ECONOMIC COMMISSION FOR EUROPE

CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

emep

**Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe**

# STRATEGY FOR EMEP 2000-2009

UNITED NATIONS

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ECONOMIC COMMISSION FOR EUROPE
Geneva

CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

COOPERATIVE PROGRAMME FOR MONITORING AND EVALUATION OF THE LONG-RANGE TRANSMISSION OF AIR POLLUTANTS IN EUROPE
(EMEP)

# STRATEGY FOR EMEP 2000-2009

**UNITED NATIONS**

**NOTE**

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## List of acronyms and abbreviations

| | |
|---|---|
| AMAP | Arctic Monitoring and Assessment Programme |
| AOT40 | Accumulated dose over a threshold of 40 parts per billion (ppb), i.e. the sum of the differences between the hourly mean ozone concentration (in ppb) and 40 ppb for each hour when the concentration exceeds 40 ppb, accumulated during daylight hours |
| AOT60 | Accumulated dose over a threshold of 60 ppb, i.e. the sum of the differences between the hourly mean ozone concentration (in ppb) and 60 ppb for each hour when the concentration exceeds 60 ppb, accumulated during daylight hours |
| CCC | Chemical Coordinating Centre |
| CIAM | Centre for Integrated Assessment Modelling |
| EC | European Community |
| ECE | United Nations Economic Commission for Europe |
| EEA | European Environment Agency |
| EMEP | Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe |
| EUROAIRNET | Europe-wide air quality monitoring and information network of EEA |
| EUROTRAC | Eureka Project on the Transport and Chemical Transformation of Environmentally Relevant Trace Constituents in the Troposphere over Europe |
| GAW | Global Atmospheric Watch |
| GDP | Gross domestic product |
| HMs | Heavy metals |
| ICAO | International Civil Aviation Organization |
| ICP | International cooperative programme |
| IGAC | International Global Atmospheric Chemistry Project |
| IGBP | International Geosphere-Biosphere Programme |
| IMO | International Maritime Organization |
| LOICZ | Land Ocean Interaction in the Coastal Zones |
| MSC-E | Meteorological Synthesizing Centre - East |
| MSC-W | Meteorological Synthesizing Centre - West |

## List of acronyms and abbreviations

| | |
|---|---|
| NARSTO | North American Research Strategy for Tropospheric Ozone |
| NGO | Non-governmental organization |
| OECD | Organisation for Economic Co-operation and Development |
| PM | Particulate matter |
| POPs | Persistent organic pollutants |
| QA/QC | Quality assurance/quality control |
| UNECE | United Nations Economic Commission for Europe |
| UNEP | United Nations Environment Programme |
| VOCs | Volatile organic compounds |
| WMO | World Meteorological Organization |

**Article 9 of the Convention on Long-range Transboundary Air Pollution:**

Implementation and Further Development of the Cooperative Programme for the Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe

The Contracting Parties stress the need for the implementation of the existing "Co-operative programme for the monitoring and evaluation of the long-range transmission of air pollutants in Europe" (hereinafter referred to as EMEP) and, with regard to the further development of this programme, agree to emphasize:

(a) the desirability of Contracting Parties joining in and fully implementing EMEP which, as a first step, is based on the monitoring of sulphur dioxide and related substances;

(b) the need to use comparable or standardized procedures for monitoring whenever possible;

(c) the desirability of basing the monitoring programme on the framework of both national and international programmes. The establishment of monitoring stations and the collection of data shall be carried out under the national jurisdiction of the country in which the monitoring stations are located;

(d) the desirability of establishing a framework for a co-operative environmental monitoring programme, based on and taking into account present and future national, subregional, regional and other international programmes;

(e) the need to exchange data on emissions at periods of time to be agreed upon, of agreed air pollutants, starting with sulphur dioxide, coming from grid-units of agreed size; or on the fluxes of agreed air pollutants, starting with sulphur dioxide, across national borders, at distances and at periods of time to be agreed

upon. The method, including the model, used to determine the fluxes, as well as the method, including the model used to determine the transmission of air pollutants based on the emissions per grid-unit, shall be made available and periodically reviewed, in order to improve the methods and the models;

(f) their willingness to continue the exchange and periodic updating of national data on total emissions of agreed air pollutants, starting with sulphur dioxide;

(g) the need to provide meteorological and physico-chemical data relating to processes during transmission;

(h) the need to monitor chemical components in other media such as water, soil and vegetation, as well as a similar monitoring programme to record effects on health and environment;

(i) the desirability of extending the national EMEP networks to make them operational for control and surveillance purposes.

## Executive summary

### Mandate

The Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) was initiated in 1977 as a special programme under the United Nations Economic Commission for Europe (UNECE). It has operated under the Convention on Long-range Transboundary Air Pollution since the Convention entered into force. In 1999, the Executive Body for the Convention (decision 1999/2, appendix III) decided that the main objective of EMEP was:

"To provide sound scientific support for the Convention, in particular in the areas of:

- Atmospheric monitoring and modelling,
- Emission inventories and emission projections, and
- Integrated assessment."

The protocols to the Convention on Long-range Transboundary Air Pollution aim to reverse freshwater and soil acidification, forest dieback, eutrophication, exposure to excess ozone, the degradation of cultural monuments and historic buildings, and the accumulation of heavy metals and persistent organic pollutants in the soil, water, vegetation and other living organisms. The Convention has established a unique network of scientific cooperation, which was initiated by EMEP and has evolved over the years in cooperation with the Working Group on Effects and other bodies under the Convention.

The monitoring network, the quality control system, the emission data and the modelling work have demonstrated the transboundary nature of air pollution problems and made it possible to quantify the source-receptor relationships between countries and regions and convincingly communicate the results to policy makers and to the public. Integrated assessment modelling has made it possible to

calculate the most cost-effective ways to reduce emissions across Europe.

There are still several air pollution problems affecting human health and causing ecosystem damage for which both national and transboundary emissions are responsible:

(a) Fine particulate matter and human health;
(b) The recovery of acidified soils and ecosystems;
(c) Ozone and human health, vegetation and ecosystems;
(d) Eutrophication;
(e) Nitrogen dioxide and human health;
(f) Persistent organic pollutants, heavy metals and human health and ecotoxicological effects; and
(g) Urban air quality and human health.

Following the adoption of the 1998 Protocols on Heavy Metals and Persistent Organic Pollutants and the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, the Convention and its subsidiary bodies, including EMEP, are at an important turning point. The priorities for the Convention now are:

- The review and extension of existing protocols; and
- The implementation of, and compliance with, existing agreements.

Effective implementation of the protocols requires a dedicated system for measuring success. Success has to be measured by properly integrating monitoring, modelling and emissions assessments. Tools need to be developed and applied to assess and verify that implementation is achieved and that further measures will be cost-effective. At the same time exploratory work must continue on new substances that may be harmful to health and ecosystems.

**Vision**

The Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) will continue to be the main science-based and policy-driven instrument for international cooperation in atmospheric monitoring and modelling, emission inventories and projections, and integrated assessment to help solve transboundary air pollution problems. To this end it seeks to develop:

- **SCIENCE -** EMEP establishes sound scientific evidence and provides guidance to underpin, develop and evaluate environmental policies;
- **PARTNERSHIP -** EMEP fosters international partnership to find solutions to environmental problems;
- **OPENNESS -** EMEP encourages the open use of intellectual resources and products;
- **SHARING -** EMEP is transparent and shares information and expertise with research programmes, expert institutions, national and international organizations, and environmental agreements;
- **ORGANIZATION -** EMEP is organized to integrate information on emissions, environmental quality, effects and abatement options, and to provide the basis for solutions.

