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# ***Interactive comment on “A parameterization of sub-grid particle formation in sulphur-rich plumes for global and regional-scale models” by R. G. Stevens and J. R. Pierce***

**Anonymous Referee #1**

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This manuscript is a continuation for the previous work by Stevens et al. (2012, ACP) investigating new aerosol particle formation in power plant plumes. The novel feature of this paper is that it provides, to my knowledge, the first comprehensive parameterization of in-plume aerosol formation that can be used in large-scale modeling frameworks. I find the manuscript useful for the scientific community and definitely original enough to be published in Atmospheric Chemistry and Physics. There are no apparent errors in the manuscript, but the overall presentation could be made a bit more reader-friendly, especially what it comes to applying the derived parameterization by others. My detailed comments are given below.

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The idea of providing advice how to use the parameterization in case some essential model input is missing is a very good one (see Appendix). I think the authors should provide some other type additional information as well, especially for those who are willing to program this parameterization by themselves. First, most of the equations used in the parameterization are not scale-independent in the sense that they contain a mixture of numerical values and physical quantities. As a result, the user needs to know in which units each of the quantities need to be inserted into these equations. This information should be given somewhere in the paper, either after each equation or in a separate table. Second, it might be worth summarizing somewhere (e.g. in Appendix) which model output corresponds to which equation, and which equations are really needed to calculate all the desired output quantities (are all the equations presented in section 3 necessary?).

When discussing the accuracy of the parameterization, it should be mentioned explicitly that while the parameterization does a good job in reproducing model simulations, its accuracy cannot be not better than the underlying theory, in this case the assumed linear dependency of the nucleation rate on the gaseous sulfuric acid concentration. It is clear that our understanding on in-plume sulphuric acid production and connection between the sulphuric acid and both nucleation and subsequent nuclei growth rate continues to be far from perfect.

Finally, even though it is extremely important to investigate the sensitivity of the parameterization to various input parameters, I am still not convinced about the usefulness of Figures 2 to 6 in their current form. Each sub-plot of these figures contain a large number of lines, and very few of them a really informative. I do not say that some of these figures should be removed from the paper, I simply encourage the authors to reconsider if all this information could be provided in a bit more compact way.

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 19583, 2013.

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