We thank the reviewer for your constructive comments, which significantly improve the quality of our manuscript. Based on these comments, we have revised the manuscript thoroughly. The changes made to the manuscript are noted in the revised manuscript, and described in detail below (reviewer comments are in *italic* and cited texts are in **bold**).

This article developed the essential data needed to make urban climate simulations based on WRF-Urban as accurate as possible for any city in the world. As the author points out, building morphology data significantly impact the accuracy of urban climate simulations, but such data have only been available for a limited number of cities. This research, which aims to develop a global dataset, is significant in that it attempts to overcome this situation. There is no doubt that the dataset in this paper will be helpful for many WRF-Urban users.

Response: We sincerely thank the reviewer for your positive recognition of our work.

On the other hand, I am concerned that the paper does not refer to previous research that has undertaken similar initiatives. As a result, from the perspective of an individual data user, it is unclear how these data differ from existing global data and what their characteristics and novelties are. There is a need to compare these data with existing global data and describe the characteristics of this dataset before publication is considered.

Response: We thank the reviewer for your valuable feedback. In response, we have incorporated recent developments in global urban parameter datasets into the revised manuscript, including the global dataset developed by Knanh et al. (2023), the UT-GLOBUS data developed by Kamath et al. (2024), and the U-Surf data developed by Cheng et al. (2024). Based on your constructive comments, we have thoroughly revised the manuscript and hope that our responses and revisions meet your expectations.

References:

Cheng, Y., Zhao, L., Chakraborty, T., Oleson, K., Demuzere, M., Liu, X., Che, Y., Liao, W., Zhou, Y., and Li, X.: U-Surf: A Global 1 km spatially continuous urban surface property dataset for kilometer-scale urban-resolving Earth system modeling, Earth Syst. Sci. Data Discuss., 2024, 1-

38, 10.5194/essd-2024-416, 2024.

Kamath, H. G., Singh, M., Malviya, N., Martilli, A., He, L., Aliaga, D., He, C., Chen, F., Magruder, L. A., Yang, Z.-L., and Niyogi, D.: GLObal Building heights for Urban Studies (UT-GLOBUS) for city- and street- scale urban simulations: Development and first applications, Sci. Data, 11, 886, 10.1038/s41597-024-03719-w, 2024.

Khanh, D. N., Varquez, A. C. G., and Kanda, M.: Impact of urbanization on exposure to extreme warming in megacities, Heliyon, 9, e15511, https://doi.org/10.1016/j.heliyon.2023.e15511, 2023.

Major comment:

As mentioned above, the characteristics of the global dataset proposed in this study must be described in relation to similar existing global datasets.

Specifically, we know that a global dataset has been developed and published by Knanh et al. (2023), and these data have been adopted in WRF v4.6.0.

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Paper

https://www.cell.com/heliyon/fulltext/S2405-8440(23)02718-4

Dataset

https://figshare.com/articles/dataset/Present_and_future_1_km_resolution_global_population_density_and_urban_morphological_parameters/17108981?file=31635521 (10 Dec 2024, last access)

WRF Github

https://github.com/wrf-model/WRF/releases/tag/v4.6.0 (10 Dec 2024, last access)

https://github.com/wrf-model/WRF/commit/3cadf04277ac3a050e65461efb6aa939349c60a8 (10 Dec 2024, last access)

https://github.com/wrf-model/WRF/pull/1986 (10 Dec 2024, last access)

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Response: We sincerely thank the reviewer for the constructive suggestions. Regarding the recently released datasets mentioned above, the U-Surf dataset developed by Cheng et al. (2024) and our GloUCP dataset are both derived from the same building vector data released by Che et al. (2024) to calculate urban morphological parameters. As a result, there is no difference in mean building height between the two datasets. We have clarified this in the revised manuscript and further explained that the urban morphological parameters provided by U-Surf, which are designed for the UCM in the Community Earth System Model, differ from the UCPs required by WRF/UCM and therefore cannot be directly applied in the WRF model. We highlight that the uniqueness of our study lies in utilizing a newly-developed building-scale height map to produce a global, spatially continuous, high-resolution UCP dataset specifically tailored for the WRF model.

