Geosci. Model Dev. Discuss., 4, C1080–C1084, 2011
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Interactive comment on "The 1-way on-line coupled atmospheric chemistry model system MECO(n) – Part 1: The limited-area atmospheric chemistry model COSMO/MESSy" *by* A. Kerkweg and P. Jöckel

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Received and published: 15 November 2011

Dear Volker, dear referees,

first of all we express our appreciation for your comments, in particular for the in-depth re-analysis of our tracer tests. Indeed, we went fatally wrong in the interpretation of our results, which forced us to rewrite the complete section (5.2.1) on "Tests with artificial tracers without emission", including figure updates and modifications of the conclu-

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sions. The good result is, however, that by this revision we are able to show that the transport characteristics of COSMO/MESSy **are** of sufficient quality for atmospheric chemistry applications.

The specific comments are answered below.

- *A) Please state clearly ...*

  We reorganised the section roughly along this red-line:

  - What transport processes are we looking at?: advection, convective transport, vertical diffusion.
  - What do we expect from them?: mass conservation, monotonicity and positive definiteness.
  - How are our tests designed?: tracers with three different initial patterns, combined with 5 different transport process combinations
  - Discussion of the results for monotonicity, positive definiteness and conservation of mass
  - Summary

- *Example: Homogeneous tracer H ...*

  This has been our key misinterpretation. We completely agree and show in the revision the evolution of the tracer masses **and** of the dry air mass in the domain.

- *As far as I understood, the influx and outflux is not explicitely calculated ...*

  This is also correct. We state this more clearly: "... Inside a regional model domain the mass of a specific tracer is not expected to be conserved. With a perfect transport scheme, however, the mass budget of passive tracers (i.e., without

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sources or sinks in the regional domain) is expected to be closed, implying that the tracer mass within the domain plus inflow minus outflow in/out of the domain is conserved. The latter (inflow and outflow) are determined, at least implicitly, by the boundary conditions. As there is no in- and outflux budgeting routine in COSMO/MESSy yet, our analyses are somewhat limited, but as a first step artificial passive tracers are used to diagnose, to the extent possible, the mass conservation, positive definiteness and monotonicity of the transport processes as implemented in COSMO/MESSy. ..."

- *I suggest to replace (or add) the figure 5a by ...*

The revised figure (now Fig. 6) shows the evolution of the dry air mass and of the tracers H and $V1$+$V2$ within the domain, each normalised to the corresponding time average, so they can be directly compared. The results is: the mass of H and the sum of masses of $V1$ and $V2$ strictly follow the mass of dry air.

In addition, two more panels show the masses (normalised to their time average and divided by the mass of dry air normalised to its time average) of the $V1$ and $V2$ tracers. The corresponding discussion is added to the text.

- *Example V1 / V2. This case is even more tricky. ...*

We also agree with that. From the evolution of masses of $V1$ and/or $V2$ individually no information on the mass conservation can be deduced. However, our new analysis shows that $V1 + V2 = H$ in very good approximation throughout the domain and the simulation (and the boundary conditions). As a consequence, this also holds for the sum of integrated (over the domain) tracer masses: $M(V1)+M(V2) = M(H)$. $M(H)$ (see above) follows exactly the evolution of the dry air mass. From this strict linearity, we **can almost** conclude that the tracer

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transport is **not** subject to mass conservation violations, except for those potentially caused by mass-wind inconsistencies (*Jöckel et al., 2001*).

- *B) Figure 6 indicates a mass correction by TRACER_PDEF ...*

  We now write: "... The generic MESSy sub-submodel TRACER_PDEF (*Jöckel et al., 2008*) provides the possibility to detect negative tracer mixing ratios, for instance caused numerically, to correct them (locally) to zero, and to diagnose the corresponding mass conservation violation. This has been applied here. ..."

- *It would be good to have a ...*

  We now indeed conclude that the tracer transport characteristics are of sufficient quality for atmospheric chemistry applications.

- *page 13 "The latter (inflow and outflow) are determined ...*

  See third comment above.

- *A violation of the homogeneity of the H tracer ...*

  This statement has been wrong and does not longer occur.

- *Conclusion / abstract ...*

  We think that our revised tracer tests, which are also mentioned in the abstract and conclusions of the revised manuscript are of potential interest to other limited area modelers as well.

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