HUNGAIRY

Operational experience of the particulate matter monitoring system in Miskolc

Csongor Báthory
Project manager, University of Miskolc

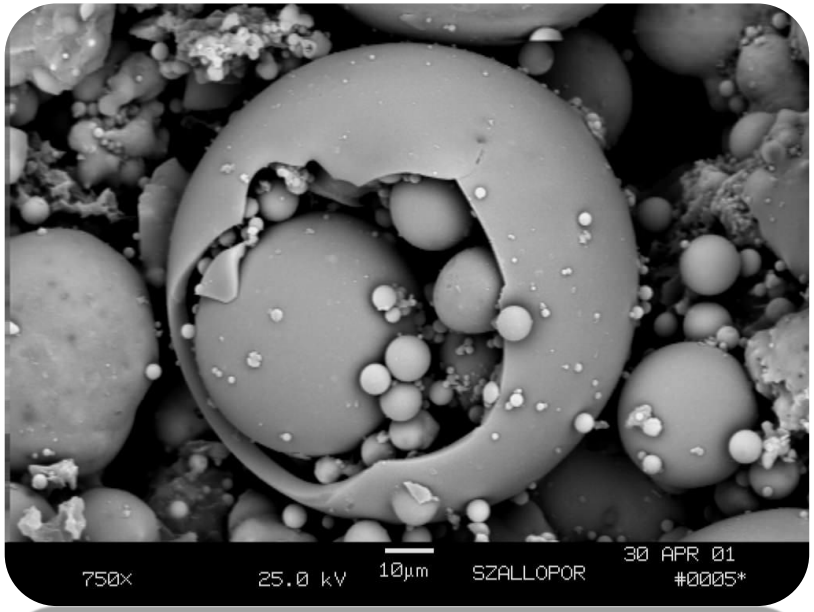
Life

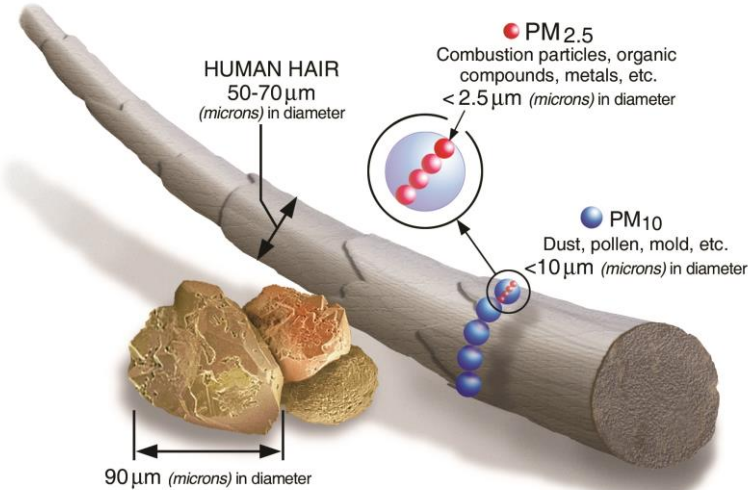
MISKOLC

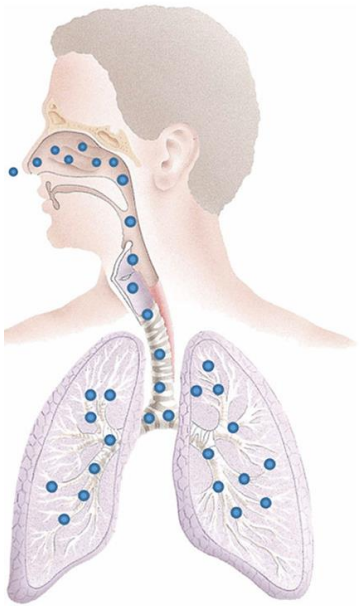
17 35

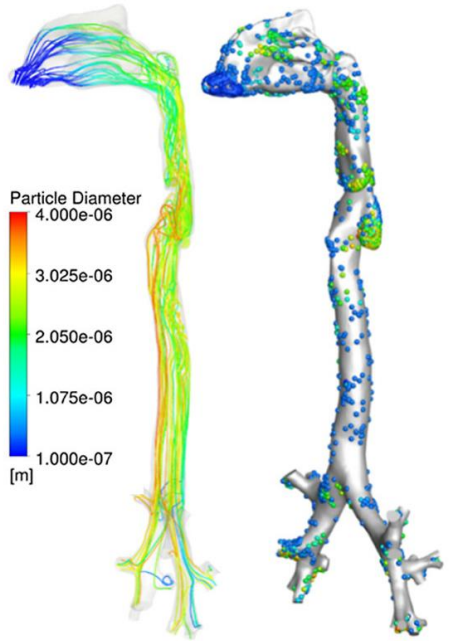
UNIVERSITAS MISKOLCINENSIS

Particulate Matter









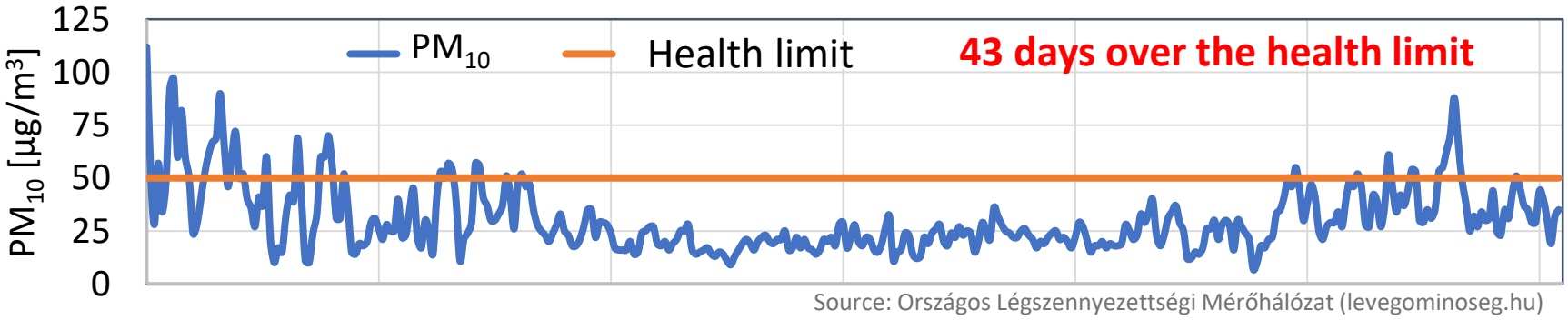
Health limit:

PM_{10} 50 µg/m³
(daily average)

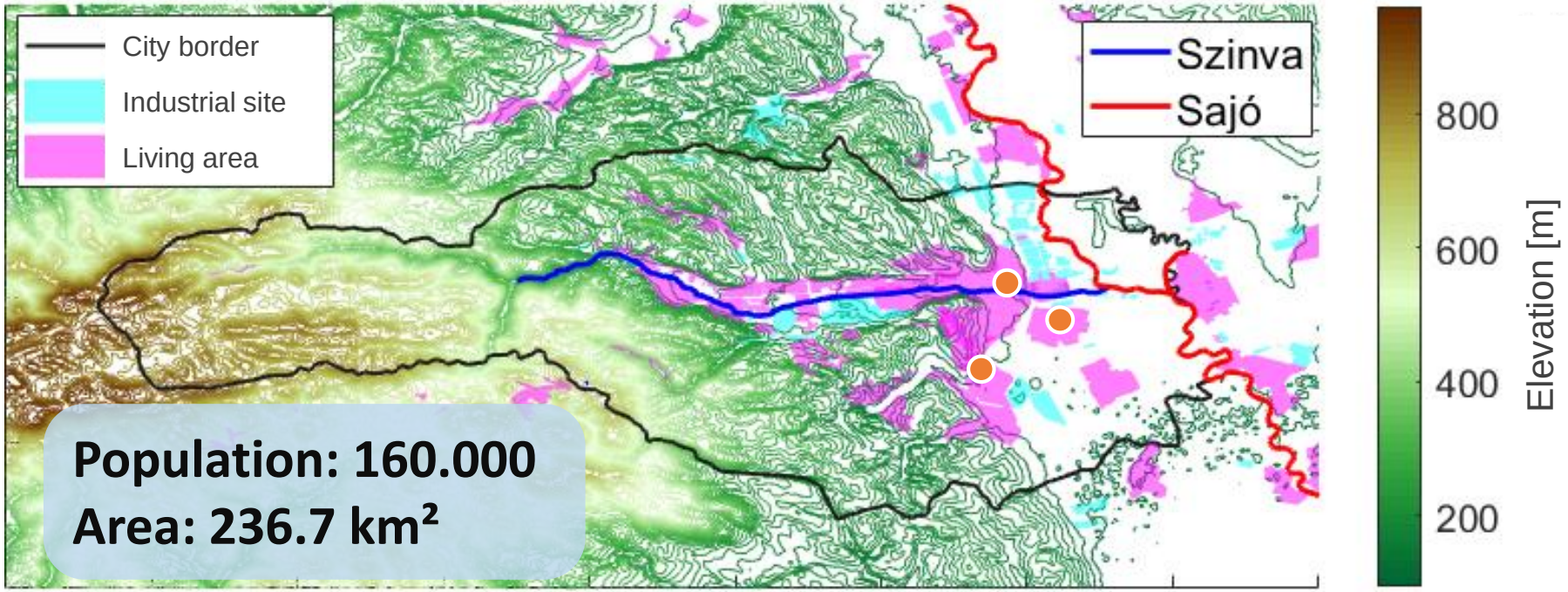
$PM_{2,5}$ 25 µg/m³
(yearly average)

