

Interactive comment on “Revision of the convective transport module CVTRANS 2.4 in the EMAC atmospheric chemistry–climate model” by H. G. Ouwersloot et al.

Anonymous Referee #2

Received and published: 8 June 2015

The manuscript describes a set of modifications/improvements made to the convective transport code of the EMAC (ECHAM MESSY Atmos chem) model. The impact of the changes on constituent transport are evaluated with a series of idealized tracers with different lifetimes. The improvements include a time sub-stepping scheme to avoid numerical instabilities, the extension of the subsidence to include the sub-cloud layer, a change in the tracer mixing ratio entrained into the cloud at base, and a change in the assumed convective cloud fraction. The changes in simulated mixing ratios of idealized passive tracers are attributed largely to the time sub-stepping that was added to the convective transport.

The study reported here contributes to the increasingly important examination of con-
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vective transport in climate models. Moist process parameterizations are generally evaluated for the heat and moisture budgets but not for the impact on tracer transport. The improvements reported here are necessary elements for realistic convective transport (for instance, that the limits on the convective transport of mass based on numerical constraints not all but eliminate convective transport), and will be of use to developers of models that do not contain these sort of improvements.

The study here reports on the results of a series of experiments that make it difficult to assess differences among them, and improvements/degradations are gauged using one of them as the standard. I recommend, therefore, that the manuscript undergo the major modifications outlined here before it is published.

General:

The use of a single experiment of one year's length for each configuration makes it quite difficult to gauge the significance of any differences. The manuscript uses the vocabulary "significant" throughout the manuscript with no foundation. I would recommend either running small ensembles, longer experiments, or as a minimum removing the word "significant" from the manuscript and substituting the vocabulary about definitive differences with more relative terminology (ie., the mixing ratio in the xxx experiment is 10% larger than in the xxx experiment).

The use of one of the sub-stepping experiments as the standard for other experiments seems unwarranted. At best an experiment with small time steps seems like a potential "ground truth". Without a better "standard for truth" the vocabulary about improvements and degradations has no basis. Please either use a short time step run as the standard, or amend the vocabulary about differences to remove the value assessments.

section 2.

it is not clear whether CVTRANS is used for transport of chemical species only, passive tracers only, or for the transport of moisture and heat as well. it reads as though

CVTRANS is NOT use to transport moisture (and cloud condensate). if that is the case, please discuss/justify.

In addition - the restriction on the convective in the control experiment is not quite clear-when the CFL criterion is violated, is all transport turned off, or is the transport limited to the amount needed to meet CFL?

The description of the "analytical expression" is also not clear. Does the control experiment not use this "analytical expression" for the change in mixing ratio below cloud base? So the subsidence does not extend down into the cloud base in the control experiments?

Please explain why you reduce the mass flux per unit area in the CC experiment. One could imagine an option where the conv mass flux per unit area is unchanged and the assumption of total cloud cover would mean an INCREASE in total mass flux in a grid box.

section 3.

the description of the experiments is confusing at best. a table listing the experiments and their names is sorely needed. How long did the experiments run for?

section 4.1

There is no reference for the relevance of the magnitude of the standard deviations. For instance, P. 3127 Line 12 refers to standard deviations of 5% of mixing ratio. Is that large (as the text suggests?) or small, or within natural variability?

A single experiment with each configuration of 2-year's duration (where we see only the results of the averages for one of the years) is not sufficient to measure differences. Longer (or more) experiments would strengthen any argument about differences.

Discussion of figure 1 - what is the surface value? i.e., the figure shows values near 5-10 or less in the ORG experiment and another 30 in the 100I experiment. difficult to

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assess without knowing surface mixing ratio. is vertical transport in the ORG experiment almost eliminated? What is the behavior of the transport in this experiment with a smaller time step?

Not clear that both figures 1 and 2 are needed to show that the difference between an experiment with and an experiment without much convective transport of constituents is to find more tracer aloft. perhaps figure 2 suffices.

Page 3129 lines 1-5 - by what criterion do you assess the ORG transport to be overestimated and the 100I experiment to be overestimated? If you have no basis for these terms please use relative terminology.

section 4.3

The material in this section illustrates the issue with not having any sort of objective criterion about which transport is correct. Please add some discussion in either the introduction or in the section describing the model of the performance of the control (ORG) simulation with realistic tracers as compared to observations.

section 4.4

the discussion about small (and probably not statistically significant) differences between two experiments should be removed. if the differences cannot be shown to stand above noise then there are no differences.

section 4.5

line 3 on page 3133 says that the differences are "very significant". please remove this as it has not been shown. Differences of 4% would probably be within the noise, and 27% may or may not be. The description of the results of these experiments can be removed.

General: Please remove the use of the word "significant" when discussing differences among experiments. Please use the value of the RMS relative to the mean mixing ratio,

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ie., 10% difference.

Figures 2,3 - please add some values to the vertical axis other than 1000 and 100. In addition, because the color bar chosen makes it difficult to see the zero line, please add a zero contour.

figure 4 - the text in the legend is garbles in the pdf file.

Panel 'a' of figures 2,3,5,6 can be removed. it is the difference that is being discussed in the manuscript.

Interactive comment on Geosci. Model Dev. Discuss., 8, 3117, 2015.