European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

Final Meeting at PRAGUE (CZ), 5-7 October 2016

New Sensing Technologies for Air Quality Monitoring

Action Start date: 01/07/2012 - Action End date: 15/11/2016 - EXTENSION: 15/11/2016

CONCLUSIONS FROM ONE YEAR OPERATING A LOW-COST SENSOR NETWORK IN ZURICH

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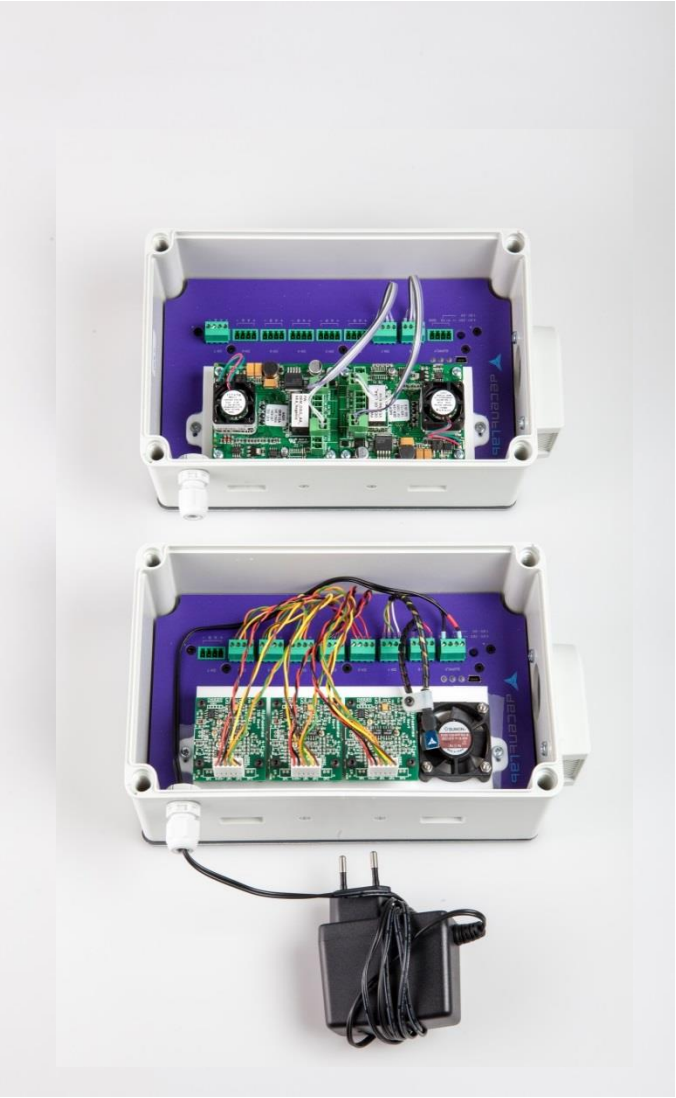
NO_2/O_3 sensor unit – Aircube (AC)



- **2x Aeroqual O_3 SM50**
- **3x Alphasense NO_2 B42F**
- **Temperature**
- **Relative humidity**

- **GSM module for data transfer**

Empa-SN + AQM sites of UGZ/FOEN

11 Juni 2015 – 03 August 2016

Setting of the case study

- Extension of an air quality monitoring network
- Replacement of passive samplers

Main interests

- Operation of a low-cost sensor network
- Achievable accuracy
- Options for performance monitoring

- Current state
- Specific devices
- ➢ Findings probably transferable to other settings

ETH

PFI

STB

NO_2 passive samplers (two-week mean)

