



Multiannual Programme of the Joint Research Centre 1980-1983

1982 Annual Status Report

Protection of the environment

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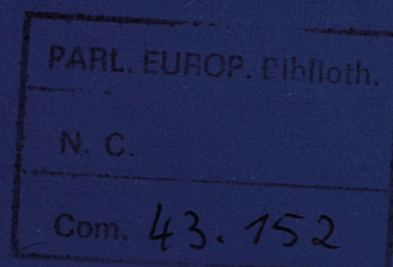


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PROTECTION OF THE ENVIRONMENT

1982

Research Staff: 92 men-year
Budget: 11.123.000 ECU

Projects:

- ECDIN: Environmental Chemical Data Information Network
- Exposure to Chemicals:
 - Indoor Pollution
 - Chemical Products (Organics)
- Air Quality
- Water Quality
 - Nutrient Mass Balance in Aquatic Ecosystems
 - Ecological Effects of Chemical Pollution
- Heavy Metal Pollution
 - I.L.E. (Pathway of Automotive Lead)
 - Exposure and Health Effects
- Environmental Impact of Conventional Power Plants

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1. INTRODUCTION

The present 4 years programme (1980-1983) «Protection of the Environment» is the follow-up of the former programme «Environment and Resources» (1977-1980).

With a research staff of about 90 people working mainly at the Ispra and to a smaller extent at the Petten establishment, this programme represent about 8% of the total research effort of the Joint Research Centre.

The principal scope of the programme «Protection of the Environment» it to provide together with the related Indirect and Concerted Action Programme, scientific support to the Community's Programme of Action on the Environment (1982-1986). The following table gives a synoptic view of the major links of this action programme managed by D.G. XI (Direction: Protection and Improvement of the Environment) at Brussels with the above mentioned research programmes.

ECDIN, a pilot-data bank on environmental chemicals is by face the largest project in financial volume and already now acting as an internal consultant to other Commission services and has given proof of its use and competence especially in establishing the European core inventory EINECS in behalf of the D.G. XI. The longend survival of this project will depend, however, on the successful implementation of a «commercial»

ECDIN justifying an ongoing research effort of a «scientific» ECDIN inside the Joint Research Centre.

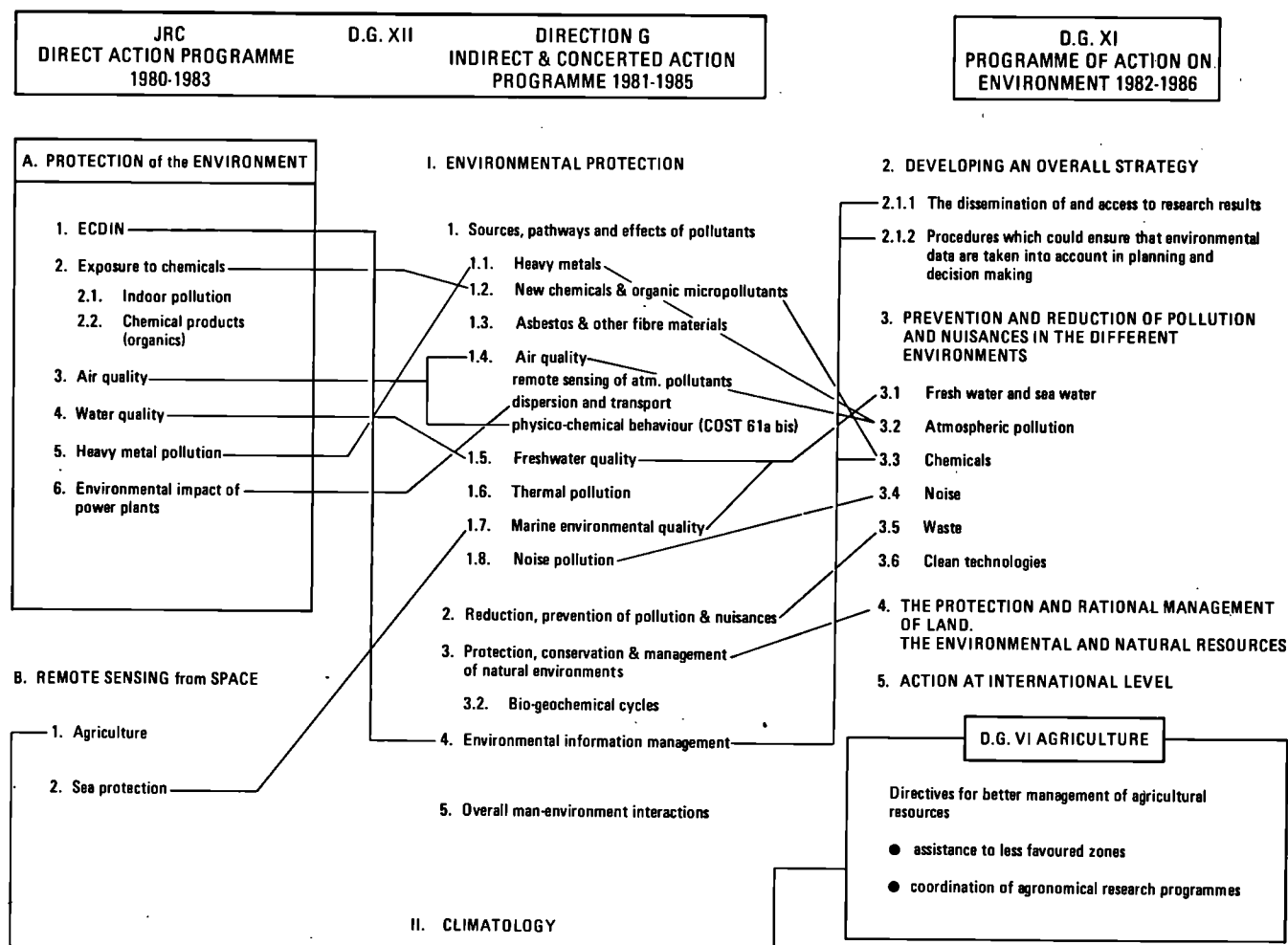
Striking differences in air pollution levels inside and outside of private houses and public buildings led to the conception of the «Indoor Pollution» project. The study will be focussed on organic emissions in private houses, school rooms and department stores. The final goal is to reconsider the relevance of air quality standards.

The title «Chemical Products (Organics)» is related to the activities of a research group at the Petten establishment. This work is mainly concerned with analytical and synthesis aspects of organic chemicals related to environmental protection problems (e.g. carcinogenic and toxic substances).

The project «Air Quality» deals with the analysis of atmospheric pollutants with special regard to particle formation and photochemical reactions. It is fully integrated into the COST 61a-bis concerted action «Physico-chemical behaviour of atmospheric pollutants».

