Response to acp-2021-645 reviews for RC3

We are grateful to reviewer 3 for reviewing our manuscript acp-2021-645. Please find our responses in below and corrections in the revised manuscript. Your comments are reproduced **in bold** and our responses are given directly afterward in normal font. *The original text in previous reviewer's RC document and our response document is reproduced in red italic* and *the text changed in the revised manuscript is in blue italic*.

- **Minor:**

1 **In the last paragraph of the Summary, it might be helpful to provide a couple of sentences to discuss the implications of the findings of this work to the model community. Should the aerosol models keep track of the amount of H_2SO_4 coated on soot particles for more accurate INP calculations?**

R: Thank you. We added relevant statements in the last paragraph in the Summary as below (in the revised manuscript L767-772):

'*...Moreover, this study contributes to the climate impact evaluation of soot emissions. Despite the various coating thicknesses in the atmosphere, a thin H_2SO_4 coating (≤ monolayer coverage) onto soot particles can lead to suppressed ice nucleation. As such, aerosol-climate model may only need to differentiate coated and uncoated soot particles when evaluating the H_2SO_4 coating effects on soot ice nucleation abilities as monolayer of sulphuric acid coating can be easily achieved in the atmosphere (Pósfai et al., 1999; Adachi et al., 2011).*'

2 **In response to Comment #5 of the first reviewer (RC1), the authors mentioned that they have submitted a manuscript to ACP where they present ice nucleation onto soot particles down to 60 nm (Gao et al., 2021). I think that the authors should cite Gao et al.'s paper and summarize its key relevant findings here.**

R: Thank you for this suggestion. Yes, we agree that the investigation of size threshold for soot ice nucleation is important. A new statement was added at the end of the Sect. 5 as below (L767-770 in revised manuscript):

'...Moreover, measuring the lower size limit to identify the threshold of soot ice formation will be important for future laboratory studies, given the strong particle size dependence of (soot) ice nucleation and that the Aitken mode dominates size distribution from aviation soot emissions and also other high temperature combustion sources.''

Now, the revised manuscript in L762-767 is as below:

'… *The findings in this study have implications on the ice nucleation of smaller size soot particles (< 100 nm). The understanding of the lower size threshold for soot ice formation is important, given the strong particle size dependence of (soot) ice nucleation and that the Aitken mode dominates size distribution from aviation soot emissions and other high temperature combustion sources. A recent study reported that small size (< 100 nm) soot particles, even as active as uncoated FW200 in this study, nucleate ice homogeneously for T < HNT (Gao et al., 2021), implying that H_2SO_4 coated soot particles of a size smaller than 100 nm require homogeneous freezing conditions to form ice in the cirrus cloud regime.*'

Adachi, K., Freney, E. J., and Buseck, P. R.: Shapes of internally mixed hygroscopic aerosol particles after deliquescence, and their effect on light scattering, Geophys. Res. Lett., 38,

http://10.1029/2011gl047540, 2011.
Gao, K., Friebel, F., Zhou, C.-W., and Kanji, Z. A.: Enhanced soot particle ice nucleation ability induced by aggregate compaction and densification, Atmos. Chem. Phys. Discuss., *in press,* http://10.5194/acp-2021-883, 2021.
Pósfai, M., Anderson, J. R., Buseck, P. R., and Sievering, H.: Soot and sulfate aerosol particles in the remote marine troposphere, J. Geophys. Res. Atmos., 104, 21685-21693, https://10.1029/1999jd900208, 1999.