HEU

ZUE

GES

SCH

BUE

GoogleEarth

NO_2 sensors

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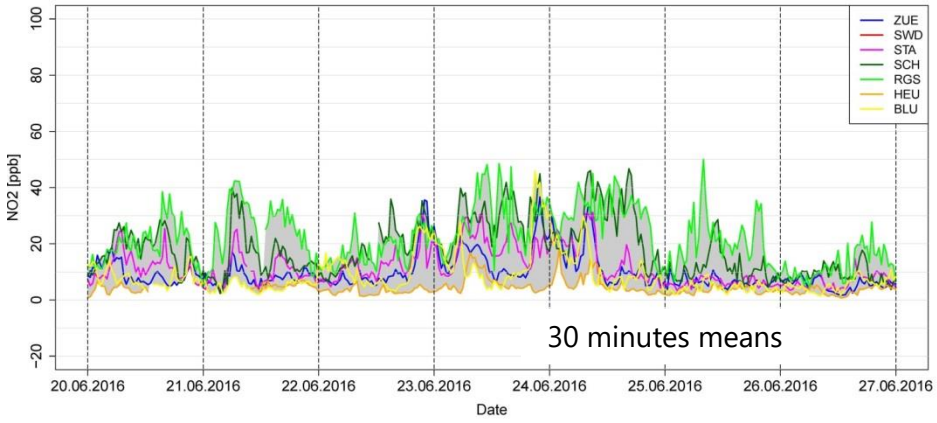
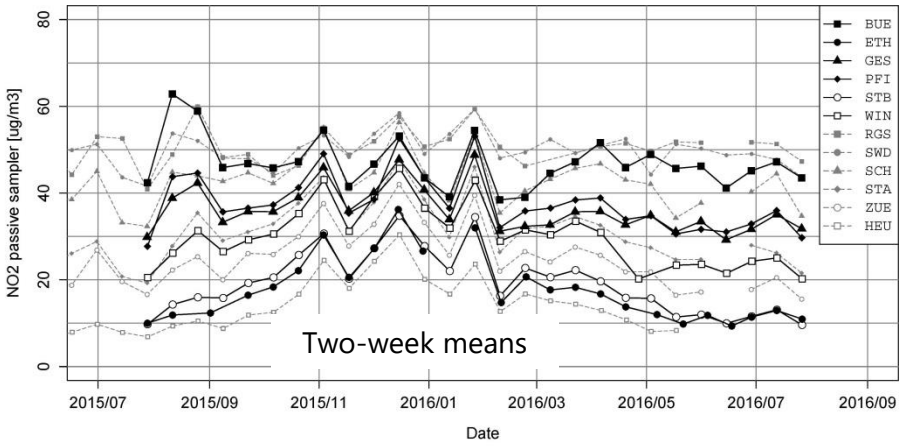
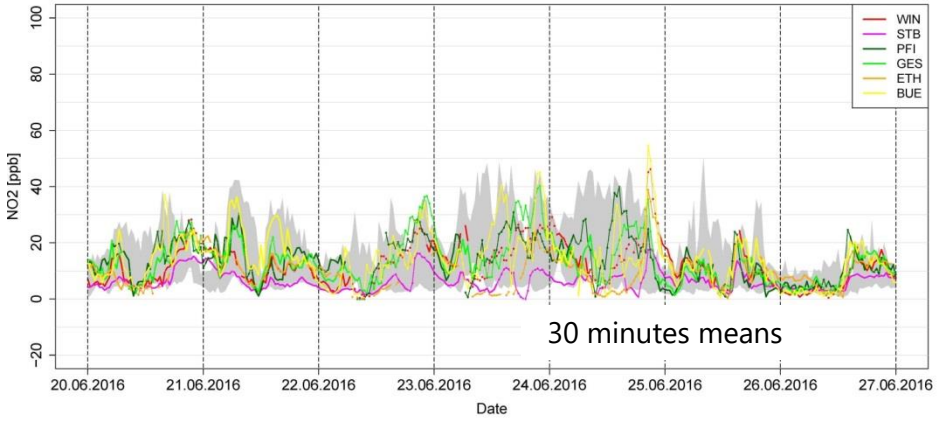
NO_2 air quality monitoring stations



NO_2 passive samplers



NO_2 Aircubes



AC: 18 months of continuous operation

- ✓ Reliable sensor unit
- ✓ Wireless data transfer
- ✓ Sensor raw data stored in database
  - Data analysis
  - Post-processing

Summary of NO_2 sensor performance

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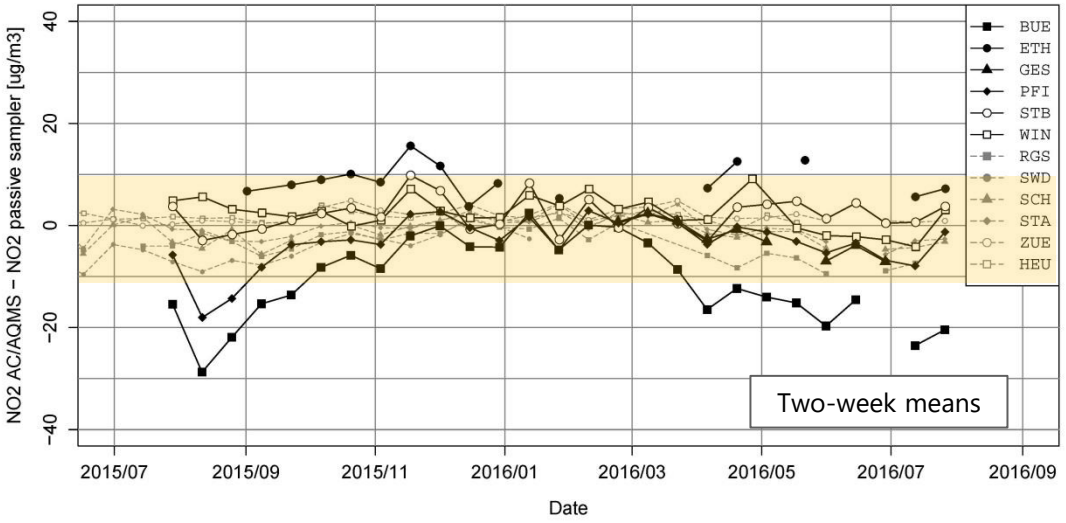
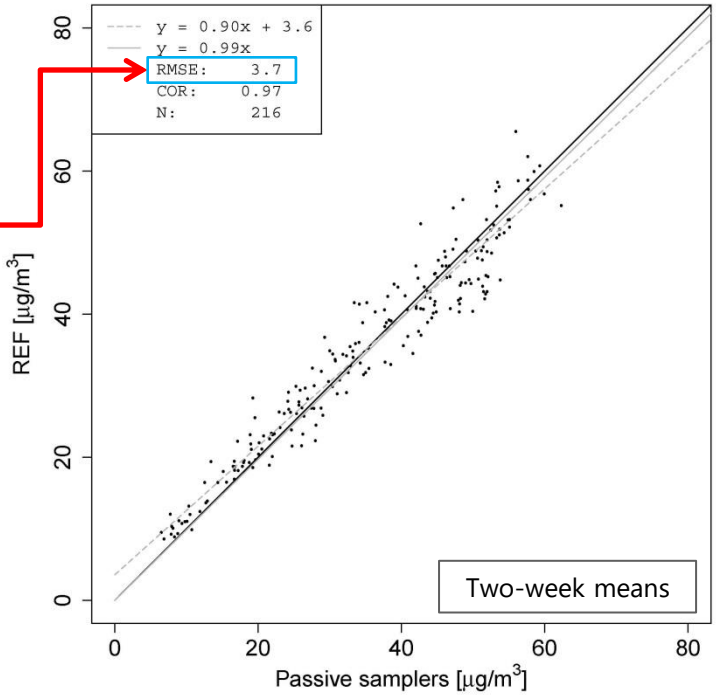
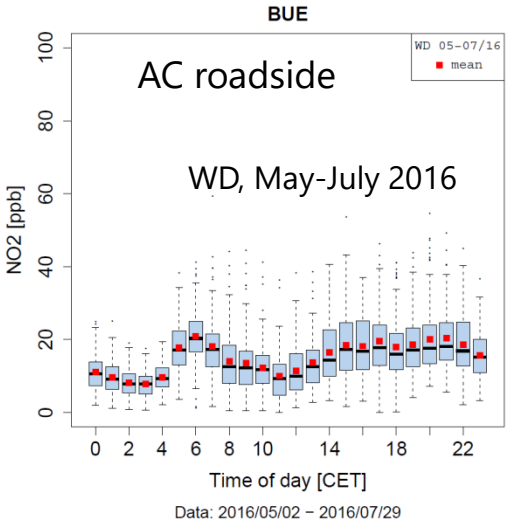
AC NO_2 sensors vs NO_2 passive samplers (PS)

