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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Particle number concentrations over Europe in 2030: the role of emissions and new particle formation" *by* L. Ahlm et al.

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We would like to thank Dr. Saunders for his interest and comments on our manuscript. Our response to his questions and comments can be seen below.

Comment 1:

Why was the year 2030 specifically chosen? Would not a year-to-year trend up to say 2030 be more informative? Do the authors seriously envisage submitting a follow-up paper in 18-20 years time to indicate whether their predictions were within reasonable agreement with reality or not?! That may seem a pedantic question but unless it happens, what true value are such distant predictions?

Response:

In this study we investigate how predicted or potential changes in trace gas and primary aerosol emissions in Europe, presented in the IIASA report (Amann et al., 2012), are reflected in the particle number concentrations and size distributions. In addition, we investigate how sensitive the particle number concentrations are to reductions in emissions of individual species. The IIASA report focuses specifically on scenarios for 2030 and 2050. Since most of the expected reductions in SO2, NOx, and PM2.5 are predicted to occur between present time and 2030, with only minor reductions between 2030 and 2050, we think that 2030 is more interesting to focus on. However, the exact year is not the most important issue here, but rather how sensitive atmospheric chemistry and aerosol formation are to the potential emission reductions during the coming two decades. We do not thus intend to provide exact yearly forecasts of aerosol concentrations for the next 20 years, but rather provide useful insights into the sensitivity of the atmospheric chemistry to emissions. We believe this information is valuable in e.g. designing win-win policies for air quality and climate.

Comment 2

I'm sure that the model is state-of-the-art but with all the inherent assumptions and uncertainties and presumably untreated factors (i.e. secondary inorganic particle formation, background scavenging and the effects of a whole host of organics and other species not treated which may participate in particle formation and growth) can the predictions of such a singular and specific parameter as total particle number over Europe realistically be claimed to be valid? In reality, this parameter must be highly variable from day-to-day – does the model capture such innate variability?

Response:

We used a three-dimensional chemical transport model with detailed microphysics, PMCAMx-UF. This model uses the DMAN model (Jung et al., 2006) to simulate nucleation, coagulation, condensation/evaporation, and emissions using 43 size bins from

0.8 nm to 40 μm diameter. In addition, PMCAMx-UF simulates horizontal and vertical advection, horizontal and vertical diffusion, wet and dry deposition, and gas-phase chemistry. The model domain includes 150 x 162 cells in the horizontal with 14 vertical layers. The model thus does take into account secondary inorganic particle formation using state-of-the-art nucleation parameterizations that have been shown to work relatively well in the continental boundary layer (see e.g. Fountoukis et al., 2012 and reference therein) – which is the focus of this work. The scavenging of particles by background aerosol population (we assume that this is what is meant by "background scavenging") as well as wet and dry deposition are also accounted for, along with the most important primary species including a primary number emission inventory developed within the EUCAARI project. Furthermore, PMCAMx-UF is not restricted to simulating the total number concentration only, but the number and mass size distributions including 43 size bins – which is also reflected in the results and analysis presented in the manuscript.

Finally, we fully agree that the particle number concentration is indeed highly variable both spatially and temporally. As described in the introduction, Fountoukis et al. (2012) used the same model set up and evaluated the simulated particle concentrations with observations from seven different European sites at present-day conditions. The model did relatively well in reproducing the magnitude, trends and diurnal patterns of the particle number concentrations at the different sites. Therefore, while we agree there are certainly aspects that can be improved as the scientific understanding of aerosol processes and constituents increases, we believe that our model simulations represent a reasonable first estimate of the effects of the emission scenarios on aerosol particle concentrations.

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