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Contents

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Editorial

The encouraging response to the publication of the first Newsletter has reinforced our conviction of the importance of communication as part and parcel of the implementation of the EC Environmental Research Programmes. Constant efforts should be made to establish contact with actual and potential participants in the programme, i.e. research workers in universities, research centers and industry in the twelve Member States, and also with potential users of information acquired through research.

The Newsletter is also intended as a vehicle for disseminating news on noteworthy activities in the Member States relevant to environmental research, as well as for announcing upcoming events of interest. We hope that many of our colleagues in the Member States will want to avail themselves of this opportunity.

Emphasis in this issue is placed on research and regulatory actions in the field of **Air Quality**. For the sake of completion, references to activities prior to 1988 have been included, this makes this issue larger than usual.

Air quality is a topic of growing importance. Human activities are inducing modifications of atmospheric composition, not only regionally but globally and from the lower troposphere to the stratosphere. The impact may be through chemical effects on ecosystems, as in the case of acid deposition and photooxidants, or through climate alterations from greenhouse gases.

A recent manifestation of political concern on this issue was the Conference on "the changing atmosphere, implications for security" which was held on 27-30 June 1988 in Toronto. This conference resulted in a declaration proposing the opening of negotiations toward a "Law of the atmosphere" expanding the recently signed Montreal Protocol on the preservation of the ozone layer. It also called for a 20% reduction in greenhouse gases emissions by the year 2005.

Several years ago increased emphasis was given to the subject of air quality in the EC Environmental Research Programme, as a response to the evidence of forest decline observed initially in the FRG. A symposium organised in September 1983 in Karlsruhe produced an initial assessment of the relevant research activities. More EC funding was made available and a series of transnational projects were launched. A second large symposium was held in Grenoble in May 1987 to take stock of progress achieved in studying the effects of air pollution on aquatic and terrestrial ecosystems. In parallel the COST 611 Concerted Action proceeded with its series of symposia on the physico-chemical aspects of atmosphere pollution.

Currently, as will be seen, a vast effort of coordination of European research in this general field is on-going. It will undoubtedly yield additional results which will support EC regulations on emissions from stationary and mobile sources.

In the near future, an additional action will be initiated on the ozone issue, involving European Free Trade Area (EFTA) countries as well as those of the European Community.

The present research programme on climatology and natural hazards will be expanded. Details will be given in a forthcoming issue of the Newsletter.

Ph. Bourdeau
Director of DG XII / E
Environment and Non-Nuclear Energy Sources

EC Research Actions Programmes (DG XII)
Air Quality

Air Quality is one of the topics of the Environmental Protection programme the implementation of which is carried out by means of shared-cost, concerted and direct actions.

Further information concerning shared-cost and concerted actions, managed by Directorate General XII / E, can be obtained from:
H. Ott, CEC-DG XII / E, 200 rue de la Loi, B - 1049 Brussels.
Tel. + 32 2 2351182.

Further information concerning direct actions can be obtained from:
B. Versino, Environmental Protection Programme,
JRC Ispra, 21020 Ispra (VA), Italy. Tel. + 39 332 789958

1. Shared-Cost Actions (1986 - 1990)

In the framework of the Fourth Environmental Protection R & D Programme of the Commission of the European Communities a number of research contracts were established with various laboratories in the Member Countries. They were selected from the two thousand or so proposals received in response to the Call for Research Proposals which was published in June 1986 (Supplement to the Official Journal of the European Communities No S 116/48, 19.6.86). As indicated by their appellation, these contracts contribute a share of the cost involved.

In the research area Air Quality the following projects are actually in progress. They are grouped in four topics and are listed below with an indication of the institution concerned as well as the responsible scientist. Some projects are linked with existing concerted COST projects (see below). A registry of data sheets with a description of the various projects will be soon available through H. Ott, quoted above.

1.1. Analysis, Sources, Transport, Transformation and Deposition of Pollutant

- Development of automated chemical sensors for dry deposition measurements of acidic substances:
  - Fraunhofer Institute for Atmospheric Research Garmisch-Partenkirchen, FRG, F.X. Meixner;
  - Netherlands Energy Research Foundation ECN, Petten, The Netherlands, J. Slanina;
  - Consiglio Nazionale delle Ricerche, Rome, Italy, M. Possanzini.
- Laboratory studies of nitrate radical reactions of tropospheric importance:
  - University of Oxford, UK, R.P. Wayne;
  - Centre National de la Recherche Scientifique, Orléans, France, G. Le Bras;
  - Max Planck Institut, Mainz, FRG, J.P. Burrows.
- Laboratory studies of peroxyradical reactions of importance for tropospheric chemistry:
  - Max Planck Institut für Chemie, Mainz, FRG, G.K. Moortgat;
  - United Kingdom Atomic Energy Authority, Harwell, UK, R.A. Cox;
  - Bergische Universität, Wuppertal, FRG, K.H. Becker;
  - Université de Bordeaux, France, B. Veyret.
- A quantitative study of organonitrogen and sulphur atmospheric transformations:
  - University College, Dublin, Ireland, H.W.S. Sidebottom;
  - Dublin Institute of Technology, Dublin, Ireland, J. Treacy;
  - Riso National Laboratory, Roskilde, Denmark, O.J. Nielsen.
- Kinetics and mechanisms of acid generation in clouds and precipitation:
  - Max Planck Institut für Chemie, Mainz, FRG, P. Warneck;
  - University of Leeds, UK, G.A. Salmon;
  - Central Electricity Research Laboratories, Leatherhead, UK, W.J. Mc Elroy.
- Investigation on physico-chemical processes leading to acid production in radiation fog and captive clouds:
  - Universität Frankfurt, FRG, W. Jaeschke;
  - Consiglio Nazionale delle Ricerche, Bologna, Italy, S. Fuzzi.
- Labile nitrogen compounds forming potential and conversion to HNO_3:
  - University of Bonn, FRG, U. Schurath;
  - University of Patras, Greece, S. Glavas.
- "OCEANO NO_x". The influence of Atlantic air masses on oxidation processes over Western Europe:
  - Centre National de la Recherche Scientifique, Orléans, France, G. Le Bras;
  - Centre National de la Recherche Scientifique, Gif-sur-Yvette, France, B. Nguyen;
  - Université Paris VII, Paris, France, P. Carlier;
  - United Kingdom Atomic Energy Authority, Harwell, UK, R.A. Cox;
  - Kernforschungsanlage, Jülich, FRG, U. Platt;
  - Bergische Universität, Wuppertal, FRG, K.H. Becker.
- Mesometeorological cycles of air pollution in the Iberian Peninsula:
  - Centro de Investigaciones Energeticas Medioambientales y Tecnologicas - JEN, Madrid, Spain, M. Millan.
- A field measurement study of the night time oxidation of naturally emitted hydrocarbons:
  - Max Planck Institut für Chemie, Mainz, FRG, D. Perner;
  - Consiglio Nazionale delle Ricerche, Rome, Italy, P. Ciccioli.

All these research projects are related to COST Project 611.

1.2. Effects of Air Pollution on Terrestrial Ecosystems

- Effects of air pollution on forest trees and ecosystems (early specific indicators of physiological responses):
  - Fraunhofer Gesellschaft Schmallenberg, München, FRG, F. Ott;*
  - University of Birmingham, UK, D. Wilkins;
  - Universität Göttingen, FRG, A. Hütterman;
  - Universität Bayreuth, FRG, E. Schulze;
  - University of Manchester, UK, J. Lee;
  - Technische Universität, München, FRG, K. Lendzian;
  - Universiteit Antwerpen, Belgium, Y. Impens;
  - Faculté des Sciences Agronomiques, Gembloux, Belgium, R. Impens;*
  - NERC-Institute of Terrestrial Ecology, Edinburgh, D. Fowler;*
  - Gesellschaft für Strahlen- und Umweltforschung, Neuherberg, FRG, H. Payer;
  - Universität Essen, FRG, R. Guderian;*
  - Bundesforschungsanstalt Grosshansdorf, FRG, F. Scholz;
  - University of Newcastle-upon-Tyne, UK, A. Davison;
  - NERC-Institute of Terrestrial Ecology, Edinburgh, N. Cape.
- Contribution to the analysis of the impact of airborne pollutants on forest trees (Baden-Württemberg Research Programme PEF coordinated with the French National Programme DEFORPA):
  - Kernforschungszentrum Karlsruhe, FRG, F. Horsch;
  - Universität Hohenheim, FRG, U. Arndt;*
  - Fortsl. Versuchs- und Forschungsanstalt Baden-Wurttemberg, FRG, F.H. Evers;
  - Universität Tübingen, FRG, F. Oberwinkler/ R. Hampp;
  - Universität Freiburg, FRG, H.W. Zöttl/ H. Mohr;

- Fortsl. Versuchs- und Forschungsanstalt Baden-Württemberg, FRG, W. Bücking.

- Air pollution and forest decline (French National Programme DEFORPA coordinated with the Baden-Württemberg Research Programme PEF):
  - Institut National de la Recherche Agronomique, Paris, France, M. Bonneau;*
  - Centre National de la Recherche Scientifique, France, O. Queiroz/ M. Ambroise;
  - Université de Grenoble, France, B. Souchier;
  - Université de Bordeaux, France, C. Bernard-Dagan;
  - Université de Nancy, France, P. Dizengremel;
  - Université de Paris Val de Marne, France, D. Louguet;
  - Université de Strasbourg, France, M. Gounot;
  - Centre de Recherche en Environnement du Département des Pyrénées Atlantiques, Mourenx, France, J. Bonte;*
  - Université de Clermond-Ferrand, France, R. Rosset;
  - Météorologie Nationale, France, M. Zephoris;
  - Institut National de la Recherche Chimique Appliquée, I.R.C.H.A., France, M. Hennequin;
  - Parc National des Cévennes, France, M. Begue.
- Acid deposition effects studies by manipulating forest ecosystem:
  - Universiteit Wageningen, The Netherlands, N. Van Breemen;
  - Universität München, FRG, K. Kreutzer;
  - Universität Göttingen, FRG, B. Ulrich;
  - Technical University of Denmark, Lyngby, Denmark, L. Rasmussen.
- European Open-Top Chambers (OTC) project on agricultural crops:
  - Institut für Produktions- und Ökotoxikologie, Braunschweig, FRG, H. Jäger;*
  - Trinity College Dublin, Ireland, D. Richardson;*
  - Institut de Recherche Chimique, Bruxelles, Belgium, J. Istas;*
  - Centre de Recherche en Environnement du Département des Pyrénées Atlantiques, Mourenx, France, J. Bonte;*
  - University of Nottingham, UK, M. Unsworth;*
  - Imperial College of Science and Technology, London, UK, N. Bell;*
  - Riso Research Centre, Roskilde, Denmark, I. Johnsen;*
- Projects related to the OTC project on agricultural crops:
  - Universiteit Wageningen, The Netherlands, A. Posthumus;
  - Universität Göttingen, FRG, H. Fehrmann;
  - University of Lancaster, UK, T. Mansfield.

All these research projects are related to COST Project 612.

1.3. Effects of Air Pollution on Aquatic Ecosystems

- Impact of a major new sulphur emission on sensitive surface waters in an unacidified region:
  - An Foras Forbartha Teoranta, Dublin, Ireland, J. Bowman;
  - Department of the Environment for Northern Ireland, UK, G. Alexander;
  - University College Dublin, Ireland, D. Murray;
  - University College London, UK, R. Battarbee.
- Regional modelling of acidification and predicting reversibility of catchment acidification:
  - Universität Göttingen, FRG, M. Hauhs;
  - NERC-Institute of Hydrology, Wallingford, UK, P. Whitehead;
  - Norwegian Institute of Water Research (NIVA), Oslo, Norway, R.F. Wright (sub-contractor of the University of Göttingen, without financial contribution from the EC).
- Aquatic ecotoxicity of organic aluminium complexes:
  - Nuclear Research Centre (SKC/CEN), Mol, Belgium, O. Vanderborght;
  - NERC-Freshwater Biological Association, Ambleside, UK, E. Tipping;
  - University of Nijmegen, The Netherlands, S.E. Wendelaar-Bonga.
- Quantification of the susceptibility of Alpine lakes to acidification:
  - Consiglio Nazionale delle Ricerche, Istituto Italiano di Idrobiologia, Pallanza, Italy, R. Mosello;
  - Laboratorio Biologico Provinciale di Laives, Bolzano, Italy, A. Cumer.

  Further collaboration, without EC funding with:
  - University of Innsbruck, Austria;
  - Environmental Laboratory of the Canton Tessin, Bellinzona, Switzerland.

All these research projects are related to COST Project 612.

1.4. Effects of Air Pollution on Historic Buildings and Monuments

- Effects of air pollution on historic buildings and monuments:
  - Univ. Instelling Antwerpen, Belgium, R. van Grieken;
  - University of the Aegean, Greece, D. Sikiotis;
  - University of Patras, Greece, N. Katsanos;
  - 1st. de Recursos Naturales y Agrobiologia de Sevilla, Spain, J. Saiz-Jimenez;
  - Service d'Etude des Matériaux, CEBTP, France, M. Mamillan;
  - Consiglio Nazionale delle Ricerche Padova, Italy, D. Camuffo;
  - University of Bologna, Italy, D. Camuffo;
  - University of Pavia, Italy, U. Zezza;
  - Trinity College Dublin, Ireland, T. Cooper;
  - Istituto Superior Tecnico, Portugal, L. Barros;
  - Institute of Science and Technology, University of Manchester UK, G. Wood.

A cooperation is established between this research area and EUREKA project EUROCARE.

A newsletter entitled EUROPEAN CULTURAL HERITAGE NEWSLETTER is publihed and distributed free of charge by the CEC. This publication is addressed to individuals and institutions concerned with research, conservation, administration, etc... in the field of preservation of cultural heritage.The Newsletter contains interdisciplinary notes, reports on research projects supported by the CEC and on research activities at the national level, information on the EUREKA Project EUROCARE involved in the development of conservation materials and techniques, abstracts, book reviews, meeting reports, forthcoming events, essays, etc...

The newsletter is edited by Michel Benarie, 12 rue de l'Yveline, 91220 Brétigny, France.

Open-Top Chambers

2. Concerted Actions (1986 - 1990)

The objective of the concerted actions is to coordinate national research carried out in Member States as well as in countries associated with the Community by scientific cooperation agreements.

It is achieved by organising technical workshops and symposia and also by stimulating the development of joint coordinated research projects, associating several scientific teams from different countries. Information concerning these activities is given below for the various concerted actions.

Proceedings of most workshops and symposia, organized in the framework of the various Working Parties of the Concerted Actions, are published in *Air Pollution Research Report series* of the Commission of the European Communities, Directorate-General XII, Science, Research and Development. Further information will be found below.

2.1. Concerted Action "Physico-Chemical Behaviour of Atmospheric Pollutants" (COST Project 611)

This concerted action started in 1978 is an extension of the previous Concerted Action on the physico-chemical behaviour of SO2 in the atmosphere and is organized in five Working Parties (WP). A reorientation towards well defined, specific projects of high priority with more cooperation between European institutions is under way. Three Working Parties instead of five were proposed by regrouping WP1 and 3, 4 and 5, while WP2 would be unchanged (see below the titles of the five Working Parties).

