

Elaborated outline:

“Assessment of the EMEP measurements and modelling work in Europe from 1977 until today”

The report is divided into three major parts:

- General introduction, serve as an introduction for Part 1 and Part 2.
- Part 1 The European assessment
- Part 2 The national assessments

An executive summary is to be added

2003-02-08

Gun Lövblad

Executive summary

WHAT CHANGES ARE OBSERVED IN EMISSIONS, CONCENTRATIONS AND DEPOSITION OF SULPHUR IN EUROPE DURING THE LAST 20 YEARS?

European emissions of sulphur dioxide have decreased with xx% between 1980 and 2000.

WHAT CHANGES ARE OBSERVED FOR NITROGEN DURING THE SAME PERIOD?

European emissions of nitrogen oxides have decreased with xx% between 1980 and 2000, while the emissions of ammonia have decreased xxx%

HOW ARE THE CHANGES IN CONCENTRATIONS FOR OZONE AND HOW CAN THESE BE EXPLAINED?

The peak concentrations have decreased The mean concentrations have

ARE THE CHANGES SIMILAR OVER EUROPE OR ARE THERE DIFFERENCES BETWEEN REGIONS?

The sulphur and nitrogen emissions have decreased in southern Europenorthern Europe

ARE THE CONCENTRATIONS AND DEPOSITIONS STILL EXCEEDING CRITICAL LOADS AND LEVELS?

There has been a large progress Environmental problems still exist..... Acidification.... Particle and health Ozone Ammonia from the agricultural sector, Deposition and soil leakage of nitrogen to marine areas cause eutrophication.

Large-scale pollution problems.... Ozone is a semi-hemispheric pollution problem Enrichment of heavy metals and persistent organic pollution over the Arctic area....

WHAT IS THE MAIN CAUSE FOR THE REDUCTIONS?

Pollution has declined over Europe via direct emission control measures and via structural changes of energy and industry.

HAVE THE WEATHER HAD ANY SIGNIFICANT INFLUENCE ON THE POLLUTION LOADS AND LEVELS?

The weather may have influenced the situation since the winters have mainly been milder (in northern Europe ..., maybe also in other parts of Europe) resulting in less occasions with very stable atmospheric conditions and consequently less occasions with very high concentrations....

ARE THERE ANY NON-LINEAR CHANGES BETWEEN EMISSIONS/CONCENTRATIONS/DEPOSITIONS FOR SULPHUR AND NITROGEN

The concentrations of sulphur dioxide have in large parts of Europe declined with approximately the same magnitude as the emissions of sulphur. The concentrations of sulphate particles in air and sulphate in precipitation have decreased to a less extent.

WHICH SECTORS HAVE CONTRIBUTED TO THE REDUCTION?

The energy sector have reduced their emissions

The transport sector -.....

Industrial emissions

The agricultural sector

WHAT ARE THE FUTURE NEEDS FOR ABATEMENT?

What is needed in the revision of the Göteborg protocol to ...

WHAT ARE THE FUTURE NEEDS FOR FURTHER MONITORING AND MODELLING?

The EMEP programme

ETC...

General introduction to the EMEP-programme, the European and national assessments and data used

1 Assessment of EMEP data

The EMEP monitoring programme is the spatially and temporally most extensive environmental monitoring net in the world. In the beginning sulphur compounds in air and precipitation were the main parameters measured. Over the years the programme has expanded to include nitrogen compounds in air and precipitation, base cations in precipitation and ozone in air. It covers more than 100 monitoring stations all over the continent in as many as 35 countries. The monitoring has been going on since 1978 and has produced monitoring data over a very important and interesting period in the European part of the world. The 20 years monitoring data series have documented the decreasing pollution over Europe and at the same time the results have driven the further pollution abatement work. Information achieved through the measurements have improved the knowledge and influenced both the monitoring and modelling methods.

The data have now been subject to an extensive assessment, as regards the development in pollution levels from the end of the 1970s and until today in different parts of Europe. The assessment will include the outcome of control measures in Europe 1980 – 2000, trends in emissions, atmospheric concentrations and deposition, comparison between measured and model-calculated data and will answer questions such as:

- **What is the result of the emission reductions?**

Trends during the period should be assessed and as far as possible the reasons behind the trends should be analysed. Have the emission reductions in Europe as a whole and in different nations lead to changes in pollution concentrations and deposition, and has it contributed to changes in spatial pollution patterns? Are the changes observed in concentration and deposition in line with our current understanding? Air pollution emissions have decreased during the two decades due to active control measures, but also other changes have occurred during the period. Many parts of Europe have undergone economical and political restructuring, which in turn have had an influence on emissions. In addition, there has been a tendency of a slightly changing climate over the period, towards milder winters at least in parts of the area. This change has most certainly influenced the frequency of extreme concentrations, but may also have had an influence on transport situations, precipitation etc. The aim of the assessment is to separate the possible factors behind observed trends.

- **What is the present status of environmental quality?**

Do the present levels of pollution exceed the critical loads and levels? Are the present levels above risk levels as defined by health limit values and guidelines? This question should be answered in co-operation with the evaluation made by the Working Group on Effects.

- **What is the need for further actions?**

The result of the assessment will form a basis for further negotiations within the Convention on Long-range Trans-boundary Air Pollution and a revision of the Gothenburg protocol in 2004 - 2005.

The assessment was initiated and carried out as a joint task between

- A large part of the EMEP parties,
- The EMEP centres; The Chemical Co-ordination Centre, The Meteorological Synthesising Centre West and The Meteorological Synthesising Centre East, and
- The Swedish ASTA-project "...". This part of the work could be regarded as a contribution in kind from Sweden.

Most of the assessment has been carried out during the years 2002 and 2004 within the framework of the EMEP Task Force on Measurements and Modelling.

2 The EMEP programme

2.1 BACKGROUND OF THE PROGRAMME

The Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe – in short EMEP – is one of the activities under the Convention of Long-range Trans-boundary Air Pollution. EMEP was initiated in 1977 as a special programme under the UN ECE, before the adoption of the convention. The programme has now been in operation in Europe during more than 20 years and the data produced form the basis for the negotiations within the convention on reductions of the air pollution flux across boundaries.

Initially the EMEP-programme was focussed on the assessment of acidification effects via long-range transported acidifying pollutants. Acidification in combination with die-back of fish had been found during the 1960s in small lakes in Scandinavia, with no obvious source of pollution but the atmosphere. The cause was first unclear. But other observations, such as those of simultaneous episodes of elevated black particles pollution in Swedish urban areas and at light-houses along the Swedish west coast, completed the picture and the occurrence of long range transport was highly suspected. To follow up the suspicions, a monitoring campaign was started in a large number of countries in Europe during the middle of 1970s within the framework of OECD. The outcome of the project confirmed that long-range transport is a fact (ref).

2.2 THE CONVENTION OF LONG-RANGE TRANS-BOUNDARY OF AIR POLLUTION

The outcome of the OECD-project also formed the basis for the Convention of Long-range Trans-boundary Air Pollution (CLRTAP), established under the United Nations Economic Commission for Europe (UNECE). The Convention was adopted in 1979 with acidification of fresh waters as the original driving force. Currently there are a

number of additional tasks included. The protocols to the convention at present aim at reversing acidification of fresh waters and soil, forest die-back, eutrophication, exposure to excess ozone, the degradation of cultural monuments and historic buildings, accumulation of heavy metals and POPs in soil waters, vegetation and living organisms.

