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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol particle formation in the upper residual layer" *by* Janne Lampilahti et al.

Anonymous Referee #1

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The manuscript is well written and easy to follow. There are two main drawbacks to this paper. 1) it is lacking the substance. More case studies, with detected start and end times and particle growth rates, are needed. 2) the paper does not acknowledge previous studies on the topic and brings little new scientific insight into the topic of residual layer nucleation events. For example, the discussion regarding the residual layer nucleation particle growth after the entrainment in the mixed layer is limited to a schematic drawing. However, I still think this paper might be of scientific interest. I, therefore, would recommend accepting this paper for publication after the authors have addressed the following issues.

Introduction

A number of previous studies, i.e., Nilsson et al. (2001), Stratmann et al. (2003),

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Discussion paper

Stanier et al. (2004); (Wehner et al., 2007), and (Platis et al., 2016) suggested that enhanced turbulent mixing, related to the growth of daytime convective boundary layer and the lift of the inversion could cause downward mixing of the particles, which had already grown in size. In addition, there have been several recent studies that point out direct evidence for NPF occurring aloft, in the interface between the shallow convection and inversion (Chen et al., 2018; Größ et al., 2018). By using turbulence statistics and the boundary layer dynamics (Meskhidze et al., 2019) and (Zimmerman et al., 2020) quantified the frequency of the residual layer and the ground level nucleation events and assessed their contributions (relative to other sources) to the near-surface fine particle number budgets during different seasons. The authors don't seem to acknowledge many of these studies. That leaves the impression that the residual layer nucleation and the particle entrainment into the mixed layer is a novel mechanism for explaining the appearance of >10 nm-sized particles at the near-surface layer. I would encourage the authors to clearly discuss how their research builds upon these prior studies and highlight the similarities.

Results and discussion

The airplane flight profiles seem to be different between Fig. 3 and Fig. 4. Are these two different profiles? If so, please explain.

Fig. 4 shows that the negative flux was measured at the surface starting at 9:30 am. However, according to Fig. 3, there was no significant vertical gradient between the surface and the 1000 m. Please explain the presence of strongly negative fluxes between 9:30 am and 12:30 pm. According to Fig. 4, a new 10 nm particle mode only appeared at the ground-level at ∼12:35 pm. So, what causes negative fluxes in the morning?

Please include several more case studies so the reader can compare the similarities and contrast the differences. For each case study please show the normalized spectral density plots so the reader can ascertain that there was indeed a growth event following

the appearance of >10 nm-sized particles at the near-surface layer.

Please include the flux values for each of the 8 cases shown in Fig. 8. Since the DMPS was running at the ground site, it would be interesting to know the detected start and the end time of the events, as well as the growth rate for different size particles.

Fig. 8 shows 6-hour differences between the times when the mixed layer reaches the top of the residual layer. Please provide an explanation based on the full analysis of the meteorological data.

Please compare the monthly fractions of new particle formation events (Fig. 9) in Hyytiälä with the data reported in other studies discussed above.

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