



High-precision gas analysis made simple

EPIC Online Technology Meeting on Mid-IR Technologies for  
Environmental Monitoring

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# Multicomponent Gas Analyzer

## Highlights

- › Measures up to 10 gases simultaneously
- › Direct measurement of all components
- › High precision for trace gas monitoring
- › High time resolution for mobile applications (up to 10Hz)
- › No sample pretreatment

18 cm  
4 RU



Vacuum pump



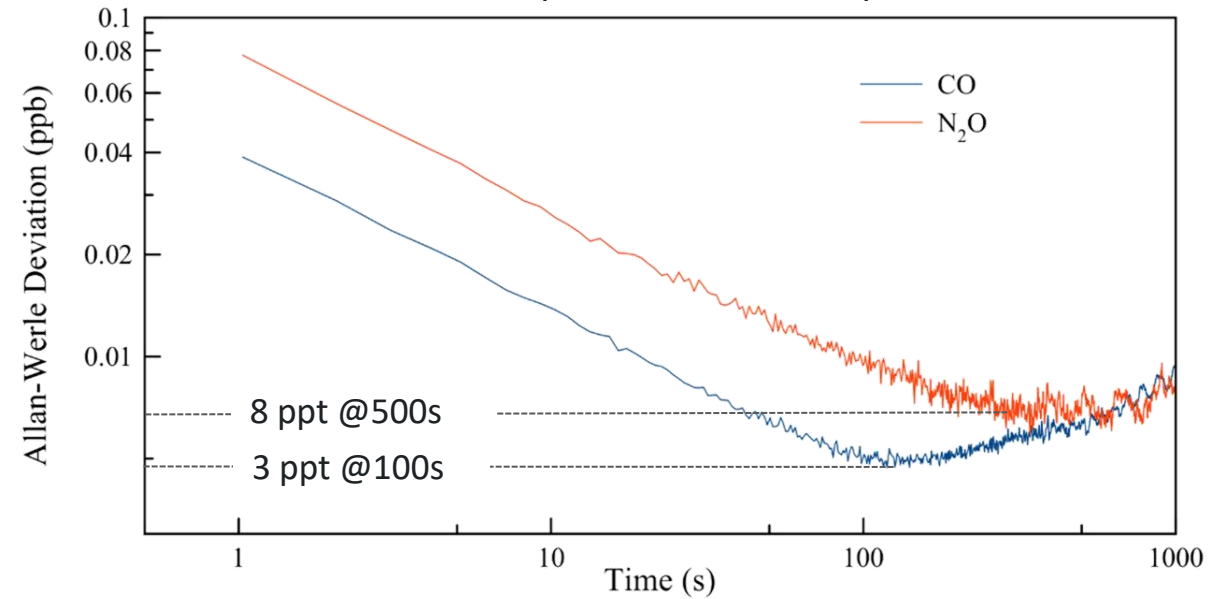
Water chiller

# Specification and Performance

## Precisions determined by Allan-Werle Variance

Gas	Precision @ 1s	Best precision	Range, ppm
CO (ppt)	40	10	0 – 20
N <sub>2</sub> O (ppt)	200	30	0 – 20
H <sub>2</sub> O (ppm)	12	2	0 – 15%
NO (ppt)	300	40	0 – 100
NO <sub>2</sub> (ppt)	80	20	0 – 40
CH <sub>4</sub> (ppb)	1	0.1	0 – 200
SO <sub>2</sub> (ppb)	2	0.2	0 – 150
NH <sub>3</sub> (ppt)	50	10	0 – 15
CO <sub>2</sub> (ppb)	900	90	0 – 8000
O <sub>3</sub> (ppb)	1	0.2	0 – 300

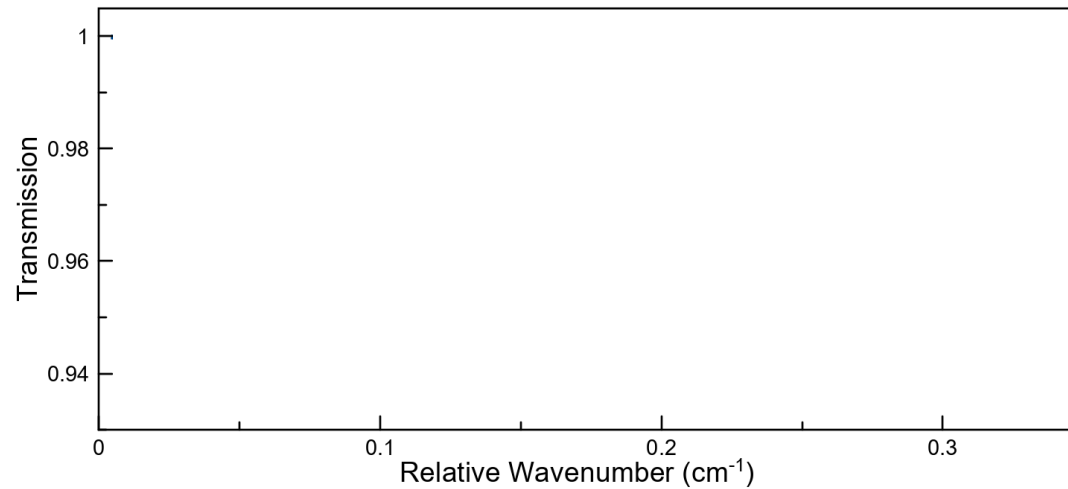
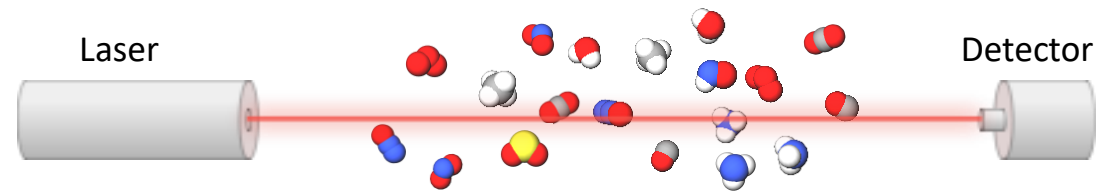
Example of Allan-Werle plot