The Convention has set up a process for negotiations on emission reductions, resulting in agreements between the parties in the form of legally binding protocols. The protocols so far are summarised in table x

Table x Protocols to the Convention of Long-range Transboundary Air Pollution (CLRTAP). Status 2002-10-04. More information on the compliance for the protocols can be obtained via 2000 Review of Strategies and Policies for Air Pollution Abatement and http://www.unece.org/env/lrtap/cov/lrtap_s.htm

Protocols to the convention signed	No of parties	In force	Agreed reduction	Between years	
The first sulphur protocol Helsinki 1985	22 ratified (19 signed)	1987	30%	1980	1993
The nitrogen oxides protocol Sofia 1988	28 ratified (26 signed)	1991	no increase of emission, some countries voluntarily agreed to cut emissions by 30%	1987	1994
The VOC – protocol Geneva, 1991	21 ratified (23 signed)	1997	30%	1984-1990	1999
The second sulphur protocol Oslo, 1994	25 ratified (28 signed)	1998	* as a total over Europe; 62% of the emission in 1980	1980	2000
The protocol on heavy metals, Aarhus 1998	12 ratified (36 signed)	Not yet	Reduce, controle and eliminate emissions and use of cadmium lead and mercury		
The protocol on persistent organic pollutants, Aarhus 1998	13 ratified (36 signed)	Not yet			
The multi-pollutant protocol Gothenburg, 1999	4 ratified (31 signed)	Not yet	as a total over Europe; 75% SO ₂ , 50% NO _x , 58% VOC, 12% NH ₃ in relation to emissions in 1990	1990	2010

* Effect-based protocol, national ceilings for emissions depending on the exceedance of critical loads in influenced areas

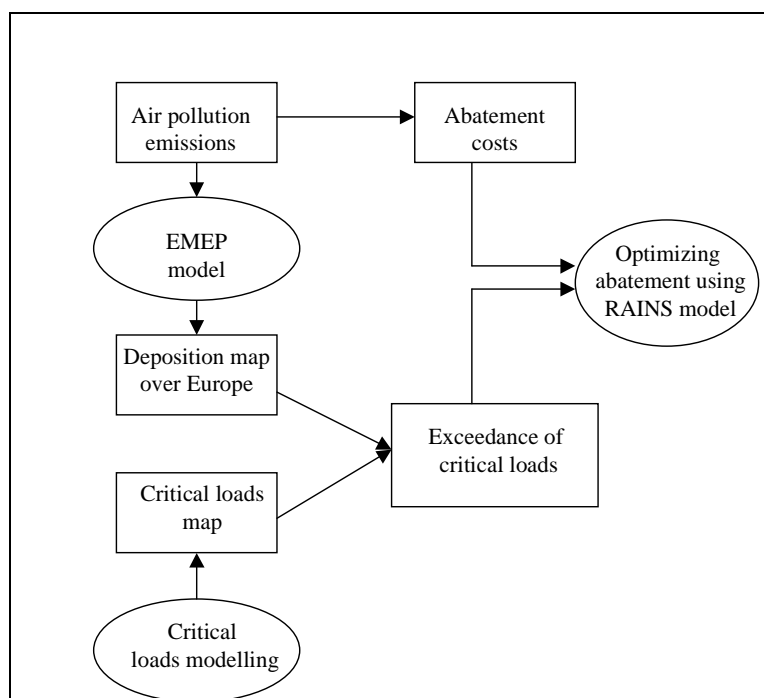
Data obtained in the EMEP project are used for elaborating cost-effective abatement strategies. Emissions from the countries are used as input data to calculate the deposition map over Europe. The model-calculated critical loads compared to the actual deposition load will give a map of critical loads exceedances.

From these data and the costs for abatement, it can be calculated how it is possible to reach deposition around or below critical loads in all areas and the costs involved. Optimising over the possibilities will give the most cost-effective way of reaching the

environmental goal. When costs for reaching the final goal were considered too high, as was the case for the Multi-multi-protocol (Gothenburg), closing the gap between deposition and critical loads was used. This can be seen as a step-wise approach of reaching the long term sustainable goal.

The legislative process for air pollution in the European Community (EC) runs in parallel to the work under the Convention. In dealing with trans-boundary air pollution the same effect-based approaches are applied and EC shares the same scientific tools. An effective co-operation is taking place and more of this cooperation is needed and expected for the future enlarged EC.

The integrated assessment modelling, which forms the basis for the effect-based abatement strategies, rely strongly on the data provided within EMEP. Emissions, monitoring data and model calculation results all go into the working scheme as in Figure x.



2.3 THE CONTENT AND FOCUS OF THE EMEP PROGRAMME

The original mandate of the EMEP programme is
“... provide governments with information on the deposition and concentration of air pollutants as well as on the quantity and significance of long-range transmission of pollutants and fluxes across boundaries. Information on the relative importance of local and distant sources resulting from such a programme will guide national authorities in setting appropriate local and regional permissible emission levels, taking into account international implications of these levels. The information on the deposition and concentration of air pollutants will be a basis of abatement strategies in

the regions affected....”

The main objective of EMEP, as it was formulated 1999, is “To provide sound scientific support for the Convention in particular in areas of atmospheric monitoring and modelling, emission inventories and emission projections and integrated assessment”

EMEP consequently consists of a number of activities:

- A monitoring programme measures pollutants in air and precipitation. A number of sites have been running since the start of the programme.
- A modelling system model-calculates the dispersion, transport and deposition over Europe of pollutants emitted.
- An emission data base for the
- Protocols on the reduction of trans-boundary pollution
- A complete environmental management system for Europe (Integrated Assessment Modelling)
- Task Forces for the discussions and scientific exchange between national experts and scientists on topics related to the activities under the programme

48 nations and the European Community are parties to the convention. Many, but not all of these, take part in the assessment.

48 nations and EU are parties to the convention
Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Turkey, Ukraine, United Kingdom, United States, Yugoslavia, European Community.
X of the parties are involved in the assessment process.

As mentioned, the initial focus was on acidification and emissions of sulphur and nitrogen compounds. Later was included eutrophication, the formation of oxidants and ground-level ozone, and more recently, heavy metals, persistent organic pollutants and fine particles in air. Emissions covered are sulphur dioxide, nitrogen oxides, ammonia, volatile organic compounds, heavy metals and persistent organic pollutants.

Every country runs their own measurements and reports their results to the Chemical Co-ordination Centre (at NILU in Norway). Emissions are estimated by the countries and reported to the Meteorological Synthesising Centres, where model calculations

are made of the dispersion, transport and deposition of pollution. The Meteorological Synthesising Centre West (at DNMI in Norway) carry out the calculations for sulphur, nitrogen and oxidants, while the Meteorological Synthesising Centre East (at xxx in Russia) deals with the calculations for metals and persistent organic pollutants.

3 The EMEP – monitoring data

3.1 THE MONITORING PROGRAMME

KJETIL

The monitoring programme has developed through the years

The monitoring programme is based on the emission and fate of pollutants in the atmosphere over Europe. All relevant compounds are measured, even though consideration is paid to cost-effectiveness and robustness of the monitoring programme.

