

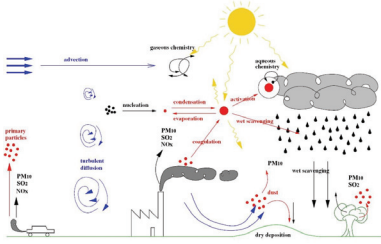


UNCERTAINTY IN AIR QUALITY FORECASTS CAUSED BY EMISSION UNCERTAINTY

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1. Main processes of air pollution dispersion



$$\frac{\partial c_i}{\partial t} + \mathbf{u} \nabla c_i - \nabla \cdot K_i \nabla c_i - \frac{\partial}{\partial z} K_z \frac{\partial c_i}{\partial z} - R(c_1, \dots, c_n) + q_i = E_i$$

4. Uncertainty range and correlation of emission input data

	SO2	NOX	PM10	PM2.5	BAP	Ni	Cd	Pb	Uncertainty (95% of data)
SO2	1	0.7	0.7	0.7	0	0	0	0	± 15%
NOX	0.7	1	0.7	0.7	0	0	0	0	± 20%
PM10	0.7	0.7	1	0.8	0	0	0	0	± 25%
PM2.5	0.7	0.7	0.8	1	0	0	0	0	± 25%
BAP	0	0	0	0	1	0	0	0	± 20%
Ni	0	0	0	0	0	1	0	0	± 20%
Cd	0	0	0	0	0	0	1	0	± 20%
Pb	0	0	0	0	0	0	0	1	± 20%

Point sources of energy sector

	SO2	NOX	PM10	PM2.5	BAP	Ni	Cd	Pb	Uncertainty (95% of data)
SO2	1	0.7	0.7	0.7	0	0	0	0	± 20%
NOX	0.7	1	0.7	0.7	0	0	0	0	± 30%
PM10	0.7	0.7	1	0.8	0	0	0	0	± 40%
PM2.5	0.7	0.7	0.8	1	0	0	0	0	± 40%
BAP	0	0	0	0	1	0	0	0	± 40%
Ni	0	0	0	0	0	1	0	0	± 40%
Cd	0	0	0	0	0	0	1	0	± 40%
Pb	0	0	0	0	0	0	0	1	± 40%

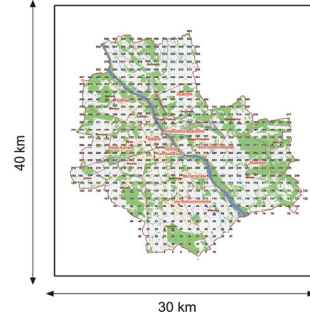
Industrial point sources

2. Uncertainty of urban emission inventory

Basic categories of emission sources

- high point sources (energy sector)**
relatively well characterized combustion process
- low uncertainty of emission data
- intermediate/low point sources (other industry)**
more uncertain description of combustion process
- higher uncertainty of emission data
- area sources (housing, residential districts)**
estimate data on fuel use and parameters
- high uncertainty of emission data
- linear sources (urban transportation system)**
estimate data on traffic, fuel use and car characteristics
- high uncertainty of emission data

3. Computational domain - Warsaw Metropolitan Area



Dispersion model: CALPUFF
Categories of emission sources:
1) high point sources (p. plants) - 16
2) low point sources (industry) - 1002
3) area sources (residential) - 878
4) linear sources (transportation) - 1157
Meteorology: 2005 data (1h step size)
Area discretization: 1 km x 1 km
Receptors: 563

5. Uncertainty range and correlation of emission input data

	SO2	NOX	PM10	PM2.5	BAP	Ni	Cd	Pb	WVA	TSP	LZO	Uncertainty (95% of data)
SO2	1	0.7	0.7	0.7	0.6	0	0	0	0	0	0	± 30%
NOX	0.7	1	0.7	0.7	0.6	0	0	0	0	0	0	± 40%
PM10	0.7	0.7	1	0.7	0.6	0	0	0	0	0	0	± 40%
PM2.5	0.7	0.7	0.7	1	0.7	0	0	0	0	0	0	± 40%
BAP	0.6	0.6	0.7	0.7	1	0	0	0	0	0	0	± 50%
Ni	0	0	0	0	0	1	0	0	0	0	0	± 50%
Cd	0	0	0	0	0	0	1	0	0	0	0	± 50%
Pb	0	0	0	0	0	0	0	1	0	0	0	± 50%
WVA	0	0	0	0	0	0	0	0	1	0	0	± 50%
TSP	0	0	0	0	0	0	0	0	0	1	0	± 50%
LZO	0	0	0	0	0	0	0	0	0	0	1	± 50%

Area sources (housing)

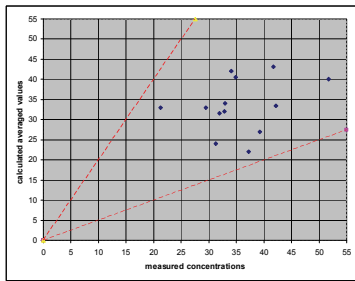
	SO2	NOX	PM10	PM2.5	BAP	Ni	Cd	Pb	WVA	Uncertainty (95% of data)
SO2	1	0.7	0.5	0.5	0.5	0	0	0	0	± 30%
NOX	0.7	1	0.6	0.6	0.6	0	0	0	0	± 40%
PM10	0.5	0.5	1	0.7	0.6	0.5	0	0	0	± 40%
PM2.5	0.5	0.5	0.6	1	0.7	0.5	0	0	0	± 40%
BAP	0.5	0.5	0.5	0.5	1	0	0	0	0	± 50%
Ni	0	0	0	0	0	1	0	0	0	± 50%
Cd	0	0	0	0	0	0	1	0	0	± 50%
Pb	0	0	0	0	0	0	0	1	0	± 50%
WVA	0	0	0	0	0	0	0	0	1	± 50%

Linear sources (transport)

6. Location of the main high point sources in computational area (power/heating plants)



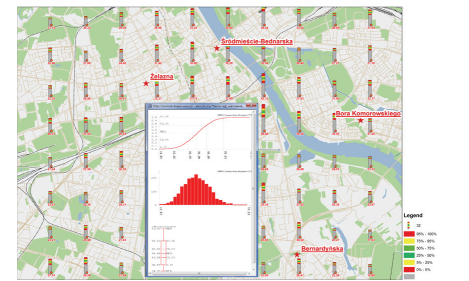
7. Calculated vs. measured PM10 concentrations [µg/m³] in 2005



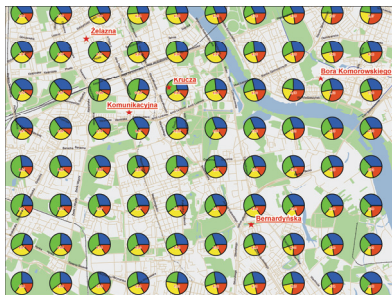
8. Averaged PM10 concentration and uncertainty at the receptor points



9. Uncertainty distribution of PM10 concentration at receptor 275



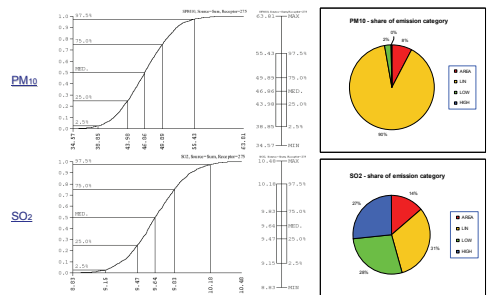
10. The share of source type in SO2 concentration at receptors



11. The share of source type in PM10 concentration at receptors



12. Uncertainty and the share of source type in pollution (receptor 275)

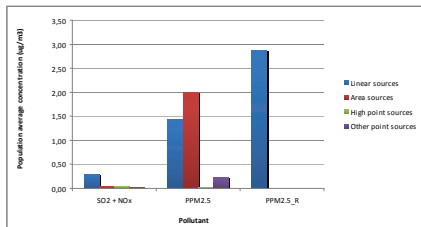


13. Population average exposure (mean and 95% confidence intervals) to PM2.5 concentrations in Warsaw Metropolitan Area

Pollutant	High point sources	Other point sources	Area sources	Linear sources	Together
SO ₂ + NO _x	0.04 (0.04-0.04)	0.03 (0.03-0.03)	0.04 (0.04-0.04)	0.31 (0.31-0.31)	0.41 (0.41-0.41)
PPM2.5	0.02 (0.02-0.02)	0.24 (0.24-0.24)	2.00 (1.98-2.04)	1.44 (1.41-1.46)	3.69 (3.65-3.73)
PPM2.5_R	-	-	-	2.89 (2.85-2.92)	2.89 (2.85-2.92)
Together	0.06 (0.06-0.06)	0.27 (0.26-0.27)	2.04 (2.01-2.07)	4.63 (4.58-4.67)	6.99 (6.94-7.05)

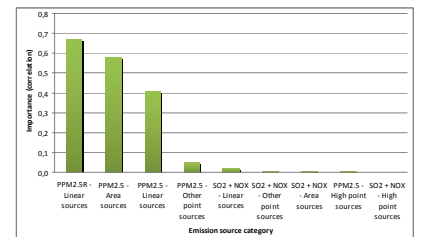
The table presents resulting population average concentration (exposure) for different pollutant and sources. Primary PM2.5 contributes approximately half of total exposure. Total average exposure to PM2.5 due to local sources is about 7.0 µg m⁻³.

14. Population average concentration (exposure) of PM2.5



Population average concentration was estimated by taking into account population densities around different receptor points.

15. Results of sensitivity analysis



Sensitivity analysis reveals on how the emission uncertainty of emission source categories impacts on the uncertainty of population average PM2.5 concentration