

Referee 1:

This paper investigates the effect of urban areas on supercells using a semi-idealized approach. The main findings are that supercells weaken when passing over an urban area. Overall, the paper is interesting but I believe that the authors' are overselling their results and are misrepresenting previous studies in an attempt to validate their current findings.

- Addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>)
- "provides a benchmark" in the abstract has been removed.
- In the Conclusions lines 481-482 were edited.

The authors attribute their findings primarily to the presence of an urban dry island which reduces CAPE over the city. This is not a universal truth. There are many studies that have found that urban areas can increase CAPE. The driving factor for this difference is the overall synoptic pattern—dry conditions tend to lead to UDIs and a reduction in CAPE, while moist seasons can produce increased CAPE over urban area.

- Addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>)
- Lines 421-422 have been edited according to inputs coming from this comment.

1. I think the results are only valid for this specific environmental scenario. For example, it is easily seen in figures 13 & 14 that the largest perturbations to CAPE and upward motion are found 'downwind' of the city at 950 mb and the primary supercell in your simulations is not passing over that area. In an environment without a near surface easterly wind, this area of upward motion (and strongest SRH anomalies) would be to the east of the urban area. A storm passing over this may be amplified. A similar argument can be made for SRH. Perturbations in SRH appear to be due to obstacle flow around the urban area. These perturbations would be different with a different wind profile.

- Addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>)
- "provides a benchmark" in the abstract has been removed.
- In the Conclusions, lines 481-482 were edited.
- Caption of Fig. 16 has been edited.

2. UHI magnitude of 1.5 K, which the authors' state is in-line with a previous study (Hidalgo et al. 2010). However, that study is based on theoretical scaling arguments. The first line of that paper says that nighttime UHI magnitude can be as high as 5-8 K in European cities. The stated UHI value of 1.5 K seems to be what

they calculated the UHI to be for a specific urban breeze—they then stated that this breeze is close to that observed in a specific city on a specific day. My main point is that this value seems small. Naylor and Mulholland (2023) and Naylor et al. (2024) found that a stronger UHI was necessary to induce substantial modification.

References at line 335 have been added in according to our response of this comment (<https://doi.org/10.5194/egusphere-2026-815-AC1>)

3. How deep is the UHI in your simulations? Does the depth match observations?
Addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>).
4. There's a lot of emphasis on urban dry island. I would like to see more justification of the dry island assumption as well as the magnitude of the UDI, especially since several studies have noted that urban areas can increase CAPE. The authors are justifying the UDI magnitude with results from a single study (Meili et al. 2022), yet another study from the same journal shows that UDI and UMIs both occur with regularity (Huang and Song 2023). Other previous studies have noted (e.g., Huff and Changnon 1973) noted that urban modification to convection is most prominent during wetter summers. In addition, the reduction in CAPE noted by the authors is much greater than that observed by Rozoff et al. 2003 and Reames and Stensrud (2018). Reames and Stensrud also note that the reduction in CAPE is 'generally neutralized as the storm approaches', while Rozoff et al. noted an *increase* in CAPE near the urban center. How can you be confident that your observed reduction in CAPE is a reasonable representation of reality?

Addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>).

5. How is your methodology any more sophisticated than that of Naylor et al. 2024? You are performing idealized simulations similar to Naylor et al. 2024 with a simple circular city (I believe with horizontally homogeneous characteristics) but at a reduced horizontal and vertical resolution. I do not understand how the use of BEP makes the simulation more 'realistic'. Changing the BEP parameters such as urban fraction, building height, etc are simply modifying surface fields. For example, changing the building plan area fraction modifies the surface drag coefficient. These experiments seem conceptually similar to that of Naylor and Mulholland 2023 in which the surface roughness and skin temperature were altered.

Addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>).

6. Why is 1 km horizontal grid spacing appropriate for this study? It has been known for over 20 years that turbulence is not well resolved at this grid spacing and that that convection needs grid spacing of 250 m or less (e.g. Bryan et al. 2003).

The motivations for this choice are reported in the response and are partly included in the revised manuscript at lines 103-110.

7. Your input sounding has a rather sharp low level inversion. Is it possible that this inversion is preventing UHI air from entering the storm updraft? Have you ensured (via trajectory analysis) that urban area is being ingested by the storm updraft?
An answer to this concern is mentioned in the revised manuscript at lines 160-161 and addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>).
8. What is the integration depth for your UH calculation? In addition, have you looked at 0-1 km SRH in addition to 0-3 km SRH? How are you calculating CAPE? Are you using a surface-based parcel or a mixed layer? Are you calculating CAPE with temperature or are you using virtual temperature?
- Addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>).
 - CAPE has been substituted in the revised manuscript with Surface Based (SB) CAPE for clarity in the Method/Results sections.
 - We mention that we use virtual correction at line 159.
 - At lines 413-414 a reference to SRH 0-1 km has also been added.
9. Periodic boundary conditions are an interesting choice. Why not use open boundaries like other studies? The initial warm bubble creates a fast moving wave that propagates across the domain
Addressed in the response (<https://doi.org/10.5194/egusphere-2026-815-AC1>).