PM issues in Miskolc

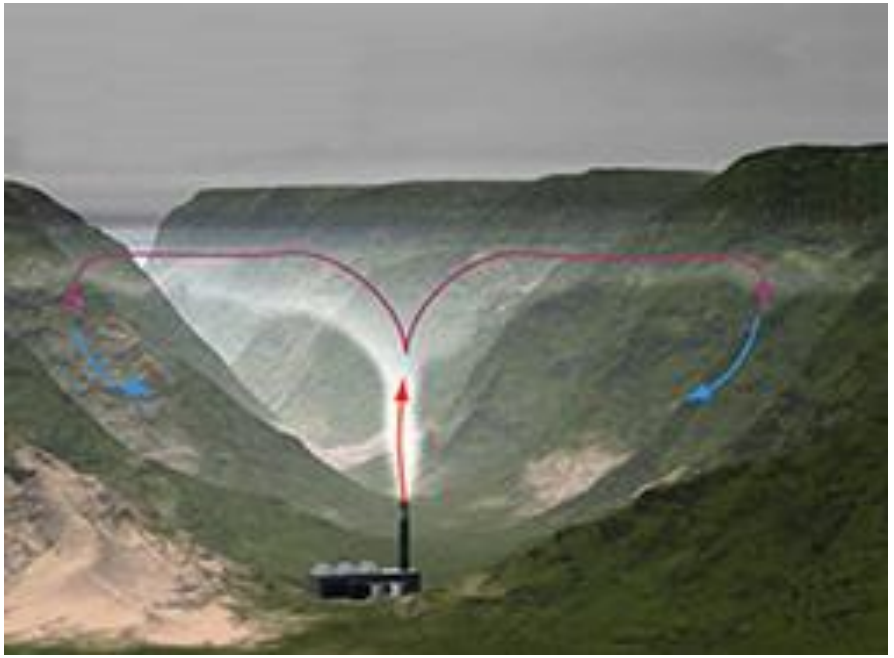
PM_{10} daily average in 2020 Miskolc, official monitoring station



Source: Országos Légszennyezettségi Mérőhálózat (levegominoseg.hu)



