Spatial Representativeness (SR) analysis in 3 cities in Sweden

Stockholm , Uppsala and Umeå

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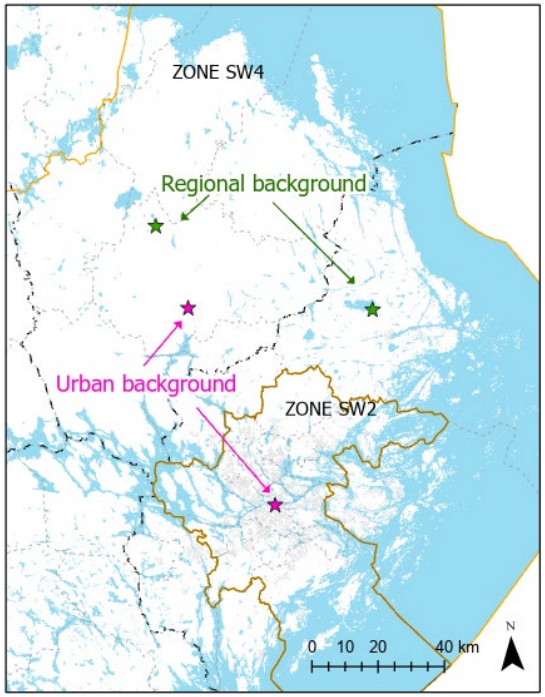
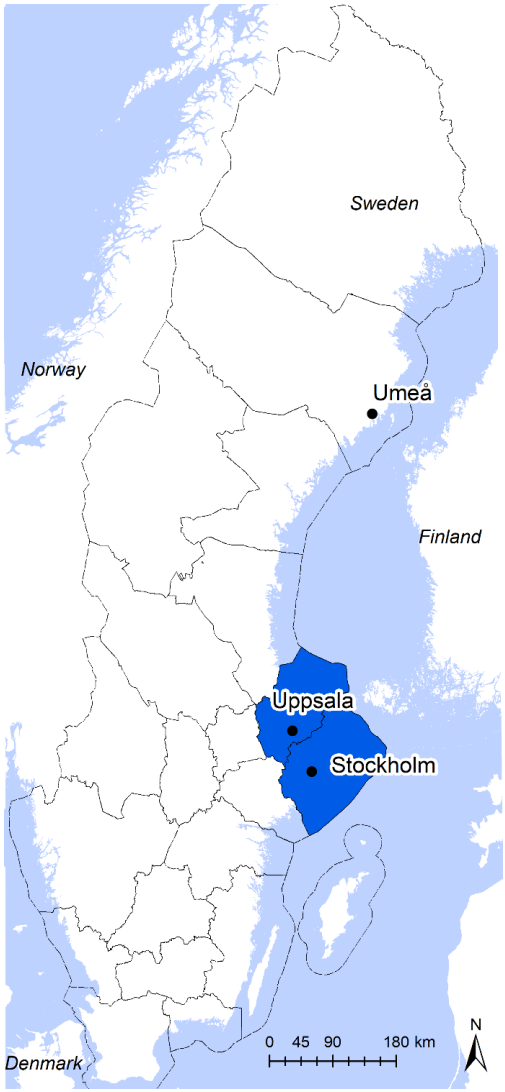
Study area

- Stockholm, capital and largest city in Sweden
- Uppsala, 4th largest city
- Umeå, 13th largest city





Specification of the model data – Stockholm & Uppsala

Emission data

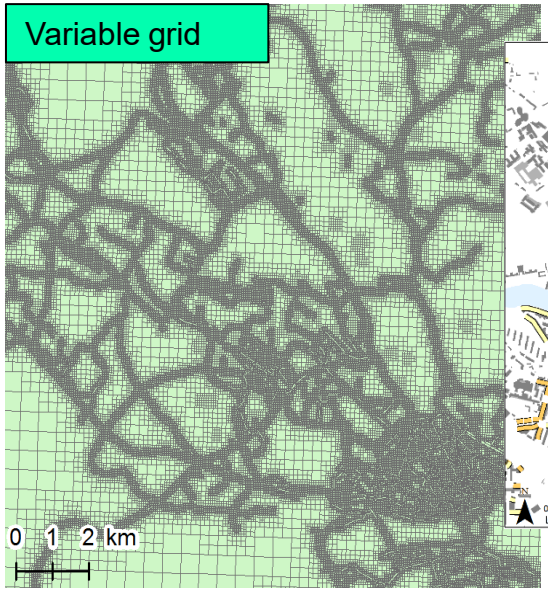
- Local emission data (mostly bottom-up data)

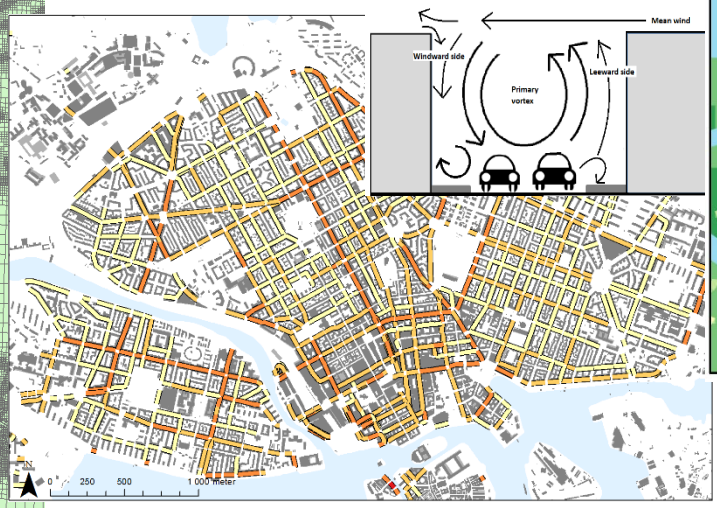
Models

- Airviro Gaussian model with a variable grid (35-500 m)
- Airviro OSPM (Open Street Pollution Model)

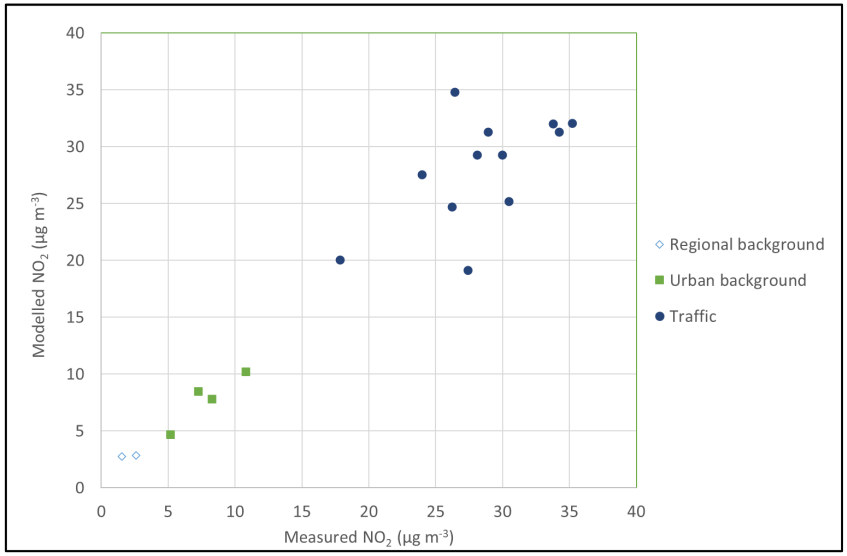
  NERI, Department of Atmospheric Environment in Denmark

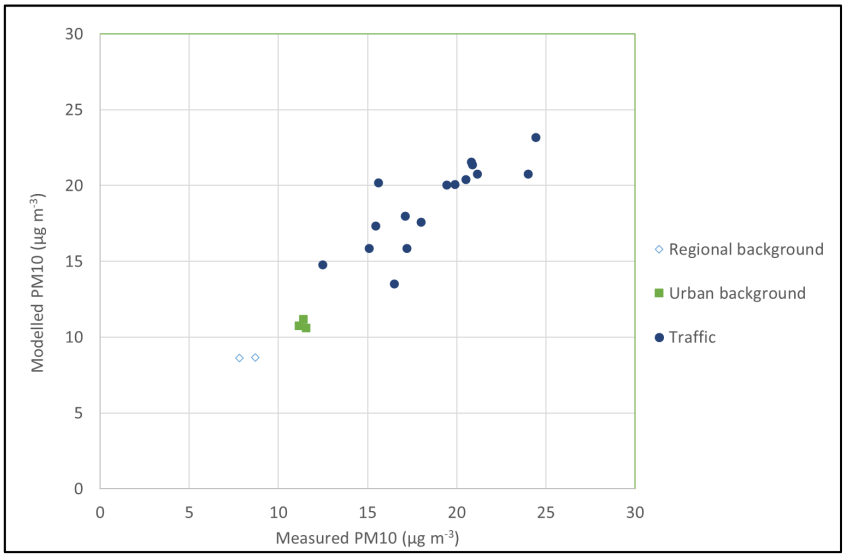
  - Simplification: the same concentration on both sides of the street canyon (the highest)

