

## ***Supplementary Information***

### **Urbanization is projected to increase local surface temperature by 2100**

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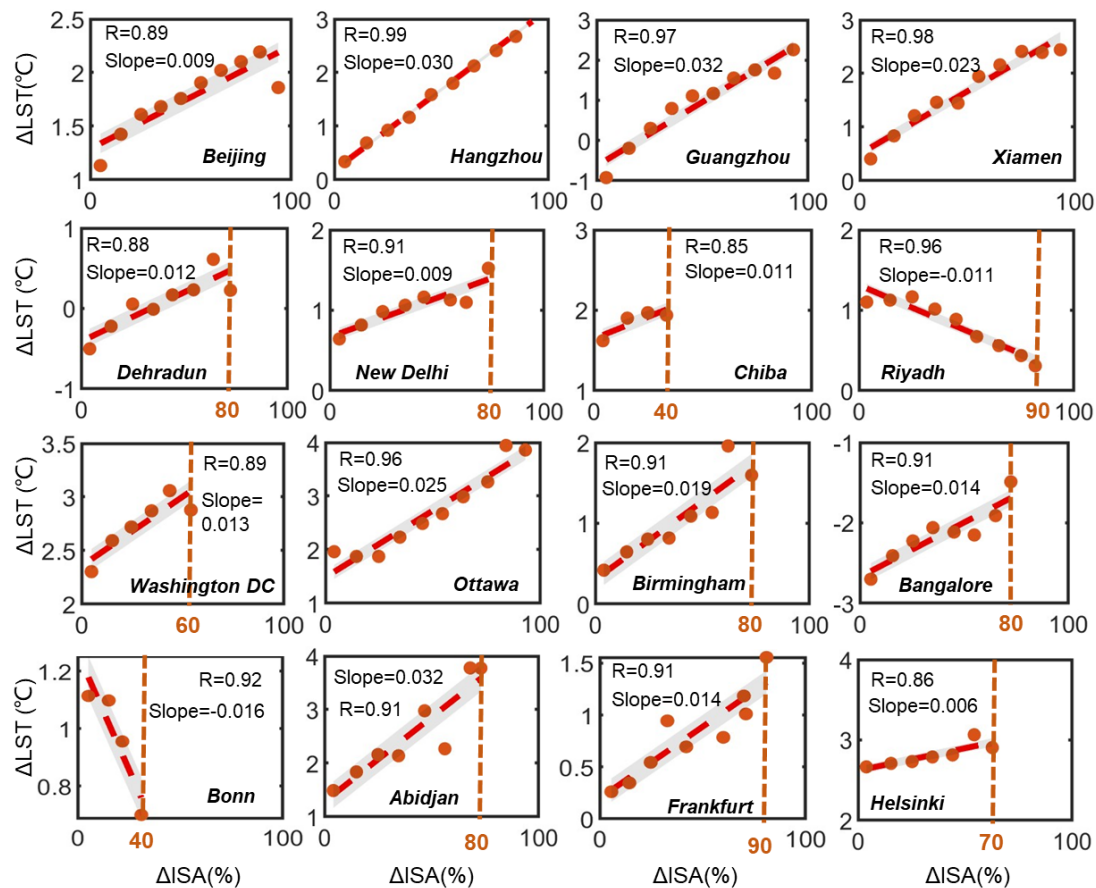
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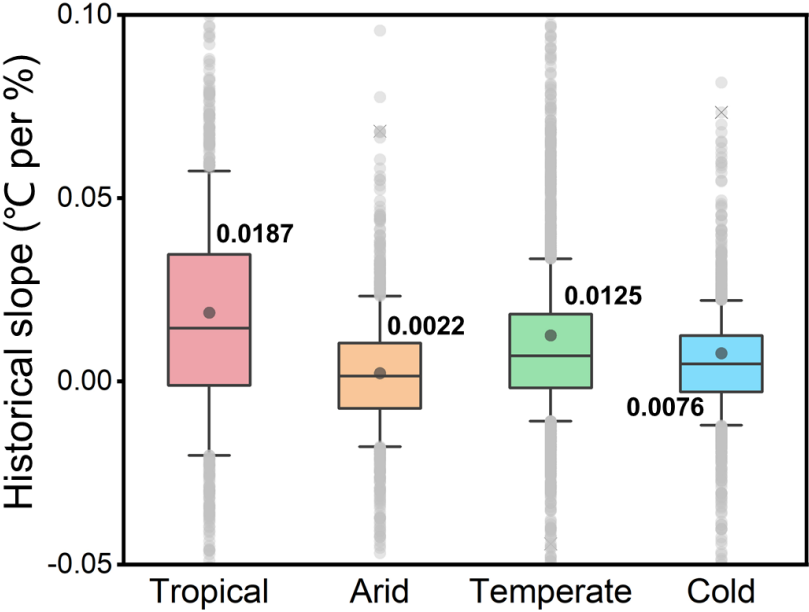
[Supplementary Tables 1–3.](#)

[Supplementary Figures 1–16.](#)

