Supporting Information for Local cloud enhancement in cities depends on urban morphology

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Materials and Methods

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Materials and Methods

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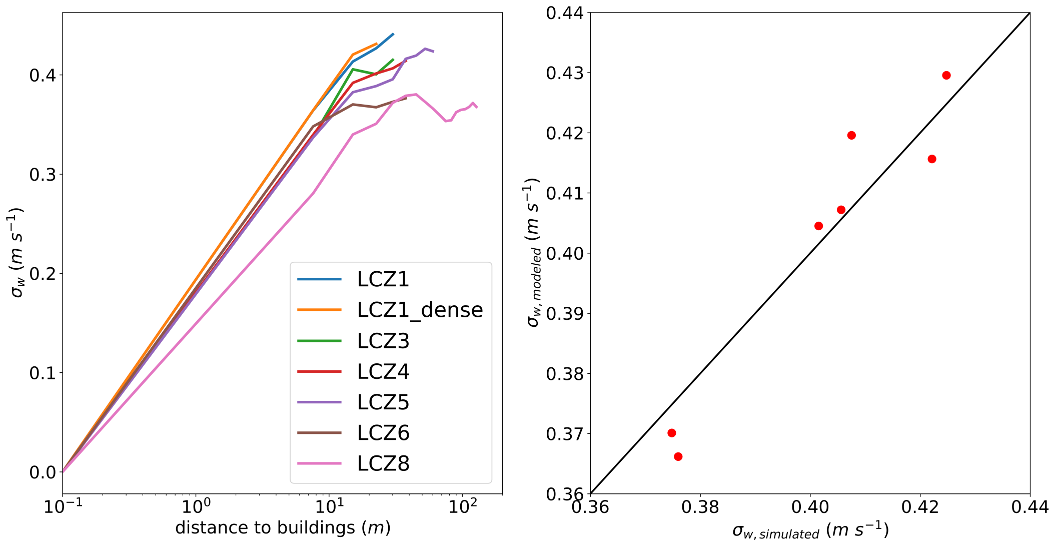

Figure S1: **Simulated results of vertical turbulence and validation of vertical turbulence model.** (left) Magnitude of vertical turbulence with respect to distance to the buildings at z = 15 m for cases with urban canopy. σ_w at a certain distance from the buildings is calculated as the standard deviation of vertical velocity at that distance from the buildings. (right) Comparison of modeled and simulated vertical turbulence at z = 15 m.

