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FAKULTÄT FÜR PHYSIK
METEOROLOGIE
MIM

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Human exposure assessment to air pollutants: Application of a new portable air monitoring instrument

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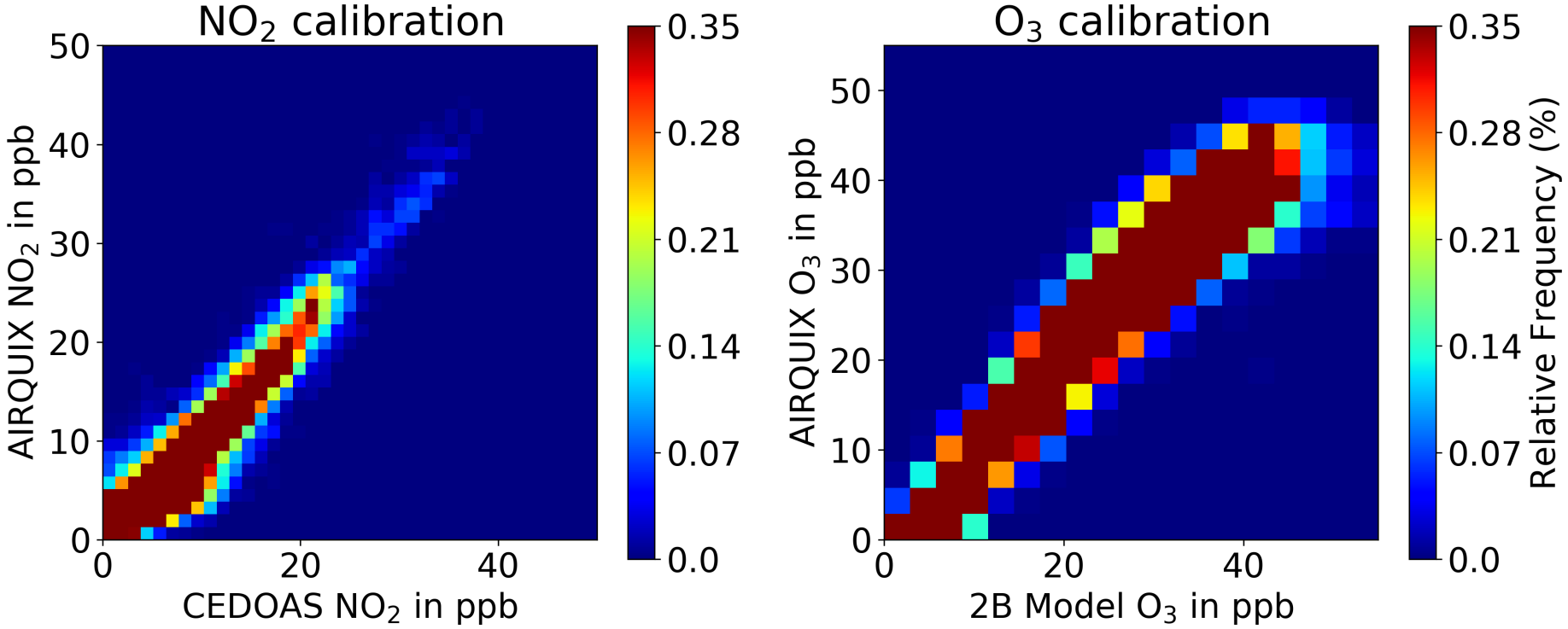
Agenda

- Evaluation of low-cost gas sensors;
  - NO_2, NO, O_3, CO_2, PM
- Handheld device development;
- Personal exposure Measurements by volunteers;
- Corona-related episode.

Evaluation of low-cost gas sensors – Full calibration

- ICAD system(CEDOAS)[1] was used for NO_2 calibration;
- 2B Model 205 Dual beam Ozone monitor was used for O_3 calibration



Horbanski M, Pöhler D, Lampel J, Platt U. The ICAD (iterative cavity-enhanced DOAS) method. Atmospheric Measurement Techniques. 2019 Jun 1;12(6).

