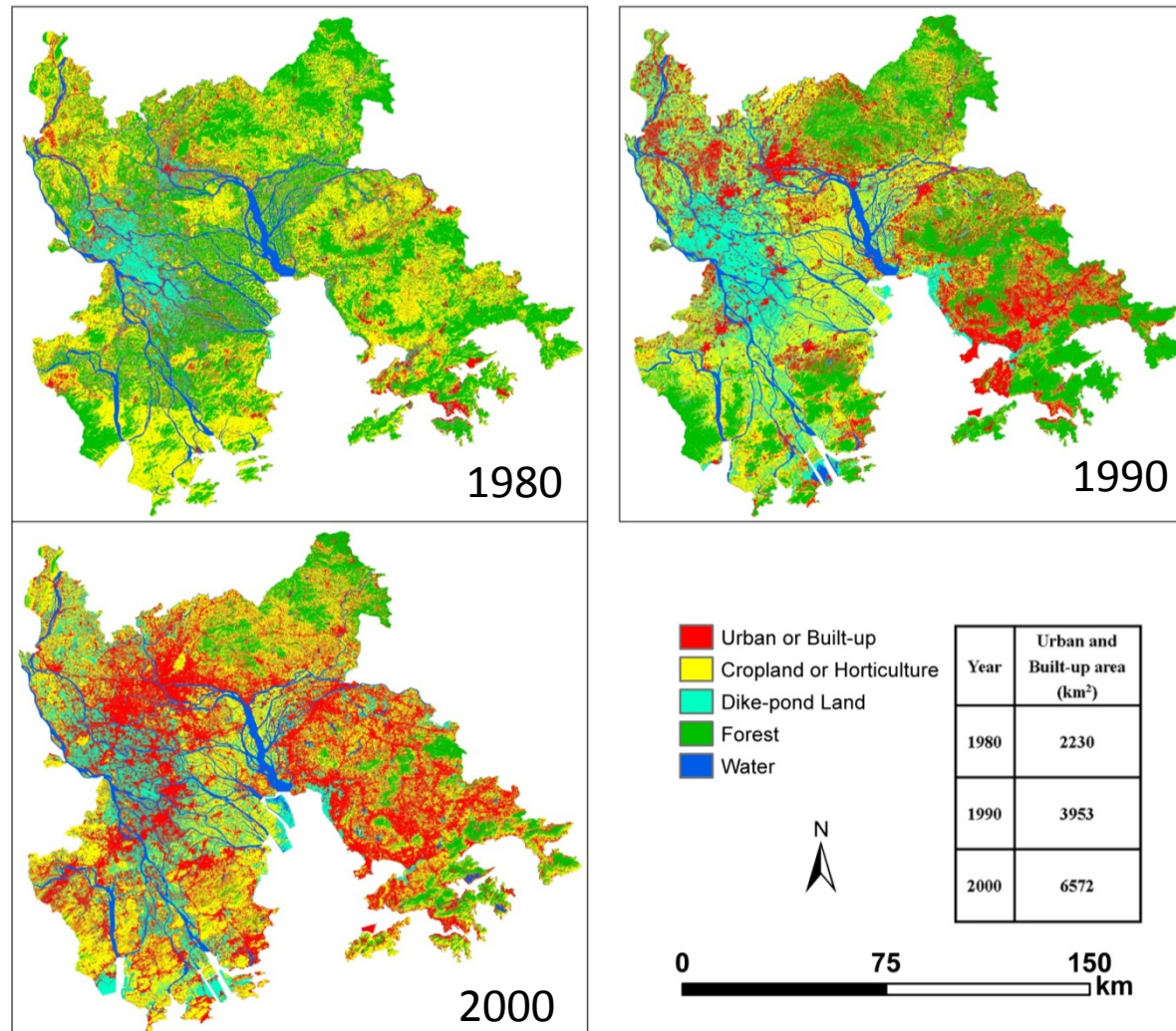
“The World Meteorological Organization (**WMO**), National Oceanic and Atmospheric Administration (**NOAA**), and National Aeronautics and Space Administration (**NASA**) all reported that **2000 to 2009 was the warmest decade** since instrumental measurements of temperatures began in the 1880s”