The project «Water Quality» focuses on the mass balance of nutrients in lakes, using a physico-chemical modelistic approach and the use of bio-indicators for the characterization of freshwater pollution.

CEC ENVIRONMENTAL PROGRAMMES



In future these more or less randomly assembled projects and research activities will be regrouped under three major chapters.

- ENVIRONMENTAL CHEMICALS** aiming at studying chemicals (and their transformation products) of major environmental concern likely to have ecological effects and health effects on man.
- ENVIRONMENTAL QUALITY** including activities related to the identification of pollutants (and their reaction products) in air and water and their impact (fate, pathways, effects) on non human targets in the different environmental media.
- ENERGY and the ENVIRONMENT** aiming at studying pollution problems related to the energy production processes: dispersion and transport of pollutants, risk assessment studies.

2. RESULTS

ECDIN (Environmental Chemicals Data and Information Network)

The experimental ECDIN service, launched in 1981, began effective operation in Spring 1982 after the administrative for-

malities (user contracts, etc.) had been completed. The planned target of 100 users of the experimental service was soon reached. The reaction of users were closely monitored by a team from ASLIB who participated in a user workshop which was organised in Ispra in October 1982. The workshop followed a number of training sessions held earlier in the year in London, Delft and Paris.

Soon after the experimental service had begun, new and unanticipated problems were encountered with the interface between EURONET and the JRC Ispra AMDAHL 470/V8 computer.

When more than two users were simultaneously accessing the computer, the commands and responses from one user session became intermixed with those from another session - a situation which one user described as feeling like communicating with a dyslexic computer. The ECDIN display system was modified to echo back to the user any unacceptable instructions it received so that the user was aware of the nature of the problem. Despite various attempts by the JRC computer centre to improve the situation, the problem was only finally resolved in November 1982 when a new «black box» was installed. It was decided to give experimental service users an extension of six months until 30 June 1983 to compensate for these difficulties.

Initial reactions of users attending the workshop were inevitably conditioned by the problems of access to the data base which had been compounded by telecommunication problems in national networks and in EURONET itself. Nevertheless the workshop provided a fruitful discussion of the ECDIN concept and many positive recommendations for improving the service, the ECDIN display system and the data base were made. Unfortunately the loss of a programmer in August 1982 and the diversion of resources to EINECS slowed down the development of ECDIN at this crucial stage.

During 1982 a considerable portion of the efforts of the ECDIN group was devoted to the EINECS inventory. The second phase of EINECS, the 9 month supplementary reporting period, began on schedule on 31 March 1982. The early months of 1982 were concerned with the logistical problems of the preparations for EINECS. Some 350.000 reporting forms in seven languages had to be printed and distributed to industry through the Member State Contact Points for EINECS. During the reporting period the Commission's contact point for EINECS (based in JRC Ispra) answered nearly 100 enquiries on the reportability of various types of substances and on policy questions. The EINECS form tracking and processing system was designed and progressively implemented. Input of reporting forms began in October 1982 and transmission of data and forms to CAS in Columbus, Ohio via the dedicated telecommunications line began in November 1982. It is now known that almost 80.000 completed reporting forms were received by Member State Contact Points by the end of the reporting period on 31 December 1982.

During 1982 preparations for the commercial ECDIN service to be based on the computer centre of Data Centralen in Copenhagen accelerated. A test version of the ECDIN data base and display system was successfully installed in Copenhagen. At the end of the year a contract was concluded with Data Centralen for the installation, operation and marketing of the commercial ECDIN service. The target date for the start of this service is 1 July 1983.

EXPOSURE TO CHEMICALS

INDOOR POLLUTION

This activity developed along three lines:

Promotion of European collaboration

An expert group was convened in Ispra in order to assist JRC and DG XII staff in defining an appropriate frame for a European collaboration in the field of indoor air quality. It was concluded that a Concerted Action should be proposed. It was further agreed to initiate work for an inventory of pollutants detected indoors as a first step towards practical collaboration. A draft proposal for a concerted action «Indoor Air Quality» has been prepared and was revised at a second expert group meeting at Aarhus University. For the same meeting a first version of a format for the indoor pollutant inventory has been prepared. As a result of the discussion, a second version is under elaboration which will also serve as core of a protocol for field measurements of indoor pollution.

Intercomparison campaigns have been started in order to assess the usefulness of passive samplers for organic indoor pollutants (see below).

Analytical Development

Exposure to organic compounds is the most complex but least investigated problem of indoor air pollution. Among others the lack of simple, inexpensive but reliable and not disturbing sampling techniques is one of the reasons for lack of comprehensive data. Work has therefore been started to assess the reliability and sensitivity which can be obtained using so-called passive samplers. Passive samplers have been devised for occupational exposure monitoring where concentration levels are in general considerably higher than in non-occupational indoor environments. The maximum safe exposure time for currently encountered organic indoor pollutants has been determined to be about 1 week. At longer exposure time losses may occur. As further parameters sampling and desorption efficiencies have been investigated. An intercomparison program has been started involving different European laboratories in order to assess the reliability of different types of samplers and of results obtained in different laboratories.

Among other work the setup of a reliable method for the simultaneous detection of a wide range of carbonyl compounds including formaldehyde at levels down to a few nanogram per liter of air should be mentioned.

Field Measurements

Measurements of organic pollutants have been performed in a series of private residential dwellings with the threefold scope to contribute data to a European inventory of indoor pollutants, to gain experience with a core protocol for indoor pollutant measurements, and to assess various sampling and analysis strategies.

The following classes of compounds have shown to be virtually ubiquitous at concentrations which are systematically higher indoors than outdoors:

aldehydes, chloroaliphates, alkanes and alkenes, alkylbenzenes and terpenes.

Table I reports organic compounds which have been detected during our field measurements, together with the lowest (LDC) and highest (HDC) detected concentrations and, where defined, one tenth of the maximum admissible workplace concentration (MAK - values valid in FRG) which is often tentatively used as an indoor air quality criterium.

At the present stage, the reported results can only be regarded as a small part of a complex since they refer to a few types of residential buildings, living habits and situations only.