Referee 2:

1. 1) The plot of normalized mean UH (Figure 5) shows that the number of ensemble members changes across the different urban sizes. For Figure 5a there are 8 members for an urban diameter of 15 km and 7 members for an urban diameter of 60 km. Some urban diameters have as few as 5 members displayed on the plot. It is earlier stated that every experiment has eleven ensemble members, indicating that only some of the simulated supercells are actually reaching the urban area before they dissipate. This large variability in the number of the members that are used in the analysis is a significant concern. This variability influences the

calculations of ensemble mean UH from the urban runs (Figures 6b-f) which show large fluctuations from the beginning of the storm track and could be due in part to having fewer members. It also will influence the calculations of mean slope shown in Table 9. The no_urban ensemble has the most consistent mean UH track of the ensembles; other tracks show greater variation in mean UH along the track. If roughly half the supercells are dissipating before reaching the city within such a favorable environment, then this behavior raises questions about the experimental design. For example, Figure 7 shows that the developing supercell dissipates entirely before reaching the city (and doesn't appear to produce a left-moving storm) while Figure 10 shows only small differences in environmental conditions in this area of storm demise that is well outside the zone of perturbations associated with the urban areas shown in Figures 12-15. It is important to understand what is causing so many storms to dissipate within such a favorable environment prior to reaching the city, as this behavior clearly influences (and indeed may dominate) your results.

This comment has been addressed extensively in the response (<https://doi.org/10.5194/egusphere-2026-815-AC2>). In the main manuscript, additional discussion has been included in lines 340–347. Figure S9 has also been added to the Supplementary Material and includes the plots shown in the response to the referee.

2. Your results show that many supercell characteristics decrease as city size increases, but the results also have large spread and some members intensify as city size increases. A deeper dive is needed to understand this behavior. Results shown in the supplemental materials indicate that the supercell tracks from the ensemble members deviate from each other sufficiently to pass over different parts of the urban area in the no_urban run. Similar tracks are expected for the urban runs, such that some storms may pass along the southern urban edge, while others may pass along the northern urban edge. Results from Reeves and Stensrud (2018) indicate that the impact of the urban area on the supercell is influenced by the location of the urban area relative to the storm. Since the figures of normalized UH as a function of urban area size show both enhanced UH and reduced UH, the question of where the urban area is located relative to the storms for these simulations is important to address. One way to explore this question is to look at a few of the members with the largest normalized UH and compare with the same number of members with the lowest normalized UH for a fixed urban size. Plot the tracks, explore the supercell characteristics, and determine if these storms are passing consistently across different parts of the urban area.

This comment has been addressed extensively in the response (<https://doi.org/10.5194/egusphere-2026-815-AC2>) . A footnote has been incorporated into the main text (lines 269–270), and a sentence has been added at lines 224-225 to answer these concerns.

3. The control no_urban ensemble plot of cumulative ensemble mean UH (Figure 6a) shows a lowering/break of mean UH over the city location that is specified. This suggests that the simulated supercells are undergoing some transition at this point. Thus, all the supercell storms likely all pass over the urban area at a time when the storm behavior in the control ensemble is arguably most sensitive to the environment, as the storm is in transition. This needs to be mentioned and discussed, as it could influence the results.

Footnote 4 at pag. 16 has been added to mention this potential issue.

4. The simulated sounding at storm initiation (4 pm LST) shows that the surface winds are quite weak at this time (Figure 1b). This will greatly reduce the impact of friction owing to buildings on the flow. This deserves greater attention in the discussion.

This aspect has been emphasized in the Discussion at lines 461-462.

5. It is also important to mention that the no_urban run shows SBCAPE, 0-3 SRH, and 0-1 SRH all decreasing by storm initiation time. Thus, the supercells are moving into a less favorable environment as they approach the city, which could influence your results.

This aspect is mentioned at lines 154-156 in the revised manuscript.

6a. Soil moisture in urban and cropland regions.

This information has been added at line 96.

6b. Depth used in UH calculation (2-5 km AGL?)

Reported in Table 9.

6c. How mean UH is calculated (over what area? How determined?)

The area considered is the circle with 8 km radius around the storm center (line 228).

6d. Multiple figures show comparisons without a time stamp (Figures 11-14).

Addressed in Figures 11 and 12.

7. You state on lines 100-101 “the most accurate parameterization of urban processes in mesoscale modeling.” This is an opinion, unless you have a reference to a study that clearly shows this. Please delete.

Removed.