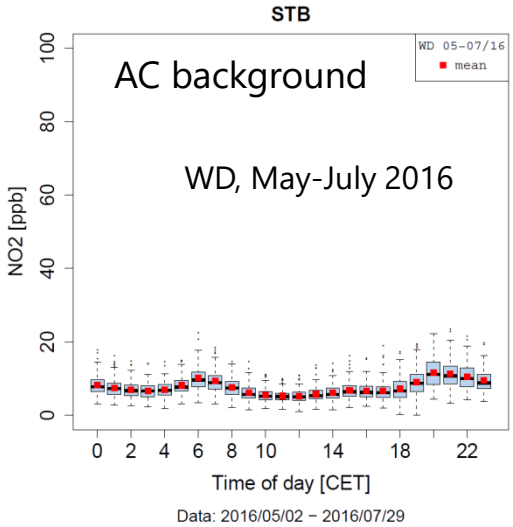


PS vs CLD



Diurnal variations





NO_2 sensors

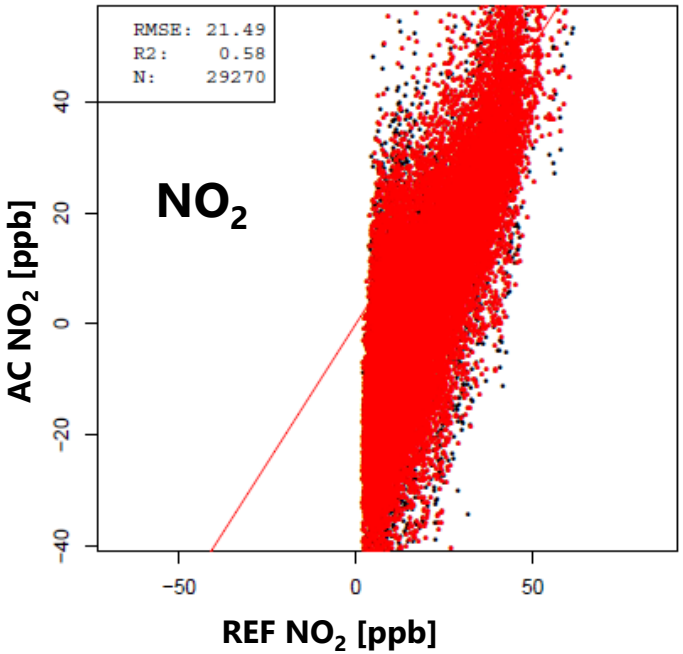
- Results sufficient ???