CHEMICAL PRODUCTS (ORGANICS)

Environmental Carcinogens

In 1982 the project work was focused on the chemical characterization and mutagenicity testing of a tar derived from coal gasification and on mutagenicity determinations of a set of individual components of environmental importance. As a

Table I. Lowest (LDC) and highest (HDC) detected concentrations of organic compounds identified during 1982 measurements in residential dwellings

COMPOUND	MAK/10 ($\mu\text{g/l}$)	LDC (ng/l)	HDC (ng/l)	COMPOUND	MAK/10 ($\mu\text{g/l}$)	LDC (ng/l)	HDC (ng/l)
ALDEHYDES				BENZENE AND ALKYL BENZENES			
formaldehyde	0.12	8	50	benzene	- c)	8	28
acetaldehyde	36	2	26	toluene	75	32	270
n-pentanal	—	n.d.*	20	ethylbenzene	43.5	4	21
n-hexanal	—	n.d.	15	m, p-xylene	87	11	84
n-heptanal	—	n.d.	2	o-xylene	87	2	10
n-octanal	—	n.d.	4	Σ C3-benzenes	24.5 d)	3	190
n-nonanal	—	n.d.	10	TERPENES			
n-decanal	—	n.d.	5	a-pinene	56 e)	7	900
KETONES				camphene	56 e)	n.d.	24
acetone	240	2	12	β -pinene	56 e)	n.d.	200
methylisobutylketone	40	n.d.	3	1,8-cineol	56 e)	n.d.	30
cyclohexanone	20	n.d.	4	limonene	56 e)	5	230
				a-terpineol	56 e)	n.d.	3
CHLORO-COMPOUNDS				VARIOUS ALIPHATIC COMPOUNDS			
dichloromethane	35	n.d.	4000	ethanol	190	n.d.	9
chloroform	5 a)	n.d.	1.5	ethylacetate	140	n.d.	3
1,1,1. trichloroethane	108	1	5	isobutylacetate	95	n.d.	48
carbontetrachloride	6.5 a)	1	20	n-butylacetate	95	n.d.	5
trichloroethylene	26 a)	1.5	30	VARIOUS AROMATIC COMPOUNDS			
tetrachloroethylene	67	2.5	100	styrene	42	2	14
1,4 dichlorobenzene	45	n.d.	65	phenol	1.9	n.d.	5
pentachlorophenol	0.05	n.d.	0.25	naphthalene	5	2	8
				1-methylnaphthalene	—	n.d.	2
Σ ALKANES + ALKENES	36 - 200 b)	50	1200	2-methylnaphthalene	—	n.d.	4

* n.d. = not detected, i.e. concentration < 1 ng/l

a) value to be reconsidered in view of the suspected carcinogenicity of the compound

b) 360 = MAK - value for n-hexane; 2000 = MAK - value for n-heptane and methylcyclohexane.

No MAK value defined for other alkanes or alkenes

c) in view of the recognized carcinogenicity of benzene no MAK value can be defined

d) value of isopropylbenzene; for other C 3-benzenes no MAK values have been defined

e) value defined for oil of turpentine. No values have been defined for its single components

result of the chemical and biochemical characterization of the coal gasification tar it can be concluded that the major contribution in its mutagenetic activity comes from the fraction which contains the polycyclic aromatic compounds (about 75% of total mutagenetic activity). The remaining mutagenetic activity is accounted for by the basic fraction, containing the aromatic amines (approximately 20% of total activity) and the insoluble fraction (in cyclohexane), about 4% of the total activity, presumably containing also the inorganic components. The mutagenicity testing of individual compounds resulted in the identification of several new strong mutagens, which occur in coal combustion, gasification or liquefaction, and in air particulates or diesel exhausts (see table II). Very high mutagenic effects were found for some isomers of an aromatic amine exceeding in one case 2000 revertants in *Salmonella typh.* TA98 per μg of substance. Isomers with the same mass number are regularly found in process stream of coal liquefaction.

Experimental work for the systematic collection of the molecular spectra under standard conditions was concentrated on the determination and evaluation of IR-spectra. Most of the 350 spectra (including IR—, UV—, fluorescence—, mass—

and NMR-spectra) which are needed for the planned spectral Atlas are now available. In addition to the molecular spectra of 42 PAH-compounds of environmental and occupational importance, the edition is to include a concise overview and evaluation of environmental sources and biological effects for each compound (for an example, see table III).

Occupational carcinogens/Toxic chemicals

Under this activity, the experimental work aiming at reducing contamination risks of packed foodstuffs from packaging components which pose health hazards has shown further progress. A new type of plastic additive (antioxidant) which had been developed and synthesized previously, was built into polymers which are used in food packaging applications, to study its behaviour and migration tendency into food simulating liquids.

In these experiments, the expected improvements in reducing food contamination risks was fully confirmed and as a result a patent application was filed in the United Kingdom (UK Nr. 8233681 - 25/11/1982).

Table II. Results of screening tests for mutagenic activity

COMPOUND	OCCURRENCE	MUTAGENIC ACTIVITY	CARCINOGENICITY (LITERAT. DATA)
Benz(a)acridine	air particulates, coal conversion,	±	—
Dibenz(a,c)acridine	coal combustion and conversion air	++	(not available)
Dibenz(a,h)acridine	particulates, car exhaust coal combustion and conversion	(++)	++
Dibenz(a,j)acridine		+	(not available)
Dibenz(a,i)acridine	air particulates, car exhaust	+	+
Dibenz(c,h)acridine		(++)	+
2-Aminobenzo(c)phenanthrene	coal gasification and liquefaction (isomers)	+++ (toxic)	
3-Aminobenzo(c)phenanthrene		+++ (toxic)	(not available)
4-Aminobenzo(c)phenanthrene		+++ (toxic)	
Benzo(a)fluoranthene	coal combustion, used motor oil, coal tar	++	(not available)
Benzo(ghi)fluoranthene	air particulates, diesel exhaust, coal and peat combustion, coal tar, food	+ / ++	—
Benzo(b)chrysene	coal tar	—	—
Benzo(c)chrysene	coal tar	(+)	++
Dibenzo(a,l)pyrene	coal gasification, air particulates	+++	+++

Key: — negative
 ± weak/inactive
 + mutagenic
 ++ significant mutagen
 +++ strong mutagen

(bracketed values are based on results of a single bact. strain)

Table III. Example: Chrysene

OCCURRENCE

FOSSIL FUELS ENVIRONMENT				FOOD	
Mobile sources	Ref.	Stationary sources	Ref.	Foodstuff	Ref.
- car exhaust	(1,2,3)	- coal/oil combustion	(9,10)	- smoked meat	(29,30)
- motor oils	(4,5,6)	- coal conversion	(9,11,12)	- fish	(31,32)
- crude oils	(7,8)	- wood/peat combustion	(11,14,15)	- vegetables	(33)
- motor fuels	(1)	- other industrial effluents	(13)	- cereals	(34)
		- tars, pitch, carbon black	(7)	- others	(35)
Regulations					
			- water: EPA priority pollutant		(44)

BIOLOGICAL ACTIVITY

Mutagenicity (Ames test)			Carcinogenicity (Animal studies)		
Result	Bact. Strain	Ref.	Result	Animal species	Ref.
+	TA 100	(36)	—	Mice	(39,40)
+	TM 677	(37)	+	Mice	(41,42)
+	TA 09	(38)	+	Rats	(40)
			—	Rats	(43)

AIR QUALITY

This project comprises two lines of activities.

