Senatsverwaltung
für Mobilität, Verkehr,
Klimaschutz und Umwelt

BERLIN

FAIRMODE WG8
SPATIAL REPRESENTATIVENESS – STREET CANYONS - BERLIN

Dr. Andreas Kerschbaumer

Senate Department for Urban Mobility, Transport, Climate Action and the Environment
Unit: Air Quality Planning

General information:

- City of Berlin, Germany.
- Year: 2015
- Pollutant: NO_2 annual mean
- Type of model: Street Canyon IMMIS^{Luft} (Canyon Plume Box (CPB) based dispersion model for predicting air pollutant concentrations near roadways), screening model
- Model scale: road sections from junction to junction (lines)
- no bias adjustment
- Monitoring stations: urban traffic

Sampling points shall in general be sited in such a way as to avoid measuring very small micro-environments in their immediate vicinity, which means that a sampling point must be sited in such a way that the air sampled is representative of air quality for a street segment no less than **100 m length** at traffic-orientated sites [...]

[...] for all pollutants, traffic-orientated sampling probes shall be at least **25 m from the edge of major junctions** and no more than 10 m from the kerbside.

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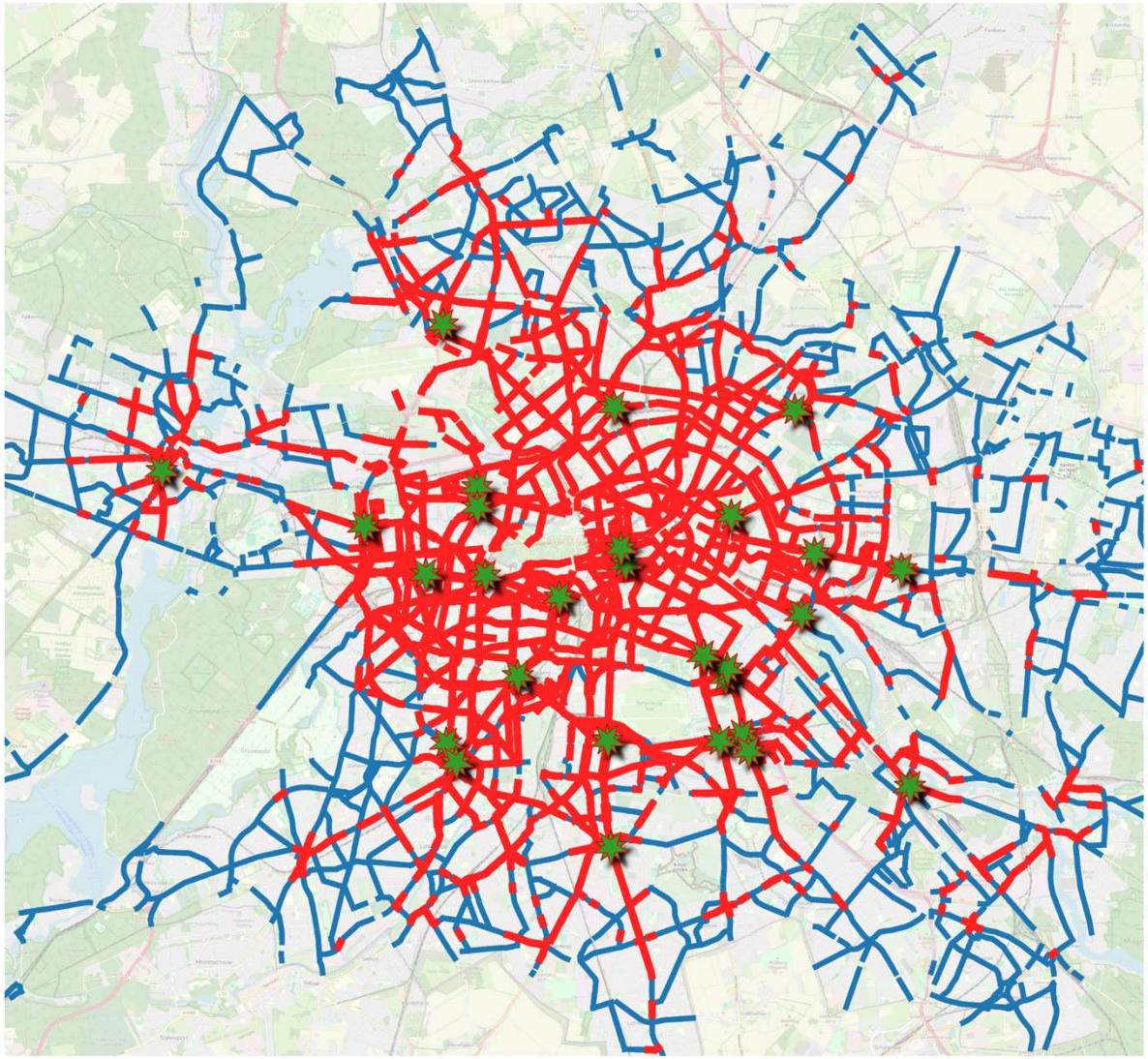
2015 NO_2: urban traffic sites – tolerance level +- 15 %



