Urban NH_3 in the UK- Are we measuring in the right places?

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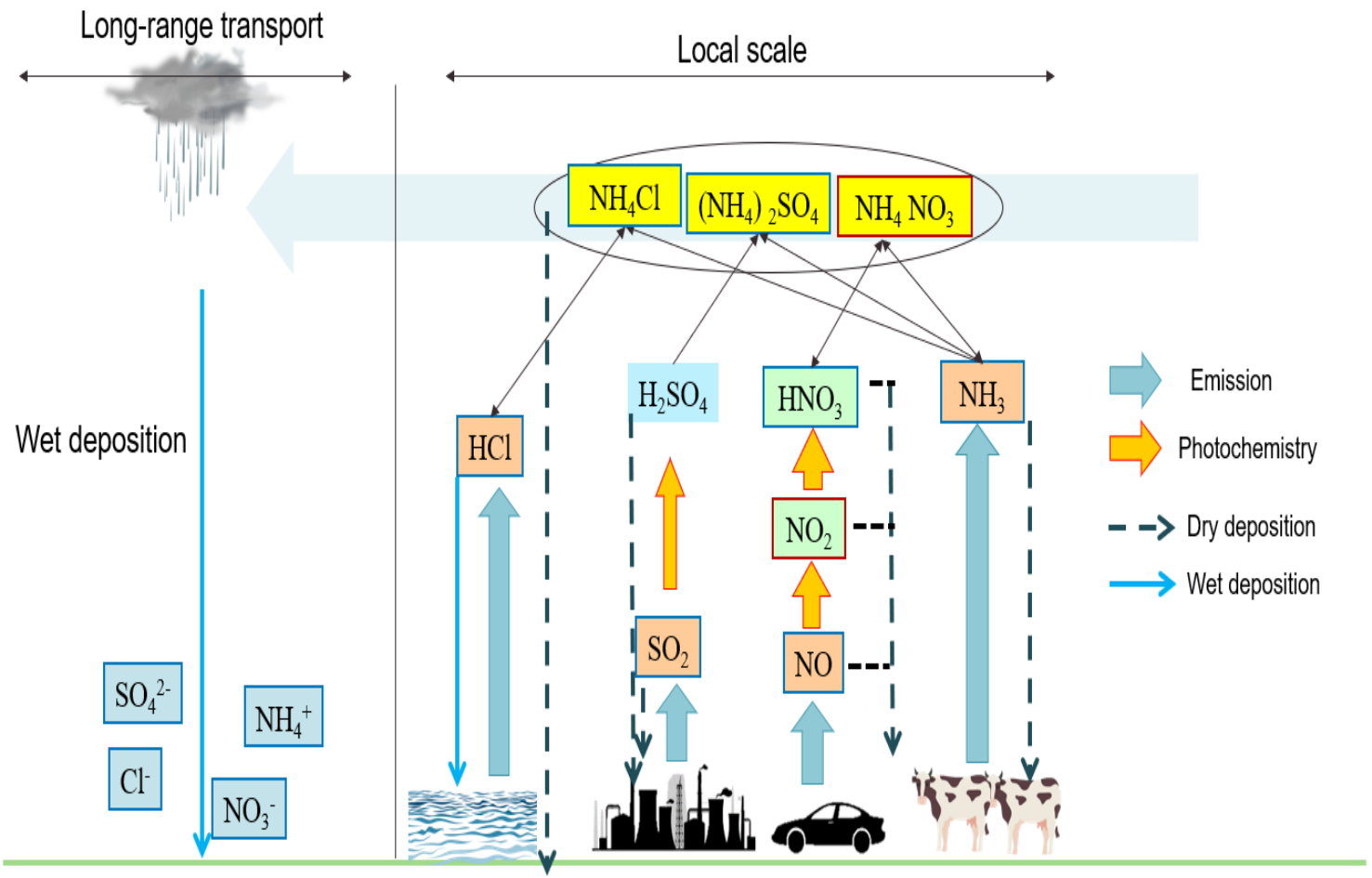
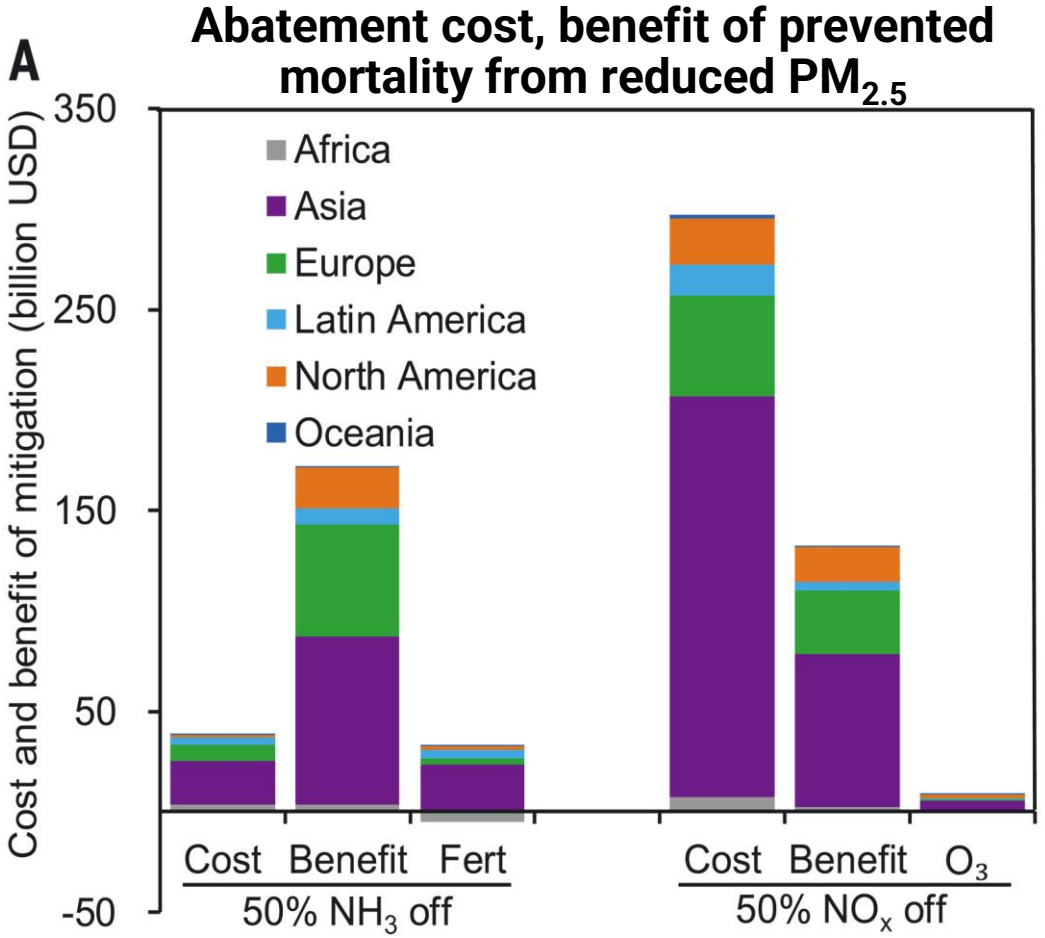
Urban ammonia: Why measure it?