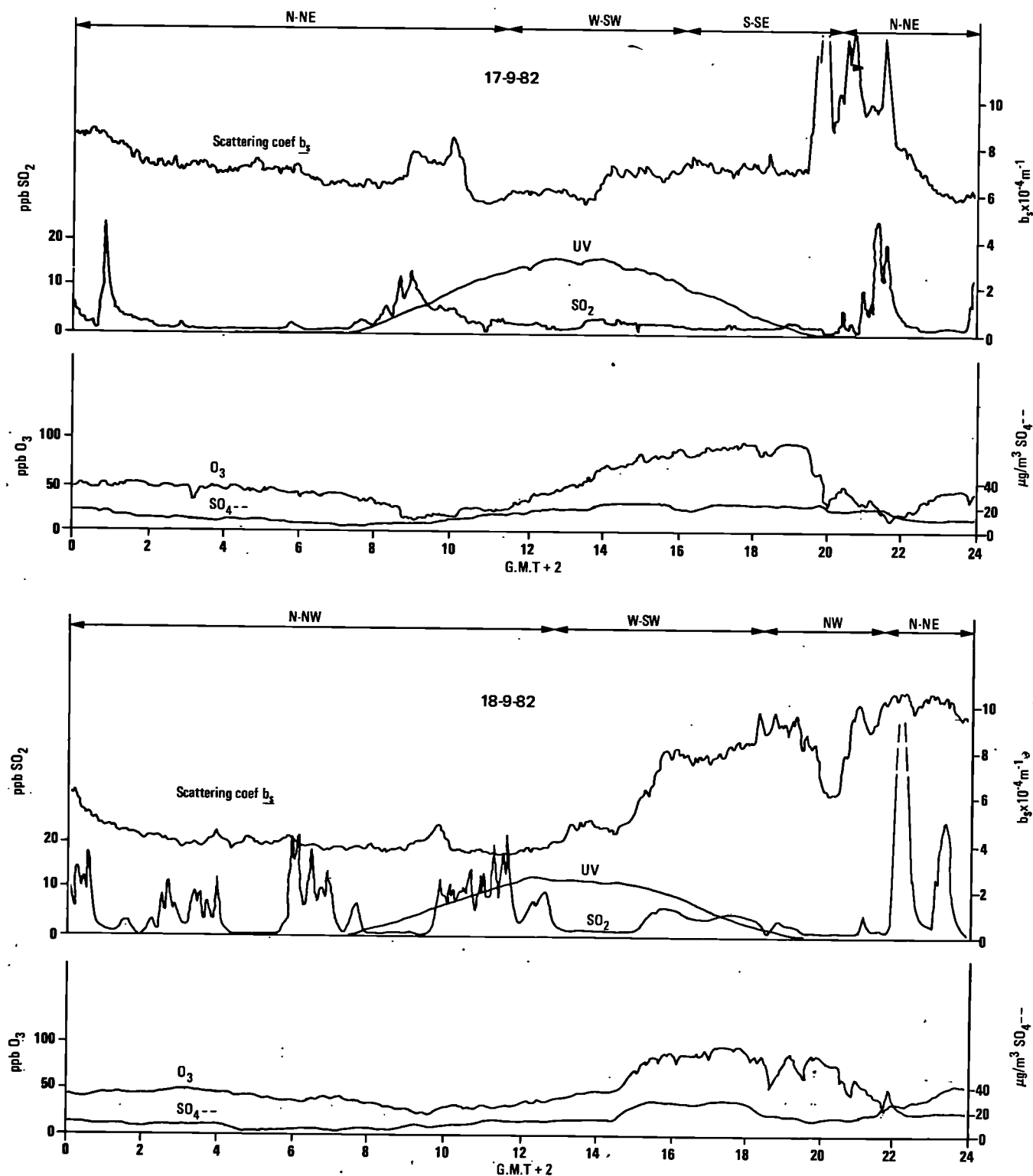
The first one is rather advanced and aims at a description of the processes leading to ozone and particle formation in the troposphere. The experimental approach involves field measurements of different nature (comparative monitoring of

pollutants, air-borne measurements) and experiments under simulated atmospheric conditions for the study of chemical and photochemical reactions. These conditions are chosen as realistic as possible, for instance by using natural sunlight for irradiation and often ambient air samples. The activity is completed by developments for the analysis of important organic trace gases.

The second line of activity is centered around the analytical possibilities of Infra-red Fourier Transform Spectroscopy. Besides an analytical support to the above activity it should provide in the long term an orientation versus the study of Environmental Chemicals in the atmosphere, which are of increasing importance to the environment. Their behaviour and degradation under photo-oxidation conditions is of major concern.

Field Measurements

Aircraft measurements, planned for 1982, in the framework of a collaboration contract with the «Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt (DFVLR)», could not be performed due to difficulties of our contractor to obtain the necessary flight permits for the Po Valley till the end of summer. However, some flight measurements were carried out