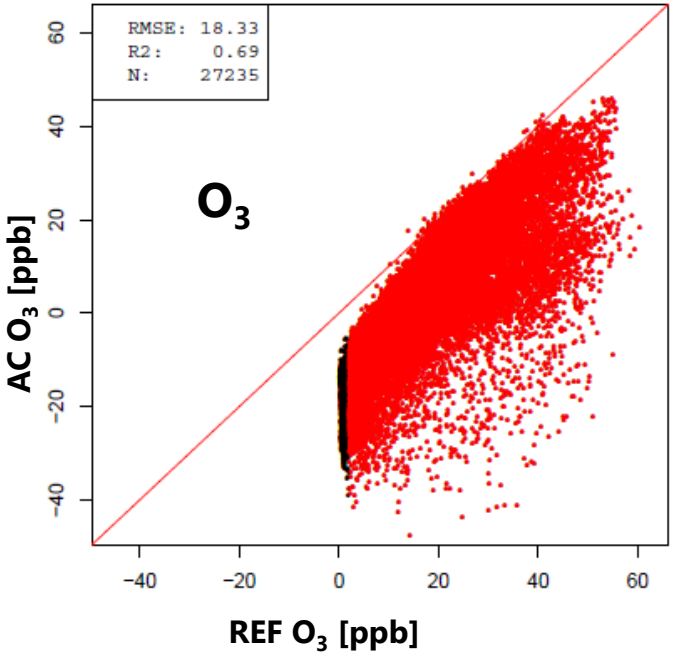
➢ Several issues remain to be resolved / improved for sufficient usability

Individual sensor calibration

- **Individual sensor calibration necessary**
- In-field calibration at AQM stations
  - Limitations of procedure
    - Obtained data set may not well constrain the sensor model
      Pollutant $P \in [P_{min}...P_{max}]$, $T \in [T_{min}...T_{max}]$, $RH \in [RH_{min}...RH_{max}]$
  - Logistic effort
    - Requires the availability of infrastructure
    - Calibration time / manpower

