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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Retrieving global sources of aerosols from MODIS observations by inverting GOCART model" *by* O. Dubovik et al.

Anonymous Referee #2

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General Comments:

This significant paper describes an algorithm for deriving aerosol sources via inverse transport modelling, without using a-priori assumptions on emissions that would have a strong influence on the results. The lack of quantitative information on emission fluxes is a major uncertainty in large-scale aerosol modelling, and this inverse approach is very useful and promising for reduction of ambiguities in estimates of aerosol effects at global scales. The method is tested at global scale using MODIS satellite retrievals of fine and coarse mode aerosol optical thicknesses. The first tests described here show promising results, but certainly in the future further tests will be needed to fully establish this method. A large portion of the paper is devoted to describing the methodology of inverse modelling including descriptions of previous work, which by itself is a very

useful review.

I recommend publication of the paper in ACP with just minor modifications/clarifications.

Specific Comments:

1. Title: It should reflect the fact that a large part of the paper describes the inversion method, which is then tested with inverting the GOCART model using MODIS observations. The source retrieval is only shown as a first test for a limited time period.

2. The Abstract is very long; maybe some detail can be removed.

3. The section on the methodology of inverse modelling is very educational and useful, but I feel unable to comment on the details the mathematical methods involved. Please be sure to be very clear in this section and all variable names etc are properly explained.

4. Page 3642: How applicable is the smoothness constraint for the case of aerosols? Can you add some words on the meaning of this constraint?

5. Page 3644: What is the variable a in Equation 28 (and following)?

6. Page 3646: n-th difference - do you actually mean n-th derivative here?

7. Page 3647: A remark on using knowledge of typical time, horizontal and vertical variability: - in fact this knowledge is not very great in most cases (but still better than using a-priori guesses on emission fluxes).

8. Page 3649: Some more explanation of the steepest descent method would be helpful for the non-expert reader.

9. Page 3662: The number of dust size bins is unclear, here 7 dust size bins are mentioned (the sentence 'in some versions of GOCART up to seven' appears unnecessary), later in the paper a number of 8 dust size bins is mentioned (Page 3665) (this

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is not relevant for the paper, but should be clarified).

10. Section 3.2 (pages 3663, 3664): The description of the algorithm tests could be clearer: Do I understand correctly that the BC type aerosol is just used as 'simple', mono-modal chemically inert primary aerosol type to test the algorithm? Emissions are taken as the sum of BC and OC emissions that are usually used in GOCART. (The term 'prescribed' emissions is somewhat ambiguous.) It would be clearer to use a term like 'test aerosol' (or similar) instead of BC to avoid confusion with the 'real' BC. I suggest to use a term like 'synthetic measurements' to describe the modelled 'observations' (also in the respective figure captions). The aerosol sources were allowed at the first 10 model layers (which height o pressure level is this in GOCART?), what was the reason for this choice? Primary aerosol would be emitted from surfaces (or is it assumed to be mixed within the boundary layer?) Are the retrievals of this test aerosol improved if sources are only allowed at the surface level?

11. Page 3665: Please state which size bin is used for the coarse mode aerosol. The achieved accuracy for the coarse mode is slightly worse compared to the fine mode aerosol in the fist test, what could be a reason? Does the higher gravitational settling of the coarse particles reduce the accuracy of the retrieval?

12. Page 3667/3676: The fine aerosol mode can also contain considerable amounts of soil dust and sea salt particles. Existing model estimates (which are of course highly uncertain by themselves) show that maybe 2-10 % of dust aerosol is contained in the submicron fraction - which is a small fraction of the total dust mass, but given that the total emissions of dust aerosol are currently estimated to be at least 1000 Mt/year globally, 10% would still correspond to a considerable global emission of 100 Mt/yr submicron dust aerosol.

13. Page 3671, line 9: Something appears to be missing in the sentence-better agreement between GOCART output and what?

14. Page 3672: In the tropical Atlantic, where some aerosol sources are falsely iden-

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tified, subpixel clouds are quite common. Are these pixels removed in the MODIS retrieval, or is there the possibility that MODIS misinterprets those pixels as aerosol?

The authors state that the high variability in retrieved coarse mode aerosol is unrealistic, but in fact we do not well know the actual variability in coarse mode aerosol - in particular dust aerosol emissions can be highly variable, as soil conditions allowing dust production can vary on spatial scales that are clearly smaller than the GOCART resolution.

15. Section 3.4.1: As the vertical aerosol distribution is an uncertainty factor in the retrievals, the potential usefulness of the CALIPSO retrievals should be discussed as well.

16. Page 3680: I suggest to briefly discuss the potential importance of sub-daily aerosol emissions.

Technical comments:

The language contains some glitches. For example: Page 3648, line 17: in the each layer -> in each layer; line 25: in Kalman filter -> in the Kalman filter, and several more such minor problems throughout the manuscript. Please go through the text carefully to remove those errors.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 3629, 2007.