Atmos. Chem. Phys. Discuss., 6, S7270–S7274, 2007
www.atmos-chem-phys-discuss.net/6/S7270/2007/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "A numerical study of tropical cross-tropopause transport by convective overshoots during the TROCCINOX golden day" *by* J.-P. Chaboureau et al.

J.-P. Chaboureau et al.

Received and published: 15 March 2007

The authors thank the reviewer for the historical review and his/her helpful remarks.

Minor comments

The title

Following your suggestion, the title has been shortened to "A numerical study of tropical cross-tropopause transport by convective overshoots"

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Section 1. Introduction:

Indeed the wording was misleading. It is now ”The concentration of the water vapour transported in the stratosphere is controlled by the cold point, the coldest temperature.”

The work of Potter and Holton (1995) has been added.

Section 2. Model and experimental design:

More characteristics of the nested domains, including their size, are now given in a table.

The vertical spacing around the tropopause is 400 m at high altitude. The sentence describing the vertical spacing has been made more explicit by writing ”The vertical grid has 90 levels up to 27 km with a level spacing of 40 m close to the surface to 400 m at high altitude.”

The initial conditions, including the stratospheric water vapour, were given by ECMWF analyses. The water vapour concentration was stable during the simulation except in areas of deep convective overshoots.

Model configuration is related to the choice of the grid nesting setup (a framework of real meteorological conditions) with a gridmesh of 625 m for the model-4. As stated in the text, a finer gridmesh (a few 100 m) would better represent the convective motions inside the clouds. It is, however, too expensive numerically. The wording ’ momentum

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accuracy' is indeed misleading. It has been changed to 'high resolution'.

Section 3. Overview of the convective event:

FLASH is only a water vapour sensor, not a total water sensor. It has a special aspiration scheme which avoids the influence of particles inside the clouds. Large experience of joint measurements with the FISH instrument (for total water measurements) in different meteorological situations confirms this. To avoid of optics contamination, FLASH has a hermetically closed chamber which is opened at altitudes higher than 8 km. The window of the hydrogen lamp is more critical for contamination, therefore the L-alpha intensity is usually checked before and after every flight. To avoid the influence of water vapour from the walls inside the instrument, the chamber is carefully prepared (dried) before every flight and hermetically closed.

The temperature sensor was a Rosemount sensor.

We agree that using radiosounding at nearby stations would be more suitable to characterize the environmental atmospheric conditions, but with a low vertical resolution. Therefore, and also for convenience, we preferred to use the aircraft ascent data. Furthermore, to be more precise, we have changed "at 16.3 km both temperature and water vapour experience a strong change in their vertical gradient, with local minima of -80.0 C and 3 ppmv, respectively" to "at 16.3 km both temperature and water vapour underwent a strong change in their vertical gradient, remaining almost constant over a 1.5-km layer, with local minima of -80.0 C and 3 ppmv, respectively". So this ascent profile does not correspond to the hypothetical changes by Danielsen (GRL, 1982).

The vertical spacing is not mentioned again as other modelling weakness can explain

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the discrepancies between the observation and the simulation, such as the micro-physics.

The vertical spacing is not mentioned again as other modelling weakness can explain the discrepancies between the observation and the simulation, such as the micro-physics.

We have added ”Overshoots were defined as clouds with their tops located higher than the cold point altitude. In that case,” before ”larger BTs at 6.2-micron than at 10.8-micron can be explained by stratospheric water vapour, which absorbs radiation from the cold cloud top and emits radiation at higher stratospheric temperatures.”

Section 4. Overshooting plumes:

We prefer to keep MKS unit for BT.

Indeed the numbers for vertical wind velocity maximum are dependent on the averaging period or space resolution. Wind velocity exceeding 60 m/s is not uncommon as observed for the case simulated by Wang (2003, see Table 1, page 5). We also cite the work of Mullendore et al. (2005). Their simulation, with a maximum of 88 m/s, compares well with the observed storm in terms of cloud top (19 km with a tropopause at 14 km), propagation speed, and radar reflectivities (with a 65 dBZ maximum!). Such continental storms can give more vigorous vertical wind than the tropical cyclones you cite. To be more explicit on the work done by Wang (2003), the sentence is now ”Maximum vertical velocities of 50–55 m/s (60 m/s) were observed (simulated) for a 3-D deep supercell storm characterized with an environment of 3012 J/kg CAPE.

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A new figure has been added showing a change in temperature consistent with the hypothesis of Danielsen (GRL, 1982).

Section 5. Mass and water vapour transport:

It is stated in the text that the estimates obtained from the present study are daily averages (p 13011, l 12). But the estimates obtained from the other studies are averaged over longer periods.

Some comments for Figures:

The time is now in LT in most parts of the text.

Fig. 5 shows the time evolution of the vertical velocity maximum from the model-4 domain as soon as the simulation in model-4 begins, i.e. at 15:00 LT only.

Figs. 3 and 6 have been shown over a half page only. Their publication over a larger space would render them more readable.

In Fig. 8, mass fluxes are daily averages for estimates from this work only.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 13001, 2006.