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Institut Ochrony Środowiska
Państwowy Instytut Badawczy

Air quality modelling for 5 year assessment

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IEP-NRI is legislated to carry out AQ modelling for policy support

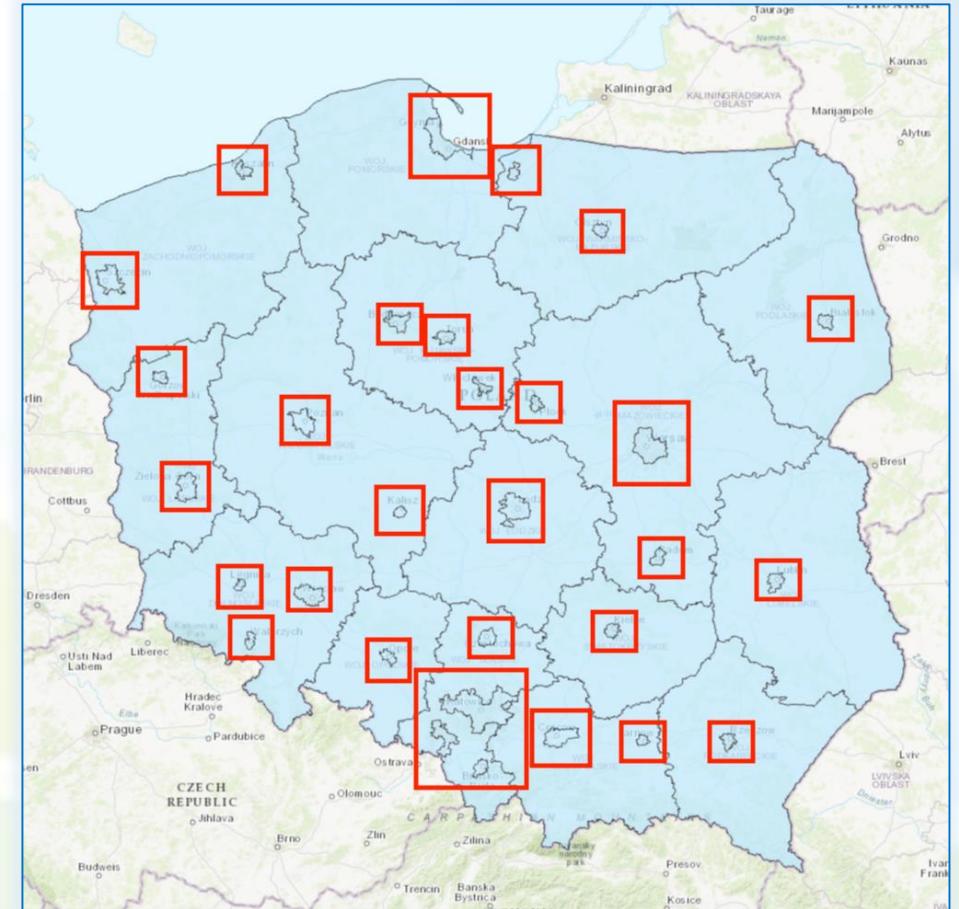


- Chief Inspectorate of Environmental Protection:
 - Daily operational forecast (3 day forecast)
 - Annual air quality assessment (20th of March)
 - 5-year assessment (20th of May)
 - Impact of transboundary transport (30th of June)
 - Station representativeness (30th of October)
- Ministry of Climate and Environment:
 - National Air Quality Improvement Plan (30th of September)

Modelling domains



- Central Europe: ~ 10km
 - Boundary conditions
 - Transboundary assessment
- Poland: ~2.5 km
 - Annual assessment, **5-year assessment**
 - Forecast
 - Station representativeness
- 30 urban zones: 500m
 - Annual assessment





GEM-AQ model

Global Environmental Multiscale – Air Quality model

- MAQNet (2001-2008) – Kaminski et al., 2008
- On-line model (host meteorological model GEM, from Environment and Climate Change Canada)
- Optimal Interpolation used for surface station assimilation
- Gas phase chemistry based on the extended ADOM-IIB mechanism
- Sectional aerosol module (12 bins)
- Anthropogenic and biogenic emissions
- HDD modulated residential emissions
- For the national modelling Central Emission Database is used

Central Emission Database – key features



- Developed by the The National Centre for Emissions Management (KOBiZE)
- Purpose: consistent database for national AQ modelling
- Estimated pollutants: SO_x, NO_x, CO, PM₁₀, PM_{2.5}, B(a)P, NMVOC, NH₃, CH₄
- Vector data for each sector, sharing in 0.005°x0.005°
- Emissions in SNAP category (plan to transfer to GNFR)
- BUP (bottom-up): residential combustion, industrial, road transport
- TOD (top-down): air transport, agriculture

Central Emission Database



Central Emission Database

Point sources	<ul style="list-style-type: none">• Organized emission from instalatios• Unorganized emission from instalatios
Line sources	<ul style="list-style-type: none">• roads• railroads• airports
Resitential comubstion	<ul style="list-style-type: none">• individual low-power heating systems
Agriculture and crops	<ul style="list-style-type: none">• breeding• cultivation, fertilization• tractors (combustion of fuels)
Unorganized emission	<ul style="list-style-type: none">• ladnfilds• excavations and heaps
Natural emission	<ul style="list-style-type: none">• Forets and soil

Pollutions

- sulfur oxides
- nitrogen oxides
- CO
- PM10
- PM2.5
- B(a)P
- NMVOC
- NH₃
- CH₄