Additionally, based on the reviewer's suggestion, we compared our dataset with the recently released UT-GLOBUS dataset by Kamath et al. (2024) and the global urban morphological dataset developed by Khanh et al. (2023). For the UT-GLOBUS dataset, our dataset offers more comprehensive spatial coverage, as the UT-GLOBUS dataset has significant data gaps, particularly in regions such as East Asia. We also conducted a comparison of our GloUCP dataset with the UT-GLOBUS dataset across three cities in the United States. Overall, compared to the reference data, our dataset and the UT-GLOBUS dataset demonstrate similar levels of accuracy (Figs. S5–S7).

For the global urban morphological dataset developed by Khanh et al. (2023), we used their UCPs estimated based on GDP and population density information in 2010 (hereafter referred to as Knanh2010) to compare it with our data in representative regions in China and the United States, respectively. The results show that our dataset still has an advantage in terms of spatial coverage (Figs. S8 and S9). In terms of accuracy, the Knanh2010 dataset performs well in capturing low- to mid-rise buildings but significantly underestimates the height of high-rise buildings in China (Fig. S10). In contrast, both datasets perform reasonably well in U.S. cities, although our dataset shows slightly better accuracy across different building height categories (Fig. S11).

In summary, we have added a brief description of the above-mentioned datasets in the introduction section and highlighted the advantages of GloUCP compared to these recently released UCP datasets. Furthermore, we included a detailed comparison between our dataset and existing global datasets in the results section to emphasize their differences in the revised manuscript, as detailed below.

"**Recently, Kamath et al. (2024) released a global building heights for urban studies (UT-GLOBUS) for city-and-street-scale urban simulations. Although UT-GLOBUS covers more than 1200 cities or locales worldwide, UCP data for East Asia remain unavailable due to the lack of building vector data in this area. For study areas without detailed UCP data, urban changes can**

only be described from a two-dimensional perspective, with three-dimensional morphological parameters often represented by a fixed value, failing to reflect the true impact of urban three-dimensional structures on local climates. In addition, Khanh et al. (2023) developed a global 1 km urban morphological dataset by using empirical formulas to estimate UCPs based on gross domestic product (GDP) and population density information. While this dataset performs well in terms of spatial coverage, the accuracy of the estimated parameters has not yet been compared with results derived from actual building data."

"**Based on the building vector data, Cheng et al. (2024) developed a global 1 km spatially continuous urban surface property dataset (U-Surf) for the UCM in the Community Earth System Model. However, the urban morphological parameters calculated in U-Surf, including building height, canyon height-to-width ratio, roof fraction, pervious canyon floor fraction, and urban percentage, differ from the UCPs required by WRF/UCM and therefore cannot be directly used in the WRF model. Therefore, the aim of this study is to use a newly-developed building-scale height map to further produce a global spatially continuous high-resolution UCP dataset (hereafter referred to as GloUCP), updating the default parameters in the WRF model to improve simulation accuracy.**"

"**To demonstrate the advantages of our dataset, we further compared it with the recently released UT-GLOBUS dataset by Kamath et al. (2024) and the global urban morphological dataset developed by Khanh et al. (2023).**"

"**Furthermore, we compared our dataset with the recently released UT-GLOBUS dataset by Kamath et al. (2024) and the global urban morphological dataset developed by Khanh et al. (2023). Because the UT-GLOBUS dataset only provides three parameters (i.e., area weighted mean building height, plan area fraction, and building surface to plan area ratio), we conducted a comparison of these parameters in three cities in the United States (Figs. S5-S7). Overall, our GloUCP dataset and the UT-GLOBUS dataset exhibit similar levels of accuracy. Compared to the reference data, both datasets show relatively high estimation accuracy for most parameters, except for an underestimation of the building surface to plan area ratio. On average, the R^2**

values for our GloUCP dataset across the three cities are generally above 0.8, slightly outperforming the UT-GLOBUS dataset. Nevertheless, our dataset offers more comprehensive spatial coverage of global urban areas, particularly in East Asia. This broader coverage provides greater support for urban climate simulations, especially for small and medium-sized cities worldwide."