Two examples of sensor raw data



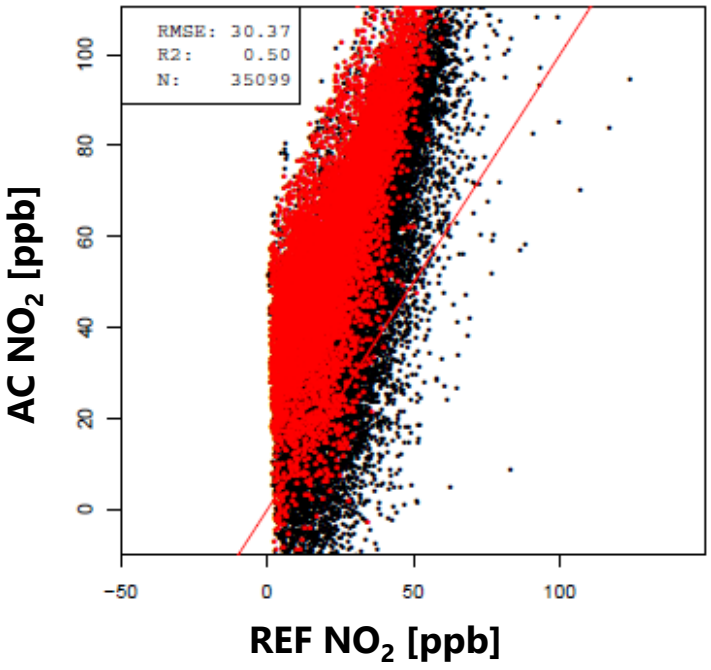


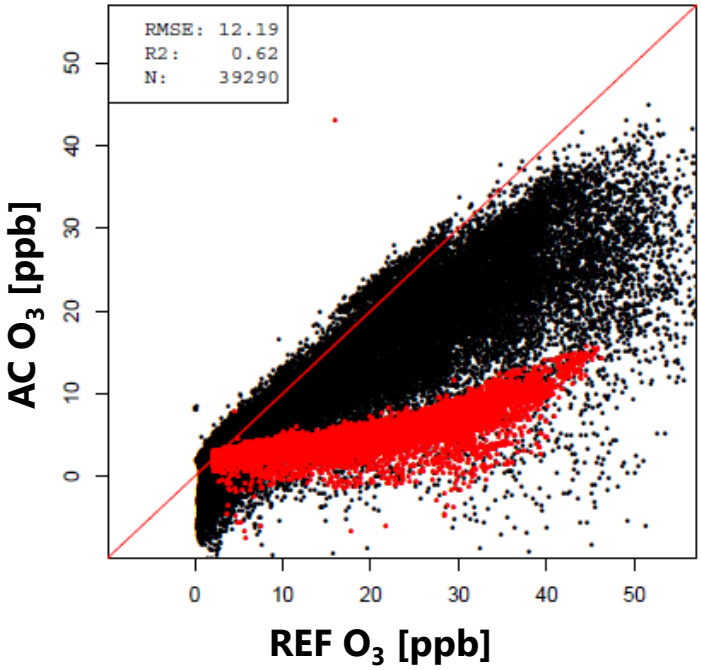
Changes in sensor behavior

Need for continuous sensor performance monitoring / sensor adjustment

- Redundancy in sensor network
- Link sensor data to data from AQM sites

Initial calibration:	06 Feb 2015 – 18 May 2015
Check:	05 Feb 2016 – 14 Mar 2016





➢ Slow / sudden changes in sensor behavior possible

Performance monitoring / calibration

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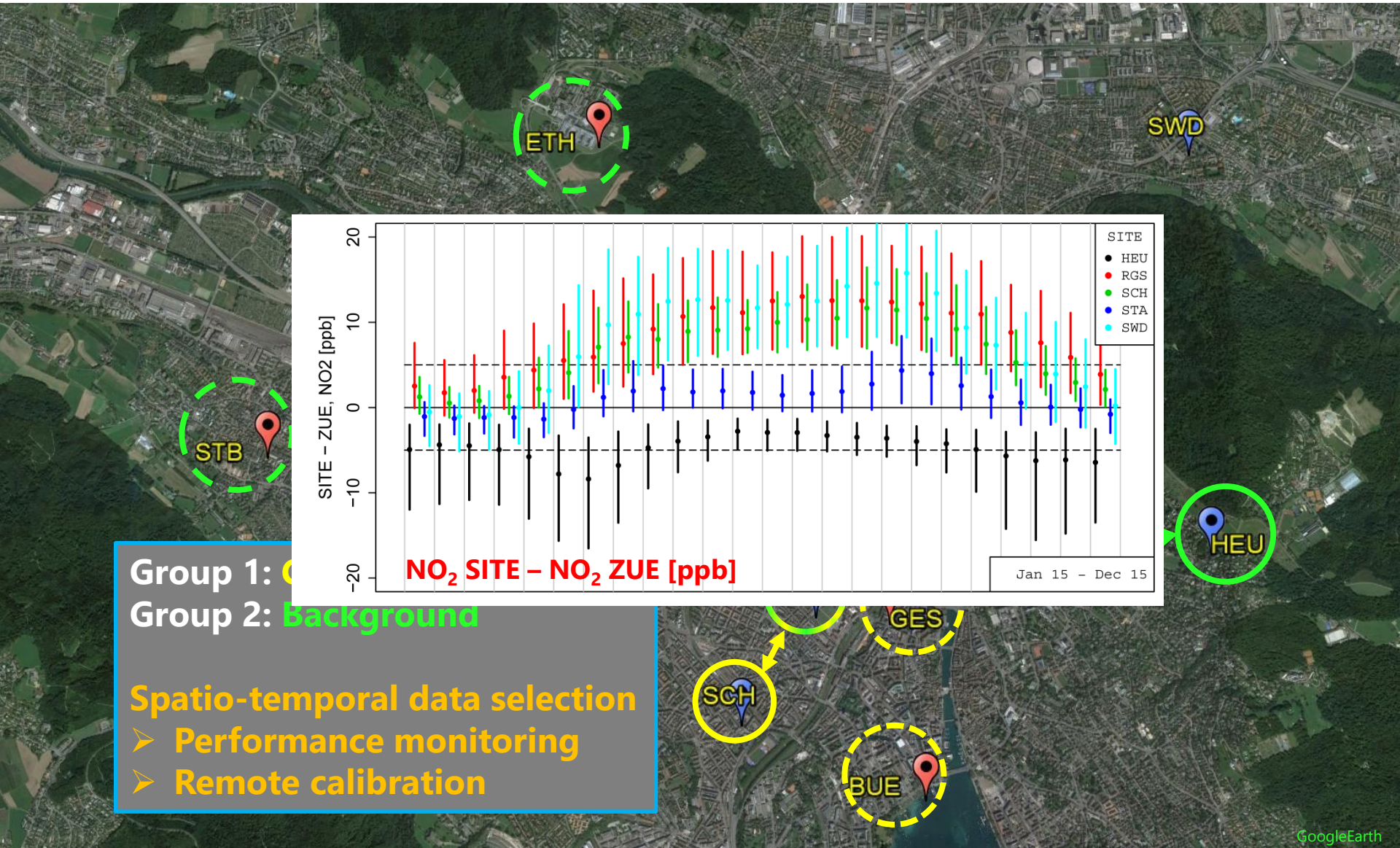

Group 1:
Group 2: Background

Spatio-temporal data selection
- **Performance monitoring**
- **Remote calibration**

