2nd review of the manuscript

Impacts of coagulation on the appearance time method for sub-3 nm particle growth rate evaluation and their corrections

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The manuscript describes corrections for the calculation of growth rates after gas to particle conversion in an aerosol nucleation and growth model. Compared to the 'standard' model the initial growth with the new corrections are smaller than in the original 'conventional' calculation method.

The corrected growth rates are than compared to one day of ambient measurements in Beijing in Winter 2018.

The authors made some corrections to the manuscript to prevent misunderstandings and added and claim in a summary:

 We clarified that the models in this study were used to test the proposed formulae for the appearance time method. There is no comparison between the modeling results and measurements in this study. Besides, we clarified the input background aerosol concentration for the model in the revised manuscript.

Fig. 7 shows a comparison of model results and measured ambient data. The input background aerosol concentration is given in a wide range of one order of magnitude. Due to the rapid change during the day a diurnal variation would be necessary.

 We added more details on the experiments.

The reference Deng et al, 2020b mentiones the weather sensor, its location would be necessary. Also needed are diurnal variations of a complete set of meteorological variables.

 We added a paragraph on the classification of the new particle formation event shown in Fig.7. The continuous formation of aerosols down to the cluster size and their subsequent growth are in accordance with the features of a regional new particle formation event rather than those of a plume event.

The classification of a new particle formation event is not in agreement with a sulphur dioxide plume event (see Fig. R1).

 The size-dependency of particle growth rate in the observed new particle formation event is similar to those reported in previous studies.

Yes, but, this is not a proof of concept. There are many more nanoparticle events (NPE), classified as NPF but, clearly traceable to primary particle plumes.

 The appearance time of H2SO4 and new particles on Feb. 24, 2018 indicates that the observed intensive new particle formation was mainly driven by daytime photochemical reaction.

Daytime photochemical reactions are temporally not in agreement with the SO2 and H2SO4 diurnal pattern in Fig. 7 and Fig. R1, see for example Junkermann et al, 1989.

The question, which photochemical reaction is assumed to be responsible for the OH radical and H2SO4 production was not answered.

Further comments

While the coagulation description is understandable, still the model description is marginal and does not allow a decision whether the model for the nucleation and growth rate calculation is applicable at all for a comparison with experimental data from the real atmosphere. It should be discussed under consideration of the limits of particle size distribution development in polluted atmospheres described by Kulmala et al (2017).

However:

It's well known since Aitken's (1890) work that horizontal transport and vertical mixing are the dominate factors controlling nanoparticle number concentrations. It's also known that under certain conditions, mainly in sulphur rich plumes, gas to particle conversion takes place (Mohnen and Lodge 1969, Stevens et al, 2012).

Thus, it is clear that during advection of sulphur rich air as shown in Fig R1 a rapid gas to particle conversion and nanoparticles in all size ranges can be expected. Whether these nanoparticles survive a few minutes or hours during transport and grow or shrink is a matter of the environmental conditions and the presence of other, especially larger, particles as recently discussed by Kulmala et al, (2017) , Kerminen et al, (2018), and Deng et al, (2020a). A complete description of these is conditions and their diurnal variation is required.

As mentioned by Deng et al, (2020b) also other local sources contribute (Rönkkö et al, 2017). For an example of nanoparticle transport from single elevated primary particle sources see Junkermann and Hacker (2018) and literature cited therein. For the distribution of such potential large sulphur, ammonia and nanoparticle sources affecting Beijing air pollution see for example www.endcoal.org.

Minor comments:

The argument that emission control and reduction of SO2 in China together with no corresponding change in NPE frequency is not an argument against industrial nanoparticle sources (see Junkermann et al, 2011). The claimed link between SO2 and H2SO4 peaks and the appearance of 1.5 nm particles on February 24 is even contradicting this argument.

It is not necessary to mention the software package used for the calculations, it would rather be interesting to learn more about the different physical and chemical processes modelled and considered as relevant.

The reference to Iida (2008) is missing.

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