

Atmos. Chem. Phys. Discuss., referee comment RC2  
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## Comment on acp-2021-22

Anonymous Referee #2

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Referee comment on "Large hemispheric difference in nucleation mode aerosol concentrations in the lowermost stratosphere at mid- and high latitudes" by Christina J. Williamson et al., Atmos. Chem. Phys. Discuss.,  
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The manuscript "Large hemispheric difference in ultrafine aerosol concentrations in the lowermost stratosphere at mid and high latitudes" by Williamson et al. presents observation and model based study on new particles formation in the lowermost stratosphere. The paper is for the most part well written and offers a comprehensive analysis on sources and processes affecting the number concentrations of ultrafine aerosol in the lowermost stratosphere. The topic is well within the scope of Atmospheric Chemistry and Physics and I can recommend publishing after the following issues have been addressed:

- The description of how box modelling is done needs to be detailed better. In its current form it is really difficult to understand how to simulations are done. The reader is pointed to Kupc et al., 2020 for the description of the box model setup. However, in that paper both MAIA and TOMAS models are used, so it would be easier for the reader to understand the modelling part if it was briefly summarized in this paper.

- The comparison between CEDS emission rates and observed aerosol concentrations in Figure 11 is problematic since it in now way takes into account the transport of SO<sub>2</sub>. As mentioned in the text, observations were made mostly outside of the flight corridors and there the number concentrations of ultrafine particles did not correlate with SO<sub>2</sub> concentration. Can it be that new particle formation occurred near flight corridors and these particles were transported to the regions of aircraft observations?

- Page 2, Lines 36-37: Solomon et al., 2011 does not discuss aerosol size distributions. Wouldn't Williamson et al., 2019 reference be more suitable reference here?

- Page 2, Lines 126-130: Where is this information about condensation and coagulation

rates used?

- Page 5, Line 146: oder  order

- Page 8, Lines 229-237: Here you discuss that the SO<sub>2</sub> concentrations (40 pptv) were higher than the median observed values. Why was this value chosen? Was this level required to initiate nucleation? It is said that SO<sub>2</sub> concentrations decreased to the observed concentrations. Was NPF still ongoing at these levels?

- Section 6: The first three paragraphs explain how aerosol emissions are calculated. The motivation for this procedure is unclear to me. Is this done in order to obtain higher temporal resolution emission rates from CEDS monthly fields?

- Page 13, Line 400: Can higher observed SO<sub>2</sub> concentrations be due to transport from regions with higher emissions?

- Page 14, Line 430: "influence from fires may suppress NPF in the LMS, or that the additional surface area from biomass burning particles shortens the lifetime of newly formed particles". Aren't these two the same thing?