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Convention on Long-range Transboundary Air Pollution

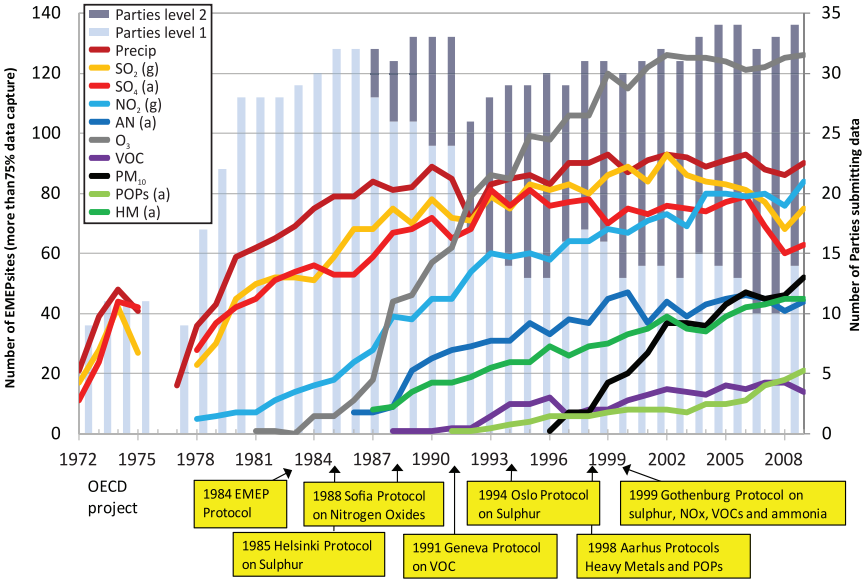
emep Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe

Observed atmospheric composition change during 1972-2009

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 form the basis for legally binding emission reduction protocols under the UNECE Convention on Long-range Transboundary Air Pollution (*www.unece.org/env/lrtap*).



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_3+NH_4^+ and/or HNO_3+NO_3^-.

The Birkenes 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.

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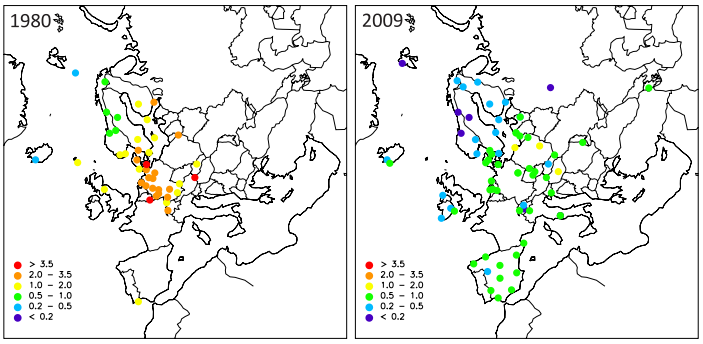
Sulphur

Results from the EMEP monitoring show 70-90% reductions in ambient concentrations and deposition of sulphur species since 1980, which correspond well with reported emission changes. Despite these significant reductions, sulphate still remains one of the single most important compounds contributing to regional scale aerosol mass concentration. As a result of the large reductions in sulphur concentrations, the acidity of precipitation has decreased across Europe.



Annual mean concentrations of SO_4^{2-} in aerosols in 1980 and 2009. Unit: µg S m^{-3}.

