The AQUAVIT formal intercomparison of atmospheric water measurement methods

H. Saathoff [1], C. Schiller[2], V. Ebert[3], D. W. Fahey[4], R.-S. Gao[4], O. Möhler[1], and the AQUAVIT Team

[1]Institute for Meteorology and Climate Research, Forschungszentrum Karlsruhe, Germany
[2]Institute of Chemistry and Dynamic of the Geosphere, Forschungszentrum Jülich, Germany
[3]Institute for Physical Chemistry, University of Heidelberg, Germany
[4]NOAA Earth System Science Laboratory, Boulder, CO, USA

Accurate determination of water vapour and total water concentrations is a prerequisite to understand upper tropospheric and stratospheric water and energy budgets, with implications for cloud formation, for fluxes of water and radiation, and for atmospheric chemistry. The discovery of massive supersaturations with respect to ice in upper tropospheric cloud-free air and inside cirrus clouds is one example that calls into question our understanding of the physics of ice cloud formation or the quality of the humidity measurements.

The AQUAVIT campaign offered a framework for a formal intercomparison of water vapour measurement techniques at the AIDA (Aerosol Interaction and Dynamics in the Atmosphere) facility of Forschungszentrum Karlsruhe. A number of 22 different instruments, both state-of-the-art and newly developed techniques, were provided by 17 groups from 7 countries. All major groups which are currently employing sophisticated water vapour instruments on U.S. and European research aircraft, participated in the AquaVIT campaign and agreed on a data protocol which assured, together with three independent referees, a careful and blind intercomparison of the data from the different instruments. Whereas some of the instruments made measurements inside the AIDA simulation chamber of 84.5 m^3 volume, most of them were connected to it by heated high-quality stainless steel tubes. A calibrated permeation source and a high-quality frost point mirror were also available for additional calibration runs of the different instruments.

In a series of five experiments the instruments were compared under well defined conditions e.g., static pressure and temperature, no aerosol or clouds present. In these experiments the temperatures were 243, 223, 213, 196, and 185 K, the pressure was varied between 50 and 500 hPa, and the water mixing ratio varied from about 0.5 to 100 ppmv. In a second phase of five experiments with dynamic changes in pressure, temperature, water mixing ratio, and ice supersaturation, aerosol particles and clouds were present so that up-drafting cloud parcels as well as balloon ascends & descends could be simulated. In this phase the temperature was varied between 243 and 185 K, the pressure was varied between 50 and 300 hPa, and the water mixing ratio ranged from about 0.5 to 3740 ppmv.

This paper describes the usefulness of the AIDA simulation chamber for such type of intercomparison and gives an overview of the results.