Inversion in Miskolc

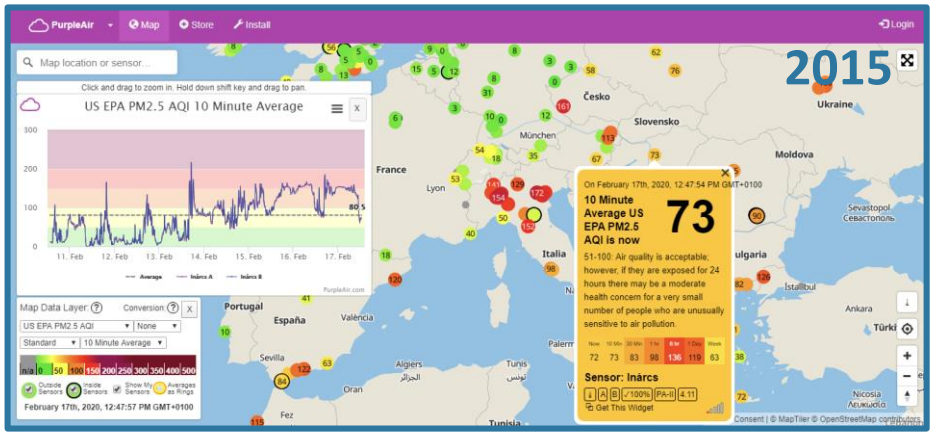


N S

W E

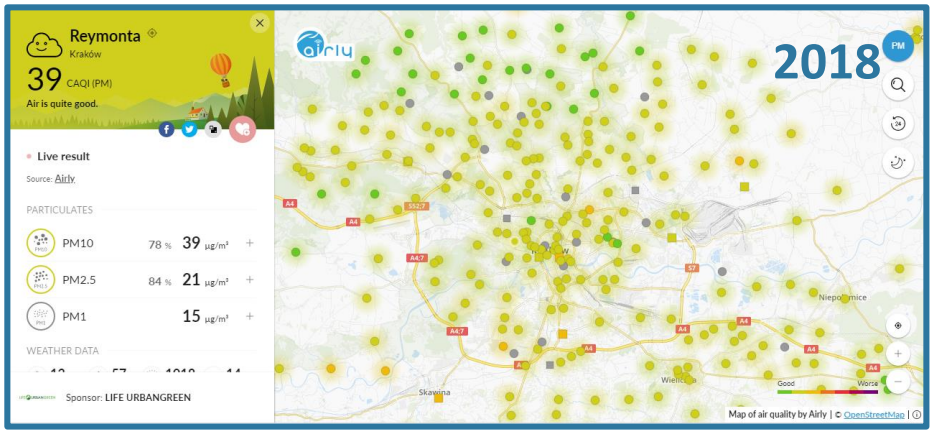
International examples

USA

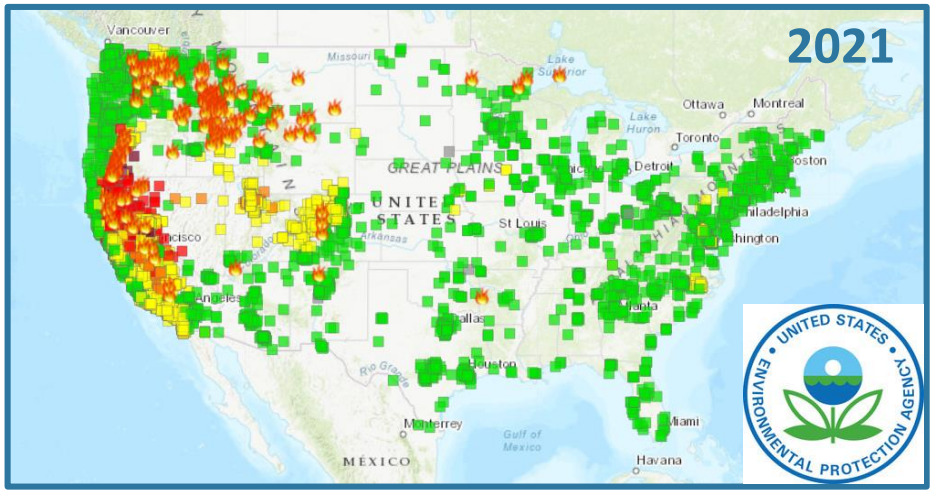


https://purpleair.com

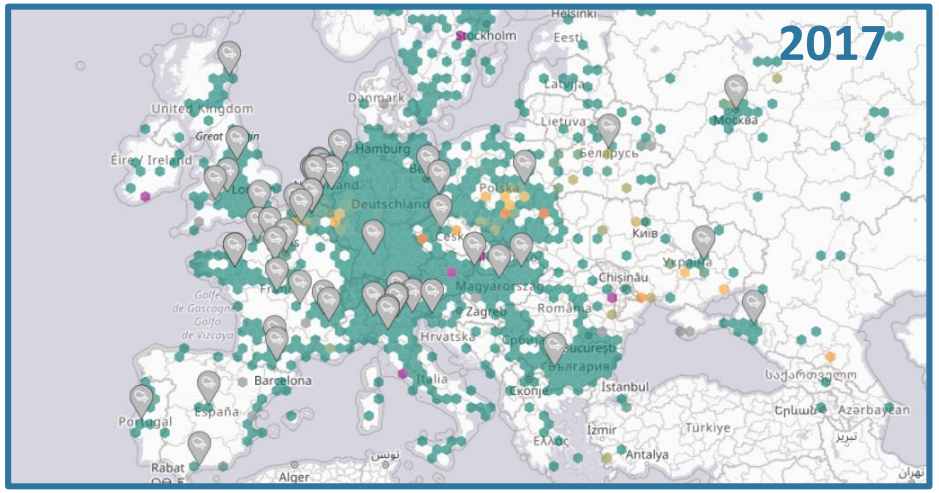
Europe



https://airly.eu

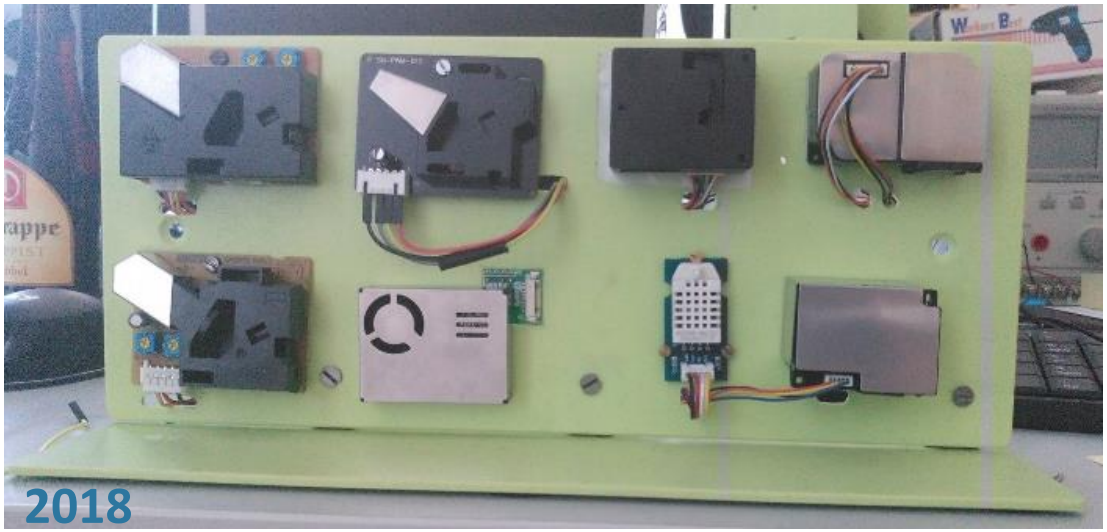


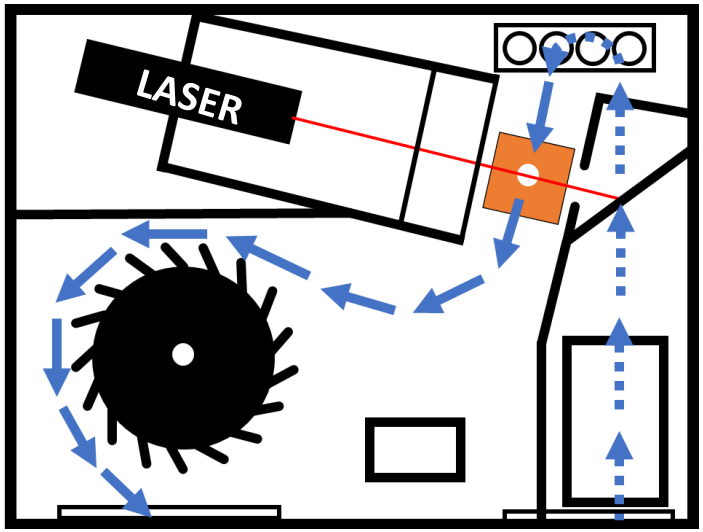
https://fire.airnow.gov



https://sensor.community

Sensor selection

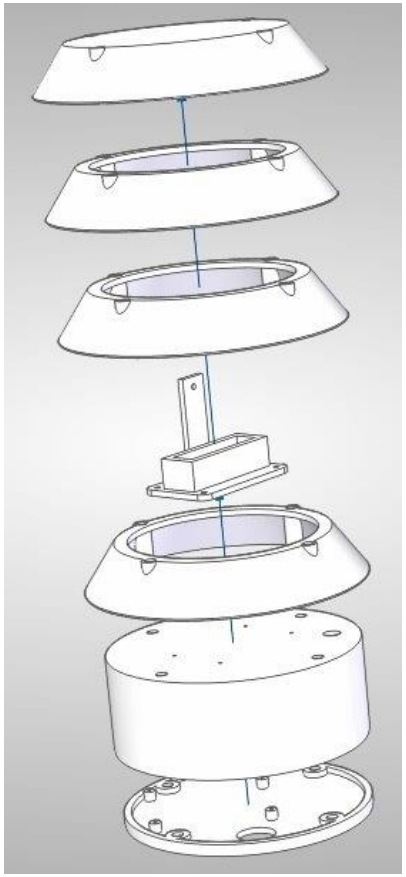




Plantower PMS7003

- Sensor with fan
- Measured $PM_{2.5}$ and PM_{10} concentrations [µg/m^3]
- Best correlation compared to a reference method
- Low humidity dependence
- Growing scientific interest:
  - 2018: 8 articles
  - 2019: 8 articles
  - 2020: 20 articles
  - 2021: 26 articles

