

Interactive comment on “Impact of the aging process of black carbon aerosols on their spatial distribution, hygroscopicity, and radiative forcing in a global climate model” by D. Goto et al.

Anonymous Referee #1

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The authors present a study using the SPRINTARS global aerosol transport model, investigating three different treatments of the aging of black carbon from a water insoluble to a water soluble state. It is well known that current aerosol models vary greatly in their predictions for the global direct radiative forcing from BC, even when using harmonized emissions. Lifetime treatment is thought to be among the reasons, but its impact is not well quantified. The present paper is therefore a welcome addition to the literature, and should be published in ACP after minor revisions.

General comments:

I have two main comments which relate to making the results in the paper easier to

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compare to other models:

Firstly, in section 2.2.1 the variable BC aging method is presented and a good set of constants for the methodology are given. However the authors do not present the actual lifetimes that the method yields, other than stating that there's a maximum value of 20 days. Without the SPRINTARS SO₄ field it is hard to estimate these values. Arguably the results that follow on are more important, but if another model was to try the same method a comparison of the actual lifetimes would certainly be interesting – either as a pdf or as an annual mean map?

Secondly, BC ARF normalized by either AOT or burden are very useful measures of the impact of BC in a given model. The authors present these in section 4, but especially for what they term β_s (BC ARF per change in column burden) I don't quite understand the numbers. The unit for this value should be W/g, and is commonly of the order 1500–2000 W/g on global, annual average. The authors give no units here, and in figure 12a numbers between -0.1 and 0.7 are shown. Can the BC-ARF over Europe, relative to a no-aerosol run, really be negative for the AGF method as shown here? I probably misunderstand what the authors are actually presenting, but this is an indication that the presentations should be clarified and proper units given.

Minor/technical comments:

P29802, line 3: particle -> particles

P29802, line 7: one of main -> one of the main

P29802, line 8: an impact -> the impact

P29803, line 4: thus have -> thus has

P29807, line 12–13: You claim that 11.4 Tg/y emissions are higher than the aerocom phase 1 mean of 11.9 Tg/y. This doesn't add up – please reformulate to make clear what you mean.

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P29807, line 20: "The global mean BC emission amount is estimated to be 2.6Tg/y. . ." You just stated it was 11.4Tg/y. Do you mean biomass emissions here, as discussed above? Also, I wasn't able to locate this number in Bond et al. (2007), but this may be because I don't quite see what you're describing. Please clarify.

P29814, line 11: "These models can also calculate the radiative forcing under clear-sky and all-sky conditions at any vertical levels". A linguistic point: RF is defined as a change in net top-of-atmosphere fluxes, or similarly at the surface. The RF at a given vertical level isn't really meaningful. Maybe change to "exerted at any vertical level"?

P29815, line 14: "the higher BC emissions" Are they higher? See comments above.

P29818, line 25: This description of sulfate treatment, sizes, internal/external mixing etc. seems like it belongs in Methods.

P29819, line 27: Second ref. is not in References.

P29822, line 27: 80-90% (AGV) stated twice, missing AGF?

P29824, line 15: "could be underestimated". Why under and not over? Please give the reasoning.

P29836: "where S_i represents. . ." Variables S_i and O_i are not used in the table.

P29845: ". . .with a random var." Please either explain or remove this statement.

P29848: Figure is missing (a), (b) etc. which are referenced in the caption.

P29849: As commented above, please add units to this plot.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 29801, 2012.