We are pleased to hear that our responses to the comments of the two reviewers have been satisfying. We would also like to thank the editor for the additional comment that helped us clarify the specific new challenges and the methods needed for the gigacity area. Our detailed responses are given in blue below. The page and line numbers are referring to the "track changes" -version of the revised manuscript.

Comments from the editor:
Your Opinion has been well received by two reviewers and I am satisfied with your responses, which have clarified some details and expanded the discussion to include some wider considerations.

We would like to thank the editor and the reviewers for their kind words.

I would like to add one more point for you to take account of before acceptance. You make a strong point that modelling needs to consider all scales. What is not clear is why this is particularly the case for a Megacity environment. The handling of sub-grid-scale phenomena has been at the heart of large-scale model development since the first models were developed. Almost all key processes in large-scale models are described using sub-grid parameterizations, such as clouds, radiation and turbulence. I find it a somewhat 'lazy' assertion that we need to consider sub-grid-scale processes in relation to Megacities. I also find that your Opinion does not adequately address how that should be done and what the specific challenges are. Ultimately it will require parameterizations, which has been the focus of probably 90% of model development for several decades. So the onus is on you in the Opinion to spell out more clearly what the specific new challenges are.

Recent studies have shown that the impact of anthropogenic processes, such as those related to air pollution, are not well described in the larger scale models by the current parameterizations. Therefore, there are notable biases e.g. in the prediction of free-tropospheric air temperature in the gigacity region. In addition, there are most likely interaction between the different megacity clusters within the gigacity, and therefore we need to study the interactions of the local-scale phenomena with the larger scale circulation and boundary layer dynamics. We added some more explanation to clarify this in the text (P4 L118-125):

"Many recent studies (e.g. Huang et al., 2018) have demonstrated that the impact of anthropogenic processes, such as those related to air pollution, have not been included in the nowadays weather forecast models. As a result, these models show notable biases in the prediction of free-tropospheric air temperature in the gigacity region. In fact, in the gigacity region, anthropogenic aerosols (e.g. black carbon) could significantly influence the development of PBL via not only the reduction of surface solar radiation but also its "dome effect" by heating the upper-PBL (Ding et al., 2016; Wang et al., 2018). In addition, aerosol-PBL feedback could also occur at the gigacity scale by amplifying the transboundary transport of haze, including secondary pollutants, between different megacity clusters, such as the Yangtze River Delta and the Beijing-Tianjin-Hebei Area (Huang et al., 2020)."

In addition, some of the processes might be unique to the gigacity region and therefore are not well described in the current models and their parameterizations. Therefore, we need

comprehensive observations with high enough spatial coverage and concurrent fully-coupled models in all scales, so that we could characterize the complex processes and their interactions in different scales. We have now clarified this in the revised text (P6 L157-160):

“Currently, detailed studies within the gigacity are typically covering the few different phenomena, such as weather forecast, urbanization or air quality, as separate issues. As mentioned above, in gigacity areas human activities could influence the climate system all the way from the nanoscale to the global scale.”

And (P6 L169-179):

“Therefore, we need comprehensive observations and high-resolution fully-coupled models to accurately describe the molecular-scale chemistry, microphysics of aerosol-cloud-interaction, and the multi-scale processes of aerosol-PBL-weather feedback at the gigacity and even global scale. The spatial coverage of observations and the model resolution needs to be high enough to well characterize the complexity of emissions and chemistry, land-surface processes, and their interaction with the PBL meteorology. We also need to understand aerosol physics and atmospheric chemistry in molecular and nm scales, as the majority of particle number and mass concentrations, as well as ozone, is caused by secondary processes taking place in the atmosphere (e.g. Kulmala et al., 2021). To understand such secondary processes, we need proper observations and process level models – including quantum chemistry (e.g. Kulmala et al., 2021). Since some of the processes might be unique to the gigacity area, and possibly still unknown, we need comprehensive observations and concurrent models that cover different regions of the gigacity (Kulmala 2015, 2018), in order to characterize different processes and their interactions and to force the models and validate the results.”

Also, some smaller changes have been made to make the text more compatible with the revised version (P5 L130, P5 L153-155, P6 L164-167)