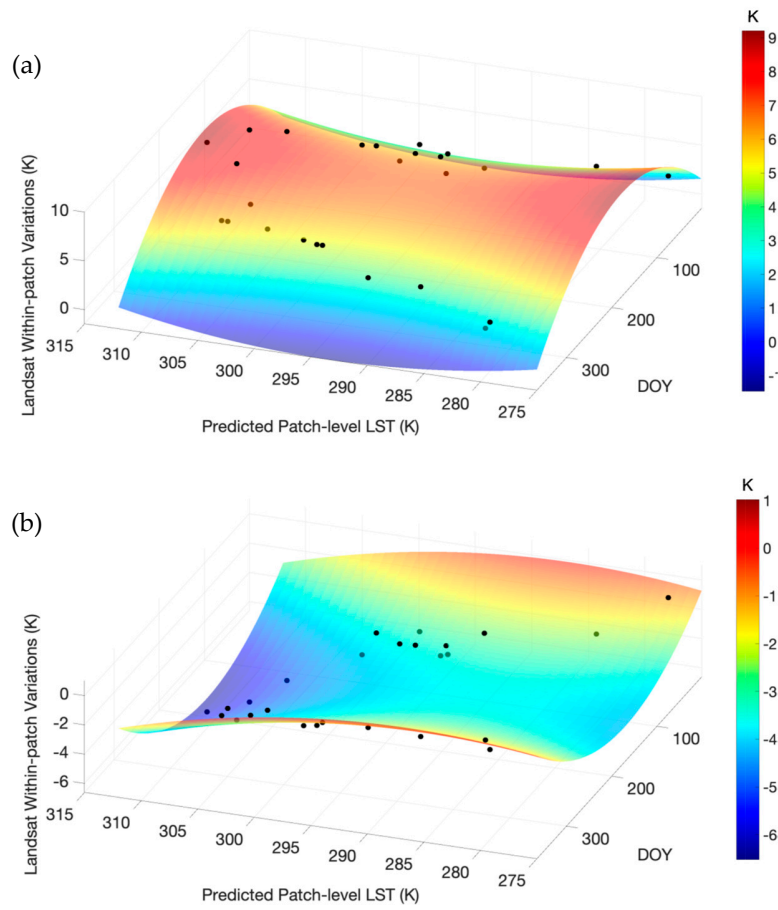
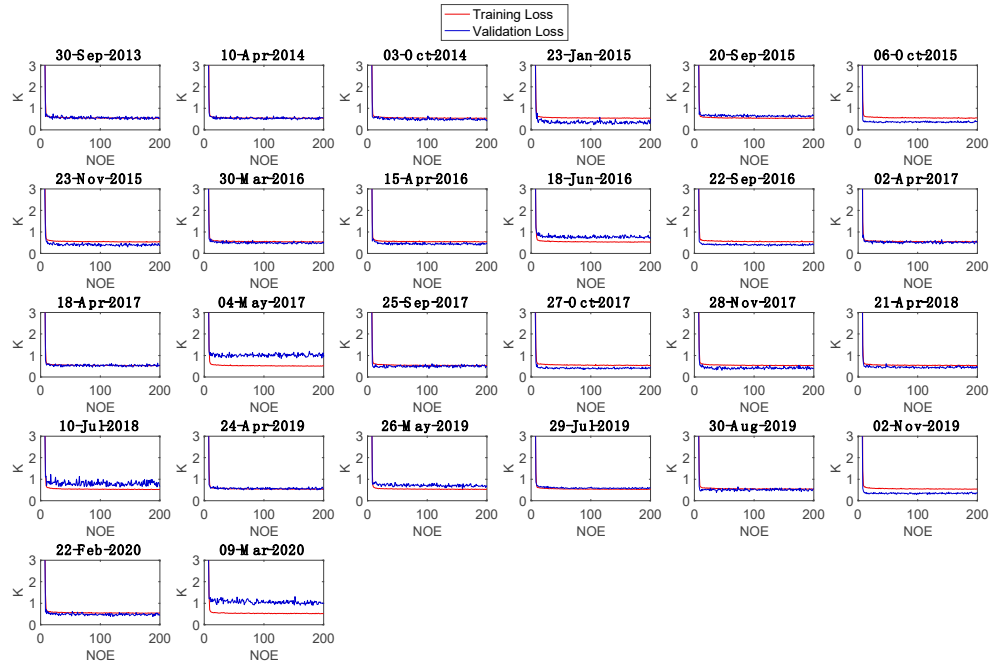


