



南京信息工程大学  
Nanjing University of Information Science & Technology

# Method for Grade Evaluation of AWS based on Satellite Data & DEM Data

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NUISIT, NANJING, CHINA  
2017.10.26

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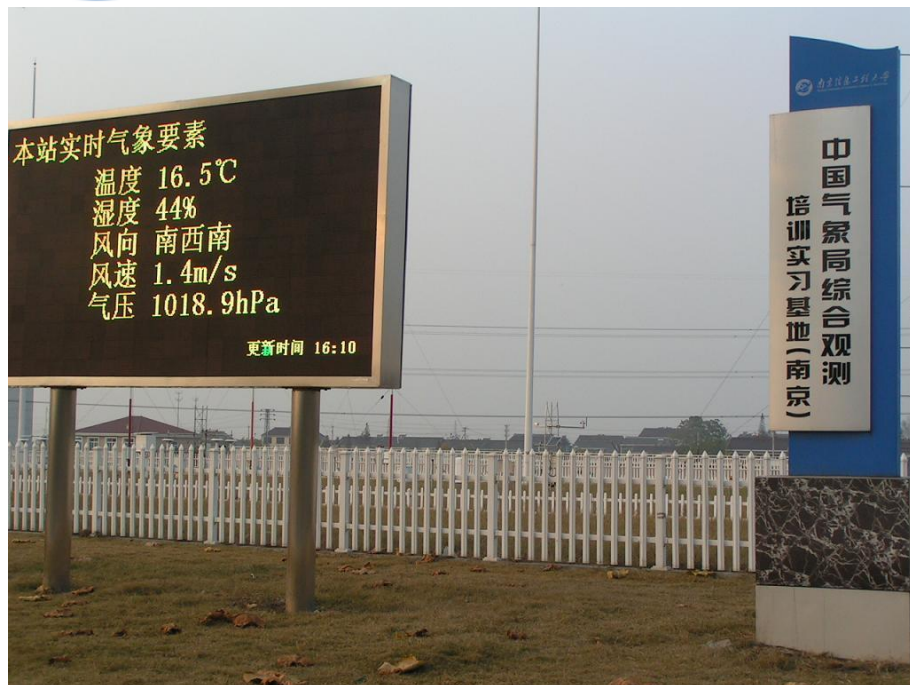
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Summary



# Research Motivation



2010年5月11日

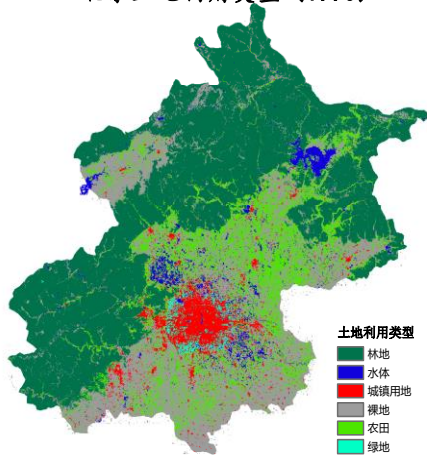
2017年10月20日



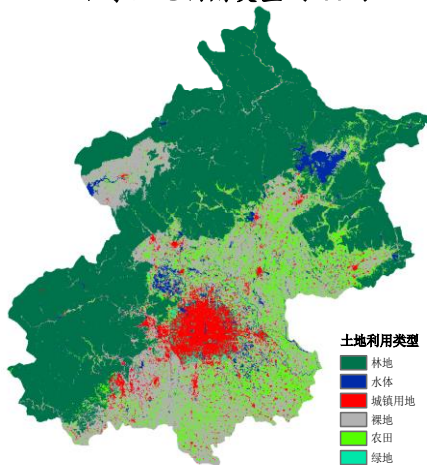


# Urbanization of Beijing

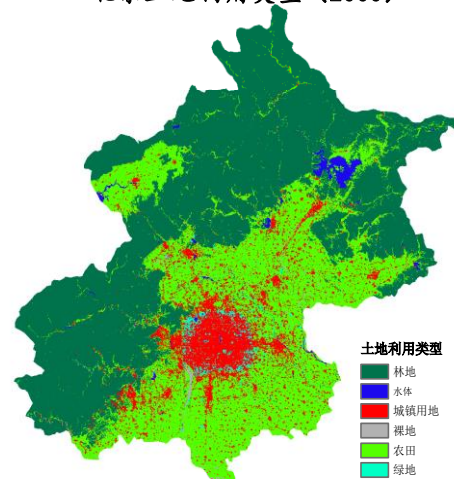
北京土地利用类型 (1990)



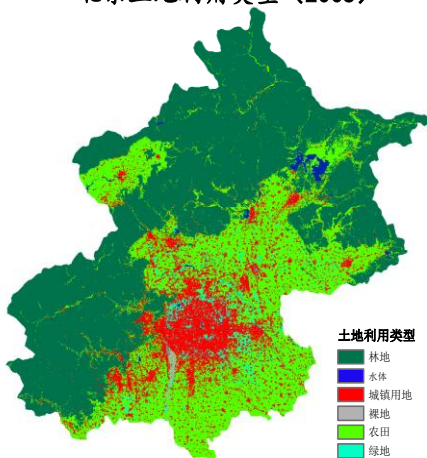
北京土地利用类型 (1994)



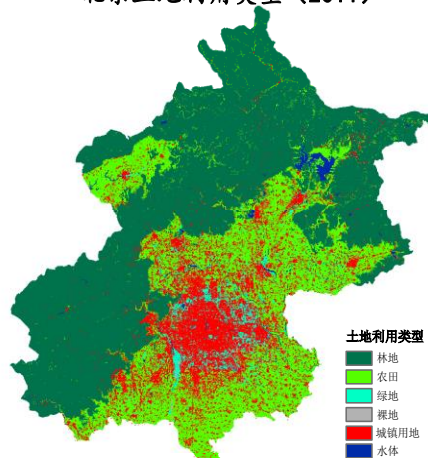
北京土地利用类型 (2000)



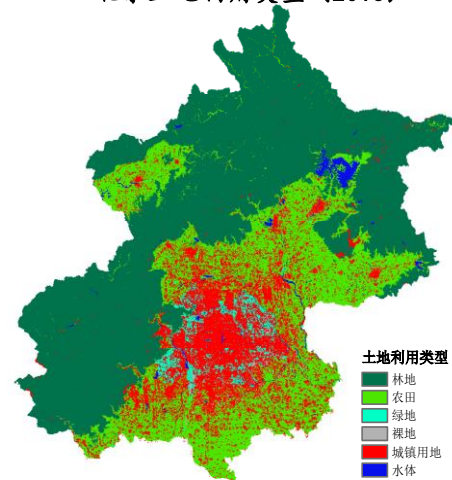
北京土地利用类型 (2005)



北京土地利用类型 (2011)



北京土地利用类型 (2013)



**Urban area**

4.5%  
(1990)



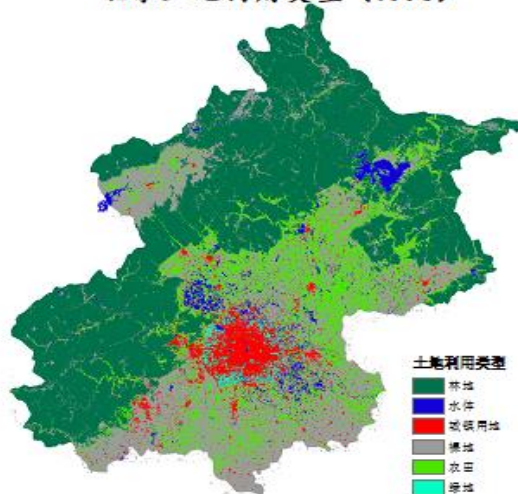
16.6%  
(2013)

# Issues

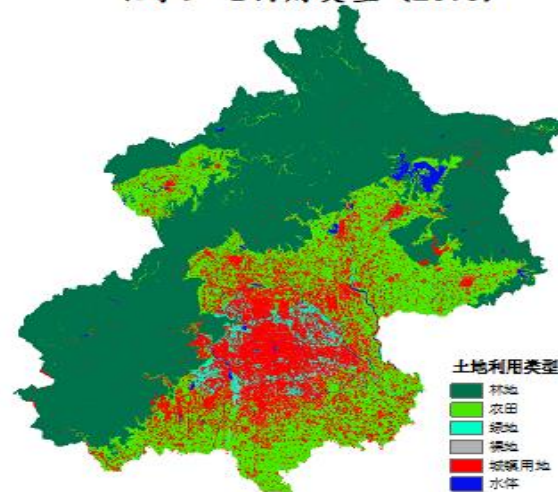
Under the rapid urbanization, the **observational environment** changed a lot.