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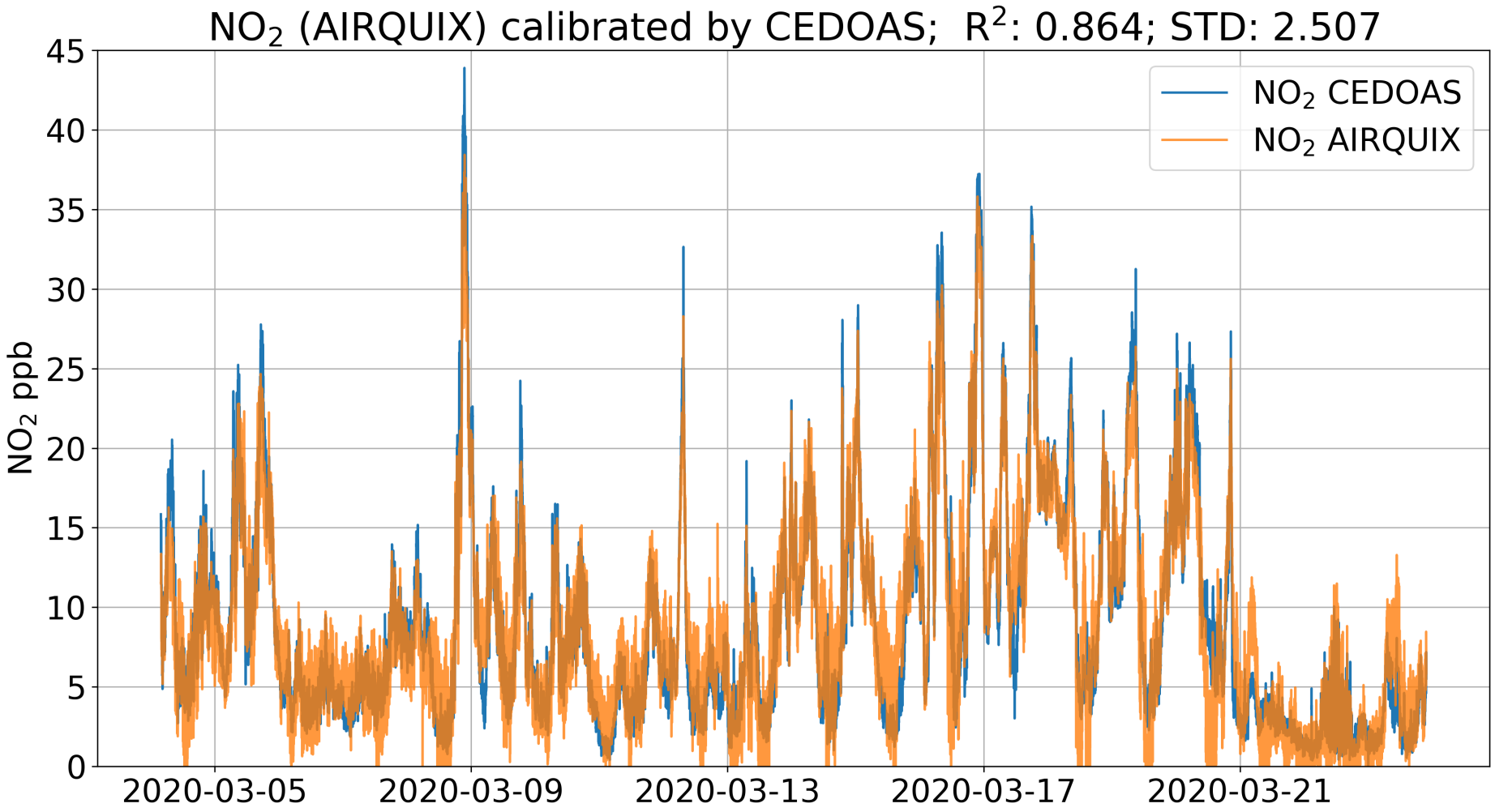
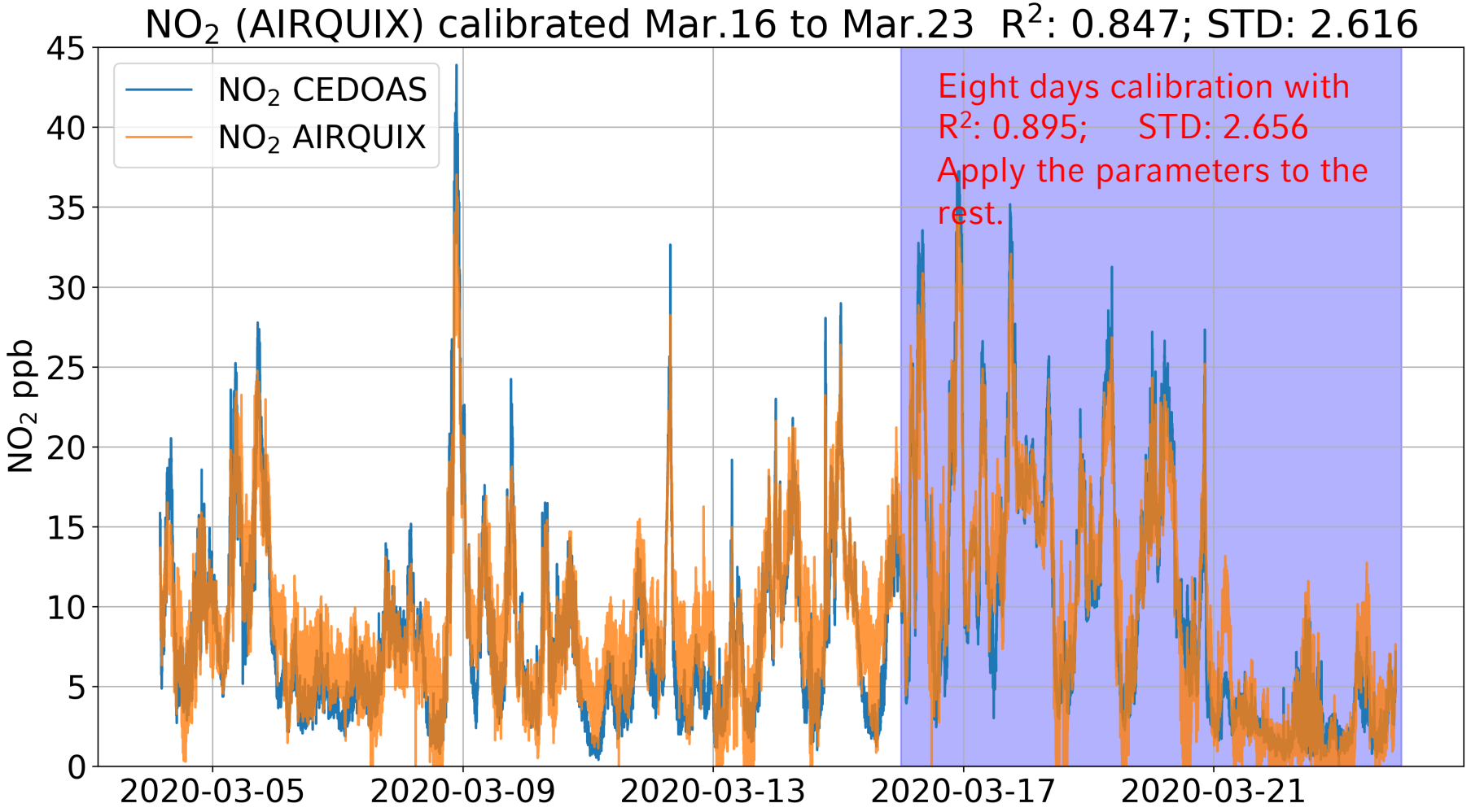


