Geosci. Model Dev. Discuss., 2, C167–C171, 2009
www.geosci-model-dev-discuss.net/2/C167/2009/

Geoscientific
Model Development
Discussions

Interactive comment on "Simplified aerosol modeling for variational data assimilation" *by* N. Huneeus et al.

Anonymous Referee #2

Received and published: 12 August 2009

1 General comments

This paper presents a simplified aerosol model (SPLA) derived from the general circulation model LMDz and developed to estimate aerosol emissions using variational data assimilation. The simplified model is evaluated against the full–blown model in terms of aerosol burden and optical depth. Comparisons with AERONET aerosol optical depth observations at selected locations are also presented. Model nonlinearity and sensitivity are investigated using the tangent linear and adjoint of SPLA which have been derived with an automatic differentiation software. Overall the performance of the simplified model is comparable to that of the full model and its suitability for assimilation is demonstrated.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

Major shortcomings in aerosol modelling derive from the uncertainties in emissions. Hence, estimates of emissions from satellite data are a step forward to address these problems. In this context, this study is an important contribution to the field of aerosol assimilation. The simplified model is presented in very clear terms and differences with the LMDz model are justified within the assumptions made to develop the simplified version. The investigation of the model sensitivity using the adjoint has its own merits as it highlights where and how the observations might impact the estimation of aerosol emissions. Overall this study provides useful information and insight into designing an aerosol model for variational assimilation.

Some specific comments and technical corrections aimed at improving scientific relevance and readability are provided below.

2 Specific comments and technical corrections

Section 3 and 4: I believe the section with the validation of SPLA should come before the section on the nonlinearity and sensitivity studies. I suggest switching section 4 with 3.

Section 3.2, last paragraph: What made the authors choose to restrict the linearity and adjoint sensitivity analyses to areas where MODIS data are available? I suggest to show global fields. During the assimilation, the information from the observation location is spread to the rest of the model grid through the horizontal and vertical structure functions which are often prescribed based on the model itself. Moreover, in the linear case, the analysis state is the sum of the background state plus the observation departure weighted by a convolution between the Jacobian and the background error covariance matrix (HBH^T) plus the observation covariance matrix (R). Hence it is interesting to see how the model responds precisely in data-void regions to be able to understand how the observations will still impact areas that are not directly observed,

GMDD
2, C167–C171, 2009

thanks to the assimilation process.

Section 3.2.1: how long of an integration did the authors perform with the tangent linear? Please elaborate on how the average for the month of July was obtained. Non-linearities are of course more severe the longer the integration. Usually, the tangent linear is deemed suitable for assimilation if it can reproduce the nonlinear model results over a span of 48 hours, given that the assimilation window in 4D-VAR systems is usually 12 hours. Of course, this also depends on the specific application. Perhaps for the evaluation of the emissions one can get away with a longer assimilation window. Can the authors comment on this?

Section 4.1.2: can the authors comment on the implications of the large daily variability of SPLA on the assimilation? Specifically, what are the implications on the choice of the assimilation window? Of course, for the assimilation, the variability with respect to the observations that are to be assimilated is more crucial than that with respect to the full–blown model.

Along these lines, when the authors perform the verification with respect to the AERONET observations they only show monthly averages over a whole year. Perhaps it would be also relevant to show the verification of the daily averages over, say, a period of a month. Again, since the goal is to use SPLA for assimilation, one has to make sure that the first guess provided by the model is good enough over the assimilation window.

Section 5, last paragraph: only at the very end do the authors state clearly that they are going to assimilate daily averages of AOD. I would recommend making this statement before so that the reader can make sense of the results keeping the final goal in mind.

Page 640, line 4: Add “estimates of" before “aerosol emissions".

Page 640, line 9: Check spelling of sulfur here and throughout the document. BE prefers “sulphur".

GMDD
2, C167–C171, 2009

Page 642, line 10: Replace “into numerical weather prediction (NWP)" with “into the Naval Research Laboratory (NRL) numerical weather prediction (NWP) system."

Page 644, line 9: Replace “acount" with “account".

Page 645, line 14: Parenthesis missing after ω symbol.

Page 646, line 1: Replace “than" with “as".

Page 646, line 11: Remove line (statement has already been made at the beginning of the page).

Page 648, line 5: Replace “one" with “coefficient".

Page 648, line 6: Replace “followed" with “follows".

Page 651, line 17: Put a period after “AOD" and start a new sentence with “Results corresponding..."

Page 651, line 21: Have the symbols “BB" and “FF" been defined before? Please check throughout the document that all acronyms are defined before being used.

Page 652, line 17: See previous comment on showing global fields instead of restricting the analysis to regions where MODIS AOD data are available.

Page 653, line 18: I could not see the region of sensitivity over western i Central Africa in figure 2g and 2h.

Page 654, line 3: References have already been provided, no need to repeat them.

Page 654, line 5: For the benefit of the reader, please explain better what the adjoint test is and why it is so important to attain such an high accuracy.

Page 654, line 15: Replace “the single observation is most" with “the fine mode AOD in that particular location is more".

Page 654, line 16: A strong sensitivity to the east of the observation location is also

GMDD

2, C167–C171, 2009

visible in figure 3a. Page 654, line 25: Please comment on implications for assimilation. If the assimilation is performed over a 12-24 hour window, it will be mainly the local sources that will be corrected. If the assimilation window is longer then more distance sources will also be adjusted.

Page 659, line 20: Sentence starting with “Variational data..." is a bit heavy. Please rephrase.

Figures 4-7: a third panel showing difference between the SPLA and the LMDz runs would be helpful.

Figure 8: labels do not show well. Please re-do the figure.

GMDD

2, C167–C171, 2009