Response to Referee #2 Andrew Heymsfield:

Dear Andrew Heymsfield,

Thank you for your comprehensive and thoughtful review of our manuscript. We appreciate the time you invested in providing feedback.

We have carefully considered all the points raised and have incorporated your suggestions into the revised manuscript. Our point-by-point responses are provided in the following, with referee comments in blue, our responses in black and manuscript changes in grey.

I read carefully through this interesting article. I have some suggestions.

We thank the reviewer for his feedback. We are pleased that he found the manuscript interesting.

1. Contrails form at temperatures below about -40C, unless there are some extenuating circumstances. "Hole Punch Clouds". I suggest using temperature as another way of checking your results.

While using temperature as another method of validating contrail detections might seem like an intuitive method, the practical implementation is significantly hampered by vertical uncertainty. In geostationary satellite imagery like MSG, pinpointing the exact altitude of a contrail remains a complex challenge, e.g. the cirrus detection algorithm CiPS has an uncertainty of 10 % in estimating cloud top height. Because the specific height of these contrails is so uncertain, relying on temperature as a validation metric introduces more noise than clarity. Furthermore, it takes some time (probably 30-60 min or even longer) for contrails to become visible in MSG observations. Thus, we detect persistent contrails that have lived already for some time and whose age is unknown. In principle, they could have formed significant fall streaks over a range of > 1000 m below the contrail core that also contribute to the brightness temperature observations and height determination. The resulting altitude could thus correspond to temperatures higher than the Schmidt-Appleman temperature necessary for contrail formation. Consequently, we do not utilize temperature-based verification at this point.

2. It would be interesting to use ERA5 relative humidity/temperature data to see how well those fit with your analysis

While the inclusion of ERA5 humidity data might theoretically offer a physical basis for validating detected contrails, its utility is severely limited by two primary hurdles. First, the above-mentioned issue of vertical uncertainty plays a critical role. Second, the systematic underestimation of humidity in the upper troposphere within the ERA5 dataset presents a significant reliability gap (Gierens et al., 2020). Correcting for these dry biases requires complex, non-linear post-processing and calibration against observational data, such as radiosondes or aircraft sensors (see e.g. Teoh et al. 2024, Wolf et al. 2025, Wang et al. 2025). Given these two uncertainties, using ERA5 humidity as a definitive validation metric would introduce unacceptable levels of error. Consequently, we do not use this data from our current validation framework. Nevertheless, we are planning an investigation where we use detected contrails from COCOS and MSG to evaluate ice supersaturated regions in the ICON model of the German Weather Service where a 2-moment ice cloud microphysical scheme is used (see Hanst et al. 2025, Schumann and Seifert 2025) that allows for supersaturation with respect to ice.

3. EarthCare lidar data will be helpful in the future to further quantify how well your method fits the observations. You did use the CALIOP data in quantifying your results and the EarthCare lidar data can be used in the future.

We thank the reviewer for the interesting suggestion on possible future synergies with EarthCARE data. The following has been added to the manuscript in line 474:

In the future, high-resolution lidar data from the EarthCARE mission may prove helpful in addressing these gaps, providing the precise vertical profiling necessary to quantify the detection accuracy and physical characteristics of these features with far greater certainty.

Also, we would like to clarify that CALIOP data was not used to validate the results of this study. The confusion likely stems from our description of the CiPS retrieval (Section 2.2), which utilized CALIOP data during its own internal development and validation. In our study, we use this pre-existing retrieval as a tool, but our actual validation was performed against the human labeled dataset (Section 2.4).

References:

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Schumann, U. and Seifert, A.: On the Weather Impact of Contrails: New Insights from Coupled ICON–CoCiP Simulations, Atmos. Chem. Phys., 25, 18571–18597, https://doi.org/10.5194/acp-25-18571-2025, 2025.

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