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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of business-as-usual anthropogenic emissions on air quality" *by* A. Pozzer et al.

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We thank the referee #1 for the positive review. All the corrections suggested have been implemented in the manuscript, while the clarifications requested are listed here below.

p.8620, l.11-18 I think this paragraph could be moved to section 2.[..].

We thank the referee for the corrections and the better text formulation which was incorporated in the manuscript. We are however reluctant in moving this paragraph to section 2. Here previous work is described to provide a background of the literature. We hence believe that the introduction is the correct place for such a description.

p.8625, l.10 A discussion of how emissions from solvents were projected is missing from this paragraph.

Emissions from the solvent industry were scaled with the population projections, as mainly driven by population growth. We added this information in the manuscript.

p.8626, l.3 I would also recommend adding a table or a plot to the main text with the total anthropogenic emissions for the key species [..].

A new table with the total emissions has been added in the revised manuscript, showing the global changes in the emissions for some species.

p.8628, l.13 Did the authors compare their *SC_2005* simulation with observations for year 2005 or a climatological average of observations for each network considered?.

We compared the results from simulation *SC_2005* with the observations of the year 2005. We use the year 2005 observations and not a multi-year "climatology" as this year is expected to be represented by the model with the highest consistency, mainly because the chosen emission setup of primarily emitted species was compiled for this year. We added this information in the revised manuscript

p.8632, Sect.3.2.1 It would be informative to include plots of the spatial distribution of emissions for 2005, 2010, 2025 and 2050 simulation [..].

We have added spatial plots of the emissions in the supplement for all the simulated years (2005, 2010, 2025, 2050). In the manuscript we decided not to show spatial plots for simulation *SC_2010*, as requested by referee #1. In fact, the tracer/aerosol concentrations in simulation *SC_2005* and simulation *SC_2010* are very similar and difficult to distinguish, especially due to the reduced dimension of the pictures. Hence we expect that the reader would not find it useful to see spatial mixing ratios/concentrations plots for the year 2010, and we prefer

to keep the figures as they are, i.e. showing only the results from simulations *SC_natural*, *SC_2005*, *SC_2025* and *SC_2050*.

p.8634, l.18 Is it possible that wintertime titration of O3 may be occurring over Europe and eastern North American, thus resulting in almost a flat change in O3 over these regions from 2005 to 2050?

As the referee correctly mentions, titration may be significant over Europe during wintertime, especially over northern Europe (Wild and Prather, 2006). Nevertheless, the small changes in the ozone mixing ratios over Northern America and Europe between the different simulations are largely due to the emissions projection. Emission of NO_x over Western Europe is projected to increase (with respect to the year 2005) by 2%, 7% and 13% for the year 2010, 2025 and 2050, respectively. Furthermore, NMVOC emissions are expected to decrease by 2%, 12% and 20%. The increase of O_3 over western Europe with respect to the year 2005 is 0%, 6% and 10% for the year 2010, 2025 and 2050 respectively. Hence, the low increase of ozone is mainly due to a small increase (or even a decrease) of the precursors.

p.8635, l.8 Can the authors confirm that local ozone titration indeed occurs over China after 2005 and if there is a seasonality?

Differently from Europe, titration over China plays a large role. The emissions with respect to the year 2005 are expected to increase by 20%, 76% and 233% for NO_x and 15%, 40% and 65% for NMVOC for the year 2010, 2025, 2050. It must be stressed that the emissions increase largely occurs during winter time. Analysing the increase of ozone (i.e. 1%, 10% and 16% as annual mean for the year 2010, 2025 and 2050, respectively) we find a very strong seasonality in the relative increase of ozone with respect to the year 2005. During winter the relative increase of ozone is lowest (i.e. -1%, 2% and 6% for the year 2010, 2025 and 2050), indicating that substantial titration is taking place. During winter

the higher emissions of NO_x are increasing the titration, hence reducing ozone. During summer, instead, the ozone relative difference with respect to the year 2005 is much higher, i.e. 2%, 12% and 28% for the year 2010, 2025 and 2050. It can hence be concluded that titration is indeed occurring over China and that it is mostly happening during winter time.

p.8637 Could the authors elaborate on the naturally occurring PM2.5 levels as seen over desert regions of Africa, northern India, Mongolia, and Southern Ocean. How does the increase in PM2.5 for 2050 compare with that occurring naturally?

The absolute increase of $PM_{2.5}$ between simulation *SC_natural* and *SC_2050* is shown in Fig.1. It appears that that the largest increase occurs over East USA, Europe and especially over Northern India and eastern China. The changes over Europe and eastern USA ($\sim 30 \mu gr/m^3$) are however lower in magnitude that what occurs naturally over some desert area (up to $\sim 350 \mu gr/m^3$ yearly averaged), and it is comparable to $PM_{2.5}$ present in the pristine region of the Southern Ocean. Higher increases of $PM_{2.5}$ are projected in China and northern India in the year 2050. These increases, added to the already present natural $PM_{2.5}$, will lead to concentrations similar to desert areas. In Fig.2 also the relative differences are shown, describing the relative local impact of the $PM_{2.5}$ increase. Again, India and China will suffer a 10 fold increase in their $PM_{2.5}$ concentrations, which indeed, will have strong implication for the population in terms of air quality. Although the increases over Europe and USA may appear less significant, the changes are between a factor of 2 to 6. Since $PM_{2.5}$ can strongly impact human health, these values suggest the importance and the need of further legislation against air pollution. We added these considerations in the revised manuscript.

