CLAIRO CONFERENCE: LIVABLE AND CLIMATE RESILIENT EUROPEAN CITIES

How to use air quality data for greenery planting in the city

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CLAIRO

OSTRAVA!!!

SLEZSKÁ UNIVERZITA

Moravskoslezský kraj

VŠB TECHNICKÁ UNIVERZITA OSTRAVA

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Air monitoring has been carried out in the Czech Republic historically intensively since the 1970s. The first stations were fully manual, gradually being replaced by automatic ones. In the 1980s, virtually every city in the Czech Republic monitored and there were hundreds of air quality measuring stations. They focused primarily on sulfur dioxide and overall dust.

At that time, there was a problem of air contamination, especially SO2 from power plants and other non-desulfurized sources. This situation has changed dramatically after the modernization of power plants and today SO2 monitoring is being abandoned. Until 2011, the statutory regulatory system only applied to SO2.

Today, the most fundamental pollutant in the air is dust aerosol, namely fine fractions PM10 and PM2.5.

An even more significant problem is the content of organic substances in the dust aerosol, especially polycyclic aromatic hydrocarbons, especially the dangerous benzo (a) pyrene.

In 2014, there are around 150 air pollution monitoring stations throughout the Czech Republic.

SENSORS +/-

- Rapid development; the future of monitoring (drones, smart cities, urban networks, corporate networks)

- Dust sensors – optical principle

- Gas sensors – electrochemical detectors

- Orientation measurements - the need to follow the reference methods

- Projects fot the sensors testing

- Cairpol, Alphasense, Plantower, Scentroid,...

SENSORS +/-

- very small size (cm)
- low energy consumption
- fast response
- low price
- dynamic development

no legislation
orientation measurement
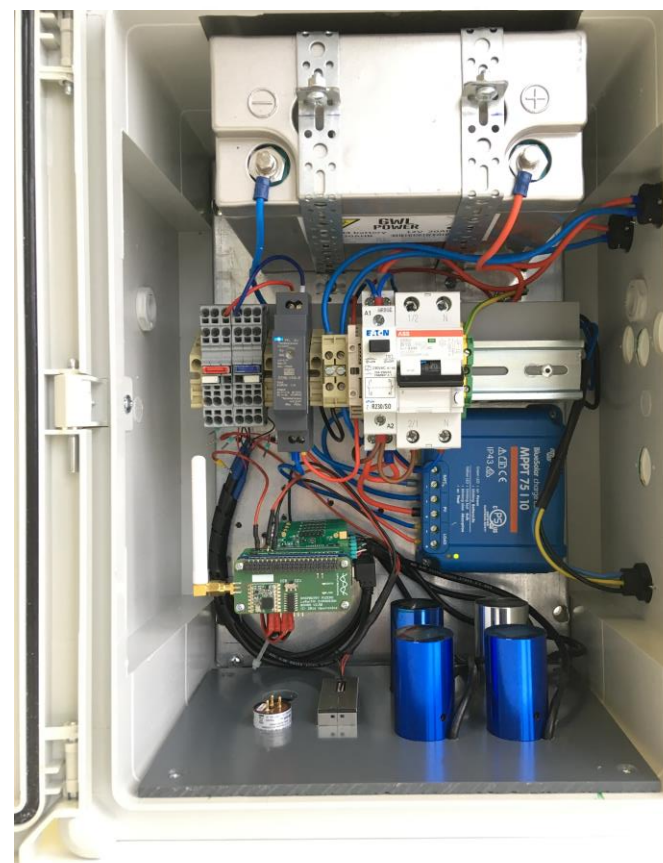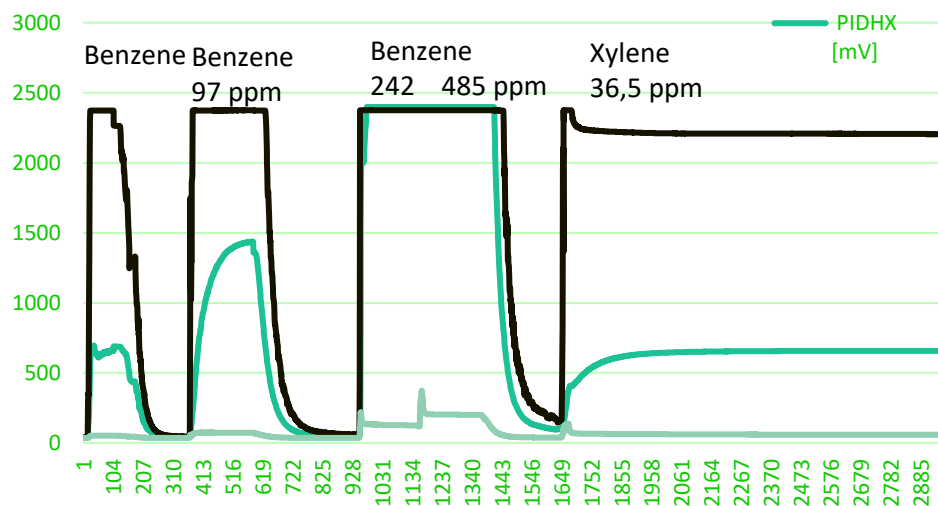congestion or poisoning
shorter service life

