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

COST Action TD1105

WGs & MC Meeting at SOFIA (BG), 16-18 December 2015

New Sensing Technologies for Indoor Air Quality Monitoring: Trends and Challenges

Action Start date: 01/07/2012 - Action End date: 30/04/2016 - Year 4: 1 July 2015 - 30 April 2016

O$_3$ and NO$_2$ sensor network in Zurich: Operation, data processing and performance analysis

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

Motivation for operating low-cost sensors

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- Low costs per sensor unit
- Autonomous operation
- Compact design

- ➢ Dense sensor networks providing data with high spatio-temporal resolution
- ➢ Potential for improving knowledge on air quality

NO_2

$NO_2 [\mu g/m^3]$

(Mueller et al. Atmos. Env. 2015.)
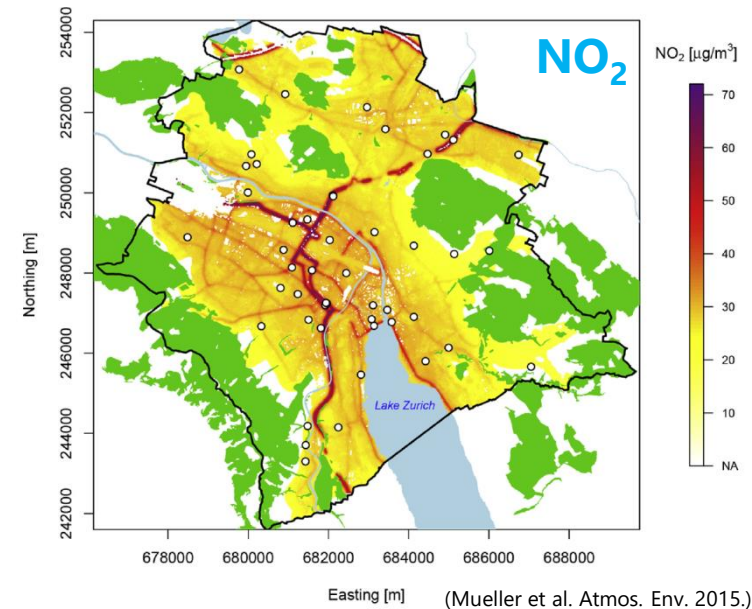
| Viable sensor unit	Accurate sensor model	QA/QC in sensor network

• Integration of the sensors in sensor units
  • Airflow
  • Data transmission
  • Redundancy of sensors
	• Sensor data characteristics
	  • Sensitivity
	  • Cross-sensitivity
	  • Response time
	  • Noise
	• Sensor model
	  • Parameterization
	  • Calibration
		• Longterm stability of sensors
		  • Δ sensitivity
		  • Δ zero-point drift
		  • Δ cross-sensitivity
		• Applicability of sensor calibration

«Aircubes»

Box 1

Box 2

Box 1
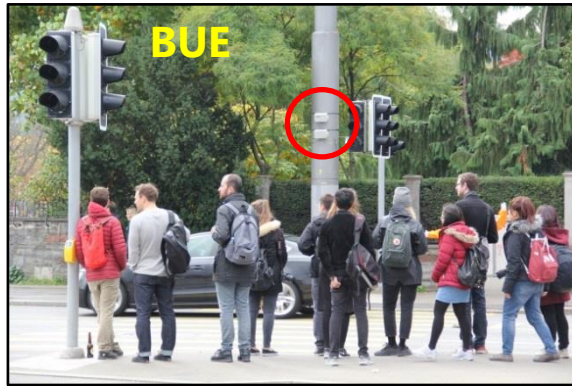- 2 Aeroqual O_3 sensors (SM50)
- GSM module
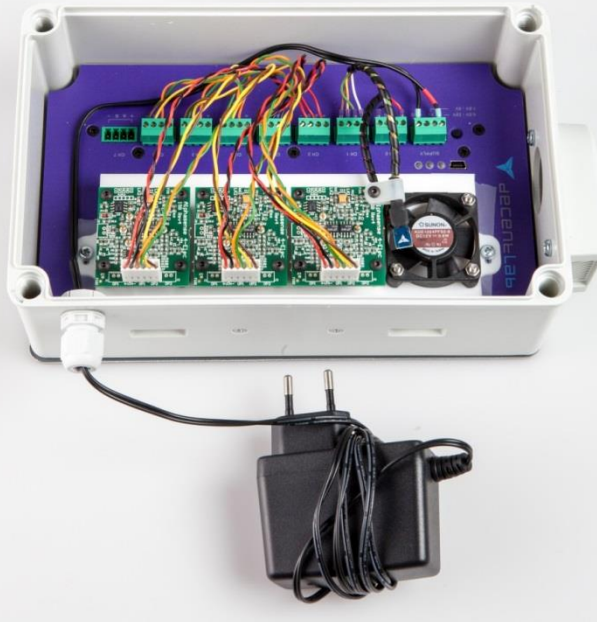
Box 2
- 3 Alphasense NO_2 sensors (B42F)
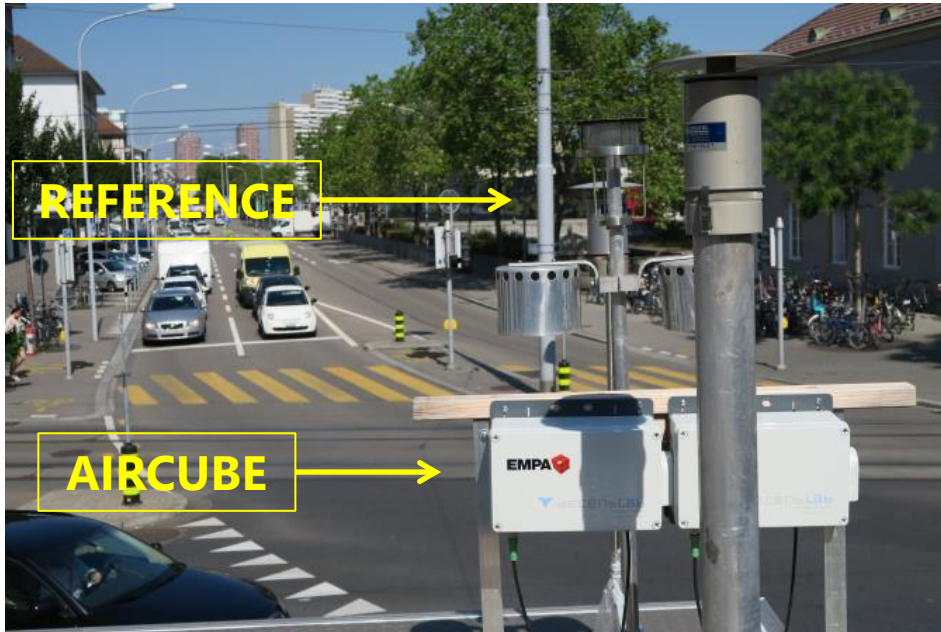- Temperature sensor
- Humidity sensor
- Ventilator

