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A discussion on the paper

"The footprint of urban heat island effect in China"

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Outline

Background

Objective

Method

Analysis and discussion

Conclusion

Background

Urbanization, one major anthropogenic modification to the Earth system, is accelerating at an unprecedented rate in recorded human history worldwide. More than half of world's population live in urban areas now, and this number is projected to be 67% by 2030. To meet the needs of soaring city dwellers ,global urban land is now expanding. Urbanization can pose many negative impacts on Earth's environments that transcend far from its physical boundary.

What is the UHI?

The urban heat island (UHI), referred as the phenomenon that urban areas tend to have higher temperatures than surrounding areas.

UHI intensity, UHII is loosely defined as the temperature difference between urban and surrounding areas.

The UHI effects have been observed in both urban and adjacent suburban areas. Thus , there is a strong impetus to systematically understand the UHI not only in its magnitude (UHI intensity , UHII) but also in its extent (FP).

Previous methods often cause large bias in the UHII estimates so a comprehensive study on the FP is thus needed across diverse cities to understand the spatial patterns and controlling factors.

Main objectives

(1) investigate the trends of UHI effect along urban-rural gradients

(2) explore the spatiotemporal variability of the FP

(3) examine the possible UHII bias induced by ignoring the FP by comparing urban-suburban and urban-rural LST differences for those 32 major cities across China.

Data and Method

Urban coverage maps of each city were derived from the cloud-free Landsat Tematic Mapper (TM) and Enhanced Tematic Mapper Plus (ETM+) images with a resolution of 30 m.

Land surface temperature (i.e., LST)was obtained from Aqua MODIS 8-days composite products (version 5) with a spatial resolution of 1km (MYD11A2) from 2003 to 2012. The LST data, including temperature observations that were monitored at 13:30 h (daytime) and 1:30 h (nighttime) local solar time, were estimated using a generalized split-window algorithm