Monitoring Points Street 2015

Monitoring Points 2015 +- 15 %

- MP 525 (78.9 µg/m³) +-15%
- MC 174 (39.7 µg/m³) +- 15%
- MP 501 (42.5 µg/m³) +- 15%
- MP 528 (50.1 µg/m³) +- 15%
- MP 504 (53.4 µg/m³) +- 15 %
- MP 505 (53.7 µg/m³) +- 15%
- MC 117 (51.4 µg/m³) +- 15%
- MP 533 (58.7 µg/m³) +- 15%
- MP 562 (33.2 µg/m³) +- 15%
- MP 581 (37.2 µg/m³) +- 15%
- MP 507 (37.2 µg/m³) +- 15%
- MP 514 (45.4 µg/m³) +- 15%
- MC 143 (48.6 µg/m³) +- 15%
- MC 220 (38.6 µg/m³) +- 15%
- MP 555 (50.7 µg/m³) +- 15%
- MP 545 (50.6 µg/m³) +- 15%
- MP 547 (38.5 µg/m³) +- 15%
- MP 530 (56.9 µg/m³) +- 15%
- MP 531 (37.4 µg/m³) +- 15%
- MP 537 (56.5 µg/m³) +- 15%
- MP 539 (39.8 µg/m³) +- 15%
- MC 124 (48.7 µg/m³) +- 15%
- MP 542 (51.4 µg/m³) +- 15%
- MP 559 (37.1 µg/m³) +- 15%
- MC 115 (28.9 µg/m³) +- 15%
- MP 573 (40.0 µg/m³) +- 15%
- MP 579 (37.2 µg/m³) +- 15%
- MP 576 (53.5 µg/m³) +- 15%
- Modelled NO2 Annual Mean 201