Comments
- Radio link between Box 1 and Box 2.
- Power supply for both boxes.
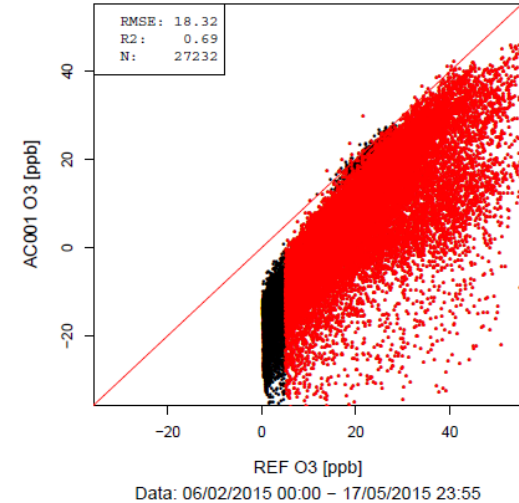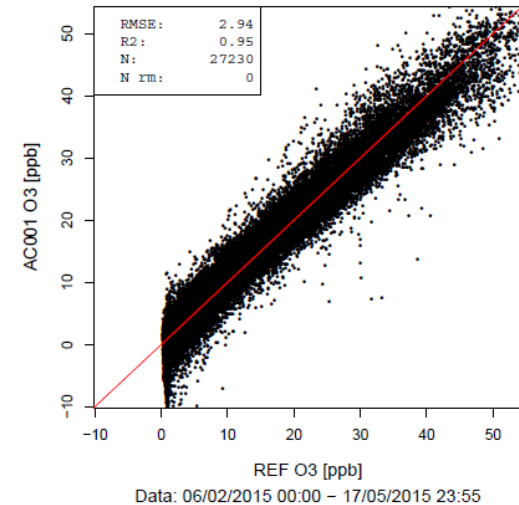
decentLab

Empa Sensornet – Locations

BUE

GES

PFI

WIN

STB

ETH

Sensor calibration

REFERENCE

AIRCUBE

- Calibration of individual sensors required

- Use of a statistical sensor model
  - Description of sensor behavior in specific conditions (w.r.t. pollutant concentration, meteorology)
  - Calibrated data associated with larger uncertainties in strongly deviating conditions

- In-field calibration
  - Conditions given by location and time period
  - Correlations between observations (e.g. T, O_3, NO_2)

O3 raw data
(Feb - May 2015)

RMSE: 18.32
R2: 0.69
N: 27232

AC001 O3 [ppb]
REF O3 [ppb]
Data: 06/02/2015 00:00 – 17/05/2015 23:55

O3 calibrated data
(Feb - May 2015)

