

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

COST Action TD1105

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O3 and NO2 Sensor Network in Zurich: Operation and Strategies for QA/QC

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Materials Science and Technology

AQ monitoring in Zurich - NO₂ in Zurich, 18.01.2016 08h



77 $\mu\text{g}/\text{m}^3$



42 $\mu\text{g}/\text{m}^3$



NO₂ passive
sampler network
(2 week)



24 $\mu\text{g}/\text{m}^3$



35 $\mu\text{g}/\text{m}^3$

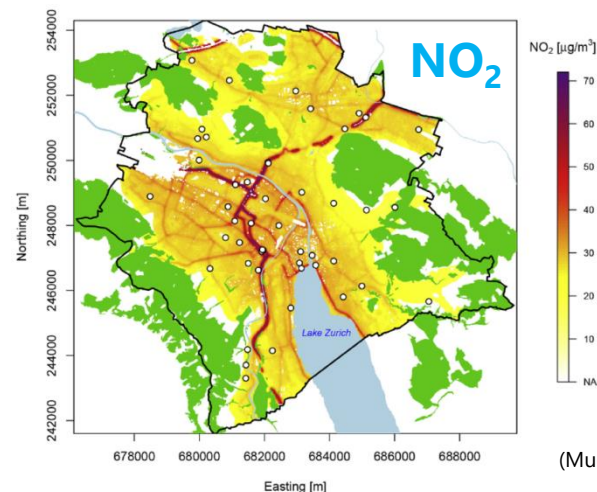


63 $\mu\text{g}/\text{m}^3$

Low-cost pollutant sensors could contribute:

- **Augmentation of information on air quality**
 - **Complement of existing AQM sites**
 - **Replacement of passive samplers**
- **Facilitation of extended modelling (e.g. highly resolved statistical models)**

- Limited experience in using low-cost sensors for air quality monitoring
 - Operation of a small sensor network in a controlled field environment in Zurich
- Investigation of subjects related to sensor operation
 - Integration of sensors in viable sensor units / sensor networks
 - Optimal calibration strategies for individual sensors
 - QA/QC within sensor networks
 - Application fields



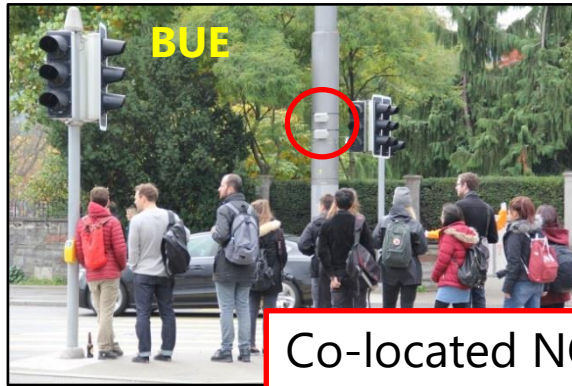
NO₂/O₃ sensor system – Aircube (AC)



- **2x Aeroqual O₃ SM50**
- **3x Alphasense NO₂ B42F**
- **Temperature**
- **Relative humidity**

- **GSM module for data transmission**

Empa SensorNet – Locations



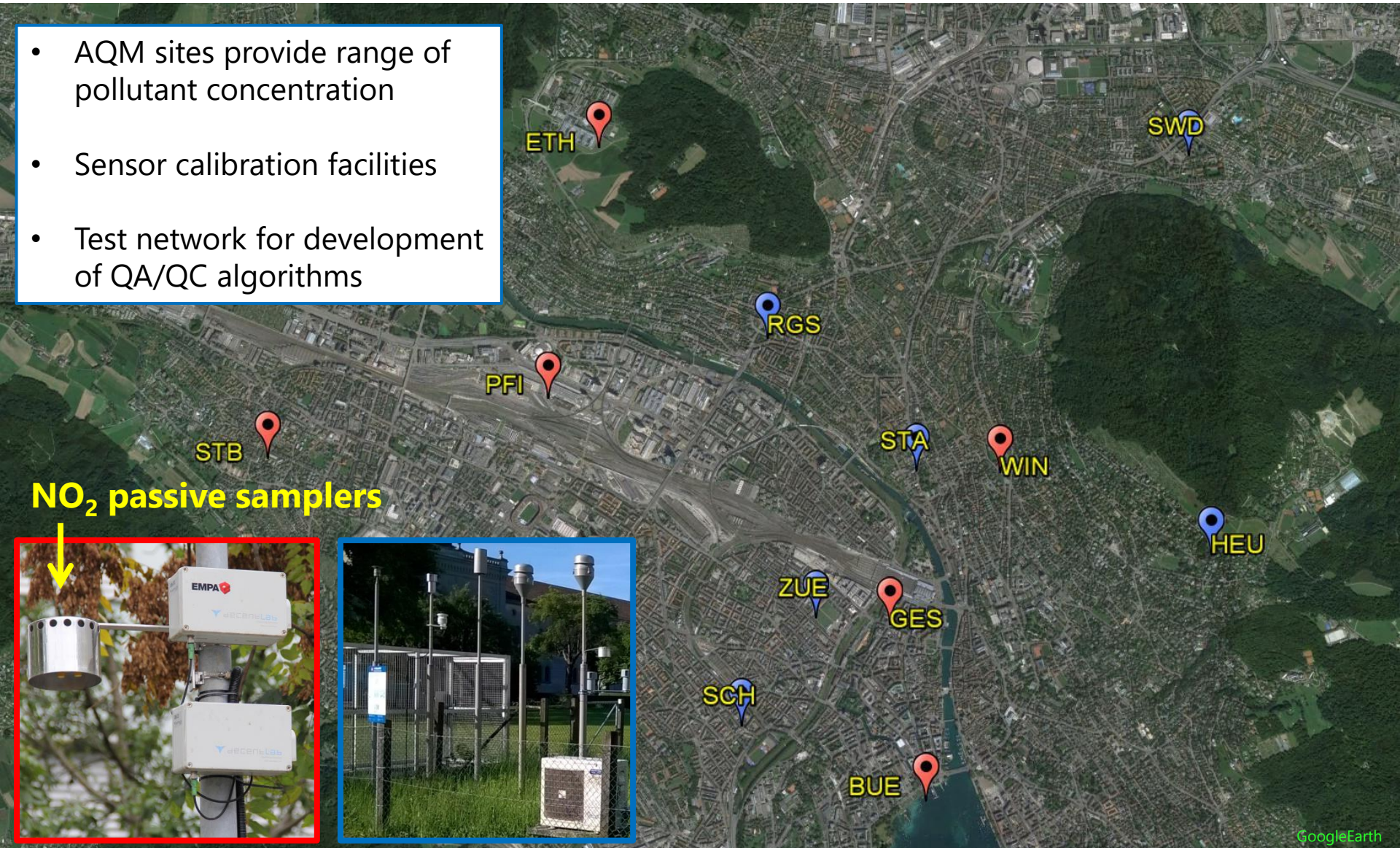
Co-located NO₂ passive samplers at each site providing 2 week average concentration.