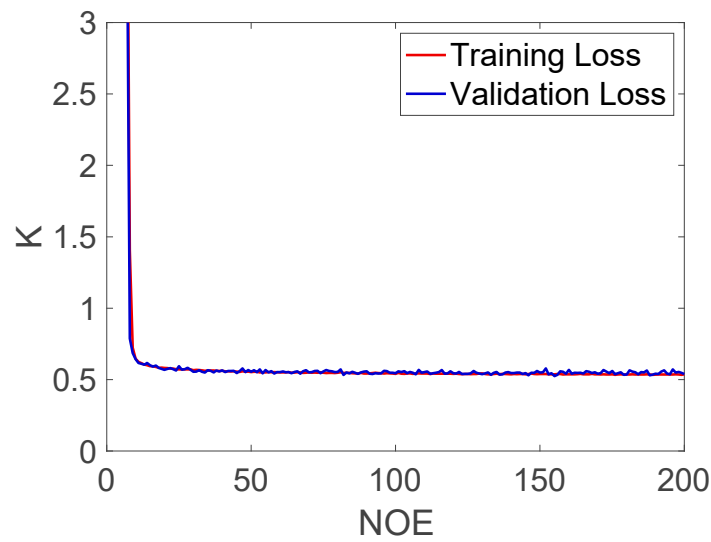
**Figure S1.** Collective information of the Landsat-MODIS regressions for all the patches in LSAT on an example date, July 29, 2019. (a) is a map of slopes. (b) and (c) show the corresponding  $R^2$  and p-value, respectively.



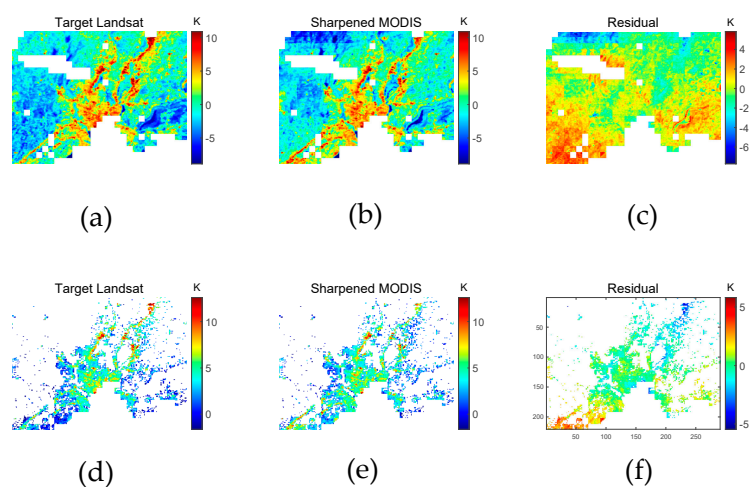
**Figure S2.** The modeling results same as Figure 8 but using predicted patch-level LST.



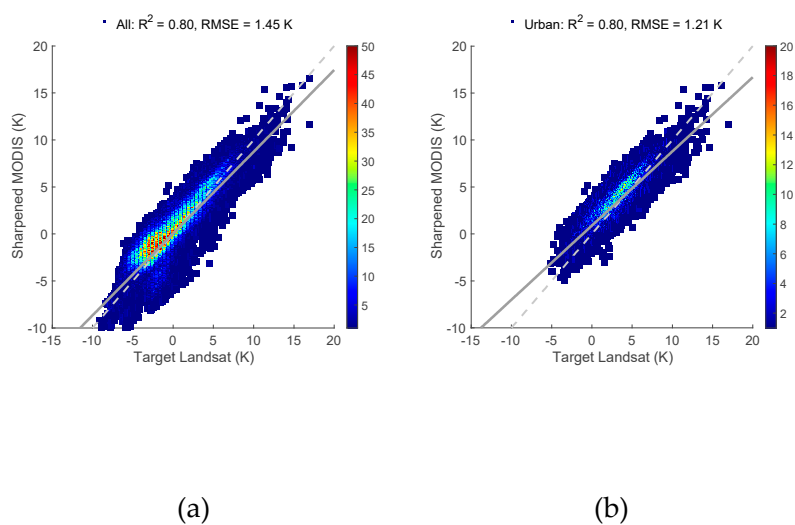
**Figure S3.** The training and validation losses for each target date, using the pair of adjusted MODIS LST and resampled Landsat LST (both free of scene average) on the target date for validation and the rest pairs for training.