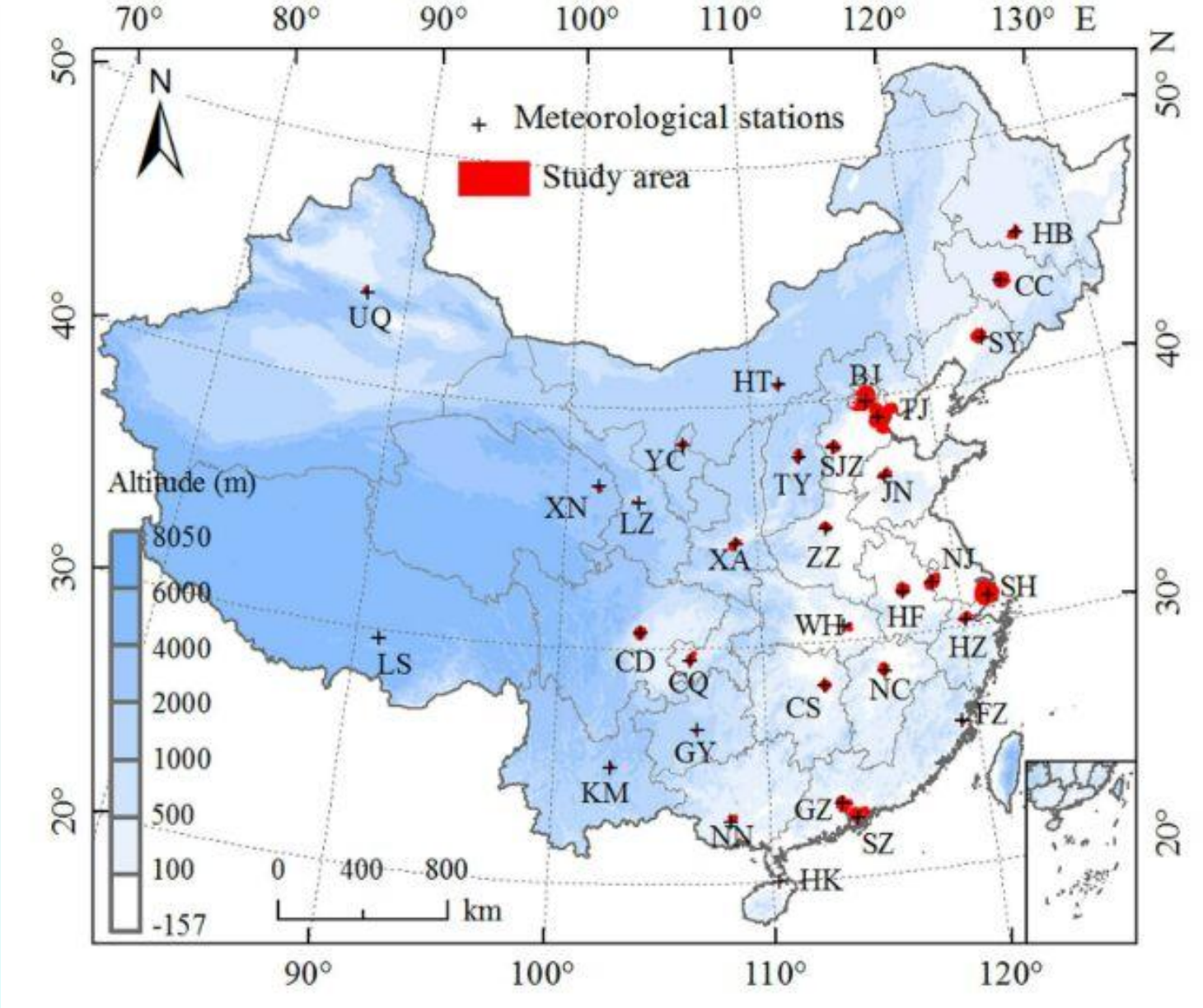


Figure 1. Locations of the 32 major cities in China

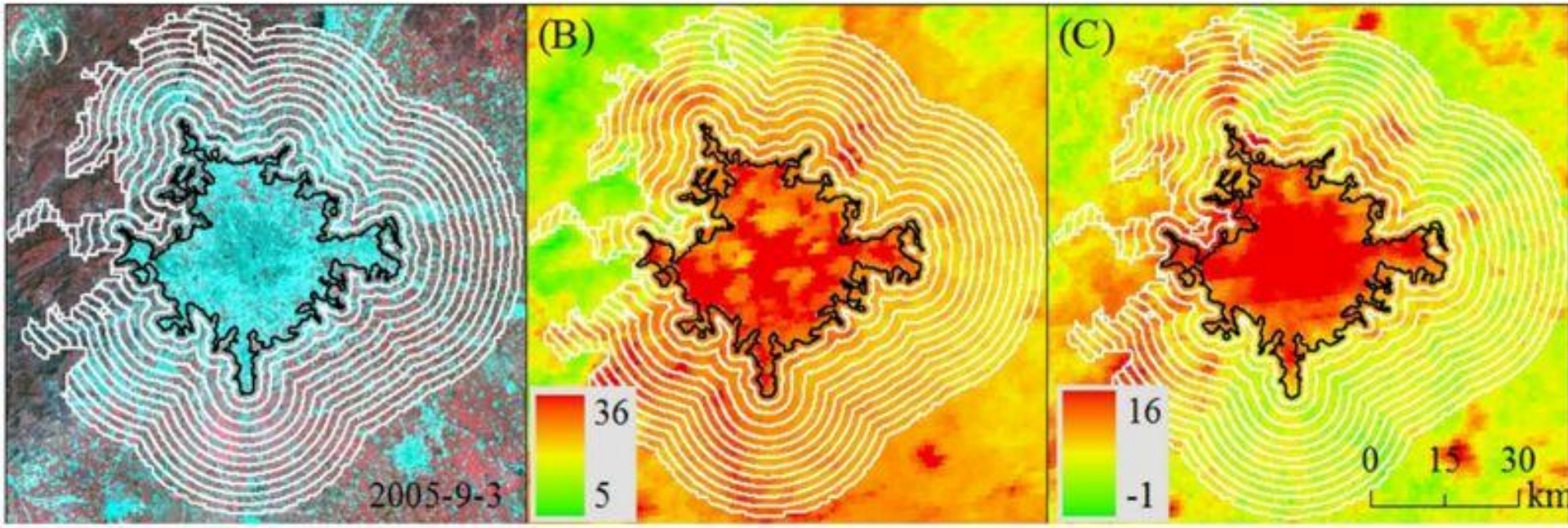


Figure 2. Te delineation of urban area and twelve buffer zones, an example of Beijing

Landsat TM false color image acquired in Sep 3rd 2005 with a spatial resolution of 30 m × 30 m (A), daytime land surface temperature (LST) (B), and nighttime LST (C) in 2005