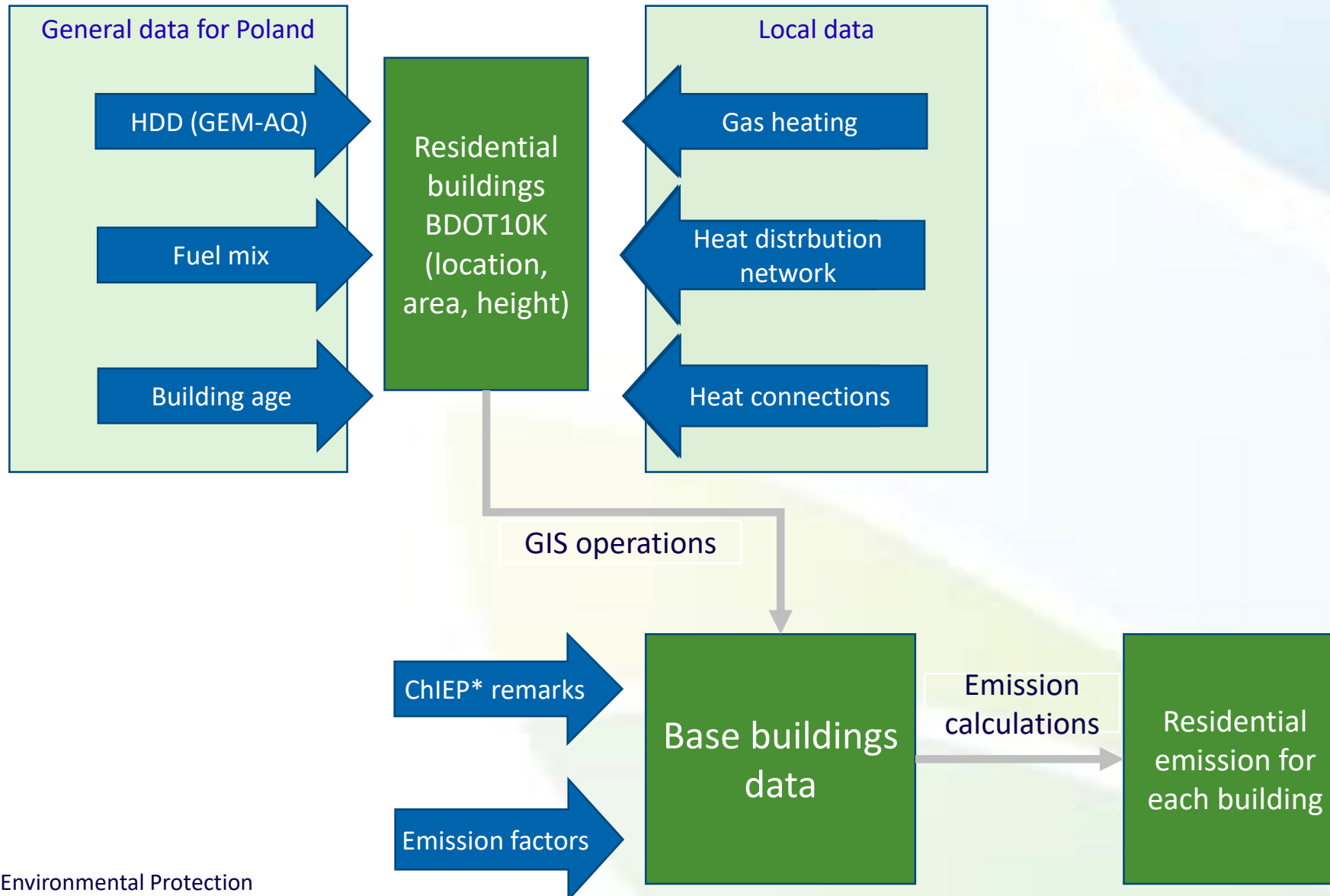
Emissions in SNAP category (plan to transfer to GNFR)

Resolution

- Vector data for each sector
- Sharing in 0.005°x0.005°

Residential combustion emission

<https://doi.org/10.3390/atmos12111460>

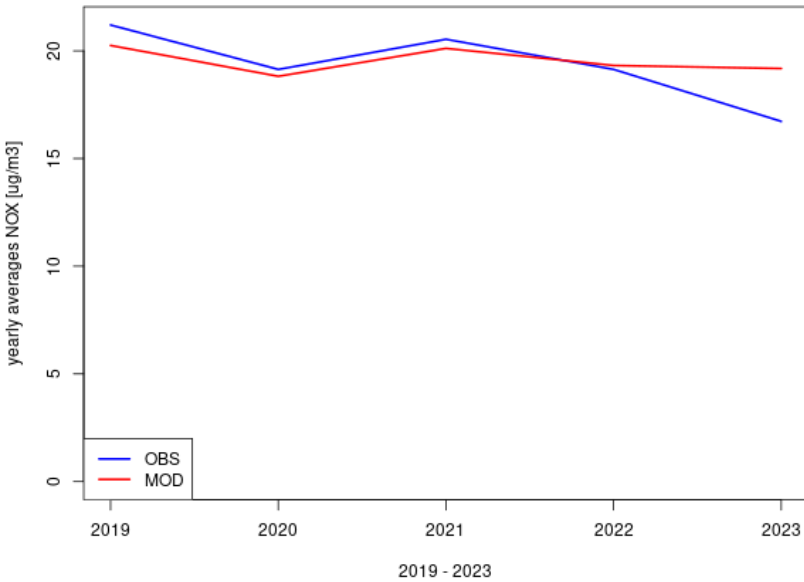


*Chief Inspectorate for Environmental Protection

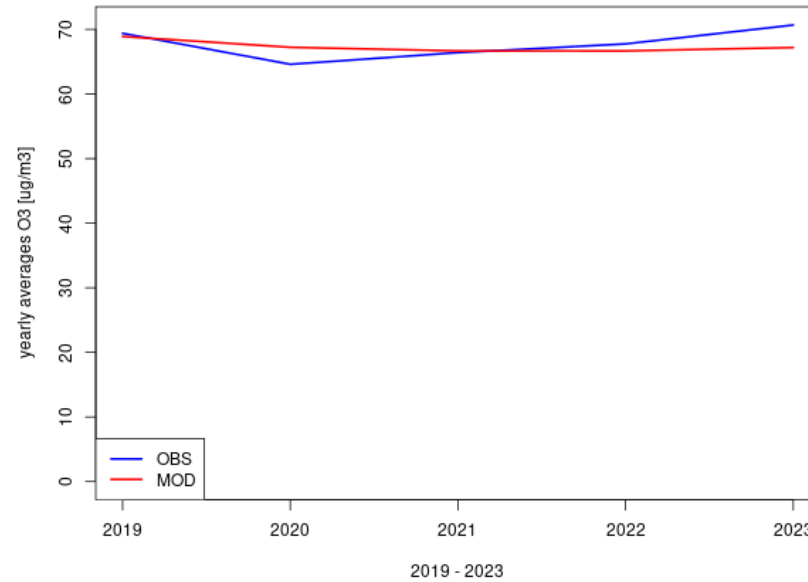
Trends in concentrations - gaseous pollutants



