Continuous CO_2/CH_4 Measurement at Zotino Tall Tower Observatory (ZOTTO) in Central Siberia

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Other Greenhouse Gases and Related Tracer Measurement Techniques

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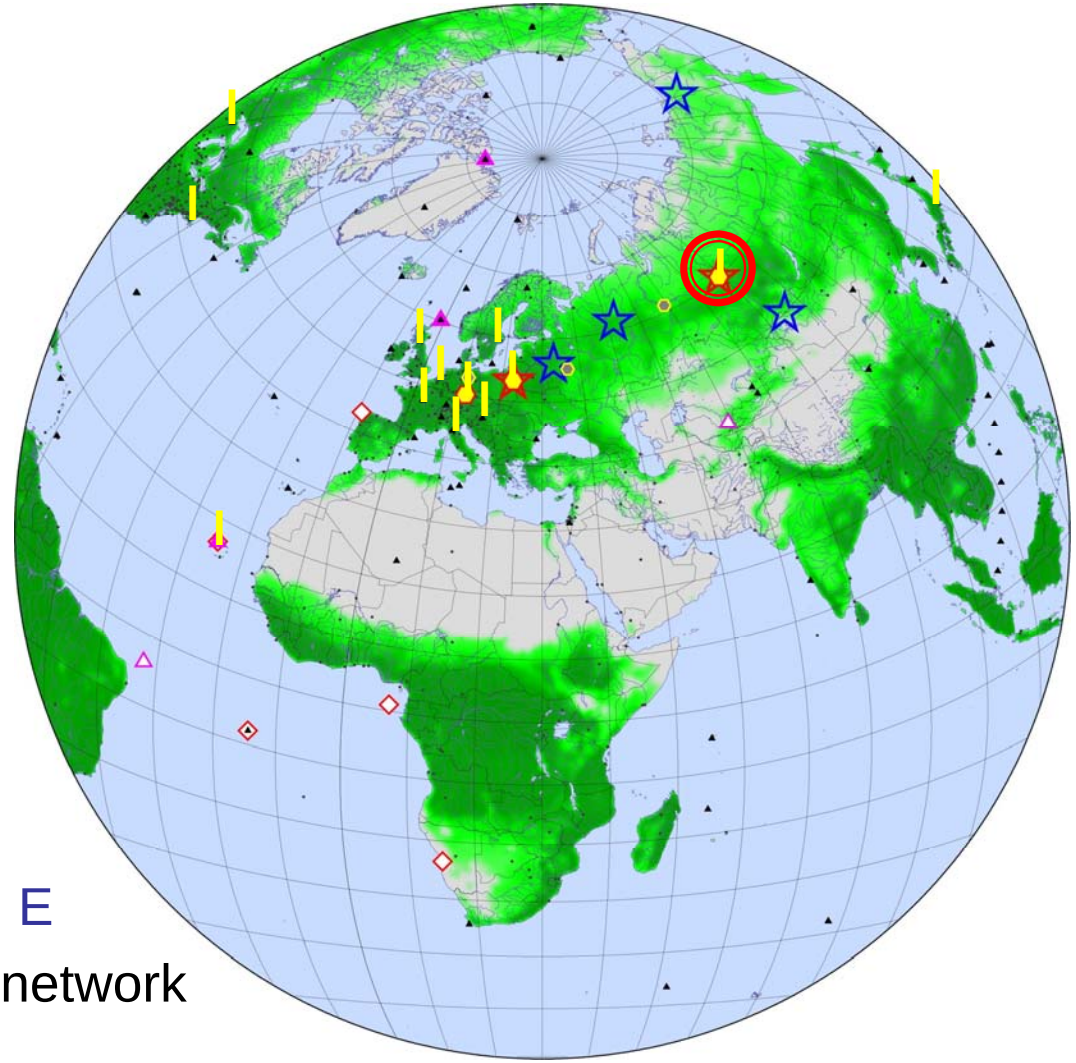
Tall Tower Network