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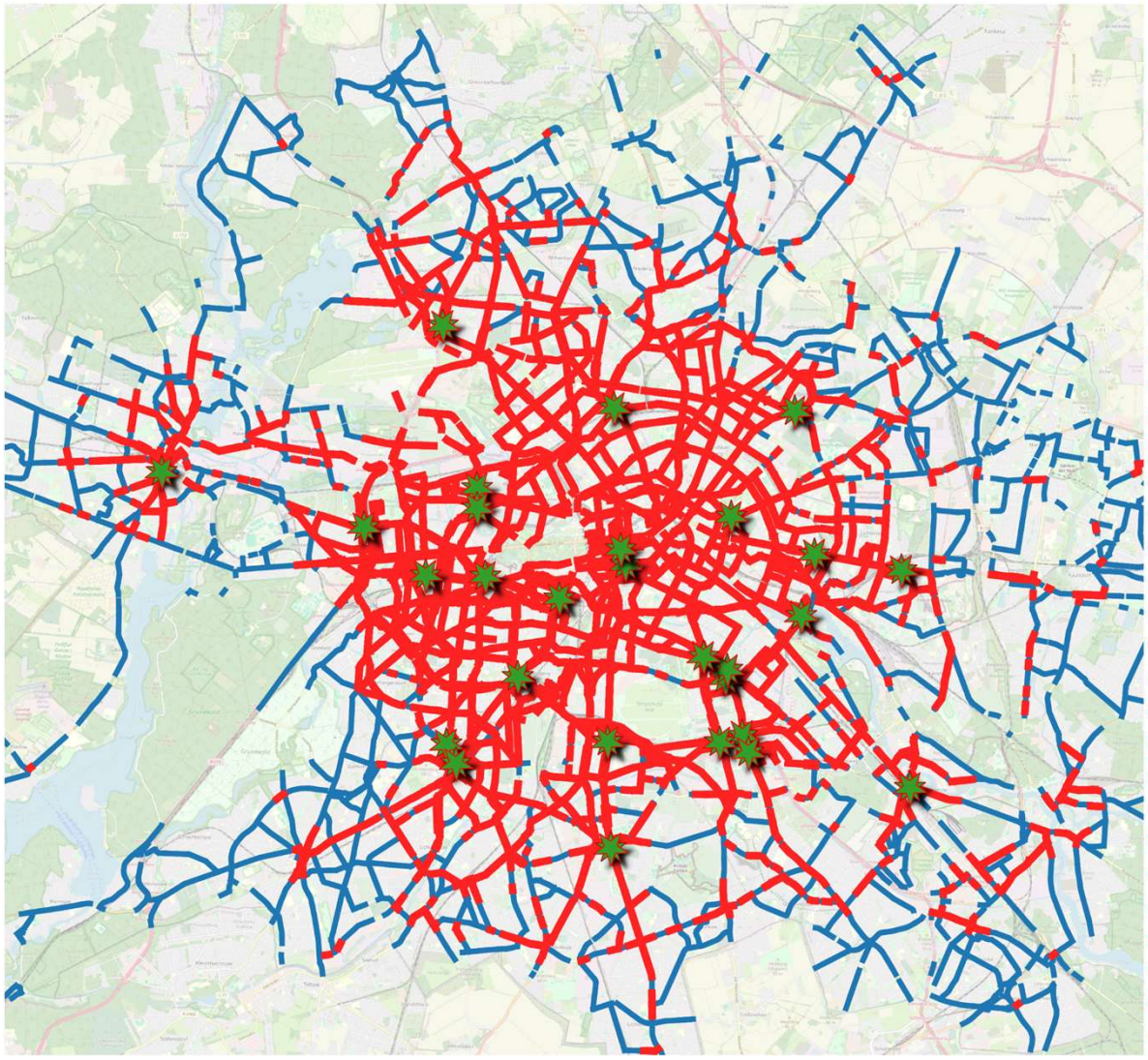
2015 NO_2: urban traffic sites – tolerance level +- 20 %



Monitoring Points Street 2015

Monitoring Points 2015 +- 20%

- MP 525 (78.9 µg/m³) +-20%
- MC 174 (39.7 µg/m³) +- 20%
- MP 501 (42.5 µg/m³) +- 20%
- MP 528 (50.1 µg/m³) +- 20%
- MP 504 (53.4 µg/m³) +- 20 %
- MP 505 (53.7 µg/m³) +- 20%
- MC 117 (51.4 µg/m³) +- 20%
- MP 533 (58.7 µg/m³) +- 20%
- MP 562 (33.2 µg/m³) +- 20%
- MP 581 (37.2 µg/m³) +- 20%
- MP 507 (37.2 µg/m³) +- 20%
- MP 514 (45.4 µg/m³) +- 20%
- MC 143 (48.6 µg/m³) +- 20%
- MC 220 (38.6 µg/m³) +- 20%
- MP 555 (50.7 µg/m³) +- 20%
- MP 545 (50.6 µg/m³) +- 20%
- MP 547 (38.5 µg/m³) +- 20%
- MP 530 (56.9 µg/m³) +- 20%
- MP 531 (37.4 µg/m³) +- 20%
- MP 537 (56.5 µg/m³) +- 20%
- MP 539 (39.8 µg/m³) +- 20%
- MC 124 (48.7 µg/m³) +- 20%
- MP 542 (51.4 µg/m³) +- 20%
- MP 559 (37.1 µg/m³) +- 20%
- MC 115 (28.9 µg/m³) +- 20%
- MP 573 (40.0 µg/m³) +- 20%
- MP 579 (37.2 µg/m³) +- 20%
- MP 576 (53.5 µg/m³) +- 20%
- Modelled NO2 Annual Mean 201

