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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The effect of coal-fired power-plant SO_2 and NO_x control technologies on aerosol nucleation in the source plumes" *by* C. R. Lonsdale et al.

Anonymous Referee #1

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The authors describe model calculations of the particle production in power plant plumes and the dependence on SO2 and NOx concentration levels. The chemistry discussed is matched to the observations of the TEXAS air quality study (TexAQS) which provides airborne measurements of aerosols within the plumes of the city and the Parrish Coal fired power plant. It is stated that the model was compared to the observations and claims that it is capturing the essential features of aerosol size distributions measured. The model than is applied for the two actual emission conditions in 1997 and 2010 which are characterized by a strong reduction in NOx and a smaller reduction in SO2. As shown previously, the emission reduction measures lead to a considerable increase of the particle production by nucleation from chemical reactions

within the plume after the flue gas left the chimney. Primary particle emission from in factory nucleation is neglected in the model calculations. The manuscript discusses the effect of increased preexisting particle load and additionally modified SO2 and NOx emissions, which are changing the results considerably. Finally an attempt is made to show how overall US coal fired power plant cleaning measures between 1997 and 2010 may change new particle production.

The manuscript describes one of the possibly major issues in new particle formation from energy production and can serve as a good base for future work on emission scenarios under varying technological progress. The particle number production rates described confirm earlier measurements and current observations in coal fired power plant plumes and the significant differences to previous studies in the 1970's. It also shows that the removal of fine particles, that was implemented in most of the power plants in the US even before 1997 can contribute to the survival of the new ultrafine particles.

However, the manuscript does not give any information about the particle sizes produced. This size distribution would be critical in comparing the model to measurements, either to the existing results of the Texas (Parrish) plume measurements or any other future power plant plume experiments. Differences or agreement between the model and the experiment could be a valuable information about a possible contribution of initially emitted new particles that do not need OH radicals to be produced, particles from SO3 and H2SO4 production described by Srivastava (2004) inside the power plant.

Also not mentioned, but possibly important for the emission szenarios is the change in the particle size distributions in the plumes from fine to ultrafine particles. The changes in NOx and SO2 emissions in the short time scale from 1997 to 2010 for all the US power plants are possibly minor compared to the changes following the introduction of filters that removed most of the primary emitted fine particulate mass.

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The two figures 4 and 6 show a difference of more than an order of magnitude in the particle production rate. Compared to 2006 with further reduced NOx emissions the OH concentration should be even higher, see figure 1. How can this be explained?

Figure. 3 is used as an illustration for relatively clean and polluted background conditions. For readers that are not that familiar with size distributrions, can these data be converted into something like PM2.5 values?

The second half of Section 5.3, "Observational evidence and comparison" is difficult to read. This might be due to the frequent jumps in the text from 2000 (high) to 2006 (low) emissions and 2000 (low) and 2006 (high) background conditions. An additional table could help as the figures 3 and 6, which are necessary for comparison with these results most probably are not very close to the text in the final version.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 19683, 2012.