German Environment Agency

Umwelt Bundesamt

Expert Panel on Clean Air in Cities (EPCAC)
29 September 2020

Uncertainties in the emission-concentration-exposure-complex – experiences from selected UBA-studies

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Section II 4.1 / General Aspects of Air Quality Management

Terminology – Can simulations be uncertain?

Uncertainty

Measurements usually have an uncertainty range.

Sensitivity

Models / simulations are sensitive to various variables. The assumed values of these variables can be true or false (retrospectively) or more probable or less probable (prospectively), but usually not uncertain (except a measurement gives the value of one variable and includes an uncertainty range, e. g. emission factors).

Terminology – Sensitivity analysis

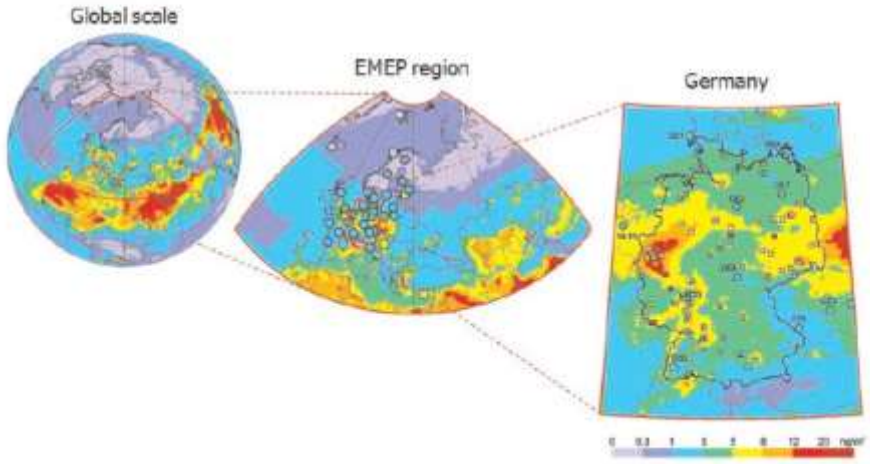
Convention on Long-range Transboundary Air Pollution

emep *Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe*

TECHNICAL REPORT 1/2020 June 2020

Country-scale assessment of heavy metal pollution: A case study for Germany

Technical Report 1/2020



Joint MSC-E & German Environment Agency Report

Reference:

http://en.msceast.org/reports/1_2020.pdf

Terminology – Sensitivity analysis

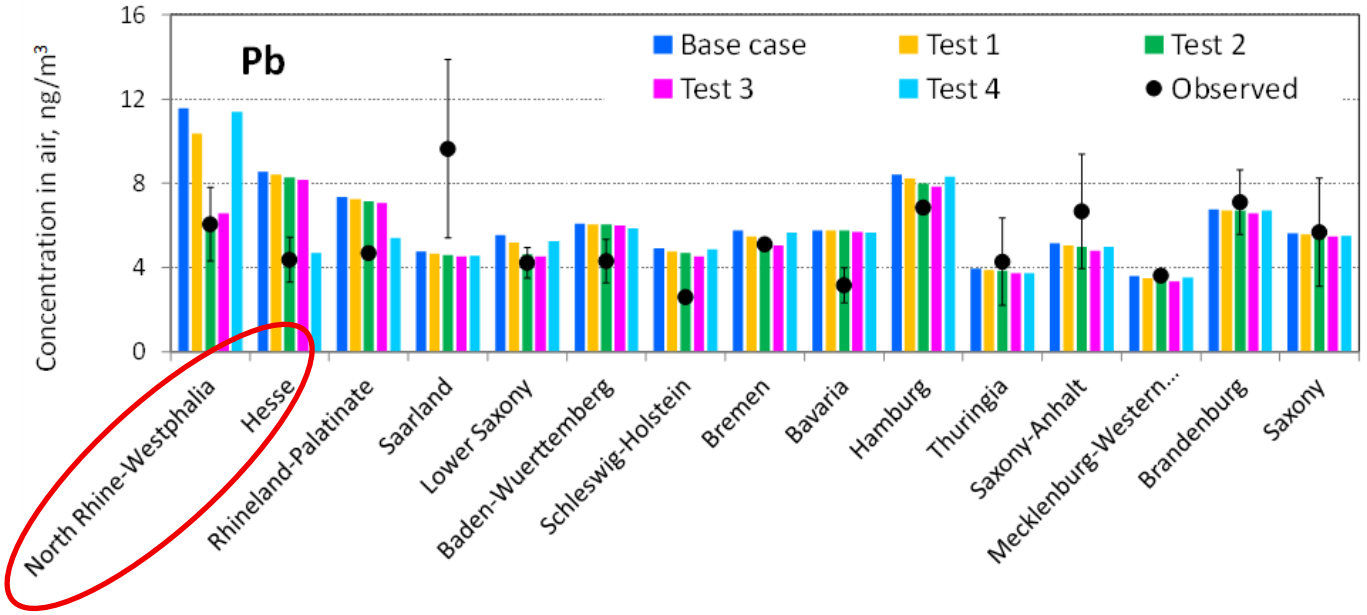


Fig. 5.11 *Comparison of measured and modelled Pb air concentration averaged over measurement stations in German provinces for different sensitivity tests (2015).*

Base case – overestimation in NRW and Hesse

Test 1 – all Pb emissions from industrial and public power production sources in North Rhine-Westphalia were placed to the 5th model layer (540-860 m) instead of the 3rd and the 4th layers

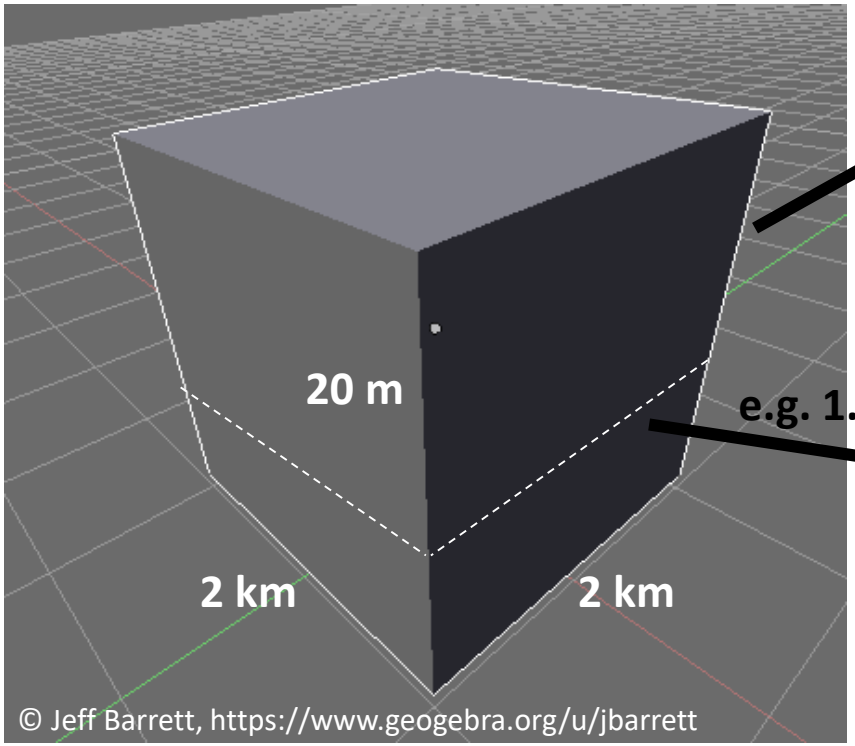
Test 2 – all PB emissions in North Rhine-Westphalia are placed to the 6th model layer (860-1200 m)