Four symposia have been organized within the framework of the Concerted Action. They aimed at reviewing current studies and technical progress achieved in the various sectors. Reference to the Fourth Symposium is given below. Detailed information relative to the various topics discussed

during the symposium are mentioned under the corresponding Working Parties'activities.

Numerous meetings were organized in the framework of the various working parties. Information is given only for the last ones.

Further information concerning this concerted action can be obtained from:

G. Angeletti, CEC-DG XII/E, 200 rue de la Loi, B-1049 Brussels.
Tel. + 32 2 2358432.

Fourth European Symposium on "Physico-Chemical Behaviour of Atmospheric Pollutants", Stresa, Italy, 23-25 September 1986.

The aim of the symposium was to review current studies and technical progress achieved in the various sectors of the Concerted Action since the third symposium held in Varese (Italy) in April 1984.

The programme included five sectors corresponding to the five Working Parties, i.e. analysis of pollutants; chemical and photochemical reactions, mechanisms and rates; aerosol characterisation and particle formation; pollutants cycles; transport and modelling. Aspects related to the physico-chemistry of acid deposition and formation of photochemical oxidants in the troposphere received particular attention.

Proceedings containing oral papers and posters presented at the symposium give a useful overview of current activities in the physico-chemical studies of atmospheric pollutants in Europe. Summaries by the sessions chairmen are reported below for each working party.

Proceedings entitled *Physico-Chemical Behaviour of Atmospheric Pollutants*, ed. G. ANGELETTI and G. RESTELLI, were published by D. Reidel Publishing Company, P.O. Box 17, 3300 AA Dordrecht, The Netherlands, as Air Pollution Research Report N°2, EUR 10832, 1987, ISBN 90-277-2464-4. They are sold and distributed by Kluwer Academic Publishers, P.O. Box 322, 3300 AH Dordrecht, The Netherlands or, in the USA and Canada, 101 Philip Drive, Assinippi Park, Norwell, MA 02061, USA.

Fifth European Symposium on "Physico-Chemical Behaviour of Atmospheric Pollutants" to be held in Varese, Italy, 25-28 September 1989.

2.1.1. Detection, identification and analysis of pollutants (WP 1)

The activity of WP 1 focuses on the development and evaluation of sampling and analysis techniques for the measurement of minor components in the atmosphere, with major emphasis on species related to atmospheric acid deposition.

2.1.1.1. Stresa Symposium, September 1986.

"Measurements of species which are present at ppb-ppt level in the complex atmosphere system and the evaluation of temporal and geographical distribution are a challenging analytical problem. Two main approaches can be taken to achieve this aim: the use of optical and electronic instruments, which might be able to yield concentration of a certain species in real time or the adoption of enrichment processes to obtain measurable amounts of the selected species: both approaches have been followed.

Research activity in the field of instrumental analysis has been oriented to the application of fluorescence generated by laser irradiation which can be used for the detection of nitric acid, by surface chemiluminescence due to the reaction with various laser dyes of ozone for its determination in the troposphere and stratosphere and to the development of monitors based on infrared tunable diode lasers and derivative detection. These lines of research seem to be very promising.

Investigations on enrichment processes making use of diffusion samplers (denuders) have been carried out in various research centers of the European Community (FRG, Italy, The Netherlands, Denmark) and in Sweden and in this area remarkable results have been obtained. Denuders have proven to be indispensable tools for the analysis of reactive compounds such as NH_3, HCl, HF, HNO_3, HNO_2, H_2SO_4, NH_4NO_3 and $(NH_4)_2SO_4$.

The extensive research activity carried out in various centers brought to overcome some limitations related to these devices, which have been originally conceived as low volume samplers. The development of the annular geometry where the sample flows 20 to 100 times higher compared to simple denuders as well of the thermo-denuder where a fractionated compound is converted to a easily to quantify product and measured with high sensitivity, enlarged the field of application of these devices and extended the possibility of application.

A workshop on new procedures developed to measure atmopsheric acidity has been held in Rome in June 1985 and in order to assess the reliability of various methods a field intercomparison study was organized. This workshop was held at the Schauinsland-EMEP Station (Freiburg, FRG) in October 1985 where five measuring methods have been compared during a 5-day experiment. The workshop showed that the sampling through denuders permits to measure gaseous and aerosolic atmospheric species at the trace levels. The various methods yield a sufficient agreement on sulphate, ammonium and sulphur dioxide while noticeable differences for other species have been observed.

There is no doubt about the outstanding performances which can be obtained with the denuders but it is believed that minor operational procedures might exert a noticeable impact and further research is needed to optimize the analytical procedures.

Through the use of denuders it has been shown that it is possible the determination of nitrous acid, a compound which has been identified very recently in the gas phase by differential optical absorption spectroscopy in the ultraviolet region. It seems this species has been overlooked in atmospheric chemistry whereas the possibility of determining it quite accurately can supply useful information on a scientific and practical stand point.

Noticeable results have been obtained in the determination of hydrogen peroxide in gas and condensed phase and upon its role in solid precipitation.

Interesting results have been obtained in the determination of species related to photochemical smog. Peroxy-acetyl nitrate (PAN) can be determined without any enrichment in a semi-automatic analyzer by using a gas chromatograph equipped with an electron capture detector and a suitable column to operate the fractionation of various oxidants."

(From the summary by the chairman A. Liberti, CNR Roma, Italy)

2.1.1.2. Second Field Intercomparison Study. Landesanstalt für Immissionschutz. Essen, FRG, 15-19 December 1986.

This study was a continuation of the first intercomparison experiment organized at Schauinsland-EMEP Station,Freiburg in October 1985 (see above) in the framework of a collaborative programme for the identification of problems related to measurement.

Eleven groups (FRG, I, S, UK) participated in the second experiment designed to compare different techniques in simulated atmospheres to avoid artifacts during the sampling stage. Measurements of HCl, HNO_3, NO_2 in gas phase as well as NH_4 and NO_3 in particular matter were performed using denuder and filter pack techniques as well as a tunable diode laser equipment for the measurement of compounds in gas phase.

Results reported that concentrations obtained by filter pack are lower than those measured by diffusion tubes. Denuders can be used for reliable analysis of the species relevant to acid deposition. However, different coatings and different design caused significant changes in the analytical response. For HNO_3, it seemed that annular and cylindrical denuders coated with Na_2CO_3 gave the best results, comparable to those obtained by tunable diode laser.

Discussions of results obtained in 1985-1986 led to the conclusion that for a more accurate information the campaigns must consider specific compounds either in the gas phase or in particulate matter since many analytical methods are not suitable for multiparameter detection. It was pointed out that the duration of the experiment must be accurately planned so as to collect enough analyte for a reliable quantitative measurement to ensure statistical validity. Location of experiments should insure suitable analytical support and a wide variation of the concentrations of the relevant species.

2.1.1.3. Symposium on Monitoring of Gaseous Pollutants by Tunable Diode Lasers. Freiburg, FRG, 13-14 November 1986.

This meeting was organised jointly by CEC and the Fraunhofer Institut fur Physikalische Messtechnik, Freiburg, FRG.

The main emphasis of this conference was put on the applications of TDL techniques to the solution of problems of environmental relevance such as the measurement of atmospheric trace gases and the monitoring of exhaust gases from automobile and power plant stack emitters. The state of diode laser development and application of TDL instruments to scientific molecular spectroscopy were not directly involved in the meeting.

Presentations were grouped into three sections: Atmospheric Trace Gas Detection, Exhaust Gas Monitoring and Special Applications. Two presentations dealing with trace gas analysis by other optical means were also included because of their importance in the general topic.

Results reported that objective difficulties related to diode lasers and optical components still limit an extended use of tunable diode lasers in

atmospheric trace gas analysis. However, the projected potentials in terms of sensitivity (detection of radicals), speed of response (deposition studies, aircraft measurements) and multicomponent measurement, appeared to justify further research in this field.

Proceedings contain the papers presented at the symposium, the minutes of a post-symposium round table discussion on future development trends as well as recommendations for system/component developments and applications areas.

Proceedings entitled *Monitoring of Gaseous Pollutants by Tunable Diode Lasers*, eds. R. Grisar, H. Preier, G. Schmidtke and G. Restelli, were published by D. Reidel Publishing Company, P.O. Box 17, 3300 AA Dordrecht, The Netherlands, as Air Pollution Research Report N° 3, EUR 11060, 1987, ISBN 90-277-2603-5. They are sold and distributed by Kluwer Academic Publishers, P.O. Box 322, 3300 AH Dordrecht, The Netherlands or, in the USA and Canada, 101 Philip Drive, Assinippi Park, Norwell, MA 02061, USA.

2.1.1.4. Future activities:

- ***Workshop Intercomparison Exercise on the Measurement of Atmospheric Concentration of Nitric Acid in Gas Phase and Nitrates in Particulate Matters***. Rome, Italy, 18-24 September 1988.
- ***Symposium on Monitoring of Gaseous Pollutants by Tunable Diode Lasers***. Freiburg, FRG, 17-18 October 1988.

2.1.2. Chemical and photochemical Reactions (WP 2)

This project aims at understanding the chemical transformations of atmospheric trace gases in the gas phase, in aqueous droplets and aerosols and include studies of rate constants and mechanisms of gas phase reactions. Studies are carried out in the laboratory and/or in the field, the first being the most numerous.

2.1.2.1. Stresa Symposium, September 1986.

"The three main topics reported on at the meeting were atmospheric sulphur chemistry, NOx chemistry and hydrocarbon oxidation reactions. The results of the activities in these areas are as follows.

a) Atmospheric Sulphur Chemistry: The main objective of the work has been to obtain quantitative information on the rates of atmospheric oxidation of sulphur compounds from man made sources (mainly SO_2) and natural sources (organic sulphur compounds such as dimethyl sulphide, DMS). Oxidation processes in the gas phase and the liquid phase have been studied.

   For the gas phase, the approach has been to establish the rate constants and reactivity patterns of the reactions with sulphur compounds of OH radicals, NO_3 radicals and also the completely novel oxidising radical IO, which is believed to be present in marine atmospheres.

   The data, together with previous knowledge, now allow a fairly clear understanding of the mechanism for the homogeneous oxidation of SO_2 although there remain some minor discrepancies in the rate constant.

   The reactions of OH with a range of organic sulphur compounds has been studied. A clear pattern of structure/reactivity is emerging and some of the earlier discrepancies in the rate studies have been resolved by observing the effects of NO and O_2 concentration on the reaction rates.

   Further information on the products of DMS oxidation have been reported. It is clear that there is a significant flux of DMS from the sea but it is not known what the oxidation products are and how much they contribute to atmospheric sulphate burdens. Thus the impact of marine sulphur on atmospheric acidity cannot be assessed at the present time.

   Oxidation of sulphur dioxide and its hydrolysis products in the liquid phase has also been studied. Evidence from field studies appears to confirm the earlier suggestion, based on laboratory work, that hydrogen peroxide in solution is a major oxidising agent for dissolved S^{IV} species.

b) NO_x Chemistry: The reactions of N_2O_5 and NO_2 with water vapour have been investigated using infra red spectroscopy to follow reactants and products. An upper limit for the homogeneous reaction:

   $N_2O_5 + H_2O \longrightarrow 2HNO_3$

   implies a very slow gas phase reaction. The reaction probably occurs rapidly on droplets and aerosols, however. A detailed study of the kinetics of the heterogeneous reaction

   $2NO_2 + H_2O \longrightarrow HNO_2 + HNO_3$

   is also reported. If the laboratory results are scaled to account for typical conditions in the atmospheric boundary layer a small source of HNO_2 is predicted. The reaction rates were insufficient to account for all field observations of HNO_2 unless surface characteristics in the outside environment are generally more favourable for reaction, as is indeed possible.

   Laboratory studies of reactions of the nitrate radical, NO_3, have been reported. The reaction of NO_3 with CO is too slow to provide a significant pathway for either NO_3 or CO in the troposphere.

   New measurements of the absolute absorption cross section for NO_3 in its visible absorption band at 662 nm confirm the "high" values which now seem to be emerging from studies in the USA.

c) Hydrocarbon Oxidation Chemistry: Experimental studies have been reported in which the reactive free radical species OH and HO_2 have been directly monitored during photo-oxidation of selected organics. These studies have given new insight into the reaction mechanism of these oxidations.

   Rate constants for the reaction of OH radicals with a series of oxygenated organics have also been determined. These data allow the atmospheric lifetimes of several industrially important organics to be estimated as well as providing useful structure/reactivity relationships which can be used as a basis for estimating the reactivity of other organics towards OH radicals.

   The problems of modelling the complex chemistry of hydrocarbon oxidation were also illustrated.

Conclusion: The study of reaction kinetics and mechanisms today involves application of a variety of novel, spectroscopy based techniques, particularly for the detection and measurements of trace concentrations of chemically reactive species. The development of these techniques, which is one of the activities of WP 1 goes hand in hand with the kinetics studies in WP 2 and relates closely to applications for in situ field measurements in the atmosphere."

(From the summary by the chairman R.A. Cox, Harwell Laboratory, Harwell, UK)

2.1.2.2. Tropospheric NO_x Chemistry - Gas Phase and Multiphase Aspects. Roskilde, Denmark, 17-18 September 1987.

This meeting was organised jointly by the CEC and Riso National Laboratory, Roskilde, Denmark.

"A first part of the meeting was devoted to the NO_x chemistry, in particular the conversion of NO_2 to NO_3 at night-time and the fate of the NO_3 radical as well as the influence of NO_x chemistry on OH radical concentrations and feedback of this to the conversion of NO_x to NO_y.

Papers provided information on heterogeneous chemical reactions involving NO_x, and some related processes in which gas phase NO_x (NO, NO_2) and NO_y (NO_x + N_2O_5, HNO_3 etc...) is converted to liquid phase NO_3. More information on the surface reactions of NO_2 and H_2O to produce HONO were reported, which provide further support to previous measurements of the rate and stoichiometry of this reaction. This work demonstrated the application of a technique more often associated with field measurements, i.e. the annular denuder tube, for laboratory studies. This simple device could be conveniently used to test the effect of changing the nature of the surface on the rate of HONO production, and other heterogeneous reactions.

Measurements of the "sticking coefficients" for incorporation of gases into the aqueous liquid phase were presented. The technique uses a well defined and continuously replaced liquid column of known and variable surface area, exposed to a flowing trace gas/air mixture.The rate of arrival of gas molecules at the surface was calculated from a model of gas diffusion and the amount passing into the liquid determined by analysis of the bulk liquid collected.

New and interesting information on the interaction of NO_x with organic species was reported. The fast reaction of NO_2 with acetyl peroxy radicals was investigated using the flash photolysis technique. The values obtained are significantly higher than obtained previously and part of the problem may be due to errors in the earlier work arising from the very fast self reaction of CH_3CO_3 radicals. More work is required to define fully the temperature and pressure dependence of peroxyacetylnitrate formation in this reaction.

