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Interactive comment on "Variable CCN formation potential of regional sulfur emissions" *by* P. T. Manktelow et al.

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Referee 2 makes a useful suggestion to quantify the CCN potential at sizes other than 50 nm. We have done that and added the results to the paper, including the table. In summary, the CCN potentials change as follows: 50 nm (US: 0.1, Eur: 0.06, Asia: 0.08) as already reported; 80 nm (US: 0.15, Eur: 0.14, Asia: 0.06); 100 nm (US: 0.22, Eur: 0.21, Asia: 0.08). So as we move to larger sizes the CCN potentials of Europe and USA increase, but the CCN potential of Asia barely changes. This makes sense because Asia produces many more CN compared to Europe and USA, so there is more competition for H_2SO_4 vapour and fewer particles grow to large sizes. At larger sizes the difference in CCN potential between the regions increases (max ratio at 50 nm is 1.7 as reported, but 2.75 at 100 nm). In addition to the table, we have clarified throughout the paper which CCN size we are referring to.

Referee 2 goes on to mention other processes we could look at, including boundary layer nucleation and sub-grid sulfate CN formation. We agree that these are important processes that could cause further inter-regional differences. We think the sub-grid sulfate aerosol formation issue is too poorly constrained by observations to handle properly in a global model and any identified differences between regions would be speculative at present. Further work is needed to constrain the plume-scale particle formation in different locations. The regional variability in particle production in the boundary layer is currently being investigated (partly in the EUCAARI project to which we contribute here) and we expect to report on that problem soon. In Merikanto et al. (Atmos. Chem. Phys. Discuss., 9, 5263-5287, 2009) we have highlighted the importance of regional variations.

Referee 1 raised issues related to the dependence of our results on (1) the model, (2) the emission inventory, (3) the domain coordinates, (4) the nucleation algorithm.

As pointed out by the referee (1) cannot be addressed here without a larger model intercomparison, which is not the aim. Issue (4) has been dealt with in the paper already. Issues (2) and (3) are probably contributing to differences between our model and previous studies concerning the sulfate burden potential, sulfate lifetimes etc. But there will also be other causes in addition to these. Given the cost of additional model simulations we have decided not to do more sensitivity studies related to these quantities, which are not the focus of our paper. Previous aerosol intercomparisons such as AEROCOM and COSAM have highlighted large differences between models in terms of sulfate burden, lifetime etc, and our model is within the range predicted by other models (see Spracklen et al., 2005). As we note in the paper, there are only 3 studies of regional sulfate burden potential, and they all differ. So the justification for attempting to converge with one of these models is weak.

The main aim of our paper is to show that microphysical processes mean that the CCN potential changes in a different way to the sulfate burden potential and is driven by different processes (e.g., lofting height, etc.). Other models, which have different ad-

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vection, emissions etc. will probably get somewhat different results but our conclusion that CCN potential is different to sulfate potential would still be valid.

Spracklen, D. V., Pringle, K. J., Carslaw, K. S., Chipperfield, M. P., and Mann, G. W.: A global off-line model of size-resolved aerosol microphysics: I. Model development and prediction of aerosol properties, Atmos. Chem. Phys., 5, 22278211;2252, 2005.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 3095, 2009.