The tasks of EMEP focus on five subjects:

- Acid deposition/eutrophication;
- Photochemical oxidants;
- Heavy metals;
- Persistent organic pollutants;
- Fine particulate matter.

Scientific support in these five areas requires the systematic collection, analysis and reporting of information from monitoring networks, from emission inventories, from modelling studies, and on various abatement measures, as well as the integrated assessment of this information. In order to find new options for reducing emissions cost-effectively, structural measures in energy, transport and agriculture need to be more closely examined and incorporated into the assessment.

EMEP, via its technical centres and in cooperation with the Working Group on Strategies and Review, the Working Group on Effects and the Convention's other subsidiary bodies, is well placed to carry out these activities.

EMEP relies on participating countries to meet its objectives and responsibilities. EMEP should identify and take advantage of opportunities for strengthening its partnerships with national and international research programmes and develop mechanisms to incorporate these programmes into its work-plan to improve the scientific quality of its work. While the centralized activities at the EMEP centres providing Europe-wide analysis of transboundary air pollution should be maintained, partnerships between the EMEP centres and national and international research and monitoring activities should be strengthened.

Environmental policy development in the European Community (EC), including its proposed enlargement, is an additional important driving force for further scientific work within EMEP. The EC has a legislative system of its own, but both the EC itself and its member countries are Parties to the Convention. This opens possibilities for cooperation in order to maximize the benefits, and minimize the costs, of monitoring and research. The opportunities for technical integration of activities coordinated by the European Commission and those of the Convention should, therefore, be exploited as far as possible.

The climate-change policies driven by the Kyoto process aimed at reducing greenhouse-gas emissions, and international agreements to reduce emissions from, for example, international shipping and

aviation constitute a further impetus that should receive appropriate attention in EMEP activities.

To best serve the Convention, EMEP should pay more attention to the regional differences in environmental problems across Europe. In the Mediterranean the focus is more on mesoscale meteorological cycles, ozone and fine particle formation, while in northern Europe long-range transport is important. In the Alps and in other mountainous regions the local topography is a major factor in pollution distribution.

It is also becoming increasingly clear that some environmental problems in Europe need to be considered on a hemispheric or global scale. The work of EMEP should embrace developments in North America and elsewhere. As global emissions increase, transport between the continents, and even globally, is raising European levels of the pollutants controlled by the protocols to the Convention. In future EMEP will need to address these issues and interact with the appropriate international research programmes.

Of increasing significance in environmental policy development are the interests and concerns of individual citizens, local authorities, industry, non-governmental organizations, expert institutions and other bodies. This means that there will be a need for greater openness and transparency in the work of EMEP. The dissemination of information within EMEP and from EMEP should be transparent, two-way and easily accessible to everybody.

The work of EMEP will continue to be dependent on support for the EMEP centres, especially through effective implementation of the Protocol on Long-term Financing of EMEP. In addition, the Parties should be urged to implement the EMEP monitoring programme fully so that uncertainties in present observations, model estimates and emission inventories can be resolved.

## Introduction: Why do we need a strategy document?

The protocols to the Convention on Long-range Transboundary Air Pollution aim to reverse freshwater and soil acidification, forest dieback, eutrophication, exposure to excess ozone, the degradation of cultural monuments and historic buildings, and the accumulation of heavy metals and persistent organic pollutants in the soil, water, vegetation and other living organisms. The Convention has established a unique network of scientific cooperation. This network was initiated by EMEP and has evolved over the years in cooperation with the Working Group on Effects and other subsidiary bodies. For 20 years the Convention has carried out a carefully planned work programme, which has provided the scientific evidence required to develop reasonable environmental policies.

The monitoring network, the quality control system, the emission data and the modelling work have demonstrated the transboundary nature of the pollution problems and made it possible to quantify the source-receptor relationships between countries and regions and convincingly communicate the results to policy makers and to the public. Integrated assessment modelling has made it possible to calculate the most cost-effective ways to decrease emissions across Europe and achieve an agreed reduction in the gap between current pollutant loads and levels and the critical loads and levels.

In the year 2000, the Convention and its subsidiary bodies, including EMEP, were at an important turning point. As more Parties to the Convention also ratify the 1998 Protocols on Heavy Metals and Persistent Organic Pollutants and the 1999 Gothenburg Protocol, these will come into force and will have to be implemented. The protocols will require countries to make significant investments and structural changes. EMEP should support countries in the implementation of the protocols through its centres, and by facilitating the exchange of information and scientific knowledge between Parties. In addition, EMEP must seek to verify that the agreements are implemented as intended and provide further guidance to the Parties to the Convention regarding the amendment of current policies and the development of new ones.

There are still several air pollution problems affecting human health and causing ecosystem damage for which both national and transboundary emission are responsible:

(a) Fine particulate matter and human health;
(b) The recovery of acidified soils and ecosystems;
(c) Ozone and human health, vegetation and ecosystems;
(d) Eutrophication;
(e) Nitrogen dioxide and human health;
(f) Persistent organic pollutants, heavy metals and human health and ecotoxicological effects; and
(g) Urban air quality and human health.

The legislative process in the European Community (EC) runs parallel to the work under the Convention. In dealing with transboundary problems, it takes the same effects-based approach and, to a large extent, shares the same scientific models, databases and effects-related indicators. EMEP should serve the needs of the Parties to the Convention, to which all EC countries and EC itself belong. To succeed, the opportunities for cooperation between the EC and the Convention, in the scientific underpinning of policy development and review, need to be exploited and reinforced.

The enlargement of the European Community and the climate-change policies driven by the Kyoto commitment to reduce greenhouse-gas emissions are political developments of significant importance for the future work under the Convention. Moreover, it is becoming increasingly apparent that a number of the environmental problems in Europe will require consideration of emissions and atmospheric behaviour on a hemispheric or global scale, so that the future work of EMEP will need to reflect this. Both EMEP and the Convention itself are well placed to act as a bridge between North America, Europe and the rest of the northern hemisphere in this context.

Another important development over the past few years has been the increasing recognition of the need to involve stakeholders, the public, industry, NGOs and others in the process of developing abatement strategies. This is particularly important as emissions are reduced and objectives are approached and the marginal costs of

abatement increase. In this context EMEP has to provide robust and sound scientific results.

This publication reviews the mandate and the past and current driving forces of EMEP. In conclusion, it presents a strategy for the future development of EMEP. This strategy should be seen as a living product that will be continuously updated as work progresses. The challenge is to foster the international partnership required for using the opportunities already given in the Convention, and to develop future international environmental solutions,

(a) Through scientific work;
(b) Through better communication;
(c) By making the best use of existing infrastructure, products and tools;
(d) By challenging intellectual resources;
(e) By providing free access to the data, information and tools and the appropriate guidance for their use.

The international scientific partnership in EMEP is to be reinforced in the assessment of:

(a) The quality, completeness and applicability of past and present emissions data and measured and modelled air concentrations and deposition distributions;

(b) The measurement network, national programmes and other infrastructure,

and in developing a comprehensive scientific basis for further cost-effective, effects-based international environmental legislation.