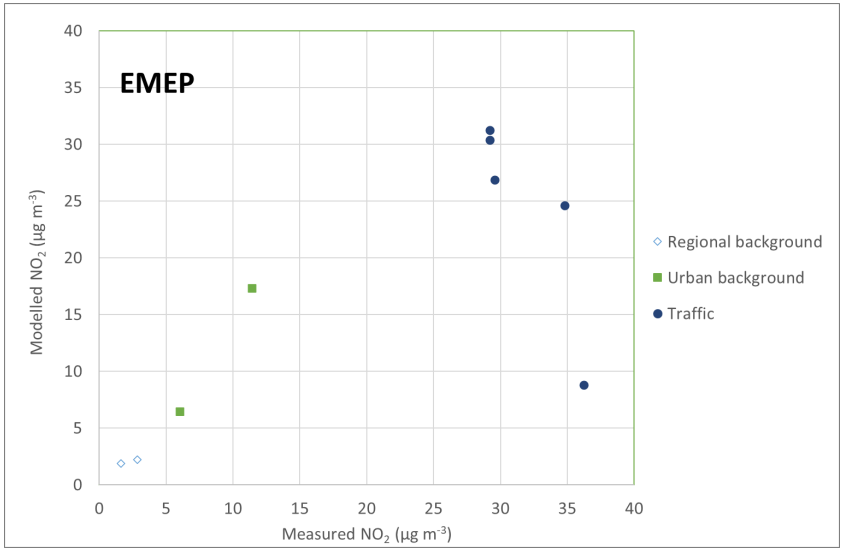


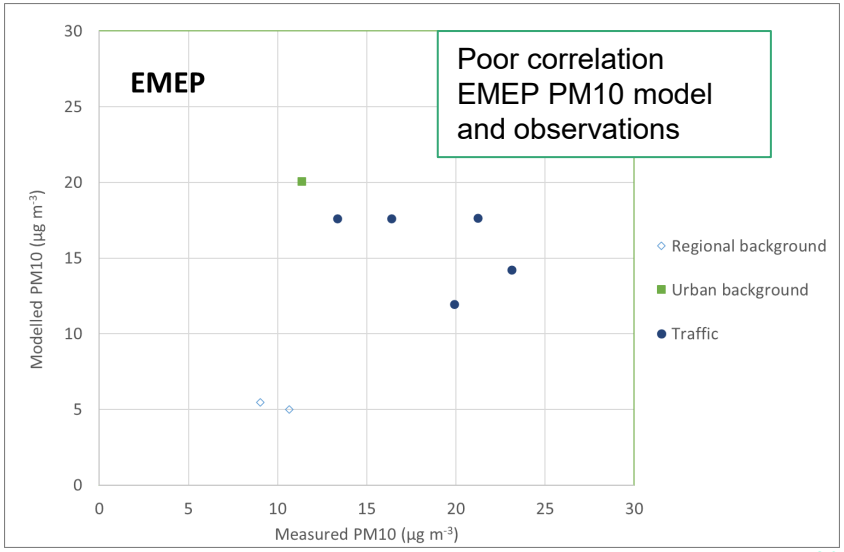


Model vs observations & uEMEP vs observations

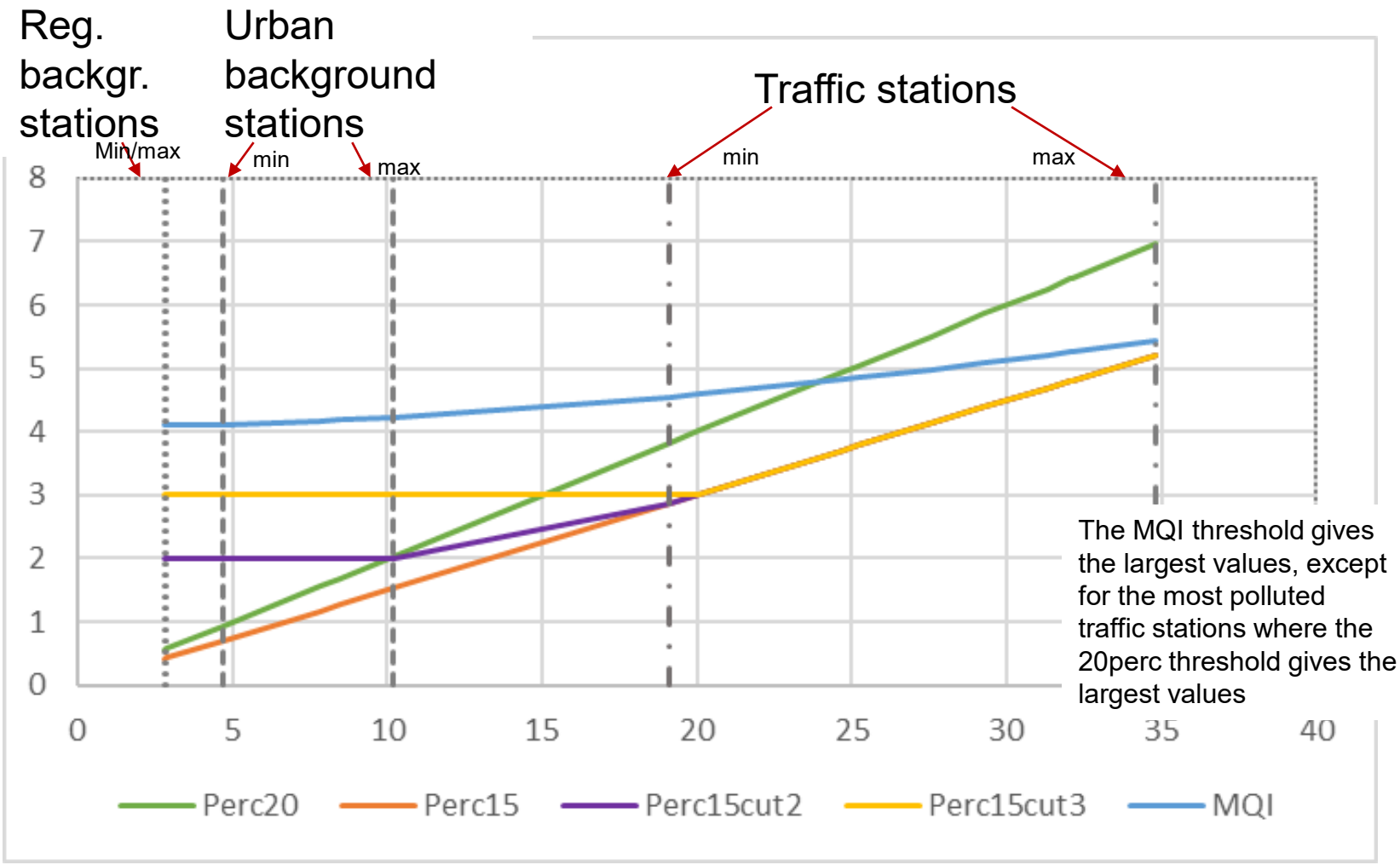








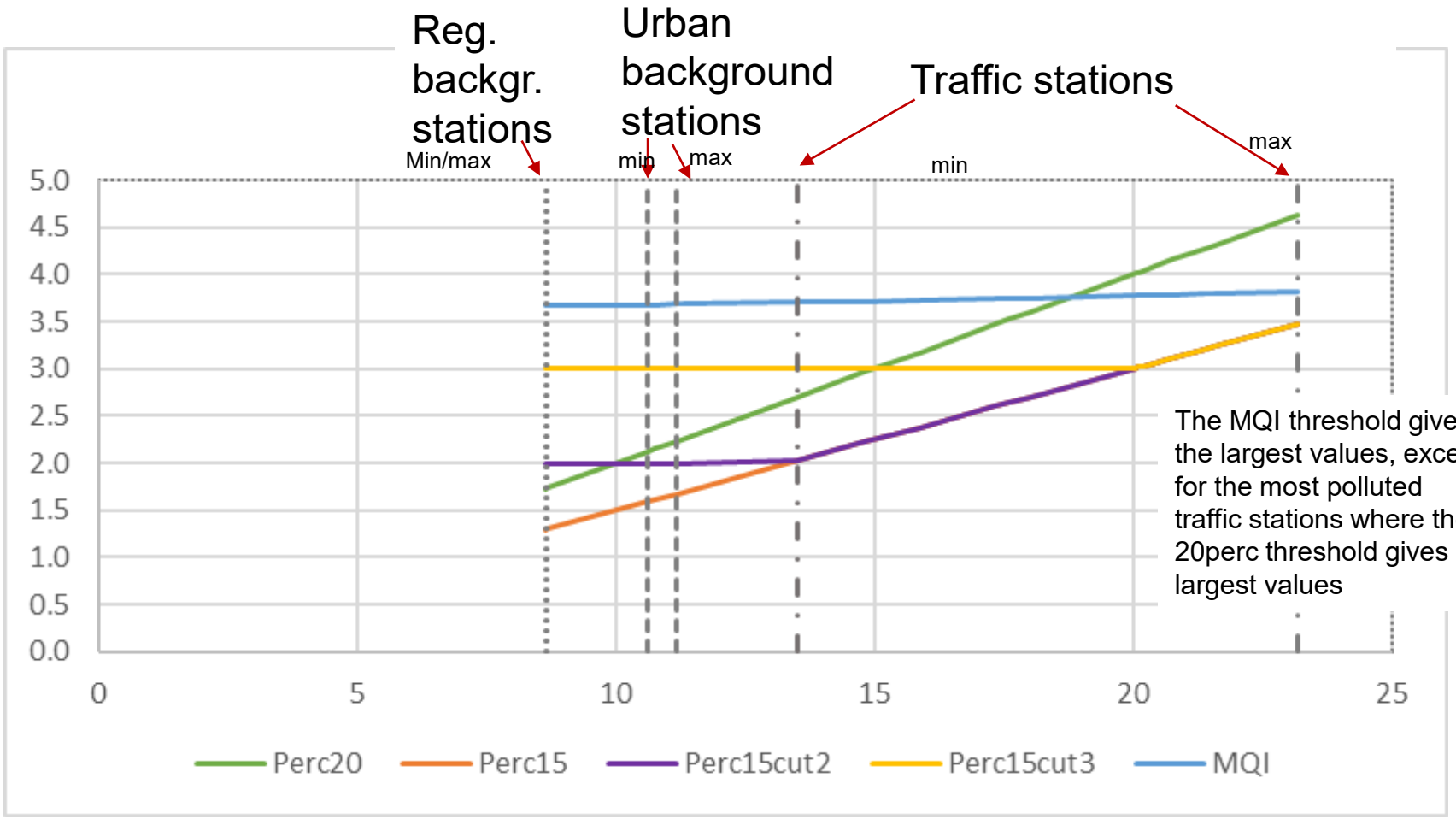
Thresholds versus observed yearly mean NO_2



NO_2 threshold for Stockholm/Uppsala stations

Station	Zone	Type	NO2yr mean	Perc20	Perc15	Perc15cut2	Perc15cut3	MQI
Norunda	SWE2	Rural	2.8	0.56	0.42	2.00	3.00	**4.10**
Norr Malma	SWE2	Rural	2.9	0.58	0.43	2.00	3.00	**4.10**
Kanaan	SWE4	Urban backgr	4.7	0.93	0.70	2.00	3.00	**4.12**
Klosterg	SWE2	Urban backgr	7.8	1.56	1.17	2.00	3.00	**4.17**
Dragarbrunnsg	SWE2	Urban backgr	8.5	1.69	1.27	2.00	3.00	**4.19**
Torkel Kn	SWE4	Urban backgr	10.2	2.04	1.53	2.00	3.00	**4.23**
Haggvik E4	SWE4	Traffic	19.1	3.83	2.87	2.87	3.00	**4.54**
Rasundav	SWE4	Traffic	20.1	4.01	3.01	3.01	3.01	**4.59**
Folkungag 70	SWE4	Traffic	24.7	**4.95**	3.71	3.71	3.71	4.82
Folkungag 57	SWE4	Traffic	25.2	**5.04**	3.78	3.78	3.78	4.85
St Eriksg 83	SWE4	Traffic	27.6	**5.51**	4.13	4.13	4.13	4.98
Sveav 59 W	SWE4	Traffic	29.3	**5.86**	4.39	4.39	4.39	5.09
Sveav 59 E	SWE4	Traffic	29.3	**5.86**	4.39	4.39	4.39	5.09
Hornsg 87 N	SWE4	Traffic	31.3	**6.26**	4.70	4.70	4.70	5.21
Hornsg 87 S	SWE4	Traffic	31.3	**6.26**	4.70	4.70	4.70	5.21
LillaEssingen E4	SWE4	Traffic	32.0	**6.41**	4.81	4.81	4.81	5.26
Kungsg 67	SWE2	Traffic	32.1	**6.42**	4.82	4.82	4.82	5.26
Skonertv E4	SWE4	Traffic	34.8	**6.96**	5.22	5.22	5.22	5.44

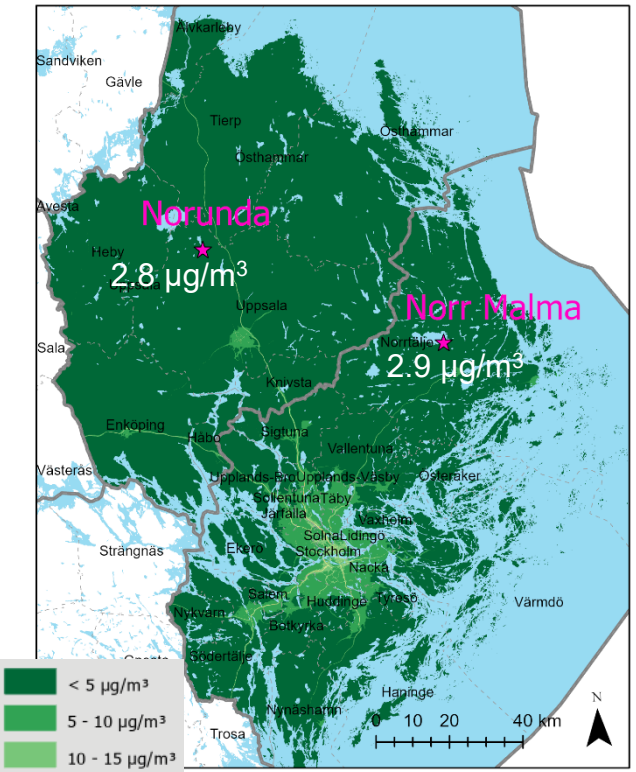
Thresholds versus observed yearly mean PM10



PM10 threshold for Stockholm/Uppsala stations

Station	Zone	Type	PM10yr	Perc20	Perc15	Perc15cut2	Perc15cut3	MQI
Norunda	SWE2	Rural	8.6	1.73	1.30	2.00	3.00	**3.67**
Norr Malma	SWE2	Rural	8.7	1.73	1.30	2.00	3.00	**3.67**
Klosterg	SWE2	Urban backgr	10.6	2.12	1.59	2.00	3.00	**3.68**
Dragarbrunnsg	SWE2	Urban backgr	10.8	2.15	1.61	2.00	3.00	**3.68**
Torkel Kn	SWE4	Urban backgr	11.2	2.24	1.68	2.00	3.00	**3.68**
Danderydsv	SWE4	Traffic	13.5	2.70	2.03	2.03	3.00	**3.70**
Eriksbergsskolan	SWE4	Traffic	14.8	2.96	2.22	2.22	3.00	**3.72**
Rasundav	SWE4	Traffic	15.9	3.17	2.38	2.38	3.00	**3.73**
Ekmansv 11	SWE4	Traffic	15.9	3.17	2.38	2.38	3.00	**3.73**
Haggvik E4	SWE4	Traffic	17.3	3.47	2.60	2.60	3.00	**3.74**
Folkungag 70	SWE4	Traffic	17.6	3.52	2.64	2.64	3.00	**3.75**
Folkungag 57	SWE4	Traffic	18.0	3.60	2.70	2.70	3.00	**3.75**
Sveav 59 W	SWE4	Traffic	20.1	**4.01**	3.01	3.01	3.01	3.78
Kungsg 67	SWE2	Traffic	20.1	**4.02**	3.02	3.02	3.02	3.78
Skonertv E4	SWE4	Traffic	20.2	**4.04**	3.03	3.03	3.03	3.78
St Eriksg 83	SWE4	Traffic	20.4	**4.09**	3.06	3.06	3.06	3.78
Hornsg 87 N	SWE4	Traffic	20.8	**4.15**	3.12	3.12	3.12	3.79
Birkakorset	SWE2	Traffic	21.4	**4.28**	3.21	3.21	3.21	3.80
Turingeg	SWE2	Traffic	21.6	**4.31**	3.24	3.24	3.24	3.80
LillaEssingen E4	SWE4	Traffic	23.2	**4.64**	3.48	3.48	3.48	3.83