More information:

<https://www.miro-analytical.com/mga9-mga10/>

# Mid-IR gas sensing by direct absorption spectroscopy



## MGA<sup>9</sup> – MGA<sup>10</sup> series

Multi-compound analyzers for  
GHG and Pollutants

Example: MGA<sup>10</sup> – GP

CO, NO, NO<sub>2</sub>, O<sub>3</sub>, NH<sub>3</sub>, CO<sub>2</sub>, N<sub>2</sub>O, H<sub>2</sub>O,  
CH<sub>4</sub>, SO<sub>2</sub> or OCS

## MGA<sup>6</sup> – MGA<sup>8</sup> series

Multi-compound analyzers that  
can be tailored for specific  
applications

Example: MGA<sup>8</sup> – Nitro

NO, NO<sub>2</sub>, O<sub>3</sub>, NH<sub>3</sub>, CO<sub>2</sub>, N<sub>2</sub>O, H<sub>2</sub>O, HONO

## MGA<sup>1</sup> – MGA<sup>5</sup> series

Analyzers for up to 5 gases for  
best possible precision

Example: MGA<sup>5</sup> – GHG

CO, CO<sub>2</sub>, N<sub>2</sub>O, H<sub>2</sub>O, CH<sub>4</sub>

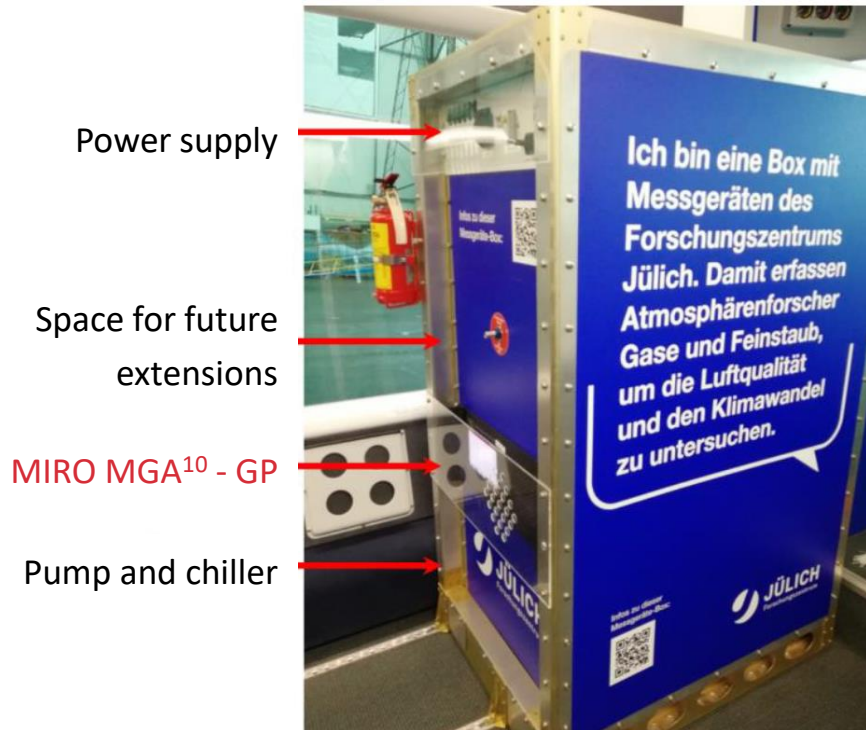
MGA – NO<sub>2</sub>

# Application examples



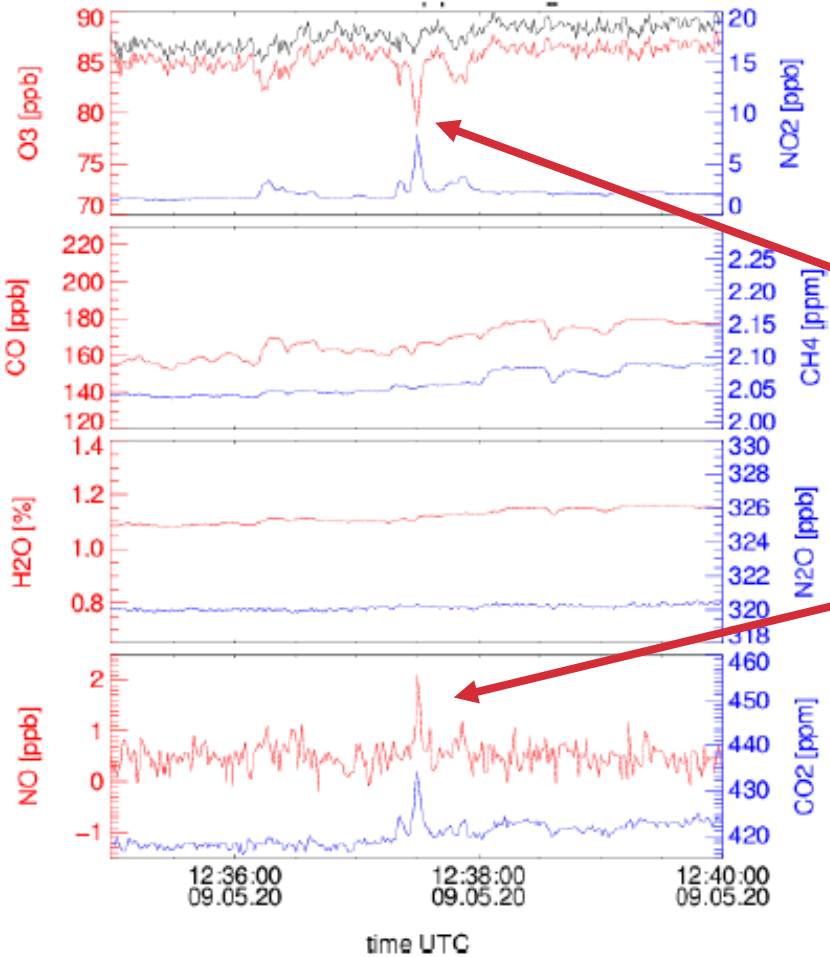
# Mobile measurements with Zeppelin airship

Altitude profiles of air pollutants and GHG





# Zeppelin: results example



Camp fire fingerprint:  
NO<sub>2</sub>, NO, CO<sub>2</sub>, O<sub>3</sub>



Publication in preparation (AMT)  
R. Tillmann et al.

# Mobile measurements with electric vans

## Air pollutants and GHG in the cities

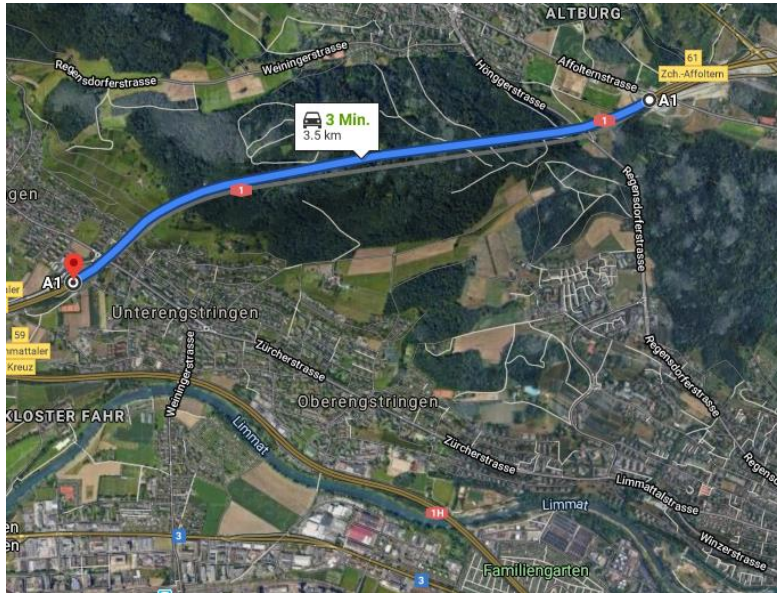
Mobile measurements in collaboration with Canton of Zurich (AWEL)\*  
from 4/29-5/5/2020

- MIRO MGA<sup>10</sup>-GP placed in electric mini-van
- Analyzer powered by 3kWh battery (sufficient for >10h)
- Coupled with GPS antenna and particle counter\*

\* We thank Jörg Sintermann and Michael Götsch (AWEL/Caton of Zurich) for performing the measurements and providing the vehicle

