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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Aerosol model selection and uncertainty modelling by adaptive MCMC technique" *by* M. Laine and J. Tamminen

**Anonymous Referee #3**

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General Comments:

The manuscript proposes a Bayesian framework for an inverse problem. In particular, the manuscript uses an adaptive MCMC technique (called Adaptive Automatic Reversible Jump MCMC method) to demonstrate its applicability to inversions of constituents observed from the GOMOS instrument. The advantage of having a Bayesian framework is discussed in the manuscript, quite thoroughly, with a focus on the added capability of the proposed approach to aerosol model selection and estimating its uncertainties. The results shown in the manuscript provide insights on the sensitivity of the inversion results to the selection of aerosol model in the inversion. Indeed, the Bayesian approach is appealing especially for complex problems and the growing necessity to provide error estimates of the inversion results. Exploratory studies, such

as this, provide motivation for improving the current algorithms. In my view, the study addresses relevant scientific questions within the scope of ACP.

However, I have some minor concerns on the presentation. It seems that sections 2 and 3 are rather long (more of a tutorial I think), and can be more likely describe elsewhere. I would rather like to read more about its application and the issues involved in applying the algorithm to an operational or research-based setting. In particular, issues like computational expense, sensitivity of the results to the choice of burn-in time, number of chains, prior and proposal distributions, convergence criteria, and the like. I am also wondering if this algorithm can be extended to estimate time-dependent model parameters.

Specific Comments/Technical Corrections: 1) Abstract: (the motif is to study which type of aerosol model best fits the data). I am not sure if this has been completely addressed, as there were only 4 simple models used in the experiments.

(the algorithm is easy to implement and can readily be employed). I am not clear if this has been addressed as well. I understand that the Bayesian concept is rather simple and flexible but I do not see sufficient discussion of the implementation part.

2) Line 24 p. 10792. (statistically correctly)?

3) Para 1 p. 10793. Can you briefly elaborate more on the GOMOS retrieval so as to provide sufficient context of the proposed investigation?

4) Line 12 p. 10794. (it is reasonable to model also the uncertainty in the model). Do you mean (estimate the uncertainty)?

5) Line 26 p. 10794 (for the constituent the line densities). Do you mean (constituent line densities)?

6) Para 3 p. 10794. Can the algorithm be applied effectively (or is it even feasible) if the aerosol model is more complex than just a function of cross-section parameters?



**ACPD**

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Interactive Comment



7) Line 7 p. 10795. Can you define here what do you mean by (forward model)? There are several references to the term (model) in the manuscript, so it might be clearer if this is defined (or perhaps differentiated for example from a statistical model).

8) Line 27 p. 10798. (paramet[e]rization);

9) Line 6 p. 10804. Can you expand on this in terms of the computational cost? This might be helpful for readers who would like to implement the algorithm.

10) Line 24. p. 10804. (positivity prior). What prior did you use for this? How sensitive are the results to the choice of prior?

11) Line 26 p. 10806. What is the rationale behind the choice of chain length? How many chains for each model?

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Interactive comment on Atmos. Chem. Phys. Discuss., 8, 10791, 2008.



**ACPD**

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Interactive Comment