RMSE: 2.94
R2: 0.95
N: 27230
N rm: 0

AC001 O3 [ppb]
REF O3 [ppb]
Data: 06/02/2015 00:00 – 17/05/2015 23:55

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O₃ measurements during week with exceptionally high temperature and ozone
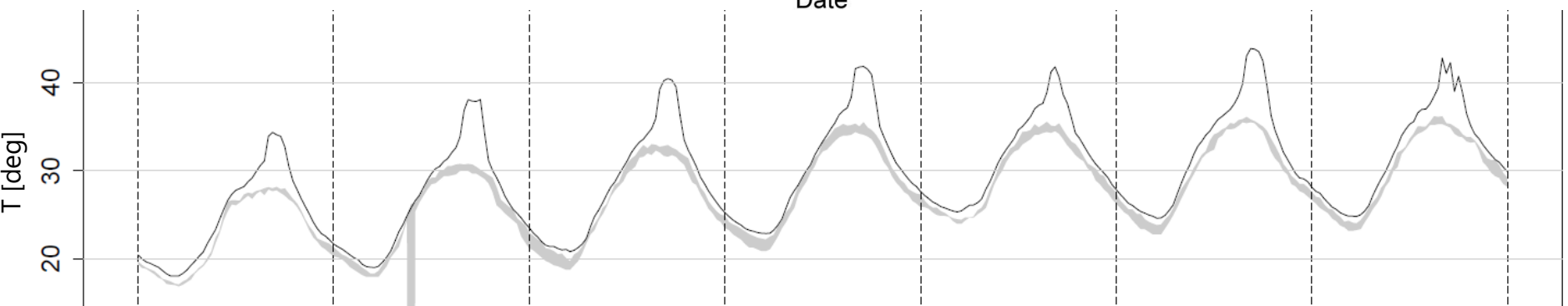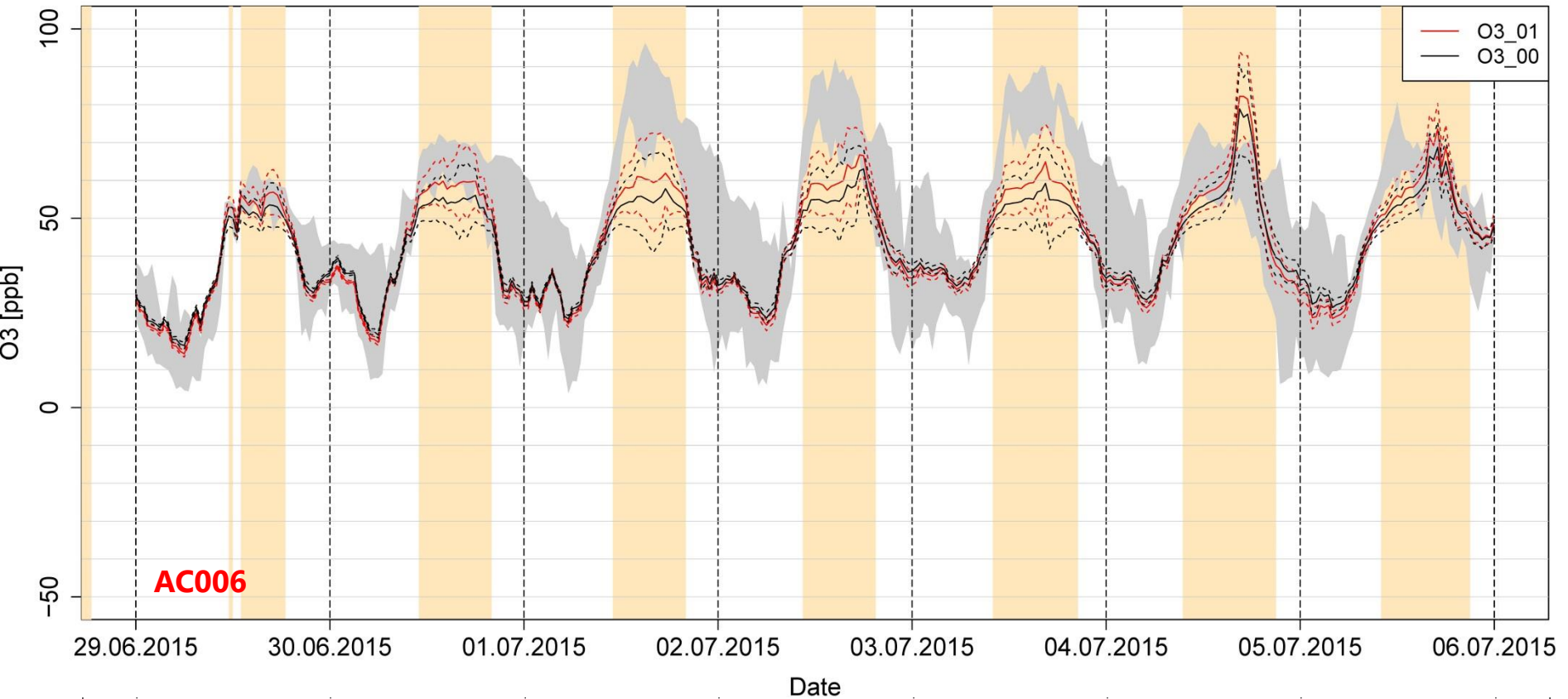
Empa-SN + federal/municipal AQM stations

Empa sensor network operating since June 2015.