AIR MONITORING
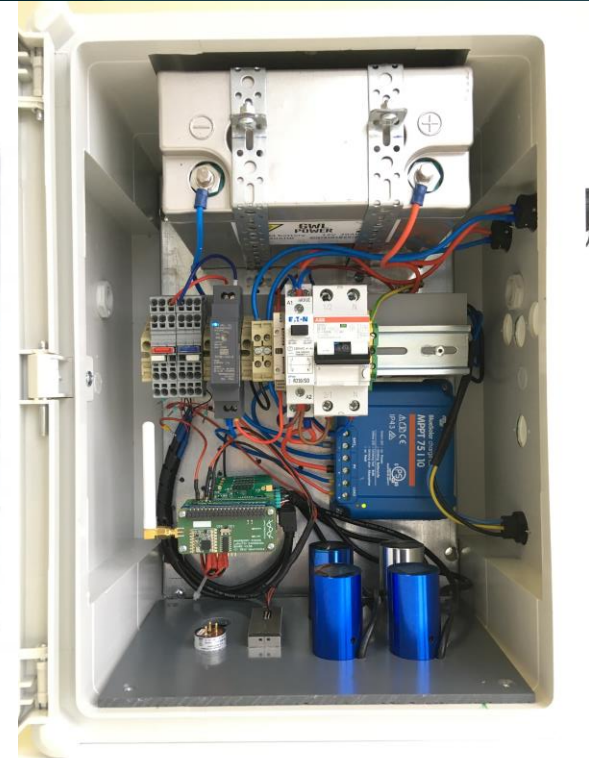
PROCESS IDENTIFICATION

ONLINE BOILER DIAGNOSTICS

CLAIRO

inteligentní identifikační systém zdrojů znečištění ovzduší

INOVATIVNÍ VÝSADBA STROMŮ V OSTRAVĚ

IDENTIFICATION OF POLLUTION SOURCES

OPERATIONAL MEASUREMENT

ACCIDENT PREVENTION

LARGE NETWORKS

Trends of hourly ozone concentrations (ug/m³)

	Stanice	Velicina	Vzorkování [min]	Všechna pozorování	Validní pozorování	Minimum	Ar. průměr	Geom. průměr	Maximum
1	stc-02 [31.08.2019. - present]	O3 [ug/m3]	60	2185	2173	0.4	58.9	48	180.3
2	stc-06 [25.06.2019. - present]	O3 [ug/m3]	60	2185	2172	0.4	58.5	48.9	144.1
3	stc-07 [31.08.2019. - present]	O3 [ug/m3]	60	2185	2173	0.4	49.8	30.2	136.2
4	stc-08 [25.06.2019. - present]	O3 [ug/m3]	60	2185	2172	0.4	62	52.2	146.7
5	stc-10 [31.08.2019. - present]	O3 [ug/m3]	60	2185	2172	0.5	71.4	59.9	179.5
6	stc-12 [29.08.2019. - present]	O3 [ug/m3]	60	2185	2172	0.4	63	53.4	171.9
7	stc-17 [01.07.2019. - present]	O3 [ug/m3]	60	2185	2172	0.4	72	61	170
8	stc-21 [25.06.2019. - present]	O3 [ug/m3]	60	2185	2181	2.8	72.6	65.2	175.4

Measuring units composed of selected sensors were designed and constructed for the project

