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Interactive comment on “Technical note: A new comprehensive SCAVenging submodel for global atmospheric chemistry modelling” *by* H. Tost et al.

H. Tost et al.

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We thank the two anonymous referees for their valuable and constructive comments, to which we reply in the following:

Comments to Referee No. 1:

1) The monodisperse cloud droplet spectrum is used, since in most GCMs no detailed information about cloud microphysics is available. Since the droplet size determines the transfer velocity in and out of the droplets this is going to vary. However, most of the species are in equilibrium after a very short time, compared to the timestep of a GCM. For cloud droplets in the range of about 10μm, this effect is relatively weak and can be neglected. For very short timesteps in the range of seconds and large droplets

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it becomes become relevant and is applied for rain droplets. This is mentioned in the revised version to reason the assumption.

2) The scavenging of gaseous species by solid hydrometeors is not adressed in the current work, but planned for a future development. This is mentioned in the outlook, that is added in the revised version. To overcome this weakness temporarily, for convective clouds in a GCM the assumption is made that even above the freezing point, still some part of the water is liquid. In that part the scavenging takes place as described.

The scavenging of aerosols by frozen hydrometeors follows the approach proposed by Stier et al.(2005). This is mentioned in the aerosol section of the revised version.

3) The input parameter list is completed.

4) The figure captions are corrected.

5) A short comment is given in the description of aerosol nucleation scavenging with respect to the applied simplifications, e.g., neglecting the supersaturation (clouds and their microphysical properties are used diagnostically as parameters) and aerosol chemical composition.

6) Figure 1 is revised according to the suggestions of the referee. We prefer to leave Figure 2 mostly as it is to show the difference in our calculations for nanometer-sized particles.

7) An outlook is added to mention future development plans of the submodel and studies, that will be presented in future publications, applying the scheme in a global chemistry climate model.

The corrections of expressions and typing errors are, of course, corrected.

Comments to Referee No. 2:

1) We try to distinguish between nucleation scavenging and impaction scavenging. Since it is also possible for cloud droplets (taking part in nucleation scavenging) to undergo Brownian motion this process for cloud droplets is taken as a part of nucleation

scavenging. Therefore this terminology is also not used perfectly, but better than 'in-cloud scavenging' for scavenging by cloud droplets within clouds and impaction scavenging for scavenging by falling hydrometeors in precipitation in and below clouds. It is reformulated.

2) Since the nucleation scavenging for aerosols is very much simplified (as mentioned above) the equation mainly depends on aerosol size. The removal of aerosol particles out of the cloud is, of course, dependent on the liquid water content and the precipitation formation rate to take into account the effects the referee mentioned. This is clarified in the revised version.

With further model development this parameterisation will be replaced by better formulations of the aerosol-cloud-interactions (see outlook). The equation itself is derived from measurements that are cited in the revised manuscript. The derivation was part of the model development and therefore a reference cannot be given.

3) Since in the model only bulk values of clouds and precipitation are used with a prescribed droplet distribution, the individual droplet interactions are not calculated. This is part of the microphysical model routines. If the precipitation increases from one model layer to the next by collecting cloud droplets, this is assumed to be nucleation scavenging (scavenging by cloud droplets, subsequent precipitation formation and conversion from cloud to rain water).

4) The velocity v_t used in eqn. 3 is the transfer velocity of gases into the droplets and not the terminal velocity of the rain droplets. Since the diffusion velocity of gases in air is much higher than the terminal velocity of the droplets it can be assumed that the droplets are relatively fixed compared to the gas molecules. As written in the manuscript, for aerosol scavenging this assumption is not valid and the terminal velocity of droplets and aerosols are both calculated, for the droplets according to Beard and Pruppacher (1969) and for the aerosol particles as described in the book of Pruppacher and Klett (2000) as cited in the manuscript.

5) The figures present the scientific content of the parameterisations and are therefore presented in the section describing that part while the equations belong more to the

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technical part. Therefore we would like to keep the order as it is. We will add references to the corresponding equations in the figure captions and in the equation sections references to the resulting figures to establish the links.

6) As already mentioned in the comment of the other referee, the input list is completed in the text section of model description in the revised version.

7) The fractional cloud cover is also an input parameter and is added to the list (see topic 6).

8) Most of the cited calculations are done with box, column or regional models. As is mentioned in the outlook of the revised manuscript, the application on the global scale in a chemistry climate model is one of the future projects.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 11157, 2005.