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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aircraft pollution: a futuristic view" *by* O. A. Søvde et al.

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Thank you very much for your helpful comments, they help improving the article a lot.

First of all, I must say - as I did in my author comment - that I'm very sorry for the mix-up of the figures. I somehow managed to get Figures 3 to 11 to become Figures 2 to 10, so that in the paper the figures 10 and 11 are the same, and figure 2 is missing. So I apologize for the frustration felt.

We wanted to study the new emission scenarios provided by the Scenic project, with focus on aerosol emissions from aircraft. The regular emissions (NOx and H2O) is also investigated to assess the impact of this scenario, and for comparison with the scenario including aerosol emissions. New in this study is the rather large effect of aircraft aerosol emissions.

Thanks for the assessment references. The Oslo CTM2 model is not a new model, and has previously been evaluated and described in various works ([Grini et al.(2002)]; [Brunner et al.(2003)]; [Isaksen(2003)]; [Eskes(2003)]; [Gauss et al.(2003)]; [Berglen et al.(2004)]; [Isaksen et al.(2005)]; [Brunner et al.(2005)]; [Gauss et al.(2006)]) and also in [Søvde et al.(2007)] (as written in the text) where the is has been improved by a new heterogeneous and microphysics scheme, and where extensive evaluations against UTLS measurements (sondes, aircraft, satellites) are carried out.

1 Answer to specific comments

Reference to Johnston (1971) will be added.

The choice of T21 horizontal resolution was made due to the number of scenarios and the long spin-up time required for a stratospheric study, combined with the computational cost. The model includes 98 species, whereof 77 are transported (done with the second order moment scheme of [Prather(1986)]). Combined with the comprehensive chemistry (both tropospheric and stratoshperic chemistry), the model requires high computational power. There are some comparisons of the Oslo CTM2 against MOZAIC measurements in [Søvde et al.(2007)], given for both T42 and T21 resolution, showing that the different horizontal resolutions are capable of capturing most of the same features in the UTLS region. In view of this, and given the number of scenarios and the long spin-up time required for a stratospheric study, it was decided that T21 would yield the best scientific output.

As meteorology we have chosen year 2000 due to lack of more years of data at our department at the time of the simulations. I believe it can be argued that any choice of meteorology could be atypical for 2050 conditions, and as you say probably not a major one. In respect to the cold bias of 2000, the UTLS could be more similar to

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year 2050 conditions with increased CO_2 levels. In case it is too cold (warm) for 2050, the heterogeneous conversions would be overestimated (underestimated), which would lead to a smaller (larger) O_3-loss due to NOx and larger (smaller) loss due to halogens. However, due to the uncertainty of this, we have chosen to keep this a pure CTM study to focus only on the chemical issues.

H_2O in the troposphere is taken from the meteorological data, and in the stratosphere it is calculated assuming constant total hydrogen. Only CH_4 is transported. The H_2O emitted from aircraft is transported as a separate species, which is superposed on this calculated value of H_2O. When PSC2 is formed, the solid H_2O is calculated and removed from the gas phase, and we keep track of the sedimented amount of solid H_2O, so that dehydration is taken into account.

The coupling between NOx and HOx is taken into account in the chemical scheme, although we have not studied the degree of reduction in the ozone depletion due to HOx.

The ECMWF IFS meteorological data used are forecasts produced with 12 hours of spinup starting from an analysis at noon on the previous day. An age of air study has been done for the 60-layer IFS data in the Scout-O3 project, showing an improvement in the age compared to ERA-40. The model's ability to reproduce measurements ([Søvde et al.(2007)]) indicates that the model transport is well handled.

The aircraft emissions are described more closely in the revised paper. More specifically, the NOx emissions are divided into commercial subsonic (6.987Tg(NO_2)/yr), commercial supersonic (0.274Tg(NO_2)/yr), general aviation (0.074Tg(NO_2)/yr) and military fleet (0.110Tg(NO_2)/yr). Total is 7.445Tg(NO_2)/yr. The H_2O emissions are

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given as 1.25 times the fuel consumption. A new table will be added to put light on this. The emissions are based on 501 supersonic aircraft and 114.1 million supersonic passengers per year. The number of subsonic and supersonic flights (in thousands) are 110189 and 608.6, respectively. More detailed information about the engine types assumed, emission indices for different parts of the flights, routes and more, are given in [Rogers(2005)], and will also be described in Maritzy et al in this SCENIC issue.

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