----- M. Zhao, S. W. Running, 2010, *Science* , 329, 940

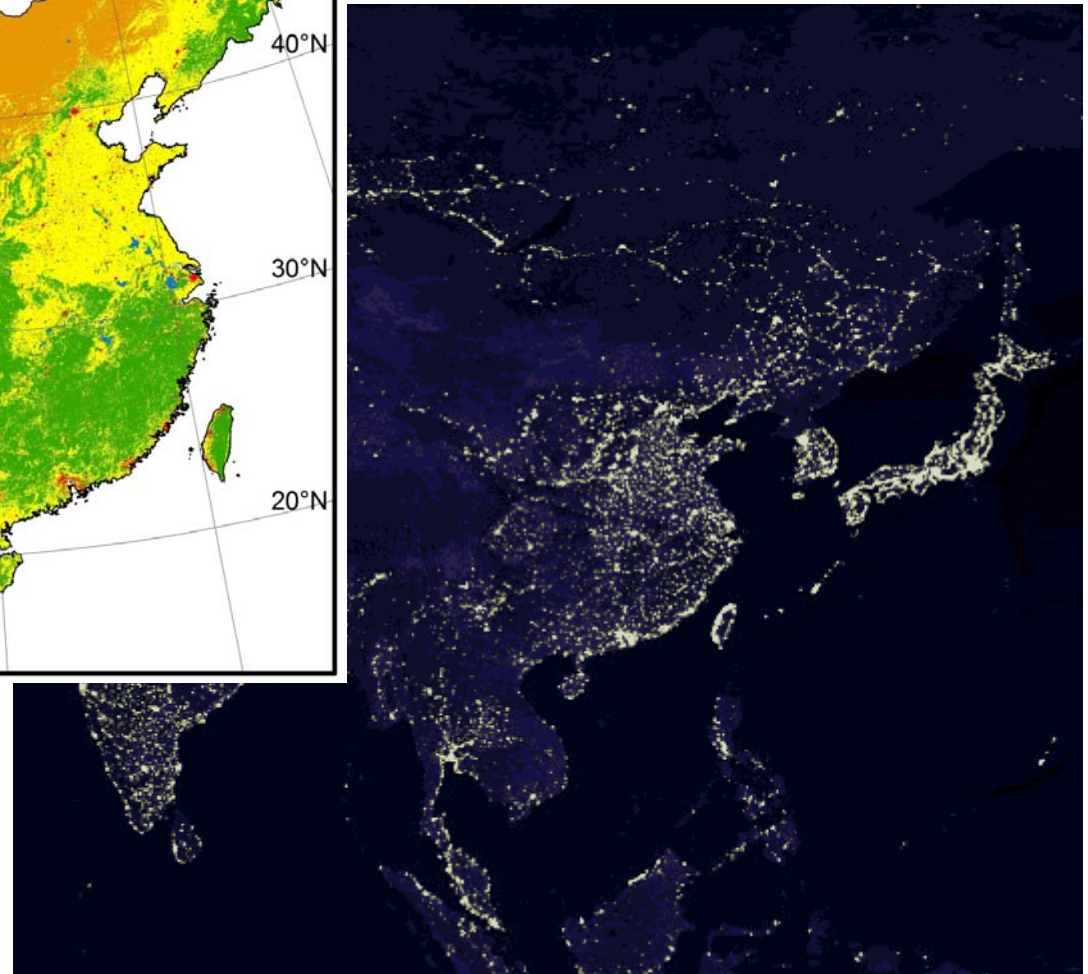
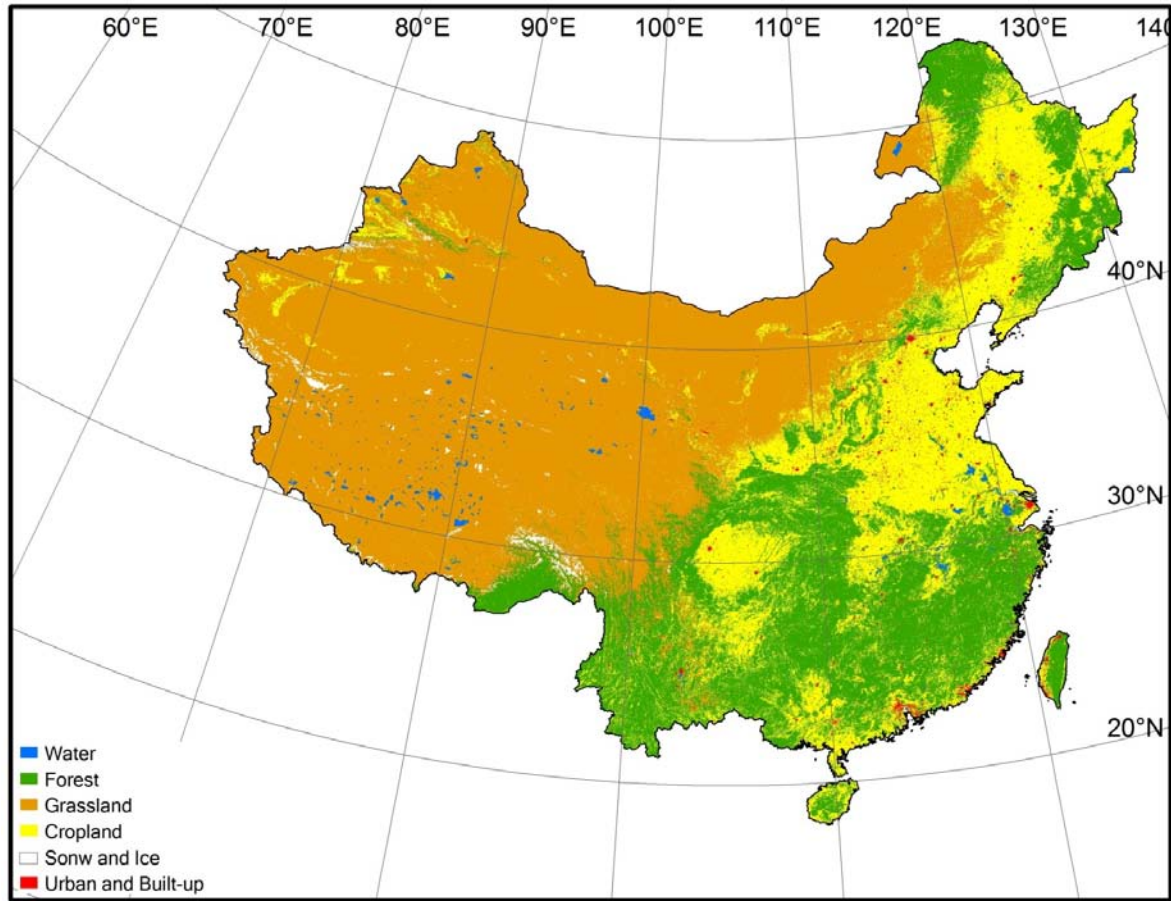
Intergovernmental Panel on Climate Change (IPCC) 2007 Synthesis Report