NH_3: controls secondary inorganic aerosol formation!





Gu, B., Zhang, L., Van Dingenen, R., Vieno, M., Van Grinsven, H. J., Zhang, X., Zhang, S., Chen, Y., Wang, S., Ren, C., Rao, S., Holland, M., Winiwarter, W., Chen, D., Xu, J., and Sutton, M. A.: Abating ammonia is more cost-effective than nitrogen oxides for mitigating $PM_{2.5}$ air pollution, Science, 374, 758–762, https://doi.org/10.1126/science.abf8623, 2021.

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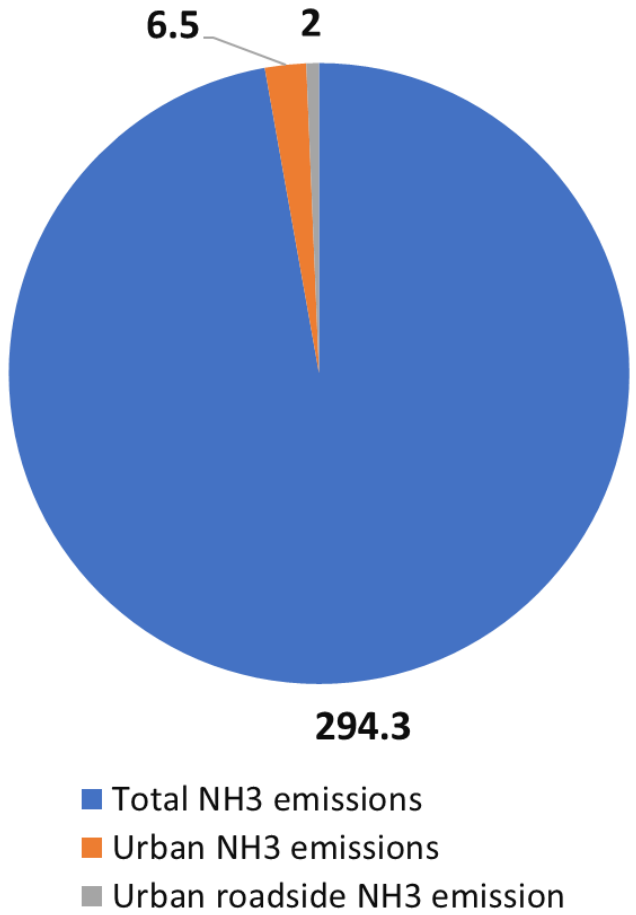
Urban ammonia: Why measure it?

NH_3 Ammonia emissions in 2017 (ktonnes)



Braban, C.F., Tang, Y.S., Dragosits, U., Twigg, M.M., Leeson, S., Jones, M., Simmons, I., Harvey, D., Sutton, M.A., Nemitz, E., Reis, S., 2020. Ammonia in a time of COVID-19. A submission of evidence to Defra/AQEG [WWW Document]. URL https://uk-air.defra.gov.uk/library/reports.php?report_id=1005 (accessed 10.1.24).

EMEP/EEA air pollutant emission inventory guidebook 2019

NFR	SOURCE CATEGORY	SO_2	NO_x	VOC	CO	NH_3	PM	HM/POP
1.A.1	Public power, cogeneration and district heating	A	B	C	B	E	C	D
1.A.2	Industrial combustion	A	B	C	B	E	C	D
1.A.3.b	Road transport	A	C	C	C	E	C	E[2]
1.A.3.a 1.A.3.c 1.A.3.d 1.A.3.e	Other mobile sources and machinery	B	D	D	D	E	D	E
1.A.4	Commercial, institutional and residential combustion	A	C	C	C	E	D	E
1.B	Extraction and distribution of fossil fuels	C	C	C	C		D	E
2	Industrial processes	B	C	C	C	E	C	E
3	Solvent use			B			D	E[1]
4	Agriculture activities		D	D	D	D	E	E
5.a 5.b	Waste treatment	B	B	B	C		C	D
5.c	Waste disposal activities	C	C	C	C	E	C	E
11	Nature[3]	D	D	D	E	E	E	E[3]

Rating	Typical error range
A	10 to 30 %
B	20 to 60 %
C	50 to 200 %
D	100 to 300 %
E	order of magnitude