"**For the global urban morphological dataset developed by Khanh et al. (2023), we used their UCPs estimated based on GDP and population density information in 2010 (hereafter referred to as Knanh2010) to compare it with our data from the representative regions in China and the United States, respectively. Generally, the spatial coverage of our GloUCP dataset is still larger than that of Knanh2010 (Figs. S8 and S9). In China, compared to the reference data, the Knanh2010 dataset performs well in capturing low- to mid-rise buildings but significantly underestimates the height of high-rise buildings (Fig. S10). In the United States, the accuracy of our GloUCP dataset is similar to that of Knanh2010, though our dataset performs slightly better across different building height categories (Fig. S11). Overall, while the Knanh2010 dataset already offers better spatial coverage than most existing datasets, our GloUCP dataset provides even greater coverage. In China, the accuracy of most datasets remains suboptimal, but our dataset slightly outperforms others, particularly in representing high-rise buildings.**"

References:

Che, Y., Li, X., Liu, X., Wang, Y., Liao, W., Zheng, X., Zhang, X., Xu, X., Shi, Q., Zhu, J., Zhang, H., Yuan, H., and Dai, Y.: 3D-GloBFP: the first global three-dimensional building footprint dataset, Earth Syst. Sci. Data, 16, 5357-5374, 10.5194/essd-16-5357-2024, 2024.

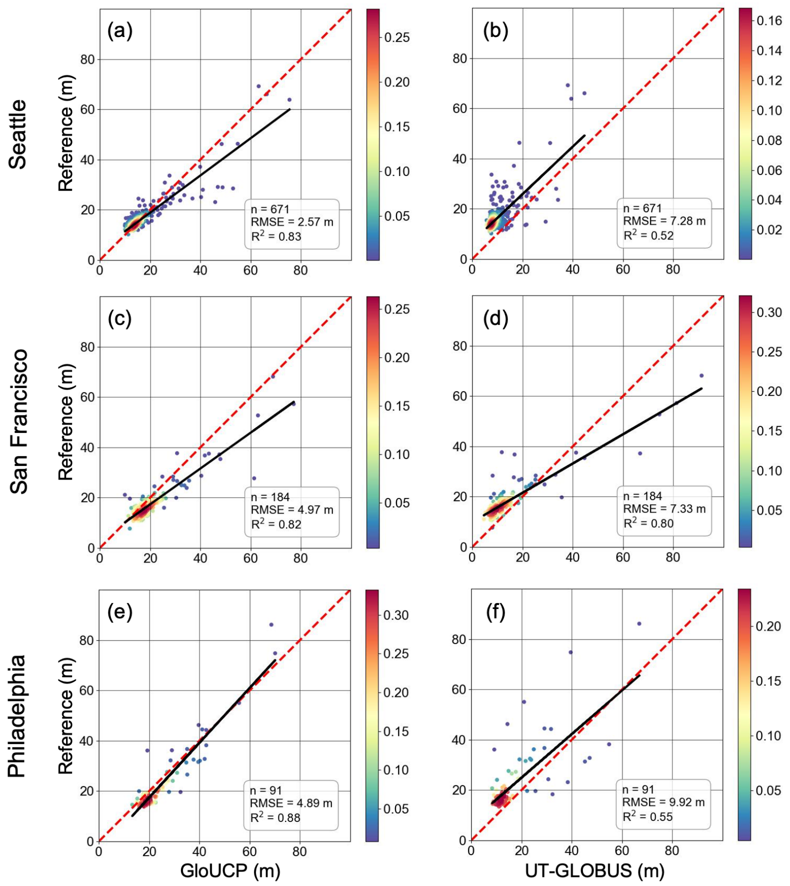

Figure S5. Pixel-scale comparison of area weighted mean building height between GloUCP and UT-GLOBUS across three representative cities in the United States. The red dashed line represents the 1:1 line, while the black solid line indicates the fitted regression line.