Figures

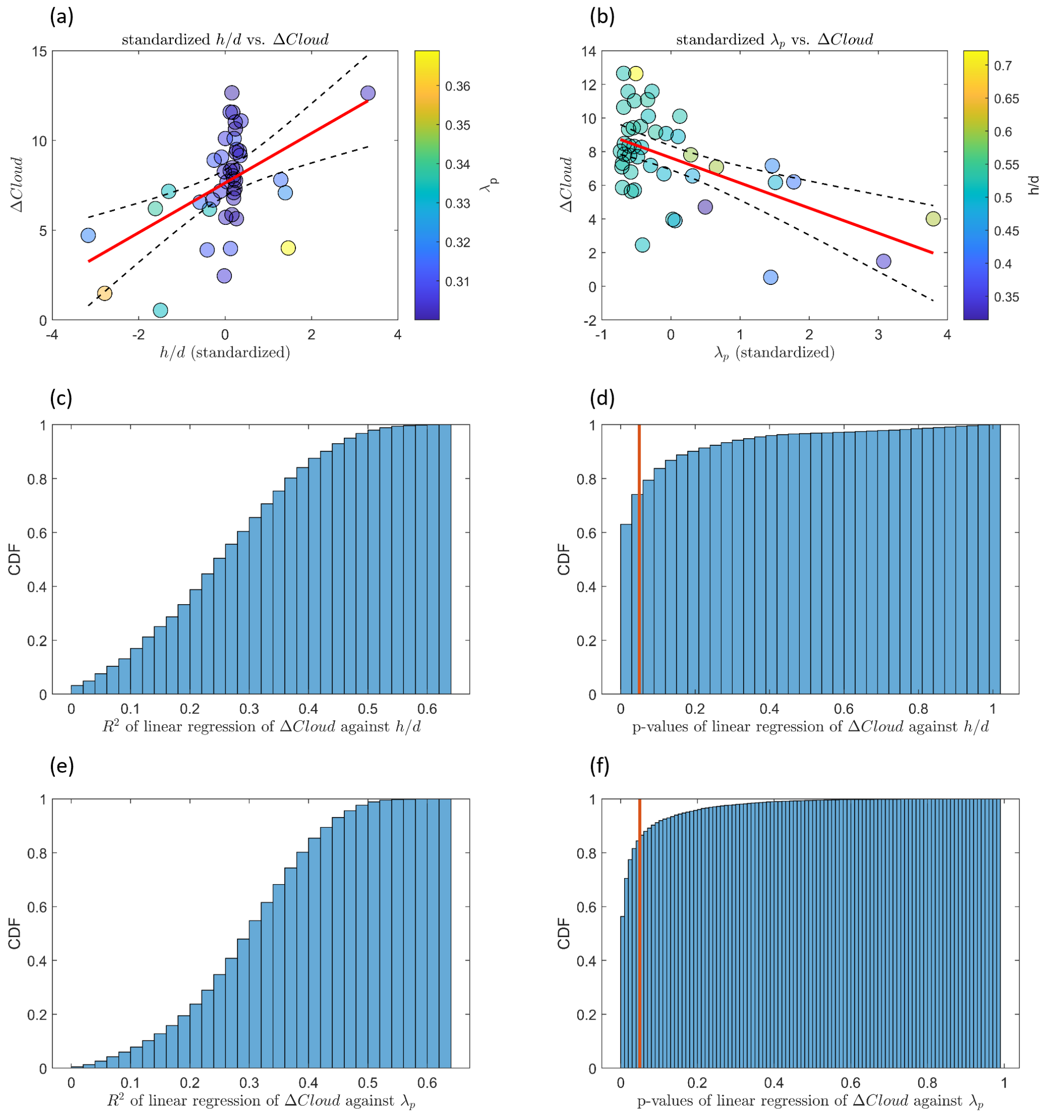

Figure S2: **Nighttime cloud cover discrepancies with respect to urban form parameters across major U.S. cities.** (a)-(b): Observational results of nighttime cloud cover discrepancies between urban and rural areas across 44 major U.S. cities during warm seasons (April to September), with respect to urban form parameters of (a) building density and (b) street-canyon aspect ratio of building height divided by canyon width. Red lines are linear fits of the dataset, (a) $y = 1.384x + 7.632$, $R^2 = 0.25$, $p = 5.1 \times 10^{-4}$; (b) $y = -1.493x + 7.632$, $R^2 = 0.29$, $p = 1.5 \times 10^{-4}$. Black dashed lines are confidence intervals at 95%. (c)-(f): Distributions of (left column) R^2 and (right column) p-values of linear regression of cloud cover discrepancies against (upper row) h/d and (lower row) λ_p in the bootstrap sampling of half of the cities for 10000 times.