- Sensor calibration facilities

- AQM sites provide range of pollutant concentration

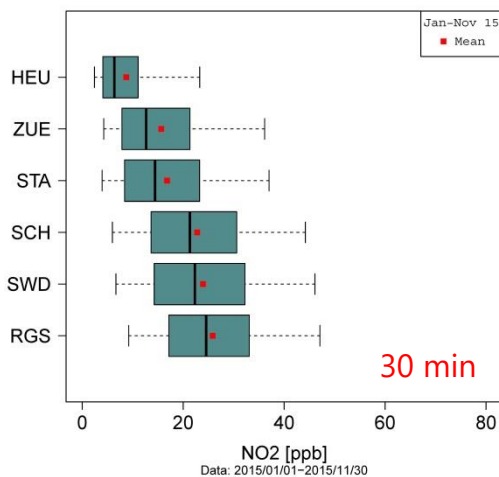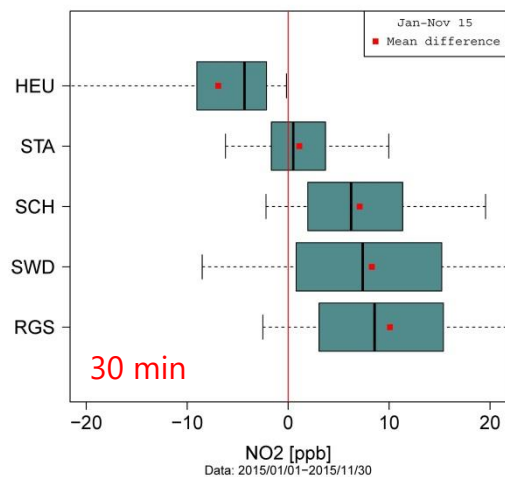- Testnet for development of QA/QC algorithms
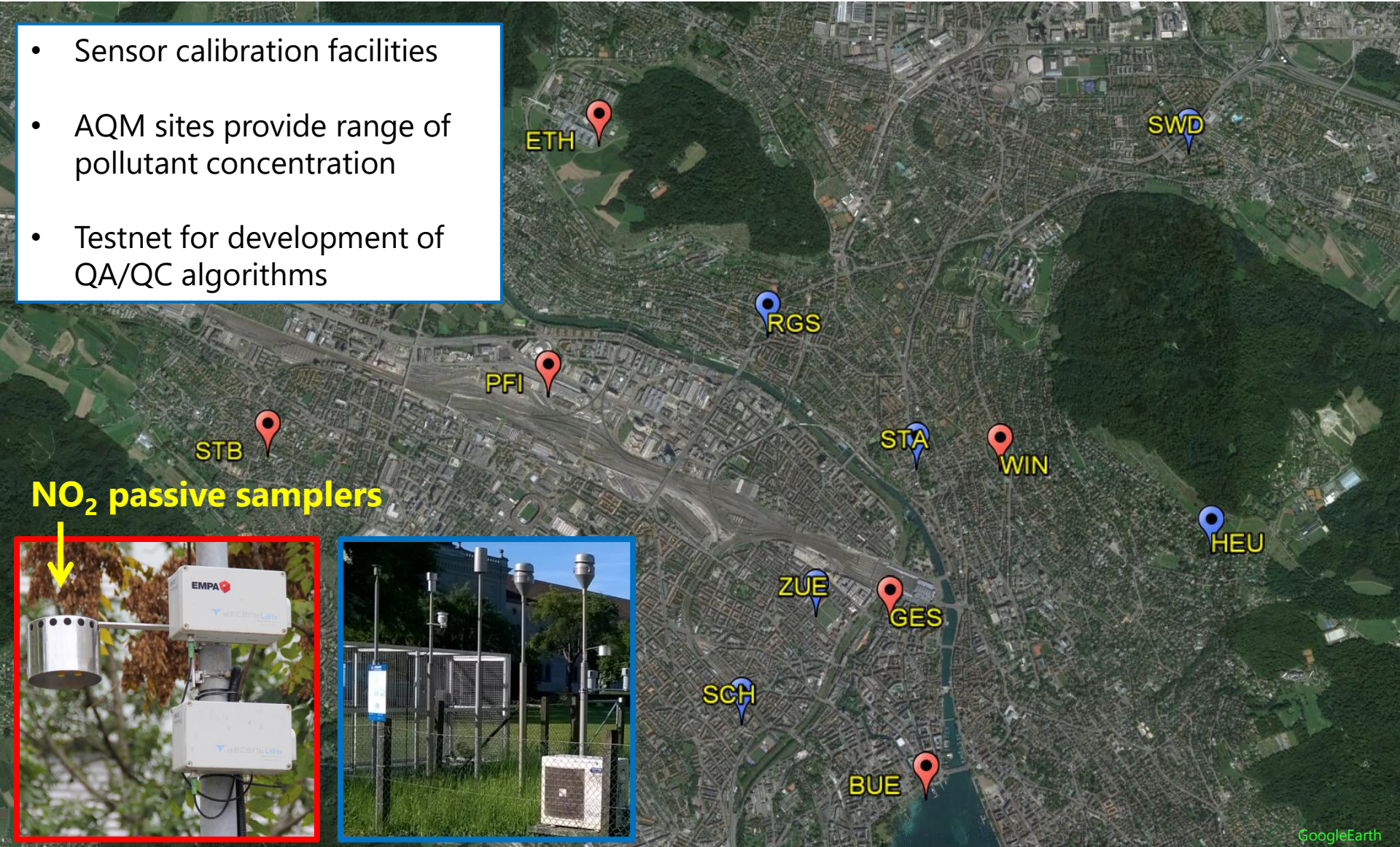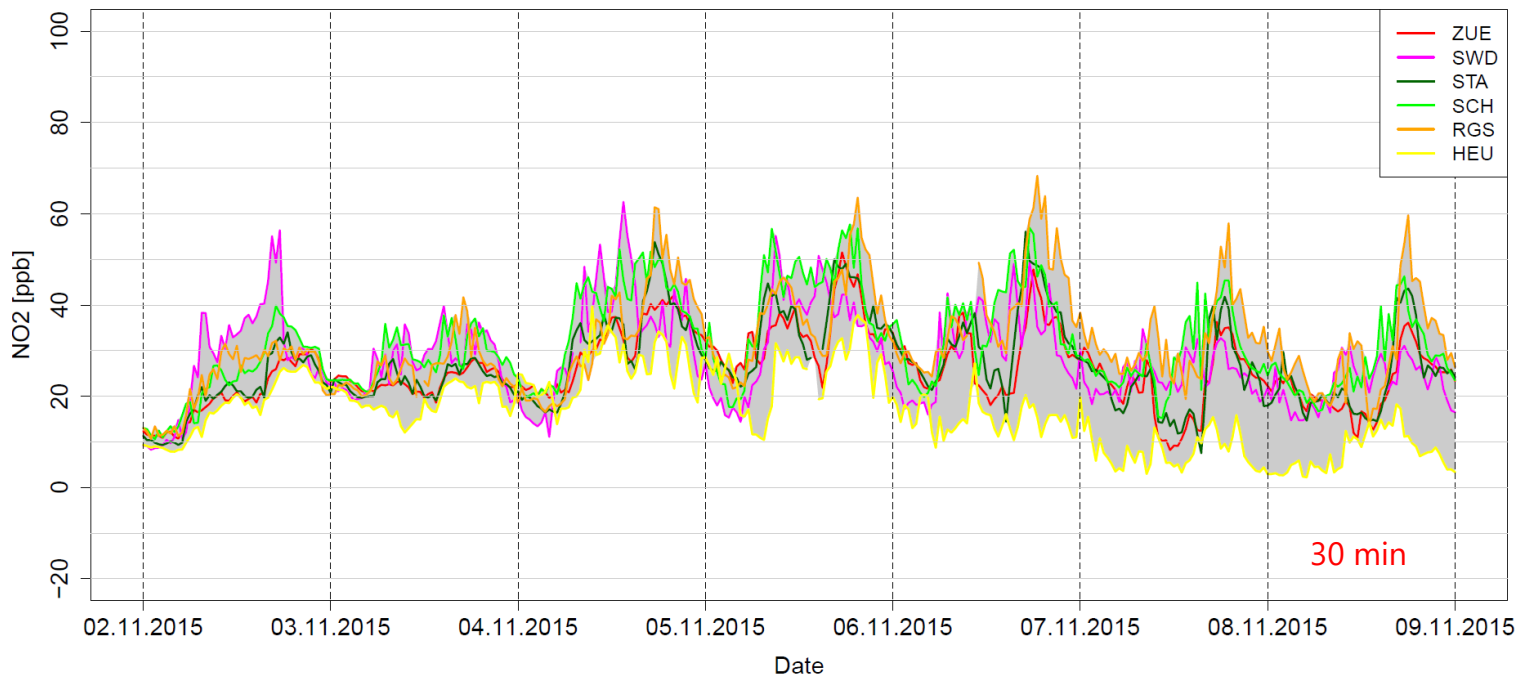
NO$_2$ passive samplers