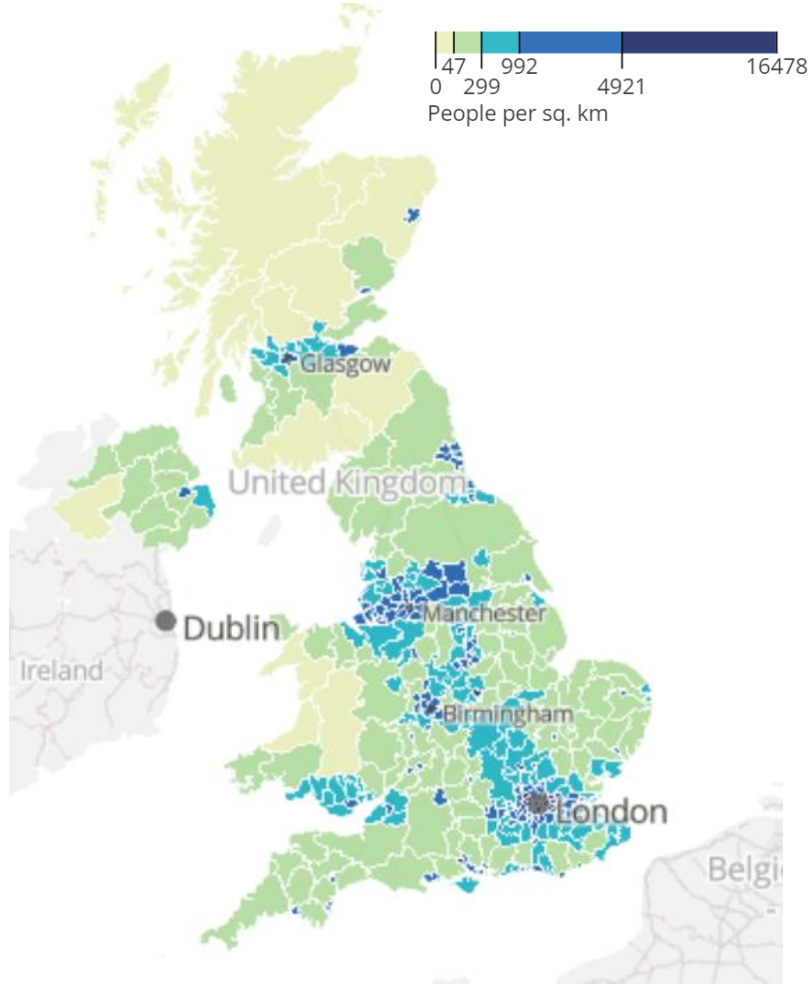
Urban ammonia: Why measure it?

UKEAP National Ammonia monitoring network (NAMN)

Total network sites:113

Urban sites:2

UK population density 2022



There is a big gap of information for one of the main PM_x drivers in highly populated areas in the UK!

Observation System for Clean Air **(OSCA)**

- Long-term measurements of several gaseous and particulate pollutants, including NH_3.
- Three monitoring air quality supersites **(AQS)** in London, Manchester and Birmingham.
- Aim: Understand and predict changes of sources, emissions and atmospheric processes at urban areas.
- Operative from late 2018 until Autumn 2023.

Objectives of this study

1. Understand the temporal variability of NH_3 at the three OSCA supersites.
2. Compare AQS urban NH_3 temporal trends with nearby NAMN stations.
3. Characterize spatially NH_3 sources near AQ supersites (OSCA).

NH_3 monitoring sites & methods

High-time resolution NH_3 monitoring

LGR NH_3/H_20

Birmingham AQ Supersite (BAQS)

London AQ Supersite (LAQS)

Manchester AQ Supersite (MAQS)

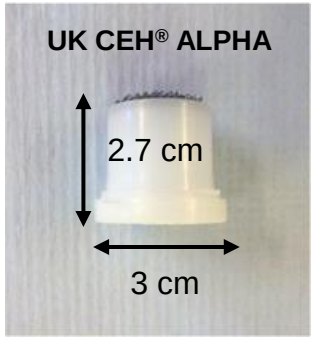
- Dataset period: 01/2019 – 08/2023
- 1-min time resolution
- LOD : 0.1 ppb

} Manufacturer specifications

- No reference method to compare and maintain these instruments.