Evaluation of low-cost gas sensors – Calibration and apply



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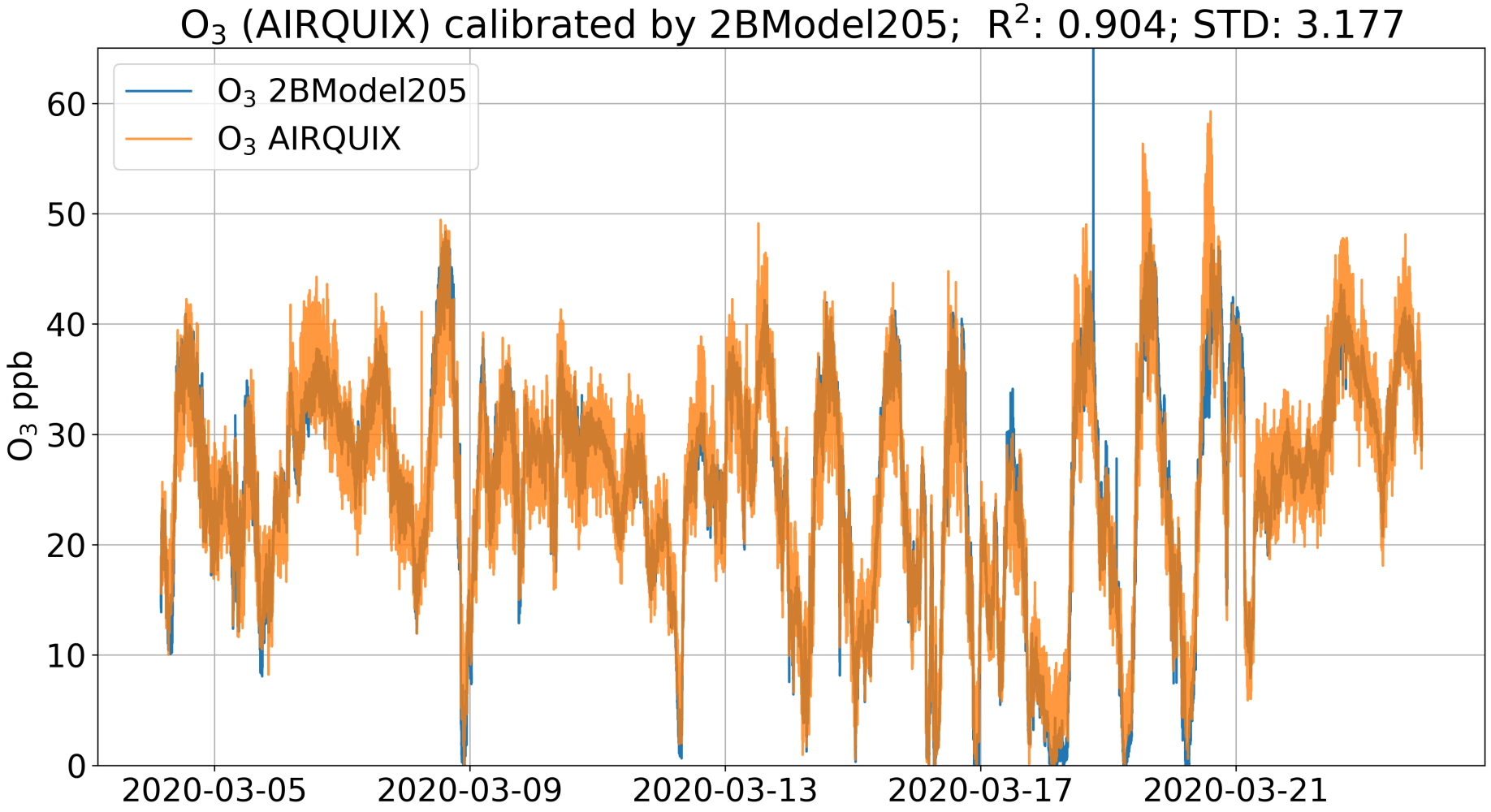

