Atmos. Chem. Phys. Discuss., 15, C2970–C2972, 2015
www.atmos-chem-phys-discuss.net/15/C2970/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelled and observed changes in aerosols and surface solar radiation over Europe between 1960 and 2009" *by* S. T. Turnock et al.

Anonymous Referee #1

Received and published: 26 May 2015

The study presents an extensive comparison between climate-chemistry model results and observations of recent decadal changes in aerosol properties and surface solar radiation in Europe. The model represents well overall annual European sulfate mass, AOD, PM10 and SSR trends, but doesn't capture SPM annual trends or the total magnitude. Incomplete representation in the model of coarse mode particles processes and large uncertainty in observations are mentioned as possible causes for such disagreement. The seasonal variation of sulfate aerosol mass and AOD are not fully captured by the model, either. Despite that, surface solar radiation is well represented after 1980 when aerosol radiation effects are present in the model and poorly repre-

sented when aerosol radiation effects are not included. This suggests that aerosol effects are responsible for important changes in SSR over Europe in the past decades. The authors' effort to consistently evaluate model performance against observations gives the manuscript value, both to the modelling and experimental communities, and increases credibility in the results and conclusions. Such detailed regional comparison using a GCM with online aerosol microphysics and chemistry is novel as far as I know. I suggest publication of the manuscript after the authors address a few comments that follow.

General comments:

1. The study focuses mostly on mass properties of atmospheric aerosol, but tells little about aerosol size distribution representation in the model. Aerosol size distributions have large effects on optical properties and aerosol-cloud interactions. In order to make the study stronger , I highly recommend including a figure or table comparing present day aerosol size distribution properties over the different European locations (or a few representative locations) as presented by Asmi et al., (2012). Asmi et al., (2012) presents a comprehensive analysis of present day aerosol size distributions in several locations across Europe and the data is freely available. The model results could help explain differences between modeled and observed AOD and shed some light on changes in CCN over Europe in the recent past. For example a simple comparison of the model ability to capture particle concentrations in the ranges 30-50nm, >50nm and >100nm, would complement the existing comparison. If the model represents well present day size distributions, changes over time in those parameters would be of special value to the community.

2. Show, if possible, an additional plot similar to figure 12 of the seasonal SSR changes with time in addition to the annual values. It would be interesting to learn if the model captures the SSR seasonal cycle better than it does AOD and sulfate aerosol mass seasonal cycles, and the possible reasons why it does or does not.

3. Please mention in the text the mean global radiative forcing induced by changes in European aerosol emissions between periods with largest and smallest aerosol loadings. This value makes a direct comparison to GHG global forcing direct, and tells how important the regional aerosol perturbation is.

Specific comments:

-Page 3(13459), line 26. How much have NOx, CO and BC emissions decreased between 1980 and 2010?

-Page 13(13469), line 19. How was the interpolation made? Please add a short sentence explaining how this was done.

References: 1. Asmi, A. et al. Number size distributions and seasonality of submicron particles in Europe 2008-2009. Atmos. Chem. Phys. 11, 5505–5538 (2011).

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 13457, 2015.