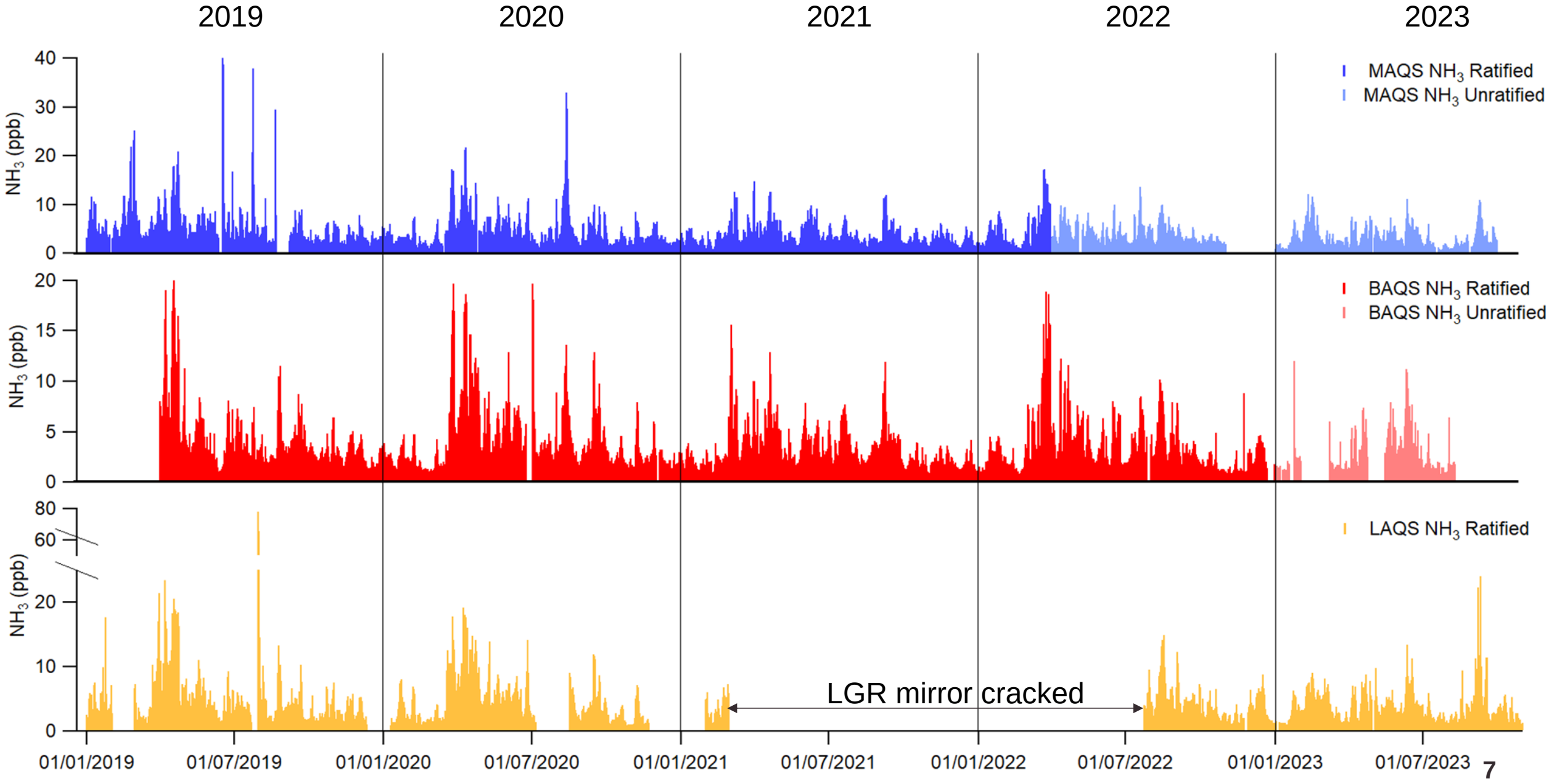
Spatial NH_3 monitoring July & August 2023

UK CEH® ALPHA: Citric acid-coated paper filters enclosed in a PTFE body to measure NH_3 by gas diffusion over extended periods of time.



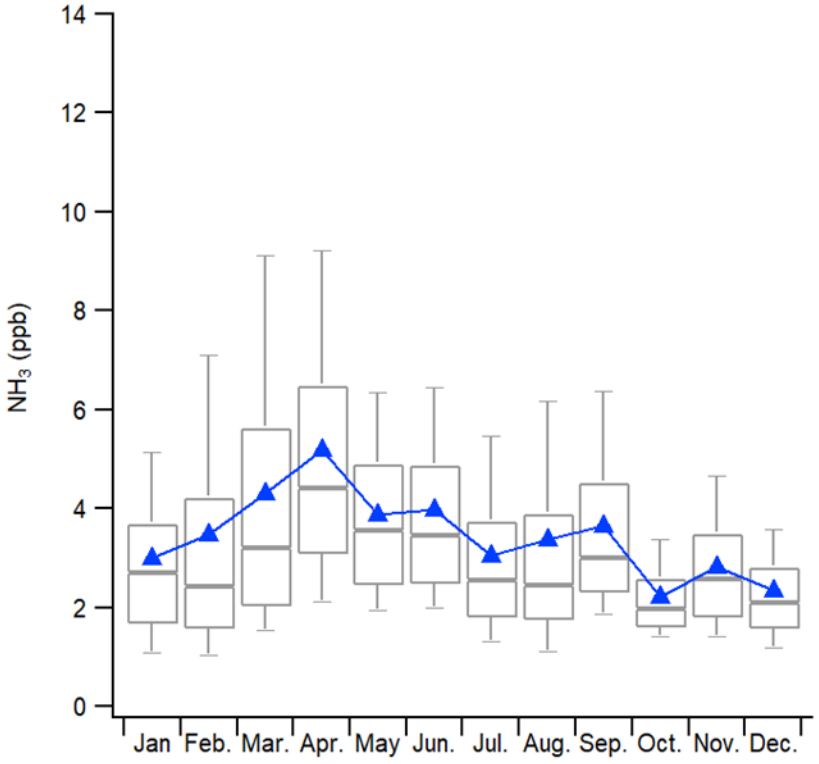
- Used in the NAMN to report monthly NH_3 concentrations.
- 3-week campaign in summer 2023 to determine local NH_3 sources potentially impacting the AQS.

