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Interactive comment on "Statistical Analysis of Contrail to Cirrus Evolution during the Contrail and Cirrus Experiments (CONCERT)" *by* Aurélien Chauvigné et al.

Anonymous Referee #2

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The authors present aircraft observations of the scattering properties of ice crystals and the trace gas properties sampled inside 17 contrails during two phases of the CONCERT field experiment. While the results presented here are relevant and interesting, the paper has several areas where more explanation is warranted before I can recommend it for publication. For example, some parts of the introduction need to be reorganized.

The most major flaw of the paper which needs to be address is the selection of the clusters. The authors base their cluster classification on a rough examination of the first three principal components in the x-y plane and seem to draw ellipses around

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where they "roughly identify" where the clusters are. However, with recent advances in machine learning, there are more objective methodologies for classifying data into clusters, with the most applicable methodology for a feature space of three variables to be k-means clustering. The authors should either better justify why their current ellipses were chosen and why the feature space was used for the PCA, or use automated clustering techniques. Finally, I think a section on how their contrail cirrus observations fit in with past studies is warranted, since the paper lacks much discussion on how their observations fit in with what is already in the literature. I list some other comments below.

Major comments:

Lines 51-91. This paragraph is too long and needs to be reorganized. For example, there is too much detail on how NO from aircraft exhaust is converted into acids that does not really add to the major point that NO interacts with OH to make nitr(ic)ous + sulfuric acid. I also feel that this can really be 3 paragraphs: one about NO interacting with OH to produce acids, one about the contrail production process and one about the contrail aging process.

Line 109-146: I feel that a lot of the individual data points cited here are better suited for an extra section in the paper comparing your contrail observations against past studies. Right now, no link is made to how your categories compare against these past observations and I think such a comparison is needed in order to justify that the range of values that you observe in your clusters correspond to contrails properties that are observed in nature. Therefore, I recommend shortening this paragraph to just briefly explain how the microphysical properties of contrails evolve with time with leaving specific numbers to a later comparison.

Line 223-225: You aren't using the 2DC for calculating IWC though! I don't see why this sentence is needed. However, I think text here justifying why you are not using observations below 70 microns due to the 2DC's limited response time and depth of

field need to be here.

Section 3.2: I think more justification needs to be given for the choice of your feature space for the PCA, since right now it is presented without really linking the feature space to looking for quantities that we expect to vary in differing stages of contrail cirrus. For example, why did you conduct a PCA on the entire scattering phase function instead of just apply clustering to the asymmetry parameter?

Also, why were the clusters manually chosen instead of using automated techniques like k-means clustering?

Lines 505-512: How do you know that you flew in an aged contrail with no verification from ATC? I think the important conclusion here is more that, microphysically, aged contrails and cirrus are very similar and are difficult to distinguish with this data alone.

Line 518-522: I think this analysis can be better supported by showing the distributions of contrail ages from ATC.

Line 593-595: I would not interpolate data in this range since the interpretation of extrapolated data could be quite dangerous. I would simply state that concentrations in this size range are too uncertain to report due to the 2DC's poorly characterized depth of field and response time.

Lines 607-610: Your YC1 contrails seem to have roughly similar 2DC number concentrations to the aged contrails. Why is that?

Lines 640-667: I would convert this into a bulleted list of conclusions to make this paragraph easier to read.

Figures/Tables:

Figures 5c,d: A logarithmic x-axis would make the lines easier to distinguish.

Figure 6: I would advise removing the lines where you don't have the PSD from the two probes in the ~20 to 70 micron range. Can you also add size distributions from past

studies and include them in the comparison?

Table 2: I think some data from contrails sampled in past studies should be shown and comapred against here and in the paragraph discussing Table 2.