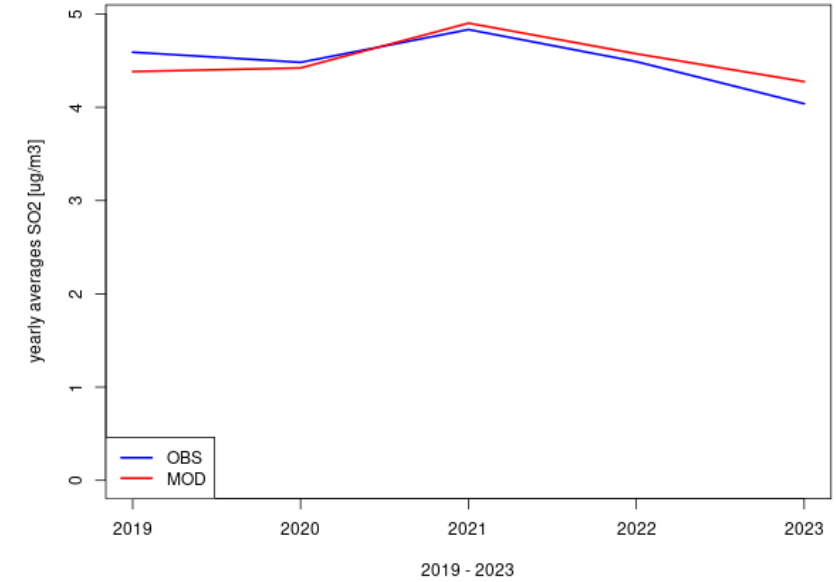
NOX 5 year assesment



O3 5 year assesment



SO2 5 year assesment

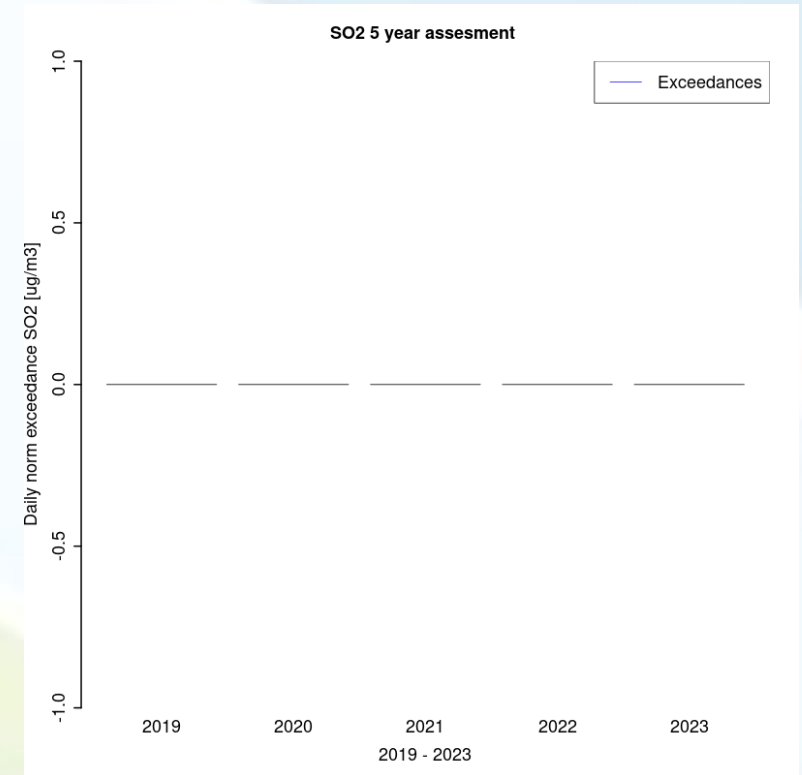
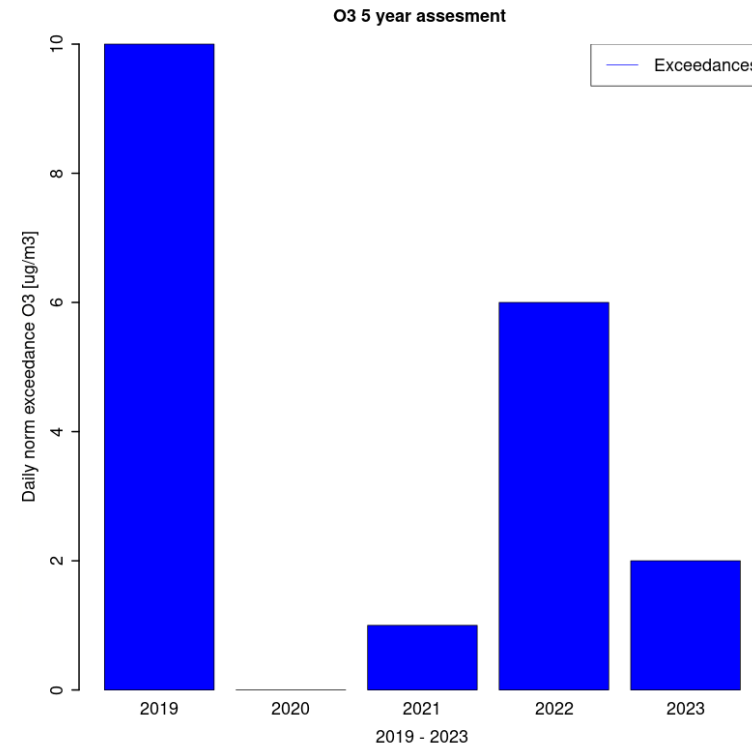
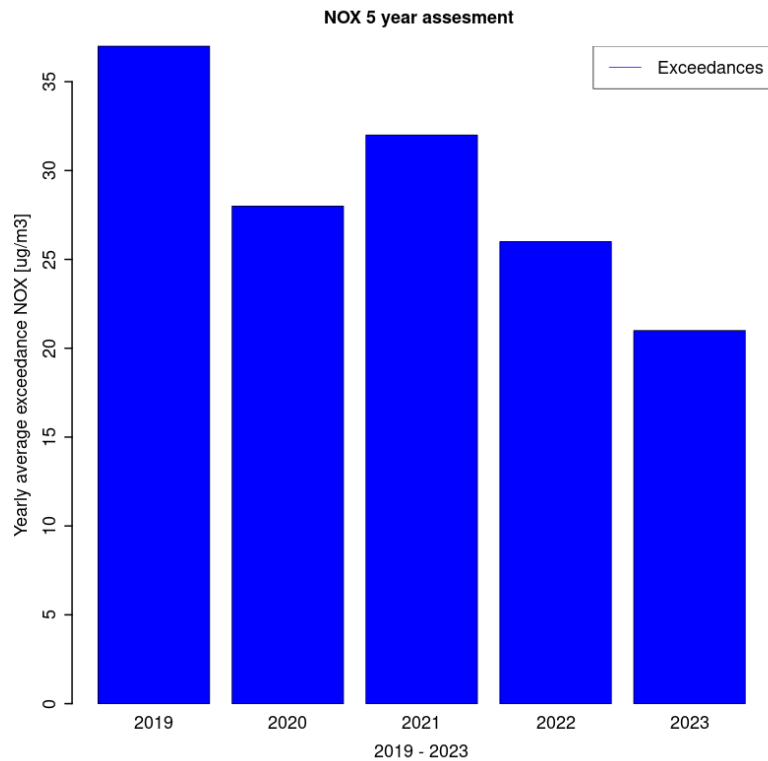