OSCA AQS: NH_3 time series (2019 -2023)

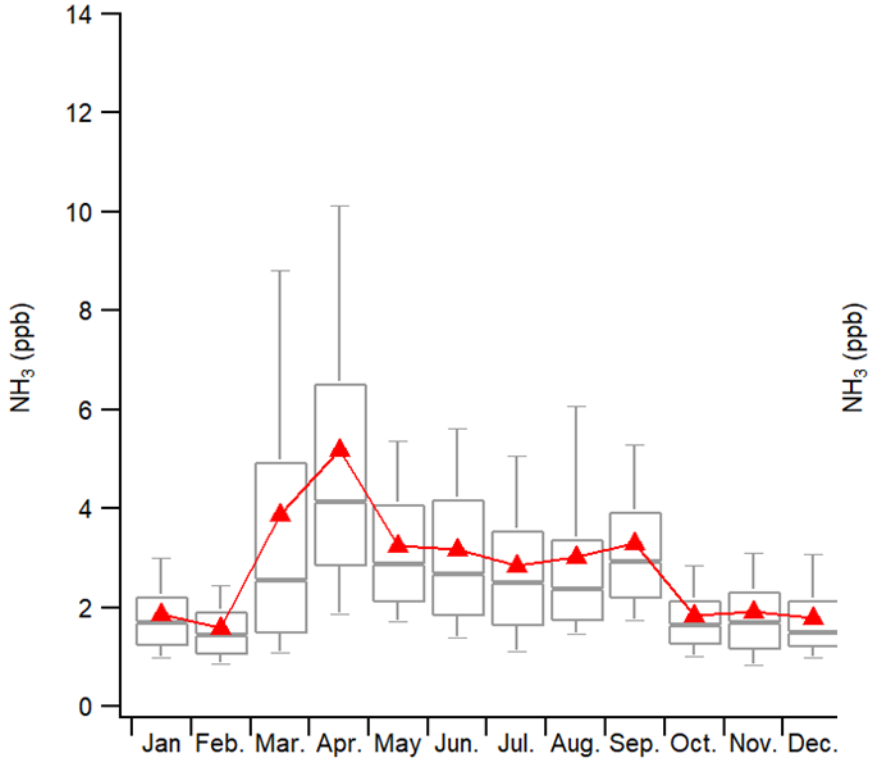


OSCA AQS: NH_3 monthly profiles (2019 – 2023)

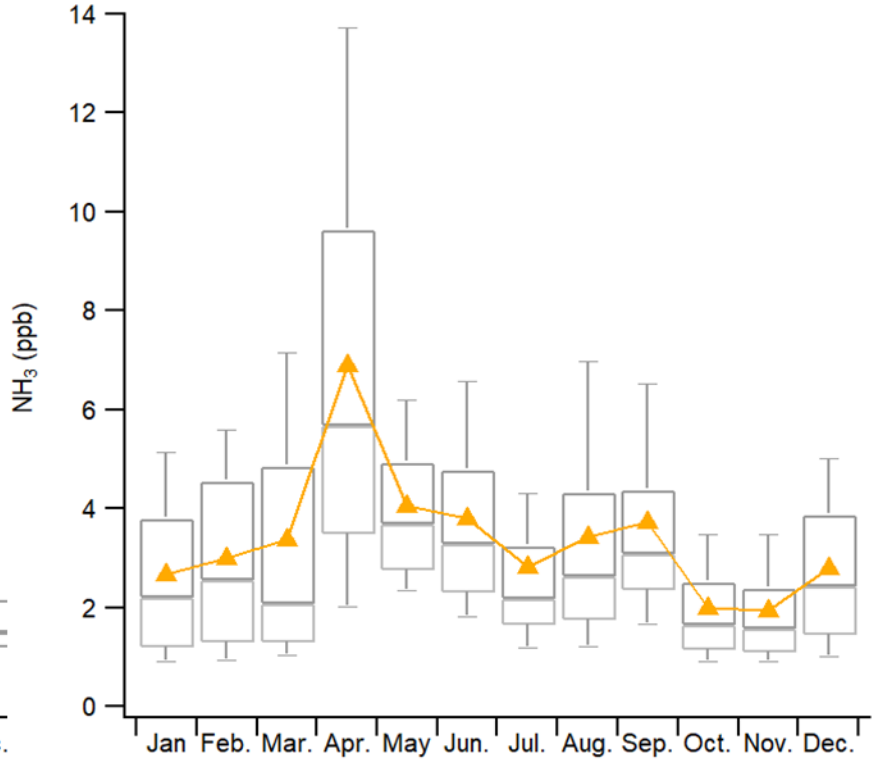
MAQS



BAQS



LAQS



- The three AQS show very similar monthly profiles.
- Highest concentrations during March-April and September: agricultural cycle of fertilization

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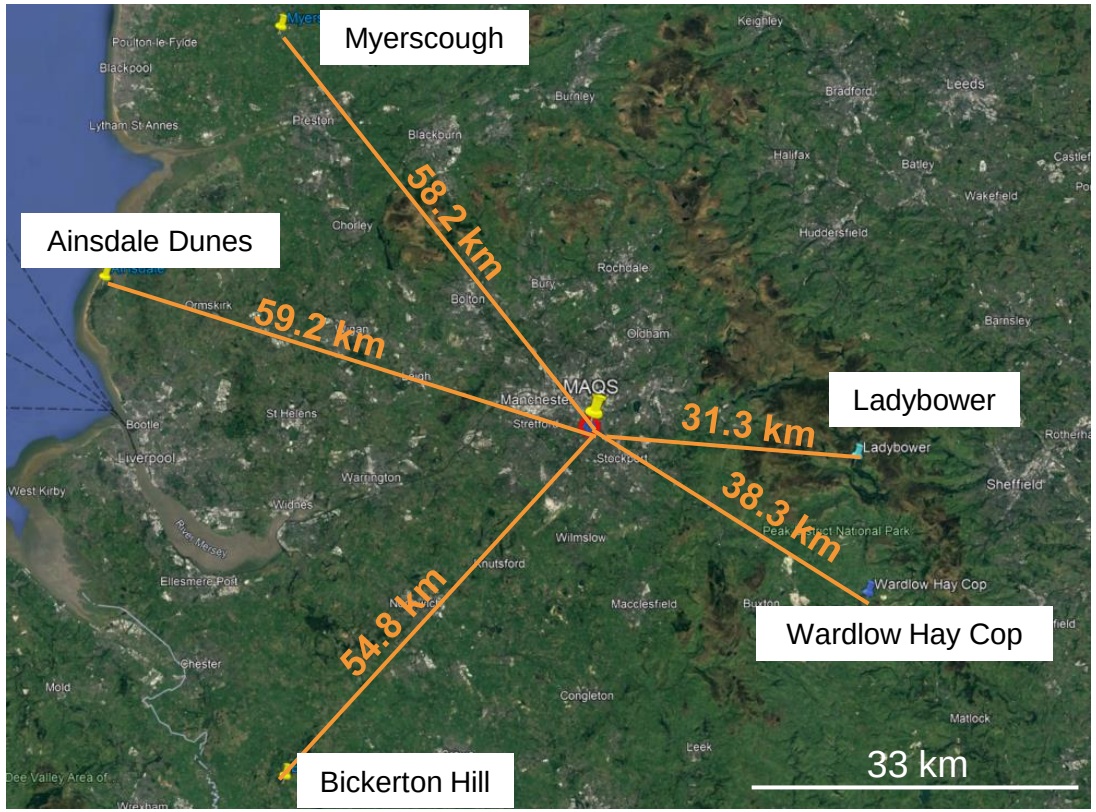
AQS comparison with ALPHA datasets