Test 3 – Pb anthropogenic emissions were reduced in NRW by the factor 2.7

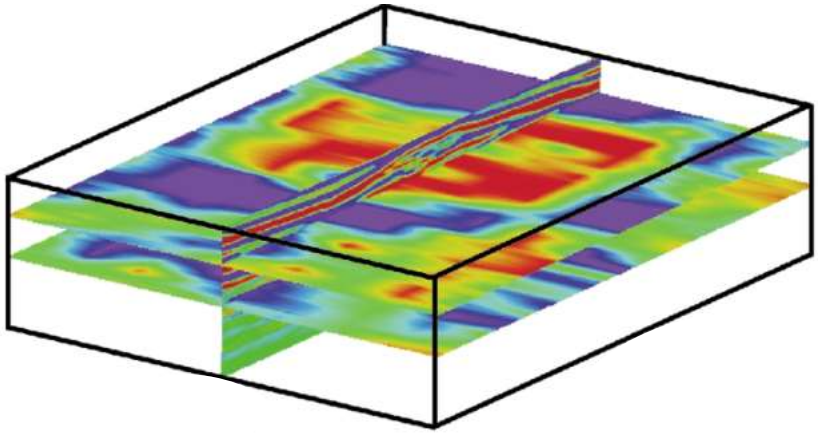
Test 4 – Pb anthropogenic emissions were reduced in Hesse by the factor of 4

Regional CTM vs. micro-scale – The basic difference

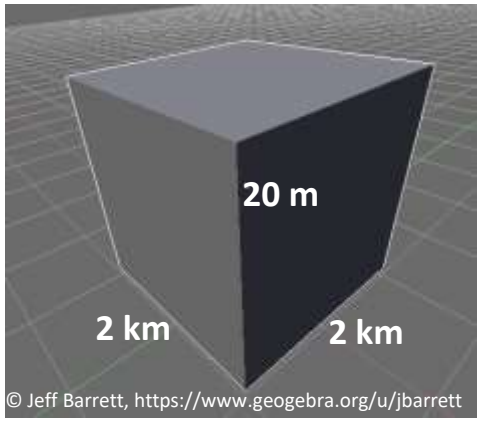
Volume vs. point information

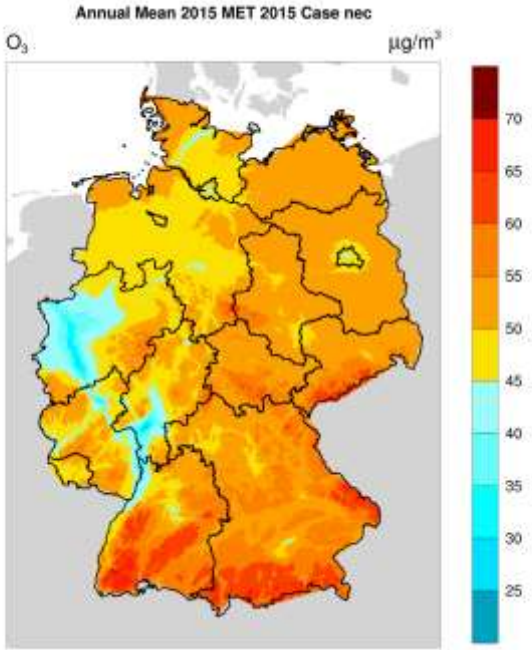


e.g. 1.5 m



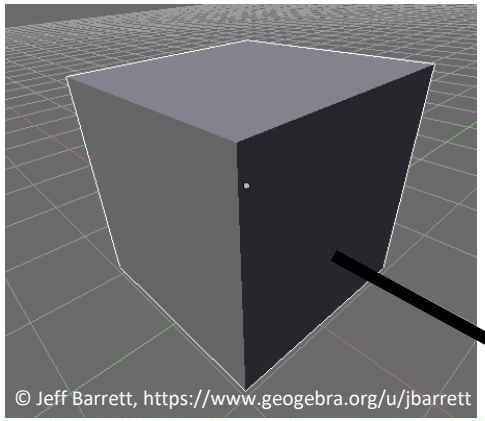
Sensitivities of regional CTM (volume) simulations