# I. MANDATE OF EMEP

The Cooperative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe (EMEP) was initiated in 1977 as a special programme under ECE. Its original objective was mainly to

> *"... 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…"*

EMEP has operated under the Convention on Long-range Transboundary Air Pollution since the Convention entered into force. In 1999, the Executive Body for the Convention (decision 1999/2, appendix III) decided that the main objective of EMEP was:

> *"To provide sound scientific support for the Convention, in particular in the areas of:*
>
> - *Atmospheric monitoring and modelling,*
> - *Emission inventories and emission projections, and*
> - *Integrated assessment."*

The Executive Body for the Convention has stressed the importance of EMEP and the need to implement it. The Executive Body also believes that the emphasis should be, inter alia, on:

(a) Monitoring, using the framework of both national and international programmes;

(b) Exchanging data on emissions or transboundary fluxes and making available the models used to calculate the latter;

(c) Providing meteorological and physico-chemical data relating to atmospheric processes;

(d) Monitoring chemical components in other media, and similarly monitoring their effects on health and the environment;

(e) Extending the EMEP networks to make them operational for control and surveillance purposes.

In line with article 10 of the Convention, the Steering Body of EMEP plays an integral part in the operation of the Convention, in particular in data collection and scientific cooperation. The annual costs of its international centres are covered in accordance with the Protocol on the Long-term Financing of EMEP. These costs may be met via mandatory and voluntary financial contributions to the General Trust Fund, or through contributions in kind.

As well as the more general requirements of the Convention itself, individual protocols require EMEP to carry out other tasks and to provide further information annually, for areas relevant to its geographical scope.

For instance, the 1988 Protocol concerning the Control of Emissions of Nitrogen Oxides requires EMEP to provide calculations of nitrogen budgets and transboundary fluxes and deposition of nitrogen oxides. The 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds (VOCs) requires EMEP to provide relevant information on the long-range transport of ozone. The 1994 Protocol on Further Reduction of Sulphur Emissions requires Parties to report to EMEP their data on emissions of sulphur, and EMEP to provide information on ambient concentrations and depositions of oxidized sulphur compounds and calculations of sulphur budgets. The 1998 Protocol on Heavy Metals requires EMEP to specify methodologies for heavy metals emission inventories, to receive emission data on heavy metals and to provide calculations of their transboundary

fluxes and depositions. The 1998 Protocol on Persistent Organic Pollutants (POPs) requires EMEP to receive information on the levels of emissions of POPs and to provide information on their long-range transport and deposition. According to the 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, EMEP is required to provide information on ambient concentrations and depositions of sulphur and nitrogen species, as well as, where available, on ambient concentrations of VOCs and ozone, and calculations of sulphur and oxidized and reduced nitrogen budgets and relevant information on the long-range transport of ozone and its precursors.

## A. Obligations of the Parties to the Convention

The Parties to the Convention are obliged to carry out national research and development, to communicate with international partners, to exploit and use existing data and research tools and to challenge their own intellectual resources. The Convention specifies these requirements as follows:

(a) Instrumentation and other techniques for monitoring and measuring emission rates and ambient concentrations of air pollutants (art. 7 (b));

(b) Improved models for a better understanding of the transmission of long-range transboundary air pollutants (art. 7 (c));

(c) Meteorological and physico-chemical data relating to the processes during transmission (art. 8 (e));

(d) The need to use comparable or standardized procedures for monitoring whenever possible (art. 9 (b));

(e) The establishment of monitoring stations and the collection of data under the national jurisdiction of the country in which the monitoring station is located (art. 9 (c));

(f) The establishment of a framework for a cooperative environmental monitoring programme, based on and taking into account present and future national, subregional and other international programmes (art. 9 (d));

(g) The desirability of extending the national EMEP networks to make them operational for control and surveillance purposes (art. 9 (i)).

Finally, countries are also required to provide information on emissions for use in the model calculations performed by the Meteorological Synthesizing Centres.

## II. DRIVING FORCES

### A. Past driving forces

EMEP started in 1977 and built on the results of a programme on the long-range transport of air pollution run within the Organisation for Economic Co-operation and Development (OECD) (1971-1977). At the outset there were three -- partly scientific and partly political -- driving forces:

(a) The acidification of rivers and lakes in Scandinavia with the associated dieback of fish populations;

(b) The need for independent scientific advice and consensus; and

(c) The need for constructive operational cooperation between Eastern and Western Europe in an area in which progress could be made without challenging the respective political systems.

These driving forces still exist but their emphasis has shifted, and new ones have emerged.

### B. Current driving forces

The first driving force has broadened considerably and now includes, in addition to freshwater acidification, the acidification and eutrophication of forests, natural and farmed soils and other ecosystems, ozone damage to crops, and the effect of air pollution on buildings and monuments. Increasingly, the impact of air pollutants on human health and that of ecotoxics such as POPs and heavy metals on ecosystems and wildlife are also driving policy.

Human health can be seriously affected by fine atmospheric particulate matter, ozone, $NO_2$, POPs, and heavy metals. A significant part of the fine atmospheric particulate matter arises from emissions of acidifying compounds. In addition, anthropogenic emissions of elemental and organic carbon are important. Natural

emissions also play a significant role. However, there are important gaps in our understanding of the origin of atmospheric particulate matter. Ozone and fine atmospheric particulate matter are transboundary pollutants and thus can only be reduced through international cooperation.

The importance of independent scientific advice and consensus is increasing in importance as it is realized how all the important environmental issues related to the atmosphere – urban air quality, transboundary air pollution, climate change and ozone-layer depletion – are interlinked. Scientific evidence indicates that the effect of acid deposition on aquatic ecosystems is to a large extent reversible and, if the Parties adhere to the obligations outlined in the protocols, the situation of the Scandinavian aquatic ecosystems will gradually improve. Much more work is needed, however, to understand how acidic and nutrifying deposition and ozone exposure change as a consequence of the planned emission reductions, and how ecosystems in general recover.

The geographic perspective is European, although the priorities differ from one subregion to the next. For instance, the state of the Scandinavian aquatic ecosystems remains an issue between the Scandinavian countries and those countries whose emissions caused the problem in the first place, whereas in southern Europe ozone exposure is of greater concern than acidification.

Environmental policy in the European Community (EC) is developed in parallel to the work under the Convention. The proposals for a European Community directive on national emission ceilings and for a new ozone directive are taking the same effects-based approach and to a large extent they share the same scientific models, databases and effect indicators. The European Community framework also includes air quality legislation under the Framework Directive for Air Quality, which requires air quality standards for several pollutants to be achieved over the next few years. As the EC countries, the applicants for EC membership and some new republics of the former Soviet Union are Parties to the Convention, the Convention and EMEP provide the best geographical and political platform to tackle the transboundary aspects of air pollution. It is also clear that emissions from outside Europe will play an

increasingly important role, so that the work of EMEP will need to embrace North America and the rest of the northern hemisphere.

Following the adoption of the Aarhus Protocols on Heavy Metals and on Persistent Organic Pollutants in 1998 and of the Gothenburg Protocol in 1999, the Executive Body set its priorities for the next few years. They are:

(a) The review and extension of existing protocols;
(b) The implementation of and compliance with existing agreements.