PERMANENT DATA PLATFORM

WWW.AIRSENS.EU

SENSORS

- 📈 Analýza
- 🗺 Mapa
- ≔ Správa
- ➡ Odhlásit

INTELIGENTNÍ IDENTIFIKAČNÍ SYSTÉM ZDROJŮ ZNEČIŠTĚNÍ OVZDUŠÍ | VŠB TECHNICKÁ UNIVERZITA OSTRAVA | CENTRUM ENET | VŠB TECHNICKÁ UNIVERZITA OSTRAVA | INSTITUT ENVIRONMENTÁLNÍCH TECHNOLOGIÍ | VŠB TECHNICKÁ UNIVERZITA OSTRAVA | IT4INNOVATIONS NÁRODNÍ SUPERPOČÍTAČOVÉ CENTRUM | CLAIRO | INOVATIVNÍ VÝSADBA STROMŮ V OSTRAVĚ

EVROPSKÁ UNIE
Fond soudržnosti
OP Životní prostředí

Nastavení

Vyberte tabulku

Měření neupravené ▾

Vyberte datum od

01.01.2021 📅

Vyberte datum do

30.04.2021 📅

Vyberte projekty

PAV identifikace ▾

Vyberte stanice

stp-90 [02.07.2020. - present] ▾

Vyberte veličiny

AI1 [V] ▴

🔄 Aktualizovat data

Tabulka —

Obecná identifikace.
❌ Ne

Postupný růst - hodina.
❌ Ne

Dlouhé překročení limitu - hodina.
❌ Ne

Postupný růst - půlhodina.
❌ Ne

Rychlý nárust.
❌ Ne

Dlouhé překročení limitu - 2 hodiny.
❌ Ne

Zobraz záznamů 50 ⬍   Hledat:

Projekt	PAV identifikace
Stanice	stp-90
Parametr	CF [V]
Kalibrační hodnota	1 ⬍
Validní od	02.07.2020 📅
Validní do	02.07.2070 📅

Odeslat změny

Zrušit

View ⭥	Proje...	...od ⭥	Validní do ⭥	Vytvořeno ⭥	Potvrzeno ⭥
All	PAV		All	All	All
Upravit	PAV ident...	0	2. 7. 2070 6:47:00	27. 10. 2020 13:15:41	true
Upravit	PAV ident...	0	2. 7. 2070 6:47:00	27. 10. 2020 13:15:41	true
Upravit	PAV ident...	0	2. 7. 2070 6:47:00	27. 10. 2020 13:15:41	true
Upravit	PAV identifikace	stp-90	CN3 [V]	1	2. 7. 2020 6:47:00	2. 7. 2070 6:47:00	27. 10. 2020 13:15:41	true

Obecná identifikace.
❌ Ne

Postupný růst - hodina.
❌ Ne

Dlouhé překročení limitu - hodina.
❌ Ne

Postupný růst - půlhodina.
❌ Ne

Rychlý nárust.
❌ Ne

Dlouhé překročení limitu - 2 hodiny.
❌ Ne

Zobraz záznamů 50 ⬍   Hledat:

Projekt ⭥	Stanice ⭥	Látka ⭥	Interval ⭥	Platný od ⭥	Platný do ⭥	Hodnota ⭥	Validní ⭥	Varování ⭥
All	All	All	All	All	All	All	All	All
PAV identifikace	stp-90 [02.07.2020. - present]	AI1 [V]	1	7. 1. 2021 16:15:00	7. 1. 2021 16:15:59	21.5	1	0

MEASUREMENT OF QUALITY OF MEASUREMENT

Nastavení —

Vyberte tabulku

Historie kalibrací ▾

Vyberte projekty

PAV identifikace ▾

Stanice a veličiny není nutno vybírat.

Vyberte stanice

stp-90 ▾

Vyberte veličiny

23 items selected ▴

↻ Aktualizovat data

Tabulka — ↗

Zobraz záznamů 50 ⇕   Hledat: [ ]