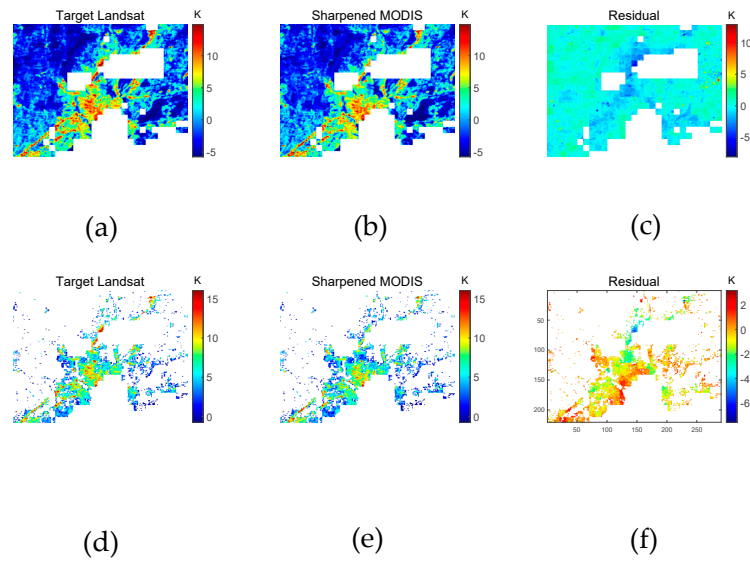
**Figure S4.** The ensemble mean training and validation losses for Figure S3.



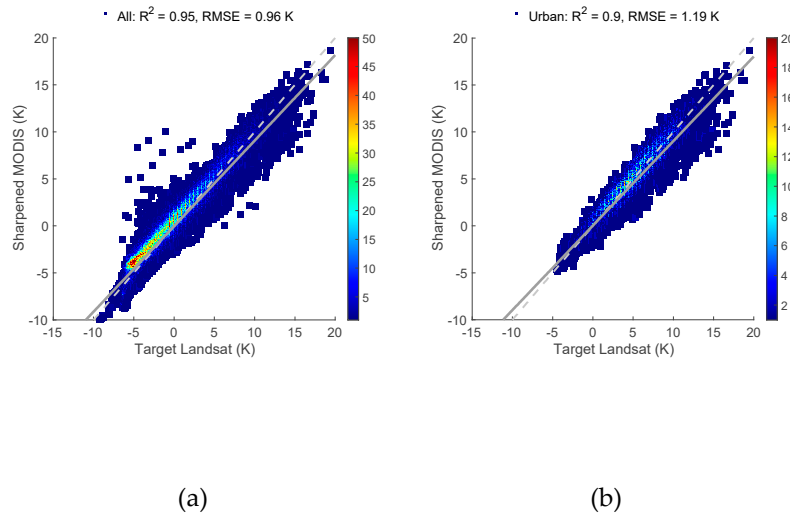
**Figure S5.** The sharpening results for May 4, 2017 (same as Figure 13).



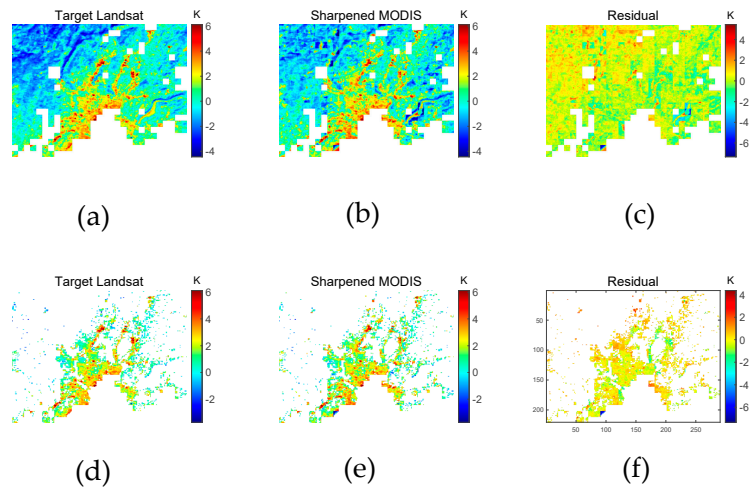
**Figure S6.** The pixel-by-pixel correlation between the target Landsat LST and the sharpened MODIS LST for May 4, 2017 (same as Figure 14a&b).



