Monitoring of long range transported air pollution

Wenche Aas and Kjetil Tørseth

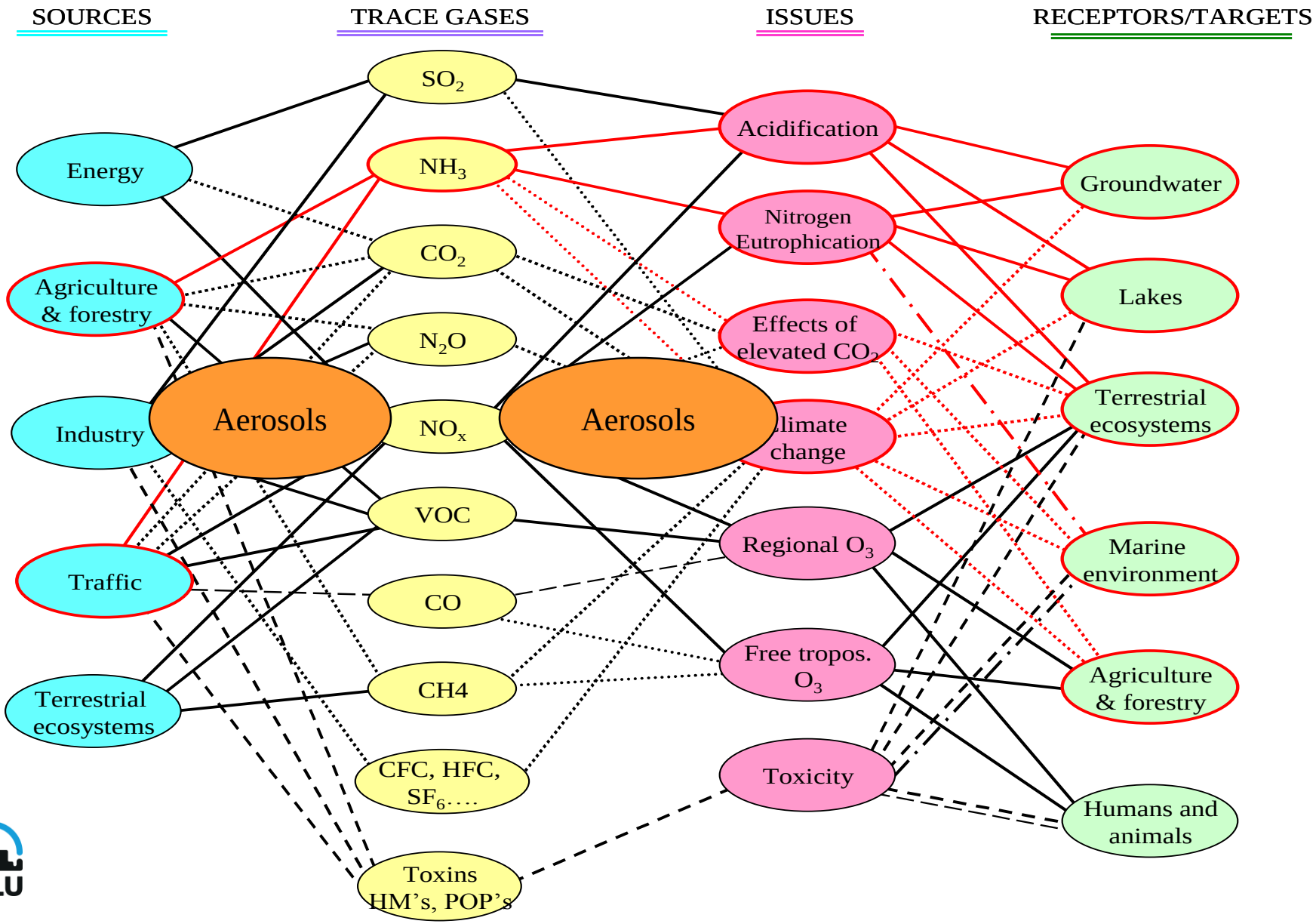
NILU/EMEP-CCC

emep

Convention on Long-range Transboundary Air Pollution

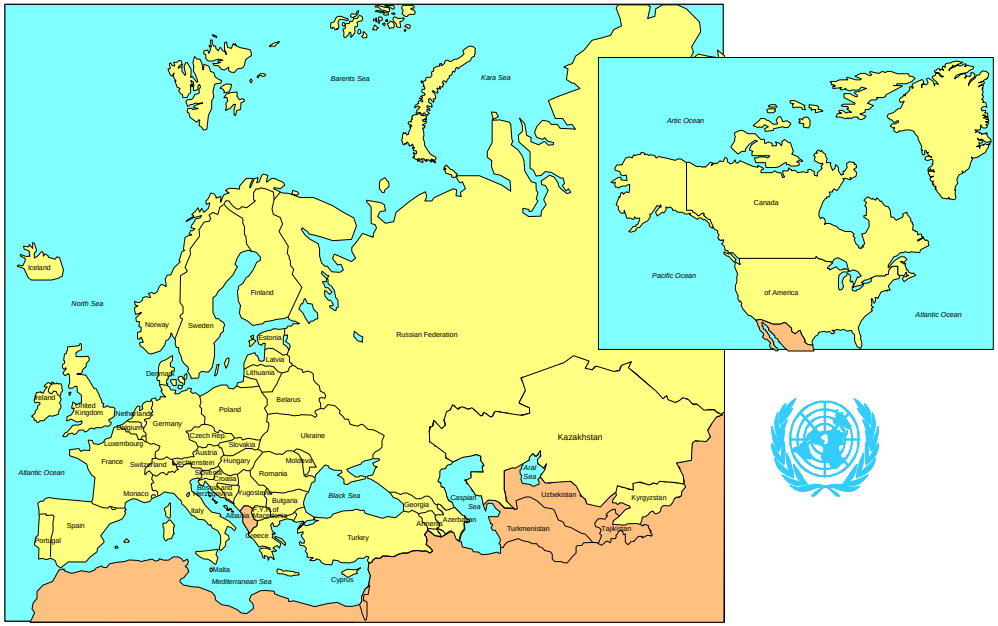
emep Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe

Air pollution and impacts



NILU

UN-ECE Convention on Long-Range Transboundary Air Pollution (1979)



The first legal binding instrument to deal with problems of air pollution on a broad regional scale

8 protocols,where EMEP is the first (42 parties)

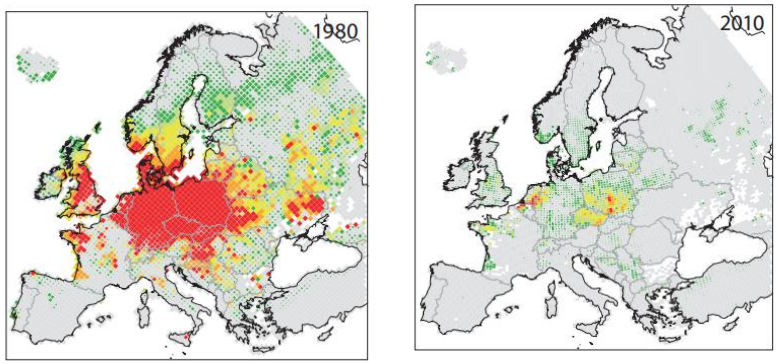
European Monitoring and Evaluation Programme (EMEP)

science based and policy-driven

- Emission inventories and projections
- Monitoring
- Modelling activities
- integrated assessment

Large improvements over the last decades

- One extra year of average life expectancy in Europe (reductions on PM and peak O_3)
- declining acidification in lakes has led to fish stocks recovering