A second part of the meeting was devoted to the presentation and discussion of results on the chemistry of the NO_3 radical. With regard to the reaction of NO_3 with organics, there is now reasonably good agreement on the rate constants for the NO_3 + organic rate constants from several laboratories. The nature of the reaction products under at-

mospheric conditions needs to be explored further. The reaction of NO_3 with "closed shell" inorganic molecules e.g. SO_2, CO, HCl, H_2O_2 appears to be relatively slow but fast reactions occur between NO_3 and atoms and radicals. New rate data were reported for the reactions of NO_3 with H, OH, HO_2, Cl. The agreement between the different studies is by and large good, although some differences remain and need to be resolved. Some of the work presented was of a preliminary nature and progress towards an understanding of these reactions is expected in the future. A compilation of the rate constants for NO_3 reactions, reported at the meeting, is included in the proceedings."

(From the summary by the chairman R.A. Cox, the Harwell Laboratory, Harwell, UK)

Proceedings entitled *Tropospheric NO_x Chemistry - Gas Phase and Multiphase aspects*, ed. O.J. Nielsen and R.A. Cox, were published by the CEC as Air Pollution Research report N° 9, EUR 11440, 1987.

2.1.2.3. Future activities

- ***Workshop Mechanisms of Gas Phase and Liquid Phase Chemical Transformations in Tropospheric Chemistry***. Norwich, UK, 20-22 September 1988.

2.1.3. Aerosol characterization and particle formation (WP 3)

WP 3 deals with projects concerning the formation of atmospheric aerosols (size, concentration and diurnal variation) as well as their chemical characterization and measurement. The projects can be broadly grouped into two main categories: laboratory work and field measurements.

2.1.3.1. Stresa Symposium, September 1986

"The papers presented dealt largely with the chemical composition of aerosols and were mainly results of field measurements. These ranged from an in-depth analysis of samples of washout taken from beneath the plume of a 1000 MW coal fired station near the centre of The Netherlands to a comparison of the chemical composition of fly ash produced by coal fired stations with the composition of microspherules from the plume of Mount Etna. This latter work provided an interesting comparison between man-made and natural sources of pollution.

The results of work carried out in Madrid showed that the anionic composition of aerosols in that city are mainly sulphate, nitrate and chloride, with the nitrate and chloride displaying a bimodal size distribution while the nitrate exhibit a trimodal distribution. As part of the Acid Rain Programme in France the laboratory at Fontenay-Aux-Roses analysed, from the view point of size, concentration and chemical composition, aerosols sampled in the Vosges forest. They related their results to the meteorological conditions and the gaseous composition of the atmosphere.

An interesting paper on correlation analysis as applied to sulphate and nitrate aerosols showed that sulphate concentrations are mainly determined by large scale transport from eastern regions. This suggested a technique that could usefully be tested by other laboratories participating in the COST programme.

While present projects must continue and develop some effort must be made to enable intercomparisons between laboratories both as to sampling and measuring techniques and indeed into the complex question of aerosol formation."

(From the summary by the chairman J.A. Scott, University College Dublin, Ireland)

2.1.4. Pollutant cycles, sources and sinks (WP 4)

This Working Party is concerned with the study of tropospheric pollutant cycles under special consideration of the processes involved in acid deposition and photochemical air pollution.

2.1.4.1. Stresa Symposium, September 1986

"The principal precursors of acid deposition are SO_2, NO_x, NH_3 and NMHC (non methane hydrocarbons) which are emitted both by natural and man-made sources. In general our present knowledge about the emissions of these substances is quite different for the various species concerned. A broad data base exists for SO_2 for different European regions and countries. A major problem is probably the different quality of the emission data estimated for different regions and countries because definitions of emission sources and procedures for estimating emissions may differ from country to country in Europe. The uncertainties in national values could be at best $\pm$ 20% for SO_2 and much greater for other gases like NO_x, NH_3, HCl and NMHC.

There is growing concern about increasing emissions of NH_3 from agricultural activities in certain European regions and countries. As ammonia is of considerable importance for the acid deposition problem in Europe, more research is necessary to study its cycle on the regional scale of Europe including the development of long-range transport models for ammonia and ammonium.

As far as the emissions of NMHC are concerned some anthropogenic emission inventories are available but these data seem to be even more uncertain than the corresponding data for SO_2, NO_x and NH_3. The uncertainty is increased by the largely unknown biogenic emissions of natural NMHC.

The treatment of chemical transformation processes in long-range transport models for acid deposition should be based on the present stage of knowledge which is very different for chemical processes occuring in the gas and liquid phase.The most important gas phase reactions of SO_2 and NO_x seem to be relatively well known and should be incorporated into LRT models along with their thermodynamic and kinetic quantities. A source of uncertainty seems to be the computation of the true atmospheric OH concentration and an exact quantification of the night time nitric acid generation due to NO_x oxidation. As far as the situation in cloud droplets is concerned, the conversion of SO_2 and NO_x is more complicated than in the case of the corresponding gas phase reactions. Laboratory experiments have shown that SO_2 oxidation by H_2O_2 proceeds very fast but the importance of this reaction is not really known under atmospheric conditions. For NO_x conversion in atmospheric droplets into HNO_3 the real importance is even more uncertain. From a chemical point of view, indications are strong that a significant non-linear conversion occurs for transformation of SO_2 to H_2SO_4 in cloud droplets.

Considering the present stage of knowledge about acidity generation in clouds, it is not yet possible to treat this type of transformation in long-range transport models in a similar detailed manner as in the case of homogeneous gas phase reactions.

In order to provide a more realistic chemical input to episodic long-range transport models in a relatively short period of time it is suggested to measure SO_2 and NO_x conversion rates in clouds under different meteorological and chemical conditions as a function of distance and time from well-defined-area sources using aircrafts.

As far as deposition of acidic substances is concerned, there is considerable uncertainty about the relative contributions of acidic substances deposited by dry and wet deposition mainly due to a lack of reliable dry deposition measurements which makes estimates of this removal mechanism much less accurate than estimates for wet deposition.

In general more research is necessary to study dry deposition of substances relevant to the acid deposition problem. Special attention should be paid on measuring dry deposition of nitrogen compounds such as NO_x and HNO_3. For species which undergo a rapid chemical conversion like O_3, NO and NO_2, caution should be exercised when using the gradient method for determining deposition velocities because the observed gradients may be influenced by chemical reactions.

A serious problem associated with long-range transport modelling is that in some models dry deposition is treated parametrically by using a constant deposition velocity regardless of spatial coordinates and time. In order to obtain deposition fluxes these mean deposition velocities are weighted by concentrations. The major uncertainty arises from the wide variations of deposition velocities and concentrations with season, time of day, weather conditions and surface properties. Another problem in modelling of LRT of substances relevant to the acid deposition arises from the uncertainty of particle dry deposition. A considerable controversy remains concerning the values of the deposition velocity for particles in the size range between 0.1-1μ m where most sulfate nitrate and acidity is found. Some authors advocate the use of values in the range of 1 cm/s whereas other authors use values of 0.1 cm/s or less in this size range. The reasons for the considerable disagreement of particle deposition could be the influence of wind velocity and roughness height. If the higher values of ca. 1 cm/s were representative for European regions with rough surfaces like areas covered with forests dry deposition of particles would be an important removal process for atmospheric acidity."

(From the summary by the chairman S. Beilke, Umweltbundesamt, Frankfurt, FRG)

2.1.5. Transport and modelling (WP 5)

The study of transport and diffusion of atmospheric pollutants and the physical and chemical changes they undergo is done through field ex-

periments and computer modelling.

2.1.5.1. Stresa Symposium, September 1986

"Two points should be noted as regards the general approach adopted by WP 5:

- the participation of several scientists involved in the large-scale international cooperation programmes (EMEP, PHOXA, TULLA, etc...), which tends to enhance the integrating role of COST 611 in the field of atmospheric pollutant transport modelling and empirical studies;
- the increasing attention devoted to the study of meso-meteorological geographical and/or time scales; almost half of the talks and posters presented concern these questions.

This concern should be seen in the light of the current interest shown by the national meteorological departments in the development of fine-mesh models which can be initialized on the basis of data of various origins and are aimed at providing better descriptions of the current weather conditions or improved short-term forecasts.

From the symposium, a number of general conclusions regarding the various tools can be drawn:

- we now have models which permit both concentrations and deposits (photooxidants and acid compounds) to be estimated on a climatological or episodic basis, to an often acceptable degree of accuracy;
- the importance of models for determining a strategy for emission monitoring is broadly recognized in view of the chemistry involved and its highly non-linear aspects. The need to consider photooxidants and acid compounds in conjunction has been clearly established;
- an aircraft fitted with the appropriate instruments is the most useful of the various experimental tools;
- the most sophisticated models require input data which are not all routinely available, since they demand, for example, a combination of traditional meteorological data and data relating to the fields analysed and/or scheduled for analysis, together with satellite information.

However, one should not forget the less positive aspects such as the following:

- our understanding of even the climatology of certain compounds (e.g. O_3, NO_x, etc...) is extremetly limited or non-existent at the European scale;
- empirical measurement, in a network, of dry deposits still poses a challenge to the scientific community, although these account for the major proportion of the total deposists - and hence play an important role in the models;
- there are currently no high quality sets of meso-scale data available concerning all the relevant meteorological, physico-chemical and microphysical parameters. Experiments such as TULLA can serve as a model for the major experimental prgrammes which will be called for in the next few years and which will probably require considerable involvment at the design stage by the people responsible for producing the models, since a model should, if possible, indicate what must be measured, where and how often.

In view of the spatial and temporal scales and the wide range of techniques involved (ground network, airborne equipment, remote sensing, etc...), international cooperation will be essential if such projects are to be completed on a European scale.

Finally, we should stress the vital and complementary role of studies concerning the chemistry of the atmosphere, in view of the observed and/or modelled behaviour of certain substances which could have a major climatic impact, as in the case of radioactive gases (CO_2, O_3, CH_4, etc...), or chemical impact, such as the very probable increase of hydroxyl radicals resulting from the steady increase in NO_x emissions."

(From the summary by the chairman P. Bessemoulin, National Meteorological RC, France)

2.1.6. Task Forces

Cost 611 concertation Committee decided to establish a number of task forces to evaluate various topics, to report on the present knowledge and to identify important gaps or weaknesses in knowledge. They also recommend research programmes to close theses gaps.

2.1.6.1. Evaluation of the photooxidants-precursor relationship in Europe.

Established in 1985, the task force aimed at reporting on the present knowledge about the distribution in time and space, as well as on the chemical and physical processes that determine the level of photooxidants in Europe, with the main interest concentrated on ozone.

A report from the task force treats mainly the effects of changes in atmospheric ozone, the meteorology in relation to the formation of ozone, the emissions as well as chemistry and deposition of ozone , models of formation of photochemical oxidants and ozone measurements. The report contains research recommendations so as to understand both the episodic (i.e. over a few days) and longer term (i.e. over weeks, seasons and years) behaviour of ozone in the atmosphere over Europe.

Report from the task force entitled *Evaluation of the Photooxidants-Precursor Relationship in Europe* was published by the CEC as Air Pollution Research Report N° 1, 1986.

2.1.6.2. Evaluation of atmospheric processes leading to acid deposition in Europe.

Established in 1986, the task force aimed at evaluating the atmospheric processes leading to acid deposition in Europe, including the distribution in time and space as well as the determination of chemical and physical processes.

A report on the acid deposition phenomenon was outlined in terms of emissions of precursors, atmospheric transformation, transport and deposition. Measurements of acid substances in air and precipitation, as well as measurement methods and analytical techniques, are discussed and reviewed. A separate chapter is devoted to the formulation of numerical models for the calculation of the source-receptor relationship in acid deposition. Each chapter concludes with research recommendations.

Report from the task force entitled *Evaluation of Atmospheric Processes leading to Acid Deposition in Europe* was published by the CEC as Air Pollution Report N° 10, EUR 11441, 1987.

2.1.7. Cooperation with the EUREKA Environmental Project (EUROTRAC)

Following contacts between the Community - COST Concertation Committee and the International Executive Committee of EUROTRAC (IEC), the modalities for cooperation have been established. Chemical laboratory experiments of EUROTRAC (previously CHEMTRANS, now LACTOZ and HALIPP subprojects) will be considered by COST 611.

For further information on EUREKA Environmental Project ,see

- Environmental Research Newsletter N° 1, and
- EUROTRAC Newsletter edited and ditributed by International Scientific Secretariat, c/o Fraunhofer Institute for Atmospheric Environmental Research (IFU), Hindenburgstr. 43
  D-8100 Garmisch-Partenkirchen.
  Tel. + 49 8821 1830; Telefax +49 8821 73573; Telex 592474 iau d.

2.2. Concerted Action "Effects of Air Pollution on Terrestrial and Aquatic Ecosystems" (COST Project 612)

This concerted action started in 1984 is organised in three Working Parties (WP) which held relevant workshops and one symposium.

The structure and terms of reference of working parties will remain unchanged in the future. The programme endorsed previously by the Community-COST Concertation Committee will be implemented and new priorities for workshops identified. The task of the working parties will be subdivided into several projects or working groups, each entrusted with well-defined tasks to be achieved in a limited time. The working goups subjects are: Crop Loss Assessment, Open-Top Chambers, Conceptual Models, Whole Tree Physiology, Catchments and Critical Loads.

Further information concerning this Concerted Action can be obtained from:

- P. Mathy, CEC-DG XII/E, 200 rue de la Loi, B-1049 Brussels.
  Tel. + 32 2 2358160, for Working Party 1 (see 2.2.1.) and Working Party 3 (see 2.2.3.).
- H. Barth, same address. Tel. + 32 2 2356452, for Working Party 2 (see 2.2.2.).

International Symposium on "Effects of Air Pollutants on Terrestrial and Aquatic Ecosystems", held in Grenoble, France, on 18-22 May 1987. Organised by the CEC and the Ministère Français de l'Environnement, the programme included:

- The atmospheric "pollution climates in Europe": characterisation and classification; mechanisms of deposition; fate of pollutants within the ecosystem and transfer to biota.
- The effects of atmospheric pollutants on trees and forest ecosystems.

- The effects of atmospheric pollutants on natural (other than forests) and semi-natural vegetation.
- The effects of atmospheric pollutants on aquatic ecosystems.
- The effects of atmospheric pollutants on agricultural crops.
- Preventive and restorative measures.

Presentations and discussions at the meeting aimed at updating scientific knowledge and views on the effects of air pollution on terrestrial and aquatic ecosystems. Particular attention was given to the elucidation of the role of acid rain on forest damage throughout the world. The urgency of the matter led the Commission of European Communities to urge scientists to define further research priorities. The adoption of regulatory measures concerning air quality to allow the setting up of a Community Policy in the field of environmental protection require accurate scientific information.

Conclusions which emerged from discussions emphasized the complexity of the processes leading to ecosystem disturbance, particularly on forest, as observed in western Europe. Air pollution, including acid rain, remains a matter of serious concern. However, it was underlined that its effects interact with a cascade of other potential detrimental factors such as climate, biotic stresses and/or ecosystem management practices.

