Atmos. Chem. Phys. Discuss., 5, S1448–S1451, 2005
www.atmos-chem-phys.org/acpd/5/S1448/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Black carbon ageing in the Canadian Centre for Climate modelling and analysis atmospheric general circulation model" *by* B. Croft et al.

B. Croft et al.

Received and published: 30 June 2005

The authors wish to thank the referee for the helpful comments pertaining to the revision of this manuscript. Below is a point by point response that shows how we have addressed each item noted in the review.

Page 1385, line 18: the sentence has been revised to state that the exponential half-life is in the vicinity of 24 hours as opposed to exactly 24 hours.

Page 1390. This parameterization accounts for the effects of both condensation and coagulation. During day-time condensation is the dominant process and during night-time coagulation is the dominant process. Both equations (1) and (2) apply to the parameterization of the ageing time-scale at night-time when coagulation is the dominant process. During the day-time, condensation is dominant, and then aerosol number is not a good parameter to use to present the ageing time-scale. We agree that equation (3) is more universal for the parameterization of coagulation. However, since the equation (3) was not published at the time that these GCM simulations were conducted, this equation was not used in the study. This point is noted in the revised manuscript and also a brief discussion on the predicted difference that using equation (3) instead of equations (1) and (2) is included in the revised manuscript. We have also expanded the discussion of the physical meaning of the terms of the parameterization. Note that Equations 1-3 are Equations 6-8 in the revised manuscript.

Page 1391, line 2: In the fourth paragraph of the section 3, a discussion is now included relating our results to those of the study by Tsigaridis and Kanakidou (2003). The lifetimes due to oxidation are shorter in the Tsigaridis and Kanakidou study than in our study. However, the important point to note is that the T&K (2003) results are sensitive to their assumptions about the size of the particle and monolayer required before the particle is considered to be hydrophilic, and likewise our results are sensitive to the scaling factor we have included in the OXID parameterization. Thus, it is easy to predict considerably different lifetimes with either parameterization. This points out the need to be better understand the chemical ageing processes before this approach could be used with a high degree of confidence.

Page 1392, line 21: changed to 'the fastest'

Page 1392, line22: the day-time ageing time-scale comes from the studies conducted by Riemer et al. (2004). This is now discussed with more detail about the characteristic time-scale of 2 hours that is used during the day to account for the ageing process dominated by condensation. We also added a discussion of the limitations of the assumptions made to arrive at this time-scale. See the revised third paragraph of Section 3.

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Page 1392, line25: a discussion is now included to explain why the smaller contribution of the chemical process of oxidation was modelled to be smaller than the contributions by the physical processes of condensation and coagulation. The oxidative contribution was modeled to be small since 1) the the COND-COAG parameterization already appeared to account for most of the ageing and 2) previous studies had also suggested that the chemical ageing was slower. We acknowledge more clearly in the text that there remains a high uncertainty regarding the chemical ageing. See the fourth paragraph of Section 3, sub-section 3.2 and the discussion in Section 4 related to Table 7. Also, as is noted in the response to referee 1 we no longer state that our study can be used to draw conclusions regarding the global impact of oxidation on the ageing time-scale since this is simply not yet known.

Page 1393, line 4: words are added as noted.

Page 1394, line 10: this model requires the choice of a globally applicable mode radius. Any mode radius when applied globally will fail in certain regions. Our choice is justified since we use one of the few published values for this parameter and discuss the limitations of our approach. This discussion is now in the text in the second paragraph of sub-section 3.1

Page 1394, line14: the MODB-COND-COAG simulation is now explained in more detail. The basic idea is to isolate regions where the BC number concentration is sufficiently high and the sulfate production is relatively low, such that the ageing due to condensation is expected to be longer than the 2 hours used in the COND-COAG simulation. If we reduce this ageing to an extreme, we get an upper limit on the concentrations predicted.

Page 1394, line 19 and Figure 7: the threshold contour is now clearly plotted

Page 1394, line 24: re-fix 'semi' is added.

Page 1396, line 7 and Figure 10: Now all plots use a log scale for ease of comparison.

Page 1396, line 8 and page 1397, line 3: we do feel that a regionally averaged plot for the USA is meaningful. It is common practice for global modellers to compare annual and global mean values, and along this same line of thought we also present regional mean values here. However we agree that more detailed statistical analysis can help in the interpretation of the observation to model comparison. We have now added Table 7 that shows model to observed correlation coefficients and ratios. These added statistical comparisons help the reader to see more clearly the performance of the different parameterizations in comparison to the FIX-LIFE assumption.

Page 1396, line 15: we have reversed the order of these sections.

Page 1396, line 16-17: the discussion is now reworded to acknowledge that while the annual mean predicted concentrations are within a factor of 2 of the observations, some of the monthly means are closer to within a factor of 10. We also discuss the results using the other emission inventory (FIX-LIFE2) as being many times far from the observations. See the sixth paragraph of Section 4.

Page 1397, end of section 4: A comparison with observations from biomass burning sites is briefly made over a portion of the year, but a complete annual cycle was not available for full comparison. See Table 8 and the second to the last paragraph of Section 4. The seasonal cycle is now shown in Figure 13. Additional validation methods are presently being conducted using AERONET observations from several sites in biomass burning zones. This results will be shown in future publications but are beyond the scope of this present work.

Page 1399, last sentence: This result is now mentioned in the abstract and given more emphasis in the conclusion section.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 1383, 2005.