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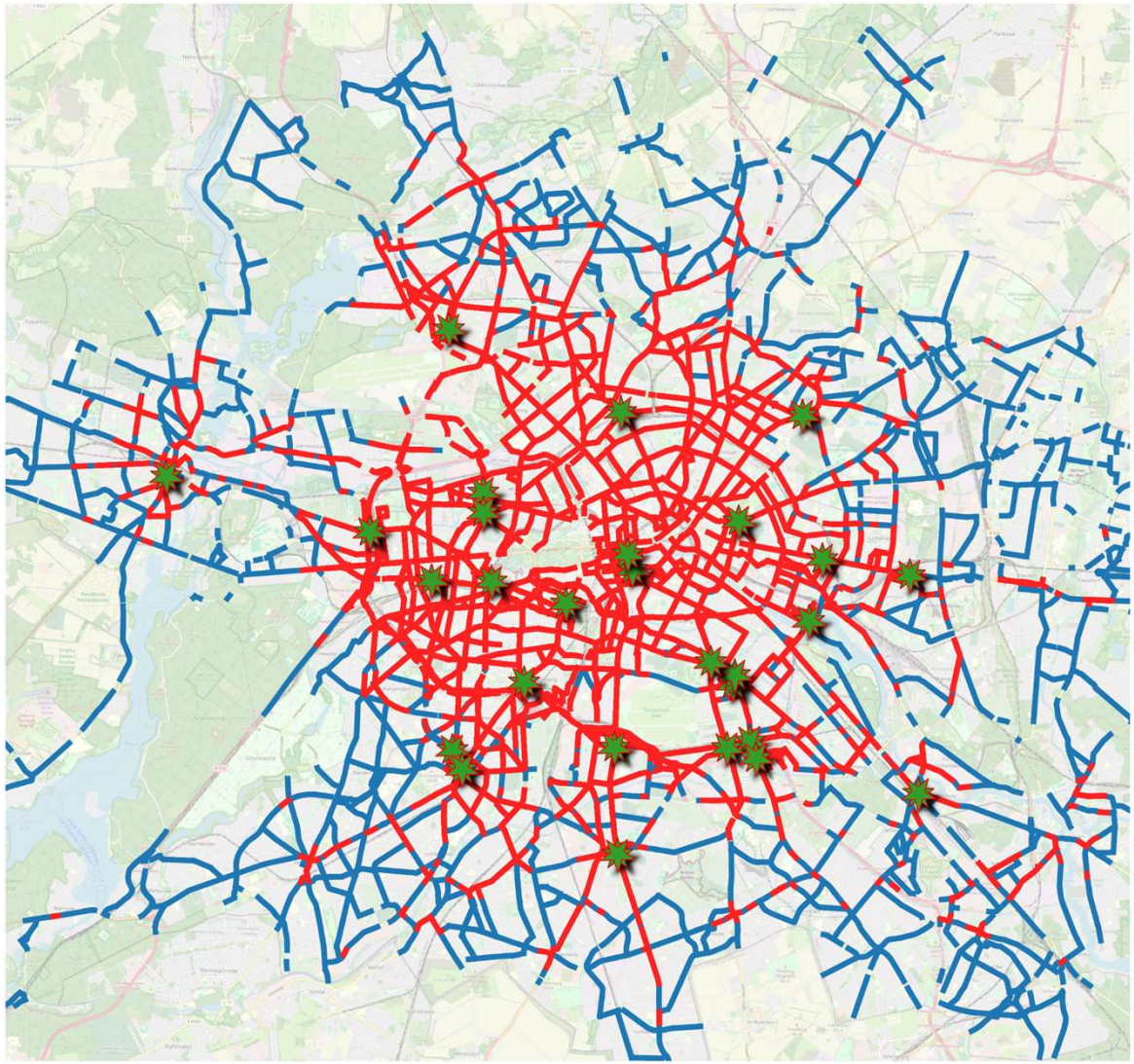
2020 NO_2: urban traffic sites – tolerance level +- 15 %
(same meteorology as for 2015)