Scientific evidence was given for the effects of air pollution on European forests and lakes, while the importance and potential consequences of acidity accumulation in soils for ecosystem equilibrium also were underlined.

Considering the complexity of the multifactorial relationships which caracterize ecosystem functioning, the necessity to develop appropriate and complementary methodological approaches was emphasized. Despite the gaps in knowledge and uncertainties regarding the mechanisms of action of air pollutants, their critical loads and their interactions with other stresses, results reported at the symposium, confirm the view that emissions of primary pollutants SO_2 and NO_x are very important and should be reduced.

Proceedings entitled *Air Pollution and Ecosystems*, ed. P. MATHY, were published by D. Reidel Publishing Company, P.O. Box 17, 3300 AA Dordrecht, The Netherlands, as Air Pollution Research Report N° 7, EUR 11244, 1988, ISBN 90-277-2611-6. They are sold and distributed by Kluwer Academic Publishers, P.O. Box 322, 3300 AH Dordrecht, The Netherlands or, in the USA and Canada, 101 Philip Drive, Assinippi Park, Norwell, MA 02061, USA.

2.2.1. Effects of Air Pollution on Terrestrial Ecosystems, in particular forests (WP 1)

Since 1985, WP 1 organized one workshop each year on various aspects of the response of forest trees to pollutants.

*2.2.1.1. **Indirect Effects of Air Pollution on Forest Trees. Root-Rhizosphere Interactions**.* Julich, FRG, 5-6 December 1985.

Proceedings were published as an internal report.

*2.2.1.2. **Direct Effects of Dry and Wet Deposition on Forest Ecosystems - In particular Canopy Interactions**.* Lokeberg, Sweden, 19-23 October 1986.

Proceedings entitled *Direct Effects of Dry and Wet Deposition on Forest Ecosystems - In particular Canopy Interactions* were published by the CEC as Air Pollution Research Report N° 4, EUR 11264, 1987.

*2.2.1.3. **Ectomycorrhiza and Acid Rain**.* Berg en Dal, The Netherlands, 10-11 December 1987.

The workshop Ectomycorrhiza and Acid rain combined with an Expert Meeting was organized jointly by the National Institute of Public Health and Environmental Protection, Bilthoven, and the Wageningen Agricultural University under the auspices of the European Communities Concerted Action COST 612.

The meeting was divided in two sessions. The first one dealt with methods of research on ectomycorrhizas, problems and solutions. The second one dealt with mycorrhizas in relation to air pollution: existing hypothesis and tests.

It was stressed that the identification of mycorrhizal types is essential for all ecological and physiological research. The standardization of methods (sampling in field situations, assessment of mycorrhizas, etc...) is necessary in order to allow comparison between laboratories.

The important question of whether pollutants affect mycorrhiza directly and thereby affect the tree, or affect mycorrhiza indirectly by first affecting the tree cannot be answered yet.

Proceedings entitled *Ectomycorrhiza and Acid Rain*, ed. A.E. Jansen, J. Dighton and A.H.M. Bresser, were published by the CEC as Air Pollution Research Report N 12, EUR 11543, 1988.

*2.2.1.4. **Interrelationships between the above and below ground influences of air pollutants on forest trees.*** Gennep, The Netherlands, 14-17 December 1987.

The workshop was organised jointly by the CEC and the Research Institute for Forestry and Landscape Planning "De Dorschkamp", Wageningen.

The main objective of the workshop was to establish the state-of-the art in the analysis of whole-tree physiological and nutritional processes which determine canopy-root interactions in order to set the stage for an analysis of interrelations between above and below ground influences of air pollutants on forest trees.

The main topics of the meeting were:

- State-of-the art in whole-tree studies.
- Understanding of whole tree and stand response to disturbances such as air pollution.
- Methods and models currently available to investigate and predict whole plant response, and indicators that can be used to determine degrees of damage.
- Gaps in current knowledge of whole-tree physiology.
- Research priorities, in general, and within the CEC Environmental Protection Programme in particular.

Proceedings entitled *Interrelationships between the above and below ground influences of air pollutants on forest trees* are published by the CEC as Air Pollution Research Report N° 16, EUR 11738, 1988, and will be available as soon as possible.

*2.2.1.5. **Forest Decline Symptomatology**.* Edinburgh, UK, 20-24 March 1988.

The workshop was organised jointly by the CEC and the Institute of Terrestrial Ecology, Bush Estate Research Station, Penicuik, Midlothian, UK.

The aim of the workshop was to evaluate the influence of air pollutants on visible symptoms, in the context of the scientific understanding of the effects of other factors. The role of specific diagnostic tests and their application in the field to measure cumulative or long term responses were discussed.

Proceedings entitled *Forest Decline Symptomatology* are published by the CEC as Air Pollution Research Report N° 15, EUR 11737,1988, ISBN 2-87273-010-4, and will be available as soon as possible.

*2.2.1.6. **Subjects of scheduled workhops:***

- Physiology and Ecology of Cryptograms living on Leaves and in Litters.
- Monitoring Air Pollution in Forests and Ecosystem Research.

2.2.2. Effects of Air Pollution on Aquatic Ecosystems (WP 2)

Since 1986, WP 2 organised one workshop a year on various aspects of the effects of pollutants on aquatic ecosystems.

*2.2.2.1. **Reversibility of Acidification**.* Grimstad, Norway, 9-11 June 1986.

Proceedings entitled *Reversibility of Acidification*, ed H. BARTH, were published by Elsevier Applied Science Publishers LTD, Crown House, Linton Road, Barking, Essex IG11 8JU, UK, as Air Pollution Research Report N° 8, EUR 11287, 1987, ISBN 1-85166-172-7. Distributor in the USA and Canada Elsevier Science Publishing Co., Inc., 52 Vanderbilt Avenue, New York, NY 10017, USA.

*2.2.2.2. **Ecophysiology of Acid Stress in Aquatic Organisms**.* Antwerp, Belgium, 13-16 January 1987.

The 2nd scientific workshop of COST 612 WP2 combined with an international symposium on "Ecophysiology of acid stress in aquatic ecosystems" was organised jointly by the Belgian Royal Zoological Society, SCOPE Belgium, the Belgian Nuclear Research Centre (SCK/CEN) and the CEC.

The objectives of the meeting were:

- To update the knowledge on the effects of acidity and aluminium concentration present on the physiology of aquatic organisms. Field studies, laboratory experiments and modelling approaches were considered.
- To better understand the impact of physiological responses of acid-stressed organisms within the structure and functioning of aquatic communities and ecosystems;
- To indicate gaps of knowledge and priorities for future research and co-operation.

Data on survival, adaptation and tolerance to as well as effects of acid and/or Al on physiological processes in vertebrates, invertebrates and plants were discussed.

Discussions and conclusions confirmed that physiological studies are an important tool to detect and understand early biotic responses to acidification in aquatic ecosystems. The knowledge on sublethal or subdeleterious physiological responses is needed to predict the level of permissible acid emissions to prevent or overcome ecosystem damage.

Ionic regulation as well as other possible sensitive mechanisms such as respiration, endocrinology, reproduction and behaviour need further investigation.

Ecophysiological research on aquatic plants in acidified waters was recommended, utilizing experimental conditions representative of relevant conditions to undertake parallel experiments in the laboratory and in the field.

A community and ecosystem approach is therefore recommended.

Proceedings entitled *Ecophysiology of Acid Stress in aquatic Organisms*, ed. H. WITTERS and O. VANDERBORGHT, were published as a special issue of the Annales de la Societe Royale Zoologique de Belgique, v. 117, supplement 1, March 1987. This supplement can be ordered from Dr. F. FIERS, K.B.I.N., Vautierstr. 29, B-1040 Brussels.

2.2.2.3. Effects of Land Use in Catchments on the Acidity and Ecology of Natural Surface waters. Cardiff, UK, 11-13 April 1988.

The workshop was organised jointly by the CEC and the University of Wales, Institute of Sciences and Technology (UWIST).

The objective of the workshop was to summarise the present knowledge about the effects of historic and current land-use practices, such as changes in agricultural and forest management, on the transmission of atmospheric pollution, soil chemistry, hydrology and water quality as well as their implications for aquatic life. A major part of the workshop was also devoted to the assessment of mitigation and land manipulations in watersheds, and to the prediction of acidity changes in catchments.

The workshop strongly underlined in the conclusions the usefulness of catchment studies as an important tool to study the fate of acidic air pollutants and the processes of acidification. The holistic and multidisciplinary catchment approach was considered particularly useful to discriminate between the various triggers in the acidification processes, to distinguish between acid episodes and chronic impacts of acidity, and to identify long term trends of acidification and its effect in the air-soil-water complex.

The following most prominent needs for further research and cooperation were identified:

- Development and refinement of predictive ecological whole catchment models.
- Quantitative assessment of nitrate and ammonia inputs into catchments (atmospheric inputs, fertilization, etc...).
- Role of humic substances, organics and aluminium in the catchment acidification processes.
- Palaeolimnological and historical acidification trend studies to differentiate between natural biogeochemical background data and cycles, anthropogenic (air) pollution impacts, and effects of land use changes.
- Comparison of biological / ecological changes of the biota with or without acid impacts.

The workshop formulated also the need for some synthesis and setting of management objectives; e.g. the classification of catchment studies in view of their representativity and regional response ("pollution climate"); the adoption of at least minimum research programmes in the various catchment studies for their integration in a European development of strategic management objectives for catchments in view of their uses and protection.

Proceedings entitled *Effects of Land Use in Catchments on the Acidity and Ecology of Natural Surface waters* will be published by the CEC as Air Pollution Research Report N° 13 (in preparation).

2.2.2.4. Subjects of scheduled workshops:

- Acidification of mountain lakes.

2.2.3. Effects of Air Pollution on Agricultural Productivity (WP 3)

Since 1986, WP 3 organized two workshops dealing with fundamental aspects regarding agricultural crops.

2.2.3.1. How are the Effects of Air Pollutants on Agricultural Crops influenced by the Interaction with other Limiting Factors? Copenhagen, Denmark, 23-25 March 1986.

Proceedings were published as an internal report.

2.2.3.2. Pollution Climates in Europe and their Perception by Terrestrial Ecosystems. Liebefeld-Bern, Switzerland, 27-30 April 1987.

The workshop was organised jointly by the CEC and the Swiss Federal Research Station for Agricultural Chemistry and Hygiene of Environment, Liebefeld-Bern. It concerned both WPI and WP3 with the participation of experts in monitoring.

The first part of the workshop was devoted to the definition of pollution climates in Europe on the basis of data generated all over Europe by the air pollution monitoring networks (EMEP, BAPMON, national or regional networks,....). The description of European pollution climates was done by taking into account the occurrence, the frequency, the duration and the intensity of the pollution events for the main atmospheric pollutants (SO_2, NO_x, O_3 and wet deposition). In an attempt to establish a classification of European pollution climates, mathematical procedures used in classifying environmental variables and a simple expert system exploration of pollution climates were discussed.

The second part of the workshop dealt with the perception of pollution climates by terrestrial ecosystems including factors affecting dry, wet and occult deposition, pathways at the surface - exchange reactions,interactions with the biota - and critical loads of pollutants.

It was concluded that a better understanding of pollution climates, deposition rates and surface exchange processes could result in an improved estimate of loads that are critical for sensitive ecological systems, as well as a better insight into the complex relationship between terrestrial ecosystems and air pollutants. Such an approach needs integrated sudies involving the collaboration of researchers with an expertise in micrometeorology, chemistry or biology.

Proceedings entitled *Pollution Climates in Europe and their Perception by Terrestrial Ecosystems* were published by the CEC as Air Pollution Research Report N° 6, EUR 11432 EN, 1987.

As a result of this workshop and in order to fill gaps in this important area, the Commission decided to grant a research project on "Measurement of Dry Deposition and Characterization of European Pollution Climates".

2.2.3.3. Subjects of scheduled workshops:

- Feasibility of Assessment of Crop Losses in Europe
- Genetic Factors influencing the Response of Plants to Air Pollution.

2.2.4. Coordination of the European Open-Top Chambers Programme.

The common research project on Open-Top Chambers initiated in 1985 and partly funded by the CEC in the framework of the third Research and Development Programme in the field of Environment (1981-1985) was incorporated in the Concerted Action.

The Open-Top Chambers Network Programme is divided into two sub-programmes: one on forest trees and one on agricultural crops. Seven scientific institutions from Member Countries are participating in each of the two sub-programmes (see 1.2.). In addition, there are two scientific teams associated with the agricultural crops sub-programme without being funded by the Community, the Swedish Environmental Research Institute and the Eidgedom Forschungsanstalt für Agrikulturchemie und Umwelthygiene in Switzerland.

The objective of the programme is to coordinate existing experiments to investigate the mechanisms of injury in relation to the various pollution climates which characterise Europe as well as the influence of interacting factors.

Common protocols for the coordination of experiments were designed in order to generate comparable data still preserving the advantages of the existing diversity.

For the two sub-programmes, a common protocol for the recording of the microclimate and the pollution climate inside and outside the chambers was established. Such measurements should allow the characterization and the mapping of pollution climates as well as the evaluation of the chamber effects. The data will be processed in a common data base.

Regarding the forest trees sub-project, the investigations are concerned with anatomical as well as with biochemical and physiological parameters. Three treatments are compulsory: filtered air, non-filtered air in chambers and open-field. Additional treatments are allowed also.

Regarding the agricultural crop sub-programme, there are two levels of coordination. The first level is the more stringent one wereby all teams have to record plant growth and development in filtered and non-filtered air and in open-field plot. This is done according to a common protocol, to display any effect of specific pollution climates on plant growth and development. The second level concerns the most advanced teams who are examining mechanisms. To do so, they may develop additional treatments, such as fumigations or experiments with interacting factors.

An extension of the existing European Open-Top Chambers network has to be envisaged for all the Community regions in order to cover the whole range of physical and chemical climates encountered in Europe.

2.2.4.1. Microclimate and Plant Growth in Open-Top Chambers. Freiburg, FRG, 17-19 September 1986.

The workshop was organised jointly by the CEC, the Kernforschungszentrum of Karlsruhe, the University of Stuttgart and the Forest Research Station of Baden-Württemberg.

The programme of the workshop was essentially directed to characterising the climate inside open-top chambers and comparing it to the climate outside. Consequences for data interpretation, design experiments, etc... were discussed.

It was concluded that the use of open-top chambers in forestry research should focus on mechanisms of physiological response to air pollution. Their use should be integrated with other approaches using closed chambers and field fumigation systems. These different facilities with their different strengths and weaknesses are regarded as complementary warranties. To facilitate prediction, studies of mechanism injury must be encouraged. In contrast to the situation with forest trees, open-top chambers can be more appropriately used to estimate field losses of agricultural crop.

During the Freiburg Workshop, changes were made to the protocols common to all the scientific teams involved in the Open-Top Chambers Programme.

Proceedings entitled *Microclimate and Plant Growth in Open-Top Chambers* were published by the CEC as Air Pollution Research Report N5, EUR 11257, 1986.

