Review of "Effects of business-as-usual anthropogenic emissions on air quality" by Pozzer et al. for publication in Atmospheric Chemistry and Physics

In "Effects of business-as-usual anthropogenic emissions on air quality", Pozzer et al. assess the effect of changes in only anthropogenic pollutant emissions from preindustrial to future (2050) on air quality for a business-as-usual scenario without considering any changes in climate or other environmental factors (e.g. land-use change). They do so by first simulating the distribution of key air pollutants in a chemistry-climate model and then applying these concentrations to calculate a multi-pollutant index. The multi-pollutant index identifies future hotspots of poor air quality. When weighted by population, the index highlights that regions with increasing population will be subjected to poor air quality in the first half of the 21st century. This is a well-written paper with valuable information. The paper is appropriate for publication in ACP after minor corrections have been made. See details below.

Specific comments:

- p. 8619, l.6: Provide references in chronological order.
- P. 8620, l.11-18: I think this paragraph could be moved to section 2. The authors are comparing their methodology with studies done in the past. Without having read what the resolution of the model is or the type of analysis performed here (which is discussed in detail in sections 2), a reader will not understand the significance of this work relative to published studies. Also, instead of "Some studies performed similar analysis to this work…", it would be clearer to say "Previous studies of historical evolution and future projections of air quality (references) did consider optimistic, realistic and pessimistic cases."
- p. 8620, l.18: I would recommend adding recent work such as Annenberg et al. (2010) to the references along with Knowlton et al.
- p. 8621, l.4: Replace semi-colon after "…index" with "and"
- p. 8622, l.2: Insert "described" after "submodel"

- p. 8622, l.18: For clarity the sentence "The same dynamics …." may be revised to "Comparison of different simulations with identical dynamics and meteorology allows to diagnose differences caused by only emissions/chemistry."

- p. 8623, l.9: The authors indicate that more information about the emissions is provided in Sect 2., but isn't this the section 2? Perhaps "Anthropogenic emission scenario" needs to be numbered as Sect 2b.

- p. 8623, l.12: Insert "As noted previously," before "The GHG used in the …."

- p. 8623, l.18: Replace NO_2 with N_2O in "for NO2 from Machida et al…"

- p. 8625, l.10: For consistency, I would recommend using the same source names as outlined on p.8624, l.6. For example, "manufacturing processes" and "crop production" should be referred to as "industrial processes" and "agriculture", respectively. A discussion of how emissions from solvents were projected is missing from this paragraph.

- p. 8626:, l.3: While the breakdown of emissions sector over the 2005-2050 time period provided in the supplementary is very useful, I would also recommend adding a table or a plot to the main text with the total anthropogenic emissions for the key species for 2005, 2010, 2025 and 2050. This would allow for a quick look at the evolution of BaU emissions over the time period considered in the study.

- 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?

- p. 8628, l.19: Remove "Ozone is accurately…." and revise "In this case…" to "Model average ozone compares well with the EPA observations, and almost ….".

- p.8629, l.26: Insert (Fig. 1) after "observed values"

- p. 8630, 1.11: Replace "what" with "that". Also on lines 14 and 15.

- p. 8630, 1.13: Insert space after "(NOAA ESRL GMD),".

- p.8630, l.25: Which year of MOPITT data has been used for comparison?

- P.8631, para 1: Model underestimation of observed CO concentrations particularly, during spring over the extra-tropics has been well-documented by Shindell et al. (2006). A reference to that study would be helpful.

- p.8632, section 3.2.1: It would be informative to include plots of the spatial distribution of SO2 (and other species discussed here) emissions for 2005, 2010, 2025 and 2050 simulations, in at least the supplementary material, because most of the discussion of the

changes SO2 burden here is geared towards regional trends. Is the plot of SC_2010 SO2 purposely not shown in Figure 4 (similarly for other species)? I suppose it could be included in the panel plot to support the discussion here.

- p.8634, l.18: Is it possible that wintertime titration of O_3 may be occurring over Europe [Wild and Akimoto, 2001] and eastern North American, thus resulting in almost a flat change in O_3 over these regions from 2005 to 2050? Perhaps the authors can just compare wintertime O_3 for their SC_2005 and SC_2050 simulations over these regions to confirm if the titration is occurring.

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

- p.8626, l.5: A reference to Levy (1971), who first demonstrated the cleansing property of OH, would be appropriate here.

- p.8637, l.14: Replace "of" by "by" in "projected to increase of only …" Similarly on line 15.

- 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?

- p.8642: Figure 14 should be referenced in the last paragraph.

- Figure 1: The plots are too small to read. Perhaps the panels can be split into different columns, with obs on the left and model on the right. The caption reads "The trace gases (from top to bottom) are NO2, SO2, CO, and O_3" while the panels from top to bottom refer to O_3, SO2, CO, and NO2. Please rectify this oversight.

- Figure 2 could be combined with Figure 1.

- Figures 2-8 do not include SC_2010 as I mentioned before. I think those can be added to the panels.

- Figure 7: The blue colors encompassing the values 100, 150, 200, 250 are hard to distinguish on the plots. It would be helpful to use a different color scheme.

References:

Anenberg, S.C., L.W. Horowitz, D.Q. Tong, J.J. West (2010) An estimate of the global burden of anthropogenic ozone and fine particulate matter on premature human mortality using atmospheric modeling, Environmental Health Perspectives, 118(9):1189-1195.

Shindell et al. (2006), Mutimodel simulations of carbon monoxide: comparison with observations and projected near-future changes, J. Geophys. Res., 111, doi:10.1029/2006JD007100.

Wild, O., and H. Akimoto (2001), Intercontinental transport of ozone and its precursors in a three-dimensional global CTM, J. Geophys., Res., 106, D21, 27739-27744.

Levy II, H. (1971), Normal atmosphere: Large radical and formaldehyde concentrations predicted, Science, 173, 141-143.