



Supplement of

Urban underlying surface modulates summertime thunderstorm processes and associated lightning activities

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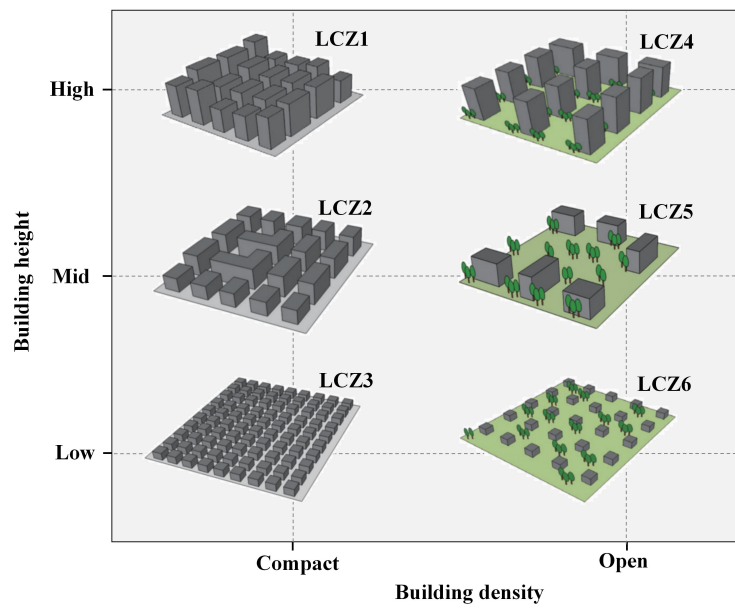


Figure S1: Schematic diagram of urban morphology based on different categories of LCZ datasets.

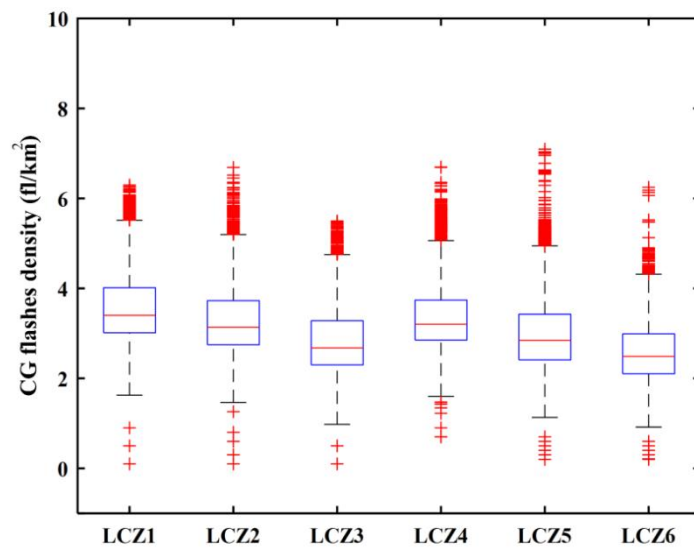


Figure S2: Statistical results of CG density for different types of LCZ. In the plots, the central box represents the values from the lower to upper quartile (25th to 75th percentile). The vertical line extends from the maximum to the minimum value, and the middle red solid line represents the average values.

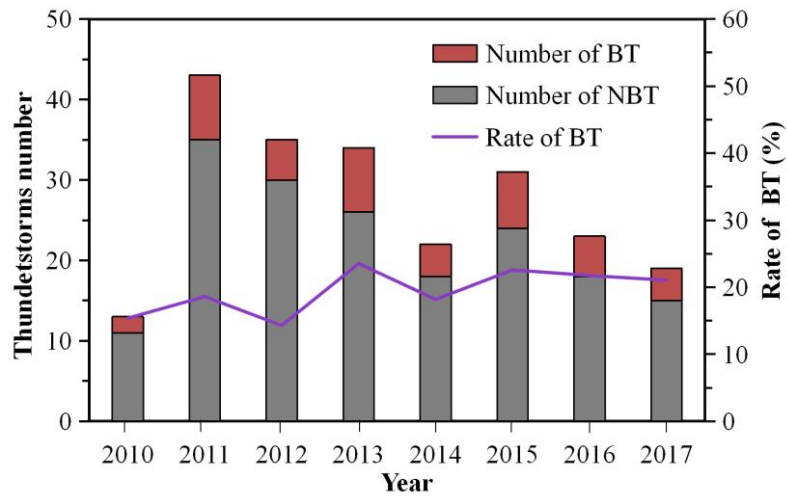


Figure S3: Interannual variation of bifurcated thunderstorms (BT) and non-bifurcated thunderstorms (NBT) in the built-up area of Beijing.

