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Design and ground-based testing of a tunable diode laser spectrometer for airborne water isotopic ratio measurements

C. Dyroff (1), **A. Zahn** (1), P. Werle (1), W. Freude (2)

(1) Institute of Meteorology and Climate Research, Germany, (2) University Karlsruhe, Germany (Christoph.Dyroff@imk.fzk.de / FAX: 0049-7247-82-4742)

Water vapor is undoubtedly one of the most important gases in Earth's atmosphere, inter alia, due to its contribution in the global radiative budget and as the most important source of OH-radicals. The stable isotope ratios of water vapor (δ^{18}O, δ^{17}O, and δD) in the upper troposphere and lower stratosphere (UTLS) have found increasing interest in recent years. This is in particular due to their unique capability to work as a powerful and independent tracer for the transport of water vapor [1,2]. While there have been quite a few measurements by remote sensing instruments and water sampling devices, the number of in situ measurements is very limited [3-5]. However, only in situ laser spectroscopic techniques can provide the very high temporal ($<$30 s) and spatial ($<$7 km) resolution required to resolve small-scale atmospheric processes, such as isolated convective systems.

In this talk we will present the design of a newly developed, compact airborne H_2O tunable diode-laser (TDL) spectrometer to measure water vapor stable isotope ratios. The focus of the development was both on compactness of the instrument as well as on high-sensitivity measurements employing an in situ calibration scheme. Results obtained by extensive ground-based testing regarding instrument precision and stability time of our compact and light-weight spectrometer will be discussed.

The extreme scarcity of in situ measurements along with our long-term interest in water vapor measurements (and also other trace atmospheric constituents) aboard the CARIBIC airborne platform, as well as the capabilities provided by the new German high-altitude platform HALO, have lead to the design of this TDL spectrometer. An outlook to future (long-term) airborne deployment on these platforms, as well as future improvements that will lead to an even better performance will be given.

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