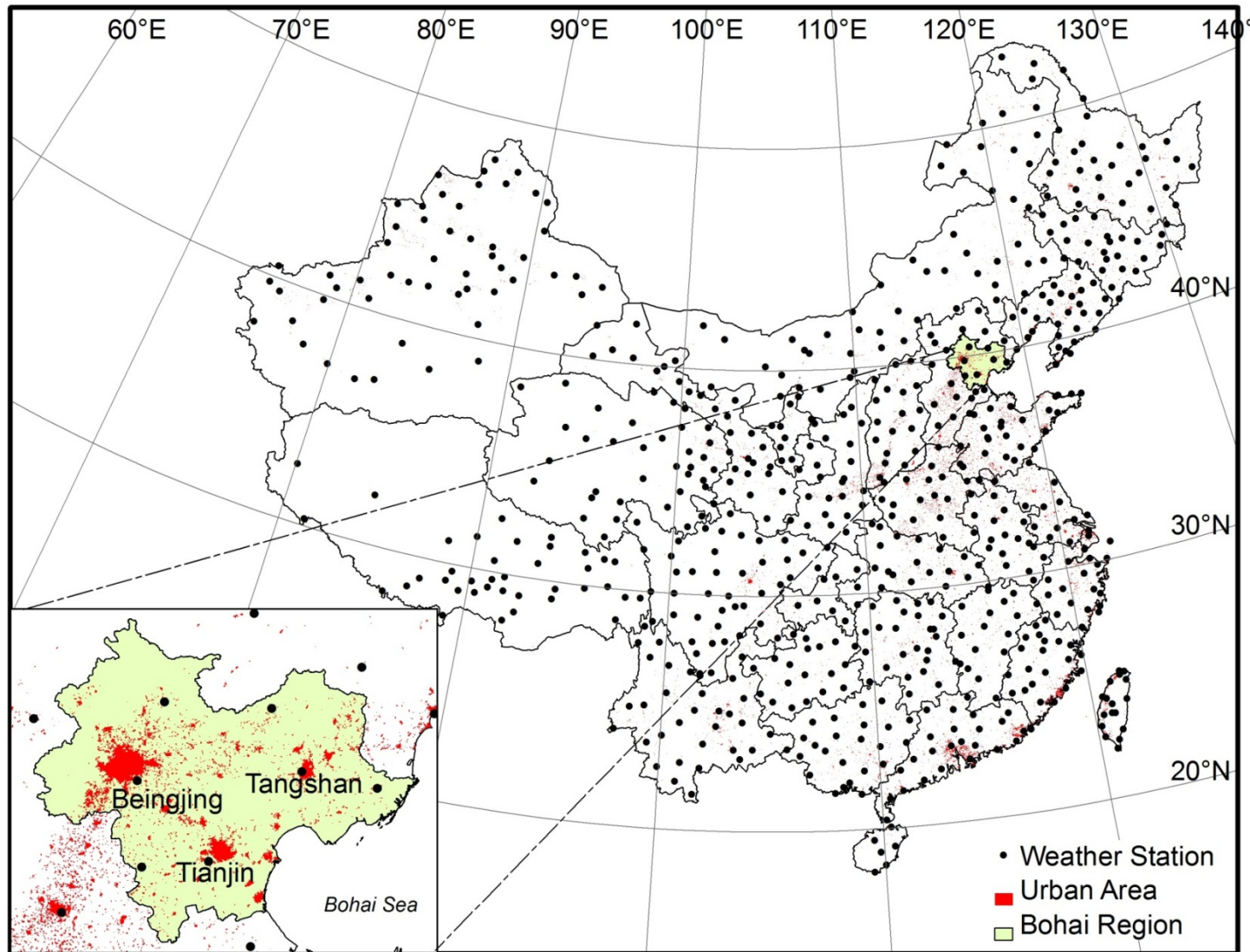
An example of land use change (Urbanization) -----Pearl River Delta from 1980 to 2000



Data: Moderate Resolution Imaging Spectroradiometer (MODIS) land cover product (MCD12Q1) of 2008