21     **Supplementary Figure 1**

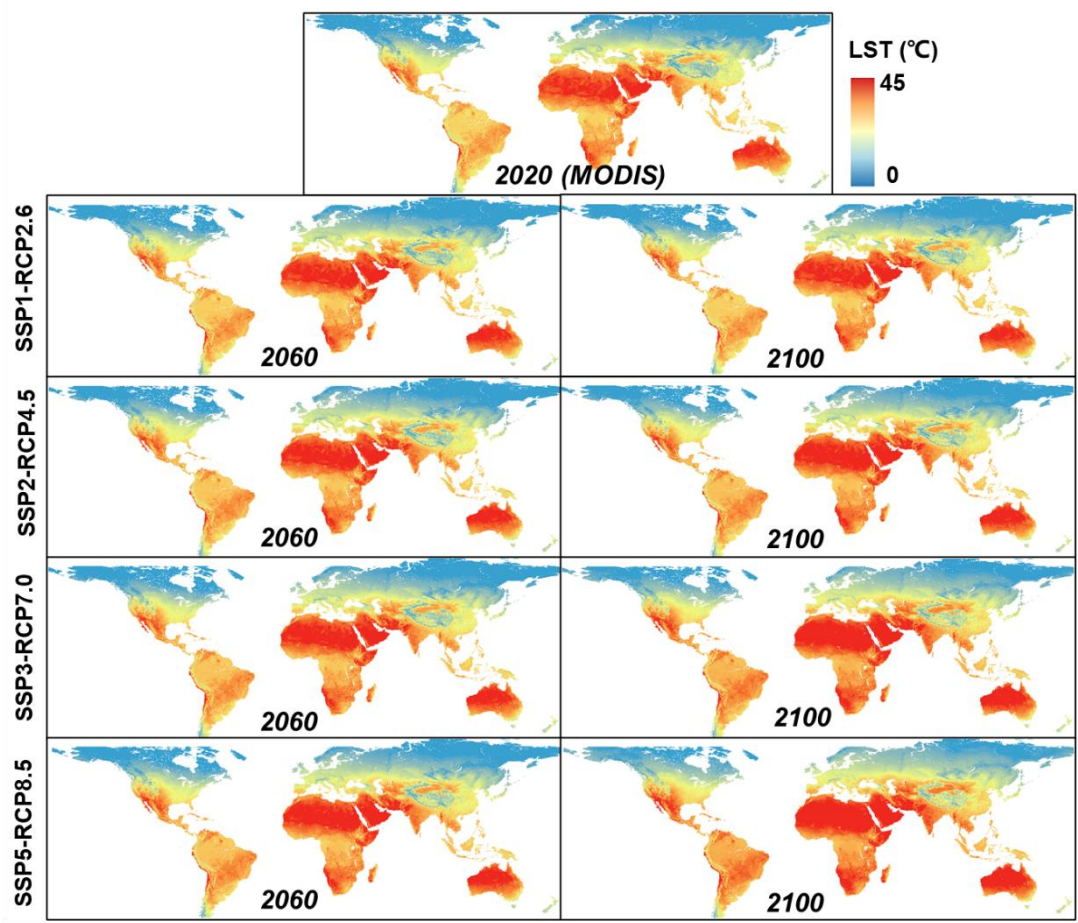


27 **Supplementary Figure 2**



28  
29 **Supplementary Figure 2** Historical slope for climate zone. Note: In the box plot, the  
30 dots represent the mean values, while the horizontal line within each box indicates the  
31 median. The top and bottom edges of each box correspond to the 75th and 25th  
32 percentiles, respectively, and the whiskers extend to the 95th and 5th percentiles.  
33 Values labeled are mean values.

34

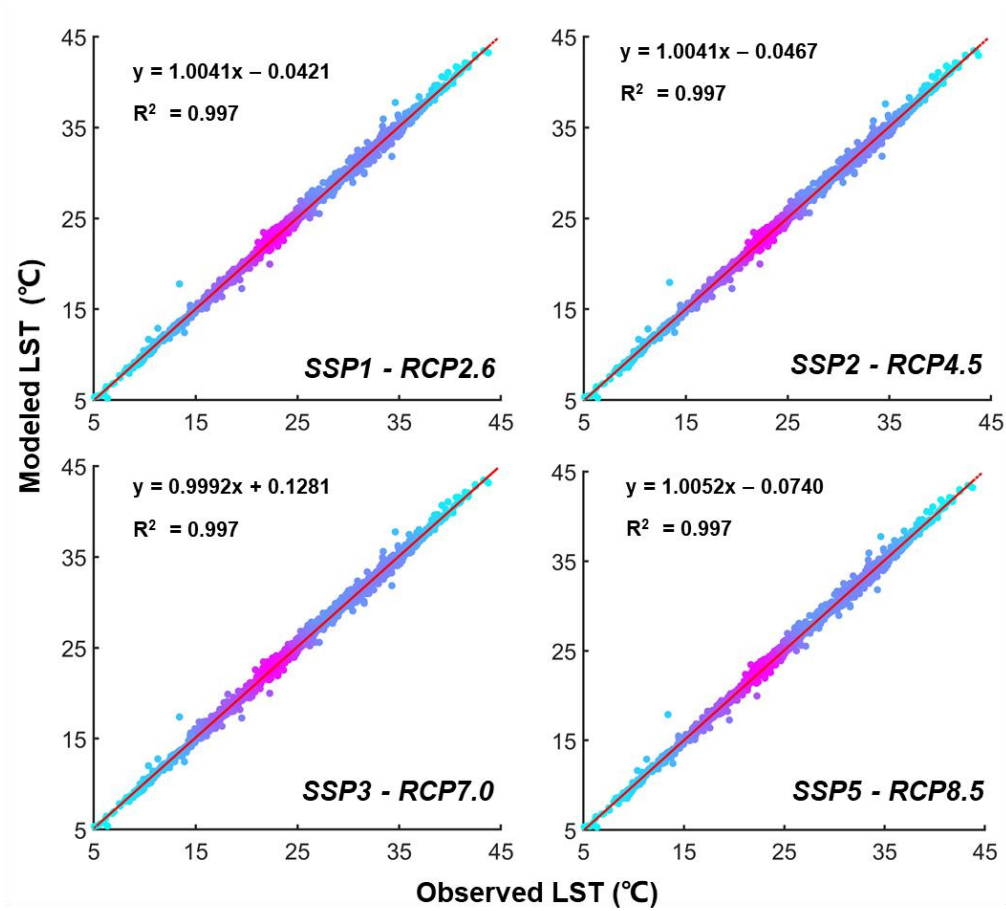


36

37     **Supplementary Figure 3** Global pattern of compounded LST in 2060 and 2100 under  
38     four SSP-RCP scenarios.