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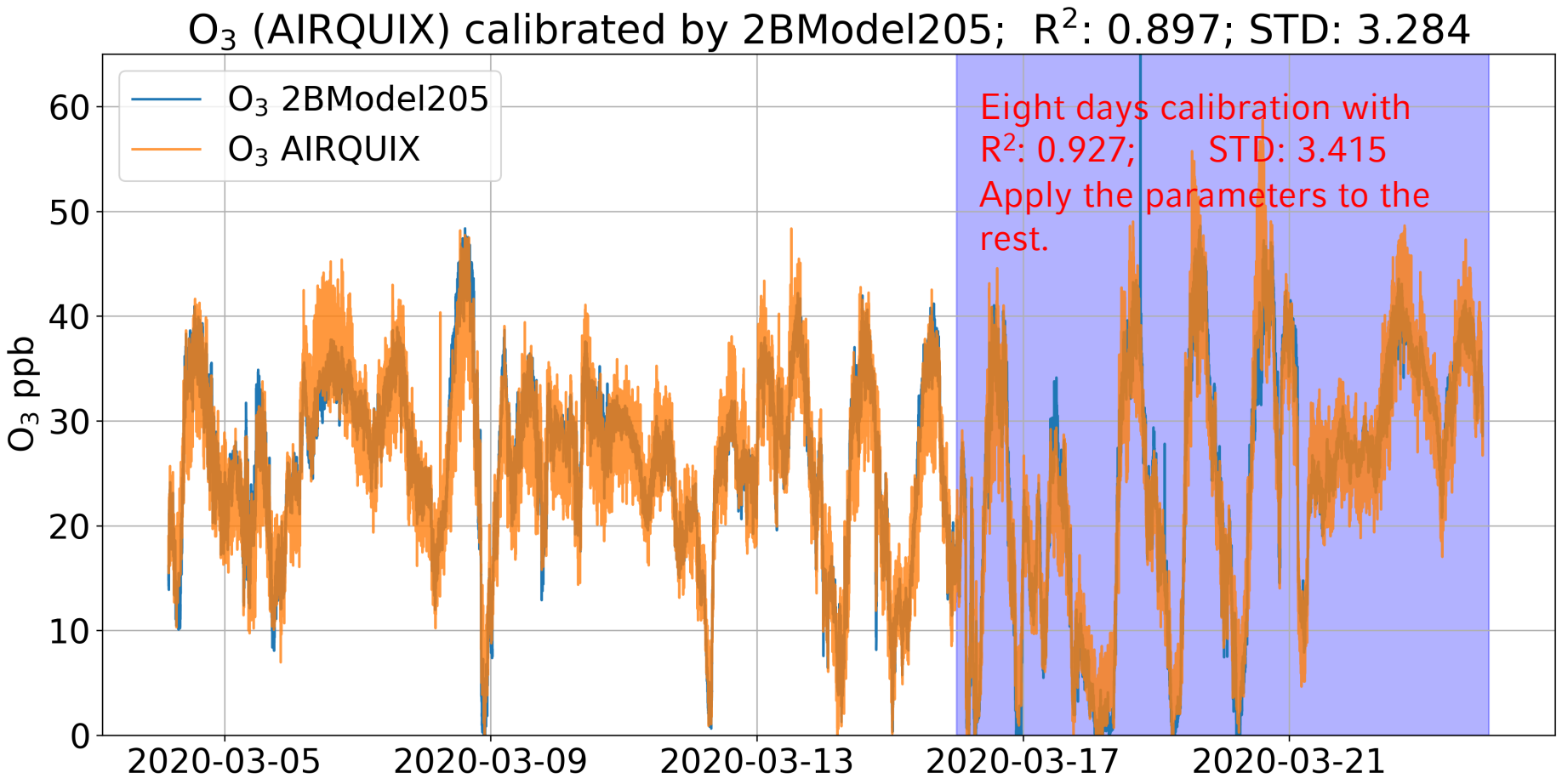
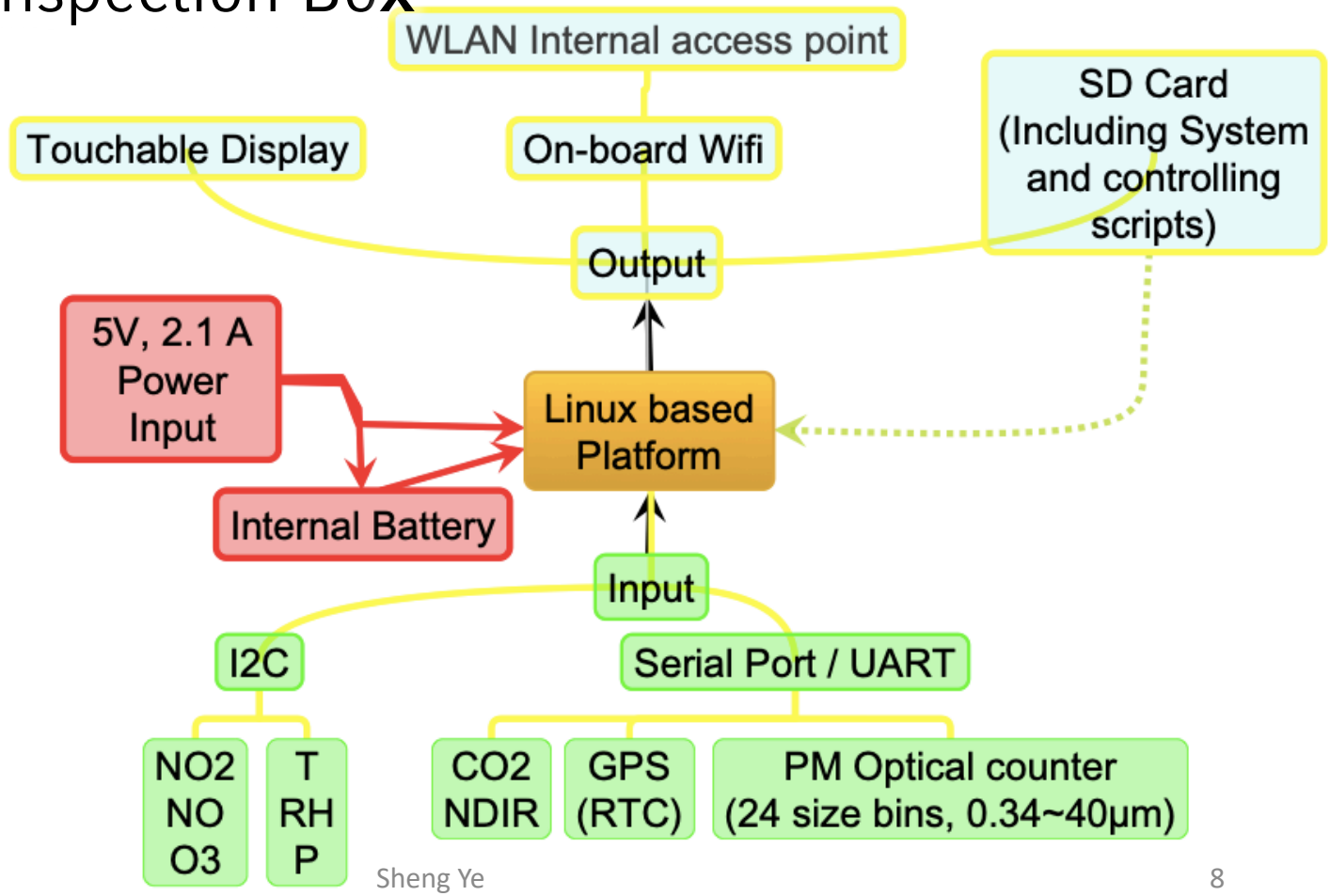