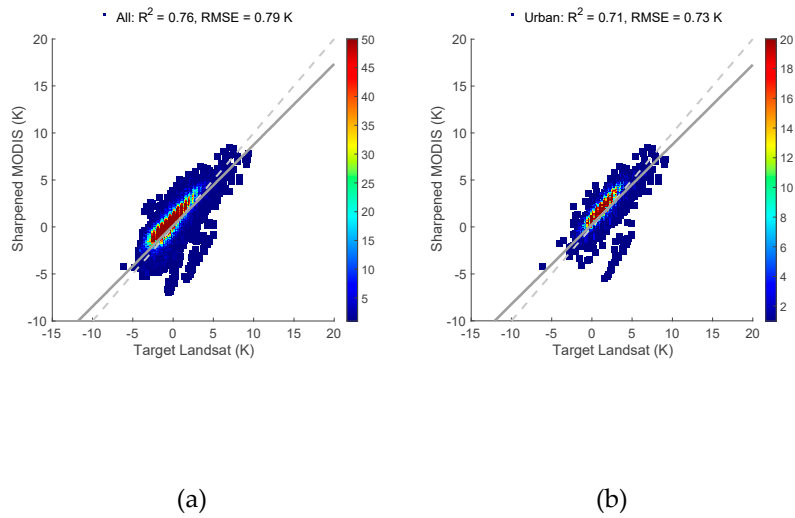
**Figure S7.** The sharpening results for July 29, 2019 (same as Figure 13).



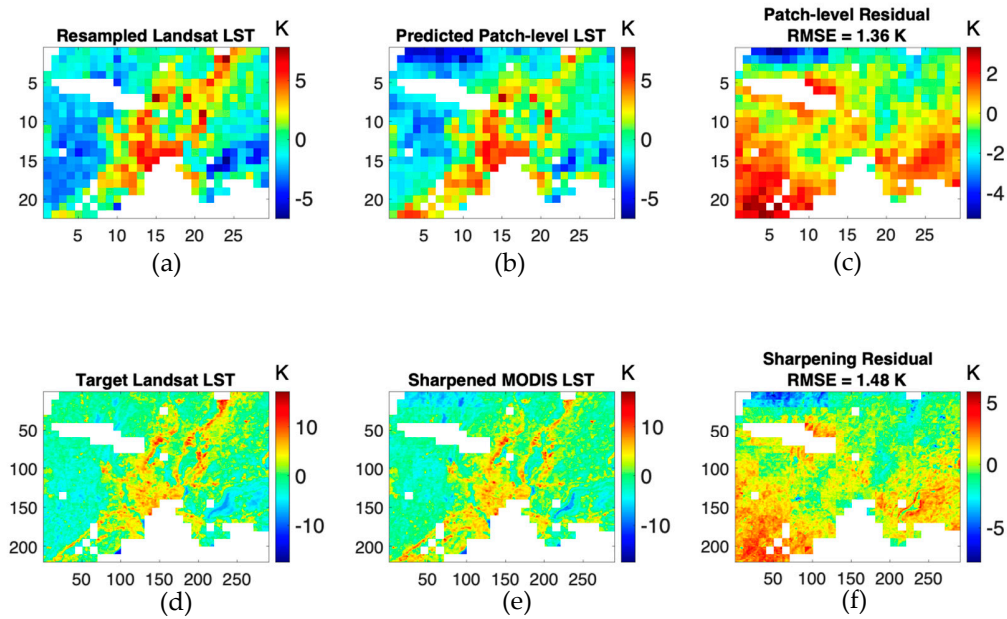
**Figure S8.** The pixel-by-pixel correlation between the target Landsat LST and the sharpened MODIS LST for July 29, 2019 (same as Figure 14a&b).