NO_2 year regional background



Norr Malma

- NO_2 yearly mean: 2.9 µg/m³
- ± 20 %: 2.3 – 3.5 µg/m³

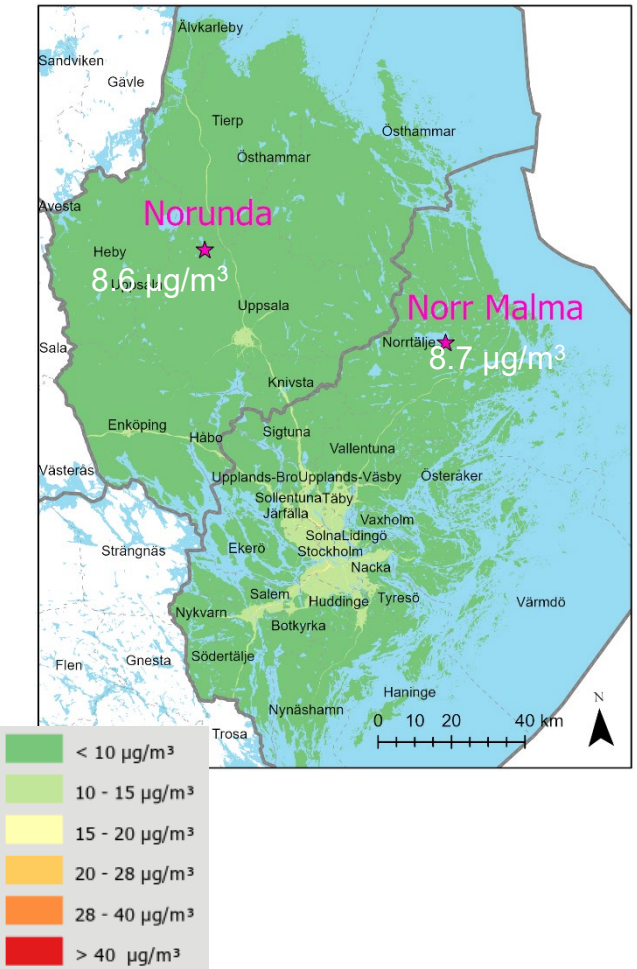
Norr Malma

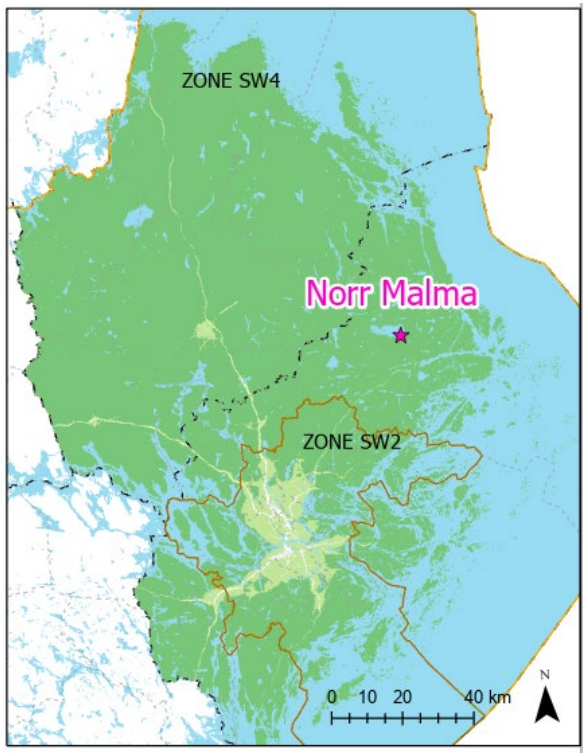
- NO_2 yearly mean: 2.9 µg/m³
- MQI: 0 – 7.0 µg/m³

PM10 year regional background

Norr Malma
- PM10 yearly mean: 8.7 µg/m^3
- ± 20 %: 6.9 – 10.4 µg/m^3

Norr Malma
- PM10 yearly mean: 8.7 µg/m^3
- MQI: 5.0 – 12.3 µg/m^3





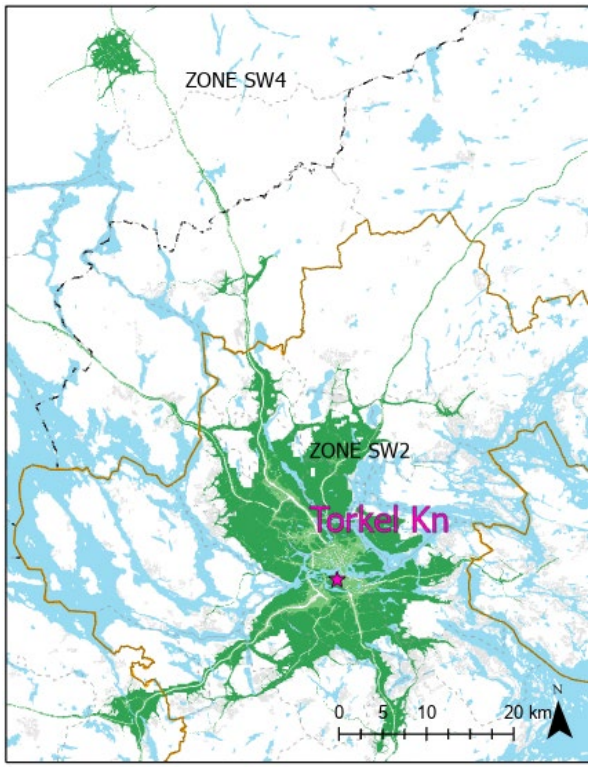
NO_2 year urban background

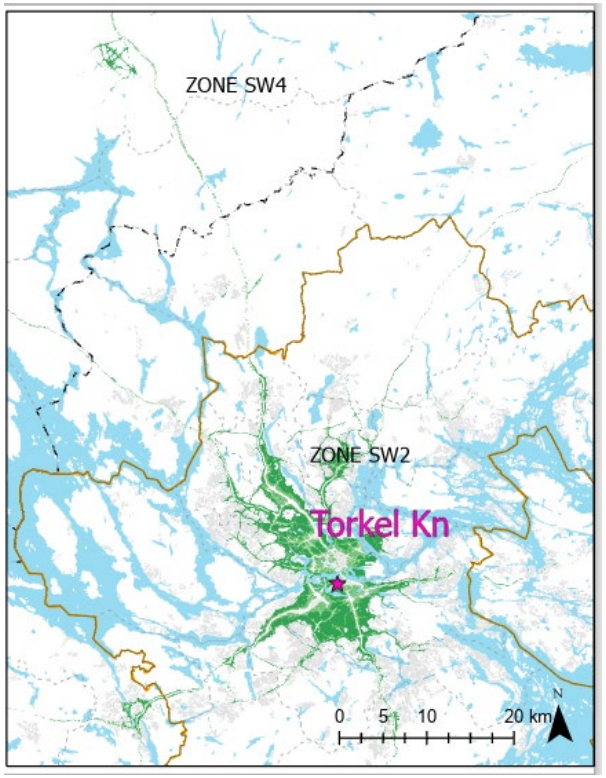
Torkel Kn, Stockholm

- NO_2 yearly mean: 10.2 µg/m^3
- MQI: 6.0 – 14.4 µg/m^3

Torkel Kn, Stockholm

- NO_2 yearly mean: 10.2 µg/m^3
- ± 20 %: 8.2 – 12.2 µg/m^3



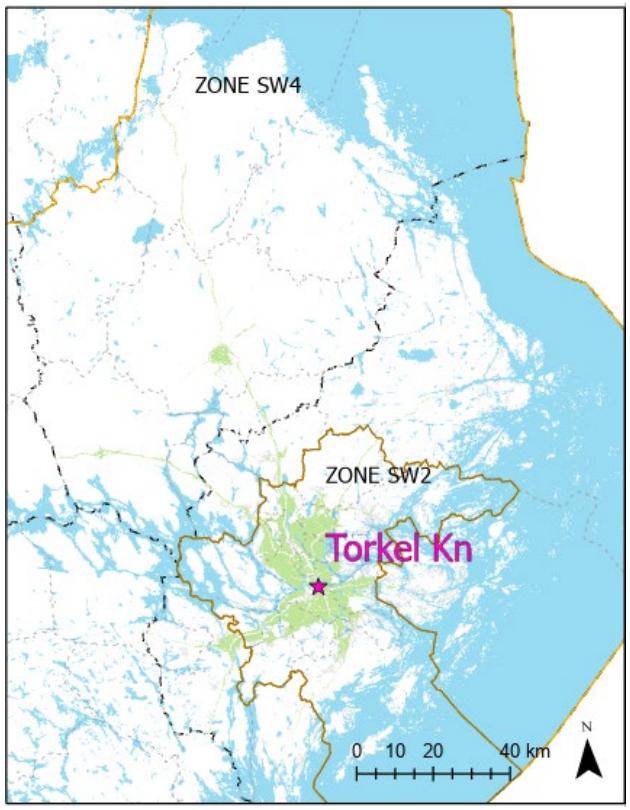


PM10 year urban background Stockholm

Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m^3
- MQI: 7.5 – 14.9 µg/m^3

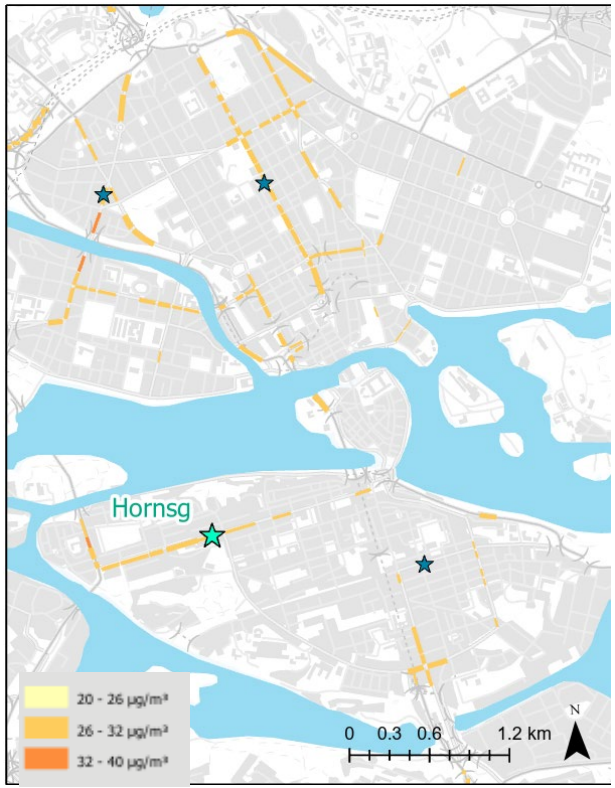
Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m^3
- ± 20 %: 8.9 – 13.4 µg/m^3

Torkel Kn, Stockholm
- PM10 yearly mean: 11.2 µg/m^3
- ± 10 %: 10.1 – 12.3 µg/m^3

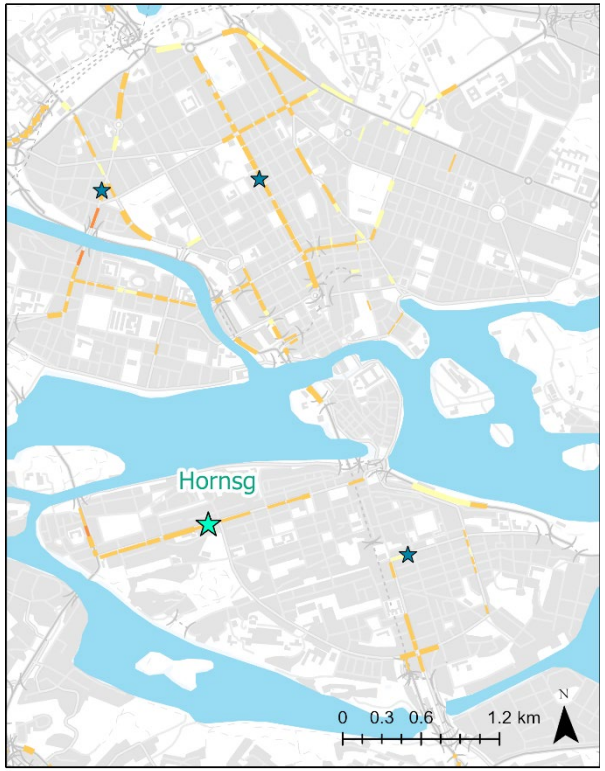


NO_2 year Hornsgatan street stations in Stockholm city

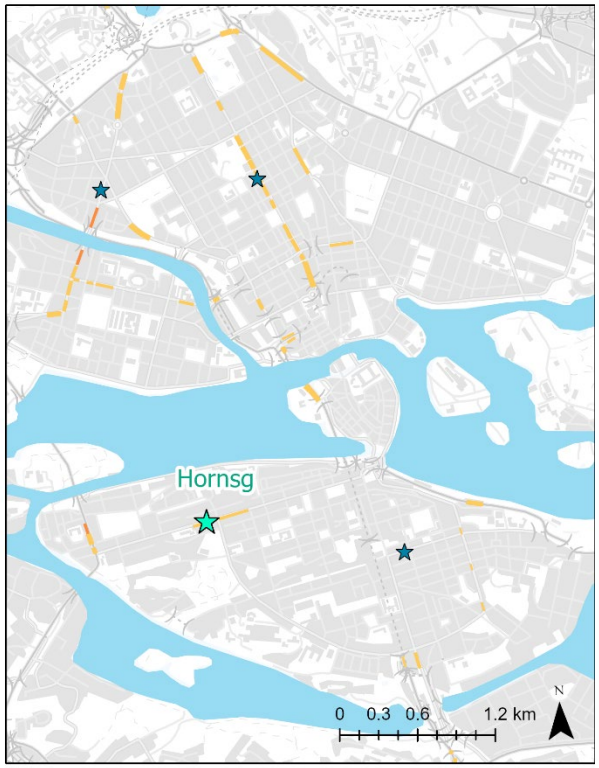
Hornsgatan, Stockholm
- NO_2 yearly mean: 31.3 µg/m^3
- MQI: 26.1 – 36.5 µg/m^3



Hornsgatan, Stockholm
- NO_2 yearly mean: 31.3 µg/m^3
- ± 20 %: 25.0 – 37.6 µg/m^3

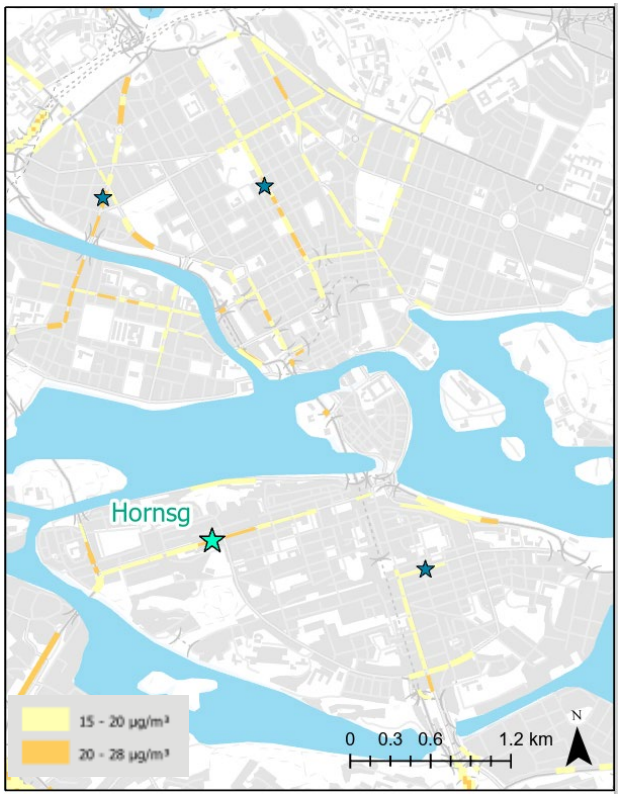


Hornsgatan, Stockholm
- NO_2 yearly mean: 31.3 µg/m^3
- ± 10 %: 28.2 – 34.4 µg/m^3

