Mixing and Transport in the UTLS: Results from the Wave-driven Isentropic Exchange (WISE) mission

Peter HOOR[1], Martin RIESE[2], Daniel KUNKEL[1], Martin KAUFMANN[2],
and the WISE-Team

[1] *Johannes-Gutenberg University, Mainz, Germany*
[2] *Forschungszentrum Jülich (IEK-7), Jülich, Germany*

Mixing and transport in the upper troposphere / lower stratosphere (UTLS) region introduce a substantial uncertainty to the effect of composition changes on future surface climate. Changes in the distributions of trace gases, like water vapor and ozone, and thin cirrus clouds in the upper troposphere and lower stratosphere (UTLS) strongly impact radiative forcing of the Earth's climate and surface temperatures (e. g. Solomon et al., 2010). Therefore a quantitative understanding of the interaction and feedbacks between small scale processes and the global scale are essential to reduce the uncertainties.

We present results from the recent HALO campaign WISE, which took place in autumn 2017 in Shannon / Ireland. A unique data set combining high resolution in-situ data with novel remote sensing observations allows unprecedented views on mixing and transport processes in the tropopause region.

The main focus of WISE was on:

(1) The relation of the tropopause inversion layer (TIL) and trace gas distribution

(2) The role of planetary wave breaking for water vapor and pollutant transport into the extra-tropical lowermost stratosphere

(3) The role of halogenated substances for ozone and radiative forcing in the UTLS region

(4) The occurrence and effects of sub-visual cirrus (SVC) in the lowermost stratosphere

During the campaign we encountered a great variety of interesting meteorological situations and observed strong signatures of air originating from the Asian monsoon or tropical cyclones (e. g. hurricanes Maria and Ophelia). Furthermore, the meteorological situation was dominated by a period of strong Rossby wave activity associated with frequent mixing events, which led to a rather tropospheric chemical signature of the UTLS and a clear chemical distinction between the lowermost stratosphere and the region above 380K.

We will give a brief overview on the mission and will present results of transport and mixing across scales with a focus on the mixing processes associated with a strong modification of the tropopause structure during baroclinic developments.

During these flights we could probe air masses which are mixed into the lowermost stratosphere above and downwind of warm conveyor belts (WCBs) during the processes of mixing. The combined tracer measurements and curtain observations of static stability with operational data and ERA 5 reanalysis show that this mixing process occurs in close vicinity to regions of enhanced static stability.

Key words: mixing, tropopause, aircraft measurements