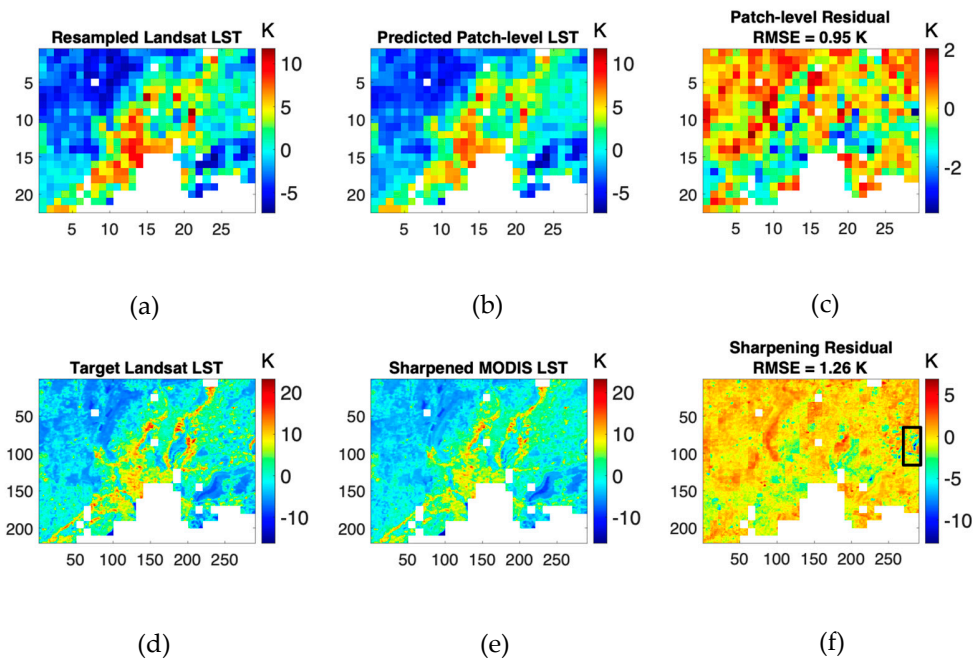
**Figure S9.** The sharpening results for November 28, 2017 (same as Figure 13).



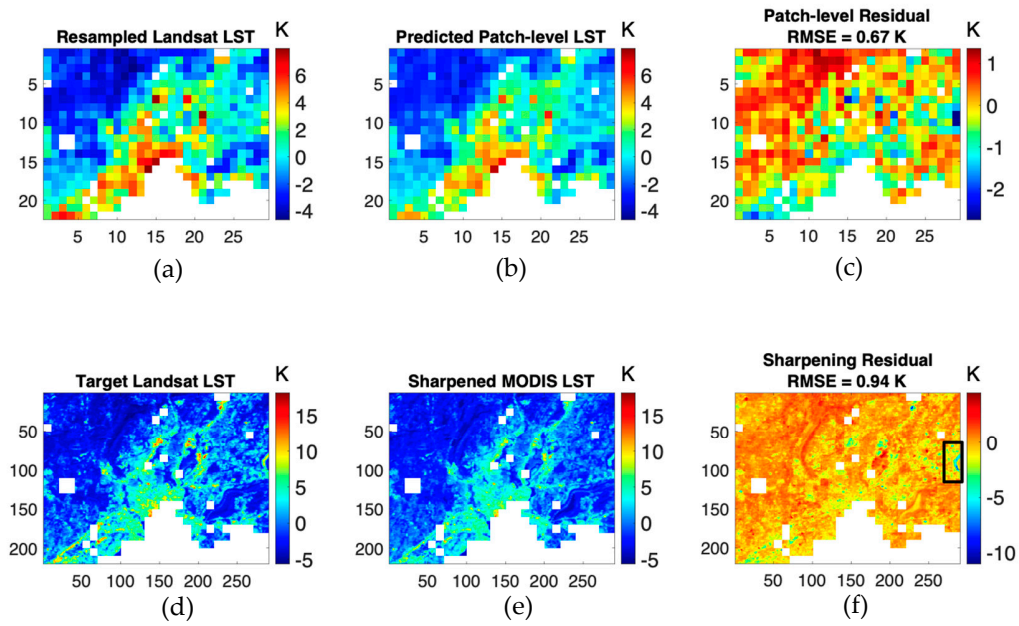
**Figure S10.** The pixel-by-pixel correlation between the target Landsat LST and the sharpened MODIS LST for November, 28, 2017 (same as Figure 14a&b).