3.2 MONITORING PARAMETERS

KJETIL

Emitted sulphur dioxide (and reduced sulphur compounds) is oxidised in the atmosphere to sulphuric acid/sulphate. Gaseous **sulphur dioxide and particulate sulphate in air** is measured as well as concentrations of **sulphate in precipitation** are parameters of interest to follow from emission to deposition. **Acidity in precipitation (pH)** is of interest to follow due to the acid character of the sulphur – and the nitrogen oxides emissions.

Nitrogen compounds emitted to the atmosphere as nitrogen oxides and ammonia and **nitrogen dioxide, nitric acid/nitrate particles and ammonia/ammonium particles in air** are measured, plus concentrations of **nitrate and ammonium in precipitation**.

Base cations in precipitation - and preferably in air – are important for the acidification process.

VOCs... (Sverre)

Ozone is the dominant oxidant formed in photochemical reactions, which take place between nitrogen oxides and hydrocarbons under the influence of sun radiation. Ozone is an important parameter in the programme.

For these main pollutants, monitoring data are available from a large number of sites all over Europe and has been running for a considerable time. During the latest decade, measurements of **heavy metals and selected POPs in air and precipitation** have started, but the number of sites and the time series are not as extensive as for the major pollutants.

3.3 MONITORING SITES

KJETIL

Monitoring sites are selected in areas where local contributions are of minor importance in relation to the large-scale pollution. The site should be representative for not only the site itself but for a larger area. Criteria for siting.....

There is a large number of monitoring sites in all parts of Europe

Stations Map of sites

3.4 MONITORING METHODS

KJETIL

Very short

Parameters List of parameters and method or ref to CCC reports

Methods Ref to EMEP manual

3.5 DATA QUALITY OF MONITORING DATA

KJETIL

In short here, more detailed under the different chapters.....

Data quality has improved over the years, as a consequence both of changes to more robust methods and of the implementation of a more extensive quality assurance and quality control programme.

A number of **analytical intercomparisons** have been made. The results from these establish the relative quality of performance, and have gradually contributed to the improvement of the analytical skills of the laboratories. The intercomparison exercises have been supplemented by an **expert consultation programme** in which experts from the Chemical Co-ordination Centre visited the collaborating laboratories to become familiar with operation of sites and laboratories, to give guidance, and to provide information on the quality of the measurement programme.

There are **accreditation mechanisms** for ascertaining the quality of laboratory work, such as EN-45001 "General Criteria for the Operation of Testing Laboratories", ISO/IEC Guide 25 "General Requirements for the technical competence of testing laboratories", and ISO 9000 concerning certification of quality systems. A new standard for testing and calibration laboratories, EN ISO/IEC 17025, will replace earlier ones. Many of the national laboratories conducting analysis within the EMEP

programme have achieved the standards.

Field inter-comparisons have been an equally important part of achieving and maintaining quality measurements, as large-scale exercises with parallel measurements using different equipment from different organisations at one location over 4-6 weeks.

The quality of data is also **validated and flagged** by the CCC before entry into the database.

It is requested that both monitoring and modelled data should search to achieve 30% accuracy. Comparisons indicate that many laboratories are less than 5% away from theoretical values in tests, and that most achieve better than the 10 and 15%.

Table of data quality??

4 The EMEP modelling data

LEONOR

Model calculations are made

4.1 MODELLING OF SULPHUR, NITROGEN AND OZONE

LEONOR

The La Grangian model was the first model developed (reference to a report). It should be mentioned and reference made to the data available on the web page.

The Eulerian model is developed for the future

4.2 DESCRIPTION OF THE MODEL SYSTEM FOR SULPHUR, NITROGEN AND OZONE

LEONOR and DAVID

Summarised description of the Eulerian model, meteorology, atmospheric chemistry scheme, deposition simulation

4.3 NECESSARY INPUT DATA FOR THE MODEL

LEONOR et al.

Necessary input data consists of emission data and meteorological data.

The meteorological data needed are: ...parameters, time resolution,

Data are provided via ...

Emissions are needed per grid-square. For sources with elevated exhausts (>100m height above ground)

Calculations are based on yearly emissions. Seasonal, weekly and diurnal resolution is introduced by using temporal functions.

4.4 VALIDATION OF THE MODEL

LEONOR

A considerable part of the model calculation work consists of validation. Monitoring data from the EMEP network is in the validation process.

Short on the procedure and validation results.

4.5 MODELLING OF HEAVY METALS AND PERSISTENT ORGANIC POLLUTANTS (POPs)

ILIA

The model...

4.6 DESCRIPTION OF THE MODEL SYSTEM FOR HEAVY METALS AND POPs

ILIA

Summarised description of the Eulerian model, meteorology, atmospheric chemistry scheme, deposition simulation

4.7 NECESSARY INPUT DATA TO THE HEAVY METAL AND POP MODEL

ILIA

As for sulphur and nitrogen, the model requires emission data and meteorological data.

The meteorological data needed are: ...parameters, time resolution,

Data are provided via ...

Emissions are needed per grid-square. For sources with elevated exhausts (>100m height above ground)

Calculations are based on yearly emissions. Seasonal, weekly and diurnal resolution is introduced by using temporal functions.

4.8 VALIDATION OF THE HEAVY METAL AND POP MODEL

ILIA and JOZEF

A considerable part of the model calculation work consists of validation. Monitoring data from the EMEP network is in the validation process.

5 The EMEP emission data base

LEONOR

An essential part of the EMEP work is the collection, quality checking, storage and display of emission data. Emissions are used as input to the model calculations and they form the basis for agreements on reductions of trans-boundary air pollution, and consequently for checking the fulfilment of protocols. The aim is that data should be transparent, consistent, comparable, complete and accurate.

5.1 OFFICIAL DATA AND EXPERT ESTIMATES

The basic data are the officially reported emissions from the countries, but these data are completed with expert estimates, when data are incomplete or inconsistent in some way.

Officially reported data are now and then subject to recalculations. The recalculations are made in line with new procedures for the inventories and with the discovery of sources earlier not included, and will gradually improve the data base quality, but may also slightly change the conclusions on achievements.

5.2 THE EMISSION DATA BASE – WEB DAB

LEONOR

The database contains large datasets and will be growing further with the new protocols on heavy metals and POPs and with coming agreements including parameters such as particles.

At present data included are emissions of sulphur dioxide, nitrogen oxides, ammonia, carbon monoxide and non-methane volatile hydrocarbons. The data are compiled year by year from 1980 until 2000, as national totals. From 1990 many countries have submitted their data divided into sectors and divided into grid squares, earlier as 150 by 150 km, and lately with the resolution of 50 by 50 km.

The emissions per country are divided into activity sectors such as energy production, industry, transports, agriculture, etc. Also natural sources are to some extent included.

The data base also contains the projected emission data for 2010 and 2020 for each country, based on commitments in protocols, directives and national legislation decided or under implementation during coming years.

Data are stored at www.emep.int/emissions (web dab).

6 Data available for the assessment

GUN + input from all

Data for the assessment are available at the EMEP web site.

