Cross-tropopause transport by convective overshoots in the tropics

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Overshooting features reaching 14 km in DJF

HIBISCUS-TROCCINOX, Brazil, Feb. 2004-2005

(Liu and Zipser, 2005).

Overshooting features reaching 14 km in JJA

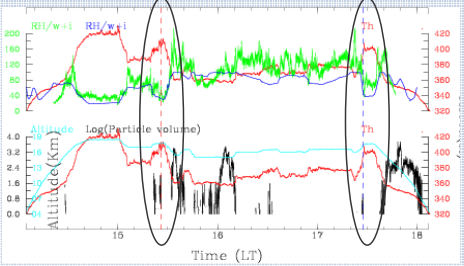
SCOUT-AMMA, Niger, Aug. 2006

(Liu and Zipser, 2005).

TROCCINOX case study

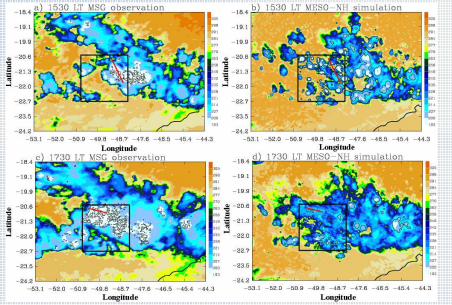
Observations obtained during the TROCCINOX golden day have revealed the presence of ice particles up to 410K (18.2 km), 2 km above the local tropopause. The case was investigated using a three-dimensional quadruply nested non-hydrostatic simulation and MSG observations showing troposphere stratosphere by convective overshoots (Chaboureau et al. 2007).

Particles observed at 410 K



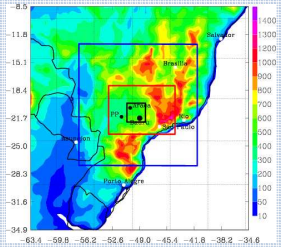
Top: observed potential temperature (red line, K), relative humidity (green line, %) and simulated relative humidity (blue line, %) during the Geophysica flight. Bottom: observed potential temperature (red line, K) and total particle concentration (black line, cm3) as measured by the FSSP-100 instrument.

Verification with MSG



(Left) Observed and (right) simulated MSG BTs over the model-3 domain at (top) 15:30 LT and (bottom) 17:30 LT on 4 February 2005. The colour scale indicates BT at 10.8 μm. The 3-K isoline of the BTD between 6.2- and 10.8 μm band is superimposed. The red lines indicate the Geophysica flight track. The square shows the location of the model 4 domain.

Meso-NH set-up



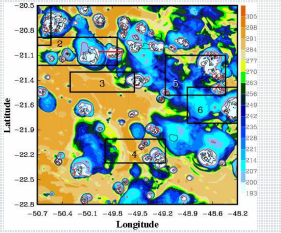
4 domains (30, 10, 2.5 km, and 625 m; 2-way interaction)

90 levels up to 27 km with Δz = 400 m (free troposphere)

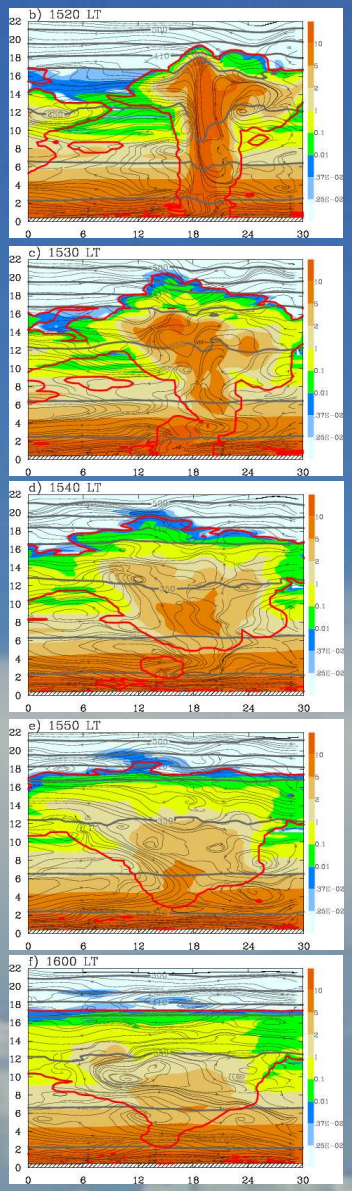
Initial & coupling fields with ECMWF operational analysis