Empa-SN + federal/municipal AQM stations

Empa sensor network operating since June 2015.

- AQM sites provide range of pollutant concentration
- Sensor calibration facilities
- Test network for development of QA/QC algorithms

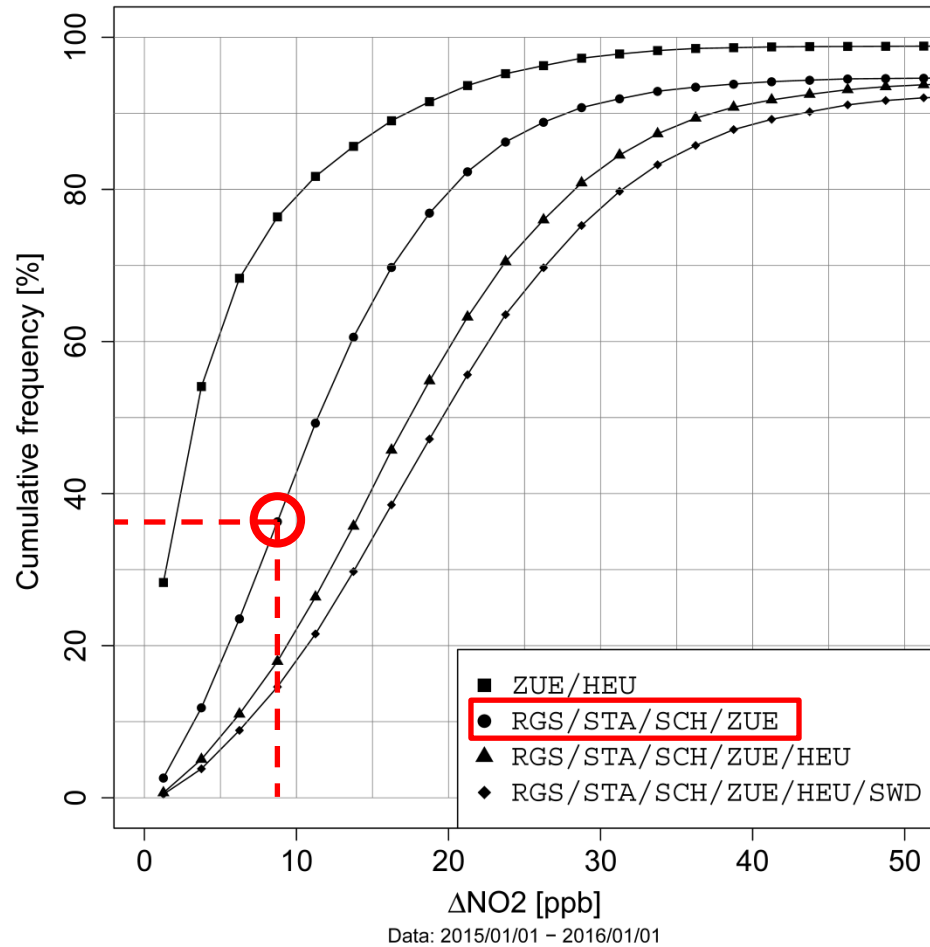
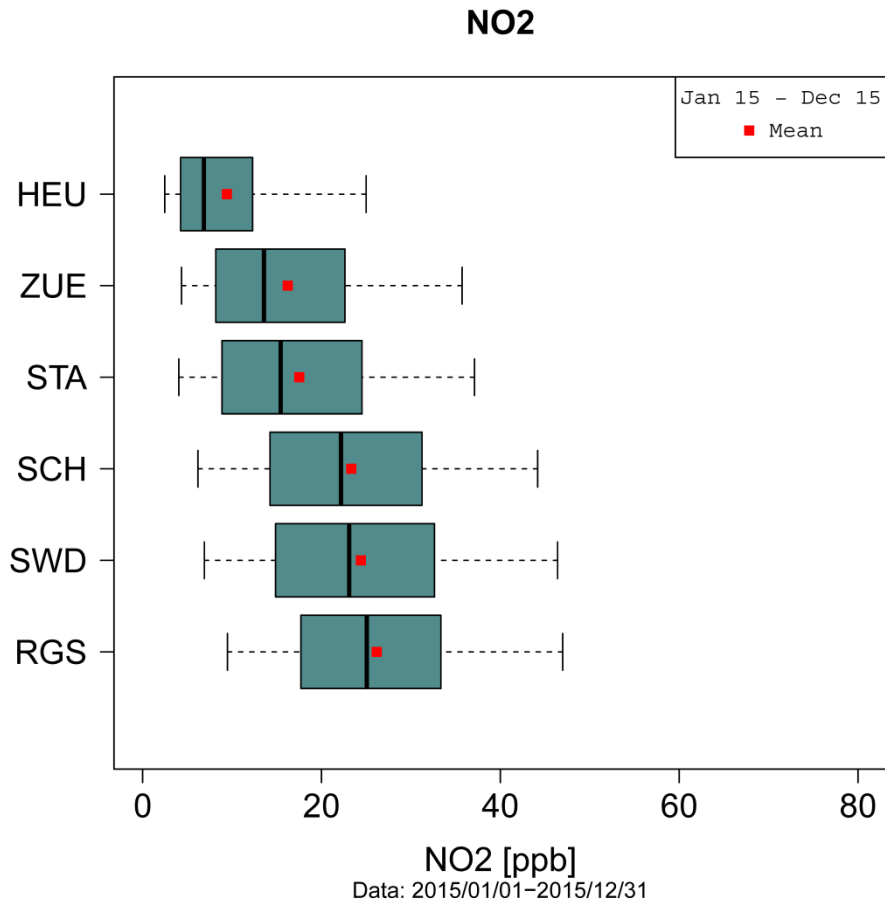