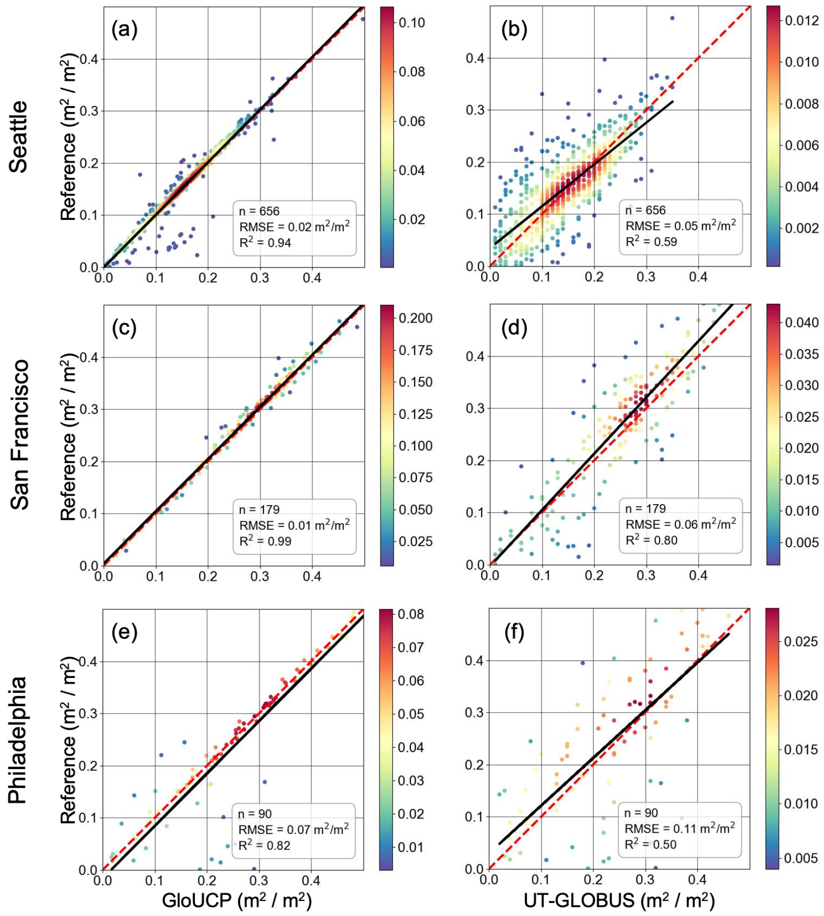

Figure S6. Pixel-scale comparison of plan area fraction between GloUCP and UT-GLOBUS across three representative cities in the United States. The red dashed line represents the 1:1 line, while the black solid line indicates the fitted regression line.