Monitoring Points Street 2020

Monitoring Points 2020 +- 15 %

- MP 525 (55.8 µg/m³) +- 15 %
- MC 174 (30.1 µg/m³) +- 15 %
- MP 501 (31.2 µg/m³) +- 15 %
- MP 528 (22.7 µg/m³) +- 15 %
- MP 504 (39.2 µg/m³) +- 15 %
- MP 505 (33.6 µg/m³) +- 15 %
- MC 117 (35.5 µg/m³) +- 15 %
- MP 533 (40.6 µg/m³) +- 15 %
- MP 562 (25.2 µg/m³) +- 15 %
- MP 581 (29.9 µg/m³) +- 15 %
- MP 507 (29.1 µg/m³) +- 15 %
- MP 514 (33.9 µg/m³) +- 15 %
- MC 143 (33.4 µg/m³) +- 15 %
- MC 220 (24.1 µg/m³) +- 15 %
- MP 555 (35.1 µg/m³) +- 15 %
- MP 545 (42.0 µg/m³) +- 15 %
- MP 547 (29.8 µg/m³) +- 15 %
- MP 530 (39.7 µg/m³) +- 15 %
- MP 531 (43.4 µg/m³) +- 15 %
- MP 537 (46.2 µg/m³) +- 15 %
- MP 539 (26.4 µg/m³) +- 15 %
- MC 124 (34.9 µg/m³) +- 15 %
- MP 542 (36.0 µg/m³) +- 15 %
- MP 559 (32.5 µg/m³) +- 15 %
- MC 115 (21.9 µg/m³) +- 15 %
- MP 573 (34.5 µg/m³) +- 15 %
- MP 579 (27.8 µg/m³) +- 15 %
- MP 576 (37.2 µg/m³) +- 15 %
- Modellel NO2 Annual Mean 2020

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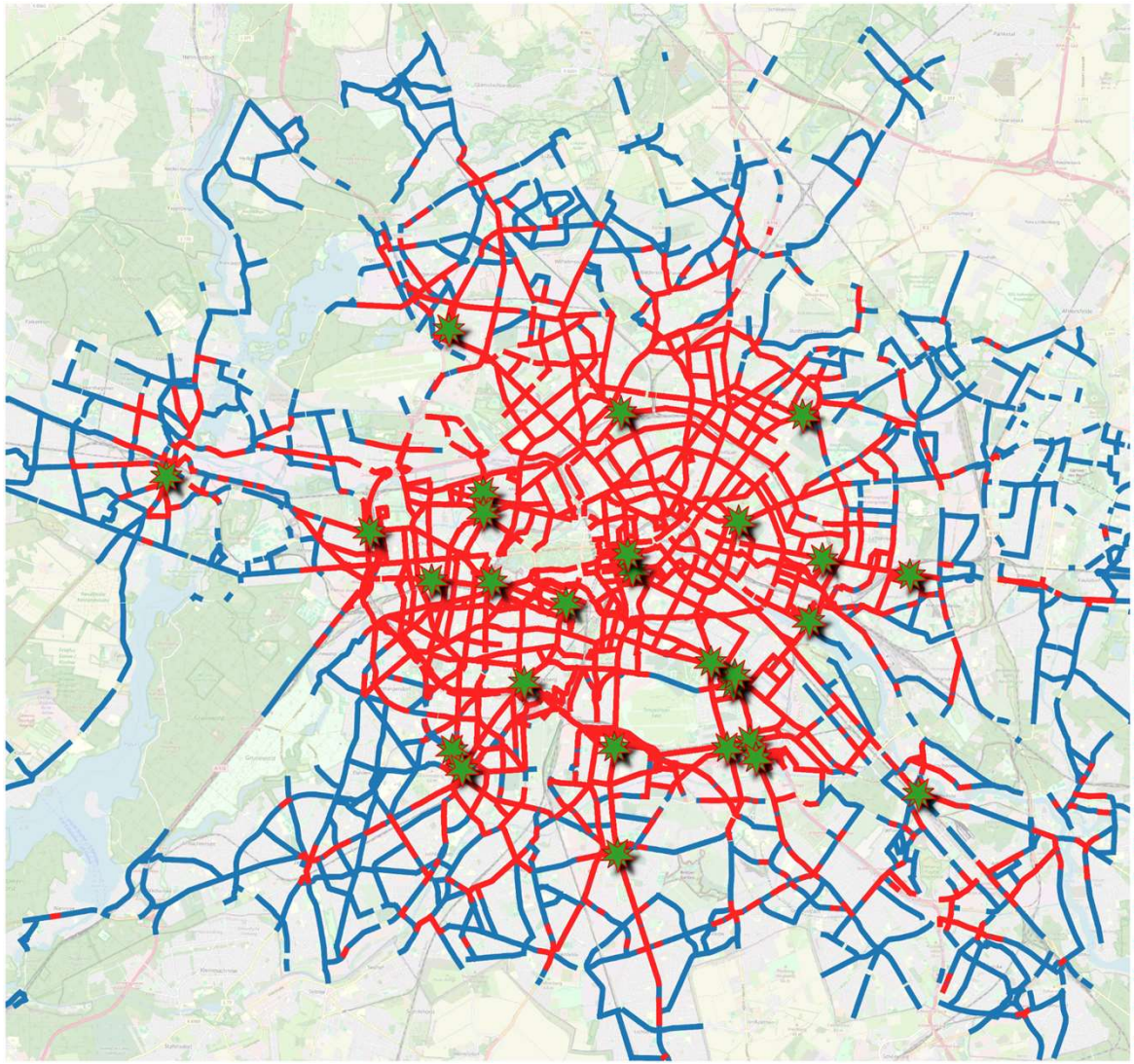
2025 NO_2: urban traffic sites – tolerance level +- 15 %