Parameterization schemes: turbulence scheme, ECMWF radiation package, ISBA surface scheme, mixed-phase 1-moment microphysics

Convective plumes up to 19 km



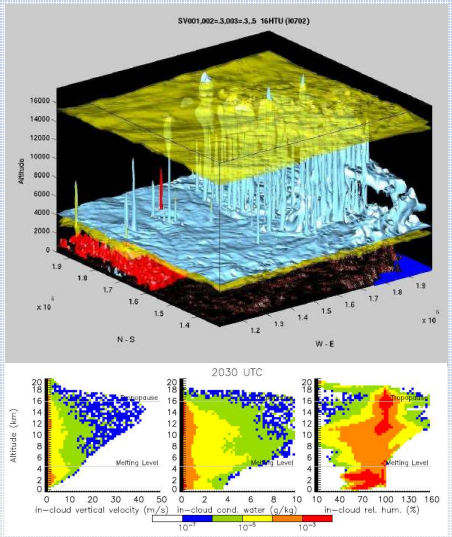
Model-4 fields at 15:30 LT: BT at 10.8 μm (colour, K), BTD between 6.2- and 10.8 μm band (3-K isoline in red), and water vapour mixing ratio over a 390-K θ surface (4-ppmv isoline in black). The red line gives the position of the vertical cross sections shown to the right.



Reference: Chaboureau, J.-P., J.-P. Cammas, J. Duron, P. J. Mascart, N. M. Sitnikov, and H.-J. Voessing, 2007: A numerical study of tropical cross-tropopause transport by convective overshoots. Atmos. Chem. Phys., 7, 1731-1740.

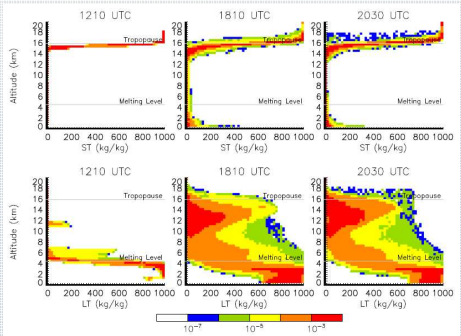
Revisitation of the case

The objective of the ongoing work is to assess the results previously obtained by looking at the sensitivity of the results to the advection and microphysical schemes, and to detail the convective and the mixing processes using tracer diagnostics.



PDF of incloud variable as function of altitude at 17:30 LT

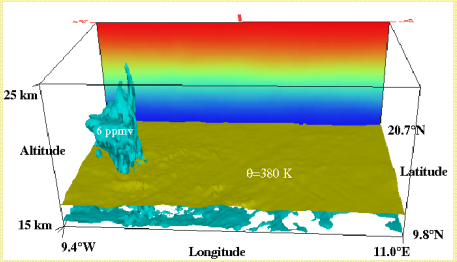
Convective transport of tracers



(Left) PDF of Low Troposphere (LT) and Stratosphere (ST) tracer mixing ratios as function of altitude for three different simulation times.

African case study

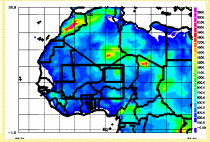
Observations obtained during the AMMA campaign have revealed the presence of multiple layers of enhanced water vapour up to 20.5 km (Khaykin et al. 2008). The case was investigated using a three-dimensional triply nested non-hydrostatic simulation and MSG observations showing strong hydratation. By extrapolation the contribution from convection may represent 30% of the total flux



Isosurface of water vapour at 6 ppmv after 54 h of simulation.

Meso-NH set-up

3 domains (40, 10, 2.5 km), 70 levels up to 27 km with Δz = 600 m (free troposphere),



Transport at 19 km