Measurement device



3D printed lamellar protective housing

Raspberry Pi 3 B

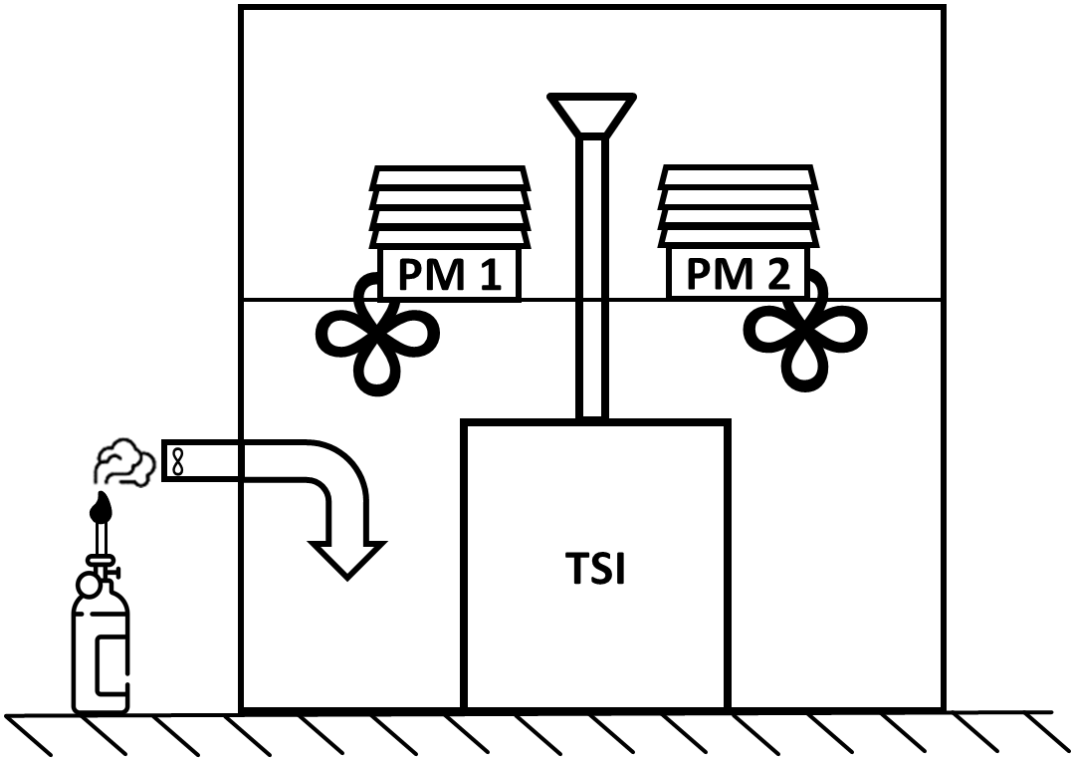
Environmental sensor

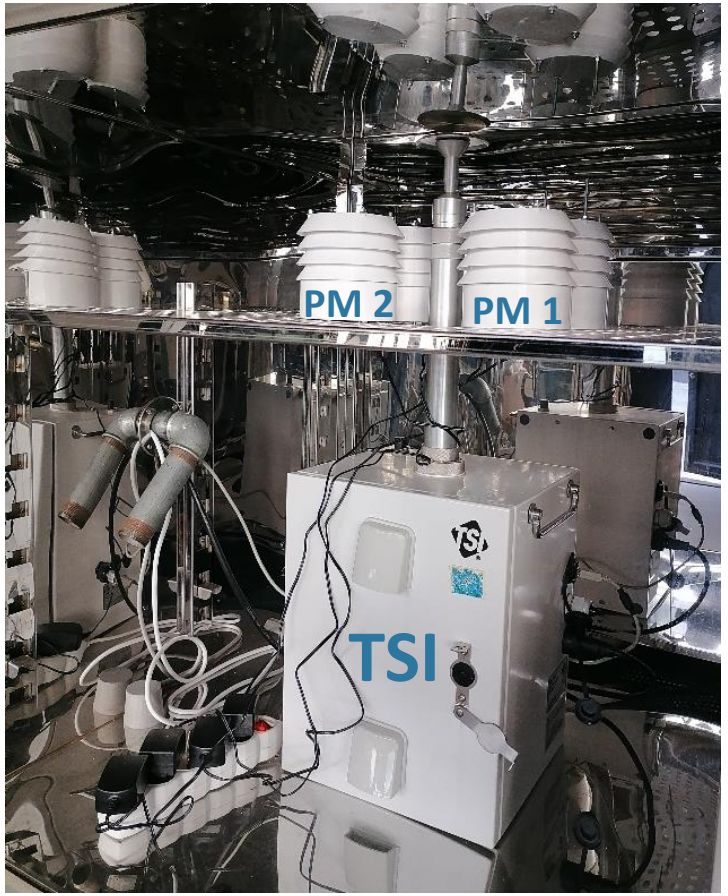
SIM modul

PM sensor

Calibration in climate chamber

Climate chamber

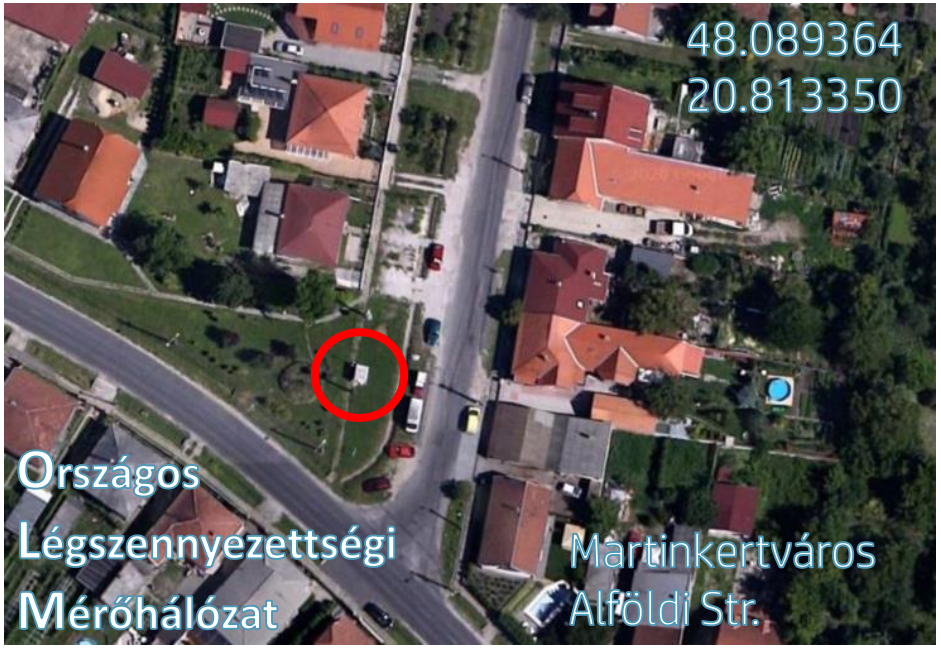


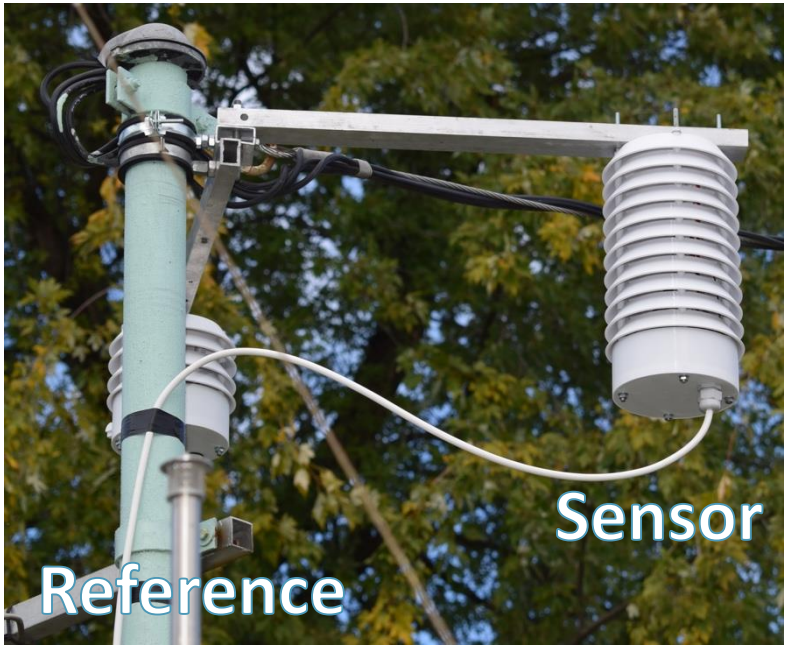


Reference: TSI DustTrack 8534-M (TSI) (light scattering)

