

**Comments on “Constraining a Radiative Transfer Model with Satellite Retrievals: Implications for Cirrus Cloud Thinning” by Ehsan Erfani and David L. Mitchell**  
<https://doi.org/10.5194/egusphere-2025-1165>

The aim of this study is to quantify the difference in the cloud radiative effect between homogeneous and heterogeneous cirrus clouds at the top of atmosphere, at the surface, and the atmosphere between. The radiative effect is estimated using the radiative transfer model libRadtran. The simulations are initialized with retrieved values of ice water content and effective diameter from CALIPSO profiles.

The study suggests that homogeneous cirrus clouds exert a stronger radiative effect. Therefore, cirrus cloud thinning could induce a cooling of the climate and used as a climate intervention method. The authors also provide suggestions for improving the representation of homogeneous and heterogeneous cirrus in global climate models.

The authors provide a comprehensive introduction and cite recent literature, which provides a good overview of the topic and the current state. The paper is well written, the structure is logical, and the conclusions are easy to follow. The setup of the radiative transfer model libRadtran is explained in detail and the chosen parameters for the simulations are justified by the current literature. The paper fits well within the scope of ACP and I recommend the paper for publication.

I have only some minor comments of a suggestive nature. The authors can consider them in the next version of the paper.

Minor comments:

- The title is a bit conservative and does not cover all the work presented in the paper. How about: "Estimated radiative effects of cirrus cloud thinning based on radiative transfer simulations and retrieved cloud microphysics"?
- When multiple references are given you may consider ordering them by year of publication.
- L93-95: Perhaps "10.6 and 12  $\mu\text{m}$ " instead of "12 and 10.6  $\mu\text{m}$ "
- L166: You might add "solar" in front of "zenith angle", to be consistent with the following text
- L173: Can you explicitly mention the microphysical properties that you retrieved from CALIPSO and that use in the RTM simulations?
- Figure 3 and others: In figure 3 the y-axis is H (Km), while in later plots it is "Height (Km)". Please check for consistency. In general: units should also be lower-case and not in italics.
- Eq.4: To be more precise,  $\text{CRE}_{\text{het}}$  would be  $\text{CRE}_{\text{net\_z,het}}$ , right?
- L369: You could add that cirrus cloud altitude is synonymous to cirrus cloud temperature, since both are connected via the vertical temperature profile.
- Fig 7: Units not in italics
- L475: You may write: "The SZA, which is the angle between the Sun's rays and the vertical..." Aktaş & Kirçicek, 2021

Aktaş, A., & Kirçiçek, Y. (2021). Examples of Solar Hybrid System Layouts, Design Guidelines, Energy Performance, Economic Concern, and Life Cycle Analyses. *Solar Hybrid Systems*, 331–349. <https://doi.org/10.1016/B978-0-323-88499-0.00013-6>

- L479: "a SZA"?
- Particular Fig. 8 but also the other figures. What is the purpose of using different colors for "hom" and "het" freezing in each row? It would be more intuitive to use the same color for "hom" and "het" in all panels and across figures.
- L495: This is just personal preference. You might use "retain" instead of "trap"? Trap sounds a little "colloquial". Also in later instances. But I don't insist on that.
- L500-501: Some nitpicking: "Furthermore, the warmer temperature profile and in particular warmer surface in mid-latitudes emit ..." The temperature profile itself cannot emit radiation but the atmospheric column of air that has a certain temperature.
- L503: Adding "radiation" after LW?
- L518ff: Perhaps discuss the TOA effect first and then the surface effect. This would follow the order of the columns in the figure.
- L520: In the text you write "-0.2 W m-2" but in the figure a value of +0.2 W m-2 is given. Please check.
- L534: Would it be better to use  $P_{\min}$  and  $P_{\max}$  instead of  $T_{\min}$  and  $T_{\max}$ , where P represents a (P)rofile that includes both, the temperature and specific humidity". "T" might give the impression that only temperature is being varied.
- L592: Adding at the end of the sentence: "when looking at TOA"?
- L642: Adding "...retrieved cloud microphysical products from...." between *implemented* and *satellite*?
- L699: Could you provide possible solutions to mitigate the overestimation of pre-existing ice in the models?
- L763: The problem of "overseeding" is mentioned for the first time. You could include one or two sentences about this problem in the introduction. The introduction is already well written but adding the problem of overseeding in the introduction would further emphasizes the need to more accurately determine the, potentially negative, consequences of CCT.
- L793ff: Recent publications indicate that Arctic low cloud cover has decreased in recent decades. In this respect, CCT may still be effective or may become more effective in the future. I admit that these studies partly contradict each other and feedbacks are much more complex, e.g., also changes in mid-level and high-level cloud cover can occur. However, the authors might consider the following publications:

Schweiger, A.: Changes in seasonal cloud cover over the Arctic seas from satellite and surface observations (<https://doi.org/10.1029/2004GL020067>)

Wang, X. and Jeffrey R. Key,: Recent Trends in Arctic Surface, Cloud, and Radiation Properties from Space (<https://doi.org/10.1126/science.1078065>)

Boccolari, M. and Parmiggiani, F., Trends and variability of cloud fraction cover in the Arctic, 1982–2009 (<https://doi.org/10.1007/s00704-017-2125-6>)

Kato et al., Seasonal and interannual variations of top-of-atmosphere irradiance and cloud cover over polar regions derived from the CERES data set (<https://doi.org/10.1029/2006GL026685>)

Liu, Y. and Key, J. R., Assessment of Arctic Cloud Cover Anomalies in Atmospheric Reanalysis Products Using Satellite Data (<https://doi.org/10.1175/JCLI-D-15-0861.1>)