Sensor tests in the laboratory

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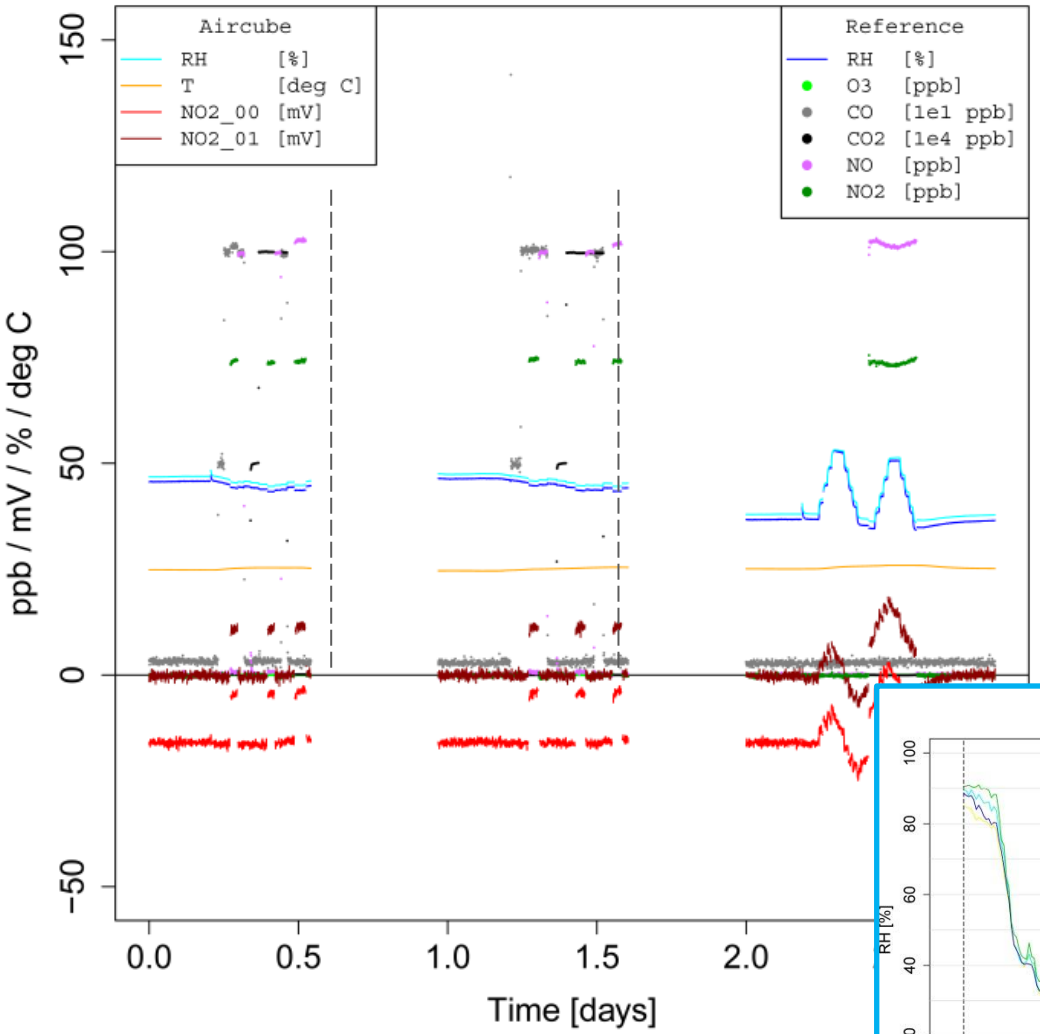
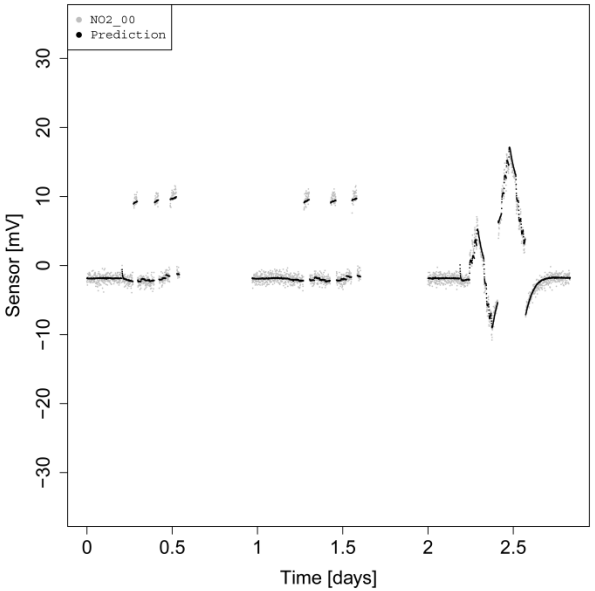
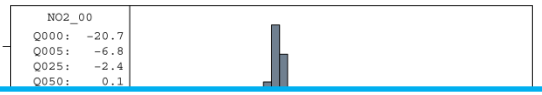
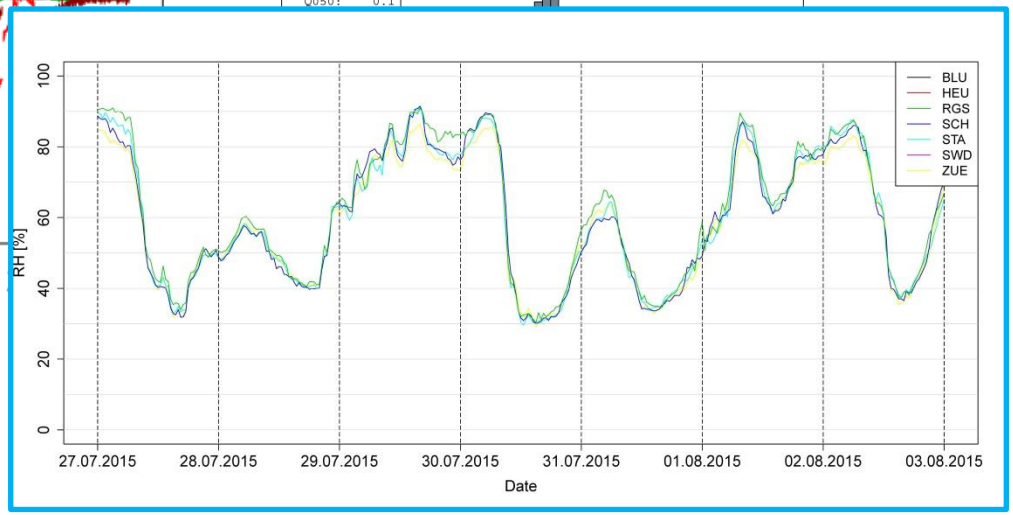
Lab tests (sensitivity to different pollutants, RH)









