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Atmospheric ammonia in-situ long-term monitoring: review worldwide strategies and recommendations for implementation

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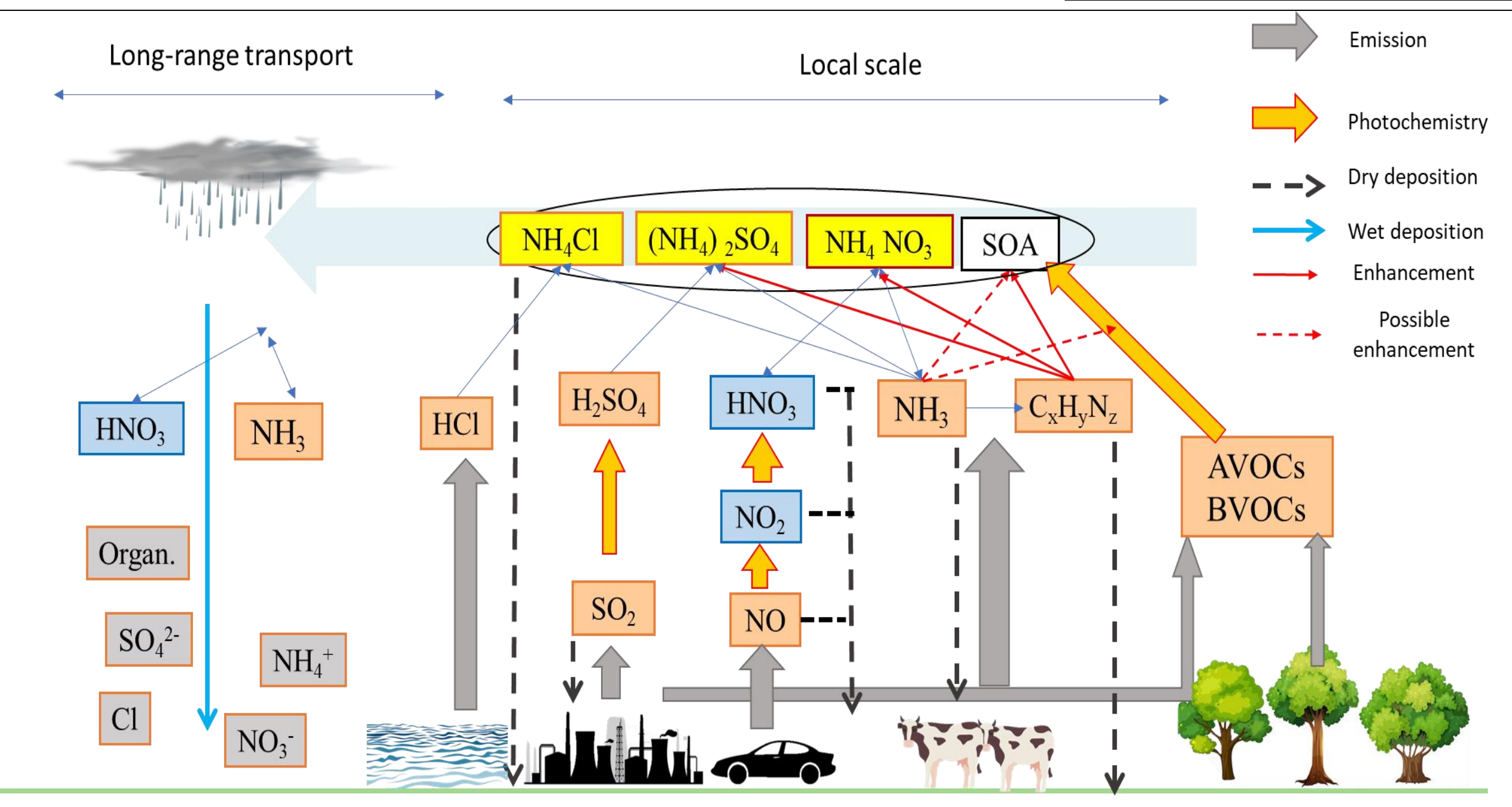
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Ammonia (NH₃): Atmospheric role