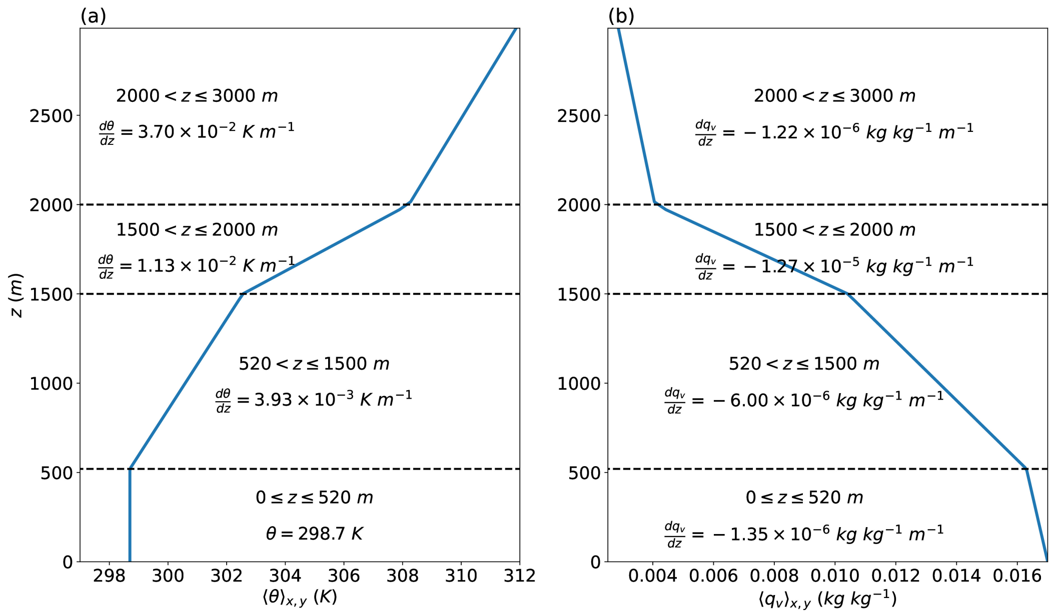

Figure S3: **Initial profiles.** (a) Potential temperature; (b) water vapor mixing ratio.