39

40     **Supplementary Figure 4**

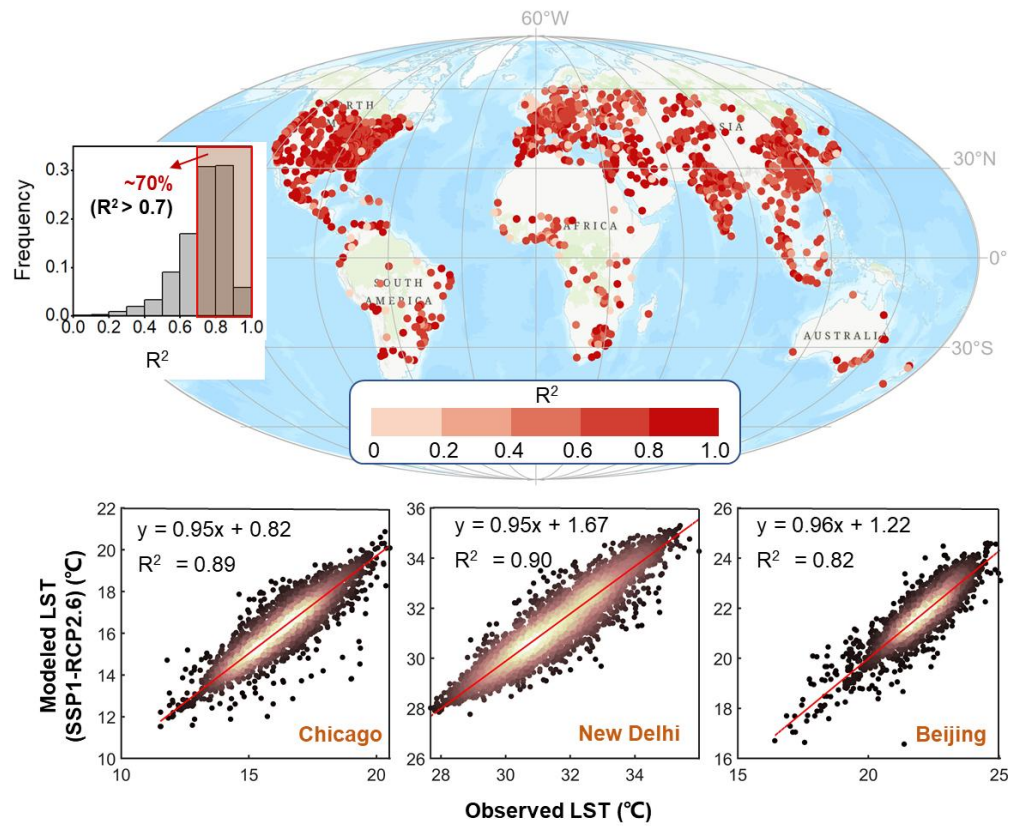


41

42     **Supplementary Figure 4** Comparison between modeled LST and observed LST (from  
43     MODIS) in 2020 at the global scale. Note: each point represents the average LST  
44     value with a city (GUB > 100 km<sup>2</sup>), with a total of 1,979 units. When aggregating  
45     pixels to the city level, we excluded those without ISA changes.

46

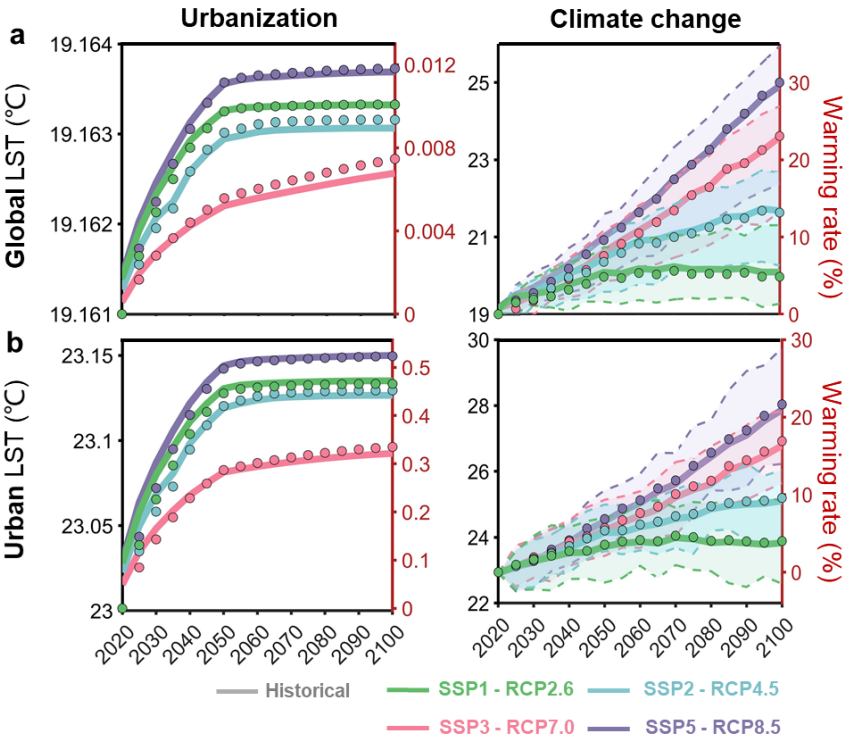
47 **Supplementary Figure 5**



48

49 **Supplementary Figure 5** Comparison between modeled LST (SSP1-RCP2.6) and  
50 observed LST (from MODIS) in 2020 at the city scale. The filtering criteria of  
51 changed pixels are the same as Supplementary Figure 4. Same base map source as  
52 Figure 1.