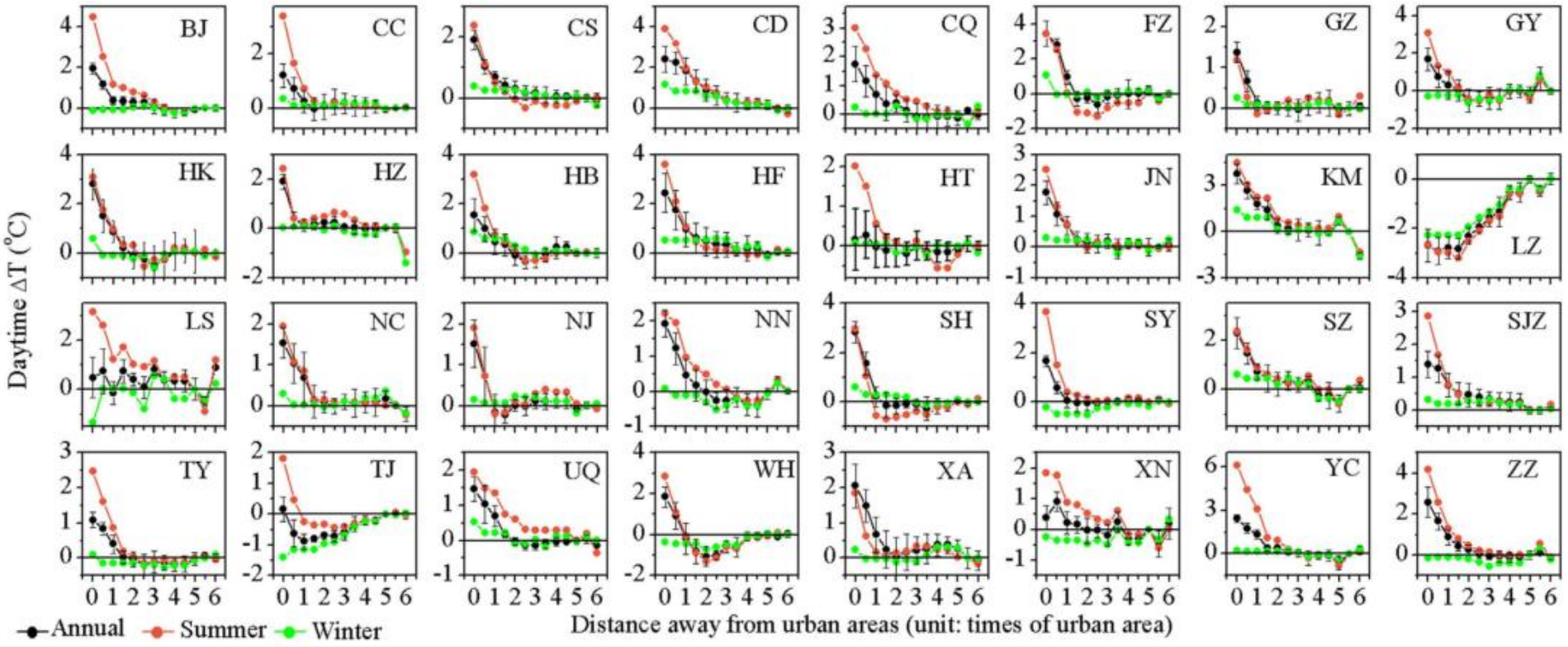


Figure 3. Trends of urban heat island effect (△T, defined as the LST differences relative to unaffected rural areas) from urban to rural areas during the day for China’ s 32 major cities averaged over 2003–2012

