Atmos. Chem. Phys. Discuss., 8, S9995–S9998, 2008
www.atmos-chem-phys-discuss.net/8/S9995/2008/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical Note: A new method for the Lagrangian tracking of pollution plumes from source to receptor using gridded model output" *by* R. C. Owen and R. E. Honrath

P. Seibert (Referee)

petra.seibert@boku.ac.at

Received and published: 18 December 2008

General comments

The authors present a very detailed analysis of long-range CO transport from North America to the Azores. They base their work on forward and backward simulations with the FLEXPART Lagrangian particle dispersion model. This presentation serves as illustration for a new way of using the output of such models, called folded retroplume. This is a method to determine (and then present graphically) subspaces of the 4-D (x, y, z, t) simulation space that impact a defined 4-D receptor subspace.

The paper is an interesting and useful contribution to the still difficult task to understand

and visualise the complicated 4-D transport patterns in the atmosphere.

I agree with Anonymous Referee #1 that the method employed is not totally convincing, as the same information could be obtained by tagging and evaluating computational particles fulfilling the desired conditions in either a forward or a backward run. As far as I understand, there are two arguments why the proposed folding method could nevertheless be a useful or desirable method:

1. The method does not necessitate frequent particle dumps that may occupy a lot of disk space and also slow down the calculations.
2. The method can also be applied as a combination of a forward simulation of a chemistry-transport model (nonlinear chemistry included!) with a backward LPDM simulation. Although the result will obviously not include all the nonlinear chemical effects, it may still give useful insights that could not easily achieved otherwise.

I think that the method has one major potential problem, that has already been encountered and described by the authors, and also addressed by Referee #1. This problem requires more attention and I shall try to provide a bit of input.

The method is based on the assumption that both simulations included are consistent, in the sense that for all source-receptor pairs, source-receptor sensitivities derived from backward and forward simulations are equal. This condition will only be fulfilled approximately, as all simulations involve various errors and these errors manifest differently in the different runs. One such error is the discretisation error when producing gridded quantities if there are significant subgrid-scale gradients. However, interpolation errors (probably the main source of errors in such simulations) and transport errors triggered by the interpolation errors and then amplified in deformative flow patterns are also major sources of problems (see Seibert and Frank, 2004). If things go wrong too much, the result could become rather useless.

ACPD

8, S9995–S9998, 2008

Interactive Comment

We could even turn this method around: where the folded retroplume looks reasonably, and the UMR stays sufficiently constant, the general accuracy of the simulation is good, and vice versa. I admit that I am carrying around with me the idea to develop this into an operational uncertainty quantification for atmospheric transport modelling already for some time!

A few specific comments:

1. I do not see how the claim that the method would be more accurate than standard LPDM products (what is standard?) is backed.

2. Backward simulations do not necessarily produce residence times as output, though the output is closely related to residence times (see Abstract).

3. A transport simulation does not necessarily simulate a tracer (see near Eq. 2). *Tracer* in my understanding is something like a *marker* which helps us to trace transport. However, often we simulate *trace substances* but they are not tracers.

4. Is instantaneous output from FLEXPART an important feature for users? For us FLEXPART developers it could be useful to know that. It is not difficult to make it possible. However, one has to be aware that the stochastic uncertainties will become larger if the output is based on one sampling time only. This should also be mentioned in the paper. The problem of the shift between sampling periods being located before / after the time stamp in the forward / backward run could be overcome by shifting the whole simulation periods accordingly.

5. I think that the paper is rather long and could be shortened.

Acknowledgement. Much of the work on Lagrangian modelling of this reviewer has been supported by the Fonds zur Förderung der wissenschaftlichen Forschung (FWF), presently through grant P17924.

ACPD

8, S9995–S9998, 2008

Interactive Comment

Reference Seibert, P. and Frank, A., 2004: Source-receptor matrix calculation with a Lagrangian particle dispersion model in backward mode, Atmos. Chem. Phys., 4, 5163, 2004, http://www.atmos-chem-phys.net/4/51/2004/.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 18843, 2008.

ACPD

8, S9995–S9998, 2008