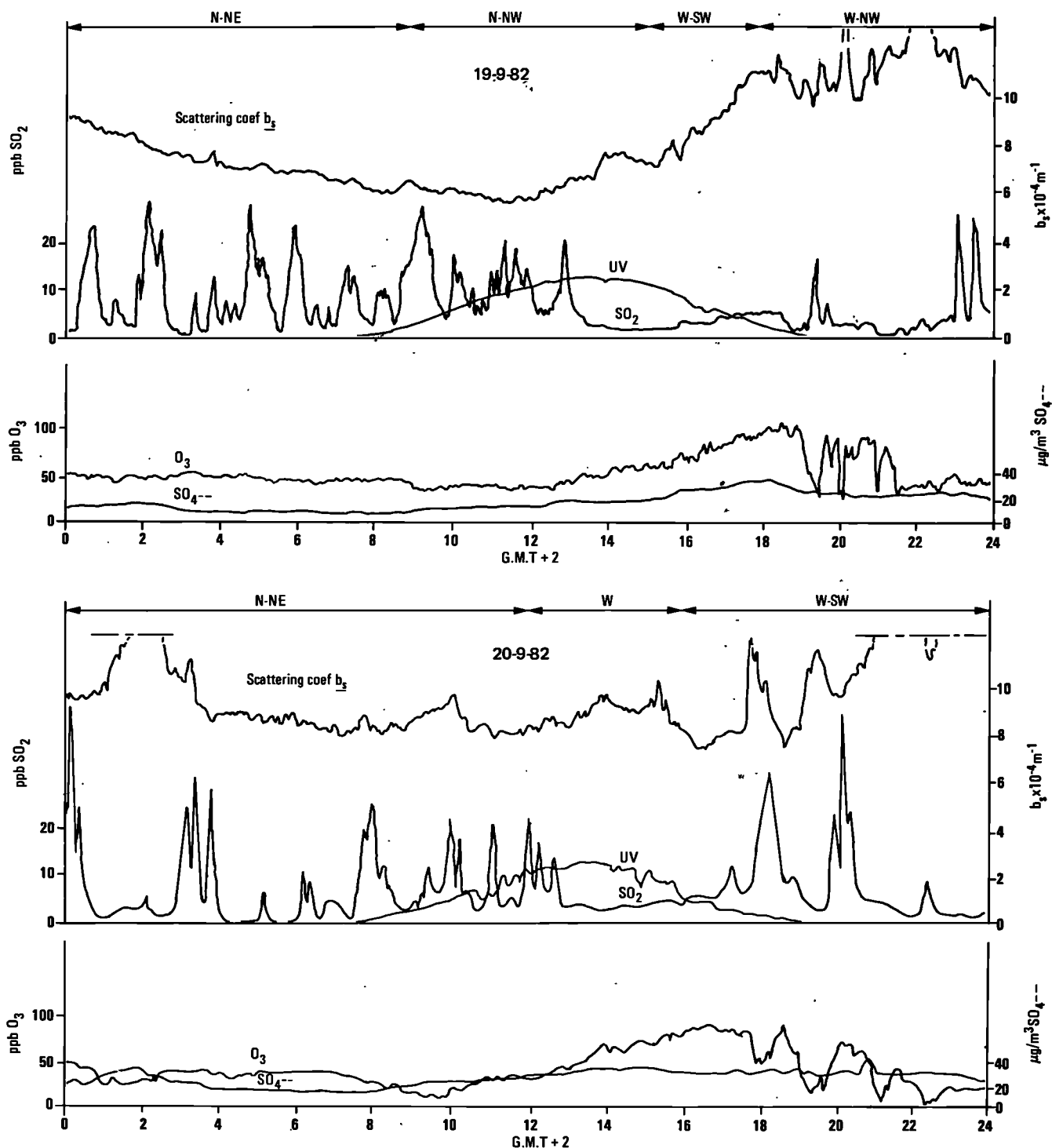


Fig. 1. Measurement of ozone, sulfur dioxide, sulfate, scattering coefficient (b_s), sun light UV - intensity and wind direction on four consecutive days during a severe haze episode in September 1982

around DFVLR's air base at Oberpfaffenhofen, near Munich, during severe haze conditions and with quite high ozone concentrations.

Some horizontal tracks, west of Munich, have been flown and vertical profiles to over 3.000 m were obtained as well.

These data are under evaluation.

A method for the continuous measurement of sulfate in air, based on a modified flame photometer was further improved and applied for correlation studies of different meteorological

and pollutant parameters during photo-oxidation episodes at the Ispra site.

In Figure 1 are reported the results of a severe haze episode during September 1982.

Ozone and Sulfate concentrations are lowest in the early morning and reach their maxima in the late afternoon. Such a behaviour for SO_4^{2-} could not be found for a comparable rural site in the United States so that our results give clear evidence for the photo-chemical conversion of SO_2 to sulfate particles.

Application of Infrared Spectroscopic Techniques

Monitoring of CO and CH₄, slowly reacting atmospheric species supposed to contribute to background photo-chemical reactivity, started with the 72 m cell. Air sampling was performed near to the routine monitoring station for NO, O₃, SO₂ and meteorological parameters. A two month period (April-June) gave CH₄ concentrations ranging from 1490 to 1925 ppbv and CO concentrations from 228 ppbv to 700 ppbv, the higher values being related to early April with a slow decrease towards 250-300 ppbv.

A technique of **cryogenic enrichment** to concentrate trace gases in the atmosphere has been set up with the advice of Dr. Hanst from EPA, Research Triangle. The evaluation of paraffinic hydrocarbons is made with respect to the N₂O band intensity used as reference standard.

The multiple reflection system of the **photochemical reactor** has achieved a satisfying performance with a good signal to noise ratio over the total beam length of 256 m.

The Computer Programme for the **generation of synthetic infrared spectra** has been expanded for the simulation of different relative abundances of the isotopic species of some gases (e.g. CO, CH₃, ...). This offers the possibility to simulate in the infrared spectral conditions which then will be experimentally dealt with in isotopic dilution techniques (important for the study of CO release from sun irradiated Teflon bags).

WATER QUALITY

Nutrient mass balance in aquatic ecosystems

In order to reach general conclusions about the influence of Phosphorus release from sediment on the lake trophic evolution, the experimental and modellistic analysis previously related to the Ponte Tresa basin of Lake Lugano has been extended to the deeper and more complex Agno bay.

Sampling campaigns during 1982 were aiming:

- at completing experimental information about the evolution of the water body between two consecutive overturns.
- at collecting new data about the distribution of the dissolved component in the organic Phosphorus pool in the bay.
- at providing samples for the detailed (species-specific) study of an autumn algal bloom, to be performed by means of a light scattering technique.

Algal bioassays, using *Selenastrum capricornutum* as test organism and sediment from the lake as the only Phosphorus source, have showed the following results for sediment Phosphorus algal availability.

Beside the non apatite inorganic form which is in general the only P source available and utilized for algal growth, in summer months a relatively high availability of organic and apatite forms has been found. The percentage of sedimentary total P utilized is between 8% and 11% in winter, spring and autumn, and 22% in summer (Phosphorus directly utilizable between 40 and 144 mg P/kg fresh sediment; average value 80 mg P/kg). Some modellistic results obtained in 1982 concern:

- hypolimnetic eddy diffusion coefficient evaluated by means of a one-dimensional model applied to P-PO₄ diffusion in the hypolimnion ($\chi_{hyp} \sim 10\chi_{th}$).

- the effect of an important (50%) dissolved component in the organic P-pool leads to a 10% increase of the phytoplankton biomass concentration level.
- conclusion of the methodological analysis for the calculation of vertical eddy diffusion coefficients in lakes by means of measured temperature profiles.
- the introduction of intracellular Phosphorus concentration as state variable in the description of phytoplankton dynamics, and first assessment of the related parameters (minimum and maximum cell quotas, maximum uptake velocity), in applying a one-box model to algal culture experiments.

Ecological effects of chemical pollution

The aim of this study is to evaluate the effects of toxic metals (e.g. Cu, Cd, Hg) on freshwater communities under semi-natural conditions («enclosure» method).