Yearly concentrations – all stations averaged

Red line – modelled concentrations

Blue line – measurements

Threshold limits exceedances - gaseous pollutants



Based on measurements – number of station with exceedances

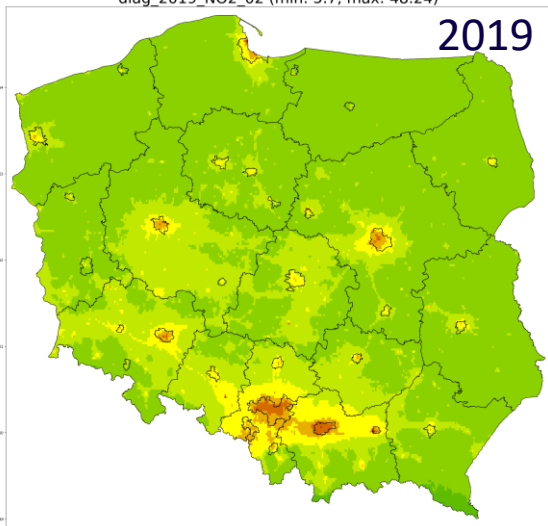
NOX – yearly average exceedances

O3 – daily threshold exceedances

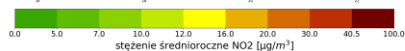
5-year assessment 2019-2023 – NO₂



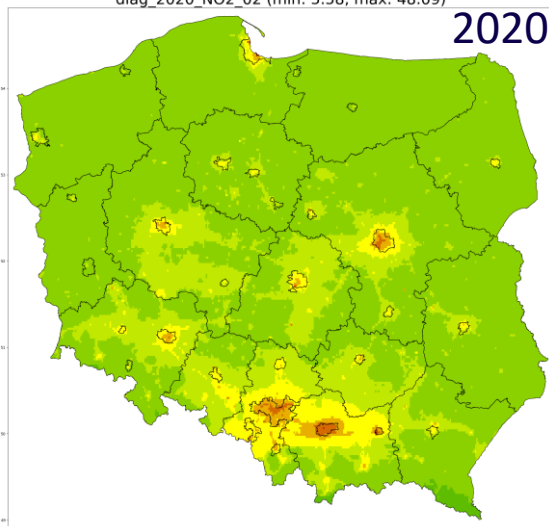
diag_2019_NO2_O2 (min: 5.7, max: 48.24)



2019



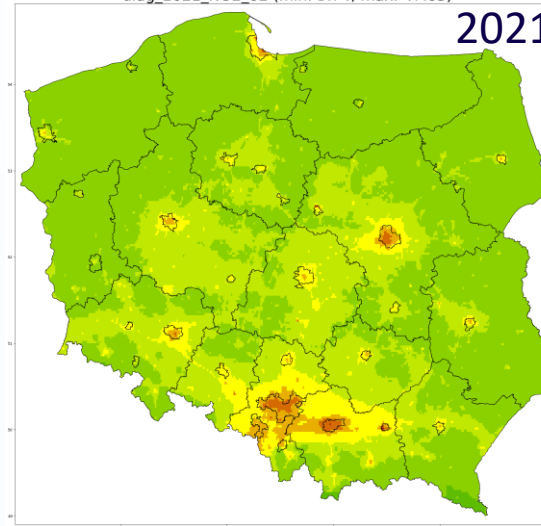
diag_2020_NO2_O2 (min: 5.58, max: 48.09)



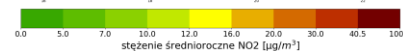
2020



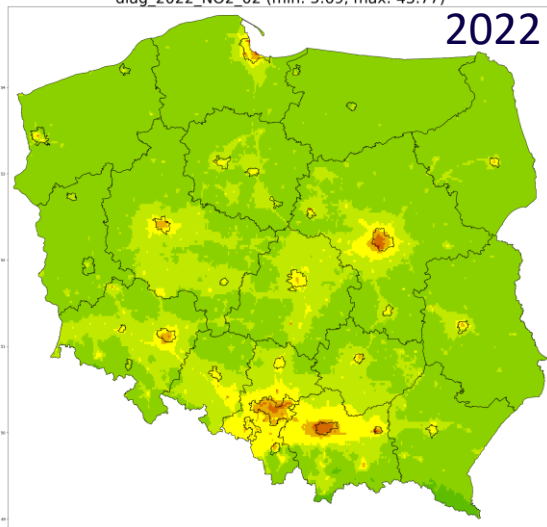
diag_2021_NO2_O2 (min: 5.74, max: 47.03)



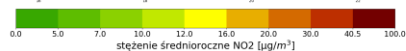
2021



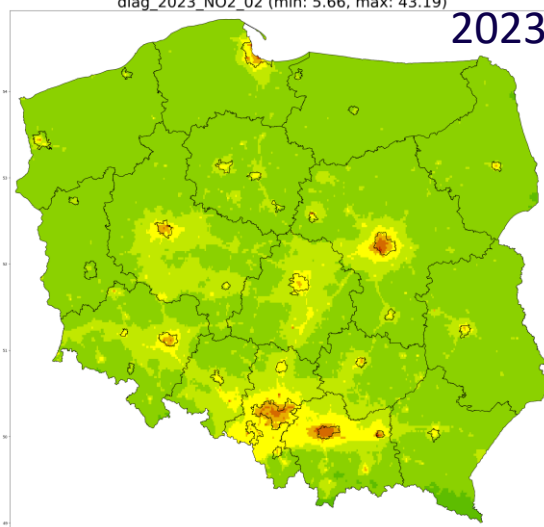
diag_2022_NO2_O2 (min: 5.69, max: 43.77)



