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Interactive Comment

Interactive comment on "Regional modelling of tracer transport by tropical convection – Part 2: Sensitivity to model resolutions" *by* J. Arteta et al.

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General comments: You pointed out the lack of quantitative results in the paper (similarly to Part 1). This is in agreement with the other referee's review. This general remark has been taken into account in the revised version, in particular by providing more quantitative results for TRMM comparison (see details below) and a more focused discussion.

We have modified the text in order to shorten the long sentences in the paper.

The motivation of the paper was given in the introduction. Since it was not fully clear, it was modified in the revised version. Compared to previous studies, the present work addresses an issue not previously discussed in the literature: the impact of model resolution on tracer transport by tropical convection with a mesoscale model. This is now clearly stated in the introduction in the revised version. The model description has been completed in the revised version of Part 1 (see the answer given for Part 1). In Part 2 the similarities with the general model setup used in Part 1 are now clearly explained (see section 2). In Part 2 we added information in the model description section but the detailed description remains in Part 1. We did this to not increase too much the size of the paper.

Measures of the model performances: More quantitative measures of the model performances are now added in the manuscript (see section 4.1). As in Part 1, we now use common measures for the precipitation forecast accuracy: the equitable threat score, the probability of detection and the false alarm ratio. We have also plotted the daily evolution of these measures (see Figure 6 in the revised version) and of the accumulated rainfall rates (see Figure 3 in the revised version). This allows us to analyse the model behaviour as a function of time. We also added a distribution plot of the monthly mean TRMM rainrates versus model (see Figure 5 in the revised version) to characterize the model behaviour for the different model resolutions. The analysis of all these plots shows that increasing the model vertical and horizontal resolutions provides significantly better results for surface precipitation, both in terms of accumulated value and of spatial distribution. It also gives a better prediction of the occurrence of convective events.

Flight tracks: Since the model simulations cover a large area, a comparison with the extended flights (23rd, 25th, 29th November and 5th December) was preferred for the model evaluation. On the 5th December, aircrafts flew southward and the main part of the flight was done outside or close to the limits of our model domain. Therefore this flight has not been used. This is the same for the beginning of the 29th November flight for legs done before 8:30 UT. The other two extended flights were on the 23rd and 25th November. In accordance with one of referee #1's remarks, we shortened the manuscript by removing results for the 25th November flights. This is possible since

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the general results are similar for both days.

Model differences smaller than differences with observations: The lack of variability of the model results compared to the observations is discussed in the revised version (see section 3). It can be attributed to two facts. Firstly the model horizontal resolution is large (even with 20 km) compared to most of the small scale structures that are captured by the aircraft measurements. Secondly the model is not always able to trigger convection exactly when and where observed whatever resolutions are used (see statistical results in section 4). Therefore the local impact provided by the convection parameterization is generally missed in the model-measurement comparison. This could be improved by running the model over a shorter time period starting about 48h before the flight but we feel this is out of the scope of the paper.

Statistical analysis: The term "mean bias standard deviation" has been corrected. It is the standard deviation of the bias which is related to RMSE by a simple relation. The statistics given use a fairly large set of data. Although Manus is located in a convectively active area convection only occurs during a small fraction of the time. Therefore we do not expect to have large differences between the model simulations and the radiosounding data on average. Nevertheless the HR results (biases and standard deviations) being better than CVR and REF by at least few percents we think that the differences are significant. More discussion on the comparison between REF, HR and Manus radiosoundings has been included in the revised version (see section 4.2). The temperature biases and standard deviations are related to an underestimation in the troposphere, except in the TTL. In this layer the model overestimate the cold point temperature which is very low with a sharp gradient in this geographical area. For the temperature bias at the cold point the 300m the vertical resolution used in REF and HR simulations is not sufficient to reproduce the very sharp gradient observed. The wind speed biases are mainly related to an underestimation by the model of the wind speed and its large gradients in the TTL. The positive water vapour bias indicates an underestimation by the model of the water vapour conversion into precipitation. The vertical

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profiles of temperature, wind and water vapour are partly driven in the simulation by the convective activity. It induces a warming by condensation and the conversion of water vapour into precipitation in the troposphere below the TTL, strong outflows and a cooling above convection. All the model biases indicate an underestimation of the convection intensity and frequency in the model. HR run gives the lowest biases and standard deviations and therefore better meteorological fields. Using a fine horizontal resolution provides more active convection (as shown by the results from the TRMM analysis) corresponding to stronger updraft/outflows and to more precipitation. This leads to a larger impact in HR fields improving the model statistics compared to radiosounding data. The interpretation of the comparison of CVR against REF has to be done keeping in mind that the CVR statistics are calculated on a smaller number of levels. This means that the mean profile calculated using the radiosounding data for CVR is smoother in the upper troposphere and lower stratosphere. Nevertheless REF simulation generally gives better statistical results than CVR. This indicates an improvement when using a fine vertical resolution in the TTL. This is linked to convection which is more active in REF as shown in section 4.1 (revised version).

Figure captions have been checked.

Paper merging: We have included in both papers some additional figures/tables and discussions. Each of the two papers discusses a specific issue: convection parameterization for Part 1 and model resolution for Part 2. We feel that now each paper contains sufficient material. Therefore the two papers were not merged. Conclusion has been modified to be more focused and clearer. We have strengthened the tracer analysis based on the new results of the meteorological analysis.

CNRS-INSU is the organisation to which the Laboratoire de Physique et Chimie de l'Environnement et de l'Espace belongs to. There is an agreement between CNRS-INSU and EGU and we guess that this is the reason why the logo appears. We cannot do anything about it.

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Interactive comment on Atmos. Chem. Phys. Discuss., 9, 5929, 2009.

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