Were these data **accurate and reliable** for our work and our research?

北京土地利用类型 (1990)



北京土地利用类型 (2013)





# Purpose

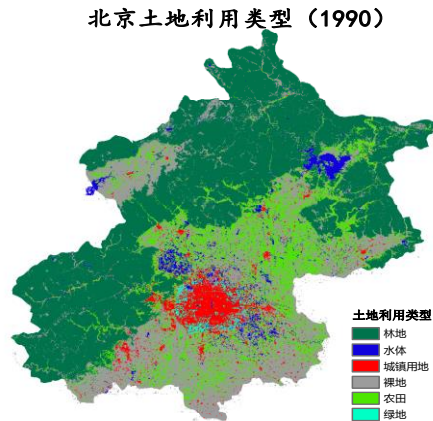
To add a column data for describing the sites information

A	B	C	D	E	F	G	H	I
Station ID	lon	lat	Ave WS	Ave Temp	Ave RH	Press	Grade	
A1001	116.3906	39.9	1.86	25.38	58.6	1000.07	5	"Big City"
A1003	116.4433	39.93139	0.66	25.56	58.4	998.76	5	Central Business district
A1006	116.3544	39.93306	0.82	25.33	55.4	999.56	5	Tall buildings
A1007	116.3967	39.98194	0.82	25.54	57.6	1000.22		less grass
A1008	116.4614	39.97556	1.63	24.9	62.9	1000.7		
A1009	116.475	39.85306	1.05	25.22	60.9	999.51		
A1010	116.3058	39.86194	0.91	24.85	61.1	998.29		
A1013	116.3144	39.94444	0.65	24.7	64.5	999.8		
A1014	116.4283	39.90528	0.77	25.58	56	999.27		
A1015	116.3506	39.87139	1.23	25.58	60.5	1000.23	4	"Middle City"
A1016	116.4047	39.88444	1.16	24.74	63.5	1000.24	4	Tall buildings
A1017	116.3906	40.0225	1.36	24.61	66.2	1000.79	4	a little grass
A1018	116.4819	39.94444	0.99	24.68	63.2	996.51		
A1019	116.2117	39.91556	1.24	24.76	62.1	999.74		
A1020	116.3889	39.87194	0.9	25.59	59.3	999.05	3	
A1021	116.2814	39.80667	0.87	24.33	66.3	991.83	3	"Small City"
A1022	116.1661	39.87889	1.77	24.49	59	1000.01	3	Residential area
A1023	116.3983	39.83	1.54	25.82	54.7	994.34	3	more grass
A1024	116.2911	39.94528	2.07	25.75	55.6	998.55		
A1029	116.3058	39.91389	0.81	25.43	59.6	999.79		
A1030	116.4278	39.87306	0.67	24.75	65.1	962.31	2	
A1031	116.1714	39.96417	1.75	23.01	62.7	993.54	2	"Rural"
A1032	116.195	39.99667	0.95	24.29	62.9	999.04	2	Farm land



# Data

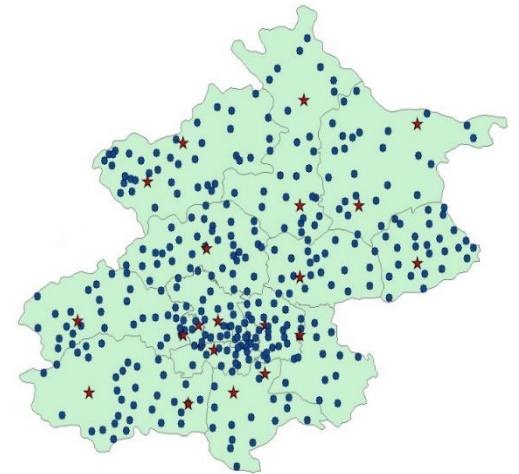
LandSat/TM Data  
1990, 1994, 2000,  
2005, 2010, 2013。