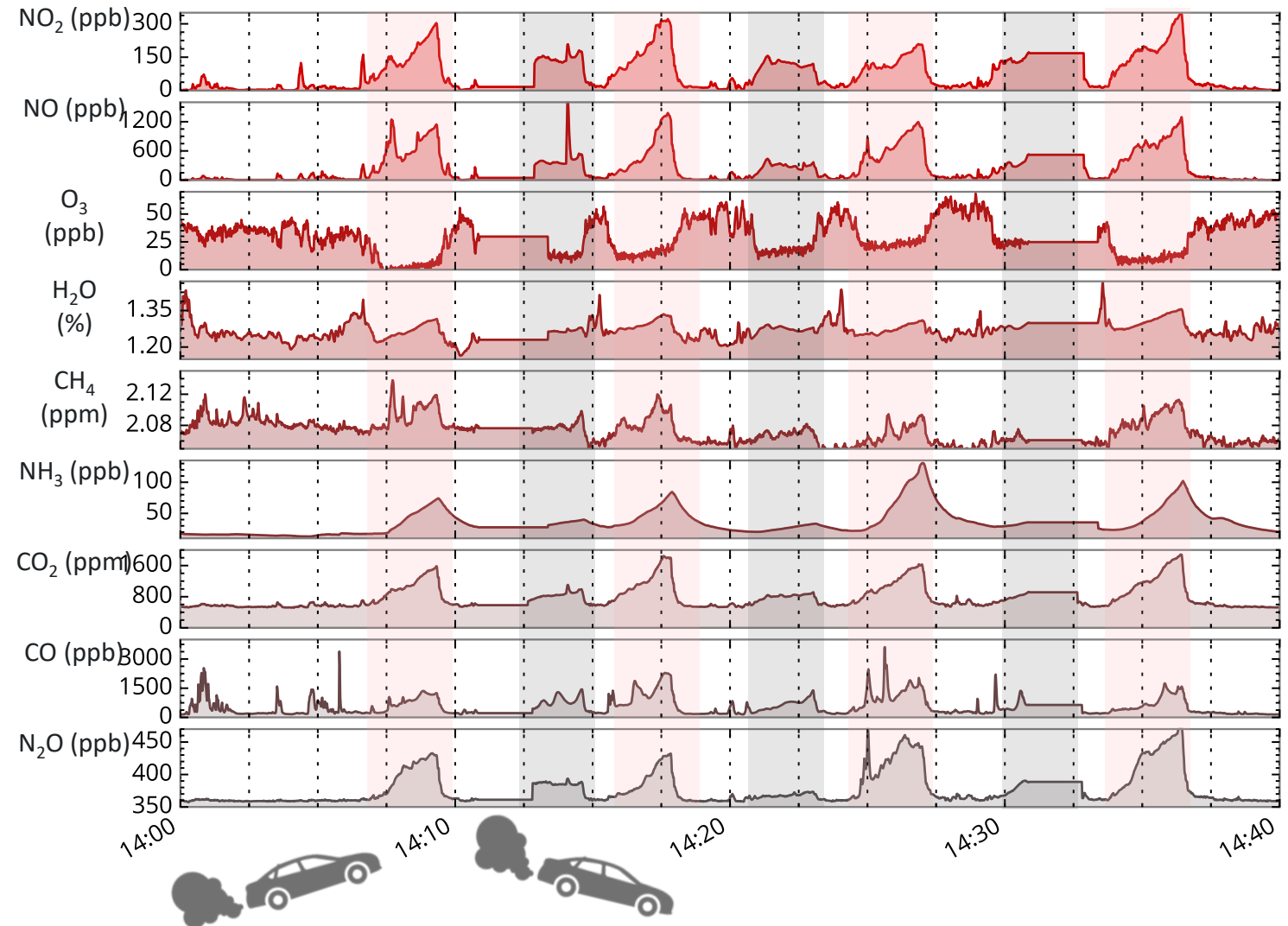


# Mobile measurements with electric van



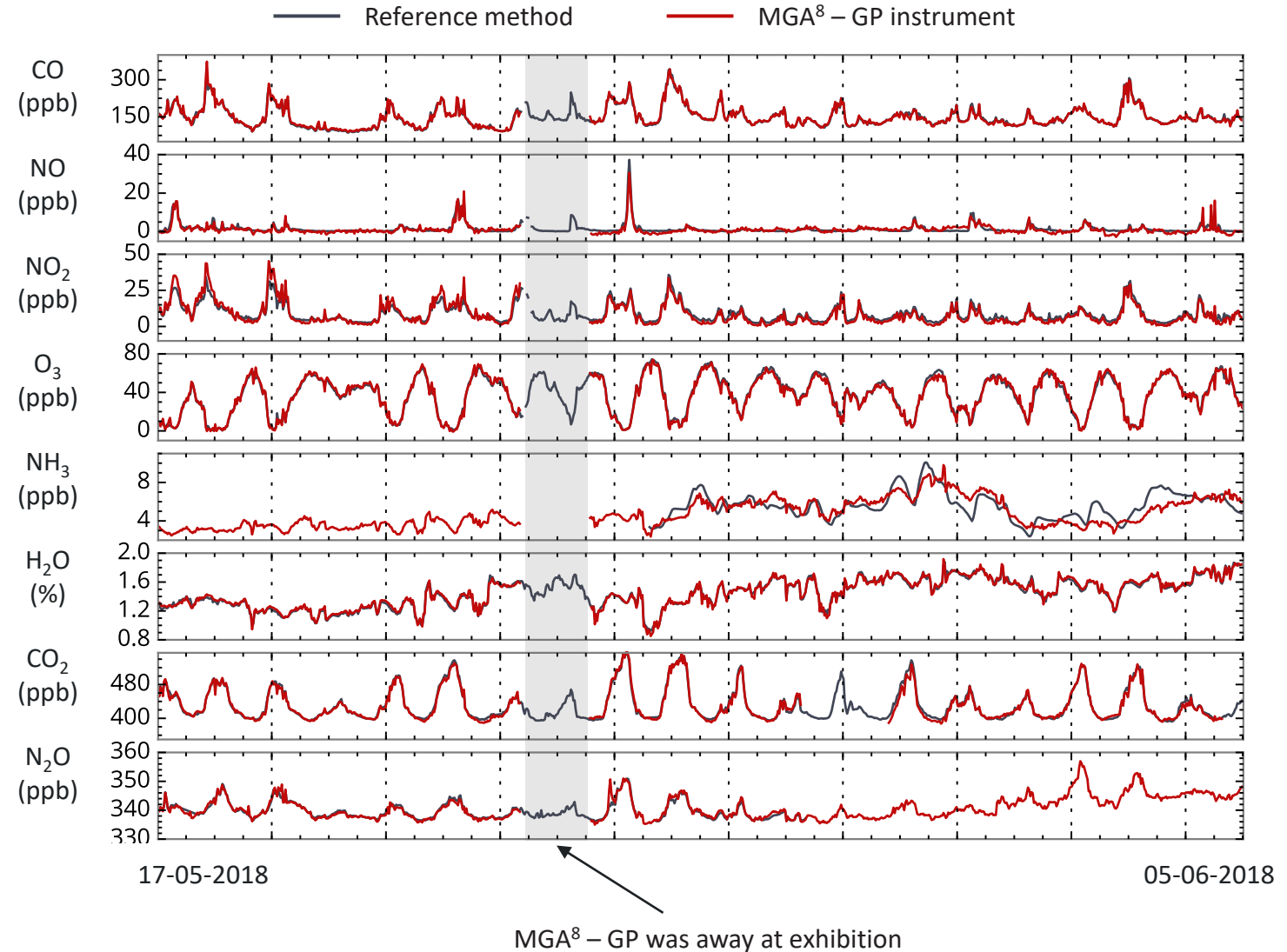
## Tunnel-Passage (Gubrist Tunnel, Zürich)

- › Measurement vehicle passed tunnel 7 times
- › East-West passage is 70m uphill -> Vehicles under constant load (grey)
- › West-East passage downhill (pink)