As the effect of current environmental legislation is evaluated, additional measures will have to be considered to meet interim and long-term objectives and/or critical thresholds for acidification, ground-level ozone, $NO_2$ and $PM_{10}$. Moreover, new measures and strategies may be required to meet critical thresholds for previously unregulated pollutants; and policies need to be developed to off-set the negative effects of continued growth in some economic sectors, notably transport. It is clear that further and significant progress needs to be made if the Parties to the Convention are to be protected from the threat of air pollution. It is equally clear, however, that the closer we get to achieving the objectives the more we need to identify those solutions which are cost-effective, and the more searching will be the scrutiny of the work of EMEP.

Apart from the impetus given by the enlargement of the European Community, the climate-change policies driven by the Kyoto commitment to cut greenhouse-gas emissions and international agreements to reduce emissions from, for instance, international shipping and aviation will also have an impact on EMEP.

Finally, of increasing significance in environmental policy development is the stakeholder involvement, taken as the interest and concern of individual citizens, local authorities, industry, non-governmental organizations, expert institutions and other bodies.

## III. STRATEGY

### Vision

The Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) will continue to be the main science-based and policy-driven instrument for international cooperation in atmospheric monitoring and modelling, emission inventories and projections, and integrated assessment to help solve transboundary air pollution problems. To this end, it seeks to develop:

- **SCIENCE** - EMEP establishes sound scientific evidence and provides guidance to underpin, develop and evaluate environmental policies;

- **PARTNERSHIP** - EMEP fosters international partnership to find solutions to environmental problems;

- **OPENNESS** - EMEP encourages the open use of intellectual resources and products;

- **SHARING** - EMEP is transparent and shares information and expertise with research programmes, expert institutions, national and international organizations, and environmental agreements;

- **ORGANIZATION** - EMEP is organized to integrate information on emissions, environmental quality, effects and abatement options, and to provide the basis for solutions.

### A. Science

A system is needed to measure the success of the protocols to the Convention. To assess how the environmental goals are being fulfilled, monitoring, modelling and emissions data must be integrated. Without a well-planned, supported and visible science-based system for measuring implementation, it is likely that the

protocols will fail in their mission. Tools need to be developed and applied to assess and verify that the implementation process is taking place and that it is cost-effective.

At the same time exploratory work must continue on new substances that may be harmful to human health and ecosystems. Alongside implementation, the scientific findings of EMEP can lead to new protocols or to revisions that improve the cost-effectiveness of the abatement strategies advocated.

The five thematic areas of EMEP are:

(a) Acid deposition and eutrophication;
(b) Photochemical oxidants;
(c) Heavy metals;
(d) Persistent organic pollutants; and
(e) Fine particulate matter.

Scientific support in these five areas requires the systematic collection, analysis and reporting of information from monitoring networks, emission inventories, modelling studies, and on abatement measures, as well as the assessment of all this information. In this context, assessment may be defined as the quantification, analysis and evaluation of air quality and deposition in relation to their causes and impacts.

A very significant task which will help in assessing the effectiveness of the Convention within several of these thematic areas is the use of the data produced by EMEP since 1977. The measurements collected since then represent a large and underexploited resource. However, sampling and analysis methods have varied between countries and have changed over time, so to facilitate the scientific use of historical data, data quality criteria should be set in dialogue with national experts.

Every year since 1977, the measured data produced by EMEP have been evaluated and related to the pollutant emissions by means of models for atmospheric transport and deposition. These models have been improved over time. Interpreting the measurement data would be greatly facilitated if these could be paired with calculated

data from one consistent model run, as far as possible covering the complete measurement period and preferably carried out with the best operational model tools now available within EMEP. This has so far not been possible because of the large amount of computer time needed and the lack of meteorological data required by the new models. The development in computer technology, and the extension of the meteorological re-analysis project at the European Centre for Medium-Range Weather Forecasts back to 1979, now seems to make this feasible. Of particular interest in this context is to find out what resulted when European sulphur emissions were reduced from their maximum of 60 million tons $SO_2$ around 1980 to half this value around 1995, and with different changes over time in different regions of Europe. Such a large-scale experiment in atmospheric chemistry could reveal some new scientific findings.

At recent EMEP workshops (Helsinki, Dubrovnik), statistical methods particularly suitable for air pollution data analysis and interpretation were presented with the emphasis on measured data. The Chemical Coordinating Centre (CCC) should make a suitable collection of such tools with software and user instructions freely available on the Internet. The software should be adapted to the structure of the EMEP measurement database. Tools should be evaluated and further developed in cooperation with the Parties.

To facilitate the analysis and interpretation of measurement data, the EMEP centres should also provide models that can be run locally by Parties. Alternatively, the model output could be provided to the user, with all other data required to run the model remaining at the centre, thus avoiding the transfer of large amounts of, for example, meteorological data.

Strategic elements are outlined below for each of the five thematic areas of EMEP. Goals are related to the effects of the pollutants. These define the products needed by the Parties and the subsidiary bodies of the Convention. The shortcomings of EMEP with respect to its goals and needs form a basis for the suggested improvements. In addition, separate sections deal with regional focus, integrated assessment modelling, and recommendations.

## 1. Acidification and eutrophication

The main goals are to:

(a) Determine the state of and the trends in deposition fluxes so that their effects can be assessed;

(b) Verify the reductions in sulphur and nitrogen emissions, and their effect on the deposition fluxes, particularly in relation to exceedances of critical loads;

(c) Calculate transboundary fluxes and provide source attribution of estimated or measured deposition fluxes in the form of contributions from emissions in one country to the deposition in a particular country or region;

(d) Investigate, in cooperation with the Working Group on Effects, the recovery of ecosystems.

Requirements in order of priority for fulfilling these goals:

(a) Measurements and derived data are required on a European scale, with source allocation. The spatial resolution in model predictions should be 50 km or better;

(b) The use of the data to assess effects requires that the difference between measurements and model results should generally be less than +/-30%, with a minimum of systematic differences in error between different geographical regions. These accuracy requirements apply equally to the determination of deposition fluxes and to their source attribution, and put a combined demand on the quality both of measurements as given by station representativeness, geographical coverage, analytical methods, component spectrum, time resolution and quality assurance/quality control (QA/QC) procedures, and of modelling as given by the quality of emissions, meteorological data, land-use

information and physical and chemical parameterizations;

(c) Monitoring implementation, based on trends in measured concentration and deposition, requires long and consistent time series of well-documented measurements at sites that are representative of regions where critical loads have been exceeded. Alternatively, implementation may be assessed on the basis of the general agreement between the model and the measurements. Time series analyses require that long-term average values should be accurate or consistent to at least within 5-10%.

Improvements needed:

(a) The completeness of reported emission data should be improved, particularly for sectoral emission data and trends;

(b) The modelling capability needs to be further developed, using the data provided by the measurement programme as well as other information, to provide a representative and sufficiently detailed overview of the deposition fluxes of sulphur and nitrogen compounds, and of base cations, over Europe;

(c) The importance of the level of oxidants for the design of control strategies for acid deposition should be clarified, as should the importance of re-emission of ammonia for the design of control strategies for eutrophication and acid deposition, and the accuracy of model estimates of both dry and occult deposition;

(d) The monitoring system should be strengthened in all countries using the techniques recommended for sampling and analysis. This is particularly important for future trends analyses and for the assessment of implementation. Monitoring efforts need to be increased in eastern Europe and in the Mediterranean area, for

nitrogen compounds in particular. Data quality criteria must be adopted at all working levels;

(e) National participation in interpretation and assessment should be increased. It is essential to interpret time trends, to reconstruct historical emissions, to determine site representativeness, and to relate EMEP data to other data from national networks and to assessments at the national level.