ZOTTO station: 60 °N, 90° E

- part of global tall tower network

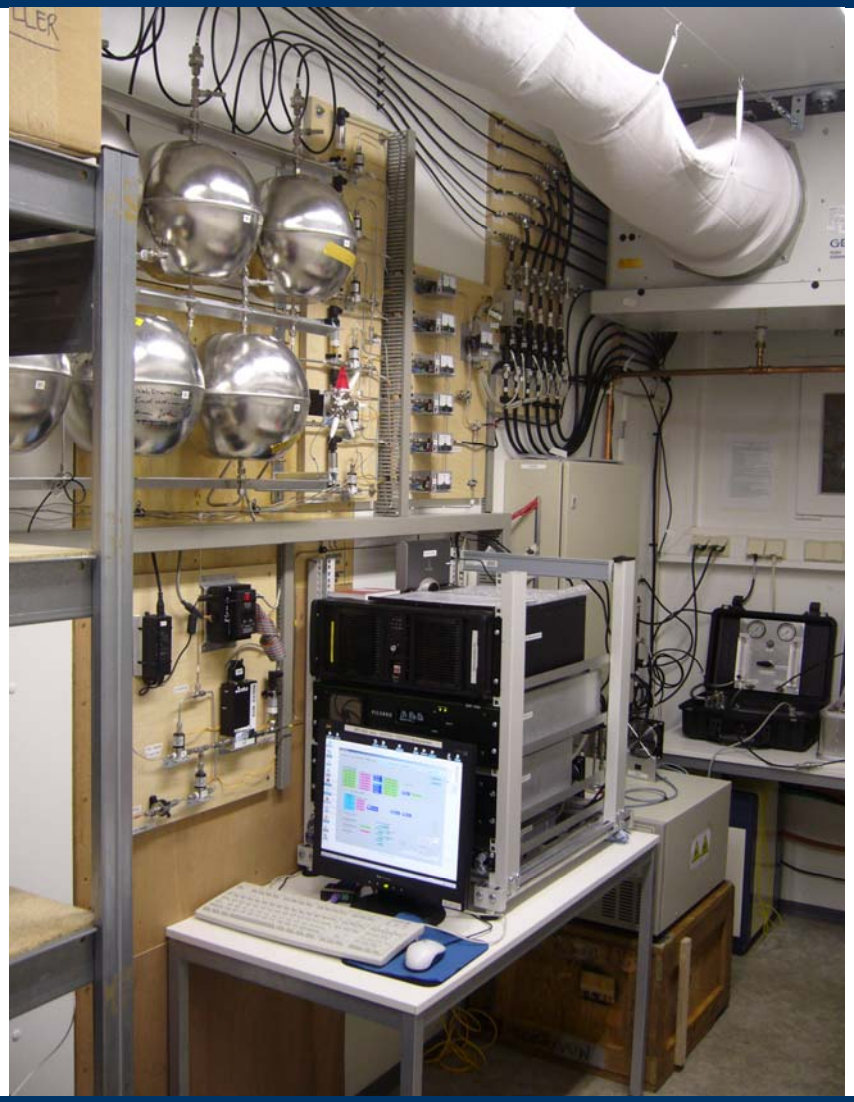
Outline

1) Current Setup in ZOTTO
   - Setup
   - Data

2) CO_2 / CH_4 Analyzer
   - Cavity Ring Down Spectroscopy
   - Measurement performance

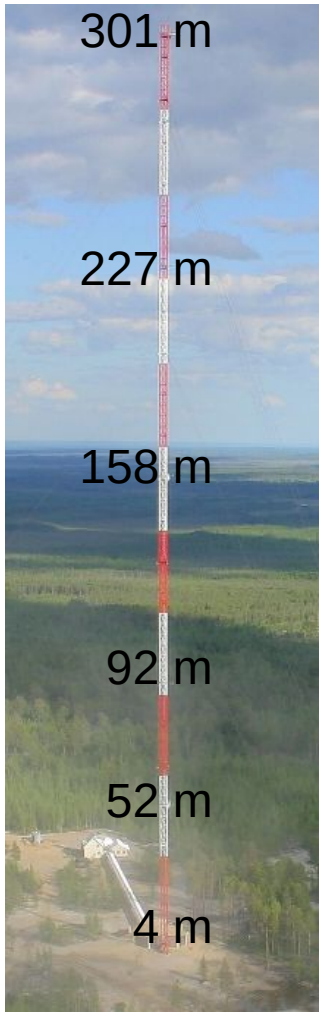
3) Water vapor
   - Disturbances
   - Corrections