# MGA<sup>10</sup> – GP comparison with standard methods

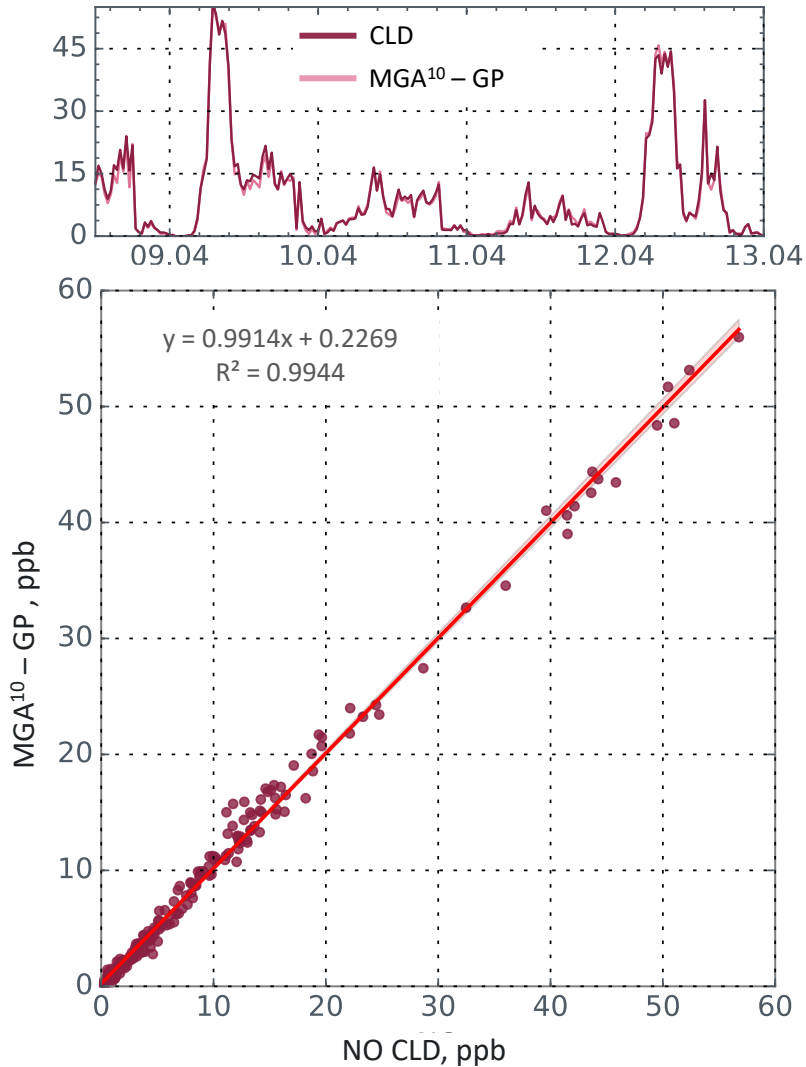
Gases	Reference method
NO & NO <sub>2</sub>	Chemiluminescence detection (CLD)
O <sub>3</sub>	Ultraviolet (UV) absorption spectroscopy
CO	Non-dispersive infrared (IR) spectroscopy
NH <sub>3</sub> , H <sub>2</sub> O, CO <sub>2</sub> , N <sub>2</sub> O	Cavity ring-down spectroscopy (CRDS)