## 2. Photochemical ozone formation

The main goals are to:

(a) Assess the exposure of man, crops, forests and other ecosystems to ozone;

(b) Verify emission reductions under the 1991 VOC and the 1999 Gothenburg Protocol;

(c) Attribute to sources the precursors contributing to ozone formation;

(d) Establish trends for ozone over Europe.

Requirements in order of priority for fulfilling these goals:

(a) The evaluation methodology must include emissions, chemistry, meteorology, land use and surface properties. This can only be achieved by a model that describes the concentration of precursor chemical compounds and reaction products with appropriate spatial and temporal resolution;

(b) Emission inventories should have the necessary detail, particularly with respect to chemical species and temporal variations, and national totals should be accurate to within 10%. Emissions from natural

sources, particularly emissions of VOCs from vegetation, are also needed;

(c) Improved methodology for source attribution for ozone is needed. Emission inventories for VOCs and $NO_x$ should have a margin of error in total national emissions no greater than 10%. Accuracy and temporal consistency of data series are essential for trend assessment. High-quality exposure and dose data (i.e. integrated concentration exceeding some limit value over a given time period) are required for the assessment of effects on man and the environment;

(d) Assessment of effects needs both measurements and models which can be used to generalize the measurement results, and an understanding of the exposure and the effects mechanisms. At present, the mapping of AOT40 and AOT60 doses is required for 50 km x 50 km grids. Using more sophisticated plant-uptake mechanisms may result in more accurate exposure and damage estimates;

(e) Regional sites for ozone measurements can be placed 50 to 200 km apart, depending on the local conditions and surroundings of the sites. Specific sites for emission verification and compliance monitoring are located closer to the emission areas and have larger variability. Site representativeness of both existing and new sites needs to be carefully evaluated;

(f) Since ozone concentrations vary only slightly across regional sites, measurements of other primary and secondary components are needed to evaluate models, particularly with respect to the chemical transformation processes. Such measurements are also needed to study trends and verify emission changes, e.g. with respect to VOC emission reductions;

(g) Ozone and its precursors on the hemispheric or global scale are strongly influenced by photochemical ozone

formation on the European, national and local scales, and vice versa. A description of these phenomena requires a linking of models for different scales. Understanding the interactions between ozone formation on the different spatial scales requires models that resolve the most important spatial scales.

Improvements needed:

(a) The quality of the emission survey and the measurement data needs to be assessed in all parts of the network and for all components, and data quality will need to be improved to meet the requirements. QA/QC procedures for ozone, nitrogen dioxide and VOCs will need to be reviewed and further improved;

(b) In particular, the demand for very high-quality data for trend studies could be met by a limited number of carefully selected and dedicated sites ("supersites" or "trend sites");

(c) The photochemical models should be further developed to reach a good performance in all regions, e.g. to clarify the importance of long-range transboundary transport for the high ozone concentrations in Mediterranean countries;

(d) The importance of North American sources of $NO_x$ and VOCs for the ozone concentrations in Europe should be clarified;

(e) Work is needed to clarify further the extent of areas where ozone is VOC-controlled rather than $NO_x$-controlled and to clarify the significance of situations where reductions in $NO_x$ emissions lead to higher ozone concentrations, for the design of better control strategies for ozone;

(f) The methodology to estimate the population exposure to ozone and fine particulate matter in urban as well as rural areas is to be improved

### 3. Heavy metals

The main goals are to:

(a) Quantify national emissions, minimizing emission uncertainties for cadmium, lead and mercury, and in the longer term for copper, zinc, arsenic, chromium and nickel;

(b) Verify the emission reductions of the same substances;

(c) Calculate transboundary fluxes, deposition and source attribution; analyse trends;

(d) Contribute to research on the effects on human health and the environment.

Requirements in order of priority for fulfilling these goals:

(a) The 1998 Protocol on Heavy Metals specifies limit values for emissions from stationary sources. In order to detect reductions in emissions of less than 30%, measurements of both air and precipitation need, ideally, to be accurate to within 5-10%. Likewise, a 90% accuracy in national total emissions is needed;

(b) For model estimates, historical emissions and detailed emission inventories, including particle size distributions, characteristics of large point source emissions, and chemical speciation of mercury in the emissions are needed. Natural emissions and re-emissions of mercury and its hemispheric and global cycling needs to be assessed, including mercury from non-European anthropogenic sources;

(c) Analysis of trends and compliance needs well-characterized sites with regard to representativeness, source regions and meteorology;

(d) Heavy metal transport models need further development, including the linking of local, regional and, as in the case of mercury, hemispheric processes. The reaction rate coefficients for the chemical reactions involving mercury, the physical transformations and exchange processes between various media need more accurate determination.

Improvements needed:

(a) The methods to assess and verify heavy metal emissions need improving;

(b) The size distribution of particulate matter needs to be understood and included in dispersion models for heavy metals;

(c) A limited number of carefully selected and dedicated sites for trend studies and model validation is urgently needed;

(d) Existing methods and QA/QC protocols should be reviewed and strengthened considering the data targets;

(e) The regional concentration and deposition patterns of mercury, which are influenced by the hemispheric and global mercury distribution, need to be better characterized;

(f) The adsorption to, and chemical transformation of, heavy metals on particles, as well as the parameterization of dry and wet removal processes, are not well-characterized and must be studied;

(g) The relationship between changed emissions of heavy metals and their residence times in different compartments needs further study;

(h) Existing models need to be improved and validated to develop operational ones.

4. Persistent organic pollutants

The main goals are to:

(a) Quantify national emissions, quantifying and minimizing emission uncertainty especially for pesticides;

(b) Determine the source-exposure relationships through a better understanding of exchange processes between atmosphere, soil, sea and biota;

(c) Improve and validate models to develop operational ones;

(d) Assess transboundary fluxes, as well as the deposition and concentrations of selected POPs in the atmosphere, soil, sea and biota, to evaluate the harmful effects on ecosystems and human health;

(e) Establish trends for assessing implementation;

(f) Analyse how different environmental compartments respond to emission reductions.

Requirements in order of priority for fulfilling these goals:

(a) Methodologies are needed to establish and apply national, hemispheric and global emission inventories, including verification procedures, to assess accuracy. Measurements at a national level are needed to derive partitioning coefficients and kinetic parameters for the exchange between the media that determines the

dispersion, transformation, degradation and accumulation of POPs;

(b) POP multi-compartment models need further development and validation to be operational;

(c) Indicative substances with representative toxicities and which cover a wide range of chemical and physical properties need to be selected and their emissions, physico-chemical properties, concentrations and contribution to exposure determined. The deposition of POPs needs to be assessed across Europe, in particular for the indicative POPs. POP transport between Europe and other continents in the northern hemisphere and at a global level needs to be assessed.