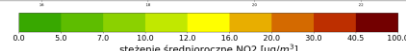
2022



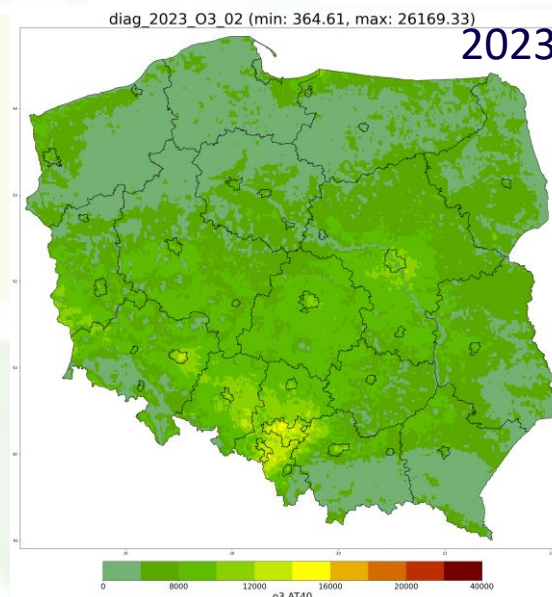
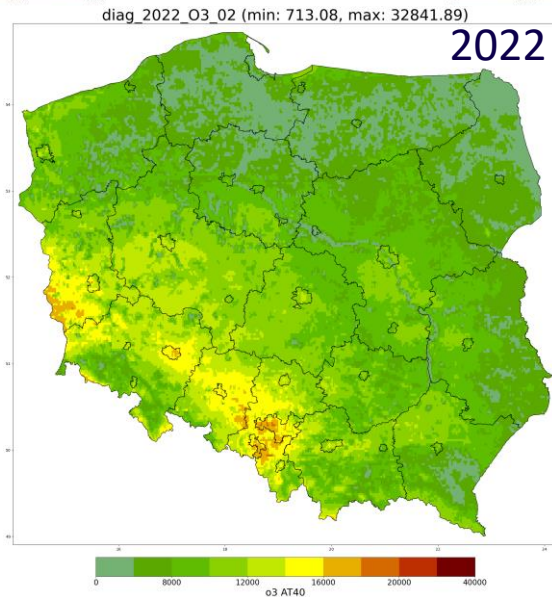
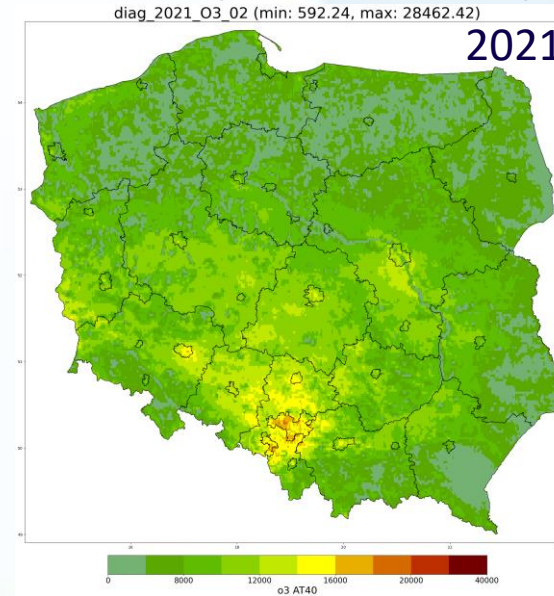
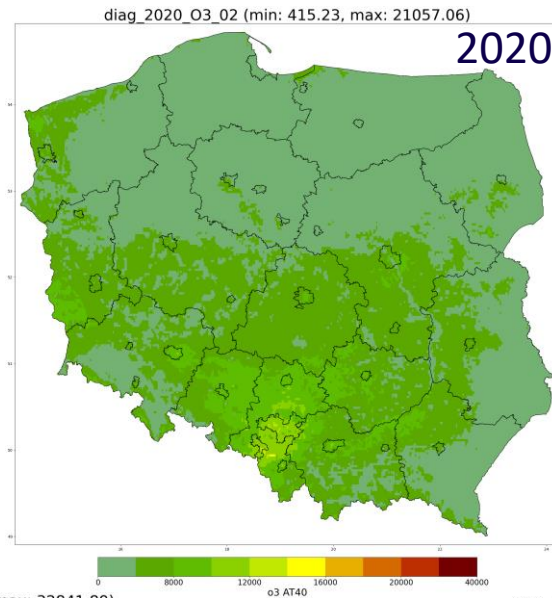
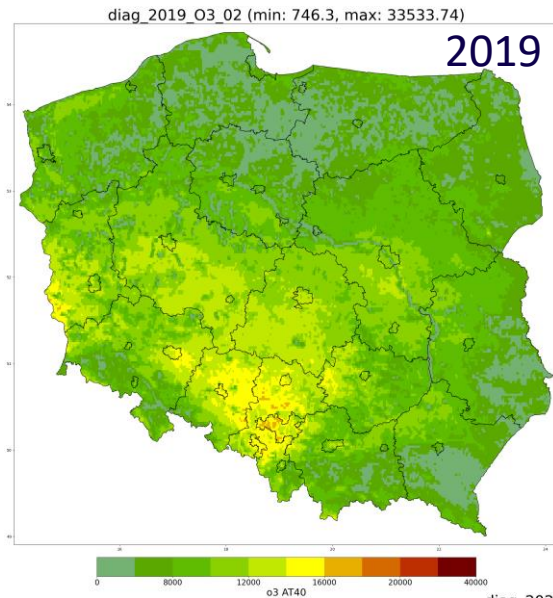
diag_2023_NO2_O2 (min: 5.66, max: 43.19)



2023



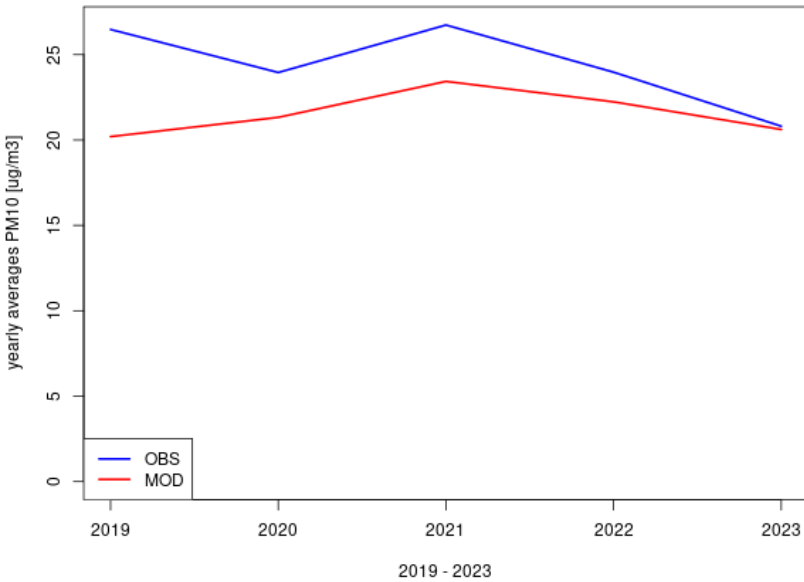
5-year assessment 2019-2023 – O3 (AOT40)