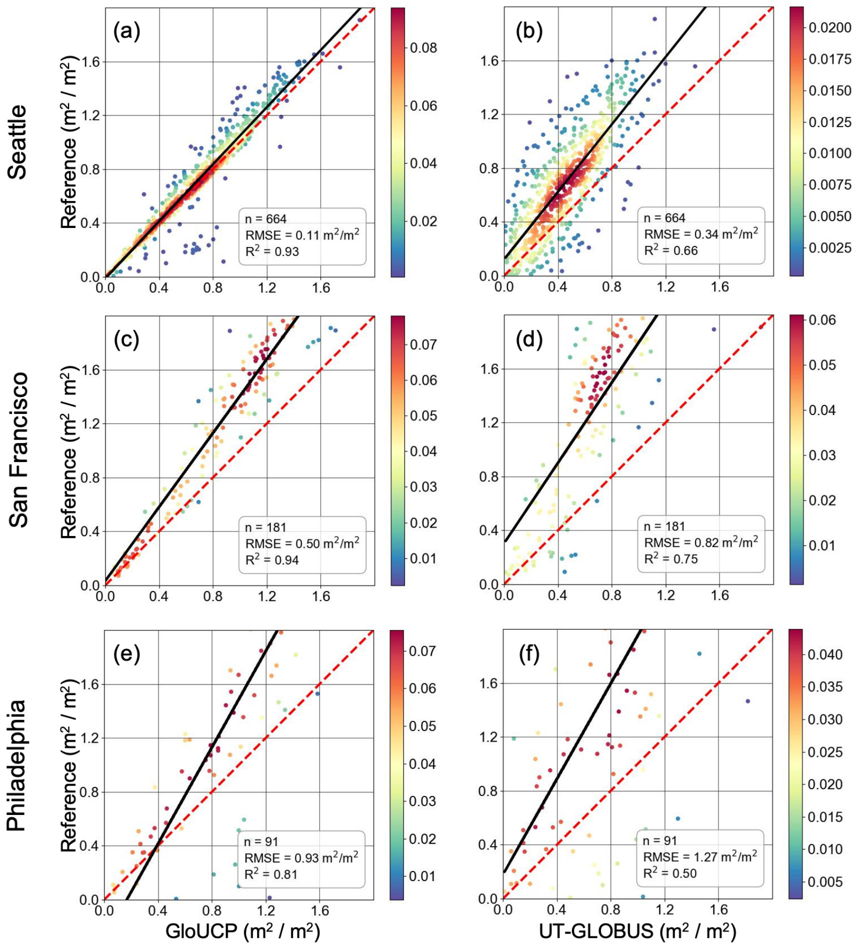

Figure S7. Pixel-scale comparison of building surface to plan area ratio between GloUCP and UT-GLOBUS across three representative cities in the United States. The red dashed line represents the 1:1 line, while the black solid line indicates the fitted regression line.

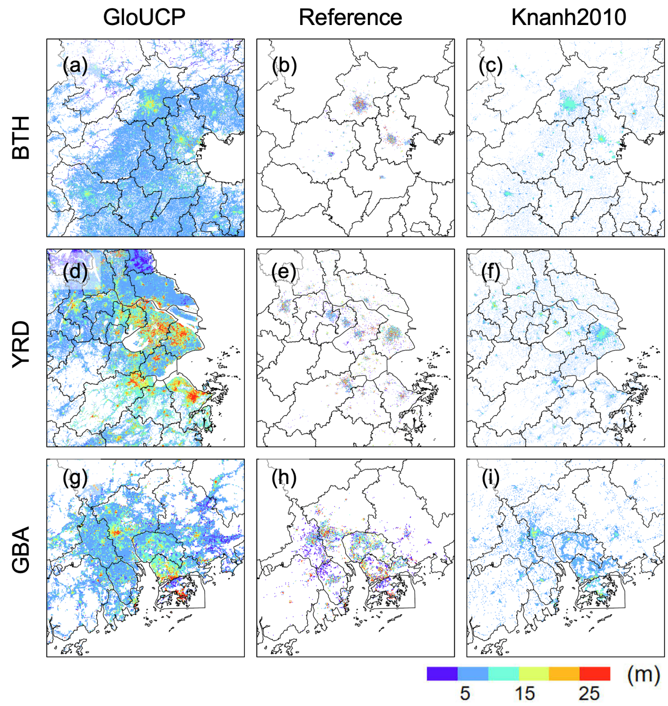

Figure S8. Comparison of the spatial distribution of mean building heights in GloUCP, reference data, and Knanh2010 across three major urban agglomerations in China.

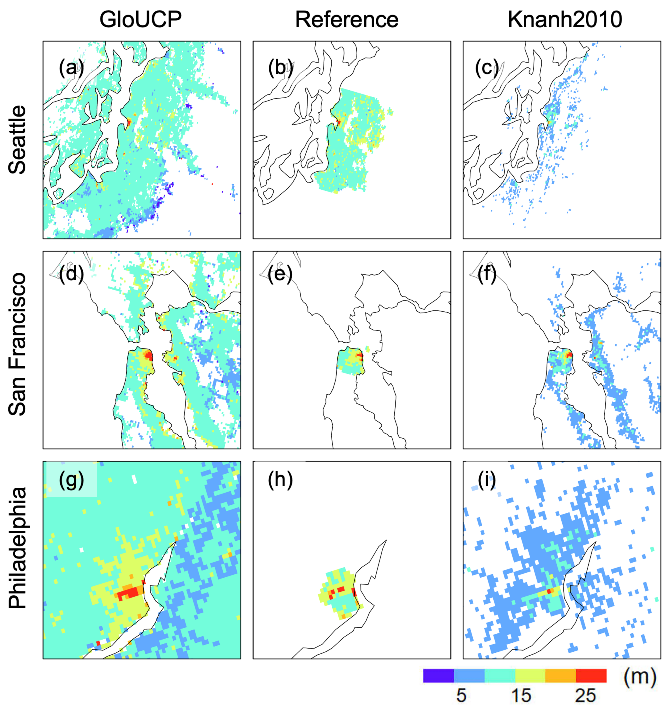

Figure S9. Comparison of the spatial distribution of mean building heights in GloUCP, reference data and Knanh2010 across three representative cities in the United States.

