Dear Referee #2,

Thank you for your decision and constructive comments on my manuscript. Our revision notes, point-to-point,are given as follows:

-Major comments:

1. While I admit a heterogeneous wind field may improve the simulation of meteorological processes (lines 68-71), but the authors only focus on the neutral atmospheric conditions (neither buoyancy nor thermodynamics is accounted for in their theoretical framework), so I am questioning the validity of using the IWSUS scheme to estimate the surface energy fluxes.

Response:

We quite agree with you. The vertical stability of the near ground atmosphere is indeed an important factor affecting the wind profile and the surface flux transport. But in this article, we mainly focus on how the spatial distribution of urban near-surface wind profiles change when the assumption of heterogeneous urban canopy structure is applied instead of the assumption of homogeneous underlying surface in the urban canopy model.

It should be emphasized here that the logarithmic-exponential vertical wind profile, which acts as the control group in the simulation comparison of this paper, is based on the assumption of horizontal homogeneous underlying surface. It was originally used to simulate the wind profile over the land surface of vegetation-soil type in the meso-scale models. Then it was later applied for the urban canopy land surface in the most current urban canopy models/ schemes, by modifying some key parameters, such as roughness length and zero plane displacement, to make it more coincide with the characteristics of the urban underlying surface.

Therefore, there is no need to explicitly consider the difference of the vertical wind profile in various vertical atmospheric stability conditions, such as buoyancy or thermodynamics atmospheric layer scenarios, in the log-exponential vertical wind profile model. Correspondingly, the IWSUS wind profile scheme obtained in our study, which is applied to replace the log-exponential profile scheme in the urban canopy model, have not further considering the effects of **buoyancy or thermodynamics** conditions though it is the quite important scientific issue.

Compared with the log-exponential profile scheme, the IWSUS scheme has many advantages: on the one hand, the mean wind profile and energy flux in the land surface grid in model by IWSUS are closer to the observation; on the other hand, the IWSUS scheme can obtain the wind profile for different types of locations in the street canyon. Instead of obtaining only the average wind profile in each land surface grid in model as the log-exponential profile.

2. I encourage the authors to provide more complete description in Section 2.2. In this case, I think the length of the building is also a relevant controlling parameter, while the authors vary the aspect ratio H/W, the shape of the building H/Lh is also different. I am wondering if it is reasonable to take AR as the sole controlling parameter in developing the IWSUS scheme.

Response:

I agree with you that the Height Length Ratio (HLR) of the building canopy may indeed affects the wind field distribution and urban land-surface flux. For example, in Figure 1b of the article, when the length of the street canyon tends to infinity, the wind speed profile of most areas in the street canyon should be close to those over points C and D, which represent the situations in the middle of the street valley. Thus the weights of these two points for calculate the average wind speed and flux in the urban grid points will be close to 1; On the contrary, when the HLR is small, the weights of points A, B, E and F in the figure will be larger. Therefore, HLR is a factor in the aerodynamic modeling in and over the urban canyon.

However, we note that most of the current urban canopy models, including Masson's TEB and WRF-UCM, do not introduce HLR as the main input parameter to describe the urban canopy geometry character. Only the building Height and street Wide Ratio (HWR) is usually used for this purpose. This performance is based on practical experience of model development: first, introducing more input parameters into a numerical model often results in greater complexity and the calculating instability. Secondly, according to our current work progress (but regrettably no published paper yet), the impact of HLR on urban canopy simulation results is not only far less than that of HWR, but also be more effective in the radiation energy balance. That's why we have not applied HLR into IWSUS in this study.

3. Equation 6 and Figures 8 and 9: I am curious why the wind profile within the urban canopy is uniformly distributed, shouldn't the exponential wind profile be a function of z?

Response:

Equation 6, 8 and 9 is from TEB model (Masson, 2000) , where U_{can} does not represent the variation of wind speed with height (Z) in the street canyon, but it is the value of wind speed at a specific height in the street canyon by TEB. The author believes that the U_{can} can well represent the average wind speed in the street canyon, which is modeled as infinite long valley with various orientations. This scheme is currently used in many earth system models, such as CLMU (Community Land Model, Urban module), we were easily to obtain the corresponding model code from CLMU and compare its simulation results with these by our IWSUS scheme. Therefore, we list the corresponding equations as Equations 6, 8 and 9 in this paper.

4. The authors didn't provide sufficient information on the boundary conditions and grid resolutions. Also, pls justify the use of such a small domain size. Given the building height H can be as much as 30m, I don't think a 50m domain height is large enough to carry out a convincing CFD simulation.