53



55

56 **Supplementary Figure 6** Future LST trends under the separate influences of

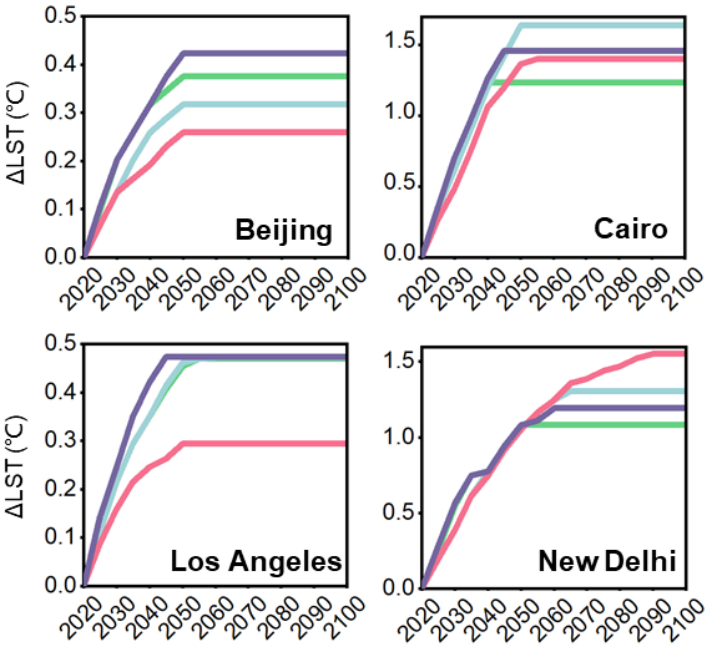
57 urbanization and climate change. (a) LST averaged globally; (b) LST averaged within

58 the urban areas. Note: The left axis represents the average LST (shown as a line),

59 while the right axis indicates the warming rate (shown as points). Dashed areas

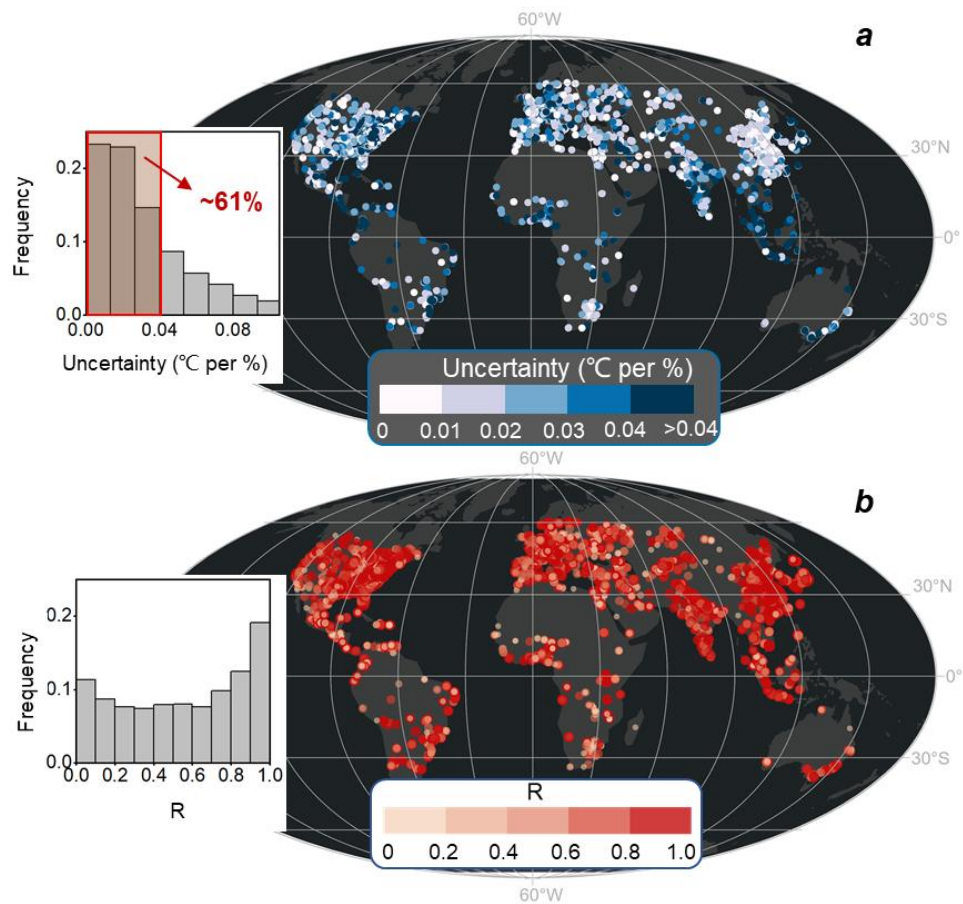
60 representing the 5th and 95th percentile error intervals from 26 GCMs.

62     **Supplementary Figure 7**



64     **Supplementary Figure 7** Future urbanization-induced extremely warming within  
65     urban areas relative to 2020 baseline in typical cities.

67 **Supplementary Figure 8**

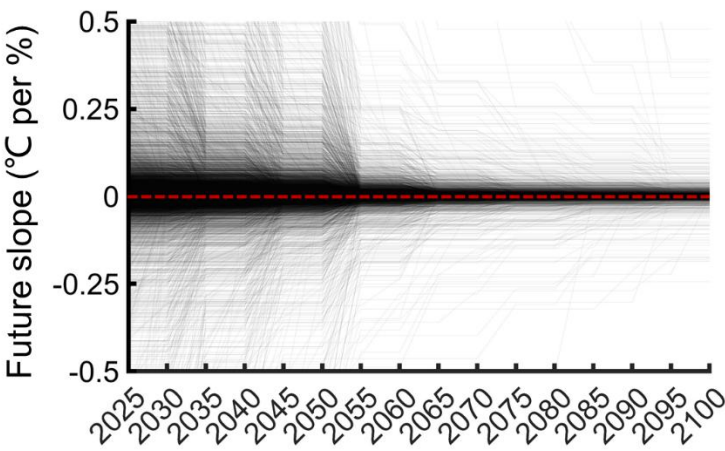


68

69 **Supplementary Figure 8** Spatial uncertainty and correlation of the  $\Delta\text{ISA}-\Delta\text{LST}$  linear  
70 model. (a) Spatial distribution of the 95% confidence interval of the slope in the  
71  $\Delta\text{ISA}-\Delta\text{LST}$  linear regression, representing uncertainty in the estimated urbanization-  
72 induced warming. (b) Spatial distribution of correlation coefficients (R-values)  
73 between  $\Delta\text{ISA}$  and  $\Delta\text{LST}$ . Same base map source as Figure 1.