NO₂ passive samplers



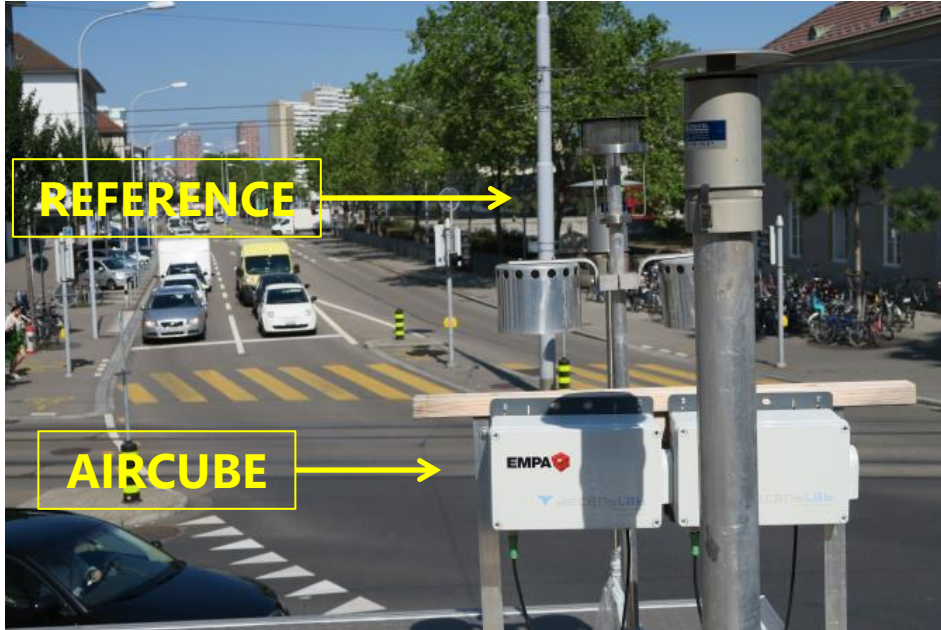
Range of NO₂ within Zurich

(30 minutes average)

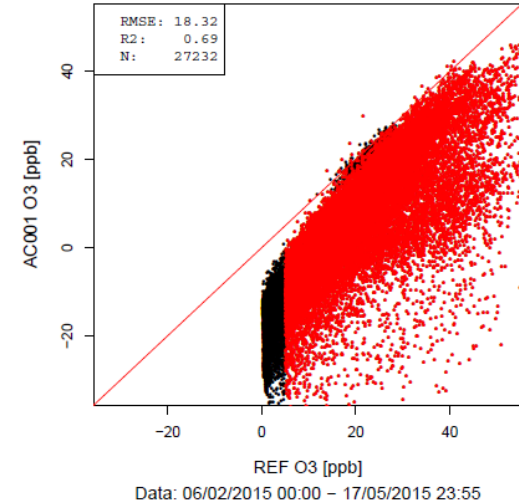


□ No elevated sites, sites not located at a motorway

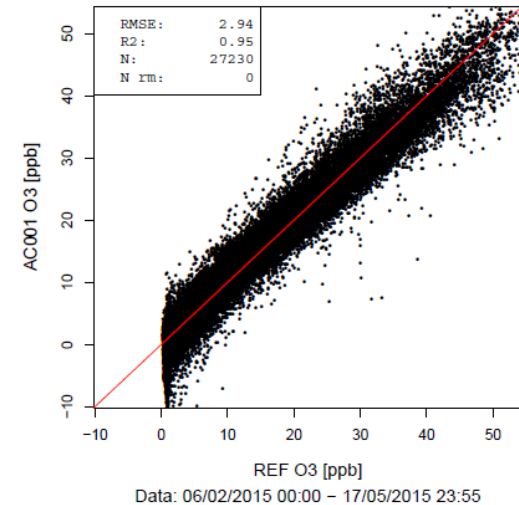
Sensor calibration



O3 raw data
(Feb - May 2015)