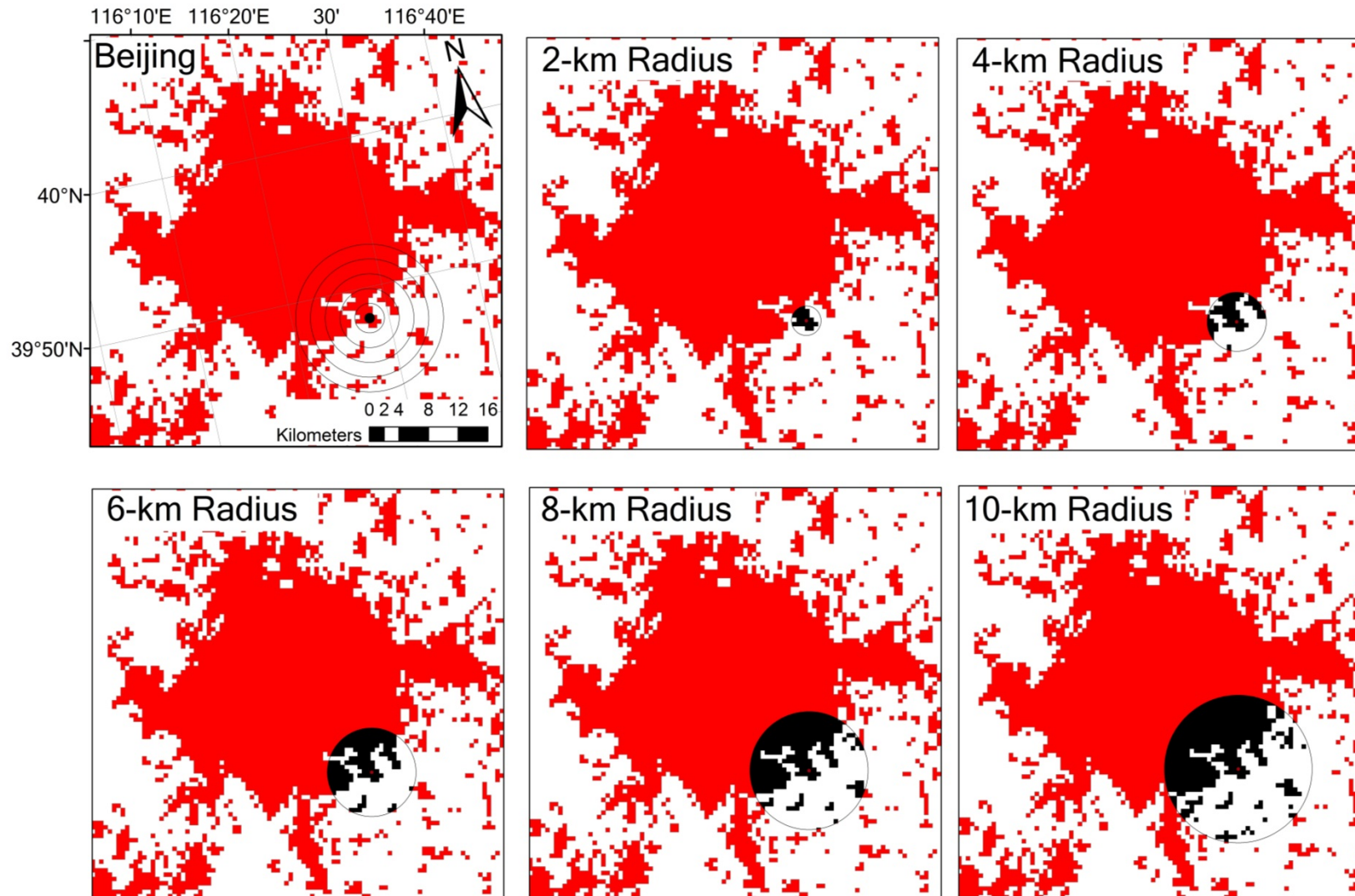


Data: Weather Station Observed Surface Air Temperature Data

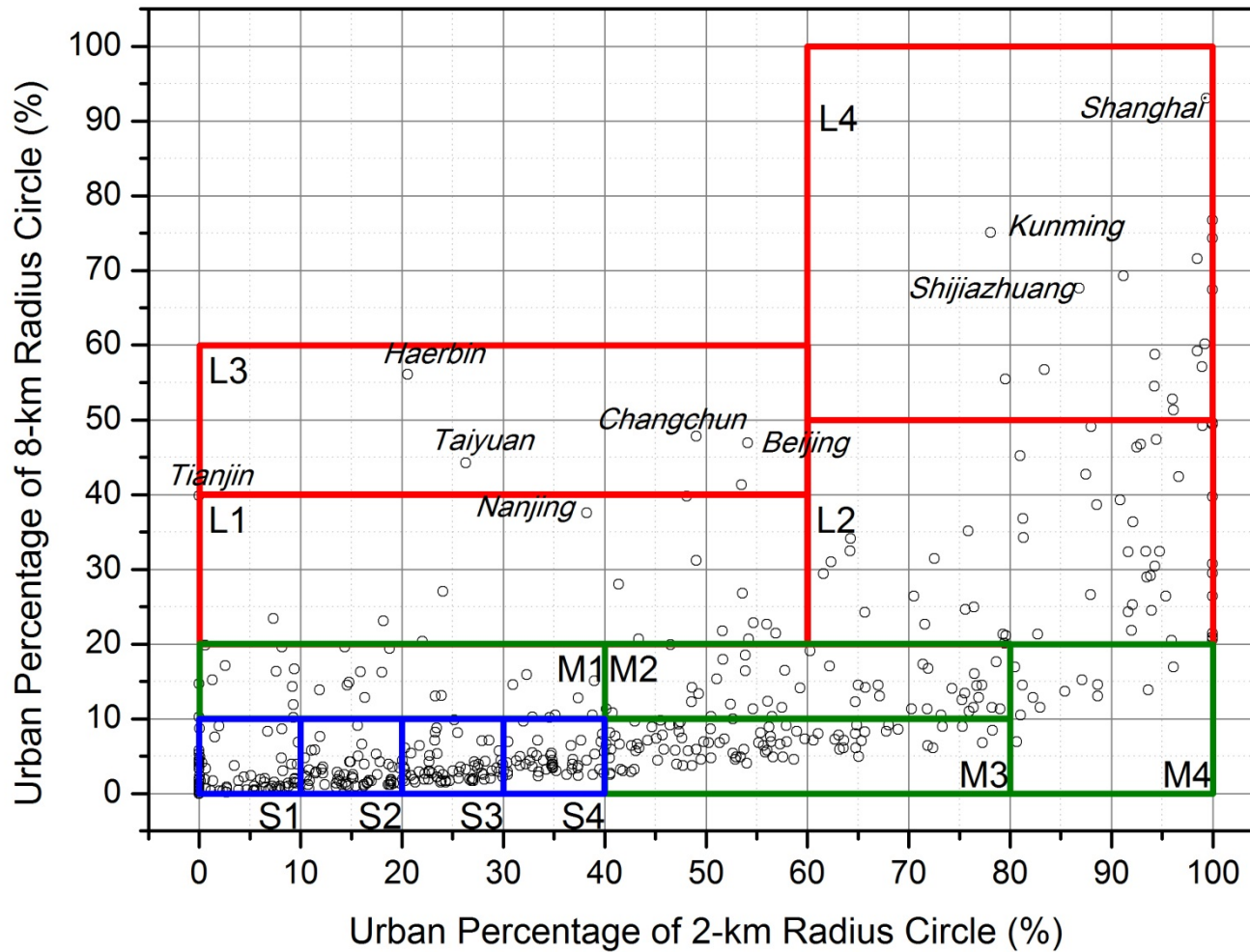


Total: 715 stations

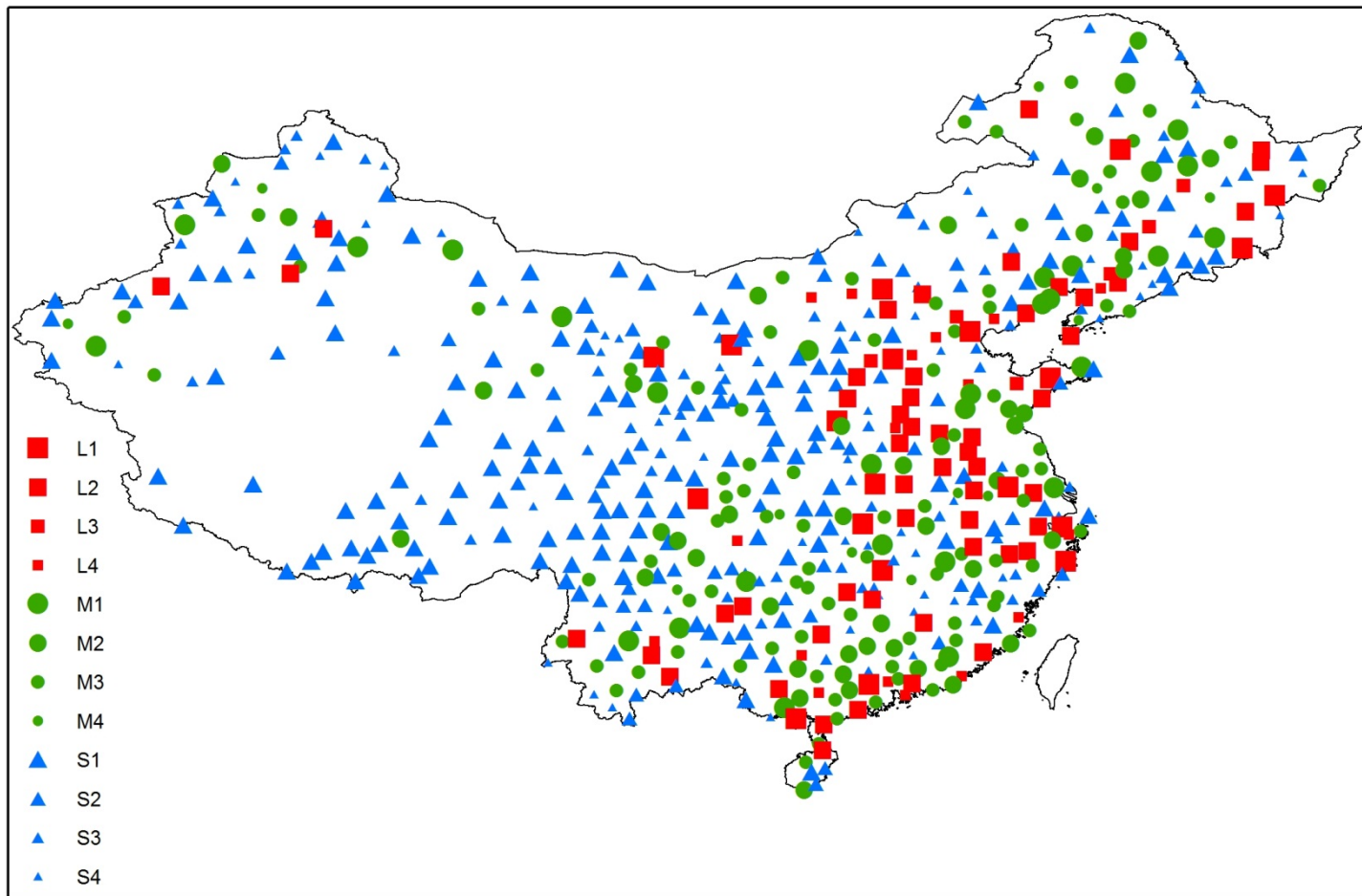
To create circles centered at each weather station with the radii of 2 km, 4 km, 6 km, 8 km and 10 km



