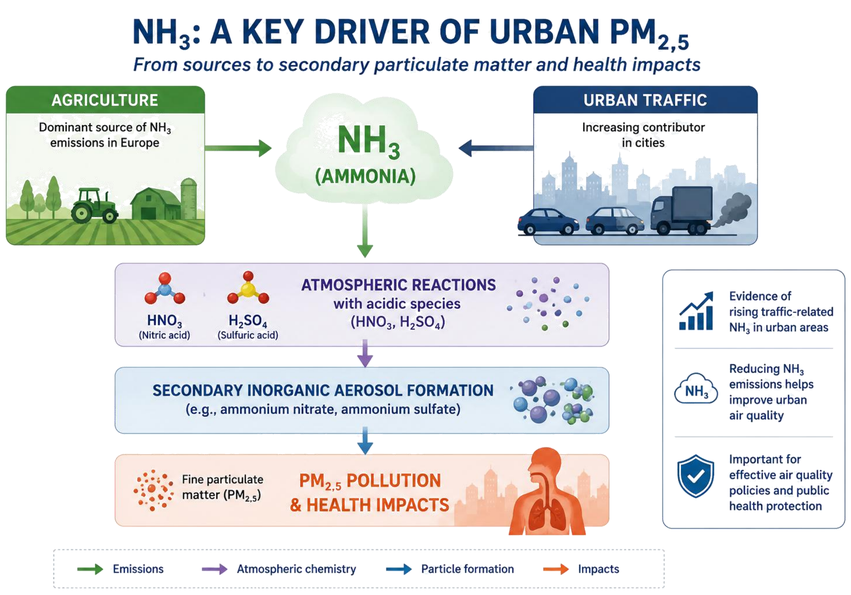
Urban Ammonia Across European Cities: Results from a Pan-European Campaign

J. Soares[a], S.O. Barrault[a], M. Nybakken, S. López-Aparicio[a], R. Baalbaki[e], N. Kalivitis[e], E. von Schneidemesser[f], A. Rana[g], F. Silva Domingues[h], E. van der Gaag[i], M. Van Poppel[j], S. Drossaart van Dusseldorp[k]

[a] NILU Climate and Environmental Research Institute, Kjeller, Norway; [b] Climate and Atmosphere Research Center (CARE-C), Nikosia, Cyprus; [e] University of Crete (UOC), Heraklion, Greece, [f] Research Institute for Sustainability (RIFS) at GFZ, Potsdam, Germany; [g] Institute of Climate and Energy Systems, Forschungszentrum Jülich, Germany; [h] Universitat Autònoma de Barcelona (UAB), Barcelona, Spain; [i] DCMR Environmental Protection Agency, Rotterdam, Netherlands; j Flemish Institute for Technological Research (VITO), Mol, Belgium ; [k] Zurich University of Applied Sciences (ZHAW), Winterthur, Switzerland