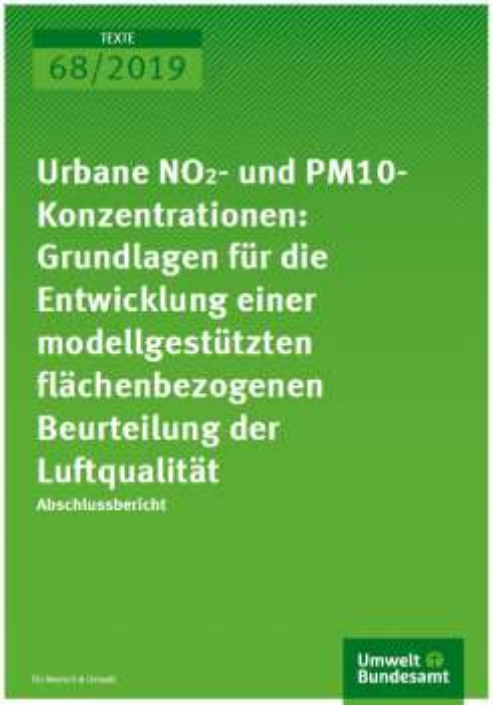


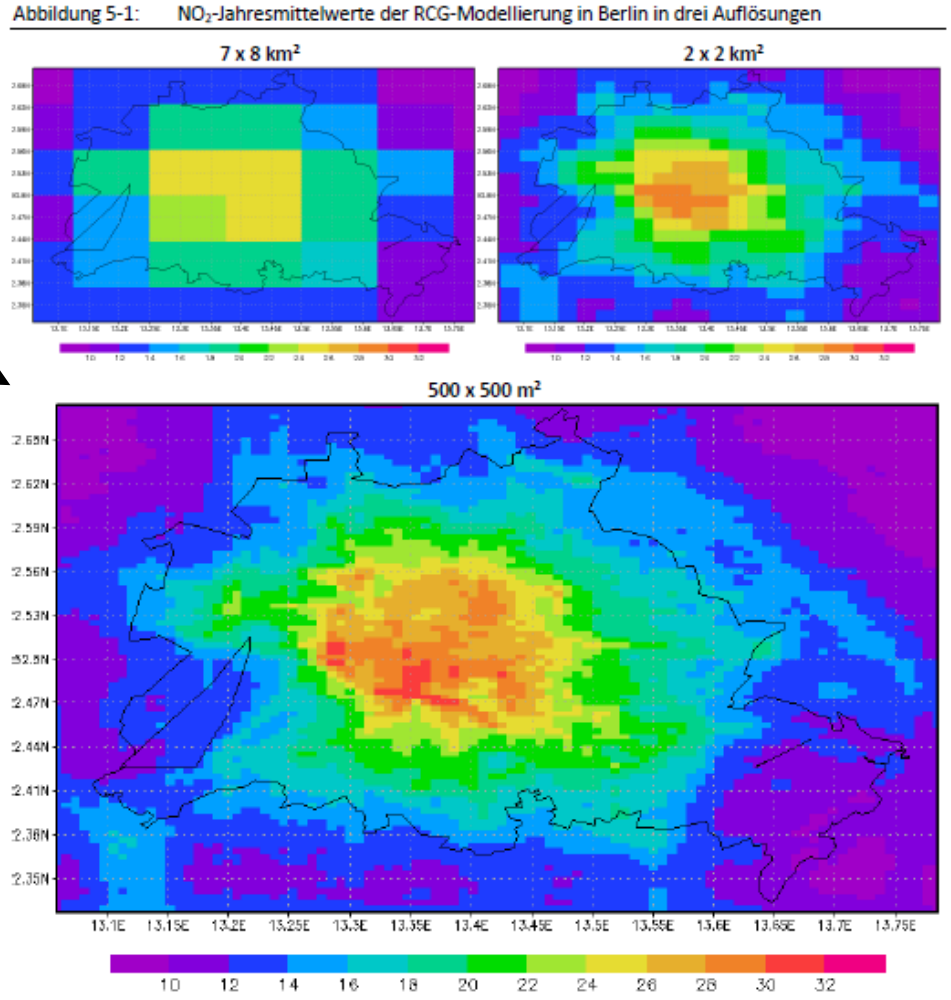


- absolute emissions (inventory total, inland principle)
- horizontal distribution of the emissions
- vertical distribution of the emissions
- temporal distribution of the emissions
- horizontal (and vertical) resolution of the model grid
- boundary conditions
- process parameterization (e. g. reactivity, completeness, roughness length, etc.)
- meteorology
- etc.

Sensitivities of regional CTM (volume) simulations - resolution

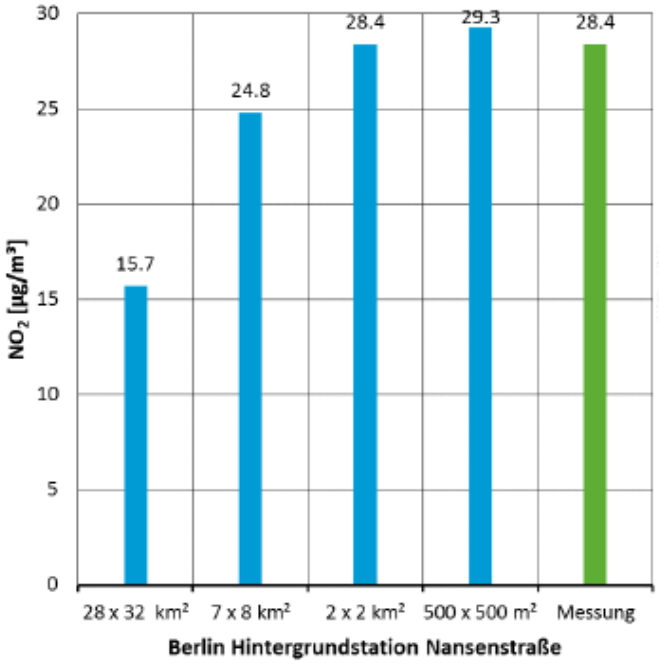




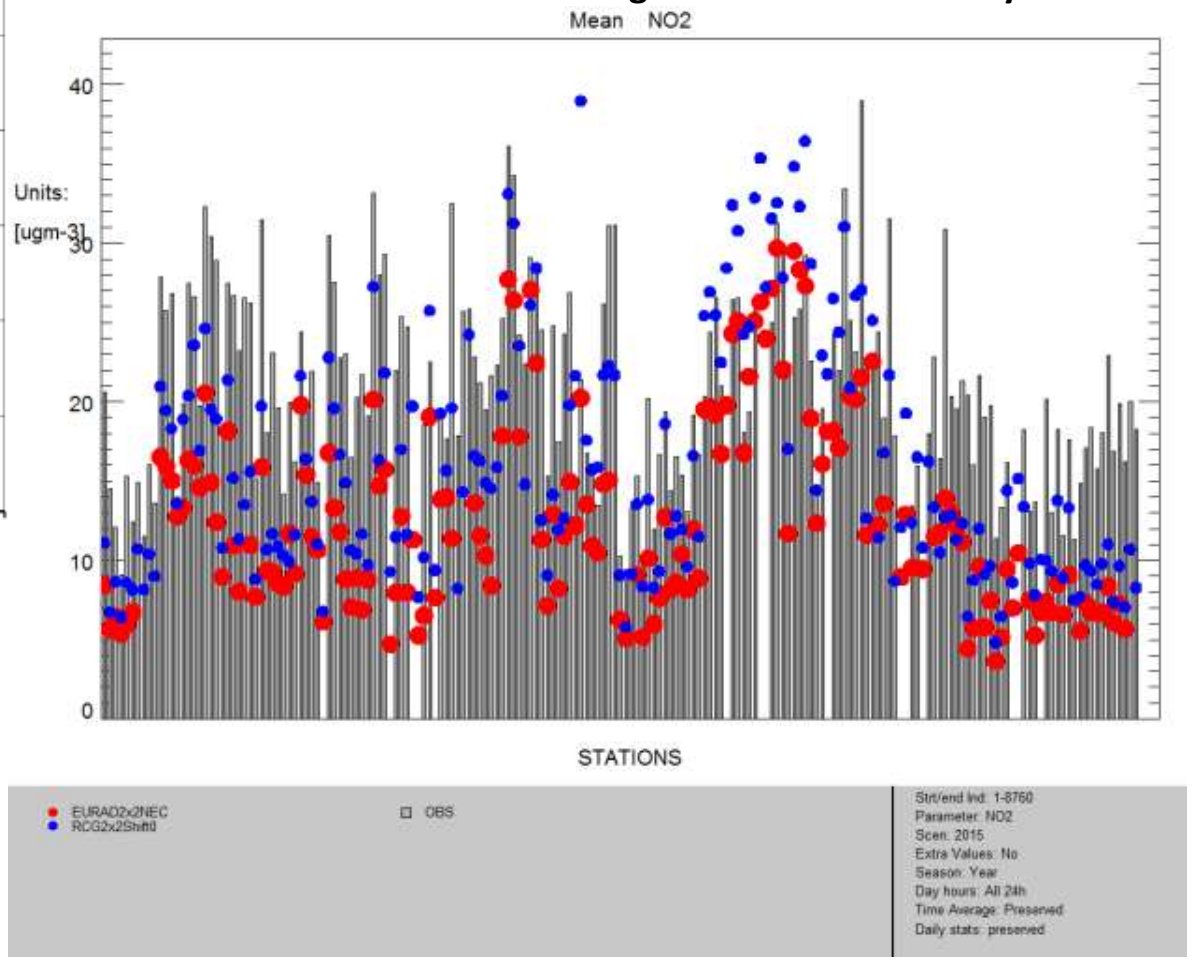


Reference:
https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2019-07-03_texte_68-2019_urbane-hintergrundbelastung-no2-pm10.pdf