2.2.4.2. Third Meeting of the European Collaborative Research Programme on Open-Top Chambers. Pau, France, 29-30 September 1988.

This meeting, restricted to project leaders and associated Swedish and Swiss teams involved in the agricultural crops sub-project, will be devoted to the presentation of results obtained in the framework of the programme and to the discussion of future orientations. Report will be included in a next issue of the *Environmental Research Newsletter* devoted to Air Quality.

2.2.4.3. Contacts with other programmes.

U.S. National Crop Loss Assessment Programme.

The International Conference on "Assessment of Crop Loss from Air Pollutants" in Raleigh, USA, 25-29 October 1987 was attended by P. Mathy who reported on the European Open-Top Chambers Programme. Future collaboration between US and European scientists should stem from contacts established at this conference.

International Co-operative Programme on the investigation of the effects of air pollutants on agricultural crops.

See "Other Activities relevant to EC Environmental Programmes", p. 17.

3. Direct Actions: Joint Research Centre, Ispra Establishment, Italy (1988 - 1991)

As outlined in *Environmental Research Newsletter N° 1*, the Joint Research Centre of the European Community at Ispra is contributing from 1973 to the CEC Environmental Protection Programme. It also acts as support to the EC environmental policy established by Directorate General XI.

The research area Atmospheric Pollution of the Environmental Protection Programme is subdivided in: Air Quality, Central Laboratory for Air Pollution, EMEP station, Mass Balance and Transport of Pollutants, Ispra MARK 13A process for flue gas desulphurisation.

Programme Progress Reports are published annually and are available from B. Versino (for address see p. 2).

3.1. Air Quality

The activity is focused on aspects related to the role of ozone and nitrogen oxides in the photochemical transformation of atmospheric pollutants.

3.1.1. Role of terpenes in the dry deposition of O_3/SO_2 mixtures onto forest trees.

The aim is to quantify the natural plant emissions of terpenes as well as their role in the formation of acidic pollutants (e.g. H_2SO_4) in the presence of acid precursors and ozone. The fast reaction between ozone and terpenes leads to formation of strongly oxidizing intermediates that can oxidize SO_2 to sulphuric acid. A similar oxidation process for nitrogen oxides resulting in nitric acid was also suggested and is under investigation.

The reactions of SO_2/O_3 with a selected terpene (ß-pinene) as well as with a natural mixture of volatile compounds emitted from a spruce branch (Picea abies) have been studied. In both cases SO_2 was found to be oxidized to sulphate, which was measured by ion chromatography. At least 75% of the consumed SO_2 in the SO_2/O_3/ß-pinene mixtures could be found as sulphate.

The natural mixture of terpenes gave a relatively fast oxidation of SO_2 to sulphuric acid. Assuming that terpene concentrations close to needles and bark are relatively high a fast reaction with ozone and subsequent oxidation of SO_2 to sulphuric acid could be expected. However, a more quantitative evaluation of the importance of this route to acid deposition onto forest trees still has to be done.

3.1.2. Kinetics and mechanisms of gas phase reactions of nitrogen containing pollutants.

The objective is the study of the chemistry of the NO_3 radical formed in the atmosphere by the reaction of NO_2 and O_3. While NO_3 is rapidly photolized in daylight, this radical, and the species in equilibrium N_2O_5, play a key role in the nighttime tropospheric chemistry. The chemistry of these species was recently demonstrated to provide an important pathway for deposition of HNO_3, to generate secondary radicals such as HO_2, and to represent a sink for a variety of natural and anthropogenic species. Eventually NO_3 can act as a precursor to noxious compounds such as organic nitrates.

The kinetics and mechanisms of reactions involving the NO_3 radical were investigated in a 480L reaction chamber where different spectroscopic analytical techniques were implemented.

Isotopic labelling by C^{13} was used to improve the effectiveness in the study of the reactions:

$NO_3 + CO \longrightarrow NO_2 + CO_2$
rate constant at 295K $\leq 4 \times 10^{-19}$ cm^3 molec^{-1} s^{-1}

$NO_3 + CH_2O \longrightarrow HNO_3 + CHO$
rate constant at 295K $(5.4 \pm 1.1) \times 10^{-16}$ cm^3 molec^{-1} s^{-1}.

Aspects of the equilibrium among the different nitrogen species present in the nighttime troposphere were also investigated with the study of the kinetics of the gas phase homogeneous reactions:

$N_2O_5 + H_2O \longrightarrow 2HNO_3$
rate constant at 296K $(1.48 \pm 0.42) \times 10^{-21}$ cm^3 molec^{-1} s^{-1}

$NO_3 + NO_2 \longrightarrow NO + O_2 + NO_2$
rate constant at 296K $(5.1 \pm 1.6) \times 10^{-16}$ cm^3 molec^{-1} s^{-1}.

Presently attention is focused on the reaction of NO_3 with alkenes in order to clarify the fate of unsaturated natural organic compounds such as terpenes (see 3.1.1.) at nighttime, and to evaluate the dominant mechanisms in the degradation of alkenes by NO_3 possibly leading to noxious compounds (organic nitrates).

Preliminary studies of the NO_3 reaction with α- and ß- pinene permitted the evaluation of the kinetics of the reactions, and put into evidence in the infrared spectra characteristic absorption bands of organic nitrates (dinitrates?).

In order to clarify the mechanism of this reaction and the product formation simpler model compounds of the type $R_1R_2C = CR_3R_4$ where R_1, R_2, R_3, R_4 are H or CH_3 were then studied. It appears that nitrate and pernitrate compounds are the main products at the beginning of the reaction; later on aldehydes and ketones increase while the pernitrate band slowly disappears.

Work is in progress to evaluate the dependence of the mechanisms and products on the branching of the alkenes which reacted with NO_3 radicals.

3.1.3. Analytical spectroscopic techniques.

The importance of the application of spectroscopic analytical techniques for the measurement of the concentration in air, or in simulated atmosphere, of the reactive nitrogenous pollutants is the basis of a continuous effort in this field.

- **Tunable diode laser (TDL) absorption monitor.**
  The operational characteristics of tunable diode laser second-derivative-absorption monitors are being investigated with special attention to the use of a direct calibration technique for NH_3 and of post-detection-signal handling for sensitivity enhancement.
- **Evaluation of spectral parameters in support of spectroscopic analytical techniques.**
  The availability of accurate spectral data is a mandatory prerequisite for the exploitation of analytical spectroscopic techniques. However, in the case of reactive molecules and radicals, spectral data are still lacking.
  Line and band intensities, as well as broadening coefficients, are evaluated by high resolution FT or TDL techniques.
  Measurements were completed on the band intensity of N_2O_5 (710-780 cm^{-1} and 1225-1270 cm^{-1} bands), HCOOH (υ_6 band at 1105 cm^{-1}), HNO_3 ($\upsilon_5 + \upsilon_9 - \upsilon_9$; υ_5, $2\upsilon_9$ at about 885 cm^{-1} and υ_3, υ_4 at about 1310 cm^{-1} band systems). Band intensities (υ_3, υ_5 and υ_6) and broadening coefficients in the υ_6 band were evaluated for CH_3D in collaboration with the Laboratoire Infrarouge Orsay.
- **Computer generation of spectra.**
  Informatic tools for handling the existing compilations of spectral data (AFGL, GEISA, ATMOS) and for computer generation of spectra (direct transmission, second harmonic, instrumentally convoluted spectra) of single gases or of complex mixtures were set up. The programmes allow the analysis of the large data bases, and the generation of spectra in the different gas regimes (Doppler, Voigt, Lorentz).

3.2. Central Laboratory for Air Pollution (CLAP)

The JRC Central Laboratory for Air Pollution Measurements provides the Commission with the technical support for implementing EC directives on air quality standards. Concerning the directive fixing the limit and guide values for sulphur dioxide and suspended particulates in air (black smoke and gravimetric methods), the CLAP is involved in:

- The improvement of the SO_2 reference method (tetrachloromercurate/pararosaniline method) which needed to be updated, particularly concerning dye-reagent purification and 24-hour sampling procedures.
- The harmonisation of sampling and measuring methods used in the Member States to be compared with the reference methods of the Directive.

To achieve this goal, two European quality assurance programmes (QAP/1 and QAP/2) were planned in cooperation with the Member States.

- The QAP/1 programme, already completed, concerned intercomparisons of calibration methods implemented in pilot laboratories in charge of measuring station networks. Reference materials (air-SO_2 mixtures at low SO_2 concentrations, stained and loaded filters of particulates) prepared and measured by the CLAP according to the reference methods of the directive were circulated in 30 laboratories. The results of these round robin tests, discussed in a meeting held in March 1988 in Ispra, showed the need for a careful maintenance of primary SO_2 calibration standards and a more stringent definition of the black smoke reference method.
- The QAP/2 programme, still under way, is directed to the quality of the measurements routinely obtained at the measuring stations. The intercomparisons are planned in 30 measuring network stations which are visited once a year by means of a mobile laboratory. The visits include parallel measurements during the 24-hour sampling period, as referred to in the directive.

3.3. EMEP Station

The Programme on "Evaluation and Monitoring of European Pollution (EMEP)" is carried out under the auspices of the Economic Commission of Europe (ECE) and the United Nations Environment Programme (UNEP).

Its main objective is to provide governments with information on the deposition and concentrations of air pollutants and on the quantity and significance of pollutant fluxes across national boundaries.

Actually 89 monitoring stations in 25 countries all over Europe are participating in the EMEP-Programme in order to evaluate the long range transmission of air pollutants.

According to the Council resolution No 81/462/EEC, article 9, the Commission Services DG XI and JRC proposed to participate actively in this programme by setting up at Ispra an EMEP monitoring station. Since November 1985, this station is working on a regular basis and each month data are transmitted to the Norwegian Institute for Air Research (NILU) for further statistical evaluation.

The geographic coordinates of the station are: 45°49' of latitude, 8°38' of longitude and 209 m above sea level.

The extended EMEP Programme, based on daily averages, is being applied for air (SO_2, NO_2, NO, NO_x and O_3), for atmospheric particulate (acidity, total suspended matter, SO_4^{2-}, NO_3^- and sporadically heavy metals), and for atmospheric precipitations (pH, electrical conductivity, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, K^+, Na^+, Ca^{2+} and Mg^{2+}). An annular denuder technique was sometimes applied for the determination of HCl, HNO_3, SO_2 and NH_3 in air and SO_4^{2-}, NO_3^-, Cl^- and NH_4^+ in the atmospheric particulate.

All the detailed results (including the meteorological parameters) obtained by the JRC EMEP Station are reported in the 1986 Annual Report of the JRC, EMEP Station, by W. Leyendecker et al. (EUR 11618 EN) and in the 1987 Annual Report, in preparation.

3.4. Mass Balance and Transport of Pollutants

This activity was initially devoted to the development of instrumentation and methods for the remote sensing of atmospheric pollution. Presently it is focused on their applications to pollution distribution and air-mass trajectories on the mesoscale (about 100 km). The mobile laboratories available participated in European and national field experiments. Initially involved in studies of pollution dispersion from isolated large sources (power plants, refineries, etc...), the investigations are now directed to pollution problems on a regional scale.

Three laboratories are contributing to this project: monitoring by remote-sensing and conventional techniques, meteorology and tracers. Each laboratory is equipped with a mobile unit, usually employed in field studies.

3.4.1. Monitoring.

A mobile unit was specifically assembled to facilitate a wide range of chemical monitoring instruments to analyse various pollutants in a large area and a computer to analyse the incoming data. It is equipped with:

- two correlation spectrometers (Cospec V) for the mapping of total burden and mass flow determinations of SO_2 and NO_2;
- a fluorescence monitor for SO_2 ground concentration;
- a chemiluminescence monitor for NO and NO_x ground level concentrations;
- an IR absorption monitor for CO ground level concentration;
- an UV absorption monitor for O_3 ground level concentration;
- a light scattering monitor for aerosols (0.5 μ mean size);
- an odometer connected to one of the driving wheels of the van to measure the distance travelled;
- a digital clock;
- a HP-9825 desk computer allowing a quasi-simultaneous acquisition of 9 parameters every 100 m of travelled distance at an average speed of about 70 km/h.

This mobile unit was proficiently used in European Measuring Campaigns on the Remote Sensing of Atmospheric Pollution and in national campaigns. The two latest ones are described below.

The air quality in the Varese area of Lombardy, Italy, was checked in winter 1986 at the request of local authorities. The approach consisted in (a) the evaluation of an emission inventory for the Varese district where the two main polluting sources are the heating systems and the traffic, (b) an analysis of the local climatology in order to forecast days with pollution accumulation and (c) some surveys during episodes. These latter measurements were performed with the mobile laboratory equipped as

mentioned above along the main traffic roads of the area. Supplementary information were available from the Aeronautica Militare in Milano, the Meteosat images from the Centro Geofisico in Varese and the EMEP Station at Ispra. The data showed that pollution episodes were particularly evident in the presence of a weak wind circulation, associated with an anticyclonic area over continental Europe and Nothern Italy, and a levelled pressure field. Evident pollution sources were the heating systems (fuel with high S-content) and the traffic. A conclusive report was submitted to the local authorities in April 1987; it was suggested to control the fuel on the market and where to install three monitoring stations.

A monitoring campaign in Greece was organized in September 1987 in collaboration with the Greek Ministry for the Environment. Two monitoring stations in Athens (PERPA, Patission Street. and Pyreus) were calibrated by the CLAP team for sulphur dioxide, black smoke and total suspended particles. At the same time the mobile laboratory measured some pollutants along pre-selected roads inside the urban (Athens and Pyreus) and industrial (Elefsina) areas. One measurement day coincided with a "nephos" episode, a brown smog of unknown origin, which is considered to be responsible for extended human health problems. At the same period, analysis of methane and non-methane hydrocarbons were performed by the Central Chemical State Laboratory. A similar survey was performed one week later in Thessaloniki, in the framework of a collaboration with the Ministry of Northern Greece. A particularly high level of sulphur dioxide in the urban area, probably due to a transport from the industrial area, was observed.
A more detailed data analysis will be done as soon as meteorological data will be available from the Greek laboratories.

3.4.2. Micrometeorology

In recent years sophisticated micrometeorological instruments (ultrasonic anemometer/thermometer, monostatic acoustic sounder) together with conventional instruments (various radiometers, barometer) and a computerized data acquisition system for continuous operation were installed in a large motorhome equipped with a telescopic mast and the necessary support for autonomous measurements in the field. This unit participated in several European measuring campaigns on atmospheric transport and diffusion of atmospheric pollutants (i.e. the SIESTA campaign, Switzerland, in November-December 1985).

