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Comment on acp-2022-705

Anonymous Referee #1

Referee comment on "Contribution of regional aerosol nucleation to low-level CCN in an Amazonian deep convective environment: results from a regionally nested global model" by Xuemei Wang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-705-RC1, 2022

Review ACP-2022-705

Contribution of regional aerosol nucleation to low-level CCN in an Amazonian deep convective environment: Results from a regionally nested global model, by Xuemei Wang et al.

General Comment:

This well-designed study aims to investigate the new particle formation related to the deep convection transport and the horizontal advection from neighbors' regions by using the HadGEM3 climate model nest with a regional domain over Amazonia. Combining high resolution with resolved convection with the GLOMAP-mode aerosol scheme and the global model with raw resolution allows for testing different hypotheses. The findings are interesting and corroborate empirical data from the ACRIDICON-CHUVA experiment. Furthermore, results allow discriminating of the regional/deep convection and the long-range transport contribution to the aerosol profile in Amazonas.

I would recommend the authors revise the new literature on this subject; for instance, the three recent studies from Bardakov et al. on Tellus, JGR, and James (https://doi.org/10.1080/16000889.2021.1979856, https://doi.org/10.1029/2022JD037265, and https://doi.org/10.1029/2019MS001931). These studies, using large eddy simulation, were able to present and quantify the convective transport, chemical reactions, and new particle formation in detail. As these models with 100 m resolution are much more appropriate to describe the updrafts and downdrafts, these studies provide a detailed description of the aerosol-deep convection interaction. I recommend authors read/refer to these studies and consider what is new in the present study. Another comment is related to the deep convection described by the

regional model; convection is too deep, deeper than observed. The typical height of deep convective cloud in this region, at this season, is around 9 km (observed by radar – rain drops) and 14 km of cloud top (lidar). Therefore, 20 km, as shown in the figures, is out of the reality of the convective system. It is higher than tropopause (around 16 km). In addition, the looping simulations show the accumulation and Aitkens mode moving westerly, so above tropopause flow. How do these particles penetrate the stratosphere? Are these features real? The conceptual model presented in the conclusions shows the maximum height as 12 km, well below the layer shown in the results.

The regional model shows an increase of around 100% in the nucleation particle concentration in the lower levels. This is not well discussed in the manuscript. From where do these particles come? Are these particles formed in the boundary layer by monoterpenes oxidation?

I am curious to know the concentrations of Monoterpenes and Ozone employed in the simulations and how they compare with the data measured at ATTO. Finally, the simulations BioOxEmCCS used in the main simulations showed a peak well above the measured in ACRIDICON-CHUVA (12 km, against 14 km) and with much less middle levels concentration (around twice). What is the effect of these differences in the results?

Minors comments:

- Line 155 - Discuss the limitations of 4 km resolution in representing the deep convective processes and the grey zone issues.
- Line 210 – Please specify the profiles of gas assimilated and explain if they are fixed, or the chemical processes consume them. Convection brings ozone into the boundary layer, as mentioned in the text. Why does this process not modulate ozone concentration in the boundary layer? Isoprene has around ten times more concentration than monoterpenes. Why is isoprene not included in the chemical process?
- Line 235 – The average maximum rain rate seems very high (118 mm/hr). Convection in the model usually occurs at 1100 LST and rainfall at 1300 LST. However, convection in Central Amazonas occurs later, and precipitation occurs around 1600 LST. Please comment on how do this early convection impact the results?
- Line 255 – "We do not increase the oxidation rates because they will drive the simulations away from the observations by producing too few aerosols in the UT". Should this effect happen because isoprene has not been considered in the simulation? When enough oxidation is available, I see no reason for the isoprene not to be considered.
- Line 410 – Figure 10 legends are wrong – (NPF altitude range /km);
- Line 520 – Figure 11, The vertical motion inside the clouds appears very low to be the core of deep convection.
- Line 591 – Figure 14 – the conceptual model is unclear to me. In real life, there is no regional and large-scale domain. What is observed is the combination of both effects. Is it realistic to show the bimodal Aitken concentration upwind followed by a monomodal downwind? We always have clouds and downdrafts along the path. In addition, we also see the bimodal for nucleation in the regional model simulations; why is it not

represented?