

Atmos. Chem. Phys. Discuss., referee comment RC2  
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## Comment on acp-2022-797

Anonymous Referee #2

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Referee comment on "Analysis of new particle formation events and comparisons to simulations of particle number concentrations based on GEOS-Chem-advanced particle microphysics in Beijing, China" by Kun Wang et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-797-RC2>, 2022

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This study simulates NPF events in Beijing by applying GEOS-Chem/APM model, considering four nucleation mechanisms. It improved our understanding on nucleation and influence by meteorological factors. The TIMN nucleation scheme can predict nucleation well, however, more direct measurement data needed for validation the modeling results. The effect of meteorological conditions and precursors on nucleation should be further discussed in details. This paper is well organized and written. I recommend it can be accepted after the following major revisions.

Major issues:

- Line 113, The nucleation mechanism used in APM model is IMN parameterization scheme, which is developed based on the measurement and laboratory data elsewhere (Yu, 2006b). However, whether the parameterization is applicable in urban Beijing, with the high pollution level and unclear role that organics take place? Can you talk about the uncertainties or bias of the simulation result due to the four parameterizations?
- Figure 2, can you explain why there no clear difference of sulfuric acid concentration between NPF and non-NPF days. Table 1 is not necessary as only two numbers are given. It can be given in the text, and better to give the mean±standard deviation. In addition, as the authors mentioned, the sulfuric acid reported in this study is lower than the other studies, can you give the concentration level given by other studies? As SO<sub>2</sub> decreased recent year in Beijing, the comparison should be conducted at the recent years, and also differed by seasons.
- Line 214, some studies reported that temperature can influence the NH<sub>3</sub> stabilizing with sulfuric acid, which finally affect the nucleation rate. However, in this work, it can not be concluded the roles of temperature. In Beijing, NPF occurs more frequent in

spring, winter than summer. The higher temperature on NPF days probably related with stronger solar radiation on clear days. It is difficult to evaluate the roles of temperature, as temperature, RH and solar radiation correlated under the similar synoptic conditions. As well as in line 228, I don't think a simple metrological factor, RH or solar radiation, can explain the NPF reasonably (such as, high RH usually occurs under cloudy days with low solar radiation). The meteorological factors have systematically influence on NPF.

- Figure 7, can you explain why modeled RH is much lower than the observed value? It this reasonable with the model uncertainties? For example, on March 26 and 27, the bias can be 10 K.
- Figure 10, can you calculate the observed nucleation rate, as compared with the simulated nucleation rate. Figure 11, the vertical distribution of nucleation rate has large uncertainties, and even no vertical data can validate the model result. I don't think it is robust confidence to represent the nucleation rates in the upper boundary layer in line 297.
- Can you model the sulfuric acid and validate the results by the measurement data? This can improve the confidence of model results.

Minor problems:

- Line 31-34, First, "new particle nucleation" is a repetitive phrase, normally we call this phenomenon "new particle formation", which includes nucleation and growth process. For the second sentence, the nucleated particles undergone condensation and coagulation processes and grow into larger sizes. However, water absorption is an independent process that characterize the particle hygroscopicity, which should not be included in the new particle formation process.
- Line 99 and 101, for the data sources from website, the latest access time should be given.
- Figure 1, the contour plot of PNSD near the detection limit below 5 nm looks wired, it seems only data of NPF was given. How is the data on other days? It is zero or has been excluded from the dataset? The author should provide the details about how to handle the PNSD data.
- Line 213, 8 to 16:00 UTC or Local time, o'clock is not a formal written language.
- Table 2, the restricted conditions (RH and solar radiation) proposed for identifying NPF only based on one-month measurement data is not robust. Even at the same location, the criterion can be changed due to seasonal variation of meteorological factors.
- Figure 13, APM model can not capture the peaks of  $PM_5$  and  $PM_{10}$ , especially the severe pollution episode from March 14 to 18, is this due to the model spatial resolution or the emission inventory uncertainty?