Emissions

[http://www.emep.int/.....](http://www.emep.int/)

Monitoring data per site

[http://www.emep.int/.....](http://www.emep.int/)

Model-calculated data

[http://www.emep.int/.....](http://www.emep.int/)

Publications

....etc

PART 1, European EMEP Assessment

Kjetil Tørseth, Leonor Tarrason, Gun Lövblad

1 Sulphur and nitrogen

1.1 EMISSIONS OF SULPHUR DIOXIDE TO AIR

Special contributions?

Emission data

Figures over country emissions from 1980 until today

Tables are available

- in an appendix, such as pp 25-33 in MSC-W Status Report for 2002?
- Or just on the web??

Emissions from anthropogenic sources

Emissions from vessels

Natural emissions from marine sources and volcanic

Emission data quality over the years

The EMEP emission database relies mainly on official estimates from the countries. To fill gaps of missing data or to level off inconsistencies, expert estimates have completed the data series.

The data quality has improved over the years.

The earliest estimates The present data

Difference between substances....

The trend since 1980 and the present situation over Europe

The emissions in Europe show a clear downward trend for sulphur dioxide during the period 1980 to 2000. The decrease has been more than 60% as a total including all countries, international shipping in related sea areas and natural sources; volcanoes and marine emissions of reduced sulphur. From 1990, which is the base year for the Gothenburg protocol, the decrease has been 48%.

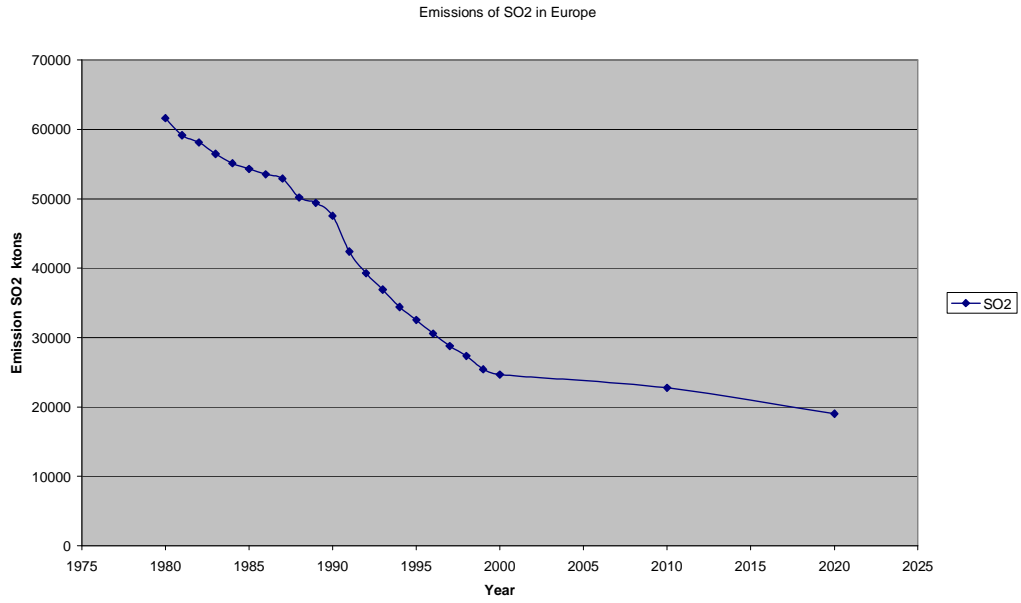


Figure xx Annual emissions of SO₂ in Europe 1980 to 2000, plus projected emissions from 2010 and 2020 (in kt)

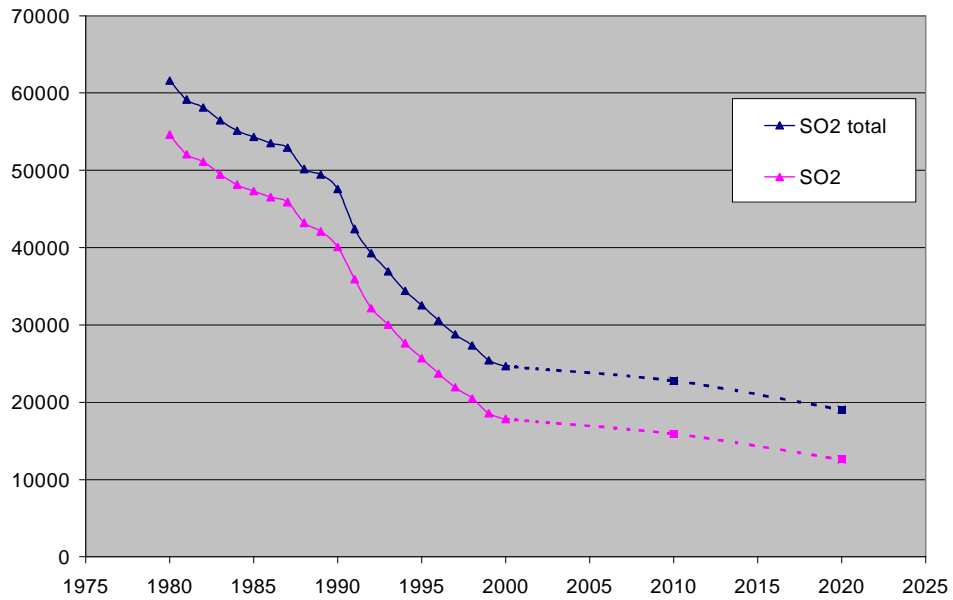
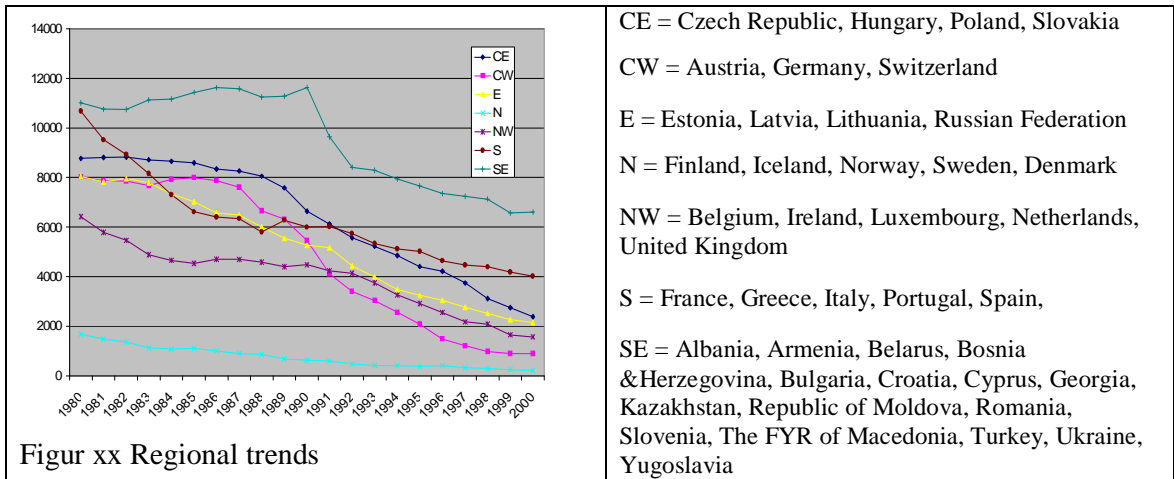


Figure xx Annual emissions of SO₂ in Europe 1980 to 2000 (in kt), for all countries and as a total including countries, marine emissions and natural emission sources. Projected emissions from 2010 and 2020 are also shown

The emission reductions have been of different extent in various parts of Europe: If grouped into mainly geographical regions according to the list below, the regional emission trends can be seen in Figure xx. The emission reductions have decreased

over all the area. The spatial pollution pattern shows no obvious larger decrease in any special area....., but the time scales are different.



