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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Is there a trend in cirrus cloud cover due to aircraft traffic?" *by* F. Stordal et al.

F. Stordal et al.

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1. General

The most extensive changes made in the revised manuscript are as follows:

- All referees questioned either the documentation or the value of the NILU/METEOSAT retrieval. We have decided to leave the work based on this retrieval out. As a consequence the analysis of ISCCP IR data, which were introduced as a bridge between ISCCP VIS/IR and NILU/METEOSAT, is also left out.

- The referees demanded an uncertainty analysis, which has now been included.
- All referees had some questions regarding the global extrapolation of the results to arrive at a global impact of aircraft on cirrus cover (e.g. the factor 2 in the estimate). We have made this clearer by including some equations and providing an extended discussion.
- One of the referees suggested a change in one of the section titles. This has been made, along with other adjustments of subtitles in Section 3, to be consistent with the extended discussion mentioned above. Also, as more of the discussion is moved to Section 3, Section 5 is now “Conclusions” rather than “Discussion”.

2. Referee #1

2.1. Overall comments:

- We have improved our trend analysis by including uncertainty analysis.
- There is some focus on NAFC as one of the regions selected in the METEOSAT region is within NAFC. However, as explained below, NAFC is covered by several satellites in ISCCP, and thus a major focus on NAFC is difficult.

2.2. Major comments:

- The abstract is worded more cautiously, in line with the discussion
- There are clear problems in ISCCP. However, there is a long and continuous data record. This makes ISCCP probably one of the best tools for studies of long term

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trends in cirrus. A sentence describing this has now been added in the method section on ISCCP.

- The NILU/METEOSAT retrieval is removed
- Flight density in the original was annual average and in the unit was per month. Unfortunately this unit (per month) was not given. In the revised manuscript we have given a time unit. However, as we have used yearly average, we have found it more appropriate to convert our numbers to the unit per year.
- Estimation of trends were actually calculated from yearly average in the original version, and unfortunately erroneously described as monthly averages. This has been corrected.
- We agree that ideally trends in air traffic should be applied regionally. However, as the reviewer indicates, they are not known at a regional level.
- We acknowledge the fact that the NAFC region has been subject of many studies of impacts of aircraft. Thus we agree that a particular focus in our study on NAFC would have been interesting. However, there is a problem that NAFC is covered by several different satellites, and thus a careful study of NAFC is difficult and not focused in particular. But we do use a fraction of NAFC in our study, namely the part which is covered by METOSAT.
- The extrapolation to global scale has now been made in a more rigorous way, and some equations have been introduced to clarify the procedure adopted.

2.3. Small and editorial comments

- P6475, L 4: The mentioned distinction in Boucher's finding (cloud occurrence) is made in our revised manuscript

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- P6475, L29: “Three days periods”, corrected to “three day periods”
- P6476, L19: Geostationary, typo corrected
- P6478, L10–11: In the Indian Ocean two geostationary satellites cover the eastern and western parts. Unfortunately there is no geostationary satellite covering the central part, where data from the polar orbiter NOAA-A are used. We have modified the text to explain this better.
- P6479, L25–26: The NILU/METEOSAT method is taken out.
- P6480, L5: Typo corrected
- P6483, L9: We agree. The reference to Lelieveld et al. (2002) is taken out
- P6487, L9: Typo corrected
- P6488: The two IPCC references have been corrected
- P6488, L3: Typo corrected
- P6489, L1–8: capitalization is dropped
- P6492, Figure 2: the figure has been removed
- P6493, Figure 3: the figure has been removed
- P6498, Figure 8: typos are corrected and the year is specified

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3. Referee #2

3.1. General comments

- Uncertainty estimates have now been made and confidence intervals are introduced
- The abstract is worded more cautiously
- In addition to a best estimate lower and upper bounds have been included
- This is an original contribution and not a review paper. We have compared our results with other work. Although we see that a "detailed comparison of methods" could be beneficially, we regard this to be beyond the scope of this paper.
- We have included a sentence by the end of the conclusions where we point to potential improvements in future research based on our method.
- The original Figures 9–11 have been replaced with only one figure illustrating the main points.

3.2. Main specific comments

1. We have introduced some additional explanation of methods used in various papers. The methods of Boucher (1999) and Minnis et al. (2004) have been better explained in the introduction. Regarding the Zerefos et al. (2003) paper, some clarification of their method is included in the discussion later in our paper.
2. This confusion should be avoided now, as we use only one cloud product
3. NILU/METOSAT is removed

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4. There is a very weak correlation between cirrus trends and air traffic in eastern US and eastern Europe. We have now included a short discussion of this fact in the revised manuscript.

5. The trends from the two methods are somewhat different, as pointed out by the referee. As we now include an uncertainty analysis for the two methods it is easier to compare the two. In general the confidence intervals overlap. This is mentioned in the revised manuscript.

6. We have changed the title of Section 4. In addition we have adjusted some other titles to be consistent.

7. The extrapolation to global scale has now been made in a more rigorous way, and some equations have been introduced to clarify the procedure adopted.

8. Uncertainty estimates are included

9. Minnis et al is mentioned in the introduction

10. “from” is deleted, and the fact that IPCC estimates are uncertain are mentioned

11. Sentence is removed/rephrased

12. A reference to ISCCP D2 data has been included here (one which was already in the reference list)

13. In the original manuscript we used two ISCCP products. In the revised manuscript we use only the VIS/IR product, representing cirrus only. We hope that we now avoid the problems in distinguishing between cirrus and other types of high clouds.

14. The NILU/METEOSAT method has been removed

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15. This sentence is removed along with the NILU/METEOSAT method

16. This sentence regarded comparison of trends in the two ISCCP products and is now removed

17. This sentence regarded comparison of trends in the two ISCCP products and is now removed

18. This sentence regarded comparison of trends in the two ISCCP products and is now removed

19. “the years” have been added before 1992 and 2000

20. The term “Revenue passenger kilometers” has now been explained

21. This sentence is removed along with the discussion of results from the NILU/METOSAT method

22. This sentence is removed along with the discussion of results from the NILU/METOSAT method

23. There is a tendency that correlation coefficient and slope vary similarly. The discussion of the correlation has been renewed along with introducing uncertainty analysis and equations. We are not including the point raised here in the revised manuscript.

24. The section on Europe has been moved along with a reorganization of Section 3.

25. “Quite important” has been removed.

26. The change to “was estimated to be” is made

27. The sentences have been removed to Section 4, somewhat modified to go with the renewed discussion.

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28. The sentence has been rewritten, and is now hopefully easier to understand.
29. Only Figure 1 is now used, the two latter are removed
30. The figure has been removed (NILU/METEOSAT)
31. The figure has been removed (ISCCP IR)
32. The figure has been removed, as suggested by referee #3
33. The figure has been removed (NILU/METEOSAT)
34. A zero line has been included
35. The figure has been removed (NILU/METEOSAT)
36. The typo is corrected
37. The typo is corrected
38. The typo is corrected

4. Referee #3

4.1. Specific comments and technical issues

1. The NILU/METEOSAT retrieval has been removed
2. The NILU/METEOSAT retrieval has been removed
3. The paper has now been improved by introducing significance of trends in terms of confidence intervals.

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4. We have removed the figure as suggested.

5. Several weak points in our original figures are pointed to here. However, they regard figures that are removed.

6. The figures have been replaced by global plots with reasonable numbers on the axes

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Interactive comment on Atmos. Chem. Phys. Discuss., 4, 6473, 2004.