Vertical and quasi-isentropic transport pathways through the Asian monsoon anticyclonic circulation into the lowermost stratosphere

B. Vogel[1], G. Günther[1], R. Müller[1], J.-U. Grooß[1], and M. Riese[1]

[1]*Forschungszentrum Jülich, Institute of Energy and Climate Research – Stratosphere (IEK-7), Jülich, Germany*

The Asian summer monsoon region is characterised by strong convective activity causing substantial upward transport of boundary layer air to high altitudes. This boundary layer air will carry with it strong signatures of tropospheric air (e.g. enhanced HCN, CO, and water vapour; low ozone). It has been suggested that the monsoon circulation thus provides an effective pathway for pollution from Asia, India, and Indonesia deep into the global stratosphere. Here we will discuss vertical transport in the Asian monsoon circulation based on simulations of the Chemical Lagrangian Model of the Stratosphere (CLaMS) driven by ERA-Interim meteorological fields. The model results indicate that the tropical tropopause in the monsoon region constitutes a clear barrier to upward transport of tropospheric air, with only a minor fraction of the uplifted tropospheric air entering the stratosphere vertically. However, horizontal, quasi-isentropic transport into the lowermost mid-latitude stratosphere is very efficient. Air masses in the core of the monsoon anticyclone are separated from stratospheric air by a horizontal transport barrier, but the anticyclonic circulation also extends to air masses outside the core of the Asian summer monsoon region. We show a case, where air masses originating from the boundary layer in the Southeast Asia/West Pacific are rapidly lifted (within 1–2 days) in a typhoon up the outer edge of the Asian monsoon anticyclone, circulate around the monsoon core and are then transported (within 8–14 days) to the lowermost stratosphere in northern Europe. The chemical signature of air masses affected by the Asian monsoon anticyclone were measured in situ in the lowermost stratosphere over northern Europe on 26 September 2012 during the TACTS aircraft campaign. We suggest that the combination of rapid uplift by a typhoon and eastward eddy shedding from the Asian monsoon anticyclone is a novel fast transport pathway that may carry the chemical signature of boundary emissions from Southeast Asia/West Pacific within approximately 5 weeks to the lowermost stratosphere in northern Europe.