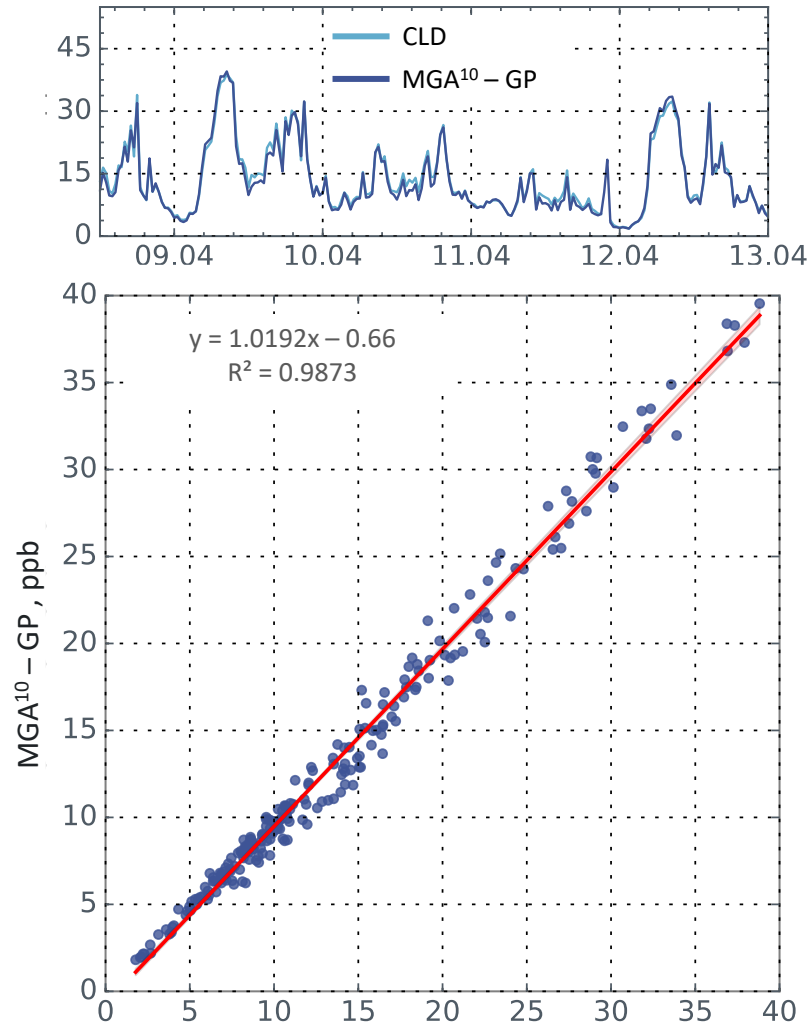


# MGA<sup>10</sup> – GP comparison with standard methods

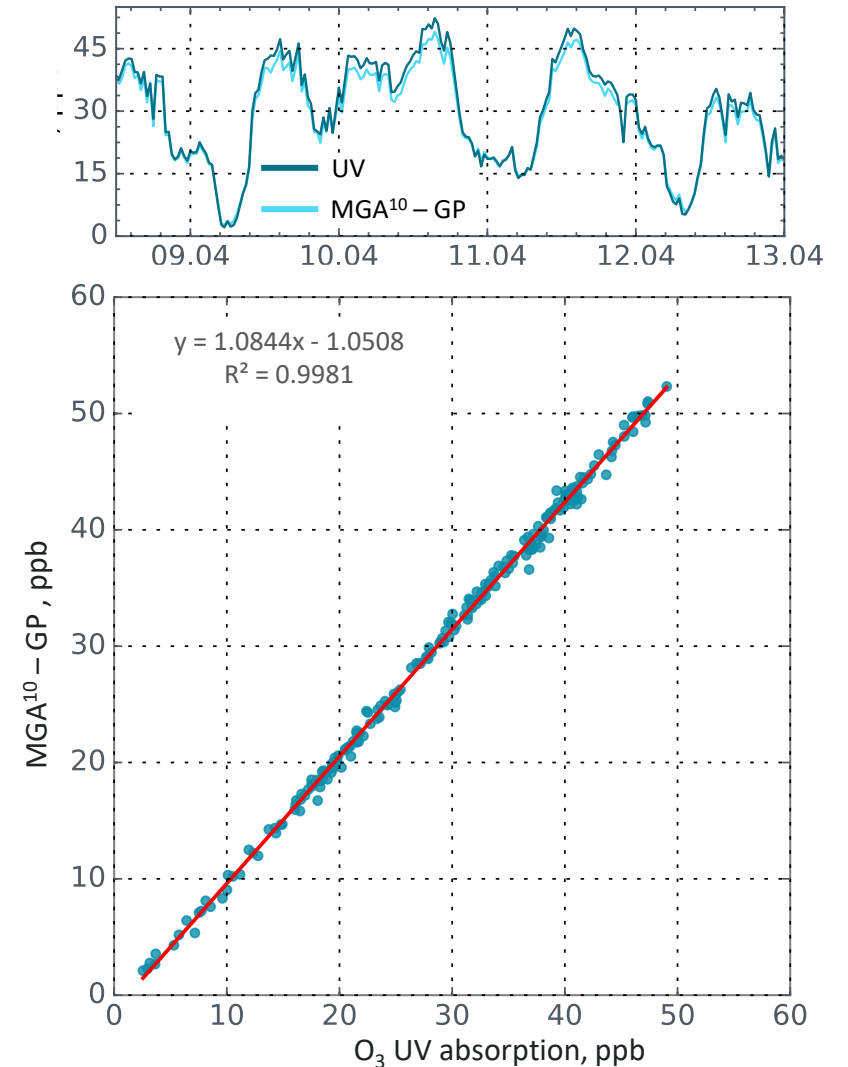
### NO: MGA<sup>10</sup>-GP vs CLD



### NO<sub>2</sub>: MGA<sup>10</sup>-GP vs CLD



### O<sub>3</sub>: MGA<sup>10</sup>-GP vs UV spectroscopy



# Measurements at background stations

## High-precision NO<sub>2</sub> Analyzer for High Altitude Research Station Jungfrau-Joch



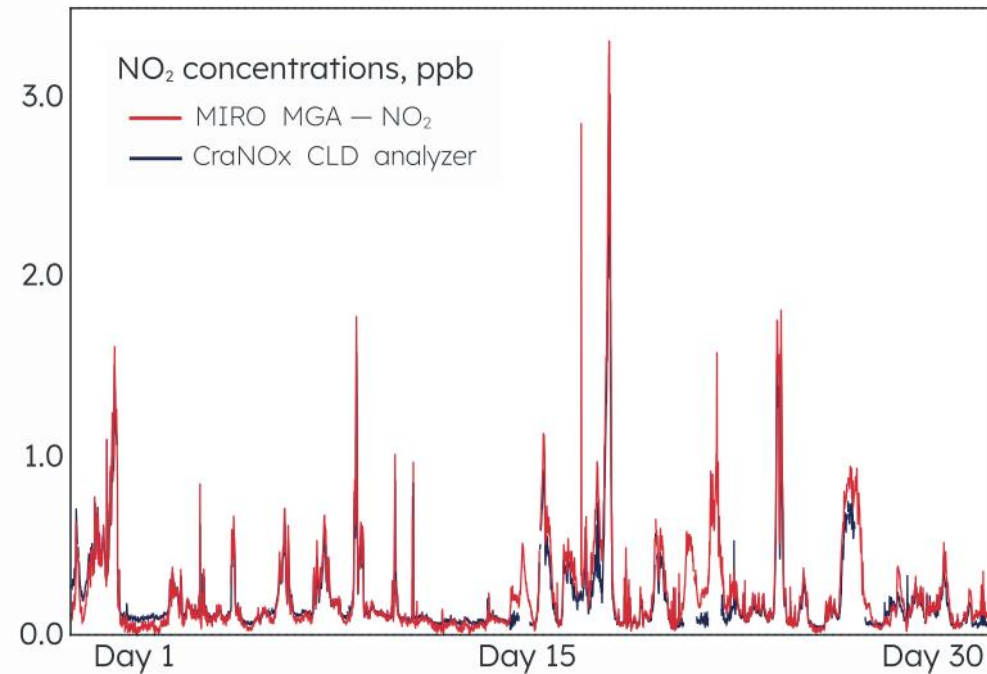
- Research station at 3571 m
- Unattended operation for > 1 year
- Continuously providing data to the Swiss national air monitoring network (NABEL)



# High-precision MGA-NO<sub>2</sub> at Jungfrau-Joch station

Species	Precision @ 1s	Precision @100s	Zero drift	Range	Response time
NO <sub>2</sub>	< 0.03 ppb	< 6 ppt	< 0.03 ppb	0 – 40 ppm	< 2s

