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Interactive comment on "The success of emissions control legislation in mitigating air pollution is higher than previously estimated" *by* N. Daskalakis et al.

Anonymous Referee #2

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Review of the paper "The success of emissions control legislation in mitigating air pollution is higher than previously estimated" by Daskalakis et al., acpd, 2016

The paper by Daskalakis et al. (2016) deals with the assessment of emission control measures in improving global air quality through the development of hindcast simulations over the past 30 years. The authors performed simulations using 3 sets of anthropogenic emissions, corresponding to different scenarios:

1) CL: current legislation data based on the ACCMIP database till the year 2000 and then using projections till 2010

2) AE1980: anthropogenic emissions of 1980 are assumed constant over the years

3) BA1980: business as 1980 accounts for constant per capita emissions per region. Emissions are then calculated following the observed population changes reported by the World Bank. No technological improvement, mitigation policy and change in per capita energy demand are taken into account.

The authors also show the comparison of their simulations with surface measurements of O3, CO, SO4 and BC obtaining a relatively good agreement.

General comments

Even though population growth is one of the drivers of emissions, the emissions are not directly scaled with population growth but with human activity. Human activity is more directly scaled with mainly global population growth (not as such with local population growth because of the globalization of industry and trade). Looking into the population growths in different parts of the world and comparing this with the emissions growth, one sees clearly huge differences for different regions. Let us have a look at the population growth rate and the CO2 emissions growth rate (which excludes the effects of technology and end-of-pipe measures) for different parts of the world:

- Whereas China and the USA show similar population growth rates (of respectively 0.012 /yr and 0.011 /yr), CO2 emissions in China increased much stronger than in USA (0.099/yr and 0.051/yr respectively).

- Moreover China showed an acceleration in emissions increase (more than 10% in average) in 2002-2010, the period with flattening of the population growth rate (only 0.0047 /yr).

- Africa and the Middle East show a fast population growth rate (0.037 /yr) but modest emissions growth rate of 0.047/yr (similar to USA).

- EU showed only a very small population growth rate of in average 0.0030%/yr which is difficult to link with the emissions decrease rate (of -0.0035/yr in average).

This exercise illustrates that a constant emissions per capita factor has different mean-

ings for different regions and as such, it is unclear what the meaning of a BA1980 scenario with constant per capita emissions is. A compensation with a factor 2 and 3 for China and India to account for increased energy demand seems also quite ad hoc. The reviewers wonder why the more elaborated retrospective emissions scenarios for 1970-2010 of the PEGASOS FP7 project (acknowledged in this work) are not used instead. Moreover the most important emissions trend, is the trend in China in the last decade 2000-2010, for which the reference case (ACCMIP) uses only a projection of emissions from RCP6.0, although the HTAP paper (cited in this work) provides monthly global emissions gridmaps for 2008 and 2010. At least a comparison of the reference case with more recent bottom-up inventories is needed.

So for the paper specifically:

1)In chapter 2.2 (lines 18-20) the authors explain the data preparation for the BA1980 scenario. They say "The BA1980 inventory assumes that land anthropogenic emissions per capita remained constant from 1980 until now in major geographic regions, while population and thus overall human driven emissions changed".

The basic assumption of this scenario is that anthropogenic emissions scale with population. Although it is correct that emissions increase with population growth (e.g. due to higher energy demand, economy growth, etc.), the increasing economic activities are not always in the same place where the population grows. For example African countries have a growing population but the increase in economic activities is not happening there. On the other hand, Chinese population is stabilizing, while Chinese economy is exploding. These are just examples to highlight that population is not a driver for emissions in a certain location. This is also true for industrialized countries, having a rather stable population but increasing energy consumptions and thus increasing emissions. Therefore the assumption behind the BA1980 scenario is not correct and the authors need to reconsider how to build this scenario. One option could be to focus on certain emission sectors, for example the road transport or the residential ones, where population can possibly be considered as a driver for the emissions (the authors will need

to prove it anyway). For other sectors, like the power generation or the industrial ones, population growth in a certain location is not driving the increase of such activities in the same area. So, the population driven scenario is not applicable at all. Due to this major criticism, the authors should define a new methodology for developing hindcast simulations. Then all results should be modified accordingly and possibly the main message of the paper will change.

2)The authors should also explain the novelty of their work compared to recent literature about hindcast scenarios published within the same FP7 project they acknowledge. For example, Crippa et al. (2015) published a paper about retrospective scenarios assessing the effectiveness air quality legislations at global scale. Turnock et al. (2016) used a composition-climate model to simulate the impacts of European air quality legislation and technology measures implemented between 1970 and 2010. They used 2 scenarios, one with actual emissions in 2010 and the other with emissions that would have occurred in 2010 in the absence of technological improvements and abatement measures.

3)The authors should compare their CL scenario with other emission datasets since this scenario is based not only on historical data but also on projections (from 2000 to 2010)

4)The authors state: "Emission factors per species per capita per year for each HTAP source region were calculated for the year 1980 by dividing the 1980 anthropogenic emissions by the population of each region" (page5, lines 31-32). When dividing emissions by population you do not get emission factors, but population wheighted emissions that is a completely different concept since emission factors are calculated from activity data.

5)The introduction deals mainly with O3 and just in the last few lines the authors introduce their work which seems not to be related with what discussed above. Moreover, the authors state that "Traditionally, air quality assessments are performed by compar-

ing the pollutants concentrations at present with those of a past year". They should provide literature references about this approach since usually modelers make projections for future air quality then looking at past concentrations.

6)it is not completely clear the scope of this paper. From the title the authors claim to have shown the success of emission control legislation in mitigating air pollution. However, most of their results focus on the quality assessment of their simulations through the comparison with measured concentrations (paragraphs 3.2 and 3.3). Only in paragraph 3.4 they want to address the legislation impacts on air quality, but they actually do not show the impact of any specific legislation, or the impact of certain abatement measures or technological advancement. Therefore the objective of the paper should be reconsidered.

7)For a more detailed review new scenarios need to be developed and more in depth analyses will be required in order to assess the role of mitigation policies on emissions.

Specific comments

1) In Figure 2, the BA1980 and AE1980 scenarios are not needed since the aim of this figure is to compare measured concentrations with the simulated ones (CL)

2) In figure 4 the authors should say to what they normalized the concentrations

3) The authors state (page 2, line 7): "Most anthropogenic activity takes place in the northern mid-latitudes with approximately 80% of global population residing there (Kummu and Varis, 2011)". The authors should report the definition of northern-mid latitudes (degrees or countries included) and the year they are referring to, since population distribution might change in the next years (e.g. higher contribution from India?)

References

Crippa, M. et al. "Forty years of improvements in European air quality: the role of EU policy–industry interplay." Atmos. Chem. Phys., 16, 1–17, 2016 www.atmos-chem-phys.net/16/1/2016/ doi:10.5194/acp-16-1-2016.

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