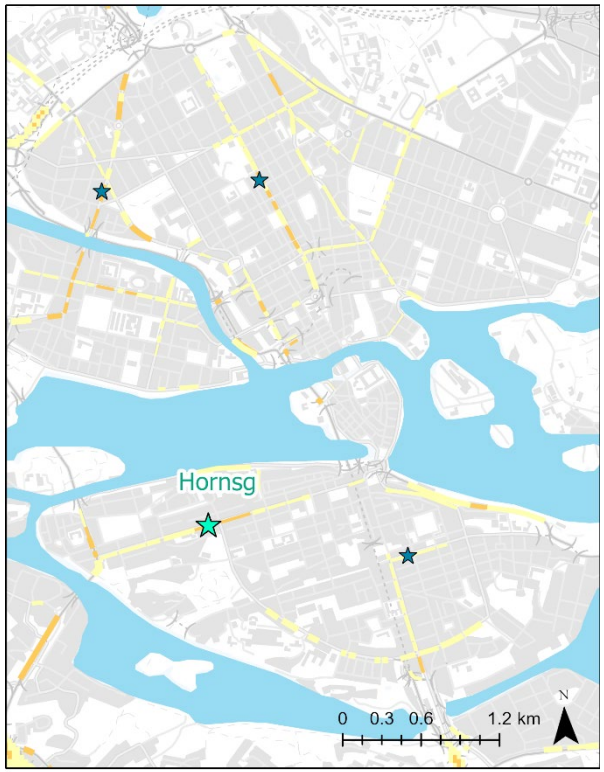


PM10 year Hornsgatan street stations in Stockholm city

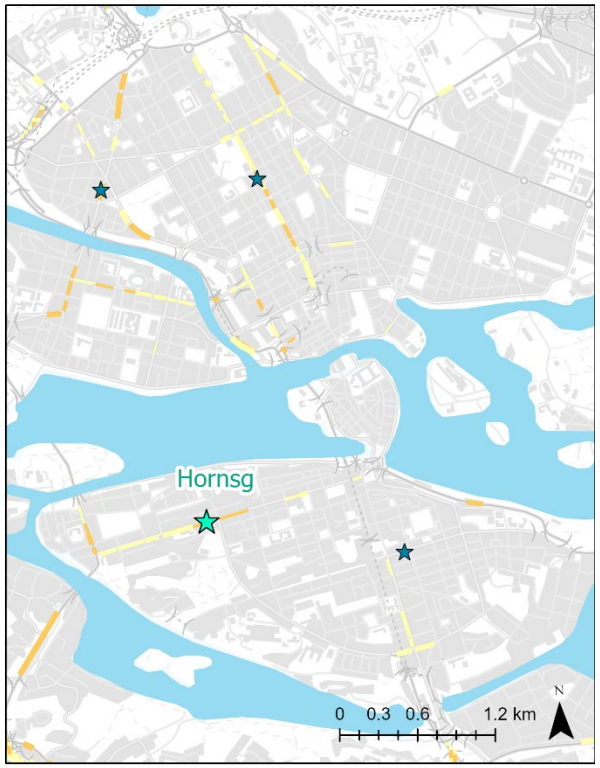
Hornsgatan, Stockholm
- PM10 yearly mean: 20.8 µg/m^3
- MQI:17.0 – 24.6 µg/m^3



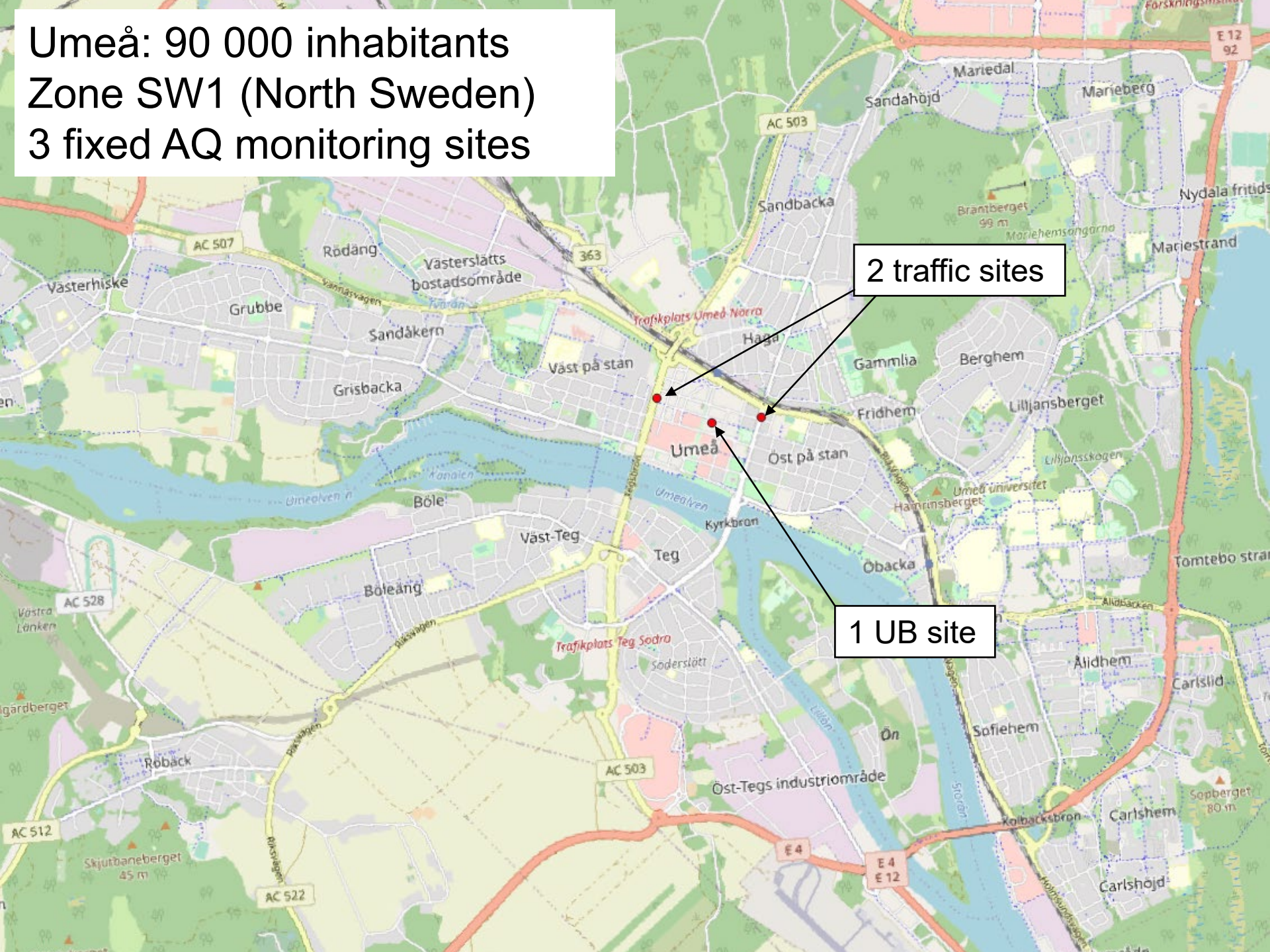
Hornsgatan, Stockholm
- PM10 yearly mean: 20.8 µg/m^3
- ± 20 %: 16.6 – 24.9 µg/m^3



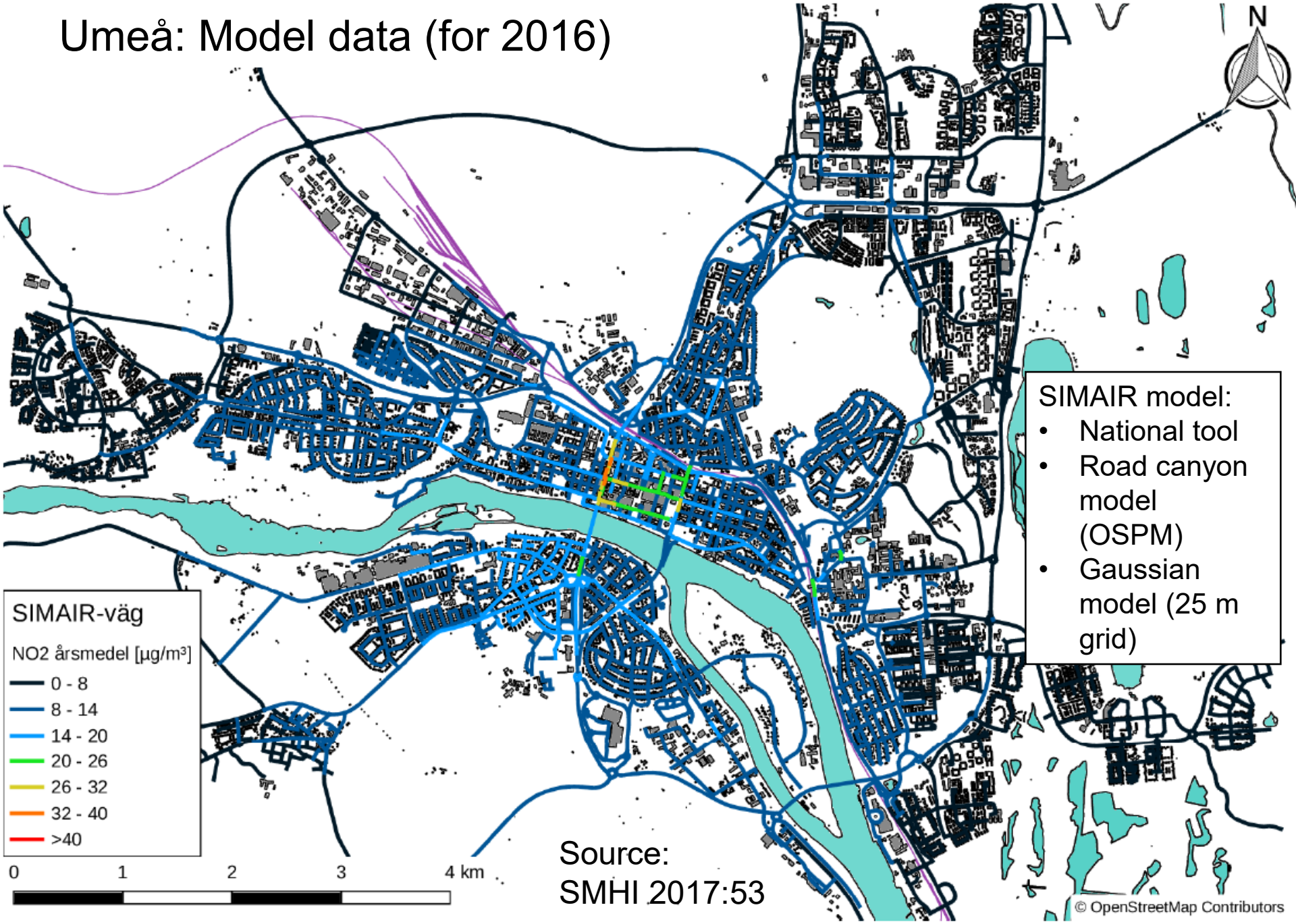
Hornsgatan, Stockholm
- PM10 yearly mean: 20.8 µg/m^3
- ± 10 %: 18.7 – 22.8 µg/m^3



Spatial representativeness in Umeå


Umeå: 90 000 inhabitants
Zone SW1 (North Sweden)
3 fixed AQ monitoring sites
2 traffic sites
1 UB site
Umeå
Öst på stan
Väst på stan
Teg
Öbacka
Gammlia
Berghem
Fridhem
Lilljansberget
Sandbacka
Sandahöjd
Mariedal
Marieberg
Mariestrand
Nydala fritids
Rödäng
Västerslätts bostadsområde
Grubbe
Sandåkern
Grisbacka
Västerhiske
Haga
Trafikplats Umeå Norra
Trafikplats Teg Södra
Böle
Väst-Teg
Boleäng
Röbäck
Öst-Tegs industriområde
Ön
Sofiehem
Ålidhem
Carlslid
Carlshem
Carlshöjd
Tomtebo
Umeälven
Kyrkbron
Kolbacksbron
Umeå universitet
Hammrinsberget
Skjutbaneberget
Sopberget
AC 503
AC 507
AC 528
AC 512
AC 522
363
E 4
E 12
E 12
92