Regional NH_3 comparison against NAMN stations



- LGR monthly-averaged data compared to ≤ 60 km ALPHA NAMN stations.
- Comparison between 2019 – 2023 datasets.

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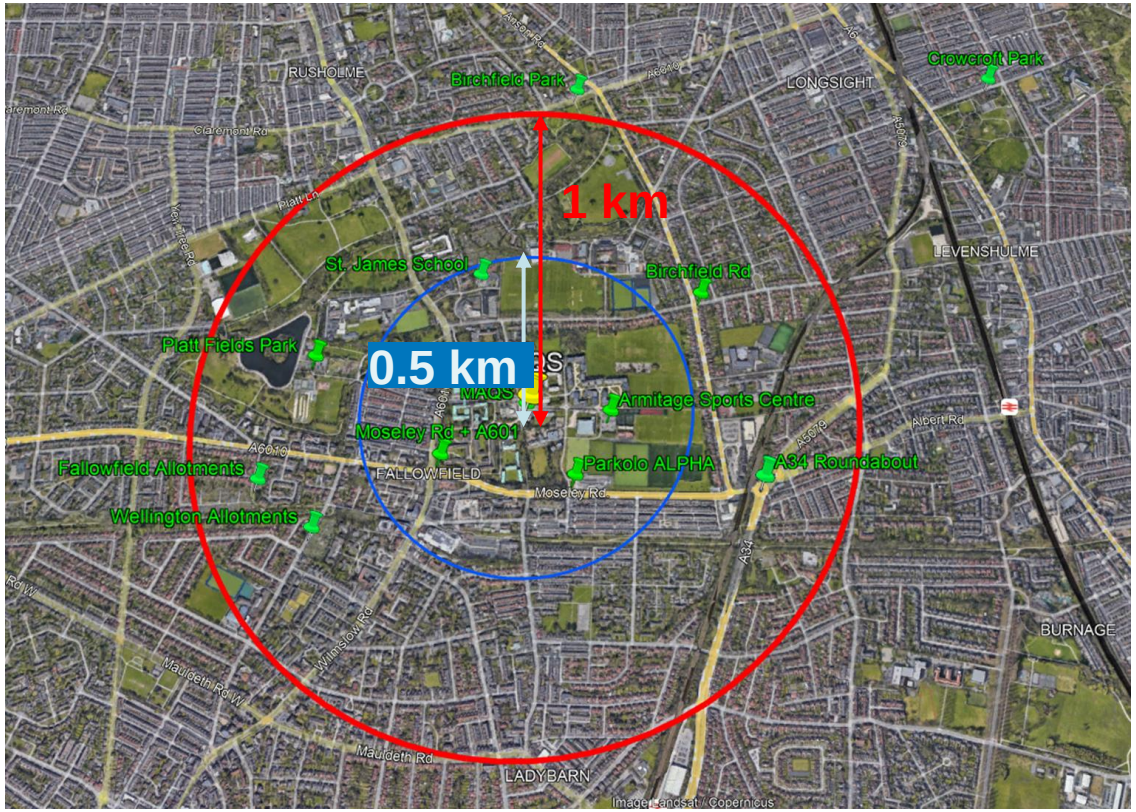
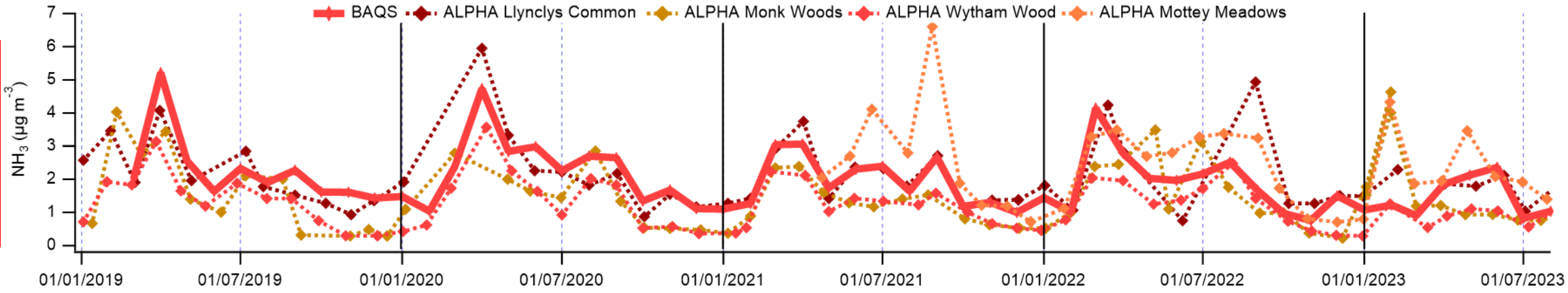
Local NH_3 assessment within 1.5 km from AQS



