Atmos. Chem. Phys. Discuss., 2, S911–S914, 2002
www.atmos-chem-phys.org/acpd/2/S911/

Atmospheric Chemistry and Physics Discussions

ACPD

2, S911–S914, 2002

Interactive Comment

Interactive comment on "Estimated variability of below-cloud aerosol removal by rainfall for observed aerosol size distributions" *by* C. Andronache

C. Andronache

Received and published: 22 January 2003

I would like to thank the reviewer for the suggestions that were helpful in making several clarifications in the revised manuscript. My answers to the reviewer's comments are presented here:

1) Regarding the abstract details: The abstract was revised to provide a better description of the content and results.

2) Regarding the description of the goal of the paper: In Introduction I included a more detailed description of the goal of this work. Thus, the work is directed to users of aerosol models, who are interested in numerical modeling of the wet removal of

Full Screen / Esc
Print Version
Interactive Discussion
Discussion Paper

aerosol. The practical outcomes of this paper are BCS coefficients that can be used to describe boundary layer (BL) aerosol changes due to precipitation. The presented results are suitable for two modeling approaches. One approach is the study of the evolution of detailed bin resolved aerosol mass size distribution (as in the case of analysis of high resolution aerosol measurements from field experiments). The second approach is the study of evolution of the total aerosol mass concentration during rain events (as in the case of local and regional models used in pollution studies).

3) Concerning the physical meaning of the BCS coefficients described in the Method section: In the Method section I included a more detailed description of the physical meaning of $L(d_p)$ and L_m coefficients. The loss of aerosol mass of particles of diameter d_p is described by eq. (3) and $L(d_p)$ represents "relative variation of aerosol mass concentration per unit time for particles of diameter d_p, due to aerosol removal by collisions with falling raindrops in the BL" . Thus, $L(d_p)$ is appropriate to be used in a model that resolves many size bins and can capture the changes in various parts of the aerosol size spectrum. In large scale models, or for rapid evaluations of the effects of rain on aerosol mass, a BCS coefficient average over the mass distribution is used, L_m. Thus, L_m will satisfy the equation (5) for the total aerosol mass concentration. L_m is the "relative variation of the total aerosol mass concentration per unit time due to aerosol removal by collisions with falling raindrops in the BL". The advantage of this form is the simplicity of L_m which can be expressed as aR^b where R is the rainfall rate. This work shows the variations of L_m with aerosol size distribution and illustrates that coarse particles have L_m quite different from those with submicron particles.

In the revised manuscript I also leave out some well known equations such as the description of the aerosol size distribution.

4) Related to the use of data from Jaenicke: The data from Jaenicke (1993) were used

ACPD

2, S911–S914, 2002

Interactive Comment

in the previous manuscript to illustrate the main features of BCS coefficient for distributions that include coarse mode. In the revised manuscript I leave out the comparisons with Jaenicke aerosol types in various figures. Reference to results based on Jaenicke data is made in Table 3 where I compare BCS coefficients from various sources. Overall, I found that the BCS coefficients based on Jaenicke aerosol types are consistent with calculations based on various particular cases from field experiments.

5) Regarding the change in the size distribution due to rain: In the revised manuscript, I included illustrations of the effect of rainfall on the BL aerosol size distribution. Figure 10a illustrates changes in the aerosol size distribution due to BCS. I chose to show changes in the aerosol volume distribution because this is directly related to changes in aerosol mass distribution. Figure 10a shows the change of aerosol volume distribution after one hour of rain with a rainfall rate $R = 1$, 10 and 100 mm hr^{-1}. The initial aerosol volume distribution is marked by a solid line and we note that after one hour, for moderate rain of $R = 10$ mm hr^{-1}, the changes are dramatic (most of the coarse particle volume is removed). Figure 10b illustrates the changes in the aerosol volume distribution for $R = 10$ mm hr^{-1} after a duration of rain of $t = 0.5$, 1 and 10 hr. Again, after about 1 hour of rain, the coarse aerosol volume is depleted. In these plots only the BCS was considered, while in more realistic situations, the aerosol size distribution will change due to many other interactions not included here.

6) Concerning comparisons with data from Sparmacher et al.: Comparisons with experimental results from Sparmacher et al. (1993) were made in the previous manuscript based on the following: Sparmacher et al. (1993) et al. made experiments to determine the BCS in which they used 4 different prescribed aerosol sizes (diameters are given in the paper, Table 3) and real precipitation events. They collected data, and fitted BCS coefficient as function of measured rainfall rate R and provided relationships of the form $L_m = aR^b$ with a and b determined from experiment. (We

ACPD
2, S911–S914, 2002
Interactive Comment

Full Screen / Esc
Print Version
Interactive Discussion
Discussion Paper

note that $L(d_p) = L_m$ if the aerosol is monodisperse). Comparisons of our model for $L(d_p)$ and Sparmacher et al. data for the same diameters show good overall agreement. The comparisons shown in the previous manuscript were intended to illustrate that measured L_m for small particles agrees with our calculations for size distributions dominated by submicron particles. To improve clarity of the presentation, in the revised manuscript these comparisons are taken out from Figures, and I mention the values of Sparmacher et al. (1993) in Table 3, where I compare various results.

ACPD
2, S911–S914, 2002