

## ***Interactive comment on “H<sub>2</sub>SO<sub>4</sub>-H<sub>2</sub>O binary and H<sub>2</sub>SO<sub>4</sub>-H<sub>2</sub>O-NH<sub>3</sub> ternary homogeneous and ion-mediated nucleation: Lookup tables for 3-D modeling application” by Fangqun Yu et al.***

### **Anonymous Referee #1**

Received and published: 2 January 2020

This work documents aerosol-nucleation-rate lookup-tables generated based on the results from a kinetic model (Yu et al. 2018ACP). Four major aerosol nucleation mechanisms are considered in these lookup-tables and they cover a wide range of key parameters relevant for aerosol nucleation. The lookup-tables can be used in 3-D models to save computational cost, so they are potentially useful for other modelers who want to simplify the aerosol nucleation treatment in their models.

Overall, the manuscript is well written. The documentation is clear and key information is provided. I think the work could be further improved by comparing these tables (calculated nucleation rates) with other widely-used aerosol nucleation parameterizations,

C1

so that other users can have an idea about what to expect in their model result. For example, the Vehkamäki et al (2002, hereafter V2002) binary nucleation scheme is used by many aerosol models (e.g. CAM5 Liu et al., 2012GMD, ECHAM5-HAM, Stier et al. 2005ACP, etc). How does the BHN lookup-table compare with V2002? The ion-induced aerosol nucleation is considered in the ECHAM5-HAM2 model (Zhang et al., 2012ACP), using a similar lookup-table method (Kazil and Lovejoy, 2007ChemPhys and Kazil et al, 2010ACP). How does the BIMN lookup-table compare with K2010?

In addition, some aerosol models (Wang et al, 2009ACP, Zhang et al, 2012) use the nucleation parameterization for the boundary layer (e.g. Kuang et al., 2008JGR) in combination with the binary nucleation scheme. Can the THN/BIMN/TIMN schemes be used along with such boundary nucleation scheme? It would be nice to provide such information to other users as well.

Other specific/minor comments:

P1L11, abstract: have -> has

P1L12, L30 and throughout the text: Better use either “Ion” or “ion”.

P1L25: “for BHN, THN, BIMN, and TIMN” could be deleted

P2L11: Maybe also mention the nucleation pathways involving organics?

P4L12: Is RH the hybrid relative humidity or the RH respect to water? Please clarify.

P4L15-24: It would be nice to provide some quantitative estimate of the lookup-table accuracy here.

P4L24: Can two points for S to get sufficient accuracy?

P5L1: extrapolation -> linear?

P5L21: very lower -> very low

P6L20: the online program (<http://apm.asrc.albany.edu/nrc/>) didn't work for me (both in

C2

safari and firefox). Better fix it before the final publication.

#### Reference

Kazil, J., Stier, P., Zhang, K., Quaas, J., Kinne, S., O'Donnell, D., Rast, S., Esch, M., Ferrachat, S., Lohmann, U., and Feichter, J.: Aerosol nucleation and its role for clouds and Earth's radiative forcing in the aerosol-climate model ECHAM5-HAM, *Atmos. Chem. Phys.*, 10, 10733–10752, <https://doi.org/10.5194/acp-10-10733-2010>, 2010.

Kuang, C., McMurry, P.H., McCormick, A.V. and Eisele, F.L., 2008. Dependence of nucleation rates on sulfuric acid vapor concentration in diverse atmospheric locations. *Journal of Geophysical Research: Atmospheres*, 113(D10).

Vehkamäki, H., Kulmala, M., Napari, I., Lehtinen, K.E., Timmreck, C., Noppel, M. and Laaksonen, A., 2002. An improved parameterization for sulfuric acid–water nucleation rates for tropospheric and stratospheric conditions. *Journal of Geophysical Research: Atmospheres*, 107(D22), pp.AAC-3.

Stier, P., Feichter, J., Kinne, S., Kloster, S., Vignati, E., Wilson, J., Ganzeveld, L., Tegen, I., Werner, M., Balkanski, Y., Schulz, M., Boucher, O., Minikin, A., and Petzold, A.: The aerosol-climate model ECHAM5-HAM, *Atmos. Chem. Phys.*, 5, 1125–1156, <https://doi.org/10.5194/acp-5-1125-2005>, 2005.

Zhang, K., O'Donnell, D., Kazil, J., Stier, P., Kinne, S., Lohmann, U., Ferrachat, S., Croft, B., Quaas, J., Wan, H., Rast, S., and Feichter, J.: The global aerosol-climate model ECHAM-HAM, version 2: sensitivity to improvements in process representations, *Atmos. Chem. Phys.*, 12, 8911–8949, <https://doi.org/10.5194/acp-12-8911-2012>, 2012.

---

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-290>, 2019.