In 1987, the Micrometeorological Station was equipped with:

- *a three-dimensional Doppler acoustic radar (SODAR)* supplying vertical wind vector profiles;
- *a three-dimensional ultrasonic thermo-anemometer* measuring the three wind vector components and the temperature with a sampling frequency of 20 Hz at a fixed height;
- *an automatic meteorological station* consisting of a wind vane and anemometer, a temperature and humidity sensor, and a data logger;
- *a telescopic 10-meter-high mast.*

The sonic anemometer coupled with a fast-response NO_2 analyser was used during a test campaign near Raisting, Bavarian Plateau, FRG, in collaboration with the Atmospheric Chemistry Group of the Fraunhofer Institut für Atmosphärische Umweltforschung, Garmisch Partenkirchen, FRG, on November 1987. The main objective of the campaign was to test the performance of a dry deposition measuring system which works by making use of the eddy-correlation principle, i.e. by deriving vertical fluxes of a trace atmospheric gas from the eddy-correlation, or covariance between the fluctuations of the trace gas concentration and the vertical wind vector component. The data acquisition system made use of a software developed at Oak Ridge, USA.

3.4.3. Atmospheric tracers

Tracer techniques are used for the experimental validation of source-receptor relationships for pollution transport over complex terrain and different meteorological situations. They use chemically inert substances like sulphur hexafluoride and perfluorocarbons which are not normally present in the environment.

Multi-Tracer experiments

Multi-tracer experiments (SF_6, C_7F_{14} and C_8F_{16}) were carried out in the Ispra area to check the reliability of the perfluorocarbon tracer technique by comparing perfluorocarbon data with those obtained for SF_6, assuming the last one as a correct reference. From a comparison of the ratios between tracers at the release point with the ratios observed in the collected field samples, it appeared that the technique for the dispersion and measurement of three independant tracers is sufficiently advanced to carry out experiments up to ~100 km.

Mobile Unit for Trace experiments

A mobile unit was assembled in order to have ready for use in the field the release systems and the measuring equipment of the three tracers mentioned above. This mobile unit is composed of two cabins one of which, containing the release systems, is fixed to the lorry, while the other one, equipped with the tracer measuring instruments, can be taken off and fixed on the ground. The electricity supply is provided with two power units.

The release systems for the SF_6 and the perfluorocarbons can operate independently between the extreme ambient temperature of -10°C and + 40°C. The tracers are released in the atmosphere through a telescopic tube which can be extended up to 8 m height.

The tracer-measuring equipment contained in the second cabin consists of:

- two commercial instruments especially designed for SF_6 air concentration measurements (model 215 BGC, Tracer Monitor, System Science and Software). These instruments can detect the SF_6 tracer in air at ppt level (10^{-12} v/v);
- one Dual-Trap Perfluorocarbon Analyser especially manufactured by the John Booker and Co (Austin-Texas). This instrument originally conceived and developed by Lovelock and then modified by the Brookhaven Laboratory can perform direct determinations of perfluorocarbon tracers in air samples at concentrations of about 10^{-2} ppt. The time required for the simultaneous measurement of the two prefluorocarbons C_7F_{14} and C_8F_{16} in air at the ppt level is about 5-6 minutes. For this reason this instrumentation can be used also as a semi-continuous real time analyser in a mobile van or aircraft.

3.4.4. Participation in European projects

Since 1975 the JRC-Ispra participated in CEC-sponsored European Measuring Campaigns on the Remote Sensing of Atmospheric Pollution (1975 Lacq, France; 1976 Drax, UK; 1979 Turbigo, Italy; 1981 Ghent, Belgium and 1983 Fos-Berre, France).

In 1985 the JRC-Ispra gave a significant contribution to the German TULLA project by direct participation with COSPEC and Tracer measurements and by coordinating and sponsoring air craft measurements.

Presently the JRC-Ispra is contributing to the EUROTRAC Project with the proposal TRANSALP (Transport of Air Trace Constituents over the Italian-Swiss Alps).

3.5. Ispra MARK 13A Process for Flue Gas Desulphurisation

The Ispra MARK 13A process for flue gas desulphurisation is a patented method of removing sulphur dioxide from flue gases, particularly in fossil-fuel-fired power stations. The process was invented and developed at the JRC Ispra Establishment. It is a direct spin-off from the former hydrogen energy research programme.

The process is a cycle based on the oxidation of sulphur dioxide to sulphuric acid by bromine and the subsequent recovery of bromine by electrolysis of hydrobromic acid with formation of hydrogen. Potential advantages of this process are:

- sulphuric acid and hydrogen produced are valuable chemicals which can be marketed or reutilised;
- all reactants are generated inside the process so that the disposal of solid products and waste water is not required;
- the reaction takes place in the liquid phase which allows high reaction rates and small equipment volumes, probably leading to lower investment and operation costs.

Development work started in 1981 with preliminary laboratory tests, followed by a feasibility study, bench-scale operation with flue gases from heavy oil combustion at the Ispra Establishment and with flue gases from coal combustion at the laboratories of ENEL at Livorno, Italy. After successful completion of the bench-scale work, the construction of a large-scale pilot plant was decided. For this purpose, a call of tenders was published in 1984.

On 15 December 1985 a contract was signed with the firm Ferlini Technology of Genova for the construction and operation of a pilot plant. The plant is designed for a throughput of 32 000 m^3/h of flue gas (max. 40 000 m^3/h) with SO_2 contents of up to 4 500 mg/m^3. The degree of desulphurisation has to be higher than 90%. The plant is being erected at the site of the SARAS Refinery in Saroch, Sardinia, where there is a need for sulphuric acid. The design, engineering and construction of the plant is sub-contracted to the firm Kraftanlangen Heidelberg. Technical

supervision of the project is entrusted to J.R.C.-Ispra. The Commission participates financially in the project for 50% of the total cost to a maximum of 5 Mio ECU.

The construction of the pilot plant is in progress. The first previsions for the completion of the construction were for the end of May 1988. However, unforeseen events caused additional delays. Cold tests (e.g. running of reactants, leak tests, etc...) started at the end of July and the commissioning and start-up procedure proceeded during August and September. Hot start-up and start of the operation with hot flue gases will be successively performed.

Further research aiming at extending the Ispra MARK 13A process to a combined desulphurisation/denoxing process is under way. Two methods are investigated.

One method consists in the absorption of the nitrogen oxides in an aqueous solution containing Fe(II)EDTA as a complex agent followed by an electrochemical decomposition of the formed NO-complex. Preliminary experiments on the formation of the Fe(II)EDTA. NO complex, the electrochemistry of the Fe EDTA complex, the electrochemistry of the Fe(II)EDTA.NO complex were carried out. Particular attention was paid to the study of basic electrochemistry of the Fe(II)EDTA/Fe(III)EDTA redox couple.

Another method is based on the catalytic reduction of nitrogen oxides with hydrogen formed by the electrolytic decomposition of hydrobromic acid. Screening tests for candidate catalysts are in course since 1987.

3.6. Participation in COST 611.

Two sectors participate in COST 611 with specific projects:

- *Air Quality*
  - IR-Tunable diode laser techniques for trace gas detection at ppbv level.
  - FT-IR laboratory studies of kinetics of the NO_x/O_3 system of tropospheric interest.
- *Central Laboratory for Air Pollution*
  - Use of air-SO_2 mixtures for intercomparison of SO_2 monitors in the EEC.

3.7. Ispra courses

Since 1973, the JRC is involved in activities of "Education and Training" in disciplines related to the research activities of the Establishment. The latest courses organised in the framework of the Environmental Protection programme, specially on Air Quality problems, are reviewed below.

3.7.1. *Regional and Long-Range Transport of Air Pollution*. Ispra, Italy, 15-19 September 1986.

Starting from an updated presentation of physical and chemical processes in the atmosphere, the course provided a critical survey of the possibilities offered by advanced experimental techniques (tracer, remote sensing and airborne) and models (for episodes, lon-terms and complex orography) on regional and larger scales. Results of the most recent exercises performed in Western Europe and future trends were analysed.

Proceedings entitled *Regional and Long-Range Transport of Air Pollution*, ed. S. SANDRONI, were published by Elsevier Science Publisher, Amsterdam, The Netherlands, EUR 10832 EN, 1987, ISBN 0- 444- 42818- 6.

3.7.2. *Ecological Assessment of Environmental Degradation, Pollution and Recovery*. Ispra, Italy, 12-16 October 1987.

The course provided a review of the evolution trend of stressed and non-stressed ecosystems and compared the techniques for environmental recovery. In addition, the influence of air pollution on the various environments was discussed. Terrestrial ecosystems as well as standing and current waters were considered.

Proceedings entitled *Ecological Assessment of Environmental Degradation, Pollution and Recovery*, ed. O. RAVERA, are being published by Elsevier Science Publisher, Amsterdam, The Netherlands.

3.7.3. *Meteorology and Air Pollution in the Mediterranean Sea*. Madrid, Spain, 26-30 September 1988.

This course is organised in collaboration with the Centro de Investigaciones Energeticas Medioambientales y Technologicas (CIEMAT) in Madrid, Spain.

The purpose of the course is to examine the role of local and mesoscale atmospheric circulations in the diffusion, transport and deposition of atmospheric pollutants within the Mediterranean area. Major topics includes: the origin and evolution of local circulations, air pollution cycles associated with them and their review for some selected cities, their seasonal variations, methods to characterize the dynamics of polluted air masses and the regional and long-range transport mechanisms and deposition processes prevailing in the area. Photochemical processes occuring in urban areas and modellistic approaches for atmospheric dispersion on complex terrain will be also considered. Special emphasis will be placed on the interpretation of air pollution data from fixed monitoring networks in the light of local conditions.

Proceedings will be published. Related information will be referred to in the next issue of *Environmental Research Newsletter* devoted to Air Quality.

3.7.4. *Sulphur Dioxide and Nitrogen Oxides in industrial Waste Gases; Emission, Legislation, Abatement*. Scheduled for Spring 1989.

Further information on Ispra Courses can be obtained from:

Secretariat **Ispra-Courses**, CEC, JRC Ispra, I-21020 ISPRA (VA) Italy.
Tel. + 39 332 789819/789839/781128
Telefax + 39 332 789001
Telex 380043 - 380058 EUR I

4. Announcements

International Conference on Acid Deposition: its nature and impacts.

This conference is organised by The Royal Society of Edinburgh in Glasgow, 16-21 September 1990.

Six aspects of atmospheric pollutants, including ozone, whose occurence is dependent upon the combustion of fossil fuels, will be discussed:

- The chemistry of atmospheric pollutants;
- Processes of deposition to natural and man-made surfaces;
- The effects on soils and soil processes;
- The effects on terrestrial ecosystems including (a) forest declines and (b) the interacting influences of pollutants and other stress factors;
- The effects on aquatic ecosystems and the physiology of aquatic plants and animals;
- The effects on materials and buildings.

Further details can be obtained from:

Secretariat, Acidic Deposition '90
CEP Consultants Ltd
26-28 Albany Street
EDINBURGH EH1 3QH
Scotland, UK

5th European Ecology Symposium

Anthropogenic Perturbations of Ecological Systems: the Need for Transfer from Principles to Applications. Sienna, Italy, 25-29 September 1989.

The symposium is organised by the International Steering Group of the European Ecology Symposia. Chairman of the organising committee: Prof. O. Ravera, CEC, JRC Ispra, 21021 ISPRA (VA), Italy.

The aim of the meeting will be:

- to review the principles which underlie our understanding of perturbations to ecological systems,
- to consider how these principles can be applied most effectively to the restoration and redevelopment of damaged ecosystems.

The meeting will include the following sections:

- Introductory section - the need for transfer.
- The need for theory in perturbation studies.
- Perturbation and recovery: structural and functional responses at different levels of integration.
- Pratical implementation of ecological knowledge: restoration and redevelopment.
- Getting the message across: increasing public and government awareness of the role of ecological sciences.

Further details can be obtained from:

Prof. A. Renzoni
Dipartimento di Biologia Ambientale
3 via delle Cerchia
53100 Siena, ITALY

5. Publications

Early Diagnosis of Forest Decline, Report of a One-Year Pilot Study.

J.N. Cape, I.S. Paterson, A.R. Wellburn, J. Wolfenden, H. Mehlhorn, P.H. Freer-Smith, S. Fink.Published by Institute of Terrestrial Ecology, Merlewood Research Station, Grange over Sands, Cumbria LA11 6JU, UK, 1988, 68 pp, ISBN 1-870393-07-4.

This report desribes the results of a pilot survey to investigate potential diagnostic tests for forest decline in advance of visible symptoms. Scientists from four institutions (Institute of Terrestrial Ecology, University of Lancaster, University of Ulster, Albert-Ludwigs Universitat of Freiburg) took foliage samples form three tree species (Norway spruce, Scots pine and beech) from twelve sites, in a broad transect from SW Germany to NE Scotland. These samples were subjected to a wide range of physico-chemical and biochemical tests. The results show a clear discrimination of sites using fourteen variables. The responses of these variables to specific air pollutants is now being investigated.

This study was supported financially by the UK Natural Environment Research Council and the Commission of the European Cummunities.

Copies are available from the Publication Section of the Institute of Terrestrial Ecology, address as above.

Acid Deposition: Reversibility of Soil and Water Acidification - A Review.

M. Hauhs, Institute of Soil Science and Forest Nutrition, Gottingen, FRG, and R.F. Wright, Norwegian Institute for Water Research (NIVA), Oslo, Norway.

Published by the CEC as Air Pollution Research Report N 11, EUR 11633, 1988.

This report reviews the empirical and experimental evidence bearing on the reversibility of soil and water acidification. It contains a critical survey of a wide range of ecosystems affected by acidification.

Orders for this report are to be addressed to H. Barth (for address see p. 7).

EC Regulatory Actions Programmes (DG XI)
Air Quality

Information concerning the Community Environment Policy as well as the Fourth Environmental Action Programme were given in *Environmental Research Newsletter N° 1.*

Further information on the actions of DG XI can de obtained from:

CEC-DG XI/B2, 200 rue de la Loi, B - 1040 Brussels.

The European Community has institutions which can propose and adopt legislation that is binding on citizens and the Member States. Further, it can monitor, coordinate and enforce the implementation of these laws (see Box 1).

The Community Environment Policy in the field of atmospheric pollution is operating through:

- the fixing of "product norms", i.e. the maximum level of certain constituants in a product;
- the definition of air "quality norms" or "quality standards", i.e. the maximum concentrations of pollutants permissible in air;
- the fixing of limit values for pollutant emissions from specific sources.

1. Product Norms

Since the early '70s, before the Community's environment policy proper was implemented, action was taken to reduce emissions from motor vehicles, which play a major role in atmospheric pollution:

Council Directive 70/220/EEC - Motor vehicle pollution.

This Directive, which represents the first measure aiming at reducing pollution caused by exhaust fumes from motor vehicles, was issued under the EEC's industrial action programme. It lays down technical standards for emissions of carbon monoxide (CO) and unburnt hydrocarbons from vehicles with petrol engines, except tractors and public works vehicles. Directive 70/220was amended and updated four times under the enviroment action programmes. Limits for nitrogen oxides (NO_x) were added by *Directive 77/102/EEC.* The limits for all three pollutants were reduced in 1978 by *Directive 78/665/EEC*, and again substantially by the last amendment, *Directive 83/351/EEC.*

The measures concerning motor vehicle pollution were extended to diesel engines with *Directive 72/306/EEC* concerning air pollution from diesel engines and *Directive 77/537/EEC* on diesel engines from tractors.

Other product norms were adopted by the Council, in particular on the sulphur content of gas oil:

Council Directive 75/716/EEC - Sulphur content of gas oil.

