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Discussions

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Interactive comment on "Impact of an improved WRF-urban canopy model on diurnal air temperature simulation over northern Taiwan" by C.-Y. Lin et al.

Anonymous Referee #1

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General Comments

The combined use of a gridded 2-D anthropogenic heat emission dataset and spatially varying urban fraction parameterization derived from a GIS creates a useful and original adaptation of the WRF Urban Canopy Model (UCM) for mesoscale modeling of the urban environment. The concept of a critical urban fraction is also a useful idea that appears to be original, as presented, and has potential for broader applications. The dataset of observed surface temperature is substantial and appears to be sufficient for validation of the new model (WRF-UCM2D) approach with respect to temperature. Both graphical and numerical results are presented in sufficient quantity and demon-

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strate the impact of the modifications to the WRF single-level canopy UCM. The figures and tables are of high quality and appropriate number; they sufficiently illustrate the key points of the manuscript. The writing is well-organized and the generally comprehensible throughout the manuscript. A few outstanding concerns remain (detailed below) that should be addressed.

Specific Comments

1. Resolved questions: The addition of Figure 2a elucidates the surface cover classification system used in the NLSMC dataset and sufficiently addresses the original concern. The added literature references are a helpful addition. Thank you also for color-coding the text changes.

2. The additional analysis conducted for the full-month of July, 2012 creates a more robust statistical result in the non-urban regions (Table 3). My original question (regarding the implications of using a single urban class) stemmed from a concern regarding test model performance in simulation of a real environment that is subject to variation over longer periods. As noted by the authors in Section 2.2(a), there are limitations to the ability of the UCM to simulate a real urban environment with varied structural shapes and vegetation cover. A full month should hopefully provide a sufficient test of the model's versatility in simulating a real environment subject to variation in observed quantities like near-surface wind, stability and surface moisture availability. As such, the robustness of the statistical results shown in Table 3 would be better supported if the reader were also shown how observed quantities varied over the corresponding model evaluation period. If these statistical results are shown to be robust over a wide range of ambient wind directions, for example, then some limitations of the single-urban-class approach may be seen as less significant. Please show a figure or statistics on how the observed quantities varied over the days evaluated in July, 2012 (wind speed and direction, temperature; it would also be helpful to know when the ground was saturated or if the sealed surface was wet). It was also mentioned that certain periods were excluded when rainfall occurred in the simulation [L 295]; could you please indicate how

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many days of July, 2012 were excluded? Was this one-month run executed from 01-31 July with a preceding 24-hr spin-up period as mentioned for the focus period in Section 3 [L 215-217]? Could you please also show the corresponding results (full-month analysis) for the urban stations as you've done for the non-urban stations in Table 3?

3. Thank you for providing the resolution of the GFS dataset used for initial and boundary conditions (L 143). One concern I have, particularly for the one-month simulation, is the drastic change in resolution between the boundary values and the parent domain (from around 50 km to 3 km). Are you applying some kind of relaxation zone at the lateral boundaries? Do the horizontal and vertical winds in grids 1 and 2 look realistic relative to available surface analyses or Reanalysis? I would suggest at least commenting on this and any potential impact in the manuscript.

4. When describing the features that affect urban climate [starting around L 69], please specifically define the urban heat island (UHI) in the manner in which you intend to identify and analyze it (e.g., difference in 2 m nocturnal minimum temperature at static locations, difference in lowest atmospheric level temperature over time averaged over pre-determined areas, etc.).

5. What does the diagnostic 2 m temperature [L 348] mean in the urban areas where surface roughness elements exceed this height? I believe in WRF these 2 m and 10 m diagnostic quantities are meant to reflect altitude above the displacement height and are calculated using Monin-Obukhov similarity theory (which is applicable at altitudes well above the height of any roughness elements), which would create a contradiction within the urban canopy. I would suggest using an alternative temperature measure for comparison between urban and non-urban areas.

Technical Corrections

1. The wording in the Abstract [L 30-32] was left unchanged. The second use of this sentence later on [L 89-91] was revised, but is still unclear. I understand the statement "such not only may lead to over- or underestimation [of AH]",and the revision "The

simplification ... underestimation", but I do not understand the meaning of the second part of the sentence ("the temperature difference between urban and non-urban areas has also been neglected") or its connection to the first part. Are both parts referring to AH? Are you implying that the default UCM treatment of AH may lead to local errors in both time (first part) and space (second part)? Or, in the second part, are you referring to the impact of spatially varying urbanized area on model estimation of temperature? I recommend re-writing this sentence (L 30-32 and L 89-91), perhaps dividing into more than one sentence if the topic covers both AH and urban fraction.

2. The term "model grid net" is used frequently, but I am not clear on what is meant by 'net'. Is this used as a synonym for 'mesh'? The term "model grid" works well also.

3. L 35: Please specify that your variable of interest is temperature

4. L 37: Please specify what 'R' is.

5. L 73: "...in their study on the urban boundary layer" OR "...in their study on urban boundary layers."

6. L 75: "...by implementing an urban canopy parameterization..."

7. L 104: What is meant by 'scale'? Population? Area?

8. L 116: Were you using WRF v3 or higher? Check for a later user guide reference (e.g., Skamarock 2008).

9. L 159-160: Sentence fragment – missing verb..."...categorized as rural are (?) totally neglected." I might suggest separating out this part after the comma into a new sentence.

10. L 215: 'till' - > 'until'

11. Section 3a: how is model air temperature derived? Is this the canyon air temperature estimated by the WRF UCM or the lowest temperature of the lowest model level above the urban canopy height (if so, please specify the level and the mean building

height for this class used in the UCM)?

12. Thank you for clarifying what makes a station 'urban' versus 'non-urban' [L 231-233]. The wording is slightly difficult to follow. May I suggest: "A station is categorized as 'urban' if its location in the inner-most model grid has an urban fraction greater than 0.5 and is categorized as 'non-urban' if the urban fraction is less than 0.4."

13. L 241: Please clarify what is meant by a "heat wave."

14. L 251: "A similar phenomenon. . ."

15. Figure 4: Could you add a third column showing the difference between WRF-UCM and WRF-UCM2D to make it easier to see the magnitude and location of the difference?

16. L 294: "a whole month simulation of July, 2012 was conducted" OR "whole month simulations of July, 2012 were conducted"

17. L 294: Omit 'further'

18. L 295: "the hourly data" – does this mean all model output? If so please clarify.

19. L 295: ". . . in case simulation rainfall occurred. . ." – this makes it sound like data was excluded as a preventative measure. In reality (?), you removed certain times/dates in post-processing where rainfall was present in the model solution, so I suggest this sentence should read something like: "Model data was excluded from analysis for all times where simulated rainfall was found to be present . . .."

20. L 296-297: Some confusion here due to wording – please re-write. To what are the results in Table 3 are similar? Of which 'conclusion' are you speaking?

21. L 341: 'focus' - > 'focuses'

22. L 350-351: How many points contribute to this average?

23. L 426: "exchange in the WRF-UCM2D simulation. . ."

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