(same meteorology as for 2015)



Monitoring Points Street 2025

Monitoring Points 2025 +- 15 %

- MP 525 (35.8 µg/m³) +- 15 %
- MC 174 (20.7 µg/m³) +- 15 %
- MP 501 (20.7 µg/m³) +- 15 %
- MP 528 (20.9 µg/m³) +- 15 %
- MP 504 (25.6 µg/m³) +- 15 %
- MP 505 (22.0 µg/m³) +- 15 %
- MC 117 (24.0 µg/m³) +- 15 %
- MP 533 (24.9 µg/m³) +- 15 %
- MP 562 (18.2 µg/m³) +- 15 %
- MP 581 (20.9 µg/m³) +- 15 %
- MP 507 (18.3 µg/m³) +- 15 %
- MP 514 (22.6 µg/m³) +- 15 %
- MC 143 (21.4 µg/m³) +- 15 %
- MC 220 (16.4 µg/m³) +- 15 %
- MP 555 (21.1 µg/m³) +- 15 %
- MP 545 (27.5 µg/m³) +- 15 %
- MP 547 (20.8 µg/m³) +- 15 %
- MP 530 (24.5 µg/m³) +- 15 %
- MP 531 (29.5 µg/m³) +- 15 %
- MP 537 (30.8 µg/m³) +- 15 %
- MP 539 (17.2 µg/m³) +- 15 %
- MC 124 (22.6 µg/m³) +- 15 %
- MP 542 (24.0 µg/m³) +- 15 %
- MP 559 (21.8 µg/m³) +- 15 %
- MC 115 (15.7 µg/m³) +- 15 %
- MP 573 (23.9 µg/m³) +- 15 %
- MP 579 (17.0 µg/m³) +- 15 %
- MP 576 (22.9 µg/m³) +- 15 %
- Modellel NO2 Annual Mean 2025

NO_2: urban traffic sites: Summary

- Tolerance level does not influence the spatial representativeness of Berlin‘s traffic monitoring sites for NO_2
  - NO_2 levels are high
  - traffic monitoring sites shall represent streets with expected highest NO_2 burden
  - low level NO_2-streets are not represented by traffic monitoring sites

- Absolute NO_2 levels do not influence spatial representativeness of Berlin‘s traffic monitoring sites for NO_2
  - for different years with declining NO_2 levels (2015 -> 2020 -> 2025) the same spatial representativeness of Berlin’s traffic monitoring sites for NO_2 is observed

- Number of traffic monitoring sites for NO_2 does not change overall picture of spatial representativeness of Berlin’s traffic monitoring sites
  - traffic monitoring sites shall represent high polluted streets.
  - required number of sites is sufficient
  - indicative measurements gives indication of special circumstances at specific street, but are not necessarily needed for better spatial representativeness

NO_2: urban traffic sites 2015

Measurements vs. modelled values for 2015

- 28 urban traffic <u>monitoring</u> sites:
  - 6 automatic monitoring station: temporal resolution: 1 hour
    - reference measurements
  - 22 passive samplers: temporal resolution: 2 weeks
    - indicative measurements
    - reliable for annual means

- <u>Modelled</u> NO_2 annual mean values for appox. 1.125 km street lengths
  - $IMMIS^{luft}$ street canyon model gives only annual mean values