Accuracy: ±1 µg/m³ or ±1%

On-field measurement



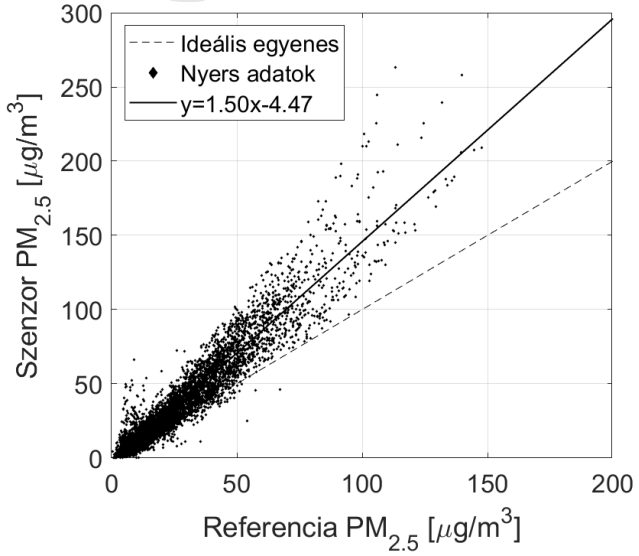


Unit	Data Log
GRIMM EDM 180	1 min
LIFE 001	5 sec

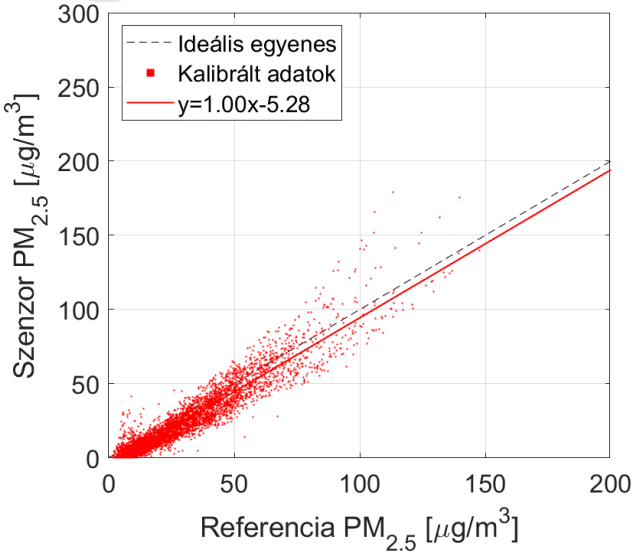
Start	Stop
2019.07.06.	2020.09.30

Calculation model

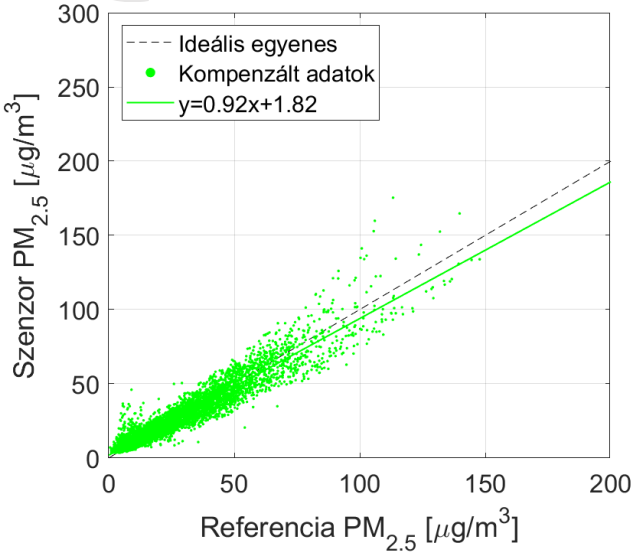
Raw data



Climate chamber calibration



Humidity compensation



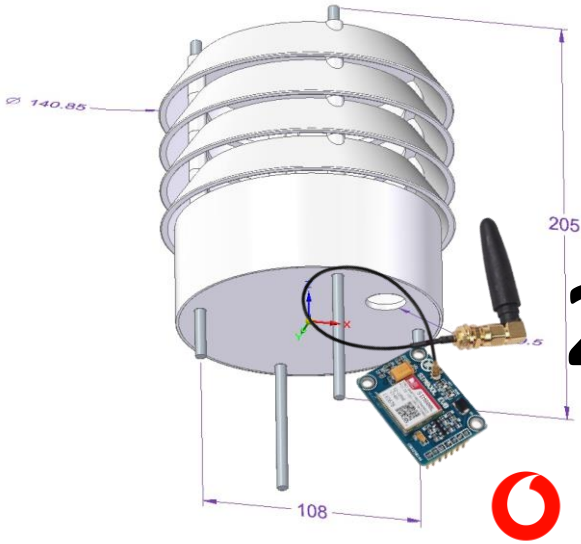
Average absolute error rate decrease

40% ⟶ **25%**

Data patch

Server

Measurement device

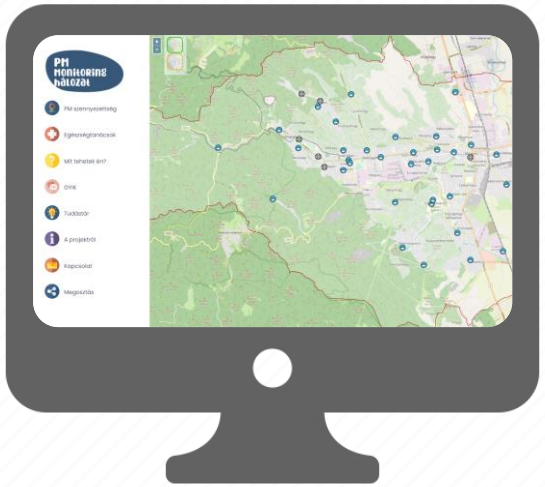


PM_{10}
$PM_{2,5}$
Temp
Hum
Press

2G

vodafone

Website



App

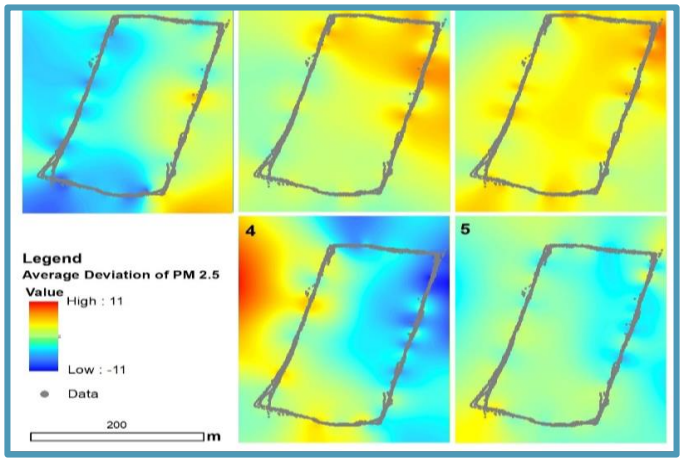
Computer PONT

Authentic/Non-authentic data

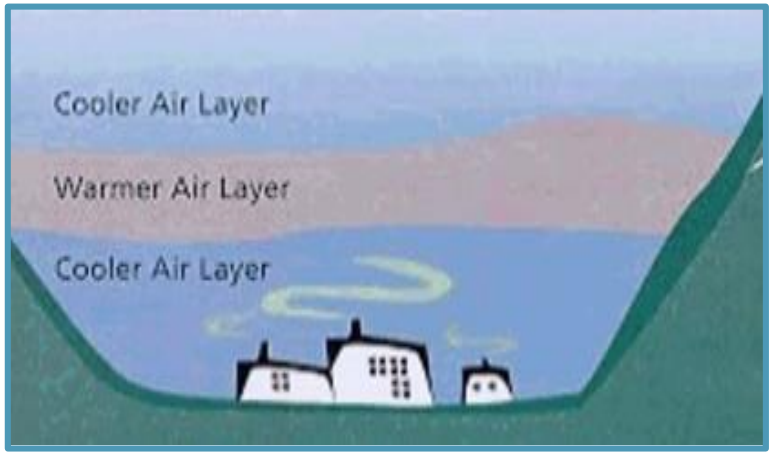
Criteria	Official	HungAIRy	Community
Device with type approval	✓	✗	✗
Accredited laboratory	✓	✗	✗
Calibration	✓	✓	✗
Validation	✓	✓	✗
Scheduled maintenance	✓	✓	✗
Service	✓	✓	✗
Urban scale	✗	✓	✓

Urban scale laboratory

Monitoring system



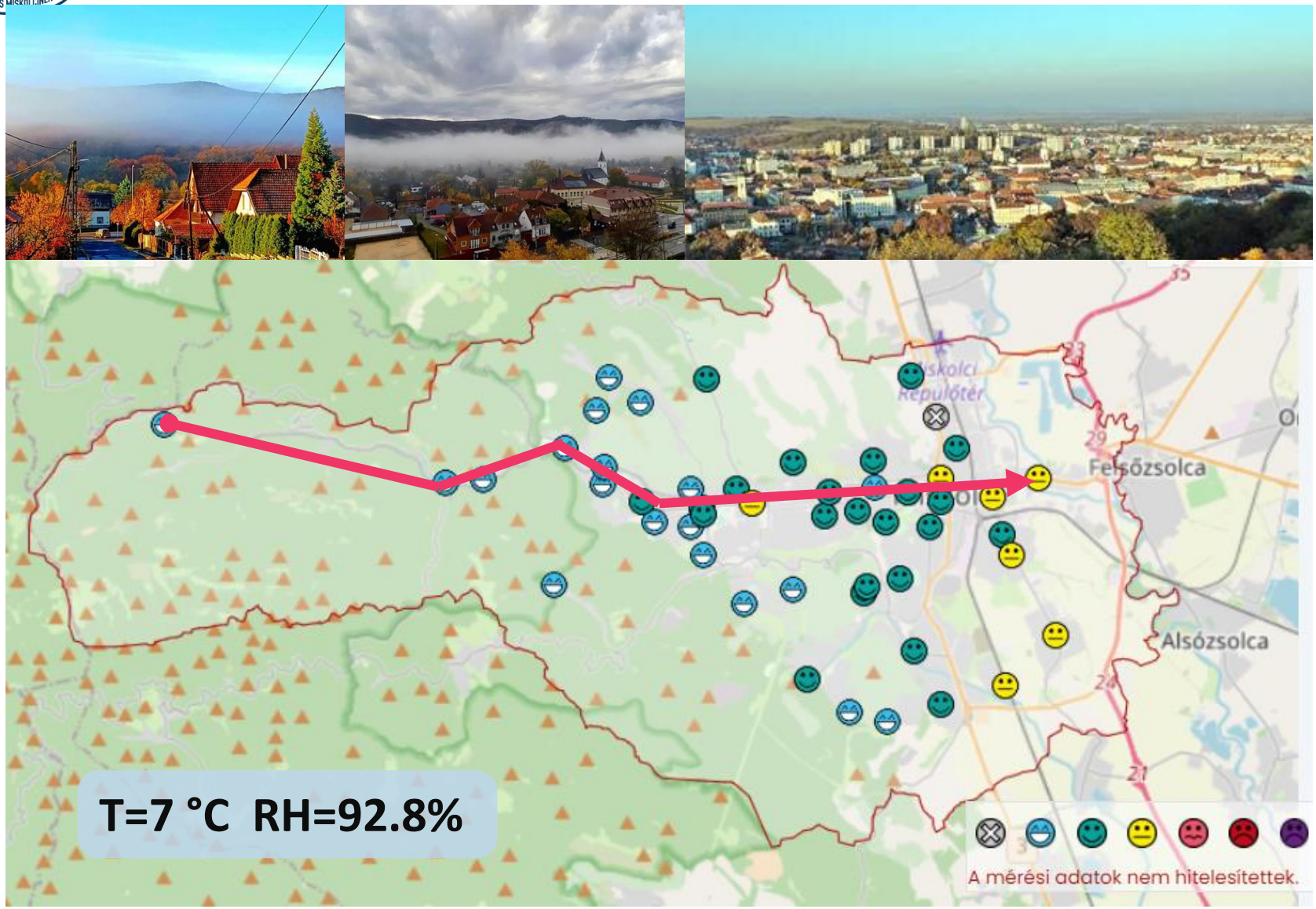
Urban air quality



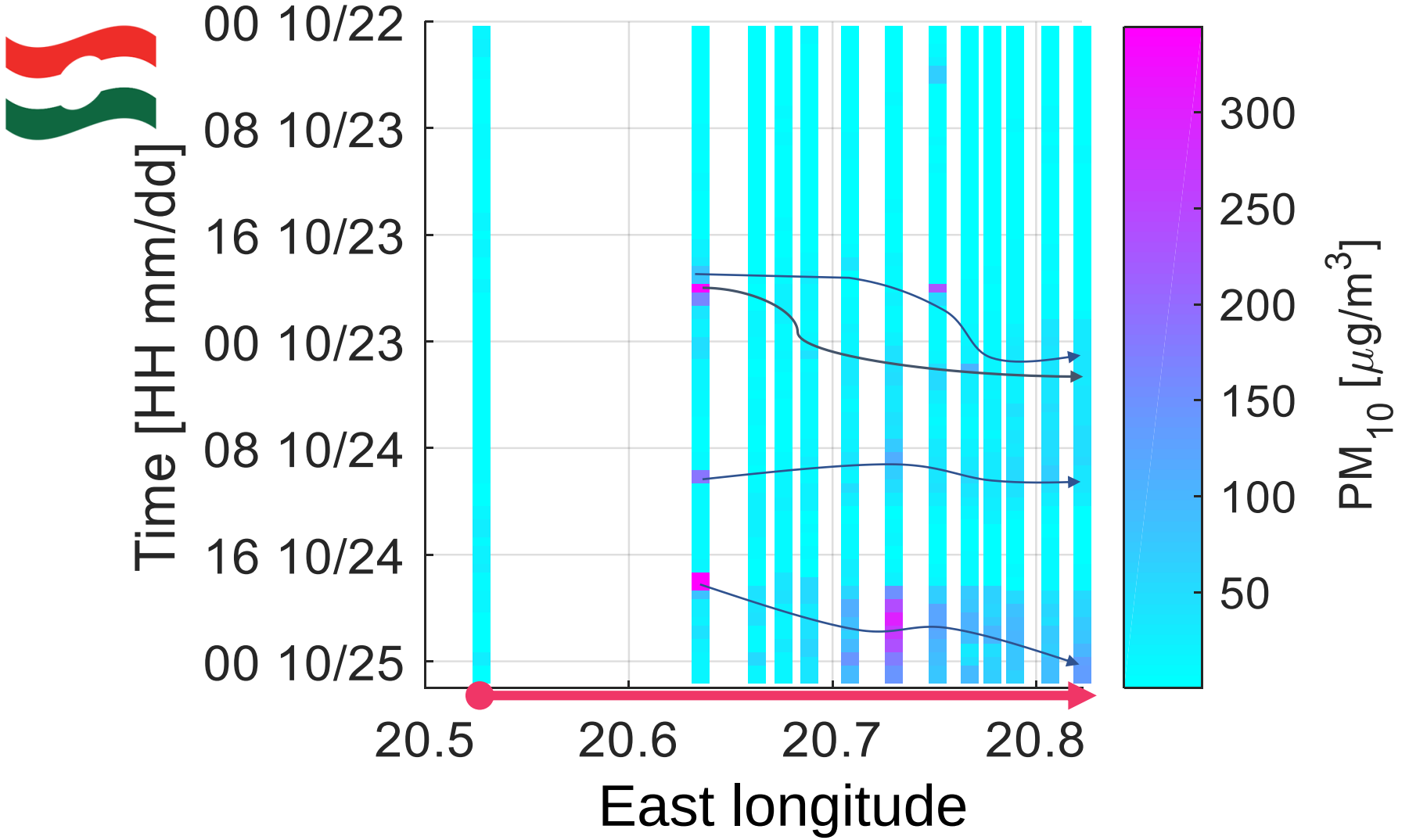
- Installation requirements
- Sensors reliability
- System accuracy
- Map display

- Distribution of pollutants
- Impact of topography
- Detection of hotspots
- Smog formation process