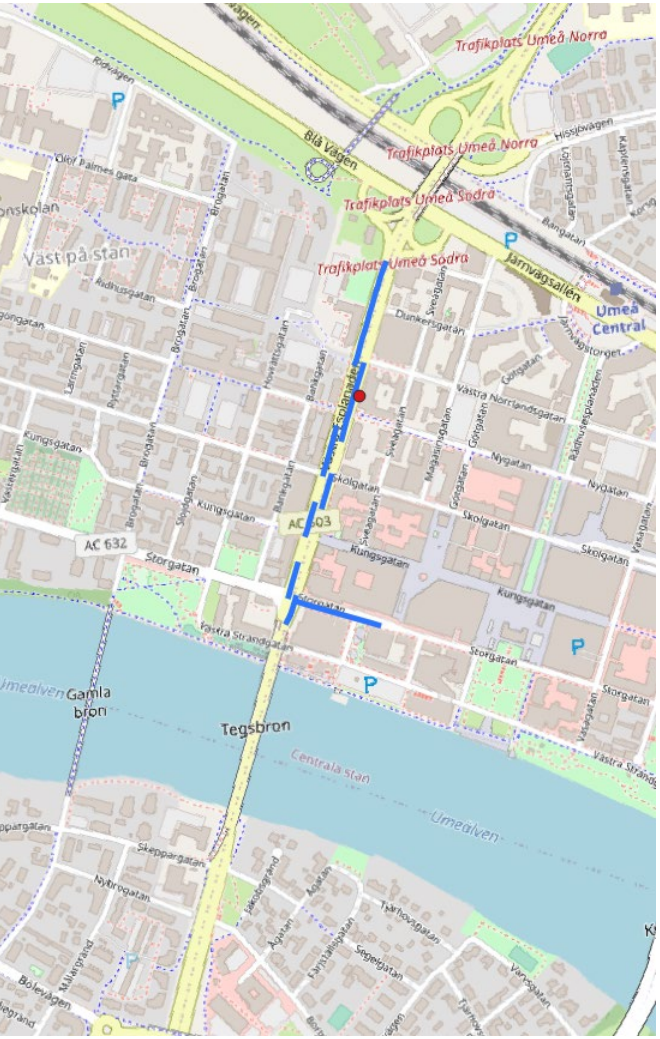
Umeå: Model data (for 2016)



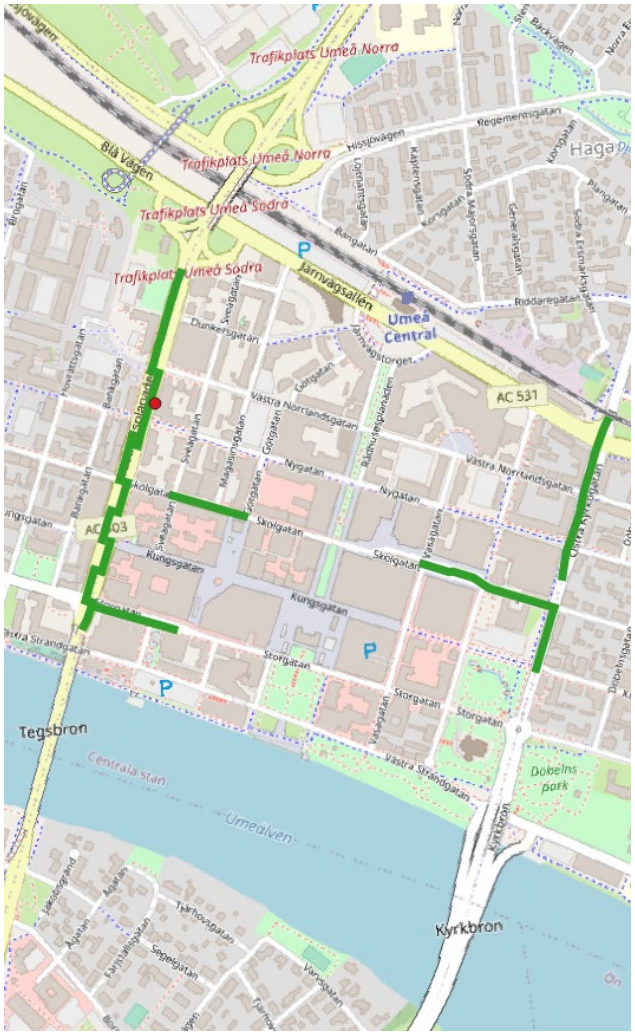
NO_2 annual mean, Umeå V. Esplanaden (traffic site)

Annual mean (2016): 33.9 µg/m^3

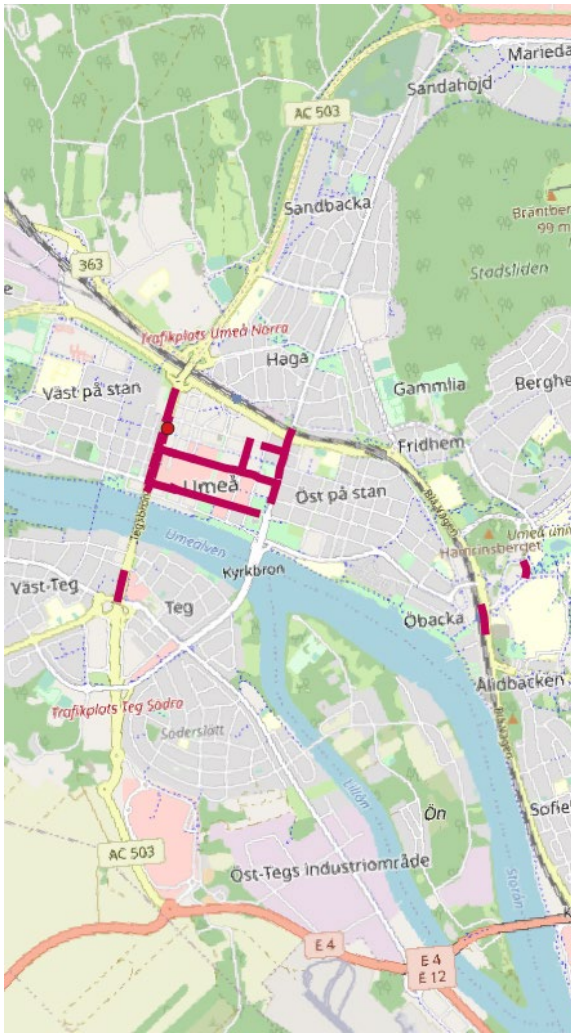
Representative area ±20%
27.1 – 40.7 µg/m^3



Representative area ±30%
23.6 – 44.1 µg/m^3



Representative area ±40%
20.4 – 47.5 µg/m^3



NO_2 annual mean, Umeå V. Esplanaden (traffic site)

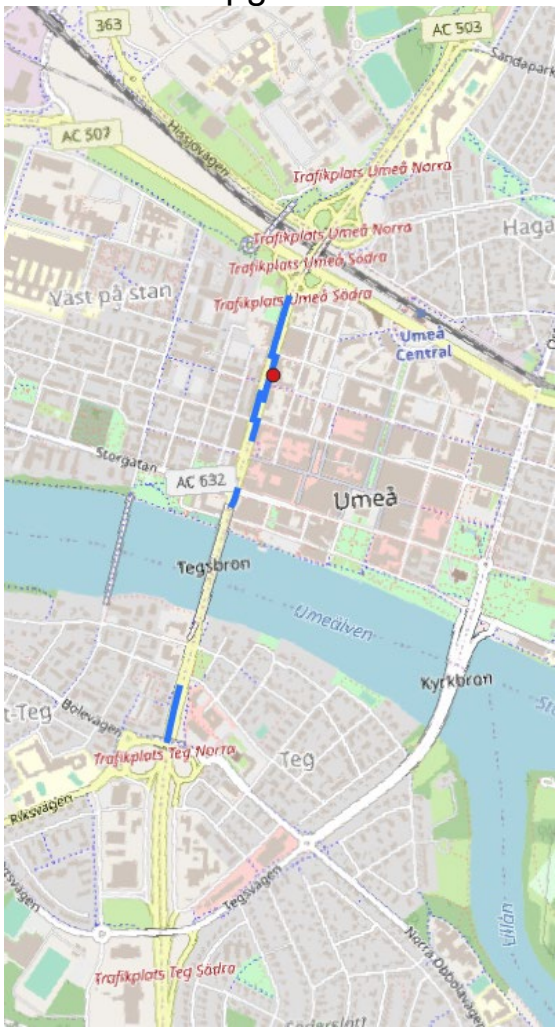
Annual mean (2016): 33.9 µg/m^3

Representative area ±5.39 µg/m^3 (measurement uncertainty)
28.5 – 39.3 µg/m^3

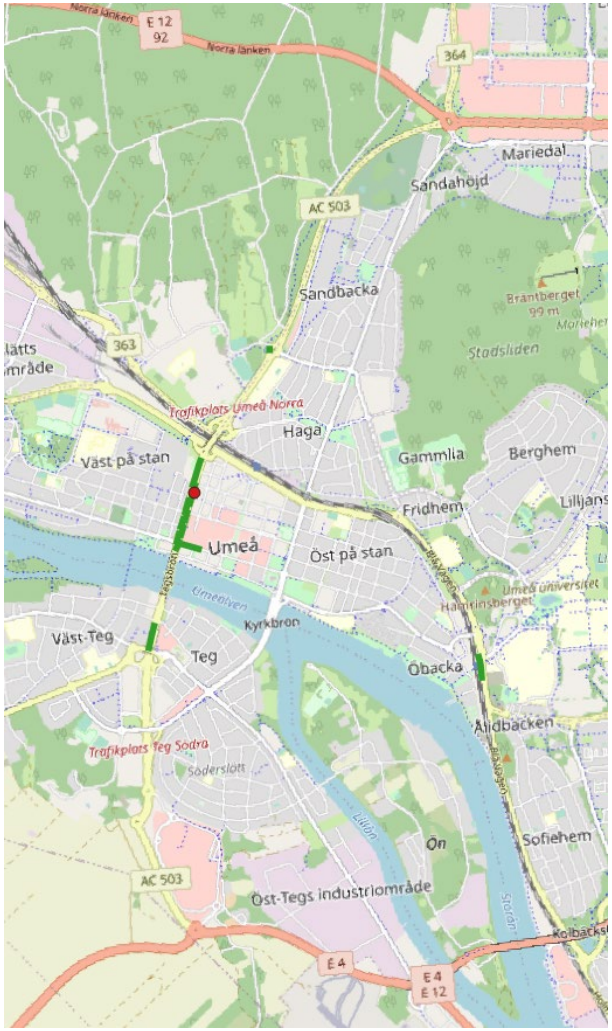
PM10 annual mean, Umeå V. Esplanaden (traffic site)

Annual mean (2016): 15.1 µg/m^3

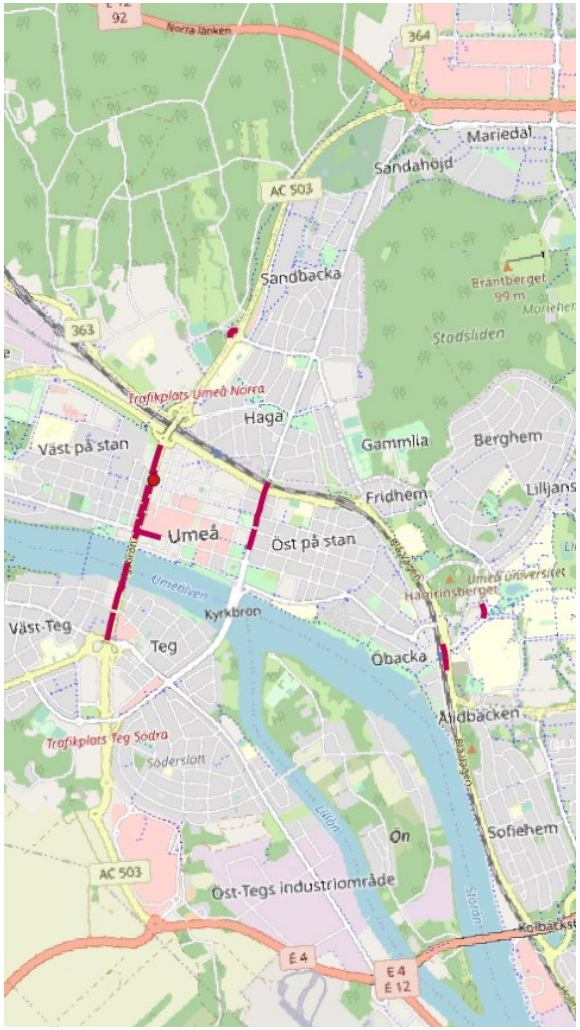
Representative area ±20%
12.1 – 18.1 µg/m^3



Representative area ±30%
10.6 – 19.7 µg/m^3



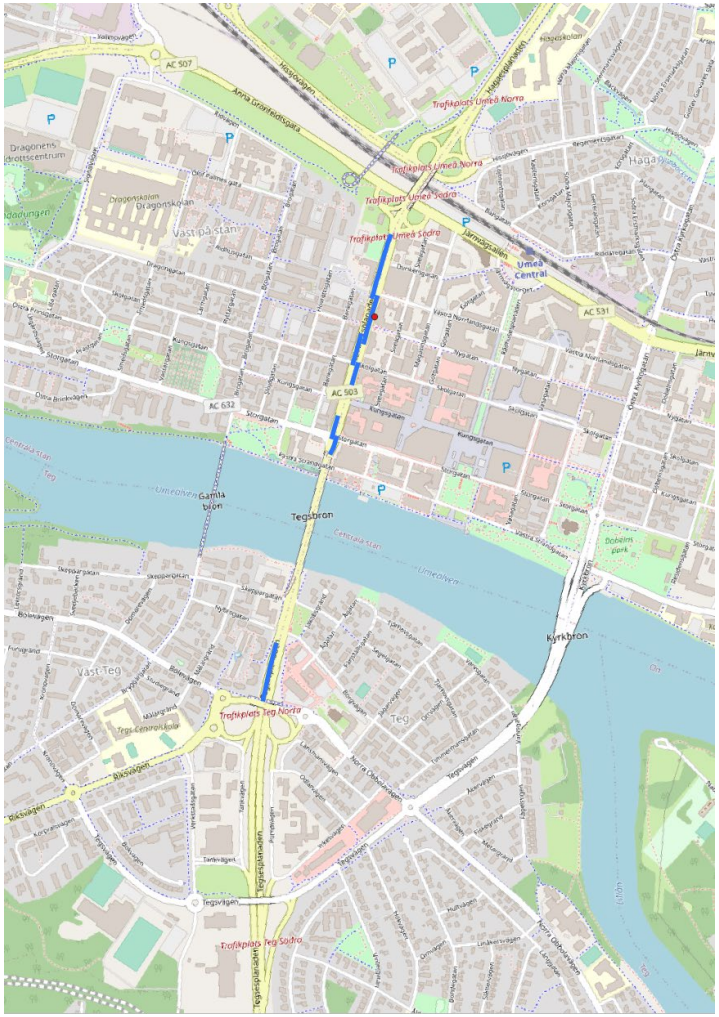
Representative area ±40%
9.1 – 21.2 µg/m^3



