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Convective transport and mixing processes in the tropical tropopause region during TROCCINOX

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One main objective of the TROCCINOX aircraft campaign was to analyse the influence of deep convection on the trace gas composition in the tropical tropopause layer (TTL). The upward transport to altitudes above the neutral buoyancy level at ∼350 K (∼13 km) can be achieved if air overshoots this level and mixes irreversibly with its surroundings. Convection and mixing processes can be diagnosed by observations of CO, CO_2, O_3, and nitrogen oxides. These tracers were measured on board of the high flying aircraft M55 Geophysica operating from Aracatuba, Brazil (21 ˚S, 50 ˚W) in February/March 2005: CO_2 by the University of Frankfurt‘s High Altitude Gas Analyzer (HAGAR), CO by the Cryogenically Operated Laser Diode (COLD), O_3 by the Fast Ozone ANalyzer (FOZAN) and NO and NO_y by SIOUX.

We focus on selected case studies to understand the mechanisms responsible for mixing following deep convection. We distinguish between uplifted air recently influenced by local thunderstorms and signatures of aged convection in the tropical tropopause region. In the first case – the local “thunderstorm chase day” on February 4^{th}, 2005, CO_2 and CO can be used as tracers for the planetary boundary layer, where – compared to the mid-troposphere - CO is relatively high and CO_2 is depleted due to uptake by vegetation. The outflow of the thunderstorm caused low CO_2 (374 μmol/mol) and high CO (130 nmol/mol) mixing ratios in an altitude range of 13-17 km. Mixing with

the background TTL air is indicated by mixing lines apparent in the CO-O_3 and CO_2-O_3 correlations.

In the second case study for the flight on February 12^{th} similarly anti-correlated signatures of CO_2 and CO are observed at an altitude of 15 km, although a low NO/NO_y ratio argues against the influence of recent convection. The trajectory model FLEXPART indicates that this air was lifted to the upper troposphere in the Western part of South America several days earlier and travelled in the Bolivian High before measured by the Geophysica at 15 km. Correlations of CO and $CO_2$with O_3 show mixing signatures also in this case.