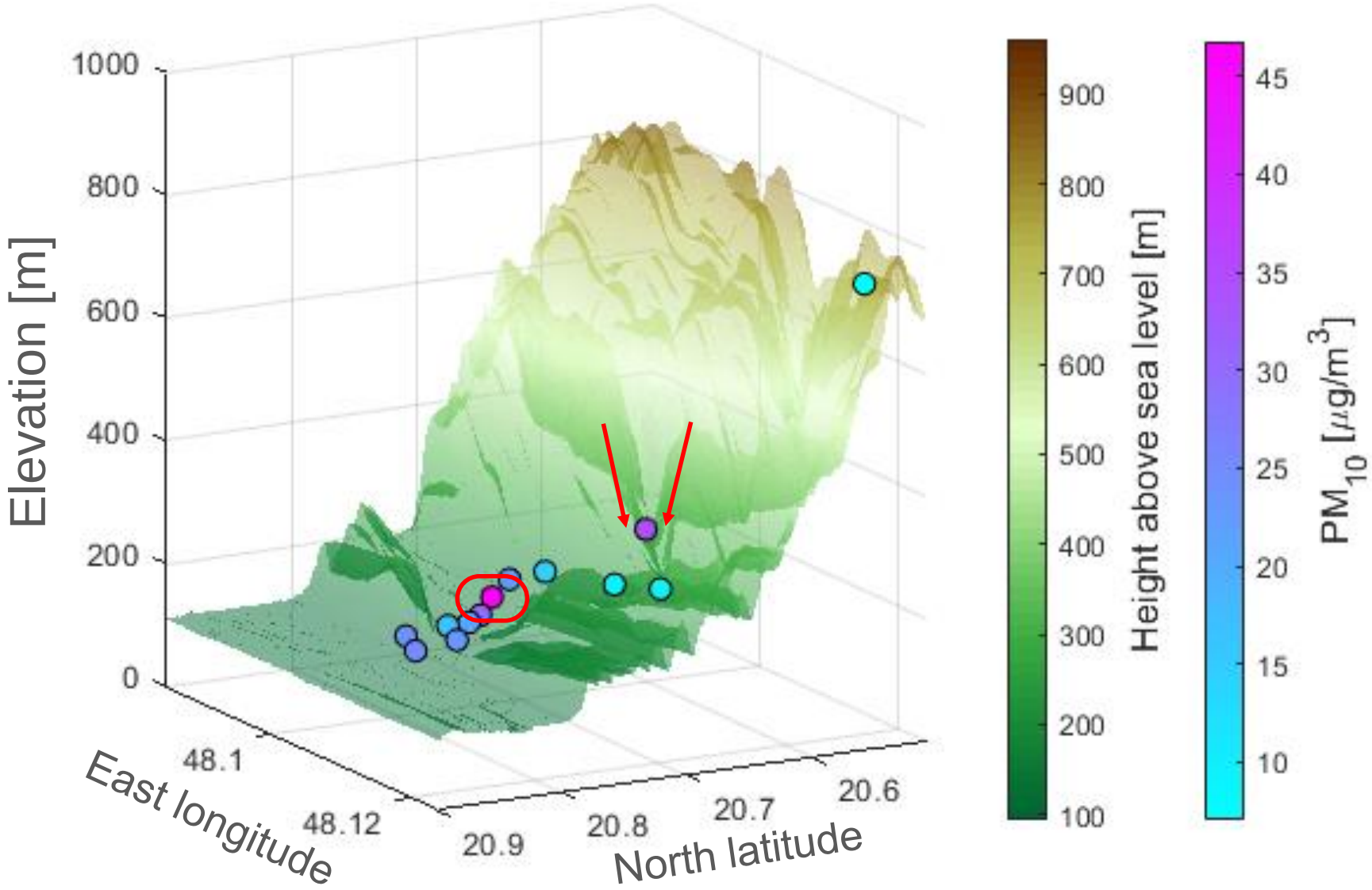
Valley effect



Valley effect

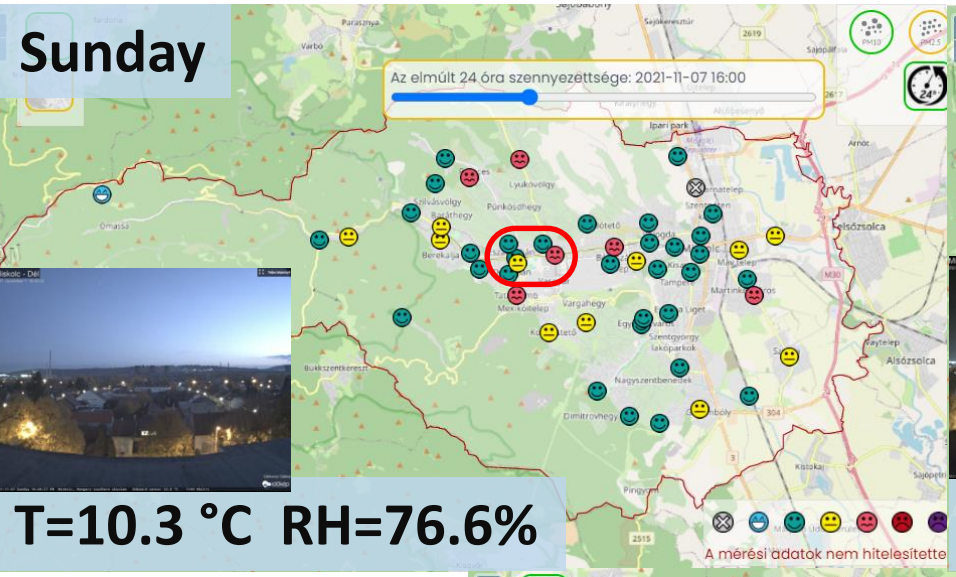


Valley effect

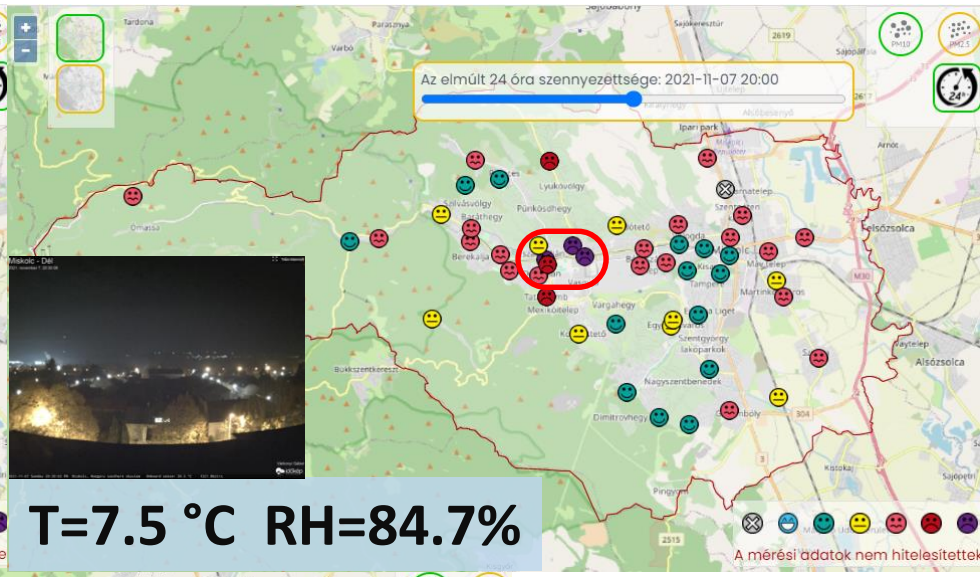


Evening PM Development

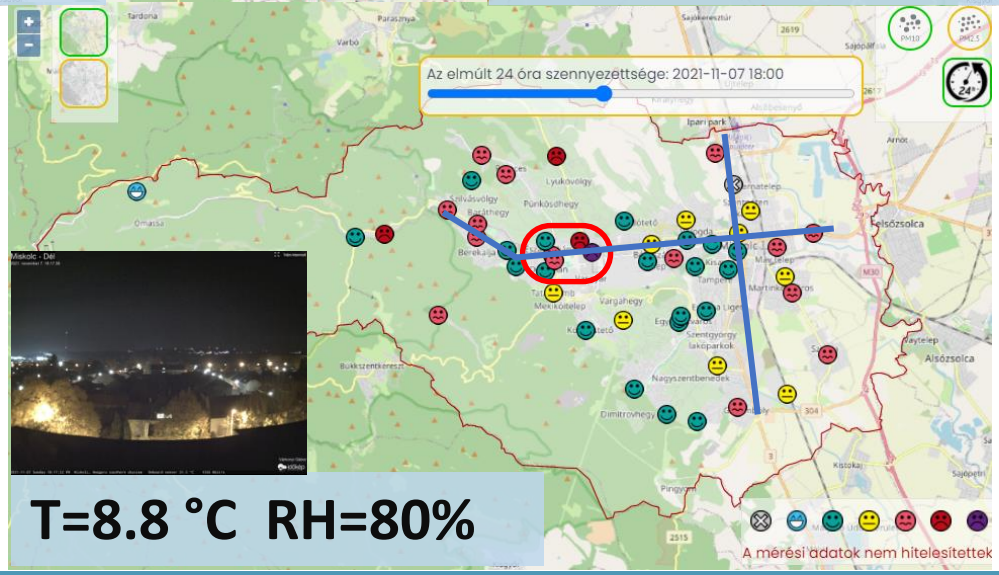
Sunday



T=10.3 °C RH=76.6%



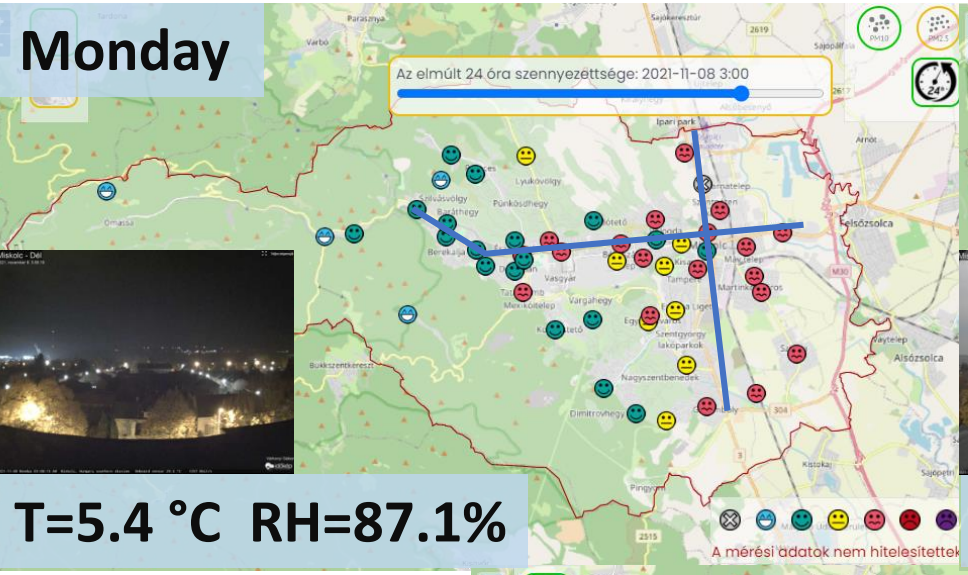
T=7.5 °C RH=84.7%



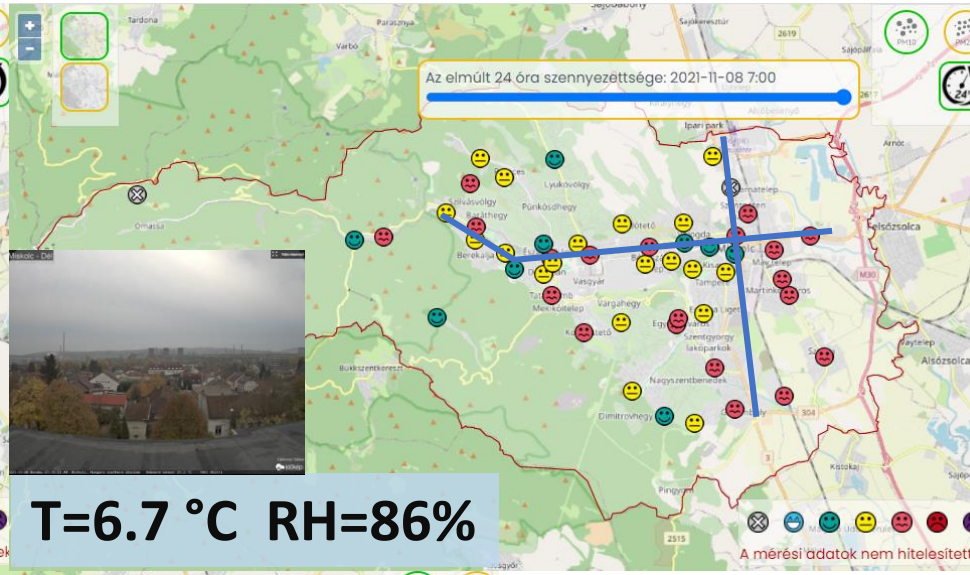
T=8.8 °C RH=80%

Morning PM Development

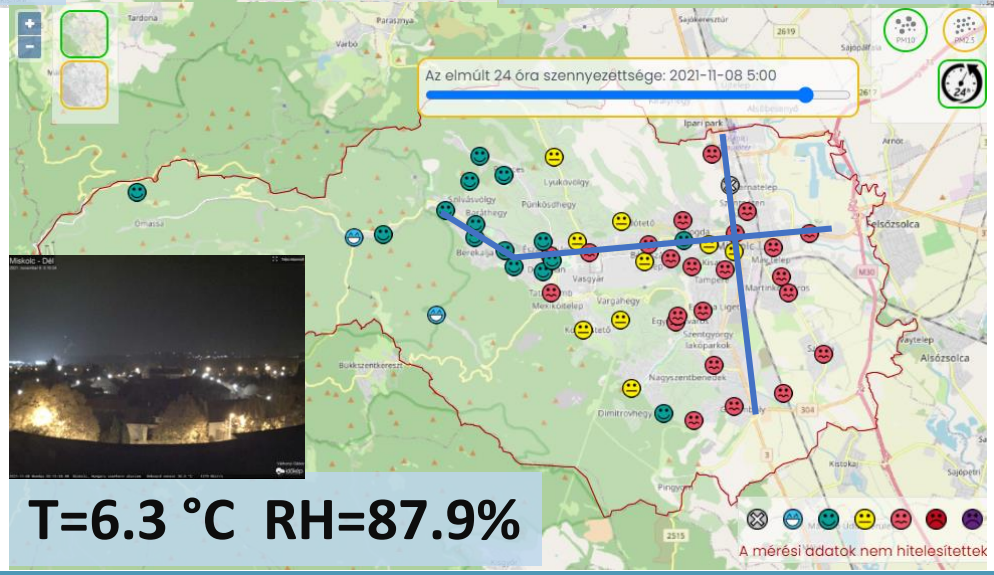