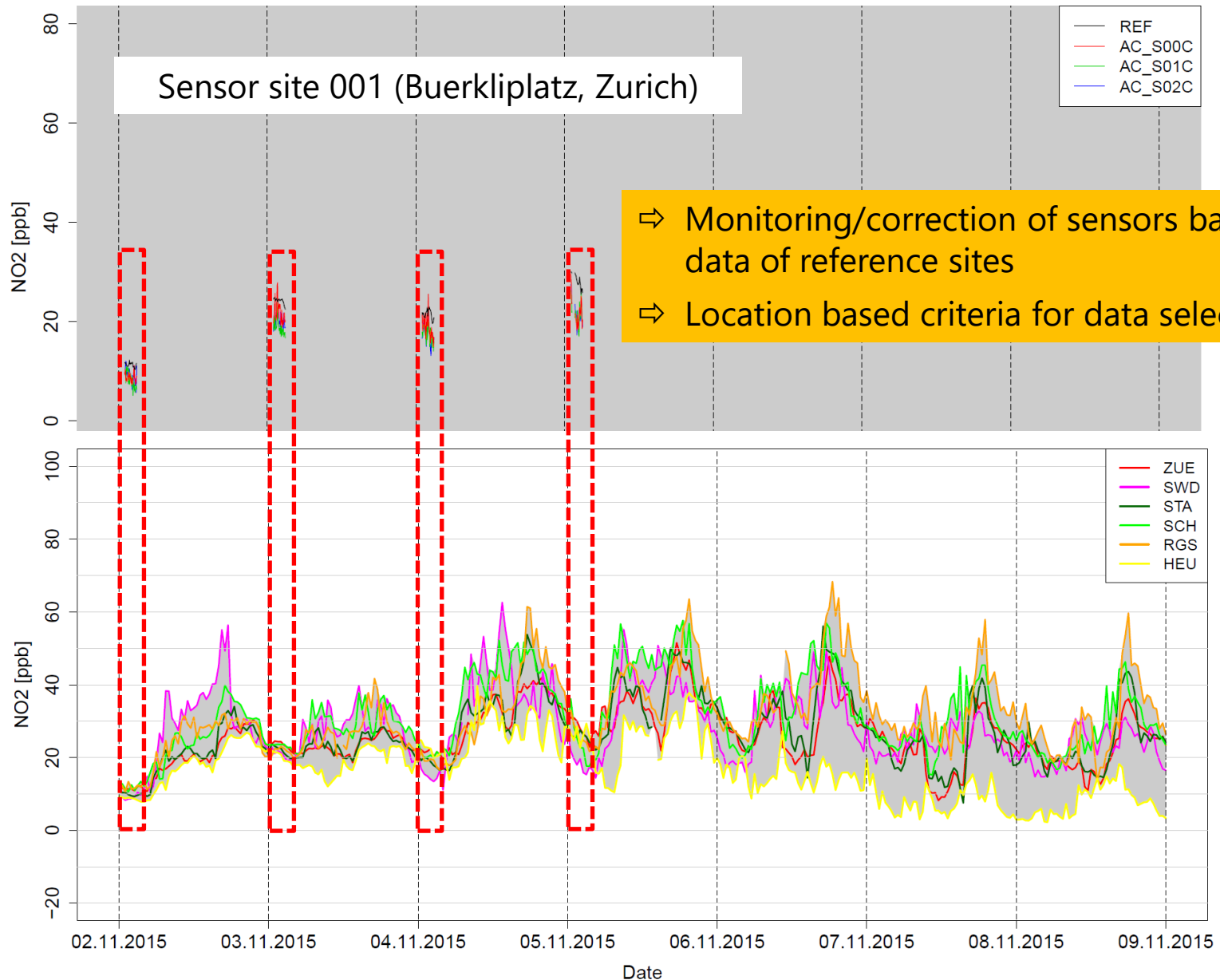


O3 calibrated data
(Feb - May 2015)



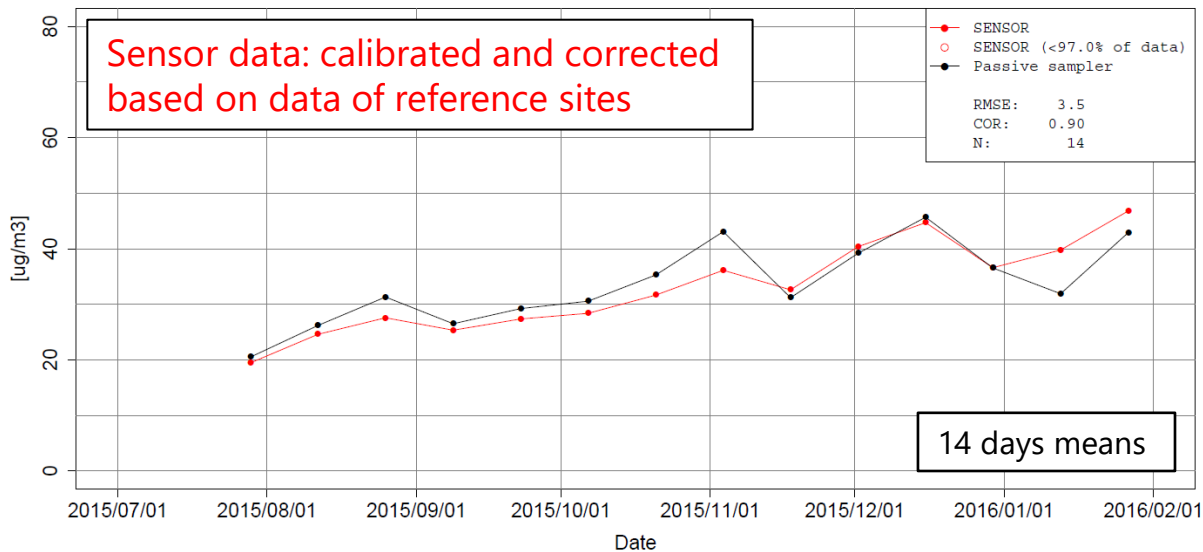
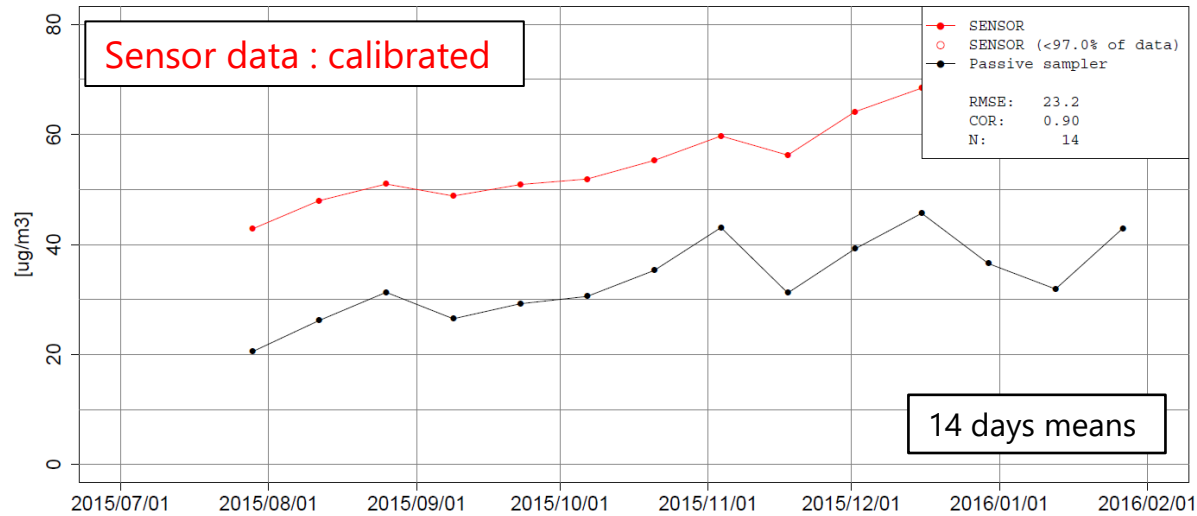
- Calibration of individual sensors required
- Use of a statistical sensor model
 - Description of sensor behavior in specific conditions (w.r.t. pollutant concentration, meteorology)
 - Calibrated data associated with larger uncertainties in strongly deviating conditions
- In-field calibration
 - Conditions given by location and time period
 - Correlations between observations (e.g. T, O₃, NO₂)