DEM Data within  
the five rings of  
Beijing, 2009

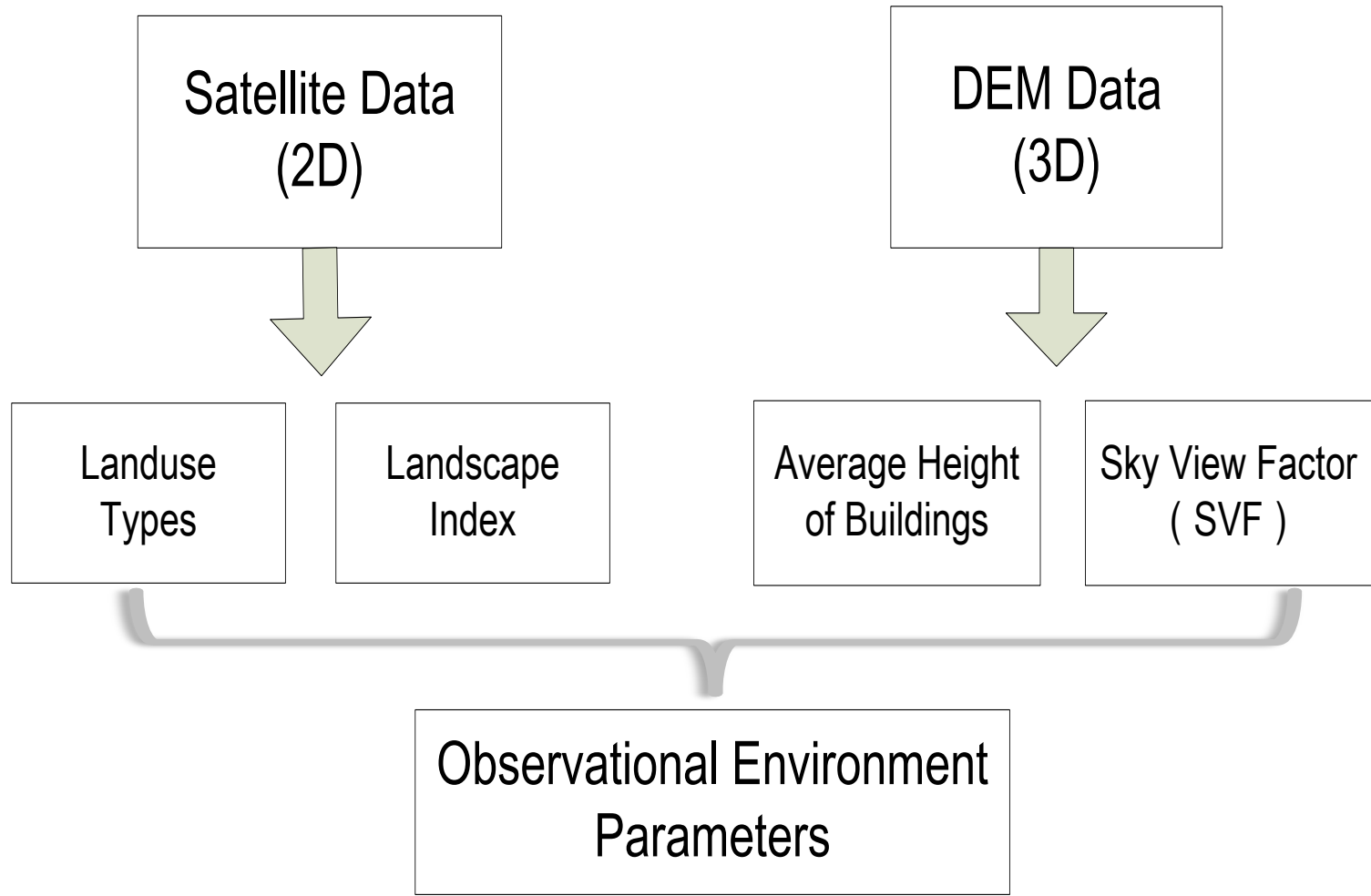


363 AWS Data in  
Beijing, 1990, 1994,  
2000, 2005, 2009,  
2010, 2013





# How to get these Environmental Parameters

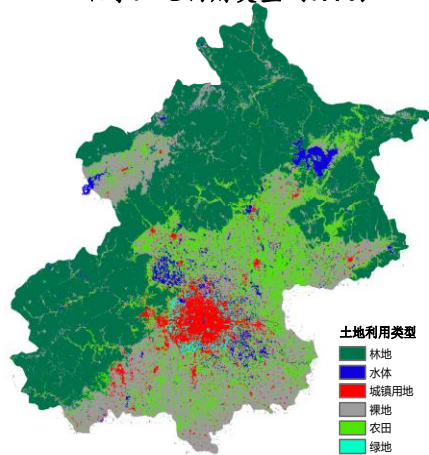




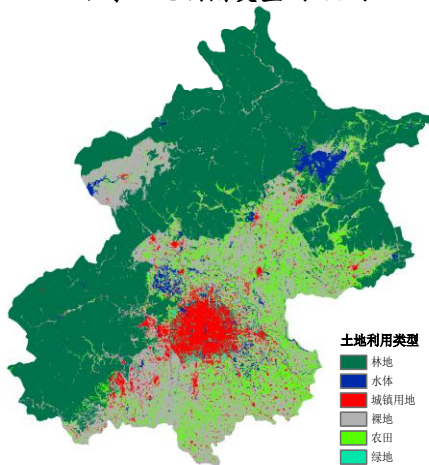


# Parameters— Landuse Types

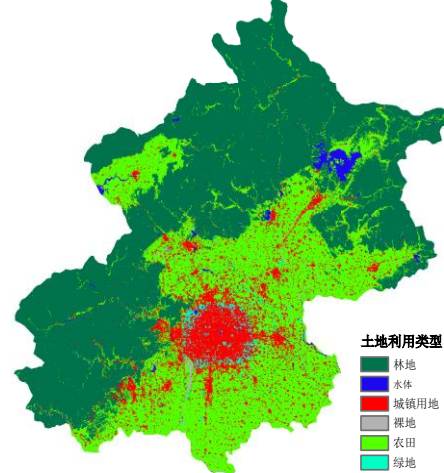
北京土地利用类型 (1990)



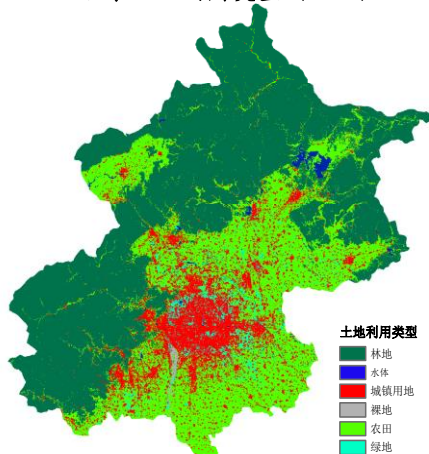
北京土地利用类型 (1994)



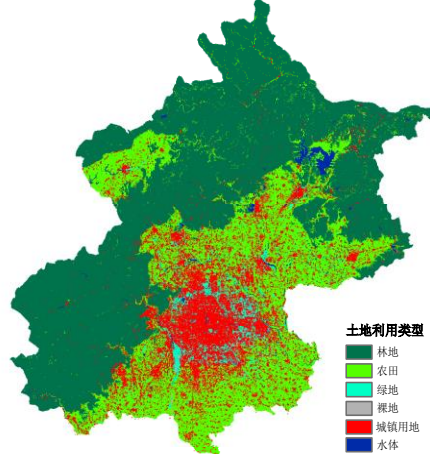
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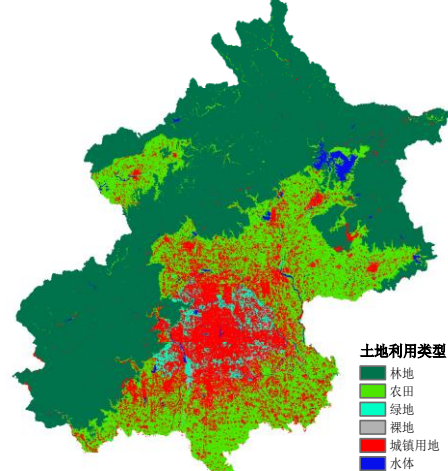
北京土地利用类型 (2005)



北京土地利用类型 (2011)



北京土地利用类型 (2013)

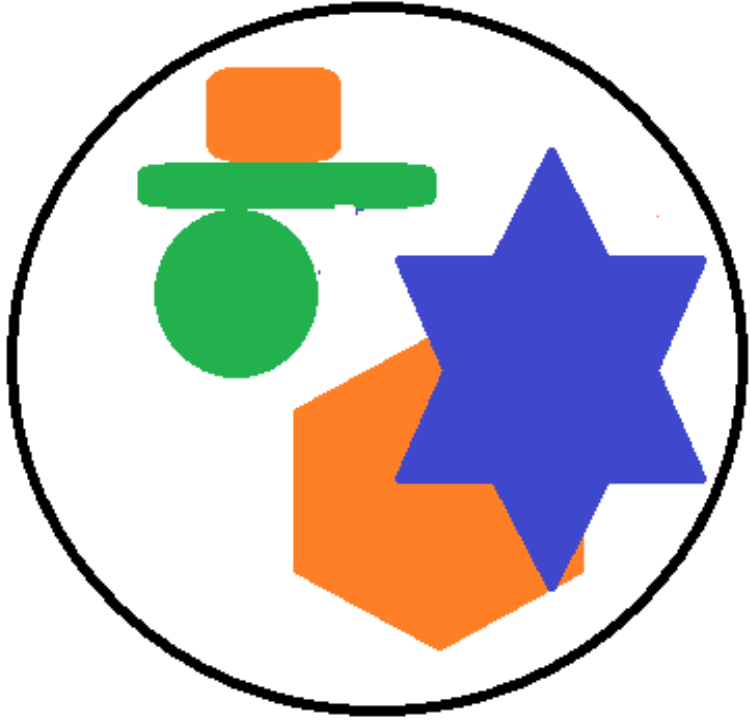




# Parameters— Landscape Indices

**Landscape indices** have been used for quantifying landscape patterns, to describe the structural composition and spatial configuration.

Landscape Index	Abbreviation	Descript
Landscape Richness Index	PR	PR is eq
Landscape Richness Density Index	PRD	$PRD = I / 100$ hect
Number of Patch	NP	$NP = N$ ,
Patch Density	PD	$PD = N / A$ value, th
Class Area	CA	$CA = \sum_{i=1}^n a_i$ is the the great
Mean Patch Size	MPS	$MPS = CA / N$ A: all th the great
Largest Patch Index	LPI	LPI is a $0 < LPI < 1$ determin abundan
Landscape Shape Index	LSI	$LSI = 0$ . E: the to $(m^2)$ , 0. the irreg
Shannon Diversity Index	SHDI	$SHDI = -\sum_{i=1}^m p_i \ln p_i$ SHDI $\geq 0$
Shannon Evenness Index	SHEI	$SHEI = SHDI / H_{max}$ th $0 \leq SHEI \leq 1$ SHEI=1
Landscape Dominance Index	DH	$DH = H_{max} - \sum_{i=1}^m P_i \ln(P_i)$ A big advantage degree includes one kind or several dominant landscape types; a small advantage degree shows that each type has a similar proportion.
Contagion Index	CONT	$CONT = \left[ 1 + \sum_{i=1}^m \sum_{j=1}^m \frac{P_{ij} \ln(P_{ij})}{2 \ln(m)} \right]^{-1}$ m: the total number of patch type, $P_{ij}$ is the probability of randomly selected two adjacent grid cells belong to the type i and j. An aggregation index usually measures aggregation degrees of the same patch type, but its values are affected by the type, the number, and the type evenness, $0 < FN \leq 100$ .