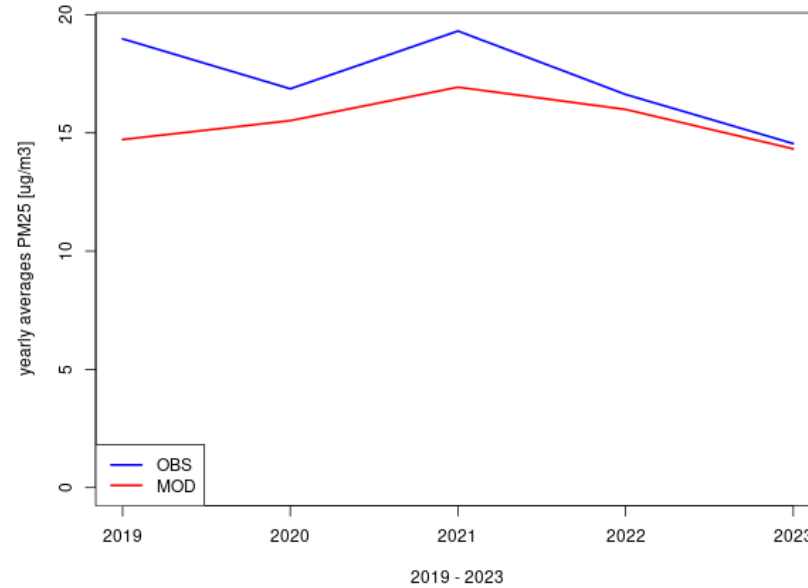
Trends in concentrations – PM and B(a)P



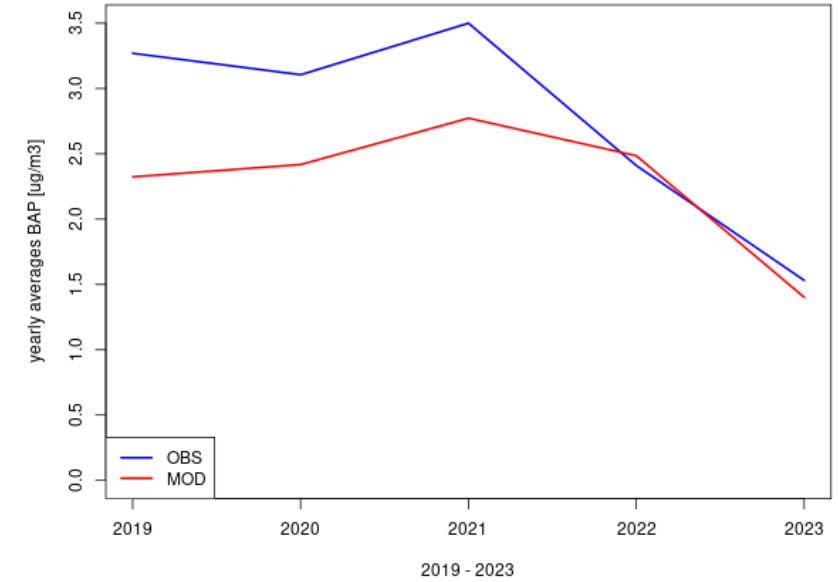
PM10 5 year assesment



PM25 5 year assesment



BAP 5 year assesment

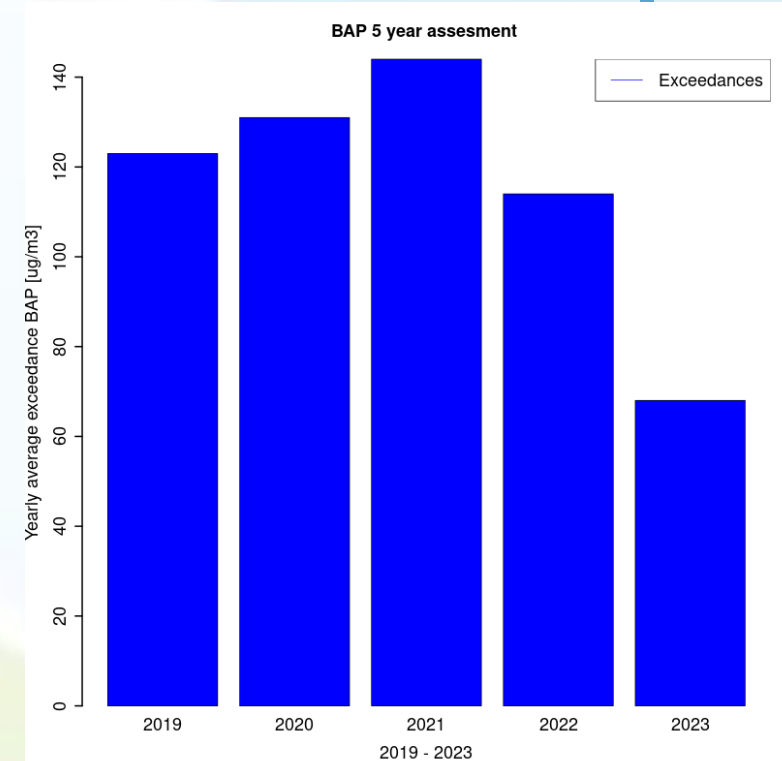
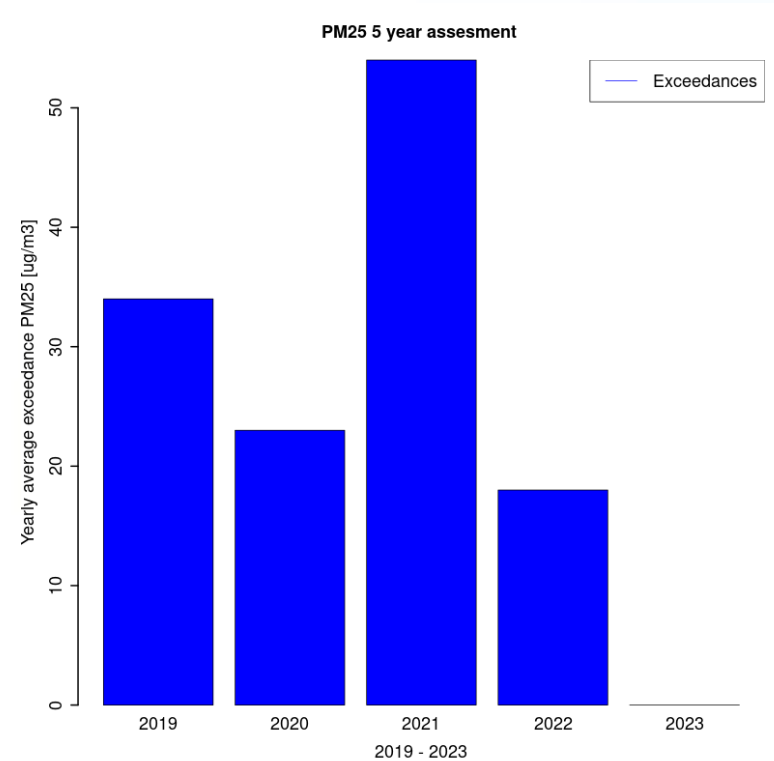
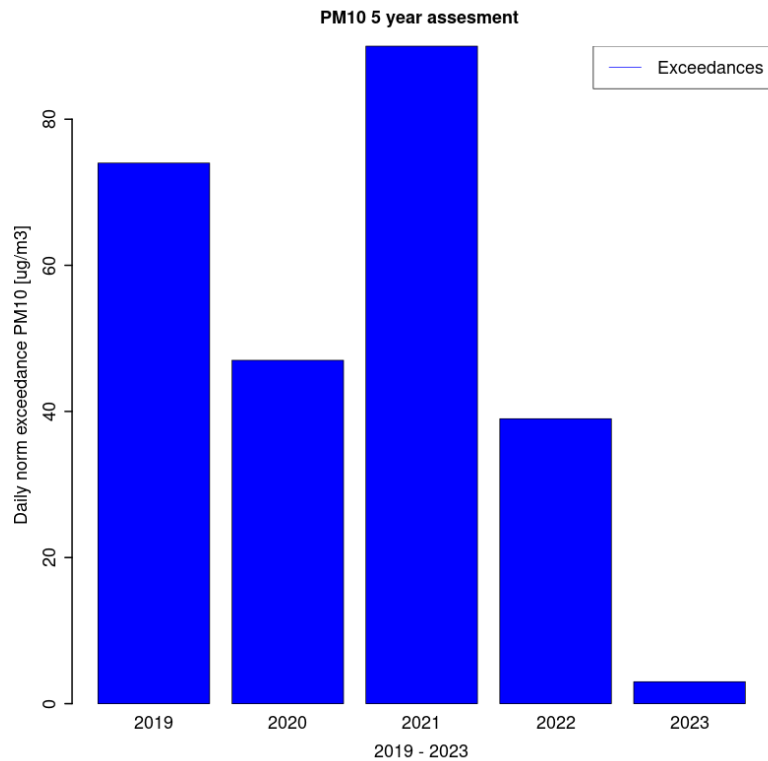