NO$_2$ concentrations in Zurich

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NO$_2$

NO$_2$ differences w.r.t. ZUE

- ΔNO_2 highly time dependent
  → demands on sensor accuracy.

- Time periods where $\Delta NO_2 \approx 0$
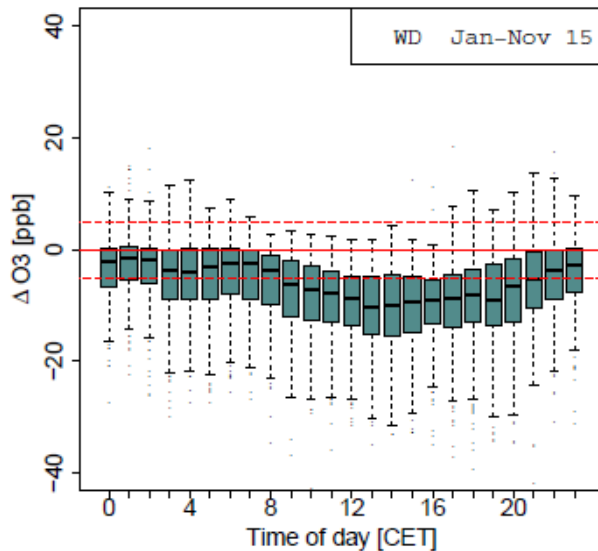 → QA/QC.