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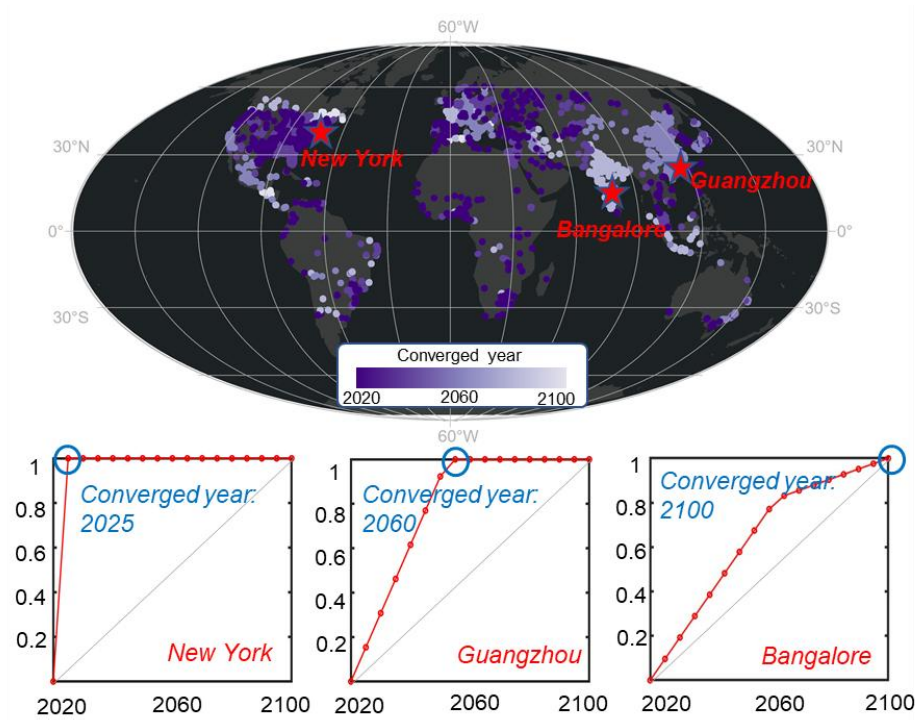
75 **Supplementary Figure 9**



76  
77 **Supplementary Figure 9** Future slope for multi-scenarios mean. The number of validly  
78 fitted Database of Global Administrative Areas level-2-administrative divisions is  
79 46,090. The x-axis is the year, e.g., 2025 indicates the slope for 2020-2025, and so on.

80

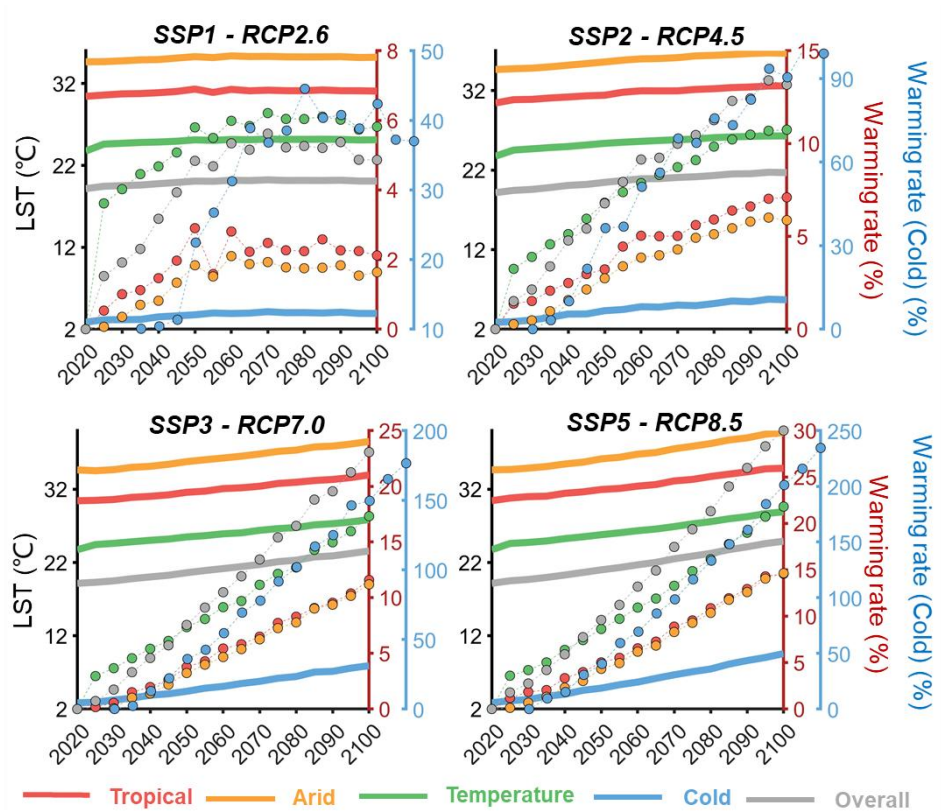
81     **Supplementary Figure 10**



82  
83     **Supplementary Figure 10** The converged year (without further urban increments) in  
84     the future. Note: the y-axis (0-1) represents integral of the  $\Delta\text{LST}-\Delta\text{ISA}$  slope area  
85     over time. The year when the y-value reaches 1 is identified as the urbanization-  
86     stagnation year. Same base map source as Figure 1.

