

European Network on New Sensing Technologies for Air Pollution  
Control and Environmental Sustainability - *EuNetAir*  
COST Action TD1105

**INTERNATIONAL WG1-WG4 MEETING on**

***New Sensing Technologies and Methods for Air-Pollution Monitoring***

**European Environment Agency - EEA**

**Copenhagen, Denmark, 3 - 4 October 2013**

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 2: 2013-2014 (*Ongoing Action*)

**Interactions with the EMEP monitoring programme**

**NILU / EMEP-CCC**



**Wenche Aas**

Function in the Action: Invited Expert

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# Outline

- UNECE LTRAP Convention and the EMEP protocol
- EMEP monitoring strategy
- Development of the programme
  1. links with EU (and other) **research** and **infrastructure** projects
  2. Secure high and known quality **QA/QC**

# Frameworks that set the monitoring agenda in Europe

- European local and regional air quality

EU's air quality directive, 2008:

<http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF>



- European regional air quality with links to local and global issues. UN ECE: LTRAP EMEP

EMEP Monitoring Strategy for 2010-2019:

<http://www.unece.org/env/documents/2009/EB/ge1/ece.eb.air.ge.1.2009.15.e.pdf>



- Global atmosphere. WMO/GAW

WMO/GAW strategic plan, 2008-2015:

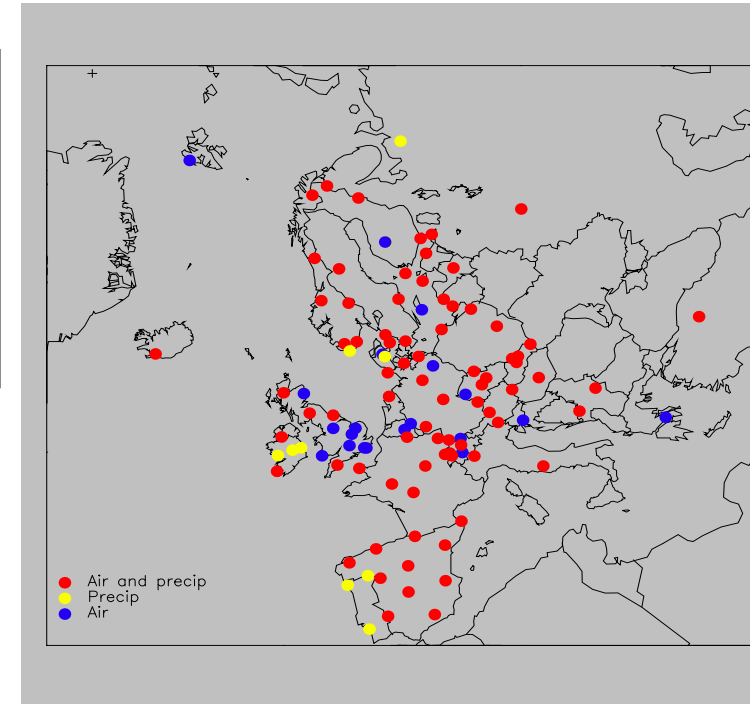
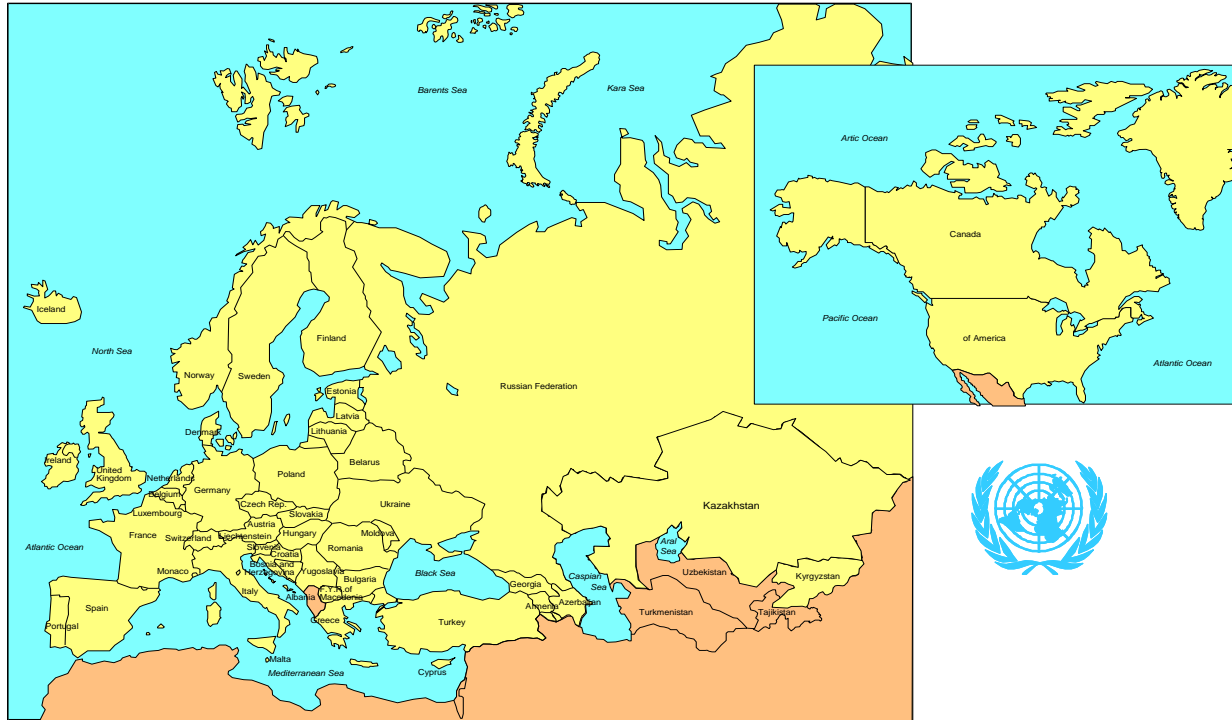
<ftp://ftp.wmo.int/Documents/PublicWeb/arep/gaw/gaw172-26sept07.pdf>



# UN-ECE Convention on Long-Range Transboundary Air Pollution (51 Parties)

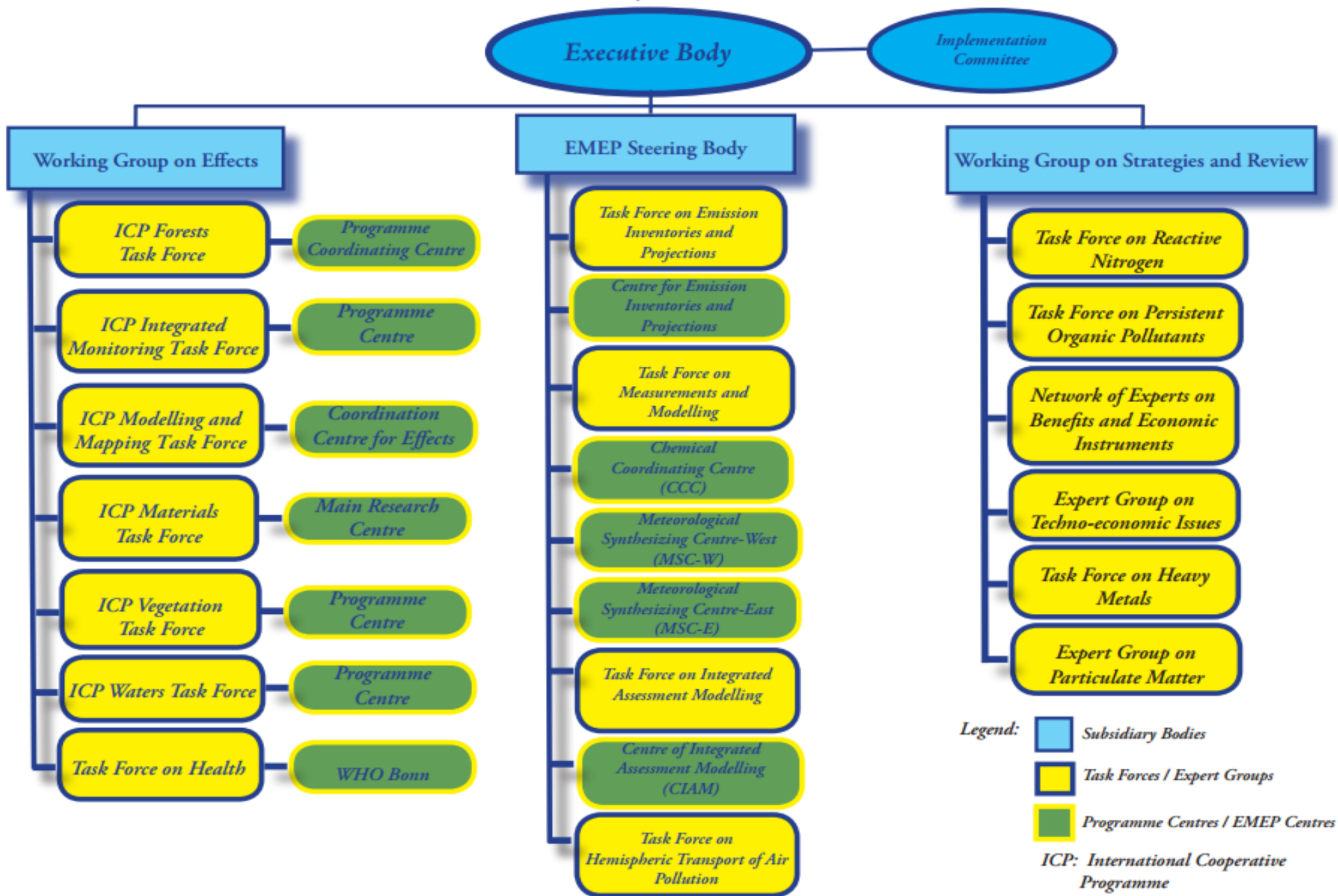
- 8 Specific protocols, where the first is

## European Monitoring and Evaluation Programme (EMEP) (42 Parties)



*The EMEP vision;  
To be the main science based and policy-driven instrument for international cooperation in atmospheric monitoring and modelling activities, emission inventories and projections, and integrated assessment to help solve transboundary air pollution problems in Europe*

# INTERGOVERNMENTAL BODIES, EXPERT GROUPS AND SCIENTIFIC CENTRES

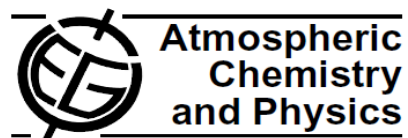


# Tasks of the EMEP CCC

- **Develop and coordinate the observation activities** required to assess air pollution across the EMEP geographical domain
- **Secure and improve quality** and representativeness of observations
- Quality assurance and quality control of data submitted by Parties
- **Archival and dissemination** of observation data and associated meta-data.
- **Assessment** of data and provide information to stakeholders about results from monitoring activities
- Serve the **interest of EMEP monitoring activities** with respect to relevant activities under other frameworks to ensure harmonization, efficient use of resources and multiple usage of data.

# Historical development

Atmos. Chem. Phys., 12, 5447–5481, 2012  
 www.atmos-chem-phys.net/12/5447/2012/  
 doi:10.5194/acp-12-5447-2012  
 © Author(s) 2012. CC Attribution 3.0 License.



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

K. Tørseth, 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

<http://www.atmos-chem-phys.net/12/5447/2012/acp-12-5447-2012.html>

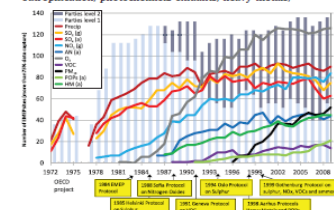


### Observed atmospheric composition change during 1972–2009 [www.emep.int](http://www.emep.int)

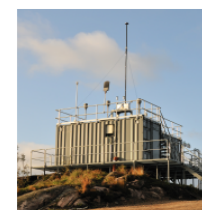
The main objective of the European Monitoring and Evaluation Programme (EMEP) is to provide governments with information on the deposition and concentration of air pollutants, as well as the quantity and significance of the long-range transmission of air pollutants across boundaries.

A network of stations undertakes observations of chemical and physical variables linked to damage to human health and the environment, in particular acidification, eutrophication, photochemical oxidants, heavy metals,

persistent organic pollutants and particulate matter. The information provided by EMEP is also fundamental for improving the knowledge of climate change and to assess rural and urban air quality. Supplemented with emission inventories, modelling of atmospheric chemistry and deposition, and integrated assessment modelling, the work of EMEP forms the basis for legally binding emission reduction protocols under the UNECE Convention on Long-range Transboundary Air Pollution ([www.unece.org/em/rtap](http://www.unece.org/em/rtap)).



Development of the measurement programmes. Bars represent the number of parties/submitting data according to the level-1 and level-2 monitoring requirements, respectively. Lines indicate the number of sites for which measurements of the various variables have been measured (g) = gaseous, (a) = aerosol, AN = NH<sub>3</sub>, NH<sub>4</sub>, and/or HNO<sub>3</sub>, NO<sub>x</sub>.



The Birkesnes Observatory is located in southern Norway.

#### History

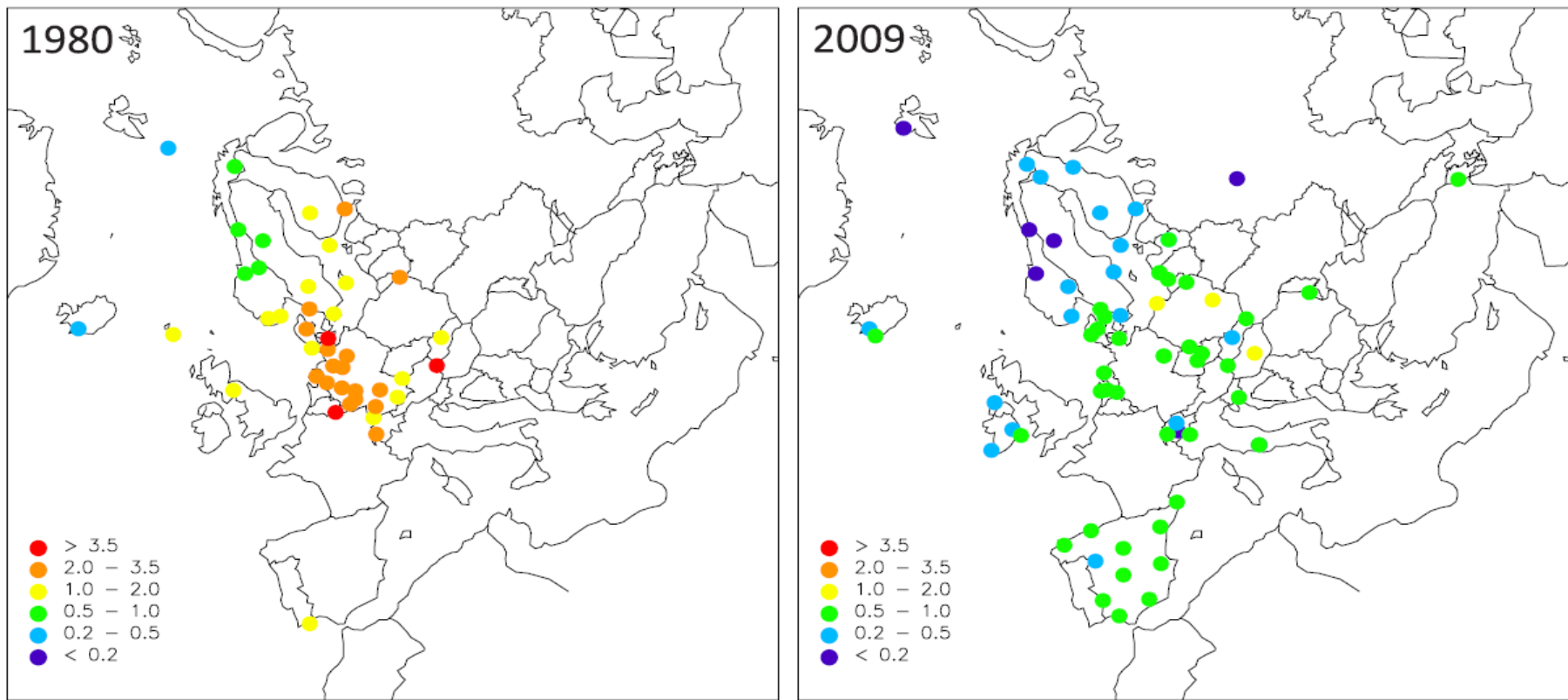
European harmonized monitoring of atmospheric composition was initiated in the early 1970s, when a project had been funded by the Organisation for Economic Co-operation and Development (OECD) to study long range transport of air pollutants. Political consensus was reached on the need for an international coordinated action and this subsequently led to the establishment of the Convention on Long Range Transboundary Air Pollution (CLRTAP) in 1979. The network of monitoring sites established for the OECD project was later continued under the European Monitoring and Evaluation Programme (EMEP), and the program was extended to

include a wide range of substances which are subject to atmospheric transport across national boundaries. Since the measurements need to be made in a comparable way at all sites and consistent in time to allow the assessment of temporal and spatial trends, the Chemical Coordinating Centre EMEP (EMEP-CCC) was established in 1977 to harmonize these efforts. The measurements are widely used by the scientific community, and have served as a basis for an extensive number of scientific studies during nearly 40 years.

[http://www.nilu.no/projects/ccc/emep\\_monitoring/EMEP-booklet\\_final.pdf](http://www.nilu.no/projects/ccc/emep_monitoring/EMEP-booklet_final.pdf)

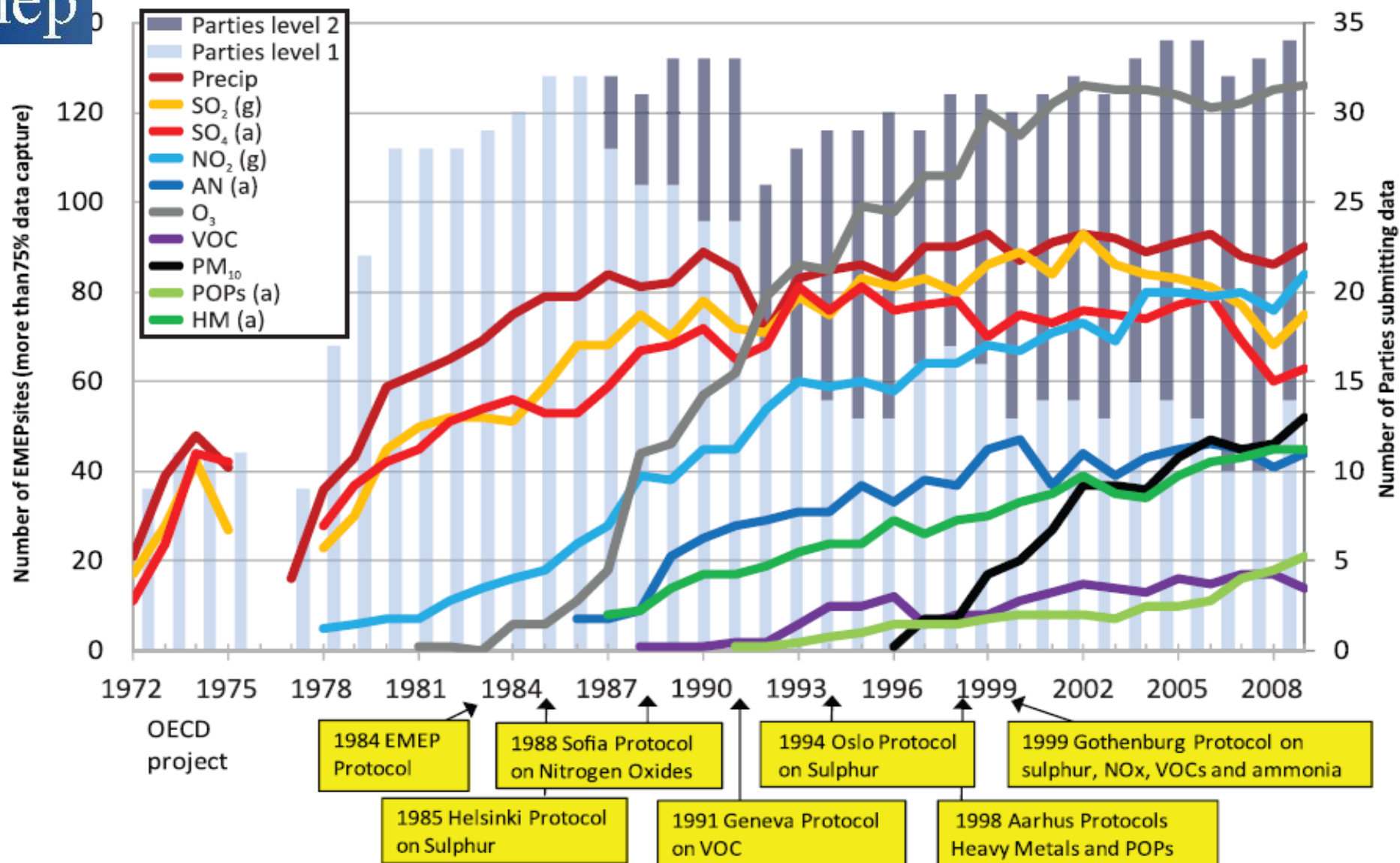
# One example of trends: Sulphur

Results from the EMEP monitoring show 70-90% reductions in ambient concentrations and deposition of sulphur species since 1980. Despite these significant reductions, sulphate still remains one of the single most important compounds contributing to regional scale aerosol mass concentration.



*Annual mean concentrations of  $SO_4^{2-}$  in aerosols in 1980 and 2009.  
Unit:  $\mu g S m^{-3}$ .*





*Development of the measurement programme. Bars represent the number of parties/countries submitting data according to the level-1 and level-2 monitoring requirements, respectively. Lines indicate the number of sites for which measurements of the various variables have been measured (g) = gaseous, (a) = aerosol, AN = NH<sub>3</sub>+NH<sub>4</sub><sup>+</sup> and/or HNO<sub>3</sub>+NO<sub>3</sub><sup>-</sup>.*

# EMEP Monitoring programme:

## Level 1

- Main ions in precipitation and in air
- heavy metals in precipitations
- ozone
- gas particle nitrogen ratios (low cost)
- $PM_{10}$  and  $PM_{2.5}$  mass
- meteorology

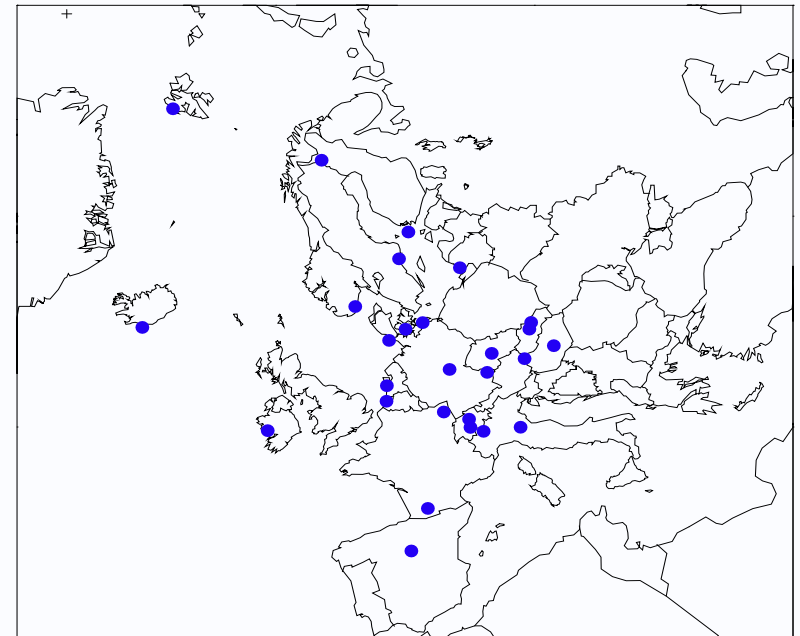
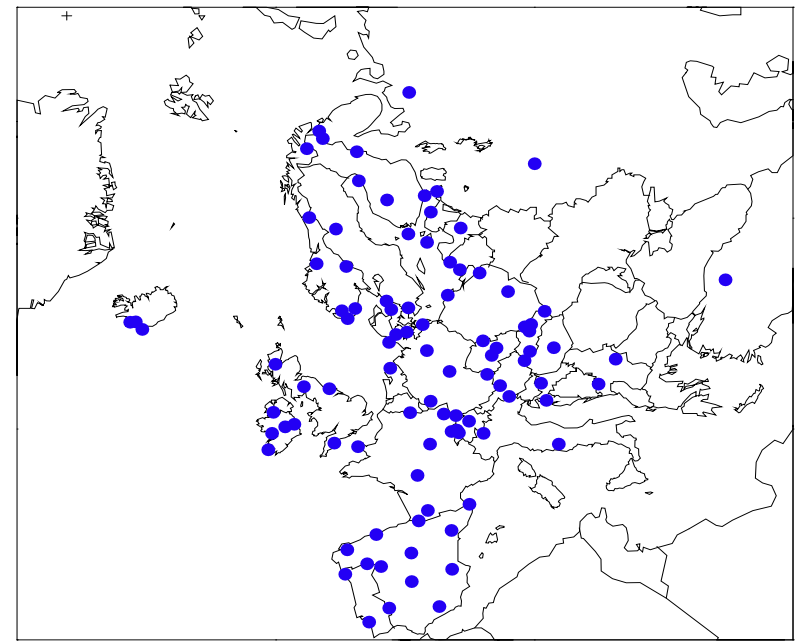
at ca 125 sites

## Level 2, supersite (joint EMEP/GAW)

- PM composition (EC/OC, mineral dust)
  - Aerosol physical and optical properties
  - $CH_4$
  - Tracers (CO and halocarbons)
  - POPs
  - Heavy metals in air and aerosols
  - VOC
- + all level 1 activities

20-30 sites

Both levels are mandatory



## EMEP level 3

- Research based and voluntary monitoring
- Includes campaign data
- Contribute to understand atmospheric processes and transport of air pollutants
- E.g: flux measurements, NO<sub>y</sub>, vertical profiles, isotopes, H<sub>2</sub>, Hg speciation WSOC etc etc

# Development at different levels

## Observational

- infrastructure incl. new method
- number of species monitored
- number of (super) sites
- database
- monitoring / research

## Quality (QA/QC)

- reference methods
- Intercalibrations
- Metadata info.
- Harmonization between networks

## Integration and cross disciplinary

- topics: health, ecosystem, climate
- scales: local, regional, global
- Policy and research

<b>Framework [48]</b> EMEP_NRT EMEP_preliminary EUCAARI EUSAAR EUSAAR_NRT EUSAAR_preliminary GAW-WDCA	<b>Country [72]</b> >>All Argentina Armenia Australia Austria Belarus Belgium	<b>Station [1068]</b> >>All Abastumani Abbeville Abington (CT15) Abisko Acadia National Park-McFarland Hill Achenkirch	<b>Matrix [24]</b> >>All aerosol air air+aerosol air+pm10 instrument met
<b>Instrument type [95]</b> >>All abs_solution abs_tube ads_tube aerosol_sampler aethalometer air_UK	<b>Component [713]</b> >>All 1-2-3-trimethylbenzene 1-2-4-trimethylbenzene 1-3-5-trimethylbenzene 1-3-butadiene 1-3-butadiene_statistics 1-butene	From >>All To >>All	

Available datasets: 59737  
[Reset](#) [List datasets](#)

**Map (Populate) (Show large)**



**Additional resources**

- Air mass trajectories
- Measurement network (EMEP)
- Measurement network (GAW)
- Data submission
- EMEP/CCC reports
- Quality assurance
- EMEP manual
- EMEP laboratory intercomparisons
- TFMM
- HTAP
- Measurement programme/strategy (pdf)
- Contact persons

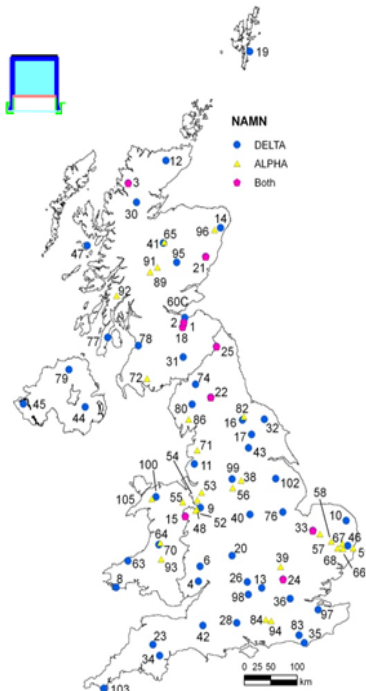
# Supporting measurements

- Low cost methods (i.e passive samplers)
  - ✓ High spatial distribution
- Satellite data
  - ✓ Filling geographical gaps where there is no/few measurements and vertical profiles
- New instruments/methods
  - ✓ High time resolution and “new” compounds
  - ✓ Study atmospheric processes and sources

# Low cost methods for better spatial coverage

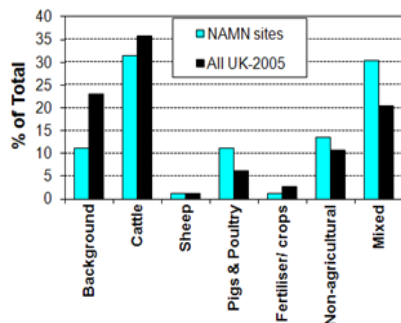
- Valuable for model evaluation, identifying source areas and representativity studies

## National ammonia monitoring network NAMN



Sites selected such that:

- No proximity to large scale sources
- Higher density of sites in regions where ammonia is of interest, e.g. East Anglia
- 29 sites are on NNR/LNRs or research sites
- 11 on ECN sites
- 11 on AURN sites
- 2 urban sites



## Acid gases and Aerosol Network (AGA-Net)



Sites selected such that:

- Co-located with NAMN sites
- Sufficient coverage across UK to allow kriging of data
- 2 urban sites

DH2

DA1

DH1

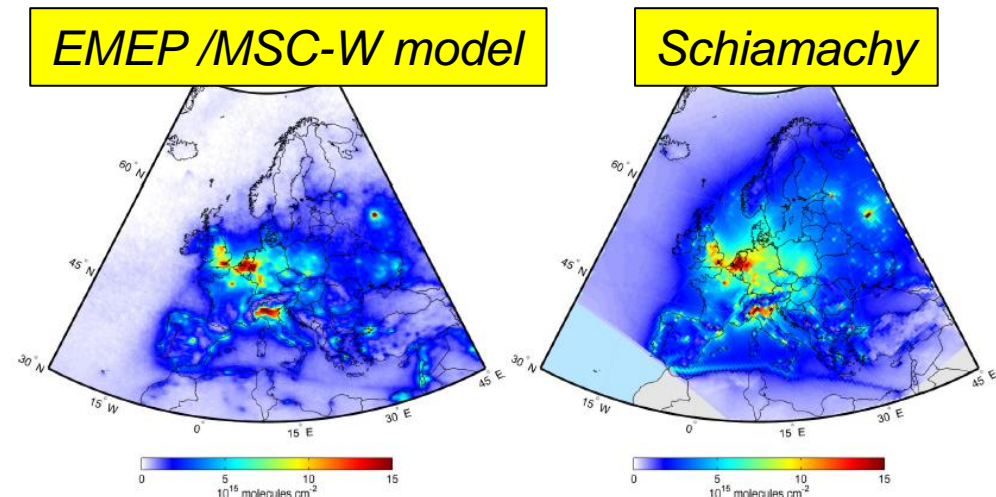
DA2

1. Basic filter  
NO<sub>3</sub>, NO<sub>2</sub>, SO<sub>4</sub>, Cl, Na, Ca, Mg
2. Acid filter  
NH<sub>4</sub>



# Satellite products

- Hence Thilo Erbertseder talk yesterday (Pasodoble, MyAir)
- Complimentary measurements to in situ observations
  - –fill in gaps (spatial and vertical)
  - Model evaluation/development
  - (chemical) forecast /data assimilation
- More advance sensors and retrievals will give new products
- Geostationary satellites







# Research activities as part of the monitoring programme

- **The importance of (EMEP + GAW) supersites**
  - Concept developed through EMEP+GAW meetings, Eurotrac (2), ACCENT...
  - EMEP Task Force on Measurements and Modeling (TFMM)
  - GAW Scientific Advisory Groups (Aerosols, Reactive Gases, Greenhouse gases, precipitation ...)
- **Individual institutions and research groups** wanting to do measurements
- **Research Infrastructures**
  - National funding opportunities
  - EU Infrastructures: CREATE, EUSAAR, EARLINET, ACTRIS, InGOS...
  - EMEP intensive measurement periods

# EMEP intensive measurement periods

To assist the implementation of the monitoring strategy, TFMM has recommended conducting co-ordinated intensive measurements between the Level-2 sites. Furthermore, cooperation and involvement of research groups with more advanced research activities (i.e level 3) has been encouraged

## 1 st Period

- ❖ 1 - 30 of June 2006
- ❖ 8 Jan -4 Feb 2007

## 2nd Period

- ❖ 17 Sep - 16 Oct 2008
- ❖ 25 Feb - 26 Mar 2009

## 3rd Period

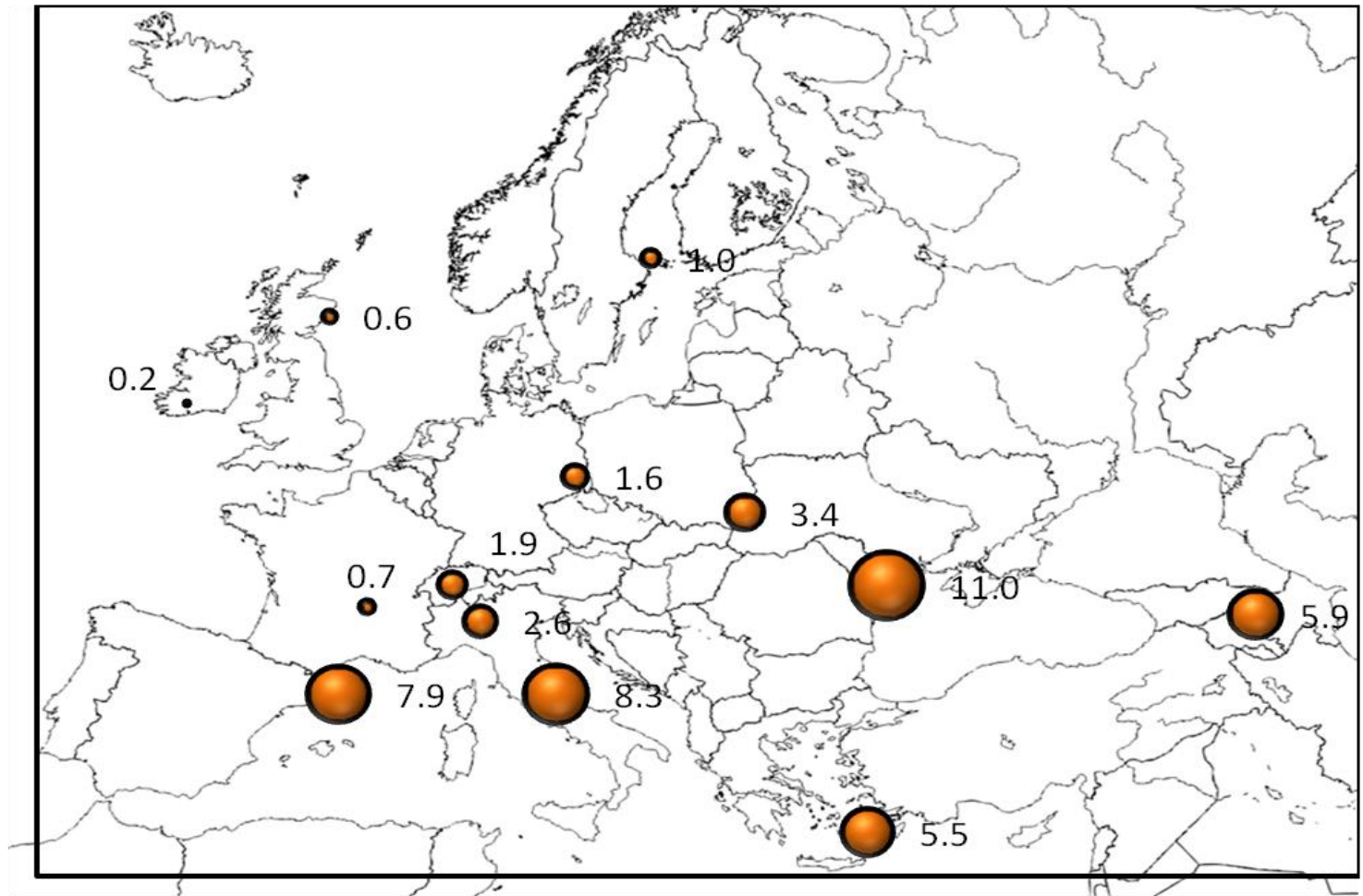
- ❖ 8 to July 17 2012
- ❖ 11 jan - 8 Febr 2013



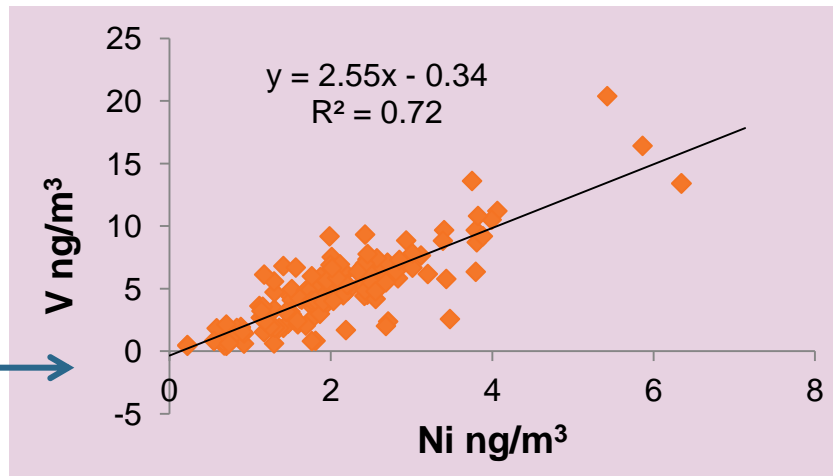
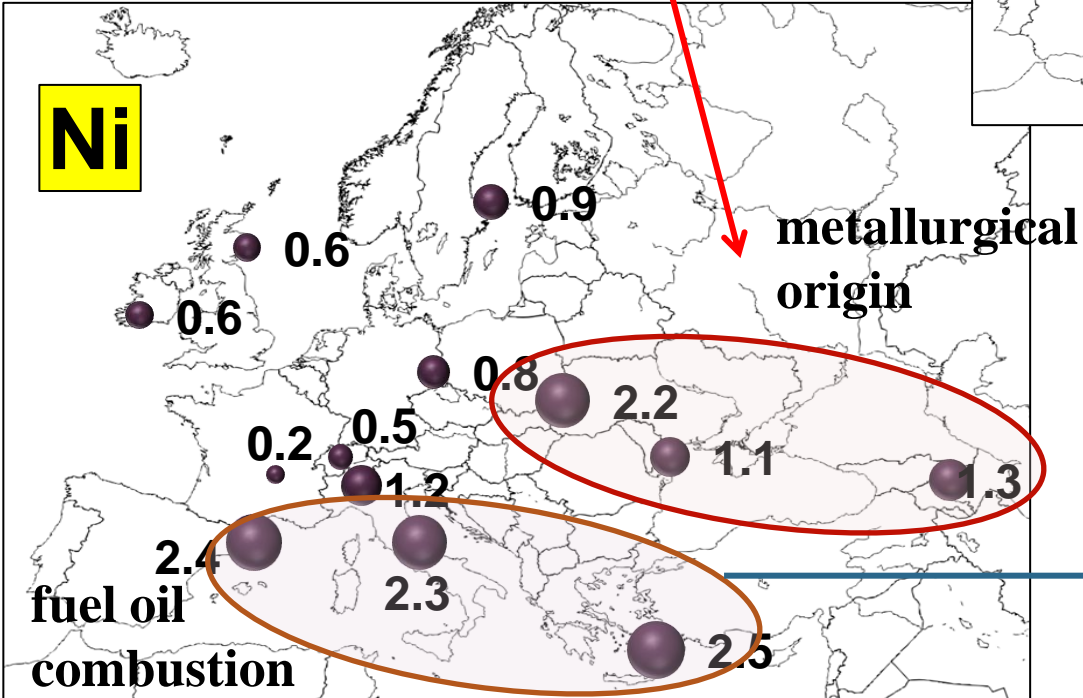
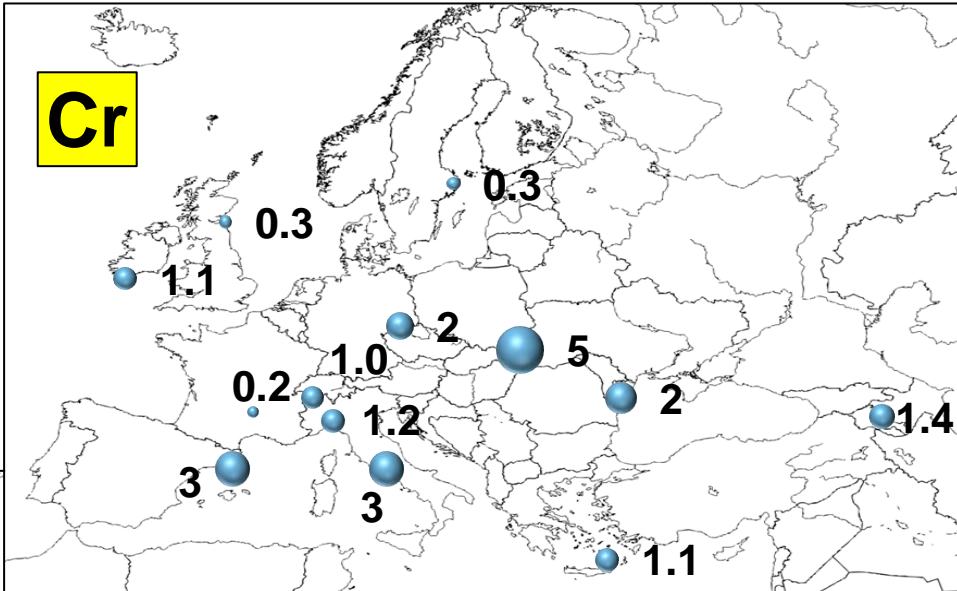
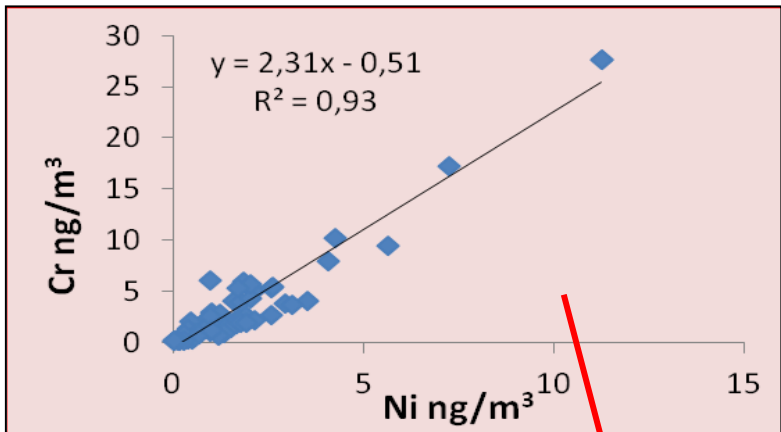
Parties	Station	Online chemistry	VOC	Org. tracers	Mineral dust
Armenia	AM0001 Amberd				X
Switzerland	CH0001 Jungfrauioch	(TOF) ACSM	GCMS		
Switzerland	CH0002 Paverne	HR-TOF AMS			X
Czech Rep	CZ0003 Kosetice	ACSM (winter)	X		
Germany	DE0044 Meloitz	ACSM: Marga			X
Germany	DE0043 Hohenpeisenberg	ACSM	GCMS/GCFID		
Spain	ES1778 Montseny	ACSM			X
Spain	Palma de Mallorca				ICP MS
Spain	Montsec				ICP MS
Finland	FI0050 Hvtiälä	ACSM. Marga	GCMS	X	
Finland	FI0096 Pallas	Marga	GCFID		
Finland	FI0007 Virolahti	ACSM			
France	FI0009 Revin	AMS-TOF	Various on/off	X	some
France	OPE / Andra at				some
France	Sirta	ACMS. Pils	Various on/off	X	some
France	FR0030 Puv de Dome	ACMS. Pils	Various on/off	X	X
France	Cape Corse	ACSM. Pils	Various on/off	X	
Great Britain	GB0048 Auchencorth Moss	Q-AMS. Marga	X		X
Greece	GR0002 Finokalia	ACSM			X
Ireland	IE0031 Mace Head	ACSM	GCMS		X
Italy	IT0001 Montelibretti				X
Italy (EC)	IT0004 Ispra			?	X
Italy	IT0010 San Pietro	HR-Tof-AMS		X	
Netherlands	NL0011 Cabauw	ACSM			
Norway	NO0001 Birkenes	ACSM	PTR-MS TOF	X	
Moldova	MD007 Leova				X
Sweden	SE0011 Vavihill	HR-ToF-AMS	Tenax tubes	X	
Sweden	SE0012 Asövreten				X
Slovakia	SK0006 Starina				X
<b>19</b>	<b>29</b>	<b>19</b>	<b>13</b>	<b>8</b>	<b>18</b>

**ACTRIS**

# Mineral dust (june 2012) ( $\mu\text{g}/\text{m}^3$ )



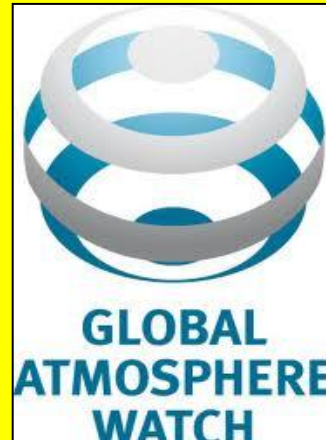
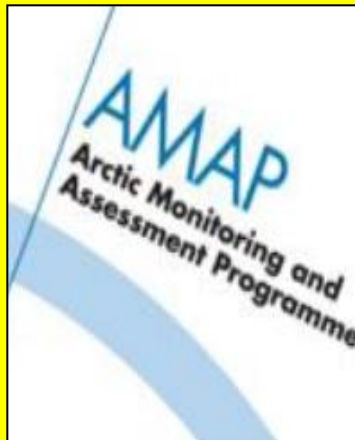
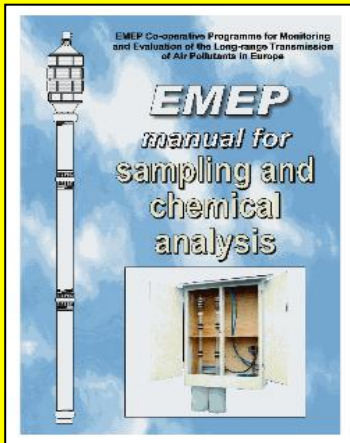
**Mineral load: obtained by the addition of the  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$  concentrations, and the dust contribution of  $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$ ,  $\text{CaO}$  and  $\text{MgO}$  after the subtraction of their marine contribution from the bulk concentrations**



# Data quality and quality control

- Essential to have **harmonized measurements** to be able to do comparison over **time** and **space**
- Standard operation procedures and reference methods developed
- Regular field and laboratory intercomparison
- Reporting guidelines, incl metadata info etc

## Monitoring frameworks:



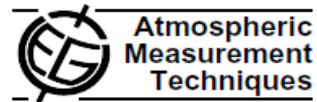
## Infrastructure projects



# Ex. of QA/QC co-operative work (1)

- EC/OC

Atmos. Meas. Tech., 3, 79–89, 2010  
 www.atmos-meas-tech.net/3/79/2010/  
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 the Creative Commons Attribution 3.0 License.



## Toward a standardised thermal-optical protocol for measuring atmospheric organic and elemental carbon: the EUSAAR protocol

F. Cavalli<sup>1</sup>, M. Viana<sup>2</sup>, K. E. Yttri<sup>3</sup>, J. Genberg<sup>4</sup>, and J.-P. Putaud<sup>1</sup>

<sup>1</sup>European Commission, Joint Research Centre, Institute for Environment and Sustainability, Climate Change Unit, via Enrico Fermi 1, 21020 Ispra, Italy

<sup>2</sup>Institute for Environmental Assessment and Water Research (IDAEA-CSIC), C/Lluís Solé i Sabaris s/n, 08028 Barcelona, Spain

<sup>3</sup>Department of Atmospheric and Climate Research Norwegian Institute for Air Research (NILU), P.O. Box 100, 2027 Kjeller, Norway

<sup>4</sup>Nuclear Physics, Department of Physics, Lund University, P.O. Box 118, 22100, Lund, Sweden

Received: 3 June 2009 – Published in Atmos. Meas. Tech. Discuss.: 1 October 2009

Revised: 8 January 2010 – Accepted: 11 January 2010 – Published: 26 January 2010

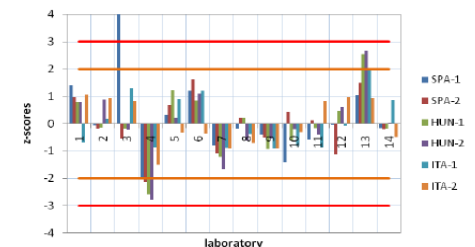


EMEP/CCC-Report 1/2013

**EMEP** Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe

## Availability and quality of the EC and OC measurements within EMEP, including results of the fourth interlaboratory comparison of analytical methods for carbonaceous particulate matter within EMEP (2011)

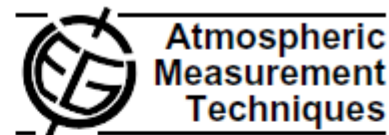
Fabrizia Cavalli, Jean-Philippe Putaud, Karl Espen Yttri



# Ex. of QA/QC co-operative work (2)

- PM size distribution (SMPS/DMPS)

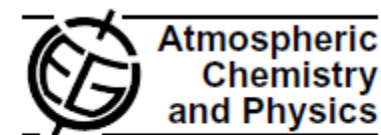
Atmos. Meas. Tech., 5, 657–685, 2012  
[www.atmos-meas-tech.net/5/657/2012/](http://www.atmos-meas-tech.net/5/657/2012/)  
 doi:10.5194/amt-5-657-2012  
 © Author(s) 2012. CC Attribution 3.0 License.



**Mobility particle size standards and data structure observations of atmospheric particles**

A. Wiedensohler<sup>1</sup>, W. Birmili<sup>1</sup>, A. Nowak<sup>2</sup>, M. Fiebig<sup>2</sup>, A. M. Fjåraa<sup>2</sup>, E. Asmi<sup>3</sup>, K. S. E. Swietlicki<sup>8</sup>, P. Williams<sup>9</sup>, P. Roldin<sup>8</sup>, P. E. Weingartner<sup>12</sup>, F. Riccobono<sup>12</sup>, S. Sanjeewa<sup>10</sup>, C. Monahan<sup>15</sup>, S. G. Jennings<sup>15</sup>, C. D. O'Donoghue<sup>16</sup>, P. H. McMurry<sup>19</sup>, Z. Deng<sup>20</sup>, C. S. Zhao<sup>21</sup>, S. Bastian<sup>22</sup>

Atmos. Chem. Phys., 11, 5505–5538, 2011  
[www.atmos-chem-phys.net/11/5505/2011/](http://www.atmos-chem-phys.net/11/5505/2011/)  
 doi:10.5194/acp-11-5505-2011  
 © Author(s) 2011. CC Attribution 3.0 License.



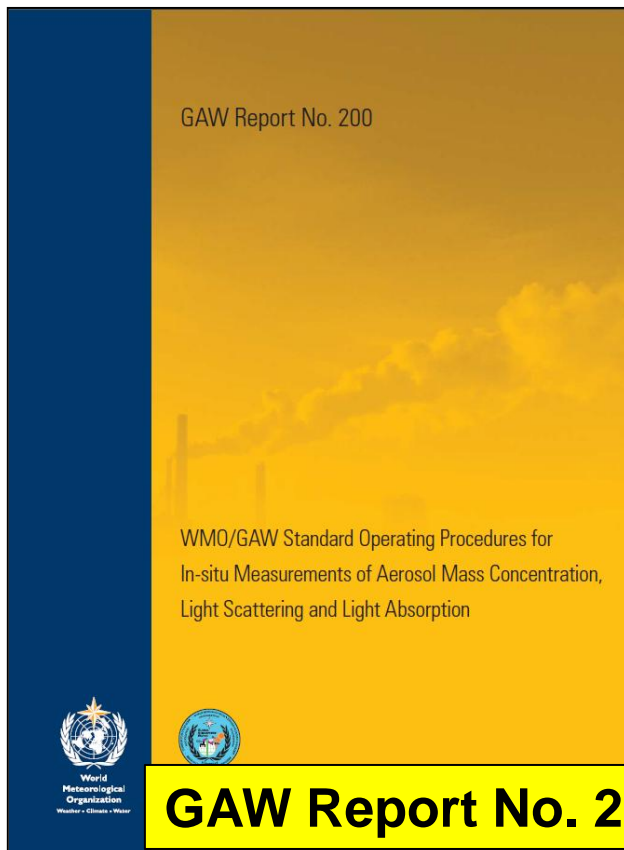
**Number size distributions and seasonality of submicron particles in Europe 2008–2009**

A. Asmi<sup>1</sup>, A. Wiedensohler<sup>2</sup>, P. Laj<sup>3</sup>, A.-M. Fjåraa<sup>4</sup>, K. Sellegri<sup>5</sup>, W. Birmili<sup>2</sup>, E. Weingartner<sup>6</sup>, U. Baltensperger<sup>6</sup>, V. Zdimal<sup>7</sup>, N. Zikova<sup>7</sup>, J.-P. Putaud<sup>8</sup>, A. Marinoni<sup>9</sup>, P. Tunved<sup>10</sup>, H.-C. Hansson<sup>10</sup>, M. Fiebig<sup>4</sup>, N. Kivekäs<sup>11</sup>, H. Lihavainen<sup>11</sup>, E. Asmi<sup>11</sup>, V. Ulevicius<sup>12</sup>, P. P. Aalto<sup>1</sup>, E. Swietlicki<sup>13</sup>, A. Kristensson<sup>13</sup>, N. Mihalopoulos<sup>14</sup>, N. Kalivitis<sup>14</sup>, I. Kalapov<sup>15</sup>, G. Kiss<sup>16</sup>, G. de Leeuw<sup>11,17</sup>, B. Henzing<sup>17</sup>, R. M. Harrison<sup>18</sup>, D. Beddows<sup>18</sup>, C. O'Dowd<sup>19</sup>, S. G. Jennings<sup>19</sup>, H. Flentje<sup>20</sup>, K. Weinhold<sup>2</sup>, F. Meinhardt<sup>21</sup>, L. Ries<sup>21</sup>, and M. Kulmala<sup>1</sup>



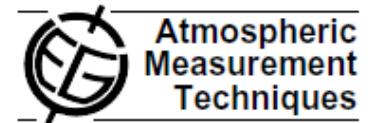
# Ex. of QA/QC co-operative work (3)

- Aerosol light scattering and absorption



**GAW Report No. 200, 2011**

Atmos. Meas. Tech., 4, 245–268, 2011  
www.atmos-meas-tech.net/4/245/2011/  
doi:10.5194/amt-4-245-2011  
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## Characterization and intercomparison of aerosol absorption photometers: result of two intercomparison workshops

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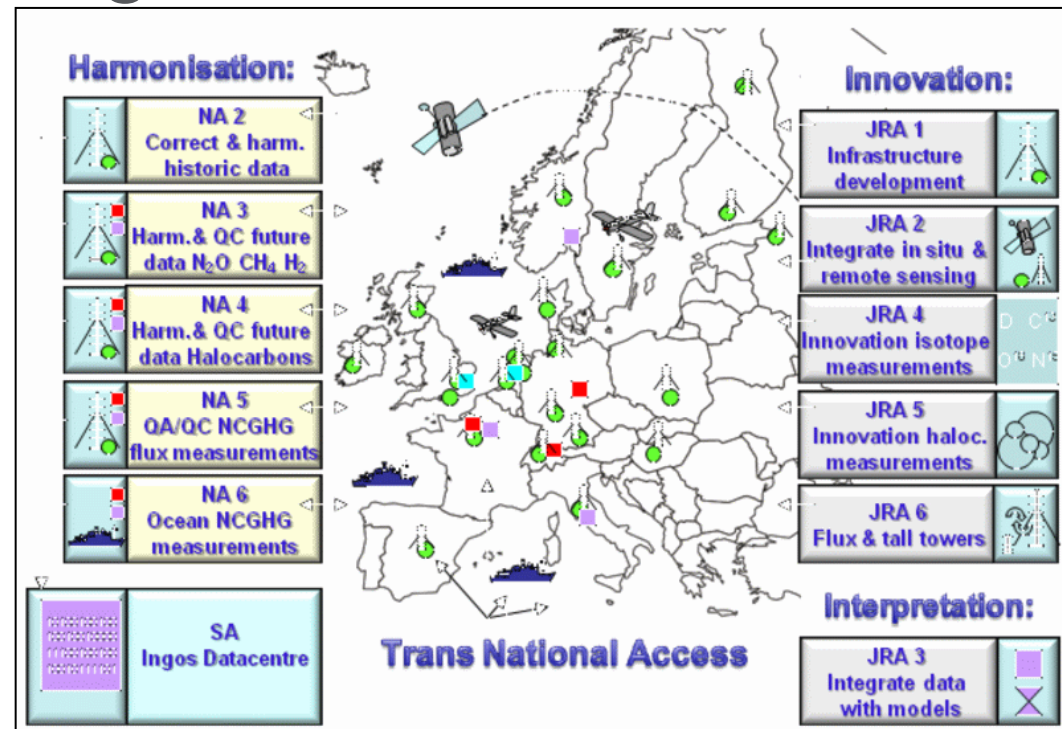


# Ex. of QA/QC co-operative work (4)

- standardizing measurements of non CO<sub>2</sub> greenhouse gases




<http://www.ingos-Infrastructure.eu>



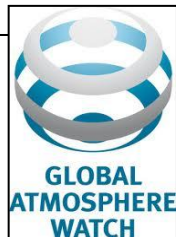
# Not always same reference methodology, ex NO<sub>x</sub>

- Urban (EU AQD): Chemiluminescence –Mo converter
- Rural: NaI abs.(manual), or monitors with photolytic converter or cavity ring down) –selective method for NO<sub>2</sub>



Deliverable WP4 / D4.2  
(M12)  
Version: 2012/04/02

WP4- NA4: Trace gases networking: Volatile organic carbon and nitrogen oxides  
Deliverable D4.2: **Draft** for standardized operating procedures (SOPs) for NO<sub>x</sub> measurements



**Key message:**

**The method of choice needs to be fit for purpose**

# CONCLUSIONS

- **Comprehensive, state-of-the-art monitoring** at rural sites, integrating ALL variables relevant to assess atmospheric composition change, atmospheric processing and effects is fundamental for EMEP.
  - **Long term** measurements with **known quality**
  - **Comparability** over time and space is essential (SOPs, manuals, QA/QC etc)
- **Research and monitoring** closely linked
  - EMEP benefits from the scientific development and development of reference methods and reporting from infrastructure projects
  - Research projects benefits from infrastructure and added value of the data (increased visibility). Partnership is often a prerequisite to get funding from the Commission
- **Intensive measurement periods** have proven to be valuable
  - Next campaign aims for 2016. Topic not decided. Depend on research need
  - One relevant topics is to get better spatial and temporal coverage of VOC. Maybe something which could be relevant for this community?