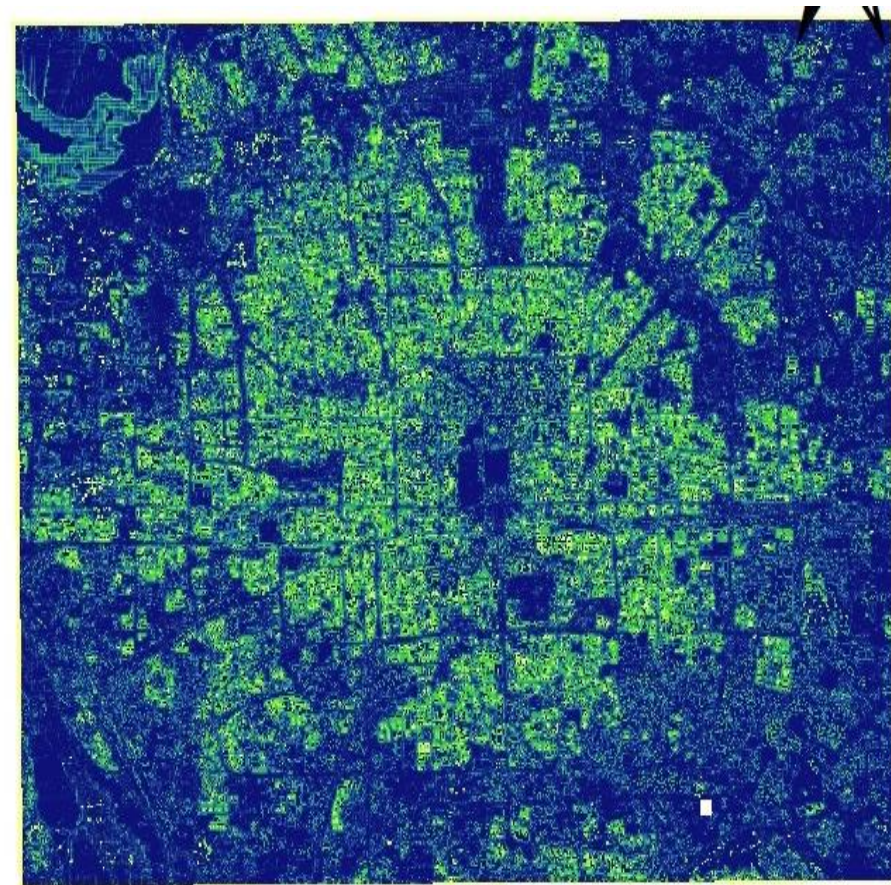
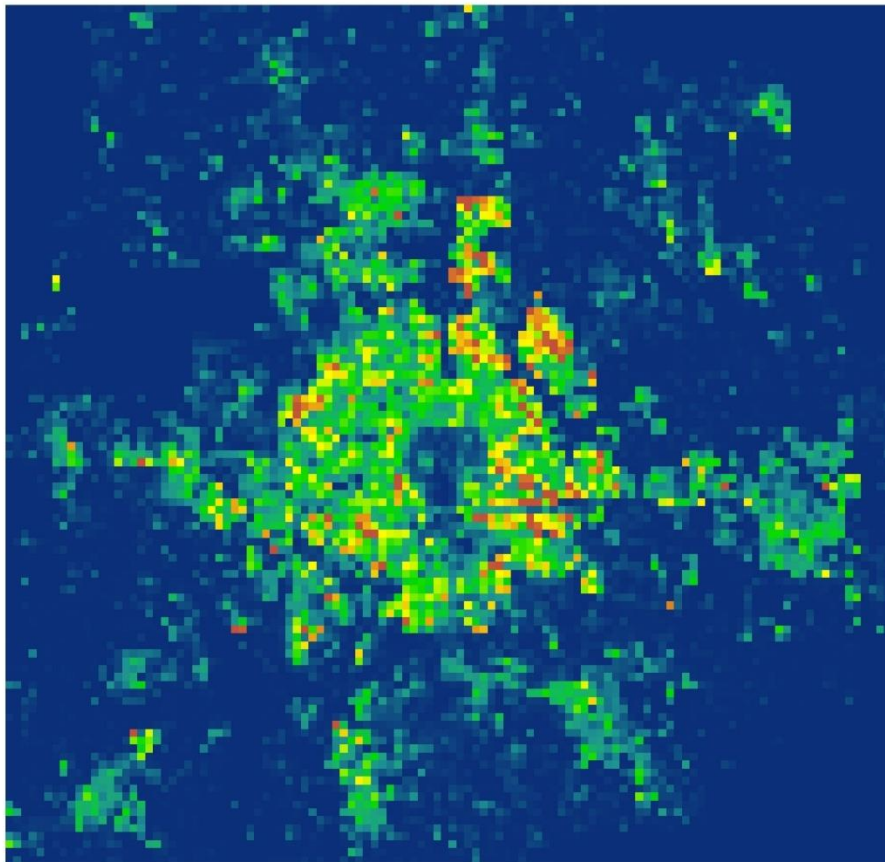




# Parameters— AHB and SVF

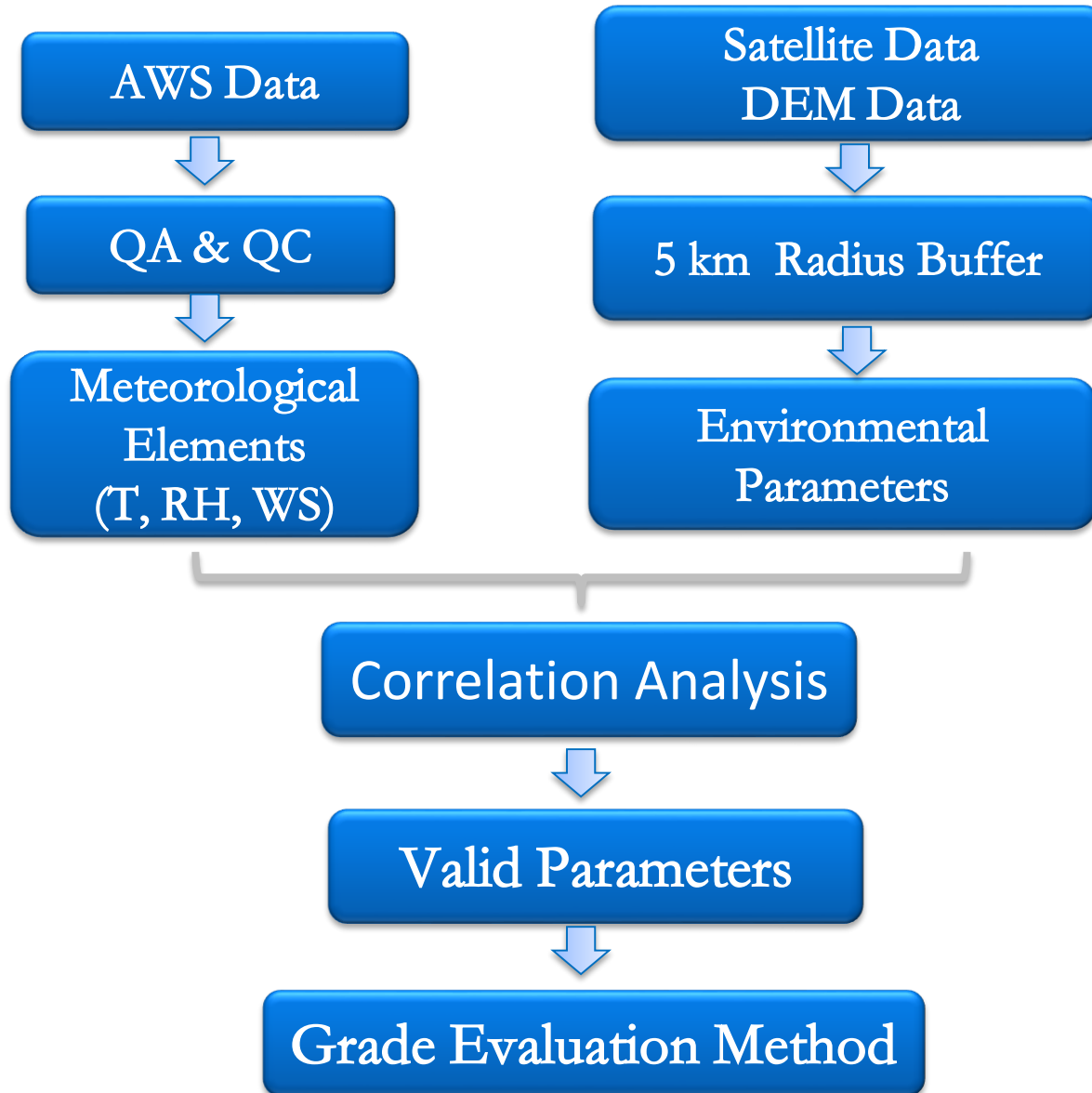
Average Height of Buildings  
( AHB )

Sky View Factor  
( SVF )





# Method





# Results & Discussion

## Tongzhou Station 1990-2013

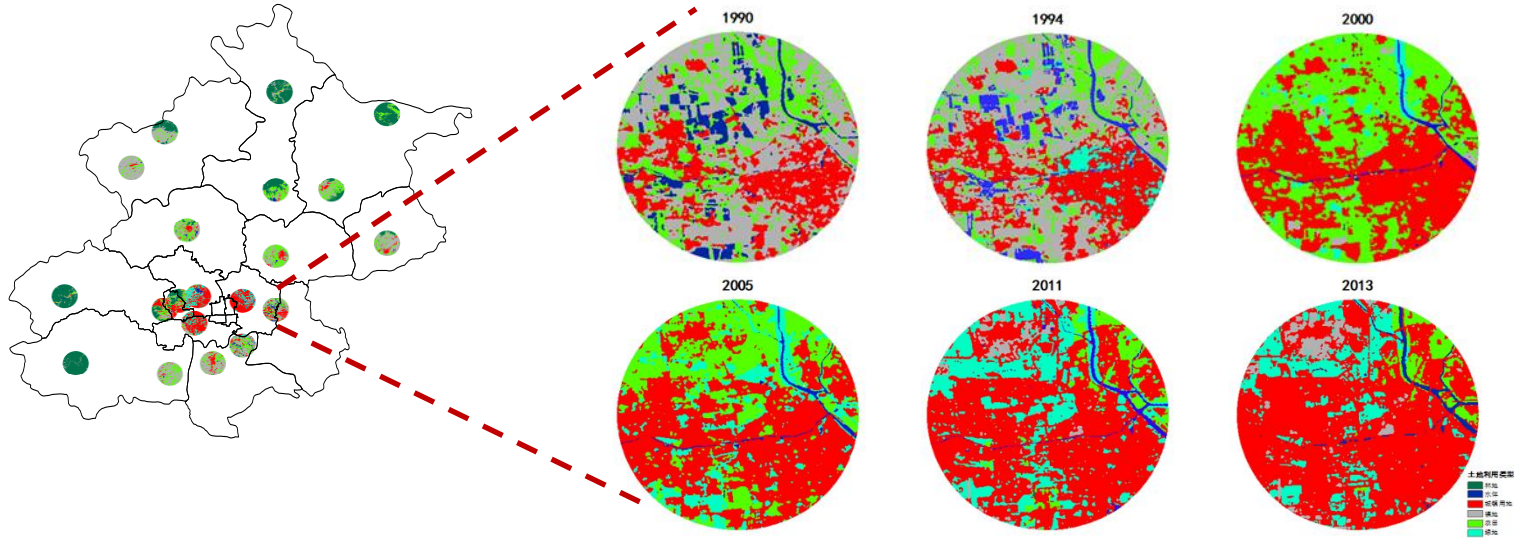


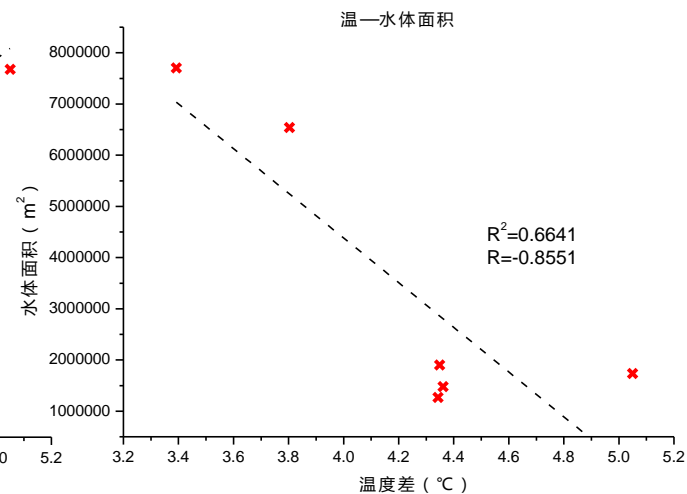
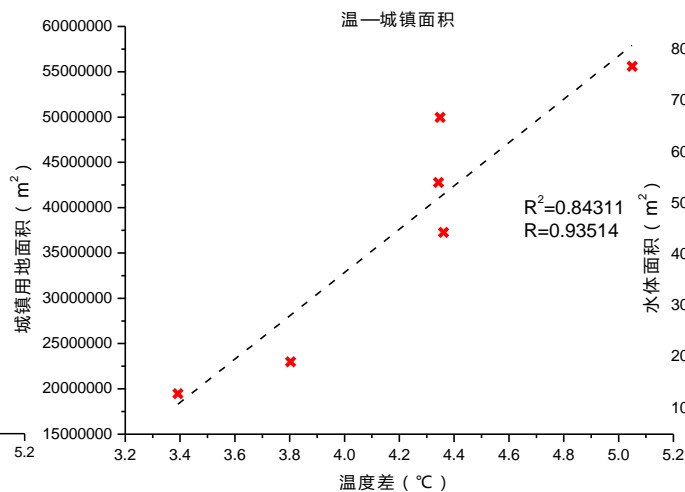
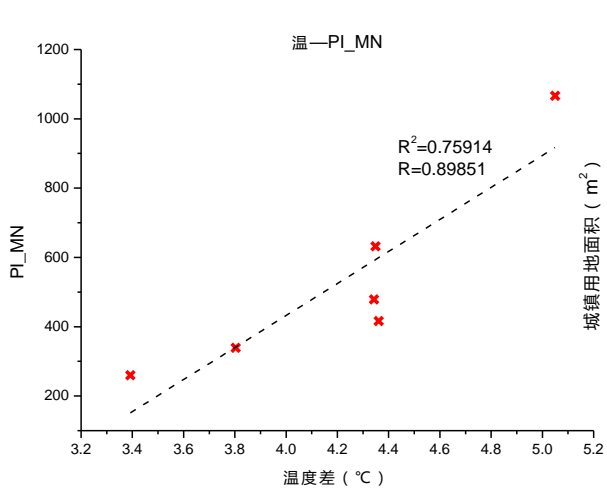
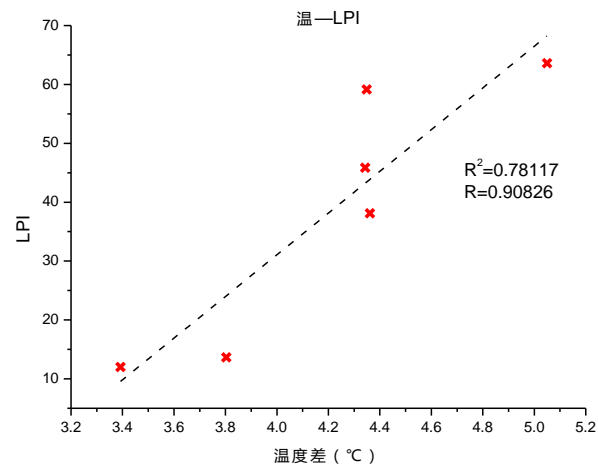
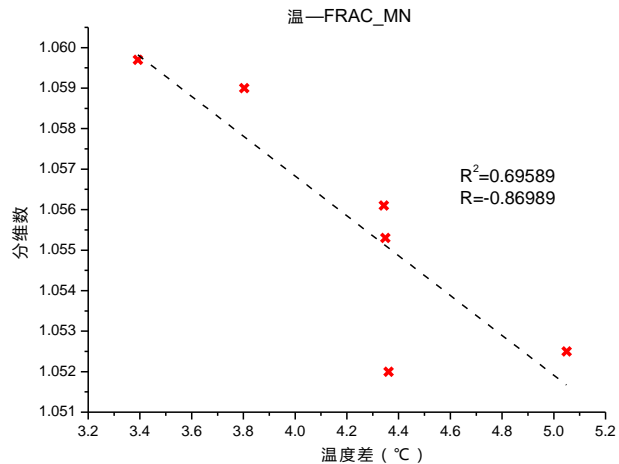
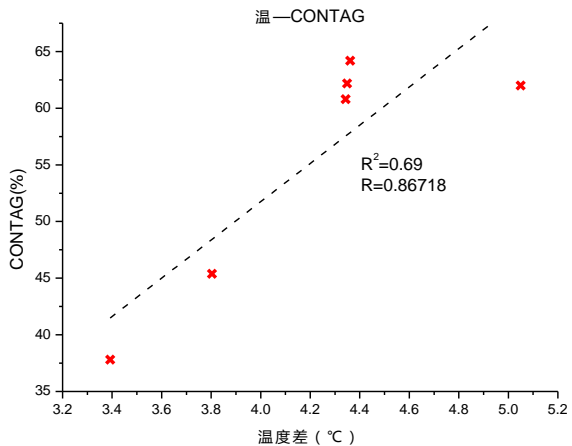
Table 1 Environmental Parameters of Tongzhou

Year	斑块数 NP	最大斑块指数 LPI	分数维 FRAC_MN	平均邻近指数 PI_MN	蔓延度指标 CONTAG	景观丰度 PR	聚集度 AI (%)	水体面积 Water (m <sup>2</sup> )	城镇用地面积 Urban (m <sup>2</sup> )
1990	967	12.0231	1.0597	260.2547	37.8096	4	88.6837	7706250	19465625
1994	1976	13.6373	1.059	339.4456	45.3951	6	84.0439	6540625	23000000
2000	449	38.1126	1.052	416.6042	64.1908	6	93.4589	1478750	37270625
2005	859	45.8496	1.0561	478.9057	60.8041	6	91.334	1268125	42785000
2011	754	59.1686	1.0553	632.3473	62.1957	6	92.1079	1901875	49957500
2013	616	63.6074	1.0525	1066.7225	62.0053	5	93.4658	1737500	55598750





# Correlation Analysis of Temp & Parameters





# Correlation Analysis of Temp & Parameters

Station ID	AI	CONTAG	FRAC_MN	LPI	PI_MN	PR	Urban Area	Water Area
Shunyi	-	-	-0.842	-	-	-	-	-
Haidian	-	0.83	-0.921	-	-	-	-	-
Yanqin	-	-	-	-	-	0.911	-	-
Pinggu	-	-	-	-	-	-	-	-0.845
Tongzhou	-	0.867	-0.87	0.908	0.899	-	0.935	-0.855
Changpin	-	0.864	-	-	-	0.942	0.919	-0.967
Mentougou	0.869	0.912	-	0.921	-	-	0.905	-
Guanxiangtai	-	-	-	0.826	-	-	0.889	-
Shijinshan	-	0.942	-	0.943	0.835	-	0.979	-
Fengtai	0.847	-	-	0.895	-	-	0.904	-



# Correlation Analysis of RH & Parameters

Station ID	NP	AI	CONTAG	FRAC_MN	LPI	PI_MN	PR	Urban Area	Water Area
Shunyi	-	-	-	-	-	-	-	-	0.942
Haidian	-	-	-	-	-0.892	-	-	-	-
Yanqin	-	-	-	-	-	-	-	-	0.83
Pinggu	-	-	-	-	-0.874	-	-	-0.911	-
Tongzhou	0.929	-0.974	-0.885	-	-	-	-	-	-
Changpin	0.902	-0.961	-0.869	-	-0.863	-	-	-0.835	0.898
Mentougou	-	-0.841	-	-	-0.898	-	-0.848	-0.922	0.855
Guanxiangtai	-	-0.87	-	-	-0.914	-	-	-0.911	-
Shijinshan	-	-	-0.814	-	-	-	-	-	-
Fengtai	-	-0.818	-0.834	-	-	-	-	-	-
Liangsha	-	-	-0.82	-	-0.878	-	-	-0.847	-
Sunyi	-	-	-	-	-	-	-0.83	-	-



# Correlation Analysis of **WS** & Parameters

**WS**: the occurrence frequency of small wind (0.5~2m/s)

Station ID	AI	CONTAG	FRAC_MN	LPI	PI_MN	PR	Urban Area	Water Area
Shunyi	-	-	-	0.827	-	-	0.765	-
Haidian	-	-	-	0.773	-	-	-	-
Yanqin	-	-	-	0.807	-	-	-	-
Pinggu	-	-	-	0.711	-	0.772	0.712	-
Tongzhou	-	-	-0.781	-	-	-	-	-
Changpin	-	-0.857	-	-	-	-0.704	-	0.855
Mentougou	-	-	-	0.749	-	-	-	-0.719
Guanxiangtai	-	-	-	-	-	-	-	-0.759
Shijinshan	-	0.745	-	0.733	-	0.782	0.811	-
Fengtai	-	-	-	0.805	-	-	0.787	-
Chaoyang	-	-	-	0.767	-	-	0.722	-
Daxing	-	-	-	-	-	-	-	0.871
Fengtai	-	-	-	0.793	-	-	0.759	-
Sunri	-	-	-	0.769	-	-0.853	0.703	-



# Selection of environmental Parameters

**Response intensity:** The number of sites those meteorological data could be influenced by these parameters.

Temp	AI	CONTAG	FRAC_MN	LPI	PI_MN	PR	Urban Area	Water Area
Response intensity	2	5	3	5	2	2	6	3

RH	NP	AI	CONTAG	LPI	PI_MN	PR	Urban Area	Water Area
Response intensity	2	5	5	6	0	2	5	3

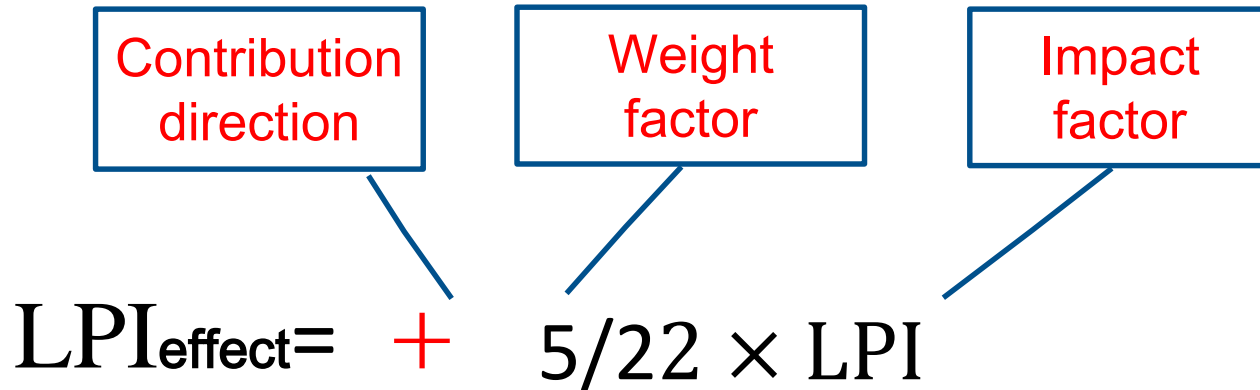
WS	AI	CONTAG	FRAC_MN	LPI	PI_MN	PR	Urban Area	Water Area
Response intensity	0	2	1	10	0	4	7	4