87

88      **Supplementary Figure 11**



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90      **Supplementary Figure 11** Future LST trend in different climate zones. The left axis is

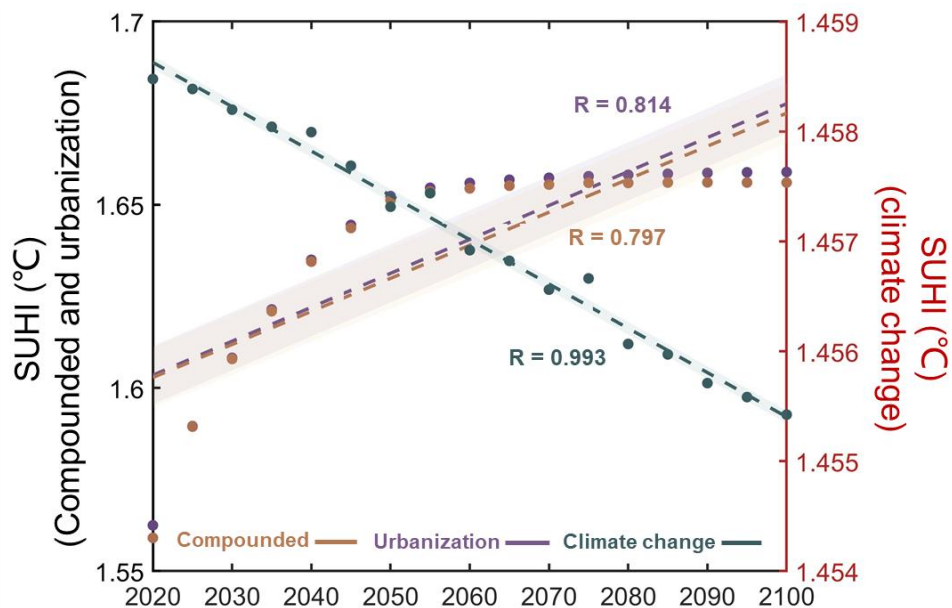
91      the LST, corresponding to the folded line, while the right axis is the warming rate,

92      corresponding to the dotted line. The red axis represents the tropical, arid and

93      temperate regions and the blue axis indicates to the cold regions.

94

95      **Supplementary Figure 12**



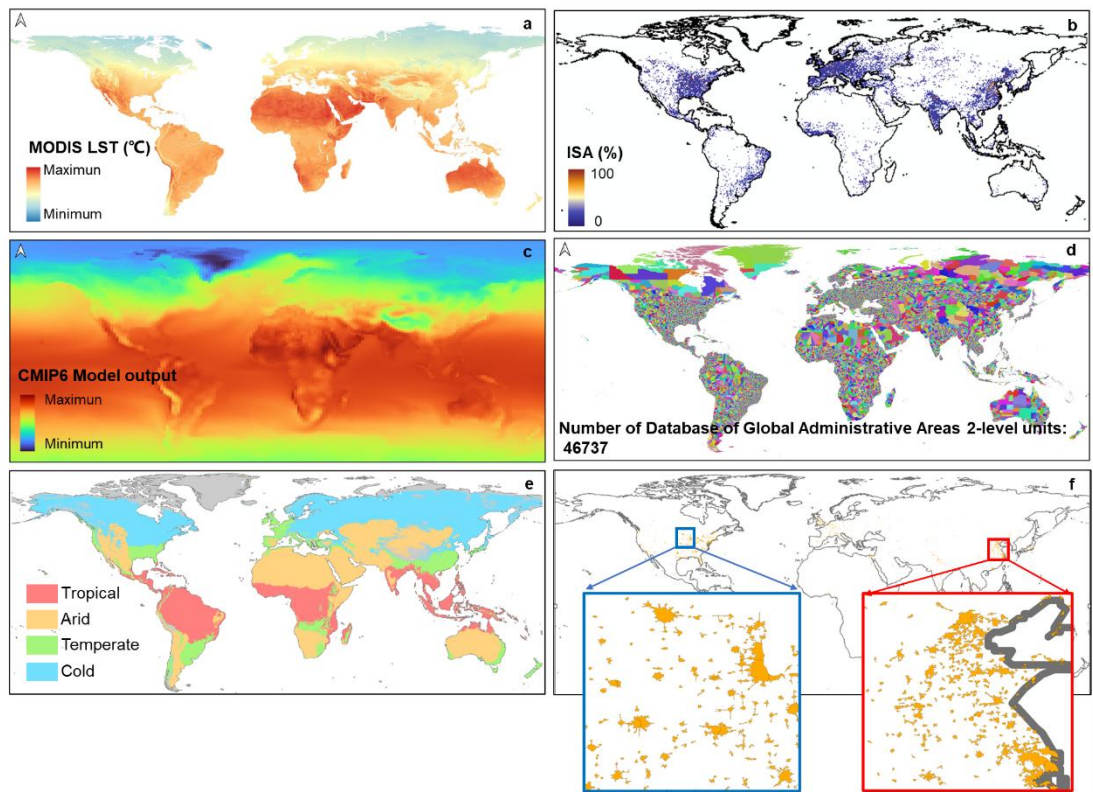
96

97      **Supplementary Figure 12** Future SUHI trends. The left axis represents the  
98      compounded SUHI (considering the compounded warming effect of climate change  
99      and urbanization) and considering warming solely from urbanization. While the right  
100      axis represents the SUHI considering warming solely from climate change.

