Wind Engineering Joint Usage/Research Center
FY2025 Research Result Report

Research Field: Outdoor Environment
Research Year: FY2025
Research Number: 252014
Research Theme: Prediction of urban climate and proposal of thermal environment improvement countermeasures for East Asian coastal megacities under global warming

Representative Researcher: Zheng Wang

Budget [FY2025]:300,000 Yen

*There is no limitation of the number of pages of this report.
*Figures can be included to the report and they can also be colored.
*Submitted reports will be uploaded to the JURC Homepage.

1. Research Aim

This study aims to analyze the characteristics of urban climate change in East Asian coastal megacities under global warming, thereby evaluate the effectiveness of existing UTE improvement countermeasures and develop potential countermeasures.

2. Research Method

Generating local climate zone (LCZ) maps for each city as landuse data of WRF, and calculating parameters such as urban morphology, land cover and anthropogenic heat release for each LCZ type as input data.

Simulating and analyzing the current urban climate of each city through WRF to clarify their urban climate characteristics and thus formulate current effective UTE improvement countermeasures.

3. Research Result

This study focused on Shanghai, using the Weather Research and Forecasting (WRF) model coupled with the local climate zone (LCZ) scheme to simulate the urban climate and analyze the characteristics of the sensible heat balance components—advection, turbulent diffusion, and anthropogenic heat release—within different regions of Shanghai. The key findings are: 1) the characteristics of advection components in different regions indicate that sea breezes and lake breezes both play significant roles in reducing the air temperature in Shanghai, with sea breezes being more effective; 2) the vertical gradient of wind velocity in the upper air of inland regions increases more than that of coastal regions, leading to a significantly lower net sensible turbulent diffusion component of urban space atmosphere in inland regions compared to coastal regions; 3) the distribution of sensible anthropogenic heat release (SAH) in Shanghai is generally correlated with LCZs, with the SAH is significantly higher in open high-rise and heavy industry types areas compared to other areas. Furthermore, this study determined the UHI mitigation countermeasures for different areas based on the heat balance characteristics of urban space atmosphere in different regions of Shanghai, contributing to the improvement of the urban thermal environment conditions.

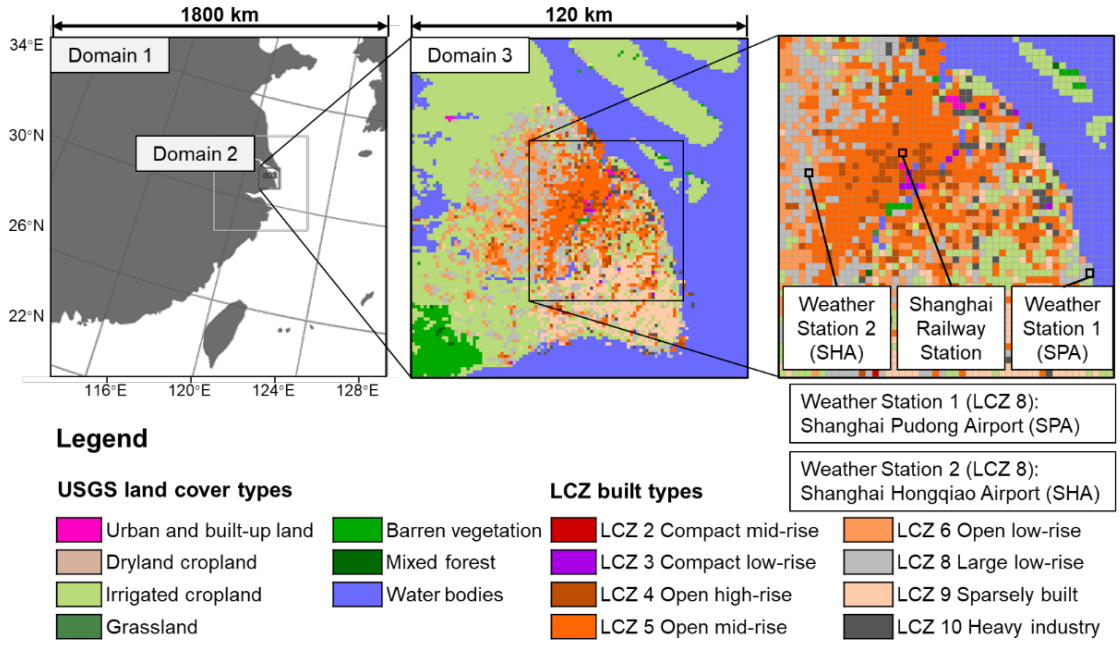

Fig.1 Domains and land use for WRF simulation in Shanghai.