NO$_2$/O$_3$ concentrations in Zurich
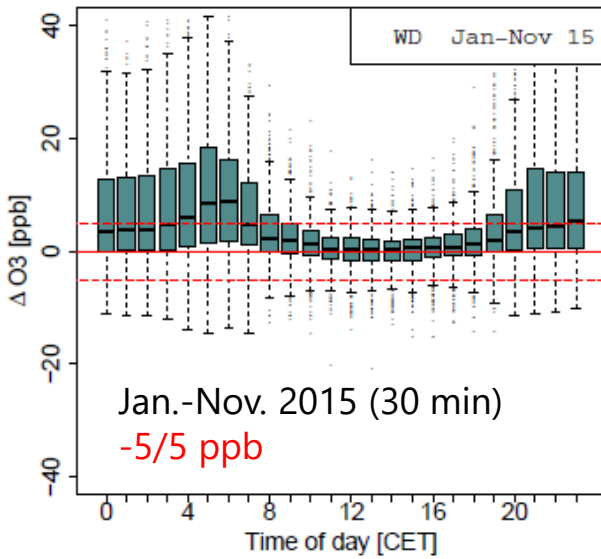
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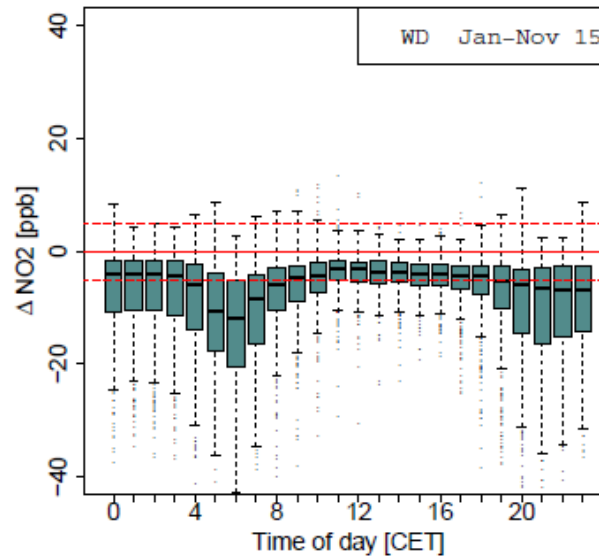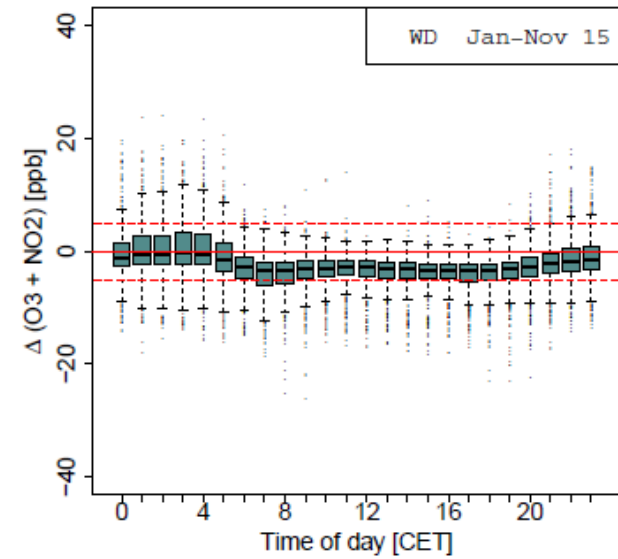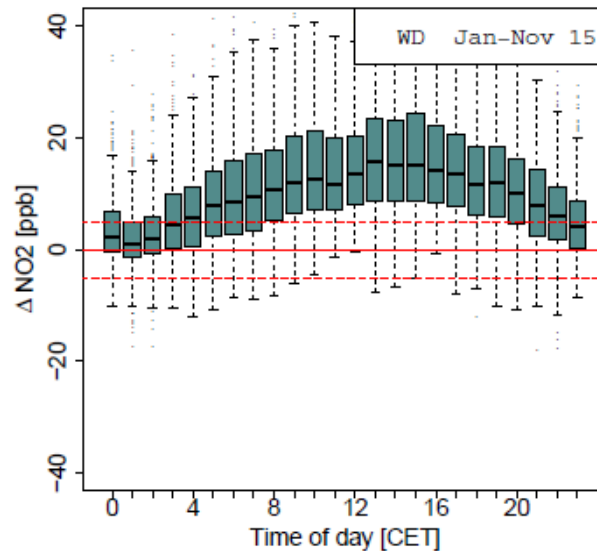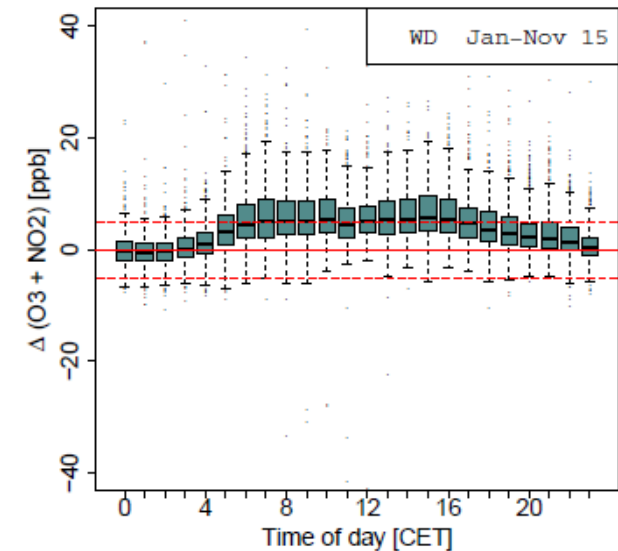
NO$_2$ concentrations Aircubes