101

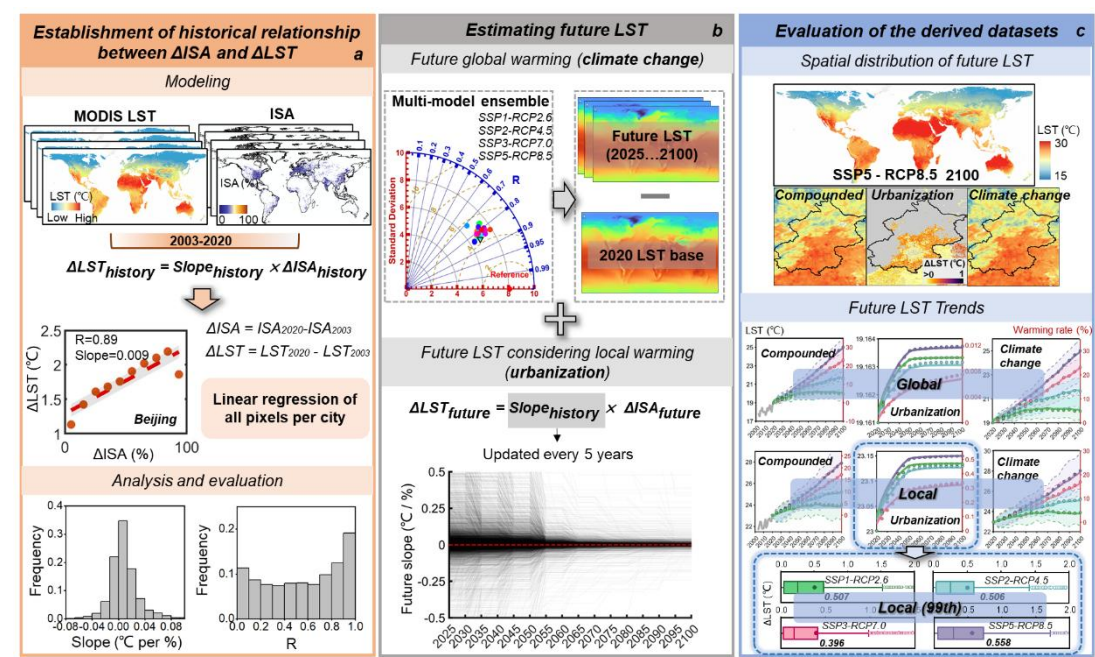
102

Supplementary Figure 13

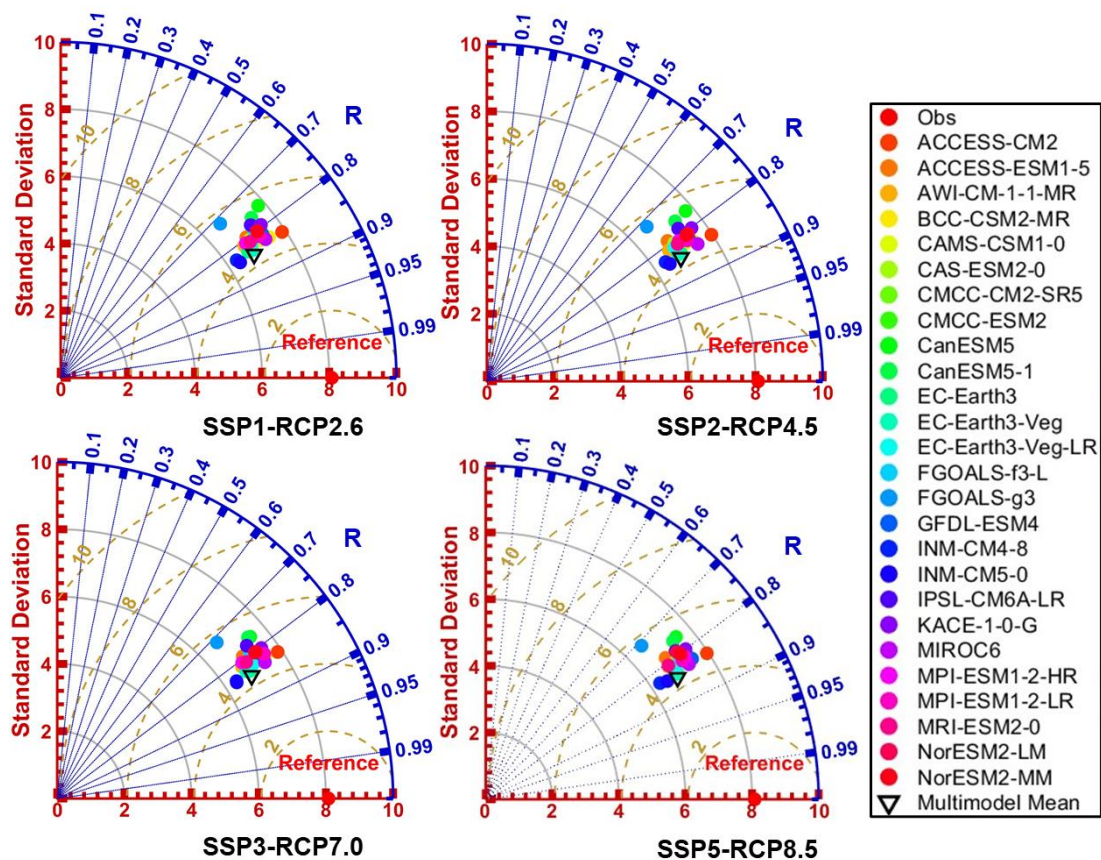


Supplementary Figure 13 Spatial patterns for data used in this study. (a) MODIS LST data. (b) CMIP6 model-simulated surface temperature. (c) Database of Global Administrative Areas level-2-administrative units. (d) ISA data. (e) Köppen–Geiger climate classification. (f) Global Urban Boundary data with urban areas greater than 100km<sup>2</sup>.