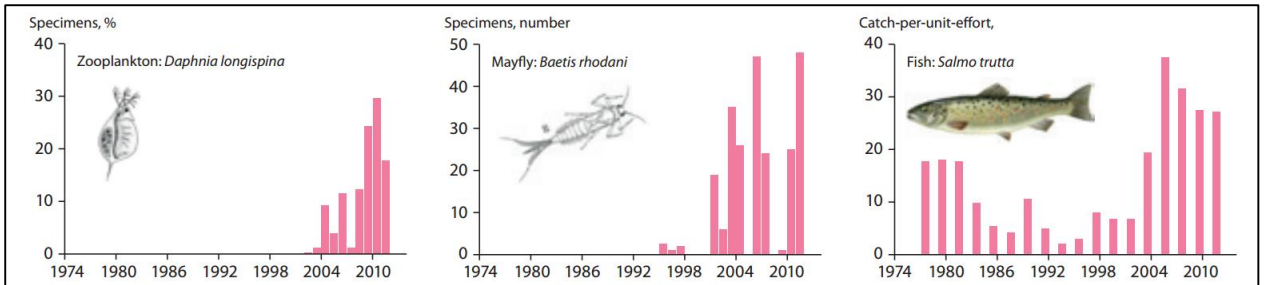
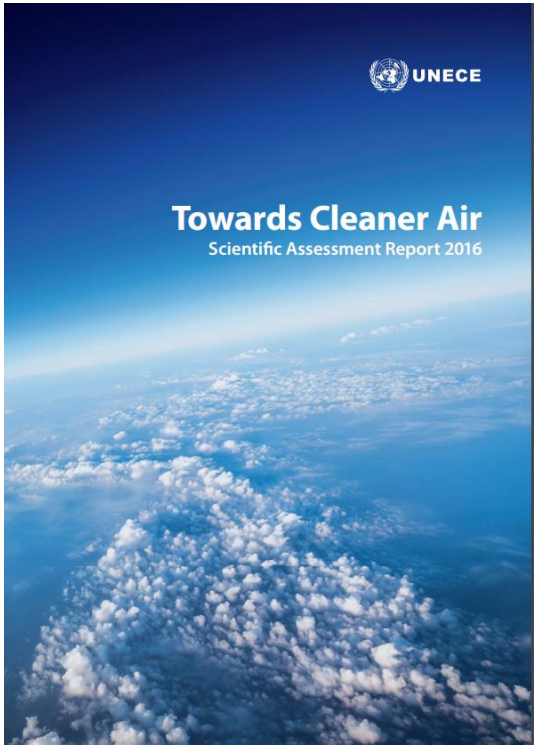
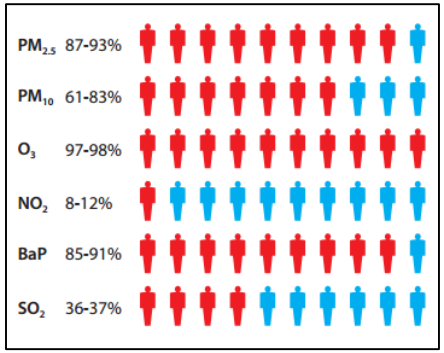


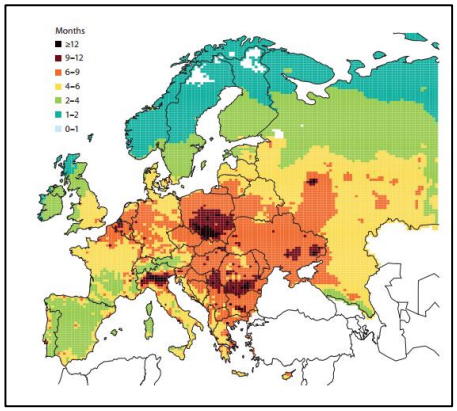
Figure 9. Recovery from acidification at Lake Saudlandsvatn, Norway. As sulphur deposition has decreased, so the acid neutralising capacity (ANC) and pH of the lake water have increased, and the populations of three sensitive species have begun to recover (modified from Hesthagen et al., 2011).



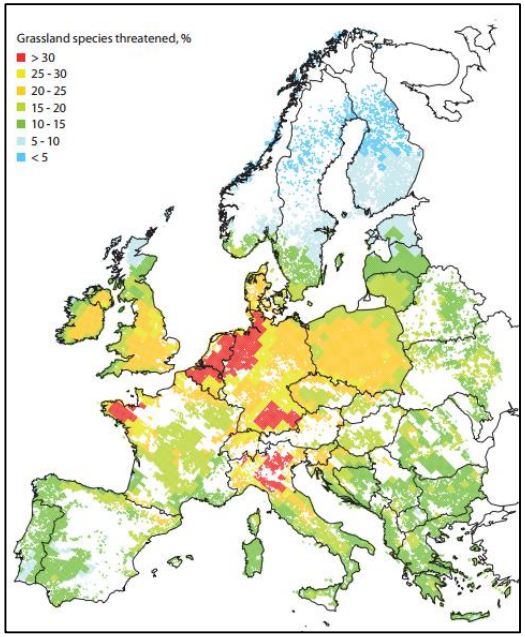
Still large challenges

Health



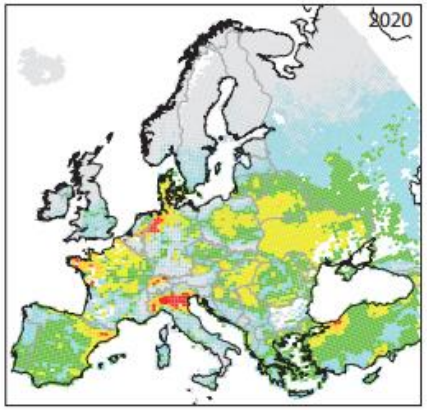


Biodiversity

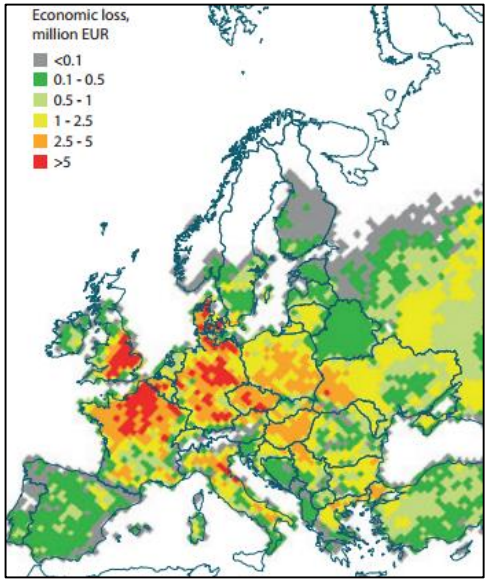


- climate change
- New contaminants

Eutrophication



Loss in crop yields



NILU

Directives, protocols and conventions that set the monitoring agenda

European

- EU's air quality directives
- OSPARCOM (and HELCOM) marine conventions
- UNECE LRTAP, its protocols and the EMEP Monitoring Strategy

Global

- Minamata Convention on Mercury
- Stockholm convention on POPs
- Paris agreement
- Montreal Protocol on Substances that Deplete the Ozone Layer

United Nations Framework Convention on Climate Change

EMEP objectives

a) **To provide observational and modelling data** on air pollutant concentrations, deposition rates, emissions and **transboundary fluxes on the regional scale** and identify the **trends** in time;

b) **To identify the sources** of the pollution concentrations and depositions and to assess the response to changes in emissions;

c) To **improve our understanding** of chemical and physical processes relevant to assessing the effects of air pollutants on ecosystems and human health in order to support the development of cost-effective abatement strategies;

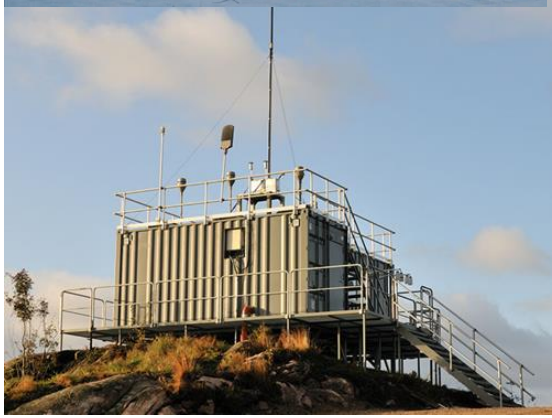
d) To explore the environmental concentrations of **new chemical substances** that might require the attention of the Convention in the future.