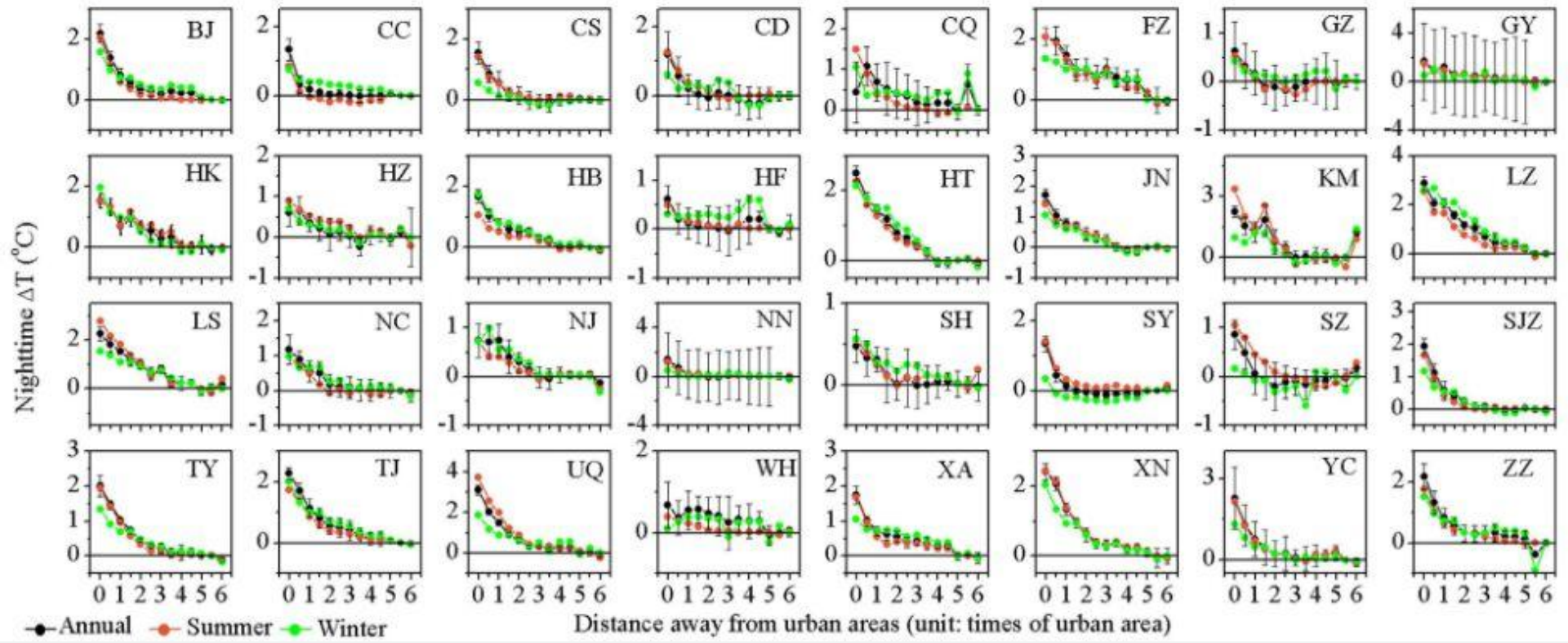
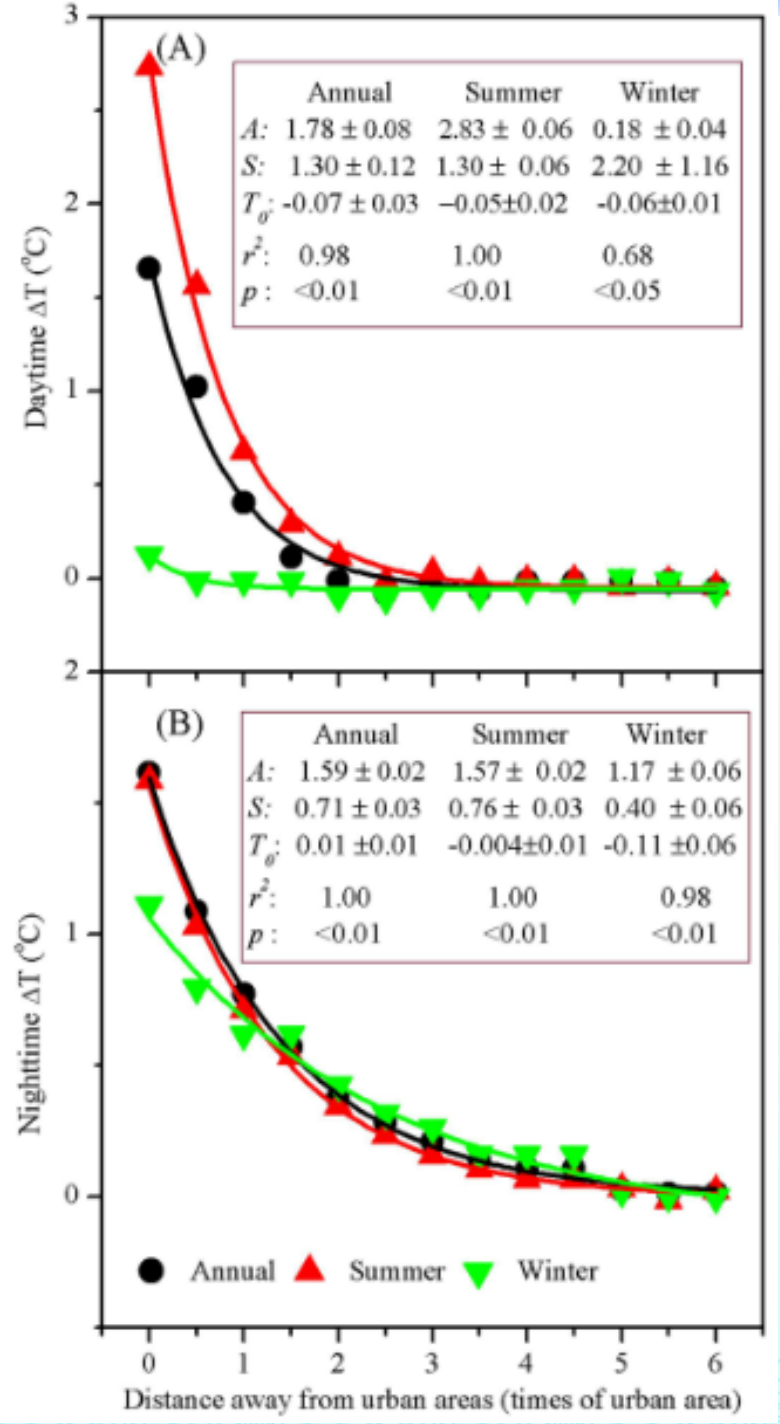