The initial concentration of each «enclosure» anchored during different seasons in the shallow and eutrophic lake Comabbio (Varese) was 100 ppb of trace metal.

The most evident results obtained were the following:

- The effects produced by the same metal on the physical and chemical characteristics of the water (e.g. pH, dissolved oxygen, water transparency) and on the biomass and the community structure of phyto- and zooplankton varied with season.
- These variations were mainly due to water temperature and the abundance of suspended material which adsorbed the greatest part of the trace metal.
- The resistance to the same metal varied with the species; for example, among phytoplankton species Diatoms were more resistant than Cyanophyceae and among zooplankton, Cladocerans were more sensitive than Copepods and these more than Rotifers.
- At the end of each experiment (20th day) a certain quantitative recovery of the planktonic communities was observed, but their structures were greatly modified.
- Mercury and Vanadium did not influence the fertility of adult snails, (*Physa acuta*) whereas cadmium decreased the fertility in proportion up to 125 ppb. At higher concentrations of cadmium, the snails were sterile.
- Viability (number of newborns/number of eggs·100) of contaminated embryos decreased with increasing concentration and becomes zero at 250 ppb for Cd, 500 ppb for Hg and 1000 ppb for V. In conclusion, *Physa acuta* adults were rather resistant to Cd (250 ppb), Hg (500 ppb) and V (1000 ppb), but at the same concentrations no embryo was able to survive; consequently, the final results was the elimination of the species from the environment.

HEAVY METAL POLLUTION

Isotopic Lead Experiment (I.L.E.)

ILE is a large scale, non radioactive tracer experiment, using as antiknock compound added to petrols, a lead from the Australian Broken Hill mine of an isotopic composition

significantly different from the lead encountered in the environment of the test area at the beginning of the project. For this purpose it was managed to effect an almost complete exchange (~90%) of the usual petrol lead, isotopic lead Pb-206/Pb-207 around 1.18, with petrol having a ratio of 1.04, for the petrol distributed in the Northern Italian Region of Piedmont. The lead concentration in petrols was about 0.60 g/l. The objectives of the ILE project were:

- to determine the contribution of automotive lead to total airborne lead in urban and rural areas.
- to determine the contribution of automotive lead to blood lead level in various population groups.
- to follow more generally the pathway of lead through the environmental compartments.

The project can be subdivided into the following phases:

- Phase «0» - background definition July 74-July 75
- Phase «1» - transition period from the old lead to the Australian lead in petrols August 75-April 77
- Phase «2» - use of about 90% Australian lead as additive in petrols May 77-December 79
- Phase «3» - gradual switch-back to the initial lead in petrols January 80-?

The major results obtained so far are as follows: the yearly average airborne lead concentration in Turin was estimated at about $2.0 \mu\text{g}/\text{m}^3$ that in the surrounding countryside up to 25 km from Turin at $0.56 \mu\text{g}/\text{m}^3$, and in the areas further than 25 km at $0.33 \mu\text{g}/\text{m}^3$. During the 1974-1979 period the mean level of the 24 h concentrations remained fairly constant. The concentration maxima over the year were observed for each place during the October-March period. They agreed well with the atmospheric circulation during the cold season over the Western Po Valley in general and over Piedmont in particular. The series of measurements in Turin itself in areas with both heavy and little traffic, gave a similar reduction in concentrations inside the dwelling with an (INDOOR)/(OUTDOOR) ratio between 0.76 and 0.85.

The airborne lead in Turin contained about 90% and in the rural areas about 60% of labelled lead.

There is evidence, both in rural and urban zones, that the isotopic ratio is closest to that of petrol for the finest fraction of the airborne particulate. Literature values show that automobile exhaust has a mass median equivalent diameter of $0.30 \pm 0.12 \mu\text{m}$ which is close to that of the airborne particles at Turin ($0.33 \mu\text{m}$). A shift to higher values with increasing distance from Turin (Santena 0.43, Druento 0.63, Ispra 0.9-1.2) was observed.

The considerable spread of isotopic ratios both in time and in place for the rural areas must be interpreted in terms of movement from other areas of air masses from regions far from the test area are advected. This is reflected by the average ratio of 1.13 in rainwater samples in Turin and Ispra with some extremes as high as 1.16.

The male blood lead concentrations are slightly higher for our rural area (average $26.9 \mu\text{g}/100 \text{ ml}$ for less than 25 km and $29.6 \mu\text{g}/100 \text{ ml}$ for more than 25 km from Turin) than for the city of Turin (average $22.5 \mu\text{g}/\text{ml}$) and there is no apparent correlation with the airborne lead concentration.

The average isotopic ratio Pb-206/Pb-207 in adult blood decreased during 1975-1979 from 1.1628 to 1.1325 in Turin. In the zone within 25 km of Turin, the Pb-206/Pb-207 ratio decreased from 1.1589 to 1.1604 to 1.1450 respectively. Limited data on schoolchildren measured only during 1977-1979 gave an average ratio of 1.1273.

The figure 2 shows the change of Pb-206/Pb-207 ratios in petrol, airborne particulate and blood from 1974 to 1981.

Using a simple model for the Turin follow-up subjects it can be calculated that the petrol fraction of blood lead is of the order of either 24% or 27% (i.e. $5.4\text{--}6.1 \mu\text{g}/100 \text{ ml}$) depending whether the calculations are based on the isotopic ratio variations measured in petrol or in airborne lead respectively. The corresponding follow-up values for adults living in the countryside less than 25 km from Turin are 12% and 21% (i.e. 3.2 and $5.6 \mu\text{g}/100 \text{ ml}$) for those living in the countryside further more than 25 km from Turin 11% and 19% (i.e. 3.3 and $5.6 \mu\text{g}/100 \text{ ml}$). Uncertainties stem mostly from the apparently continuing decrease of blood lead isotopic ratio in 1979 and a backlog of data (e.g. diet samples). No conclusions can as yet be made on the features of the recovery phase.