NO₂ in Zurich – Reference sites (UGZ/NABEL)



NO₂ comparison: sensor vs. passive sampler

Sensor site: Winterthurerstrasse

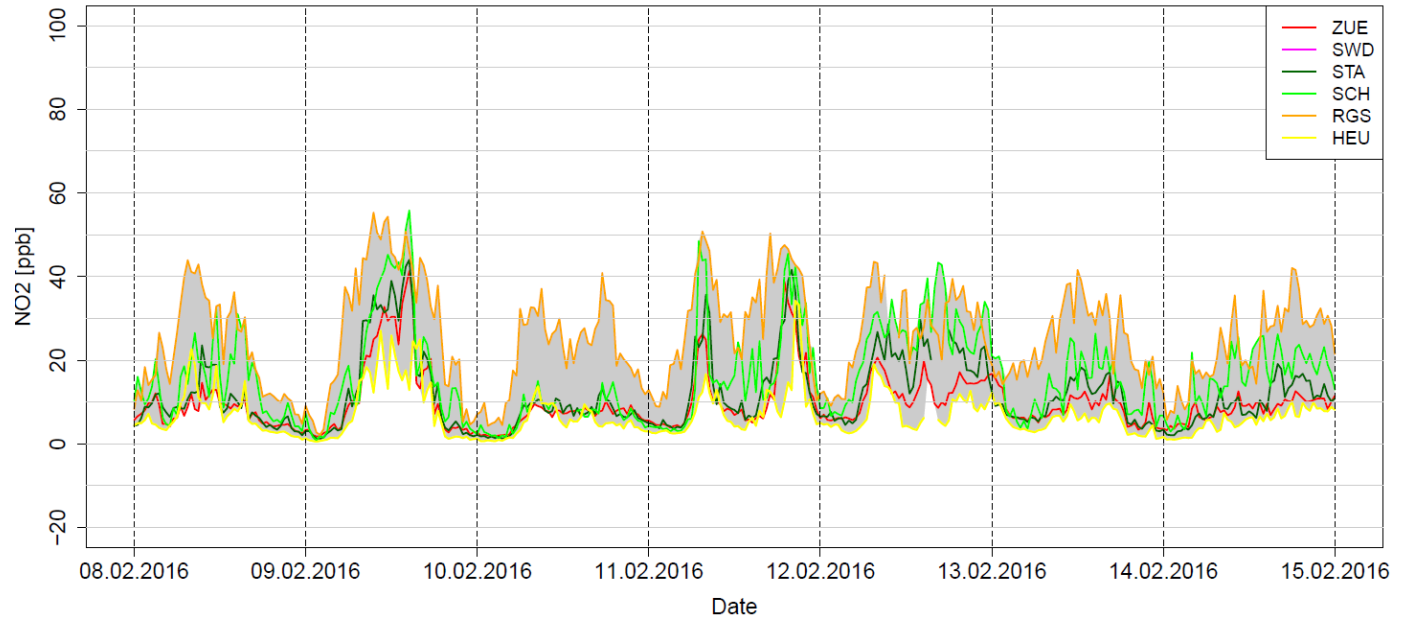


NO₂ passive sampler measurements provide an independent check of the sensor readings / data processing strategies.