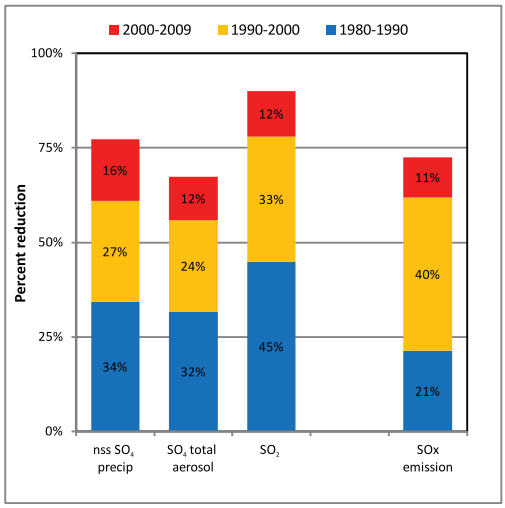
Nitrogen

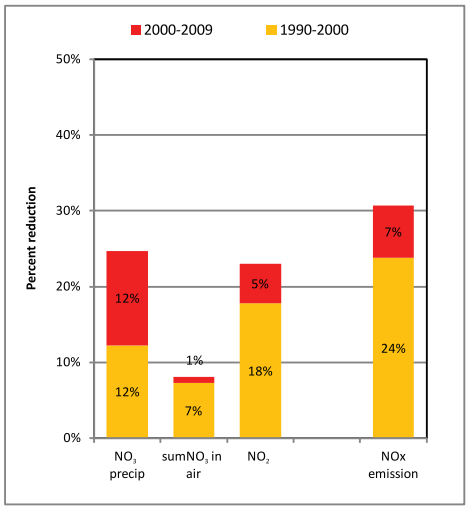
Also reduction in emissions of nitrogen oxides (NO_X) are reflected in the measurements, with an average decrease of nitrogen dioxide in air and nitrate in precipitation by about 23% and 25% respectively since 1990. Only minor reductions are however seen since the late 1990s. The concentration of total nitrate in air have decreased on average only by 8% since 1990, and few sites show a significant trend. A majority of the EMEP sites show a decreasing trend in reduced nitrogen both in air and precipitation on the order of 25% since 1990.

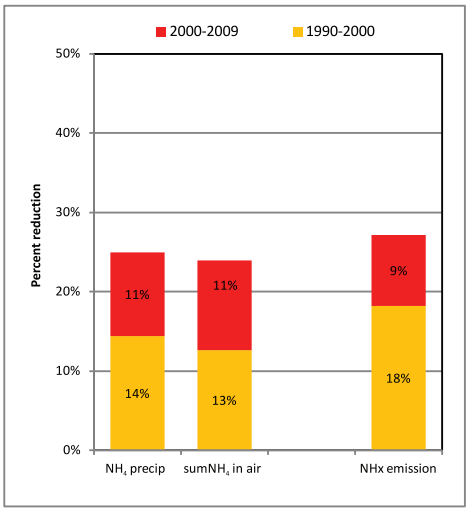
Particulate matter

Measurements of particulate matter mass concentrations are generally only available after the year 2000. Large inter annual variations in the particulate matter

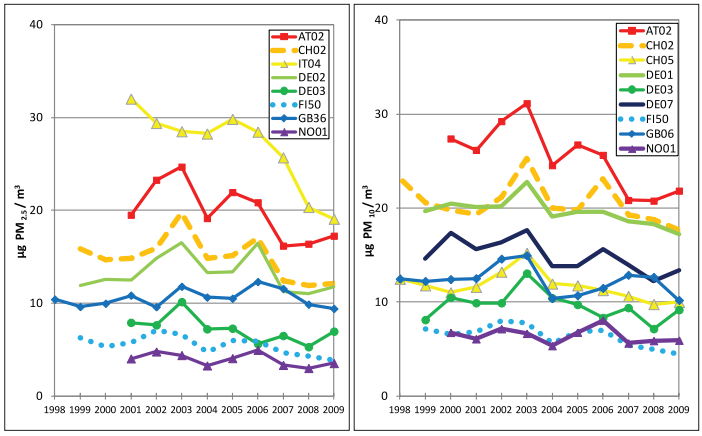
An essential part of the activity is high quality analysis of air and precipitation samples in chemical laboratories in participating countries.







Average observed reduction in sulphur and nitrogen components compared to the emission reductions in Europe for the different ten year periods from 1980 for sulphur and 1990 for nitrogen.