1) Current Setup in ZOTTO

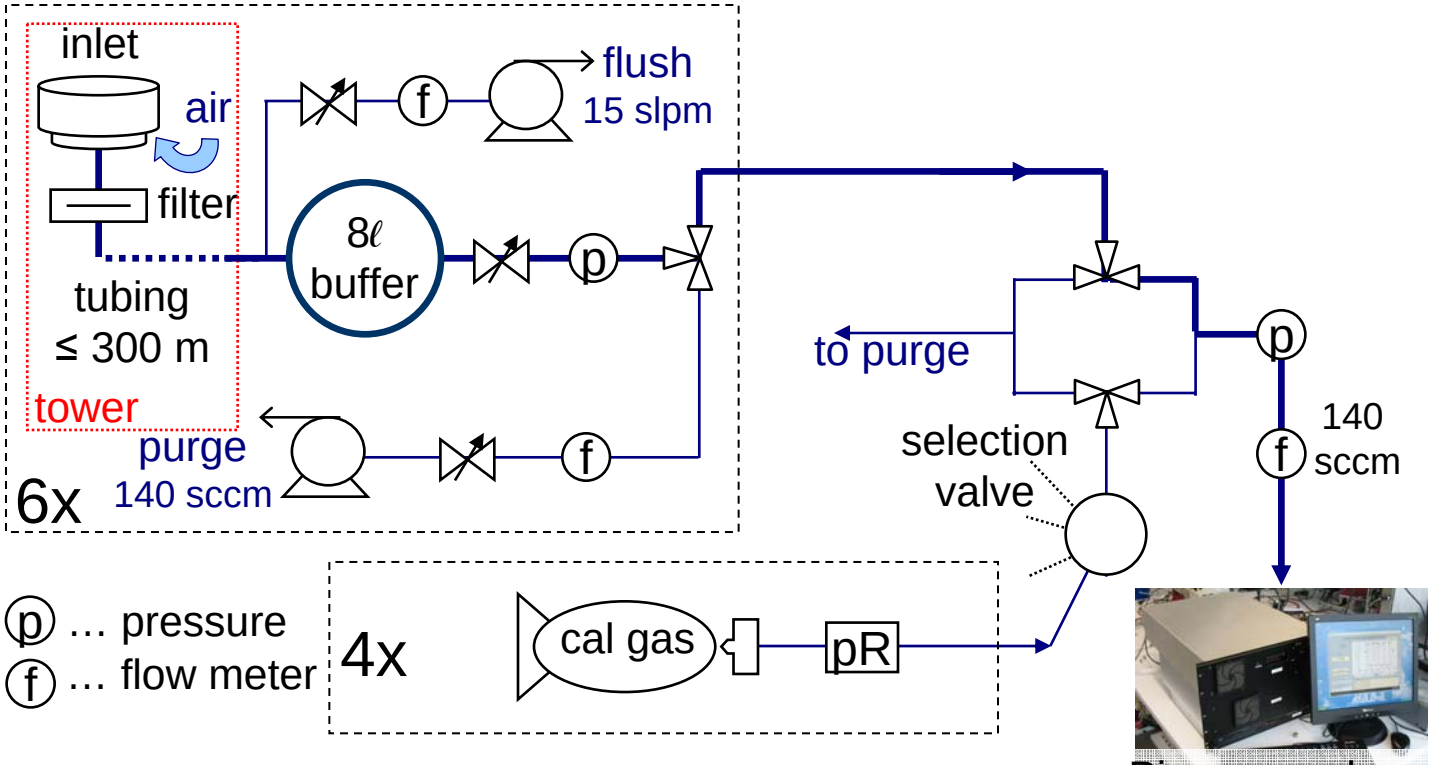


View into the Lab
since April 2009