Sensitivities of regional CTM (volume) simulations - resolution



Comparison of EURAD, RCG and measured annual averages for all German urban and sub-urban background stations in the year 2015



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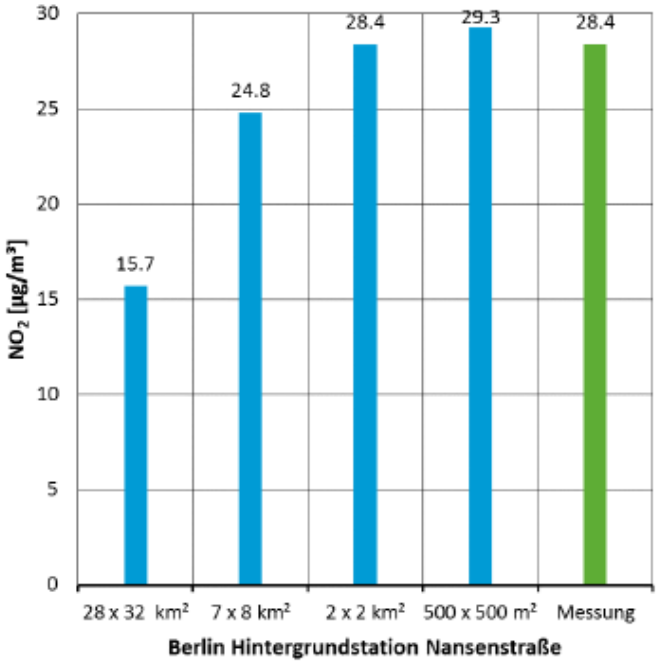
Sensitivities of regional CTM (volume) simulations - resolution



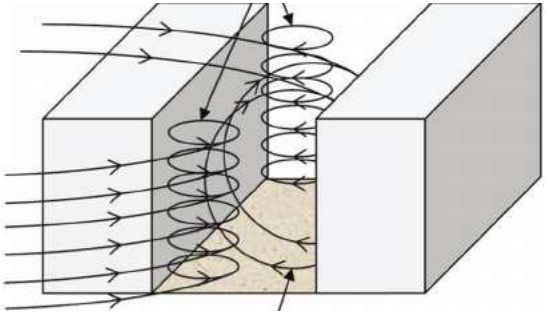
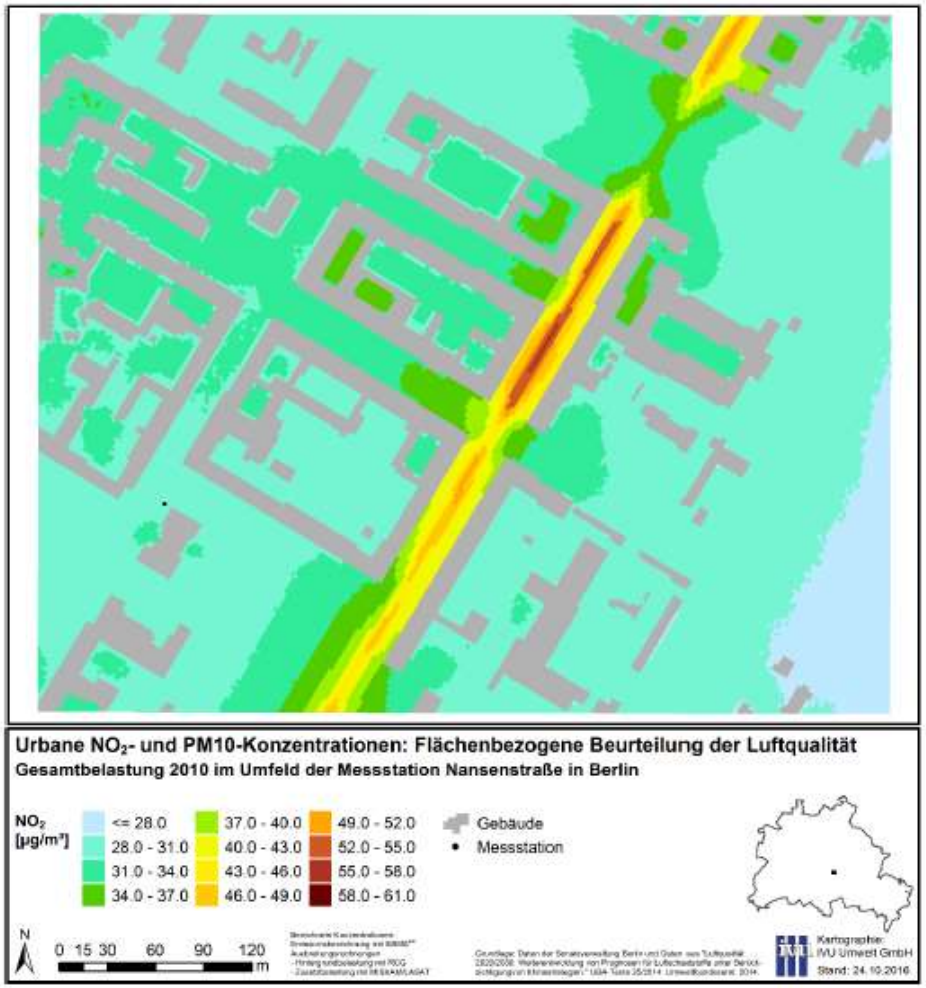


Abbildung 5-40: NO_2-Belastung im Umfeld der Messstation Nansenstraße in Berlin



Reference:

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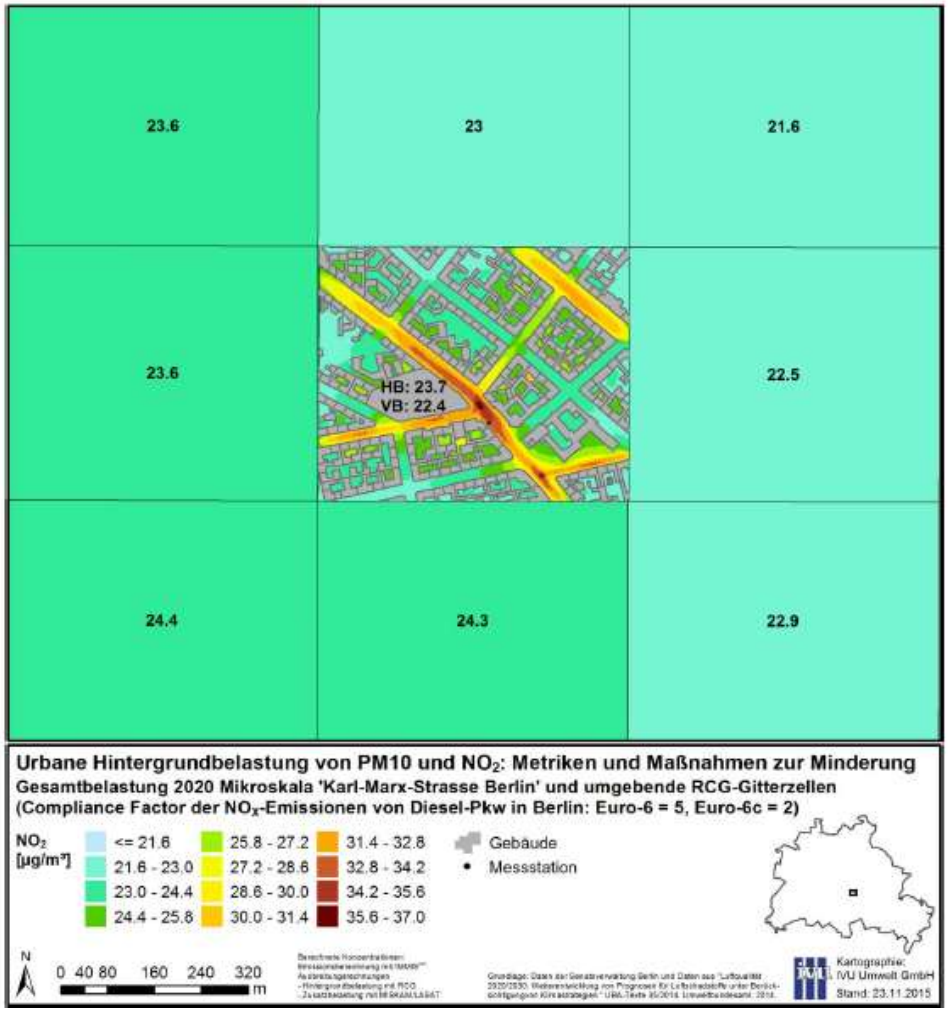
From regional modelling to hot-spot-concentrations

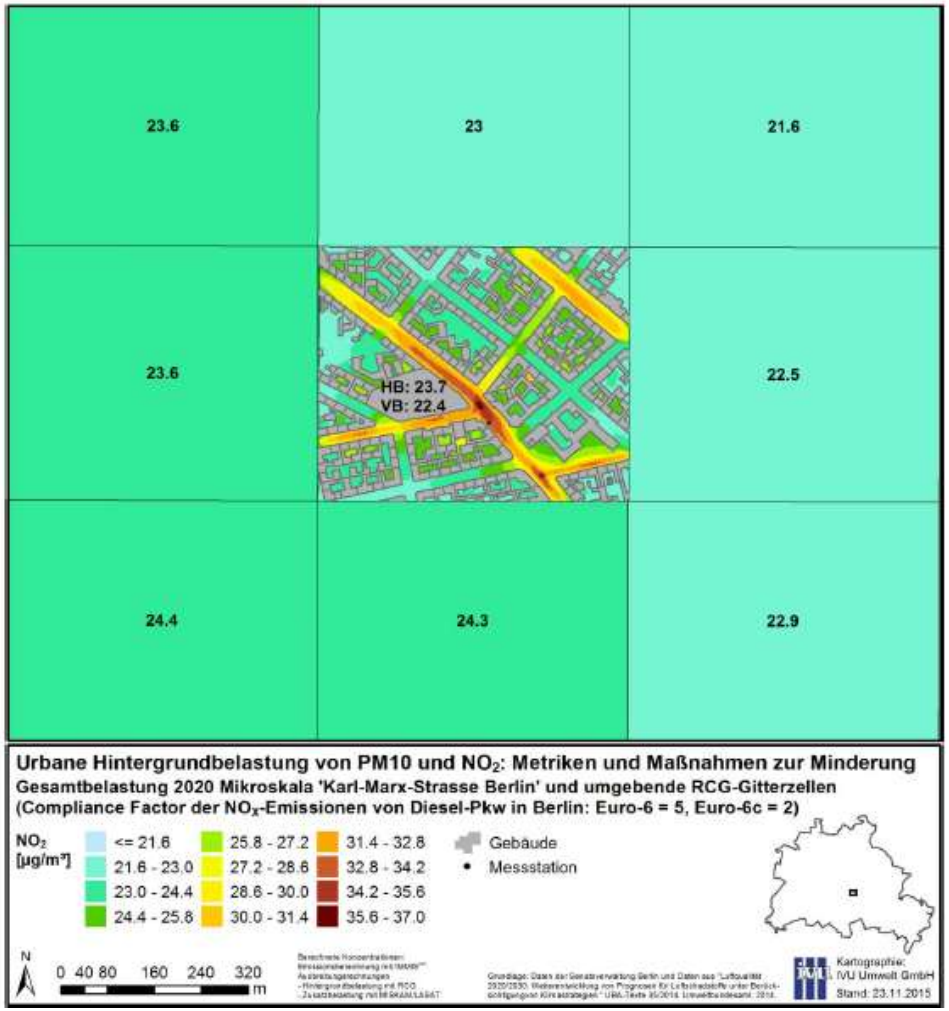


1. regional CTM (500x500)m²
2. regional CTM (500x500)m² without road transport and domestic heating emissions for one grid cell
3. Micro-scale modelling for the (500x500)m² grid cell for road transport and domestic heating emissions
4. Addition of the NO2 micro-scale concentrations (1,5-2m height) plus the background emissions of step 2 (=VB)

Reference:

https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2019-07-03_texte_68-2019_urbane-hintergrundbelastung-no2-pm10.pdf