PM10 annual mean, Umeå V. Esplanaden (traffic site)

Annual mean (2016): 15.1 µg/m^3

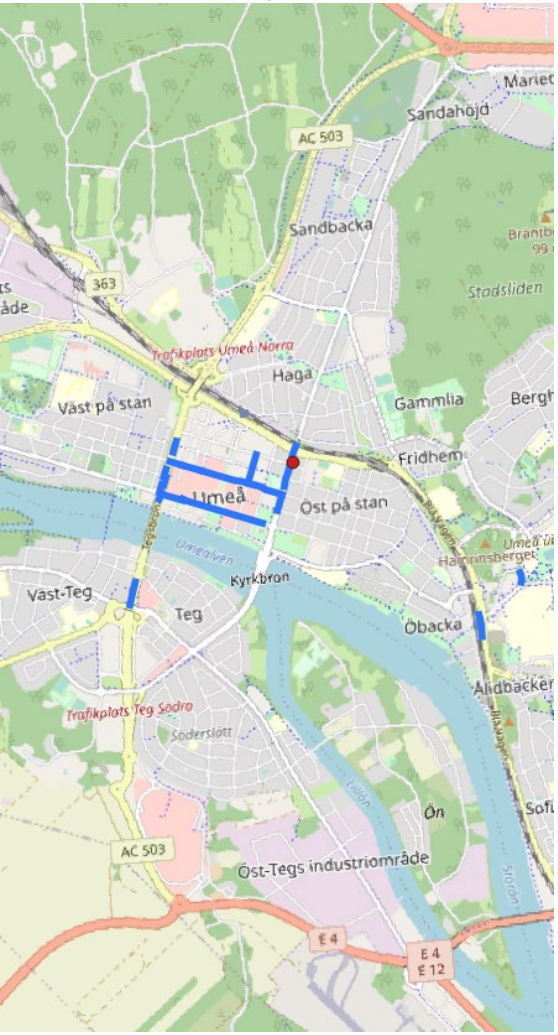
Representative area ±3.72 µg/m^3 (measurement uncertainty)
11.4 – 18.8 µg/m^3



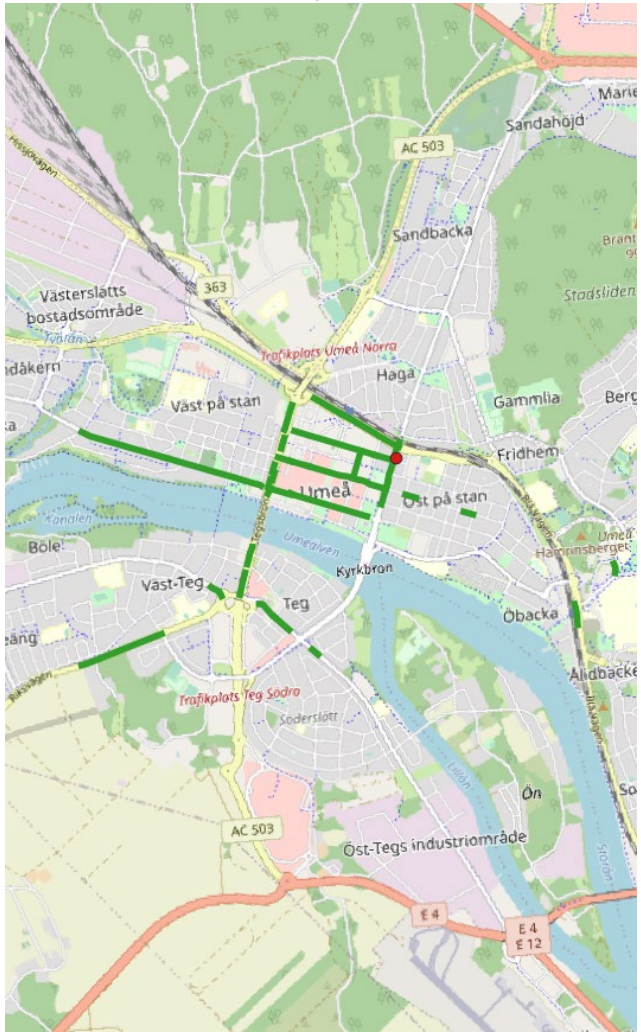
NO_2 annual mean, Umeå Ö. Kyrkogårdsgatan (traffic site)

Annual mean (2016): 25.9 µg/m^3

Representative area ±20%
20.7 – 31.1 µg/m^3



Representative area ±30%
18.2 – 33.7 µg/m^3

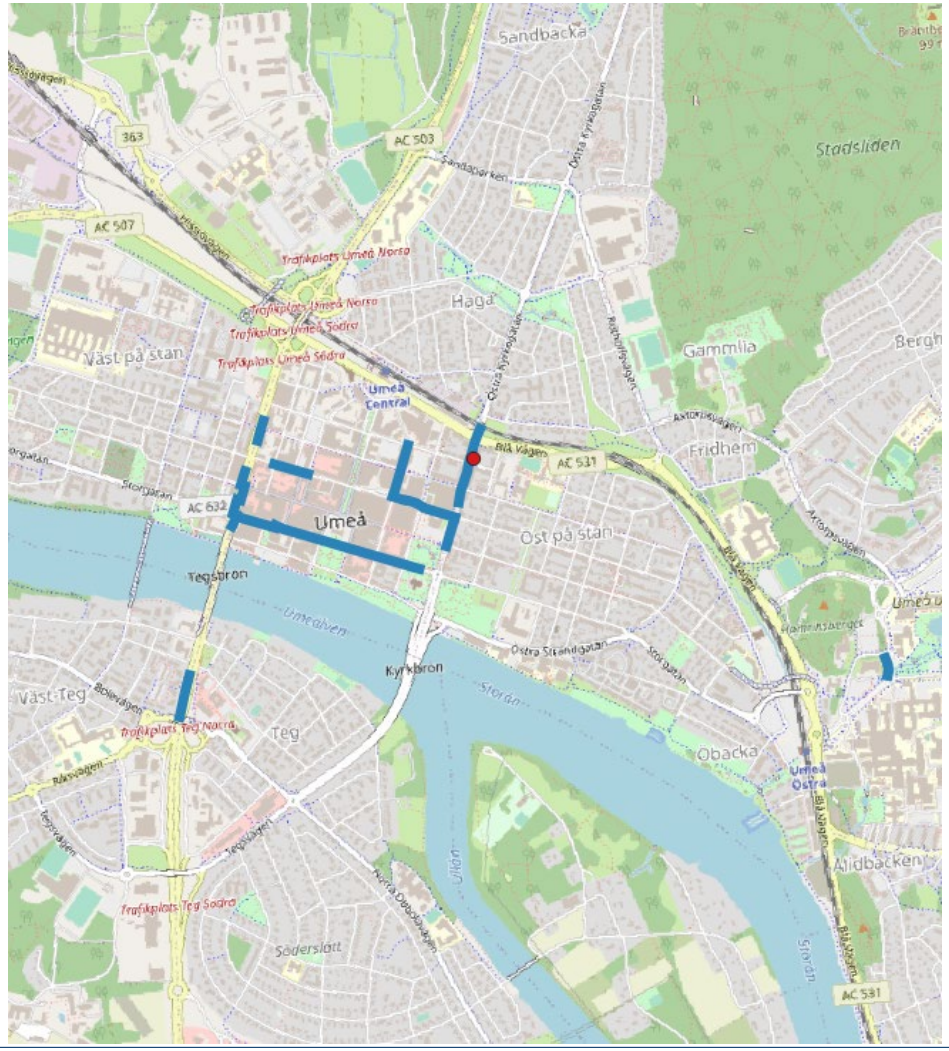


Representative area ±40%
15.6 – 36.3 µg/m^3

NO_2 annual mean, Umeå Ö. Kyrkogårdsgatan (traffic site)

Annual mean (2016): 25.9 µg/m^3

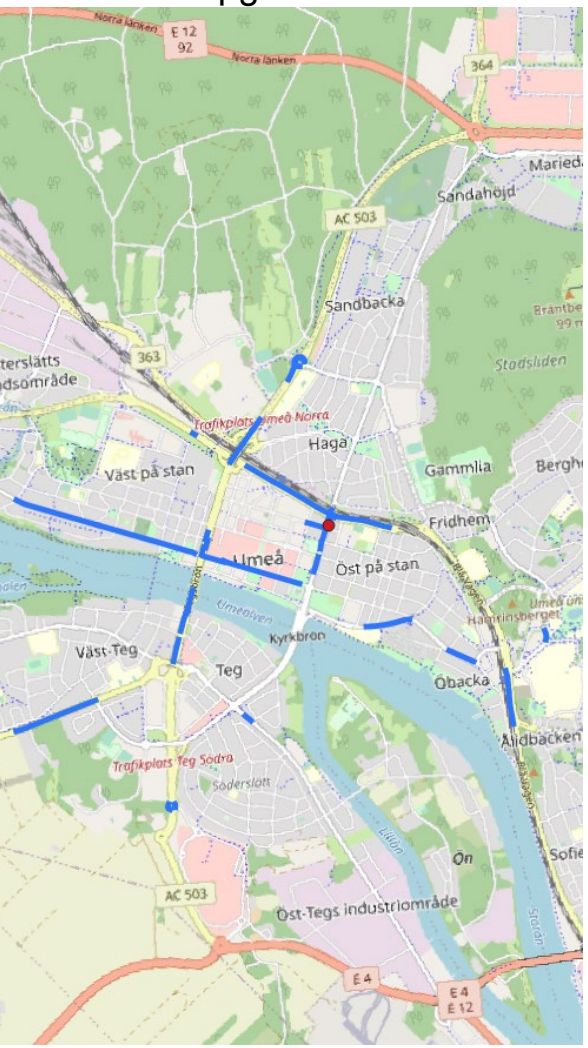
Representative area ±4.89 µg/m^3 (measurement uncertainty)
21.0 – 30.8 µg/m^3



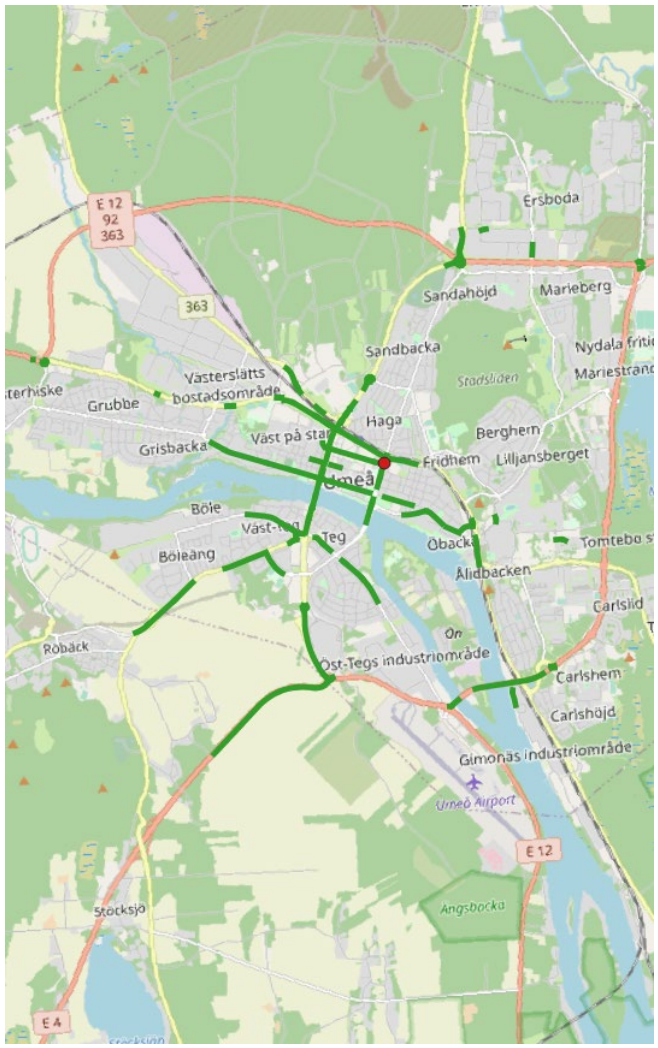
PM10 annual mean, Umeå Ö. Kyrkogårdsgatan (traffic site)

