Comment on acp-2021-1079
Anonymous Referee #2

Referee comment on "The effect of COVID-19 restrictions on atmospheric new particle formation in Beijing" by Chao Yan et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-1079-RC2, 2022

This paper presents the effect of the COVID-19 lockdown on atmospheric new particle formation. Indeed, the COVID-19 lockdown provided us a unique opportunity to investigate the effect of reduced anthropogenic emissions (probably similar to pre-industrial conditions) on a variety of atmospheric processes. Shen et al (2021) recently reported enhanced nanoparticle formation and growth during the COVID-19 lockdown in urban Beijing, but without much of the process-level explanation of nanoparticle formation and the role of key vapors. Here, the authors provide a more detailed analysis of nanoparticles and the role of sulfuric acid and oxygenated organic molecules in particle formation and growth. Authors report that the formation rate of 1.5 nm clusters was unchanged by drastically reduced traffic emissions. However, the cluster's survival probability was increased due to the higher formation of sulfuric acid, oxygenated organic molecules, and other vapors, indicating the enhanced atmospheric oxidative capacity.

Authors conclude that traffic emissions play a limited role in atmospheric NPF as opposed to the previous reports showing traffic as a high source of ultrafine particles such as Rönkkö et al., 2017 (https://doi.org/10.1073/pnas.1700830114), Guo et al., 2020 (https://doi.org/10.1073/pnas.1916366117). While Okuljar et al., 2021 (https://doi.org/10.5194/acp-21-9931-2021) also showed that traffic contribution to sub-3nm particles is lower during NPF events, Gani et al., 2021 (10.1039/D1EA00058F) showed NPF contributions to ultrafine particles in locations with high concentrations of precursors (e.g. traffic) are critical. Another recent study from an Indian urban location Kanawade et al., 2022 (https://doi.org/10.1029/2021JD035392), however, showed that NPF and growth events were suppressed under the reduced anthropogenic emissions during the lockdown. Kanawade et al. also reported an unaltered particle formation rate of 1.5 nm (and number concentrations of sub-3nm particles), but nanoparticle growth was limited by likely lower condensable vapors. This probably hints the role of micro-meteorology is also imperative. I suggest authors discussing all the above papers.
Overall Recommendation: The paper presents detailed analyses using new techniques that can characterize nanoparticles and provide new insights into the response of NPF to drastic changes in the atmospheric chemical cocktail. The manuscript should be published after the authors' elaborate discussion as indicated above and the following minor issues are addressed.

The pre-lockdown period falls during the peak winter season, followed by the lockdown during early spring, the temperature is expected to increase as the season progresses. The role of different micro-meteorological conditions should be highlighted between the time periods considered in this study. Or is it the critical factor for more occurrence of NPF and growth during lockdown with elevated temperature (more active photochemistry) rather than reduced anthropogenic emissions as background concentrations are on the higher side in urban areas.

Lines 85-90: there are laboratory studies showing clustering between sulfuric acid and organic acids e.g. Schobesberger et al. (https://doi.org/10.1073/pnas.130697311) or multi-component nucleation of sulfuric acid, ammonia, and organics (10.1126/sciadv.aau5363), and traffic is not the only source of organic acids to the atmosphere. For better readability, remove “on one hand” and “on other hand”.

Line 185: Fig. S4 cited for particles in the size range of 10-30 nm, but Fig. S4 in the supplementary shows diel patterns of temperature and UVB

Lines 202-203: Correct as Fig. S4

Supplementary figures are incorrectly cited in the main text at most places. Please check carefully.

Line 292: you mean to say “i.e., 1.3 pptv”?