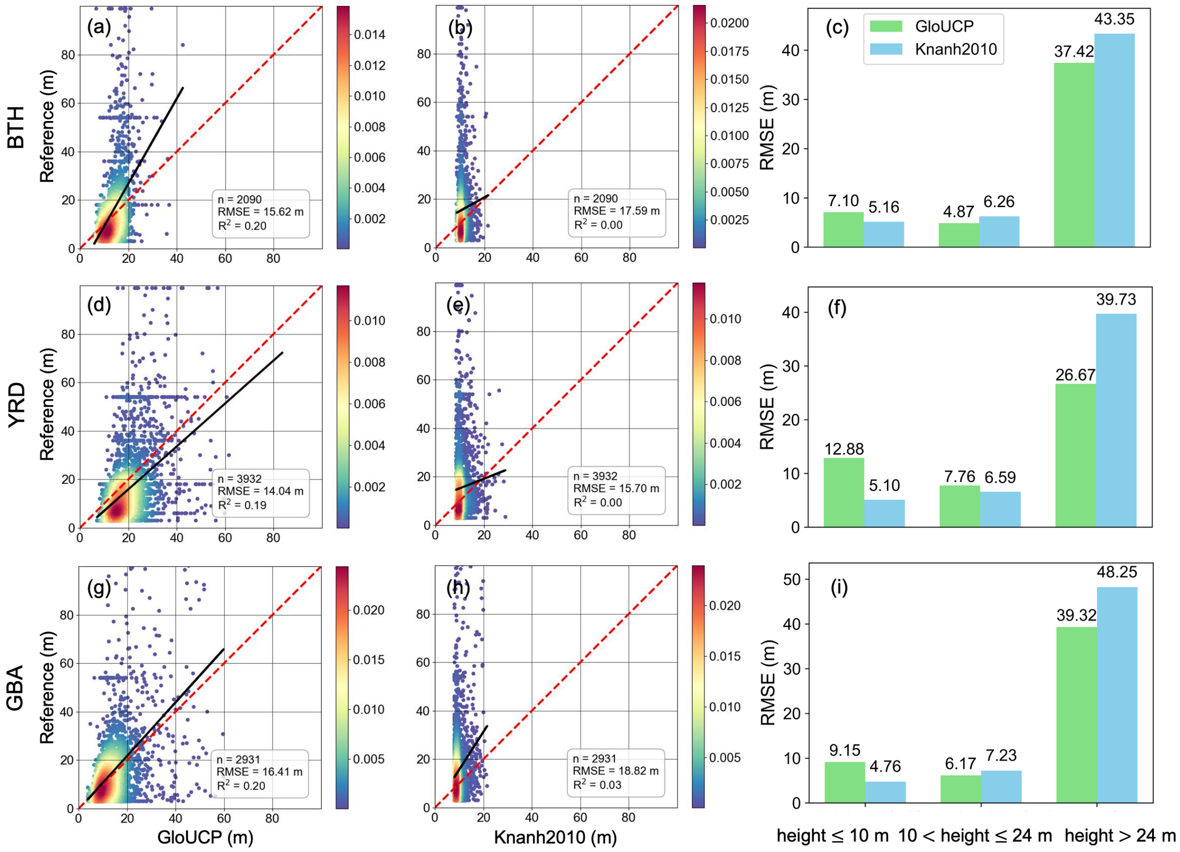

Figure S10. Pixel-scale comparison of mean building heights in GloUCP, reference data, and Knanh2010 across three major urban agglomerations in China. The red dashed line represents the 1:1 line, while the black solid line indicates the fitted regression line.