1) Current Setup in ZOTTO

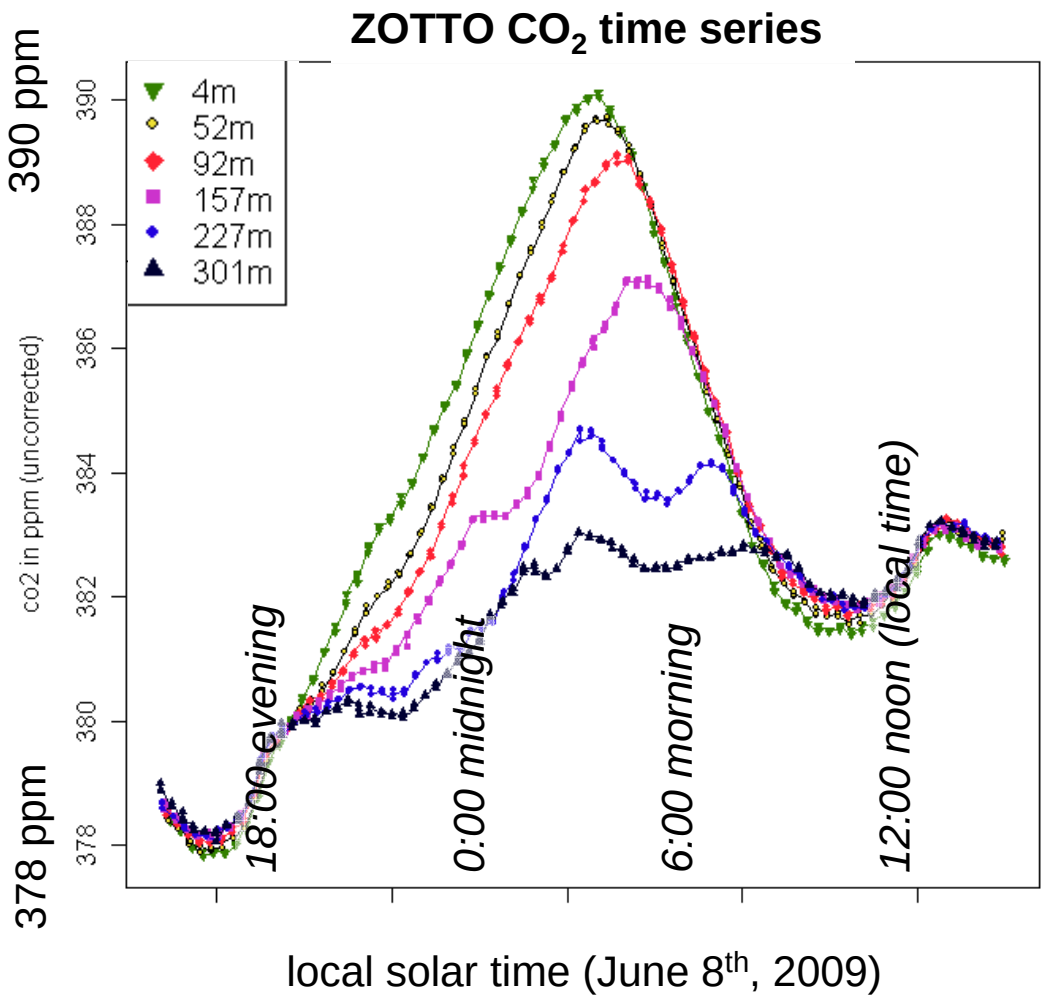


- 6 tower levels to 1 instrument → Plumbing diagram:



Picarro analyzer
EnviroSense 3000i
ESP-1000 platform

1) Current Setup in ZOTTO

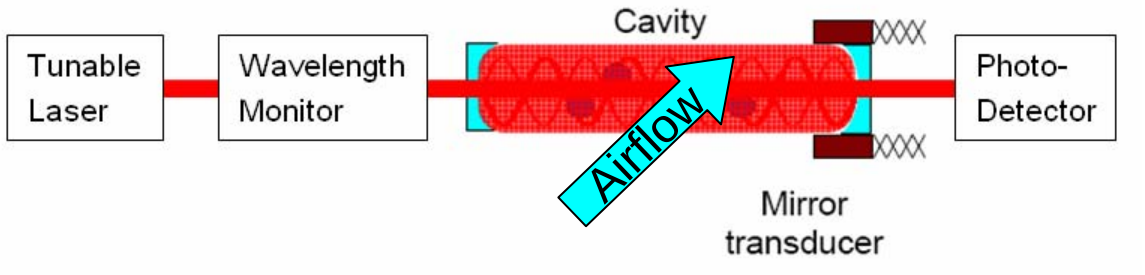


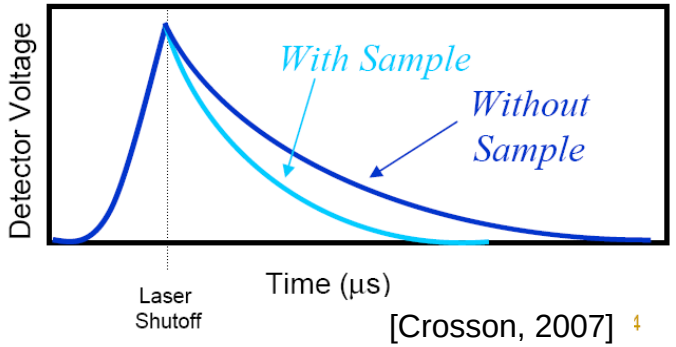
Early summer day

2) CO_2 / CH_4 Analyzer

- CO_2, CH_4, H_2O measurement system: Picarro, Inc.
  - EnviroSense 3000i, ESP-1000 platform

- Cavity Ring-Down Spectroscopy (CRDS):



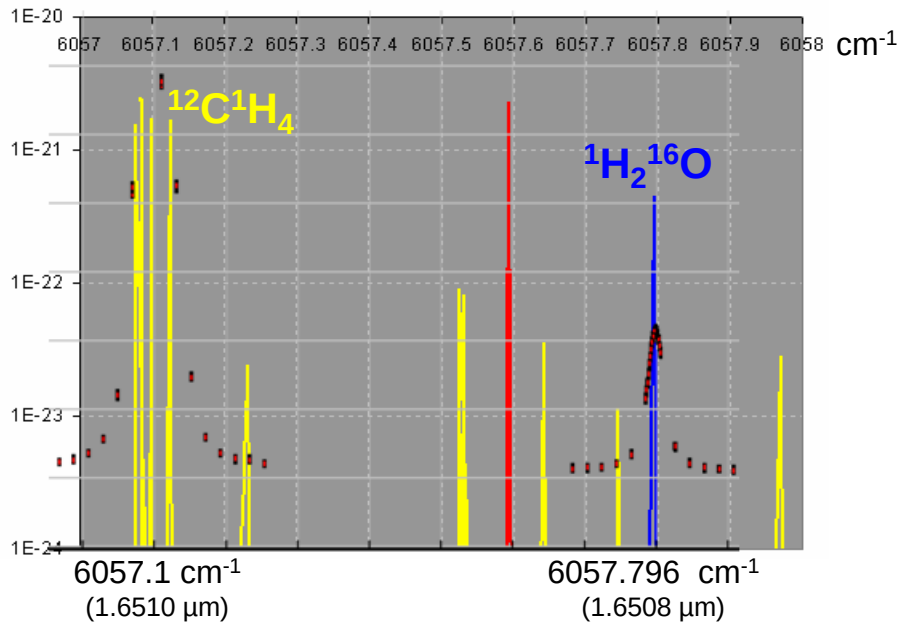


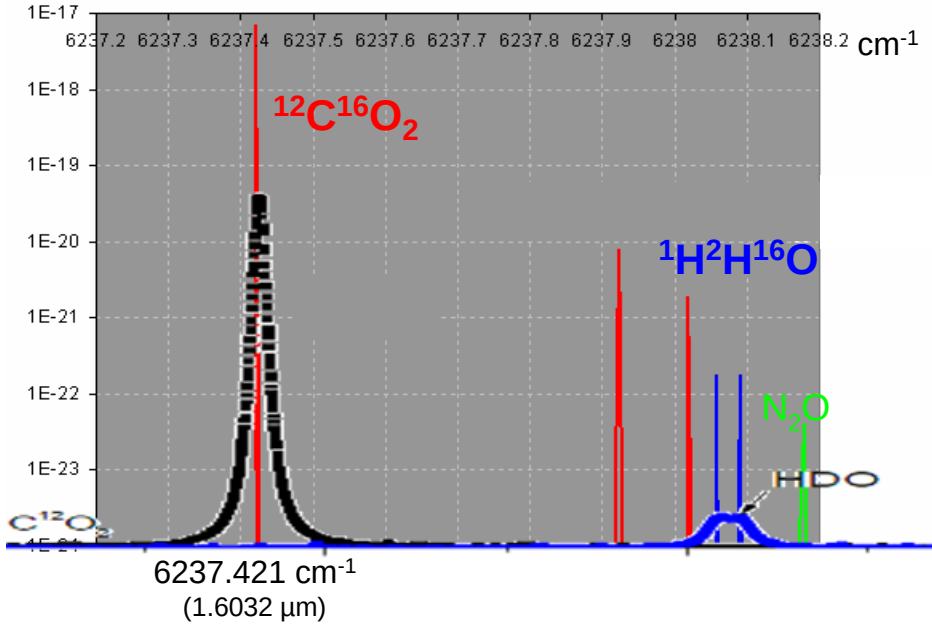
[Crosson, 2007]

