

Response to Reviewer 1

We would like to thank the anonymous Reviewer for their careful review. We found all the remarks and recommendations to be very relevant. Based on the review, we have extended the analyses to the seasonal scale, which has further enriched the paper. Below is our response to the comments on a point-by-point basis. The following convention for text fonts is used:

- Review comments in black color
- Our answers in blue color
- *Pieces of text taken from the revised manuscript in red color and in italic font.*

Comments

- Figure 5: As the regional differences here are sometimes quite significant (differences in dry mode), it would be interesting to know how much these results differ seasonally.

We thank the Reviewer for the remark. We took it into account by intercomparing the seasonal PDF of RHI over the USA, NA and EU for both the lower stratosphere (LS) and the upper troposphere (UT). We found that the difference between the three regions on the magnitude of the dry mode does not depend much on the season. We provided the analysis (Fig. S1) as Supplementary Material. It should however be noted that restricting the dataset to collocated measurements that are flagged as valid for ozone, RHI and temperature and then separating the data between tropospheric and stratospheric measurements reduced the size of the seasonal samples. Consequently, all aspects of the seasonal PDF of RHI are not statistically robust. The comments about this analysis are on line 204 in the revised manuscript.

- Section 3.4:
 - Even if reference is made to the literature on the seasonality of ISSRs, I would also find a seasonal view or statement helpful for the results of Figures 7 and 8.

We thank the Reviewer for this very relevant remark. The frequency of occurrence of the persistent contrails closely follows that of ISSR. Consequently, it is the seasonality of the frequency of ISSR that we have documented. The values are presented in a new figure (Fig. 7 in the revised version of the manuscript). The comments added in the manuscript about this figure are on lines 285 to 302. A clarification is also made in the introduction from line 57 to line 60. As recommended, we have also provided a seasonal view of the impact of switching from kerosene to ethanol or hydrogen on the occurrence of contrails. The values are presented in Tables S1,S2,S3, in the Supplementary Material. The comment about these tables in the revised manuscript are on line 337. We have removed Table 6 in the manuscript because we found that it is redundant with the current Fig. 8.

- In the explanation of the different contrail frequencies, it is mentioned that this is **partly** due to the ratio of EI_{h2o} to Q. What other reasons are there for behaviour?

The fuel-dependent parameters in the Schmidt-Appleman criterion equations are E_{H_2O} and Q . These two parameters are the main source of the differences in the frequency of contrails. Given that a switch of fuels would also likely induce changes in the aircraft design, the aircraft engine propulsion efficiency may also change and contribute to the differences. On the suggestion of Reviewer 2, we rephrase the explanation as follows: *At low ambient temperature, the contrail plume exceeds water saturation more readily due to the curvature of the vapour pressure curve, regardless of the fuel being considered. The contrail plume may stay subsaturated with respect to liquid water if the ratio of E_{H_2O} to Q is low. In such conditions, persistent contrails are less frequent with kerosene than with hydrogen and ethanol.* This new text runs from the line 338 to the line 341 in the revised manuscript.

- Could you briefly discuss how the results relate to climate projections. What is the expected impact of the different fuel types in a warming climate based on your results?

We now discuss how the results relate to climate projections between the lines 341 and 344 as follows: *With the warming of the upper troposphere expected as a result of climate change (Kumar et al. 2022), the impact of switching from kerosene to ethanol or hydrogen on contrail formation could further increase in the future, potentially affecting pressure layers (e.g., 225-175 hPa in the high and mid-latitudes) and seasons (winter and spring in the high and mid-latitudes) where it is low under present conditions.*

Minor

- P2L49 The last sentence in the paragraph sounds a bit tacked on

We have modified the paragraph by placing the statement about natural cirrus clouds at the beginning of the paragraph. Please find it on line 37 in the revised manuscript.

- Table 3: There is a word missing in the caption.

Corrected

- P14L271 remove the “by” between “essentially” and “undersaturated”

Done

- P18: Values for combustion heat Q should be in MJ /kg instead of J / k

Corrected

- P19L325 missing dash between “non” and “persistent”

Added

- P19L326 remove “and”

Done