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Interactive comment on “The impact of traffic emissions on atmospheric ozone and OH: results from QUANTIFY” *by* P. Hoor et al.

P. Hoor et al.

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We thank Ulrich Schumann for his comment and for his suggestions. We followed his suggestions and included an analysis of traffic emissions in the northern extratropics and a discussion of the effect of the model resolution. We agree with Ulrich Schumann that there is an importance to put the numbers given in the manuscript into context to previous results using similar regions and methods as in previous studies.

In general, there is a lack of metrics or common convention for such numbers, e.g. zonal mean average or absolute maximum in the domain, global average, 30°-60°N, 30°-90°N (note that we find the maximum aircraft induced ozone perturbations (mixing ratio) north of 60°N). The values in our Tab. 6 were given as annual mean values between 300-200 hPa and therefore appear to be low. We obtain -0.89±0.46 ppbv (or 0.72% relative to the base scenario) for the global annual mean. The respective

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numbers in the abstract were indeed mixed with the respective table columns, we apologize for this and changed the revised version accordingly.

As can be seen from former Figs. 4, 5 and 8 the sensitivity of ozone to aircraft emissions amounts to 3.5 ppbv between 200-300 hPa maximizing in summer. In addition to these Figures a detailed calculation for the latitude bands as suggested is now included in the revised version.

The maximum changes of ozone due to aircraft emissions are 3.69 ppbv (or 4.31%) from 30°N-60°N in the 200-300 hPa layer, which is of course much higher than the global values. Compared to the POLINAT results these values are still somewhat lower. However, more recent results by Kentarchos et al. (2002) or Gauss et al. (2006) are closer to the results presented in our study. Based on the TM4-model Kentarchos et al. (2002), calculated maximum ozone changes at 250 hPa of 1.5-3.0 ppbv for January and July, respectively (Hoor et al.: 2.0 ppbv and 3.5 ppbv, respectively). A simulation of the OsloCTM-2 within the TRADEOFF project (Gauss et al., 2006) reported maximum annual zonal mean ozone changes of 4 ppbv at 10 km north of 60°N (Hoor et al.: Maximum annual zonal mean poleward of 30°N: 2.8 ppbv, absolute maximum 4.2 ppbv). These values occur poleward of 60°N therefore exceeding the respective numbers (2.16 ppbv and 1.63%) in the modified Tab. 5, which accounts for values between 30-60°N. Note that both models participated in our study. The higher numbers of the aforementioned studies are mostly calculated by models with a rather coarse horizontal and vertical resolution. The NO_x emissions from air traffic in those examples are equal (Gauss) or lower (Kentarchos) compared to our study. Model resolution could potentially affect the results which might be the case for p-TOMCAT, which was used at a rather low resolution of T21 (5.6°×5.6°). Although p-TOMCAT calculates maximum values in our study (see also Table 6), the results for aircraft emissions are closest to the results from POLINAT or AERONOX. The values in Gauss et al. (2006), which are also higher than in our study, were calculated with the OsloCTM2 in T21-resolution. For QUANTIFY the same model at higher resolution, but the same aircraft emissions calculates significantly lower values even considering

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the effect of small scale versus 100% perturbation. A systematic investigation on the resolution would add valuable information, but here the resolution related aspects must remain qualitative.

As mentioned above we extended the ozone perturbation table and discussed the results in more detail. Concerning the effect of non-linearity, a sensitivity study by the p-TOMCAT-model indicates that the differences for ozone can exceed 0.46 ppbv at 250 hPa (zonal annual mean) when using the scaled small perturbation compared to a full 100% emission reduction. We included a detailed discussion on both aspects and added the specific ozone sensitivities for the latitude band 30°-60° to the table.

Another potential source of uncertainty is notably the amount and distribution of lightning NO_x, as already noted by Schumann et al. (1997). Kentarchos and Gauss used 4-5 TgN/year like most of the models in our study. However, one model (LMDzINCA) in our analysis only used NO_x emissions of 2 TgN/yr, but their results do not significantly deviate from the mean or the ensemble neither for aircraft emissions nor for road or ship traffic.

The recently published reaction of NO with HO_2 by Cariolle at al. (2008) is not included, since the model simulations were carried out earlier. It is difficult to estimate the effect on aircraft emissions: On the one hand one could expect a reduced sensitivity to additional NO_x from aircraft since part of it is converted to HNO_3. On the other hand HNO_3 in the upper troposphere acts as a reservoir species subject to long-range transport and a larger spread of the emission.

Radiative forcing estimates have been added to paper and are discussed in a separate subsection.

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