Monday



T=5.4 °C RH=87.1%

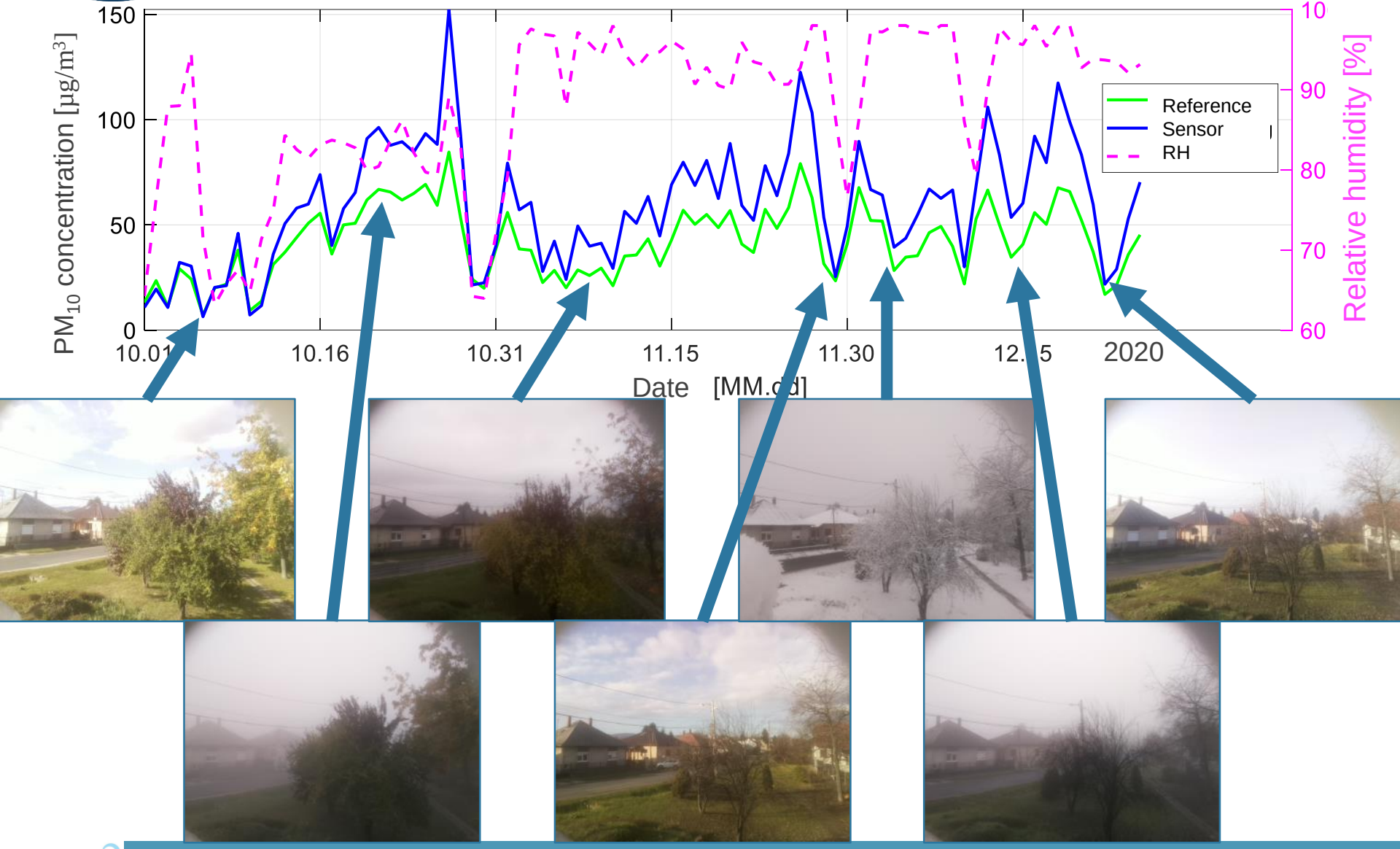


T=6.7 °C RH=86%



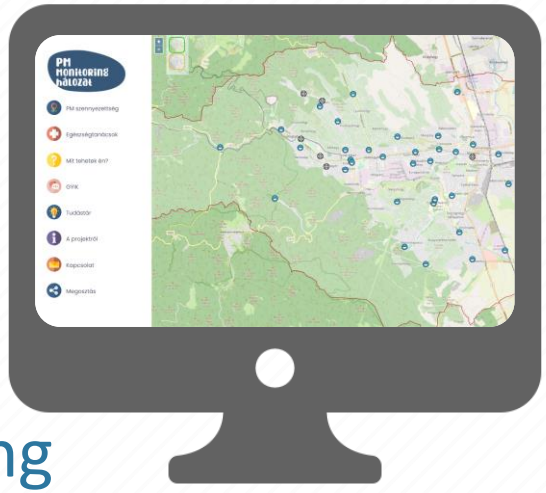
T=6.3 °C RH=87.9%

Effect of humidity and fog



Achieved goals

- Low-cost device
  - Under 300 EUR
- Science based development
  - Measurement and targeted testing
- Getting to know errors
  - Humidity dependence
- Troubleshooting
  - Calibration, Artificial Neural Network
- Tracking trends
  - Temporal and spatial specific