Yearly concentrations – all stations averaged

Red line – modelled concentrations

Blue line – measurements

Threshold limits exceedances - PM and B(a)P

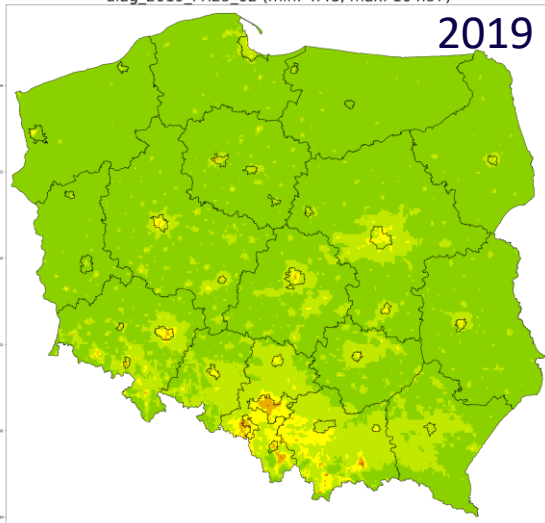


Based on measurements – number of station with exceedances
PM25 and B(a)P – yearly average
PM10 – daily theshold

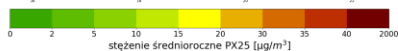
5-year assessment 2019-2023 – PM25



diag_2019_PX25_02 (min: 4.48, max: 104.57)

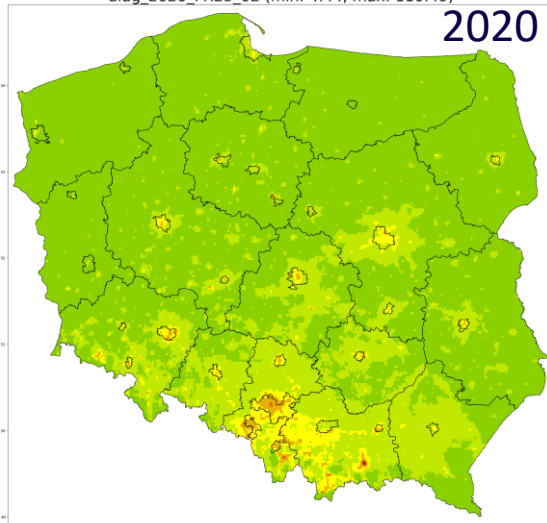


2019

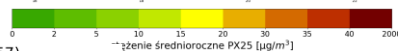


stężenie średnioroczne PX25 [µg/m³]

diag_2020_PX25_02 (min: 4.44, max: 110.49)

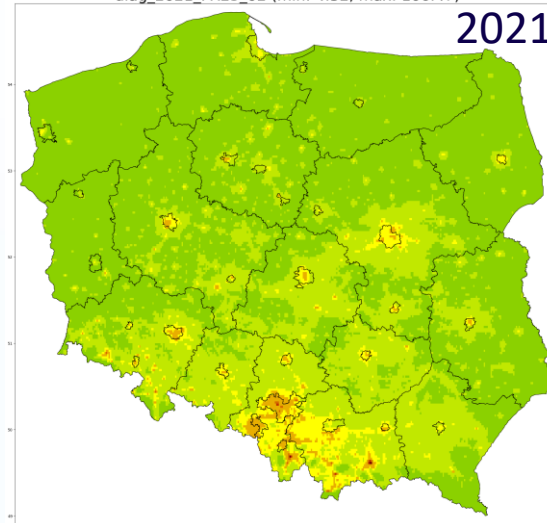


2020

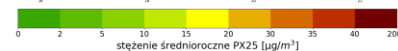


stężenie średnioroczne PX25 [µg/m³]

diag_2021_PX25_02 (min: 4.32, max: 106.47)

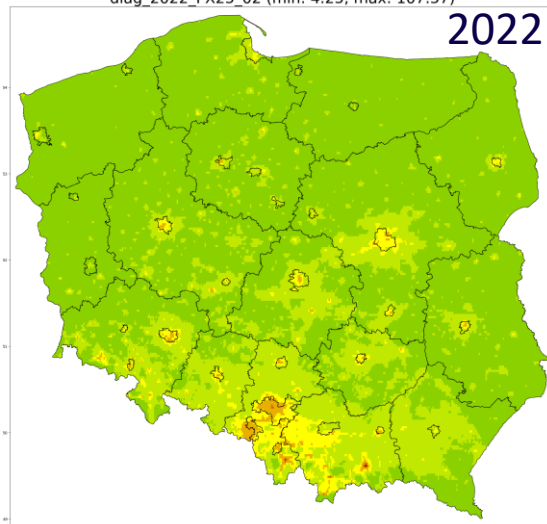


2021

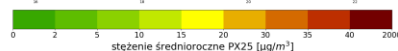


stężenie średnioroczne PX25 [µg/m³]

diag_2022_PX25_02 (min: 4.25, max: 107.57)

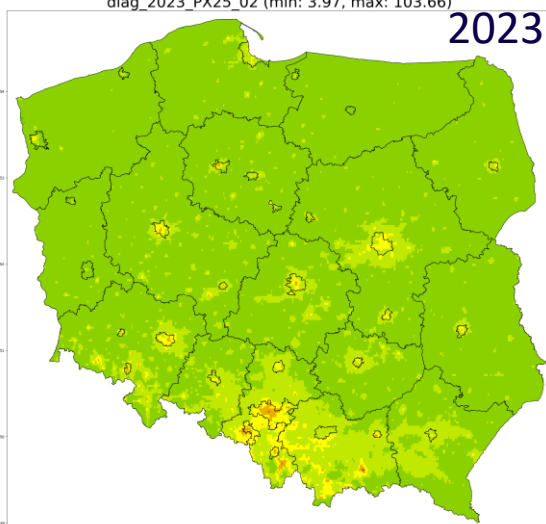


2022



stężenie średnioroczne PX25 [µg/m³]

diag_2023_PX25_02 (min: 3.97, max: 103.66)