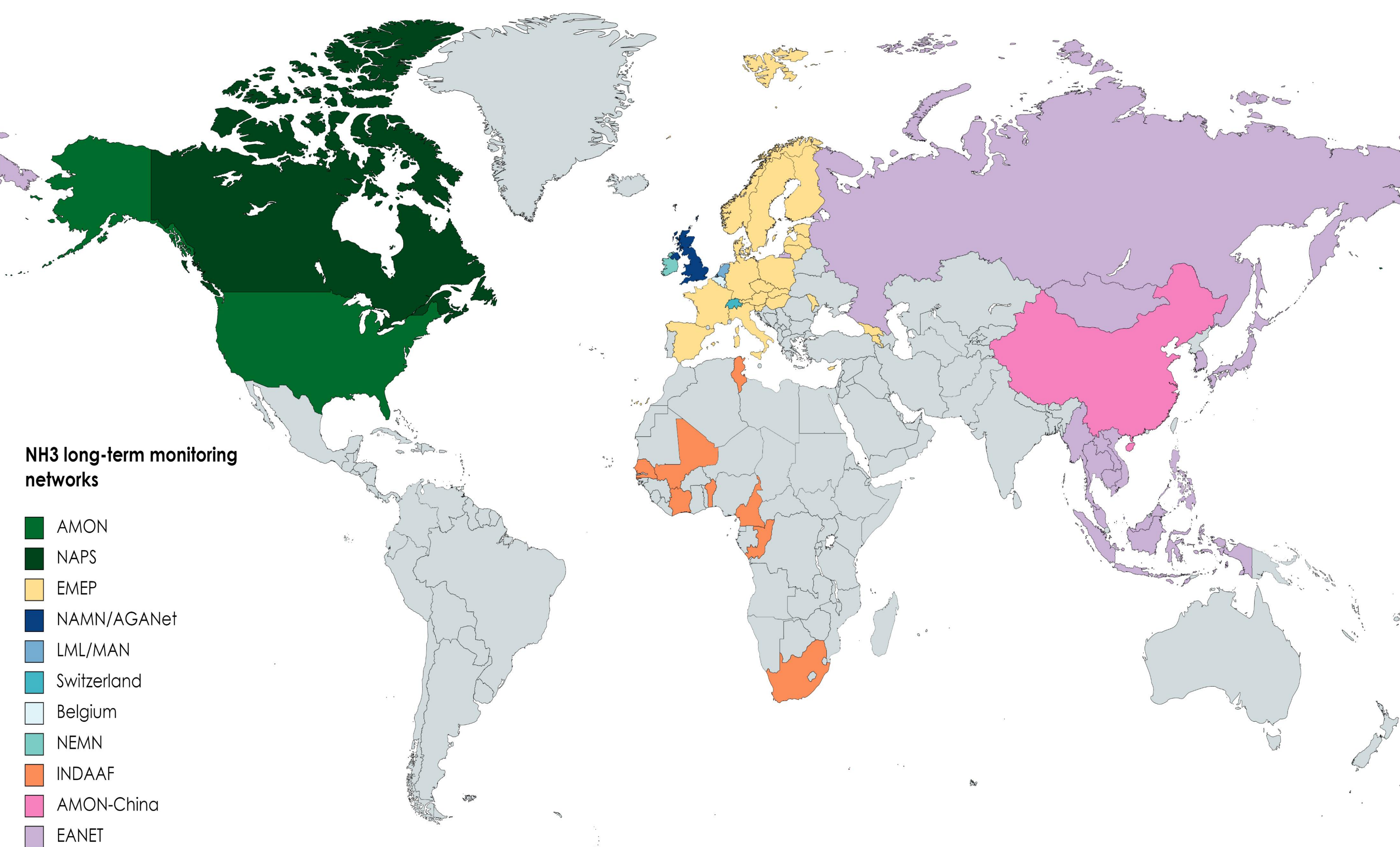
- Major alkaline gas in the atmosphere: mainly agricultural sources.
- Forms secondary salts, mostly on the fine particle fraction (PM_{2.5}).
- Dry and wet deposition: causes damage on ecosystems, eutrophication and acidification issues.
- Recent studies suggests it enhances new particle formation.