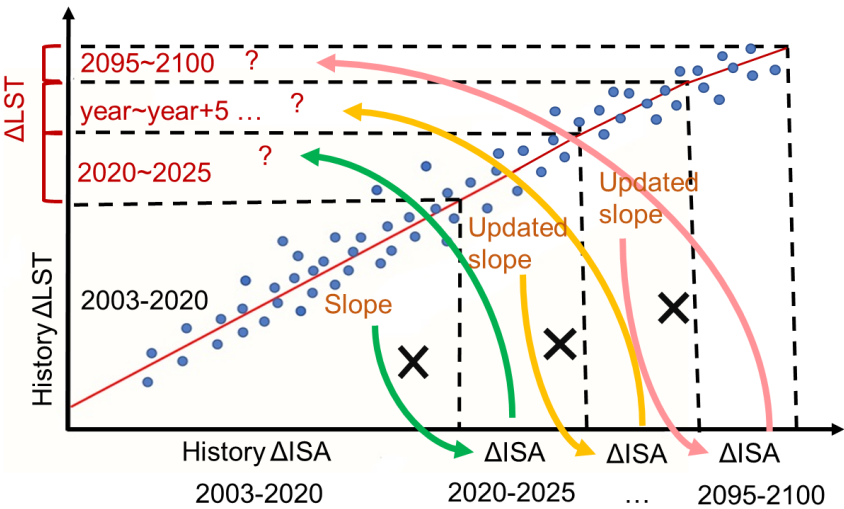
Supplementary Figure 14



Supplementary Figure 15



Supplementary Figure 15 Taylor diagram comparing the annual LST from MODIS observations and CMIP6 model simulations for 2015–2020. The radial coordinate is the magnitude of the standard deviation (denoted by the arcs). The RMSE is shown using the concentric semi-cycle. The angular coordinate depicts the correlation coefficient (R).



Supplementary Figure 16 Dynamic regression models workflow.

## Supplementary Table 1

Supplementary Table 1 Detailed description of the data used in this study.

| Products                       | Data description                                                                                                                                                           | Resolution | Time range           | Data Source                                                                                         |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------------|-----------------------------------------------------------------------------------------------------|
| LST data                       | Gap-filled MODIS global daily land surface temperature dataset (2003-2020)                                                                                                 | 1 km       | 2003-2020            | <a href="https://doi.org/10.25380/iastate.c.5078492">https://doi.org/10.25380/iastate.c.5078492</a> |
| Historical and future ISA data | The Global Artificial Impervious Area (GAIA) dataset. Coupled Model Intercomparison Project Phase 6 (CMIP6) future surface temperature projections from 26 climate models. | 1 km       | 2003~2020; 2020~2100 | <a href="https://data-starcloud.pcl.ac.cn">https://data-starcloud.pcl.ac.cn</a>                     |
| CMIP6 data                     | Database of Global Administrative Areas level-2-administrative units                                                                                                       | -          | 2020-2100            | <a href="https://esgf-node.llnl.gov/search/cmip6">https://esgf-node.llnl.gov/search/cmip6</a>       |
| Global administrative areas    |                                                                                                                                                                            | -          | -                    | <a href="https://gadm.org">https://gadm.org</a>                                                     |

## Supplementary Table 2

Supplementary Table 2 Basic information on the 26 CMIP6 models used in this study.

| Number | Country        | Model            | Resolution (Lon. × Lat.) |
|--------|----------------|------------------|--------------------------|
| 1      | Australia      | ACCESS-CM2       | 192*145                  |
| 2      | Australia      | ACCESS-ESM1-5    | 192*145                  |
| 3      | Canada         | CanESM5          | 128*64                   |
| 4      | Canada         | CanESM5-1        | 128*64                   |
| 5      | China          | BCC-CSM2-MR      | 320*160                  |
| 6      | China          | CAS-ESM2-0       | 256*128                  |
| 7      | China          | FGOALS-f3-L      | 288*180                  |
| 8      | China          | FGOALS-g3        | 180*80                   |
| 9      | China          | CAMS-CSM1-0      | 320*160                  |
| 10     | European Union | EC-Earth3        | 512*256                  |
| 11     | European Union | EC-Earth3-Veg    | 512*256                  |
| 12     | European Union | EC-Earth3-Veg-LR | 320*160                  |
| 13     | France         | IPSL-CM6A-LR     | 144*143                  |
| 14     | Germany        | AWI-CM-1-1-MR    | 384*192                  |
| 15     | Germany        | MPI-ESM1-2-LR    | 192*96                   |
| 16     | Germany        | MPI-ESM1-2-HR    | 802*404                  |
| 17     | Italy          | CMCC-CM2-SR5     | 288*192                  |
| 18     | Italy          | CMCC-ESM2        | 288*192                  |
| 19     | Japan          | MIROC6           | 256*128                  |
| 20     | Japan          | MRI-ESM2-0       | 320*160                  |
| 21     | Korea          | KACE-1-0-G       | 192*144                  |
| 22     | Norway         | NorESM2-LM       | 144*96                   |
| 23     | Norway         | NorESM2-MM       | 288*192                  |
| 24     | Russia         | INM-CM4-8        | 180*120                  |
| 25     | Russia         | INM-CM5-0        | 180*120                  |
| 26     | USA            | GFDL-ESM4        | 288*180                  |

Supplementary Table 3

Supplementary Table 3 Description of SSP and RCP Scenarios.

| Scenario    | Data description                                                                                                           |
|-------------|----------------------------------------------------------------------------------------------------------------------------|
| SSP1-RCP2.6 | A combination of the SSP1 “sustainability –taking the green road” and the ambitious emissions mitigation RCP 2.6 scenario  |
| SSP2-RCP4.5 | A combination of the SSP2 “middle-of-the-road” continuation of historical trends and the moderate-warming RCP 4.5 scenario |
| SSP3-RCP7.0 | A combination of the SSP3 “regional rivalry – a rocky road” and the high emissions RCP 7.0 scenario.                       |
| SSP5-RCP8.5 | A combination of the SSP5 “fossil-fueled development” and RCP 8.5 very high-warming scenarios                              |