

The authors would like to thank the reviewer for the constructive comments. Our replies to the comments are given below, with the original comments in black, and our response in blue. We have revised the manuscript accordingly. All changes made to the manuscript have been marked with Track-Change tool in one of submitted files.

Anonymous Referee #3

The kind of model introduced in this paper is definitely needed in atmospheric new particle formation research, so I am in principle in favor of publishing this work. I have, however, a few concerns that should be addressed before accepting the paper for publication.

I am not fully comfortable with the current structure of the paper. Sections 1 and 2.1 provide a nice introduction and background for this work. Section 2.2 is a compact description of the model and fine as well. Section 2.3 is, however, a mixture of technical details, model evaluations and scientific results/findings. I would prefer separating these issues to the extend possible. For example, the technical details related to the used thermodynamic and other data as well as QC calculations could be put into a separate Appendix/Appendicies. Such details are a very important part of this paper, but not of major interest to most of the readers.

This is a good point. Following the referee's suggestion, we have moved some of the technical details related to the used thermodynamic and other data as well as QC calculations to supplementary material.

The authors state that a detailed description of QC calculations will be reported in separate papers. The authors should be very careful in this regard: this paper needs to have enough material to justify the obtained results.

This paper contains the adequate materials (as provided in the tables now in the supplementary material) to justify the obtained results. To address the reviewer's concern, we have deleted this sentence.

Minor issues:

Please add to the text (line 197) that PH_2SO_4 refers to gas-phase production of sulfuric acid (in the atmosphere, sulfuric acid/sulfate can also be produced in liquid/aerosol phase).

Modified as suggested.

The given ammonia concentration levels (beginning of section 2.4.1) should be backed up with suitable references. The authors should better justify the statement that small ternary clusters can be considered to be in equilibrium with ammonia. Mentioning solely the typical ammonia concentrations is not enough.

We have added several references about the ammonia concentration levels. We have also added discussions about the validity of the equilibrium assumption.

CLOUD should be defined also in the abstract.

Done.

There are a small number of grammatical issues that should be corrected, e.g. indicating (line 64), a nucleation model (line 67), did not (line 107), a similar pattern (line 296), the s=a pathway (line 367), even when they (line 384), under the condition??? (line 559).

Thanks for the careful reading. We have fixed these grammatical issues.