Gridded emission map of - present situation (2000 or 2002) MAP
 - situation in 1980/1990

Marine emissions

Natural emissions

Anthropogenic emissions

Other conclusions on emissions:

The reasons behind the trend

The changes in emissions can be explained dominantly by a number of factors. Control measures have been undertaken in the European countries from the beginning of the 1980s as a part of an active emission reduction programme, aiming at the fulfilling of agreements under the first and second sulphur protocols or indirectly to achieve levels and requirements decided in EU directives and national legislation.

Such measures amount for part of the reductions. (is it possible to say how much?). Emission decreases have also been achieved as a bi-product of actions undertaken in order to reach other goals. An example is changes in electricity generating system carried out in many countries in Europe, in many cases decided during the 1970s based on economical and other reasons.

Another example is the outcome of political and economical restructuring of the eastern European countries. Due to a strained economical situation, the activities in the countries depressed and emissions of air pollutants decreased from all types of sources. When the situation improved after some years, but the conditions for running energy production and industry was completely changed.

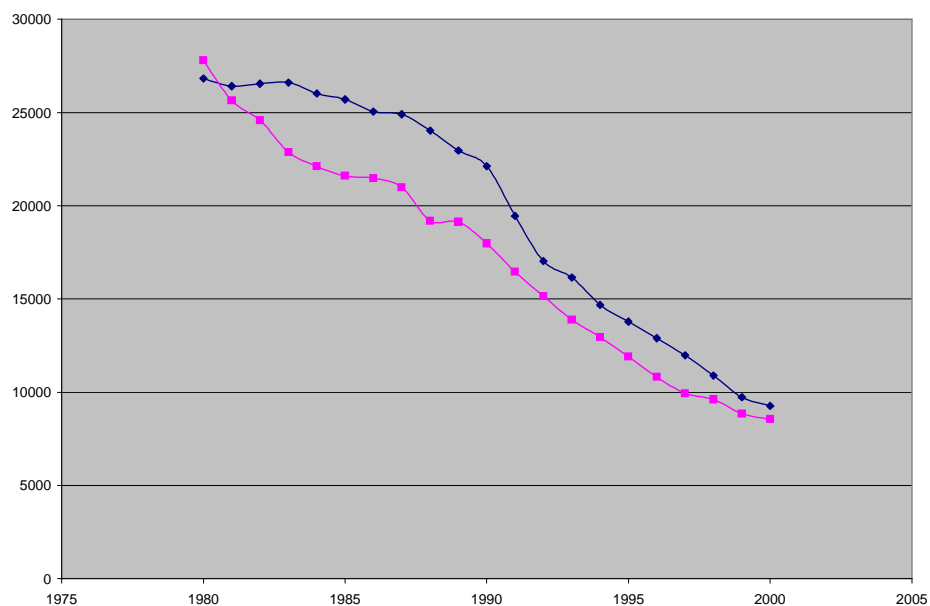


Figure xx Emission trend for East European countries in contrast to the other European countries (ktons) 1980 -2000

In some countries the reasons behind emission decreases have been studied, UK, the Netherlands and Sweden (LINK TO CHAPTER 5)

Differences in emissions from varying activities, in case of business as usual and in the actual situation have indicated the importance of the various changes. In several countries such as UK and Sweden, electricity production via nuclear power, rather than via fossil fuels could be demonstrated to cause of a large part of the achieved reduction. Also increased energy efficiency, in order to decrease the dependence of fossil fuels and/or for economical reasons, rather than straight forward emission reduction reasons, is another important factor. Introduction of flue gas desulphurisation and use of sulphur-poor fossil fuels, introduced primarily for fulfilling the emission goals, were shown to be of less importance for the sulphur dioxide emission decrease.

1.2 SULPHUR DIOXIDE IN AIR

Sulphur dioxide in air is of both local and long-range transported origin.

The present situation over Europe

Map of concentrations in relation to critical levels and EU-directive

The trend since 1980

Contribution from Ron Smith et al

Discontinuities due to changes in monitoring methods will be observed

Central Europe Czech Republic Assessment

The reason behind the trend

Meteorology changes influencing the trend will be found through sensitivity analysis using the models. (MSC-W)

Origin of pollution will be seen via cluster/trajectory analysis (NILU)

Need for further reduction and prognoses for the future

1.3 SULPHATE PARTICLES IN AIR

Sulphate particles are to a large extent long-range transported.

The present situation over Europe

The trend since 1980

Contribution from Ron Smith et al

Sulphur dioxide /sulphate particles in different parts of Europe???

The reason behind the trend

Meteorology changes influencing the trend will be found through sensitivity analysis using the models. (MSC-W)

Origin of pollution will be seen via cluster/trajectory analysis (NILU)

Need for further reduction and prognoses for the future

1.4 SULPHATE IN PRECIPITATION

Sulphate in precipitation to a large extent shows the same pattern as sulphate particles in air.

Sulphate particles

The present situation over Europe

The trend since 1980

non-marine sulphate

Sulphate in precipitation/sulphate particles in air

including pH in precipitation

Contribution from Ron Smith et al

Visibility trends???. Are there any good data on visibility over Europe??

The reasons behind the trend

Meteorology changes influencing the trend will be found through sensitivity analysis using the models. (MSC-W)

Origin of pollution will be seen via cluster/trajectory analysis (NILU)

Need for further reduction and prognoses for the future

Sulphur deposition trends

Wet deposition

Dry deposition

2.5 EMISSIONS OF NITROGEN OXIDES AND AMMONIA

Emission data

The emissions in Europe show a downward trend for nitrogen oxides during the period. The nitrogen oxides emissions should be considered with care due to inconsistencies in the time series for some countries during the 1980s. The increase seen 1986-87 is caused by a large increase in Russian emissions due to inclusion of sources earlier left out. Recalculations of data – in line with new procedures for the inventories and with the discovery of sources not included earlier – gradually improve the data base quality, but may also slightly change the conclusions on achievements. The NO_x reduction from 1990 is 25% based on the more reliable data from 1990 onwards.

Ammonia emissions have shown the least reductions. These data are also subject to larger uncertainties than the emissions of sulphur and nitrogen oxides.