Annual mean (2016): 10.1 µg/m^3

Representative area ±20%
8.1 – 12.1 µg/m^3



Representative area ±30%
7.1 – 13.1 µg/m^3



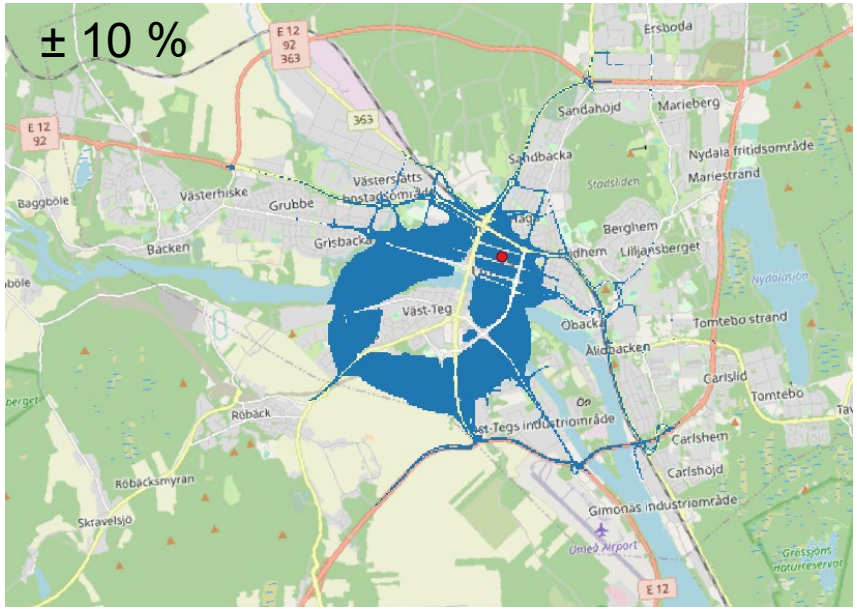
Representative area ±40%
6.1 – 14.2 µg/m^3

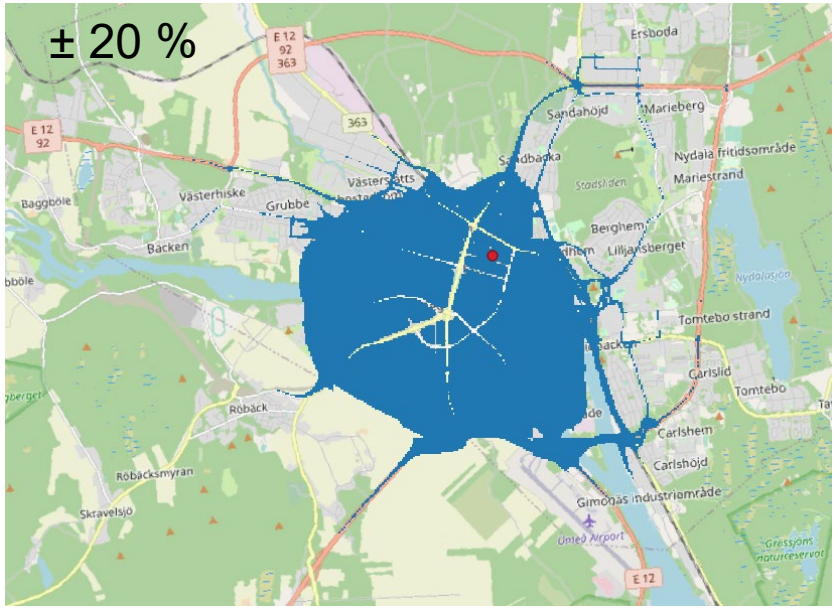
PM10 annual mean, Umeå Ö. Kyrkogårdsgatan (traffic site)

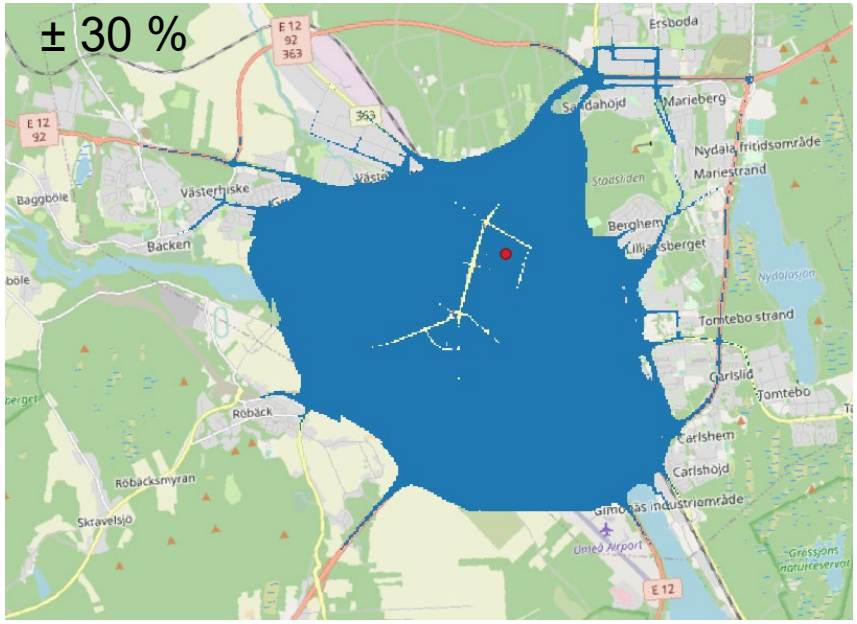
Annual mean (2016): 10,1 µg/m^3

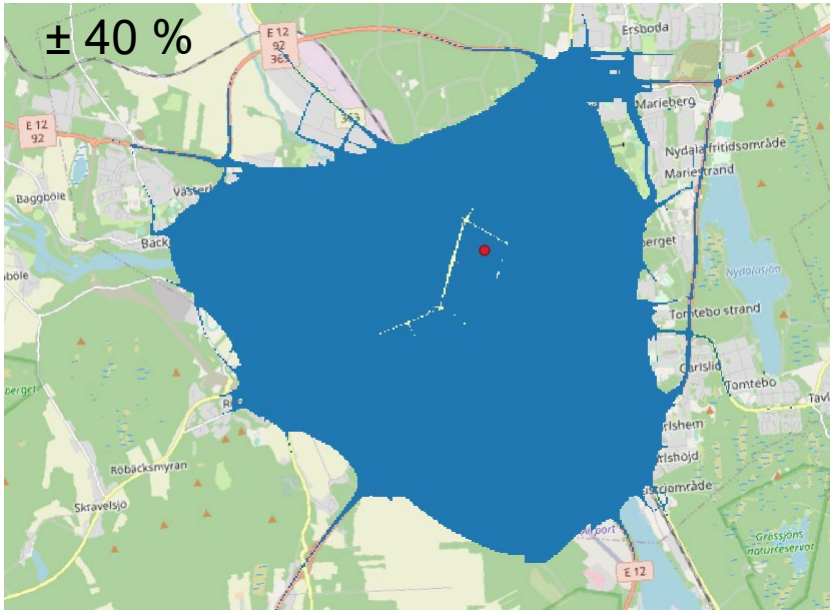
Representative area ±3.68 µg/m^3 (measurement uncertainty)
6.43 – 13.7 µg/m^3

Umeå: UB station, NO_2 annual mean (2016)