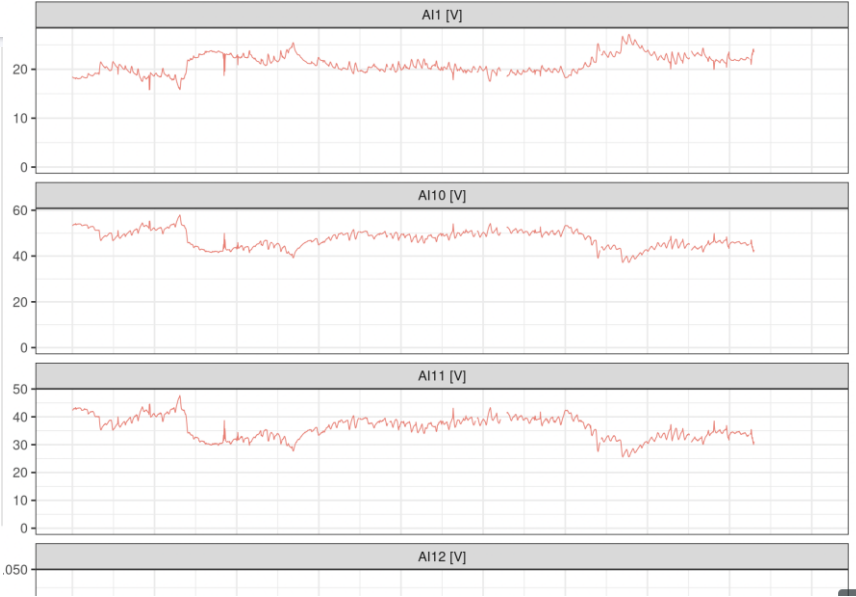| Projekt ⇅	Stanice ⇅	Parametr ⇅	Kalibrační hodnota ⇅	Validní od ⇅	Validní do ⇅	Vytvořeno ⇅	Potvrzeno ⇅
All	All	All	All	All	All	All	All
PAV identifikace	stp-90	CF [V]	1	2. 7. 2020 6:47:00	2. 7. 2070 6:47:00	27. 10. 2020 13:15:41	true
PAV identifikace	stp-90	GYR1 [V]	1	2. 7. 2020	2. 7. 2070	27. 10. 2020	true

DATA FROM THE SENSORS

DATA WORK - 25 million hours / year

| Čas/ Lokalita	1	2	3	4	5	6	7	8	9	10
13:36:00	29,50	27,20	26,00	29,60	**79,11**	27,80	26,50	25,60	24,40	26,50
13:37:00	27,40	26,30	25,10	27,40	**73,71**	26,60	27,90	26,50	25,50	27,90
13:38:00	27,60	27,30	26,20	27,60	**74,52**	27,40	27,20	26,30	25,20	27,20
13:39:00	27,50	27,20	26,10	27,50	**74,25**	27,40	25,90	24,90	23,90	25,90
13:40:00	26,70	26,50	25,70	26,70	**72,09**	26,60	26,00	25,00	23,80	26,00
13:41:00	30,20	29,80	28,40	30,20	**81,54**	29,90	24,20	24,00	23,20	24,20
13:42:00	29,10	27,90	26,60	29,10	**78,57**	28,40	23,20	23,00	22,60	23,20
13:43:00	29,10	28,30	27,00	29,10	**78,57**	28,60	20,70	20,50	19,90	20,70
13:44:00	29,80	28,20	26,80	29,80	**80,46**	28,80	19,70	19,50	18,90	19,70
13:45:00	25,50	25,10	**39,10**	**45,40**	**68,85**	**90,20**	21,00	20,90	20,40	21,00
13:46:00	27,10	26,40	25,10	27,10	**73,17**	26,70	21,70	21,20	20,50	21,70
13:47:00	27,00	26,50	25,70	27,00	**72,90**	26,70	22,70	22,40	21,50	22,70
13:48:00	26,10	25,30	24,50	26,10	**70,47**	25,50	21,20	21,10	20,50	21,20
13:49:00	24,40	24,20	23,40	24,40	**65,88**	24,30	21,70	21,00	20,10	21,70
13:50:00	26,00	23,80	22,60	26,00	**69,66**	24,40	21,20	20,80	20,30	21,20
13:51:00	24,80	23,50	22,50	24,80	**66,69**	23,80	22,00	21,10	20,20	22,00
13:52:00	23,70	23,40	22,60	23,70	**63,99**	23,50	21,40	21,10	20,50	21,40
13:53:00	23,90	23,60	22,90	23,90	**64,53**	23,70	20,30	20,10	19,70	20,30
13:54:00	22,50	22,50	22,00	22,50	**60,75**	22,50	18,70	18,30	17,80	18,70
13:55:00	23,00	22,50	21,50	23,00	**62,10**	22,70	18,70	18,70	18,40	18,70
13:56:00	23,00	23,00	22,50	23,00	**62,10**	23,00	19,40	19,30	18,70	19,40
13:57:00	23,90	23,70	22,90	23,90	**64,53**	23,80	19,90	19,80	19,00	19,90
13:58:00	24,00	23,70	23,30	24,00	**64,80**	23,80	18,40	18,30	17,80	18,40
13:59:00	24,00	23,80	23,20	24,00	**64,80**	23,90	17,20	17,10	16,90	17,20
14:00:00	24,00	23,60	22,50	24,00	**64,80**	23,80	19,90	19,70	19,20	19,90
14:01:00	23,60	23,40	22,60	23,60	**63,72**	23,50	20,10	20,00	19,60	20,10

