Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-1182-RC1, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modeling the impact of solar "brightening" on summer surface ozone over Europe between 1990 and 2010" *by* Emmanouil Oikonomakis et al.

Anonymous Referee #1

Received and published: 10 February 2018

The authors explore the summer surface O3 change over Europe in response to the potential aerosol emission change from 1990 to 2010 via their impact on direct radiation effect (DRE) using CAMx air quality model. They expand their study by taking into account the feedback of biogenic emission through the chain of aerosol emission change to radiation change and perform all studies at different chemistry backgrounds (i.e. base and high NOx emissions). This is an interesting study and the study content is suitable for ACP. I recommend publishing the paper after the authors make minor modifications suggested below.

General Remarks:

Printer-friendly version

Discussion paper

It would be good if the authors could explain why it is better to use the designed emissions in 1990 instead of using the emissions in 1990 provided directly from emission inventories. The authors use emission inventory TNO-MACC-III for 2010. To derive the emission in 1990, they first analyze the observed PM10 between 90s and 2010 over 3 Netherlands stations and 3 Switzerland stations to infer potential enhancement factors of emission in 1990 verses in 2010. They then generate three potential emissions representing the situation in 1990 by increasing the emissions in 2010 with these enhancement factors. However, there are emission inventories, such as A2-ACCMIP that can provide emissions directly back to 1980. A2-ACCMIP is one of the multi-year emission datasets available from the international initiative AeroCom project for its second phase (A2) hind-cast model experiments (http://aerocom.met.no) (Chin et al., 2014).

It might also be good to claim the study as a sensitivity study of O3 change in response to aerosol emission change via DRE. The impact of solar "brightening" on surface ozone is not limited to aerosol DRE. Aerosol indirect effect (AIE) is another potential pathway as the authors discussed in the paper. Although the authors indicated that AIE is not a driving reason for surface solar radiation (SSR) trend over Europe during the study period based on some previous studies, AIE is still a non-negligible factor as suggested by a recent study (Mian Chin 2018, personal communication). Furthermore, aerosol can impact ozone chemistry via heterogeneous reaction and the effects of photolysis and heterogeneous update are typically nonlinear (Bian et al., 2003). Feedbacks of O3 production and loss due to changes in O3 precursors leads to the complicated nonlinear feature.

Specific comments 1. Page 1 lines 13-14 in Abstract: PHOT1, PHOT2, and PHO#3 is not in the effects of increased radiation on photolysis rates. 2. Page 2 line 14: φ and σ depend not only on the gaseous species and air temperature, but also on air pressure for some VOCs. 3. Page 2 line 15: Please add "O2, O3 and" before "water vapor". Please also add references of Bian et al., 2002 and Wild et al., 2000 at the end of this sentence. 4. Page 5 line 9: Is the two-weeks long enough spin-up for O3

chemistry? 5. Page 7 line 14: Could you elaborate on how to increase NOx emission? 6. Page 7 line 22: Do you really use the same emissions for both cases? 7. Page 9 line 29: It seems to me that you are not holding the aerosol coarse fraction constant during the period, but holding the absolute coarse model aerosol amount unchanged. 8. Page 10 lines 4-6: The criteria III should not be listed here since all PM2.5 data in this study are estimated based on PM10, while not measured. 9. Page 11 line 28: What aerosol components are included in FPRM? 10. Page 12 lines 18-20: To support the assumption in this study, the spatial distribution of AOD should be consistent with that of PM2.5, not PM10. 11. Page 13 line 22: Where is the J(NO2), surface, column? 12. Page 13 line 20 to Page 14 line 2: Other chemistry and physics processes may join with the photochemistry to impact tracer change in a nonlinear way.

References:

Bian, H., and C. S. Zender, Mineral dust and global tropospheric chemistry: The relative roles of photolysis and heterogeneous uptake. J. Geophys. Res., 108, 4672, 2003. Bian, H., and M. J. Prather, Accurate simulation of stratospheric photolysis in global chemical model. J. Atmos. Chem., 41, 281-296, 2002. Chin, M., T. Diehl, Q. Tian, J. M. Prospero, R. A. Kahn, A. Remer, H. Yu, A. M. Sayer, H. Bian, et al., Multi-decadal variations of atmospheric aerosols from 1980 to 2009: sources and regional trends, Atmos. Chem. Phys., 14, 3657-3690, doi:10.5194/acp-14-3657-2014, 2014. Wild, O., X. Zhu, and M. Prather, Fast-J: Accurate simulation of in- and below-cloud photolysis in tropospheric chemical models, J. Atmos. Chem. 37, 245-282, 2000.

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