Tables

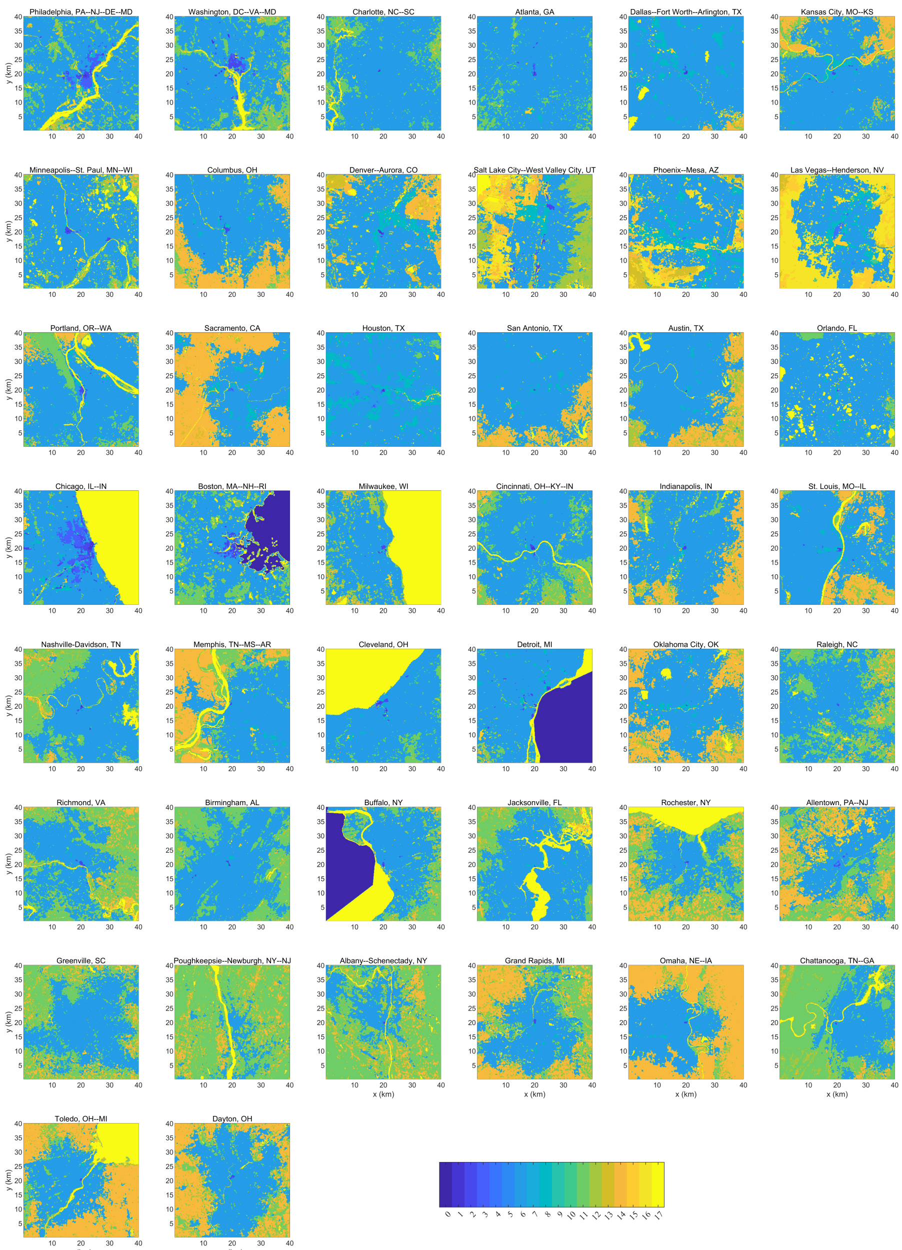

Figure S4: **LCZ maps of all cities in the observation.** LCZ 1: compact highrise; LCZ 2: compact midrise; LCZ 3: compact lowrise; LCZ 4: open highrise; LCZ 5: open midrise; LCZ 6: open lowrise; LCZ 7: lightweight low-rise; LCZ 8: large lowrise; LCZ 9: sparsely built; LCZ 10: heavy industry; LCZ 11: dense trees; LCZ 12: scattered trees; LCZ 13: Bush, scrub; LCZ 14: low plants; LCZ 15: bare rock or paved; LCZ 16: bare soil or sand; LCZ 17: water.

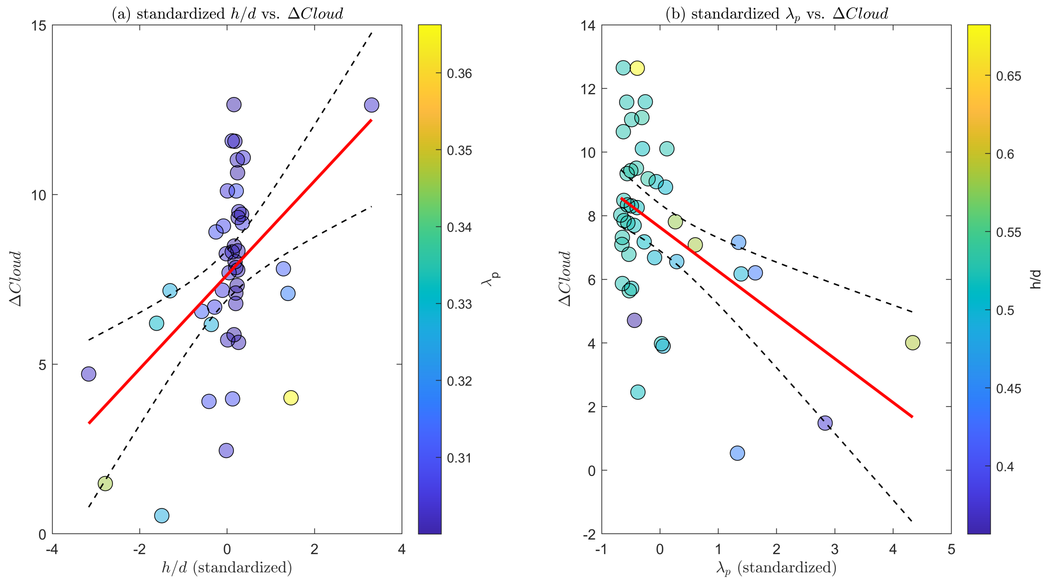

Figure S5: **Observational results of nighttime cloud cover discrepancies between urban and rural areas across 44 major U.S. cities during warm season** (April to September), with respect to urban form parameters of (a) aspect ratio of building height divided by canyon width and (b) building density. The size of urban center is taken as 500 km^2. Red lines are linear fits of the dataset. Black dashed lines are confidence intervals at 95%.