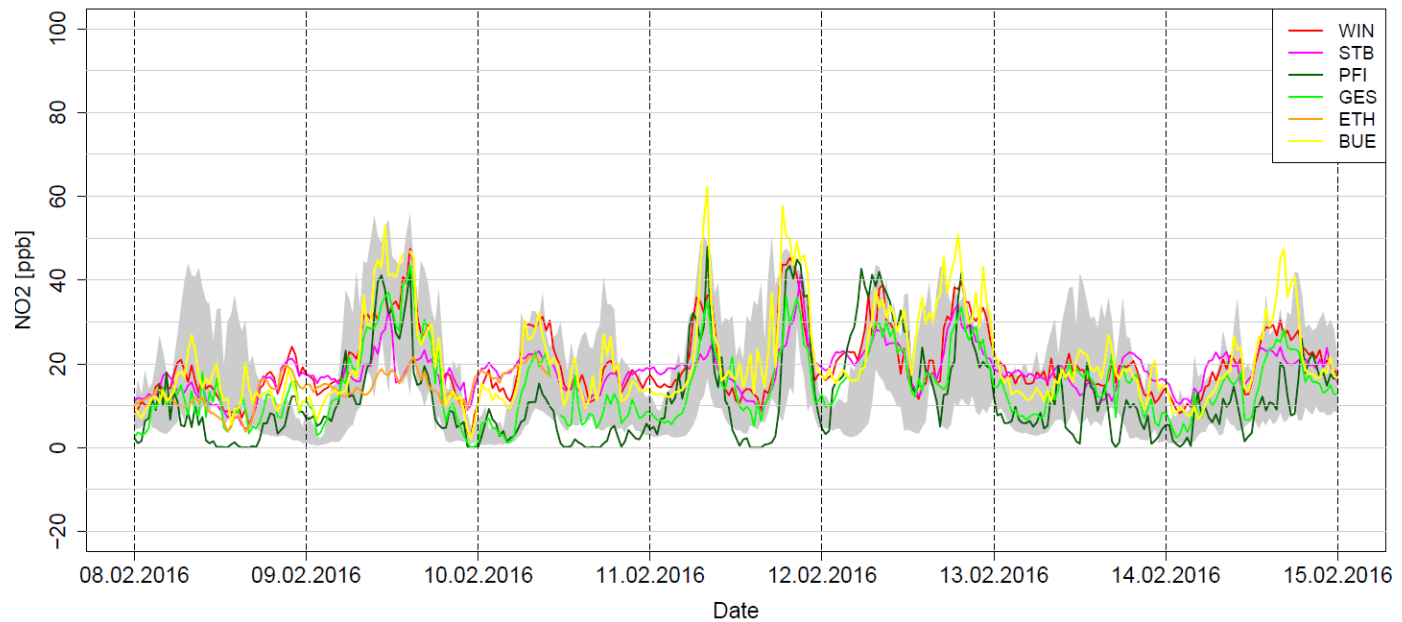


NO2 time series

AQM sites

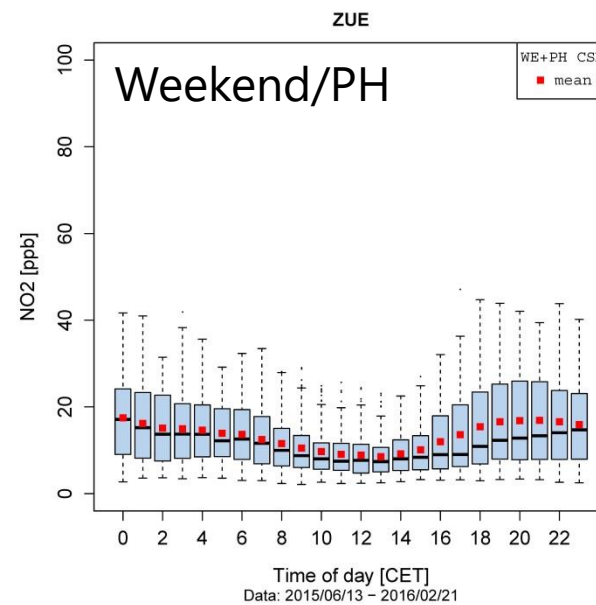
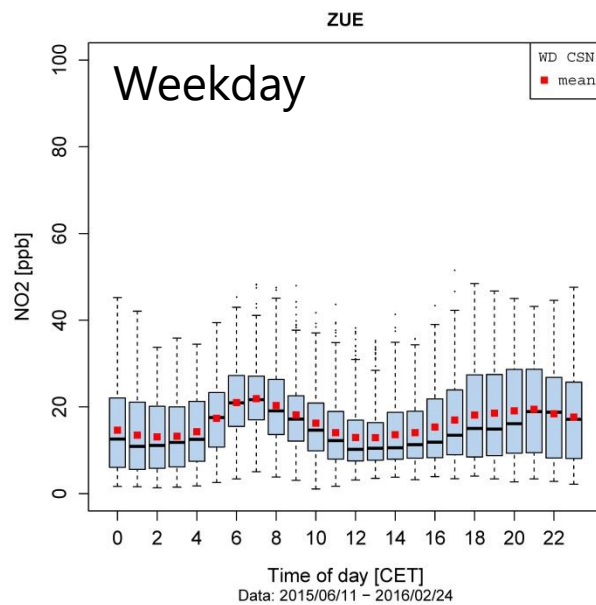


