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Comment on acp-2022-476

Anonymous Referee #1

Referee comment on "Survival probability of new atmospheric particles: closure between theory and measurements from 1.4 to 100□nm" by Runlong Cai et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-476-RC1, 2022

Survival probability of atmospheric new particles: closure between theory and measurements from 1.4 to 100 nm

Runlong Cai et al.

This paper presents nice closure results of the survival probability of freshly nucleated particles calculated from different approaches and its sensitivity to the measurement or derived parameters. This is an excellent piece of work and should be published in ACP.

The measured and theoretical survival probabilities are indeed sensitive to associated uncertainties and environmental variations. Authors discuss the implications on particle survival probability in measurements and models and the challenges to retrieve some of the parameters. What is the uncertainty range in particle survival probability associated with uncertainties in measurements and simulations? Can such a range of uncertainties be derived, e.g., from Figure 7?

Authors cite a limited number of studies reporting the measured survival probabilities retrieved from aerosol size distributions (Page 2, Lines 50-53). Undoubtedly, the major limitation is validating the estimated survival probability for specific particle size (>1 nm) as it is not possible to track individual particles in the atmosphere and therefore their survival probabilities. Given this limitation, authors should consider referring to other methods/studies based on measurements and modelling approaches (typically different environments and therefore aerosol size distribution properties) such as Westervelt et al., 2013, Zhu et al., 2020; Sebastian et al., 2021; Pierce et al., 2014, etc., and survival

probabilities for same particle size could be compared, discussed, and tabulated, which would make the reader easier to visualize.

The regional NPF occurs in relatively homogenous air mass (the one shown in Fig 1a seems to have occurred in homogeneous air mass and can be checked by calculating air mass backward trajectories at each hour (0 to 24) for that day) so that atmospheric inhomogeneity can be avoided for NPF events to reduce underlying uncertainties. Any recommendation on how uncertainties arise from traffic emissions and other sources may be reduced/corrected?

There are typos, not all but the critical ones can be taken care of. I list here a few of them

Page 2, Line 40: I feel it should read as "is an important irreplaceable parameter"

Page 2, Line 60: add "on" between "based" and "other parameters"

Page 3, Line 64: add "to" between "be equal" and "the ratio"

Page 8, Line 192: using "the" appearance time method

Page 4 and 8: "time-and-size-dependent", it should be "time- and size-dependent", or correct as appropriate throughout the text

Figure 7 caption: correct as "using the condensation sink (CS) "of" the sulfuric acid"

References

Pierce, J. R., D. M. Westervelt, S. A. Atwood, E. A. Barnes, and W. R. Leaitch (2014), New-particle formation, growth and climate-relevant particle production in Egbert, Canada: analysis from 1 year of size-distribution observations, *Atmos. Chem. Phys.*, *14*(16), 8647-8663.

Sebastian, et al., New particle formation and growth to climate-relevant aerosols at a background remote site in the Western Himalaya. *Journal of Geophysical Research: Atmospheres*, 126, e2020JD033267, 2021

Westervelt et al., Formation and growth of nucleated particles into cloud condensation nuclei: model–measurement comparison, *Atmos. Chem. Phys.*, *13*(15), 7645-7663, 2013.

Zhu, et al., Increased new particle yields with largely decreased probability of survival to CCN size at the summit of Mt. Tai under reduced SO_2 emissions, Atmos. Chem. Phys., 21, 1305–1323, https://doi.org/10.5194/acp-21-1305-2021, 2021.