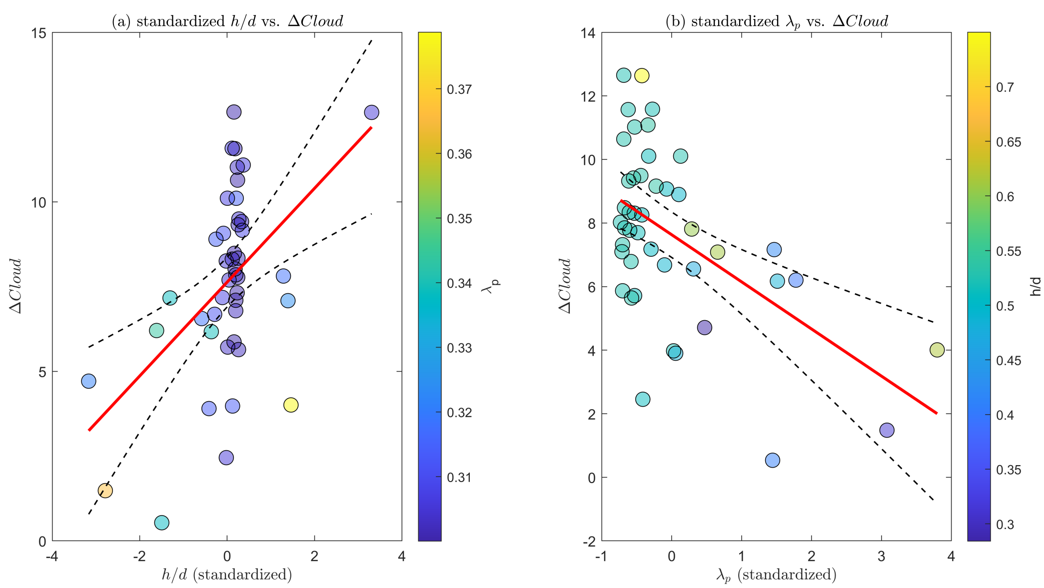

Figure S6: Same as Figure S5 but the size of urban center is taken as 350 km^2.

Table S1: **Partial correlation coefficients and spearman correlation coefficients of the observational dataset.** Partial correlation coefficient $r_{XY,Z} = \frac{r_{XY} - r_{XZ} r_{YZ}}{\sqrt{(1-r_{XZ}^2)(1-r_{YZ}^2)}}$; spearman correlation coefficient $\rho = 1 - \frac{6\Sigma d_i^2}{n(n^2+1)}$, in which d_i is the rank difference for the i-th pair of observations and n is the number of observations.

$r_{h/d\ \Delta Cloud, \lambda_p}$ = 0.40	p = 0.0088
$r_{\lambda_p\ \Delta Cloud, h/d}$ = -0.45	p = 0.0025
$\rho_{h/d, \Delta Cloud}$ = 0.45	p = 0.0024
$\rho_{\lambda_p, \Delta Cloud}$ = -0.40	p = 0.0075

Table S2: **List of US cities in the observation.** A: city size (km^2).

City	Description	$log_{10}(A\ km^2)$
Boston, MA–NH–RI	coastal	4.2200
Chicago, IL–IN	coastal	4.0178
Atlanta, GA	inland	4.0280
Philadelphia, PA–NJ–DE–MD	coastal	3.9813
Detroit, MI	coastal	3.8955
Dallas–Fort Worth–Arlington, TX	inland	3.8661
Houston, TX	coastal	3.7748
Washington, DC–VA–MD	coastal	3.7537
Minneapolis–St. Paul, MN–WI	inland	3.7359
Phoenix–Mesa, AZ	mountainous	3.6632
St. Louis, MO–IL	inland	3.5944
Cleveland, OH	coastal	3.5519
Cincinnati, OH–KY–IN	inland	3.5321
Denver–Aurora, CO	mountainous	3.4936
Indianapolis, IN	inland	3.4930

Kansas City, MO–KS	inland	3.4650
Charlotte, NC–SC	inland	3.4609
Portland, OR–WA	mountainous	3.4397
Milwaukee, WI	coastal	3.4241
Columbus, OH	inland	3.3566
Nashville-Davidson, TN	inland	3.3467
Orlando, FL	inland	3.3133
San Antonio, TX	inland	3.3119
Raleigh, NC	inland	3.3110
Richmond, VA	inland	3.3072
Sacramento, CA	mountainous	3.3011
Birmingham, AL	inland	3.2971
Memphis, TN–MS–AR	inland	3.2853
Buffalo, NY	coastal	3.2631
Austin, TX	inland	3.2601
Jacksonville, FL	coastal	3.2394
Las Vegas–Henderson, NV	mountainous	3.2159
Oklahoma City, OK	inland	3.2058
Rochester, NY	coastal	3.2018
Allentown, PA–NJ	mountainous	3.1946
Greenville, SC	inland	3.1924
Poughkeepsie–Newburgh, NY–NJ	inland	3.1852
Dayton, OH	inland	3.1824
Albany–Schenectady, NY	mountainous	3.1545
Grand Rapids, MI	coastal	3.1357
Omaha, NE–IA	inland	3.0971
Salt Lake City–West Valley City, UT	mountainous	3.0956
Chattanooga, TN–GA	inland	3.0637

Toledo, OH–MI	coastal	3.0472