

Atmos. Chem. Phys. Discuss., referee comment RC3  
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## Comment on acp-2021-1038

Anonymous Referee #3

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Referee comment on "A global view on stratospheric ice clouds: assessment of processes related to their occurrence based on satellite observations" by Ling Zou et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-1038-RC3>, 2022

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This manuscript presents a thorough evaluation of the global occurrence of stratospheric ice clouds (SICs) and their relationships with tropopause temperature, recent deep convection, gravity waves, and stratospheric aerosols. Potential relationships with modes of climate variability (QBO and ENSO) were also examined, but did not reveal strong association. The identification of SICs is based on the CALIPSO lidar observations, which are arguably the best available resource for global analysis, complemented by additional high-quality, satellite-based identification of the remaining parameters related to SICs. It was demonstrated well throughout that tropopause temperature and convection/gravity waves are strong controls for the occurrence of SICs, as expected. The analysis presented is thorough and the methods used are appropriate. It will be a meaningful contribution to the literature. I have one general comment related to an important element of the discussion that I believe is missing, but otherwise only a collection of suggested minor edits.

General comment: an important limitation resulting from the use of CALIPSO data is bias introduced by the lack of sampling the diurnal cycle (critical for evaluating deep convection and, one would assume, much of the related SICs). I do not know how large the bias would be and am not aware of studies that allow one to quantify/estimate it well since it will be dependent not only on the frequency of sources, but also on the timescale of sublimation (which implies microphysics may be important, etc.). However, I do expect it is significant (especially over land masses). For example, overshooting convection in North America has a pronounced diurnal cycle with a frequency maximum that falls almost entirely between the CALIPSO sample times (e.g., see 10.1175/JAMC-D-15-0190.1, 10.1002/2017JD027718, & 10.1029/2021JD034808). Other regions with frequent land-based overshooting storms have similar diurnal cycles. This suggests that much of the SICs that occur may not even be sampled, especially over land. Thus, the discussion throughout the manuscript requires an acknowledgement of this bias and how interpretations of the results might change.

Minor suggested edits:

Line 17 - "and western" should be "and the western"

Line 37 - "hydrate stratosphere" should be "hydrate the stratosphere"

Line 40 - ", intensity" should be ", and the intensity"

Line 49 - "Six encounters..." the opening of this sentence is poorly phrased. Please revise.

Line 72 - "ice clouds" should be "ice cloud"

Line 78 - "are" should be "is"

Section 2.1 - I recommend defining the first and second lapse-rate tropopauses as LRT1 and LRT2, respectively. LRT is commonly used in the literature and helps to clearly communicate the definition used throughout. I would also recommend not bothering to define a cold-point tropopause acronym, since it is only used here.

Line 262 - recommend revising "motion of the Sun" to "location of peak insolation". The sun isn't moving...

Figure 2 - is this analysis relative to all observations or DT events only? Please add note to clarify.

Line 400 - "we" should be "were"

Figure 12 and related analysis - the overlap of several regions seems undesirable. It would be good to test sensitivity to having them be defined more exclusively.

Line 427 - "Spear-man" should be "Spearman"

Line 448 - "Two" should be "The two"

Line 480 – “in average” should be “on average”

Line 486 – “, lowering” should be “, and lowering”

Line 527 – “In the MIPAS” should be “In MIPAS”

Line 588 – “tropauses” should be “tropopauses”

Line 599 – “its” should be “their”