- Linear calibration
- Low noise: 1σSD < 0.06 ppm CO_2
  < 0.4 ppb CH_4
- Long-term stability: drift < 0.001 ppm / day CO_2
  < 0.008 ppb / day CH_4

2) CO_2 / CH_4 Analyzer

Zoom to spectral lines used by Picarro, Inc.
(Overlaying spectra from HITRAN2004 database & Picarro)





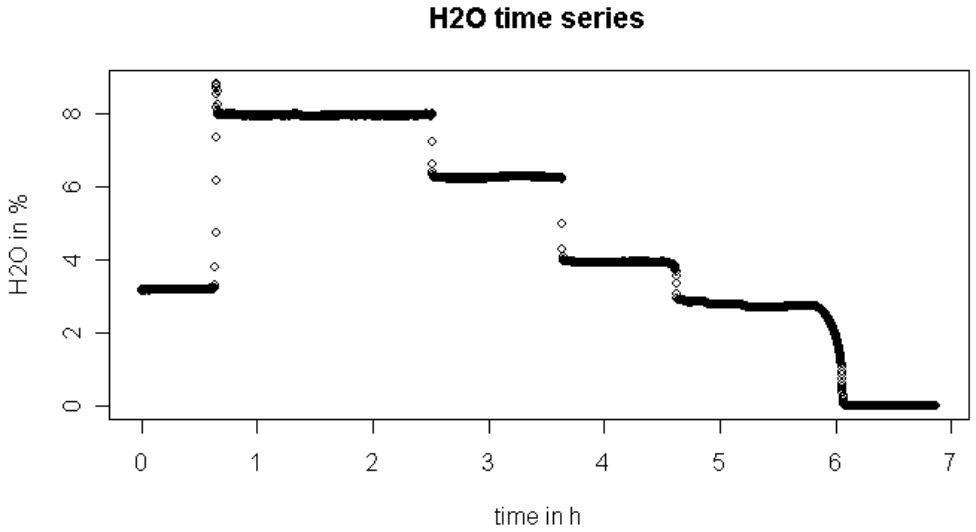
CRDS: $^{12}C^{16}O_2$
GC: all CO_2 isotopes
NDIR: $^{12}C^{16}O_2$ (partly $^{13}C^{16}O_2$, $^{12}C^{16}O^{18}O$, $^{12}C^{16}O^{17}O$)

CRDS detects only main isotops
→ δ13C & δ18O correction needed! [Tohjima, JGR, 2009]
up to 0.11+0.05 ppm for synthetic air CO_2

3) H_2O Disturbance

- Dilution correction
  (amount of H_2O vapor influences relative CO_2 ratio)
- Pressure broadening
  (gas constitution influences absorption spectra)

  – Experiment: Humidify tank air in a water trap → wet air
    - H_2O = f(droplet size, pressure, temperature)
    - $CO_{2\ dry}$, $CH_{4\ dry}$ = const.