Importance of sensor network

1. sensors are a suitable additional measurement of the existing network

2. sensors are many times cheaper than stationary monitoring systems

3. the sensors can detect "non-standard" situations in the locality and reveal the time of specific events

4. sensors should record not only air pollution concentrations of individual pollutants (PMx, NOx, O3, etc.), but also meteorological conditions, which contribute to the efficiency of capture

5. the sensors are easy to install and have almost unattended operation

6. the sensors can be independent of the energy source, thanks to the connection to the solar panel

7. the sensors differ from each other in pieces and must be calibrated to each other

8. data from sensors can be transmitted in real time to an online system, which is used for quick visualization and evaluation

9. however, in the case of wireless data transmission via the mobile data network (GPRS), the load on the sensors increases

10. evaluated data obtained from measuring sensors should be reflected in the design of the composition and deployment of local green infrastructure

Installation of a sensor network in localities of interest

- 19 sensor units and one reference system

- installation before planting greenery, evaluation of the effectiveness of catching pollution by newly planted green infrastructure.

- continuous measurement for another at least 8 years, the development over time with the development of green matter and the involvement of the stand is also evaluated.

senzory meteorologických parametrů
senzory koncentrací znečištění

Sensors parameters
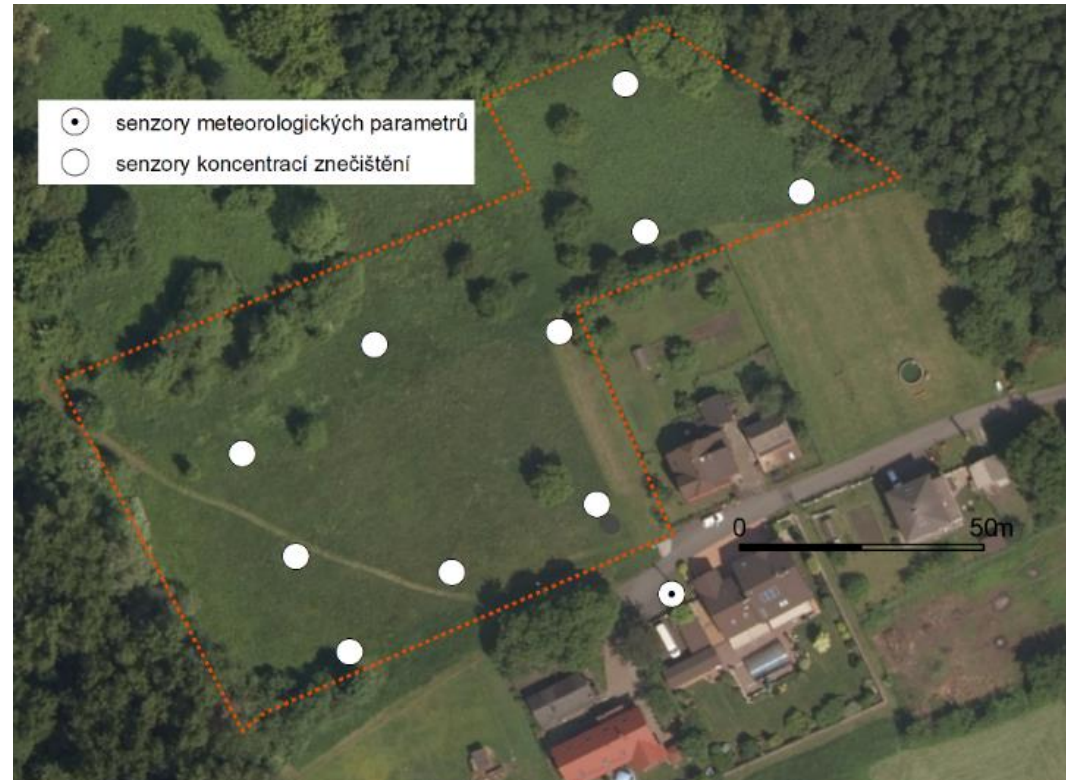
- The sensor unit is a device consisting of a measuring part with dimensions of 300x400x220 mm and a solar panel with dimensions of 620 x 670 mm

- Each sensor is alternatively independent of the power supply, it contains a battery, a connection to the solar panel and a 220V mains connection.