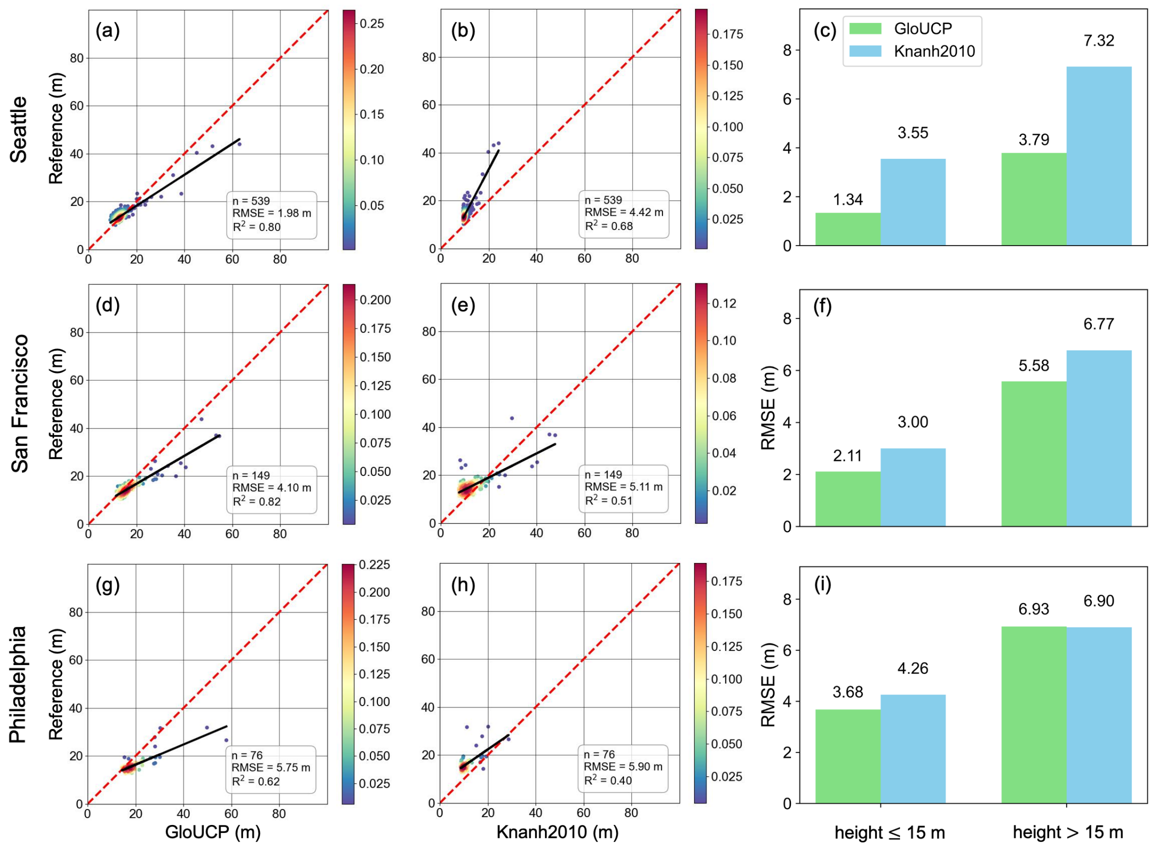

Figure S11. Pixel-scale comparison of mean building heights in GloUCP, reference data and Knanh2010 across three representative cities in the United States. The red dashed line represents the 1:1 line, while the black solid line indicates the fitted regression line.

Minor comment:

1. I think the authors developed data for both the single-layer urban canopy model (SLUCM) and the Multi-Layer UCM (BEP). If my understanding is correct, it would be better to describe this kind of information; otherwise, readers might misunderstand. If I understand correctly, a global dataset of the vertical distribution of building heights (for BEP and BEP+BEM) would be a novelty of this work.

Response: We thank the reviewer for this comment. Our dataset is indeed developed for both the single-layer urban canopy model (SLUCM) and the multi-layer UCM. In Table 1, we categorized and explained the parameters based on the requirements of the three types of UCMs in the WRF model: the single-layer urban canopy model (SLUCM), the Building Effect Parameterization (BEP), and the BEP-BEM (Building Energy Model). Additionally, we further emphasized in method and conclusion sections in the revised manuscript that our dataset provides parameters suitable for both the SLUCM and the multi-layer UCM.

"**These parameters include mean building height, standard deviation of building height, area weighted mean building height, plan area fraction, building surface to plan area ratio, frontal area index, and distribution of building heights, as detailed in Table 1. They can be applied to three types of UCMs in the WRF model: single-layer urban canopy model (SLUCM), building effect parameterization (BEP), and BEP-BEM (building energy model).**"

"**The primary purpose of GloUCP is to provide a global 1 km spatially continuous UCPs for three types of UCMs (i.e., SLUCM, BEP, and BEP-BEM) in the WRF model.**"

"**In this study, we developed a global 1 km spatially continuous UCP dataset — GloUCP, utilizing the latest available building-level information in 2020. It can be applied to all three types of UCMs (i.e., SLUCM, BEP, and BEP-BEM) in the WRF model.**"

Table 1. Calculation of GloUCP for the WRF model and the applied UCP schemes.

