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Comment on acp-2021-90

Anonymous Referee #2

Referee comment on "Empirical evidence for deep convection being a major source of stratospheric ice clouds over North America" by Ling Zou et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-90-RC2>, 2021

Review of Empirical evidence for deep convection related stratospheric cirrus clouds over North America, by L. You, L. Hoffmann, S. Griessbach, R. Spang and L. Wang proposed for publication in Atmospheric Chemistry and Physics.

In this article, the authors correlate clouds detected above the tropopause in CALIPSO observations with locations of deep convection retrieved from AIRS observations above North America. They find that a majority of occurrences of clouds in the stratosphere (50%-75%) are well correlated with deep convection. They also find that the stratospheric clouds not linked with convection are connected with gravity waves, which are frequent over the Great Plains.

This well-written article presents a good analysis of stratospheric cirrus clouds above North America, and provides convincing explanations for the mechanisms responsible for the presence of these clouds. The data is well described, the figures support the results and the discussion is interesting. I am in favour of its publication in ACP, once the minor comments below will be addressed.

A semantic issue I'd like to see addressed is the fact that the clouds described as "SCC" in the present article appear to be most often than not, according to the results presented, overshoots of convective systems. Labelling them as "stratospheric cirrus clouds" makes me a bit uneasy, as they are most frequently not independent clouds but rather a small part of a larger system, that happens to reach above the tropopause. Depending on the nature of a stratospheric cloud (independent cirrus or upper part of a convective system), I suppose the formation processes involved should be very different, as should be the impact on stratospheric water vapour. It would be useful if the authors could address this issue, either by proposing a way to avoid confusing independent cirrus with upper parts of convective systems, or by demonstrating that the distinction is not important.

Minor comments

- Introduction: this section is very good. The authors summarised very well the existing literature on stratospheric cirrus clouds, the observational evidence for their existence, and the mechanisms that might lead to their formation. It is an enjoyable read.
- L. 59: It is unclear to me what you mean by "kind of controversial". Are you suggesting the results from the previously cited works are incorrect, inconclusive, or unreliable? Maybe you mean that existing evidence for stratospheric cirrus is circumstantial and imprecise by definition (there are multiple definitions of the tropopause, etc). If that is the case, the presented results could also be labelled controversial. Please be more explicit in your statement.
- L. 192: "The example adds a further aspect... over North America" I'm not sure I understand this sentence.
- Figure 4: A visual inspection of the time series presented here does not suggest to me a good correlation between them. Spikes in N_SCC (orange) are frequently paired with flat N_DC or BT_min curves, and vice versa. The text does not attempt to discuss short-scale variability of these time series or of the correlation between the time series. The text does not really discuss the contents of that figure. Because of this, I do not think this figure really brings anything to support the paper's argument. I would actually be more interested in a visual representation of the annual evolution of the various indicators, NOD_SCC, NOD_DC, N_SCC, R_SCC-DC, etc. This would make a more interesting discussion in my opinion.
- L. 233: "Despite large day-to-day variations, the occurrences of SCC and deep convection are generally correlated." Again, looking at Figure 4, I'm not sure I see such a good correlation. The correlation coefficient between SCC and convection is sometimes as low as 0.3. Do the authors consider a 0.5 correlation coefficient high or low? I would be interested in seeing a lengthier discussion of these parameters, hopefully helped with a figure.