AC

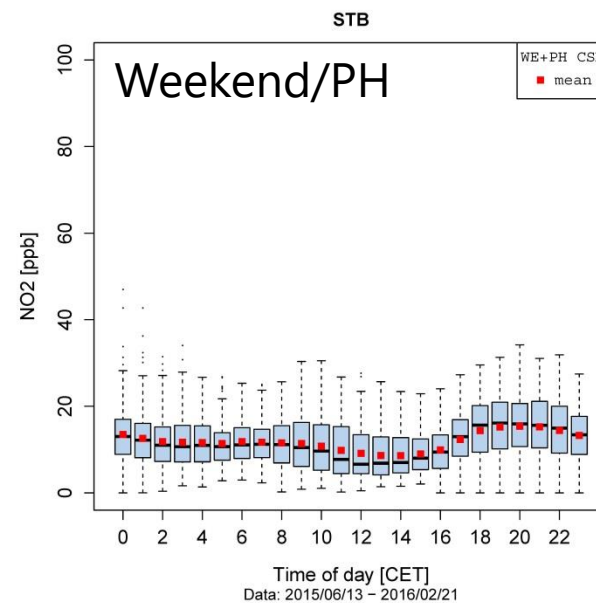
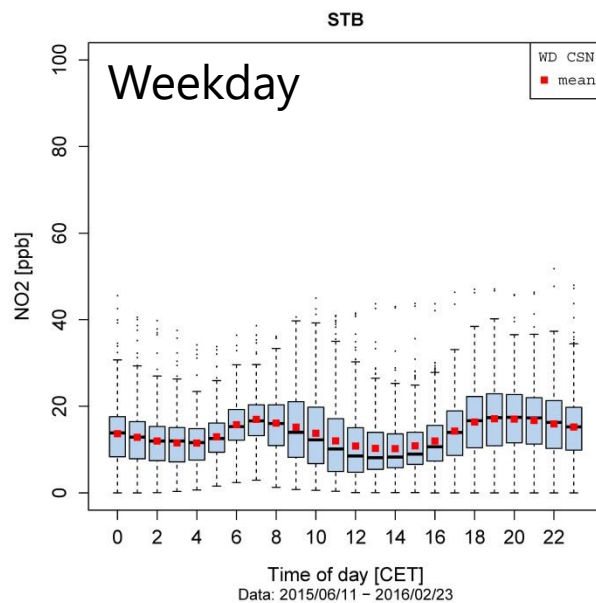


Diurnal variation of NO₂

AQM site
(background)

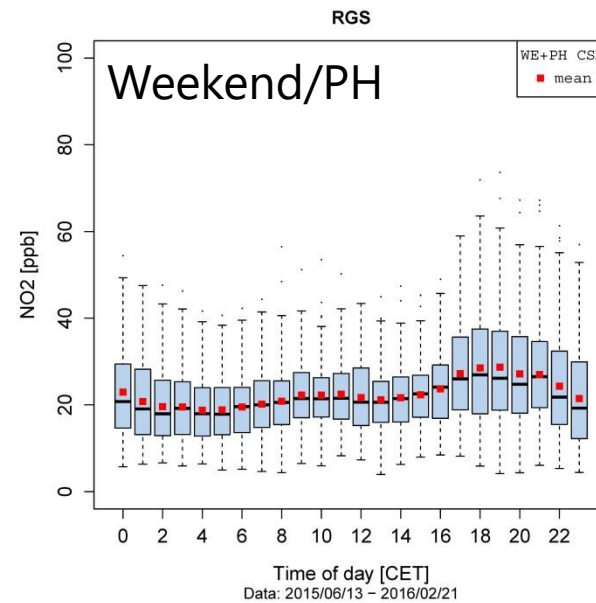
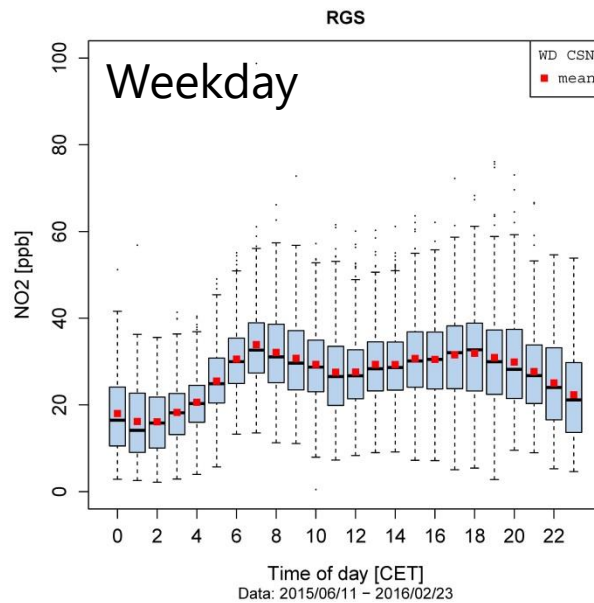


AC
(background)

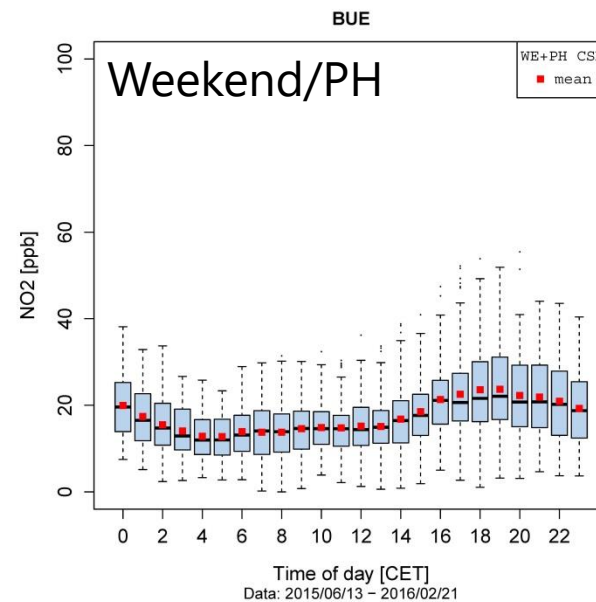
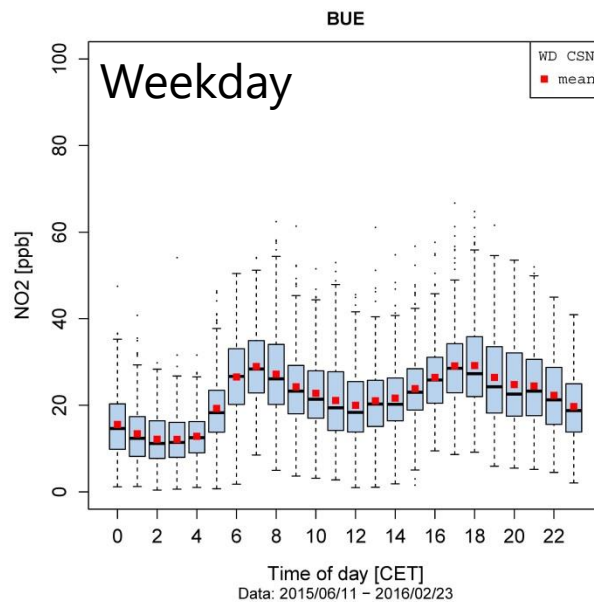


