Geophysical Research Abstracts, Vol. 8, 04912, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04912

How permeable is the tropical tropopause ? – Mixing across the TTL during the TROCCINOX campaign

P. Konopka (1), G. Günther (1), R. Müller (1), F. Santos (1), A. Ulanovsky (2), H. Schlager (3), M. Volk (4), S. Viciani (5) and C. Schiller (1)

(1) Forschungszentrum Jülich, Germany, (2) CAO, Dolgoprudny, Russia (3) DLR, Oberfaffenhofen, Germany, (4) J.W. Goethe Univ., Germany, (5) INOA, Firenze, Italy

Transport processes in the vicinity of the tropical tropopause, in particular within the tropical tropopause layer (TTL) determine the composition of the air entering the stratosphere. It is generally accepted that the tropical (deep) convection dominates this process although, owing to sparse experimental observations in this region, the details of this process are only poorly understood.

During the TROCCINOX-2 campaign that took place in Brasil in early 2005, chemical species were measured on-board of high flying research aircraft Geophysica (ozone, CH4, water vapor, NO, NOy, CO) in the altitude range up to 20 km (or up to 450 K pot. Temp), i.e. well-covering the TTL region roughly extending between 350 and 400 K. This unique data set, together with the model simulations with the Chemical Lagrangian Model of the Stratosphere (CLaMS) allow to check our understanding of the dynamical processes occurring in the TTL.

Above the tropopause, the isentropic and cross-isentropic advection in CLaMS is driven by ECMWF winds and heating/cooling rates derived from a radiation calculation. Below the tropopause the model smoothly transforms from the isentropic to hybrid-pressure coordinates and, in this way, takes into account the effect of convective transport as inplemented in the ECMWF vertical winds. The irreversible part of transport, i.e. mixing, is controlled by the local horizontal strain and vertical shear rates with mixing parameters deduced from observations.

Our studies show that even if clear signatures of fresh convection can be seen both in the observation and in the model, the composition of air above $\approx$350 K is a result of an “accumulated” transport on a time scale of weeks or even months. Based on the CLaMS transport studies where mixing can be completely switched off, we deduce that irreversible transport and diabatic ascent are necessary to understand transport of tropospheric species from the convective outflow up to the tropical tropopause around 380 K. We show that tropospheric influence extends well above the tropical tropopause. Furthermore, stratospheric signatures of isentropic transport from the lowermost stratosphere across the subtropical jet into the TTL were found both in the observed tracers and in the corresponding CLaMS simulations.