# A Simple Evaluation Method

Temp	AI	CONTAG	FRAC_MN	LPI	PI_MN	PR	Urban Area	Water Area
Response intensity		5	3	5			6	3



$$\begin{aligned} \text{Temp impact index} = & 5/22 \times LPI^* + 6/22 \times \text{Urban area}^* \\ & + 5/22 \times \text{CONTAG}^* \\ & - 3/27 \times \text{Water area}^* + 3/27 \times \text{FRAC\_MN}^* \end{aligned}$$



# A Simple Evaluation Method

$$\begin{aligned} \text{RH impact index} = & 6/24 \times LPI^* + 5/24 \times \text{Urban area}^* \\ & + 5/24 \times \text{CONTAG}^* \\ & - 3/24 \times \text{Water area}^* + 5/27 \times AI \end{aligned}$$

$$\begin{aligned} \text{WS impact index} = & -10/25 \times LPI^* - 7/25 \times \text{Urban area}^* \\ & + 4/25 \times \text{Water area}^* - 5/25 \times PR \end{aligned}$$

$$\begin{aligned} \text{Station impact index} = & \text{Temp impact index} + \text{RH impact index} \\ & + \text{WS impact index} \end{aligned}$$



# Application of the method

Station ID	Score	Grade	Station Type
Shunyi	21.52	G2	Rural
Haidian	28.72	G2	Rural
Yanqin	29.71	G2	Rural
Pinggu	30.82	G2	Rural
Tongzhou	33.22	G2	Rural
Changpin	33.45	G2	Rural
Mentougou	35.63	G3	Small City
Guanxiangta	42.79	G3	Small City
Shijinshan	46.47	G4	Middle City
Fengtai	49.20	G4	Middle City
Chaoyang	50.09	G4	Middle City
Daxing	51.65	G4	Middle City
Fengtai	54.46	G4	Middle City
Sunri	61.09	G5	Big City
Lishan	63.64	G5	Big City

G1: 0—25 G2: 25—35 G3: 35—45 G4: 45—55 G5: 55—100



# Summary

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- Landuse type, landscape index, AHB & SVF could effectively describe the observational environment.
- Parameters that affect temperature include contagion index, largest patch index, urban area, water area.
- Parameters that affect humidity include contagion index, largest patch index, aggregation index, urban area, water area etc.
- Parameters that affect wind speed include contagion index, largest patch index, urban area, water area etc.
- A preliminary method of grade evaluation was established. Meanwhile, 20 meteorological stations in Beijing were estimated.



南京信息工程大学  
Nanjing University of Information Science & Technology

A hand is shown peeling a white sheet of paper from a blue background. The paper is being lifted from the bottom left corner, revealing a white surface underneath. The blue background has a curved shape on the left side.

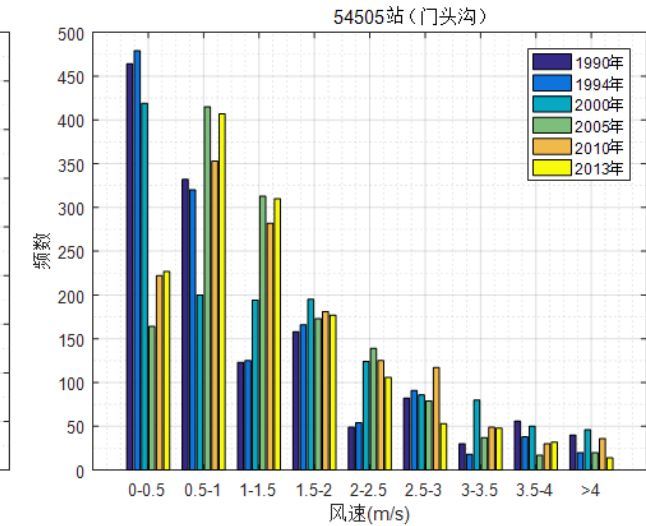
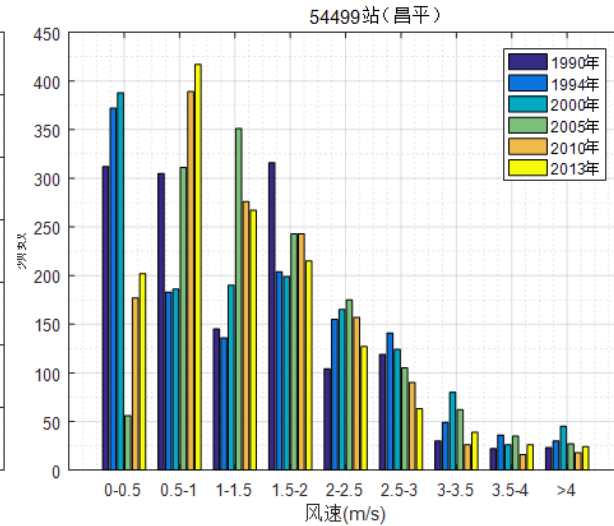
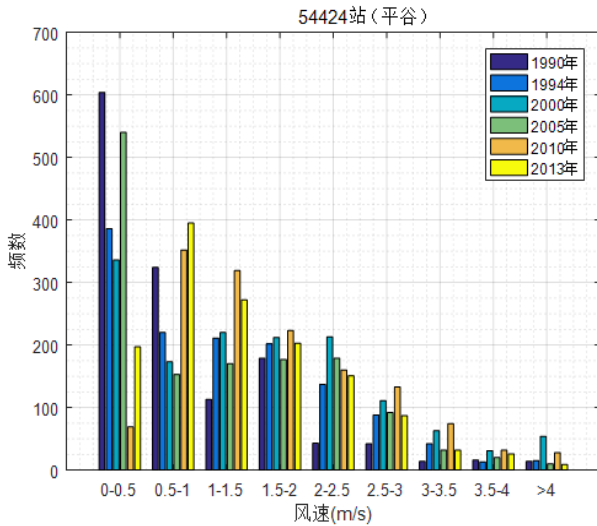
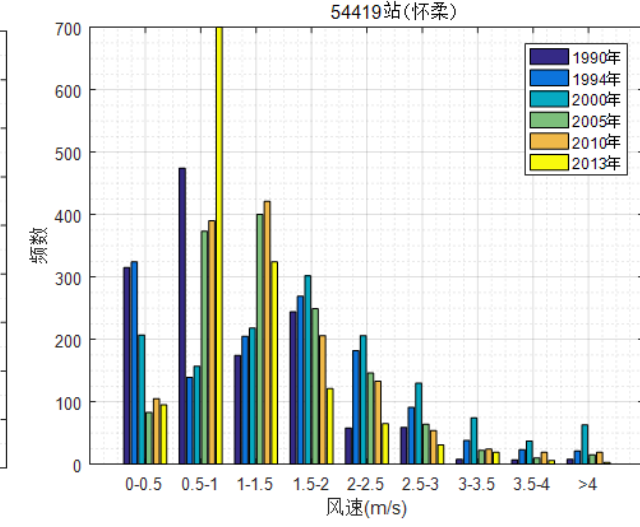
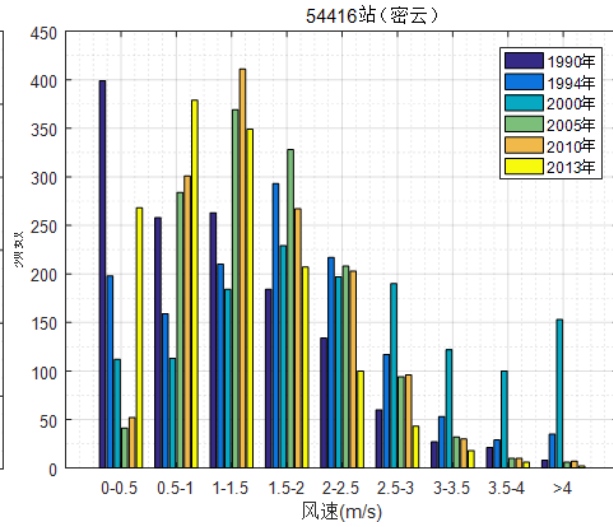
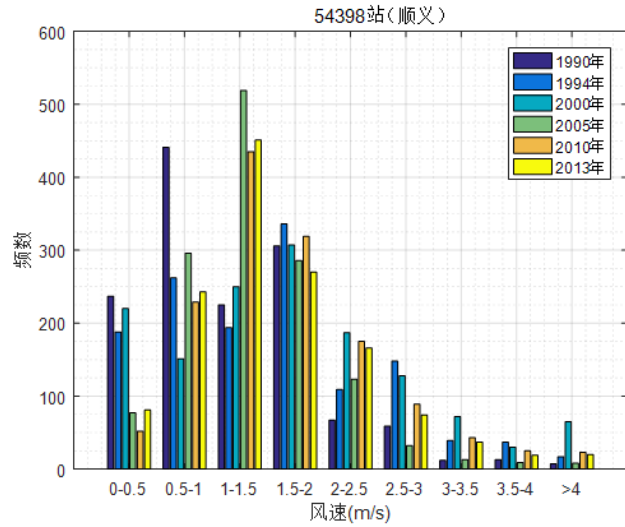
**Thank you !**





