Geophysical Research Abstracts,
Vol. 10, EGU2008-A-10066, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-10066
EGU General Assembly 2008

Simultaneous, absolute gas-phase and total water detection during cloud formation studies in the AIDA chamber using a dual 1.37μm TDL-spectrometer

V. Ebert (1), H. Saathoff (2), C. Lauer (1), S. Hunsmann (1), S. Wagner (1)
(1) Physical Chemistry Institute, Heidelberg University, Germany,
(2) Institute for Meteorology and Climate Research, Forschungszentrum Karlsruhe, Germany
(volker.ebert@urz.uni-hd.de / Fax +49-6221-545050)

Recent measurements of unusual supersaturations in and out of clouds especially in the upper troposphere are currently intensively discussed as a signature for new aspects in cloud physics. On the other hand, it is also well known that sensitive and accurate humidity measurements in the low ppmV levels are difficult to realize due to the strong water adsorption and the fragility of the H_2O phase equilibrium during the sampling process. A second quite demanding issue is the sensor calibration which can cause significant errors due to the problems in generating and delivering precisely known amounts of water vapor to the instrument. Thus there is a great demand for sensitive and if possible calibration-free humidity sensors compatible with the boundary conditions of cloud formation.

To avoid the sampling and calibration problems we recently developed an *open path* laser absorption spectrometer, APicT, which selectively detects water vapor within the cloud. Taking advantage of our extensive experience in robust diagnostics for combustion applications, we applied room-temperature diode lasers at 1.37μm to an open-path White-cell (24-125m path), mounted on the inner walls of the cloud simulation chamber to enable a rapid, highly sensitive, sampling-free, absolute water vapor detection inside the AIDA cloud chamber. Direct tunable diode laser absorption spectroscopy (d-TDLAS) plus cryo-compatible, fiber-coupled transfer optics, needed to effectively suppress water signals from parasitic absorption paths, in combination with our robust data processing software developed for combustion applications permitted in-cloud H_2O vapor detection with 15 ppbV H_2O resolution (1σ at p=1000hPa, Δt = 2 s) over a temperature/pressure range from 190 - 270 K respectively 10 - 1000hPa.

Recently we also added a new extractive TDLAS sensor, APeT, with an enclosed, fiber coupled, room-temperature Herriott cell (30m path length). By evaporating the condensed water (ice, droplets) before sampling the chamber air into the sensor we could determine the absolute, total water concentration (with up to 30ppbV detection limit 1 σ at p = 200hPa, Δt = 2 s).

Both sensors, APicT and APeT, do not require calibration as they are based on direct absorption spectroscopy, thus depending on molecular constants, time invariant laser parameters and the measured values of pressure temperature and absorption path length only. Nevertheless we verified their absolute response via a comparison with a MBW frost point hygrometer under particle-free conditions during the recent AQUA-VIT intercomparison campaign and found only small deviations of about 3%.

Simultaneous operation of both sensors thus permits for the first time a synchronized measurement of in cloud gas phase water, total water as well as the ice water content (from the difference between both sensors) with the same sensor principle and on the same spectroscopic signature, which significantly reduces systematic errors. Typical signals from both sensors will be shown and discussed.

The high sensitivity of the sensors, their high speed, excellent accuracy and absolute, calibration-free measurement characteristics in combination with an open path configuration should therefore help to resolve the super saturation puzzle in the future, especially when an improved, airborne version of the sensor is installed on the HALO research aircraft.