Comparison of FISH total water measurements with other hygrometers

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Climatological impact of water vapour

- annual increase of 0.7%
- year 2000 decrease of 10%
- bottom line 0.5ppmv matters (for both short and long term changes)
Measurements of UT/LS Water Vapour

- **Platforms:** satellites, balloons, aircrafts

- **In-situ techniques:**
  - Frostpoint hygrometers (FPH, CFH)
  - Lyman-Alpha (**FISH**, HWV)
  - TDLAS (JLH, DLH, CLH, ALIAS, HAI)
  - Mass spectrometer: CIMS

- **Remote sensing:**
  - MLS on AURA, HALOE on UARS, SCIAMACHY on EnviSat
FISH – Fast In-situ Stratospheric Hygrometer

\[ \text{H}_2\text{O} = c_k \frac{\text{fluorescence} - f_u \text{ background}}{\text{intensity}} \]

**principle:**

Ly-\(\alpha\) photofragment fluorescence

\[ \text{H}_2\text{O} + h\nu_{121.6\text{nm}} \rightarrow \text{OH}^* + \text{H} \]

\[ \text{OH}^* \rightarrow \text{OH} + h\nu_{308\text{nm}} \]

FISH - Jülich calibration bench

- reference: MBW frost point hygrometer
- 1-500 ppmv in 5-8 steps
- 35-350 hPa
- repeated before and after each flight
Water Vapour and Reference Instruments

- **FISH**
  - 2x MBW DP30, MBW373, Thunder humidity generator, PTB permeation source

- **CIMS**
  - in-flight (catalytic H₂ conversion), MBW373, Elkins standard (gravimetric)

- **HWV**
  - bubbler, UV absorption

They seem to agree within 5% or 0.15 ppmv at 3-4 ppmv.
SPARC activities

SPARC/WRCP: Stratospheric Processes And their Role in Climate/World Climate Research Programme

Peter et al., SPARC Newsletter, 2008

SPARC Water Vapour Assessment 2002
AquaVIT: Aqua Validation and Instrument Tests

Campaign 2007 at AIDA chamber

Reference water vapor mixing ratio (ppmv)

MACPEX

H₂O - comparison flights around Houston/Tx in 2011
MACPEX

<10 ppmv:
HWV > FISH
CIMS > FISH, HWV
FPH ~ FISH

>10 ppmv:
HWV ~ FISH

idx = FISHrh/HWVrh > 1.3, FISHrh > 100%
Comparison of UT/LS water measurements

Summary

• 0.5 ppmv uncertainties matter: e.g. radiative climate forcing

• 2002 SPARC Water Vapour Assessment: advanced hygrometers with 12% accuracy

• 2007 AquaVIT laboratory comparison: same tendency, but lower discrepancies around 10%

• 2011 MACPEX in-flight comparison: same tendencies, but again discrepancies around 10%

• The discrepancies are platform independent.

Further need to improve H₂O measurements!