Improvements needed:

(a) The methods to assess and verify POP emissions should be improved;

(b) As a first step, five European sites are to be established with common operational and QA/QC procedures, and with only air sampling. Deposition measurements are to be started in a second step. One central laboratory should be responsible for the analyses in the starting phase and, at the same time, laboratory comparisons and training of personnel in other laboratories should take place;

(c) Exploratory measurements should be carried out to identify components that may have to be included in EMEP;

(d) The size distribution of particles containing POPs should be evaluated and the information used to improve the description of the deposition of POPs;

(e) The knowledge of the physico-chemical properties of prioritized POPs and of their behaviour in different ecosystems should be refined;

(f) Multi-compartment models of POPs must be further developed to evaluate regional and hemispheric transboundary transport;

(g) Measurements and comparison studies between different transport models should be used to improve model formulation;

(h) The way in which POPs are scavenged, in particular with snow, should be described;

(i) A limited set of components must be developed to represent a complex mixture of POPs.

## 5. Fine particulate matter

The main goals are to:

(a) Establish concentrations and population exposures of long-range transported fine particulate matter;

(b) Calculate transboundary fluxes of fine particulate matter and their source attribution;

(c) Develop interfaces with urban modelling and assessment;

(d) Quantify the decreased visibility caused by fine airborne particulate matter in Europe;

(e) Contribute to the determination of the effects of fine particulate matter on radiation forcing and climate change in the EMEP region.

The present requirement is to provide yearly averaged concentrations of total aerosol mass and of aerosols with diameters of less than 10 μm or 2.5 μm, respectively, and relate them to emissions of primary particles and of precursors for secondary particles on a country-to-country or a country-to-grid-square basis. Further characterization is needed of chemical composition, size distribution and other physical parameters.

Improvements needed:

(a) Countries should provide national emission estimates based on a common methodology for particulate matter, especially particulate matter with an aerodynamic diameter <2.5 μm and <10 μm;

(b) All participating countries should measure and report concentrations of aerosols at representative EMEP sites. The measurements should be compatible with the measurements carried out in urban areas, to establish a data set that defines rural background concentration levels across Europe;

(c) Both measurements and emissions require speciation with respect to particle size distributions and chemical compositions, distinguishing between inorganic and organic, and between organic carbon and elementary carbon (soot), in order to verify source attribution;

(d) Models should include aerosol dynamics to calculate changes in aerosol size distributions resulting from the formation and condensation of secondary aerosols, and the depletion by deposition processes;

(e) The importance of different pollutant sources for the concentrations of fine particulate matter should be clarified for different areas of Europe.

## 6. Regional focus (Mediterranean, the Balkans, North Africa, Western Asia)

Not all parts of Europe are concerned with the same environmental issues. In the Mediterranean the focus is on mesoscale meteorological cycles and ozone and fine particle formation, while in northern Europe long-range transport is important. In the Alps and in other mountainous regions the local topography is a major factor in pollution distribution. This does not jeopardize the European dimension of EMEP or the partnership with national science activities. On the contrary, it means that national activities have much to contribute to establishing the European pollution picture.

## 7. Integrated assessment modelling

EMEP provides scientific information on emissions, measurements, projections and abatement costs to support the review and development of protocols to the Convention. The Task Force on Integrated Assessment Modelling, supported by the Centre for Integrated Assessment Modelling (CIAM), brings together all relevant scientific information in a consistent modelling framework that can be used by the Working Group on Strategies and Review to review (and negotiate) protocols. Integrated assessment models also take into account work done by, and information available from, other subsidiary bodies such as the Working Group on Effects. The Task Force on Integrated Assessment Modelling analyses the cost-effectiveness of (existing and new) international emission control strategies for acidification, eutrophication, tropospheric ozone exposure and exposure to fine particulate matter. The main goals of the modelling work are to:

(a) Incorporate abatement options for reducing sulphur, nitrogen oxides, ammonia, volatile organic compounds and primary particulate matter, including structural measures in energy, transport and agriculture, and calculate their costs;

(b) Incorporate the best data on projections of emissions, including the consequences of implementing current

legislation and of the obligations under the United Nations Framework Convention on Climate Change;

(c) Assess the atmospheric transport of substances, including transcontinental transport;

(d) Analyse the environmental and health effects and calculate the economic benefits of emission reductions.

Specialized workshops should be organized to develop model elements that are not sufficiently covered by other bodies under the Convention. All activities should be conducted in close collaboration with related work led by the European Commission.

One of the biggest challenges for integrated assessment modelling is to increase the model complexity while keeping models highly transparent for policy makers, stakeholders and scientists. Another challenge will be to move from uncertainty identification towards supporting policy makers in uncertainty management. One of the main strategic tasks is to foster closer links with experts working at the science-policy interface at the national level. The Task Force on Integrated Assessment Modelling will set up a network of national focal points for integrated assessment modelling to facilitate communication between it, CIAM and government officials, regional authorities, stakeholders and other experts and to compare international models with national data and modelling results. This network should, as far as possible, be integrated with the integrated assessment networks of the European Community and the European Environment Agency. Swift and accessible distribution of data and model results via the Internet is also important. As far as technically possible, versions of integrated assessment models should be made available via the Internet to all national experts for their use. CIAM will support capacity building at national level by hosting national experts for extended periods (several months) and assisting in national modelling activities.

## 8. Recommendations

Based on consideration of the goals and requirements for EMEP as a whole, and the suggested improvements, the following recommendations can be made regarding the scientific aspects of EMEP:

(a) All countries should reconsider their national measurement programmes' reporting to EMEP, particularly in view of the recommendation to use standardized methods (i.e. the methods specified in the EMEP manual). The location of measurement sites should also be reviewed, particularly with respect to representativeness and geographical coverage. Measurement programmes should be complete within each of the five thematic areas of EMEP, i.e. acidification and eutrophication, photochemical oxidants, heavy metals, POPs and aerosol particles;

(b) Countries should also, in cooperation with the Meteorological Synthesizing Centres (MSC-W and MSC-E) and CCC, identify sites which can be used for the evaluation of trends in the deposition of sulphur, nitrogen compounds, heavy metals, POPs, and the assessment of the implementation of protocol obligations. More complete reporting of emission data is also needed for the analysis of trends;

(c) The acidification and eutrophication model is currently being improved. The spatial resolution of the model has been increased, and the mass conservation properties and the accuracy of the model results have improved. The goal with respect to accuracy of the EMEP model results has been set at ±30% when compared with observations for all components. To determine whether this model is satisfactory, countries should consider carefully the deposition estimates within their own borders, including the representativeness of the national measurement sites used for model verification and validation;

(d) The Eulerian model for photochemical ozone formation will represent a considerable step forward in the description of surface ozone concentration fields, and the interpolation of AOT40 and AOT60 figures from measurements. Again, countries should carefully examine whether their ozone measurements are satisfactory for model validation, and if their sampling sites are representative;

(e) Trend and implementation analyses for the reduction of ozone exposures are much more complicated than for acid deposition and eutrophication. Measurement series need to be carefully validated, and calibration of ozone instruments should follow rigorously the recommendations given in the EMEP manual and the instructions of the World Meteorological Organization (WMO) calibration centre for ozone in Switzerland. The continuation of VOC measurements is required in order to see if reductions in the concentrations of ozone precursors follow the reductions in VOC emissions specified in the protocols. Reductions in the emissions of nitrogen oxides will be seen in the measurements of oxidized nitrogen compounds, which should be intensified;