Handheld device development:

AIRQUIX
LMU MIM

Air Quality **I**nspection Bo**x**



Handheld device development:

AIRQUIX
LMU MIM

Air Quality **I**nspection Bo**x**

- Overview Specification
  - Dimensions: 14.5 x 8.5 x 21 cm
  - Weight: ~1.5kg (Include battery)
  - Power: <10W (while recharging)
  - Power input: 5V, 2.1A (while recharging)
  - Internal battery: 3.7V - 12000mAh (7.5h)
  - GPS: Internal + external connector
  - Rotary knob: 10-positions for user defined scenarios
  - Display: 2.4inch touchable display
  - Wi-Fi: WLAN internal access point

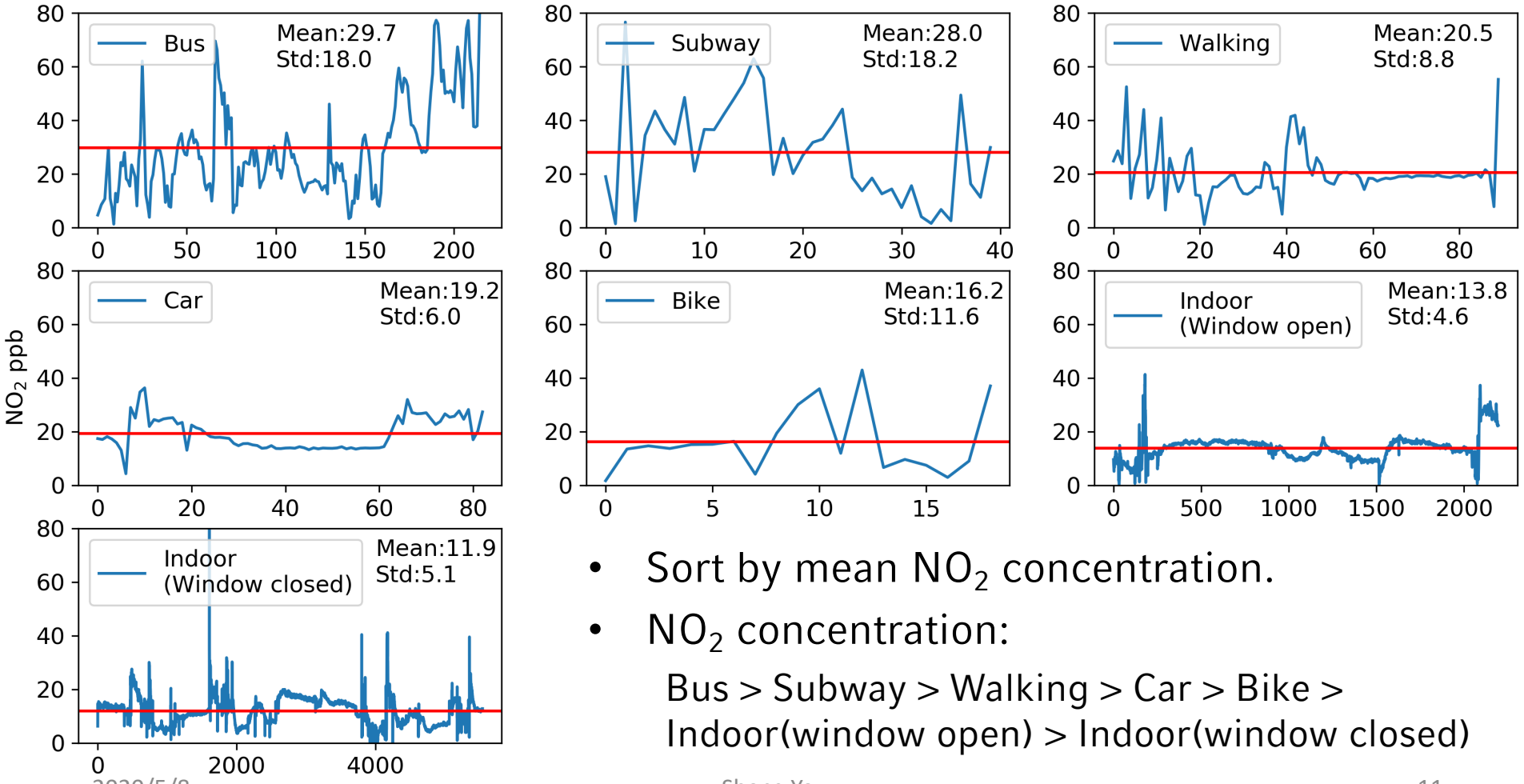
Personal exposure Measurements by volunteers.

- AIRQUIX were carried by several students for 5 days.[1]
- Pre and post calibration were performed to ensure data quality.
- The activities are sorted by events which defined by button status.
- Rotary knob decides the events performed by volunteers.
- A detail experiment record was kept for more information.

1. Erik Hofmann; Dora Thallinger; Jonathan Garben; Marcus Bürger; Tom Kosik; Ferdinand Hilgenberg; Betreuer: Florian Linder; 2020, Forschungsprojekt AIRQUIX-Luftqualitätsmessungen auf unseren Schulwegen

Personal exposure Measurements by volunteers.