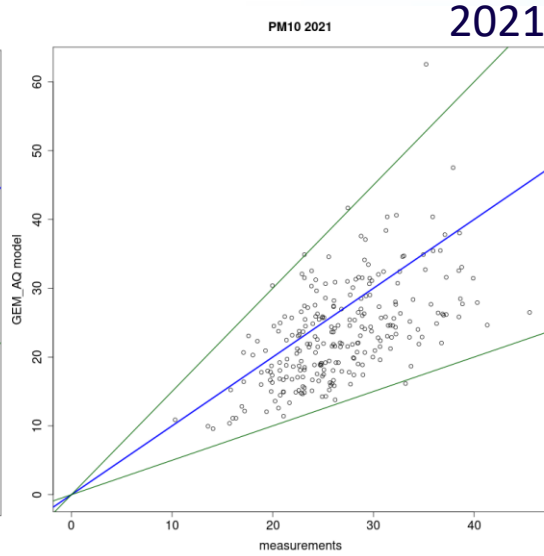
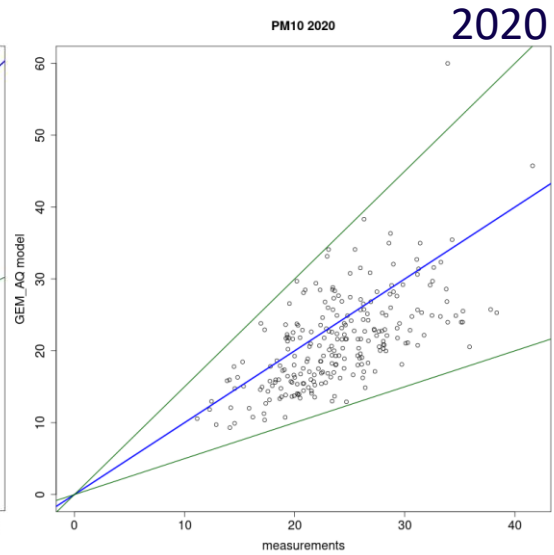
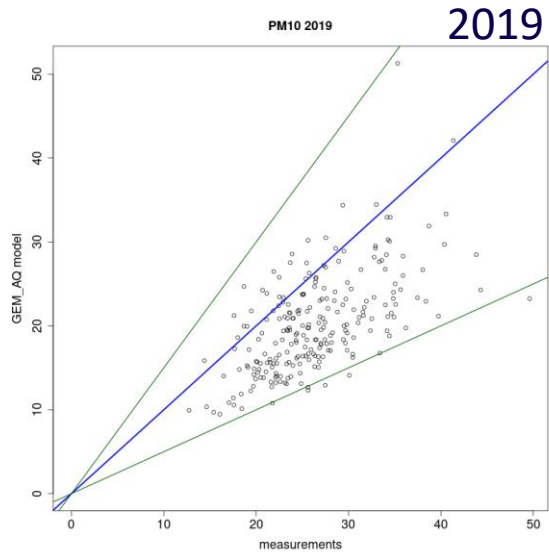
2023



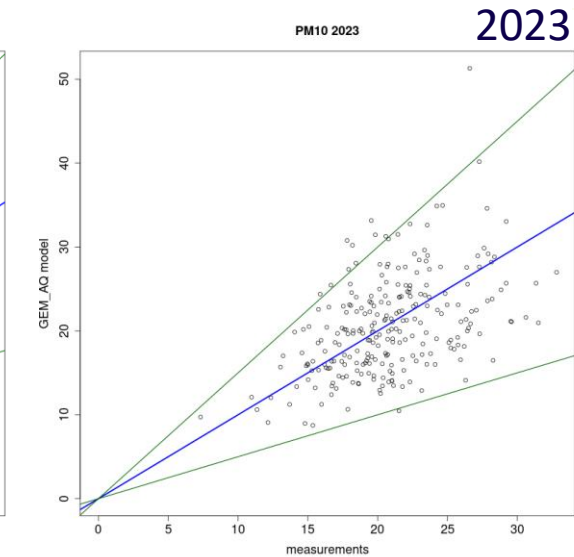
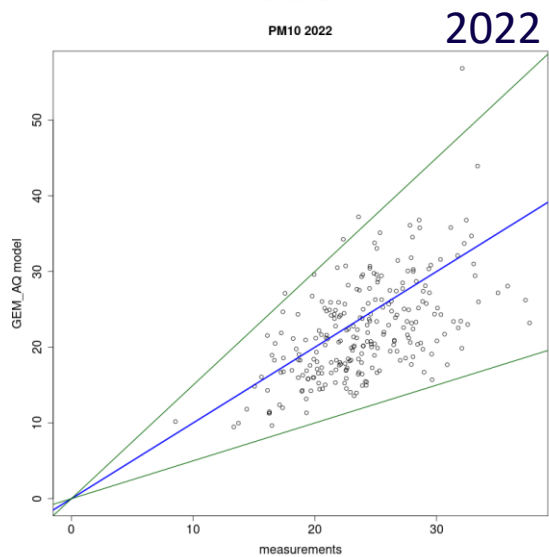
stężenie średnioroczne PX25 [µg/m³]



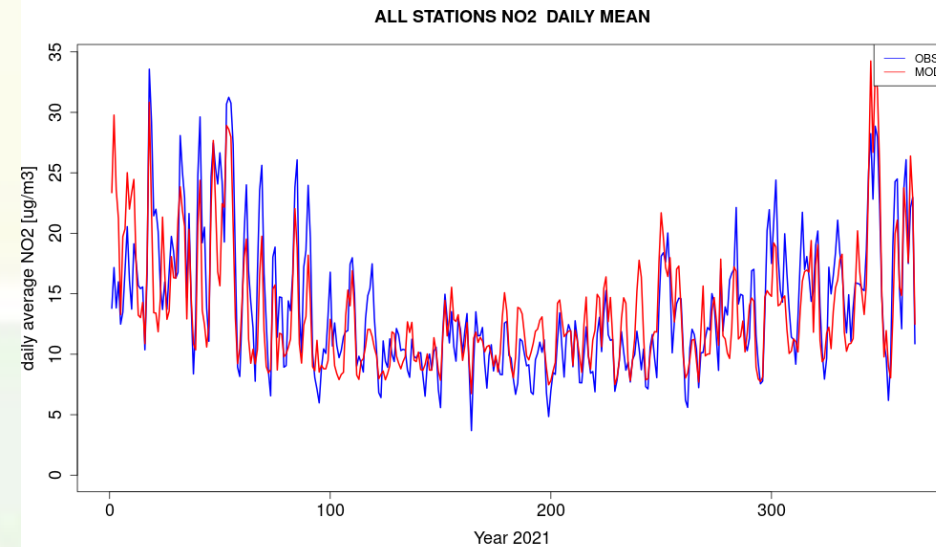
Model evaluation



Scatterplots – PM10



NO2 – time series



Summary



- 5-year assessment shows descending trends in concentrations – measured and modelled (mainly PMs and B(a)P). Highest annual average in 2021.
- Opposite trend for O₃ – slight increase.
- Biggest differences in particulate matter and B(a)P fields – comparing 2023 to 2019
- Identification of hot-spots – based on maps and measurements – south of Poland
- Modelled concentrations are in good agreement with measurements
- „To do” list before 20 of May:
 - Data assimilation
 - Postprocessing – upper, lower assessment thresholds, zone classifications
 - Full model evaluation (Fairmode Delta Tool)



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Thank you for attention!

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