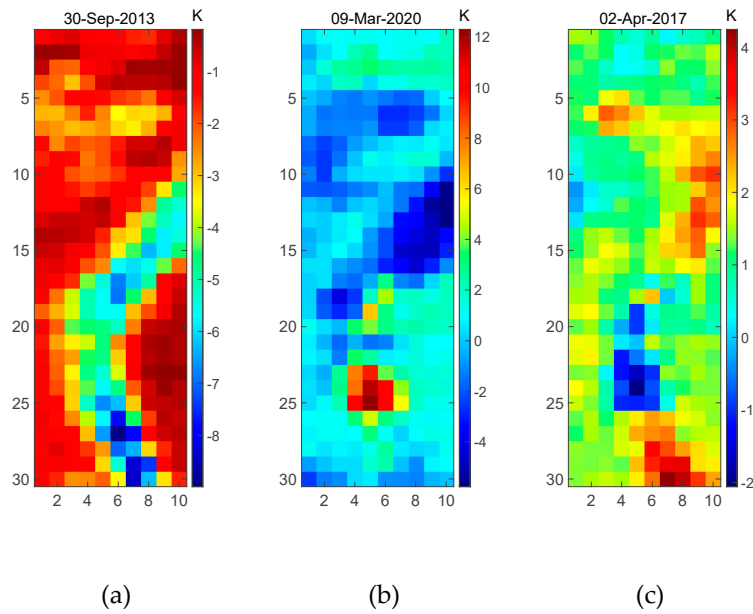
**Figure S11.** The (a) resampled Landsat LST, (b) predicted patch-level LST, (d) target Landsat LST, and (e) sharpened MODIS LST on May 4, 2017. The residual maps are (c), for patch-level biases (b) minus (a), and (f), for overall biases (e) minus (d).



**Figure S12.** Same error examination as Figure S11 except for June 18, 2016. Black box indicates an area with significant pixel-scale error.

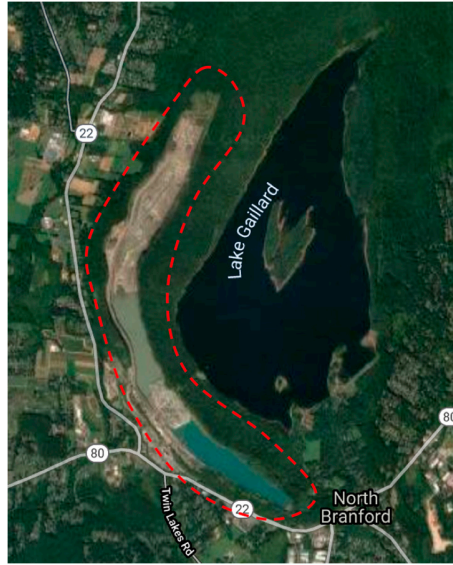


**Figure S13.** Same error examination as Figure S11 except for September 30, 2013. Black box indicates an area with significant pixel-scale error.

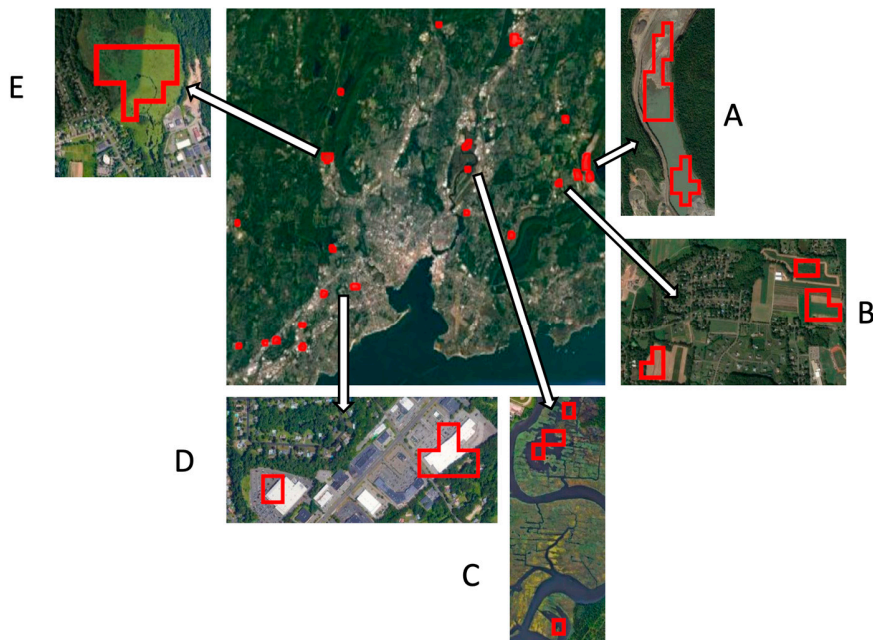


**Figure S14.** Sharpening residual of the marked area in Figure S12f and S13f on three example dates, (a) September 30, 2013, (b) March 9, 2020, and (c) April 2, 2017.