(f) The Eulerian atmospheric transport model was adopted for the calculation of long-range transport and country-to-country depositions for some heavy metals. Uncertainty of modelling results is approximately a factor of two. Emission estimates for heavy metals (first of all for lead, cadmium and mercury) need to be verified on a national basis to provide reliable source-receptor relationships from models and measurements;

(g) More exploratory work is needed on the emissions, measurements and modelling of POPs. Emission inventories for POPs need to be reviewed and their consistency and compatibility improved. Measurements of POPs in air are to be started at five sites, using identical sampling methodology and with analyses at

one central laboratory for the first year. There is an apparent need for additional measurements in campaigns, with simultaneous measurements at several sites (10-20) across Europe. Samples should be analysed at one central laboratory to obtain consistent results. At the same time, measurements of new compounds should be considered. For the assessment of transboundary transport, deposition and concentrations of selected POPs, the development of multi-compartment models for regional, hemispheric and global scales will be continued. Special attention should be given to the understanding of the physico-chemical properties of POPs and their cycling between atmosphere, soil, water and biota;

(h) In order to provide information on the long-range transport of airborne particles, measurements of the mass concentration of fine particulate matter at EMEP sites are urgently required. Measurements should specify both the particle size and the chemical composition of particulate matter. Information from countries about the emissions of primary particles has been requested by the Task Force on Emission Inventories and Projections. EMEP should specify data requirements with respect to particle sizes and chemical composition. Modelling work will consider both primary particles and secondary organic and inorganic particles. In the future, these models should be linked, providing a dynamic description of nucleation, coagulation, condensation and size-dependent deposition processes.

## B. Partnership and openness

The Parties to the Convention are committed to research and development. The international partnership of the Parties to the Convention and the EMEP centres should be strengthened through interaction between EMEP and national research and monitoring

programmes. The same quality of control procedures and targets must be followed as that required for the core activities in EMEP.

Scientific contributions from countries should be financed nationally, as voluntary contributions in kind. In practice, these contributions will often represent scientific extensions of the already existing nationally financed infrastructure for the measurement network. Plans for scientific contributions should be drafted by each country or by voluntarily formed groups of countries with similar interests in consultation with one or more EMEP centres, as appropriate. The EMEP centres may contribute to the work within their resources/priorities. Capacity building should be a part of the collaboration where appropriate. The EMEP Steering Body (and its Bureau) should discuss the proposals and make recommendations for contributions to be included in the EMEP work-plan. Each year, the EMEP Steering Body should review and discuss the progress in each of these tasks, and report its evaluations to the Executive Body.

## C. Sharing

### 1. Information

The dissemination of information within EMEP, and from EMEP, should be transparent, two-way and easily accessible by everybody. It is particularly important to develop the EMEP web site further, and to make sure that the special information needs of, for example, the Working Group on Strategies and Review and the Implementation Committee are met.

### 2. EMEP-European Community relationship

The European Community (EC) has a legislative system of its own. The EC and its member States are Parties to the Convention, and to maximize the benefit and minimize the costs of monitoring and research, technical integration of the activities coordinated by the

European Commission and those of the Convention should be developed as far as possible.

A framework programme 'Clean Air for Europe' is being formulated by the European Commission's Environment Directorate General. The aim of the programme is to identify or confirm key areas where action is required, to provide the necessary tools and databases, to perform various analyses so as to allow consideration of various options for environmental objectives and associated emission control strategies. Because of the similarities between the approaches underpinning the 1999 Gothenburg Protocol and the National Emission Ceilings Directive, opportunities should be explored for cooperation between the European Community activities and those under the Convention in their scientific investigations and analyses.

The European Environment Agency (EEA), in close cooperation with its member countries, prepares air pollution and wider environmental assessments and develops the underlying information infrastructure. In particular, it operates the air quality monitoring network EUROAIRNET, the air quality data and information system AIRBASE, and the supporting model documentation system. National EMEP sites are an important component in EUROAIRNET, and the extent to which EUROAIRNET sites could be adopted as EMEP sites and vice versa should be evaluated, with due attention to the objectives and quality requirements of both programmes. Similar actions should be taken to further increase coherence also in data reporting, data management and assessments.

## 3. Relationship with work in North America

Both Canada and the United States are Parties to the Convention and to many protocols, including the EMEP Protocol. There is a long tradition of cooperation between EMEP and North American scientists. Much of the work related to POPs and heavy metals, including the transport of these pollutants to Arctic regions, has been conducted jointly.

As global emissions increase, the transport of pollutants between the continents is raising European levels of the pollutants controlled by the protocols to the Convention. In order to address effectively the environmental problems that need to be considered on a hemispheric basis, the work of EMEP should embrace developments in North America.

North American research activities, including those under the North American Research Strategy for Tropospheric Ozone (NARSTO), are very relevant to EMEP and collaboration should be encouraged. Countries should be encouraged to organize EMEP workshops to address the transcontinental nature of many air pollution problems.

## 4. Stakeholders' interests

The work carried out in EMEP should be transparent to, interact with and enjoy the confidence of the stakeholders - the individual citizen, local authorities, industry, non-governmental organizations, expert institutions, countries and other bodies.

## 5. International programmes

Very considerable research activities in fields relevant to EMEP are carried out within international research programmes and projects. Interaction with this research and use of its results are essential for developing EMEP as our understanding of the physics and the chemistry of the atmosphere increases.

The WMO/Global Atmospheric Watch (GAW) programme, with its mission to make reliable, comprehensive observations of the chemical composition and selected physical characteristics of the atmosphere, is in a position to contribute considerably to EMEP. The European regional components of GAW and EMEP have nearly identical goals and supplement each other.

Closer cross-organizational interaction with WMO is important in order to benefit from cooperation in the monitoring of air and precipitation in Europe. The monitoring activities should be

harmonized in order to obtain a better overview of the relationships between urban and regional pollution, and between the regional and the global scale.

Monitoring, assessment and research on air pollution are also parts of international agreements and organizations, e.g. the Convention on the Protection of the Marine Environment of the Baltic Sea Area, the Convention for the Protection of the Marine Environment of the North-Sea Atlantic, the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, the Convention on the Protection of the Black Sea Against Pollution, the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). EMEP should benefit from, as well as contribute to, these activities.

The related efforts between EMEP, the Arctic Monitoring and Assessment Programme (AMAP) and the United Nations Environment Programme (UNEP) in emission inventories, measurements and modelling of long-range transport at hemispherical and global levels should be coordinated.

Some of the research funded by the European Commission's Research Directorate General in the Framework Programme 5, studies the transport and chemical transformation of pollutants in the troposphere over Europe. Some of the sub-projects of the International Geosphere-Biosphere Programme (IGBP), such as the International Global Atmospheric Chemistry Project (IGAC) and Land Ocean Interaction in the Coastal Zones (LOICZ), organize international research that is relevant to EMEP. EMEP should benefit from these major efforts.

Some of the projects in EUROTRAC-2 are very relevant to EMEP and collaboration should be encouraged.

## 6. Global change science interaction

Transport between continents, within the hemisphere and also globally is an important element in the European budget for all the species controlled by the protocols to the Convention. Interaction

with scientific work within the United Nations Framework Convention on Climate Change, IGBP (IGAC) and projects within the World Climate Research Programme can provide information to determine the hemispheric or global component of the European pollution load. Emissions from aircraft and ships, and cooperation in international forums like IMO and ICAO are of importance for EMEP.