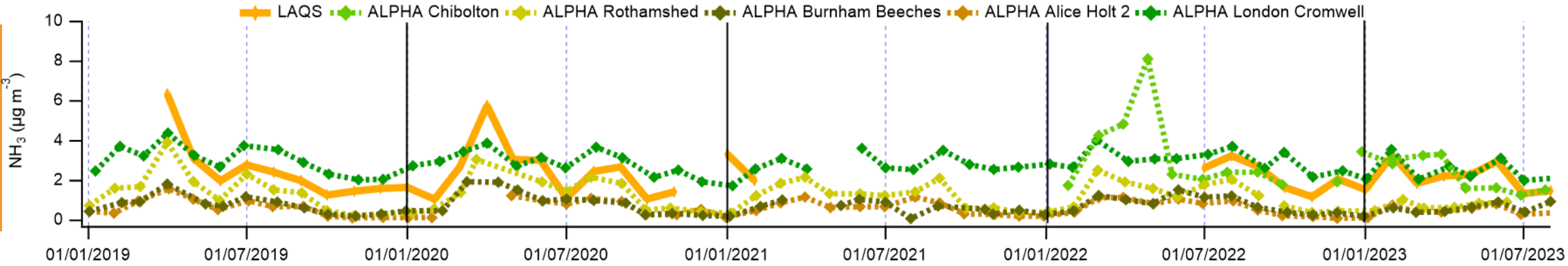
- ALPHA samplers placed near **BAQS** and **MAQS:**
  - University background – within AQS-University domains.
  - Urban background – minor traffic roads or public parks.
  - Traffic – High traffic density roads.
- Exposed between 2-3 days during 3 weeks in July & August 2023.