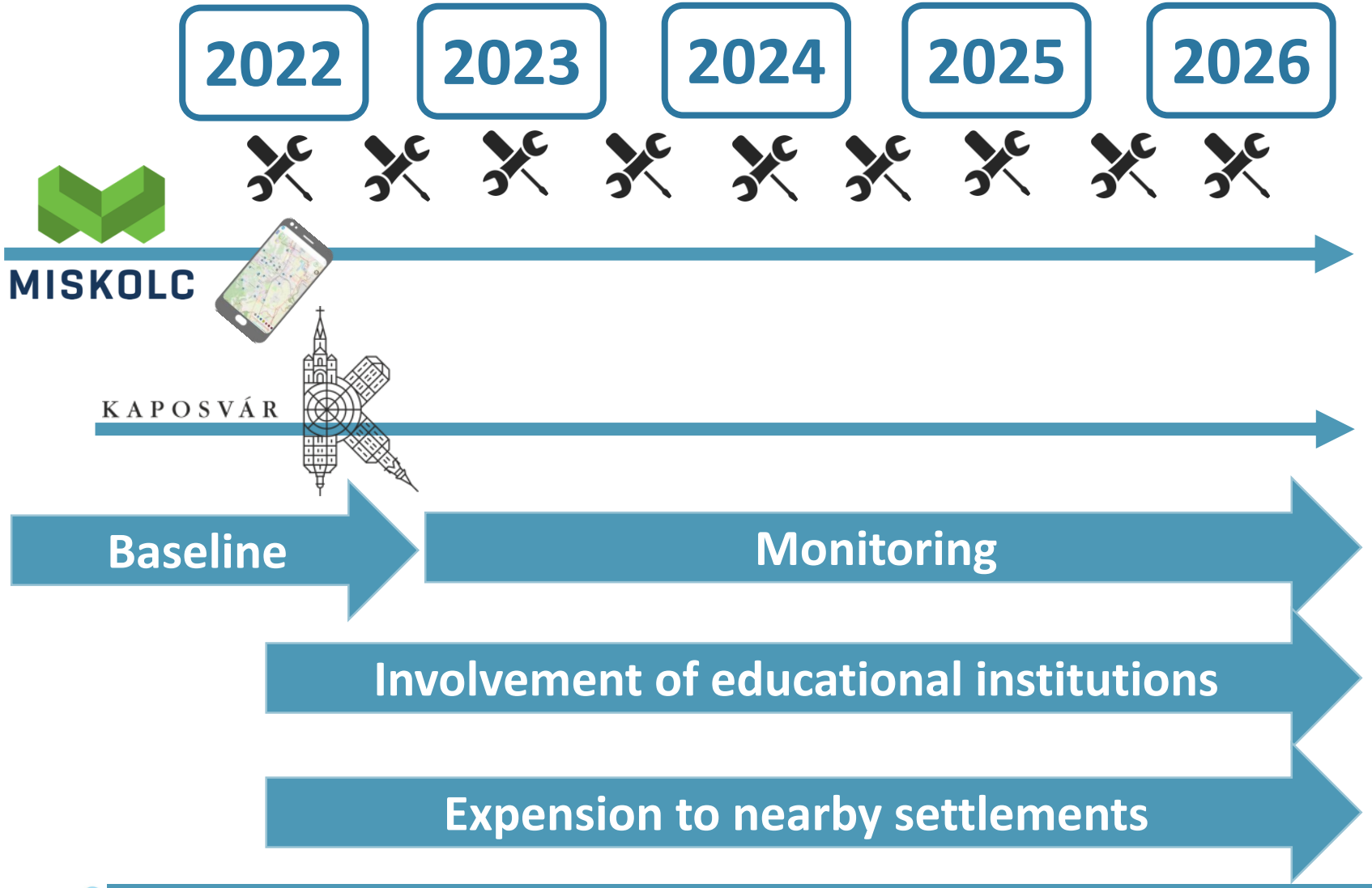


pmmonitoring.hu

Information

Communication

Future Plans



Mobile sensoring

- Microcontroller (Raspberry Pi Zero)
- GPS module (NEO-6M)
- T, RH, P sensor (BME 280)
- PM sensor (Plantower 7003)
- RTC chip (DS3231)

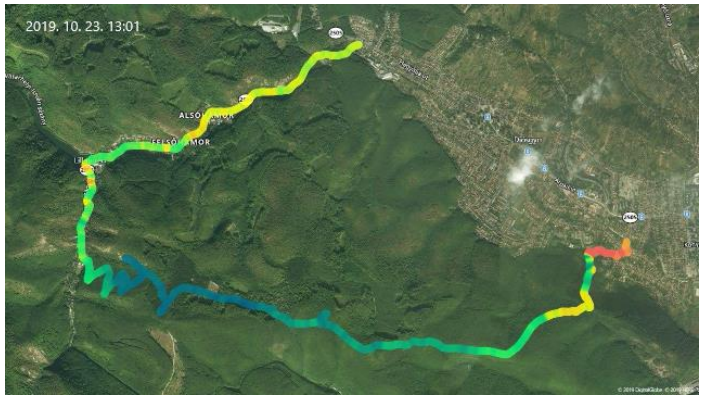
Hotspot identification with portable low-cost particulate matter sensor (International Journal of EWFN)

The Research Interest Score (4.0) at ResearchGate is higher than 93% of items published in 2019.

Mobile sensoring

$PM_{2.5}$ [$\mu g/m^3$]

Sarasota - Bentley's Boutique Hotel

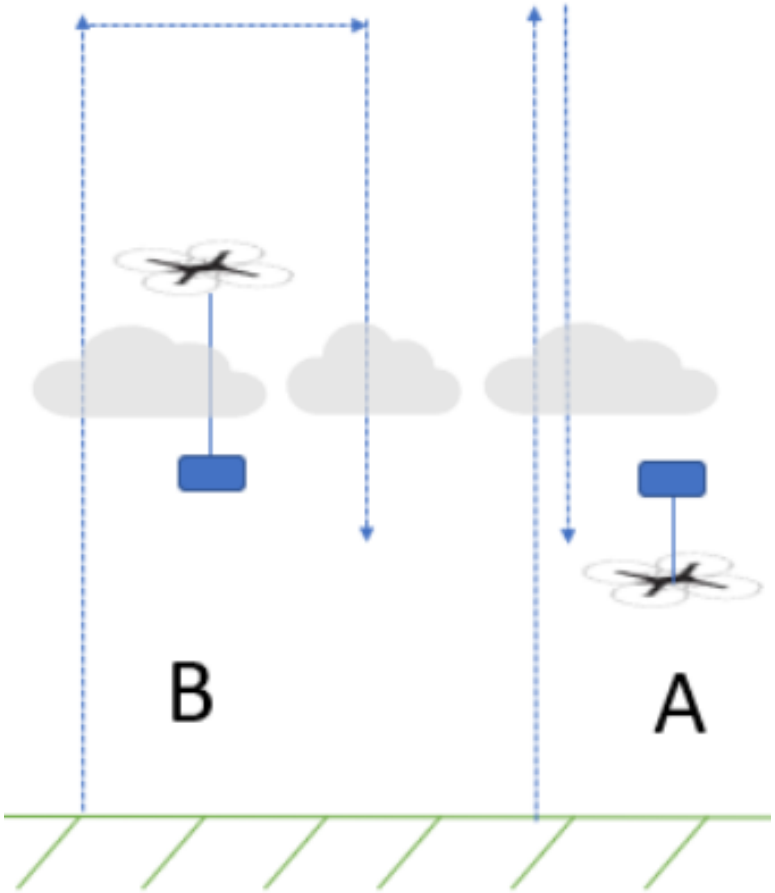


Miskolc - Fehérkőlápa

Sarasota - Sierra Beach

Miskolc – Martin-kertváros

Mobile sensoring



DJI S800
Multicopter with 6 rotor
360W

Acknowledgments

MVK Zrt.
A Miskolc Csoport tagja

MIVÍZ
A Miskolc Csoport tagja

Computer PONT

ORSZÁGOS
METEOROLÓGIAI
SZOLGÁLAT

AGRÁRMINISZTÉRIUM

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