NILU

CLRTAP – EMEP

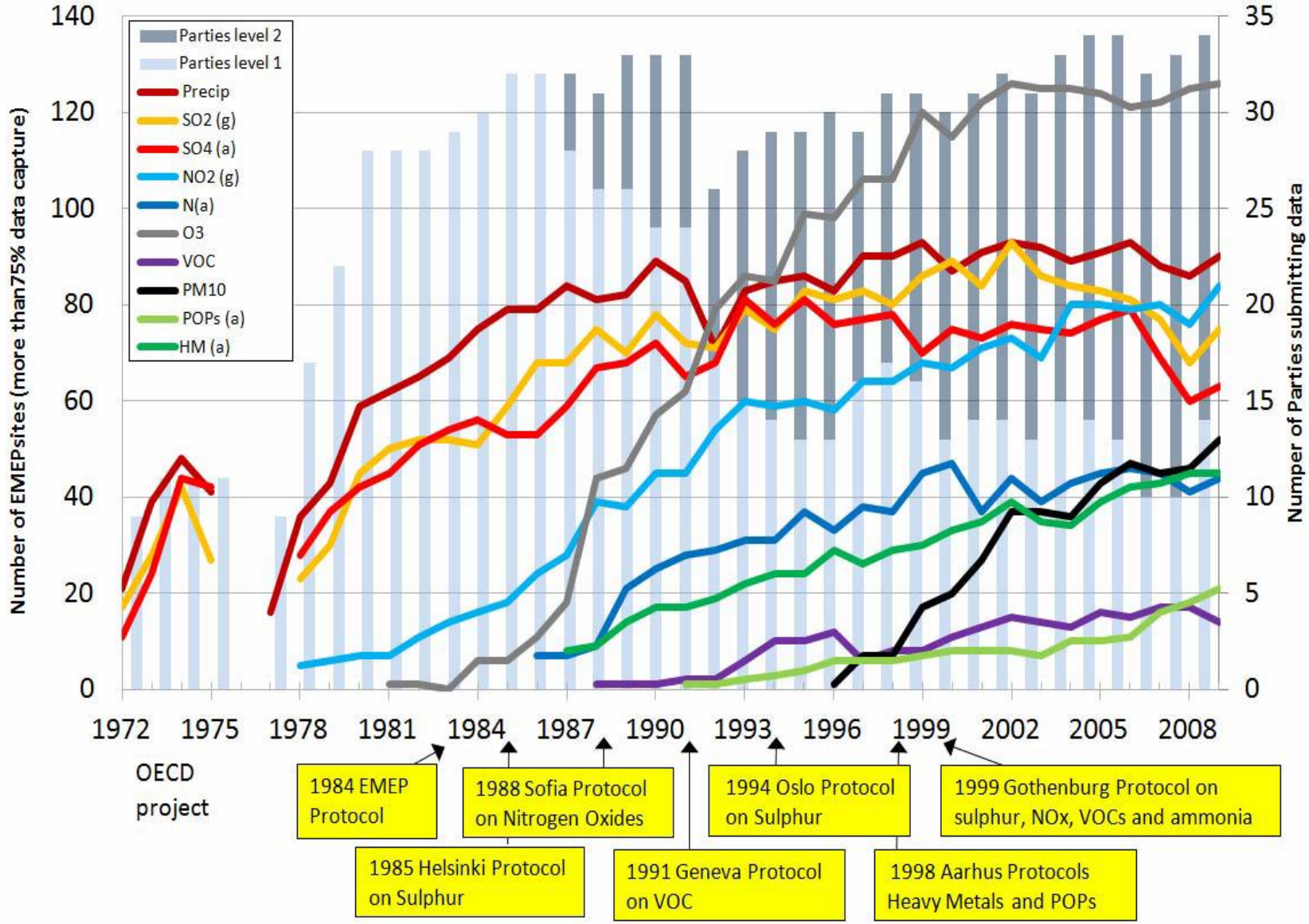
Focus areas:

- ✓ Major inorganics in air and precipitation (~1972->)
- ✓ Surface ozone, NOx, VOCs (~1977->)
- ✓ Heavy metals in air and precipitation (~1973->)
- ✓ POPs in air and precipitation (~1992->)
- ✓ Aerosol physical and optical properties (~1999->)
- ✓ Tracers, and long-lived species (~2000->)



NILU

The development of the program



Monitoring Strategy 2020-2029

Strategy from 2004, revised in 2009 and now in 2019:

https://projects.nilu.no//ccc/monitoring_strategy/index.html

- Parties to EMEP responsibility to implement the Strategy

UNITED NATIONS **E**

Economic and Social Council

Distr.
GENERAL

ECE/EB.AIR/GE.1/2009/15
23 June 2009

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

EXECUTIVE BODY FOR THE CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)

Thirty-third session
Geneva, 7–9 September 2009
Item 6 (a) of the provisional agenda

PROGRESS IN ACTIVITIES IN 2009 AND FUTURE WORK

MEASUREMENTS AND MODELLING (ACIDIFICATION, EUTROPHICATION, PHOTO-OXIDANTS, HEAVY METALS, PARTICULATE MATTER AND PERSISTENT ORGANIC POLLUTANTS)

DRAFT REVISED MONITORING STRATEGY

Prepared by the Chemical Coordinating Centre
in consultation with the Bureau of the Steering Body

1. This document presents the draft monitoring strategy for the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) for 2010–2019 as revised by the Chemical Coordinating Centre (CCC) in consultation with the Bureau of the EMEP Steering Body and as mandated by the Steering Body at its thirty-second

Atmos. Chem. Phys., 12, 5447–5481, 2012
www.atmos-chem-phys.net/12/5447/2012/
doi:10.5194/acp-12-5447-2012

Atmospheric Chemistry and Physics

Introduction to the European Monitoring and Evaluation Programme (EMEP) and observed atmospheric composition change during 1972–2009

K. Torseth, W. Aas, K. Breivik, A. M. Fjæraa, M. Fiebig, A. G. Hjellbrekke, C. Lund Myhre, S. Solberg, and K. E. Yttri

NILU – Norwegian Institute for Air Research, P.O. Box 100, 2027 Kjeller, Norway

Correspondence to: K. Torseth (kt@nilu.no)

NILU

Strategy for building a good observational system

- **Long term commitments**. Takes long time to obtain a useful time series -at least ten year
  - Shorter periods for screening and research
- Adequate **spatial resolution**
  - Enough stations to observe regional differences, especially important in regions with strong meteorological variations
- Adequate **temporal resolution**
  - Hours or days necessary to study sources and transport.

Adequate **data quality**

- Harmonized methods with international/national standards and use of reference methods and standard operational procedures
- Regularly checked

- **Co-located** measurements
  - Many different components at the same sites. Cost efficient and better understanding of atmospheric processes and sources

Monitoring and **research** in close cooperation

- Use of same infrastructure (sites, lab, database)
- Dependent on each other

NILU

Level approach

Level 1, to provide long-term basic chemical and physical measurements of the traditional EMEP parameters.

Largely engages governmental agencies and institutes and is based on long-term funding. Standardized methods and data products. QAQC internal, partly overlap with EU-Directives based monitoring. Data reported to EMEP.

Level 2, provide a more complete description of the physical/chemical speciation of relevant components that is necessary for assessing the air pollution

Do also rely in research institutes/universities, close links to RI-initiatives. Standardized methods and data products, external QAQC may occur. Data reported to EMEP.

Level 3, typically research oriented. Often no standard methods or QAQC systems in place. Often no permanent long-term commitment. Also other locations and «representativeness» than at Level 1 and level 2. Data reported to EMEP, but with exceptions (national network data)

NILU

Level 1 parameters

Variables to be measured at all basic EMEP sites. Level 1 activities should be the first priority when extending the network in areas with few sites

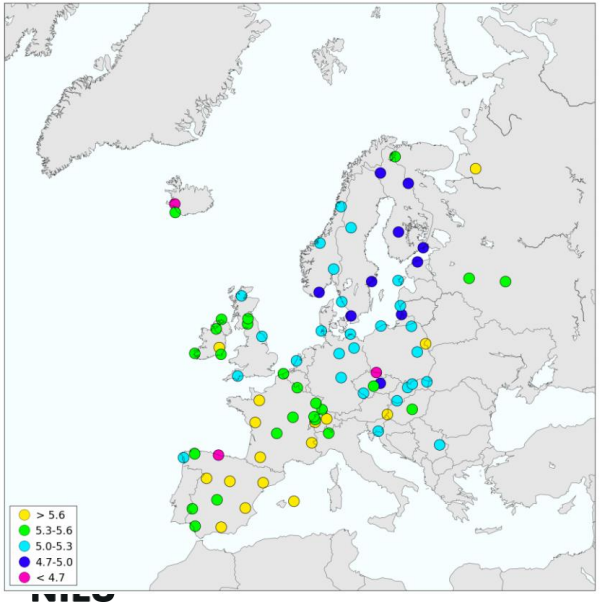
Component group	Species	resolution
Inorganic compounds in precipitation	SO_4^{2-}, NO3 - , NH4 + , H+ (pH), Na+ , K+ , Ca2+, Mg2+, Cl-, amount	24h
Inorganic compounds in air	SO2, SO42-, NO3 - , HNO3, NH4 + , NH3, (sNO3, sNH4), HCl, Na+ , K+ , Ca2+, Mg2+	24h
Elemental and Organic Carbon	EC and OC in PM2,5	24h/7d
Nitrogen dioxide	NO2	1h/24h
Ozone	O3	1h
PM mass concentration	PM2.5, PM10	24h
Heavy metals in precipitation	Cd, Pb (1st priority), Cu, Zn, As, Cr, Ni (2nd priority)	7d
Meteorology		1h