From regional modelling to hot-spot-concentrations



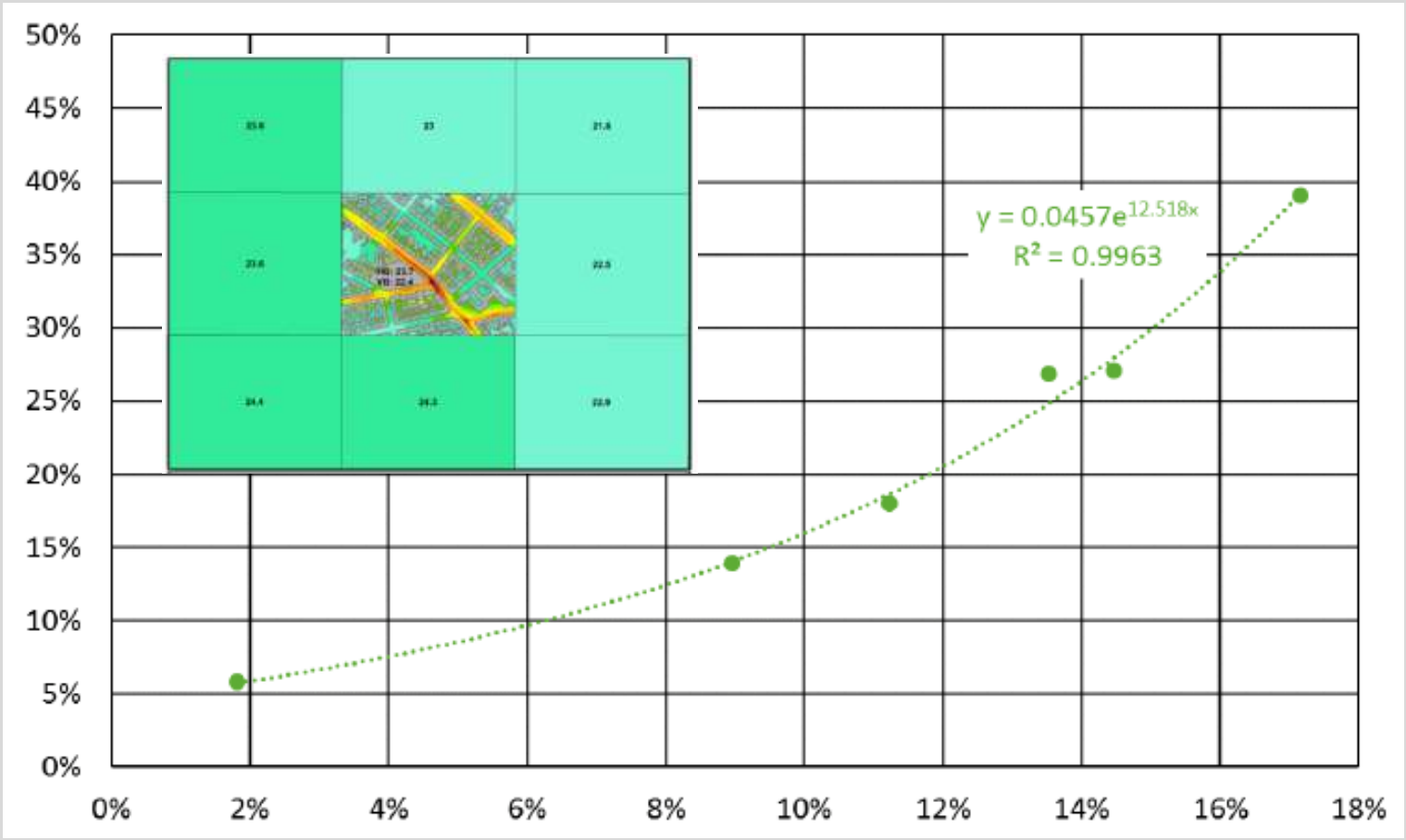
Additional sensitivities

- local fleet composition
- local traffic volume
- NO/NO_2 relation
- spatial distribution of emissions
- local wind field
- building structure
- other local emissions than transport
- local chemistry (e. g. availability of ozone)
- local sinks
- etc.

Reference:

https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2019-07-03_texte_68-2019_urbane-hintergrundbelastung-no2-pm10.pdf

Possible indicative correlations



Reference:

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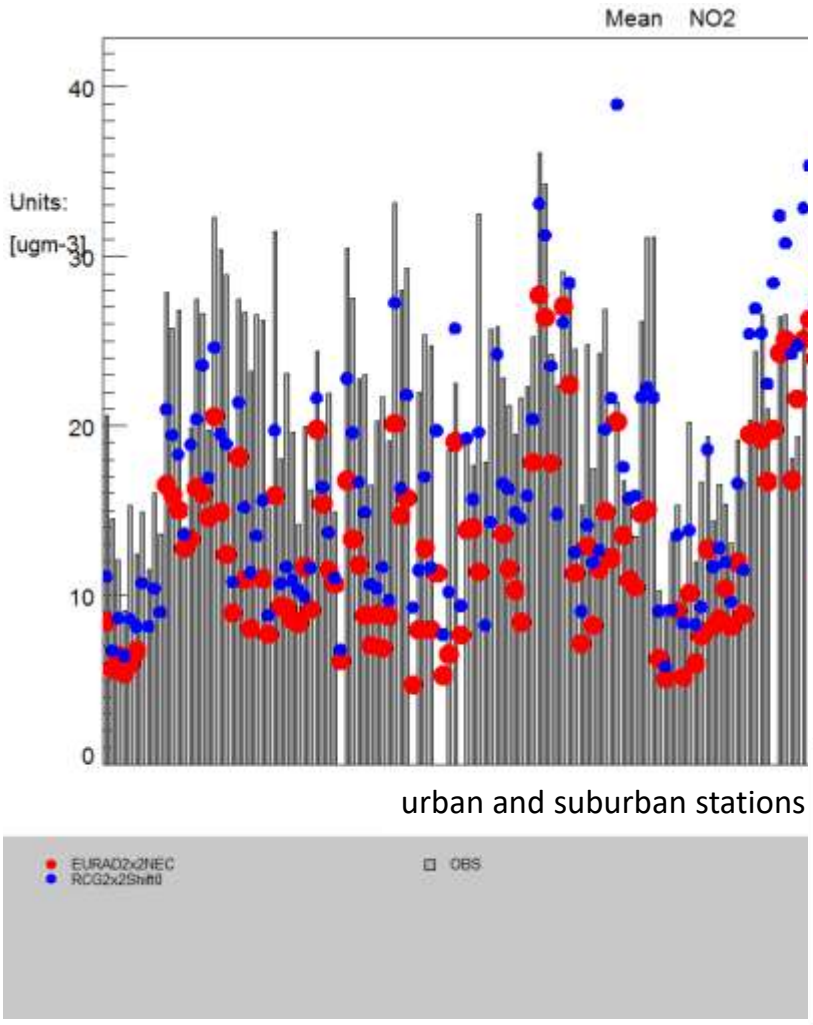
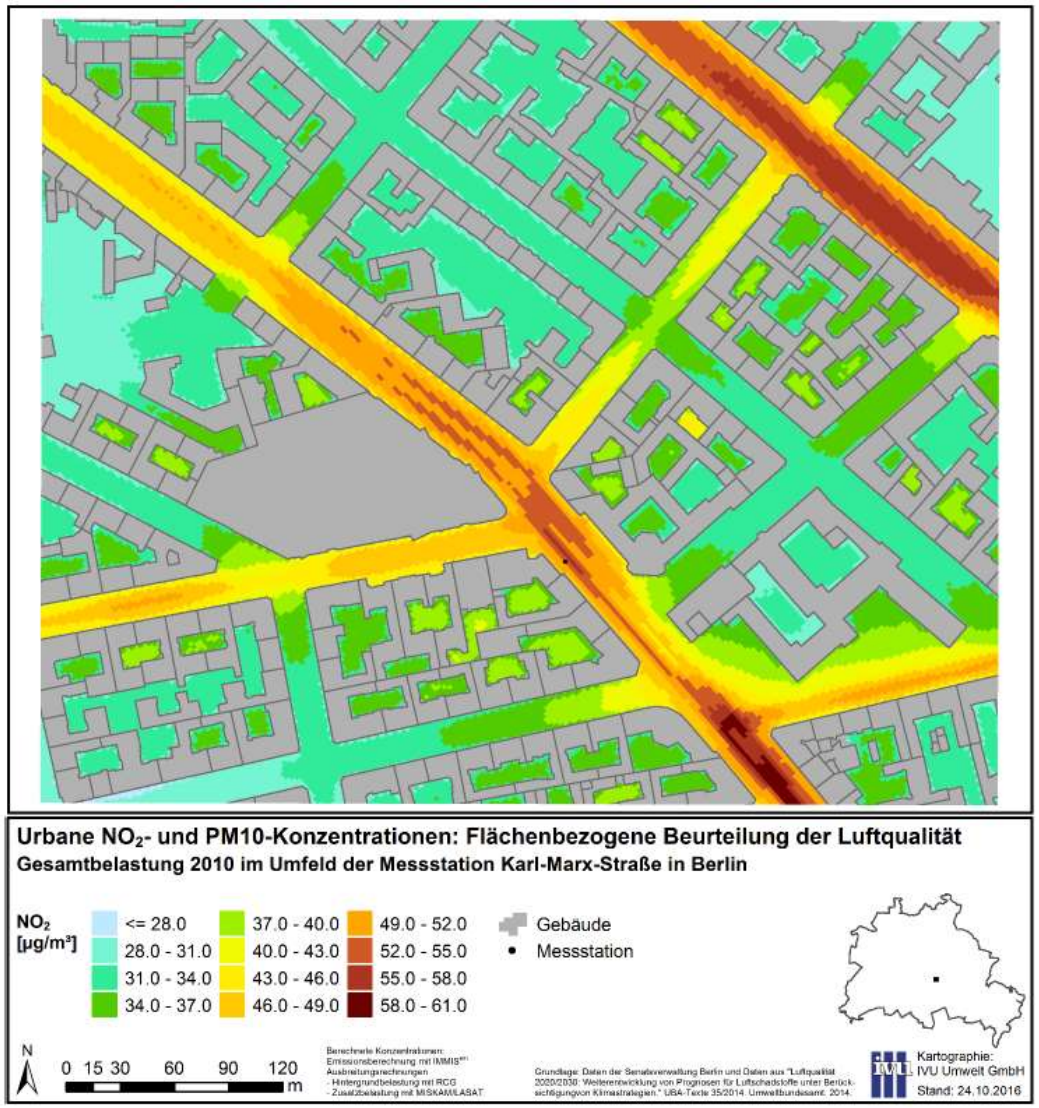
Different pollutants have different characteristics.

