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The AQUAVIT formal intercomparison of atmospheric water measurement methods

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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 addressed some open questions of upper tropospheric humidity determination by a formal intercomparison of water vapour measurement techniques at the AIDA facility of Forschungszentrum Karlsruhe. 17 groups from 7 countries participated with 22 instruments. Most of the state of the art measurement methods and instruments for atmospheric water vapour but also newly developed instruments were compared. 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 stainless steel tubes. Three independent referees assured that none of the participants knew the amounts of water present in the simulation chamber, collected the measurement results from all participating groups, and made the final data public to all participants only 5 weeks after the end of the campaign when the final data sets

were all collected.

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, and water mixing ratio, aerosol particles and clouds were present so that total and interstitial water concentrations could be measured. 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 varied from about 0.5 to 3740 ppmv. In addition to the formal and blind intercomparison different calibration sources were made available for the different instruments either based on a calibrated permeation source or frost point mirrors.

This paper describes how the intercomparison was done and discusses first results.