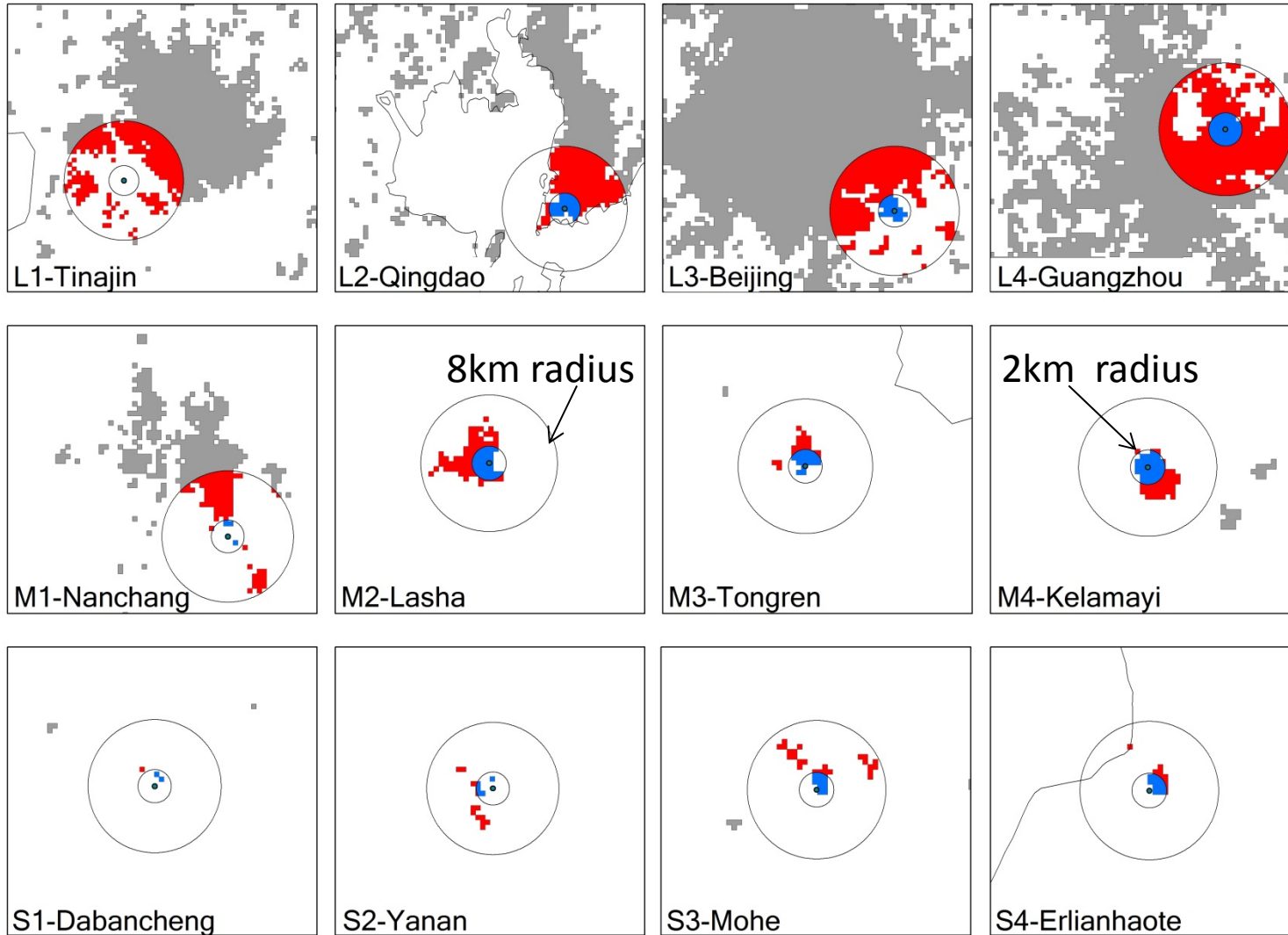
Group Scheme of Weather Stations



Distribution of the 12 weather station groups over China



Examples of 12 station groups



Urban area in different radii circles

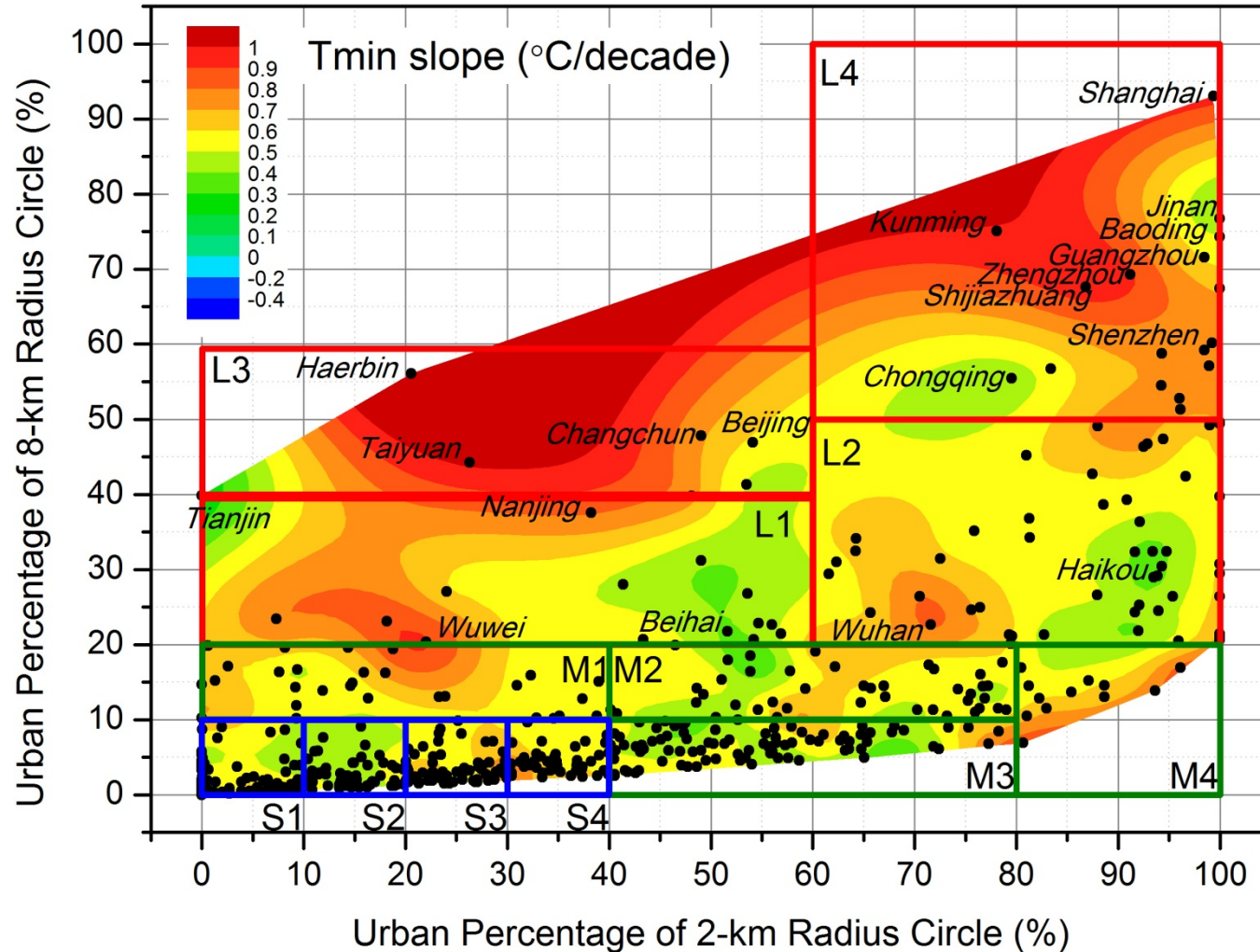
Name	Station ID	Tmin Trend (°C /decade)	Percentage of each Radius Circle (%)				
			2 km	4 km	6 km	8 km	10 km
Shang Hai	58367	0.99	99	96	96	93	88
Guang Zhou	59287	0.39	98	86	72	72	69
Kun Ming	56778	0.99	78	80	79	75	66
Shi Jia Zhuang	53698	1.03	87	81	75	68	63
Bao Ding	54602	0.83	100	95	89	74	62
Zheng Zhou	57083	1.04	91	85	77	69	60