Figure 5. Trends of ▵T from urban to rural areas during the night for China’ s 32 major cities averaged over 2003–2012



the formula takes the form of

$$\triangle T = A \times e^{-S \times d} + T_0$$

Figure 4. Exponential trends of the △T with distance (d) away from urban to rural areas for China's 32 major cities averaged over 2003–2012

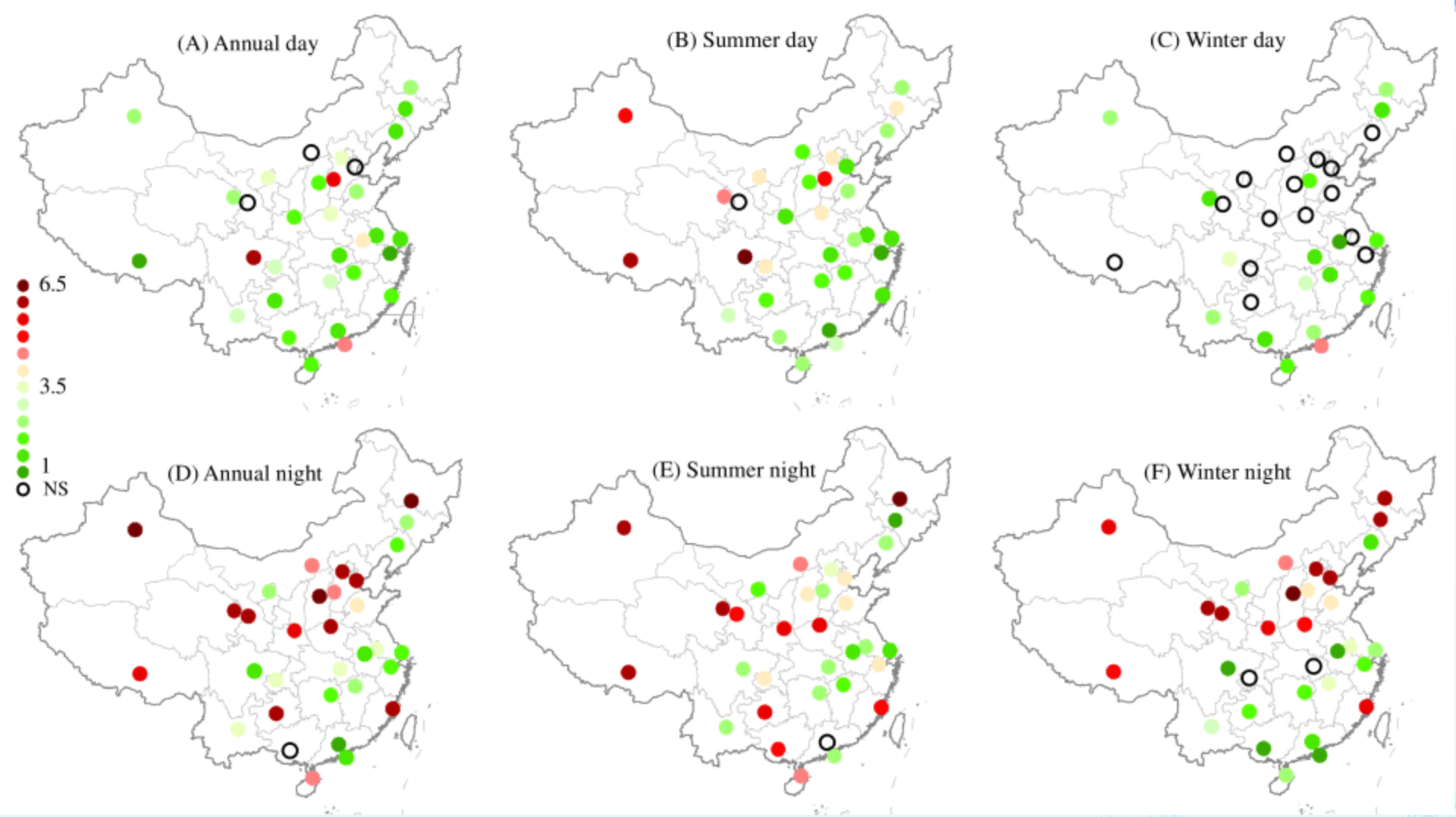


Figure 6. Te footprint of urban heat island effect (FP , times of urban area) for China’ s 32 major cities averaged over 2003–2012