Exposure study performed by school students including daily activities

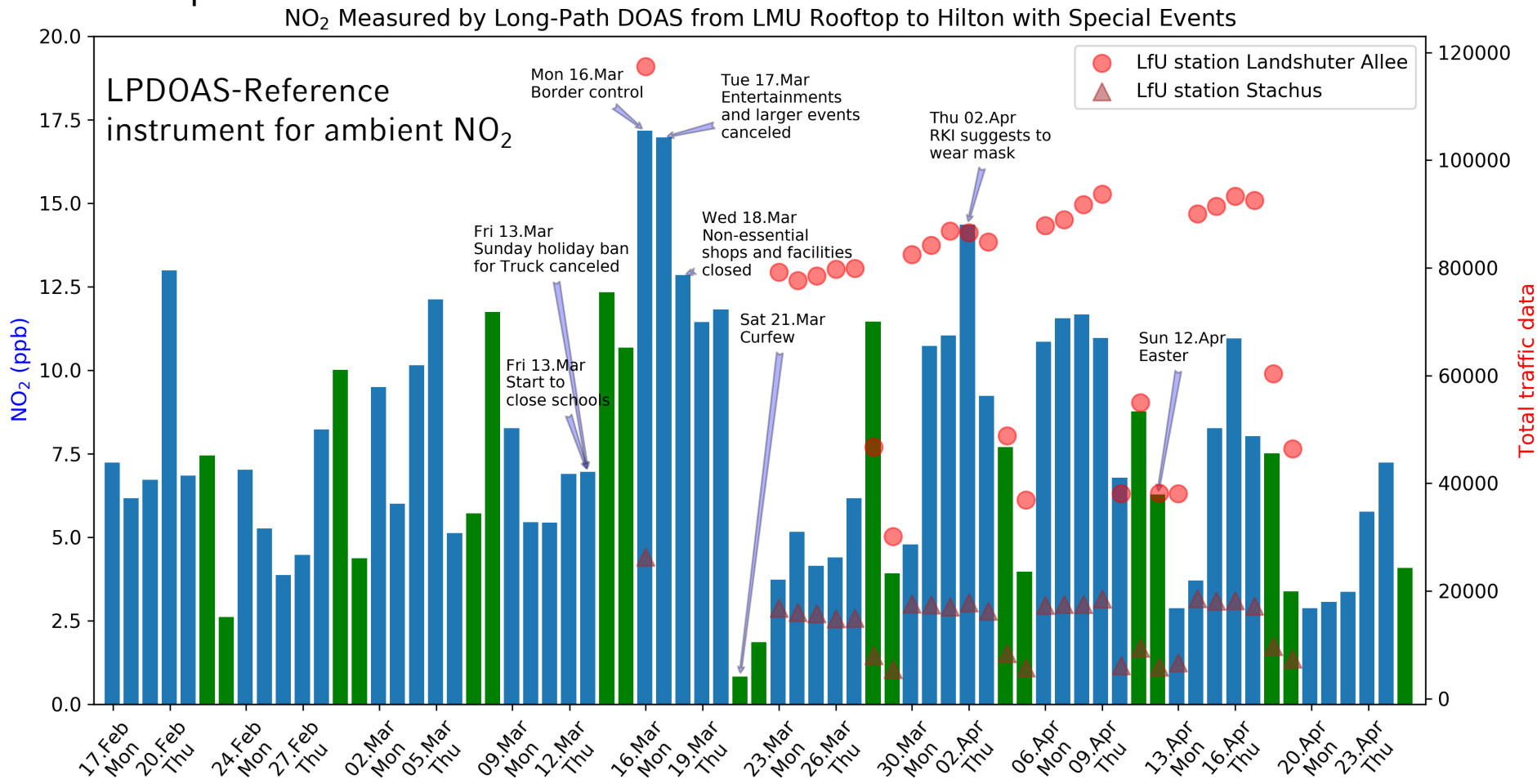


- Sort by mean NO_2 concentration.