Shan Tou	59316	0.73	100	93	80	67	60
Ji Nan	54823	0.08	100	98	90	77	60
Ha Er Bin	50953	1.30	21	49	56	56	52
Bao Tou	53446	0.77	99	88	72	57	49
Yu Lin	59453	0.72	98	85	72	59	49
Bei Jing	54511	0.63	54	42	44	47	48
Shen Zhen	59493	0.70	94	81	73	59	47
Chang Chun	54161	0.66	49	44	47	48	46
Chong Qing	57516	0.36	80	71	64	55	45
Tian Jin	54527	0.15	0	9	30	40	41

Circle Area (km ²)	12.6	50.3	113.1	201.1	314.2
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Hong Kong island: 78 km²

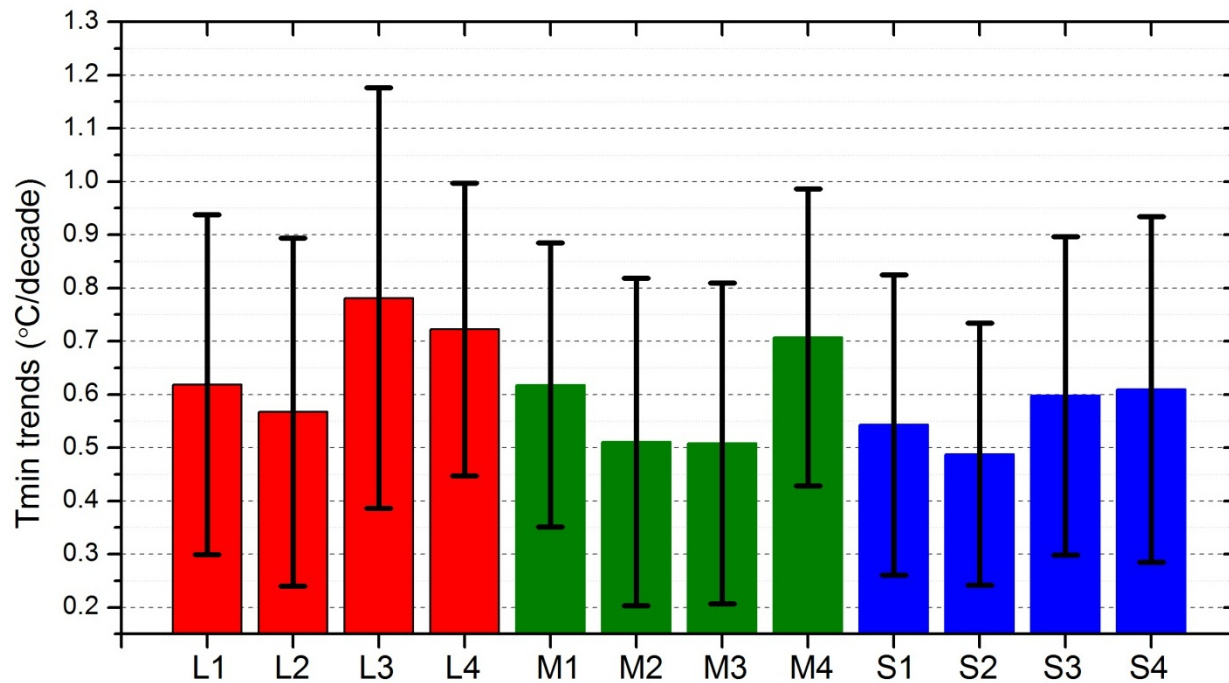
Tmin slope contour map of stations with 12 groups (2 km vs 8 km)