Sensor tests in the laboratory

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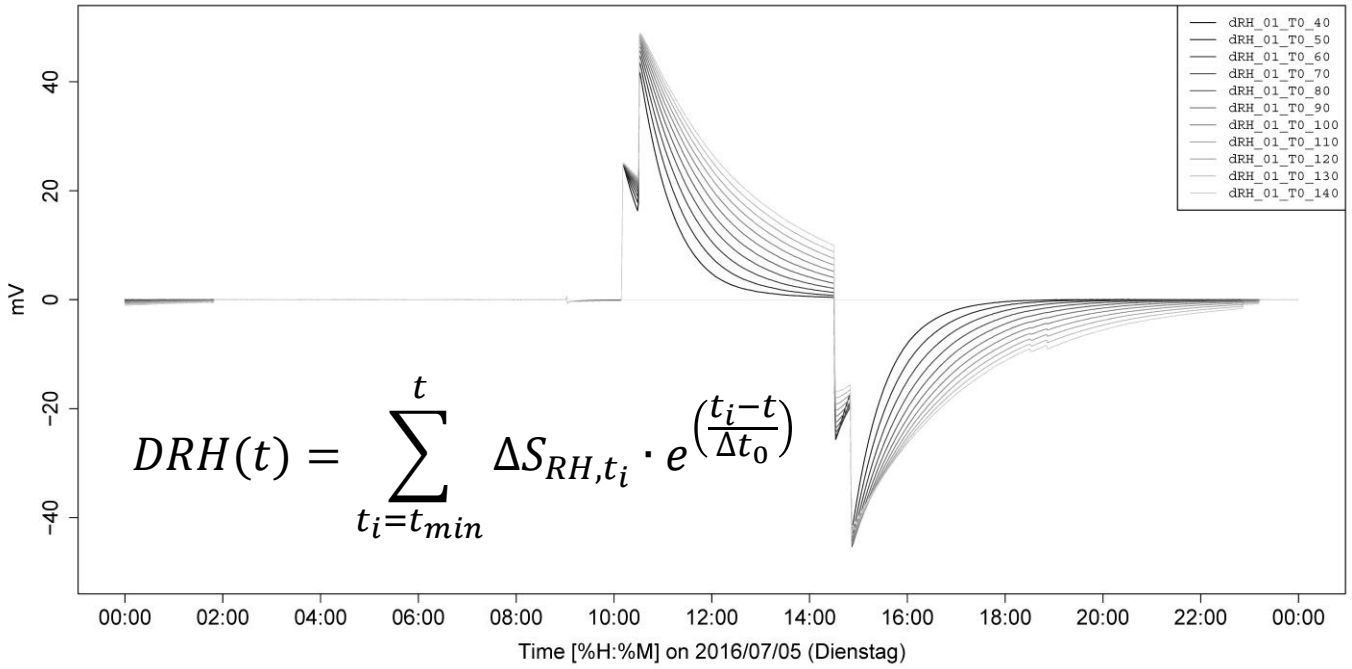
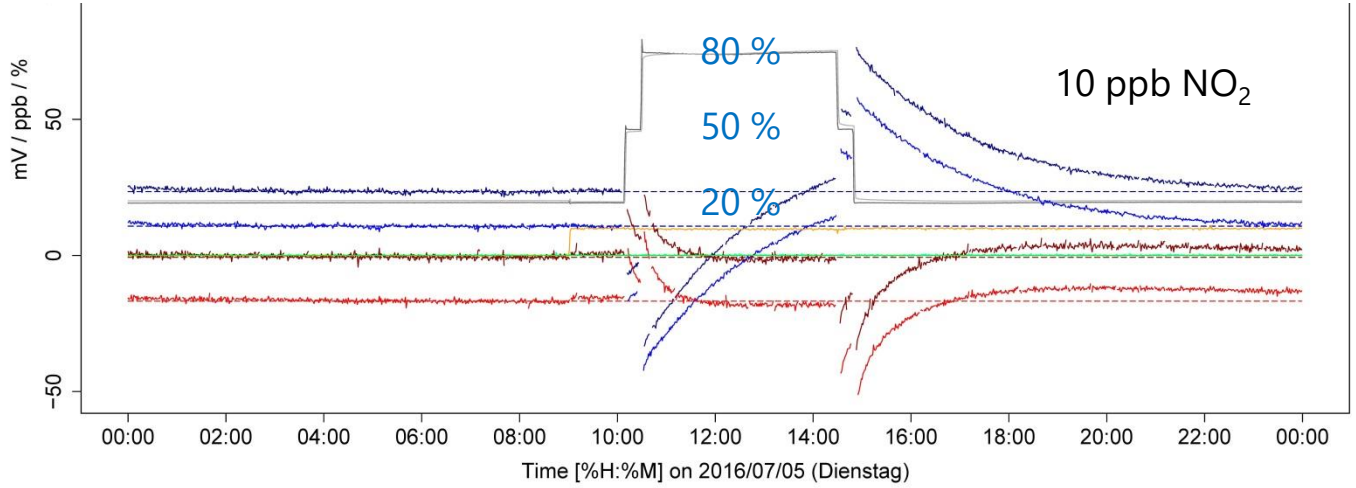