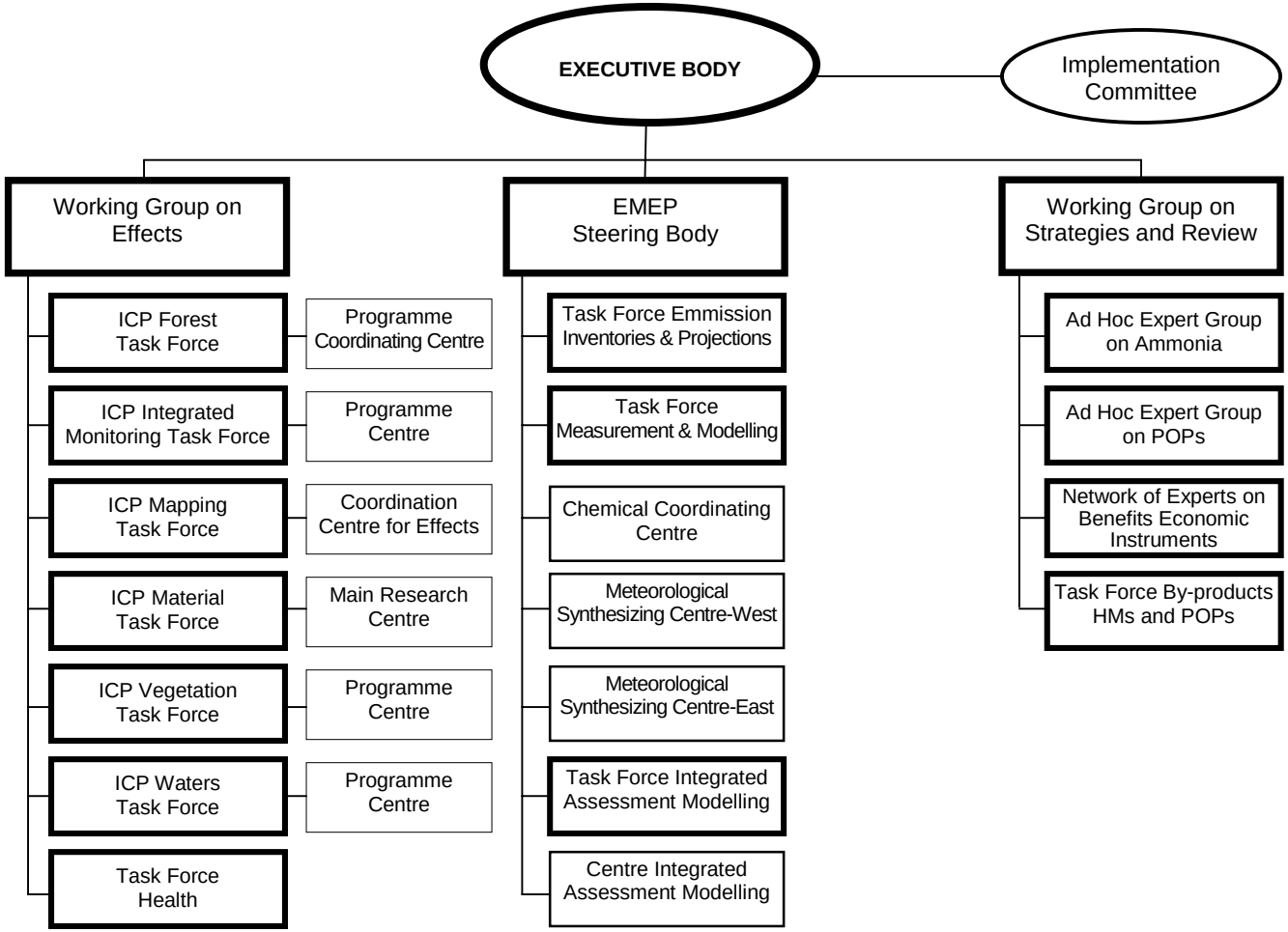
## D. Organization

The organization of the work under the Convention is shown in the figure below. The new Task Force on Measurements and Modelling should be a forum for discussing the EMEP work-plan, including the incorporation of national contributions, and for scientific evaluation and advancement.

Strengthening overall cooperation within EMEP, and in particular cooperation involving better and broader use of EMEP products at national level, will facilitate a wider acceptance of the protocols to the Convention and help their ratification.

National research and monitoring activities constitute an indispensable part of a well-functioning EMEP and Convention and it is important to ensure that such activities are carried out and that they contribute to EMEP. Here the national representatives for the Executive Body of the Convention should take responsibility for facilitating such activities in their countries. The EMEP Steering Body, its Bureau and the centres should all actively contribute towards establishing scientific cooperation with the national activities.

Appropriate links need to be maintained between EMEP and the Working Group on Effects and the policy-making segment of the Convention represented by the Working Group on Strategies and Review.


EXECUTIVE BODY
Implementation Committee
Working Group on Effects
EMEP Steering Body
Working Group on Strategies and Review
ICP Forest Task Force
Programme Coordinating Centre
ICP Integrated Monitoring Task Force
Programme Centre
ICP Mapping Task Force
Coordination Centre for Effects
ICP Material Task Force
Main Research Centre
ICP Vegetation Task Force
Programme Centre
ICP Waters Task Force
Programme Centre
Task Force Health
Task Force Emmission Inventories & Projections
Task Force Measurement & Modelling
Chemical Coordinating Centre
Meteorological Synthesizing Centre-West
Meteorological Synthesizing Centre-East
Task Force Integrated Assessment Modelling
Centre Integrated Assessment Modelling
Ad Hoc Expert Group on Ammonia
Ad Hoc Expert Group on POPs
Network of Experts on Benefits Economic Instruments
Task Force By-products HMs and POPs

Long-term financing; geographical coverage; monitoring costs

Long-term financing of EMEP centres must remain secure through the effective implementation of the EMEP Protocol. There are large differences with respect to the levels of commitment to implementing the EMEP monitoring programme in the participating countries. In general, small countries are more committed than large ones to providing measurement data, but the costs of measurements relative to the GDPs of the different countries also show large variations related to national priorities. A lack of resources prevents high-quality measurements in many countries, although these measurements are needed to resolve uncertainties in present model estimates and emission inventories.

While the measurements should continue to be under national jurisdiction, there are several possibilities for improving the measurement network and for providing the required information about ambient concentration levels and deposition rates. The best way to obtain a set of measurement data of uniform quality for components such as POPs and mercury would be to carry out a common pilot measurement programme of limited duration with the collection of samples at previously identified sites and the analysis of these samples in one laboratory only.

Attention has repeatedly been drawn to the poor geographical coverage of the EMEP measurement network in eastern Europe and in the Mediterranean area. This is clearly linked with the lack of resources in some countries, to remedy this situation:

(a) Bilateral or multilateral cooperation should be developed between countries;

(b) Cooperating organizations or networks should be involved, to the extent that these have common goals with EMEP;

(c) Sampling equipment and chemical analyses should be provided by CCC, for a limited time, at sites identified by the Steering Body;

(d) In connection with the adoption of EMEP reference measurement methods in all participating countries, standardized sampling equipment (e.g. filter holders) should be made available for use at selected sampling sites.

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