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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The global aerosol-climate model ECHAM-HAM, version 2: sensitivity to improvements in process representations" *by* K. Zhang et al.

Anonymous Referee #2

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The authors present an interesting and well-written overview of recent improvements to the ECHAM-HAM global aerosol model. The sensitivity studies presented are well designed, and good effort has been put into comparisons with data.

As a general remark, however, the paper fails to give either a simple and concise overview of the actual effects of the recent improvements, for which it is too detailed and lacks a concise overview, or to provide the full set of details needed to thoroughly evaluate the combined effects of the updates. For the latter it does not seem to provide enough quantitative detail. There are two main uses for such a paper, which the authors that they are trying to achieve. One is to document the combined effects of changes

presented elsewhere. For this, an extended model description would greatly ease the reading of the subsequent sections, as well as some extended discussions to place the sensitivity studies further in context (I note some points below, but as reviewer 1 has commented on this in great detail I will not repeat that). A second use is to serve as a baseline reference both for future studies with ECHAM-HAM2 and for intermodel studies such as the ongoing AeroCom Phase 2. For this use, a different set of details would be needed – especially regarding the radiative effects of the individual aerosol species. Details are given below. Adding this would greatly increase the impact of the paper.

Overall, however, I find the study highly relevant and believe it should proceed to ACP once some additional detail has been added.

Detailed comments:

P7550: Even though good references are given, an extended model overview of ECHAM5 (some general points only) and HAM would benefit the paper. What resolutions are used? E.g. if the resolution in the present work is higher than what most models in the AeroCom Phase 1 study (Schulz et al 2006) used, this may have an impact on the comparisons made with that work.

P7550: Sections 5.4 and 5.5 present a very interesting discussion of the simulated radiative properties of, and forcing from, aerosols. In the introduction, the authors state that "The four-band shortwave radiative transfer scheme in the atmospheric model has been extended with two additional bands (Cagnazzo et al., 2007)." Some additional detail on the radiative transfer scheme and how it has been updated from HAM1 would be relevant here.

P7550: "...are prescribed according to the specifications of AeroCom.": Please give some details here, or at least a reference, for those not familiar with the AeroCom work.

P7552: "The responses of model results to formulation/conïňĄguration changes in the

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following sections are signiïňĄcant in magnitude, and are consistently seen in diïňĂerent diagnostics." This statement is not clear to me – clarify?

P7553: "In the standard model configuration, these nucleation pathways are switched off." There are a number of statements like this in the paper (notably also on page 7561). While Table 1 (p.7585) gives a good textual overview over the features included, I kept feeling the need for an even clearer picture of what is included and not in the "default HAM2" – which I guess is what will mainly be used for future studies.

P7556: "(by changing model configuration via namelist)": Technical info beyond the level of the paper – remove?

P7562: "Various other factors, including aerosol source, horizontal and vertical transport timescale and pathway, are also relevant in determining. . ." I would appreciate more quantitative detail here, especially on the vertical transport – either here or elsewhere in the paper. (See e.g. Schwarz et al 2010 – the final profiles of esp. BC aerosol after scavenging are highly relevant for the final modeled BC forcing.)

P7563: Radiative transport is at the heart of several of the sensitivity studies presented. What is the effect of the improved shortwave treatment in HAM2?

P7568: For the discussions of figures 15 and 16, some further quantification would be interesting – e.g. in the form of global or zonal means.

P7569: Here I'm missing a concise table with the radiative properties of both the individual aerosol species and total anthtropogenic aerosols. E.g. what is the refractive index of BC now used, is POM treated as absorbing or purely refractive, what is the total single scattering albedos and absorption AOD,. . . Some of this is given in table A2 on page 7593, but an increased level of detail would greatly facilitate later intermodel comparisons.

P7571: I find this very interesting section (5.5) to be rather brief – further details here would enhance the paper. What is the regional response of the TOA forcing in the

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various sensitivity tests? Can you say something about the effects of the changes in aerosol wet deposition on the total BC forcing, which is very sensitive to the aerosols' location relative to clouds (e.g. Zarzycki et al 2010, Samset et al 2011), or the effect of the change in water uptake on sulphate forcing? (I realize that treating individual species requires further sensitivity studies, but as you state that you participate in AeroCom Phase 2 these are perhaps already performed?)

P7572: The Lohmann and Roeckner ref is given twice.

P7585: Spurious line break ("dy- namics") in upper left cell

P7593: Typo: larges -> largest

P7595: Fig 2, caption begins with "and zonal mean. . .".

P7601: This figure is central in seeing the combined effects of model improvements on the vertical aerosol profiles. However in the right column I find it hard to read off the areas of most significant change between the models, as the ratio will tend to become large when the concentration simulated by HAM1 becomes small. How does this picture look for (HAM2-HAM1) or (HAM2-HAM1)/(HAM2+HAM1)?

P7603: Fig 10: Some further degree of quantitative comparison between HAM2, HAM1 and the observations would be interesting here, in addition to the zonal profiles given. E.g. mean vertical profiles for the lat/lon regions with best coverage, or preferably a comparison close to aerosol source regions.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 7545, 2012.