Tmax and Tmin trends of the 12 station groups

Unit (°C/decade)

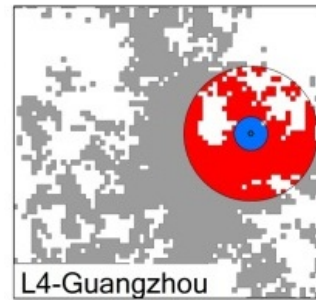
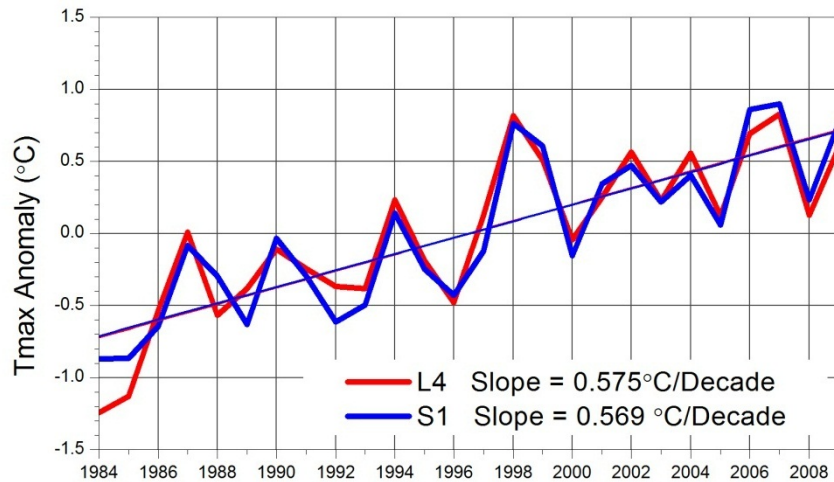
	Group	1	2	3	4
Tmax	L	0.540	0.512	0.535	0.575
	M	0.513	0.572	0.552	0.560
	S	0.569	0.567	0.600	0.567
Tmin	L	0.619	0.567	0.781	0.722
	M	0.618	0.511	0.508	0.707
	S	0.543	0.488	0.598	0.610



Group	Number of Stations
L1	15
L2	50
L3	5
L4	17
M1	29
M2	42
M3	87
M4	12
S1	149
S2	61
S3	65
S4	46

Comparison of Temperature Trends

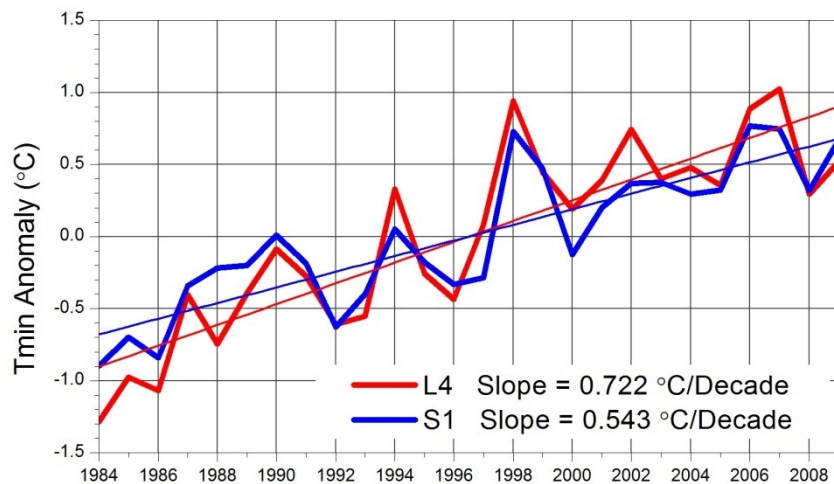
Group L4 vs S1



Large City Group 4

(17 stations)

- The stations located in urban center, and may be influenced by urbanization a lot



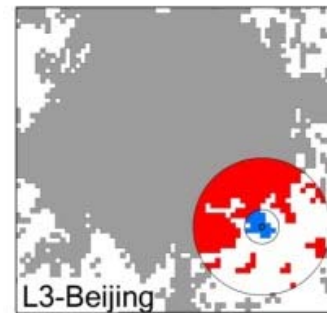
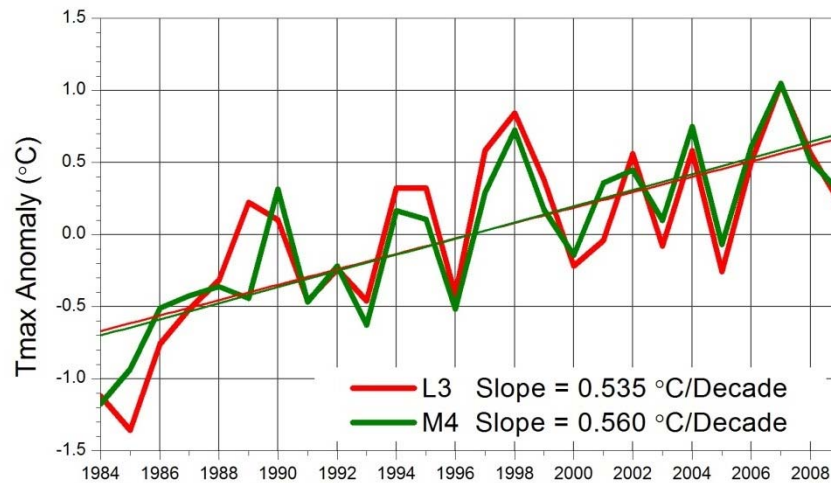
Small City Group 1

(149 stations)