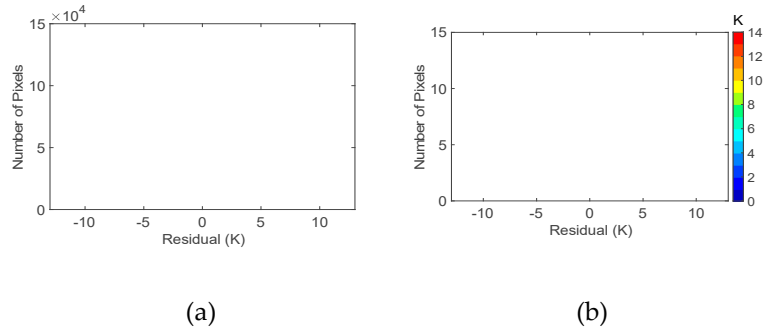


**Figure S15.** A satellite map of the marked area in Figure S12f and S13f. The strip-shape area is delineated by the red dashed line.

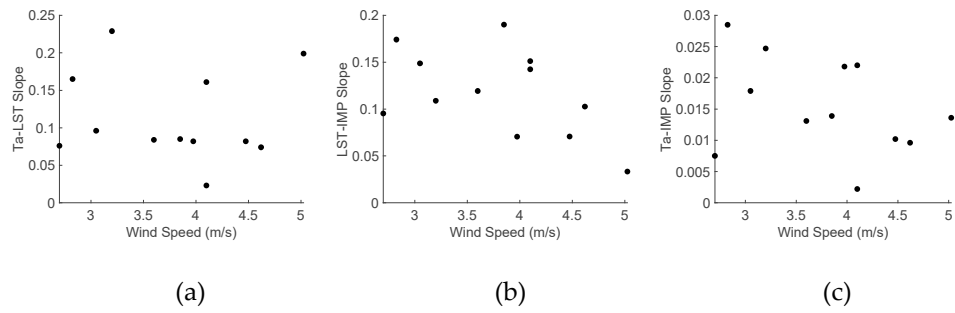


**Figure S16.** Examination of locations where significant biases in Figure 16 occurred. The locations are marked by red polygons on a satellite map in the center. A, B, C, D, and E are the detailed photos showing five types of land cover changes, quarrying, cultivated cropland, herbaceous wetland, white-roof buildings, and ponds with green algae, respectively.





**Figure S17.** Residuals of pixel-scale variations (predicted minus target Landsat) in the form of histograms. (a) displays residuals for the pixels on all the target dates. (b) is same as (a) but emphasizes the tails corresponding with great biases. The color indicates the residuals same as the x-axis but in absolute values.



**Figure S18.** The changes of slopes for Ta against LST (a), LST against impervious fraction (b), and Ta against impervious fraction (c) with wind speed. The wind speed is the average value of all the observations within 4 hours centered at the biking time. The magnitudes of LST-IMP slope and Ta-IMP slopes are rough estimations of surface UHI intensity and atmospheric UHI intensity, respectively.

**Table S1.** Summary of the statistics for each biking transects. The observation times are all approximately the Landsat 8 overpass time (10:30 AM), with the dates summarized by the first column. The second and the third column are the linear correlation  $R^2$  and the slope of air temperature (Ta) against LST for each transect, respectively. The corresponding change rates of LST and Ta in response to impervious fraction (IMP) are collected in the fourth and the last columns, respectively. All correlations are significant at  $p < 0.01$ .

Date of Transect	$R^2$	Ta-LST Slope	LST-IMP Slope	Ta-IMP Slope
2019-08-12	0.05	0.082	0.0706	0.0218
2019-10-23	0.23	0.199	0.0333	0.0136
2020-06-16	0.10	0.082	0.0707	0.0102

2020-06-17	0.17	0.084	0.1193	0.0131
2020-07-21	0.62	0.165	0.1742	0.0285
2020-07-25	0.53	0.085	0.1901	0.0139
2020-07-28	0.30	0.096	0.1488	0.0179
2020-08-01	0.51	0.161	0.1425	0.0220
2020-08-05	0.03	0.023	0.1512	0.0022
2020-09-04	0.58	0.229	0.1089	0.0247
2020-09-05	0.22	0.076	0.0953	0.0075
2020-09-07	0.25	0.074	0.1027	0.0096