- Measurements vs. model application: **min - max annual means for NO_2**
  - min: **measured: 41 µg/m³ vs. modelled: 10 µg/m³**
  - max: **measured: 73 µg/m³ vs. modelled: 90 µg/m³**

NO_2: urban traffic sites 2015: SR discussion

Measurements - modelled values at urban traffic monitoring sites: comparable sites

- Measurements vs. model application: min – max at monitoring sites
  - min: measured: 41 µg/m³ vs. modelled: 37,2 µg/m³ (**good agreement**)
  - max: measured: 73 µg/m³ vs. modelled: 78,9 µg/m³ (**good agreement**)

Proposed Cut-off consideration not relevant for NO_2-annual mean concentrations at Berlin in 2015

Overlapping spatial representative areas

- NO_2-monitoring sites at points where **high values are expected**
- Low values **at urban traffic sites** are **not relevant/interesting** within AAQD
- At many NO_2-monitoring sites **similar values are measured**
  - 4 sites with values between 40 and 45 µg/m³
  - 4 sites within values between 46 and 50 µg/m³
  - **10 sites within values between 51 and 55 µg/m³**
  - 3 sites with the same NO_2-annual mean value of 59 µg/m³
  - 4 sites with the same NO_2-annual mean value of 60 µg/m³
  - 1 site with NO_2-annual mean value of 65 µg/m³
  - 1 site with NO_2 annual mean value of 73 µg/m³

NO_2: urban traffic sites 2015: SR discussion

Overlapping spatial representative areas

- At many NO_2-monitoring sites **similar values are measured**
- **These sites shall be representative also for other urban traffic sites, where no monitoring stations exist**
  - Less kerbside monitoring sites seem to be sufficient -> "intelligent" monitoring network design necessary
- **IMMIS^{luft} is able to confirm this requirement**
- Tolerance level (+- 15% or +- 20%) is not **essential** for fulfilment of this requirement and has only very low impact for fulfilment at kerbside monitoring sites

BUT

- Spatial representativeness for low NO_2-levels can not be checked by street canyon models if no NO_2-low level measurements at urban traffic monitoring sites exist.

NO_2: urban traffic sites: SR some considerations / proposals

- Spatial representativeness checks of monitoring stations at urban traffic sites by model applications only useful / meaningful, if model applications are **fit for propose** -> especially at urban traffic site scale and for high NO_2-concentration levels

- If spatial representativeness checks by model applications also at low NO_2-levels at **kerbside sites desired,**

  - Specific measurements needed
    - few indicative measurements seem to be sufficient and/or financially justifiable (especially for model validation proposes)
  - OR
    - better definition of urban traffic kerbside monitoring sites
      - cut-off for traffic load: e.g. only streets with DTV > 15.000 vehicles
      - streets with buildings on (both) sites
      - cut-off for gaps between buildings: e.g. gaps on street section < 50 %

    - exclude streets which do not fulfil the above proposed definitions in checking spatial representativeness of monitoring stations at urban traffic sites

PM_{10}, $PM_{2.5}$: urban traffic sites: SR

- Measurements of PM_{10} and $PM_{2.5}$ at traffic monitoring sites:
  - PM_{10}:
    - 2017: between 23 µg/m³ and 28 µg/m³ annual mean
      (background: 16 - 22 µ/m³ annual mean)
    - 2020: between 18 µg/m³ and 22 µg/m³ annual mean
      (background: 14 - 18 µg/m³ annual mean)
    - 2023: between 17 µg/m³ and 20 µg/m³ annual mean
      (background: 13 - 17 µg/m³ annual mean)
  - $PM_{2.5}$:
    - 2017: between 16 µg/m³ and 19 µg/m³ annual mean
      (background: 12 - 16 µ/m³ annual mean)
    - 2020: between 12 µg/m³ and 13 µg/m³ annual mean
      (background: 9 - 12 µg/m³ annual mean)
    - 2023: between 11 µg/m³ and 12 µg/m³ annual mean
      (background: 9 - 10 µg/m³ annual mean)

- Spatial representativeness considerations for PM_{10} and $PM_{2.5}$ at street monitoring sites completely different as for NO_2
- Special considerations regarding spatial representativeness for traffic sites (at least for $PM_{2.5}$) not needed

Thank you for your attention

Dr. Andreas Kerschbaumer

andreas.kerschbaumer@senmvku.berlin.de

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