Variable	Abbreviation	Formula	Description	Used by UCM (URB_PARAM Index)
Mean building height	$\bar{h}$	$\bar{h} = \frac{1}{N}\sum_{i=1}^{N} h_i$	h_i is the height of building i; N is the total number of buildings in the grid;	SLUCM (92)
Standard deviation of building height	h_{std}	$h_{std} = \sqrt{\frac{\sum_{i=1}^{N}(h_i - \bar{h})}{N-1}}$		SLUCM (93)
Area weighted mean building height	h_{aw}	$h_{aw} = \frac{\sum_{i=1}^{N} A_i h_i}{\sum_{i=1}^{N} A_i}$	A_i is the plan area on the ground level of building i;	SLUCM, BEP, BEP-BEM (94)
Plan area fraction	λ_p	$\lambda_p = \frac{A_p}{A_T}$	A_p is the total footprint area of buildings in the grid; A_T is the total area of the grid;	SLUCM, BEP, BEP-BEM (91)
Building surface to plan area ratio	λ_b	$\lambda_p = \frac{A_R + A_W}{A_T}$	A_R is the total roof area of buildings in the grid; A_W is the total area of non-horizontal roughness elements (such as walls);	SLUCM, BEP, BEP-BEM (95)
Frontal area index	λ_f	$\lambda_f(\theta) = \frac{A_{proj}}{A_T}$	A_{proj} is the total projected area of buildings on a plane perpendicular to four wind directions (0°, 135°, 45°, 90°,); θ is the wind direction.	SLUCM (96-99)
Distribution of building heights	$h_{dis}(i)$	$h_{dis}(i) = \frac{N_{dis}(i)}{N} \times 100\%$	$N_{dis}(i)$ is the number of buildings vertically resolved with 5 m bins spanning 0-75 m.	BEP, BEP-BEM (118-132)

Notes: UCM, urban canopy model; SLUCM, single-layer urban canopy model; BEP, building effect parameterization; BEM, building energy model. The values in parentheses in the last column represent the index of the UCP in the URB_PARAM array.

2. It would be helpful for users if you added a table showing the relationship between the parameters in the dataset you developed and the parameters in URBPRAM.TBL in WRF-Urban.

Response: Following the reviewer's suggestion, we have added relevant content to Table 1 in the revised manuscript to explain the correspondence between the parameters we calculated and those in URBPARM.TBL.

3. I wonder about the correspondence between the parameters of the dataset developed this time and the categories of the global map of Global LCZ. Global LCZ is included in WRF and it is necessary to set geometric parameters etc. for each LCZ category in URBPRAM.TBL. I am therefore concerned about the above correspondence. Is the proposed dataset intended to set values for each WRF grid? Or is it intended to set values according to LCZ? It would be helpful to users if you could describe the author's thinking and recommended setting methods.

Response: We thank the reviewer for this comment. Our dataset is designed to set UCPs for each WRF grid. Currently, in the urban canopy model, urban can be classified either into three categories (i.e., low-density residential, high-density residential, and industrial/commercial), or using LCZ classifications. However, each urban type can only be assigned a single fixed set of UCP values. Actually, when the urban type of each grid is determined, our dataset can be used to reassign urban morphological parameters for each grid, thereby providing a more detailed and accurate depiction of urban morphological variations within the study areas. We have added a description of these modifications in Section 2.2 in the revised manuscript

"**Moreover, we have provided 1 km resolution impervious surface fraction data for urban areas in 2020 derived from the GAIA dataset as well. This allows users to conveniently define urban categories (i.e., low-density residential, high-density residential, and industrial/commercial) in WRF simulations based on the consistent impervious fraction data. Once the urban type of each grid is determined, our dataset can be used to reassign urban morphological parameters for each grid, thereby providing a more detailed and accurate depiction of urban morphological variations within the study areas.**"