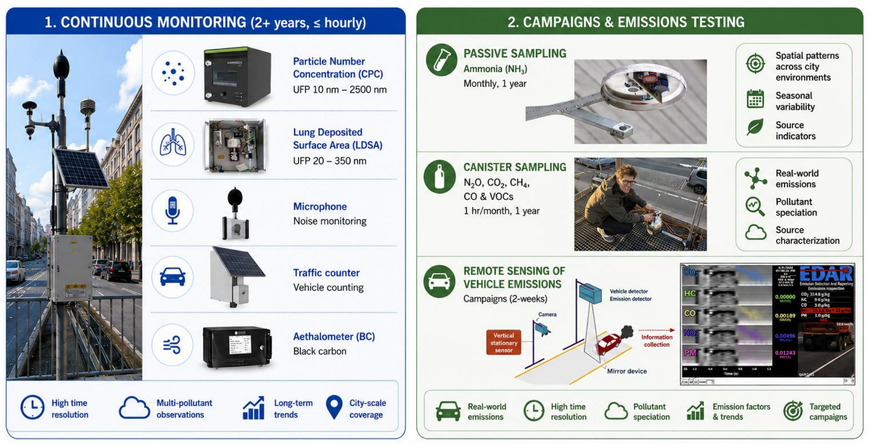
contact: jos@nilu.no

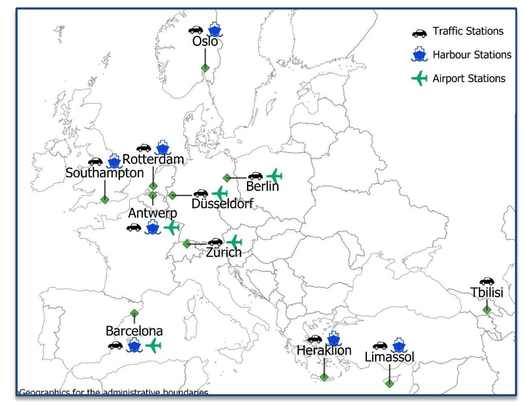
Why ammonia (NH_3) and why is Net4Cities important?



Net4Cities Aim:

- Investigate urban NH_3 levels (and other pollutants of emerging concern) and their drivers, and seasonality in urban areas through a comprehensive approach
- Support future monitoring recommendations for emerging pollutants





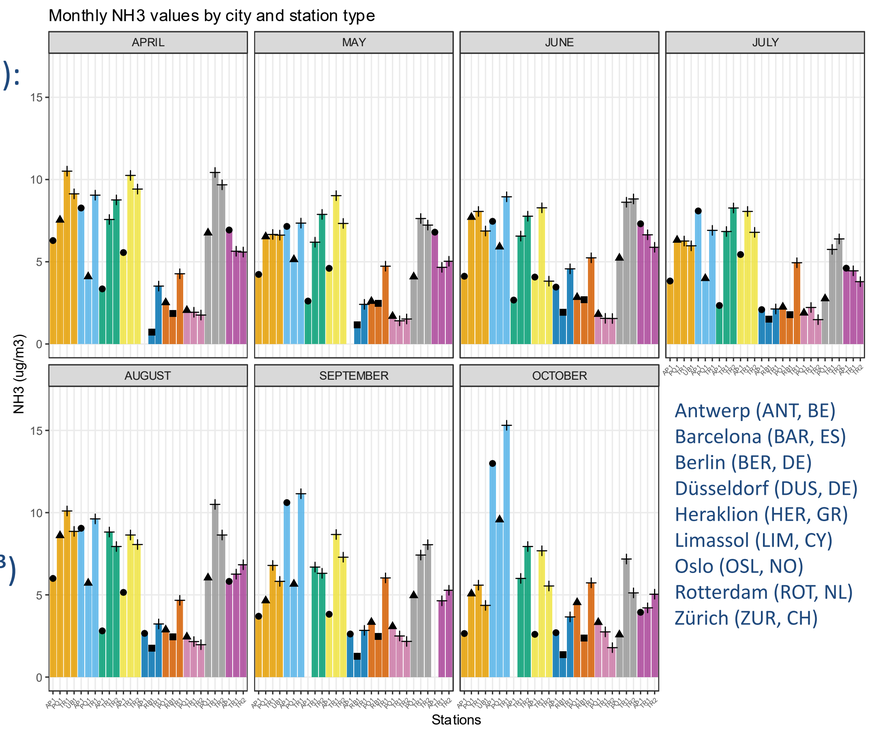
Net4Cities NH_3 monitoring campaign:

- 9 European cities, 29 monitoring locations
- Sites strongly influenced by traffic, port or airport activities
- Monthly passive sampling (1 yr)