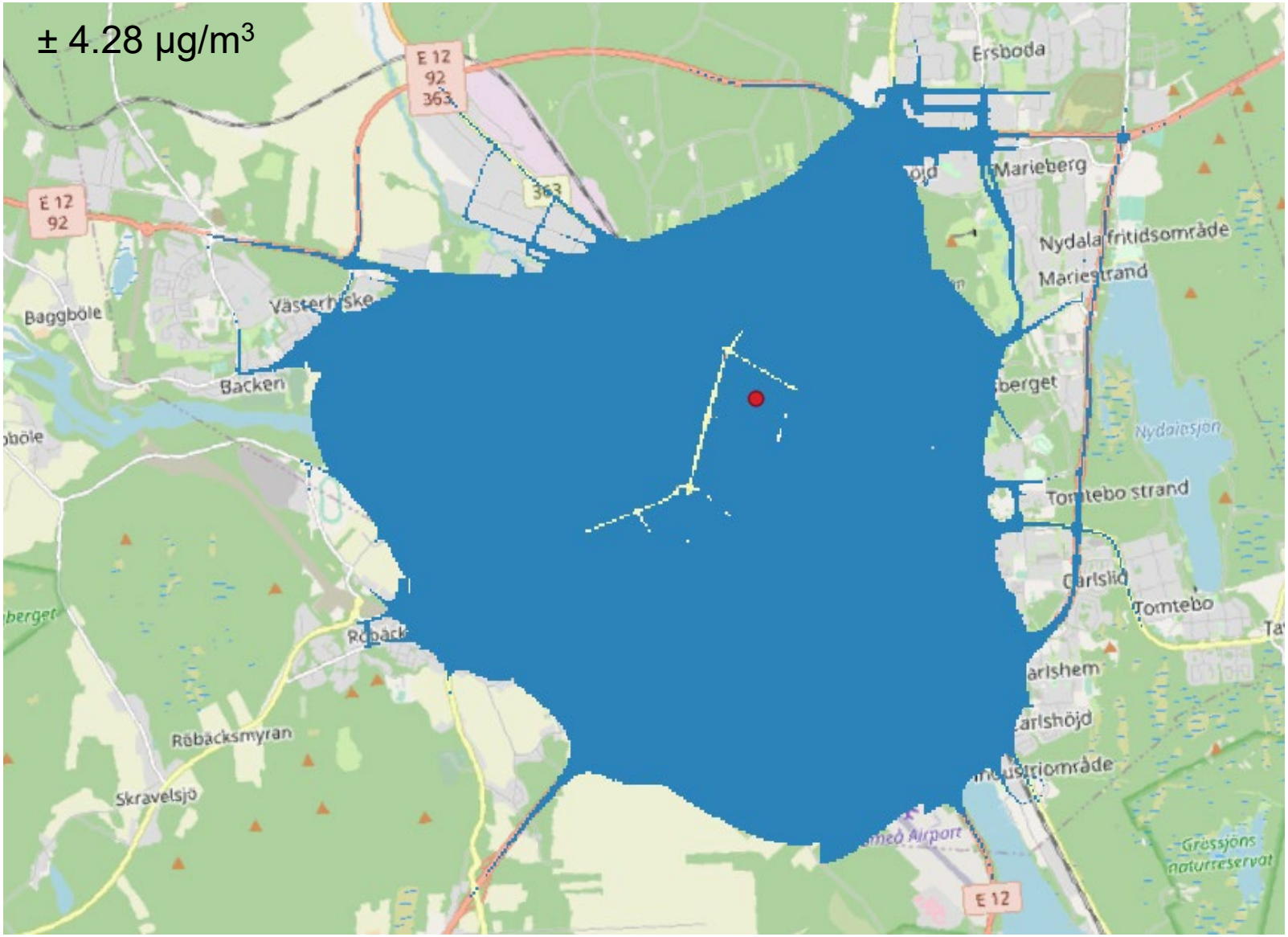




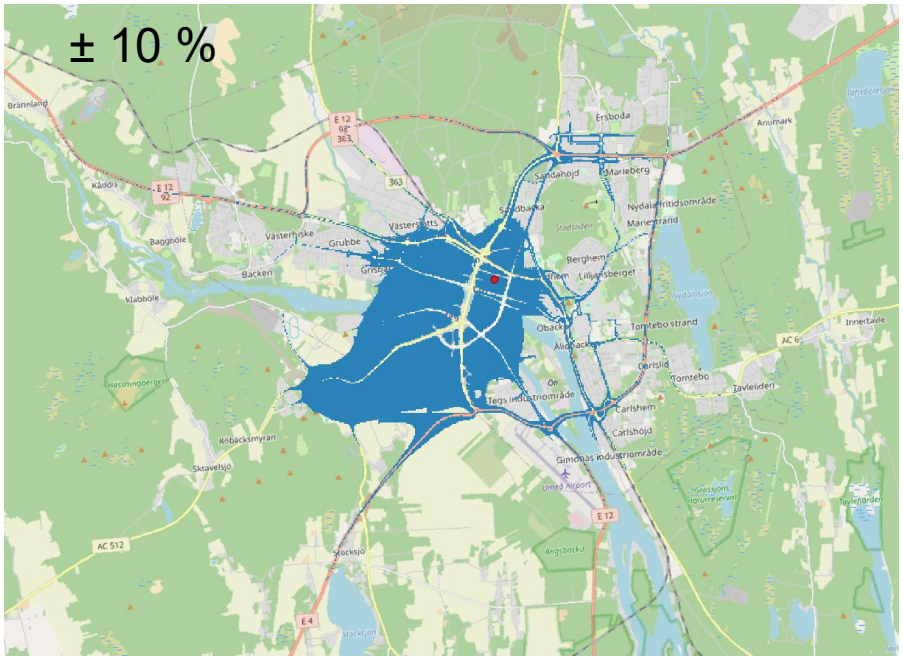


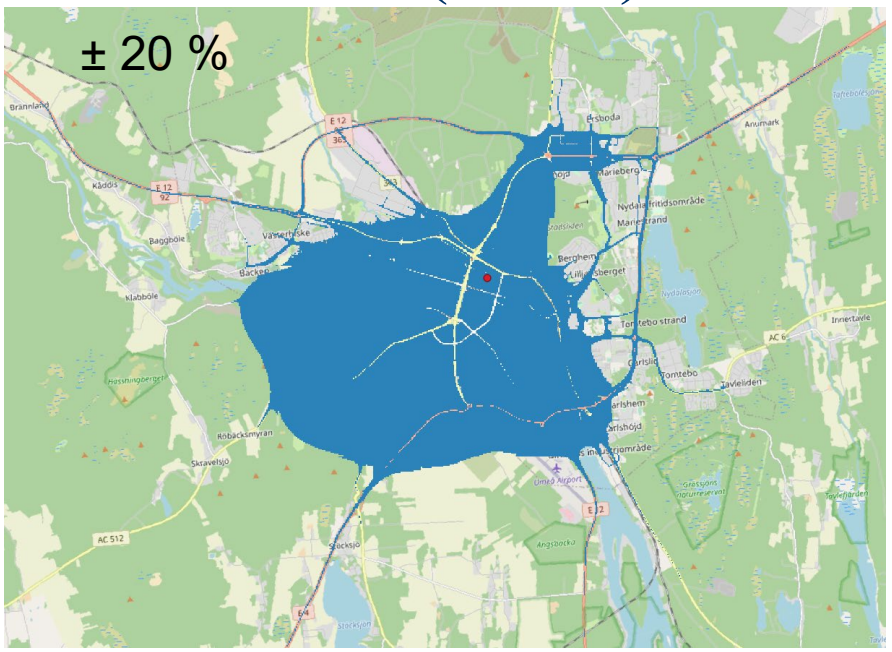


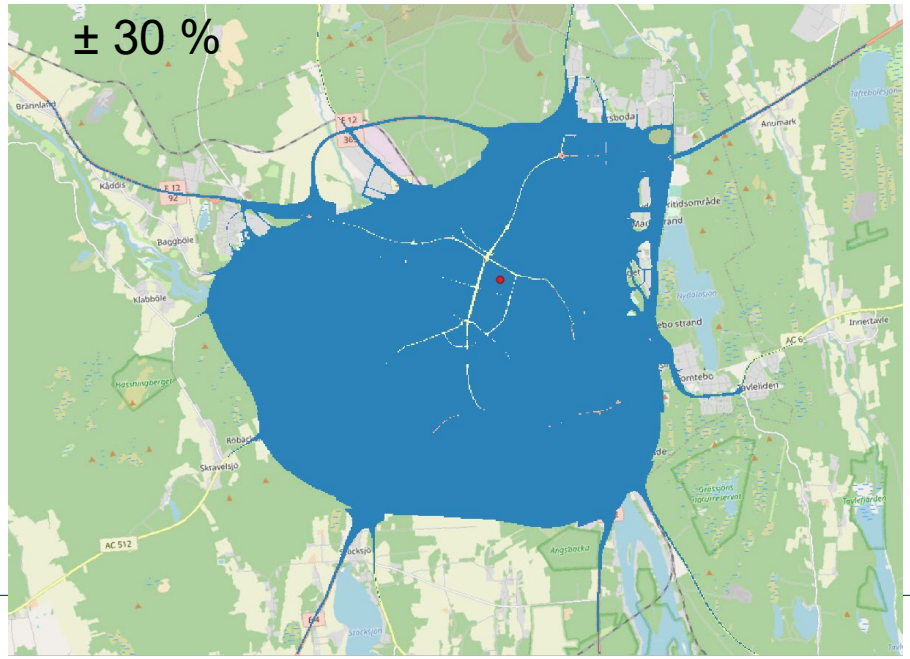
Umeå: UB station, NO_2 – measurement uncertainty

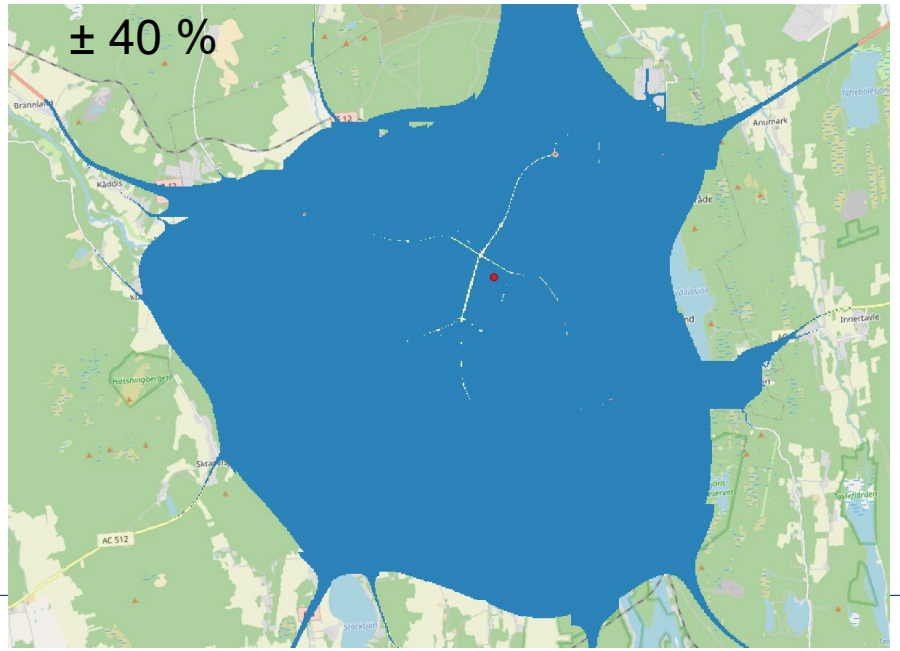


Umeå: UB station, PM10 annual mean (2016)

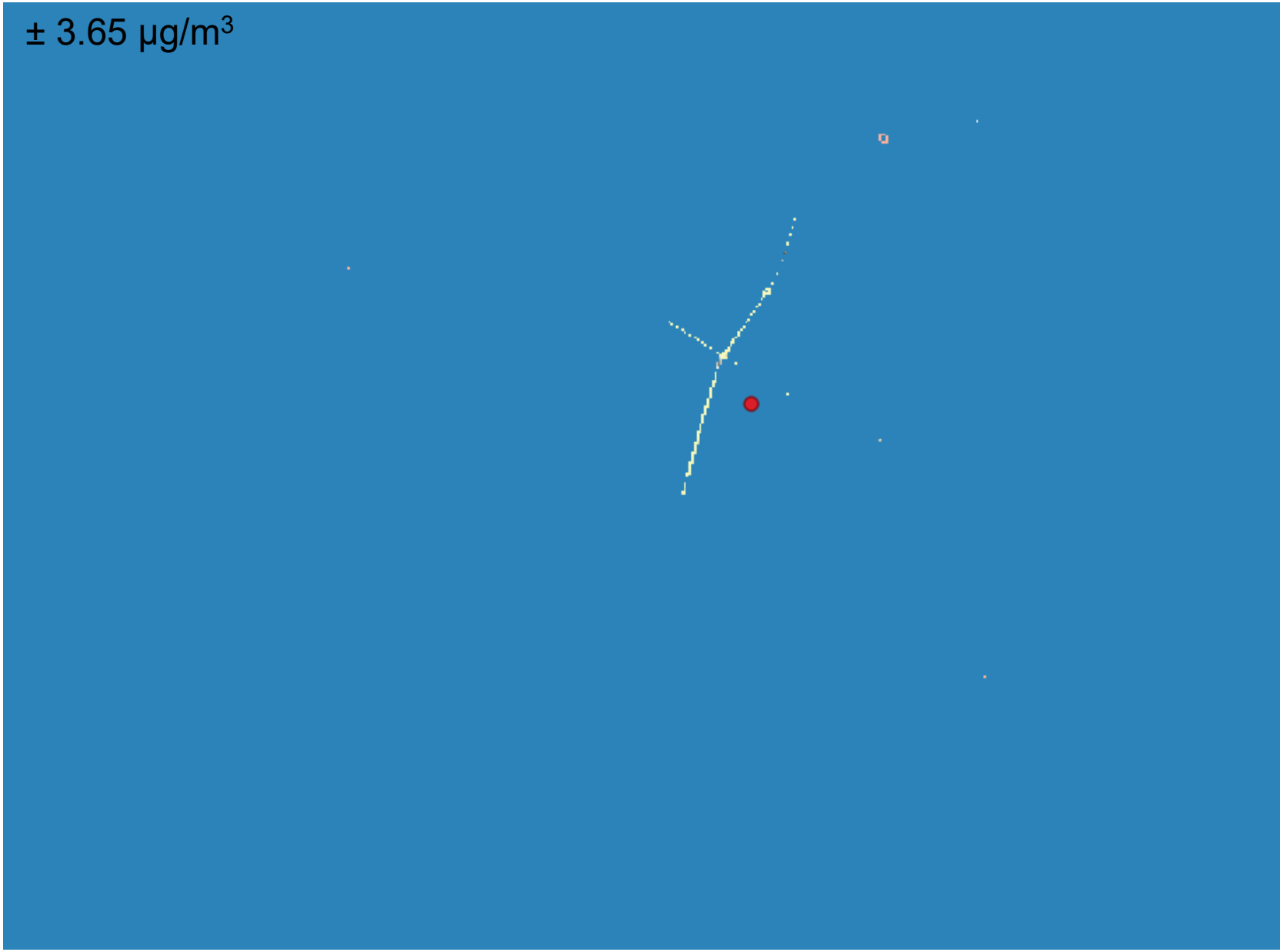




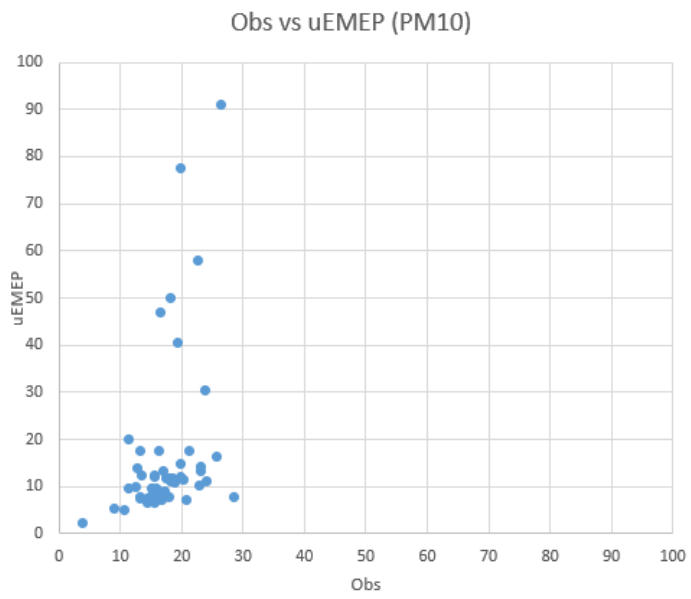


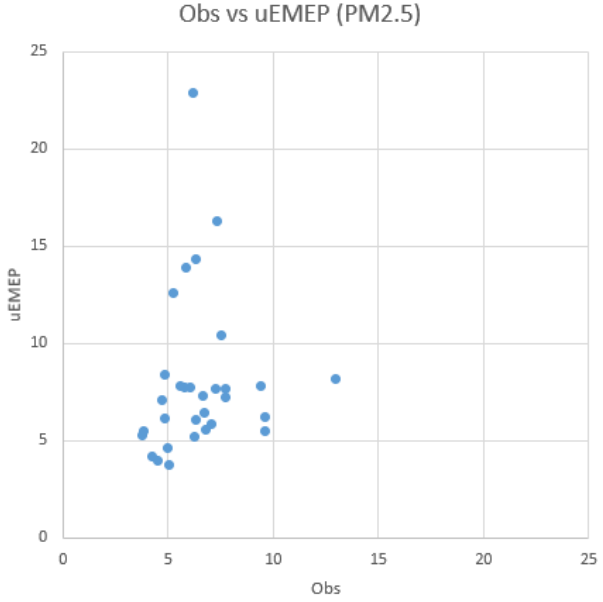


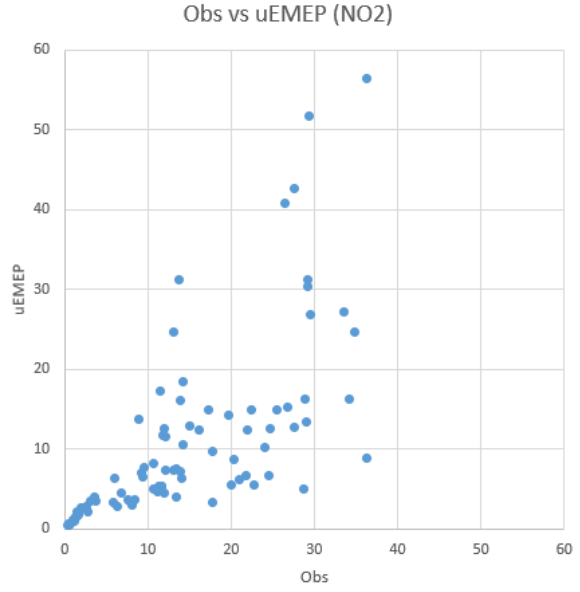
Umeå: UB station, PM10 – measurement uncertainty

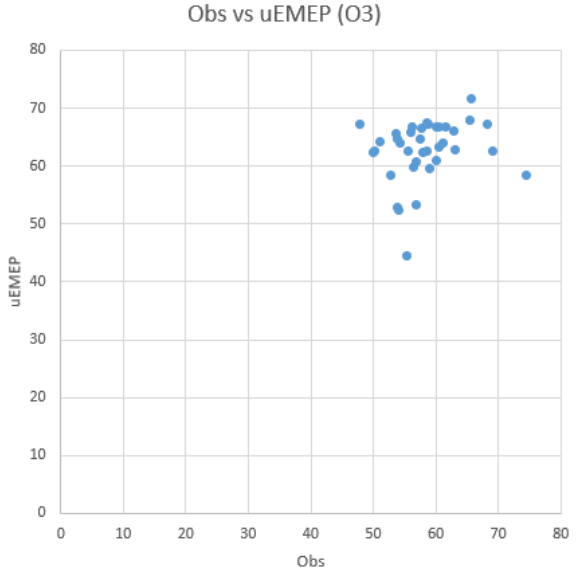


Sweden's observation data vs uEMEP









Reflections / Feedback

- Discontiguous approach is preferred, but…
  - Limit to within city for urban stations?
  - Proposed zone-based limits not so useful in Sweden

- ± 20 % on annual mean OK for traffic stations in Umeå
  - Gives overlapping SR areas for Stockholm's traffic stations
- ± 10 % more appropriate for background stations
- Use of measurement uncertainty does not seem fit for purpose as SR threshold
  - Might be OK for some traffic stations/areas with high concentrations
  - SR areas for background stations way too large (particularly for PM)
- Use of uEMEP model results to define SR of stations in Sweden not useful at present

- Need for further (optional?) similarity criteria?
  - Take account of different road types (inner city, motorways, etc)
  - Areas types (roadside, industrial, UB, rural).

- Annual mean and short-term means/percentiles can give quite different results.
  - Option to use percentiles if considered more relevant?