1980 to 2000, though not as pronounced as for sulphur dioxide

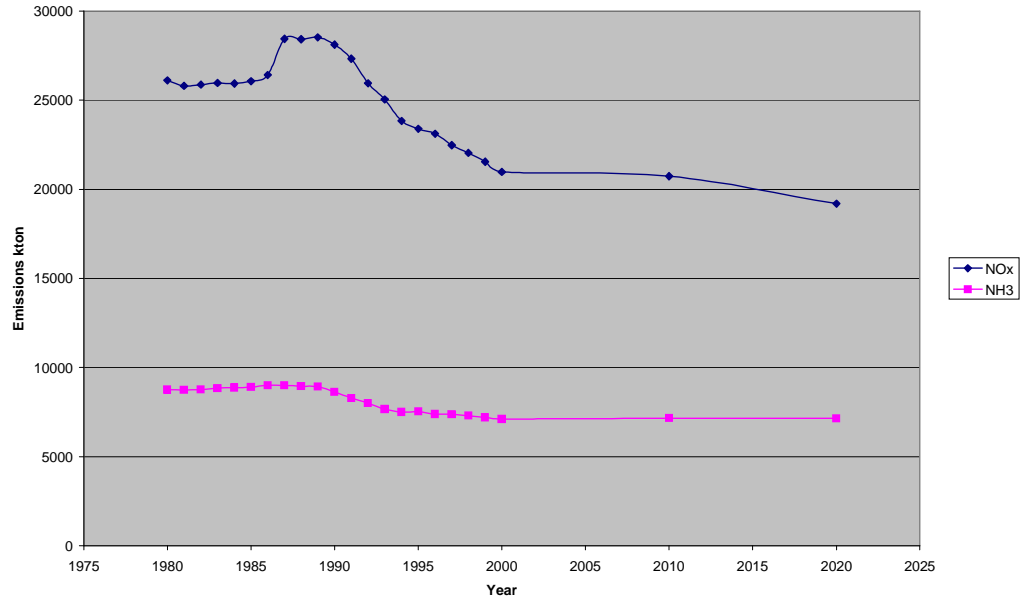


Figure xx Annual emissions of NO_x and NH₃ in Europe 1980 to 2000, plus projected emissions from 2010 and 2020 (in kt)

The emission reductions have decreased over all the area. The spatially pollution pattern shows no obvious larger decrease in any special area.....

Gridded emission map of - present situation (2000 or 2002) MAP
 - situation in 1980/1990

Marine emissions

Natural emissions

Anthropogenic emissions

Other conclusions on emissions:

The present situation is for nitrogen dioxide ... further reductions between 2000 and 2010 are necessary due to the fulfilment of the Gothenburg protocol.

for ammonia...

Emission data quality over the years

The data in the EMEP database are obtained regularly from the countries as their official estimates. For years in between the EMEP has made expert estimates of the emissions.

The present situation over Europe

The trend since 1980

The reason behind the trend

2.6 NITROGEN COMPOUNDS IN AIR

The present situation over Europe

NO₂

Total nitrate

Total ammonia

The trend since 1980

NO₃/NH₄⁺ in air

NH₄N/(NO₃N + SO₄-S) in air

Contribution from Ron Smith et al

The reason behind the trend

Meteorology changes influencing the trend will be found through sensitivity analysis using the models. (MSC-W)

Origin of pollution will be seen via cluster/trajectory analysis (NILU)

Need for further reduction and prognoses for the future

2.7 NITRATE AND AMMONIUM IN PRECIPITATION

The present situation over Europe

The trend since 1980

Contribution from Ron Smith et al

NH₄N/NO₃N in precipitation

NH₄N/(NO₃N+SO₄S)

The degree of neutralisation of precipitation

The reason behind the trend

Meteorology changes influencing the trend will be found through sensitivity analysis using the models. (MSC-W)

Origin of pollution will be seen via cluster/trajectory analysis (NILU)

Need for further reduction and prognoses for the future

Nitrogen deposition trends

Wet deposition

Dry deposition

2.8 BASE CATIONS IN AIR AND PRECIPITATION

Base cat ions and their role in relation to acidification

Ions such as calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^+) are called base cat ions. These ions are, except for Na^+ nutrients for forest and vegetation and are thus of importance when studying the sustainability of ecosystem under historical, present and future pollution conditions.

The base cat ion deposition is essential for calculating critical loads for acidity and its exceedance. Base cat ion input counteracts the acidification effects as it increases the base cat ion pool in the soil and, if associated with carbonates or oxides, they also add alkalinity to the soil. Large base cat ion deposition increases the critical load and low deposition decreases it. Accurate data on base cat ion deposition is thus of importance in the elaboration of European large-scale abatement strategies, based on the critical load concept.

However, for most areas, the data on base cat ion deposition are uncertain. This gap of knowledge may be unimportant in parts of Europe, where the soil is insensitive for acidification and where large contributions of alkaline deposition are obtained via Saharan dust. In areas such as the in part of the Nordic countries, the base cat ion input to ecosystems is very important compared to the acid pollution. For forests on acidified sandy soil in Denmark and south-western Sweden, sea-salt deposition is a major nutrient source.

Emissions of base cat ions

Present status

Trends in base cat ions in the atmosphere

Trends in base cat ion deposition

2 Ozone and photooxidants in air

Sverre Solberg, David Simpson and Gun Lövblad

2.1 THE OXIDANT FORMATION PROCESS

Dave –

this sounds like basic chemistry and the link to meteorology.

Spatial variability in ozone climatology

There is a difference between southern and northern Europe

This is easy enough to tackle, with citations of Milan Milan's famous figure, maybe something from LOOP, Athens, recent measurements on Crete, etc. Note my comment below on the possible overlap with 2.3. I suggest we keep the principles here and discuss the measurements in 2.3.

Here we should include a discussion of the differences in meteorology/radiation/chemistry from NW to SE. The ozone problem changes from a hemispheric one in N to a more local one in S superimposed on the dominant atmospheric transport from NW to SE and the more local circulation in the Mediterranean.

2.2 EMISSION OF PRECURSORS

Anthropogenic emissions 1980 - 2002

NO_x, VOC and CO

Dave + Plots from Vigdis Vestreng, DNMI

Natural emission contributions

Dave

Spatial distribution of emissions

Dave + Plots from Vigdis Vestreng, DNMI

2.3 THE PRESENT OZONE SITUATION

Sverre

Overall regional distribution patterns based on publications from TOR2, TROTREP, EEA, the EUROTRAC S&I, NEGTAPE and other national contributions. Note particularly the differences between European boundary layer air, "background" air

masses and free tropospheric air. Less information of the latter which is still highly important for Europe but some results should be available from e.g. MOZAIC(?) and the various mountain studies in Europe/Eurotrac. Remark the poorer measurement coverage in South and East. Could also include remarks to some modelling work (e.g. Joffen and/or Michiel's model initiative) showing max concentrations in coastal areas presumably due to deposition.

A special contribution from the Mediterranean countries **is being prepared (?)** by Stefan Doytchinov et al.

We have asked for a contributions from Juha-Pekka Tuovinen on AOT40 and uncertainties and he is willing to make a contribution.

A synthesis and overview of the results and experience from EEA's network and their reported ozone data have been requested from Frank de Leeuw e.g. based on their annual reports and similar publications.

Temporal distribution

Daily and seasonal variations in ozone concentrations will be taken from the EMEP ozone reports as well as the seasonal ozone cycle work within TOR2/TROTREP + NEG-TAP. Show e.g. Eckhard's monthly mean series from Jungfraujoch with a decreasing amplitude during the 1990-ies (or move that perhaps to the trend section).