- NO_2 concentration:

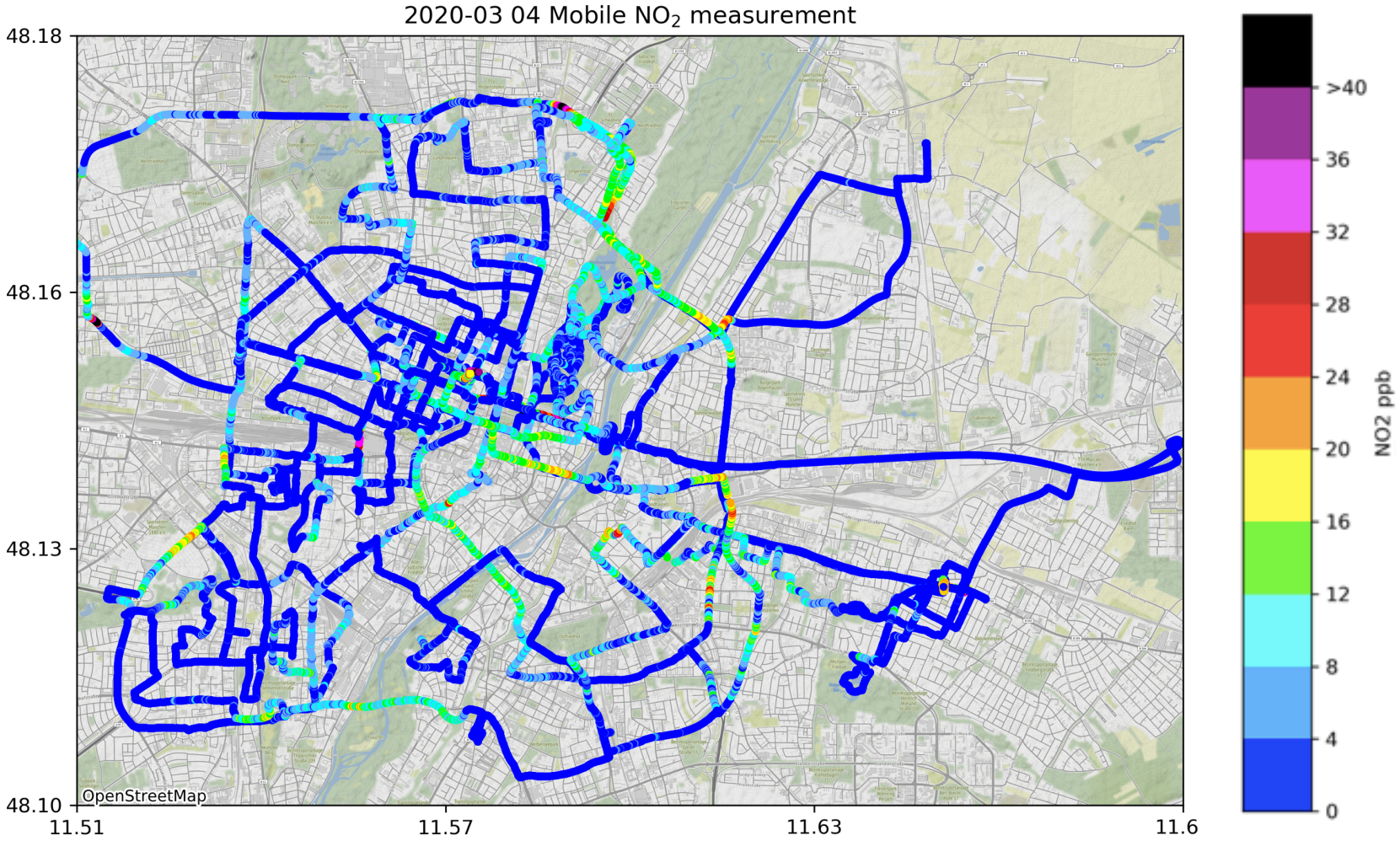
  Bus > Subway > Walking > Car > Bike > Indoor(window open) > Indoor(window closed)