Exposure and Health Effects

During the reporting period the project has been slightly adjusted according to the recommendation of the expert panel invited for a round table discussion on future trends of Heavy Metal Pollution research in November, 1981. Three are the main research lines: sources and environmental pathways

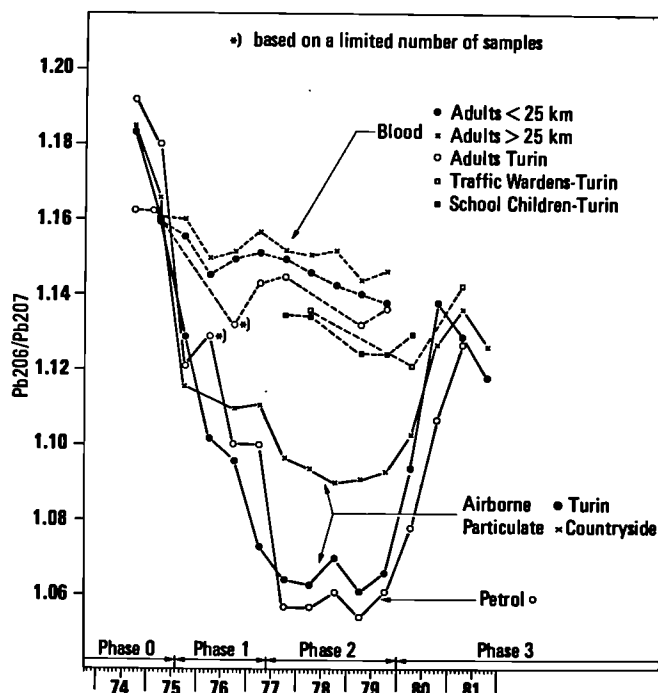


Fig. 2.

(assessment studies); environmental biochemical toxicology (metabolism and biochemical mechanisms of HM at present environmental levels and studies on tissues of human origin); analytical quality assurance studies (parameters and factor affecting the microdetermination of HM in environmental and biological samples).

Assessment studies

The compartmentalization and the design of the environmental model was further improved. The main scope of the modeling activity was to develop a sensitivity analysis capable of evaluating the degree to which the predicted time-dependent movements of HM are affected by individual parameters of the environmental model. Identification of these «critical» parameters is particularly important because they rank experimental research priorities. The need to study parameters affecting the distribution coefficients between soil components for Cd which markedly affect the percolation of the element from soil to groundwater is an example for an identified experimental research priority.

The long term prediction of HM migration from soil to groundwater was continued, paying attention to chromium (two reference cases; a 500 MW coal fired power plant (CFPP) and fertilizer application). The results (figure 3) suggest a significantly higher impact of Cr on water quality in the case of fertilizer use compared to the release from CFPP. In the first case the Maximum Permissible Concentration (MPC) adopted in the EC may be reached and exceeded after about 80 years while in the second case this limit would be never reached.

Considerable progress has been achieved in the experimental studies of the sorptive and leaching behaviour of HM's from waste of CFPP's and municipal incinerators. As, Sb, Cr, Bi, Se, Te, Mo, Ni and Cd, including their chemical forms were investigated using leaching of neutron activated fly ash by sea and distilled water in column and radiotracers from batch and column experiments.

The experimental activity for the establishment of a data base for an incinerator in Italy continued with the analysis of HM in bottom ash, fly ash and suspended particles collected in different periods over 8 months. Zn, As, Cd, Pb, Sb, and Hg present a significant enrichment in the suspended particles. These elements, with predominantly small-particle size distributions, are suspended in fumes and vapours coming from the stack.

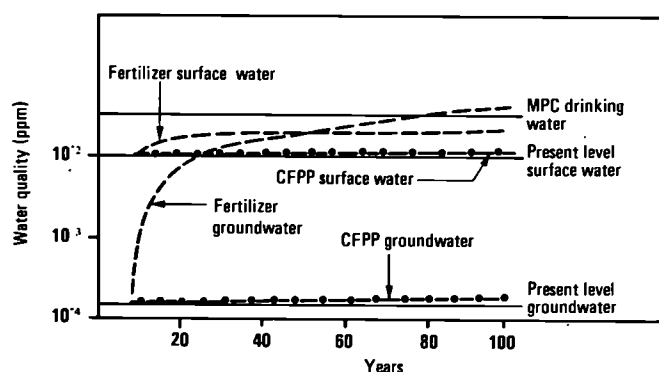


Fig. 3. Long term impact of Cr on surface and groundwater as released from CFPPs and phosphatic fertilizer

Their possible presence in condensable fraction not retained by the whole-filters has to be controlled.

Environmental biochemical toxicology

Work concerning the metabolism of environmental levels of As, V and Tl has considerably progressed. Particularly interesting are the findings from:

- *comparative metabolic studies on inorganic and environmental organic forms of As in different animal species*: the interaction of inorganic As with intracellular components of rats, mice, rabbits and monkeys varies according to the animal species depending on the biotransformation of inorganic As because arsenobetaine is not biotransformed and is excreted unchanged. This is particularly relevant for toxicological assessment studies and in establishing dose-effect relationships for As.

- *A study on transplacental transport and the chemical form of vanadium in milk* was done in collaboration with the Ecole Veterinaire de Toulouse, Laboratoire de radioéléments et d'études métaboliques.

Vanadium is capable to pass the placental barrier of rats and thus will be metabolized in the fetuses. Although it is transferred to newborn rats via the maternal milk in the form of a biocomplex with lactoferrin, the element is poorly retained in the tissues of young animals in agreement with our recent results on the absence of long term accumulation of vanadium in adult rats.

- *Long term toxicity study of thallium*. Results on the daily intoxication of rats with Tl (I) via drinking water for 9 months suggest the cumulative nature of selected toxic effects of Tl and individual variations in the susceptibility of the rat to the induced neuropathy. This suggests that continuous exposure of the rat to relatively low doses of thallous ions may be responsible of disorders of the peripheral nervous system.

- *Research on tissues of human origin by neutron activation analysis (NAA)* passed from a development period to an application oriented activity. An important aspect is the good collaboration with Institutes of Occupation Health and Medical Centres allowing for a regularly flow of samples from people exposed to different HM levels. The joint campaign with the Clinica del Lavoro of Milan and the ENEL of Piacenza for the determination of the vanadium in the blood and urine of boiler cleaners of large oil fired power plants is a good example for the usefulness of the NAA method.

Analytical quality control research

Taking into account the recommendations of a round table discussion for the need of analytical quality controls in the microdetermination of HM in biological samples, a research using NAA and radiotracer techniques in combination with atomic absorption spectroscopy (AAS) was started. Elements considered are V, Tl and Al. The determination of this latter is of particular interest in the EC for the problem of Al caused dementia in patients with renal disfunctions. In this context in-

tercomparison studies started between our laboratory with french, italian and british organizations coordinated by the DG V in view of a proposal of a directive on the Al content in renal dialysis fluids.

ENVIRONMENTAL IMPACT OF CONVENTIONAL POWER PLANTS

This project represents the follow-up of studies which were undertaken in recent years and progressively unified under the general theme «Remote Sensing of pollution phenomena around intense local sources».