Process related explanation for the diurnal (stability, deposition, NO_x emis.) and seasonal cycles from TOR2 , NEG-TAP?

The present ozone levels in relation to critical levels

Critical limits for vegetation. Base this on the EMEP reports and use maps for AOT40 for plants/forest. Yet no combined model-measurement maps of AOT40 (or other indexes) have been prepared in EMEP so we have to face the problem of diverging maps from the model and the network. Comment on this in light of the general difficulty and uncertainty of using the AOT40 concept from model calculations. We will work on this after March – kriged maps are a possibility but the subject is tricky and some thought needed.

Health risks

This should be based on the EEA/Airbase data and reports and could be mentioned in the request to Frank de Leeuw. Discuss in relation to the EU ozone directives and the two thresholds for public information and the exceedances reported by EEA.

2.4 THE TREND SINCE 1980

Sverre

As above base this on publications from TOR2, TROTREP, the EUROTRAC S&I, NEG-TAP and - if available - on national contributions. Uncertainty due to changes from chemiluminescence to UV monitors in the 80-ies should be mentioned. How reliable are e.g. the values in the first half of the 1980-ies? Discuss the problem of ozone trend evaluation in general due to meteorology varying from year to year (Dave's paper some years ago). Trends in monitoring network as well. Consider using Eckhard's Jungfraujoch data here instead (70-ies to now). Use the Wallasch/Beilke report from the German network. Is there a difference in the trend at the rural EMEP sites compared to more (semi-)urban national/EEA networks? Discuss if trends in different regions differ (e.g. Nordic study vs German study).

Prepare this part together with Joffen based on his recent results from the multi-annual runs with the Unified model. Joffen has been asked and is willing to contribute with figures/text.

Have also the Mann-Kendall exercise carried out for all TOR sites some years ago.

Special contribution from the Mediterranean countries **is being prepared (?)** by Stefan Doytchinov et al.

The following is Gun's remark in the outline. Not exactly sure what this means: O₃/SO₄ etc....Difference in trends between O₃ and other secondary species?

Maybe Gun could write something here? When looking at other species it will be interesting to look at NO_x levels, HC levels, etc., although the measurement data can be difficult to evaluate for some of these. Still, some countries do have trend data for Hcs (e.g. UK, NO – Birkenes?, NL)

Long-term trends in measured ozone-percentile values

EXAMPLE Nordic countries

An evaluation for the Nordic countries was made to find out the extent of decreases in ozone concentration and in frequencies of peak ozone episodes due to emission reductions in Europe the last 10-15 years. The results indicated that the frequency of high ozone values have decreased in the 1990-ies. The 99-percentiles of hourly measured ozone concentrations from the summer half year indicates that in the Nordic areas close to the European areas where emission density is high and where 99-percentiles have been mostly above 120 $\mu\text{g}/\text{m}^3$, episodic ozone concentrations are decreasing. It is obvious in S-Norway and S-Sweden due to European emission reductions during the 1990-ies. The reduction is estimated to be of the order of 30 $\mu\text{g}/\text{m}^3$ ozone for the highest peak values and less for the less pronounced episodes. Also, the number of episodes with exceedances of the EU threshold value of 180 $\mu\text{g}/\text{m}^3$ or has been reduced, although the few number of these episodes make the

statements uncertain. The 99-percentiles of summer six-months hourly data (approx the 40th highest value) have probably been reduced by the order of 10-20 $\mu\text{g}/\text{m}^3$ in the same region. For Finland and for the northern part of the region, the conclusions are more difficult to assess and become more uncertain.

(Question – is te report using ppb or ug/m3 for ozone. Or both since available figure may use different units, and e.g. AOTs need ppb, but critical levels mayb use ug/m3. We should decide and specify the conversion factor if we use both).

Temporal changes in ozone climatology

2.5 REASONS BEHIND THE TREND

Sverre

To what extent can we separate the variations induced by varying meteorology from that of changing emissions? What is the "signal" of the emission reductions on ozone - peak values increase while mean values are constant? The importance of increasing background concentrations (Mace Head data by Simmonds) - only in certain seasons/winter (?). A background increase is potentially highly important for AOT-trends. Is it meaningful to discuss trends in AOT40 or too uncertain? Trends in health indexes may be more reliable as they depend on peak values?

This chapter should be done in close collaboration with modellers i.e. Joffen and the results from the multi-year calculations + possibly Michiel R. (based on his model initiative study which in practice includes parts of a sensitive study with many models included). If so we should contact Michiel and ask. Include the state-space-model results from Evi S if available?

What about variations in other parameters, e.g. UV-radiation - few trend studies on this.

Model calculations

2.6 NEED FOR FURTHER REDUCTION AND PROGNOSSES FOR THE FUTURE

Dave

Some model calculations can illustrate this quite well. Later in the year we can include the effects of increasing hemispheric O3.

3 Heavy metals and POPs in air and precipitation

Iliia Ilyin, Joseph Pacyna, Gun Lövblad

3.1 Introduction

3.1.1 COMPOUNDS TO BE STUDIED IN THE ASSESSMENT REPORT

The compounds measured and model-calculated are

- HMs: Hg, Pb and Cd (possibly others)
- POPs: HCHs, PCBs, HCB and Dioxins and Furans (possibly others).

3.1.2 HEAVY METALS AND POP POLLUTION AS A REGIONAL AND GLOBAL PROBLEM

briefly purpose of this section, species of concern

3.2 Emissions

Emission data to be used are estimates by national experts in the European countries, from the MSC-West and/or directly from the countries. Emission data will need to be checked for completeness and verified through a comparison of emission factors used for these estimates with emission factors reported in emission estimation guidelines, particularly in the EMEP/CORINAR Atmospheric Emission Estimation Guidebook.

It is expected that the list of national emission estimates may be incomplete, particularly for the earlier years of the analysed period, and more generally for POPs. In this case, international expert estimates will be used. Of particular value are emission data estimated within the former and current EU projects such as POPCYCLING, MAMCS, SOCs, MERCYMS, MOE, EMECAP, where NILU has played a central role in emission estimation.

In addition, emission data from international programs and organisations will be used, including the UNEP Stockholm Convention, estimates for projects within IIASA and GKSS in Germany, data from international industrial organizations, such as ILZRO, NiPERA, and also for WHO.

HMs and POPs from the list above will then be selected on the basis of priorities described in EMEP, but also on the basis of data availability..

Annual emission trends will be analysed for these compounds since the late 1970' until 2000 (if possible). This trend analysis will be performed for Europe as a whole and for selected countries.

The following countries may be selected: Poland (East Europe and major economic changes), Germany (Central Europe), the UK (Western Europe), Norway (N. Europe), and Italy (S. Europe). Major changes in emissions over the years will be attempted to explain.

Emission maps will then be compared for the years 1980, 1990, and the latest year available. The emission maps are available with the 50 km x 50 km grid systems. The aim of this comparison is to analyse spatial changes of emissions in Europe, focusing on major emission regions and major changes in emissions over the analysed period. It will be attempted to explain the expected changes.

In the next step, the assessment will attempt to discuss and conclude on the following aspects of emission data for HMs and POPs in Europe:

- importance of emission from natural sources,
- accuracy of emission estimates,
- importance and availability of specific data, such as physical and chemical forms (chemical speciation) of reviewed compounds, isomerisation.