Reductions in NH₃ emissions and ambient concentrations are necessary to improve air quality (AQ) and recover sensitive ecosystems¹. Worldwide there are relatively few long-term national and continental NH₃ concentration monitoring networks. There is not yet information from South America, Southwestern Asia, large parts of Africa and Oceania. The aim of this study is to review current networks and provide recommendations for setting up future NH₃ long-term monitoring.

Long-term monitoring networks: Main objectives pursued

1. Estimate regional NH₃ concentrations and establish national NH₃ baselines.
2. Assess spatial & temporal patterns at short-term and long-term driving NH₃ concentration variability.
3. Estimate impacts caused by NH_x deposition in ecosystems and protected areas.
4. Apportion the origin of the reduced nitrogen (N_{red}) deposition and/or estimate the N_{red} deposition fluxes.
5. Assess the effectiveness of mitigation strategies and inform the grand public on AQ changes.
6. Validate and/or calibrate models (chemical transport, dispersion, emissions...).

Long-term monitoring networks of NH₃ worldwide



	Network	Temporal coverage	N sites	Sampling method (A: active, P: passive)	Temporal resolution	Objectives
USA ²	AMON	2007-Present	106	Radiello tubes (P)	Biweekly	1,3,4,6
Canada ²	NAPS	2003-present	14	Denuder filterpack (A)	3 -6 days	1,2,4,5
Europe-Asia ³	EMEP	1986 - Present	TBD*	Various (A, P)	Various	2,5,6
UK ⁴	UKEAP NAMN AGA-Net EMEP supersites	1998-Present	78	ALPHA sampler (P)	Monthly	1,2,3,6
			28	DELTA (A)	Monthly	
			2	MARGA (A)	1h	
Netherlands ⁴	LML	1993-Present	6	miniDOAS (A)	1h	2
	MAN	2005-Present	>300	Gradko sampler (P)	Monthly	1,3,6
Ireland ⁴	NEMN	2017-Present	TBD*	ALPHA sampler (P) DELTA (A)	Monthly	2,3,5
Switzerland ⁴	-	2000-Present	>80	Ferm sampler (P)	2-4 weeks	2,5,6
Belgium ⁴	-	2002-Present	18	Radiello sampler (P) Mini-DOAS (A)	Monthly 1h	1,2,3,6
China ⁵	AMON	2015-Present	53	Analyst sampler (P)	Monthly	2
Asian Southeast ⁶	EANET	1999-Present	44	Denuder filterpack (A)	Weekly, 10 days, Biweekly	2,3,5
Western Africa ⁷	INDAAF	1995-Present	13	INDAAF sampler (P)	Monthly	2,4

TBD*: to be determined, bibliography research not conclusive

Recommendations for future NH₃ monitoring networks

In the near future, the number of NH₃ monitoring networks using FAIR data-archiving is expected to increase to better evaluate AQ objectives and follow the long-term changes in N_{red} deposition. In this poster, we propose some recommendations and approaches used by current long term monitoring networks:

1. Co-locate with established monitoring sites to minimise costs, where possible.
2. Smaller countries may share monitoring sites with surrounding countries to keep running costs low.
3. Tiering monitoring sites by mixing passive monitoring methods with high temporal monitoring methods provides spatial distribution and evidence of the sources and processes driving the reported NH₃ concentrations.
4. The spatial strategy of having a high number of monitoring sites equipped with passive samplers allow to achieve objectives 1,2,3, and 5. Local site operators (LSOs) can help identify local sources of NH₃ and can potentially decrease the operational costs.

5. High temporal resolution active monitoring is advised to identify NH₃ temporal changes drivers and, within ACTRIS, EMEP and WMO-GAW, traceable protocols should be developed and tested and include pre-existing networks using continuous wet methods (MARGA in UKEAP), spectroscopic methods (miniDOAS in LML & Belgium) and other new technologies.
6. Data should be made open access via an online data repository, where possible. Information's such as the network operational conditions and QA/QC protocols are also beneficial.

References & Acknowledgments

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