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Comment on acp-2022-338

Anonymous Referee #1

Referee comment on "Seasonal significance of new particle formation impacts on cloud condensation nuclei at a mountaintop location" by Noah S. Hirshorn et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-338-RC1, 2022

This work reports 15 years of direct measurements of aerosol number size distribution and CCN concentrations at a remote mountaintop observatory. The combination of simultaneous measurements allows to investigate long-term impact of new particle formation events on CCN budget. It is a complex and extended dataset and the results will fit with the scope of ACP, being of interest for the international research community. However, I recommend to improve and correct some issues before it is published in ACP.

Major comments

- I suggest the authors to improve methodology section (specific comments below). Specially, it is not clear how the authors account the contribution of NPF to CCN, and only the timing of the events is presented.
- This manuscript presents a new methodology to classify NPF events, however it has been only applied at SPL site and validation, success ratio and/or comparison with other methods in detail are not provided. Despite it is a visual classification and can lead to human biases, Dal Maso et al 2005 has been used for years as an standardized method to classify NPF events. This methodology is presented as new, however it is based on Dal Maso et al methodology. Why not comparing results in deep? This is not the first automatic method in the literature (e.g. Su et al., 2022) and no comparison, benefits or improvements are shown. Finally, the authors don’t provide the procedure to calculate the GR, the formation rate is calculated with a formula that is simplified (and not correct), the diffusion coefficient is assumed to be 0.077 cm2 s-1 (this factor depends on the temperature and pressure, how representative is for SPL?) and the factor beta is also considered to be unity (why?). Kulmala et al 2012 provided guidelines to compare different NPF studies.
- When talking about the impact of NPF to CCN concentrations, this method is not well

explained and further explanations are needed. In addition, this method does not show clear advantages with those previously presented in the literature and I suggest the authors to look in deep some of the issues discussed in previous works (e.g. Dameto de España et al., 2017; Rejano et al., 2021; Rose et al., 2017). 1) We can assume that all the particles >100nm will act as CCN, however not all particles below 100nm come from NPF events, so you can explore some subtracting method to account for that? 2) SPL is a mountain site, the difference between event and non-event days will probably be affected by the transport from lower altitudes, I suggest to add some results/discussion about free troposphere conditions, influence from boundary layer, and the differences during event and non-event days. 3) Free troposphere conditions will probably reduce the number of NPF events, and boundary layer conditions will lead to higher event frequency, why not using same atmospheric conditions to subtract the effect from lower sizes? 4) SMPS measures from 8 to 340 nm, if above 100nm we have the largest contribution to CCN concentrations, which errors have the increase factors that you present here?

- The abstract doesn't provide new findings. 1) NPF occurs 50% of all days (if you use a new method to classify NPF events and you compare results with previous methods, it could be a highlight); 2) Events with persistent growth are common in spring and winter; 3) NPF enhances CCN by a factor 1.36, that combined with previous work at SPL, suggests the enhancement of CCN?. These three new findings pointed in the abstract could be results of a measurement report (not for a research paper). The results 1) and 2) have been already reported previously by Hallar et al. 2011.

Minor comments

L24-70 – There is a lack of references that have previously investigated the impact of NPF on CCN concentrations, some of them on mountain sites and combining PNSD and CCN and/or using monodisperse (e.g., Kalkavouras et al., 2019; Dameto de España et al., 2017; Kalkavouras et al., 2019; Kalivitis et al. 2015; Kecorius et al. 2019; Rejano et al., 2021; Rose et al. 2017) and some NPF studies in mountain sites.

L91-99 – CPC model? Do you routinely calibrate the instrumentation? Please, include both information.

L104, L107, 108 – These references are mainly based on the methodology presented by Dal Maso et al. (2005).

Figure 1 – "Is the average concentration below 25 nm above the 10th percentile of all data?" What means? All data serie, 10th percentile of total particle concentration of that 5min data, daily concentrations?

L127-136 – The Gaussians are calculated following the equation 1, however, I can not see the diameter parameter. Are you using lognormal distribution? The time index, where is that index? “k” is the maximum aerosol number concentration” for each of the modes I guess?. Please check some references as Huusein et al. 2008 (equations) or Hussein et al. 2005 (DO-FIT algorithm) and rewrite this explanation, difficult to understand which fit method are you applying. In addition, 5 different maximum points? 5 different Gaussians? why that number?

Figure 2 – specify what the black lines indicate (and red ones).

Figure 3 – the authors identify the bottom figure as a weak event, why? There is no new mode appearing below 25 nmor growing.

Figure 4 – please use log-scale (or log-log)

References

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