Comparison of NO<sub>2</sub> measurements of MGA-NO<sub>2</sub> with CLD



## Product advantages

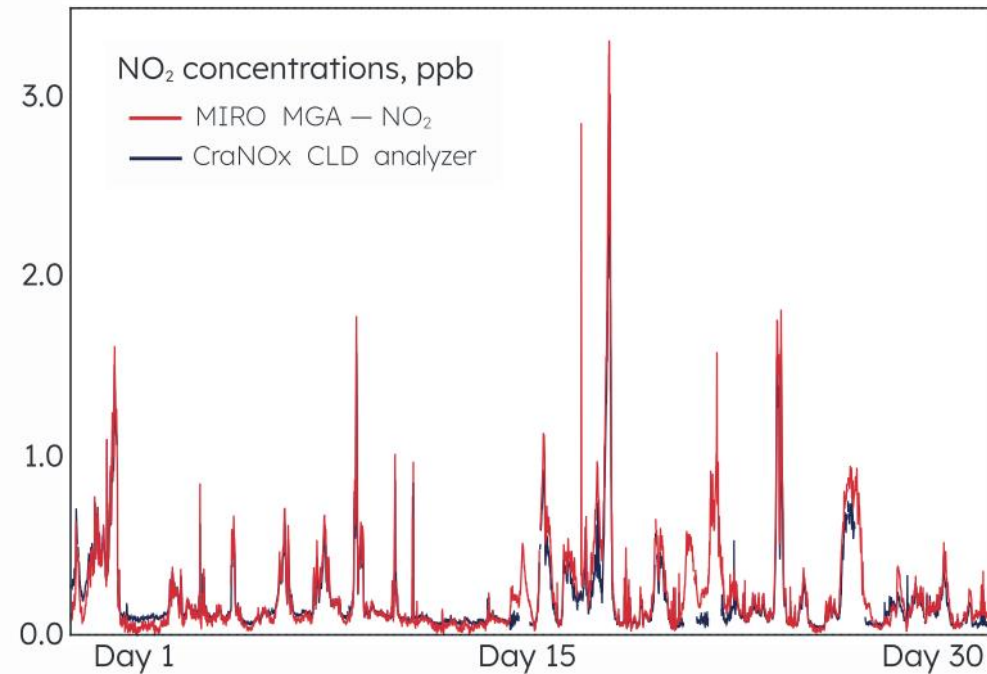
- Direct measurements of NO<sub>2</sub> – no converters needed
- High accuracy even for low concentrations



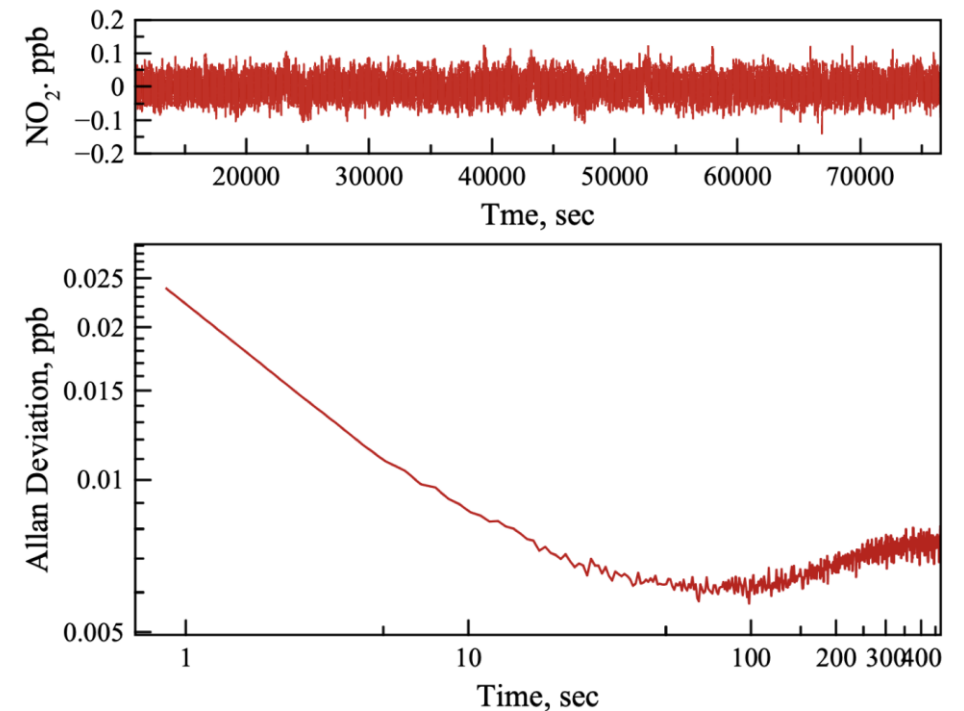
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Comparison of NO<sub>2</sub> measurements of MGA-NO<sub>2</sub> with CLD



Precision / Stability





High-precision gas analysis made simple

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