Diurnal variation of NO₂

AQM site
(kebside)

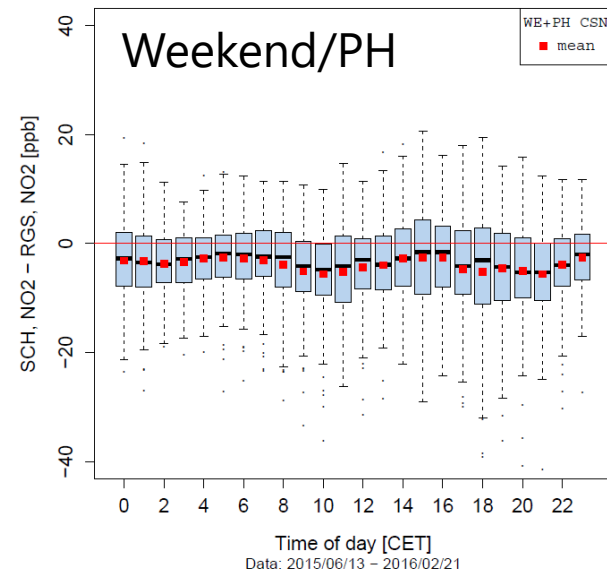
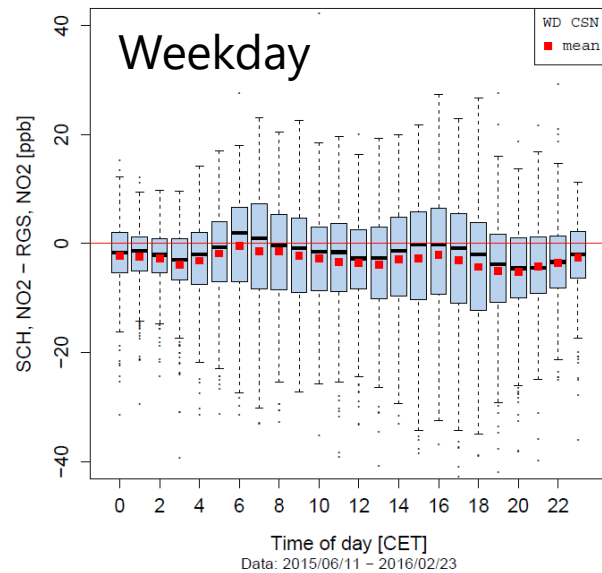


AC
(kerbside)

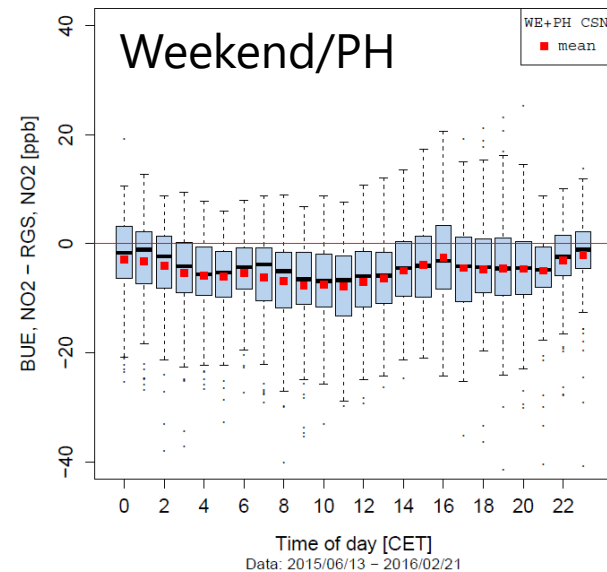
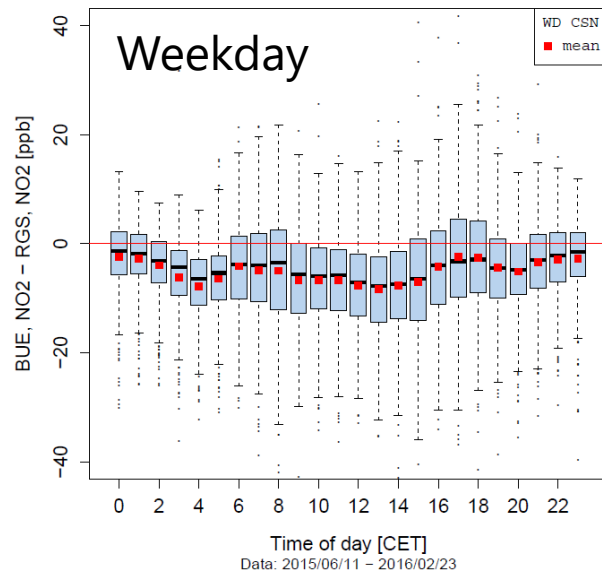


Diurnal variation of NO₂ (differences)

AQM-AQM
(kerbside)



AC-AQM
(kerbside)



- 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
 - Quantification of stochastic properties / limits of operation conditions
- Further research
 - Refinement of sensor models / calibration strategies
 - QA/QC methods in sensor networks

Many thanks!

Acknowledgement

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- Swiss Federal Office for the Environment (FOEN)
- Swiss State Secretariat for Education, Research and Innovation (SERI)