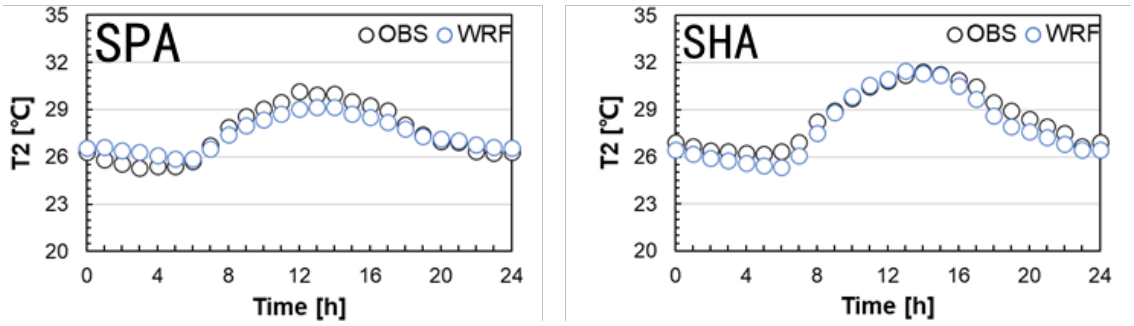

Fig.2 Validation of the WRF calculation results

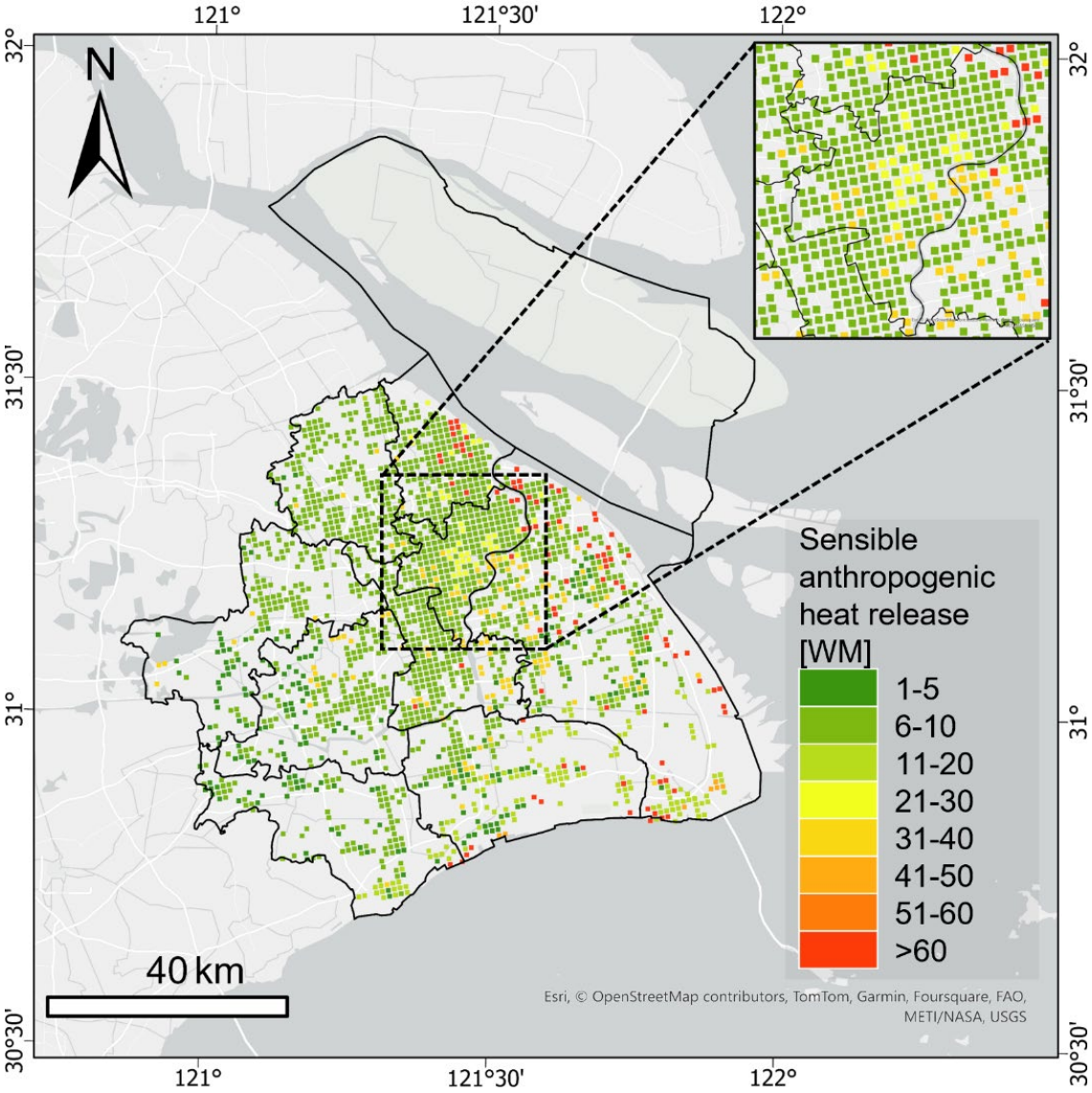

Fig.3 Distribution of average SAH from 12:00 to 16:00 of sunny days in August in Shanghai

4. Published Paper etc.
[Underline the representative researcher and collaborate researchers]
[Published papers]
1. Zheng Wang*, Yasuyuki Ishida, Yifei Peng, Jingyuan Ren, and Akashi Mochida. Exploring the heat balance characteristics in Shanghai by using the WRF model coupled with Local Climate Zone scheme. *Sustainable Cities and Society*, 2025.
2. Youfang Li, Boxu Han, Yifei Peng, and Zheng Wang*. Exploration of the spatiotemporal evolution of Surface Urban Heat Island from 2013 to 2023 and driving factors of different years in Tianjin based on Local Climate Zone Scheme. *Theoretical and Applied Climatology*, 2026.
3. Youfang Li, Boxu Han, Yifei Peng, and Zheng Wang*. A bibliometric review on the application and development of the local climate zone concept in multiple fields. *Theoretical and Applied Climatology*, 2026.

5. Research Group
1. Representative Researcher
Zheng Wang
2. Collaborate Researchers
1. Yingli Xuan

2. Yifei Peng
3. Youfang Li

6. Abstract (half page)

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Representative Researcher (Affiliation): Zheng Wang (Hebei University of Technology)
Summary・Figures

Clarifying the characteristics of the heat balance mechanism of urban space atmosphere is crucial for developing effective countermeasures to mitigate urban heat island (UHI) effect under global warming. This study focused on Shanghai, using the Weather Research and Forecasting (WRF) model coupled with the local climate zone (LCZ) scheme to simulate the urban climate and analyze the characteristics of the sensible heat balance components—advection, turbulent diffusion, and anthropogenic heat release—within different regions of Shanghai. The key findings are: 1) the characteristics of advection components in different regions indicate that sea breezes and lake breezes both play significant roles in reducing the air temperature in Shanghai, with sea breezes being more effective; 2) the vertical gradient of wind velocity in the upper air of inland regions increases more than that of coastal regions, leading to a significantly lower net sensible turbulent diffusion component of urban space atmosphere in inland regions compared to coastal regions; 3) the distribution of sensible anthropogenic heat release (SAH) in Shanghai is generally correlated with LCZs, with the SAH is significantly higher in open high-rise and heavy industry types areas compared to other areas. Furthermore, this study determined the UHI mitigation countermeasures for different areas based on the heat balance characteristics of urban space atmosphere in different regions of Shanghai, contributing to the improvement of the urban thermal environment conditions.