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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evidence of impact of aviation on cirrus cloud formation" *by* C. S. Zerefos et al.

Anonymous Referee #1

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This paper describes a study of temporal trends of cirrus cloud cover at extra-tropical latitudes, with a focus on the North Atlantic flight corridor and surrounding regions. The ISCCP dataset is used to calculate trends in cirrus cover, and the results are compared with previous studies. The study looks into the correlation between air traffic emissions and cirrus occurrence. By comparing cirrus trends in smaller areas with high and with low air traffic it is shown that cirrus trends are generally larger in the former areas. Finally, the study shows a strong correlation between cirrus trend and aircraft fuel consumption at higher latitudes whereas at lower latitudes a similar correlation is not found.

The study is written very clearly and well, and the standard of English is high. The pictures and tables are clear, and the abstract gives an adequate overview of the contents of the paper. The manuscript has been altered extensively since the first version

through addition of a comparison of the derived trends with previous studies. This increases the credibility of the trend-analysis. I have a few questions, though, regarding section 3 where cirrus trends are compared in areas with low and with high air traffic emissions. Although it is evident that contrail formation adds to cirrus cover, so that a positive relation may be expected, the evidence presented here is not indisputable.

My first remark concerns the comparison of cirrus trends between areas with high and with low aircraft emissions. It is probably not possible to find two areas that are meteorologically and dynamically exactly the same. Although the authors took care that Şcalculated trends between adjacent locations do not include substantial differences in natural climate variabilityŤ the regions are sometimes so different dynamically and meteorologically that a difference in cirrus trends between the regions may not be attributed to aircraft emissions alone. For example, one of the two gridboxes over N. America is located west of the Rockies, the other one east. The Rockies form a barrier for the jet stream so that the UTLS in the first region is, on average, characterized by winds from the northwest, and subsidence coinciding with the trough in the jet stream. In the second one, UTLS winds are generally more towards the north and east. This difference by itself may have an important impact on the absolute cirrus occurrence, and co-determine the magnitude of the response to a disturbance, e.g., increased air traffic emissions or different wind speed in the UTLS. The European grids are subject to another difference: the western region is on average much more under influence of winds from the ocean than the eastern region. It should be discussed what the effect of different dynamics may be (what are the differences in absolute cirrus cover here?), or made the authors should make it more plausible that these do not play a role.

Figure 3 shows a good correlation between fuel consumption and cirrus trend at higher latitudes. The authors write: ŞThe correlation suggests that the apparent increase of thin cirrus clouds .... could be related to contrail cloudiness formed by aviation activitiesŤ (p. 3345) and conclude that this provides Şan independent test of possible impact of aviation on contrail cirrus formationŤ (p. 3348-3349). Is a causal relation

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implied here? If so, then the lower half of Figure 3 raises a problem. The trends found at lower latitudes are of the same order of magnitude as at high latitudes, but there is no significant correlation with the Űvery small at these latitudes - air traffic emissions. So, if at higher latitudes a causal relation exists between aircraft emissions and cirrus cover trends, does that mean there is another cause for the trends found at lower latitudes? Is it plausible that there are different causes for cirrus cover trends at high and low latitudes? This aspect should certainly be discussed in more detail. Closer examination of Figure 3 shows that the longitudinal variability of the cirrus trend as well as of the aircraft emissions is strongly related to the location of continents (high trend and fuel consumption) and ocean (low trend and fuel consumption). Apart from the tropical Pacific, a similar variability in cirrus trends is found for 5-25N. Therefore, other explanations must be considered here. Is it possible that a trend in convection plays a role, causing a change in transport of humidity and aerosols to the UTLS? All in all, although the conclusions are plausible, I am not convinced that the correlations presented in this study are not, at least partly, fortuitous.

Minor remark: Caption of Table 3 mentions "italics", but there are no italics in the table.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 3335, 2003.