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## ***Interactive comment on “Impact of the modal aerosol scheme GLOMAP-mode on aerosol forcing in the Hadley Centre Global Environmental Model” by N. Bellouin et al.***

### **Anonymous Referee #2**

Received and published: 28 November 2012

The paper from Bellouin et al. presents a clean and well documented comparison between two aerosol model schemes in almost the same host model. This is very valuable to understand differences between aerosol models in principal. The presentation, the graphics, the tables are in good shape. However, I have some questions, recommendations and objections, which the authors should take up to make this paper complete. In the present form I find it a little bit too optimistic with respect to the quality of the GLOMAP model. It should be published in ACP after revisions as requested below.

Abstract : P21438, Line 10 : Missing that only AOD id compared.

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Line 12: why are the residence times different?

Line 13: Under estimate can also be due to organic Aerosol or nitrate. I do not see a thorough enough evaluation of absorption in this paper.

Line 22; Why is the cloud susceptibility different? Make this more clear... I thought the meteorological model was the same. I think the definition of cloud susceptibility is partly independent of the aerosol background. Clouds can have different susceptibility for the same background aerosol.

Line 28: I do not agree that the results really show that CLASSIC lacks sophistication or realism.

Page 21439, line 3: Again, I don't see that "those findings" "improves the fidelity in aerosol forcing". It might well be, but that would require more arguments to conclude so.

P 21441, line 18: I wonder if one could tune the CLASSIC scheme in such a way, that it outperforms GLOMAP with respect to AOD. I think this should be discussed. AOD is a limited constraint for a multi- component, multi-size model.

P 21442, line 13: Maybe insert right here that you do not activate nitrate in CLASSIC.

P21443, l 24: if SOA is diagnostic in CLASSIC, what is then done exactly for biomass burning aerosols?

P21443, l 28: what is a "dissolved mode"?

P21445, l 25: ....but dust differences will propagate to AOD. Not clear in the manuscript how dust is impacting the AOD evaluation. Also Why is the lifetime of dust different in the two aerosol schemes?

P21447 , l 15: you mean inter annual variability?

L20: the ratio in dust burden is 3.5, the AOD ratio is 2.2 . Why is there this difference?

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L24: dust is removed from CLASSIC and GLOMAP ? and then for evaluation against MACC and Aeronet added again? Unclear. It should be left in for all comparisons. Or did you remove dust from MACC?

P21449, I14: It would be interesting to know also the mean bias at Aeronet sites, not just the RMSE.

P21452, I12: I do not find this absorption evaluation convincing. I disagree that the conclusion on the superior quality of GLOMAP in the last phrase can be drawn here.

P21454, I5: While cloud phase production might falsely produce too many particles, DMS is not producing new particles through nucleation in CLASSIC ! Compensation of errors? Please discuss and quantify better.

P21456, I 25; mitigated???? mixed arguments, eventually expand sentence.

P21458, I21: I don't see how the comparison "highlights problems of CLASSIC to represent growth"? Which problems? I don't think much is shown in the respective paragraphs. Is the size distribution wrong in CLASSIC wrt data?

L25: unless you evaluate the number concentrations and cloud susceptibility in climate models one can not draw this general conclusion on the failings of mass based schemes. The mass based model could have been a priori correct wrt number concentrations on average.

P21458, I19: I suspect that also the black carbon forcing is more positive in the classic model. Please explore and document bc and sulphate forcing.

P21460, I 5: How do you know that the wet deposition of sulfate is improved? You would need to evaluate against data.. It is not so clear how different the wet deposition really is in the two aerosol models.

L28: "clear improvements"?? Maybe better "are better founded on physical principles of aerosol dynamics"

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