Corona-related Episode in 2020.03:

– Long Path DOAS measurement and traffic information from LfU on MIM Rooftop in Munich



NO_2 measured by AIRQUIX in 2020.03 for COVOD-19



Further work

- For devices:
  - The cloud solution is under development.
  - Touchable display for events record can be considered.
- For human exposure study:
  - Different kind of measurement volunteers are needed for wide sampling.
  - To distribute more instruments for intense measurement campaign.

Further sources about AIRQUIX and DOAS in Munich:

Erik Hofmann; Dora Thallinger; Jonathan Garben; Marcus Bürger; Tom Kosik; Ferdinand Hilgenberg; Betreuer: Florian Linder; 2020, Forschungsprojekt AIRQUIX-Luftqualitätsmessungen auf unseren Schulwegen

Horbanski M, Pöhler D, Lampel J, Platt U. The ICAD (iterative cavity-enhanced DOAS) method. Atmospheric Measurement Techniques. 2019 Jun 1;12(6).

Wenig, M., Chan, L., Zhu, Y., Schütt, A. M. N., Kuhlmann, G., & Brunner, D. (2016, December). A 3D NO_2 DOAS System to Capture Urban Concentrations. In *AGU Fall Meeting Abstracts*.

Zhu, Y., Chan, K. L., Lam, Y. F., Horbanski, M., Pöhler, D., Boll, J., ... & Wenig, M. (2018). Analysis of spatial and temporal patterns of on-road NO_2 concentrations in Hong Kong. *Atmospheric Measurement Techniques*, *11*(12), 6719-6734.

Zhu, Y., Chenb, J., Bib, X., Kuhlmannc, G., Chand, K. L., Dietrichb, F., ... & Weniga, M. (2020). Spatial and temporal representativeness of point measurements for nitrogen dioxide pollution levels in cities. *Atmos. Chem. Phys. Discuss.*

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Ludwig-Maximilians-Universitaet

Thank you!

Sharing Geoscience Online. EGU2020

In the presentation, we have four main parts. The following contents are highlighted:

1. Evaluation of low-cost gas sensors:

> Cavity Enhanced DOAS was used for NO2 calibration;

> 2B Model 205 Dual beam Ozone monitor was used for O3 calibration.

> The calibration is done in real-world environment. The evaluation plots are shown. A good correlation for both can be observed. (R^2, NO2: 0.86, O3: 0.90, std: NO2:2.5, O3: 3.2)

2. Air Quality Inspection Box development (AIRQUIX):

> A basic diagram for AIRQUIX is here. The platform receives the signals from necessary sensors (pollutants/gas/GPS/environmental sensors), display/broadcast(internal wifi)/store the data. The power consumption is 10W while charging. It can relies on internal battery for 7.5hours. The additional specification for AIRQUIX is shown in the material.

3. Personal exposure measurements:

> Students and their supervisor carried the AIRQUIX for several days.

> For NO2 exposure: Bus > Subway > Walking > Car(new) > Bike > Indoor(window open) > Indoor(window closed)

4. Corona-related episode in 2020.03 (Curfew in Munich)

> A Long-Path DOAS measurement on MIM rooftop in Munich and some daily traffic information from LfU. The Curfew in Munich is issued and implemented on 21st, Mar 2020. A low NO2 concentration can be observed. One week before, a panic-shopping-week can be observed.

> The week of Curfew, bicycle measurement with AIRQUIX is done. Low value in inner city of Munich.