- Adsorption effects in tubes

3) H_2O Correction

January 2009 with CFADS37:

- Quadratic fit (wet/dry ~ H_2O)
- H_2O calibrated for CFADS15

August 2009 with CFADS15:

- Empiric correction for wet CO_2/CH_4

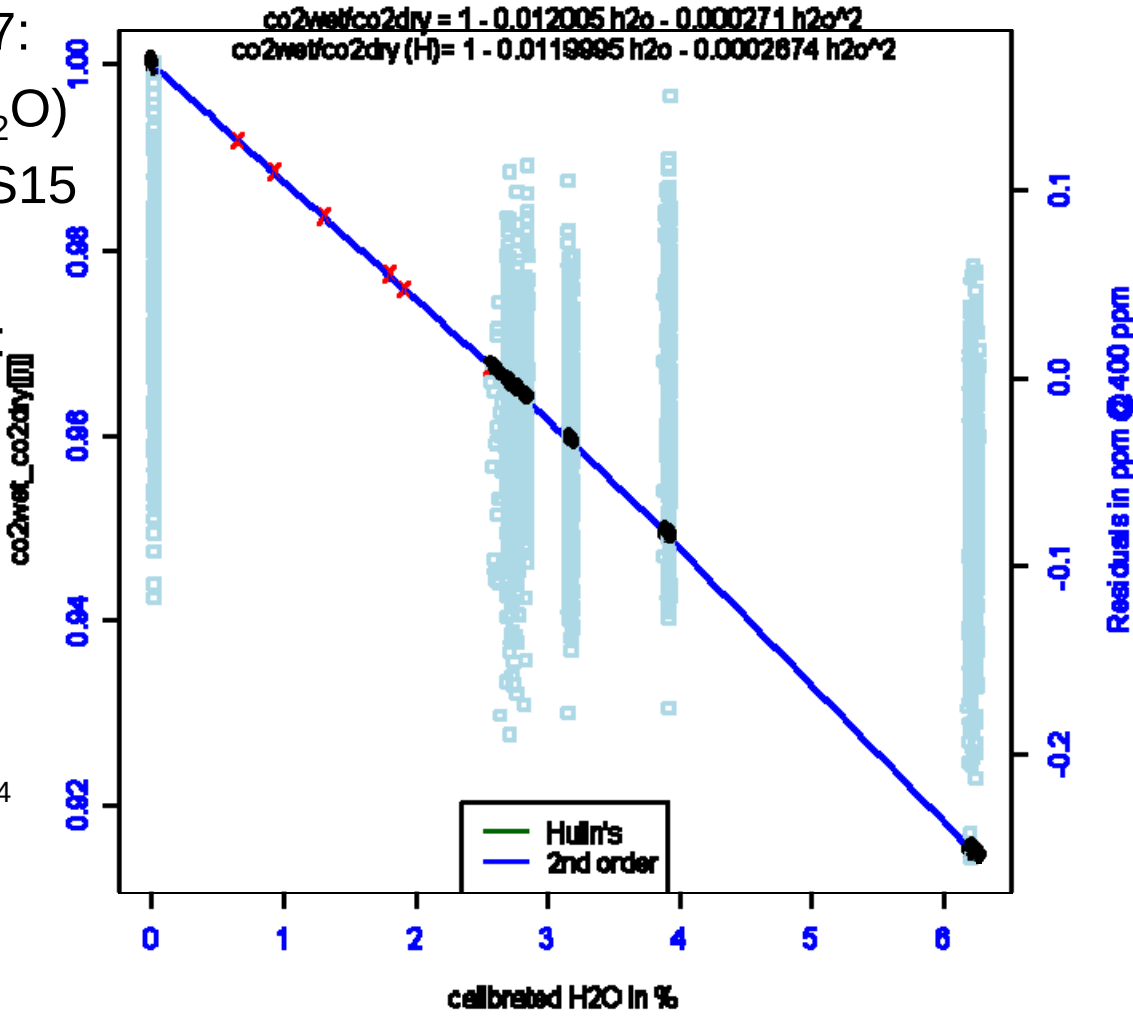
→ Residuals:

CO_2 *0.005 ± 0.053 ppm*

CH_4 *0.001 ± 0.530 ppb*

for air: 400 ppm CO_2, 2000 ppb CH_4

➔ No drying of sample air

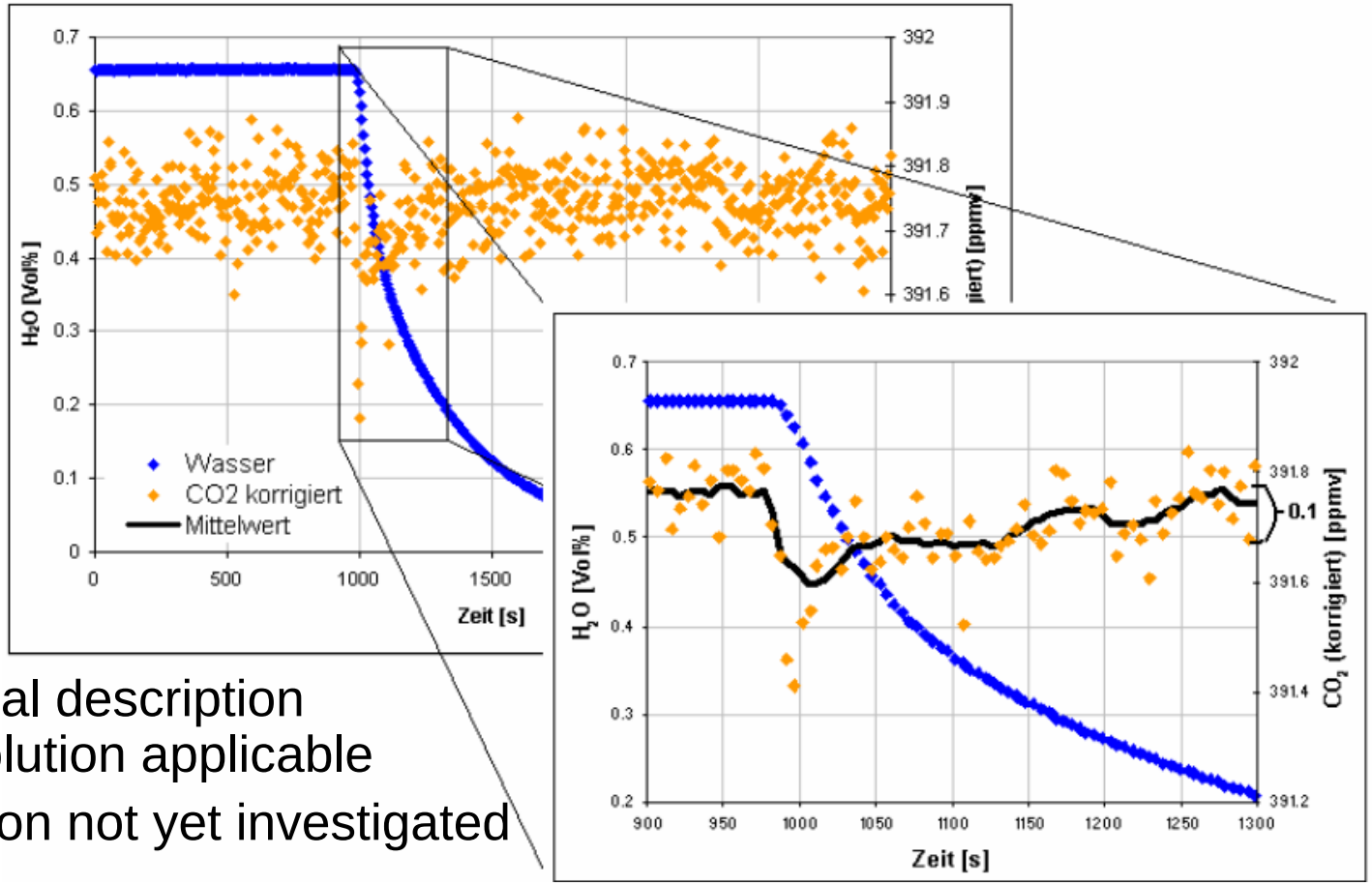


Summary

- High quality CO_2 & CH_4 measurement
  Cavity Ring Down Spectroscopy
- Quasi continuous measurement on 6 levels
  8 l Buffers
- No air drying
  Correction with H_2O measurement

Prospect: Influence of Wet Sampling Tube

- H_2O sticks to tube surface → Influence on measurement?
- Lab experiments done: Switching of several gases (CO_2, CH_4, H_2O)



[A. Höfer, 2009]

→ Mathematical description
→ Deconvolution applicable

- Condensation not yet investigated

Acknowledgements

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ZOTTO project & staff

Krasnoyarsk Institute of Forest

Thank you for you attention!

[view from 300 m level ZOTTO, Sept. 2008]