O₃ concentrations Aircubes

Processed data

Processed data
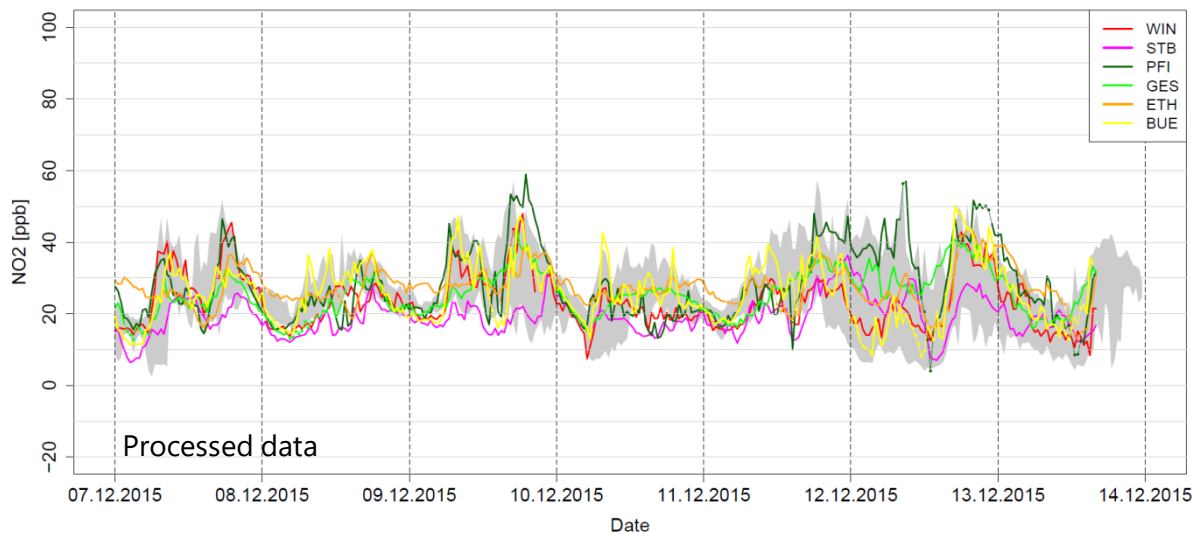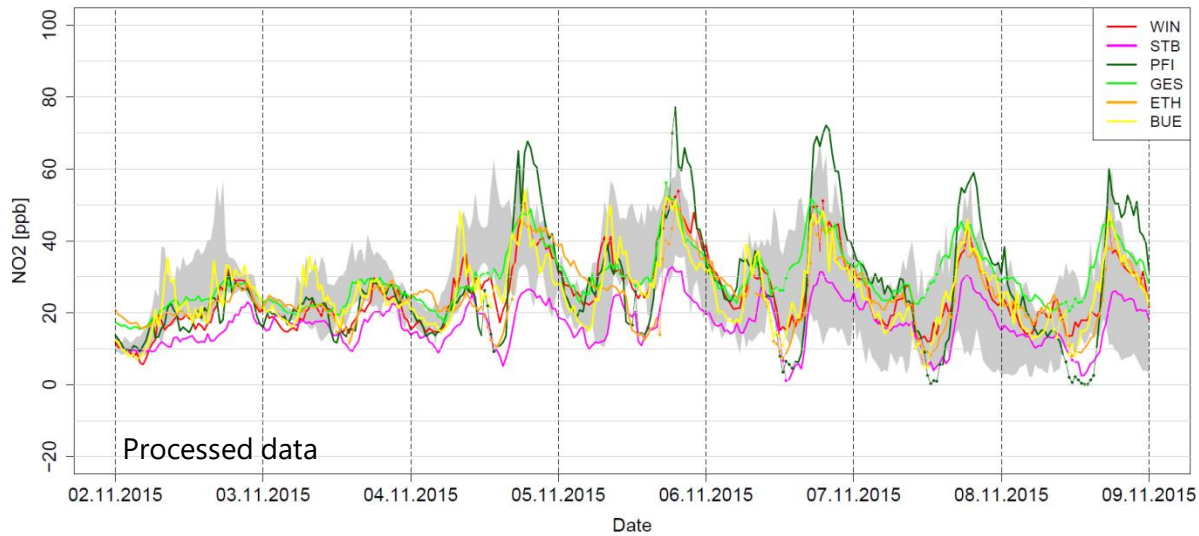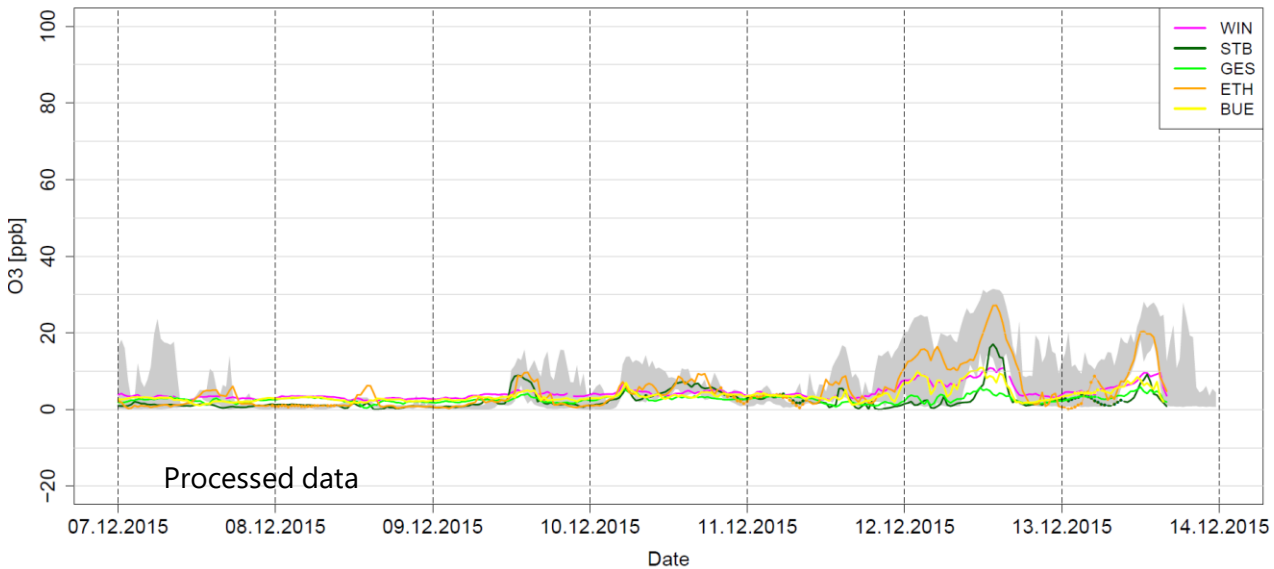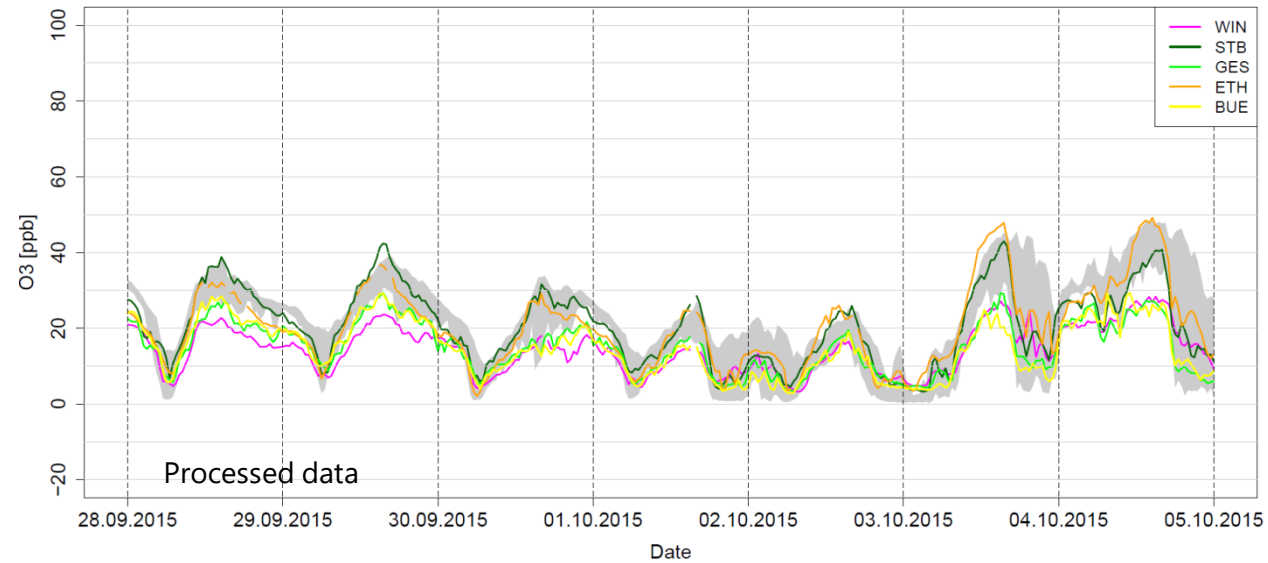
Summary and outlook

- Low-cost sensors suitable for AQ measurements available

- Operation of low-cost sensors not simple
    - Sensor model / calibration
    - QA/QC in AQ sensor networks
    - Experience in long-term sensor operation still limited

- Applications determine demands on sensors
    - Accuracy of a few [ppb] required for AQ monitoring in Zurich

- Further research
    - Refinement of sensor models
    - QA/QC methods in sensor networks

Thank you!