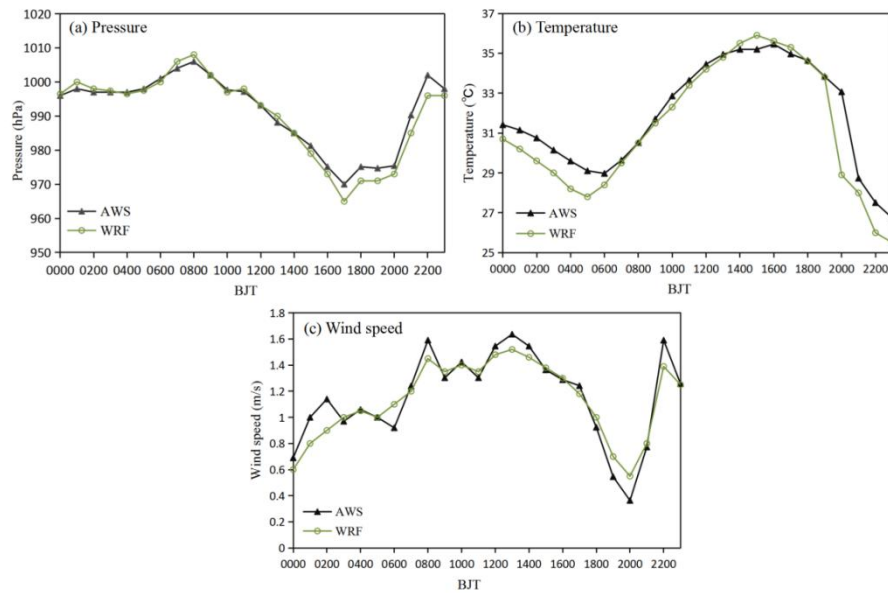


Figure S4: Comparison of observation and simulation of the near-surface element fields for the case "0713", (a) pressure, (b) temperature, and (c) wind speed.

Table S1: Descriptions and attribute parameters of different categories of LCZ datasets.

LCZ datasets	Descriptions	Attribute parameters
LCZ 1: Compact high-rise	The building are taller than 10 stories. High density of buildings and ground cover mostly hard pavement with little vegetation.	Aspect ratio >2
		Sky view factor: 0.2-0.4
		Building surface fraction: 40-60
		Impervious surface fraction: 40-60
		Pervious surface fraction < 10
LCZ 2: Compact mid-rise	Building heights span from 3 to 9 stories. High density of buildings of buildings and ground cover mostly hard pavement with little vegetation.	Height of roughness elements >25
		Aspect ratio: 0.75-2
		Sky View Factor: 0.3-0.6
		Building surface fraction: 40-70
		Impervious surface fraction: 30-50
LCZ 3: Compact low-rise	Building heights ranging from 1 to 3 stories. High density of buildings and ground cover mostly hard pavement with little vegetation.	Pervious surface fraction <20
		Height of roughness elements: 10-25
		Aspect ratio: 0.75-1.5
		Sky view factor: 0.2-0.6
		Building surface fraction: 40-70
LCZ 4: Open High-rise	Building heights of 10 stories or more. Low density of buildings and low ground cover mostly permeable ground or vegetation.	Impervious surface fraction: 20-50
		Pervious surface fraction <30
		Height of roughness elements: 3-10
		Aspect ratio: 0.75-1.25
		Sky View Factor: 0.5-0.7
LCZ 5: Open mid-rise	Building heights in the range of 3-10. Low density of buildings and low ground cover mostly permeable ground or vegetation.	Building surface fraction: 20-40
		Impervious surface fraction: 30-40
		Pervious surface fraction: 30-40
		Height of roughness elements >25
		Aspect ratio: 0.3-0.75
LCZ 6: Open low-rise	Building heights ranging from 1 to 3 stories. The low density of buildings and the ground cover is mostly permeable ground or vegetation.	Sky view factor: 0.5-0.8
		Building surface fraction: 20-40
		Impervious surface fraction: 30-50
		Pervious surface fraction: 20-40
		Height of roughness elements: 10-25
		Aspect ratio: 0.3-0.75
		Sky View Factor: 0.6-0.9
		Building surface fraction: 20-40
		Impervious surface fraction: 20-50
		Pervious surface fraction: 30-60
		Height of roughness elements: 3-10