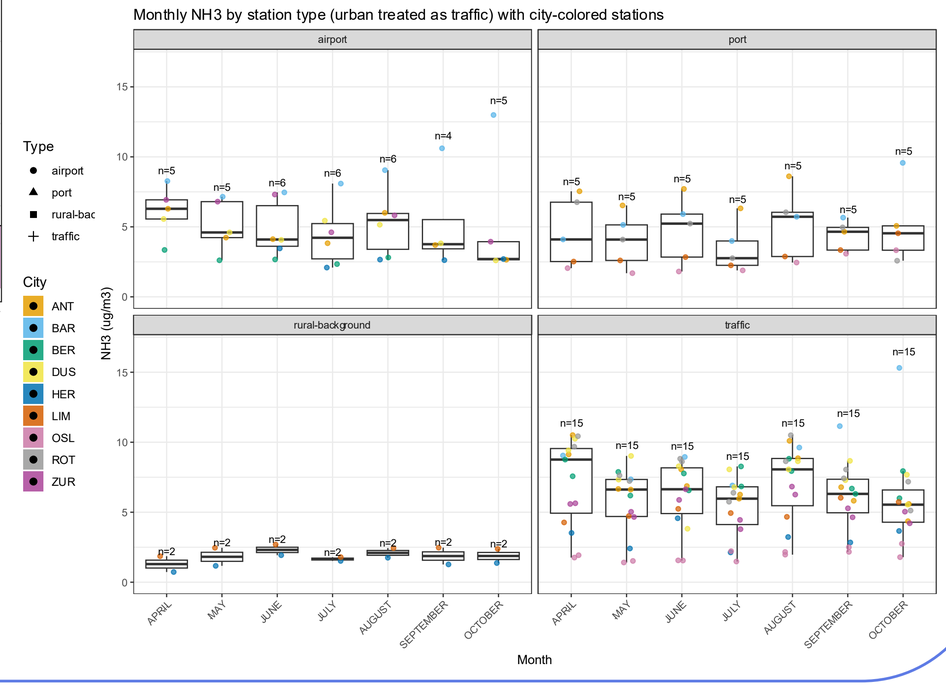
Monthly concentration between April and October 2025 for 9 cities (per station "type")

Findings align with RI-URBAN's (Liu et al., 2025): elevated NH_3 levels at traffic sites compared to other urban or rural background locations

- Mean concentration (µg m^{-3}):
  - all: 5.3 ± 2.7
  - traffic (TR, UB): 6.3 ± 2.6
  - airport (AP): 5.1 ± 2.8
  - port (PO): 4.5 ± 2.0
  - rural-background (RB): 1.8 ± 0.6
- Lowest concentrations in HER, LIM, and OSL (< 5 µg.m^{-3})
- Highest values in ANT, BAR, DUS, & ROT (up to 15 µg.m^{-3})



Antwerp (ANT, BE)
Barcelona (BAR, ES)
Berlin (BER, DE)
Düsseldorf (DUS, DE)
Heraklion (HER, GR)
Limassol (LIM, CY)
Oslo (OSL, NO)
Rotterdam (ROT, NL)
Zürich (ZUR, CH)



Are ammonia peaks traffic- or agriculture-induced?

Stations show different seasonality:

- Stations in ANT and ZUR show higher periods in April, June and August
- Stations in BER, DUS and ROT show higher values in April; 2nd peak in July/August
- Stations in BAR show higher temperatures from August
- Stations in HER and LIM_RB1 show a peak in June
- Stations in LIM (TR1, PO1) and OSL in September/October

Blue (lower) to red (higher) colour-coded concentrations

city	station	type	April	May	June	July	August	September	October
ANT	UB1	urban	9.13	6.62	6.87	5.97	8.86	5.82	4.36
ANT	TR1	traffic	10.51	6.66	8.06	6.26	10.10	6.79	5.59
ANT	PO1	port	7.54	6.53	7.71	6.32	8.61	4.65	5.07
ANT	AP1	airport	6.29	4.23	4.12	3.83	6.00	3.70	2.65
BAR	TR1	traffic	9.05	7.35	8.95	6.91	9.62	11.15	15.31
BAR	PO1	port	4.10	5.14	5.91	3.99	5.72	5.66	9.57
BAR	AP1	airport	8.27	7.15	7.46	8.09	9.05	10.61	12.99
BER	TR1	traffic	7.57	6.19	6.56	6.84	8.82	6.69	6.00
BER	TR2	traffic	8.76	7.88	7.77	8.27	7.94	6.31	7.94
BER	AP1	airport	3.35	2.61	2.67	2.34	2.81	NA	NA
DUS	TR1	traffic	10.25	9.02	8.28	8.06	8.64	8.67	7.68
DUS	TR2	traffic	9.42	7.33	3.82	6.79	8.06	7.29	5.54
DUS	AP1	airport	5.56	4.60	4.07	5.44	5.15	3.82	2.60
HER	RB1	rural-background	0.73	1.17	1.93	1.52	1.75	1.27	1.37
HER	TR1	traffic	3.52	2.41	4.57	2.13	3.23	2.84	3.66
HER	AP1	airport	*	*	3.46	2.09	2.66	2.62	2.70
LIM	RB1	rural-background	1.86	2.46	2.69	1.79	2.44	2.47	2.38
LIM	TR1	traffic	4.27	4.73	5.24	4.94	4.67	6.03	5.73
LIM	PO1	port	2.52	2.60	2.84	2.25	2.88	3.34	4.54
OSL	TR1	traffic	1.93	1.41	1.56	2.22	2.16	2.50	2.75
OSL	TR2	traffic	1.76	1.52	1.55	1.48	1.97	2.17	1.79
OSL	PO1	port	2.05	1.69	1.81	1.89	2.45	3.08	3.33
ROT	TR1	traffic	10.43	7.63	8.62	5.75	10.50	7.42	7.18
ROT	TR2	traffic	9.68	7.23	8.82	6.39	8.64	8.05	5.12
ROT	PO1	port	6.76	4.09	5.23	2.76	6.04	4.96	2.58
ZUR	TR1	traffic	5.64	4.66	6.64	4.45	6.26	4.64	4.21
ZUR	TR2	traffic	5.59	5.03	5.88	3.79	6.83	5.28	5.04
ZUR	AP1	airport	6.93	6.80	7.31	4.61	5.82	0.73	3.94