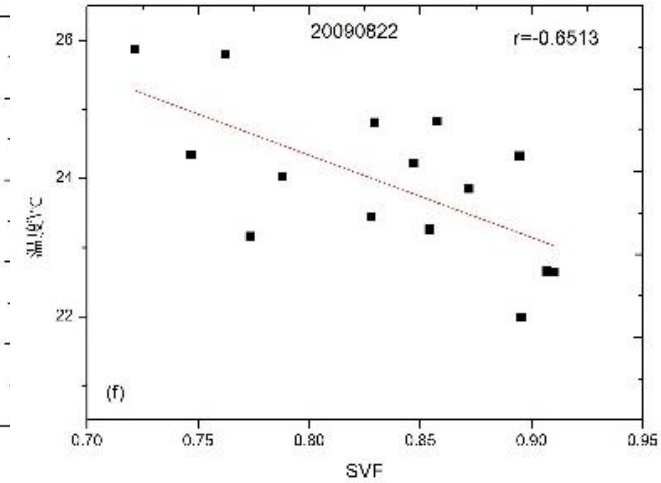
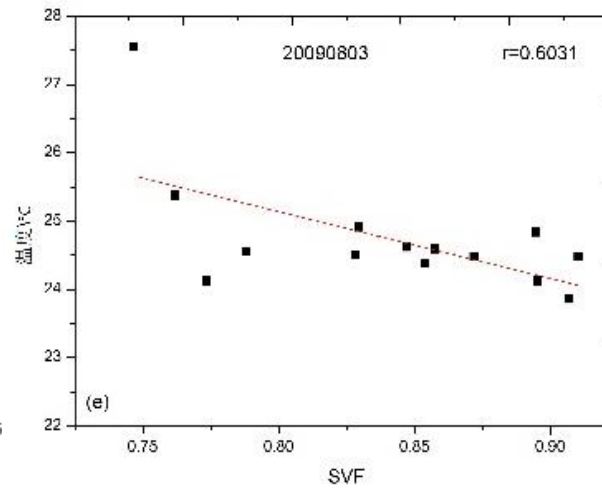
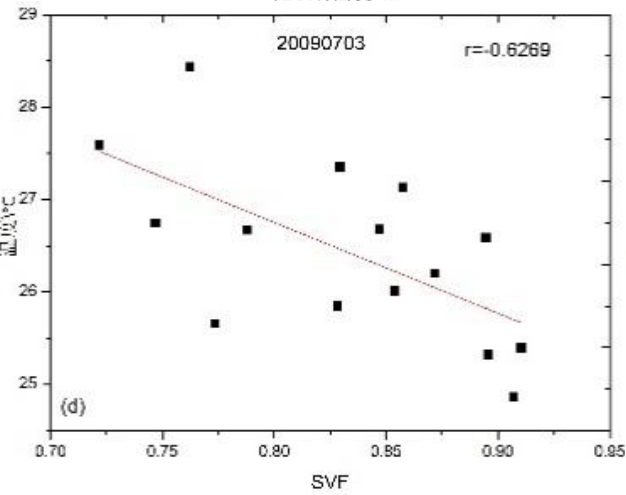
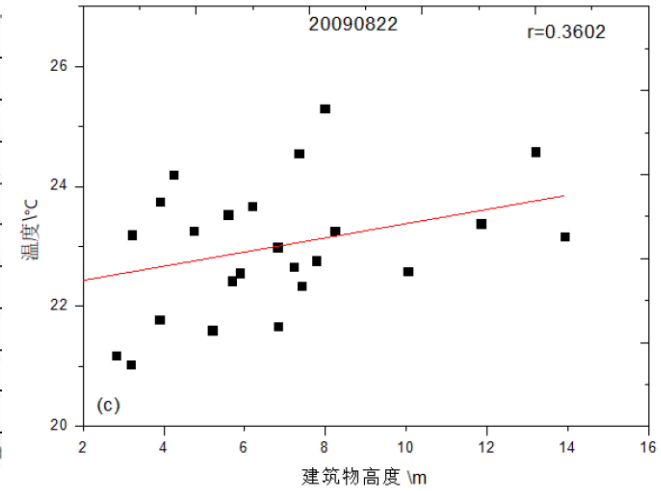
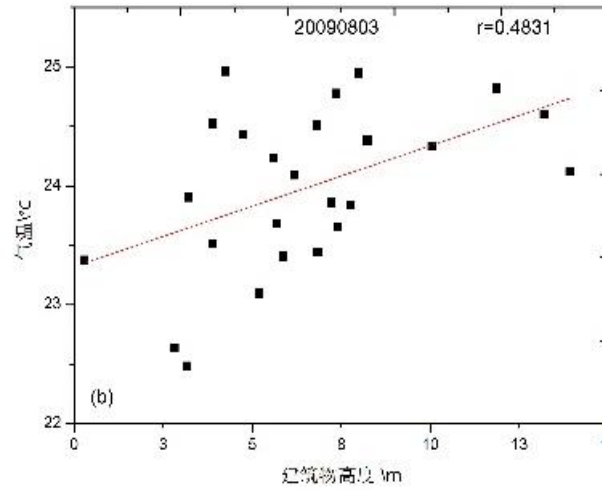
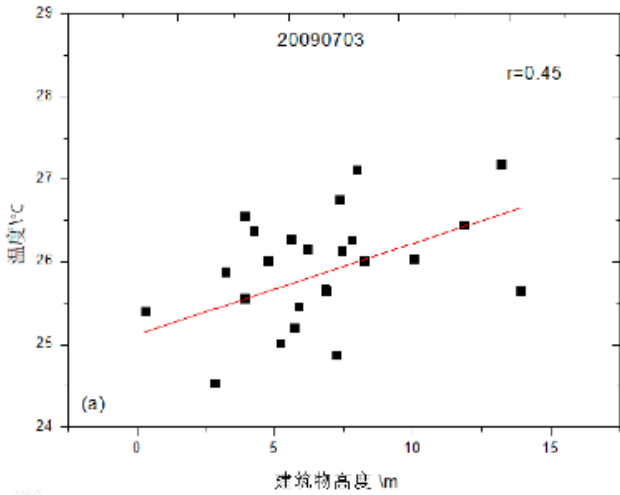
# Correlation Analysis of WS & Parameters

风场的影响因素: 海拔高度, 城市形态参数, 天气系统...





# Correlation Analysis of AHV, SVF & Parameters





# Correlation Analysis of Temp & Parameters

In order to get rid of the impact of climate change, 3 Climate background stations: Fouyeding (northwest), Xia Yunling (southwest), Shangdianzi (northeast).

Urban landuse ratio(%)

年份	佛爷顶 Fouyeding	霞云岭 Xiayunling	上甸子 Shangdianzi
1990	0.89	0.0047	7.92
1994	0.44	0.0318	0.0748
2000	2.10	0.1576	0.7570
2005	3.25	0.3231	1.08
2011	4.51	0.2148	2.08
2013	4.23	0.1886	0.6367