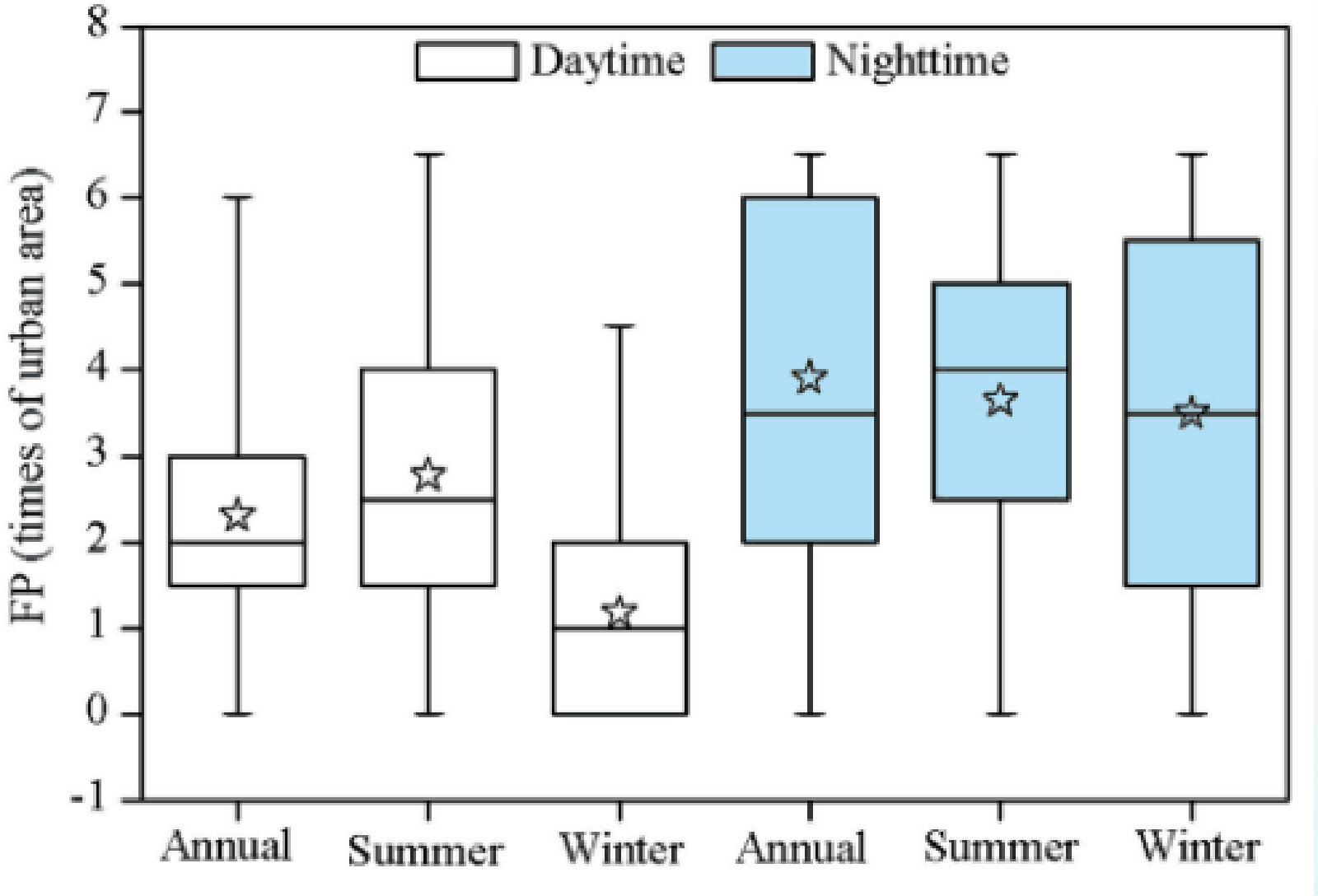


Figure 7. Box and whisker plots for annual, summer, and winter FPs during daytime and nighttime over China’ s 32 major cities

Time periods	Temperature	Precipitation	UHII
Summer day	−0.27	−0.35[b]	0.50[a]
Summer night	−0.36[b]	−0.35[b]	0.53[a]
Winter day	0.37[b]	0.48[a]	0.58[a]
Winter night	−0.63[a]	−0.59[a]	0.74[a]

