The authors would like to thank the reviewer for the useful comments. Our replies to the comments are given below, with the original comments in black, and our response in blue.

Anonymous Referee #3

This paper describes look-up tables to speed up the implementation of the state-of-theart 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.

Thank you for positive comments about the manuscript and potential usefulness of the lookup tables.

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.

Yes, we noticed the problem and fixed it.

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.

It is hard to discuss the range of validity without measurements to compare with. As discussed in Yu et al (2018) and pointed out in the Introduction, the ternary ion-mediated nucleation (TIMN) model for H_2SO_4-H_2O-NH_3-Ion system is a kinetic model with thermodynamic data derived from laboratory measurements and quantum-chemical calculations. The model generally agrees well the CLOUD measurements under a range of conditions. The lookup tables are designed to calculate nucleation rates in the troposphere, not under all atmospheric or planetary science conditions. For conditions in the stratosphere (RH<0.5%) and other planets (such as on Venus), we do not know if the model is valid or not as there are not measurements under such conditions are available to validate the model. We slightly extended the discussion on this.

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.

The initial negative ions assumed in the model is NO_3^-. While it is possible that other molecules may be ionized instead, these molecules can be replaced by HNO_3 or H_2SO_4 as long as the bonding of negative ions with HNO_3 or H_2SO_4 are stronger. As the reviewer pointed out, small ions will be mostly lost to high condensation sinks or ion-ion recombination, both having already been included in the kinetic nucleation model (Yu et al., 2018).

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 Määttanen et al (JGR 2018; https://doi.org/10.1002/2017JD027429), or in the stratosphere?

Actually, for the code provided in the Zenodo, extrapolation is allowed only for surface area for which the tables only give values at two surface area points (S = 20 and 200 $\mu m^2 cm^{-3}$). The dependence of nucleation rates on the surface area, which serves as coagulation sink (not condensation sink because [H2SO4] is fixed), is relatively linear and thus extrapolation will not cause unphysical values. The lookup tables are designed to calculate nucleation rates in the troposphere, not under conditions in the stratosphere (RH<0.5%) and other planets (such as on Venus) if the conditions are far different from the tropospheric conditions. We have clarified this in the text.

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

Yes, a discussion of the Määttanen et al paper has been added.

On page 3, line 8, there is an extraneous 't'.

Corrected.

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.

Modified as suggested.