

Interactive comment on “H₂SO₄-H₂O binary and H₂SO₄-H₂O-NH₃ ternary homogeneous and ion-mediated nucleation: Lookup tables for 3-D modeling application” by Fangqun Yu et al.

Anonymous Referee #3

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This paper describes look-up tables to speed up the implementation of the state-of-the-art Yu et al (2018) ternary nucleation parameterization in atmospheric models. These look-up tables have the potential to be very helpful to atmospheric modelers and they are well described both in the manuscript and in the well-documented code available via Zenodo. I recommend this paper for publication. I have only minor improvements to suggest.

I note that I was able to use the online program successfully, despite the comment of one of the other reviewers, so I can comment that the authors have presumably fixed it.

C1

The parameterization documented by Yu et al (2018) has not been, as far as I am aware, tested under all atmospheric or planetary science conditions, and so I think its range of validity could be discussed in this paper a little more thoroughly to ensure atmospheric modelers are aware of its possible limitations.

In polluted conditions or where there are high concentrations of biogenic organic molecules, I think it is possible that the HSO₄⁻ ion concentrations predicted by the model for a given ion production rate could be biased high since other molecules may be ionized instead. I appreciate that in these conditions the ions will be mostly lost to high condensation sinks, and so nucleation is likely to be dominated by neutral processes. So it is unlikely to be a big effect, but still perhaps worth mentioning.

Similarly, the comment that ‘extrapolation is allowed’ for conditions out of range of the table might need qualifying, since nucleation rates are very non-linear. While I appreciate that extrapolation from this parameterization should be more robust than extrapolation from, for example, the empirical parameterization of Dunne et al (2016), it still necessarily leads to uncertainty. In particular, I think nucleation rates at very low relative humidity (below 0.5%) or at temperatures above 300K are still very uncertain and extrapolating from the tables may lead to errors. Could the binary part of the parameterization be used for nucleation on Venus, for example, as discussed by Määttänen et al (JGR 2018; <https://doi.org/10.1002/2017JD027429>), or in the stratosphere?

As the authors address the comment of reviewer #1 on comparison to other parameterizations, the Määttänen et al paper should be discussed as it is in some respects an update of Vehkamäki et al (2002).

On page 3, line 8, there is an extraneous ‘t’. On page 6, line 8, I think it’s worth specifying “ternary nucleating systems with ammonia” because while the statement is perfectly correct for the ammonia system, ternary nucleation of other molecules (some amines, for example) with sulfuric acid is dominated by neutral processes.

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