- The devices are installed on metal pipes to a height of about 4 meters.

Measured characteristics

Concentration of $PM_{10,}$ O_3 and NO_x :

- 15-minutes step
- spatial interpolation (ordinary kriging) of monthly averages in a 1 x 1 m network
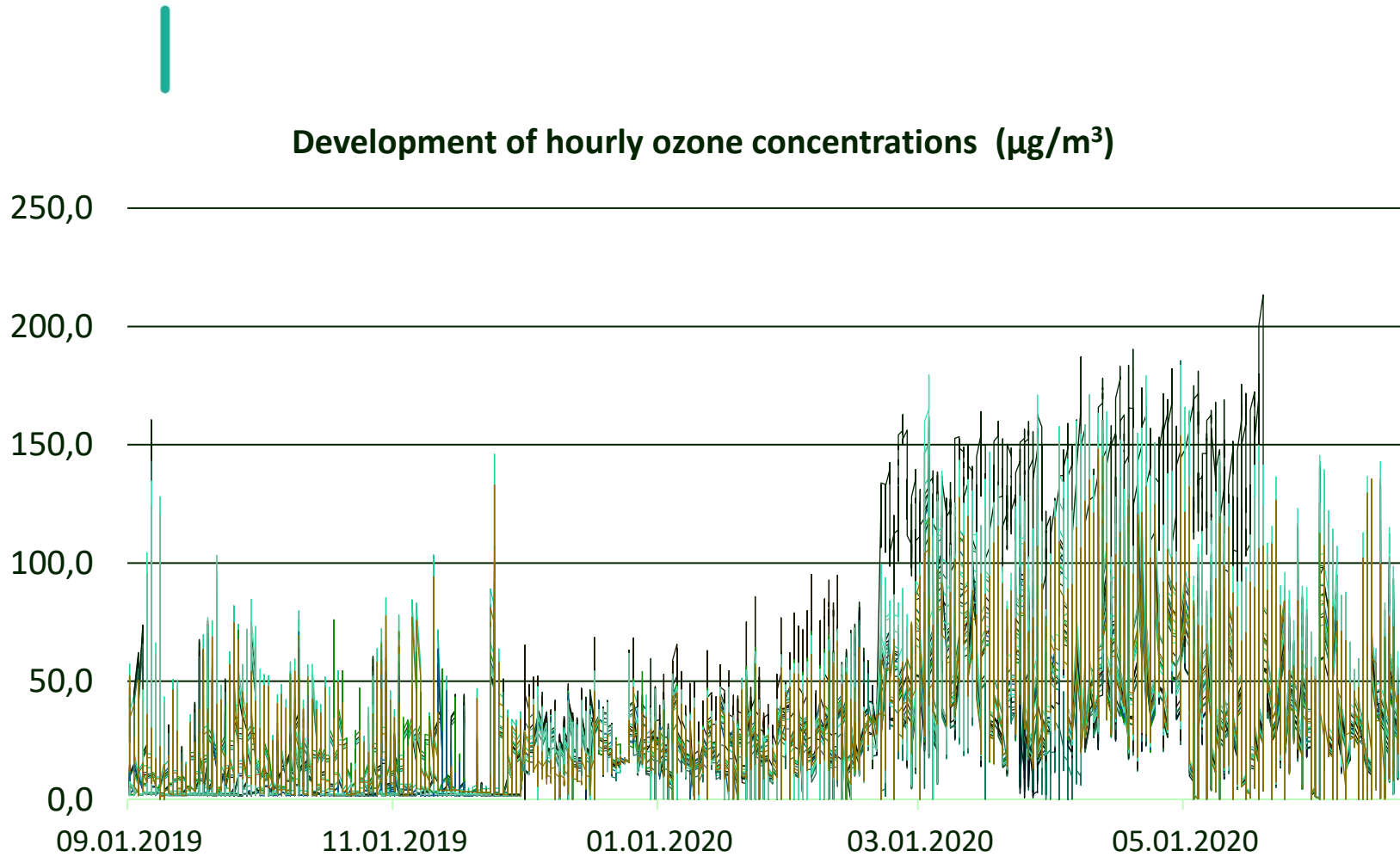
Measured meteorological parameters:

- Global radiaotion ($W*m^{-2}$) T
- Air temperature (°C)
- Wind speed (m s^{-1})
- Relative air humidity (%)