- The stations located in rural area with very small urbanization influence

Comparison of Temperature Trends

Group M4 vs L3

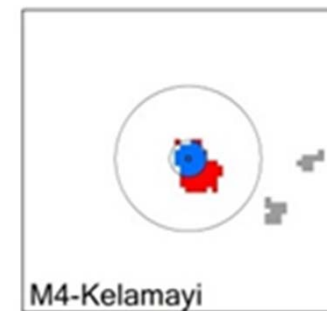
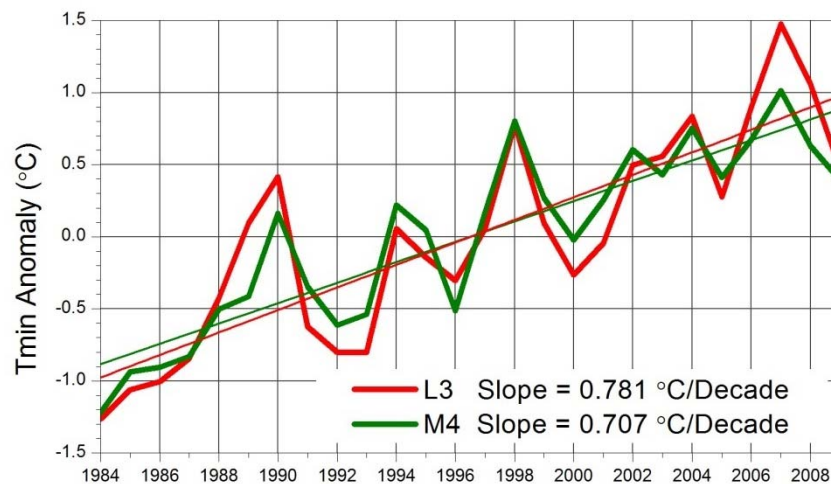


Large City Group 3

HaErBin, Tai Yuan
Chang Chun, Bei Jing
Wei Fang

(5 stations)

- The cities are large scale, and the stations are far from urban center



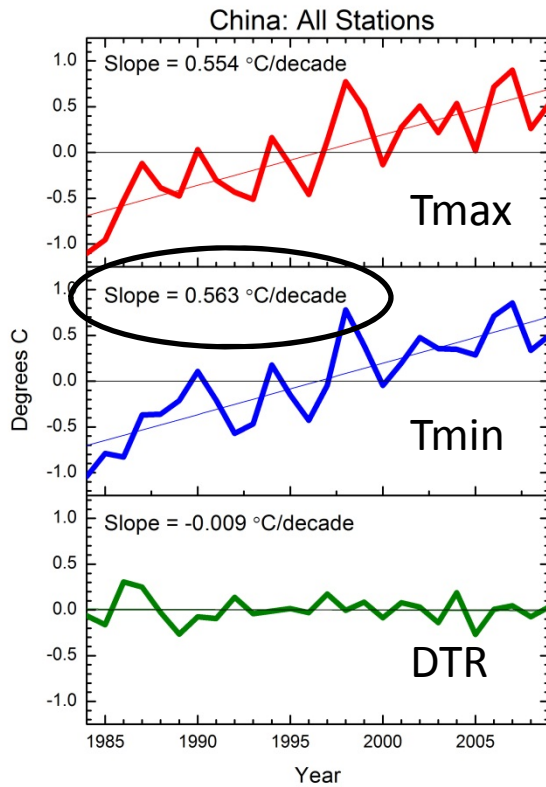
Medium City Group 4

(12 stations)

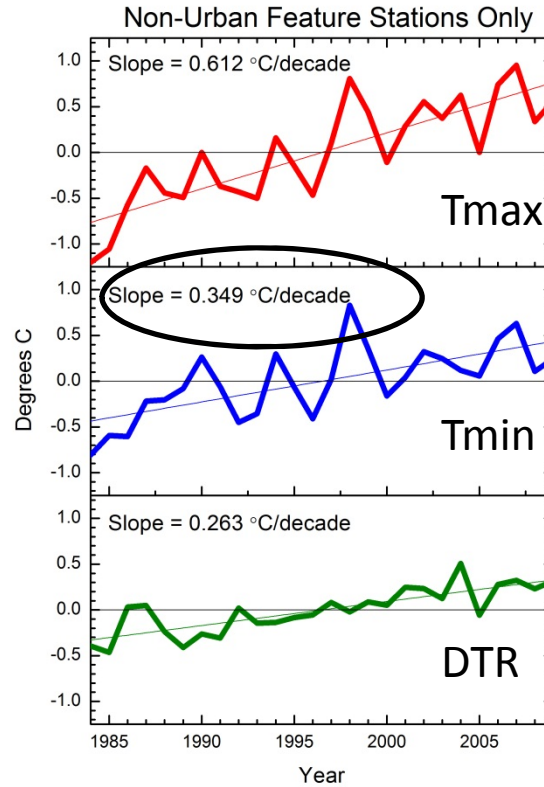
- Stations are in the urban area, but the city scale are very small

Time series of Tmax, Tmin and DTR change

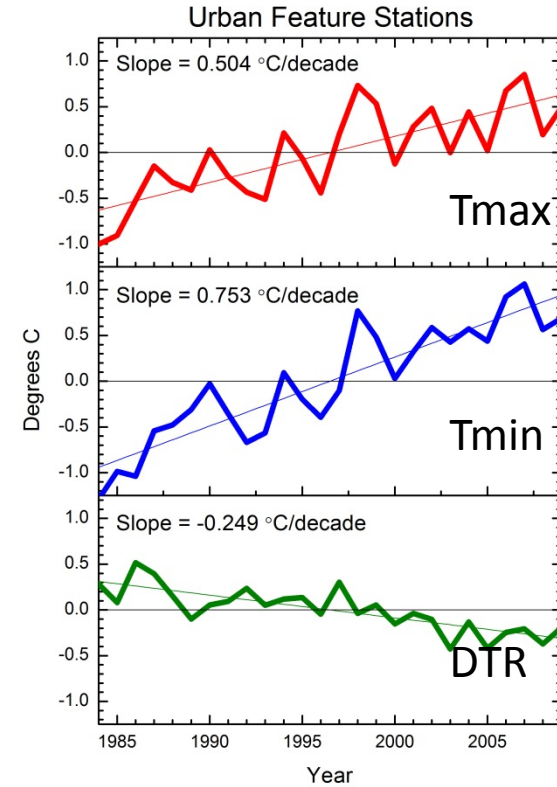
578 stations



257 stations



321 stations



$$\text{Over estimation} = 0.563 - 0.349 = 0.214$$

$$\text{Percentage of over estimation} = 0.241 / 0.349 * 100\% = 69\%$$

Conclusions

- ❖ There is no clear pattern for the Tmax trends among those stations for the period from 1984 to 2009.
- ❖ For the Tmin data, the trends are about $0.7\text{ }^{\circ}\text{C}$ /decade for the Large City groups and only $0.5\text{ }^{\circ}\text{C}$ /decade for Small City groups.
- ❖ If all of the station temperature data are used for climate change estimation, the Tmin trend in China will be over estimated about $0.214\text{ }^{\circ}\text{C}$ /decade. Urbanization effect contributes 69% of minimum temperature increasing.

Thank you!

Q&A