NILU

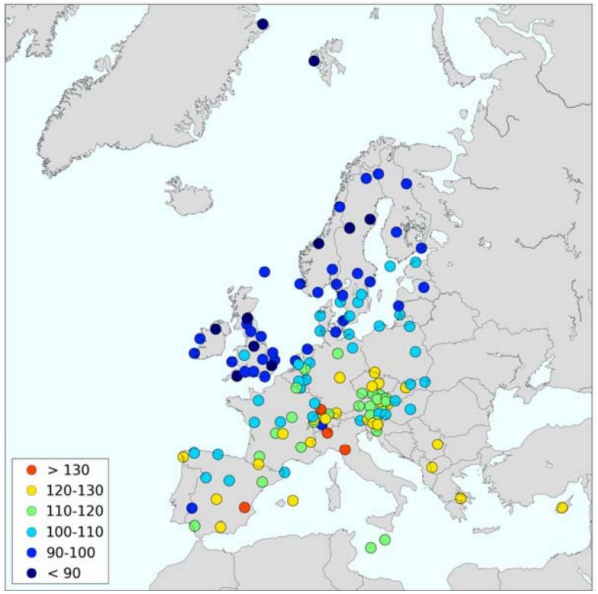
Level 1 (status 2016)

Quite good spatial coverage though lack measurements in the most Eastern part of Europe and some areas in south of Europe

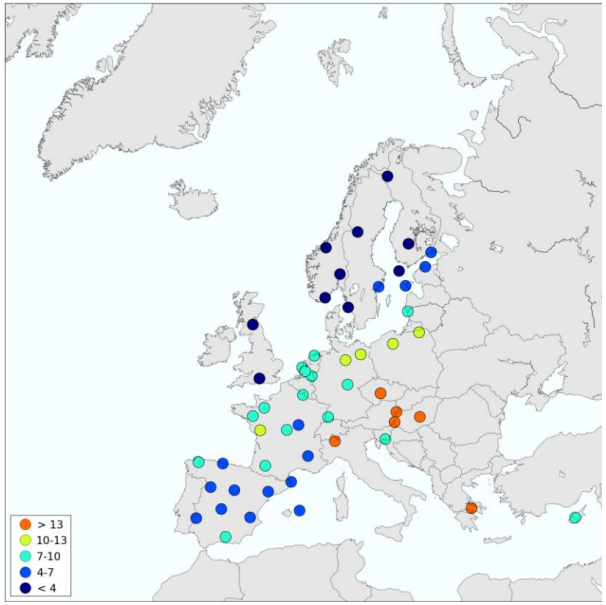
pH in precipitation



Ozone.

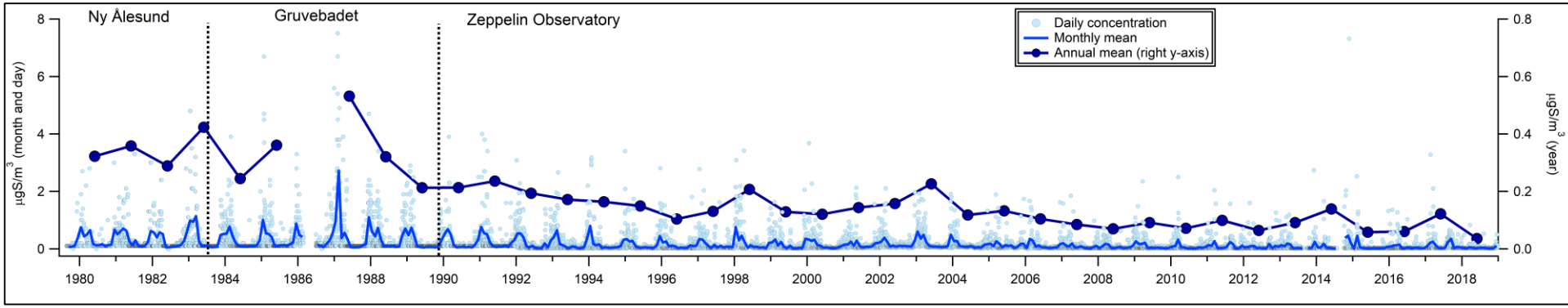


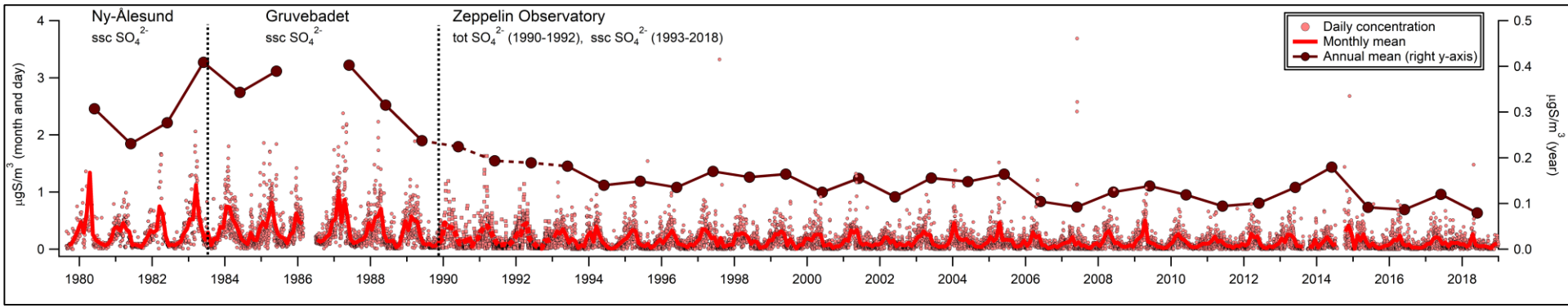
$PM_{2.5}$



Several sites with long term commitments

Example of SO_2 and SO_4 at Zeppelin in Spitsbergen:





Level 2 paramters

Oxidant precursors and gaseous SLCPs

Nitrogen oxide	NO
Light hydrocarbons	C2-C5, BTEX (Benzene, Toluene, Ethylbenzene, and Xylene)
OVOCs	Aldehydes and ketones
Hydrocarbons	C6-C12
Methane	CH4
Carbon Monoxide	CO

Aerosol properties

PM mass	PM1
Elemental and Organic Carbon in air	EC and OC in PM10
Mineral dust in PM10	Si, Al, Fe, Ca
Particle light absorption/ekv. black carbo	Light absorption coefficient, eBC
Particle number concentration	dp >10nm
Particle number size distribution	dN/dlogDp, (sub/supermicrometer)
Particle light scattering coefficients	Light scattering coefficient, Light backscatter coefficients (multi-wavelenghts)
Particle chemistry speciation	Non-refratory organic and inorganic composition (ACSM, AMS)
Aerosol Optical Depth	AOD at 550 nm

Nitrogen: gas/aerosol

Gas particle ratio of N-species	NH3/NH4 + , HNO3/NO3 - (artifact-free methods)
Gas particle ratios of N-species	NH3, NH4+, HNO3, NO3- (HCl,)(complementing the filter pack sampling)

Heavy metals

Mercury in precipitation	Hg
Mercury in air	Hg (TGM),
Heavy metals in air	Cd, Pb (1st priority), Cu, Zn, As, Cr, Ni (2nd priority)

Persistent organic pollutants observations contributes to the assessment of persistent organic pollutants

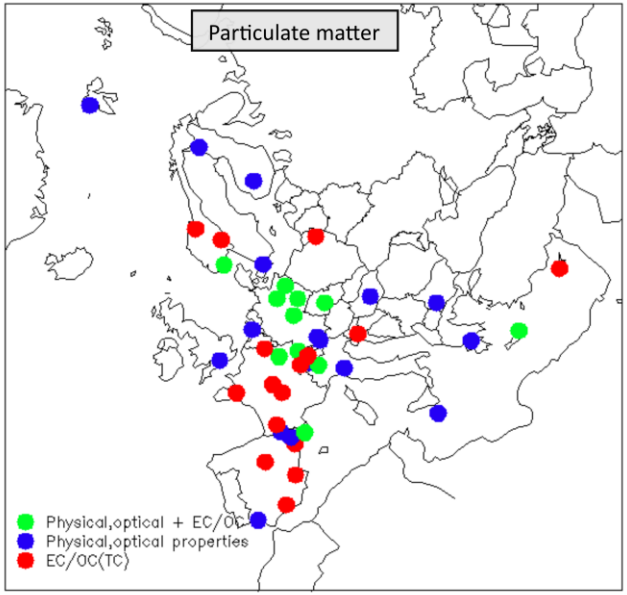
POPs in precipitation	PAHs, PCBs, HCB, chlordane, HCHs, DDT/DDE
POPs in air	PAHs, PCBs, HCB, chlordane, HCHs, DDT/DDE

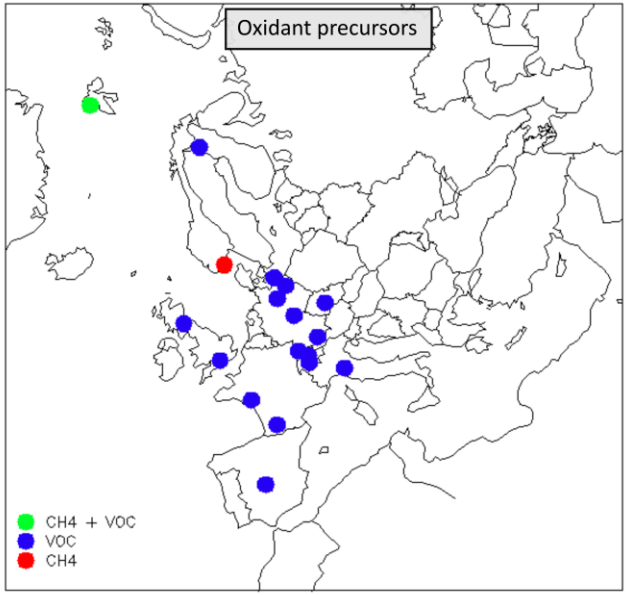
Tracers

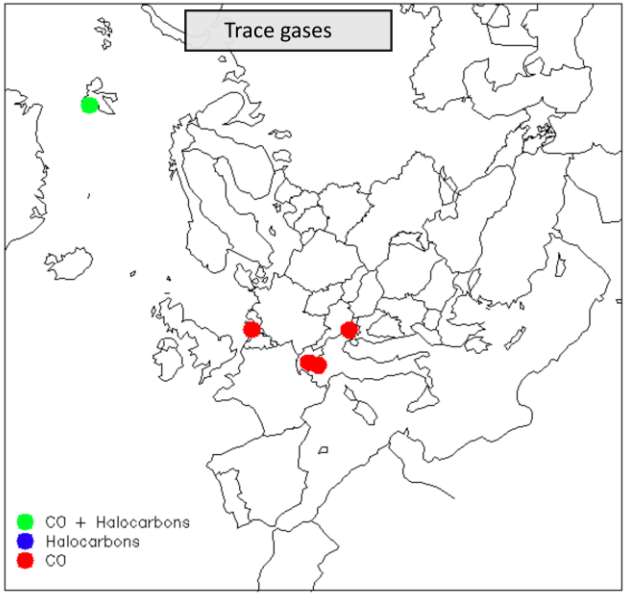
Halocarbons	CFCs, HCFCs, HFCs, PFCs, SF6

- Additional to level 1 measurements
- 1 -2 sites per country
- Not necessarily all parameters (national priorities)

Level 2 status 2016 (I)







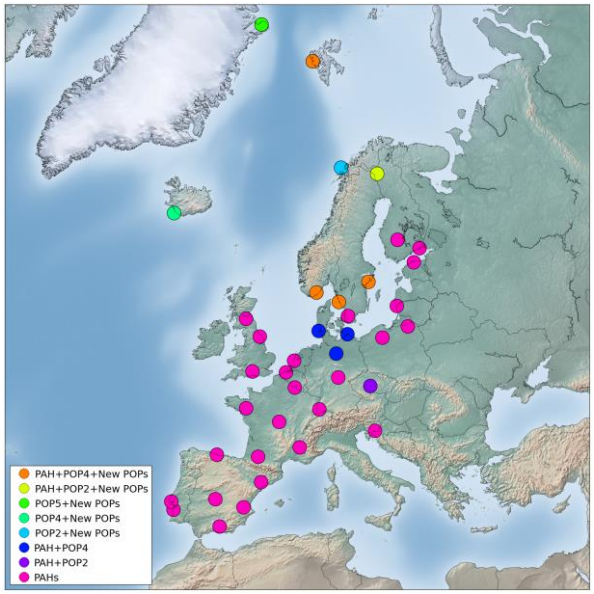
- For aerosol properties there has been a large improvements the last decade. Close cooperation with other programmes like ACTRIS and WMO/GAW
- Improvements seen in the spatial coverage of VOC measurements
- Tracers, few sites

NILU

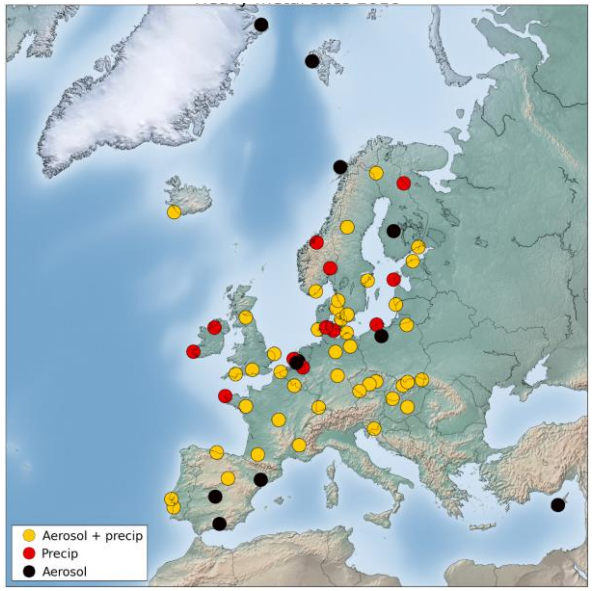
Level 2, status 2016 (II)

- Relatively good coverage of heavy metals except in Eastern Europe
- Mercury and most POPs mainly measured in northern and central Europe
- Measurements of PAHs (BaP) have quite good coverage due to EU AQD

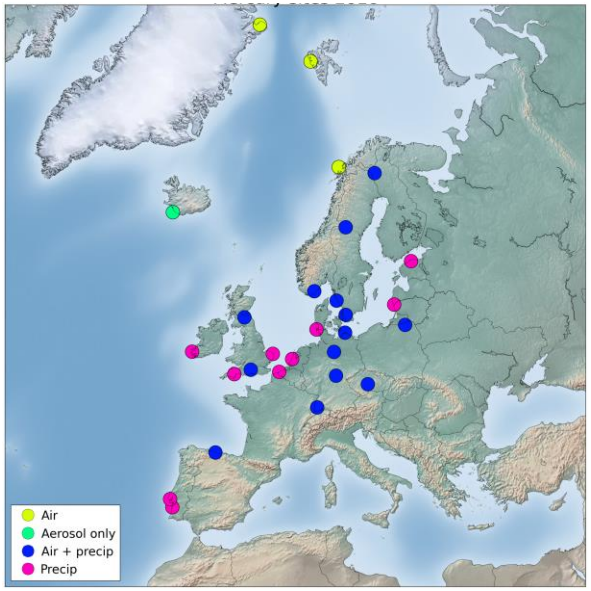
POPs



Heavy Metals



Mercury



There has been projects to establish EMEP sites in the EECCA region


Azerbaijian: Xizi


Kazakhstan: Borovoye


Moldova: Leovo


Armenia:
Amberd

Status monitoring in the EECCA region

Measurement programme

- RU, BY, MD, AR measure and report data from sites in rural areas. But it is not complete level 1 measurements at any sites.
- GE, AZ and KZ do have an EMEP site but do not measure/report

Quality assurance and standardized methods

- Encourage to take part in lab inter-comparison (some countries do)
- Participation at EMEP and GAW training courses

NILU

Expectations, EECCA countries

A very important region

- High emissions
- Strategic area for hemispheric transport issues
- Little monitoring today

Expected that most countries will sign the EMEP protocol.

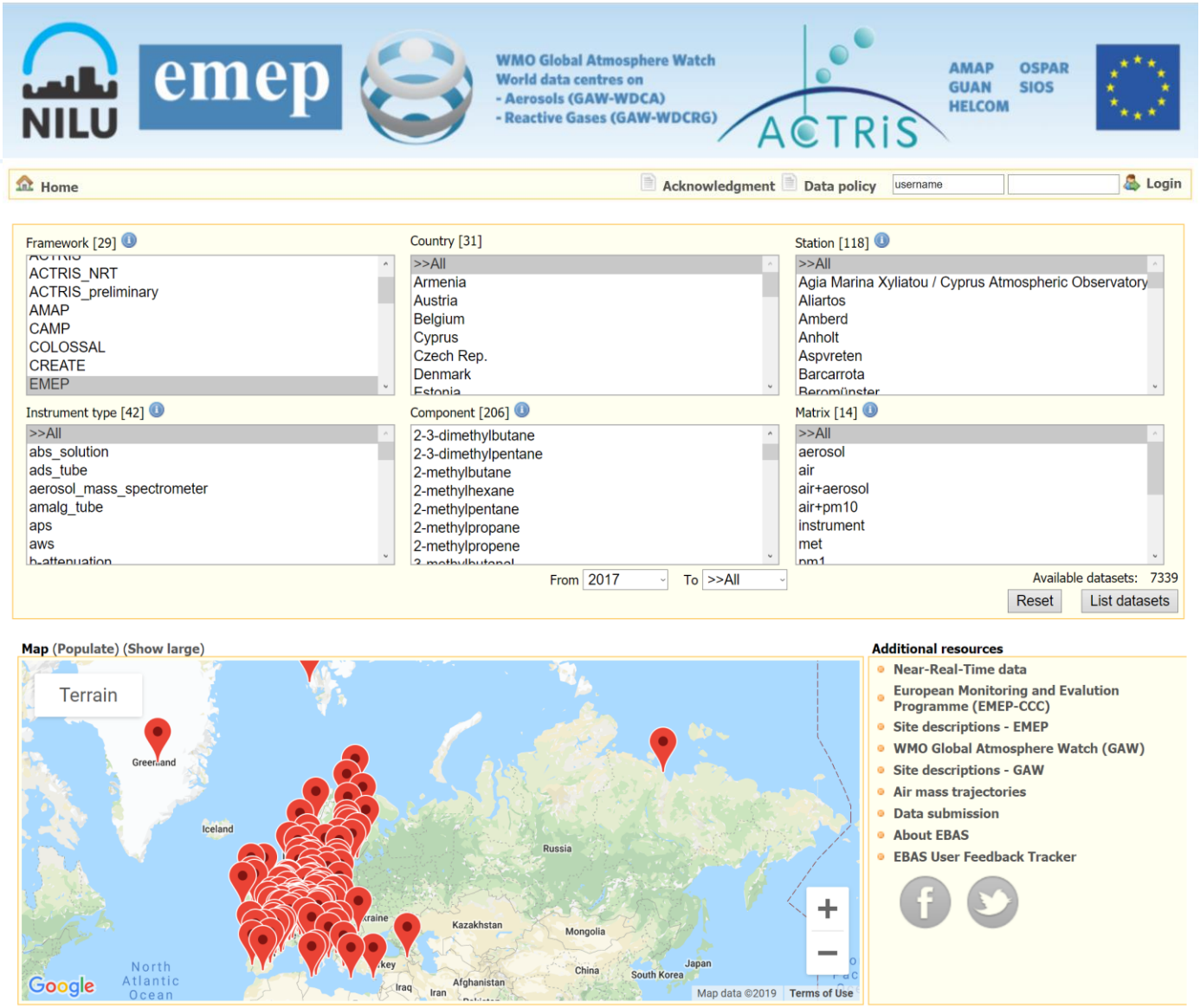
Need to establish EMEP level 1 sites in each country. Support can be found, i.e from foreign aid money, EU, UNECE. Training and capacity building is necessary.

Beeing part of an international monitoring programme, as on transboundary air pollution, will in addition, give competence and awarness on other envirionmental issues

NILU

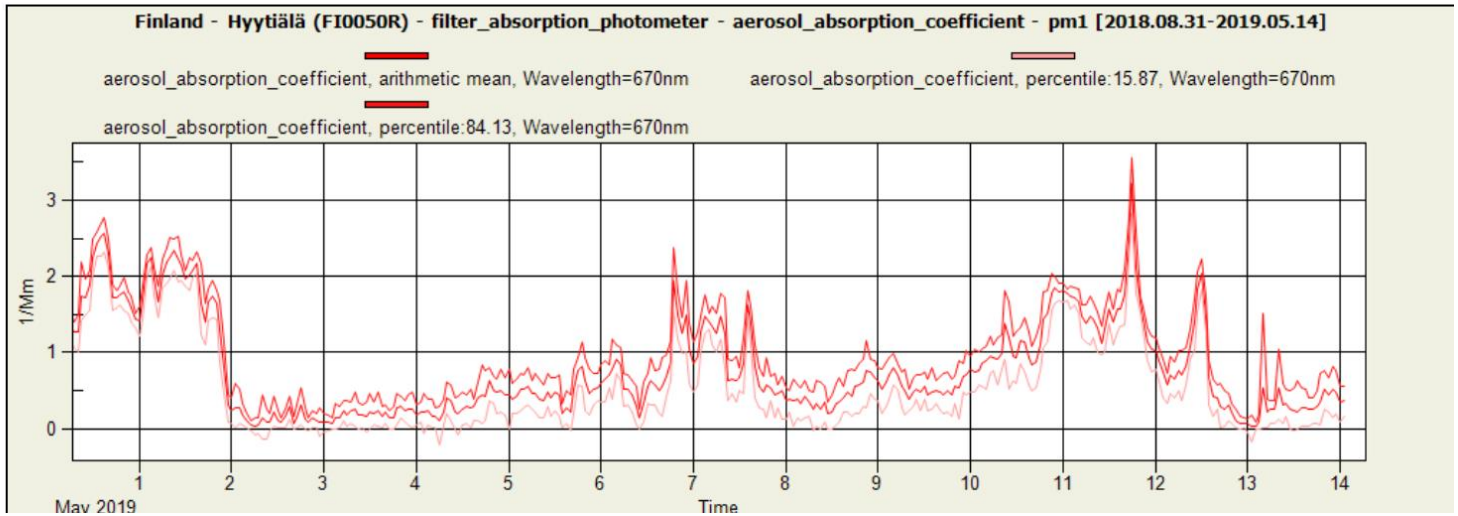
Data availability, open access:

http://ebas.nilu.no/



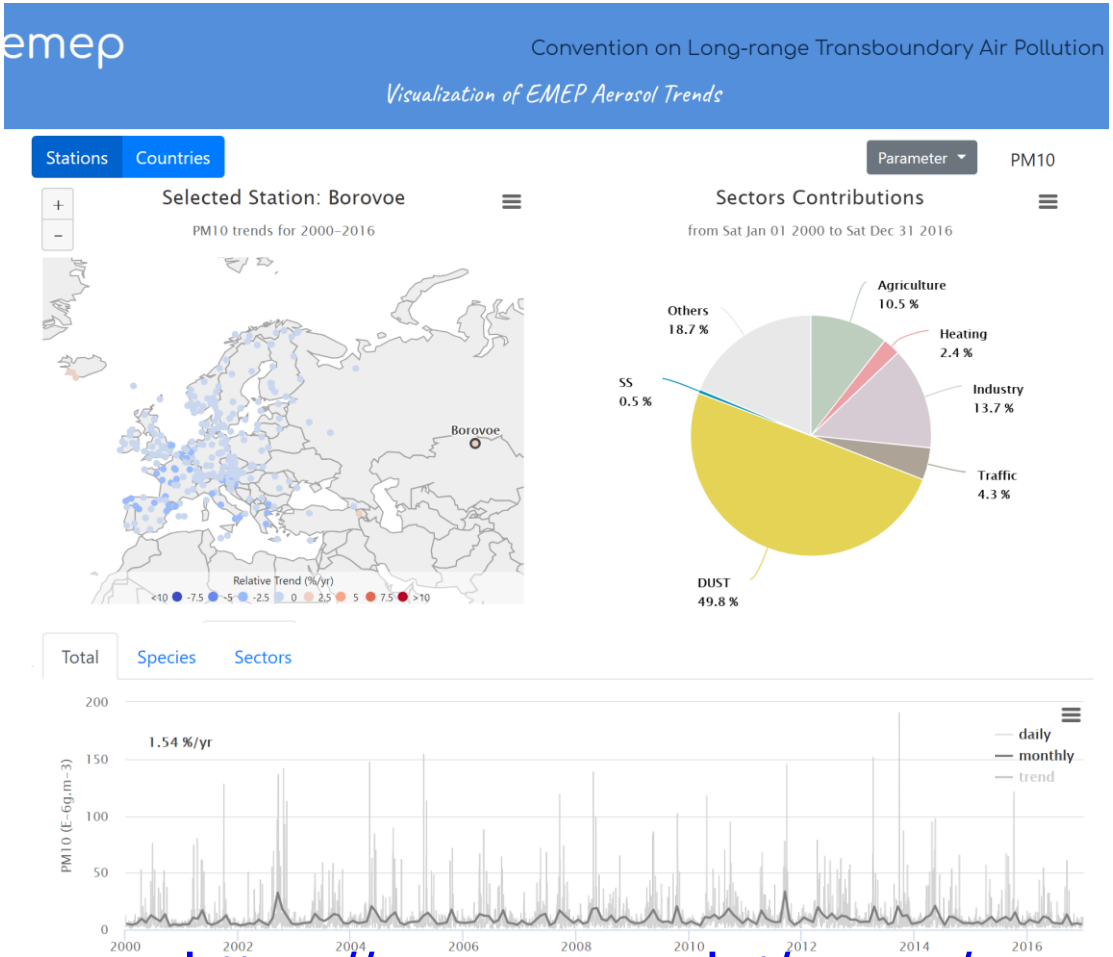
Near Real time data

http://ebas-nrt-showcase.nilu.no



New visualization tool with EMEP trends (developed by MSC-W)

- EMEP model with sector contribution.
- Currently PM_{10} and $PM_{2.5}$
- More components to be included
- Observations to be added



https://www.emep.int/mscw/

EMEP in Scientific litterature

Total Publications

751

h-index

69

Average citations per item

29,96

Sum of Times Cited

22 501

Without self citations

20 538

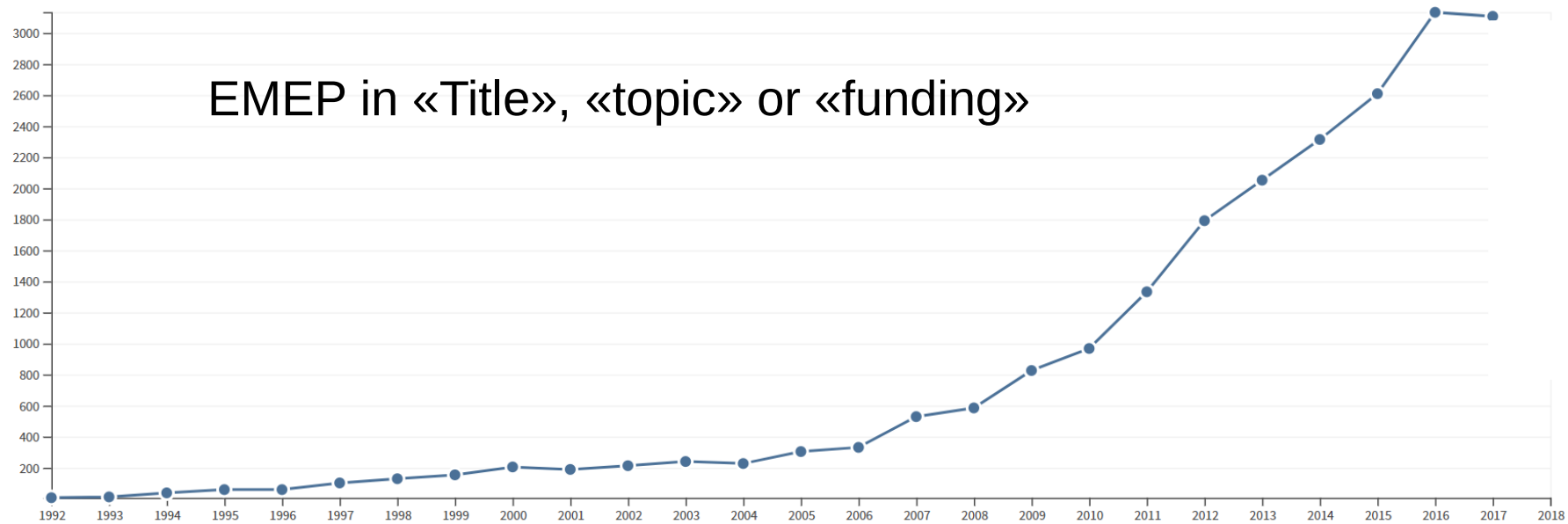
Citing articles

15 135

Without self citations

14 648

Sum of Times Cited per Year



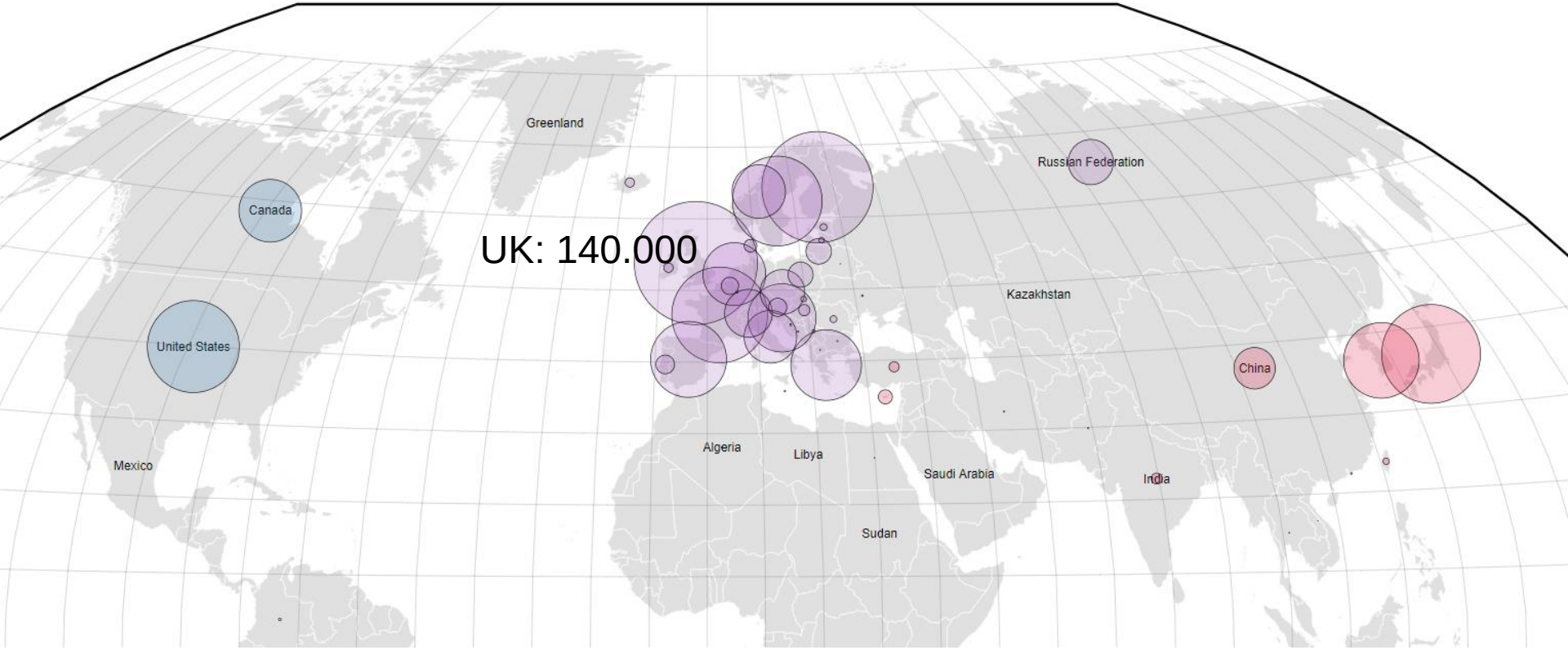
EMEP in «Title», «topic» or «funding»

NILU

Download of data by country

EMEP - Datasets by user country (2016/1/1 - 2018/29/04)

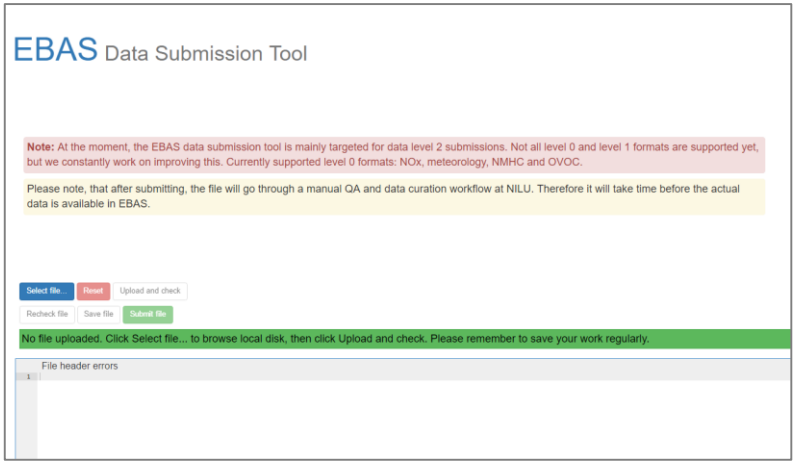
Double Click to zoom on the map, and move your mouse over a bubble to get the exact count

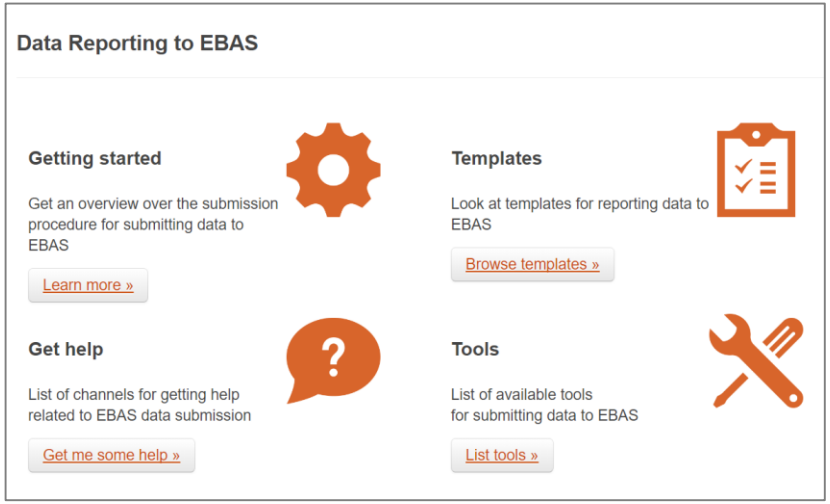


NILU

Data submission

- Specific templates needs to be use
- data submitted via a tool, which also alow for checking your data
- contact ebas@nilu.no for any questions





http://ebas-submit-tool.nilu.no

http://ebas-submit.nilu.no

NILU

Guidelines and SOPs

- Guideline for good measurement practice
- methodologies, guidelines and SOPs recommended and harmonised between EMEP, ACTRIS and WMO/GAW
- https://ebas-submit.nilu.no/Standard-Operating-Procedures

EBAS
Data Submission Manual

Submit Data | Data Policy | Standard Operating Procedures | Near real-time data submissions | Software Tools

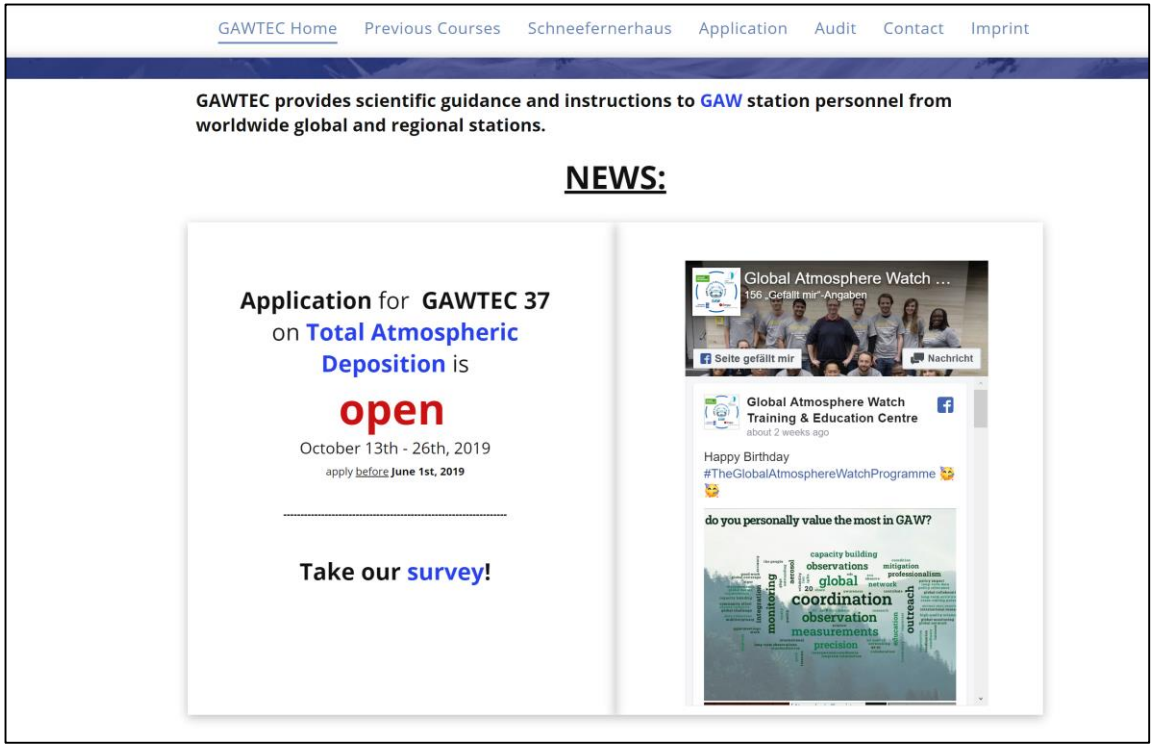
Standard Operating Procedures

Standard Operating Procedures and Measurement Guidelines for particulate matter and aerosol particle variables

Documents and reports	Category	Description	Standard method keyword - used as metadata in EBAS	Methdologies, SOP & guidelines recommended by
Manual of the Precision Filter Radiometer	Aerosol Optical Depth	Aerosol Optical Depth PFR manual, containing description of data analysis and quality assurance.	Sunphotometry_PFR_manual_2009	GAW
GAW-WCCAP recommendations for aerosol inlets and sampling	General guidelines	Guidelines on inlet design for different ambient environments and station settings.	Not applicable	ACTRIS, EMEP, GAW
Station audit check list for atmospheric aerosol property observatrons	General guidelines	The station audit check list highlights the points most critical for station operation concerning data quality assurance.	Not applicable	ACTRIS, EMEP, GAW
GAW - WCCAP recommendation for aerosol drying	General guidelines	Guidelines on conditioning and drying the aerosol sample depending on ambient temperature.	Not applicable	ACTRIS, EMEP, GAW
GAW report No. 153	General guidelines	Relevant for most aerosol variables, previous WMO/GAW Aerosol Measurement procedures, guidelines and recommendations. Superseded by GAW report No. 227 (next line).	SOP=GAW153	
GAW report No. 227	General guidelines	Relevant for most aerosol variables, current WMO/GAW Aerosol Measurement procedures, guidelines and recommendations.	SOP=GAW227	ACTRIS, EMEP, GAW
Calibration and Intercomparison of Filter-Based Measurements of Visible Light Absorption by Aerosols	Particle light absorption coefficient	Reference publication for data processing and corrections for cross-sensitivity to particle scattering for the Radiance Research Particle Soot Absorption Photometer (PSAP). The information in this article needs to be used together with the update given in the article below.	Single-angle_Correction=Bond1999	ACTRIS, EMEP, GAW
Multi-angle absorption photometry—a new method for the measurement of aerosol light absorption and atmospheric black carbon	Particle light absorption coefficient	Reference publication for data processing and quality assurance for the Thermo 5012 Multi-Angle Absorption Photometer (MAAP), including instructions on how to convert the equivalent black carbon concentration reported by the instrument to the property act	Multi-angle_Correction=Petzold2004	ACTRIS, EMEP, GAW
Comment on "Calibration and Intercomparison of Filter-Based Measurements of Visible Light Absorption by Aerosols"	Particle light absorption coefficient	Comment on the above reference publication for the Radiance Research Particle Soot Absorption Photometer (PSAP). The article includes an important update to the correction for cross-sensitivity to particle scattering. This article is to be used together with Bond et al. 1999.	Single-angle_Correction=Bond1999_Ogren2010	ACTRIS, EMEP, GAW
		Results from 2 intercomparison workshops on instruments		

Training courses and assistance

- CCC assists with technical help, inter-comparison exercises, support letters etc
- Training courses arranged regularly.



Note, upcoming hands on course in WMO/GAW: https://www.gawtec.de

Application: 1 june

Summary

- A new monitoring strategy for 2020-2029 to be accepted this year
- Data from EMEP is extensively used
- Improvements needed
  - Spatial coverage (EECCA specifically)
  - In the species measured
- Continuous focus on data quality
  - Inter-comparisons
  - Training courses
  - Reference laboratories
- Data reporting improvements
  - Tools and templates to assist reporting
  - Traceability
  - Extended metadata information

NILU

Thank you for the attention!

Contact info:
Wenche Aas: waa@nilu.no