This manuscript investigates the performance, and sensitivity to horizontal grid spacing, of the ultra-high-resolution dispersion model CAIRDIO in simulating black carbon and particular matter concentrations over a 2-day period in Leipzig. This study addresses an important topic, is well written and makes use of a solid methodological approach. The comparison with observational data is sound, albeit a bit limited in time to make strong conclusions that the CAIRDIO model performs substantially better than the meso-scale model. Overall, I think the manuscript is good and the authors clearly mention limitations of the current study. However, I still have a few comments:

Major comments

1. Considering the sensitivity of BC and PM concentrations to the near-surface meteorological conditions (i.e. 10-m wind speed, 2-m temperature), I would expect to see a short evaluation of the performance of the CAIRDIO and COSMO models for these variables (can be added as supplementary material). Such an evaluation will allow the reader to have confidence in the ability of the CAIRDIO and COSMO models to correctly predict the near-surface atmospheric forcing and consequently the BC and PM concentrations. Moreover, it could also enhance discussion/explanation of model results for the selected stations.

2. It is still not clear how the hybrid boundary approach at the model top for domain L0 treats the transport of TKE and the other variables. Is there inflow from the model top based on the forcing from the larger-scale COSMO model (i.e. vertical transport of Theta or TKE)? It would be beneficial to further elaborate on this, either in the methodology section or in the appendix. On a same topic have the authors tested the impact of different heights for the domain model top on the model performance?

3. How accurate is the use of surface temperatures from the meso-scale model for the L0 domain? Although the surface temperatures from Figure 7 seems to be okay, from a qualitative perspective, they might not be accurate as surface temperatures very much depend on the atmospheric stability and the surface energy balance. In the CAIRDIO model atmospheric stability and turbulence will be different than in the meso-scale model,
and thus surface temperature and moisture may be different. This can adversely impact the near-surface turbulent transport and thus the simulated concentrations of BC and PM. I think it would be appropriate to include a discussion on this limitation, and in the future include a land-surface parametrization to compute the surface energy balance, temperature and moisture in the CAIRDIO dispersion model rather than downscaling the surface fields from the meso-scale model.

4. In Figure 9d, the boundary-layer height seems rather low during the second day of the case study period, considering also the value of the Richardson number (< -1). Have the authors evaluated the performance of the COSMO model in simulating the boundary-layer height for this period. Such an evaluation can be very beneficial as it can help with the discussion of the simulated BC and PM values.

5. How does the CAIRDIO model ensure that turbulence is generated in the domain during the model initialization? Does the model perturb the input fields (i.e., wind speed) to fast generate turbulence in the domain or is this done using the subgrid-scale TKE from the COSMO model.

Minor comments:

1. It might be better to plot the vertical y-axis without the log-scale in figure 14 (and in some other figures), as the log-scale can mask height differences, making it difficult for the reader to distinguish differences in the profiles.

2. How does the CAIRDIO model treat the intra-urban vegetation? Are trees represented as diffused obstacles as well?

3. It would be nice to include the root-mean-squared error (RMSE) in Table 3.

4. There are some errors in Figure 14 labels (u wind labels are (a,i) in the figure but are referenced in the caption (a,j)). Please adjust.

5. In Figure 14 it would be nice to include the vertical profile of the heat flux as well.

6. It might be preferable to change the word "grid resolution" to "grid spacing" in the manuscript as the actual horizontal resolution is larger than the grid cell size.