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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling tracer transport by a cumulus ensemble: lateral boundary conditions and large-scale ascent" *by* M. Salzmann et al.

M. Salzmann et al.

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Reply to Comments by C. Wang:

- P3383, line 8: τ was re-named to τ_{adv} and a formula for τ_{adv} was added
- P3383, line 9 of ACPD paper: Mlawer et al. (1997) was changed to (Mlawer et al., 1997)
- P3387, line 21: the abbreviation SLBC was replaced
- P3390, line 6: the entire sentence was omitted based on a suggestion by Anonymous Referee #1. The small differences in total precipitation were originally judged to be "surprising" because the hydrometeor advection across the domain's

lateral boundaries was expected to differ for various domain sizes, possibly causing larger differences in the total precipitation. However, the small differences which were actually found are consistent with the assumption of negligible horizontal advection of hydrometeors into the model's domain (although, here hydrometeors were advected out of and not into the domain). This assumption is currently made in semi-prognostic model studies but has been suggested as a possible source of uncertainty.

- P3393, line 14-15: The upwards transport in the convective core is much faster than the mesoscale subsidence. On longer time scales, the mesoscale subsidence was shown to be important as well (see e.g. Lelieveld and Crutzen, 1994). In CRM studies, the efficiency of the mesoscale subsidence can be overestimated when using PLBC without VLSAT (e.g. Fig 1, Fig. 9). The fact that tracer B is not mixed as quickly as tracer A can be attributed to the more efficient transport in the updrafts and to the relatively smaller entrainment of tracer mass in the mid-troposphere compared to the LT. Consequently, the amount of tracer A in the UT increases a lot more rapidly than that of tracer B. Also in the same paragraph, the citing of Mari et al. (2000) was corrected.

- P3396, line 24: (the question concerning tracers B and C): Quasi-horizontal layers of elevated or lowered trace gas concentrations in the troposphere can easily form in the troposphere. Newell et al. (1999) for example describe frequent observations of quasi-horizontal layers with mean thickness of order 1 km occupying up to one fifth by volume of the lowest 12 km of the atmosphere. Here, however, all three tracers, especially tracer B and C, are idealized tracers and were mainly chosen in order to illustrate transport processes. The analysis of tracer B and C was found particularly useful in order to understand a number of issues in multi-day chemistry transport simulations in which VLSAT was not considered, e.g. strong downward transport of stratospheric ozone and large mid-tropospheric sources of nitrogen oxides due to the thermal decomposition of

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subsiding precursor gases.

- A plot of the cloud top heights is now included (see Fig. 14). This plot was included for the purpose of supporting the statement that the differences in downwards transport of tracer C between various runs are not caused by differences in cloud top heights. Instead it is due to the inclusion of VLSAT (see comment by Anonymous Referee #2).

  The sentence containing the abbreviation “approx.” was eliminated based on suggestions by Anonymous Referee #1.

- P. 3399, line 3-8: The sentence: “For either much smaller or much larger domains, a stronger domain size dependence may be expected” was added to the discussion.

- It would be necessary to study the influence of using radiative boundary conditions for tracers in long term model studies with changing wind directions (i.e. when outflow boundaries become inflow boundaries). In these cases, it may prove to be preferable to prescribe values at the inflow boundaries. This study is beyond the scope of this paper.

- “measurement campaigns” was changed to “field campaigns”

- P. 3412: The citing to Ekman et al., 2004 was changed

- P3412, Fig. 7: The caption was changed to indicate that normalized mixing ratios are plotted. The same was indicated in Fig. 9

References

[Lelieveld and Crutzen (1994)] Lelieveld, J. and Crutzen, P. J.: Role of deep cloud convection in the ozone budget of the troposphere, Science, 264, 1759–1761, 1994.

[Newell et al. (1999)] Newell, R, E., Thouret, V., Cho, J. Y. N., Stoller, P., Marenco, A., Smit, H. G.: Ubiquity of quasi-horizontal layers in the troposphere, Nature, 398, 316–319, 1999.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 3381, 2004.