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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.

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Reply to Comments by Anonymous Referee #2:

- The model description section (2.1) was extended to include more information about the capabilities and the purpose of the WRF model. Furthermore, a sentence was added to the conclusions focusing on model features which could prove most relevant to our own future work. Here the WRF model was used in the same way as a traditional CRM, and a complete discussion of the long list of benefits of the WRF model system should be left for future publications. The main points of this study can be expected to be largely independent of the particular model used. Furthermore, here a slightly modified version of the WRF model was used, partially because of a problem with the microphysics scheme in

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an early prototype version, which has long been solved (in part based on findings made in the framework of this study). Based on the evaluation of the modelled meteorology in this study, the model was found to be fit for simulating the conditions during the TOGA-COARE case in a semi-prognostic setup. Although it wasn't the main purpose of this work, this could be considered as one step in evaluating the WRF model. The model is currently still being evaluated under a number of different conditions and we share the opinion that WRF is becoming a tool of choice for small scale meteorological phenomena.

- The following sentence was added to Sect. 3.: "The different q biases in the SLBC runs compared to the PLBC runs are a consequence of the horizontal transport of water vapour into the domain and of the differences in total precipitation discussed above." Water vapour is a much more complex tracer than the idealized tracers in this study. This study was meant to investigate the vertical transport of tracers in convection. The vertical transport of water vapour is largely constrained by saturation.

- the observed precipitation rate was taken from the Ciesielski et al. (2003) data set. Since the model is run using a semi-prognostic setup, the good agreement is not surprising (given no major deficiencies in the model). Similarly good agreement was achieved in earlier model studies (e.g. Johnson et al., 2002). However, with another input dataset significantly different rates of precipitation can be modelled for the same episode (see Fig. 4 of Gregory and Guichard, 2001). To the authors' knowledge, these large differences between different input datasets have not yet been addressed in the literature.

- Fig. 7: We agree with the interpretation of the referee. A discussion of the general conditions for which PLBC are acceptable was added to the conclusions: "In general, if no large scale advection terms for tracers are prescribed from observations, PLBCs should not be used for model studies of tracer transport if the

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simulated time t_{sim} is longer than the advective time scale $\tau_{adv} = L/\overline{v}_{max}$ and $\tau_l > \tau_{adv}$, where τ_l is the tracer's chemical life time. For studies of reactive, or soluble tracer transport, prescribing horizontally homogeneous horizontal tracer LSA terms from observations could in some cases be problematic because large horizontal gradients can form in the simulations. This would have to be examined in future studies".

- The reference to the Andronache et al. paper was included in the introduction (last sentence, starting page 3382) and in the beginning of section 2.4. The reference to the Wu et al. study was added in the beginning of section 2.4. The references to the studies by Bechthold et al., and Redelsperger et al. were not included in the revised version. They studied a different time period during the TOGA-COARE experiment.

- A discussion on the general conditions for which PLBCs are acceptable was added to the first paragraph of the conclusions.

- A plot of the cloud top heights is now included in Fig. 14. and the following sentences were added to section 4.4: "Fig. 14 shows the maximum cloud top heights in the domain for different runs. The cloud top height was defined as the first model level where the sum of all cloud meteor masses integrated downwards starting from the model top exceeds $5 \cdot 10^{-3}$kg/m^2. Most notably, the maximum cloud top heights for the 3D run are generally above those for the corresponding 2D run. For the 500km domain 2D runs, the maximum cloud top heights are largely independent of the boundary conditions applied. Differences in the downwards transport of tracer C are most likely caused by the application of VLSAT rather than by systematically different cloud top heights."

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