PM$_{10}$ Concentrations


PM10 – trend of the concentrations (µg/m³)
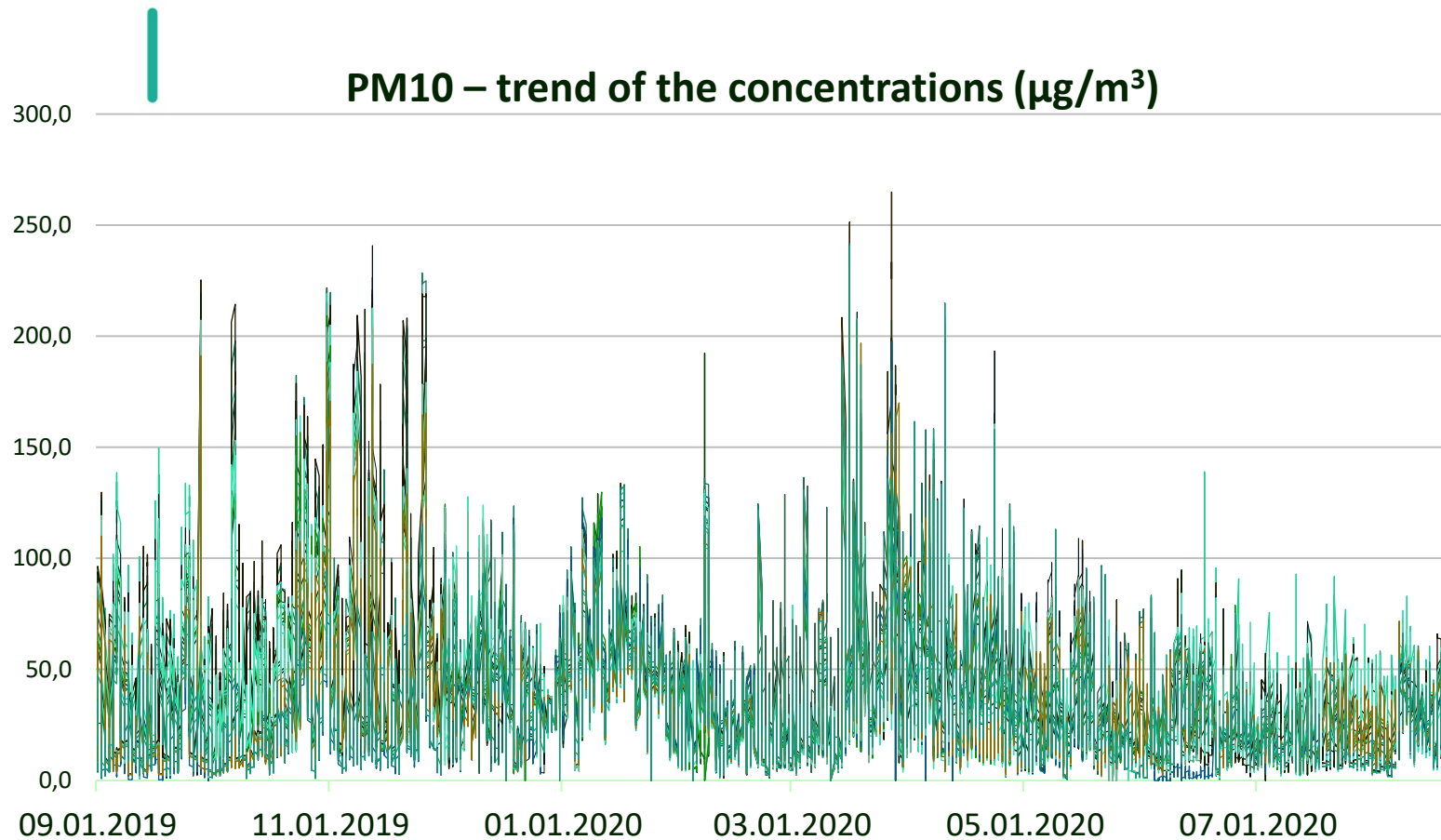
- The results so far indicate a very good compliance with the reference stations for PMx

Ozone concentrations

Development of hourly ozone concentrations (µg/m³)

Air pollution monitoring information system

The sensor units are connected to one common network and provide online data wirelessly. Data transfers are implemented to the existing intelligent information system, which allows:

- collection of short-term concentrations from sensors
- store the transferred data in a specially structured database
- perform their automatic control
- perform validation following reference measurements
- perform a manual evaluation of the validity of the data
- create concentration maps for individual pollutants
- perform model calculation based on measured meteorological indicators (wind speed and direction)
- run animated sequences for different intervals (hour, day, month)
- automatically indicate the place and time of the "non-standard" concentration in the concentration tables
- create data exports for individual IIS network points to tables
- store data and maps in a clear archive

Air quality monitoring - Information system
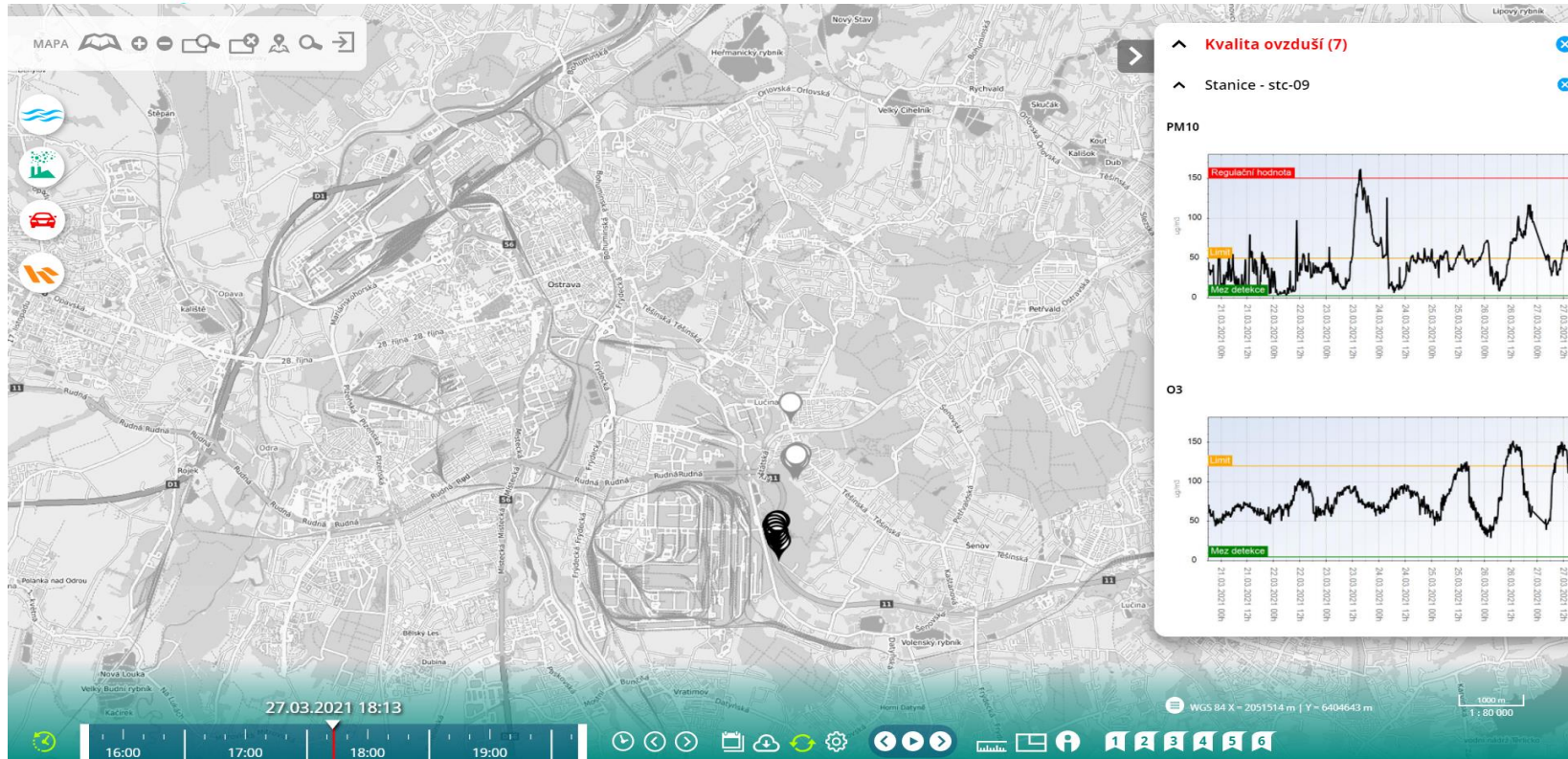
- Data overview and visualization at map portalu:
  https://floreon.eu/mapa/ or https://www.airsens.eu/

Thank you for your attention