

Interactive comment on “A study of uncertainties in the sulfate distribution and its radiative forcing associated with sulfur chemistry in a global aerosol model” by D. Goto et al.

Anonymous Referee #2

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This paper describes the development of an improved representation of sulphur chemistry within a global model, and sensitivity tests to establish the relative importance of different simplifications for sulphur surface concentration, sulphate column burden and aerosol direct radiative forcing. The studies are conducted in a systematic way with good justification, and the conclusions reached are sound and quantitative. I therefore recommend it is published subject to some minor revisions. In particular I would recommend the authors consider carefully figure 1 and whether the information there requires a figure.

Specific comments:

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Page 12270, line 15 change “led” to “brought”

Page 12270, line 16 – please quote the uncertainty in these radiative forcing values in order to allow the reader to judge whether these values are really significantly different.

Page 12271, line 16: This sentence is not quite clear, do you mean that the sulphate forcing is larger magnitude than that due to BC or OC, or that the range of forcing from sulphates is larger than that due to BC or OC.

Page 12271, line 20-25. Please consider this figure. Surely it is obvious that the aerosol direct radiative forcing should be dependent on sulphate burden given the background in the first paragraph of your introductions. I don't believe this needs to be on Figure 1. Secondly, figure 1 does not convince me that the sulphate column burden increases with fraction above 5km – this relationship appears to be weak at best. I am not disputing that burden and distribution aren't important for producing model diversity but I don't think Figure 1 shows this. Please consider removing this and leaving only reference to the AEROCOM studies, or devising a figure that makes the point better. If you do include a similar figure with the new model data on it, please ensure consistency with OS and NS on this figure so as not to confuse the reader.

Page 12272 lines 20-25: This paragraph needs rewording. It would be sufficient to say that the GISS and SPRINTARS models show substantially different ratios to the other models.

Page 12273, lines 1-5. I think you could make your point more clearly here. “It is important to quantify the impact of this simplification by comparing against models with more physical, and/or complex, representation of the sulfur cycle”.

Page 12273, line 7-8, “A discussion of the impact on aerosol direct radiative forcings is given in section 7”.

Page 12274, line 6-10. It's not very clear here which methods are more simplified and which are more physically based. For your experiments, tables 3 and 4 make it much

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clearer, is it possible to make this clearer in this paragraph when considering models in general?

Page 12281, line 6: The use of a box model is mentioned here. Why is this necessary and what is its formulation?

Page 12287, line 17 and 18, I think NS and OS are used the wrong way around in this sentence!

Page 12287, line 24: You state that the observations using in Fig 5c do not include China. This makes it hard to compare observations with simulations. It would perhaps be better to include only the simulation regions that compare with observations that are available?

Page 12288, line 1; Link back to your previous sensitivity tests here explicitly to help justify the claim that it is the suppression in sulphate production that improves the surface concentrations.

Section 6: Much of the discussion in section 6 is designed to show how much improved the new version of the model is compared to the old version, and how it agrees better with other models. However, in many quantities, the simple range of other models is so wide that either OS or NS would appear to perform equally well. Could you consider whether there are better measures to agree with from other models than the range? Perhaps you were aiming to get your model closer to the centre of that range from other models for example?

Figure 12. The huge change in radiative forcing over SE Asia deserves more discussion in the text please.

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