

## ***Interactive comment on “Sensitivity of tracer transport to model resolution, forcing data and tracer lifetime in the general circulation model ECHAM5” by A. Aghedo et al.***

### **Anonymous Referee #3**

Received and published: 22 February 2008

#### General comments

This paper analyzes the effects of model resolution, meteorological fields, and tracer lifetimes on the tracer transport in the ECHAM5 model by using idealized tracers emitted in different regions of the atmosphere. Generally, the paper is well written and provides some interesting results, but the discussion of the results should be clarified and augmented as stated below before publication.

Suggestions, questions, and specific comments

1. The meaning of the term “forcing data”; in the title is not clear by read-

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ing the title alone, so I suggest to replace it with 'meteorological fields'; or something similar.

2. A study on the dependence of model results on horizontal and vertical resolution should include a discussion on the convergence properties of the numerical solutions. In this context, the authors should also highlight the practical implications of their numerical results (recommendations on which model resolution to use, etc.). They should also briefly discuss how the quality of the transport processes could be evaluated by comparing with observations in a follow-up study (i.e. whether there is better agreement with observed quantities by increasing the resolution or by using nudging techniques).

3. p.139, lines 17-21: The underlying assumption seems to be that differences in model resolution might play an important role in explaining differences in the distribution or seasonality of atmospheric trace gases from different models. This assumption is not necessarily true. An example where this assumption does not seem to be supported is a recent study from the HTAP initiative (the passive tracer experiment) which indicates that the major cause of the spread in model results are differences in the emissions. The authors should briefly comment on whether other factors (e.g. emissions, operator splitting (this is related to point 5)) could dominate the influence of the model resolution on the tracer transport.

4. p.140, line 1: In order for this study to be an 'assessment'; (or extension of an assessment), i.e. to assess the quality of the ECHAM model in terms of tracer transport, it is necessary to provide more observational data. Otherwise, 'assessment'; should be replaced by 'analysis of the sensitivity of tracer transport in the ECHAM5 model to model resolution etc.';

5. p.141, line 25: Explain the meaning of 'strang splitting'. Although the focus of this paper is on the influence of model resolution, it would be interesting to analyze the influence the particular choice of the operator splitting method has on

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the tracer transport (see e.g. Dubal et al., Mon. Weather Rev., 132, 2004). It is not necessary that the authors provide a detailed discussion, but they should comment briefly on the potential influence this numerical technique has on the accuracy of the tracer transport, and whether this has been analyzed elsewhere with respect to the ECHAM model.

6. p. 141, lines 27-28: The authors keep the mass mixing ratio of the tracers at a constant value of 1 in each source region. On the other hand it is possible that the transport processes will cause the tracers to be redistributed within a source region and also transport tracers back into a source region. How are these potential changes to the mass mixing ration handled in the model? Are they simply discarded for grid points within a source region (i.e. are the grid points in a source region reset to 1 after each process was computed)?

7. p.142, line 12: Explain why the pressure at the second level is always 30 hPa. My understanding is that the pressure at each level changes throughout a simulation due to changes in the surface pressure and because ECHAM uses a hybrid sigma-pressure vertical coordinate. Also explain whether the level at the tropopause region changes during the runs (depending on where 100hPa or 200hPa is located) or whether this level is fixed for the duration of the simulation.

8. p. 142, line 17: The term "normally"; is confusing. The authors should state explicitly that they used 5 months for all experiments except for some special cases where the influence of the tracer lifetime was analyzed.

9. p.142, line 28: Define the term "quasi steady state"; the first time it is used. Is it an approximate steady state, defined in some statistical sense? Is it simply the 4-year average?

10. p.144, line4: The authors mention that "most"; of the simulations reached a quasi steady state. They should be more specific and note which simulations did not reach quasi steady state and provide some explanation, if possible.

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11. Figure 2: It appears that there is still a trend in the surfN plot (i.e. the simulation is not in a quasi steady state yet). Is this correct and is there an explanation why this is the case for this specific tracer? It also appears that in the tropT plot the average deviation of the T63L31 curve from 1.0 is larger than that of the T106L31 curve from 1.0, which shouldn't be the case. Please check whether this is indeed the case or not. The T63L31-era40 run shows a tendency not to reach quasi-steady-state over the 4 year period (stratS, stratT, tropT). Do the authors have any explanation for this behavior?

12. p.144, line 14ff: There does not seem to be a significant difference in the R values of the stratospheric tracers (stratS and stratN for T42L31 and T63L31, and stratT for T42L31) between the L19 and L31 runs. This should be noted. Is this due to an insufficient resolution of the stratosphere in the ECHAM5 model? The statement that there is little influence of the horizontal resolution is too general. The authors already mention two exceptions to this rule, and also see point 14.

13. p.145, line8: Since these simulations are not AMIP2 runs, the term "AMIP2"; should be omitted (or replaced by "AMIP2-style").

14. p.145, line 15 ff: The statement that there is little difference between the T42L31 and the T63L31 runs is too general. The plots in Figure 2 clearly show a difference in the tropics (stratT, tropT, surfT) which should be mentioned.

15. p.149, lines12-13: These statements are somewhat too general as I indicated previously (point 12 and 14) and they should be modified.

16. p.160: Are the plots in Fig. 4 the 4-year average? If that is the case, it should be mentioned.

#### Technical corrections

1. p. 139, line 17: "stratosphere-troposphere"; -> "the

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stratosphere-troposphere

2. p.139, lines 26-28: The evaluations by Hagemann, Roesch and Roeckner, and Wild and Roeckner are not relevant to this study and should be omitted.

3. p.140, line 2: omit the quotation marks next to emitted

4. p.140, line 5: time scale; -> time scales

5. p.140:, line 21 replace hybrid terrain following sigma-pressure; with hybrid sigma-pressure

6. p.140, line 22: cite simbur81 should be replaced with the correct citation

7. p. 141, lines 27-28: Change to: We consider nine independent idealized tracers, each constrained to have a constant mass mixing ratio of 1 in its respective source region (see Fig. 1).

8. p.1 42, lines 7-8: Change to: Vertically, we inject the tracers at three different altitude regimes: surface;, tropopause;, and stratosphere;

9. p.142, line 23: Explicitly mention that only the last 4 years were used.

10. p. 142, line 25: using 5 months tracer lifetime; -> using a tracer lifetime of 5 months

11. p.143, line 6: of tracer; -> of a tracer

12. p. 145, line6:;which is about; -> ;which are about

13. p.145, line 15: ;feature for the; -> ;feature of the

14. p.146, line 2: ;generally lead; -> ;generally leads

15. p.146, line 24: ;Also slightly higher; -> ;Also, a slightly higher

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16. p.147, line 6: tends to 0; -> approaches 0;
17. p.147, line 14: between Northern and; -> between the Northern and;
18. p.148, lines 19-20: finer resolution models; -> models with a higher vertical resolution;
19. p.148, line 20: Replace AMIP2; with AMIP2-style; or omit the term.
20. p.149, line 11: transport is more vigorous; should be replaced by transport rates are higher;
21. p.149, line 21: show; -> shows
22. p.150, line 8: finer resolution models; -> models with a higher vertical resolution;
23. p.150, line 8: Replace AMIP2; with AMIP2-style; or omit the term
24. p.151, line 12: Climatlogy; -> Climatology
25. p.158: the font size of the various figures in Fig. 2 should be increased. Replace  $m_{i,T63L31}$  with  $\hat{m}_{i,T63L31}$

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Interactive comment on Atmos. Chem. Phys. Discuss., 8, 137, 2008.

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