Comment on acp-2022-35

Anonymous Referee #1

Referee comment on "A sulfuric acid nucleation potential model for the atmosphere" by Jack S. Johnson and Coty N. Jen, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-35-RC1, 2022

This manuscript presents a novel idea on how to model atmospheric nucleation (formation rate of 1 nm particles) in environments dominated by acid-base nucleation mechanism. The theoretical approach behind the presented analysis appears scientifically sound. The paper is written in a relatively clear way, but it has some structural issues that need to be solved before I can recommend accepting this paper for publication. My main criticism in this regard is summarized below.

Section 2 should have separate sub-sections for the introduction of the NPM (current section 2.1) and for description of nucleation experiments (lines 96-106). After reading the paper, it remains somewhat unclear whether the data points presented in Figures 2 and 3 are taken from the experiments made earlier by the same research group in a series of papers cited on lines 97-102, or whether they are new experiments. This should be clarified in the paper. Furthermore, if the data are based on new experiment, the experimental method section should be expanded.

Excluding the sentence on lines 178-179, section 3.2 is really not about application of NPM to the atmosphere, but rather about estimating (indirectly) the effective base concentration in a few environments where available observation allow such estimations. This should be reflected in the title of this sub-section.

Related to the previous comment, and for highlighting the value of this work, it would be essential to add some more text on how NPM could in practice be applied in different atmospheric environments (as compared to what is currently said on lines 178-179 and 201-203). Most importantly, how we can predict nucleation rates using NPM in environments where we do not have sophisticated measurements? Sulfuric acid concentrations can be predicted using models or proxies, but what would be a plan for predicting effective base concentrations besides comprehensive measurements?