Table 1. Pearson’ s correlations between the footprint of urban heat island effect (unit: times of urban area) and the potential drivers across China’ s 32 major cities.

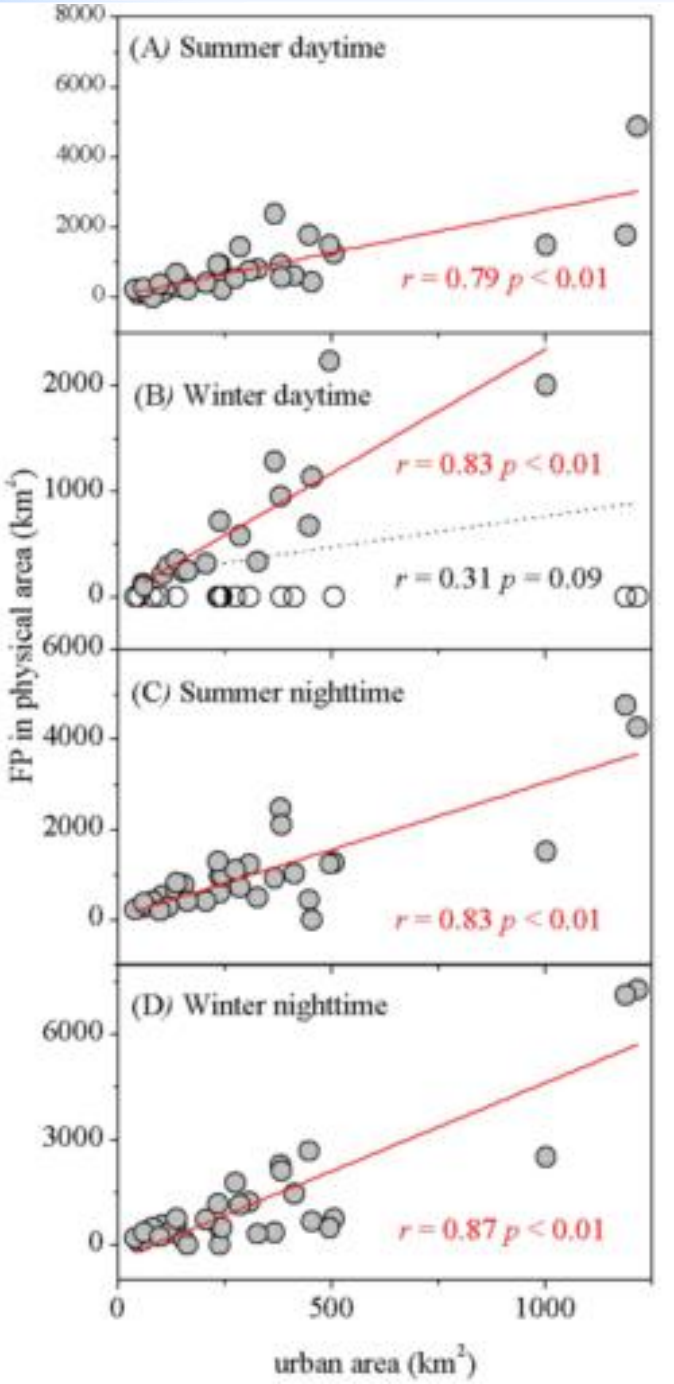


Figure 8. Relationship between the areas of the FP and actual urban land cover across China's 32 major cities.