AQS & NAMN: temporal variability

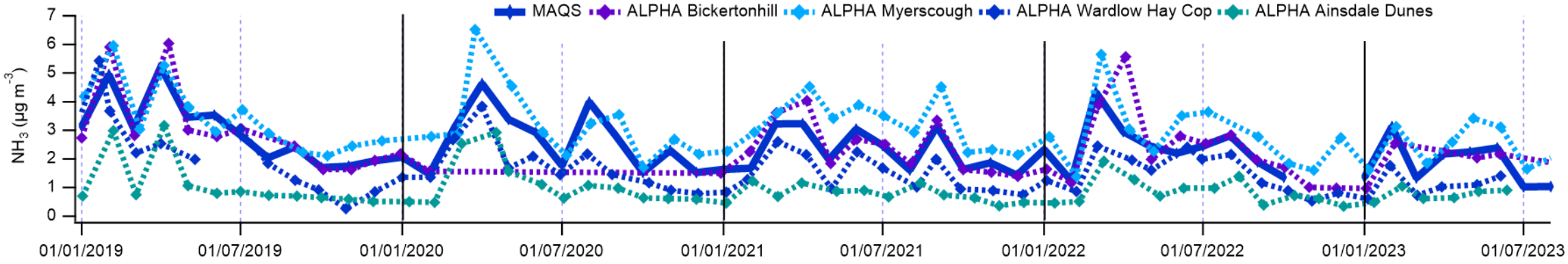
BAQS



LAQS



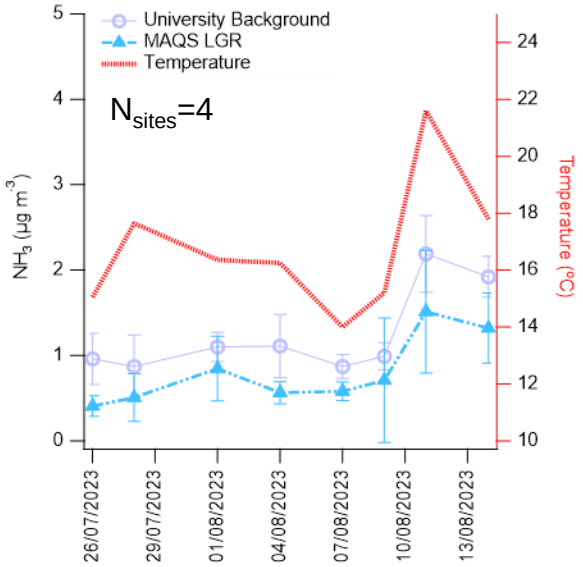
MAQS

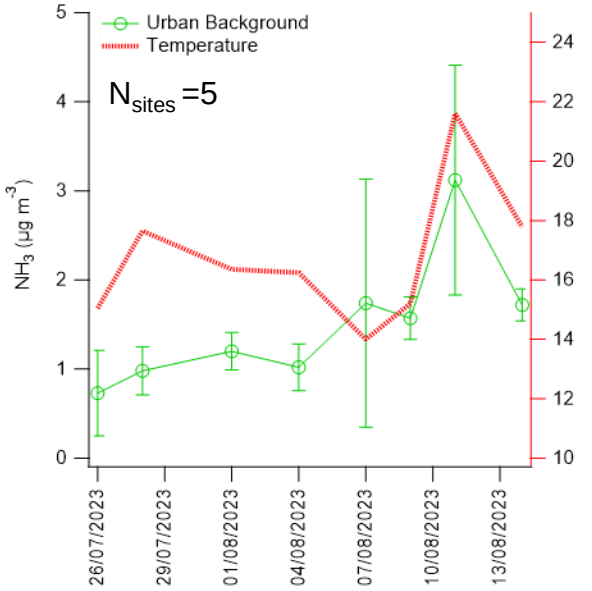


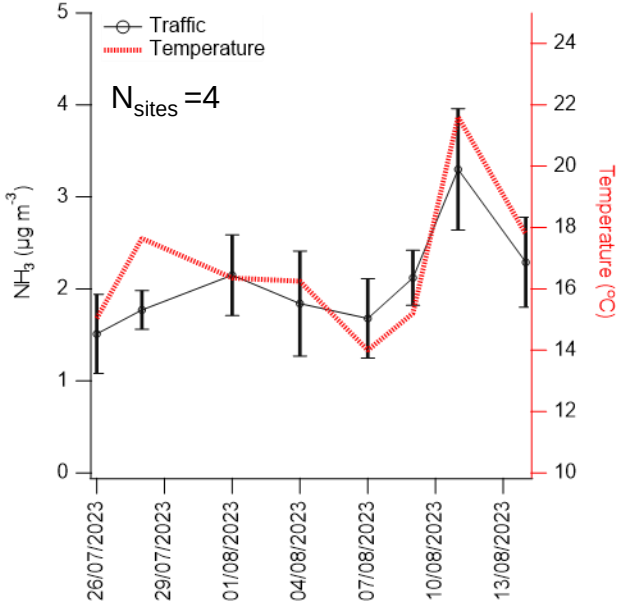
Spatial NH_3 : differences between site typologies

University background | Urban Background | Traffic

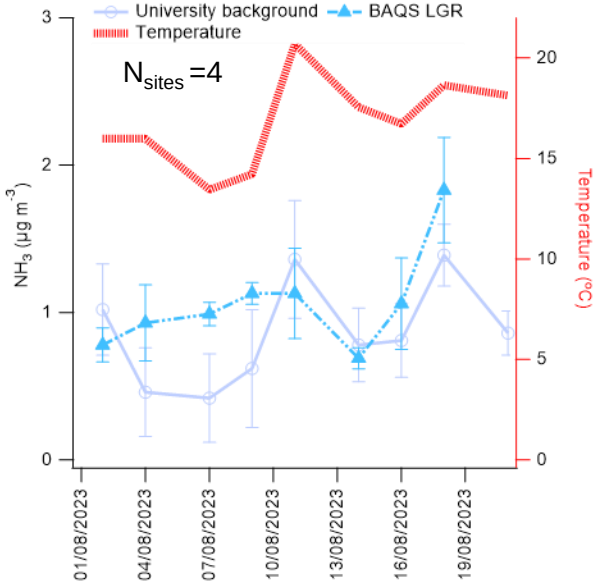
MAQS

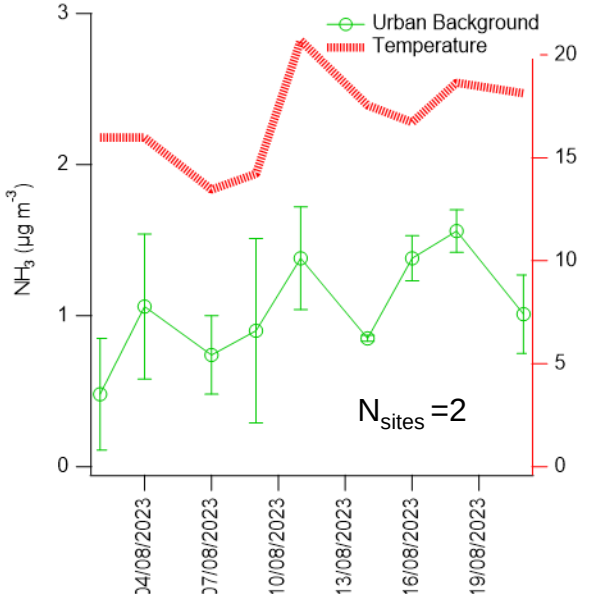


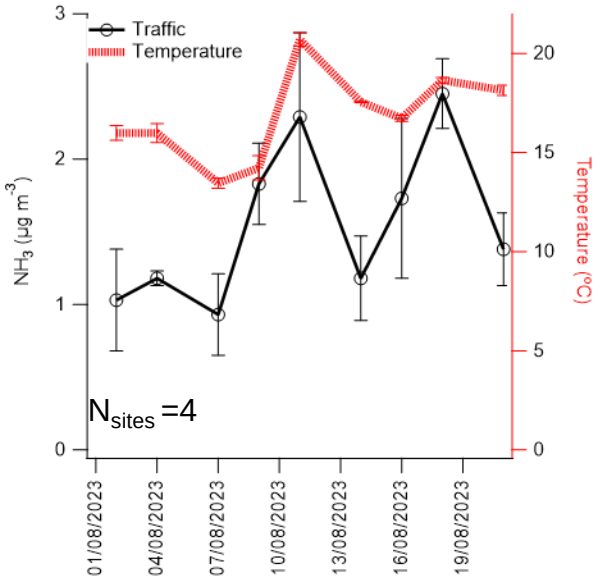




BAQS







- NH_3 temporal pattern driven by T at all stations.
- University background: lowest NH_3 of all sites. LGR mostly follows averaged conc.
- Urban background: highest variability due to local and variable sources.
- Traffic: higher NH_3. regardless of the period; **highways and busy roads are sources of NH_3.**

Conclusions

1. OSCA urban NH_3 automatic analysers allow insight into temporal variability and will deliver evidence of long-term change and trends for policy making.
2. OSCA urban AQS measure NH_3 concentrations typical of UK urban background typology.
3. UK urban background NH_3 concentrations are similar to the regional rural NAMN concentrations, driven by both **local and regional emissions**.
4. Urban roadside concentrations are higher than urban background, hence automatic analysers for these locations would be advisable to track changes in emission patterns.

Future UK monitoring efforts should aim to include **more NH_3 monitoring in urban environments to underpin clean air policies.**

Thank you for your attention!

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