This Directive limits the concentration of sulphur in light oil used for household heating and cooking, and for diesel-engine motor vehicles for the purpose of protecting the environment and ensuring the availability of the common market to these products.

This Directive was amended in 1987 by *Directive 87/219/EEC.* setting a single maximum sulphur content of 0.3%. Member States may set a limit of 0.2% within special zones or where damage to the environment from sulphur dioxide emissions requires it.

The Commission is to submit a proposal for a single value before April 1990.

Another product norm regulating the lead content in petrol was settled by:

Council Directive 85/210/EEC - Lead in petrol.

This Directive replaces and goes further than Directive 78/611/EEC which fixed a maximum value for the permitted lead-compound content of petrol of between 0.40 and 0.15 g/l.Directive 85/210/EEC requires the Member States to reduce the permitted lead content to 0.15 g/l as soon as they consider it appropriate, and also to ensure the availability and balanced distribution of unleaded petrol (below 0.013 g/l) from 1 October 1989, at the latest.

The benzene content of both leaded and unleaded petrol may not exceed 5.0% as of 1 October 1989.

Box 1: EUROPEAN COMMUNITY LEGISLATION

EC institutions:

- *European Commission:* proposes and administers laws and regulations.
- *Council of Ministers:* makes the major policy decisions of the Community.
- *European Parliament:* has an advisory role in the legislative process.
- *Economic and Social Committee:* id.
- *Court of Justice:* interprets the law and controls the legality of the decisions.

Legal instruments:

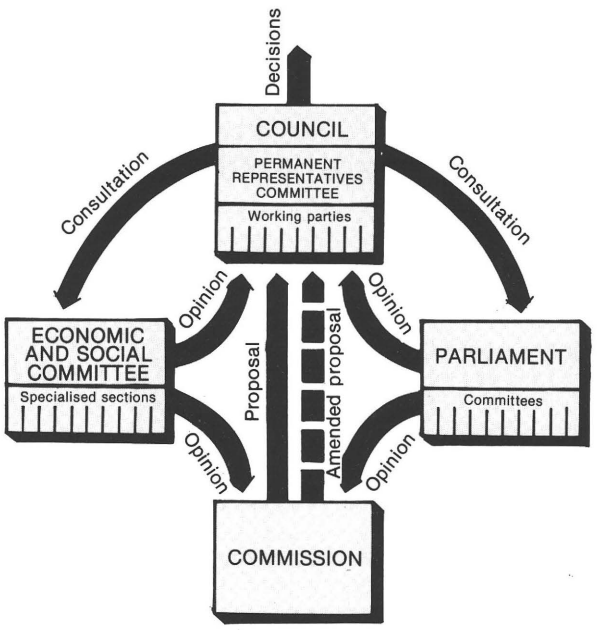
- Acts with no binding force: *recommendations and resolutions*
- Acts with binding force proposed by the Commission to the Council and adopted by the Council:

regulations:
- are binding and directly applicable in all Member States;
- are usually used for very specific purposes such as trade in products and financial matters;
- have not often been used for environmental legislation, except for controls on trade in endangered species.

decisions:
- are directly binding on the persons to whom they are addressed, including Member States, individuals and legal persons;
- have been primarily used in environmental legislation to authorise the Community to become a party to international conventions, but also for other purposes, e.g. to set up a system of information exchange on water quality.

directives:
- are binding, as to the result to be achieved, upon each Member State to which they are addressed, but leave to the national authorities the choice of form and methods;
- are the main tools of Community environmental policy.

Legislative process in the Community:



2. Air Quality Standards

One of the most important achievements to date was the setting of compulsory air quality standards, to be respected everywhere in the Member States, for the ubiquitous pollutants sulphur dioxide, suspended particulate matter (SPM), lead and nitrogen dioxide. Three directives were adopted to date.

Council Directive 80/779/EEC - Sulphur dioxide and suspended particulates.

This Directive fixes limit values and guide values for sulphur dioxide and suspended particulates in the atmosphere and conditions for their application.

The limit values were to have been met by 1 April 1983, but where that seemed unlikely in certain zones the Commission was to have been informed and plans for the progressive improvement of those zones were to have been submitted to the Commission by 1 October 1982.

The Member States must endeavour to move towards the application of the stricter guide values. These guide values govern measures taken in two types of zone which may be designated to prevent a foreseeable increase in pollution in the wake of urban or industrial development, or special environmental protection zones.

The air quality may not deteriorate substantially in areas which are already below the limit values set by the Directive.

Member States must establish monitoring stations and supply data regularly to the Commission. Once a year Member States must inform the Commission of instances where limit values have been exceeded, the reasons and the measures that have been taken to avoid recurrences. A Member State must consult its neighbour and the Commission before setting a limit value in a border region. The Commission must publish an annual report based on the data submitted by the Member States.

Council Directive 82/884/EEC - Lead in air.

This Directive lays down a maximum limit value for lead concentrations in air of 2 microgrammes per cubic metre, expressed as an annual average mean concentration. It does not apply to occupational exposure. Member States may impose stricter limit values.

The Member States must ensure that sampling stations are operated at places where individuals may be exposed continually for a long period and where they consider that the limit value is likely not to be observed. They must ensure that the limit value is met by 9 December 1987.

In places where, after 4 years, the limit value is exceeded, the Member States must draw up plans for the improvement of the air and send tham to the Commission. A final deadline for compliance is 9 December 1989, sven years after nitification of the Directive.

Member States must inform the Commission by 1 July, annually, of the places where the limit value is exceeded, by how much, and the measures to bring lead concentrations below the limit value.

Measures taken under the Directive must not bring about a significant deterioration in air quality where the level of pollution by lead is low in relation to the limit value.

Characteristics for choosing a sampling method and a reference method for analysing the concentration of lead in air are given in an Annex.

Council Directive 85/203/EEC - Nitrogen dioxide in air.

This Directive lays down limit values to protect human health and guide values to improve protection of human health and to protect the environment for nitrogen dioxide in air. It does not apply to occupational exposure or inside buildings.

The limit value is 200 microgrammes per cubic metre from 1 July 1987.

The Member States must inform the Commission of areas where this value is exceeded and draw up plans to meet the limit value "as rapidly as possible", by 1 January 1994 at the latest.

They may set lower limit values in zones where there is a foreseeable increase in NO_x from urban or industrial development. Lower guide

values may be set in areas that are considered to need special environmental protection.
They must establish measuring stations as stated in an Annex of the Directive and report annually to the Commission supplying detailed information about NO_x concentrations and abatement measures. Some specified information must be made available to the public, as well. A reference method is described in an Annex.

Measures taken under the Directive may not lead to a significant deterioration in air quality in zones where NO_x pollution levels are low in relation to the limit value.
Consultation between Member States and the Commission is required when a Member State chooses to fix lower levels of NO_x concentrations in a border region.

3. Limit Values for Pollutant Emissions from Specific Sources

Product norms and air quality standards are not the only ways to control atmospheric pollution. Much attention was paid in recent years to regulate emissions from industrial installations.
In July 1984 a directive on combating air pollution from industrial plants was adopted:

Council Directive 84/360/EEC - Industrial plants.

This is a framework directive which requires Member States to ensure specific industrial plants to receive authorization before operation or substantial alteration.
An authorization may be issued only when the competent authority is satisfied that all appropriate measures against air pollution have been taken, including the application of the best available technology, so long as the costs are not excessive; the plant will not cause significant air pollution; none of the applicable emission limit values is exceeded; all applicable air quality limit values are taken into account.
So far, asbestos is the only substance for which specific limit values have been adopted *(Directive 87/217/EEC).*
The Member States may define particularly polluted areas and impose more stringent emission limit values and special conditions on industrial plants located there.
The Council can fix emission limit values based on the best available technology not entailing excessive costs and taking into account the nature, quantities and harmfulness of the emissions. It may also stipulate measurements and assessment techniques.
The Member States must monitor emissions from industrial plants. They must follow developments in best available technology and the state of the environment and, in the light of this knowledge, impose conditions on plants authorized under the Directive, taking into acoount inter alia the economic situation of the plants. They must adopt policies to ensure that existing plants are gradually adapted to the best available technology, taking into account the plant's characteristics, its remaining life, the nature and volume of pollutants emitted, and costs.
Member States may adopt stricter provisions.
Industrial plants serving national defence purposes are exempted from the Directive.
Applications for authorizations and the decisions of the competent authorities must be made available to the public according to national procedures.
The list of most important polluting substances include sulphur and nitrogen compounds, organic chemicals, heavy metals, asbestos, chlorine and fluorine compounds.

4. Monitoring and Information Exchange Systems

The establishment of quality standards and limit values require effective monitoring and information exchange systems.

Council Decision 82/459/EEC - Information exchange.

The Decision sets up an information exchange procedure on a number of air polluting substances. It repeals an earlier *Decision 75/441/EEC* on the exchange of information about sulphur dioxide and suspended particulates (smoke).

The Decision added heavy metals, nitrogen oxides, carbon monoxide and ozone to the information exchange system. The data are to be sent annualy in a specified form to the European Commission. Member States are required to maintain the monitoring stations that had been designated according to the criteria of Decision 75/441/EEC and to select additional stattions to be repesentative of the conditions for the pollutant concerned. The Decision is valid for 7 years from 1 October 1982 to 24 June 1989.

5. Transboundary Air Pollution

In the field of transboundary air pollution control, the major actions are:

Council Decision 81/462/EEC - Convention on long-range transboundary air pollution.

The Decision adopts the Convention on long-range transboundary air pollution, which had been drawn up under the auspices of the United Nations Economic Commission for Europe (ECE).The Convention's purpose is to protect human health and the environment against air pollution by monitoring, limiting and gradually reducing such air pollution, in particular transboundary air pollution by sulphur dioxide.

It provides for the exchange of information, research and monitoring, and the development of polivies to combat the discharge of air pollutants. It was signed in 1979, and came into force in 1983.

Council Decision 87/277/EEC - EMEP.

The Decision approves the Protocol to the Convention which arranges the long-term financing of the "cooperative programme for the monitoring and evaluation of the long-range transmission of air pollutants in Europe" (EMEP).

6. Ozone Layer - Damage to Forests

In recent years there has been increasing public concern over the environment, in particular over the destruction of the ozone layer and the damage being caused by acid depositions to forests, lakes and buildings. Although not directly linked to the control of air pollution, these matter were subject of attention from Community environment policy.

In the light of the concern being expressed over the effect of chlorofluorocarbons (CFCs) on the ozone layer, for example, the European Council adopted a number of measures to limit their production and to encourage their replacement by other substances:

Council Decision 80/372/EEC - Chlorofluorocarbons.

Council Decision 82/795/EEC - Chlorofluorocarbons.
These actions were underlined, in Montreal in 1987, with the signing by the Community of the protocol concerning the protection of the ozone layer, which is part of the Vienna Convention.
Further to this, the Environment Council meeting in Luxembourg on 16 June 1988, approved the decision, regulation and resolution on the control of substances having a harmful effect on the ozone layer.

In the context of protection of environment, an action was recently initiated to limit the damage caused by atmospheric pollutants to forests:

Council Regulation 86/3528 - Protection of the Community's forests against atmospheric pollution.

7. International Agreements and Conventions

The European Community takes an active part in a wide range of international initiatives concerned with the environment. It is involved in the environment programmes of international organisations (in particular, UNEP, OECD, Council of Europe, Economic Commission for Europe of the United Nations) and is signatory to several international conventions (Geneva Convention for the prevention of long-distance transboundary air pollution in Europe, 1979- decision 1984; Vienna Convention for the protection of the ozone layer, 1985).

8. Publications

Acid Rain and Photochemical Oxidants Control Policies in the European Community-A decision Framework, ed. Cambridge Decision Analysts, 120 Huntington Road, Cambridge CB3 OHL in association with Environmental Resources Limited, 106 Gloucester Place, London W1H 3DB, printed by The Leopard Press, Woodfolds, Oaksey, Nr. Malmesbury, Wiltshire SN16 9SD, UK, 1988.

Other Activities relevant to EC Environmental Programmes
Air Quality

1. International Cooperative Programme on the Investigation of the Effects of Air Pollutants on Agricultural Crops

This programme coordinated by UK is being developed within the framework of the Convention on Long Range Transboundary Air Pollution. A Task Force (U.N.E.C.E.) was set up for its preparation.

The objectives of the long-term international cooperation programme are:

- to investigate the effects of air pollutants on the optimal production of crops;
- to provide realistic dose-response relationships for economically important crops;
- to use crops as indicators of potential damage to ecosystems.

The working plan includes:

- the elaboration of a critical review of current knowledge on air pollution-crop damage research in ECE countries in order to stress agreements and disagreements as well as gaps in the information available;
- the setting up of an International Cooperation Research Experiment Programme to assess the influence of air quality on an appropiate crop using current unsophisticated techiques. An experimental methodology is being prepared by Dr. P. Irving, from the US National Acid Precipitation Assessment Programme, in collaboration with Prof. M. Unsworth.

The European Community Coordinated Open-Top Chambers Programme and the US programmes are collaborating in the development of the U.N.E.C.E. initiative.

Further information can be obtained from:

- Prof. M. Unsworth, School of Agriculture of the University of Nottingham, UK, designated as Programme Coordinating Centre, or from
- Dr. B. Wilson, Department of the Environment,Romney House, London, UK, chairman of the U.N.E.C.E. Task Force.

2. Protection of the Community's Forests against Atmospheric Pollution, Directorate General VI (Agriculture, Forestry Department)

Community measures for the protection of forests against atmospheric pollution divide into two main categories: Preparatory and Regulatory Actions.

Preparatory Actions

Two series of preparatory actions were drawn up by the Commission in 1984 and 1986 before the Regulation on the protection of the Community's forests against atmospheric pollution was adopted.

A budget of 3 million ECU was allocated and 27 contracts were concluded to date.

Main actions:

- Feasibility study for a Community inventory of forest damage.
- Production of a booklet in the nine Community languages on diagnosis of the new types of damage to forests.
- Setting-up of a network of points for the observation of forest health at a regional scale.
- Establishment of monitoring stations to measure atmospheric pollution in forest.
- Determination of the effect of site factors on the health status of forest stands.

- Improvement of remote sensing methods for the monitoring of forest damage and standardization of a common methodology.
- Production of a booklet on diagnosis of the new types of damage in forest species of the Mediterranean region.
- Fertilisation trials on damaged stands and development of methods for damage treatment.

Regulatory Actions

The Council Regulation (EEC) No 3528/86 of 17 November 1986 on the protection of the Community's forests against atmospheric pollution (Official Journal of the European Communities No L326, 21.11.86,p.2-7) entered into force on 1 January 1987.

A budget of 10 million ECU for 5 years was allocated. The Community financial contribution is 30% of the expenditure approved by the Commission. Projects must be submitted to the Commission before 1 November each year.