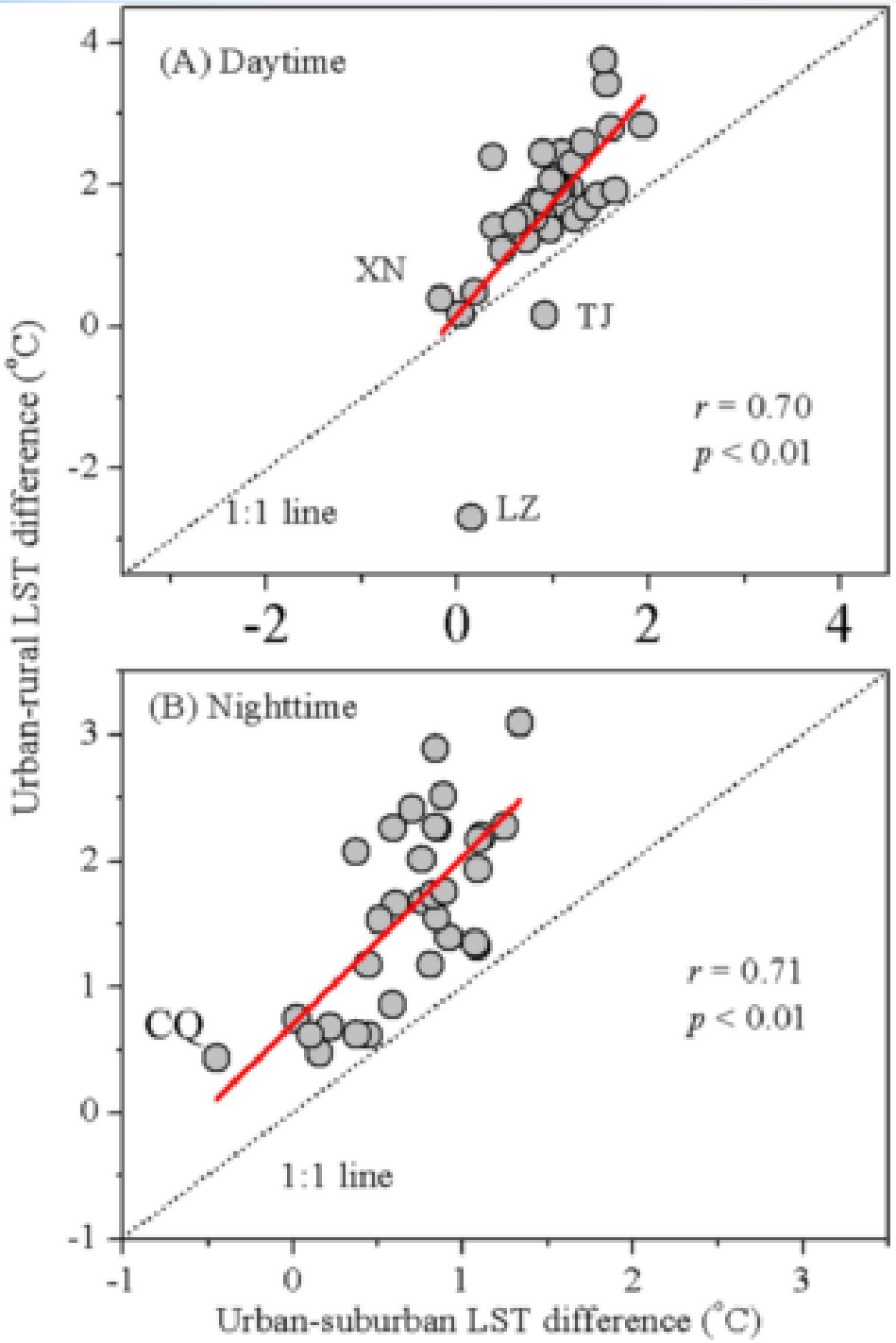


Figure 9. Relationship between annual mean urban-rural and urban-suburban LST differences averaged over 2003–2012 across China's 32 major cities.

Conclusions

(1)Exponential decay of the UHI effect along urban-rural gradients.

(2)Spatiotemporal variability of the FP across cities.

(3)Possible UHII bias induced by ignoring the FP.

(4) Uncertainties.

Thank you!!