EGU2020-21312
https://doi.org/10.5194/egusphere-egu2020-21312
EGU General Assembly 2020

Investigation of transport in the northern lowermost stratosphere between spring and fall using airborne in situ tracer measurements

Andrea Rau[1], Valentin Lauther[1], Johannes Wintel[1], Emil Gehardt[1], Peter Hoor[2], Jens Krause[2], Björn Kluschat[2], Felix Plöger[1,3], Bärbel Vogel[3], and Michael Volk[1]

[1]Bergische Universität Wuppertal, Institute for Atmospheric and Environmental Research, Wuppertal, Germany
[2]Institute for Atmospheric Physics, Johannes Gutenberg-Universität Mainz, Germany
[3]Institute of Energy and Climate Research (IEK-7), FZ Jülich, Germany

Over the course of the summer, when the subtropical jet is weakest, quasi-isentropic transport of young air from the troposphere and the tropical tropopause layer into the northern hemisphere (NH) lowermost stratosphere (LMS) is increased resulting in a drastic change of LMS chemical composition between spring and fall. The focus of this work is on the role of different transport paths into the NH LMS, including outflow from the Asian Monsoon, and their associated time scales of transport and mixing.

We present and analyse in situ measurements of CO_2 and various long-lived tracers obtained during three recent aircraft campaigns encompassing over 40 research flights in the NH UTLS during winter/spring, summer, and fall. The POLSTRACC/GW-LCYCLE/SALSA campaign probed the northern high latitude LMS in winter/spring 2016, deploying the German research aircraft HALO from Kiruna (Sweden) and from Germany. The second campaign deployed the M55 Geophysica research aircraft in July/August 2017 from Kathmandu, Nepal, in the frame of the EU-funded project StratoClim (Stratospheric and upper tropospheric processes for better Climate predications) in order to probe in situ for the first time the inside of the Asian Monsoon anticyclone. Roughly two months later the WISE (Wave-driven ISentropic Exchange) campaign deployed again HALO from Shannon (Ireland) in September and October 2017 to investigate isentropic transport and mixing in the NH LMS.

The University of Wuppertal measured CO_2 and a suite of long-lived tracers on each aircraft. On the Geophysica, the measurements were made with the HAGAR (High Altitude Gas AnalyzeR) instrument. On HALO, a recently developed extended 5-channel version, HAGAR-V, was flown, which in addition measured a suite of short-lived tracers by GC coupled with a mass spectrometer. The University of Mainz measured N2O and CO on HALO using laser absorption techniques. For our analysis we use mixing ratios of CO_2, SF_6, CFC-11, CFC-12, and N_2O.

Owing to their different lifetimes, tropospheric growth (for SF_6) and a seasonal cycle (for CO_2), the LMS distributions of these long-lived trace gases and their development between spring and fall contain key information about the origin and mean stratospheric age of LMS air as well as time

scales of rapid isentropic transport and mixing. The analysis of tracer measurements is complemented by simulations with the Chemical Lagrangian Model of the Stratosphere (CLaMS) providing information on age of air spectra and fractions of origin from specific surface regions, allowing in particular to assess the role of the Asian Monsoon in determining the composition of the NH LMS in fall.