General comments:

In this paper, the authors discuss the impact of using 100% sustainable aviation fuels (SAF) on contrail formation, involving measurements of particle emissions and contrails from 100% SAF combustion, compared to Jet A-1 fuel. The results indicate a significant reduction in ice particle numbers per mass of burned fuel when using 100% SAF, suggesting that this could be an effective way to reduce the climate impact of aviation. The research also explores the effects of different fuel compositions on soot and ice particle emissions, as well as their potential impact on atmospheric conditions and climate forcing. The study is methodologically sound, the data is very valuable and is of significant value in exploring the impact of sustainable aviation fuels on reducing aircraft contrail effects. However, I must express three major concerns as well as a few specific issues related to the content, which I will delve into more deeply below. There is no doubt that with necessary revisions, the work will be worthy of publication. Nonetheless, it is imperative to note that major revisions are required to elevate the study to its full potential.

Three major issues:

1. The method of determination of the apparent ice emission index.

There are two critical assumptions in your methodology that warrant further elucidation or validation: **a) Uniform NOy Mass Across Different Fuels:** The method you proposed utilizes the ratio of ice crystal to NOy concentration to determine the ice crystal concentration per unit mass of fuel burnt. This method's effectiveness is predicated on the assumption that different masses of fuel (e.g., SAF and Jet A-1) produce the same mass of NOy. However, it appears that the manuscript lacks experimental data or theoretical justification to support this assumption. To bolster the persuasiveness of your research, I recommend providing additional evidence or a detailed analysis to validate this key assumption. **b) Assumption of Similar Atmospheric Influence on Ice Crystals and NOy:** Your approach, based on the relative changes in ice crystal and NOy concentrations to offset atmospheric dilution effects, seems to assume that ice crystals and NOy behave similarly in the atmosphere, unaffected by processes like evaporation, growth, or droplet freezing. Given that the formation and transformation of ice crystals in contrails are dynamic and complex processes, this assumption might require further substantiation. Specifically, the evaporation or growth of ice crystals and the freezing of droplets could significantly influence ice crystal concentrations, potentially leading to divergent behaviors between ice crystals and NOy. Thus, I suggest that you further explore the validity of this assumption and consider the potential impacts of these factors on your study's outcomes.

2. The reduction of ice crystals due to only BC?

The observed reduction in ice crystal concentration in aircraft contrails, alongside a decrease in Black Carbon (BC) concentrations, is particularly noteworthy. You suggest that this reduction in BC is a significant contributing factor to the observed decrease in ice crystal formation due to the use of SAF. However, it is well-recognized that a range of particulate matter, not limited to BC, can act as ice nucleating particles, particularly at the cold temperatures typical of contrail formation altitudes. Organic aerosols, both volatile and non-volatile, can also contribute to ice nucleation (e.g. Tian, P., et al. (2022). The manuscript mentions the presence of non-volatile organic aerosol and VOC emissions that can transform into organic aerosols in aircraft exhaust. Considering this, attributing the reduction in ice crystal formation solely to the reduction in BC might overlook the potential role of these other aerosols.

3. The manuscript is based on the data collected from only one flight experiment. Figure 1 display the total observation time was smaller than one hour. While the findings are intriguing, the variability and complexity of atmospheric conditions raise concerns about the representativeness and generalizability of these results. Atmospheric conditions, including temperature, humidity, and aerosol content, can vary significantly and impact contrail formation. A single flight experiment might not sufficiently capture this variability.

Specific comments:

1. The manuscript lacks a clear description of the methodology employed for measuring Black Carbon concentrations. Understanding the measurement technique is crucial as different methods can yield varying results, commonly employing a Single Particle Soot Photometer (SP2). However, this manuscript using a thermo denuder at 250 degrees Celsius to measure refractory BC, this might cause bias in BC measurement, as some non-volatile OA could also survived even after 350 degrees Celsius suggested by Hu, K. et al., (2022) and Tian, P. et al. (2022).

2. The CAS instrument is capable of measuring droplet size distributions in the range of 2-50 micrometers. Importantly, it also provides polarization signals from the backward scattering of individual cloud particles, enabling the differentiation between liquid droplets and ice crystals. This feature is particularly relevant to your study as it can offer a more detailed understanding of the phase composition within the contrails. However, the manuscript does not appear to fully explore or utilize this capability of the CAS.

3. The manuscript indicates that comparisons were made with data above the ice supersaturation threshold to minimize atmospheric interference. However, it lacks a detailed explanation of how this supersaturation state was measured or determined. The specifics of measuring such a critical parameter are vital for understanding and replicating your findings.

4. Some sentences could benefit from better punctuation to enhance readability and clarity.

5. Ensure that all references are formatted consistently and according to the journal's guidelines.

Reference:

Tian, P., Liu, D., Bi, K., Huang,M., Wu, Y., Hu, K., et al. (2022). Evidence for anthropogenic organic aerosols contributing to ice nucleation. *Geophysical Research Letters*, *49*, e2022GL099990. https://doi.org/10.1029/2022GL099990.

Hu, K., Liu, D. T., et al. (2022). Identifying the Fraction of Core−Shell Black Carbon Particles in a Complex Mixture to Constrain the Absorption Enhancement by Coatings. Environ. Sci. Technol. Lett. 2022, 9, 272−279. https://doi.org/10.1021/acs.estlett.2c00060