Atmospheric Chemistry and Physics Discussions

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# Comment on acp-2022-146

Blaž Gasparini (Referee)

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Referee comment on "Monthly occurrence of tropical cirrus clouds explained by monthly moisture and temperature variations" by Qin Huang and Tra Dinh, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-146-RC1, 2022

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The manuscript uses 9 years of CALIPSO level 3 gridded monthly data to separate the tropical cirrus clouds into those from convective and non-convective origin. The authors define clouds associated with positive specific humidity anomalies as convective origin and clouds associated with negative temperature anomalies as non-convective origin cirrus. While their method seems overly simplistic at first sight, their robust, physically justifiable results speak for themselves and helped overcome my initial skepticism about the use of very coarse time and spatial resolution of the satellite dataset. This is a nice and clear study, and I recommend publication after the listed comments are addressed.

**General comments:**

- With CALIPSO, you are limited to clouds with optical thickness smaller than about 3. Is this a significant limitation of the study? What proportion of the clouds is missed?
- Is it fair to say that a positive specific humidity anomaly must be associated with convection? What if convection with relative humidity with respect to ice of 100% reaches an ice supersaturated region? There is ample evidence that deep convection on average hydrates the upper troposphere, but I think the authors should nevertheless discuss the other possibility and how it could influence their results.
- Could you verify your cloud classification method on a subset of instantaneous CALIPSO profile data? Would the results based on instantaneous data agree with the gridded, 1-monthly data?

**Specific comments:**

Abstract: For clarity, I suggest avoiding the use of abbreviations in the abstract (unless strictly needed).

Introduction: I'm missing a few more lines describing why it is important to separate the origin of cirrus. In principle, the models could simulate the correct cloud amount and cirrus properties even without correctly accounting for their origin.

Line 26: Li et al., 2012 (doi: 10.1029/2012JD017640) may be a good reference about the uncertainties in cirrus, at least with respect to the ice water content

Lines 46-47: The sentence starting with "Wang and Dessler" is missing something.

Line 48: It may be appropriate to add references explicitly looking at the decay of convective origin clouds. If I am not mistaken, the cited papers all refer to the evolution of in-situ TTL cirrus.

Lines 59-62: I would suggest also mentioning studies using high cloud trajectories in climate models, e.g. Gehlot and Quaas, 2012 (doi: 0.1175/JCLI-D-11-00345.1) and Gasparini et al., 2021 (doi: 10.1175/JCLI-D-11-00345.1).

Lines 90-92: Does your method work also for regions with a limited annual cycle of convection, e.g. for parts of the tropical western Pacific?

Section 3: How is cloud fraction defined? Can it be only 0 or 1 or is it also expressed as a fraction? If fractions are used, how do you consider them in the analysis of in-cloud vs clear-sky gridboxes?

Figure 3: I would suggest using a symlog scaling (https://matplotlib.org/stable/gallery/scales/symlog_demo.html), so that one can see more than just the temperature-dependent increase in Dq (i.e. basically Clausius-Clapeyron). If you use matplotlib for plotting, this is how you could do it: plt.gca().set_yscale('symlog',linthreshy=1e-2)

Figure 5: density = IWC, right? Please, be consistent. Caveat: CALIPSO lidar will not penetrate into optically thick clouds, so the lower part of the plot is biased to low IWC.

Lines 209-218: Please, don't use parentheses to indicate the opposite of an idea. This makes the text really hard to understand. See also https://eos.org/opinions/parentheses-are-are-not-for-references-and-clarification-saving-space

Figure 10: Could you explicitly mention already in the caption that you show an “all-sky” average.

Line 263: It’s really hard to see from Fig. 9 if the average/median IWC of convective and non-convective cirrus are comparable in a given temperature bin or not. Could you for example express it in numbers/median values? Also, the IWC is certainly biased low at T>240 K due to the limitations of the CALIPSO lidar measurements.

Line 303: As in the introduction, it may be worthwhile to add some citations that actually studied the decay of convective-origin cirrus, and not only the in-situ generated cirrus.