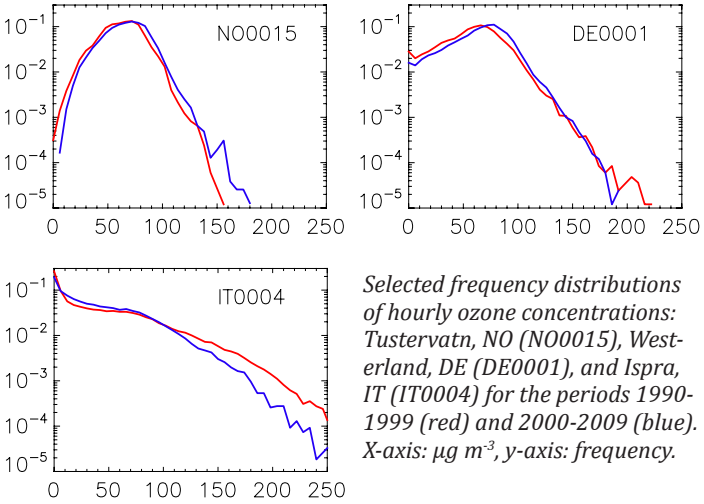


Time series of $PM_{2.5}$ (left) and PM_{10} (right) at selected EMEP sites.

(PM) mass concentrations reflect meteorological variability, but still there is a relatively clear overall decrease at several sites during the last decade. Based on observed chemical composition data extending back to the 1970s, results indicate an overall reduction of about 5 µg m^{-3} from sulphate alone.

Tropospheric ozone

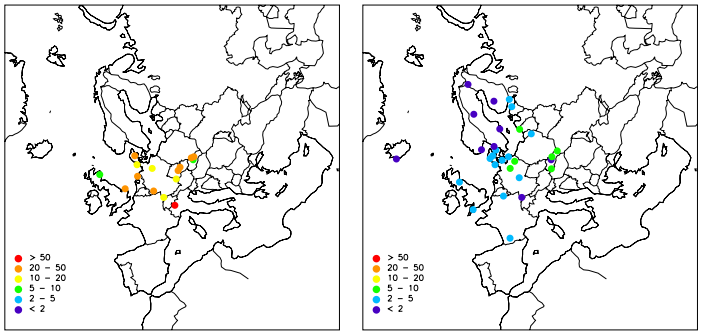
Long-term ozone trends at EMEP sites show a mixed pattern. The year-to-year variability in ozone due to varying meteorological conditions is substantial, making it hard to separate the trends caused by emission change from other effects. Several sites show no significant trends. For the Nordic countries the data indicate a reduced occurrence of very low concentrations. The most pronounced change in the frequency distribution is seen at sites in the UK and the Netherlands, showing a reduction in the higher values.



Selected frequency distributions of hourly ozone concentrations: Tustervatn, NO (NO0015), Westerland, DE (DE0001), and Ispra, IT (IT0004) for the periods 1990-1999 (red) and 2000-2009 (blue). X-axis: µg m^{-3}, y-axis: frequency.

Heavy metals

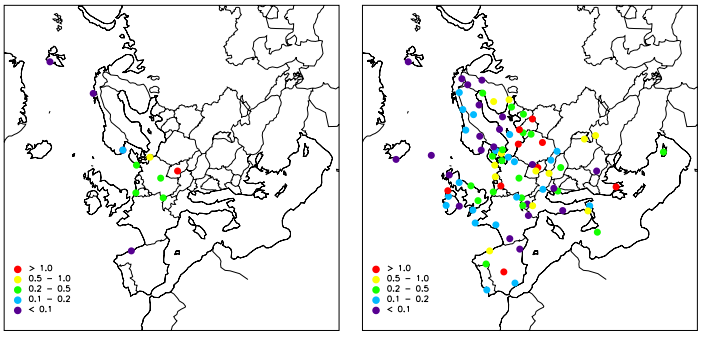
The reductions in heavy metal emissions within Europe have been extensive, and the observation data clearly reflect these changes. Concentrations of lead (Pb) and cadmium (Cd) have decreased in both air and precipitation during the last 20 years, with reductions in the order of 80-90 % for Pb and 64-84% for Cd (precipitation and air, respectively). The measurements of total gaseous mercury indicate a dramatic decrease in concentrations during 1980 to about 1993.



Average concentrations of Pb in aerosols in 1990 and 2009 (unit ng Pb m^{-3}).

Persistent Organic Pollutants

The trends in hexachlorocyclohexanes (HCHs) show a significant decrease in annual average air concentrations. For other persistent organic pollutants (POPs) the trends are more mixed.