Techniques and methods developed in this frame constitute a proven structure for applications in field, as shown by joint participation of JRC teams in national or European campaigns. Four laboratories with different measuring techniques are contributing, namely:

Micrometeorology; Correlation Spectrometry (COSPEC and TELETEC); LIDAR; Tracers.

The activities of these groups for 1982 can be summarized as follows:

— **Elaboration of data of the 5th CEC Campaign (Ghent).** In June 1981, two of our teams (Correlation Spectrometry and Micrometeorology) participated with their mobile units in the European field exercise, in association with other teams of CEC Member States. It was organised in the frame of the Belgian R & D-Environmental Programme and under the sponsorship of DG XII/G. During this Campaign, efforts have been concentrated on emission and dispersion measurements of the Ghent industrial area (power plants, refineries, chemical factories) in order to establish a pollutant mass balance in relation with the surrounding region.

The data gathered by our teams have been condensed in two reports.

A further elaboration in the light of new information by other teams is now progressing.

— **Characterisation of plume dispersion in breeze regime by remote sensing and tracer techniques.** The analysis of experimental data gathered by Lidar, Cospec, Tracers and micrometeorological groups in the 1980 Turbigio campaign has been completed. A report on this joint dispersion study has been edited.

— **Pollutant Mass Flow over Milano Area.** A validation of pollutant burden and mass flow measured in 1980 and 1981 around the Milan area has been made by the classical urban models ATDL, PLUME and an ad hoc developed analytical model. This work, performed in collaboration with ARS Milan has been described in a paper presented at the XIIIth NATO Meeting on Air Pollution Modelling held at Ile des Embiez (Fr) in October 1982.

— **Tracer experiments.** A report describing dispersion experiments carried out at the Turbigio Power Plant in collaboration with the Nuclear Research Centre of Karlsruhe has been completed. Tracer dispersion experiments on a medium-range distance (50 km) in the Rhine valley and in the Po valley are in preparation.

— **Micrometeorology.** In 1982 a thematic study for the inter-comparison of micrometeorological measuring systems in different meteorological condition started at the ENEL Power Plant at Turbigio. In this study classical instrumentation, propeller anemometer, resistance thermometer, pyranometers are compared with the ultrasonic anemometer/thermometer of the JRC.

All systems are linked to a computer for data elaboration in real time.

3. CONCLUSIONS

Progress of the ECDIN project has slowed down due to the emphasis given to the EINECS inventory for which JRC Ispra is acting as the Commission's Contact Point on behalf of DG XI.

The first reactions of users of the ECDIN experimental service were obtained at a users' workshop held in Ispra in October. The users' advice on the priorities for data collection and systems development will be considered in the further development of the data bank.

Although the backlog of data in machine readable form awaiting loading to ADABAS has been eliminated, there still exists a considerable backlog of data presented by contractors in tabular form for new files as legislation, mutagenicity, teratogenicity, carcinogenicity.

After the ECDIN ADABAS software had been successfully transferred to Data Centralen (Copenhagen) the contract for a marketing study of a commercial ECDIN with this company is ready for signature. By this way in the second half of 1983 ECDIN will probably be open to the public via EURONET DIANE.

The sponsoring of european collaboration and the preparation of a concerted action has become a central point of J.R.C.'s activity in the frame of the «Indoor Air Pollution» Project.

The experimental activities have been slightly reviewed in this context and are now stressing on sampling and analysis procedures which are potentially useful for joint studies and on work for the establishment of an indoor air pollutants inventory. A first draft of an European protocol for the collection of field measurement data, being a basis for further protocols on measurements and collection of I.A.Q. data has been prepared by J.R.C. and revised by an european expert group.

The activities of the Petten Establishment on **Chemical-Products-Organics** were continued successfully. The mutagenicity of some polycyclic and heterocyclic aromatic compounds occurring in fossil fuels combustion or conversion processes has confirmed the necessity and interest for this work. Recommendations for the standardisation of analytical procedures and data reporting for environmental and occupational PAH-analysis were elaborated. In the field of toxic additives to food packaging materials a new process retaining additives more effectively in the polymer matrix was investigated. The Project **Air Quality** finishes 1982 seriously affected by the departure of our specialist in photochemistry and by the transfer of two staff members to the new activity «Central Laboratory for Air Pollution», where J.R.C. Ispra acts on

behalf at D.G. XI for the technical part of the implementation of the E.C. directive 80/779 (control of SO_2 and suspended matter in ambient air).

The flight measurements scheduled for August/September of this year had to be cancelled due to unexpected difficulties with flight permits. The contractual arrangements with DFVLR permit however a repetition of these measurements in 1983. The application of a new method for the continuous measurement of airborne sulfates gave interesting results on the sulfate formation process by photo-oxidation of SO_2 .

The photochemical reactor (long path IR-FTS technique) is now fully operating with a 256 m total beam length. As first applications the role of CO in tropospheric ozone formation processes and the daily/yearly trend of CO and CH_4 in ambient air will be studied.

The project **Water Quality** continued along the two research lines «ecological effects of chemical pollution» and «nutrient mass balance». In parallel the preparation of the follow-up activities namely «chemical structure versus biological effects in aquatic ecosystems» and «mass balance of heavy metals in a complex freshwater aquatic ecosystem» continued.

A new powerful research vessel was purchased and will be operational in spring 1983 for sampling of water and sediments of Lago Maggiore by JRC staff.

The final version of the Status Report of the **IIE** project (pathway of automotive lead) finally was printed in December 1982 and will be available to a broader public. A 25 percent contribution of petrol lead to total lead in the blood of adults in Turin are now appearing as rather probable. Additional data

on air-borne particulate, petrols, blood, diets and other samples will hopefully reduce some uncertainties in the interpretation of results.

The project **Heavy Metal Exposure and Health Effects** continued along the research lines «environmental impact assessment of fossil fuelled power plants, municipal incinerators, fertilizer practices and similar anthropogenic activities» and the study of the «metabolic behaviour of trace metals in tissues and cellular components of laboratory animals and man» (environmental biochemical toxicology).

In the reporting period work was focused on the experimental development of sampling procedures from municipal incinerators, leaching behaviour of Chromium from precipitator fly ash and metallobiochemistry studies on Vanadium, Mercury and Thallium.

The project **Environmental Impact of Power Plants** continued with the further evaluation of the data of the Ghent campaign (June 1981). New information on the validity of the COSPEC method is expected from a critical analysis of the data collected by different teams.

The preparation of the Fos (France) CEC campaign scheduled for June 1983 has already started. From Ispra the COSPEC, LIDAR and Micrometeorology teams were invited to participate.

A thematic study on the intercomparison of two sophisticated micrometeorological measuring systems (three dimensional wind field, temperature) at the Turbigo site yielded valuable informations for the further use of these instruments in other field campaigns.

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