NO_2



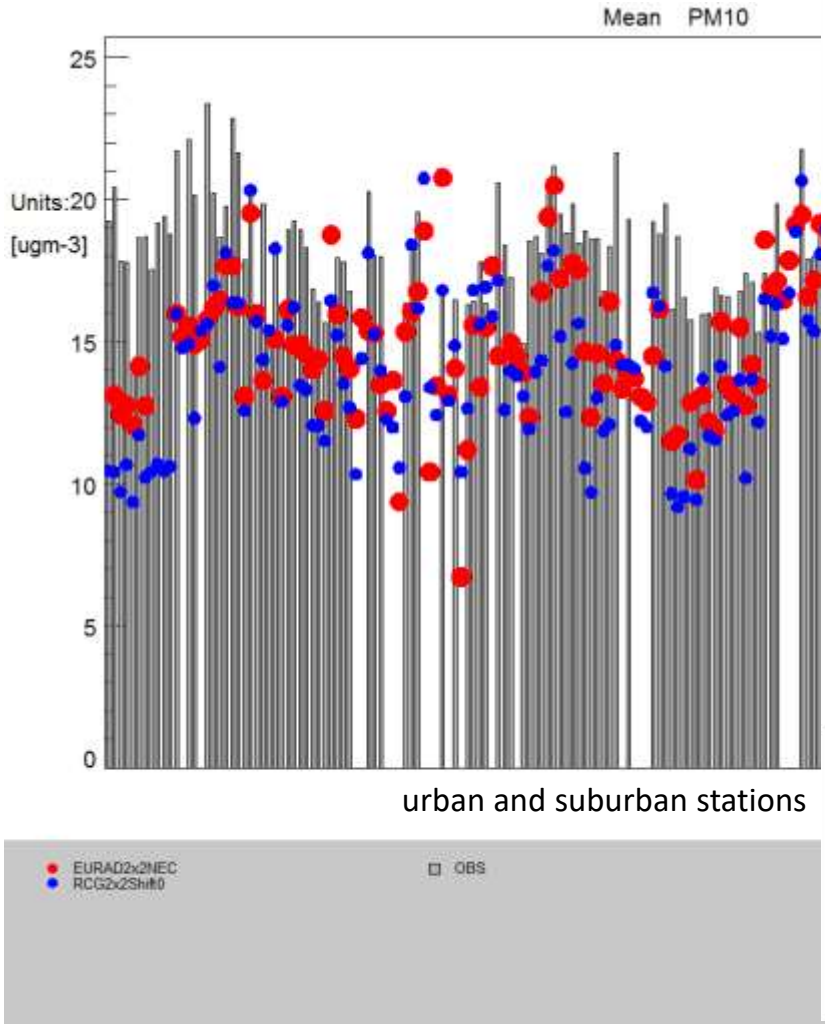
urban and suburban stations

Abbildung 5-41: NO_2-Belastung im Umfeld der Messstation Karl-Marx-Straße in Berlin



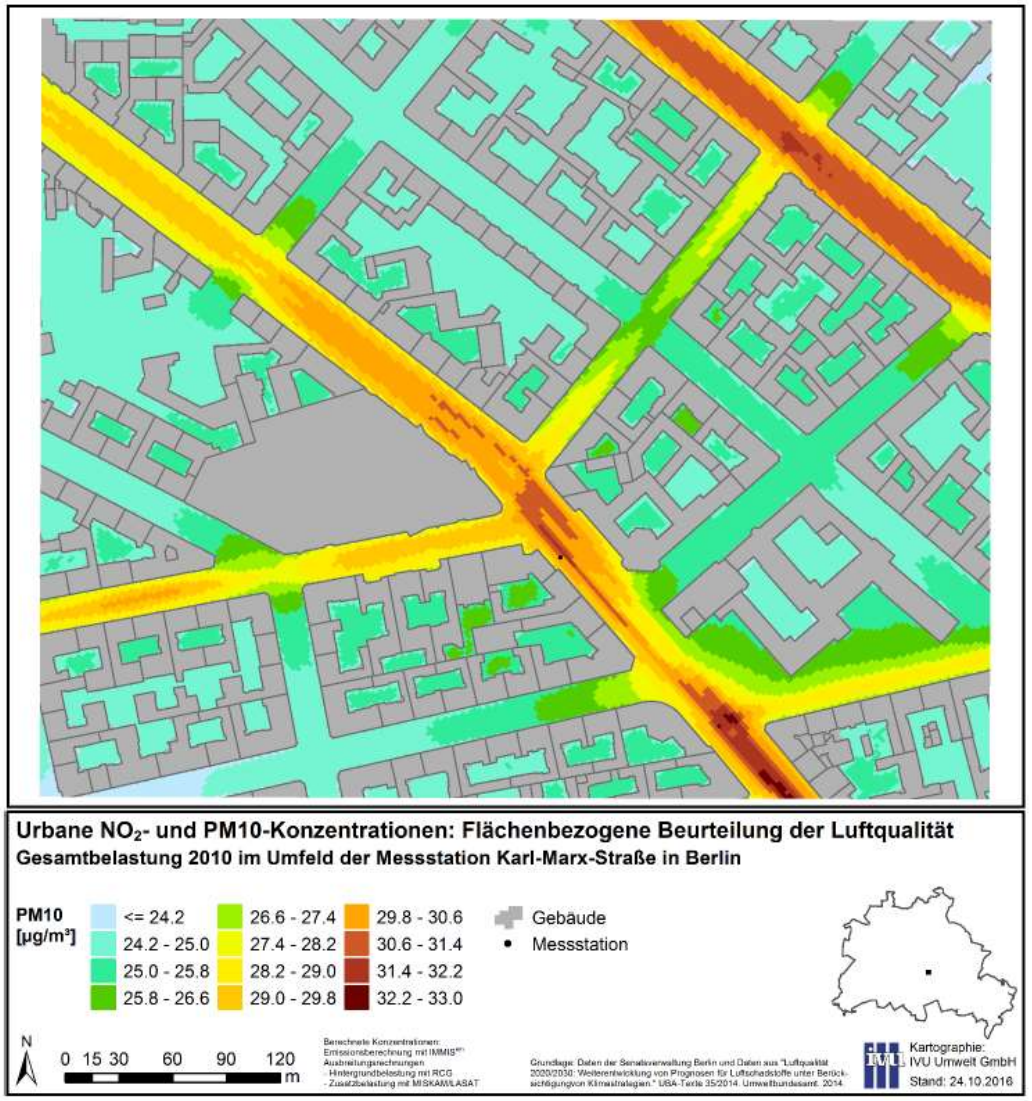
Different pollutants have different characteristics.