Left: Annual mean concentration of pyrene as an example of POPs in air at EMEP stations in 2009. Right: 3-months mean of pyrene measured by passive air samplers at European background stations in 2006. Unit: ng m^{-3}.

Outlook

The uncertainties in our current knowledge of the atmospheric composition changes are still large and a strengthening of this area will yield improved climate, health and ecosystem research results and better guidance for environmental policy. Measurements are still required to assess atmospheric pollution in general and the effect of abatement measures in particular.

There are still challenges across the EMEP domain in maintaining and developing the monitoring activities. A particular concern is the fact that some countries are reducing their monitoring activities.

Climate Change

The monitoring activities originally developed to address acid rain have evolved to comprise a comprehensive and broad programme relevant for assessing air pollution impacts on ecosystems, human health, materials and climate. Of particular importance are EMEPs activities on aerosols and ozone (including ozone precursors) which are of growing interest due to their importance as short-lived climate forcers. Inorganic substances and carbonaceous aerosols (organic carbon and elemental/black carbon) lead to scattering and absorption of radiation, and affect climate indirectly through increased cloud formation and extended life time of clouds. Particulate matter and surface ozone are also causing adverse air quality across Europe. Nitrogen remains a major challenge, and the links between the nitrogen and carbon cycles call for a continued effort in monitoring the exchange between the atmosphere and ecosystems. Mercury and POPs are addressed also by other global conventions but the monitoring program of EMEP is of key importance for the collection of comparable monitoring data within Europe as well as globally.

For more information about EMEP, please visit www.emep.int

EMEP centers

- Meteorological Synthesizing Center – West: www.emep.int/mscw/index_mscw.html
- Meteorological Synthesizing Center – East: www.msceast.org/
- Center for Emission Inventories and Projections: www.ceip.at/
- Center for Integrated Assessment Modeling: webarchive.iiasa.ac.at/rains/ciam.html
- Chemical Coordinating Centre: www.nilu.no/projects/ccc

EMEP Task Forces

- Emission Inventories and Projections: www.tfeip-secretariat.org/
- Measurements and Modeling: www.nilu.no/projects/ccc/tfmm/index.html
- Integrated Assessment Modeling: www.unece.org/env/lrtap/taskforce/tfiam/welcome.html
- Hemispheric Transport of Air Pollution: www.htap.org

Observational network

The EMEP monitoring sites are located such that significant local influences (local emission sources, local sinks, topographic features, etc.) are minimised, with the site criteria being defined in the EMEP manual. The basic idea is that the data should be representative for a larger region. EMEP monitoring focuses on species and parameters which are important for understanding the sources and exposure/fluxes of pollutants as well as to understand atmospheric processes in general. Data for more than 600 different variables have been reported to the EMEP database at EMEP-CCC (*http://ebas.nilu.no*), and the number is continuously growing as new methodologies become available, and new environmental challenges are identified.

Involvement

EMEP has since its initiation based its work on consensus driven activities where national experts and nominated institutions have collaborated to address the transboundary aspects of air pollution. The activities have thus ranged from simple but robust monitoring to innovative and state-of-the-art observations using new technologies. This synergy of operational and scientific activities has been very successful:

Firstly, the general knowledge about air pollution has greatly increased. Secondly, the legislation has lead to economical and technological changes which in turn have reduced the emissions of pollutants. In addition, certain EMEP sites operating advanced instrumentation have documented their importance as a distributed research infrastructure and have thereby qualified for support from the European Commission and from national research councils. This links the monitoring activity to the scientific community and thereby contributes to further development of the EMEP programme.

More information is available in the following article:

Tørseth, K., Aas, W., Breivik, K., Fjæraa, A.M., Fiebig, M., Hjellbrekke, A.G., Lund Myhre, C., Solberg, S., Yttri, K.E. (2012) Introduction to the European Monitoring and Evaluation Programme (EMEP) and observed atmospheric composition change during 1972-2009. *Atmos. Chem. Phys.*, 12, 5447-5481. http://www.atmos-chem-phys.net/12/5447/2012/acp-12-5447-2012.html

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