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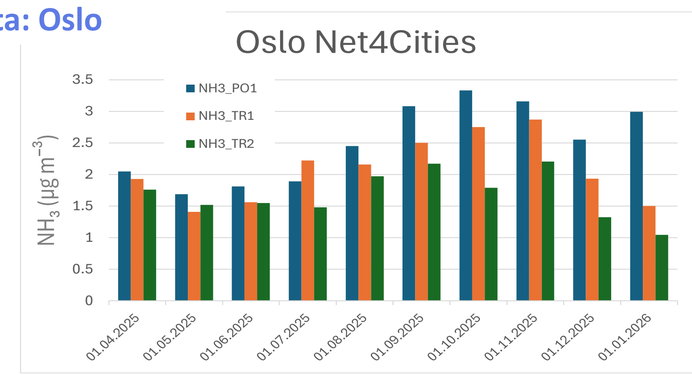
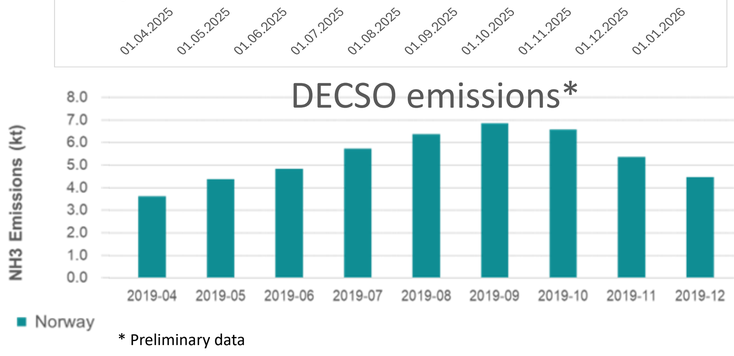
soil fertilization?

T-Driven Volatilisation?

Good agreement between measured and remote sensing data: Oslo

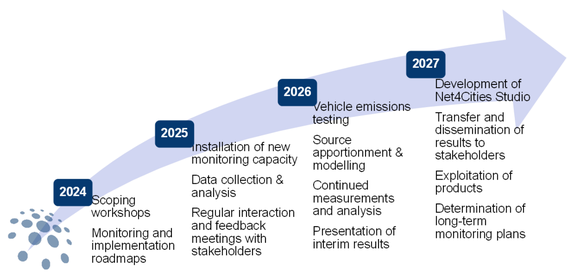




* Preliminary data

What's next?

- The interim results demonstrate that Net4Cities has successfully established a next-generation urban monitoring network capable of capturing emerging pollutants and transport-related environmental pressures.
- Further investigate the drivers for NH3 seasonality and why it varies across cities, using Net4Cities data such as traffic counters and UFP data, and meteorological, vehicle-share distribution, and emission data



Funded by the European Union

Project: 101138405 — Net4Cities — HORIZON-CL5-2023-D5-01

PROJECT PARTNERS

References

Liu et al (2024) Influencing factors on ammonia emissions from gasoline vehicles: A systematic review and meta-analysis, Science of The Total Environment, Volume 923, https://doi.org/10.1016/j.scitotenv.2024.171467