PM10/(PM2.5)



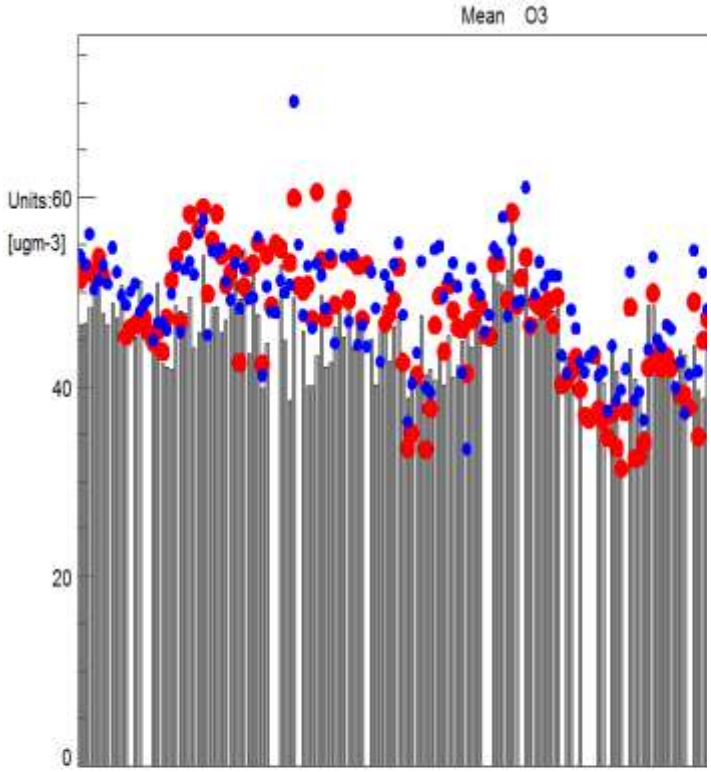
urban and suburban stations

Abbildung 5-47: PM10-Belastung im Umfeld der Messstation Karl-Marx-Straße in Berlin

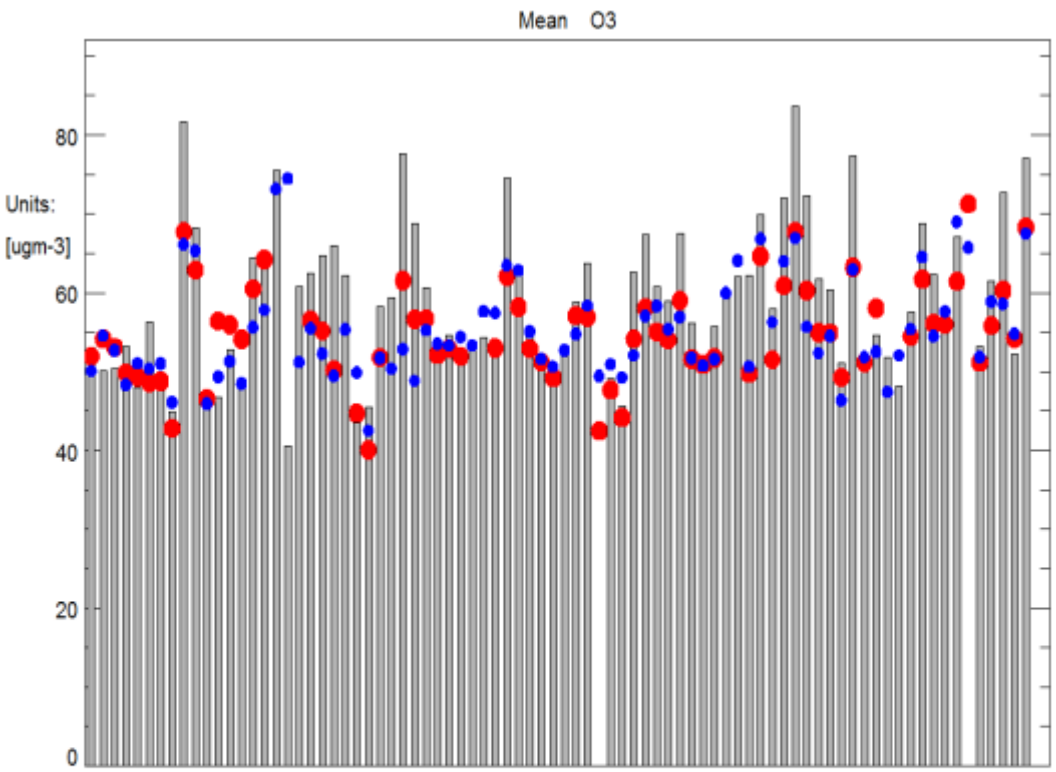


Different pollutants have different characteristics.

Ozone



urban and suburban stations



rural stations

Conclusions / Hypotheses

NO_2

- Regional CTMs are not able to simulate hot-spot-concentrations.
- Assessment of ΔC from ΔE needs micro-scale modelling or further research on indicative correlations.
- Measures that reduce emissions from transport will be the right choice anyway.
- NO_2 exposure is very individual.

PM

- Assessment of ΔC from ΔE is possible with regional CTMs.
- Emissions (and therefore concentrations) are still underestimated.
- The question which ΔE is the most effective to reduce local concentrations, is much more regional (to transboundary, and close to ground level sources sometimes local).
- The share of local to global sources varies highly over time.
- Is one PM exposure worse than another?

Ozone

- Is the CTM calculating concentrations from emissions, or is the initial ozone concentration set in the model run?
- Precursor emissions are still underestimated or incomplete, especially during episodes (BVOCs, reactivity of VOCs, NO/NO2 relation of emissions, etc.).
- The fact that global action is needed (e. g. on methane mitigation), is clear anyway.

Thank you very much.

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https://www.umweltbundesamt.de/en/topics/air