

Atmos. Chem. Phys. Discuss., referee comment RC1
<https://doi.org/10.5194/acp-2021-221-RC1>, 2021
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Comment on acp-2021-221

Anonymous Referee #1

Referee comment on "Aitken mode particles as CCN in aerosol- and updraft-sensitive regimes of cloud droplet formation" by Mira L. Pöhlker et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-221-RC1>, 2021

This manuscript investigates the contribution of Aitken mode particles to cloud droplet formation, and the sensitivity of this contribution to the main influencing factors. The study is based on a large set of simulations made using an adiabatic cloud parcel model. While the used approach itself it by no means novel, the simulations conducted here and their interpretation clearly adds new insight into the topic of cloud droplet activation. I therefore consider this paper original enough for publication. The conducted study is scientifically sound, and there no apparent errors in methods or interpretation of results. I recommend accepting this paper for publication after the authors have addressed the few comments outlined below.

Main issues

Discussion of the results of simulations is quite detailed and requires, in many places, a lot of attention from a reader. While I accept this feature in general, there is one specific place that need to be modified: Figure 3. This figure (especially panes b and c) is way too complicated, with multiple axes and legends that are difficult to digest. I would strongly recommend simplifying this figure, or even splitting it into 2 parts. The text discussing this figure might also be worth simplification.

Mathematically, two modes in a particle number size distribution overlap each other because a log-normal mode a tail that continues for infinity. In the cases simulated in this work, the overlapping region is a notable fraction of the overall particle population, as the two modes are centered relatively close to each other. As a result, some Aitken mode particles are always larger (and thereby activate easier to cloud droplets) than some accumulation mode particles. In reality, this mathematical feature might be acceptable if the two modes represented different sources and thereby had potentially very different chemical composition. But this feature is highly questionable in aged air masses, like in cloud-processed air where all particle to the right of the Hoppel minimum should be counted as accumulation mode particle and those left to it as Aitken mode particles. The

authors should bring up this issue and discuss it shortly in the paper. My main concern here is that does this upper tail of the Aitken mode (or the part of the tail that in reality should be called as accumulation mode particles) influence notably the estimated contribution of Aitken mode particles the cloud droplet population (this might be important as the criterion for notable contribution here is that 5% of cloud droplets originate from the Aitken mode, see Figure 7).

Minor issues:

line 188: It can be concluded that...

Figure 7: The labels of the panels (a, b, c and d) are missing from this figure.