Main actions:

- Establishment of a periodic inventory of damage caused to forests in particular by atmospheric pollution on the basis of a Community network of observation points taking into account the detailed rules concerning the common methods laid down by the Commission Regulation (EEC) No 1696/87 of 10 June 1987 (Official Journal of the European Communities No L161,22.6.87, p.1-22).
- Setting-up of field experiments, pilot and demonstration projects to better understand the effects of atmospheric pollution on forests, to improve methods of monitoring and measuring forest damage and to devise ways of restoring areas damaged by atmospheric pollution.
  For 1987, 26 projects absorbing a total of 1,644,443 ECU were approved by the Commission.
  For 1988, 32 projects absorbing a total of 1,564,423 ECU were approved by the Commission.
  Information concerning the application for aid from the Community are reported in Official Journal of the European Communities No L53, 21.2.87, p.14-26.
- Gathering of periodic forest health reports by Member States.

Progress:

- Network of observation points:
  In 1987: establishment of two thirds of the points (approximately 1,200 in number, with 26,000 sample trees).
  In 1988: extension of the network, particularly in Greece and France.
  From 1989 the network will cover all parts of the Community and will comprise approximately 2,000 observation points and 50,000 sample trees.
- Damage inventory:
  Initial damage inventory results derived from an inspection of 26,390 sample trees confirmed a number of observations made in individual countries and revealed considerable damage to fir, spruce, beech and oak.

A report on the results of the monitoring carried out in 1987 and that in progress in 1988 will be drawn up by the Commission and forwarded to the Council and Parliament during the first quarter of 1989.

A report on the financial aspects of the Regulation will be presented by the Commission before 1 July 1989.

Working and coordination groups:

Regular meetings are organized for the goups involved in:

- inventory of forest damage;
- diagnosis of the new types of damage to forests in Mediterranean regions;
- use of remote sensing in monitoring forest damage.

Committee on Forest Protection:

This committee acts either as a regulatory or an advisory committee according to the nature of the subject concerned.

Further information on DG VI actions can be obtained from:
F. Kremer, CEC-DG VI / F1, 200 rue de la LOI, B-1049 Brussels.
Tel. + 32 2 2356780

3. The European Forest Ecosystem Research Network (FERN)

A project proposal directed at the co-ordination of European basic research in forest ecology was adopted in 1985 by the European Science Foundation (ESF) Assembly and by the Science Research Council of 17 European countries.

An important aim of the FERN project is to contribute to the creation of a European research community in the field of forest ecology rather than attack single scientific problem in particular. The key topics on which the project focuses were chosen not only for their intrinsic value but also because they can be linked to a large segment of forest ecology research in Europe.

Major areas of concern

The FERN project concerns basic scientific problems associated with the stability and destabilisation of forest ecosystems, with particular emphasis on Europe. The actiyity focuses on nitrogen dynamics and patterns in European forest ecosystems.

Main objectives

- To strengthen the scientific understanding of forest ecosystems in Europe in order to assess the true meaning of current changes, and to predict the fate of these ecosystems on a mid- to long-term basis.
- To contribute to the elucidation of some of the key patterns and processes of forest ecosystems and to identify reliable indicators of forest ecosystem change (particularly in the context of forest decline).
- To establish a network of European research groups active in this field.
- To co-ordinate national research activities already in progress or planned for the near future, and to orientate national programmes toward common objectives.

Participants and funding

Members of the ESF from all countries except Greece joined the FERN project which groups more than 200 research teams in 17 European countries.

Funding is provided by the participant countries at the level of about half a million FF per year.

A computerised **directory of participating organisations** was set up. It contains basic information about more than 200 European research groups and is freely available from Anne Teller (for address see p. 19).

Implementation

The project officially started on1st January 1986 with a duration of 5 years.

Five **Working Groups** were selected to launch co-ordinated activities:

1. Retrospective study of man-induced changes in European forest ecosystems.
2. The influence of fire and grazing on the stability of Mediterranean forest ecosystems.
3. Changes in the nitrogen status of European forests.
4. Soil-litter compartment of nitrogen cycle.
5. Architectural patterns in European forest ecosystems.

Each Working Group, managed by a pilot, a co-pilot and a member of the Steering Committee, is entrusted with the gathering and critical analysis of the relevant information dispersed in various forms and places.

The **Scientific Steering Committee** meets twice a year to examine the suggested projects and to define orientations for future work.

Topical workshops are organized. They aim at improving the coherence of overall research carried out in Europe, harmonising methods and establishing common objectives for future investigations.

Field Methods in Terrestrial Ecosystem Nutrient Cycling. Grange-Over-Sands, UK, 3-5 December 1986.

The meeting was organised jointly by ESF and NERC (Natural Environment Research Council).

The main objectives of the meeting were to increase communication between scientists from different disciplines and countries on the existing methods to study nutrient cycling in terrestrial ecosystems and to identify gaps in knowledge.

From the conclusions of this meeting the participants recommended that ESF should support an initiative designed to establish an international network of long-term experimental sites to study nutrient cycling. This led to the elaboration of a joint research project on "Organic Matter Turnover in a West European Climatic Transect of Coniferous Forests". This project, which now comprises thirteen sites, is co-ordinated by Dr. B.Berg, Agricultural University of Uppsala, Sweden.

A register of existing long-term experiments will be compiled by the Institute of Terrestrial Ecology (ITE), Merlewood Research Station, Grange-over-Sands, Cumbria LA11 6JU, and will be available from Dr. P.Ineson in the course of this year.

Proceedings entitled *Field Methods in Terrestrial Ecosystem Nutrient Cycling* are published by Elsevier and will be available from ITE, Merlewood, by the end of this year.

Influence of Fire on the Stability of Mediterranean Forest Ecosystems. Giens, France, 23-26 March 1987.

The meeting was organised by ESF.

The main objective of the meeting was to make a state-of-the-art review on the problem of fire in Mediterranean ecosystems in order to identify the gaps and priorities of the research to be undertaken.

In conclusion of the workshop, participants recommended the initiation of a European research project on experimental fires and ecological implications. Recommendations from the discussions stressed the importance of multiplying contacts between existing multidisciplinary teams. An effort will be made to set up a common protocol for experimentation. Further information can be obtained from Dr. D.Gillon, CNRS-CEPE, Route de Mende, BP 5051, Montpellier, France.

Proceedings entitled *Influence of Fire on the Stability of Mediterranean Forest Ecosystems* are published by Ecologia Mediterranea and will be available within the next few months from Prof. P.Quézel, Université d'Aix Marseille, Faculté des Sciences et techniques de St. Jérôme, Rue Henri Poincaré, F-13397 Marseille Cédex 13.

Frameworks for Forest Modelling. Edinburgh, UK, 1-4 December 1987.

The workshop was organised by ESF.

The outcome of this meeting, which involved a small number of European experts in forest modelling and computer work, was the elaboration of a European resarch proposal. The proposed project aims at providing an environment which should facilitate the construction and modification of forest models. Development of standards for the representation of forest models allowing their exchange over a European forest modelling network would involve 5 research centres -in Edinburgh, Helsinki, Kassel, Wageningen and Bristol- with Edinburgh being the focus.

Further information can be obtained from Dr. R.Muetzelfeldt, Department of Forestry and Natural Resources, University of Edinburgh, Mayfield Road, Edinburgh, EH9 3JU, UK.

Use of ^{15}N Methods in Nutrient Cycling Studies. Vienna, Austria, 29 February - 3 March 1988.

The workshop was organised jointly by ESF and the International Atomic Energy Agency (IAEA).

The aim of the meeting was to emphasise methods, rather than results, and to bring together experts and scientists at a very practically orientated workshop in order to stress the possible use of ^{15}N techniques amongst forest researchers.

One major result of this meeting was the agreement of the IAEA to promote short-term training period on the subject of ^{15}N technique at its laboratory in Seibersdorf.

Future activities

Changes in Nitrogen Status in European Forest Ecosystems. Aberdeen, UK, 21-23 September 1988.

This workshop is to be organised jointly by ESF and the University of Aberdeen.

The main objective of the workshop is to discuss nitrogen cycling, including nitrogen mineralisation and denitrification.

The key topics are:

- Input of nitrogen from the atmosphere;
- Exchange of nitrogen at leaf surfaces;
- Throughfall, stemflow and assessment of the contribution of crown leaching as against interception deposition;
- Measurement of nitrogen mineralisation and estimates of mineralisation rate;
- Control of nitrification;
- Denitrification in forest ecosystems;
- Leaching losses of nitrogen;
- Nitrogen saturation.

Further information on this meeting will be given in the next issue of Environmental Research Newsletter devoted to Air Quality.

Human influences on Forest Ecosystem Development in Europe. Trent, Italy, 26-29 September 1988.

This workshop will be organised jointly by ESF and the Province of Trent.

The aim of the workshop should be the reconstruction of historical landscapes both in structural and functional terms.

The programme will include the following themes:

- Research methodologies to study human impact on the forest ecosystem since the Neolithic;
- Case-studies at local level;
- Case-studies at regional level;
- Social factors in the development of forest ecosystems and consecutive influences on the planning process.

On this occasion, resarch on structure and functioning of forest ecosystems through the collection and analysis of data on matter fluxes and population dynamics will be emphasised.

Further information on this meeting will be given in the next issue of *Environmental Research Newsletter* devoted to Air Quality.

Unification of European Forest Pattern Research. Strasbourg, France, and Freiburg-in-Breisgau, FRG, 24-28 October 1988.

The organisation of this workshop is planned by Prof. R.A.A.Oldeman, Agricultural University of Wageningen, The Netherlands.

The time-table is divided in keynote paper presentations and in field trips.

Keynote papers are devoted to giving a clean statement that may serve as a basis for the discussions and lead to recommendations on essential minimum packages of data to be measured in European forest Ecosystems. They are grouped in three sessions on the following themes:

- Man-induced patterns;
- Forest patterns for the understanding of ecological parameters in the environment;
- Mathematical models.

Further information on this meeting will be given in the next issue of *Environmental Research Newsletter* devoted to Air Quality.

For more information about FERN, or related activities, contact

Anne Teller, Scientific Secretary of FERN, CEC - DG XII,
200 rue de la Loi, B-1049 Brussels. Tel. + 32 2 2358446.

The European Year of the Environment

The European Year of the Environment (EYE), launched in response to the call by heads of State and government of the Member States of the Community for the years to come to be marked by significant progress in the area of the environment, ended officially on 20 March 1988.

The campaign represents 12 months of intensive activity aimed at increasing awareness at every level, from political decision makers to the general public, of the importance of environmental considerations. It also represents a period of particular significance for environmental protection in the future. The implications of the publication of the Report of the World Commission on Environment and Development, the signing in Montreal of the protocol on the control of CFCs as part of the Vienna Convention on the Protection of the Ozone Layer, and in particular the coming into force of the Single European Act, should not be underestimated. This latter event, which coincided with the first phase of the Community's Fourth Environmental Action Programme, is of considerable importance for future action in this area. The amendments to the original Treaty mean that environmental protection is now finally recognised to be one of the specific objectives of the Community, which is asked when preparing its activities to take as a base a high level of protection, and to integrate environmental protection requirements into its other policies.

Returning to the more specific activities and achievements of EYE, it should of course be said that the objectives established for this vast campaign were, and remain, fundamentally long-term. During the Year support was provided for some 150 projects at Community level, and many hundreds of others at national level. The emphasis throughout was on encreasing awareness of the importance of environmental protection, and of the legislation existing in this respect, and on encouraging the further integration of environmental considerations into all other areas.

The principal Community level initiatives concentrated on specific target groups. One of the most important of these was industry. The demand for increasingly strict environmental standards, together with the prospect of the completion of the internal market, make it essential that industry be convinced of the benefits to be obtained from environmental protection. It is now generally accepted that pollution prevention literally pays - in terms of increased efficiency, avoidance of reparatory expenses, the opening up of new and wider markets in the rapidly growing field of clean and low-waste technologies, and consequent job creation possibilities. The level of response to our participation in specialist trade fairs, where the content of the stands dispayed was largely technical, covering the environmental programmes and activities of DG XI, plus DGs XII, XIII, and XVI in some cases, to the Better Environment Awards for industry, and to the newly established Network for Environmental Technology Transfer, was such that many actions in this field are to be pursued beyond EYE.

A second major target group was that of local authorities. Again, the response in general to schemes organised in the context of the Year certainly seems to indicate genuine political will at local level to contribute to environmental protection. It would clearly be desirable to capitalise on the response to date by extending certain of the actions in future years, where possible with external sponsorship, and to stimulate independent initiatives.

Particular attention was paid to the importance of increasing environmental awareness among the citizens of the Community, and in particular among young people. General awareness raising campaigns were conducted in areas ranging from water pollution to bird protection, with further support being provided for the production of educational material, international youth camps and films.

Public response to EYE was indeed excellent throughout the Member States, with all actions at Community, national and local levels receiving considerable support. The European opinion poll carried out in 1986 indicated the extent of public anxiety at the deteriorating quality of the environment. A second opinion poll is to be carried out following the European Year of the Environment and is almost certain to indicate increased awareness of the nature of the problems involved.

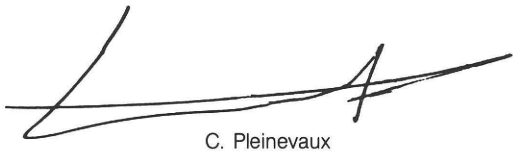
Nor were the activities confined to the countries of the Community. Pollution, as we know to our cost, is no respecter of borders -and the behaviour of one country can have catastrophic effects on the environment of another. The emphasis of the projects supported at international level was thus very much on the global dimension of environmental protection and on the potential long-term benefits for the countries in question, and in particular on education and training, publications, and policy and strategy formulation.

The European Free Trade Area (EFTA) countries expressed their solidarity with the campaign, with Switzerland setting up its own national Committee and programme of activities, and contacts were also established with other third countries, notably Hungary.

The overwhelming success of the actions undertaken is indicative of the general progress which has been made towards the achievement of the major objectives of EYE, and of the changes which are taking place at both political and public levels. There is evidence that increasing attention is being given to the environment by other directorates of the Commission, several of which have cooperated directly in the campaign, and that environmental dossier are now being integrated to a far greater extent in the structural funds. Awareness has also greatly increased in the public field, with renewed undertakings and the strengthening of existing networks among NGOs, youth organisations, nature protection bodies and trade unions. A number of national and multi-national organisations in fact provided sponsorship for actions during the Year, thus illustrating the value of the environment as a relatively untapped communications field offering considerable potential for the public image of any sponsor, and the growing awareness of industry in general of the economic benefits to be gained through environmental protection and improvement is evident.

EYE han been only the beginning, albeit a vitally important one, of a totally new moment. As the European Council recognised in its Resolution at the end of the campaign, we must now capitalise on its achievements by continuing the momentum which has been reached, and by establishing a far-reaching and permanent campaign of awareness raising and information in the field of the environment.

The emphasis then must be not only on looking back at 12 months of fruitful activity and campaigning in favour of the environment, but also on looking forward to new approaches, new priorities and a genuine long-term commitment at every level to environmental protection and improvement. Such commitment and enthusiasm for the environment and the European ideal were central to the campaign, and it is on them that the future depends.



C. Pleinevaux
Responsible for the Task Force EYE
DG XI