Future emissions are difficult to be assessed. However, an attempt will be made to present at least a policy-target scenarios which will take into account all current policies in Europe which aim at emission reductions of HMs and POPs. If requested, an analysis can be performed to provide some insight in to the issue of measures necessary for the implementation of HMs and POPs policies, as well as cost of these measures and the cost of their implementation.

3.3 Monitoring data

3.3.1 AVAILABLE DATA

Monitoring data will mainly be provided from:

- the CCC monitoring data base, and
- national experts whose interest has already been indicated. Other experts and monitoring networks will also be approached.

Monitoring data from OSPARCOM, HELCOM, and national networks are needed for the assessment due to the lack of HMs and POP data for several regions in Europe in the CCC database. A quality check will be implemented in the case of application of data from networks other than EMEP in order to assure a proper comparability with the CCC data.

Monitoring data will be available for assessment in a form of:

- data sets for a certain period of time and a given station, and
- concentration maps for the whole Europe.

A careful selection of stations will be made taken into account the representativity of a station for a given region (e.g. geographical regions or regions with major emission changes), and a long-lasting track of data, for as many as possible compounds from the selected list. Maps with monitored data will be presenting the concentration isolines.

Measured concentrations will be compared with emission data. This comparison will be made through the development of diagrams showing the emission data for a given country of a given part of Europe and concentrations measured at stations representative for these countries or regions. A selection of regions should include four geographical regions (North, South, West and East) taking to account a possible large emission changes in these regions.

3.3.2 QUALITY OF DATA IN REALTIONTO TRENDS AND RISKS

3.4 Model Assessment

This part of work should be described jointly with the team from the MSC-East. The following major suggestions from the CCC can be defined.

3.4.1

Maps with model estimates of concentrations of selected HMs and POPs can be prepared for whole Europe for the years 1980, 1990, and the latest possible. These maps shall be used to describe and conclude on spatial differences in concentrations of HMs and POPs in various parts of Europe over the studied period of time. These maps shall then be compared with emission maps with major focus on:

- identifying regions in Europe where changes of concentrations follow the changes in emissions, thus the chemical recovery of the ecosystems is in place,
- quantifying the changes in emission and concentration in the past, assuming that maps for concentrations in 1980 can be produced.

In parallel, concentrations model-estimated for certain parts of Europe would need to be compared with monitoring data - shown on concentration diagrams and on maps. Possible differences should be explained.

The assessment of model estimates should also describe the accuracy of these estimates and provide information on model sensitivity to various model parameters and input data.

The description of this part of the assessment should be further discussed with the

assessment team from the MSC-East. The following team will be available for the model results assessment:

3.4.2 SOURCE-RECEPTOR RELATIONSHIPS

???

3.2 EMISSION DATA FOR EMEP REGION

Official emission data for 1990-2000 (MSC-W)

Expert estimates for 1980 - 2000 used in the assessment

text only

Spatial distribution of the emissions

2 examples: HM emission in 1980 and 2000 and POP emission in 1980 and 2000 for Europe as a whole

Trends of total emission for Europe and for individual regions

(2-3 examples). For example, these could be Northern Europe and Eastern Europe

- Do we observe changes in emissions of studied HMs and POPs in Europe over the last 2 decades?
- Where do these changes occur in Europe and what are the major causes of these changes: implementation of environmental controls or rather change in economies of European countries?

Quality of the emission data

3.3 MONITORING DATA

(CCC)

In addition to this, POP group uses a lot of measurement data for the comparison which are found in literature and not included into CCC/EMEP database.

Pollution levels

- Are the emission changes reflected in changes of concentrations in the air and atmospheric deposition? Do we observe chemical recovery of ecosystem in Europe with regard to the studied HMs and POPs?

Long-term trends of deposition

Possible contributions from Nordic, Baltic, Czech, Slovak measurement results

Reasons behind trends

3.4 QUALITY OF MONITORING DATA IN RELATION TO TRENDS AND RISKS

- Is the monitoring network within EMEP effective in providing the necessary information on changes of major pressures and the state of the environment in Europe with regard to HMs and POPs? If not, what should be done to improve the current situation?

3.5 MODEL ASSESSMENT

Model-calculated long-term trends of depositions

EMEP region + 2-3 examples for regions; comparison with emission trends and trends of observation data. The regions could be Northern Europe and Eastern Europe, maybe Southern Europe.

Model-calculated long-term POP accumulations in media

EMEP seawater, soil, vegetation

Model-calculated fields of pollution levels

depositions - 2 maps, concentrations in soil - 2 maps,

seawater - 2 maps, for 1980 and 2000

Source-receptor relationships

I believe it is important to present contrasting examples for 2-3 countries. For example, for a small country where long-range transport is dominant, and larger one where long-range transport is important mainly along state borders but the country itself is important pollution contributor to other countries.

Model-calculated deposition to marginal seas

2 tables with total depositions to each sea - in 1980 and in 2000

Contribution to effect-based approach and risk assessment

To be placed in chapter 5??

Transcontinental transport of POPs and Hg

Contribution of Europe to the global pollution and effects of other continents on Europe (2 examples: one for Hg and one for POP). The aim of this section is to demonstrate the role of Europe with regard to pollution as a part of global environment. I think, it is relevant to present diagrams showing how much of Hg/POP is transported to Europe from other continents and how much European Hg/POP is transported to other continents.

3.6 QUALITY OF MODEL RESULTS

- Is the model development sufficient to confirm the current changes in the state of the environment in Europe with regard to HMs and POPs and to predict future changes? If not, what should be done to improve the current situation?

(0.5 - 1 page of text)

Intercomparison studies

Comparison of observed and modelled values

(2-3 examples)

Uncertainty of the model

4 Conclusions on trends of pollution and their cause

Summarising the findings in chapter 1, 2 and 3.

4.1 Decreasing trends and the reasons behind

4.2 Regions with alternative development

4.3 Contributions to trends via climate variations

Results from Ron / Marco

Result from MSC-W??

4.4 Result of pollution control in relation to the protocols

Peringe Grennfelt would like to contribute here.

See Erisman, McDill, Fowler, Grennfelt "Evaluation of progress in acidification policy in Europe"

Dick Derwent would like to contribute with "Ozone trends in north-western Europe

- could maybe be linked to the work from southern Europe via Stefan Doytchinov and his colleagues.

5 Conclusions on the present status in relation to environmental goals

In co-operation with the WG on effects or partly based on their report?

6 Future needs

6.1 Future needs for monitoring and modelling activities

What can we learn from the monitoring and modelling activities. Are there reasons to make changes in the programme? Parameters to add? Changes in time resolution? More or less sites needed?

May fall outside our mandate???

6.2 Future needs for emission reductions

What is expected from protocols so far

Environmental problems still exist. Further emission reduction ...

Do we need other approaches due to non-linear responses to emission reductions ?

6.3 Other needs

6.3.1 A NEW EUROPE – UN ECE VS EU. HOW DOES EMEP COME INTO THE PROCESS?

6.3.2 COLLABORATION WITH SCIENCE

6.3.3 FURTHER ASSESSMENTS

Part 2, National assessments

Contributions from: