University of Stuttgart
Germany

CHARITÉ
UNIVERSITÄTSMEDIZIN BERLIN

ambulante pneumologie mit allergiezentrum

Feasibility study on the application of low-cost sensors for epidemiological investigations

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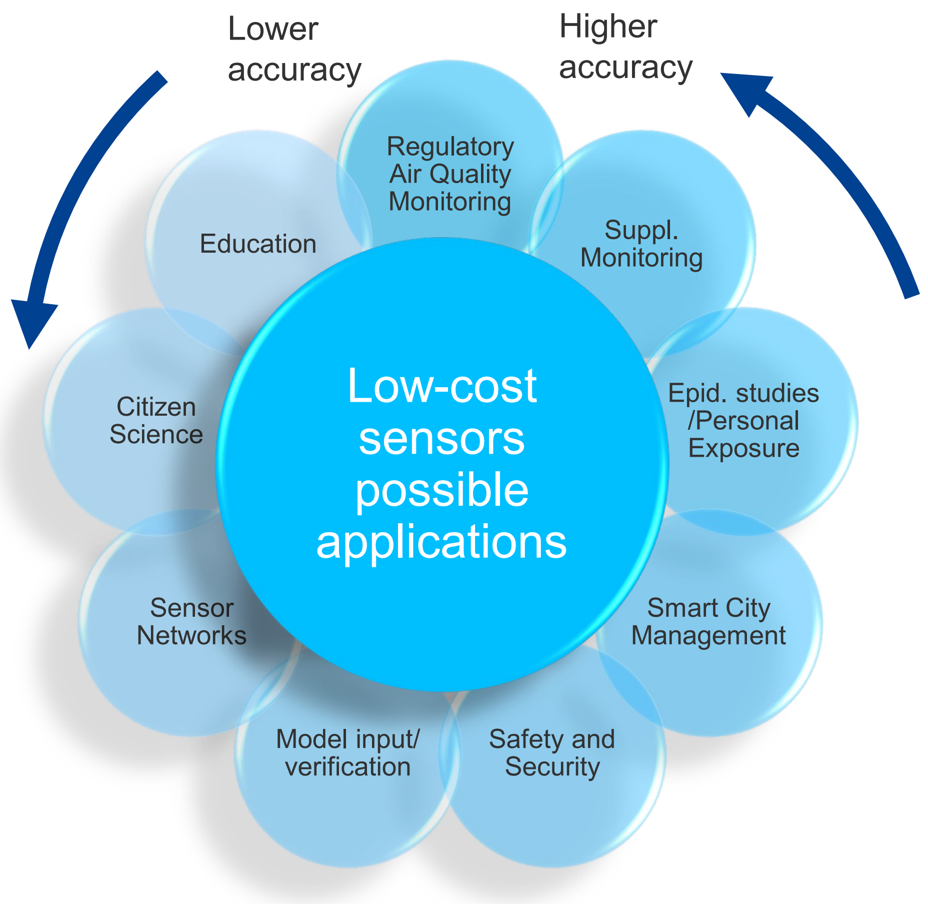
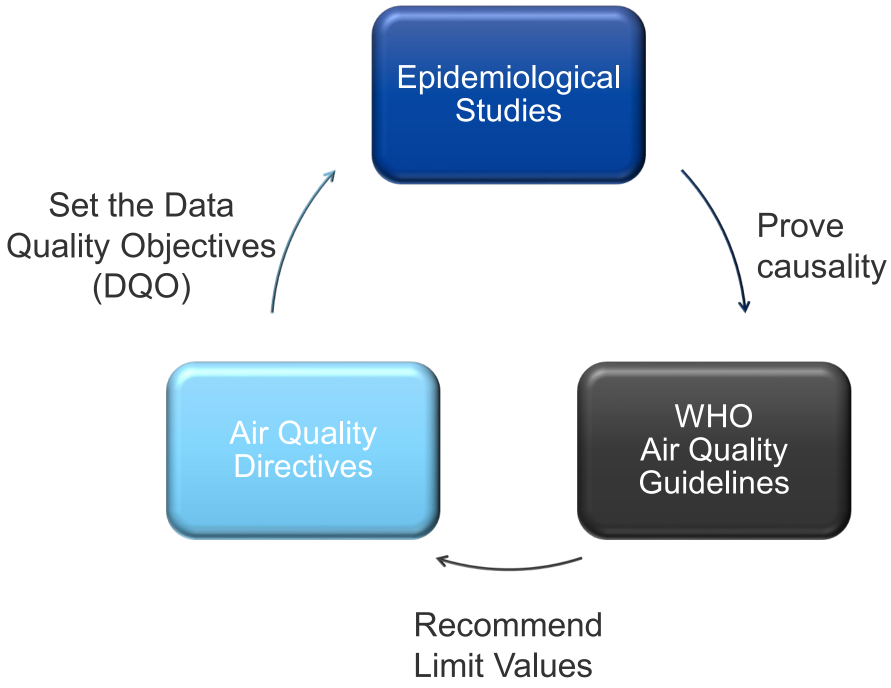
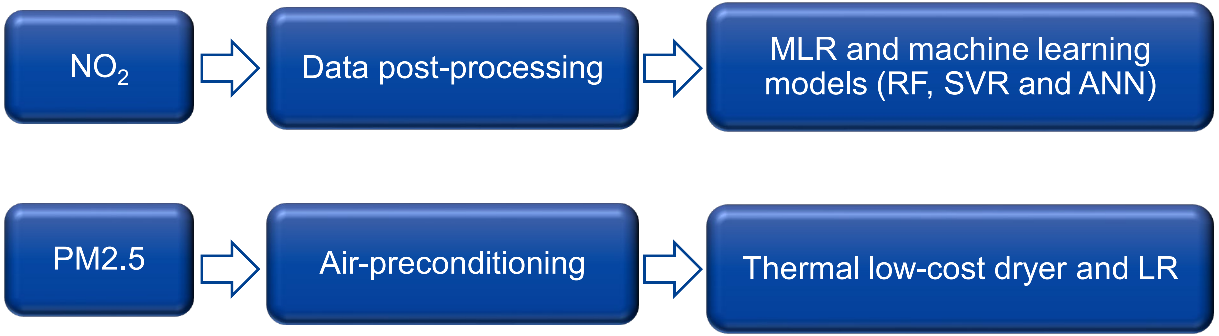
Low-cost sensors (LCS) – expanding horizons in AQ monitoring





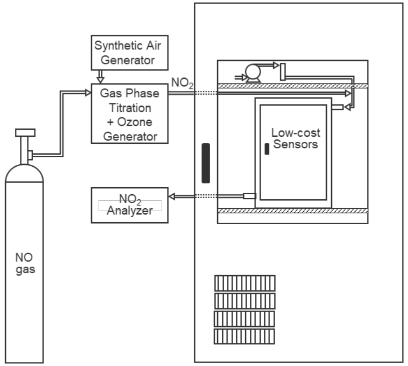
Objectives of the pilot project

- Design of a measurement strategy for the use of low-cost sensors for epidemiological investigations → Focus in QA/QC
  - Evaluation and selection of LCS for NO_2 and PM2.5
  - Design of sensor boxes for indoor and outdoor monitoring
  - Carry out the pilot project with COPD and Asthma patients
  - Evaluation of the uncertainty

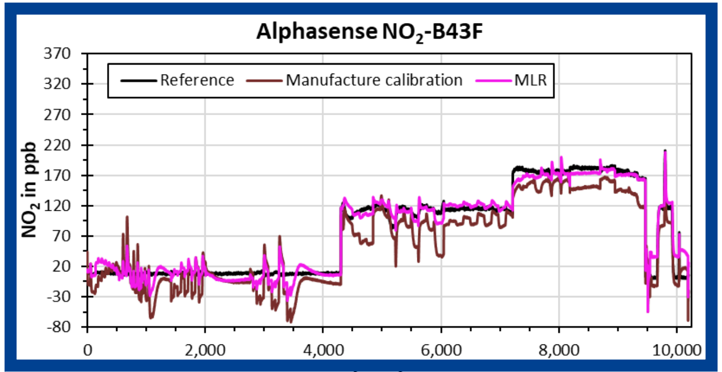


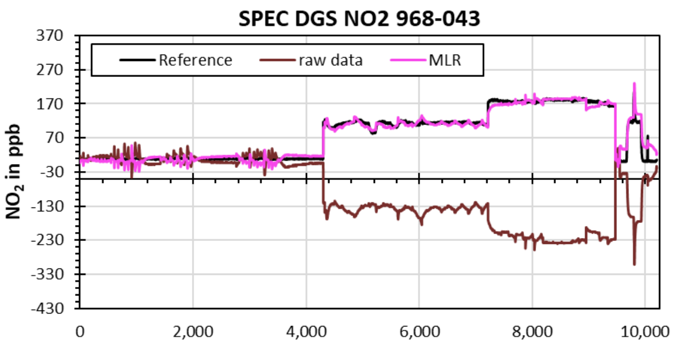
ANN: artificial neural networks
COPD: chronic obstructive pulmonary disease
LCS: low-cost sensors
LR: linear regression
MLR: multilinear regression
QA: quality assurance
QC. Quality control
RF: random forest
SVR: support vector regression

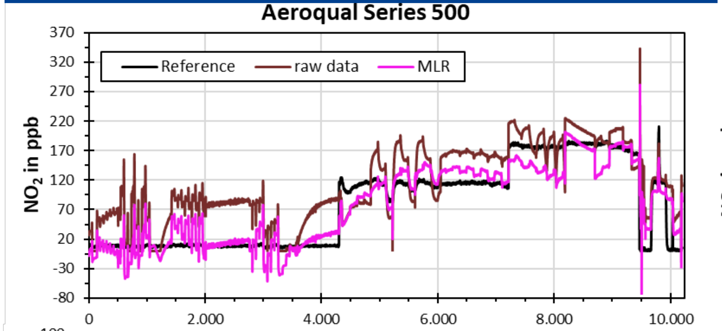
Evaluation and selection of LCS for NO_2 in a climatic chamber

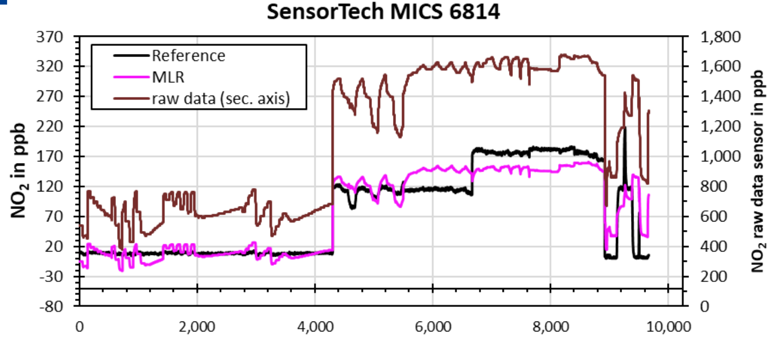


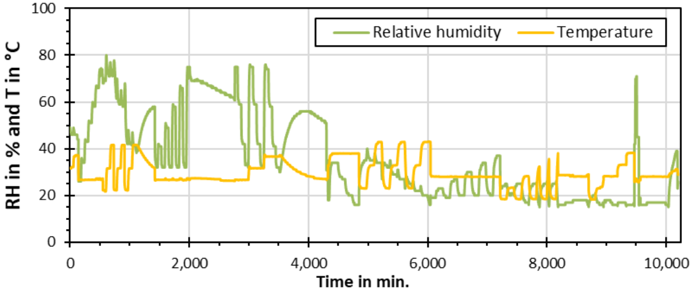
- Relative humidity: 15 - 80 %,
- Temperature: 18 - 43 °C
- NO_2 concentration: 0 - 230 ppb

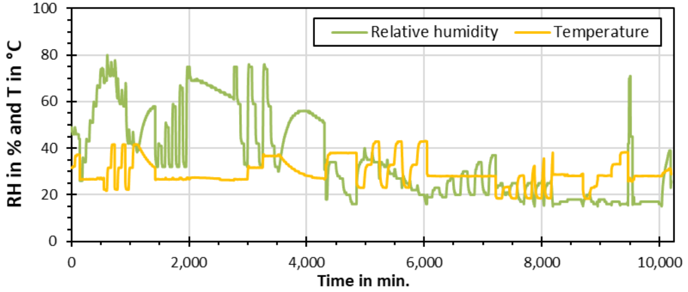




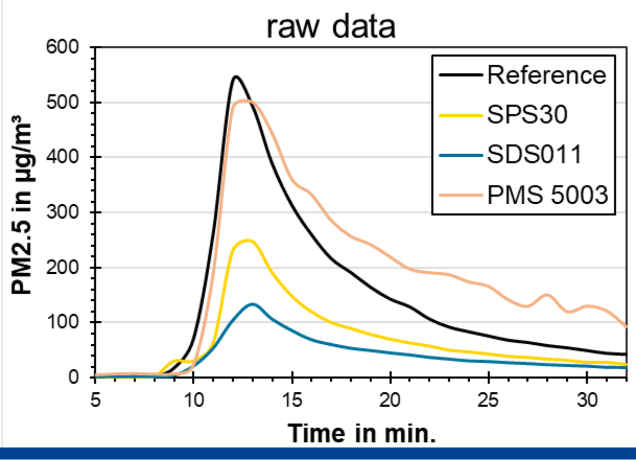


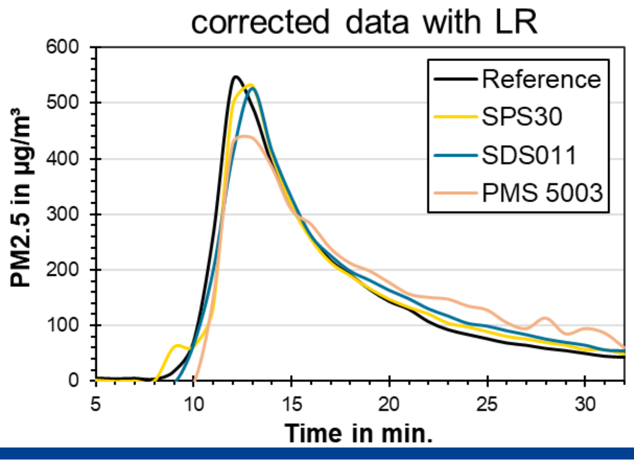


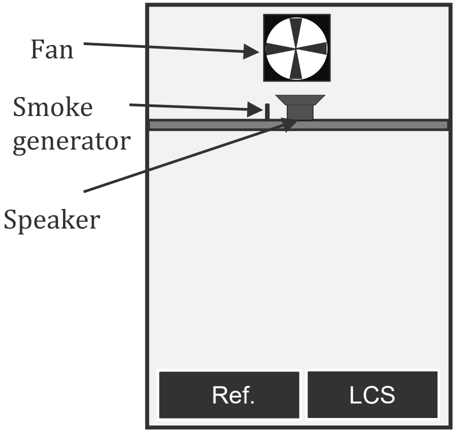


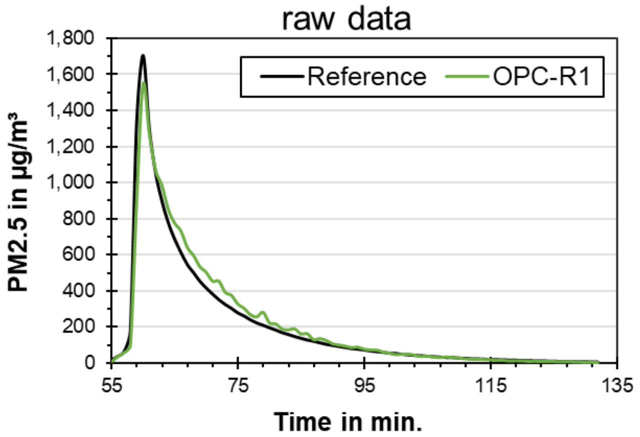


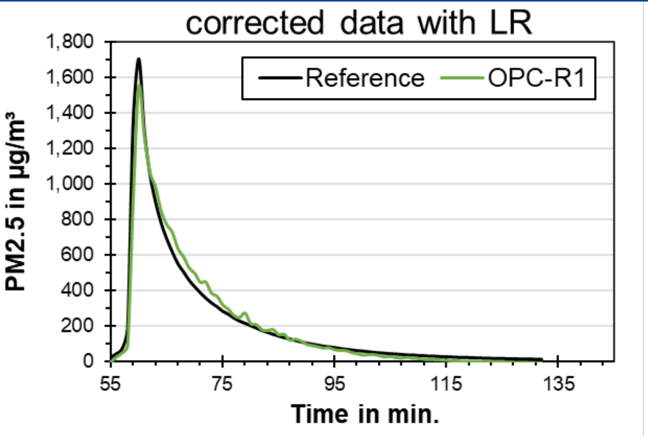
Evaluation and selection of LCS for PM2.5 in a particle chamber











Alphasense OPC-R1 was selected

LR: linear regression

Design of sensor boxes for indoor and outdoor monitoring

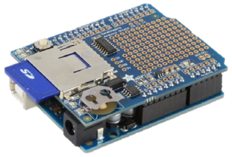
Basic components:

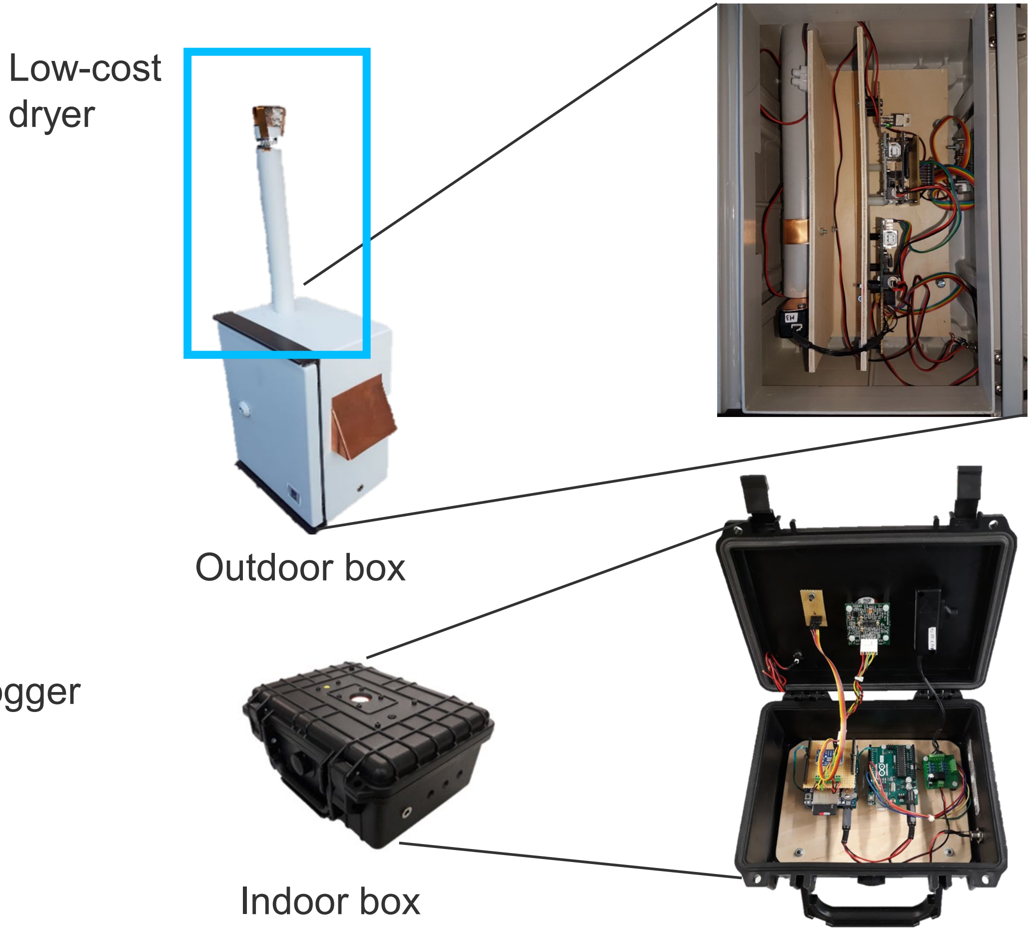
- Alphasense NO_2 B43F

- Alphasense OPC R1

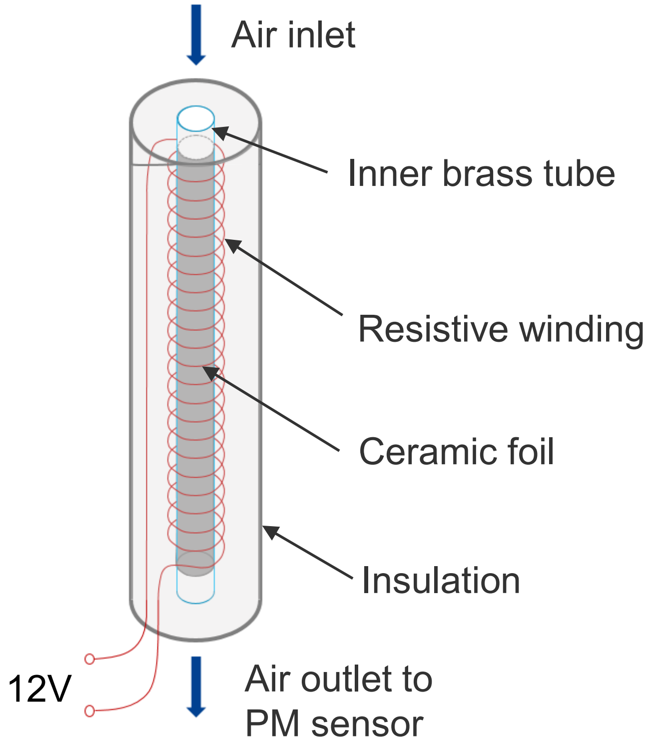
- IST AG HYT221 (Temp, RH sensor)

- Microcontroller: Arduino UNO + Datalogger





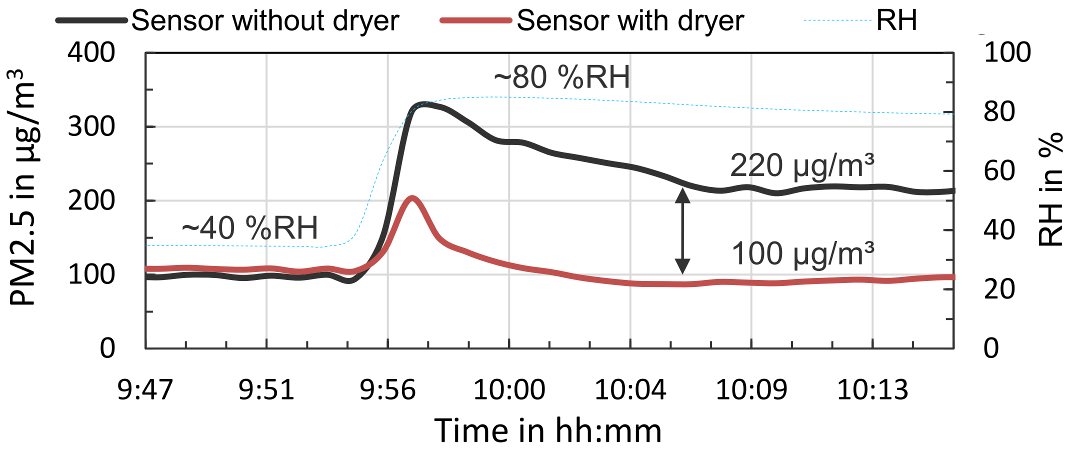
Low-cost dryer for PM sensor



- Switched on when RH>65%
- Regulated with the OPC R1 temperature to avoid excess of heating

Preprint available

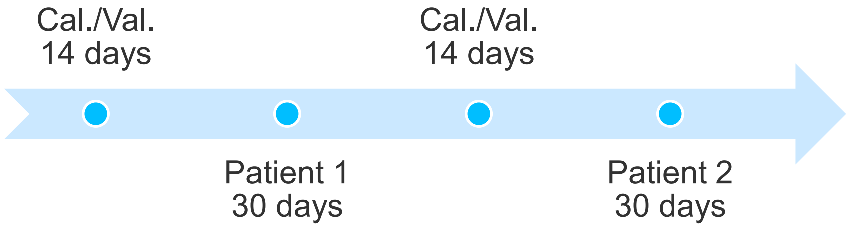
Studying the influence of the low-cost dyer on the growth of hygroscopic particles



Measurement strategy

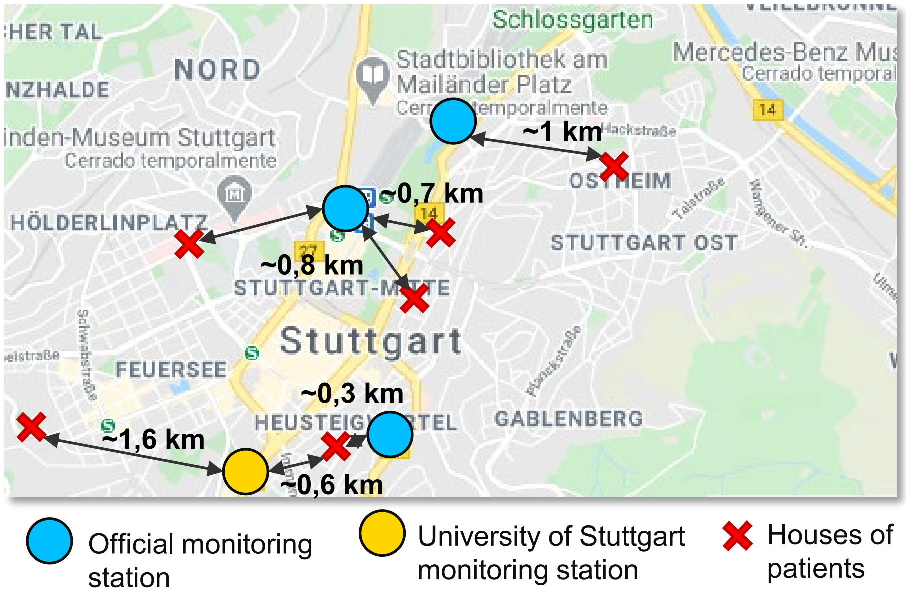
Phase I

Calibration-Training/Validation-Testing
- Indoor boxes → 14 days co-location in the laboratory
- Outdoor boxes → 14 days co-location in University of Stuttgart monitoring station



Phase II

Measurements in the houses of 7 patients with COPD or Asthma for 30 days
- Indoor and outdoor boxes with NO_2 and PM sensors
- Passive samples for NO_2
- Environmental questionnaire (once)
- Protocol of activities (daily)
- Symptomatic questionnaire + Spirometry (daily)
- Feedback (once)

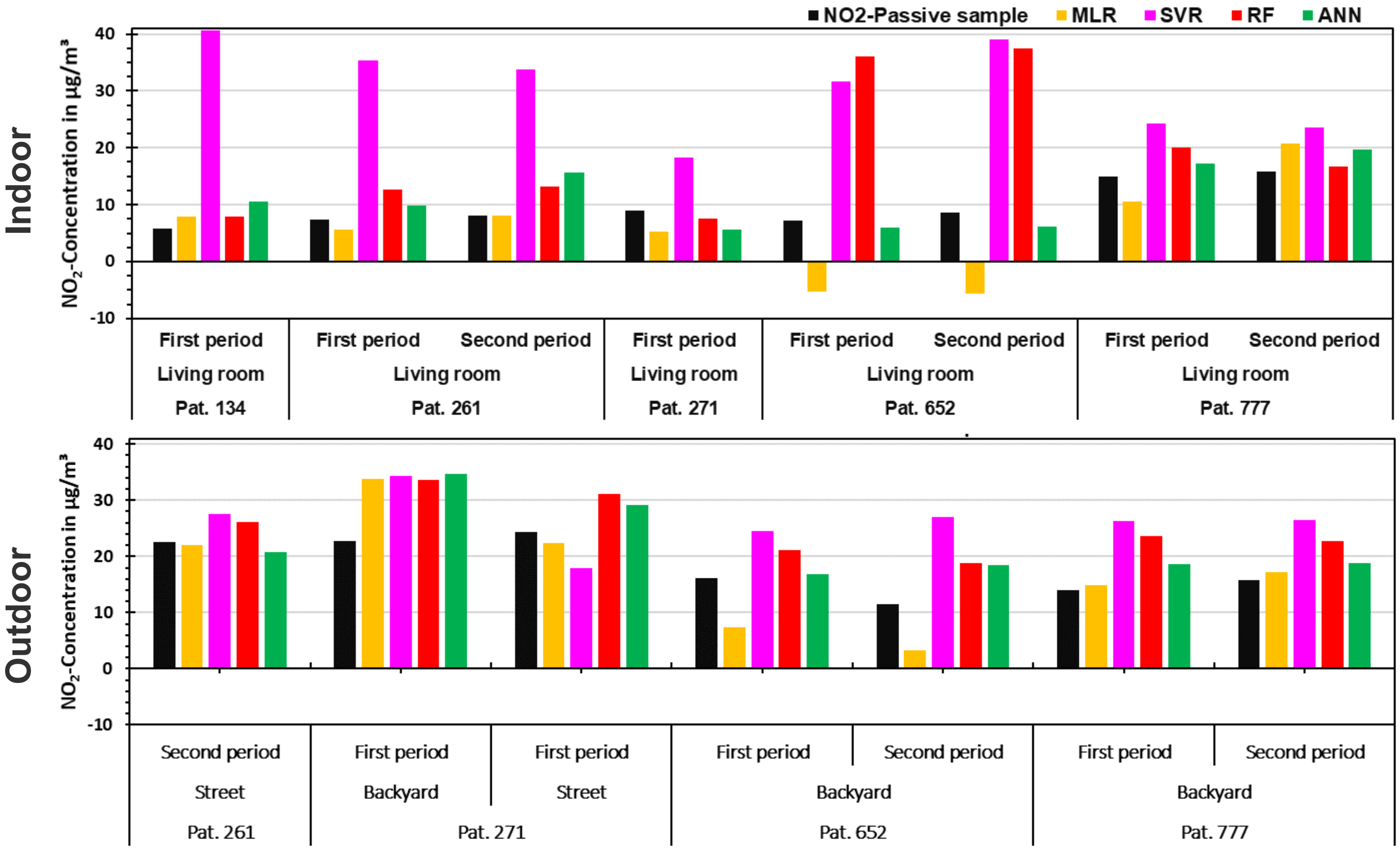


Phase III

Data post-processing and evaluation

COPD: chronic obstructive pulmonary disease

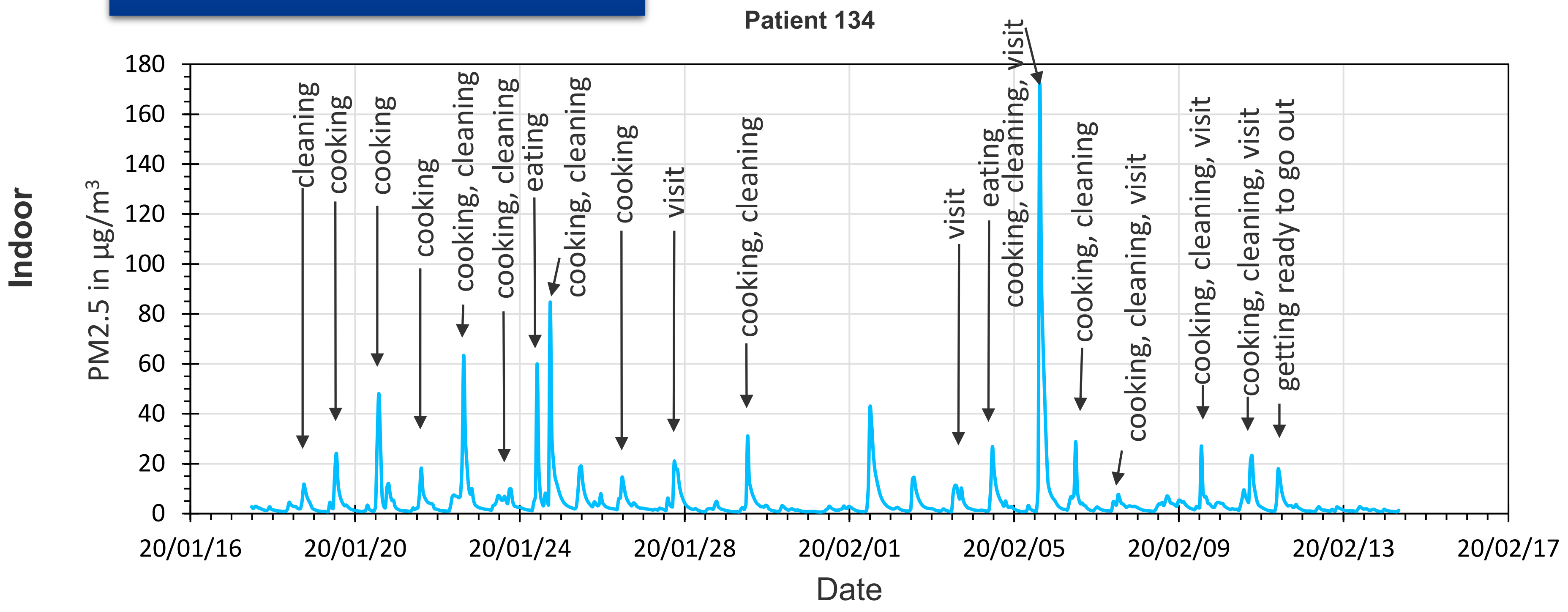
How to evaluate the performance of the LCS during the campaign?
1. Passive samples



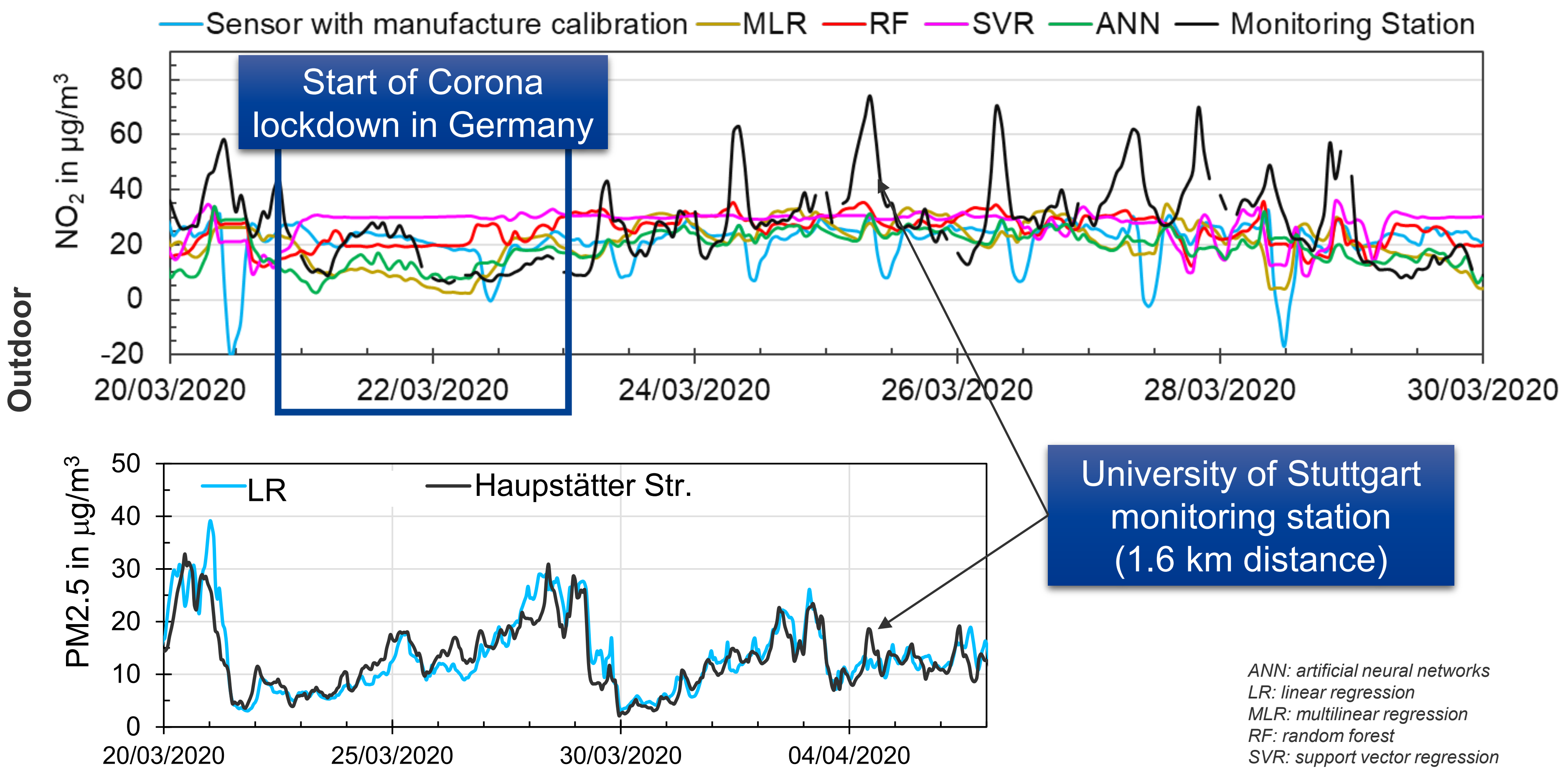
ANN: artificial neural networks
MLR: multilinear regression
RF: random forest
SVR: support vector regression

How to evaluate the performance of the LCS during the campaign?
2. Identifying possible sources of air pollution indoors

The protocol of activities helps to identify the sources of PM peaks



How to evaluate the performance of the LCS during the campaign?
3. Comparison with official monitoring stations



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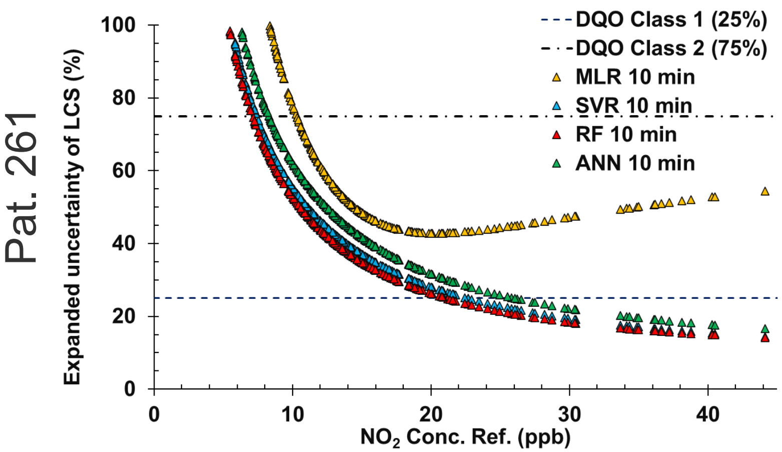
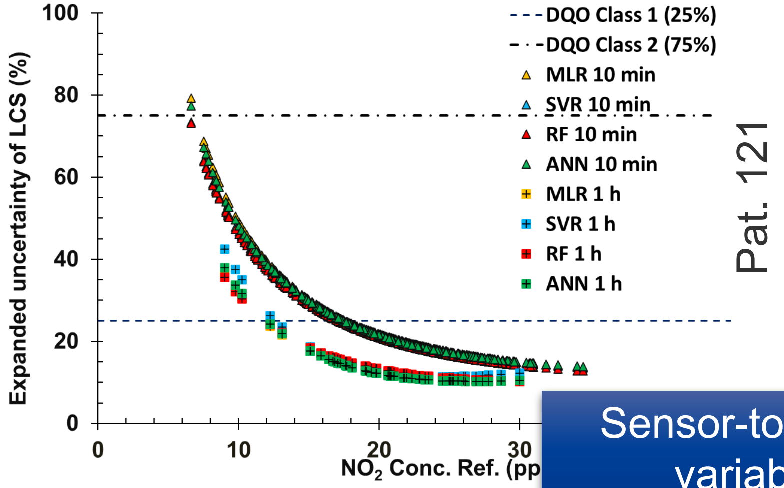
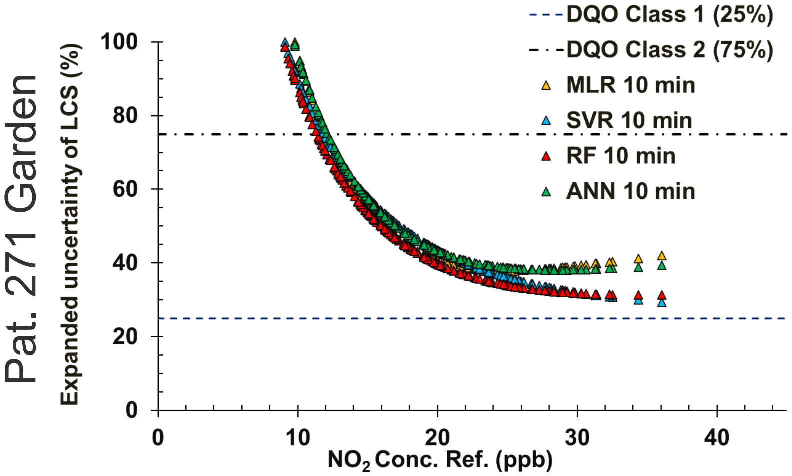
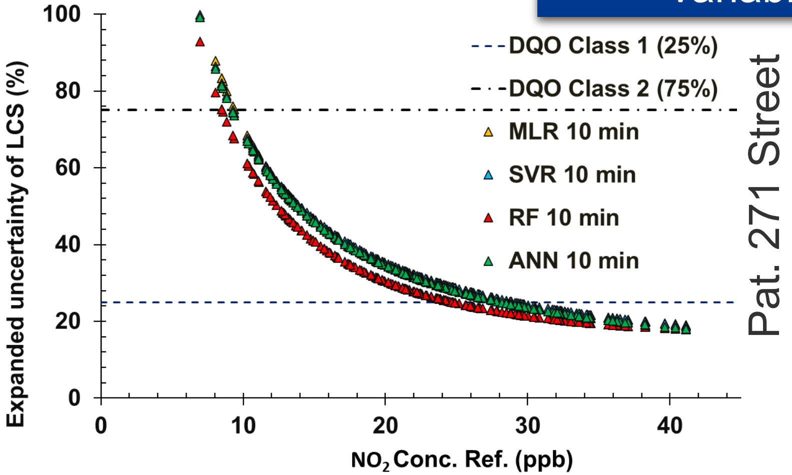
Evaluation of the measurements during the validation/testing period





Sensor-to-sensor variability





ANN: artificial neural networks
DQO: data quality objective
MLR: multilinear regression
RF: random forest
SVR: support vector regression

Conclusions

- Low concentrations has higher uncertainties with LCS, but peak concentrations are well detected → symptoms and pollutions peaks can be correlated
- LCS are a useful tool to characterize the local air quality in the surroundings of the patients.
- A combination of reference devices and LCS is the key to a successful study.

LCS: low-cost sensor

Thank you!

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