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Regular in situ measurements of HDO/$H_2^{16}O$ in the northern and southern hemispherical upper troposphere reveal tropospheric transport processes.

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Atmospheric water in form of water vapor and clouds is an enormously crucial trace species. It is responsible for ~70 % of the natural greenhouse effect (Schmidt et al., JGR, 2010), carries huge amounts of latent heat, and is the major source of OH in the troposphere. The isotopic composition of water vapor is an elegant tracer for a better understanding and quantification of the extremely complex and variable hydrological cycle in Earth's atmosphere (evaporation, cloud condensation, rainout, re-evaporation, snow), which in turn is a prerequisite to improve climate modeling and predictions.

In this context, water-isotopologues (here the isotope ratio HDO/$H_2^{16}O$) can be used to study the atmospheric transport of water and in-cloud processes. As $H_2^{16}O$ and HDO differ in vapor pressure and molecular diffusion, fractionation occurs during condensation and rainout events. For that reason the ratio HDO/$H_2^{16}O$ preserves information about the transport and condensation history of an air mass.

The tunable diode-laser absorption spectrometer ISOWAT was developed for airborne measurements of the water-isotopologue concentrations of $H_2^{16}O$ and HDO, probing fundamental rovibrational water-absorption lines at around 2.66 μm. Since April 2010 the spectrometer is regularly operated aboard the CARIBIC passenger aircraft (Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container – Lufthansa, Airbus 340-600), which measures ~100 trace gases and aerosol components in the UTLS (9-12 km altitude) on four long-distance flights per month.

During several flights across the equator (Africa) or close to the equator (Venezuela and Malaysia) an increase of HDO/$H_2^{16}O$ from the subtropics towards the tropics was measured (by more than 100 permil) at an altitude of ~12 km. This isotopic gradient can partly be attributed to differences in humidity. In addition there is a humidity independent latitudinal gradient (by more than 50 permil), revealing the strong influence of convection on the isotopic composition of water in the upper troposphere. This finding is consistent with the well-known regions of deep convection over Africa, Malaysia and South America.