Response:

Thank you for your suggestion. This is indeed a point that is worth discussing in this article.

Firstly, the CFD simulation domain in this study $L_x \times L_y \times L_z$ was set as 200 m × 100 m × 50 m, with a grid resolution of 1 m. K and ε at the inflow boundary are calculated from $k = 1.5(I\overline{u_0})^2$ and $\varepsilon = C_\mu^{3/4} k^{3/2}/l$, where I is the turbulent intensity and l is the turbulent characteristic length scale. It is a widely used methods to set the initial boundary conditions in a street canyons CFD simulation that the ground and all walls are no-slip boundary conditions, and the other outer boundaries are zero-gradient boundary conditions. The introduces of the boundary conditions setting above will be added into the revised version of the manuscript.

Secondly, as you pointed out, it is uncommon to set a domain height of only 50 m in a scenario with building height of 30 m. In most of other similar simulations, the boundary in the vertical direction is often set to be more than 6 times the height of the building. Factually at the beginning of this study, we also tried to set as the common sense, but the results did not match our research needs:

In this study, the CFD numerical experiment is set up to generate the IWSUS wind profile scheme which will be mainly applied in the meso-scale atmospheric model. In the current meso-scale model (taking WRF as an example), the wind field at the lowest atmospheric layers is the input parameters for the land surface scheme (that is, the role position of IWSUS), and then to further calculate the wind profile near the ground. The height of the lowest free atmospheric layer is often set as about 1.5-2 times the average height of the land canopy, sometimes even just slightly higher than the average height of urban buildings.

Therefore, when we set the height of the upper boundary in CFD as the more common way, for example about 6 times the building height in our CFD model, the corresponding parameterized wind vertical profiles in IWSUS were not match the physics pictures of the mesoscale model in which the IWSUS is coupled into. On the contrary, when the height of the upper boundary in the CFD simulation domain is set to 50 m while the highest building height is 30 m, the results is more matched with the scenarios of the lowest layer of the free atmosphere and the urban canopy in the mesoscale model. This unusual setting better ensures the consistency between the CFD scenarios and the requirements in the mesoscale model. In addition, previous studies on

CFD simulation of street canyons(Martilli and Santiago, 2006; Santiago et al., 2006; Santiago et al., 2008; Yang and Shao, 2008; Cui et al., 2019; Sützl et al., 2021)also support the rationality of this initial setting method.

-Minor comments:

1. Section 2.1, line 85, "The CFD method was applied in study to analyzes", grammatical mistake.

Response: Thanks for pointing out the grammatical mistake. "analyzes" has been corrected to "analyse" in the next version of the manuscript.

2. Section 2.1, line 94, "p* is a modified mean kinematic pressure", grammatical mistake.

Response: Thanks for pointing out the grammatical mistake. "a" has been corrected to "the".

3. Section 2.3, lines 135 and 136, the initial letters should be capitalized.

Response: Thank you very much. The problem has been corrected.

4. Section 2.3, line 138, "Masson (Masson, 2000)", the literature is inappropriately cited.

Response: Thank you very much. The problem has been corrected.

5. Section 2.3, line 140, "In the exp-log wind profile scheme", some relevant references are needed.

Response: We are sorry for our unclear expression. The exp-log wind profile scheme here is the scheme developed by Masson as mentioned in the former part of this paragraph. We will improve our expression in a clearer way in the next version of the manuscript.

We are very grateful to referee for reviewing the paper so carefully. We have carefully considered the suggestion and tried our best to make the changes in the manuscript to improve it.

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[2] Martilli, A. and Santiago, J. L.: CFD simulation of airflow over a regular array of cubes. Part II: analysis of spatial average properties, Boundary-Layer Meteorology, 122, 635-654.https://doi.org/10.1007/s10546-006-9124-y, 2006.

[3] Masson, V.: A physically-based scheme for the urban energy budget in atmospheric models, Boundary-layer meteorology, 94, 357-397.https://doi.org/10.1023/A:1002463829265, 2000.

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[6] Sützl, B. S., Rooney, G. G., and van Reeuwijk, M.: Drag distribution in idealized heterogeneous urban environments, Boundary-Layer Meteorology, 178, 225-248, 2021.

[7] Yang, Y. and Shao, Y.: Numerical simulations of flow and pollution dispersion in urban atmospheric boundary layers, Environmental Modelling & Software, 23, 906-921.https://doi.org/10.1016/j.envsoft.2007.10.005, 2008.