Figure 1 . The figure has been changed following the referee's suggestions to increase the readability. It has been merged with Fig.2.

Figure 7 . We changed the colour scale, but keeping the same scheme, to be consistent with Fig. 4-9.

References

O. Wild and M.J. Prather. Global tropospheric ozone modeling: Quantifying errors due to grid resolution. *J. Geophys. Res*, 111:D11305, 2006.

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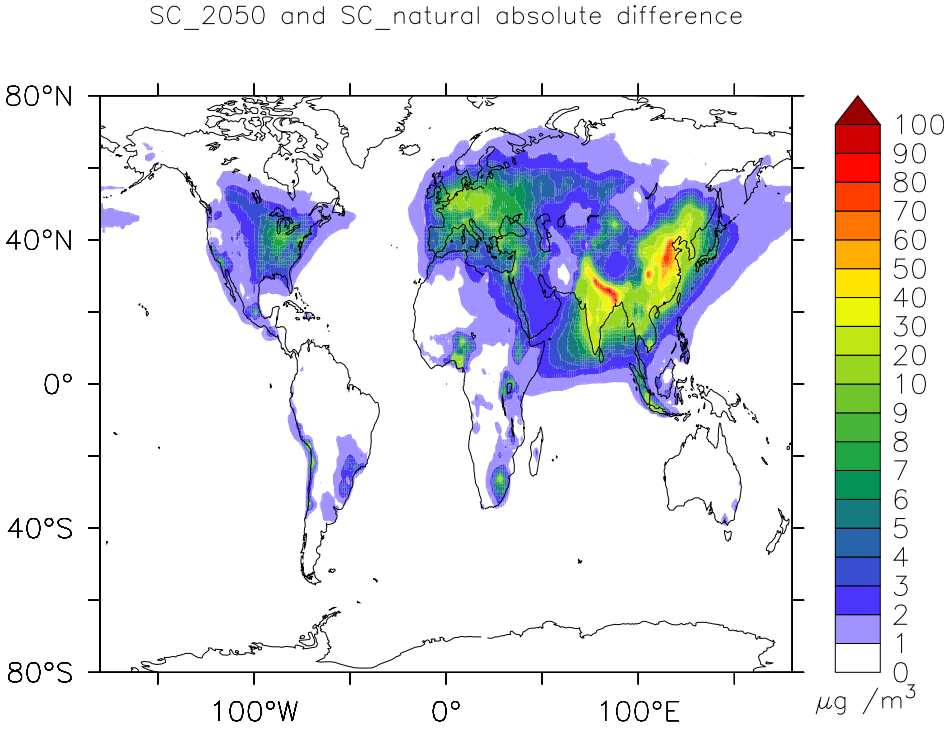

Fig. 1. Absolute difference of the annual average PM2.5 in ugr/mˆ3 between simulation SC_2050 and SC_natural

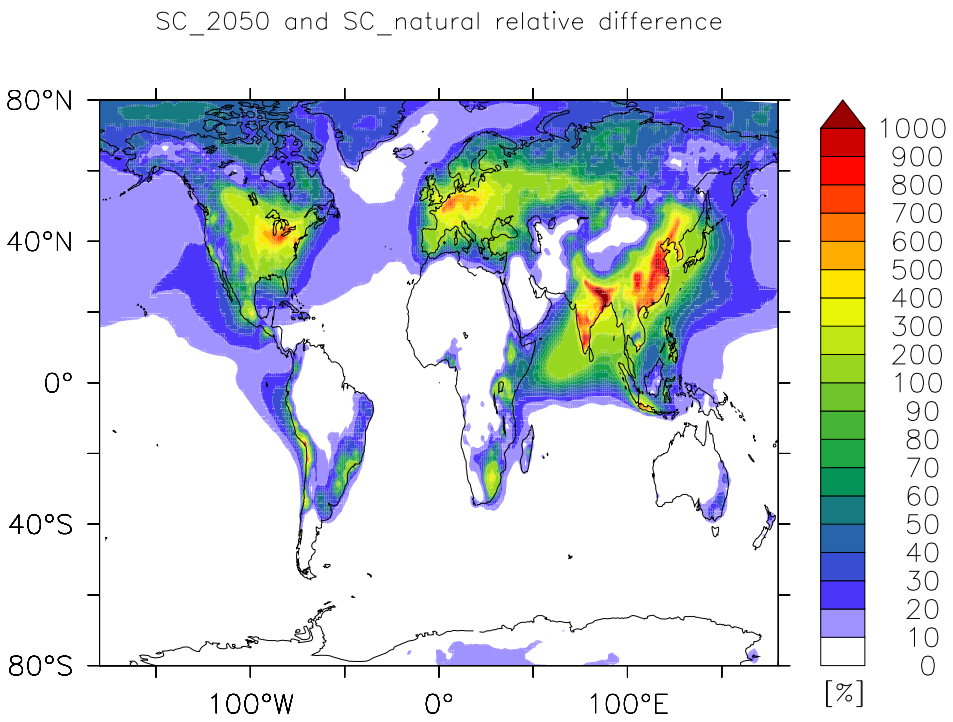

Fig. 2. Relative difference of the annual average PM2.5 in % between simulation SC_2050 and SC_natural.