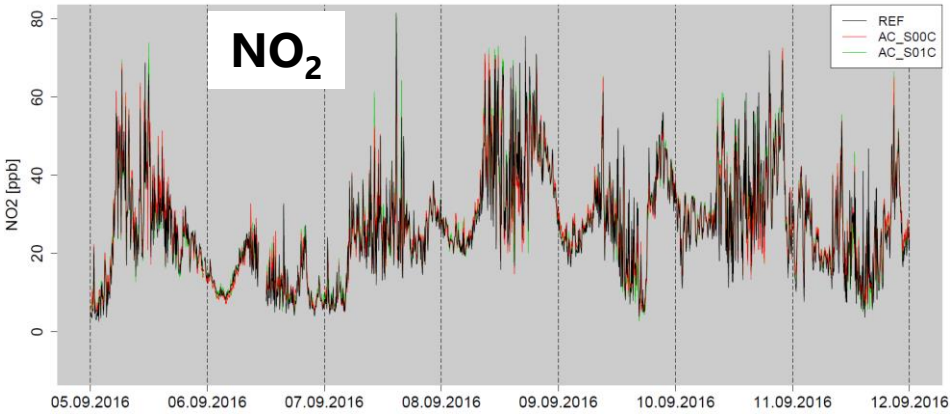
$$DRH(t) = \sum_{t_i=t_{min}}^{t} \Delta S_{RH,t_i} \cdot e^{\left(\frac{t_i - t}{\Delta t_0}\right)}$$

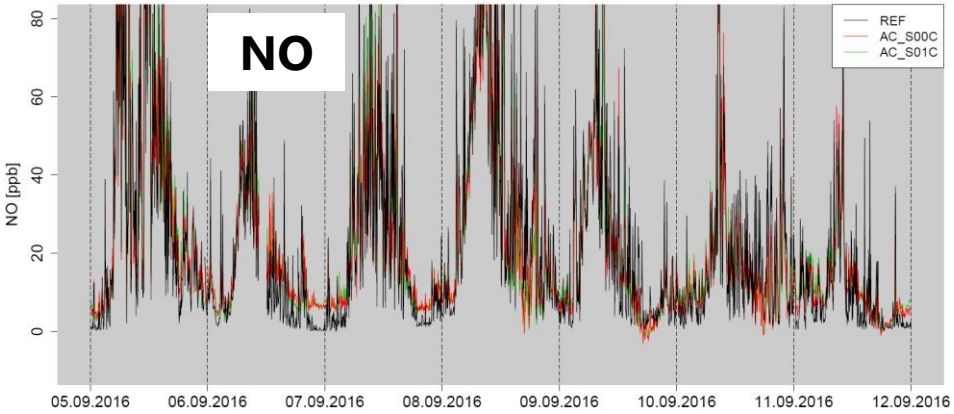


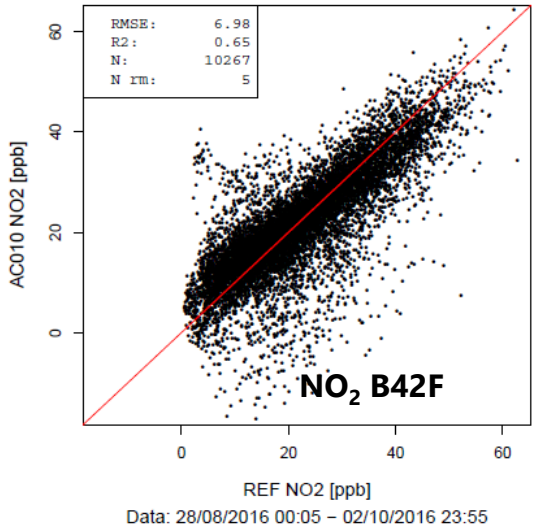
Second generation Aircubes

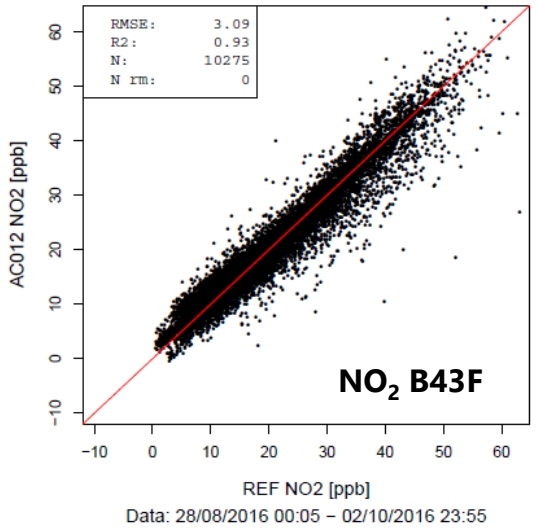
New features

- Single box
- 2 NO + 2 NO_2 sensors
- Battery-powered
- Improved inlet









Summary and conclusions

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- Performance of NO_2 sensors good but not yet sufficient
  - Data post-processing not trivial
  - Challenging to obtain accuracy of passive samplers

  - Optimized mathematical description of the sensor
  - Laboratory / Factory calibration of the sensors

  - Further improved sensors needed

- Comprehensive sensor testing necessary, depending on application
  - Required accuracy
  - Expected operating time
  - Environment conditions

- Continuous performance monitoring
  - Link between low-cost sensor data and data from AQM sites feasible

Acknowledgements

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