

# GROUND-BASED MEASUREMENTS OF MIDDLE ATMOSPHERIC WATER VAPOUR AT BERN, SWITZERLAND



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Atmospheric water vapour is a major field of the research activities at the Institute of Applied Physics (IAP) at the University of Bern. We developed a new ground-based radiometer called MIAWARA (MIddle Atmospheric WATER Vapour RAdiometer) which is designed to provide longterm measurements of stratospheric and mesospheric water vapour profiles in the range of 30-80 km by measuring the microwave emission line of  $\text{H}_2^{16}\text{O}$  at 22.235 GHz. An overview of the instrument is given in figure 1 and table 1.

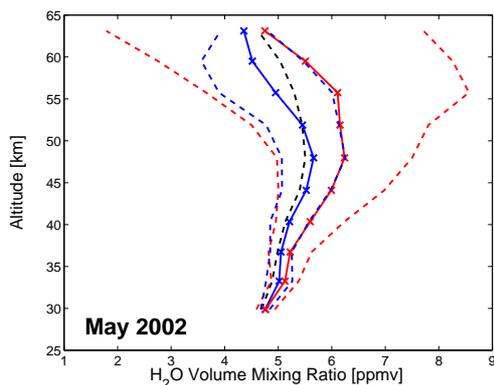
The instrument has started operation in Winter 2001/2002. During this first operational period various test measurements, including a validation of the calibration technique, were conducted.

In figures 2 and 3 two retrieved water vapour profiles from different months are shown.

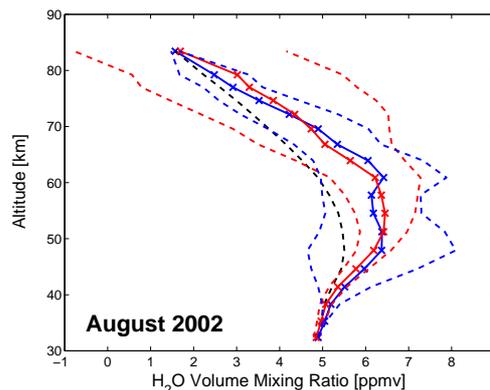
The instrument is currently operating from the roof of our institute. After this testing period we plan to operate the instrument in the frame of NDSC (Network for Detection of Stratospheric Change) and during campaigns.



**Figure 1:** The radiometer MIAWARA on the roof of the Institute of Applied Physics at Bern, Switzerland (46.95 N / 7.45 E, 550 m. above sea level).



**Figure 2:** Water vapour profile retrieved by a broadband spectrometer 3-day averaged spectrum in May 2002 (solid blue). The dashed blue lines represent the 2 times standard deviation for the observational error. The data is compared with a HALOE water vapour profile from April 10<sup>th</sup> 2002 at 44.95°N / 21.94°E (solid red) with plotted 2  $\sigma$  of the HALOE measurement uncertainty (dashed red). The dashed black line represents the a priori profile.



**Figure 3:** Water vapour profile retrieved by a narrowband spectrometer 3-day averaged spectrum in August 2002 (solid blue). The dashed blue lines represent the 2  $\sigma$  for the observational error. The data is compared with a 2-year mean HALOE 40°-50°N monthly mean water vapour profile for August 1998/1999 (solid red) with plotted 2  $\sigma$  of the HALOE measurement error (dashed red). The dashed black line represents the a priori profile.

Calibration technique	Balanced calibration (4 mirror positions: atmospheric signal, reference, hot load, cold load)
Operational mode	Single sideband (SSB) 50 dB sideband suppression
Mirror	Plane mirror (gaussbeam optimised shape)
Antenna	Corrugated horn (HPBW 6 deg)
Receiver noise-temperature	133 K SSB
Radio-frequency range	21.735 – 22.735 GHz
Broadband spectral analysis	Acousto-optical spectrometer (f: 1.6–2.6 GHz, $\Delta$ f: 0.58 MHz)
Narrowband spectral analysis	Chirp transform spectrometer (f: 390–430 MHz, $\Delta$ f: 9.5 kHz)

**Table 1:** Key parameters of the instrument.

## Calibration Technique

We determine the water vapour spectrum by performing a balancing-calibration using the sky as reference signal (zenith) and cold calibration target (60 deg elevation). The use of the sky as calibration target and the correction of the tropospheric attenuation on the middle atmospheric emission line require knowledge of the tropospheric properties. We determine these properties with the same instrument (tipping curve calibration). This calibration technique is validated with periodic liquid nitrogen calibrations. The results of both calibration techniques agree within  $\pm 0.6\%$ .

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